Repco

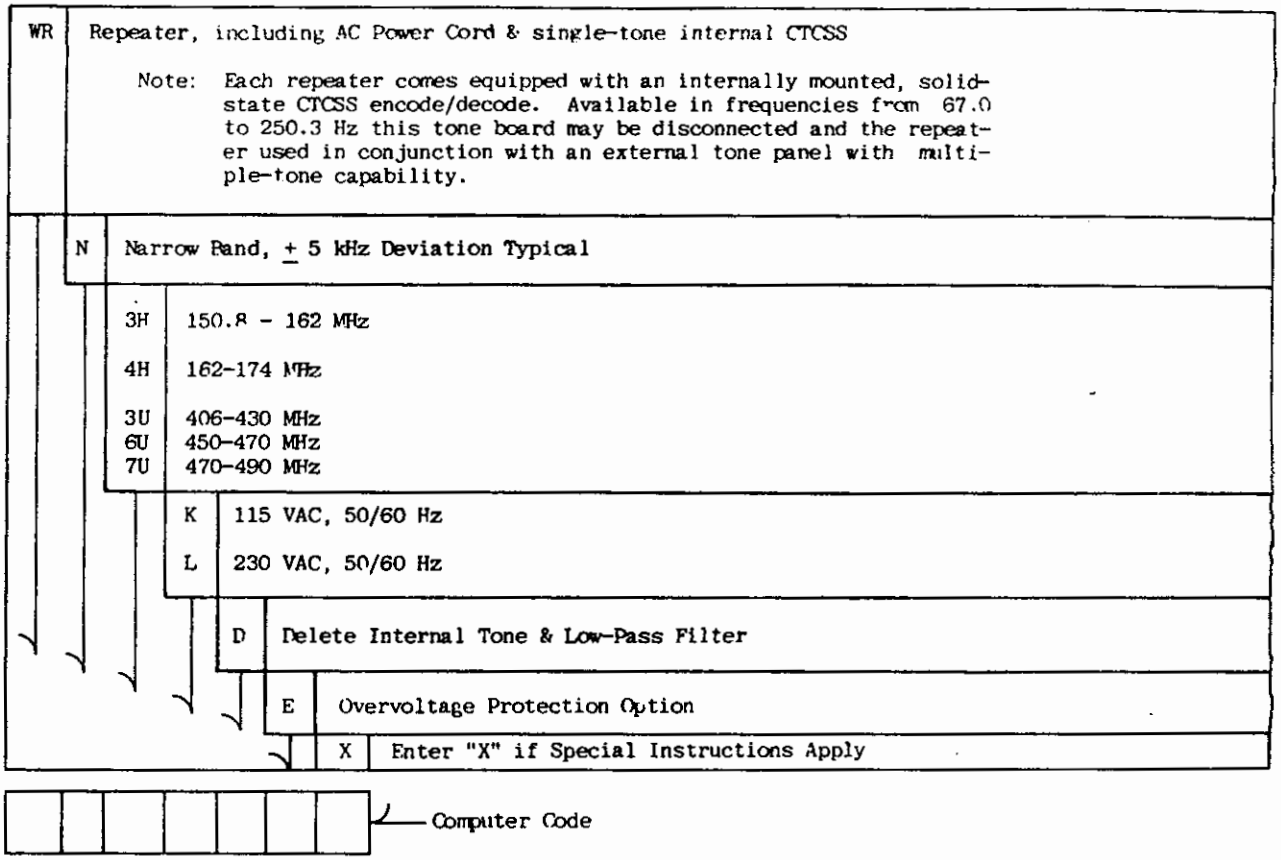
Dimension Series
VHF & UHF FM Repeater

MODEL 150 (VHF) 150.8-174 MHz, 10 & 35 Watts
MODEL 450 (UHF) 450-490 MHz, 10 & 25 Watts
MODEL 406 (UHF) 406-430 MHz, 25 Watts

42-01-029

RADIO CATALOG NUMBER AND OPTION IDENTIFICATION

The use of unapproved repair parts, or field modifications, or the addition of certain options to this transceiver may void its type acceptability. However, certain options may be covered by other type acceptance numbers. Your supplier can assist with details.



NOTE: The catalog number on the radio label plate denotes the model number and the options with which your radio is equipped. Example: WR4HK would be a Dimension Repeater equipped to operate in the 162-174 MHz frequency range, equipped with the standard single-tone internal CTCSS, and wired to operate at 115 VAC 50/60 Hz current. Standard in this repeater is a hand-microphone, Time-Out-Timer and interface capability for use with an external multiple tone panel.

Section 6: Alignment

Care should be taken during the alignment of the transmitter and receiver of the repeater. A properly aligned repeater is efficient, and performs well. The receiver section is enclosed in a metal box, and the cover should be replaced after alignment. Similarly, the exciter and the power amplifier are shielded, and their shields should be replaced after servicing or alignment.

The mode switch should be in the extreme counter-clockwise "local" position during alignment of the repeater.

6.1 TRANSMITTER TUNE-UP (VHF)

1. Rotate the mode switch to the extreme counter clockwise "local" position.

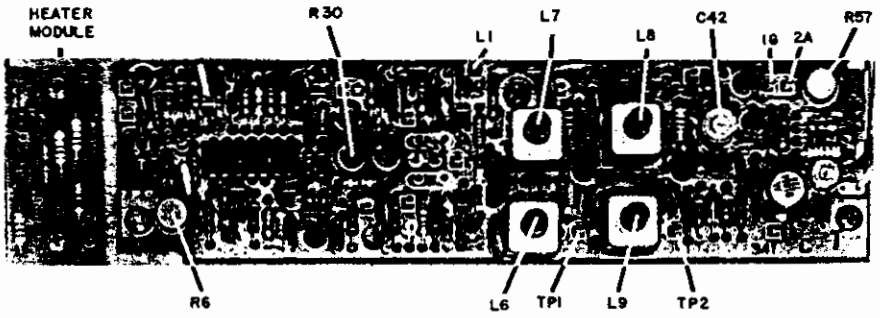


Fig. 6-1a
VHF EXCITER

2. Connect the wattmeter to the transmitter output coaxial connector (on the heatsink), and connect the microphone to its connector on the front panel. The wattmeter should be capable of measuring at least 40 watts.
3. Rotate the power level control, R57, to the full counter clockwise position, and run a jumper between pins 1G and 2A. R57 and pins 1G and 2A are on the exciter (Fig. 6-1a).
4. Connect the DC voltmeter to TP-1 on the exciter, key the transmitter, tune L6 and L7 for maximum, and L8 for minimum. 1.5 volts is typical.
5. Transfer the voltmeter to TP-2 key the transmitter and tune L8 and L9 for maximum. 1 volt is typical.
6. Observing the wattmeter, and with the transmitter keyed, tune C42 on the exciter for maximum power output.
7. Key the transmitter, tune C3 (on the RF power amplifier, Fig. 6-1b), C42 (on the exciter), and C? (on the PA) again for maximum power output.
8. Tune C21 on the power amplifier for maximum power output.
9. Remove the jumper from pins 1G and 2A (on the exciter), key the transmitter and adjust the power level control, R57 (on the exciter) for the desired power output.

Note: Transmitter output power should not be set in excess of 35 watts.

10. Normalize the repeater (connect the transmitter to the duplexer input, and rotate the mode switch to the "repeat" position), if it is not necssary to do the channel frequency and deviation adjustments.

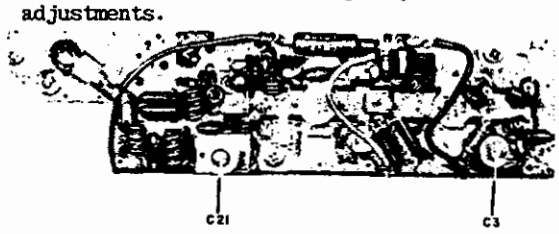


Fig. 6-1b
VHF RF P.A.

6.2 TRANSMITTER TUNE-UP (UHF)

1. Rotate the mode switch to the extreme counter clockwise ("local") position.
2. Unscrew and remove the output coaxial cable from the transmitter unit, and disconnect the RF link between the exciter and the RF power amplifier.
3. Attach and secure the microphone to the connector on the front panel, the wattmeter (with 5 watt element) through the coaxial adapter to the output of the exciter, and rotate the power level control (R57) on the exciter fully clockwise (Fig. 6-2a).
4. Connect the DC voltmeter to TP1 on the exciter, key the transmitter and tune L6 and L7 for maximum voltage.
5. Transfer the voltmeter to TP2 on the exciter, key the transmitter and tune L8 and L9 for maximum (Some power should be indicated on the wattmeter at this time. If power is indicated step 6 can be skipped.)
6. Transfer the voltmeter to TP3, key the transmitter and carefully tune C39 and C42 for maximum, and C56 for minimum DC voltage.
7. With the transmitter keyed, tune C39, C42, C56 and C59 (also C60 on the 470 to 490 MHz repeaters) for maximum power output. Unkey the transmitter. Refer to page 47 for location of C60.

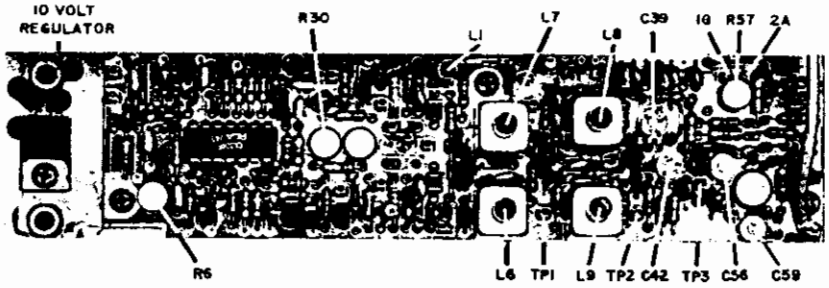


Fig. 6-2a
UHF EXCITER

8. Disconnect the wattmeter at the exciter and replace the coaxial link between the exciter and the RF power amplifier.
9. Connect the wattmeter to the output connector of the transmitter unit and change the element in the wattmeter to one rated at over 30 watts.
10. Using an alligator clip or some other convenient article, defeat the ALC loop by carefully shorting pins 1G and 2A (together) on the exciter board.
11. Key the transmitter and tune C3 and C22 of the power amplifier (Fig. 6-2b) for maximum power output. (Adjust alternately until no further increase in power is realized.)
12. Remove short from 1G and 2A, and using the power level control (R57) on the exciter module, adjust counterclockwise for the desired power output. (Between 10 and 25 watts). Skip step 13 if the frequency and deviation have to be adjusted.
13. Disconnect the wattmeter and reconnect the coaxial cable between the transmitter and the duplexer.

Fig. 6-2b
UHF RF P.A

6.3 CHANNEL FREQUENCY ADJUSTMENT

1. Rotate the mode switch to the "local" position (counter clockwise).
2. Disconnect the coaxial cable at the output of the transmitter and connect the wattmeter (with the element rated at over 35 watts) to the transmitter output connector.
3. Key the transmitter and monitor the channel frequency. (If a frequency counter is used, it can be connected at the output of the coaxial thruline attenuator).
4. If necessary, adjust L1 to pull the transmitter on frequency. Skip step 5 if the deviation has to be adjusted.
5. Disconnect the wattmeter, and reconnect the coaxial cable between the transmitter and the duplexer.

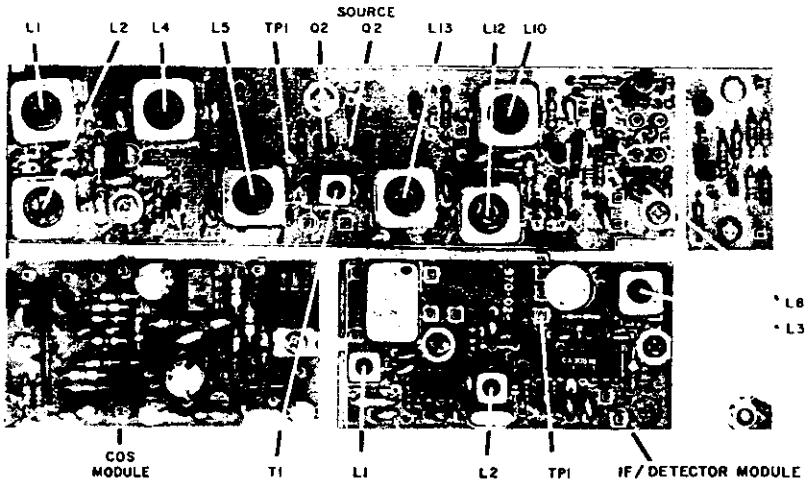
6.4 DEVIATION ADJUSTMENT

1. Connect the transmitter output to a wattmeter and/or a dummy load, rotate the mode switch to the "local" position, and the tone switch to "ON".
2. Remove the tone card, or disable the tone panel in Community Repeater installations, and monitor the transmitter with a deviation monitor.
3. Connect a 1 kHz tone at the audio input to the exciter, adjust the mike gain preset control, R6, fully clockwise, and the deviation control, R30 to the mid-position.
4. Observing the deviation monitor, key the transmitter and increase the 1 kHz level until there is no change in deviation.
5. Adjust the deviation control for ±3.8 kHz deviation for tone accessed repeaters, or ±4.5 kHz deviation for carrier accessed repeaters.
6. For community repeaters, see manufacturers tone panel instructions for individual tone transmission, and adjust each tone in turn to ± 750 Hz deviation.
7. Return R6 to the mid position.
8. Key the transmitter, and adjust tone output level control (Variable resistor labeled "tone" on the SP167 tone card) for ±750 Hz deviation. Remove the received audio if necessary.
9. Disconnect the wattmeter and reconnect the coaxial cable between the transmitter and the duplexer.

6.5 RECEIVER ALIGNMENT (VHF)

It is necessary to remove the top cover to gain access to the receiver unit.

1. Rotate the mode switch on the front panel to the extreme counter clockwise ("local") position.
2. Remove the coaxial cable from the receiver input connector, and connect the FM signal generator to the input connector. (The signal generator should be tuned to the channel frequency).
3. Connect a DC voltmeter at the source of Q2 and tune L10, L12 and L13 for maximum voltage (See Fig. 6-3). 2.5 volts is typical.
4. Transfer the voltmeter to TP1 (pin 4A) of the IF Detector module, modulate the signal generator with a 1 kHz tone and adjust the audio level for 3 kHz deviation.
5. Tune L5, L4, L2, L1 and T1 for maximum while reducing the RF input level (output of the signal generator) as necessary to avoid limiting. (Do not allow voltmeter to exceed 2 volts while tuning).
6. Connect an audio voltmeter, audio wattmeter or distortion analyzer across the loudspeaker, adjust the squelch control fully counter clockwise, and the volume control clockwise so that there is an indication on the audio level measuring equipment.
7. Adjust L3 (detector coil on the IF-Detector



NOTE: THIS VIEW SHOWS THE 970-02-052 CONFIGURATION OF THE IF/DETECTOR MODULE. FOR DETAIL OF THE NEWER 970-02-057 MODULE, SEE PAGE 40.

Fig. 6-3
VHF RECEIVER

module) or L5 (models with 970-02-057) for maximum audio.

6.6. RECEIVER ALIGNMENT (UHF)

It is necessary to remove the top cover to gain access to the receiver unit.

1. Rotate the mode switch on the front panel to the extreme counter clockwise ("local") position.
2. Remove the coaxial cable from the receiver input connector, and connect the FM signal generator to the input connector. (The signal generator should be tuned to the channel frequency).
3. Connect the RF millivolt meter to test point TP1 of the front end, and tune L9, L15, L18, L19, L17 and L16 (fig. 6-4) for maximum voltage.
4. Connect the DC voltmeter to TP1 of the IF/Detector module, (see schematic, TP1 is the socket designated 4A), and tune L1, L2, L10, L11, L12, L13 and L20 of the front end module, and L1 and L2 of the IF/Detector module (not required for models using 970-02-057) for maximum DC voltage. Reduce the RF input signal level while tuning as is necessary to avoid limiting.
5. Connect the distortion analyzer across the loudspeaker, frequency modulate the FM signal generator with a 1 kHz tone at 3 kHz deviation, and set the distortion analyzer for level measurement. (An audio power meter or audio voltmeter can be used in lieu of the distortion analyzer).
6. Rotate the front panel squelch and volume controls fully counter-clockwise and midway respectively, and adjust the detector coil, L3, (L5 for 970-02-057 modules) for maximum audio.
7. Alternately, an oscilloscope can be connected at the detector output (socket #4) of the IF/Detector module, or across the loudspeaker for observing the output while tuning L3 (L5 for 970-02-057 modules) for maximum.
8. Replace the coaxial cable between the receiver unit and the duplexer if receiver channel frequency adjustment is not necessary.

6.7 CHANNEL FREQUENCY ADJUSTMENT

The receiver channel frequency can be adjusted by zero beating at the IF with an accurate 21.4 MHz crystal oscillator, or by counting the injection frequency at the input to the mixer.

1. Rotate the mode switch on the front panel to the extreme counter clockwise ("local") position, the squelch control fully counter clockwise, and the volume control at the mid position.
2. Remove the connecting cable to the duplexer and connect the signal generator (tuned to the channel frequency) to the receiver input connector. (The signal generator should be unmodulated, and with the output level adjusted to between 5 and 10 uV).
3. Switch on the 21.4 MHz crystal oscillator and zero beat by adjusting variable inductor L6 (UHF), or L8 (VHF).
4. a. VHF: Alternately, connect the frequency counter to TP3 on the front end module and pull the oscillator on frequency by adjusting L8. Measured frequency should be equal to the channel frequency minus 21.4 MHz.
   b. UHF: Alternately, connect the frequency

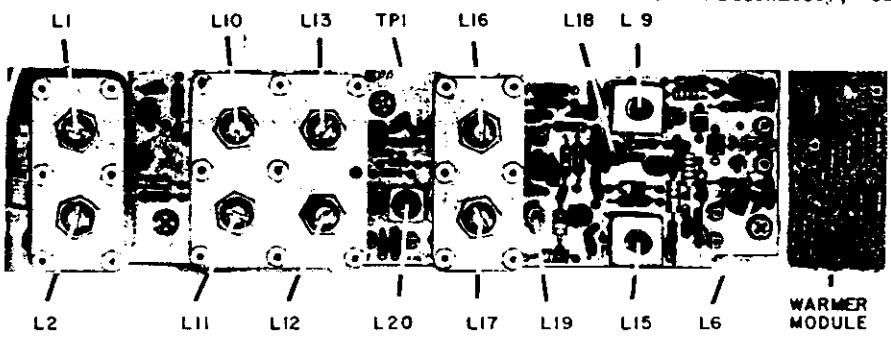


Fig. 6-4
UHF FRONT END

counter to the test point on the front end module TP1 and pull the oscillator on frequency by adjusting L6. The measured frequency is equal to the channel frequency minus 21.4 MHz.

5. Replace the coaxial cable between the receive and the duplexer, and if the repeater alignment is complete replace all covers. Rotate the mode switch to the extreme clockwise ("repeat") position.

6.8 REPEATER CONTROL CIRCUITS

6.8.1 Transmitter Delay Timer

a. Rotate the mode switch to the "Local/Repeat" position and the tone switch to the off position.
b. Connect the dummy load or watt meter to the transmitter coaxial output.
c. Key and unkey the transmitter by squelching and unsquelching the receiver with the squelch control on the front panel, or keying and unkeying a signal generator through the receiver.
d. Measure the time period between termination of signal (squelching the receiver) and carrier drop. (The time between when the receive light goes out and the transmit light goes out).
e. Adjust R47 if necessary: The variable period is 3 to 7 minutes.

6.8.3 Repeat Audio

Section 6.4 "Deviation Adjustment" has to be completed before this adjustment can be made.

a. Switch the tone switch to the "OFF" position and rotate the mode switch to the "repeat" position.
b. Connect a dummy load or wattmeter at the transmitter output and a FM signal generator to the receiver input.
c. Tune the signal generator to the receive channel frequency, and modulate it with a 1 kHz tone to 3 kHz deviation.
d. Tune the deviation monitor to the transmitter frequency and observe the transmitter deviation.
e. Adjust R7 until there is 3 kHz of transmitter deviation.
f. R8 adjusts the level to the telephone equipment, see the manufacturer's instructions for required level and other details.

6.9 DUPLEXER

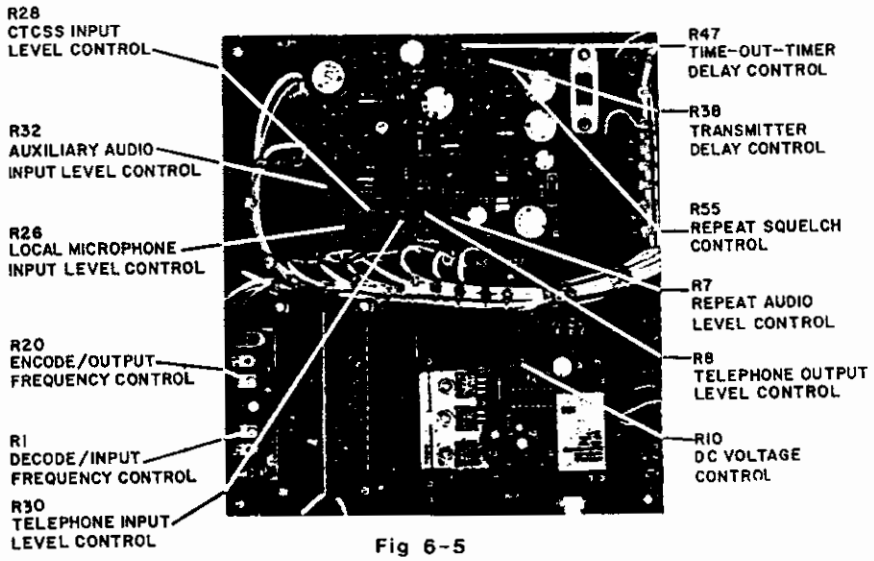


Fig 6-5
REPEATER CONTROL MODULES

e. Adjust R38 on the repeater control board (Fig. 6-5) as necessary. (Delay time adjustable from 20 mS to 4 seconds.)

6.8.2. Time-Out-Timer

The time-out-timer can either be receive reset (and is usually wired in this configuration at the factory), or transmit reset. The difference is, on receive reset, Q11 is reset whenever a carrier is detected, whereas on transmit reset, resetting Q11 depends on the setting of R38, and if the stations of the system can key up before the delay timer drops out. (See page 59 for transmit reset wiring.)

a. Connect the transmitter to a dummy load.
b. Rotate the mode switch to the "Local/Repeat" position.
c. Rotate the squelch control CCW until the transmitter keys (yellow and red indicators illuminate).
d. Time the interval the red indicator stays illuminated.

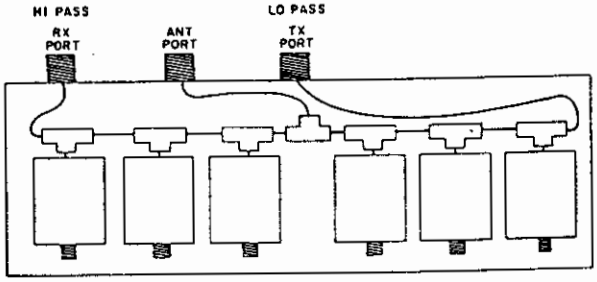


Fig. 6-6

The tuning instructions given here are typical. A Decibel Products DB-4072 UHF duplexer was used as an example, and was tuned to 462.2 MHz (transmitter frequency) and 467.2 MHz (receiver frequency).

Notch the transmitter frequency out of the receiver port.

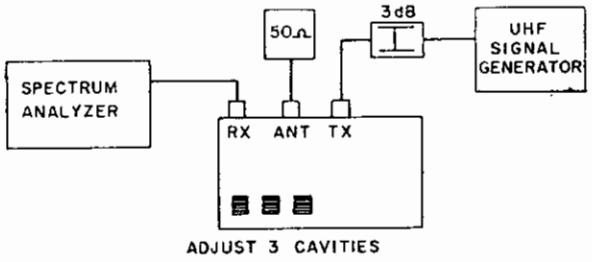


Fig. 6-7

a. Connect a 50 ohm load to the antenna port,
b. Connect a signal generator tuned to the transmitter frequency (462.2 MHz in this example) to the low pass transmitter port via a 3 dB pad.
c. Connect the spectrum analyzer to the Hi Pass receiver port, and monitor the transmitter frequency on the spectrum analyzer.
d. Adjust the tuning slugs of the three cavities associated with the receiver port for a dip of the transmitter power as observed on the analyzer. See Figure 6-7.

Notch the transmitter noise out of the receiver port.

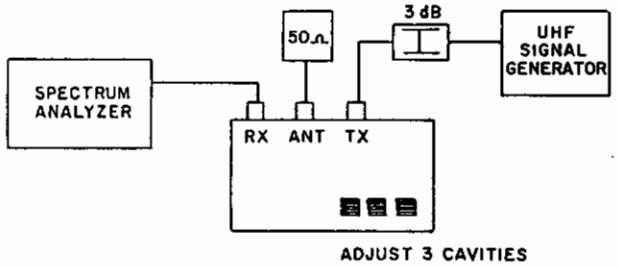


Fig. 6-8

a. Tune the signal generator to the receiver frequency (467.2 MHz in this example).
b. Monitor the receiver frequency on the spectrum analyzer.
c. Adjust the tuning slugs of the three cavities associated with the transmitter port for a dip of the receiver noise level as observed on the analyzer. See Figure 6-8.

Observe the transmitter and receiver frequencies on the analyzer at the receiver port while transmitting.

a. Remove the signal generator from the transmitter port and reconnect the output of the transmitter to the duplexer.
b. Adjust the analyzer so that both transmitter and receiver frequencies will be observed.

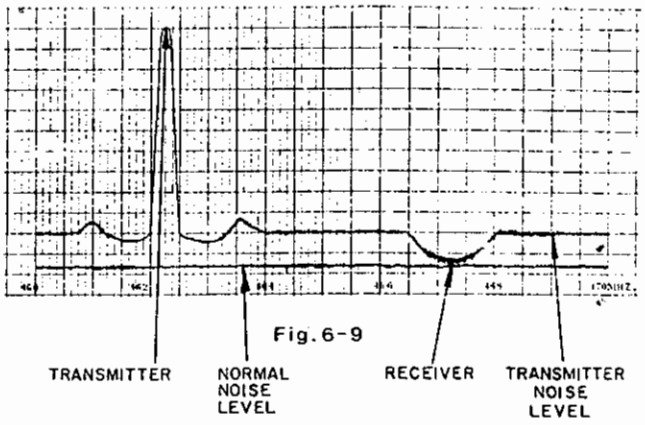


Fig. 6-9

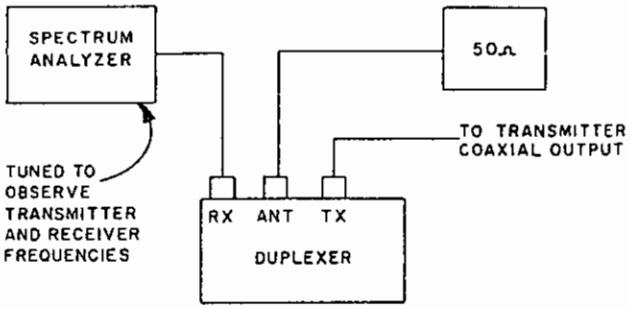


Fig. 6-10

c. Key the transmitter and observe the analyzer. Figure 6-9 is a sketch of the desired waveform. It should be noted, a well tuned duplexer wil show a dip in the noise level at the ansmitter frequency.

6.10 CTCSS DECODE/ENCODE FREQUENCY ADJUSTMENT

This adjustment is for single tone systems only.

a. Connect an FM signal generator to the receiver input, modulate the signal generator with the correct frequency (received CTCSS) tone and adjust the tone level for 500 Hz deviation.
b. Slide the transmitter control switch (S1) on the control mother board to the "off" position, connect the frequency counter to pin 3 of J5 (CTCSS accessory jack at rear of the repeater), and an audio meter to the red jack (J2) of the SP167 card.
c. Adjust the variable resistor labeled "in" (on the SP167 board) until the LED (D4) illuminates, and for maximum on the audio meter.
d. Adjust the variable resistor labeled "out" for the correct transmit CTCSS frequency as observed on the frequency counter.
e. Remove the signal generator, connect the receiver to the duplexer, and slide the transmitter control switch to the normal position. (See section 6.4 for deviation adjustment and Section 3.10 for frequency range changing information.)

Section 7: Servicing

7.1 GENERAL

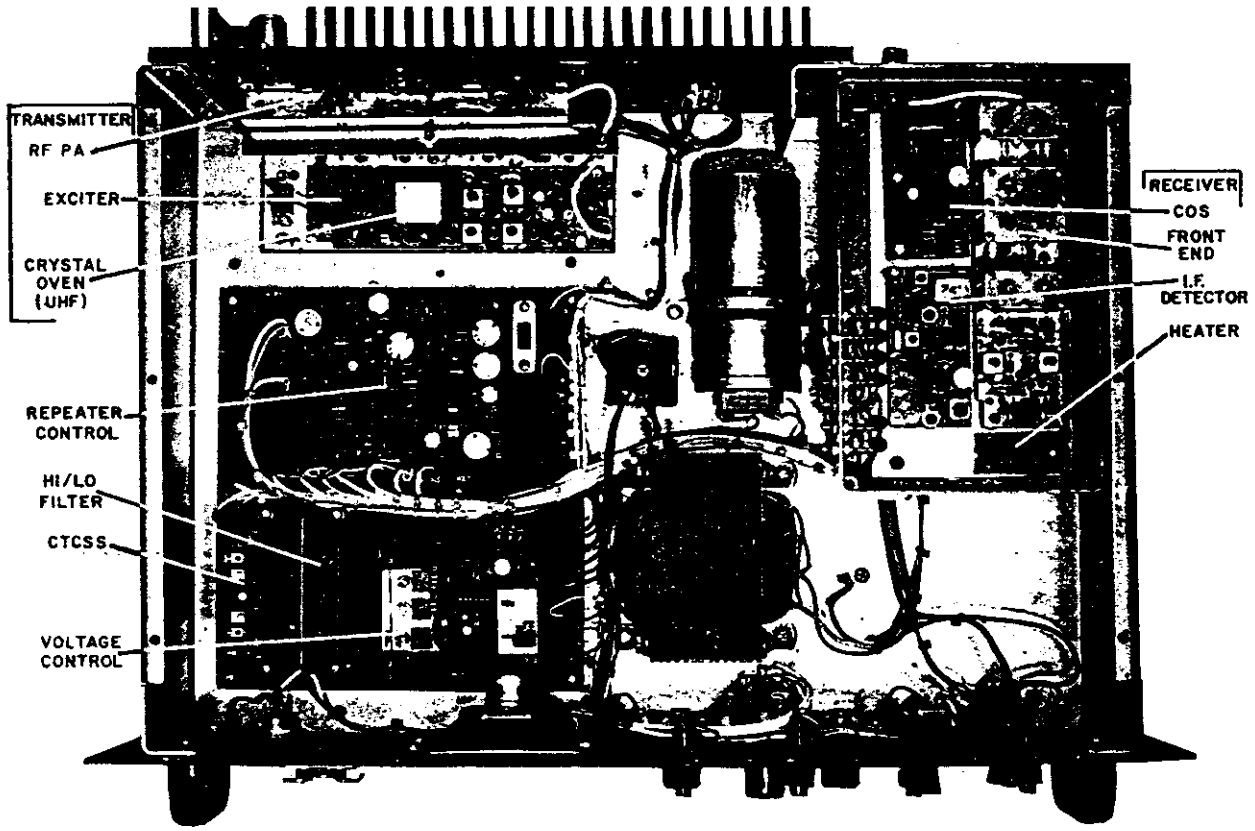
High reliability components are used in the manufacture of the Dimension repeater, and most of the servicing should be limited to routine and preventative maintenance. We recommend a maintenance log be kept for each repeater, with recordings of receiver (SINAD and/or quieting) sensitivity, squelch sensitivity, audio power output and percentage distortion measured at the output of the monitor amplifier, receiver oscillator frequency, and transmitter power output, deviation, and transmitter frequency.

For servicing, the repeater can be divided into three main sections; 1. The control section (all printed circuit boards mounted on the harness "mother" board) and power supply, 2. The receiver section, and 3. The transmitter section.

Voltage listings are given in this section to assist service persons in locating defective components. Section 8 contains the schematics and component locators for identifying components, and lists the part numbers of the components for the ordering of replacements. Some components are special parts, and have to be cut to a specific length, etc., and consequently it is recommended that replacement parts be ordered from the manufacturer, or from one of their distributors.

7.2 SYSTEM PERFORMANCE CHECK

One of the two coaxial cables from the repeater unit to the duplexer can be tagged so that identification of the receive and transmit lines can be easily and quickly made. Remove the receive coaxial cable from the input connector of the repeater unit, and connect an FM signal generator to the input connector. Similarly, remove the output coaxial cable and in its place connect an RF wattmeter of 50 ohms termination. Reduce the output of the signal generator to zero, tune the generator to the receive channel frequency, and modulate the generator with the appropriate CTCSS frequency tone. Adjust the modulating audio level for about 500 Hz deviation. Gradually increase the output of the signal generator until the yellow indicator illuminates. The red indicator should also illuminate, and RF power should be indicated on the RF wattmeter. Note the input signal level (output of the signal generator) and the RF power output. Input signal level (squelch sensitivity) should be 0.2 uV or better, and the RF power output should approximate the wattage set at the initial installation. The system performance check can be done quickly, and gives the overall performance of the system.



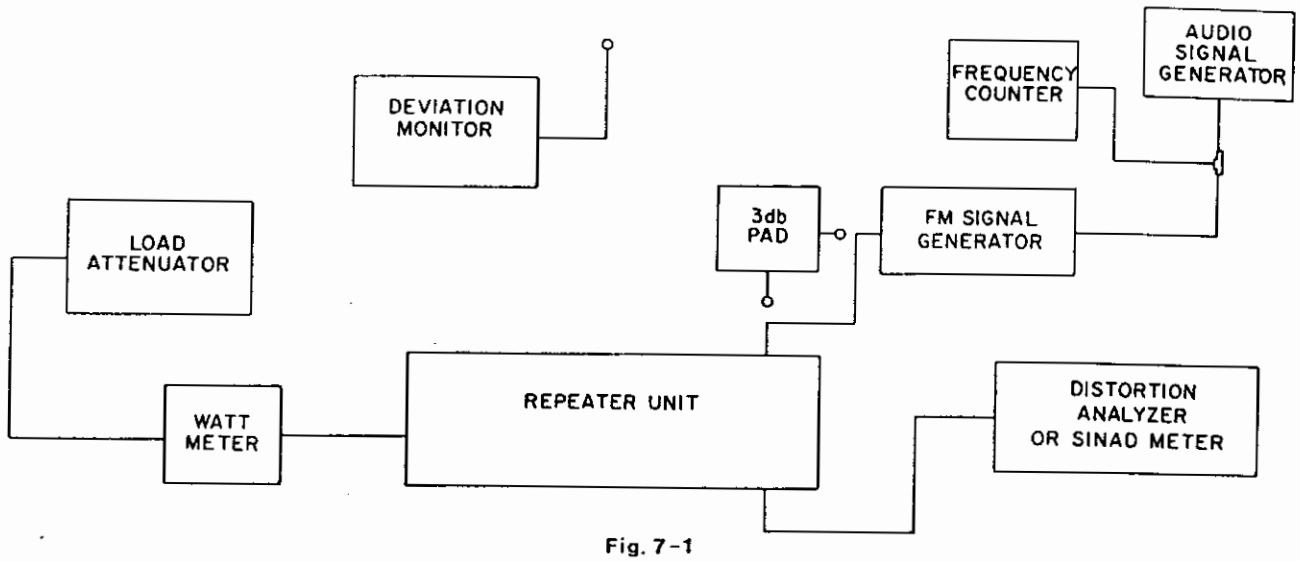


Fig. 7-1

TEST EQUIPMENT HOOK-UP

7.3 RECEIVER PERFORMANCE CHECKS

7.3.1 Receiver Channel Frequency

Receiver peformance checks are a quick way of determining the state of the receiver, and can forewarn service personnel of receiver failure.

a. Connect an accurate RF signal generator (Cushman, etc.,) to the receiver input.
b. Remove any modulation from the signal generator, and tune it to the receiver channel frequency.
c. Using an accurate 21.4 MHz crystal oscillator listen for zero beat. (Adjust the local audio output as needed.)
d. If necessary, put the receiver on frequency by adjusting the appropriate inductor on the front end module within the receiver unit. See section 6.7 for details.

7.3.2 Quieting Sensitivity

a. Rotate the mode switch to the extreme counter clockwise (CCW) position, the "local" position, and the squelch control also fully CCW.
b. Connect an audio voltmeter across the speaker terminals, and a signal generator at the input coaxial connector.
c. Adjust the output attenuator of the signal generator for no RF output.
d. Adjust the front panel volume control of the repeater for 1.8 volts of noise, as indicated on the audio voltmeter.
e. Gradually increase the output of the signal generator until the audio voltmeter indicates 0.18 volts (an output level decrease of 20 dB).

The RF output level of the signal generator should be 0.42 uV or less (VHF), 0.45 uV or less (UHF).

7.3.3 Squelch Sensitivity

a. Rotate the mode switch to the "local" position and the squelch control to the threshold squelch position.

TEST EQUIPMENT NEEDED

1. VHF/UHF FM Signal Generator
2. Audio Signal Generator
3. Frequency Counter
4. Volt-OHM-Milliameter
5. RF Millivolt Meter
6. SINAD Meter/Distortion Analyzer
7. Audio Voltmeter/Wattmeter
8. 3 dB Pad
9. RF Wattmeter
10. 50 Watt Load/Attenuator (needed for Thruline Wattmeter)
11. Deviation Monitor
12. Spectrum Analyzer (needed for Duplexer Tuning).

b. Connect the RF signal generator (tuned to the channel frequency and with the output fully attenuated) to the receiver input coaxial connector.
c. Gradually increase the output of the signal generator until the squelch opens.

The RF level required should be 0.2 uV or less.

7.4 TRANSMITTER PERFORMANCE TESTS

7.4.1 Transmitter Power Output

The transmitter power output is variable from less than 10 to over 35 Watts (VHF), (25 watts UHF) and would have been set at or between those two power levels during the installation of the system.

a. Connect a wattmeter to the transmitter output coaxial connector.
b. Rotate the mode switch to the extreme CCW "local" position.
c. Using the push-to-talk (PTT) button on the local microphone, key the transmitter and observe the power output. The power adjustment control, R57, is on the exciter module. See section 6.1. or 6.2.

7.4.2 Channel Frequency Adjustment

a. Tune the frequency monitor (Cushman etc.,) to the transmit frequency.
b. Rotate the mode switch to the "local" position.
c. Key the transmitter (using the PTT button on the local microphone) and observe the transmitter frequency.

Inductor L1 on the exciter module is used for adjusting the transmitter frequency. See section 6.3 for instructions.

7.4.3 Transmitter Deviation

a. Tune the deviation monitor (Cushman etc.,) to the transmit frequency.
b. Rotate the mode switch to the "local" position.
c. Key the transmitter and speak loudly into the microphone while observing the deviation. The deviation should not exceed 5 kHz on peaks. See section 6.4 for deviation adjustment if necessary.

7.5 CONTROL CIRCUITS SERVICING

The control circuits mentioned here are comprised of the voltage control board, the repeater control board, the filter card, and the SP167 tone card. The latter two cards are optional.

7.5.1 Voltage Control Board

A. Output Voltage Control Circuit

The two green lamps on the front panel are supply indicators. The one to the right is lit while the mains is supplying the load, and is supplied by the 13.8 volts DC (nominal) output of the main voltage regulator, IC-1.

It is possible to accidentally short the 13.8 volts output while servicing causing the main regulator, 1C-1 to shut down. This being the case, even if a fully charged storage battery is connected, the battery will not take over because the AC sense voltage will keep the relay (K1) operated. Both green lamps will be extinguished, and there will be no 13.8, 8, or 5 volts output.

To overcome this condition, the mains switch should be switched "OFF", then "ON". It should be noted however, a short developed in one of the units supplied by this circuit will have the same indication, but it will be necessary to clear the short before the main regulator, 1C-1, will function.

B. Charging Circuit

Should the specific gravity or some other check show the battery is not charging:

1. Measure the voltage at the cathode end of CR5. A reading of about 14 volts is normal.
2. If the voltage is low, measure the voltage on the middle pin of the charging regulator, 1C-2. It should be about 1.86 volts
3. If this voltage is zero, check for a short between the middle pin or the heat tab and ground.

The case of this IC should be isolated from ground when mounted. Isolating the frame of the IC from ground should cause the voltage at the middle pin to rise to 1.86 volts, and the output voltage adequate for charging.

C. Switching Circuit

Relay K1 facilitates switching of the load between the mains supply and the battery. Should K1 fail to operate while the mains is on (both green lamps illuminated):

1. Check the voltage at the cathode of CR6. No voltage at that point can indicate a shorted C4.
2. Check R2 and CR6 for continuity.
3. Check socket 15, the AC sense input for AC sense voltage.

A reading of 13.8 volts at the cathode of CR6 is normal.

VOLTAGE CONTROL BOARD DC VOLTAGES

	PINS								
DEVICES	E	B	C	1	2	3	4	5	6
Q1	14.2	14.1	0	-	-	-	-	-	-
IC-1	-	-	-	-	14	13.8	7.1	7.1	7.1
IC-2	-	-	-	24.2	1.86	13.9	-	-	-
IC-3	-	-	-	13.8	0	8	-	-	-
IC-4	-	-	-	13.8	0	5	-	-	-
DEVICE	7	8	9	10	11	12	13	14	
IC-1	0	-	-	15.1	24.2	24.2	16.2	-	

Table 7-1

D. 8 and 5 volts Regulator Circuits

1. If there is no 5 and 8 volt output, check sockets 9 and 10 for the 13.8 volts.
2. If there is only one voltage missing, check the resistance at the output of the IC with the voltage missing. An extremely low resistance indicates a shorted condition on that circuit.
3. Troubleshoot the short.

7.5.2. Repeater Control Unit

Rotate the mode switch to the clockwise "repeat" position, and switch the tone switch "ON". Connect an FM signal generator to the receiver coaxial input and a dummy load at the transmitter output.

Tune the signal generator to the receiver channel frequency and adjust the output (unmodulated) to about 1 uV.

A. Receive Indicator Circuit

1. Observe the yellow lamp (second from left), it should be illuminated.
2. If the lamp is not illuminated, check the voltage at the COS input socket, "D". It should be at or near zero volts.
3. Check the voltage at the collector of Q4. It

should be high, approaching one volt.
4. Check the voltage at the collector of Q3. It should be low, at or near zero volts.

Static voltages of Q3 and Q4 are given in Table 7-2.

REPEATER CONTROL UNIT

DEVICES	E	B	C
Q1	0	0	.72
Q2	0	.72	0
Q3	0	.12	.12
Q4	0	.7	.12

Table 7-2

B. Audio Input Clamp

1. Measure the voltage at the inverted COS input at socket "V". It should measure about 8 volts.
2. Check the voltage at the collector of Q1. It should be low, at or near zero volts.
3. Check that the ground is removed from the collector of Q2.

DC voltages for Q1 and Q2 in the non operating state are given in Table 7-2.

Connect an audio signal generator tuned to 1 kHz to the detector input, socket "A", and the probe of the oscilloscope to the collector of Q2. Connect an audio voltmeter across the loudspeaker. Adjust the output of the audio signal generator for 5 volts peak-to-peak as measured on the oscilloscope.

C. Audio Pre-amplifier

1. Using the oscilloscope, measure the voltage at the output of U1. A reading of 10 volts p-p would be normal. U1 is designed for a gain of about 2.
2. Measure the voltage at pins 5 and 6 of U1. They should measure about 5.06 volts DC.
3. Measure the voltage at pin 7 of U1. A reading of 5.12 is normal.

D. Audio Amplifier

1. Rotate the volume control fully clockwise.
2. Observe the audio output level. The output across the 3.2 ohms speaker should be at least 3.1 volts.

DC voltages for U1 and U2 are given in Table 7-3.

E. Telephone Amplifier

1. Connect the probe of the oscilloscope to the junction of R8 and C18 and adjust R8 for 1 volt p-p.
2. Transfer the probe to the output of U3-A, socke "O". A peak-to peak reading of 20 volts is normal.

F. Repeat Amplifier

1. Connect the probe of the oscilloscope to the junction of R7 and C13.
2. Adjust R7 for 1 volt p-p.
3. Using the oscilloscope, measure the output of U3-B at pin 1. A reading of about 5 volts p-p would be normal.

Table 7-3 shows the DC voltage readings for U3.

If the repeater is carrier accessed, switch the tone switch to the "OFF" position, and if tone accessed, modulate the FM signal generator connected to the receiver input with the appropriate frequency tone. If multiple tones are used in the system (community repeater), the frequency of any incoming tone in the system will be appropriate. Adjust the tone level for 500 Hz deviation. High Q filters are used in the system, and it is necessary for the tone frequency to be very accurate. When the correct frequency tone is applied, or when the tone switch is switched "OFF" in the case of the carrier accessed repeater, the red indicator on the front panel should illuminate.

G. Transmitter Delay Timer

1. Measure the voltage at the input to the transmitter delay timer, socket "K". It should be at or near zero, (less than a volt).
2. Measure the voltage at the output of comparator U4-A. It should be high, 6 to 7 volts.
3. Measure the base of Q10. It should be high, around 0.7 volts.
4. Measure the collector of Q10 (emitter of Q12). It should be at or near zero volts.
5. Measure the collector of Q12. It should be low, at or near zero volts.

H. Transmit Indicator Circuit

1. Measure the voltage at the transmit indicator circuit input socket "I". It should be low, at or near zero volts.
2. Measure the voltage at the collector of Q6. It should be about 0.7 volts.

REPEATER CONTROL UNIT NO-SIGNAL DC VOLTAGES

	LEADS				PINS											
DEVICES	E	B	C	DEVICES	1	2	3	4	5	6	7	8	9	10	11	12
Q5	0	.13	12	U1	-	-	-	0	5.1	5.1	5.2	8	-	-	-	-
Q6	0	.7	.13	U2	13.8	-	-	13.5	0.8	1.3	7.1	.01	0	0	-	6.8
Q10	0	0	5.6	U3	5.1	5.1	5.1	0	5.1	5.1	5.1	8	-	-	-	-
Q11	0	5.6	0	U4	0	7.9	3.2	0	2.6	2.6	6.6	8	-	-	-	-
Q12	5.6	4.5	5.7													

Table 7-3

3. Measure the voltage at the collector of Q5. It should be low, at or near zero volts.

Note: Within 3 and 7 minutes the Time-Out-Timer (TOT) will release Q12 causing the transmit indicator circuit to revert to normal, with voltage readings as in Table 7-3.

I. Transmitter Time-Out-Timer

1. Observe the voltage at the collector of Q11 with a DC voltmeter. It raises exponently, at a rate depending on the setting of R47.
2. Check the voltage at the base of Q12, it should be less than 4.5 but more than 0.1 volts.

Table 7-3 shows the DC voltages of Q5, Q6, Q10, Q11, Q12, and U4.

Rotate the mode switch to the extreme counterclockwise "local" position, and disconnect the signal generator from the receiver input.

J. Local Microphone Circuit

1. Key the transmitter by depressing the push-to-talk (PTT) button on the local microphone.
2. Measure the voltage at the collector of Q7; it should be at or near ground.
3. Observe the potential at the collector of Q9. The ground should have been removed.

Table 7-4 shows the DC no signal voltages of Q7, Q8 and Q9.

REPEATER CONTROL UNIT

DEVICES	E	B	C
Q7	0	.04	5.7
Q8	0	.7	.04
Q9	0	.7	0

Table 7-4

7.5.3 Filter Card

a. Connect an audio signal generator to the filter input, and tune the signal generator to 1 kHz.
b. Using an oscilloscope, observe the output of the high pass filter.
c. Observe the output of the low pass filter. There should be very little or no output at the output of the low pass filter, and a reasonably large output at the high pass output. Output levels will, of course, depend on the input levels.
d. Tune the signal generator to 100 Hz.
e. Observe the output at the high and low pass outputs. There should be no 100 Hz signal at the high pass output, and a relatively large level at the low pass output.

Note: The DC voltage on pins 1, 2, 3, 5, 6 and 7 of ICs 1, 2 and 3, and pins 5, 6 and 7 of IC-4 is 5 volts ±5%.

7.5.4 SP-167 Tone Card

a. Switch the transmitter control switch on the repeater mother board to the central "OFF" position.
b. Connect the FM signal generator to the receiver input and modulate with an appropriate frequency tone at 500 Hz deviation.
c. Tune the signal generator to the receiver channel frequency, and adjust the output level to 1 uV.
d. Connect the probe of the oscilloscope to the red test jack (J2) on the SP-167 tone card.
e. Fine tune the modulating frequency if necessary for maximum amplitude on the oscilloscope. A reading of 2.2 volts p-p is normal.
f. Check that light emitting diode D4 is illuminated.
g. Measure the output frequency, and adjust the variable resistor labeled "out" if necessary.

7.6 RECEIVER UNIT

The top of the receiver unit is held in place by six Phillips screws. The largest assembly within the enclosure is the front end assembly, to the left of which are the IF-Detector and the Carrier Operated Squelch (COS) assemblies, and the smallest assembly is the crystal heater control assembly.

7.6.1 COS Servicing

a. Connect the FM signal generator to the receiver coaxial input, and adjust the frequency to that of the receive channel.
b. Modulate the signal generator with a 1 kHz tone, adjust the AF level for 3.3 kHz deviation, and the RF output level to 10 uV.
c. Observe the input signal at the base of Q1. It should be approximately 12 mV p-p.
d. Observe the wideband audio output at the collector of Q1. It should be apprixmately 900 mV p-p.
e. Reduce the input signal to zero and measure the noise level at the output of U1-A. A reading of 4 to 5 volts peak to peak is normal.
f. Measure the voltage at the collector of Q2. It should measure 3 volts DC.
g. Increase the signal generator output to 1 uV while observing the collector voltage of Q2. It should drop to zero volts.
h. Measure the output of the comparator, (U1-B pin 7), it should be approximately 6.6 volts DC.
i. Measure the voltage at the COS output, socket 4A. It should be zero volts.
j. Measure the voltage at the inverted COS output socket 4B. It should be approximately 7.7 volts DC.

Table 7-5 shows the DC no signal voltages for all the active devices in the COS assembly.

COS NO SIGNAL VOLTAGES

	PINS					
DEVICES	E	B	C	1	2	3
Q1	.1	.72	3.6	-	-	-
Q2	0	0	3.1	-	-	-
Q3	0	0	7.2	-	-	-
Q4	0	.7	0	-	-	-
Q5	0	0	.7	-	-	-
U1	-	-	-	4	4	4
U2	-	-	-	13.8	0	8
DEVICE	4	5	6	7	8	
U1	0	2	2.1	0	8	

Table 7-5

7.6.2. IF-Detector Servicing

a. Connect the FM signal generator to the receiver input connector, tune the signal generator to the receiver channel frequency, and adjust the CW output for a level of 300 uV.
b. Measure the output of U1 (pin 8) with the oscilloscope. A reading of 270 mV p-p is normal.
c. Measure the input (pin 1) of U2. 80 mV p-p is normal.

DC no signal voltages for U1 and U2 are given in Table 7-6.

IF DETECTOR NO SIGNAL VOLTAGES

	PINS							
DEVICES	1	2	3	4	5	6	7	8
U1	13	10	1.7	2.3	3.5	2.3	0	13
U2	1.3	1.3	1.3	0	0	7	13	5.6
PINS	9	10	11	12	13	14	15	16
U2	5.8	5.8	13.8	4.2	1.5	0	4.8	0

Table 7-6

7.6.3 Front End Servicing (UHF)

a. Measure the voltage across R10 in the oscillator emitter circuit. 2.1 volts DC is normal.
b. Remove the crystal, the voltage should drop to 1.9 volts.
c. Connect the voltmeter to the emitter of Q4.
d. Remove the crystal while observing the voltmeter. The voltage should drop to almost zero.

FRONT END DC VOLTAGES

	LEADS					
DEVICES	E	B	C	S	D	G
Q1	0	.75	10.8	-	-	-
Q2	2.1	2.8	9	-	-	-
Q3	-	-	-	2.8	12.5	0
Q4	.6	1.2	12.4	-	-	-

Table 7-7

Emitter voltage of Q2 and Q4 will vary depending on crystal activity. Table 7-7 gives DC voltages.

7.6.4 Heater Control Circuit Servicing

The ambient temperature DC voltages of the heater control circuit are exhibited in Table 7-8.

a. Freeze the thermistor RT1 by spraying with "Quick Freeze" or similar servicing aid.
b. Measure the voltage at the base of Q1. It should rise to about 3.8 volts.
c. Measure the voltage at the emitter of Q1. It should rise to about 3 volts.
d. Measure the voltage at the base of Q2. It should drop to about 13 volts.
e. Measure the voltage at the collector of Q2, it increases from zero to 13.7 volts.

HEATER CONTROL DC VOLTAGES

DEVICES	E	B	C
Q1	.06	.7	13.6
Q2	13.8	13.6	0

Table 7-8

7.7 TRANSMITTER SERVICING (UHF)

The transmitter is divided into two main sections. The Exciter section is mounted on the chassis, and the Power Amplifier section (P.A.) is mounted on the heat sink. Both sections are shielded. The cover of the exciter is secured by four screws, one on the top, and one on each of the three sides securing it to the chassis. The P.A. cover is secured by two screws sunk into the heatsink. The P.A. cover can be removed by loosening the two screws and sliding it upwards.

7.7.1 Exciter Servicing

a. Connect an audio signal generator to the "mike input" of the exciter, socket 1B, and the probe of the oscilloscope to the base of transistor U1-D.
b. Adjust R6 to it's physical mid position, the output level of the signal generator for 50 mV peak-to-peak as displayed on the oscilloscope, and the frequency to 1 kHz.
c. Measure the p-p voltage at the collector of U1-D. It should be approximately 600 mV.
d. Similarly, measure the p-p voltage at the collector of U1-A. It should be around 1.1 volts, and just beginning to limit.
e. Reduce the output level of the signal generator so that the p-p voltage at the collector of U1-A is reduced to 800 mV.
f. Measure the p-p voltage at the base of Q1. A reading of about 680 mV can be expected.
g. Similarly, measure the p-p voltage at the collector of U1-E. It should be approximately 1.46 volts.
h. Connect an RF wattmeter to the output of the exciter, and remove the audio signal generator from the "mike input".
i. Slide the transmitter control switch forward to the "lock on" position. (The red transmit lamp should illuminate indicating the transmitter is keyed.
j. Measure the DC voltage at TP1; it should be approximately 0.8 volts.
k. Measure the DC voltage at TP2; it should be approximately 1.5 volts.
l. Similarly, measure the voltage at TP3; it should be approximately 0.5 volts.
m. Observe the RF power output as displayed on the wattmeter.

   It should be noted; the exciter may not be adjusted for maximum power output as the full output power of the transmitter may not be utilized.
n. Slide the transmitter control switch backwards to the "normal" position. (The mid position is "OFF".)
o. Remove the wattmeter and connect the exciter

output to the input to the RF power amplifier.

7.7.2 RF Power Amplifier Servicing

a. Ascertain the power amplifier is being driven by connecting the output of the exciter to wattmeter and observing the power output. It should be at least 400 mW.

b. Connect the exciter output to the input of the P.A., and the RF wattmeter to the output coaxial connector of the power amplifier.

c. Measure the DC voltage (transmitter not keyed) at the collector of Q1 and Q2. They should both be 13.8 volts.

d. Connect the DC voltmeter to the RF sense output, socket 4. Observe the DC voltage (transmitter unkeyed). It should be 13.8 volts.

e. Key the transmitter and observe the voltage at socket 4. The voltage drop across the sense resistor will depend on the current drawn by the final stage, and can indicate the state of that stage. For an output of 25 watts, the voltage drop is approximately 0.6 volts. It should be noted, a badly tuned and consequently inefficient final stage can cause a large voltage drop with little power output.

		PINS OR LEADS DC VOLTAGES																				
Circuit	Devices	E	B	C	S	D	G	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Voltage Control Board	Q1	14.2	14.1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	IC-1	-	-	-	-	-	-	NC	14	13.8	7.1	7.1	7.1	0	NC	NC	15.1	24.4	24.2	16.2	NC	-	-
	IC-2	-	-	-	-	-	-	24.2	1.86	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-
	IC-3	-	-	-	-	-	-	13.8	0	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-
	IC-4	-	-	-	-	-	-	13.8	0	5.06	-	-	-	-	-	-	-	-	-	-	-	-	-
Repeater Control Unit	Q1	0	0	.72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q2	0	.72	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q3	0	.12	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q4	0	.7	.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q6	0	.7	5.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q7	0	.04	.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q8	0	.7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q9	0	.7	5.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q10	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q11	0	5.6	5.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q12	5.6	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	U1	-	-	-	-	-	-	NC	NC	NC	0	5.1	5.1	5.2	8	-	-	-	-	-	-	-	-
	U2	-	-	-	-	-	-	13.8	NC	NC	13.5	.8	1.3	7.1	.01	0	0	NC	6.8	-	-	-	-
	U3	-	-	-	-	-	-	5.1	5.1	5.1	0	5.1	5.1	5.1	8	-	-	-	-	-	-	-	-
	U4	-	-	-	-	-	-	0	7.9	3.2	0	2.6	.03	6.6	8	-	-	-	-	-	-	-	-
Carrier Operated Squelch	Q1	.1	.72	3.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q2	0	0	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q3	0	0	7.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q4	0	.7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q5	0	0	.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	U1	-	-	-	-	-	-	4	4	4	0	2	2.1	0	8	-	2	-	-	-	-	-	-
	U2	-	-	-	-	-	-	13.8	13.8	8	-	-	-	-	-	-	-	-	-	-	-	-	-
IF - Detector	U1	-	-	-	-	-	-	13	13	1.65	2.3	3.5	2.3	0	13	-	-	-	-	-	-	-	-
	U2	-	-	-	-	-	-	1.3	1.3	1.3	0	0	7	NC	5.6	5.8	5.8	13.8	NC	4.8	0	NC	NC
Front End	Q1	0	.75	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q2	2.1	2.8	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q3	-	-	-	2.8	12.5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q4	.6	1.2	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heater Control	Q1	.06	.7	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Q2	13.8	13.6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

E = Emitter, B = Base, C = Collector, S = Source, D = Drain, G = Gate, & NC = No Connection.

Table 7-9

Repeater Active Devices DC Voltages

Section 8: Parts List and Schematics

8.1 GENERAL

Whenever possible, the part numbers and description of the parts of an assembly are given on the drawing. When lack of space precludes this, the schematic and other associated illustrations are followed by the relevant parts listing.

In the latter instance, the listing is structured in three columns. The first column (at the left of the page) contains the reference designators that correspond with the designation of components on the associated schematic or mechanical drawings. The reference designator is used for identifying a component, and can be alpha numeric (example; "CR1" identifies a particular diode on a schematic or component location drawing), or numeric (example; "3" identifies a part numbered 3 on a mechanical drawing). The second column is the description of the component. This column gives the value, size, specifications, etc., of the component. The third column has the part number of the component. When ordering spares or replacement parts, all three should be quoted.

Unless otherwise specified, resistors are 1/4W with a ±5% tolerance, and are carbon film.

Parts are available from the manufacturer, Repco Incorporated, or their authorized agents. The address and telephone number of the Order Service Dept. follows:

Repco Incorporated
Order Service Department
P.O. Box 7065
Orlando, Florida 32854
(305) 843-8484

The SP167 CTCSS tone card used in single tone repeater systems is a purchased item.
Replacement parts or spares can be obtained from the manufacturer whose name,address, etc. follows:

Ferritronics Limited
222 Newkirk Road
Richmond Hill
Ontario, Canada L4C 3G7

Cable Address: Ferric Toronto
Telephone: (416) 884-3180

8.2 DIMENSION REPEATER ASSEMBLIES

VHF	8-320
UHF	8-321

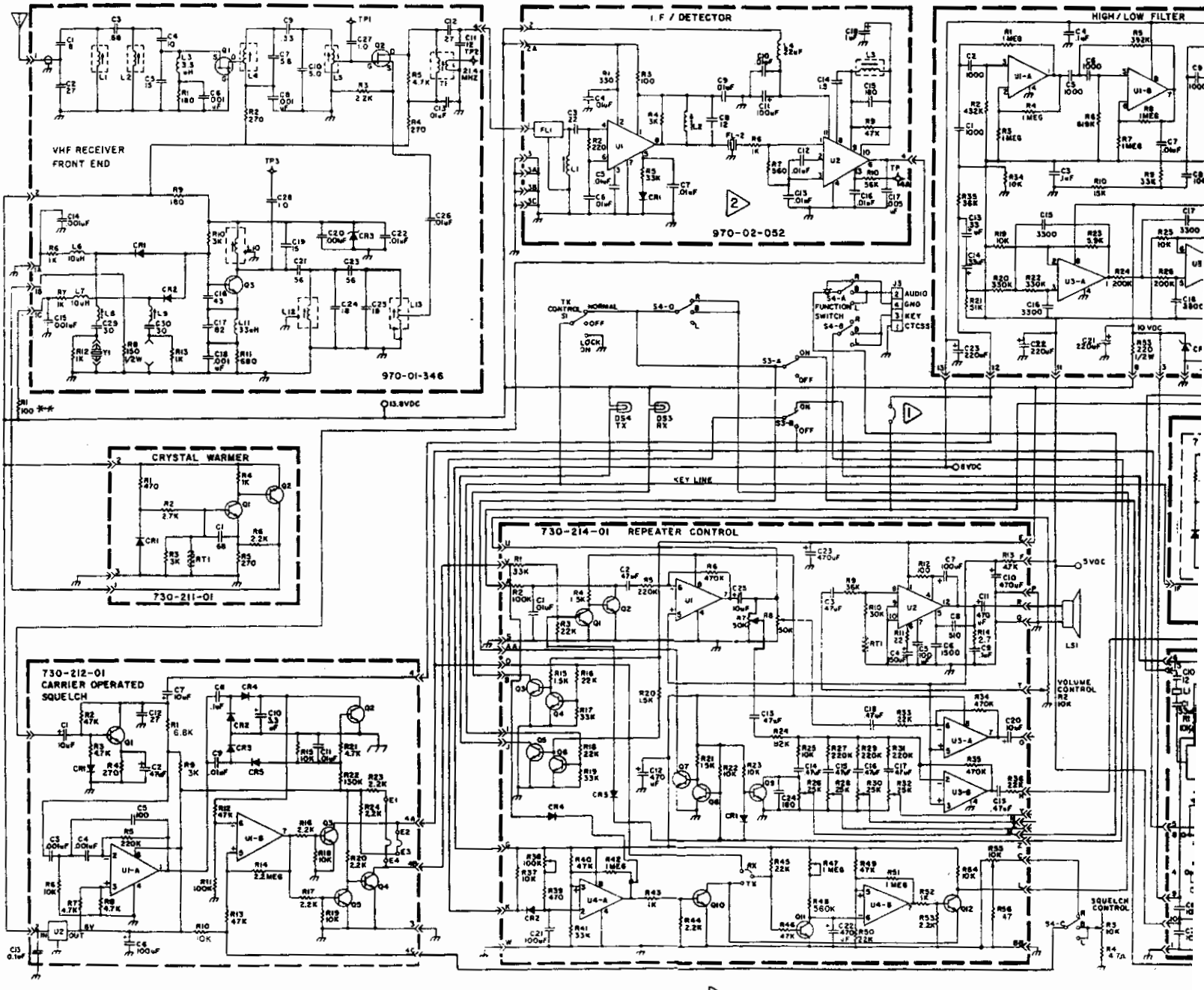
A.	Repeater Assemblies	830-250-XX 830-251-XX
	150-162 MHz 120 VAC	830-250-01
	162-174 MHz 120 VAC	830-250-02
	406-430 MHz 120 VAC	830-250-09
	450-470 MHz 120 VAC	830-250-05
	470-490 MHz 120 VAC	830-250-06
	150-162 MHz 240 VAC	830-251-01
	162-174 MHz 240 VAC	830-251-02
	406-430 MHz 240 VAC	830-251-09
	450-470 MHz 240 VAC	830-251-05
	470-490 MHz 240 VAC	830-251-06
B.	TRANSMITTER CRYSTALS	
	For 150-174 MHz VHF ($F_X = \frac{F_O \text{ MHz}}{9}$)	23-09-019
	For 406-490 MHz UHF ($F_X = \frac{F_O \text{ MHz}}{27}$)	23-10-013
C.	RECEIVER CRYSTALS (VHF & UHF) For 150-174 MHz VHF ($F_X = \frac{F_O - 21.4 \text{ MHz}}{3}$) For 450-490 MHz UHF ($F_X = \frac{F_O - 21.4 \text{ MHz}}{9}$) For 406-430 MHz ($F_X = \frac{F_O + 21.4 \text{ MHz}}{9}$)	23-09-018
	F_X = Crystal Frequency F_O = Operating Frequency	
D.	Microphone Assembly	830-025-01
E.	Overvoltage Protection Option	830-304-02

TRANSMITTER

M4	Exciter (150.8-162 MHz)	970-04-343
M4	Exciter (162-174 MHz)	970-04-353
M4	Exciter (406-430 MHz)	970-04-430
M4	Exciter (450-470 MHz)	970-04-445
M4	Exciter (470-490 MHz)	970-04-455
M5	Power Amplifier (150.8-162 MHz)	970-05-346
M5	Power Amplifier (162-174 MHz)	970-05-356
M5	Power Amplifier (406-430 MHz)	970-05-430
M5	Power Amplifier (450-470 MHz)	970-05-446
M5	Power Amplifier (450-490 MHz)	970-05-476
M5	Power Amplifier (470-490 MHz)	970-05-456
	Crystal Oven (UHF only)	730-203-01
	Heater Control Assembly(VHF only)	730-211-01
	Heat Sink Assembly	730-224-01
	Exciter Harness Board Assembly	730-215-01

RECEIVER

M1	Front End 150.8-164 MHz	970-01-346
M1	Front End 162-174 MHz	970-01-353
M1	Front End 406-430 MHz	970-01-430
M1	Front End 450-470 MHz	970-01-447
M1	Front End 470-490 MHz	970-01-457
M2	IF - Detector	970-02-057
	Carrier Operated Squelch	730-212-01
	Crystal Heater Control	730-211-01
	Receiver Box Subassembly	730-225-01

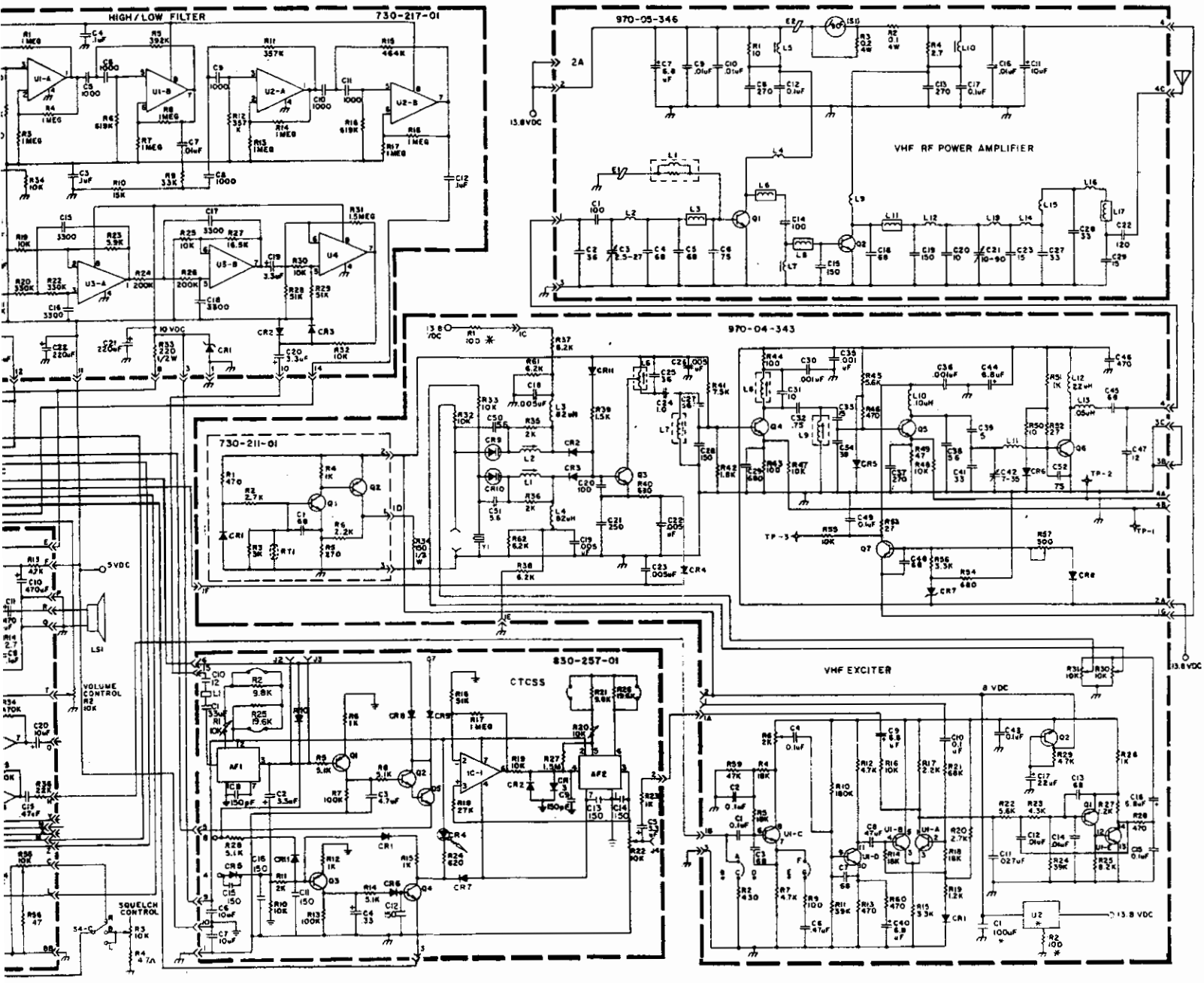


1 INSTALLED WHEN HIGH/LOW FILTER IS NOT USED.

2 ON NEWER MODELS, THIS MODULE IS REPLACED V
REFER TO PAGE 40 FOR APPROPRIATE SCHEMAT

** LOCATED ON RECEIVER HARNESS BOARD (730-213-01)

* LOCATED ON EXCITER HARNESS BOARD (730-215-01)

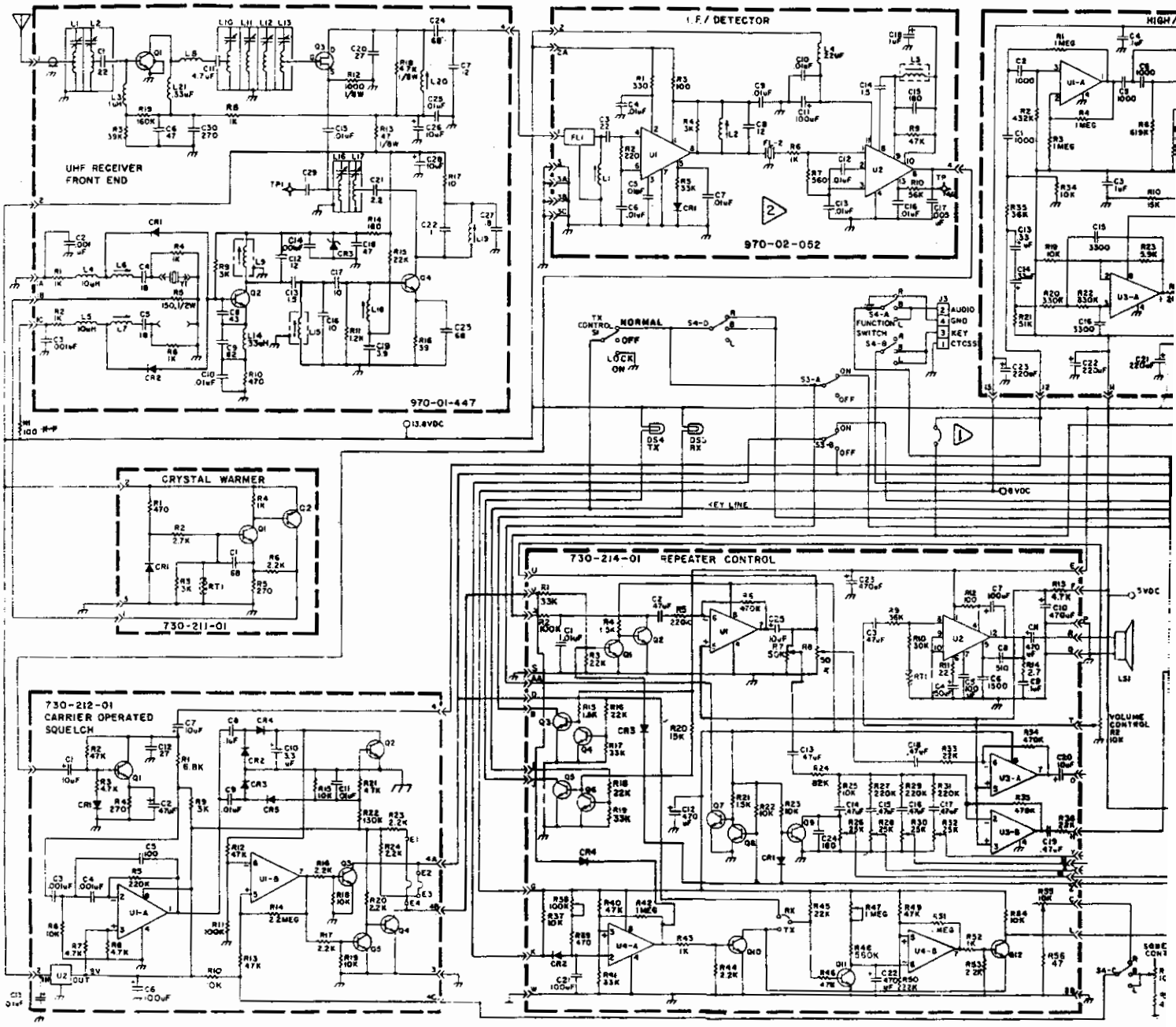


OW FILTER IS NOT USED.

G MODULE IS REPLACED WITH 970-02-057.

APPROPRIATE SCHEMATIC.

VHF REPEATER SCHEMATIC

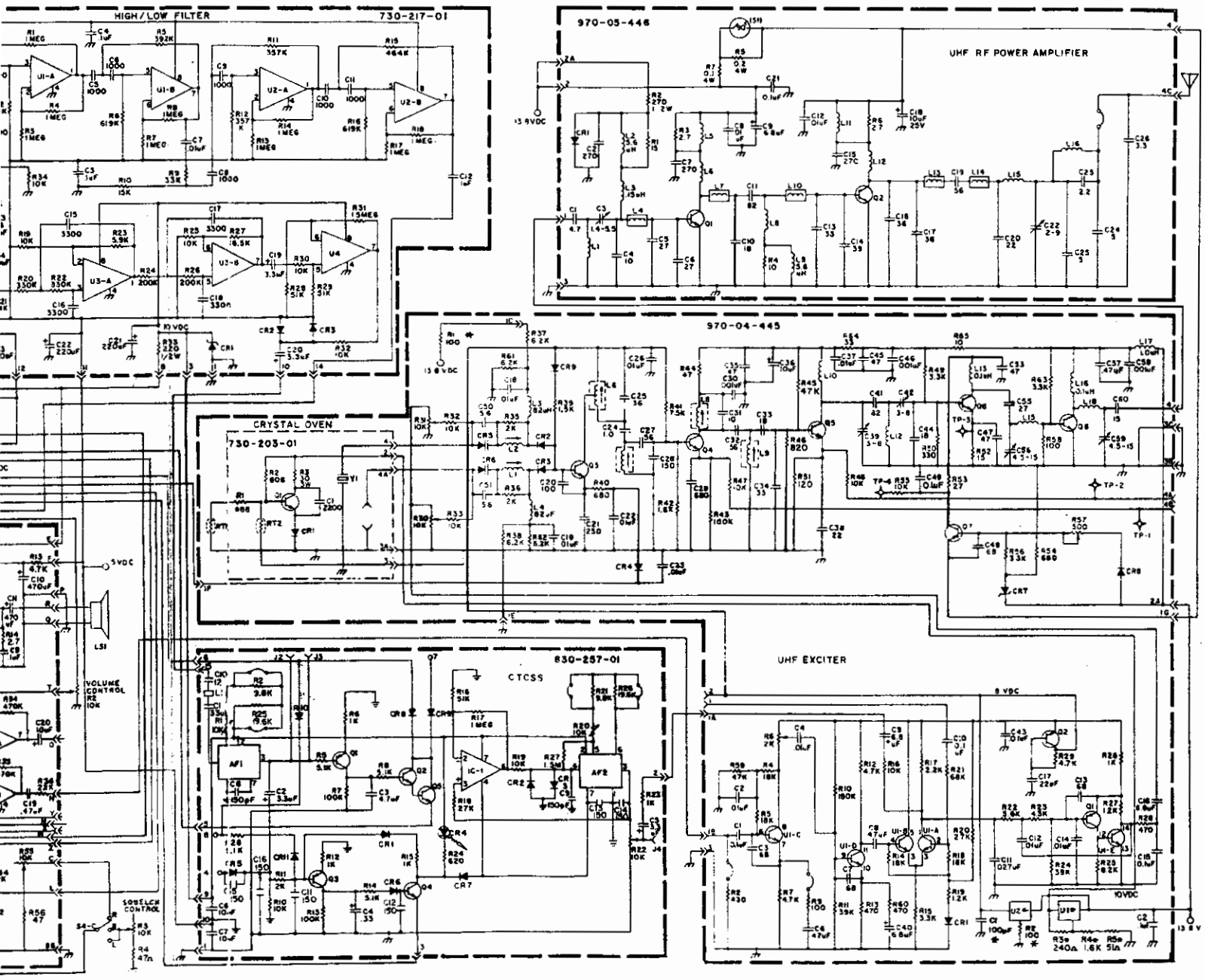


1 INSTALLED WHEN HIGH/LOW FILTER IS NOT

2 ON NEWER MODELS, THIS MODULE IS REPL
REFER TO PAGE 40 FOR APPROPRIATE SC

** LOCATED ON RECEIVER HARNESS BOARD (730-213-01)

* LOCATED ON EXCITER HARNESS BOARD (730-215-01)



/ FILTER IS NOT USED.

MODULE IS REPLACED WITH 970-02-057.
APPROPRIATE SCHEMATIC.

UHF REPEATER SCHEMATIC