MOTOROLA INC.
Communications
Sector

SAFE HANDLING OF CMOS INTEGRATED CIRCUIT DEVICES

Many of the integrated circuit devices used in communications equipment are of the CMOS (Complementary Metal Oxide Semiconductor) type. Because of their high open circuit impedance, CMOS ICs are vulnerable to damage from static charges. Care must be taken in handling, shipping, and servicing them and the assemblies in which they are used.

Even though protection devices are provided in CMOS IC inputs, the protection is effective only against overvoltage in the hundreds of volts range such as are encountered in an operating system. In a system, circuit elements distribute static charges and load the CMOS circuits, decreasing the chance of damage. *However, CMOS circuits can be damaged by improper handling of the modules even in a system.*

To avoid damage to circuits, observe the following handling, shipping, and servicing precautions.

1. Prior to and while servicing a circuit module, particularly after moving within the service area, momentarily touch *both* hands to a bare metal earth grounded surface. This will discharge any static charge which may have accumulated on the person doing the servicing.

NOTE
Wearing Conductive Wrist Strap (Motorola No. RSX-4015A) will minimize static buildup during servicing.

WARNING
When wearing Conductive Wrist Strap, be careful near sources of high voltage. The good ground provided by the wrist strap will also increase the danger of lethal shock from accidentially touching high voltage sources.

2. Whenever possible, avoid touching any electrically conductive parts of the circuit module with your hands.

3. Normally, circuit modules can be inserted or removed with power applied to the unit. However, check the INSTALLATION and MAINTENANCE sections of the manual as well as the module schematic diagram to insure there are no objections to this practice.

4. When servicing a circuit module, avoid carpeted areas, dry environments, and certain types of clothing (silk, nylon, etc.) because they contribute to static buildup.

5. All electrically powered test equipment should be grounded. *Apply* the *ground lead* from the test equipment to the circuit module *before* connecting the *test probe*. Similarly, *disconnect* the *test probe prior* to removing the *ground lead.*

6. If a circuit module is removed from the system, it is desirable to lay it on a conductive surface (such as a sheet of aluminum foil) which is connected to ground through 100k of resistance.

WARNING
If the aluminum foil is connected directly to ground, be cautious of possible electrical shock from contacting the foil at the same time as other electrical circuits.

7. When soldering, be sure the soldering iron is grounded.

8. Prior to connecting jumpers, replacing circuit components, or touching CMOS pins (if this becomes necessary in the replacement of an integrated circuit device), be sure to discharge any static buildup as described in procedure 1. Since voltage differences can exist across the human body, it is recommended that only one hand be used if it is necessary to touch pins on the CMOS device and associated board wiring.

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9. When replacing a CMOS integrated circuit device, leave the device in its metal rail container or conductive foam until it is to be inserted into the printed circuit module.

10. All low impedance test equipment (such as pulse generators, etc.) should be connected to CMOS device inputs after power is applied to the CMOS circuitry. Similarly, such low impedance equipment should be disconnected before power is turned off.

11. Replacement modules shipped separately from the factory will be packaged in a conductive material. Any modules being transported from one area to another should be wrapped in a simlar material (aluminum foil may be used). NEVER USE NON-CONDUCTIVE MATERIAL for packaging these modules.

1. INTRODUCTION

This section contains recommended test equipment lists, assembly breakdown descriptions, preventive maintenance, and instructions for operational checkout, assembly/disassembly, repairs, and troubleshooting for the *DVP MCX100* Radio. All assemblies and subassemblies are repairable to the component level except the eight hybrid assemblies. The hybrid assemblies are listed below.

- voltage controlled oscillator (VCO)
- low level amplifier (LLA)
- 10 watt power amplifier (10 W PA)
- harmonic filter/antenna switch
- 30 watt power amplifier (30 W PA)
- digital/analog converter (D/A converter) (PL/DPL models only)
- *Private-Line* or *Digital Private-Line* filter (PL filter) (PL/DPL models only)
- *DVP* Encryption Hybrid

2. TEST EQUIPMENT

2.1 REQUIRED TEST EQUIPMENT

Refer to Table 1 for recommended test equipment required for general servicing of the *DVP MCX100* Radio.

CAUTION

The poor regulation and/or transient response of many bench power supplies can apply excessive voltage to high power radios when going from the transmit to receive condition. **Avoid using these supplies or damage to the radio may result.** Such supplies can also cause improper radio operation due to loss of regulation. The following bench supplies are approved for testing the *DVP MCX100* radio:

- Motorola R1011 High Current Power Supply

CAUTION (Cont'd.)

- Motorola T1261 Transistorized 24-Volt to 12-Volt Converter driven by Motorola T1012 Power Supply
- 12-Volt automotive battery with Motorola T1012 Power Supply used as a battery charger. The power supply provides sufficient power to maintain the voltage under full load conditions, and the battery can absorb the over-voltage upon dekeying.

2.2 ADDITIONAL TEST EQUIPMENT

The equipment listed in Table 1 is sufficient to repair, adjust, and align *DVP MCX100* Radios and to verify basic performance. However, to accurately verify all radio specifications, additional test equipment or equipment with better specifications may be required. Refer to Table 2.

2.3 PROM PROGRAMMING EQUIPMENT

The PROM assemblies may be programmed in the field, as well as at the factory. To properly program PROMs for the *DVP MCX100* radio, the following equipment is necessary.

- R1801 Digital Analyzer/Controller with Reader/-Programmer
- RTL5818 Adapter Board for Frequency, PL/DPL, and *Channel Scan* PROMs
- RTL5820 Adapter Board for *Select 5* Signaling
- RTL4805 Application Program Kit for Frequency PROMs
- RTL4806 Application Program Kit for PL/DPL PROMs
- RTL4807 Application Program Kit for *Select 5* PROMs
- RTL4079 Application program Kit for *Channel Scan* PROMS

MAINTENANCE

*Table 1. Recommended Test Equipment for **DVP MCX100** Radio Servicing*

General Type	Application	Recommended Model	Minimum Specifications
AC-DC VOM	DC voltage measurements, general	Motorola T1010	Measurement range: 0-15 V dc Sensitivity: 20,000 ohms/volt
DC Multimeter	DC voltage readings requiring a high input resistance meter	Motorola S1063	Measurement range: 0-15 V dc Input resistance: 11 megohms
Distortion Analyzer	Hewlett-Packard Model 331A	Distortion and SINAD measurements	Average-responding detector
AC Voltmeter	Audio voltage measurements	Motorola S1053	Measurement range: 0-10 V ac Input resistance: 10 megohms
RF Voltmeter	RF voltage measurements	Motorola S1339	Measurement range: 100 uV-3 V from 1 MHz-512 MHz Inputs: 50-ohm and high impedance
Oscilloscope	Waveform observation	Motorola R1004	Vertical sensitivity: 5 mV-10 V/division Horizontal time base: 0.2 usec. — 0.5 sec/division
RF Wattmeter	Transmitter output power measurement	Motorola S1350 with appropriate element and T1013 RF Dummy Load	Measurement range: 0-250 Watts
Frequency/Deviation Meter	Transmit frequency and deviation modulation measurement	Motorola R2001 Communications System Analyzer with high stability oscillator (HS suffix). Frequency calibration recommended every 6 months or less.	Measurement range: 134-174 MHz 100 Hz Resolution 0-100 kHz Deviation
RF Signal Generator	Receiver alignment and troubleshooting	Motorola R-2001 Communications System Analyzer	Measurement Range: 134-174 MHz 100 Hz Resolution Output Level: 1 uV to 1 V rms
PL Tone Generator*	Tone Coded *Private-Line* decoder troubleshooting	Motorola R-2001 Communications System Analyzer or Motorola R-1100 Code Synthesizer (Single stand-alone instrument)	Frequency range: 50 Hz - 9.999 kHz Output Level: 0-3 V rms
Audio Signal Generator	Audio circuit troubleshooting	Motorola S1067	Frequency range: 20 Hz-20 kHz Output level: 50 mV-1 V
DPL Test Set**	*Digital Private-Line* encoder-decoder troubleshooting	Motorola SLN6413	
Speaker/Load	Receiver alignment and measurement	TSN6031 Speaker Kit with RPX4134 Modification Kit	
Tuning Tool Kit	Receiver and transmitter alignment	Motorola TRN4671	
DC Power Supply	DC power for shop service	Motorola R1011	1-20 V dc 0-40 A
Front Panel Extender	Troubleshooting	Motorola RTK4036	
DVP Test Set	*DVP* Troubleshooting	Motorola R1012	

*Required for tone-coded *Private-Line* models only
**Required for *Digital Private-Line* models only

NOTE

All test equipment with the exception of the DPL test set, tuning tool kit, dc power supply, *DVP* test set, and front panel extender, may be replaced by the Motorola R2001 Communications System Analyzer.

Table 2. Additional Test Equipment

General Type	Recommended Model	Application	Minimum Specifications
Low Noise RF signal generators (2 required)	Hewlett-Packard Model 8640B with option H60, "Low Single Sideband Noise"	Receiver Intermodulation and Adjacent-Channel Selectivity measurements	SSB noise 142 dB/ Hz below carrier (20 kHz offset 1 Hz bandwidth)
Broadband Signal Combiner, 50 ohm	Anzac T-1000	Receiver Intermodulation and Adjacent-Channel Selectivity measurements	25 dB minimum isolation
Three-port resistive combiner, 50 ohm	Measurements M501 or equivalent	Three-generator Intermodulation measurements	
Psophometer	Hewlett-Packard Model 3556A	CEPT method SINAD measurements	
Spectrum Analyzer	Hewlett-Packard Model 141T Mainframe with 8554L and 8552A Heads	Transmitter spurs and harmonics	60 dB (minimum) dynamic range (30 kHz bandwidth); storage and/or manual scan capability are desirable.
20 dB thruline pad, 50 ohms		Transmitter spurs and harmonics	35 watt minimum continuous power rating
10 dB thruline pad, 50 ohms		Transmitter spurs and harmonics	
Tunable notch filter, 50 ohms		Transmitter spurs and harmonics	30 dB minimum notch depth, tunable 136-174 MHz

Refer to the manuals provided with the above equipment for programming procedures.

3. DESCRIPTIONS

3.1 CONSTRUCTION AND ACCESSIBILITY

3.1.1 The *DVP MCX100* Radio is semi-modular. It is constructed and housed in a durable cast metal chassis with separate top and bottom covers. The front panel of the radio set housing contains all operating controls and indicators (front mount models). In remote mount radios, all controls and indicators are located in the control head. The rear of the front mount radio chassis contains the connectors for dc power input, microphone, speaker, antenna, and selected accessories. The rear of the remote mount radio chassis contains connectors for the dc input power, speaker, and antenna. A microphone may be installed at the rear of the radio in place of the control head microphone. This is offered as an option (alternate microphone location). The connector for the control cable is on the front of the remote mount chassis. High power models (30 watt) have a heat sink on the back of the chassis for power amplifier cooling.

3.1.2 The radio set is designed to make most assemblies readily accessible by removing the top cover, bottom cover, synthesizer cover, and PA shield. Refer to Figures 1 and 2. The assemblies for the radio set are listed below.

- main board
- option board (if used)
- external heat sink
- power amplifier interconnect board
- frequency synthesizer (consists of synthesizer board and VCO hybrid)
- 30 watt power amplifier
- front end (single or dual) (mounted on main board) (single front end shown)
- *DVP* Encryption Board
- *DVP* Interface Board

3.1.3 Access to additional assemblies is made possible by removal of the front panel assembly, and the main board. Refer to Figure 3. The assemblies shown in Figure 3 are listed below.

- front panel interconnect board
- switch board
- display board
- power interconnect board
- *DVP* Encryption Board
- *DVP* Interface Board

An assembly not shown is the remote interface board, for remote mount units only. This board is housed in a metal casting which mounts to the front of the chassis assembly, in place of the front panel assembly used in front mount units.

3.2 POWER AMPLIFIER (PA) INTERCONNECT BOARD

The PA interconnect board provides physical mounting and electrical interconnection of:

- the low level amplifier hybrid,
- the 10 watt power amplifier hybrid, and
- the harmonic filter/antenna switch hybrid.

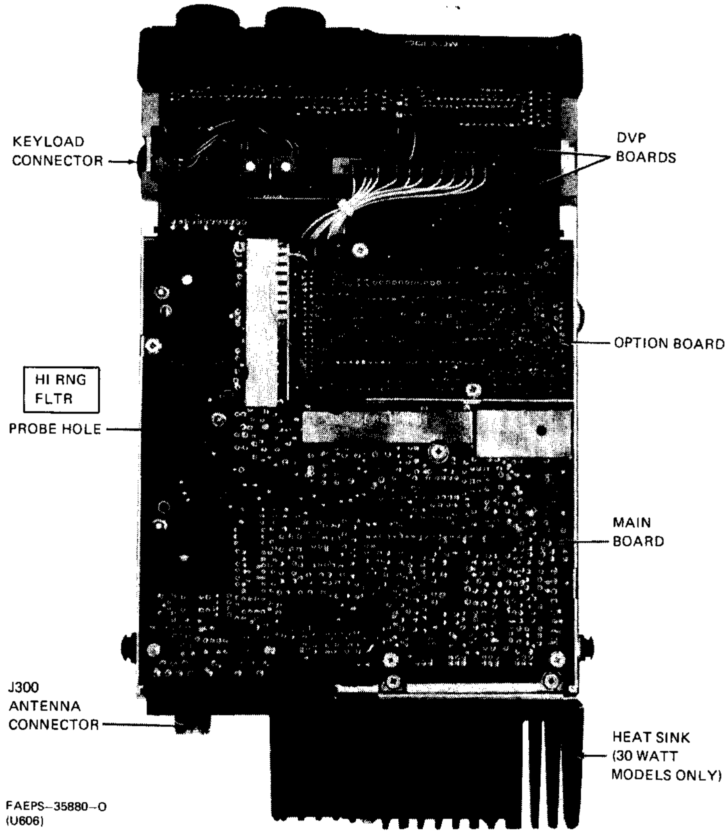

Figure 1. DVP MCX100 Radio Set-Top Cover Removed

The PA interconnect board is located on the bottom of the chassis, adjacent to the rear wall. All transmitter circuits except push-to-talk logic (PTT), transmit audio/instantaneous deviation control (IDC), and transmit power and level control are located on these hybrids.

3.3 EXTERNAL HEAT SINK
(Refer to Figure 1)

The external heat sink is used only with the 30 watt models. The heat sink is attached to the rear of the radio set chassis, and houses the 30 watt power amplifier hybrid.

3.4 30 WATT POWER AMPLIFIER
(Refer to Figure 2)

The 30 watt power amplifier hybrid is used with 30 watt models only. The amplifier is mounted inside the external heat sink and is accessed by removing the bottom cover of the heat sink.

3.5 FREQUENCY SYNTHESIZER

3.5.1 The standard lock frequency synthesizer consists of two assemblies: the synthesizer board and the VCO. The two assemblies are located side by side on the bottom of the radio set and are accessed by removing the synthesizer cover. The synthesizer board contains:

- A reference oscillator,
- Frequency selection logic circuits,
- The frequency select PROM, and
- Miscellaneous buffering, filtering, and control circuitry.

The VCO hybrid assembly contains:

- The voltage controlled oscillator circuit,
- Buffer,
- Range shift circuitry, and
- Varactor diodes, which produce frequency modulation of the VCO.

3.5.2 The *Fast-Lok* synthesizer consists of the two assemblies previously described for the standard lock frequency synthesizer and an rf synthesizer amplifier board. The synthesizer rf amplifier board is visible and accessible only after the synthesizer board is removed. The synthesizer rf amplifier board contains:

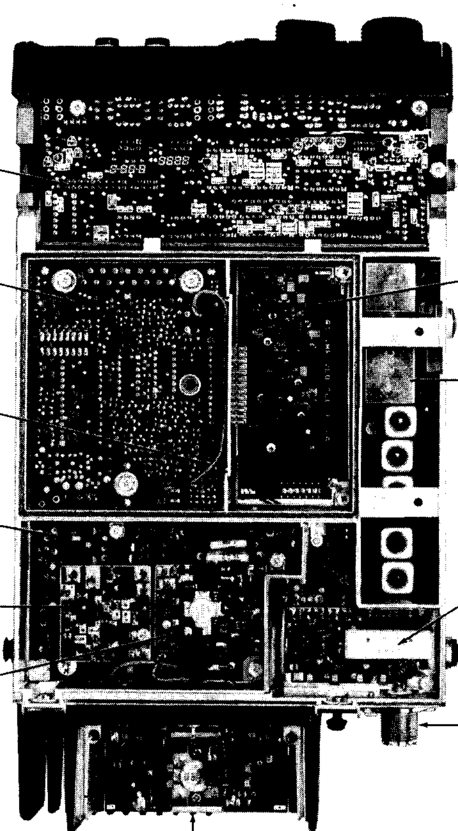

Figure 2. DVP MCX100 Radio Set-Bottom Cover Removed

- the output rf amplifier/buffer,
- the transmit/receive injection switch, and
- the injection switch driver circuitry.

3.6 MAIN BOARD
(Refer to Figure 1)

The main board is located on the top of the radio set in the rear and to the left. The main board contains receiver circuits, voltage regulation circuits, and the following transmitter circuits:

- portions of the push-to-talk logic,
- transmit audio/IDC, and
- transmit power and level control.

3.7 FRONT PANEL INTERCONNECT BOARD
(Refer to Figure 3)

The front panel interconnect board provides for the connections between the *DVP* encryption board, power interconnect board, synthesizer board, and main board. The front panel interconnect board is located in a slot at the front of the radio chassis accessable by removing the front panel casting and the *DVP* circuit module.

NOTE

In remote mount models, the front panel casting is replaced by the remote mount interface casting which contains the remote interface board. The remote interface board plugs into the *DVP* encryption board when the remote mount interface casting is mounted to the front of the radio.

3.8 DISPLAY BOARD
(Refer to Figure 3)

The display board contains visual indicators, and is mounted vertically in the front of the front panel casting (front mount models only).

NOTE

In remote mount models, the display board is located in the control head.

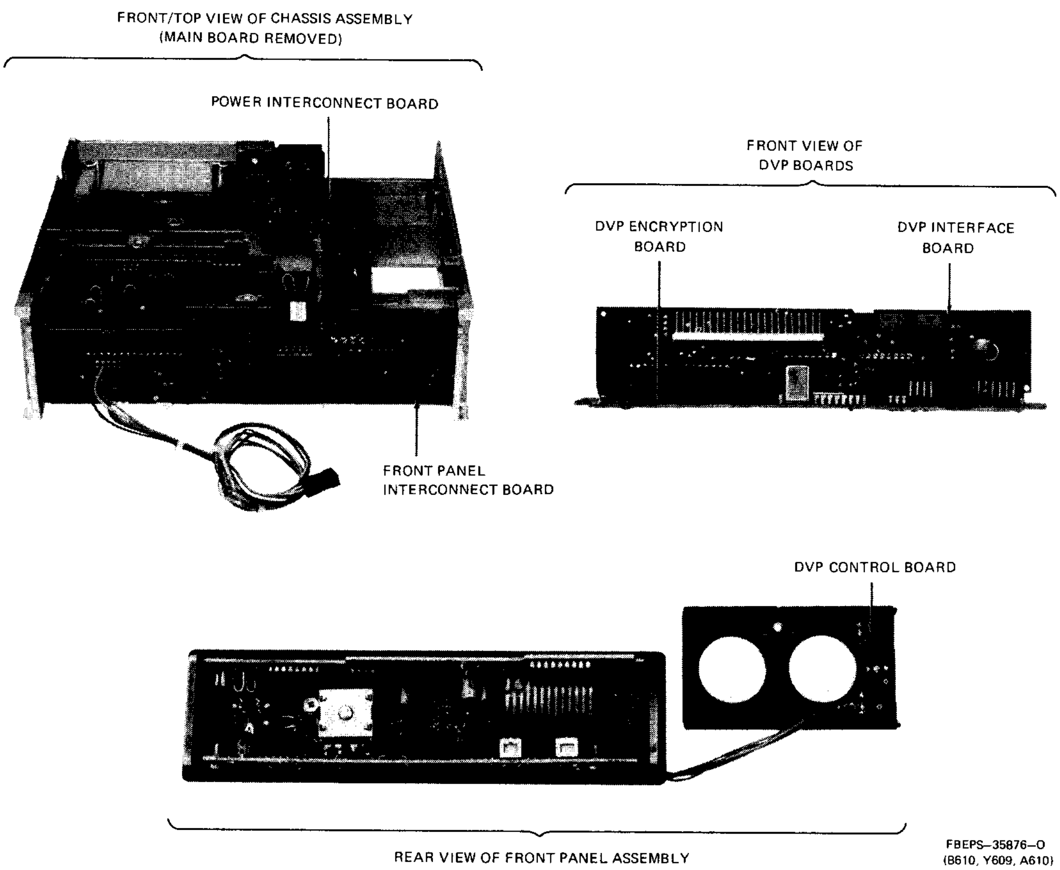

Figure 3. Chassis, DVP Circuitry, and Front Panel Assemblies

3.9 SWITCH BOARD
(Refer to Figure 3)

The switch board contains operating controls and switches and is mounted horizontally at the bottom of the front panel casting (front mount models only.)

NOTE

In remote mount models, the switch board is located in the control head.

3.10 POWER INTERCONNECT BOARD
(Refer to Figure 3)

The power interconnect board provides power distribution for the radio. This board is located below the main board and to the rear of the front panel interconnect board.

3.11 FRONT END
(Refer to Figure 2)

The front end contains the rf amplifier, mixer, and tuned filters which provide selectivity. The front end is attached to the main board. A single front end board (standard) or a dual front end casting (optional) are provided with each radio model.

3.12 OPTION BOARDS

Some models may contain one or two of the following option boards:

- PL encoder/decoder with time-out timer,
- Time-out timer,
- *Select 5* Single Board,
- *Select 5* Double Board, or
- *Channel-Scan* monitor.

Option boards are mounted in the option area located on the top of the radio in front of the main board as shown in Figure 1.

3.13 *DVP* INTERFACE BOARD AND *DVP* ENCRYPTION BOARD
(Refer to Figure 1)

The *DVP* encryption board is mounted horizontally between the front panel interconnect board and the switch board. The *DVP* interface board is mounted vertically on the top side of the *DVP* encryption board. The *DVP* interface board and the *DVP* encryption board perform the following functions:

- encoding of clear audio for transmission,
- decoding of encrypted received audio,
- portions of the push-to-talk logic, and
- radio muting logic.

The *DVP* encryption board also provides for the feed-thru of signals between the switch board and the fromt panel inteconnect board.

3.14 *DVP* CONTROL BOARD
(Refer to Figure 3)

The *DVP* control board provides visual indicators and operating controls for use with *DVP* circuitry. This board is heat-staked to the front panel of the radio.

4. MODEL, NOMENCLATURE, AND OPTION DATA

To determine the options, kits, assemblies, and subassemblies contained in various models, refer to the model breakdown charts and parts lists in this manual.

5. PREVENTIVE MAINTENANCE

5.1 INITIAL CHECKS

5.1.1 It is recommended that the transmitter channel frequencies be checked and the reference oscillator adjusted, if necessary, after the first, third, seventh, and twelfth months, and yearly thereafter. This compensates for crystal aging. If the reference oscillator crystal (or channel element) is replaced, the above schedule should be repeated for the first year.

5.1.2 At initial installation and yearly thereafter, perform the power output and the EIA modulation sensitivity transmitter tests and the 12 dB EIA SINAD and squelch sensitivity receiver tests using the procedures in this section.

5.1.3 Record these readings each time they are made and compare them with previous readings to detect possible deterioration.

5.1.4 If it is determined that adjustments or alignment is required, refer to the appropriate procedures in this manual.

5.2 ROUTINE CHECKS

Step 1. Check all controls for freedom of movement.

Step 2. Check all connectors and cables for fraying, loose connections, and bent pins.

Step 3. Remove all dust and dirt with a lint-free cloth and a non-abrasive cleaner.

Step 4. Verify proper dc input voltage.

Step 5. Check transmitter frequency, deviation, and power output periodically or as required by law, using the procedures in this section.

Step 6. Verify that front panel display indicates selected channel.

Step 7. Verify that all controls operate as specified in the owners manual.

6. MINIMUM PERFORMANCE VERIFICATION

6.1 TEST SETUP

Prior to troubleshooting or performing maintenance, connect radio set as illustrated in the test setup diagrams in Figures 4, 5, and 6, as applicable. Refer to the Owners Manual for general operating instructions.

NOTE

Unless otherwise specified, all tests are performed at 25 ± 2° C, using a power supply voltage of 13.8 V dc for 10 watt models and 13.6 V dc for 30 watt models.

6.2 PRELIMINARY PROCEDURE

After ensuring proper test setup, perform the following procedure.

Step 1. Verify proper input voltage.

Step 2. Turn Off-on/Volume switch to the on position.

Step 3. Verify that channel indicators illuminate.

6.3 PRELIMINARY RECEIVER TEST

NOTE

Test 6.3.1 through 6.3.4 are performed in the clear mode. Test 6.3.5 through 6.3.7 are performed in the coded mode.

6.3.1 20 dB Quieting Sensitivity Test

Step 1. Ensure that no rf input is present.

Step 2. Set Off-on/Volume control for 1 V rms noise at 2 ohm speaker/or load. This is the 0 dB reference level.

MAINTENANCE

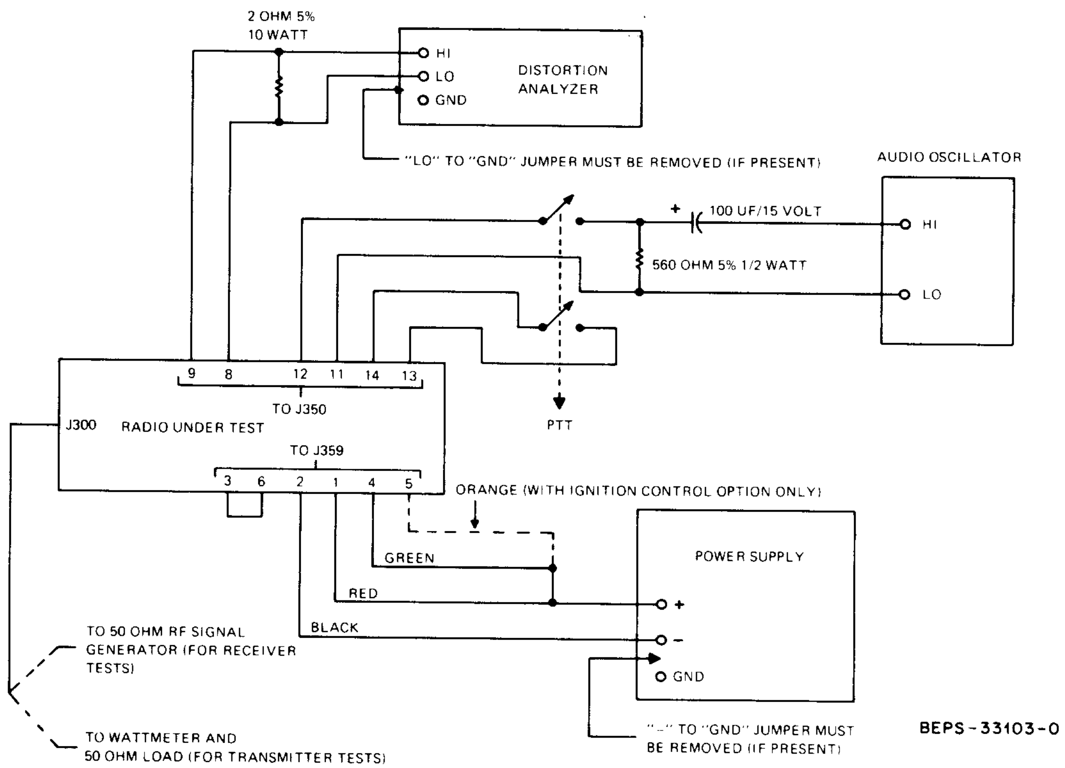

Figure 4. Bench Test Setup for DVP MCX100 Front-Mount Radios

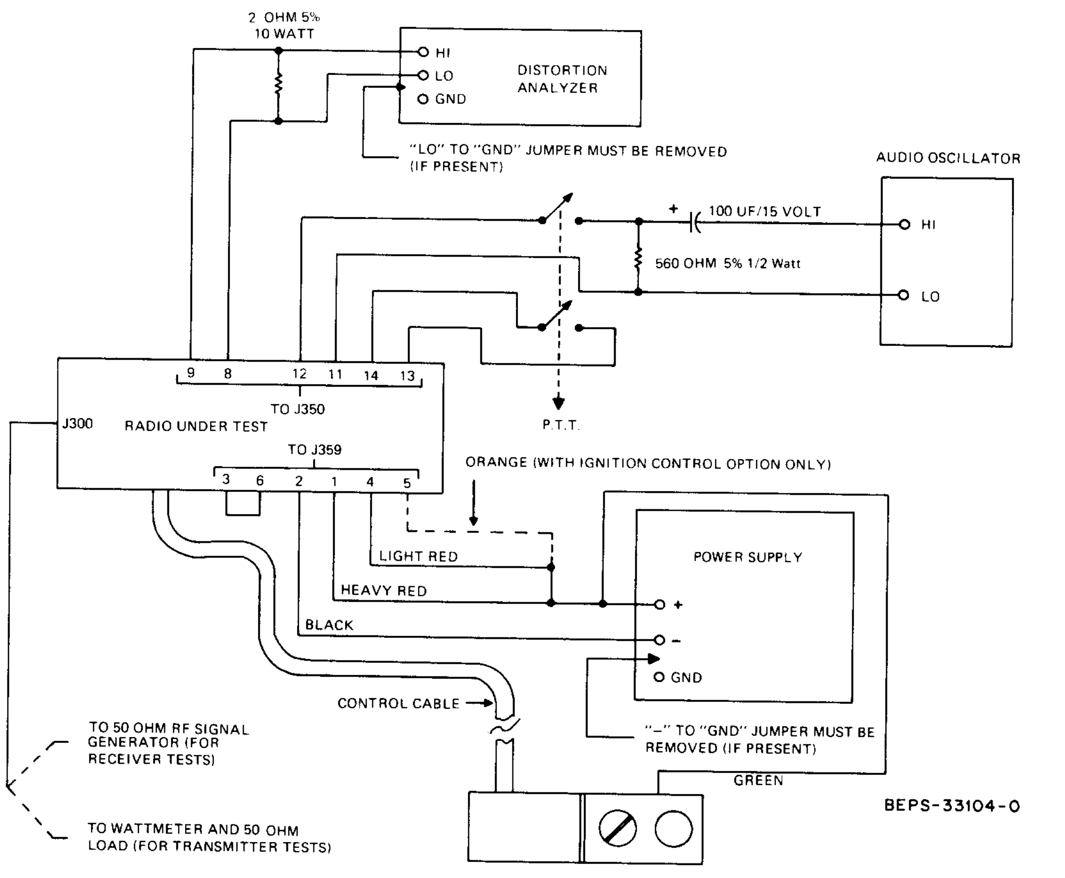

Figure 5. Bench Test Setup for DVP MCX100 Remote-Mount Radios

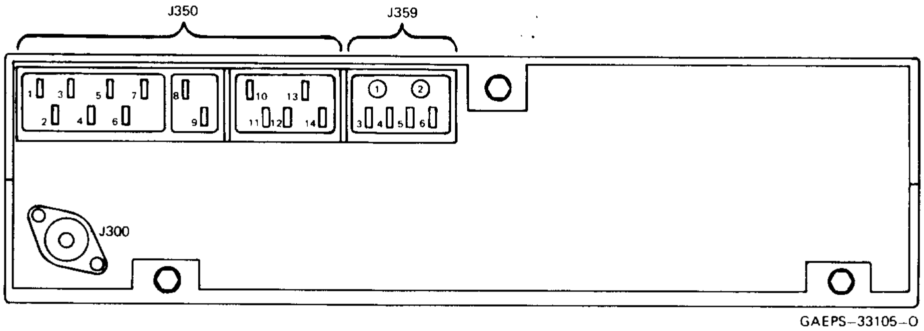

Figure 6. Pin Number Identification (Rear View of DVP MCX100 Radio)

Step 3. Increase on-channel generator level until noise level is decreased by 20 dB. Note generator rf level; should be 0.35 uV maximum (all channels).

6.3.2 12 dB EIA SINAD Test

Step 1. Apply on-channel 1 mV rf signal, modulated with 1kHz at 60% of full system deviation.

Step 2. Adjust Off-on/Volume control for 5 watts output (3.16 V rms at 2 ohm load).

Step 3. Note the difference between levels at the 2 ohm load when a 1 kHz bandstop filter is switched into and out of the distortion analyzer circuit.

Step 4. Reduce the generator rf level until the difference noted in Step 3 is 12 dB (12 dB SINAD is obtained). Generator rf level should be 0.28 uV maximum on all channels.

NOTE

Local government or industry standards may refer to this test as the SND/ND test and may require the use of a psophometric weighting network. Refer to local specifications or regulations.

6.3.3 Squelch Opening Sensitivity Test

Step 1. Ensure that there is no rf input.

Step 2. Adjust Off-on/Volume control for 1 V rms of noise across the 2 ohm load (0 dB reference).

Step 3. Place the squelch defeat pushbutton (Ⓠ) in the out position (white collar showing).

Step 4. Increase unmodulated rf generator level slowly until speaker just remains unmuted.

Step 5. Verify that the amount of noise quieting is between 9 and 11 dB for all channels.

6.3.4 Busy Light Sensitivity Test (7000-9000 Series Models Only)

Step 1. Ensure that there is no rf input.

Step 2. Adjust Off-on/Volume control for 1.0 volts rms of noise across the 2 ohm load (0 dB reference).

Step 3. Apply an on-channel, unmodulated rf signal, slowly increasing the level until the front panel Busy Light indicator (orange LED) just illuminates.

Step 4. Verify that the amount of noise quieting is at least 20 dB and no greater than 26 dB.

6.3.5 *DVP* Harmonic Distortion

Step 1. Using a R1012 *DVP* test set, program the radio under test with a key.

Step 2. With the R1012 encoder on 1 kHz, modulate an rf generator with the encode output of the R1012. Deviation should be set for 4 kHz peak. RF level should be set to 1 mV.

Step 3. Adjust Off/on Volume control on the radio for 3.16 V rms across a 2 ohm load.

Step 4. Measure the total harmonic distortion. 5% is typical while 6% is the maximum limit (see note).

6.3.6 *DVP* EOM

Step 1. Perform Steps 1 and 2 of test 6.3.5.

Step 2. Make sure that the squelch button is out (white collar showing).

Step 3. At this time you should hear a 1 kHz tone from the radio (see note). Pressing the EOM button on the R1012 to "Burst" and releasing it should result in momentary quieting at the radio speaker.

NOTE

Many RF generators are in use which have insufficient low frequency response for testing *DVP* radios. This may result in bit errors at the receiving radio. If bit errors occur a "popping" or "clicking" sound will be heard at the test radio speaker. Note that when a bit error occurs the harmonic distortion will be very high.

6.3.7 *DVP* Receive Mode Indicator

Step 1. Perform Steps 1 and 2 of test 6.3.5.

Step 2. The yellow receive coded mode indicator should be illuminated.

Step 3. Turn the rf generator off. The indicator light should go off after approximately 1 second.

6.4 SECONDARY RECEIVER TESTS

NOTE

Secondary receiver tests are performed in the clear mode.

6.4.1 Audio Power Output and Distortion

Step 1. Apply on-channel 1 mV rf signal modulated with 1 kHz at 60% of full system deviation.

Step 2. Adjust Off-on/Volume control for 3.16 V rms across 2 ohm load.

Step 3. Measure total harmonic distortion. The maximum limit for total harmonic distortion is 3 percent.

6.4.2 Modulation Acceptance Bandwidth

Step 1. Apply on-channel signal at 1 mV modulated with 1 kHz at 60% of full system deviation.

Step 2. Adjust Off-on/Volume control for 0.5 watts (1 V rms across 2 ohm load).

Step 3. Reduce generator rf level until 12 dB SINAD is obtained.

Step 4. Increase generator rf level by 6 dB and increase deviation until 12 dB SINAD is again obtained.

Step 5. The deviation level corresponds to the modulation acceptance bandwidth which must be equal to or greater than 7 kHz.

6.4.3 Receiver Spurious Response Rejection

Step 1. Connect two signal generators to the receiver input with a broadband signal combiner.

Step 2. Apply an on-channel rf signal having 1 kHz modulation at 60% of full system deviation, with the rf level adjusted to produce 12 dB SINAD at a reference audio output level of 3.16 V rms across the 2 ohm load.

Step 3. Adjust the second signal generator to generate an "undesired" signal. The undesired signal should include the following:

- Image frequency (42.8 MHz below receiver frequency),
- Half i-f (10.7 MHz below the receive frequency), and
- i-f (21.4 MHz).

Step 4. Modulate the undesired signal with 400 Hz at 60% of full system deviation. Adjust the rf level of the generator until the level is 85 dB above the level of desired signal generator output.

Step 5. Vary the frequency of the undesired-signal generator between 500 kHz and 1000 MHz.

Step 6. Note any frequency at which a spurious response is noted (other than frequencies within one channel separation from the desired receiver).

Step 7. Adjust the rf level of the undesired-signal generator (at the frequency of the spurious response) to degrade the 12 dB SINAD level to 6 dB SINAD. The difference between the two generator levels should be greater than or equal to 85 dB.

NOTE

Spurious responses should be checked on all channels for all three of the following types of undesired signals: image frequency, half i-f, i-f.

6.4.4 Adjacent Channel Selectivity Test (EIA Method)

Step 1. Connect two generators to the receiver antenna input using a broadband signal combiner.

Step 2. Adjust generator 1 to provide an on-channel signal, with generator 2 rf output level at zero.

Step 3. Modulate the on-channel signal with 1 kHz at 60% of full system deviation at an rf level that produces 12 dB SINAD. Audio reference across 2 ohm load should be 3.16 V rms.

Step 4. Adjust generator 2 for the frequency of the adjacent channel, modulated with 400 Hz at 60% of full system deviation.

NOTE

The adjacent channel is one channel spacing above or below the on-channel receive frequency.

Step 5. Increase the rf level of generator 2 until the 12 dB SINAD level is degraded to 6 dB SINAD.

Step 6. Measure the output level of both rf generators. The difference between the two levels should be:

- 85 dB minimum for units with 25 kHz channel spacing.
- 90 dB minimum for units with 30 kHz channel spacing.

NOTE

For correct measurements, generator 2 must have very low sideband noise.

6.4.5 Receiver Intermodulation Attenuation Test

Step 1. Connect two signal generators to the receive antenna input using a broadband signal combiner.

Step 2. Set generator 2 rf output level to zero.

Step 3. Adjust generator 1 for an on-channel signal, modulated with 1 kHz at 60% of full system deviation.

Step 4. Adjust the rf level of generator 1 to obtain 12 dB SINAD (audio output reference level should be 3.16 V rms across a 2 ohm load).

Step 5. Record the rf level of generator 1.

Step 6. Tune generator 1 to a frequency above the channel frequency by an amount equal to TWICE the channel spacing for the unit being tested.

Step 7. Tune generator 2 to a frequency above the channel frequency by an amount EQUAL to the channel spacing for the unit being tested.

Step 8. Adjust the output level of generator 2 to the same level as recorded previously for generator 1. Generator 2 should be unmodulated.

Step 9. Simultaneously increase the rf levels of both generators until 12 dB SINAD is obtained again.

Step 10. Calculate the difference in dB between the rf levels of either generator and the level recorded for generator 1 in Step 5.

Step 11. Repeat the above procedure with both generators tuned below the channel frequency instead of above it.

Note that the difference calculated in Step 10 should be greater than or equal to 80.

NOTE

For correct measurements, generator 2 must have very low sideband noise.

6.5 PRIMARY TRANSMITTER TESTS

NOTE

Primary Transmitter tests 6.5.1 through 6.5.3 are performed in the clear mode. Primary Transmitter tests 6.5.4 through 6.5.6 are performed in the coded mode.

6.5.1 Transmitter RF Power Output

Step 1. Refer to Table 3 and find the power set level which corresponds to the power rating of the unit being checked.

Table 3. Power Set Levels

Power Rating (Watts)	Power Set Level (Watts)	Supply Voltage (Volts)
10.0	10.5 min.	13.80
30.0	31.0 min.	13.60

Step 2. Measure the transmitter rf output power on each channel. The power output should not be less than the level listed.

Step 3. Ensure that the supply voltage level is adjusted to the level shown in Table 3.

6.5.2 Transmitter Frequency

Step 1. Couple the transmitter RF output to the input of a frequency counter or service monitor using appropriate attenuation.

Step 2. Measure the transmitter frequency on each channel.

Step 3. The measured frequency on any channel should be within ±200 Hz of the specified customer frequency for that channel.

6.5.3 EIA Modulation Sensitivity Test

Step 1. Apply a 1 kHz signal to the microphone audio input and key the transmitter.

CAUTION

An antenna or suitable rf load should be connected to the antenna connector.

Step 2. Observe the modulation on an oscilloscope connected to the output of a standard test receiver (with no de-emphasis).

Step 3. Adjust the audio oscillator until the peak-to-peak amplitude of the waveform is 60% of full system deviation.

Step 4. Measure the oscillator level at the microphone audio input while the transmitter is still being keyed. The audio input should be between 55 mV rms and 105 mV rms.

6.5.4 *DVP* Transmit

Step 1. Using a R1012 *DVP* test set, program the radio under test with a key.

Step 2. Connect the modulation output of a standard test receiver to the decode input of the R1012.

Step 3. Connect a suitable rf load to the test radio.

Step 4. Using the radio microphone talk into the test radio while transmitting in the coded mode. You should hear the microphone audio at the R1012 speaker.

NOTE

Many test receivers have sufficient low frequency response for testing *DVP* radios. This may result in bit errors at the receiving R1012. These bit errors will cause a "popping" or "clicking" sound from the R1012 speaker.

6.5.5 *DVP* EOM

Step 1. Repeat Steps 1,2 and 3 of 6.5.4.

Step 2. Using the radio microphone transmit with the test radio in coded mode. Upon dekeying the test radio the EOM indicator on the R1012 should momentarily be illuminated.

6.5.6 *DVP* Alert Tone

Step 1. Place the radio in the transmit clear mode.

Step 2. Connect a suitable rf load to the test radio.

Step 3. Transmit with the test radio. At the beginning of each transmission you should hear a 750 Hz tone from the speaker of the test radio (alert tone).

6.6 SECONDARY TRANSMITTER TESTS

NOTE

The secondary transmitter tests are performed in the clear mode.

6.6.1 Spurious and Harmonic Attenuation

Step 1. Connect the transmitter output to a spectrum analyzer through a suitable attenuator and establish a 0 dB reference. Recommended analyzer settings: 30 kHz bandwidth, 1 MHz/div scan width, and 10 kHz video filter.

Step 2. Insert a notch filter tuned to the carrier frequency between the analyzer and the attenuator. the notch filter should be capable of at least 30 dB attenuation of the carrier frequency.

Step 3. Reduce the spectrum analyzer attenuation so that responses of -90 dB can be observed. Note the frequency and vertical position of a spurious or harmonic response.

Step 4. Disconnect the transmitter from the analyzer. Connect an rf signal generator to the analyzer.

Step 5. Adjust the rf signal generator for the frequency and output level necessary to product a response identical to the one notes in Step 3.

Step 6. Note the level of the rf generator. For 10 watt radios the maximum allowable level is -80 dBc. For 30 watt radios the maximum allowable level is -85 dBc.

Step 7. Repeat Steps 4 through 6 for all spurious and harmonic responses.

6.6.2 Modulation Limiting Characteristics

Step 1. Connect an audio oscillator to the microphone audio input. Adjust the oscillator output level (while the transmitter is keyed) to 1.2 V rms.

CAUTION

An antenna or suitable rf load should be connected to the antenna connector.

Step 2. Connect an oscilloscope to the output of a standard test receiver (with no de-emphasis).

Step 3. Vary the frequency of the oscillator between 300 and 3000 Hz while maintaining the output level given in Step 1. Observe the deviation on the oscilloscope while the frequency is varied. The deviation should be between 70% and 100% of full system deviation (5 kHz).

NOTE

The peak-deviation frequency is typically 2700 Hz for models with a full system deviation of 5 kHz.

NOTE

When performing the following tests (6.6.3 through 6.6.5) on PL/DPL model radios, it will be necessary to inhibit transmission of the PL tone or DPL code to obtain correct results. This can be done by selecting a non-PL/DPL channel (multiple PL/DPL models) or by removing J377 from P377 on the PL/DPL board while performing these tests.

6.6.3 Transmitter Hum and Noise

Step 1. Connect an audio oscillator to the microphone audio input. Adjust the oscillator to provide 1 kHz modulation at 60% of full system deviation.

Step 2. Connect an ac voltmeter to the deemphasized output of a standard test receiver. Note the meter reading.

Step 3. Disconnect or switch off the audio oscillator and note the meter reading. The reading should be no higher than 50 dB below that measured in the previous step.

6.6.4 Transmitter Audio Frequency Response

Step 1. Connect an audio oscillator to the microphone audio input. Adjust the oscillator output level while the transmitter is keyed to 50 mV rms.

CAUTION
An antenna or suitable rf load should be connected to the antenna connector.

Step 2. Connect an ac voltmeter to the output of a standard test receiver (with no de-emphasis). Use 1000 Hz as the 0 dB reference.

Step 3. Vary the frequency of the oscillator between 300 and 3000 Hz while maintaining the oscillator output level given in Step 1. Observe the level on the voltmeter while the frequency is varied. The meter readings should not deviate by more than +1/−1.5 dB from the typical 6 dB per octave preemphasis characteristic between the frequencies of 400 and 2700 Hz. The meter readings should not deviate by more than +1/−3 dB from the typical 6 dB per octave preemphasis characteristic between the frequencies of 300 and 400 Hz and between the frequencies of 2700 and 3000 Hz.

6.6.5 Transmitter Distortion

Step 1. Connect a distortion analyzer to the deemphasized output of a standard test receiver.

Step 2. Modulate the transmitter with a 1000 Hz tone at 60% of full system deviation.

Step 3. Measure the total harmonic distortion.

The total harmonic distortion should not exceed 3%.

NOTE
Reconnect J/P 377 if this was unplugged prior to the above tests.

7. ASSEMBLY, REMOVAL AND REPLACEMENT

7.1 GENERAL

7.1.1 Refer to the *DVP MCX100* Exploded Views and Mechanical Parts Lists drawing in this manual. The radio set exploded view shows attachment of assemblies to the chassis. Many of the assemblies may be removed/replaced by carefully disconnecting/connecting the cables and removing/securing the attaching hardware. Refer to the following paragraphs for procedures applicable to specific assemblies involving special precautions and steps that may not be obvious. The power interconnect board and the power amplifier interconnect board can not be removed. Replacement of components on these boards, if necessary, should be done from the exposed side of the board. The leads of the replacement part must be properly trimmed prior to insetion to avoid short-circuits to the chassis. It is recommended that a spacer be placed between the board and chassis, if possible, to prevent solder from flowing below the board and touching the chassis.

7.1.2 During reassembly of the radio, it is very important to tighten all screws to the correct torque. Correct torque is essential for reliable electrical and mechanical performance. Too little torque may result in intermittent ground connections, microphonics, or insufficient heat sinking. Too much torque may cause stripping of the threads in the chassis. Recommended screw torque specifications for all fasteners in the *DVP MCX100* radio are listed in Table 4.

Table 4. Screw Torque Specifications

Screw Size	Application	Maximum Torque
M2.5 × 0.45	30 Watt final transistor; option board regulators; main board heat sink devices (4); front panel dimmer pass device.	6 ± 1 In-Lbs.
M4 × 0.7 × 9	30 Watt heat sink to chassis mtg.; top and bottom cover screws	20 ± 2 In-Lbs.
M3 × 0.5 × 10	Synthesizer cover	14 ± 2 In-Lbs.
M3 × 0.5 × 8	All other applications not listed above	12 ± 2 In-Lbs.
	10 Watt RF final mtg. stud	5 ± 1 In-Lbs.

7.1.3 Before a screw is reinserted, check the threads for foreign material. If the threads are damaged or if foreign material is present which cannot be removed, the screw should be discarded and a new one inserted. Damaged or clogged threads on a screw may damage the threads in the chassis.

CAUTION
The hybrid assemblies are not field-repairable. Attempts to repair a hybrid module will void the warranty.

7.2 STANDARD SYNTHESIZER VCO REPLACEMENT; TLD2441A, TLD2442A

Perform the following replacement steps:

Step 1. Remove three screws holding synthesizer board in casting.

Step 2. Use pull string on synthesizer board to remove board from casting. Pull straight up to avoid bending the connector pins.

Step 3. Remove two screws on shield wall between synthesizer and VCO compartments.

Step 4. Remove two screws on VCO/carrier assembly. Lift VCO out of compartment.

Step 5. Place new VCO in compartment. Replace two screws on VCO/carrier assembly, and tighten to 12 ±2 inch-pounds.

CAUTION

DO NOT over-tighten the screws in Step 5. The screw threads in the casting could be stripped if too much torque is applied.

Step 6. Replace shield wall and screws. Tighten to 12 ±2 inch-pounds.

Step 7. Replace synthesizer board and screws. Tighten to 12 ±2 inch-pounds.

7.3 STANDARD SYNTHESIZER BOARD REPLACEMENT TRN5243A

Perform the following replacement steps.

Step 1. Remove three screws holding synthesizer board in casting.

Step 2. Use pull string on synthesizer board to remove board from casting. Pull straight up to avoid bending the connector pins.

NOTE

The synthesizer has two field-replaceable integrated circuits (ICs); the divider (U115), and the PROM (U117). Replacment is described in Steps 3 through 6.

Step 3. The divider IC may be replaced by inserting a small round tool into the two holes opposite U115 on the solder side of the synthesizer board, and exerting pressure until the IC breaks free from the socket.

Step 4. The PROM IC may be replaced by inserting a thin flatbladed screwdriver between the PROM IC and the socket. Gently pry the PROM out of the socket.

Step 5. When placing either U115 or U117, bend the IC pins enough to allow them to line up with the socket holes.

Step 6. Replace IC's with firm pressure toward center of IC. Be sure to observe correct orientation as indicated by the circuit board legend.

Step 7. Replace synthesizer board and screws. Tighten screws to 12 ±2 inch-pounds.

7.4 *FAST-LOK* SYNTHESIZER VCO REPLACEMENT; TLD2541A, TLD2542A

Perform the following replacement steps.

Step 1. Remove three screws holding synthesizer board in casting.

Step 2. Use pull string on synthesizer board to remove board from casting. Pull straight up to avoid bending the connector pins.

Step 3. Remove two screws on shield wall between synthesizer and VCO compartments and remove wall.

Step 4. Remove two screws on VCO/carrier assembly. Lift VCO out of compartment.

Step 5. Unsolder bare wire interconnection between synthesizer rf amplifier board and VCO interconnect board. Lift VCO out of compartment.

NOTE

If adequate clearance cannot be made by tilting the VCO, remove the synthesizer rf amplifier board (refer to Synthesizer RF Amplifier Board Replacement paragraph).

Step 6. Place new VCO in compartment. Replace synthesizer rf amplifier board if required. Replace two screws on VCO/carrier assembly, and tighten to 12 ±2 inch-pounds.

CAUTION

DO NOT over-tighten the screws in Step 6. The screw threads in the casting could be stripped if too much torque is applied.

Step 7. Replace shield wall and screws. Tighten to 12 ±2 inch-pounds.

Step 8. Replace synthesizer board and screws. Tighten to 12 ±2 inch-pounds.

7.5 *FAST-LOK* SYNTHESIZER BOARD REPLACEMENT; TRN5129A

Perform the following replacement steps.

Step 1. Remove three screws holding synthesizer board in casting.

Step 2. Use pull string on synthesizer board to remove board from casting. Pull straight up to avoid bending the connector pins.

NOTE

The synthesizer has two field-replaceable integrated circuits (ICs); the divider (U115), and the PROM (U116). Replacement is described in Steps 3 through 6.

Step 3. The divider IC may be replaced by inserting a thin flat-blade screwdriver between the divider IC and the phase detector IC. (The phase detector IC, U140, is mounted beneath the divider IC.) Gently pry the divider out of its socket taking care not to damage the phase detector IC. An IC extractor tool may also be used.

Step 4. The PROM IC may be replaced by inserting a thin flatbladed screwdriver between the PROM IC and the socket. Gently pry the PROM out of the socket.

Step 5. When placing either U115 or U117, bend the IC pins enough to allow them to line up with the socket holes.

Step 6. Replace ICs with firm pressure toward center of IC. Be sure to observe correct orientation as indicated by the circuit board legend.

NOTE

When inserting the divider IC, prevent the socket from spreading by holding the two sides together with a pair of pliers.

Step 7. Replace synthesizer board and screws. Tighten screws to 12 ±2 inch-pounds.

7.6 SYNTHESIZER RF AMPLIFIER BOARD REPLACEMENT; TRN5218A

Perform the following replacement steps:

Step 1. Remove the synthesizer board as described in the *Fast-Lok* Synthesizer Board Replacement paragraph.

Step 2. Unsolder the connections to the rf buffer board from the VCO interconnect board, jack J357 and the transmit injection solid coax. Take care not to damage the plated-through holes into which these connections are soldered.

Step 3. Remove two screws on shield wall between synthesizer and VCO compartments, and remove wall.

Step 4. Lift synthesizer rf amplifier board straight up to remove it from the synthesizer compartment.

Step 5. Position new board in place. Make sure that the board is seated properly and solder three connections unsoldered in Step 2.

Step 6. Replace shield wall and screws. Tighten to 12 ±2 inch-pounds.

Step 7. Replace synthesizer board and screws. Tighten to 12 ±2 inch-pounds.

7.7 TRANSMITTER MODULE REPLACEMENT

CAUTION

Before installing a transmitter hybrid module, make sure all connection pins are straight, and have no solder fillet around the base that would prevent the hybrid from sitting flat. Failure to do so could damage the hybrid and void the warranty.

7.7.1 General

The following general procedures should be used to ensure safe replacement of a defective module, and proper transmitter operation.

- Use a low power soldering iron (approximately 40 watts).
- Use only 2% silver solder on all hybrids.
- Use "solder wick" or a bulb type solder sucker to remove and clean solder from connection pins.
- The transmitter alignment procedure should be performed after any transmitter hybrid is replaced.

7.7.2 Low Level Amplifier, TLD9132A

Perform the following replacement steps.

Step 1. Unsolder the six connection pins.

Step 2. Using a small screwdriver remove the module by alternately lifting at the two circuit board cutout locations. Do not pull on any hybrid components. Lift module straight up to prevent damage to transistor on underside of board; the transistor is secured in a clip.

Step 3. Clean the six connection pins and circuit board pads of any excess solder and straighten the pins if necessary.

Step 4. Place the new module over the pins to check for alignment.

Step 5. Press Q201 into heat sink using the blunt end of a non-metallic tuning tool. Apply pressure directly on top of Q201. When seated properly there should be no more than 0.05 inches gap between the module and the circuit board.

Step 6. Bridge solder between the six connection pins and their associated hybrid pads so solder is wicked around 25% of the pin.

7.7.3 10 Watt Amplifier; TLD9142A, TLD9143A

Perform the following replacement steps.

Step 1. Unsolder the five connection pins.

Step 2. Remove the main board (see main board removal/replacement procedure).

Step 3. Remove the transistor stud nut.

Step 4. From the main board side, gently tap on the stud of the transistor to remove the module.

Step 5. Clean the five connection pins and circuit board pads of any excess solder and straighten the pins if necessary.

Step 6. Install the new module being careful to check for pin alignment. Be sure to apply thermal compound to the stud of the transistor where it contacts the chassis.

Step 7. Replace the transistor stud nut and tighten to a torque of 5 ±1 inch-pounds.

Step 8. Bridge solder between the five connection pins and their associated hybrid pads so solder is wicked around 25% of the pin.

7.7.4 30 Watt Amplifier; TLD9151A

Perform the following replacement steps.

NOTE
All soldering in the removal of this module is done at the hybrid end of the wires and coaxial cables.

Step 1. Unsolder the input and output coaxial cables so they are clear of the hybrid.

Step 2. Unsolder the jumper going to thermistor RT1400.

Step 3. Unsolder the feed network L1403.

Step 4. Unsolder the solder lug next to thermistor RT1400.

Step 5. Remove the two screws holding transistor Q1400 (M1156).

Step 6. Remove the module.

Step 7. Put thermal compound on the flange of the new module device where it contacts the heat sink.

Step 8. Slide the new module into the heat sink making sure it clears all connecting wires and cables.

Step 9. Install the Q1400 (M1156) mounting screws and torque to 6 ±1 inch-pounds.

Step 10. Reconnect all wires and coaxial cables.

7.7.5 Harmonic Filter; TFD6431A, TFD6432A

Perform the following replacement steps.

Step 1. (30 watt radio only.) Unsolder the center conductor of the high power PA output coax where it goes into the PA interconnect board. Next unsolder the coaxial shield and lift it from between the two ground pins. Clean excess solder from pins and center conductor hole.

Step 2. Unsolder the five connector pins.

Step 3. Remove the wall between the harmonic filter and 10 watt amplifier.

Step 4. Remove the screw in the corner next to the antenna connector.

Step 5. Unsolder the jumper from the antenna connector to the hybrid. Remove the coil-capacitor-lug assembly if necessary. Remove the module.

Step 6. Clean the five connector pins and circuit board pads of any excess solder and straighten the pins if necessary.

Step 7. Install the new module, being careful to check for pin alignment.

Step 8. Replace the wall between the filter and 6/10 watt amplifier. Torque screws to 12 ±2 inch-pounds.

Step 9. Replace the corner screw making sure it goes through the solder lug. Torque to 12 ±2 inch-pounds.

Step 10. Resolder the jumper going to the antenna pad on the hybrid. Resolder the coil-capacitor assembly to the antenna connector if necessary. All leads in this area must be less than 1/8 inch in length.

Step 11. Bridge solder between the five connection pins and their associated hybrid pads so solder is wicked around 25 % of the pin.

Step 12. Resolder the high power PA coaxial cable to the PA interconnect board if necessary.

7.8 MAIN BOARD REMOVAL/REPLACEMENT

7.8.1 Main Board Removal

Perform the following removal steps.

Step 1A. Remove radio top cover.

Step 1B. (For dual front end radios only.) Remove radio bottom cover.

Step 2. Remove four screws securing main board to chassis; two of the screws pass through the heat sink adjacent to edge of board.

NOTE

DO NOT remove two screws securing main board to heatsink. These two screws are identified by the legend DO NOT REMOVE on the main board.

Step 3. (For dual front end radios only.) Remove two screws on bottom of radio securing dual front end to chassis crossbars.

Step 4. Remove main board by lifting alternately:

- Rear connector, J350.
- Front of board near 12-pin connector, P355.
- Side of board near 8-pin connector P351 by placing finger or non-marring tool in slot on side of chassis.

Step 5. Remove the 3 "push-pin" connectors from the main board leading to J101. Remove 22-pin connector J352, by pulling straight out to avoid bending pins of P352.

Step 6. (For remote-mount radios only.) Remove 4-pin connector, J380, located near rear connector J350.

Step 7. Lift main board part way, avoiding thermal grease on heat sink.

Step 8. Disconnect two coaxial cables from connectors under the board. Use gas pliers to twist slightly, while pulling straight up.

Step 9. Lift main boad completely away from chassis.

Step 10. Wipe thermal grease from heatsink with cloth or tissue, to avoid contact with clothing and hands while servicing board.

7.8.2 Main Board Replacement

Perform the following replacement steps.

Step 1. Plug front-end antenna coaxial cable (ANT) into connector on power interconnect board, observing legend (cable towards front of radio).

CAUTION

Seat plug fully into socket. Wrong orientation of connector, or failure to seat plug fully, will damage main board components.

Step 2. Plug injection coaxial cable (INJ) into connector on chassis. Observe orientation legend stamped into chassis.

CAUTION

Seat plug fully into socket. Wrong orientation of connector, or failure to seat plug fully, will damage main board components.

Step 3. (For remote mount radios only.) Install 4-pin connector J380. Connector is keyed; wires come out toward front of radio.

NOTE

The 3-wire cable is routed through the signaling option area. Radios with 2-board options, cable is routed between upper and lower signaling boards; route wire such that it is not pinched in upper-to-lower board connector.

Step 4. Reconnect the 3 "push-pin" connectors to the main board from J101. Install 22-pin connector J352. Connector is not keyed; orange dot on connector and square pad on main board indicate pin 1; wire length prohibits backwards-insertion. Be sure connector is not offset one or two pins to either side.

Step 5. Apply thermal grease to heat sink and chassis if it was wiped off during servicing.

Step 6. Place main board in chassis. Simultaneously align front 12-pin connector, side 8-pin connector, and rear connector into slot in chassis. Push board fully down into chassis. Avoid pinched wires.

Step 7. Install two screws securing heat sink to chassis. Tighten to 12 ±2 inch-pounds.

CAUTION

Correct torque is essential to ensure proper radio performance. Too little torque may result in intermittent ground connections. Too much torque may cause stripping of the casting threads.

Step 8. Install remaining two screws securing main board to mounting bosses. Tighten to 12 ±2 inch-pounds.

Step 9. (For dual front end radios only.) Install two screws on bottom of chassis securing dual front end casting to chassis crossbars. Tighten to 12 ±2 inch-pounds.

Step 10A. Replace radio top cover. Tighten screw to 20 ±2 inch-pounds.

Step 10B. (For dual front end radios only.) Replace radio bottom cover. Tighten screws to 20 ±2 inch-pounds.

7.9 CONTROL HEAD PLUG REMOVAL

CAUTION

Do not pull the cable plug out of the mating connector on the radio set, until the retainer clip is released. One or both of the mating connectors may break if the clip is not released.

The control head cable connector on remote mount radio sets is secured by a retainer clip. This clip automatically engages when the plug is inserted into its mating receptacle in the front of the radio. Refer to Figure 7. To remove the cable connector, push the clip toward the center of the plug while pulling the plug straight away from the mating connector. There is an access slot at the end of the cover. A tool, such as a small flat-bladed screwdriver, may be inserted through the slot to push on the retainer clip.

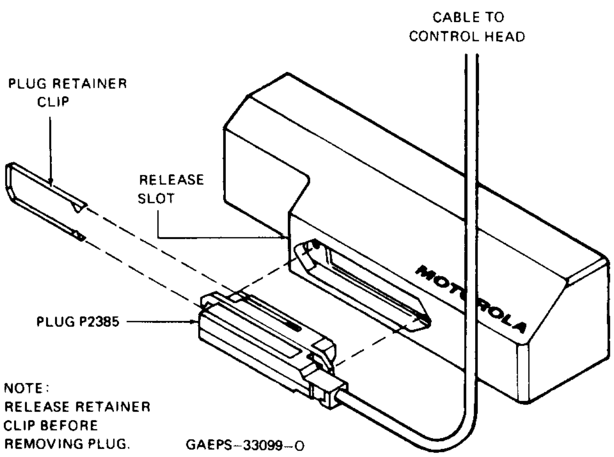

Figure 7. Control Head Plug

7.10 *DVP* ENCRYPTION HYBRID REPLACEMENT; TRN6777B

Perform the following replacement steps.

Step 1. Remove the radio top cover.

Step 2. Remove the cable attached to the *DVP* interface board.

Step 3. Lift the *DVP* interface board up and remove it from the radio.

Step 4. Replace the encryption hybrid. Make sure that the component side of the new hybrid faces the *DVP* interface board.

Step 5. Install the *DVP* interface board, taking care that the hybrid clip seats properly.

Step 6. Reconnect the cable kit to the *DVP* interface board.

Step 7. Install the radio top cover.

8. TROUBLESHOOTING PROCEDURES

8.1 TROUBLESHOOTING DATA

Troubleshooting data is shown in a set of "do and don't" notations, as well as troubleshooting diagrams and tables.

8.1.1 Do's and Don't's of Servicing

The notes listed below generally apply to the main board.

- Do replace both Q302 and Q307 if either device fails.
- Do use floating (non-chassis ground) power supply and audio distortion analyzer to avoid audio ground loops.
- Do always install at least one main board heat sink screw when testing, since major ground path to board is via heat sink.
- Do adjust transmitter deviation according to procedure in service manual. Adjusting for full system deviation at 1 kHz causes over-deviation at 2700 Hz.
- Do reference all test equipment ground leads to the chassis.
- Do turn off power supply (not radio) when repairing main board since supply voltage is present on boards with radio off.
- Do remove and reinstall solder-side shields by soldering and unsoldering from the solder-side of the circuit board.

- Don't short 9.6 T line to ground while transmitter is keyed.
- Don't short 11.7 V supply line to ground.
- Don't short 4.8 V supply line to ground.
- Don't connect test equipment ground clips to quad coil shield or to detector solder-side shield (area of U2 and L5).

Figure 8. Transmitter Troubleshooting Chart

- Don't use double-kinked stand-up resistors where single-kinked style is required unless leads are bent to avoid shorting between the two kinks.
- Don't allow flux-dissolving board cleaners to flow down into pot or coil adjustment holes since they may cause freezing of slugs, breakage of slugs, or intermittent pot operation.
- Don't overtighten mounting screws during reassembly; overtightening may strip the threaded screw halves.

8.1.2 Diagrams and Tables

The following troubleshooting Figures and Tables indicate possible problem areas, and provide aid in isolation of the problems.

Figure 8 — Transmitter Troubleshooting Chart
Figure 9 — I-F Gain Test Graph
Table 5 — Receiver and Main Board Troubleshooting Procedures, According to Symptom
Table 6 — Standard VCO and Synthesizer Troubleshooting Procedures, According to Symptom
Table 7 — Standard VCO and Synthesizer Troubleshooting Procedures, According to Circuit Block
Table 8 — *Fast-Lok* VCO and Synthesizer Troubleshooting Procedures, According to Symptom
Table 9 — *Fast-Lok* VCO and Synthesizer Troubleshooting Procedures, According to Circuit Block
Table 10 — *DVP* Troubleshooting Procedures, According to Symptom

8.1.3 Special Troubleshooting Test Procedures

8.1.3.1 I-F Gain Test

Two methods can be used to test the i-f gain of the receiver. Use the method most convenient or appropriate to accomplish the test.

- Method 1

Step 1. Connect an rf signal generator, via a 50 ohm coaxial cable, to the i-f input on the main board (center conductor to TP1, shield to ground; temporarily disconnect the center conductor of the front end i-f output coaxial cable from TP1). Set the signal generator for a 21.4 MHz (±200 Hz), unmodulated output signal.

Step 2. Connect a dc voltmeter from the rise meter point on the main board to ground. Vary the output level of the signal generator between −120 dBm and −50 dBm, in 10 dB intervals, and note the readings obtained on the dc voltmeter.

Step 3. Referring to Figure 9, plot a similar graph showing the dc voltmeter readings obtained; compare the plotted graph with the graph shown in in the figure.

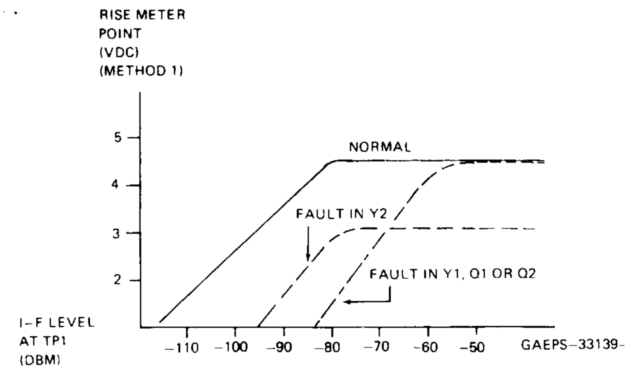

Figure 9. I-F Gain Test Graph

If an abnormal result is obtained, Figure 9 also isolates the fault to a specific component(s).

Step 4. Be sure to reconnect the center conductor of the front end i-f output coaxial cable to TP1 when test is completed.

- Method 2

Step 1. Connect an rf signal generator to the antenna connector and connect a high-impedance rf millivoltmeter between test point TP1 and ground on the main board. (Do not disconnect the front end i-f coaxial cable from TP1.)

Step 2. With the rf generator adjusted to produce an unmodulated, on-channel (±200 Hz) signal, vary generator output level to obtain dBm levels between −120 dBm and −50 dBm, as read on the rf millivoltmeter. Note the readings obtained at approximately 10 dBm intervals.

Step 3. Perform Step 3 in the Method 1 procedure.

8.1.3.2 Synthesizer VCO Range Shift Tests

It is possible to verify proper range shift operation of the VCO, as controlled by logic voltages originating on the synthesizer board.

Step 1. Determine the desired VCO operating frequency for a given channel. In the transmit mode, the VCO frquency is the same as the assigned transmit frequency for that channel. In the receive mode, the VCO frequency is 21.400 MHz lower than the assigned receiver frequency for that channel.

Step 2. Refer to Table 1, "Frequency Shifting of VCO Sub-Range Frequencies", in the Synthesizer Detailed Description (part of the Theory of Operation section).

Step 3. Compare the specified voltage levels for S1, S2, and S3 (corresponding to the VCO operating frequency as determined in Step 1) with those measured in the radio under test. "0" indicates logic low, less than

0.8 V dc; and '1' indicates logic high, between 8.0 and 8.9 V dc. If voltages are correct, there may be a fault in the range-shifting circuitry on the VCO hybrid. If the voltages are incorrect, there is a fault in the frequency select switch or circuitry on the synthesizer board.

NOTE

If this is done while servicing, be sure to remove the jumper before placing the radio back into operation.

8.1.3.3 Disabling Transmitter RF Output

While performing certain testing or troubleshooting procedures, it may be necessary or desirable to key the transmitter PTT without producing RF output. The transmitter can be defeated by soldering a short jumper wire across Q228, emitter to collector. This prevents LLA A + from being produced when PTT or MIC PTT is grounded, thus inhibiting rf power output.

Table 5. Receiver and Main Board Troubleshooting Procedures According to Symptom

Symptom	Possible Cause	Correction or Test
A. Radio does not turn on (no thump heard in speaker at turn on). Displays do not light.	1. Green lead not connected to voltage source. 2. Fuse F351 blown. 3. Jumper in power plug broken. 4. Loss of continuity between power board and on-off switch.	1,2. Check for A + at P360-3 on power board. 3,4. Jumper between P360-2 and P360-1.
B. Radio does not turn on (no thump heard in speaker at turn on). Displays light.	1. Heavy red lead (PA A +) not connected to voltage source. 2. Fuse F350 blown. 3. Audio power amp failure.	1, 2 Check for PA A + at main board (P351-1). 3. Verify dc voltages in audio PA starting with TP13.
C. No audio or does not unsquelch (thump is heard in speaker at turn on). Squelch and monitor buttons pushed in.	1. Synthesizer unlocked. 2. Synthesizer PROM missing. 3. 9.6 V regulator failure. 4. Audio is being muted. 5. Loss of continuity to squelch switch. 6. Q2102 shorted emitter to collector. 7. 9.6 T present. 8. Detector U2 bad or choke L7 open. 9. Audio op amp (U50) failure. 10. I-F amp IC failure (U1) or choke L6 open. 11. Crystal filter Y2 open. 12. Loss of continuity in volume control. 13. Failure in *DVP* circuitry.	1,2 A logic high at P355-10 (TP49) indicates unlocked. Repair synthesizer or install PROM. 3. Check for 9.5 - 9.7 volts at TP36. 4. Check for logic high (mute) at TP9 (normal voltage when unmuted is 4.2 volts at TP9). 5. Short P355-3 (TP47) to chassis. 7. Transmit LED on if 9.6 T on 8. Verify 9.5 volts at U2-11, verify approximately 6 volts at TP6. 9. Verify 4.8 volts at U50-1 and -7. 10. Verify 9.5 volts at U1-10 and 7.8 volts at U1-5 (TP4). 11. Jumper across Y2A and then Y2B. 12. Jumper P355 pin 9 to pin 1 with Off-on/Volume control at mid-position. 13. Go to Table 10.
D. High distortion, gets worse at higher output levels.	1. Main board to heatsink screws loose. 2. Heatsink to casting screws loose. 3. Supply voltage too low. 4. Ground connection reversed at distortion analyzer input. 5. Ground loops in test setup.	1,2. Tighten screws. 3. Increase to 13.2 V. 5. Float ground on power supply and distortion analyzer.
E. High distortion, approx same at any output level	1. Signal generator off-frequency. 2. Excessive test deviation. 3. Q1 bad or L1 open. 4. L2 open. 5. Q2 bad, L3 or L4 open. 6. 11.7 volt supply low. 7. Bad crystal filters. 8. Reference oscillator off-frequency.	2. Reduce to 60% of full system deviation. 3. Verify 1.4 - 2.0 volts at TP2. 4. Normal voltage at Q1-D is 11.7 V, if L2 open will be 4 volts. 5. Verify 1.4 - 2.0 volts at TP3. 7. Test i-f gain; test for good ground between filter cans and main board ground.
F. Low audio output power	1. See Condition D, causes 1, 2, 3, and 4.	
G. Very low audio output power	1. Q54 or Q56 bad. 2. See condition D, cause 4.	
H. Poor sensitivity (quieting and SINAD)	1. 11.7 volt supply low. 2. See E,3;4;5;7. 3. Dirty or corroded connection to phono plugs from front end to jacks in chassis. 4. Failure in harmonic filter/ant switch 5. Q307 open. 6. Poor i-f sensitivity. 7. Low injection level from synthesizer.	4. Measure insertion loss between antenna connector and J356; 1 dB or less typical (or) measure sensitivity directly into front end ANTenna coaxial cable. 5. Verify 9.6 T less than 0.1 volt in receive mode. 6. Disconnect center lead from front end coaxial cable at TP1, meaure i-f sensitivity from 50-ohm generator at 21.4 MHz; 0.25 to 0.30 uV (20 dBq) typical, if bad, go to K. 7. Check for at least 3.0 volts at INJection meter point, or check for + 11 dBm or higher at J357.
I. Poor SINAD, good quieting sensitivity	1. See E,1;2;8. 2. See D,1;2;3;4;5. 3. See E,4;7	

Table 5. Receiver and Main Board Troubleshooting Procedures According to Symptom (Cont'd.)

Symptom	Possible Cause	Correction or Test
J. Poor quieting, good SINAD sensitivity	1. Using too high an audio level for 0 dBq reference.	1. Reduce noise output to 1.0 - 1.5 volts rms audio ouput with no input signal.
K. Poor i-f sensitivity	1. See E,3;4;5;6;7	1. If open crystals are suspected short across the outside pins of each crystal one at a time.
L. Weak level of unquieted noise with no input signal.	1. Edge of can over R8, R9, nearest to U1 shorting to pad on circuit board. 2. Crystal filter Y2 bad. 3. L5 (quad coil) detuned. 4. Self-quieting spur is present.	1. Bend can in to clear pad. 2. Perform i-f gain test or short across outside terminals of crystals. 4. Occurs only on certain channel(s), check screws securing synthesizer board and cover; check for broken shield on front end coaxial cables.
M. Same as L, but very tinny high-frequency sound.	1. Loss of continuity through Off-on/Volume control.	1. Jumper P355 pin 9 to pin 1 with Off-on/Volume control at mid-position.
N. I-F Instability	1. Shield over L5 or under U2 shorting to chassis. 2. Broken coaxial cable shield, front end output to i-f input. 3. Front end not tuned near operating frequency. 4. Spring fingers on i-f cans bent, corroded, or missing.	3. Retune front end to center of operating range; limit receive channel spacing to specified range of front end (up to 6 MHz for single front end).
O. Excessive i-f passband ripple	1. L2 open 2. See N,1;2;3;4 3. Defective i-f crystals 4. See E,7.	1. Verify 11.7 volts (not 4 volts) at Q1-D. 3. Sweep i-f at low (−120 dBm) and high (0 dBm) levels (input to TP1, output at U2-1). Remove choke L7 when sweeping. Ripple only in out-of-limit sweep indicates bad Y1; ripple at all levels indicates bad Y2.
P. Some coils in single front end do not peak	1. (RF1 coil): Shorted or open ANTenna coax or P356. 2. (L01 coil): Shorted or open INJection coax or P357. 3. (RF4 or L02 coils): May be normal condition occassionally at band edges (146 or 174 MHz for Range II radios). 4. (RF1, RF2, RF5, L01, or L02) coil tap broken at weld. 5. (Any coil) broken coil lead.	4,5. Examine installation environment or methods for excessive vibration of radio when in use.
Q. Intermittent or abrupt changes in meter indications while tuning single front end.	1. See P,4;5	
R. Squelch closing time remains slow (200 msec) even for strong signals	1. Main board components in the area of R2118 and R2119 are shorting to pins of power connector on power board. 2. CR2106, Q2100, C2109.	1. Push components (including Q2102, Q2100, Q58) in toward capacitor C63. 2. Refer to squelch theory of operation.
S. Squelch chatter	1. C2107, C2109, R2117.	
T. Squelch exhibits high-frequency scratchy sound when closing or during fading	1. C2108 open.	
U. Squelch produces "ticks" when closing	1. C70 open. 2. C69 leaky or installed backwards. 3. Station being received is transmitting PL and receiver in question does not have PL filter in receiver audio path (part of PL/DPL option)	3. Normal operation under certain strong-signal conditions.
V. Radio does not unsquelch with squelch adjust potentiometer fully CCW and squelch button out.	1. Normal operation; minimum opening sensitivity is 3 dBq (typ).	
W. Transmitter over-deviates and splatters excessively.	1. Choke L325 open. 2. VCO MOD is set too high.	1. Verify normal dc resistance of L325 (35 ohms). 2. Refer to deviation adjustment procedure of service manual.
X. Poor adjacent channel selectivity of receiver and/or break-up of audio at high signal levels.	1. C300 in 11.7 volt supply open or Q305 shorted collector to emitter. 2. Main board-to-heat sink or heat sink-to-chassis screws loose. 3. Failure in VCO noise filter (part of synthesizer board) 4. Q300 in 9.6 V regulator shorted collector to emitter. 5. C304 open or missing.	1. Verify ac voltage at Q305-E much lower than at Q305-C at high audio output levels. 3. Refer to synthesizer troubleshooting procedures. 4. Verify 9.6 volts at TP36.

Table 6. Standard VCO and Synthesizer Troubleshooting Procedures, According to Symptom

Symptom	Possible Cause	Correction or Test
A. Synthesizer always out of lock.	1. No PROM. 2. No DC voltages. 3. Strobe control not working. 4. Reference oscillator not working. 5. Synthesizer rf feedback not working. 6. Board screws missing. 7. Wrong range VCO. 8. Open connectors. 9. U115 bad. 10. Bad frequency shift. 11. U350 bad.	1. Check or replace PROM. 2. Check 9.6 V regulator, 5 V regulator, and VCO noise filter. 3. Check pin 28 on U115 for logic low. 4. Check output of oscillator. 5. Check frequency at pin 9 on U115. 6. Insert replacement screws. 7. Check kit number. 8. Check connectors P353, J151, P374. 9. Check all outputs of U115. 10. Check inputs and outputs of U171 and Q172. 11. Check U350.
B. Synthesizer only out of lock on some channels.	1. Bad PROM. 2. Some frequency switches not working. 3. Synthesizer rf feedback not working. 4. Open connection between P353 and J353.	1. Check or replace PROM. 2. Check input and output of U177 and Q172. 3. Check frequency at pin 9 of U115. 4. Check P353 and J353 for continuity.
C. No out of lock signal.	1. Lock detector shorted or broken. 2. Open connection between P353 and J353. 3. U115 bad.	1. Check bias of Q154, Q155, and Q156. Check U350. 2. Check P353 and J353 for continuity. 3. Check operation at U115 pin 7.
D. Synthesizer does not change frequency.	1. Strobe control not working. 2. Bad PROM. 3. Open connection between P353 and J353.	1. Check operation of strobe control circuits, and U351. 2. Check or replace PROM. 3. Check P353 and J353 for continuity.
E. Low or no rf power.	1. Bad VCO. 2. Bad VCO buffer. 3. Injection switch not working. 4. Open connector between VCO and synthesizer circuit board or between synthesizer circuit board and synthesizer interconnect board. 5. Synthesizer interconnect board not connected to exciter or mixer.	1. Replace VCO. 2. Check bias on Q190. 3. Check bias of PIN switches CR190 and CR191. 4. Check connectors P374 and J1300. 5. Check continuity of circuit board.
F. Power in receive, but not transmit, or vice versa.	1. Injection switch not working. 2. Outputs shorted. 3. 9.6T not working. 4. Open connector between synthesizer circuit board and synthesizer interconnect board. 5. Synthesizer interconnect board not connected to exciter or mixer.	1. Check bias of PIN switches CR190 and 191. 2. Check outputs for shorts. 3. Trace 9.6T to Q191. 4. Check connector P374. 5. Check continuity of circuit board.
G. Poor hum and noise.	1. Bad VCO. 2. Bad or missing components in loop filter. 3. Missing grounds. 4. RF feedback power low to synthesizer IC. 5. Bad VCO AGC. 6. Bad VCO noise filter. 7. Bad 9.6 V dc regulator.	1. Replace VCO. 2. Check value of components. 3. Check screws for tightness. Check connectors. 4. Check Q192. 5. Check bias and operation of Q189 and Q188. 6. Check VCO noise filter bias and C142, C143. 7. Check ripple and voltage of regulator.
H. Poor reference spurs (spurious responses at regulator frequency intervals).	1. Missing grounds. 2. Bad VCO. 3. Bad or missing components in loop filter. 4. Strobe control malfunction.	1. Check screws and connectors. 2. Replace VCO. 3. Check values of components. 4. Check operation of strobe circuit.
I. Cannot warp oscillator.	1. Bad C101. 2. Bad crystal. 3. C101 shorted.	1. Check or replace C101. 2. Check or replace crystal. 3. Check for short circuit.
J. Oscillator drifts with time.	1. Bad crystal. 2. Bad tank capacitors.	1. Check or replace crystal. 2. Replace capacitor.
K. No modulation.	1. Bad VCO. 2. Bad or missing R180 or R181. 3. Connectors.	1. Replace VCO. 2. Check resistors. 3. Check connectors.

Table 7. Standard VCO and Synthesizer Troubleshooting Procedures, According to Circuit Block

Circuit	Symptom	Correction or Test
A. Reference oscillator.	1. Does not oscillate. 2. Level too low or too high. 3. Oscillator does not warp.	1. Check dc bias, crystal, tank capacitors. 2. Check AGC, dc bias. 3. Check C102; may be shorted or broken.
B. VCO noise filter.	1. No output. 2. No filter action.	1. Check for short circuits. Check Q140; may be open. Check drive from Q141; may be no drive. 2. Check all diodes, R142, C142, and all output capacitors.
C. Charge pump.	1. No current action.	1. Check bias on Q152 and Q153 and check for open circuits.
D. Loop filter.	1. No filter action. 2. Short circuit.	1. Check all capacitors for open circuits. Check all resistors for open circuits. 2. Check all capacitors. Check Q153.
E. Lock detector.	1. Always indicates lock. 2. Always indicates out of lock.	1. Check all dc bias. Check for open circuit between Q154 and pin 7 of U115. Check R159 and C156. Check U350. 2. Check all dc bias. Check for short circuit at base to supply and ground; transistors Q154, Q155, and Q156. Check U350.
F. PIN switching circuits.	1. Does not switch.	1. Check for output short circuits. Check for bad U170, or Q170 and Q171. Check for open circuits to U170, or Q170 and Q171.
G. VCO buffers.	1. No power or low power from main buffer. 2. No power or low power from feedback buffer. 3. Antenna switch not functioning.	1. Check bias of Q190. Check antenna switch. Check C192 for open circuit. 2. Check bias of Q192. Check R196 for open circuit. Check C190 for open circuit. 3. Check 9.6T for open circuits. Check diode bias. Check Q191 for bias.
H. AGC	1. No VCO output, AGC detect signal high. 2. No VCO output, AGC detect signal low.	1. Check R185 for short circuit. Check base of Q188 for short circuit to 8.9 V dc. Check collector of Q189 for open circuit. 2. Check for bad Q188. Check for open R188. Check for shorted Q189.
I. Strobe control circuit.	1. Flip-flop does not change state. 2. Flip-flop does not reset. 3. Does not enable strobe. 4. Does not disable strobe.	1. Check U351. Check capacitors C129 through C131 (if used) for open circuit. Check for short circuit in FC line. Check for no bias or bad bias at Q116 and Q117. Check for bad NOR gate (U116). 2. Check for open or short circuit at pin 1 of U116. Check for bad lock detector. Check for bad NOR gate inverters (U116). 3. Check for bad lock detector. Check for bad NOR gate inverters (U116). Check for bad Q120 or Q119. 4. Check pin 8 of U116; may be tied high. Check for short circuit at Q119 or Q120. Check for bad lock detector (Q154, Q156). Check for bad NOR gate inverters (U116).

Table 8. Fast-Lok VCO and Synthesizer Troubleshooting Procedures, According to Symptom

Symptom	Possible Cause	Correction or Test
A. Synthesizer always out of lock.	1. No PROM (or incorrect PROM). 2. No DC voltages. 3. Strobe control not working. 4. Reference oscillator not working. 5. Synthesizer rf feedback not working. 6. Board screws missing 7. Wrong range VCO. 8. Open connectors. 8. U115 bad. 10. Bad frequency shift. 11. No RF power. 12. Bad phase detector 13. Open circuitry in loop filter.	1. Check or replace PROM 2. Check 9.6 V regulator, 5 V regulator, and VCO noise filter. 3. Check pin 28 on U115 for logic low. 4. Check output of oscillator. 5. Check frequency at pin 25 on U115. 6. Insert replacement screws. 7. Check kit number. 8. Check connectors. 9. Check all outputs of U115. 10. Check inputs and outputs of U155 and Q156. 11. Check VCO output. 12. Check for proper inputs and output ramp. 13. Short circuit input-output of loop filter-see if synthesizer locks.
B. Synthesizer only out of lock on some channels.	1. Bad PROM 2. Some frequency switches not working. 3. Synthesizer rf feedback not working. 4. Open connection between P353 and J353. 5. Poor connection between J1300 and P1300. 6. Poor ground connections. 7. Open circuit at transmit or receive injection port. 8. Low driver level to divider (U115). 9. Bad phase detector (U140). 10. Synthesizer not changing channel.	1. Check or replace PROM. 2. Check input and output of U155 and Q156. 3. Check frequency at pin 25 of U155. 4. Check P353 and J353 for continuity. 5. Check for continuity. 6. Tighten all VCO & synthesizer screws. 7. Check connector J357-P357 for continuity and check coax from buffer amp to low level amplifier (LLA). 8. Check rf level at divider pin 25. 9. Check for proper inputs and output ramp. 10. Check frequency change (FC) pulse and strobe circuit.
C. No out of lock signal.	1. Lock detect switch shorted or broken. 2. Open connection between P353 and J353. 3. U140 bad (Phase detector).	1. Check bias of Q142 and Q143. 2. Check P353 and J353 for continuity. 3. Check operation at U140-10.
D. Synthesizer does not change frequency.	1. Strobe control not working. 2. Bad PROM 3. Open connection between P353 and J353. 4. Frequency switches not working. 5. Bad phase detector (U140).	1. Check operation of strobe control circuits (Q117, Q118). 2. Check or replace PROM. 3. Check P353 and J353 for continuity. 4. Check input and output of U155 and Q156. 5. Check operation of pin 10.
E. Low or no rf power.	1. Bad VCO. 2. Bad VCO rf amplifier. 3. Injection switch not working. 4. Open connector between VCO and synthesizer circuit board or between synthesizer circuit board and synthesizer board. 5. Synthesizer rf amplifier board not connected to exciter or mixer. 6. AGC circuit malfunction. 7. Poor ground connection. 8. Bad VCO 8.9 V supply.	1. Replace VCO. 2. Check bias on Q190. 3. Check bias of PIN switches CR190 and CR191. 4. Check connectors P190 and J1300 5. Check continuity of circuit board. 6. Short Q171 collector to GND to see if problem goes away. 7. Tighten all VCO/synthesizer screws. 8. Check output of Q180 for 8.9 volts
F. RF power in receive, but not transmit, or vice versa.	1. Injection switch not working. 2. Injection switch outputs short circuited. 3. 9.6T not working. 4. Open connector between synthesizer circuit board and synthesizer interconnect board. 5. Synthesizer rf amplifier board not connected to exciter or mixer.	1. Check bias of PIN switches CR109 and CR191. 2. Check outputs for short circuits. 3. Trace 9.6T to Q191. 4. Check connector P374. 5. Check continuity of rf amplifier circuit board and connectors.
G. Poor hum and noise. (Synthesizer and output noisy).	1. Bad VCO. 2. Bad or missing components in loop filter. 3. Poor ground connections. 4. RF feedback power low to synthesizer IC. 5. Bad VCO AGC. 6. Bad VCO noise filter. 7. Bad 9.6 V dc regulator. 8. Undesired modulation from main board. 9. Adapt line high. 10. Bad connector contacts.	1. Replace VCO. 2. Check value of components. 3. Check screws for tightness. Check connectors. 4. Check Q116. 5. Check bias and operation of Q170 and Q171. 6. Check VCO noise filter Q180 bias and C186, 185 and 184. 7. Check ripple and voltage of regulator. 8. Ground R175 to see if problem goes away. 9. See Symptom A above. 10. Check contacts between synthesizer and interconnect board (J353/P353), between VCO and synthesizer (J1300/P1300), and between main board and front panel interconnect board (J355/P355).

*Table 8. **Fast-Lok** VCO and Synthesizer Troubleshooting Procedures, According to Symptom (Cont'd.)*

Symptom	Possible Cause	Correction or Test
H. Poor reference spurs (spurious responses at regulator frequency intervals).	1. Poor ground connections. 2. Bad VCO. 3. Bad or missing components in loop filter. 4. Strobe control malfunction.	1. Check screws and connectors. 2. Replace VCO. 3. Check values of components. 4. Check operation of strobe circuit (Q118).
I. Cannot warp oscillator or oscillator drifts with time.	1. Bad reference oscillator.	1. Replace reference oscillator (channel) element (Y102).
J. No modulation.	1. Bad VCO. 2. Bad or missing R175 or R176. 3. Bad connector contacts.	1. Replace VCO. 2. Check resistors. 3. Check connector P353, J1300.

*Table 9. **Fast-Lok** VCO and Synthesizer Troubleshooting Procedures, According to Circuit Block*

Circuit	Possible Cause	Correction or Test
A. Output RF Amplifier	1. Power in receive but not in transmit, or vise versa. 2. No power in receive and transmit.	1. Check for proper bias on PIN injection switches CR190, CR191. Check outputs for short circuit. Check 9.6T at Q191 emitter in transmit. 2. Check operation of rf amplifier Q190. If no input present, perform VCO checks.
B. VCO	1. No output at any frequency. 2. Stable output present at incorrect frequency. 3. Output present but unstable. 4. Output present but low level. 5. Correct output level and frequency but excessive noise or spurious tones present (may effect hum and noise measurement, or may be heard in speaker while in receive).	1. Check VCO pin 2 for presence of 8.9 volt supply. Check all ground connections and tighten if necessary. Check AGC voltage at VCO pin 11. Replace VCO. 2. If ADAPT line is low, perform reference oscillator, and/or divider checks. If ADAPT line is high: check state of VCO PIN switches by monitoring pins 4, 6, 7, 8, 12, 13 (if bad, perform PIN driver checks). Check voltage at phase detector pin 15 for proper range (3-8 V dc - should change when channel changes) (Note 1). Check reference oscillator frequency. Check steering line voltage and compare to the voltage at phase detector pin 15. If different, perform loop filter tests. Perform PROM tests. 3. Check connections between synthesizer and VCO (J1300/P1300). Check and tighten grounds on VCO and synthesizer. If ADAPT line is high perform phase detector tests. Check for short or open circuit at receive/transmit injection ports. Check performance of VCO filter. Temporarily ground VCO MOD line. If condition disappears, check main board. Replace VCO. 4. Check all connections to VCO. Check and tighten all VCO ground connections. Perform AGC checks. Replace VCO. 5. Check and tighten all ground connections. Clean contacts between VCO and synthesizer (J1300). Perform VCO Filter tests. Perform Loop Filter tests. Temporarily ground VCO MOD line, if problem disappears check main board. If ADAPT line is high perform phase detector tests. Check AGC circuit for proper operation. Replace VCO.
C. Loop Filter	1. Output frequency unstable. 2. Noise or spurious tones present (may effect hum and noise measurement or may be heard in speaker while in receive mode). 3. Synthesizer out of lock.	1. If ADAPT line is high, perform phase detector tests. Check for intermittent contact in circuit elements of filter. Check operation of CMOS switches (U141). 2. Check ADAPT line and U141 pin 13. Replace Q143 if necessary. Check all components in loop filter for proper value. Check for short circuits between guard band and loop filter output. 3. Short circuit steering line to phase detector pin 15 (Note 2). If system locks up check all components in loop fitler for proper operation, otherwise, perform phase detector tests and/or VCO tests.

*Table 9. **Fast-Lok** VCO and Synthesizer Troubleshooting Procedures, According to Circuit Block (Cont'd.)*

Circuit	Possible Cause	Correction or Test
D. Phase Detector	1. Synthesizer does not lock on frequency. 2. Ramp voltage not present or unstable. 3. Incorrect PIN voltage at pin 6. 4. Synthesizer does not change frequency.	1. Check for stable ramp voltage at pin 24 of phase detector. If ramp is present with amplitude between 3 volts and 8 volts, check PIN drivers for correct range (perform PROM, divider or strobe checks of necessary). If ramp is present but no output voltage at pin 15, check C143, C144 and Q141. Replace phase detector. 2. Check for proper inputs from divider at pins 2 and 23 of phase detector. Perform divider checks if necessary. Check C143 and C144 for correct value and good connection. Check Q140 and C142 and replace if necessary. Monitor sample timing of U140 pin 22. Check C141 and C152 and replace if necessary. Replace phase detector (U140). 3. Check input at pin 11. If correct replace phase detector, otherwise check divider. 4. Check frequency, change pulse pin 5; if not present, troubleshoot connections from interconnect board (P353), otherwise check PROM and strobe circuits. Also, check divider. Replace phase detector.
E. Divider	1. 5 kHz reference pulse not present or unstable at pin 5 of divider. 2. Loop pulse not present at pin 9 of divider. 3. Loop pulse present but not at 5 kHz repitition rate. 4. Incorrect PIN voltage at pin 17, 19 or 20.	1. Check 14.4 MHz reference at pin 2; if present with correct level and frequency check PROM, divider and reference oscillator. 2. Check rf level at divider pin 25 if present with correct level, replace divider otherwise, check rf buffer (replace Q116 if necessary) and perform output rf amplifier tests. 3. Perform phase detector tests. Check PIN drivers for correct range. Check strobe circuit and PROM. Replace divider (U115). 4. Check strobe circuit and PROM. Replace divider (U115).
F. Pin Drivers	1. Incorrect PIN voltages at pins 4, 6, 7, 8, 12, 13 for channel selected.	1. Check PIN drives from divider (pin 19, 20 and phase detector (pin 6). Replace U155, Q156, Q155 where necessary.
G. Strobe circuit and PROM	1. Synthesizer always out of lock. 2. Synthesizer off frequency on some channels. 3. Radio does not change frequency when channel selector is rotated.	1. Check PROM socket connections. Check that PROM is installed correctly. Change PROM and recheck for lock. 2. Check that strobe circuit functions (see correction 3 below). Check or replace PROM. 3. Check for strobe pulses at PROM pin 16 when channel selector is rotated. Check components in strobe circuit (i.e. Q115, Q117, Q118) and replace if necessary. Check strobe output of divider. Check inputs A0 through A4 (pins 9 to 13 of P353). Verify that they represent binary number of the channel selected. Verify correct operation of 9.6T line (pin 14 of P353). Replace PROM.
H. Reference Oscillator.	1. Does not oscillate. 2. Does not warp. 3. Off frequency.	1. Check dc voltage supply to reference oscillator; if ok, replace reference oscillator. 2. Replace reference oscillator. 3. Adjust warp control.
I. VCO Noise Filter/8.9 V supply	1. Output voltage not present or wrong value. 2. No filter action. (causing noisy VCO output).	1. Check for short circuits. Check Q180 and Q181. 2. Check all associated capacitors for correct value and proper connection. Check all diodes.
J. AGC	1. No (or low) VCO output with AGC detector signal high. 2. No (or low) VCO output with AGC detector signal low.	1. Check R172 for short circuit. Check base of Q171 for short circuit to 8.9 V dc. Check collector of Q170 for open circuit. 2. Check Q171. Check R170 for open circuit. Check Q170 for shorted transistor.
K. Voltage Supplies	1. One or more supply voltages not present or incorrect value. 2. Supply voltage not present at input to one or more circuit blocks.	1. Check for presence of 9.6 volts at synthesizer board pin 3. Check for 5 V at output of U180; replace regulator if necessary. Check for 8.9 volts at collector of Q180, perform VCO noise filter tests if necessary. 2. Check for proper voltage at supply voltage pin of each IC on synthesizer board (refer to schematic diagram). Troubleshoot circuit board plating bypass capacitors and coupling resistors where necessary.

Notes:
1. Measurements on steering line (SL) must be made with a high-impedance (10 meg dc) voltmeter to avoid affecting circuit operation.
2. Loop filter may easily be short circuited by connecting guard band to loop filter output at J1300-10.

Table 10. DVP Troubleshooting Procedures, According to Symptom

Symptom	Possible Cause	Correction or Test
A. No verification tone when loading key.	1. Volume is turned too low on radio. 2. Code inserter not properly connected to radio. 3. Loss of continuity between *DVP* encryption board and code plug receptacle. 4. Encryption hybrid not in socket. 5. Code inserter malfunction.	1. Increase volume on radio. 2. Check connector cable from cable inserter to radio. 3. Check VLN4129A key loading cable kit. 4. Check *DVP* encryption hybrid TRN6777B. 5. See code inserter manual.
B. *DVP* front panel indicators or switches non-functional.	1. Loss of continuity between *DVP* front panel and *DVP* encryption board.	1. Check cable from *DVP* front panel to *DVP* encryption board.
C. Radio will not receive in clear or coded mode.	1. No filtered 9.6 V supply to *DVP* encryption board or *DVP* interface board. 2. No "Option Receive Audio" to *DVP* encryption board. 3. No "Switched Receive Audio" on *DVP* encryption board. 4. No "Switched Receive Audio" to radio main board or to radio option board.	1. Check voltage on R179 of *DVP* interface board. Check for shorts to filtered 9.6 V supply. 2. Check cable from main board to *DVP* interface board. 3. Check U105C and U107D. For receive coded mode U105 pin 11 should be logic high. For receive clear mode this pin should be logic low. 4. Check cable from radio main board or radio option board to *DVP* interface board.
D. Radio receives in clear mode but not in coded mode. Coded/clear indicator does not light.	1. No "Switched Receive Audio" from *DVP* encryption board in coded mode. 2. No "Option Receive Audio" to *DVP* encryption board equalizer. 3. Faulty equalizer circuit on *DVP* encryption board.	1. Check U105C and U107D. For receive coded mode pin 11 of U105 should be logic high. 2. Check C106. 3. Check equalizer filter circuit (includes U107B) on *DVP* encryption board.
E. Radio will receive in coded mode but not in clear mode.	1. No "Switched Receive Audio" from *DVP* encryption board in clear mode.	1. Check U105C and U107D. For receive clear mode pin 11 of U105 should be logic low.
F. Transmit coded/clear indicator does not go off and on when coded/clear button is depressed.	1. Lack of continuity from *DVP* front panel coded/clear switch to *DVP* encryption board. 2. No 5 V supply on *DVP* encryption board. 3. U110 not functioning. 4. U109 not functioning. 5. Q106 not functioning.	1. Check cable and connectors from *DVP* front panel to *DVP* encryption board. 2. Check 5 V regulator U101. Also check CR111A. Check for shorts on the 5 V supply. 3. Check pins 1,2,10,11,12, and 13 of U110. 4. Check pins 2,3, and 5 of U109. 5. Check Q106.
G. Transmit coded/clear indicator is functional but radio always transmits in the clear mode.	1. U105A and U105B not switching.	1. Check pins 9 and 10 of U105. Both pins should be logic high for transmit coded mode.
H. Transmit coded/clear indicator is functional but radio always transmits in the coded mode.	1. U105A and U105B not switching.	1. Check pins 9 and 10 of U105. Both pins should be logic low for transmit clear mode.

1. INTRODUCTION

Alignment of the *DVP MCX100* radio consists of four procedures which should be performed in the following sequence:

- transmitter alignment
- oscillator frequency adjustment
- deviation adjustment
- receiver alignment.

2. RECOMMENDED TEST EQUIPMENT

Refer to Table 1 which lists the recommended test equipment which should be used for performing the alignment procedures presented in this section.

Table 1. Recommended Test Equipment for ***DVP MCX100*** *Radio Alignment*

General Type	Application	Recommended Model	Minimum Specifications
AC-DC VOM	DC voltage measurements, general	Motorola T1009	Measurement range: 0-15 V dc Sensitivity: 20,000 ohms/volt
DC Multimeter	DC voltage readings requiring a high input resistance meter	Motorola S1063	Measurement range: 0-15 V dc Input resistance: 11 megohms
AC Voltmeter	Audio voltage measurements	Motorola S1053	Measurement range: 0-10 V ac Input resistance: 10 megohms
RF Voltmeter	RF voltage measurements	Motorola S1339	Measurement range: 100 uV-3V from 1 MHz-512 MHz Inputs: 50-ohm and high impedance
Tuning Probe Adapter (Note 1)	Widespace Single and Dual Front End Alignment	Motorola TRN4778	
Oscilloscope	Waveform observation	Motorola R1004	Vertical sensitivity: 5 mV-10 V/division Horizontal time base: 0.2 usec. — 0.5 sec/division
RF Wattmeter	Transmitter output power measurement	Motorola S1350 with appropriate element and T1013 RF Dummy Load	Measurement range: 0-250 Watts
Frequency Meter	Transmitter frequency measurement	Model R1200 Service Monitor with high stability oscillator (X suffix) option. Frequency calibration recommended every 6 months or less.	Measurement range: 134-174 MHz Frequency resolution: 10 Hz
Deviation Meter	Transmitter modulation deviation measurement	Motorola R1200 Service Monitor with SLN6350 Deviation Meter and SLN6381 Audio Frequency Synthesizer *(audio synthesizer required only for DPL radios).*	Measurement range: 0-10 kHz deviation Frequency range: 134-174 MHz
RF Signal Generator	Receiver alignment and troubleshooting	Motorola R1200 Service Monitor with attenuator	Frequency range: 134-174 MHz Output Level: 0.1 uV-100,000 uV Must be capable of at least ± 3 kHz deviation when modulated by 1 kHz tone.
Audio Signal Generator	Audio circuit troubleshooting	Motorola S1067	Frequency range: 20 Hz-20 kHz Output level: 50 mV-1 V
PL Tone Generator (Note 2)	Tone-coded *Private-Line* decoder troubleshooting	Motorola S1333	Frequency range: 10 Hz-9999 Hz Output level: 0-3 V rms
DPL Test Set (Note 3)	*Digital Private-Line* encoder-decoder troubleshooting	Motorola SLN6413	
DVP Test Set	*DVP* Encoder-Decoder Troubleshooting	Motorola R1012	

Table 1. Recommended Test Equipment for DVP MCX100 Radio Alignment (Cont'd.)

General Type	Application	Recommended Model	Minimum Specifications
2-Ohm Speaker/ Audio Load	Receiver alignment and measurement	TSN6031A Speaker Kit with RPX4134A Modification Kit	
Tuning Tool Kit	Receiver and transmitter alignment	Motorola TRN4671A	
DC Power Supply	DC power for shop service	Motorola R1011	1-20 V dc 0-40 A
Front Panel Extender Cables	Troubleshooting	Motorola RTK4036A	
Metric Nutdriver Kit	Radio Assembly/Disassembly	RSX4048A	

NOTES:

1. Required for dual front end models only
2. Required for tone-coded *Private-Line* models only
3. Required for *Digital Private-Line* models only

NOTE

All test equipment, with the exception of the DPL test set, tuning tool kit, tuning probe adapter, *DVP* test set and dc power supply may be replaced by the Motorola R2001 System Analyzer.

3. TRANSMITTER ALIGNMENT

Refer to Figure 1 which shows the various test points which are to be referred to in the procedure. Also refer to the pertinent schematic diagrams and circuit board details located in this manual

3.1 POWER LEVEL ADJUSTMENT

NOTE

Key the radio only while making an adjustment. The adjustments should be done at the appropriate supply voltage level specified in Table 2.

Step 1. Preset R236 (voltage limit potentiometer) by turning it fully clockwise. Preset R245 (power adjust potentiometer) by turning it fully counterclockwise.

Step 2. Refer to Table 2 and find the power set level which corresponds to the power rating of the unit being adjusted.

Step 3. Select any transmit channel. Key the radio and adjust R245 (power adjust potentiometer) for the power set level determined in Step 2.

Step 4. Switch through all the transmit channels and record the channel which gives the MINIMUM power level, as specified in Table 2.

Table 2. Power Amplifier Adjustments

Power Rating (Watts)	Power Set Level (Watts)	Supply Voltage (Volts)
10	10.5 min.	13.8
30	31 min	13.6

Step 5. Switch through all the transmit channels while observing the dc voltage indication at TP27 (P351-2). Record the voltage level and channel for the channel that gives the highest voltage level. If this voltage level is greater than 10 V dc, proceed to Step 9, do not perform Steps 6, 7, and 8.

Step 6. On the channel with the highest voltage level found in Step 5, turn R245 clockwise until the dc voltage level increases approximately 3 volts, but do not exceed 12 volts.

NOTE

A 3 volt increase may not be possible on some 30 watt models. In this case, reduce the radio power supply voltage (not lower than 10.8 V dc) while monitoring TP27, until a voltage level approximately 3 volts higher than the voltage recorded in Step 5 is obtained.

Step 7. Adjust R236 for a dc voltage level that is 2 volts higher than the level recorded in Step 5.

Step 8. Reset power supply voltage to the appropriate value given in Table 2 (if necessary).

Step 9. Switch to the channel that was determined in Step 4 and repeat Step 3 on this channel.

Step 10. Verify that all the transmit channels now have the proper output power level.

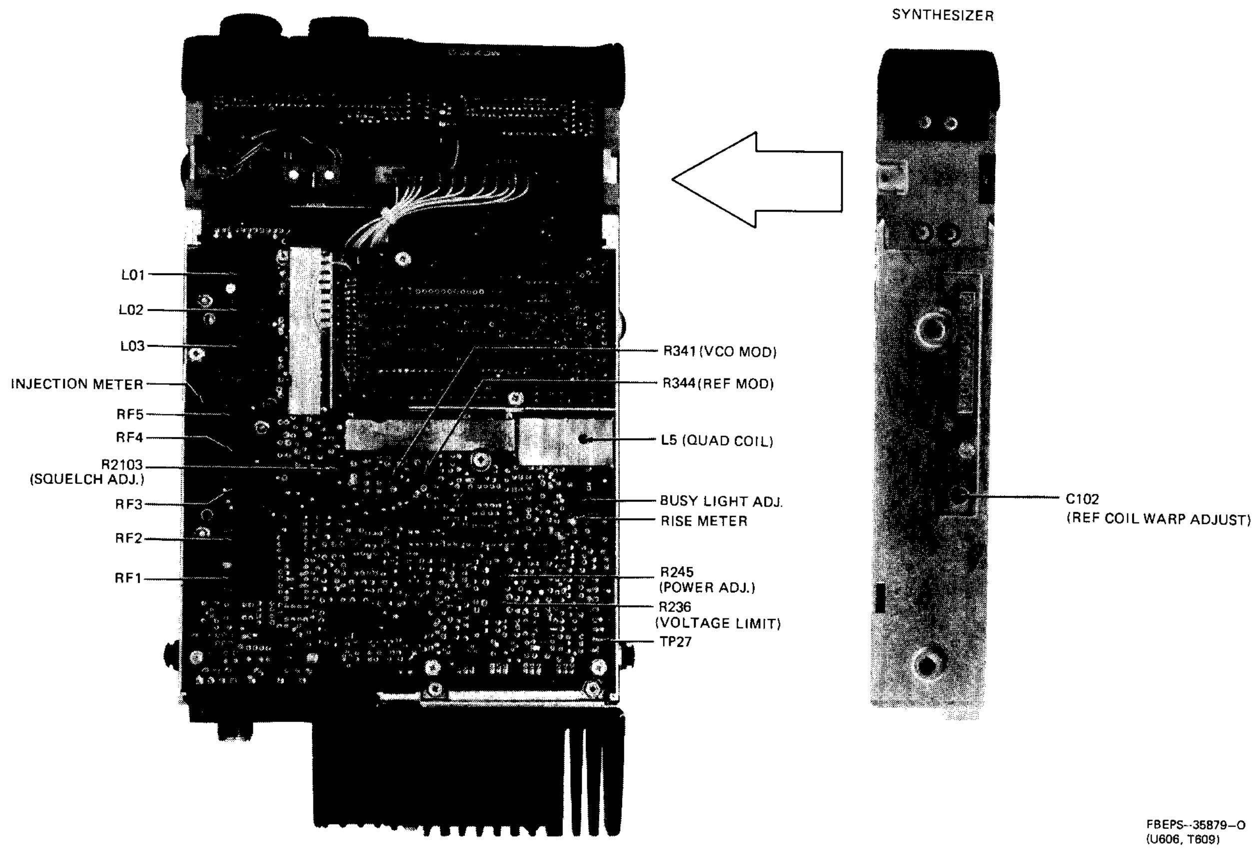

Figure 1. DVP MCX100 Radio Alignment Test Points

3.2 OSCILLATOR FREQUENCY ADJUSTMENT

Step 1. Set the channel selector switch to channel 1.

Step 2. (For PL/DPL units only.) Disconnect connector J377 from the PL/DPL board, to disable encoder modulation. Disconnect P101 from the *DVP* interface board, which enables a push-to-talk to occur. Key the transmitter to generate an unmodulated carrier.

Step 3. (For other units.) Set radio to standard transmit mode. Key the transmitter to transmit an unmodulated carrier.

Step 4. Adjust C102 (reference oscillator warp adjustment) until the proper frequency indication ± 100 Hz is obtained.

Step 5. Set the channel selector switch to channel 2 and check the transmit frequency.

Step 6. Repeat the procedure until all the channels have been checked.

Step 7. Once the oscillator frequency adjustment procedure has been completed, reconnect J377 and P101 if they were disconnected in Step 2.

3.3 DEVIATION ADJUSTMENT

NOTE

It is important that deviation be checked on all the transmit channels to ensure that no over-deviation occurs on any channel.

Step 1. Set the channel selector switch to any available channel on the radio set.

Step 2. Set radio to standard transmit mode.

Step 3. Turn R344 (REF MOD potentiometer) fully counterclockwise.

Step 4. Connect the audio oscillator output leads to the microphone audio input, as follows:

- hot lead to J350-12
- ground lead to J350-11.

Step 5. Set the audio oscillator to 1000 Hz and adjust its output level to 800 mV (RMS).

Step 6. Using the appropriate rf load, key the transmitter and observe the deviation level. Readjust audio oscillator level per Step 5 if necessary.

Step 7. Adjust R341 (VCO MOD potentiometer) until a 5 kHz deviation level is obtained.

Step 8. Set the radio set to the other transmit channels and observe the deviation level obtained on each. Make a note of the channel having the highest deviation level. If more than one channel produces the same maximum deviation level, note the channel with the highest frequency among those having the maximum deviation level. Use this channel for Steps 9 through 14.

Step 9. Adjust R341 (VCO MOD potentiometer) to obtain a deviation level of 4.6 kHz.

NOTE

Do not defeat the PL encoder on PL radio units. The procedure for DPL radio units is provided in Step 11. For radios equipped with selectable PL/DPL signaling, perform Steps 1 through 9 on any channel programmed to transmit PL signal, then perform Step 11 on the channel or channels programmed to transmit DPL signal.

Step 10. Turn R344 (REF MOD potentiometer) fully clockwise.

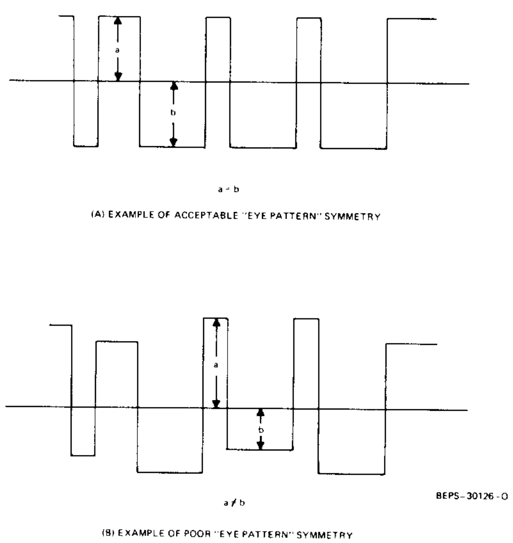

Figure 2. Examples of "Eye Pattern" Symmetry

Step 11. (For DPL radio sets only.) Connect the direct-coupled input lead of an oscilloscope to the digital output of a standard test receiver. Select the middle rf channel that transmits DPL. (For two- channel radio sets, select the channel having the lower transmit frequency.) Adjust the REF MOD potentiometer (R344) until the best eye pattern symmetry is obtained. Refer to Figure 2. Check all other channels equipped with DPL and verify that all the eye patterns are similar.

Step 12. Set the radio to private transmit mode and key the transmitter. Using an oscilloscope to monitor the voltage at P355-7, adjust the *DVP* REF MOD potentiometer (R161 on the *DVP* interface board) for an eye-pattern with a peak-to-peak voltage of 4 volts.

NOTE

In some DPL models a peak-to-peak voltage of 4 volts will not be obtainable. In this case R161 should be turned fully counterclockwise in order to obtain the maximum peak-to-peak voltage possible.

Step 13. Adjust the *DVP* VCO MOD potentiometer (R158 on the *DVP* interface board) for a deviation of 4 kHz.

Step 14. Check the deviation level on all the transmit channels and verify that it does not exceed 4.6 kHz in standard transmit mode, and does not exceed 4.0 kHz in private transmit mode.

4. RECEIVER ALIGNMENT

IMPORTANT

Proper receiver alignment first requires correct identification of the rf deck used in the radio.

- The single front end type employs a circuit board rf deck, with board mounted coils (in cans), only.
- The widespace single front end type employs a casted rf deck, with three integral coils (L707, 708, and 709).
- The widespace dual front end type employs a casted rf deck, with six integral coils (L704 thru L709).

After identifying the type of rf deck used in the radio, proceed to the appropriate rf deck alignment procedure paragraph in this section of this manual.

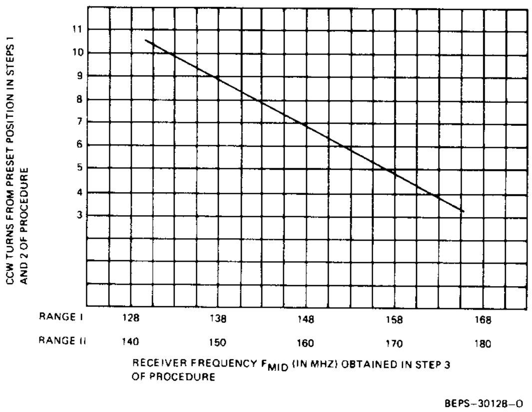

Figure 3. Coils Adjustment Graph

4.1 RF DECK ALIGNMENT PROCEDURE (SINGLE FRONT END TYPE)

Step 1. Turn the slugs of coils RF1, RF2, RF3, RF4, and RF5 clockwise until they reach the top of the coil forms.

Step 2. Carefully turn the slugs of coils L01, L02, and L03 clockwise until they touch the injection shield cover; then turn these slugs five full turns in a counterclockwise direction.

Step 3. Determine the tune-up frequency as follows:

- for single-channel sets, $F_{tune} = F_{receive}$
- for multi-channel sets, determine F_{mid} by using the following formula: $F_{mid} = (F_{high} + F_{low}) \div 2$.

NOTE

If there are channels within plus or minus 0.5 MHz of F_{mid}, the tune-up should be performed on the channel nearest to F_{mid}. If the two nearest channels are symmetrically located above and below F_{mid}, use the channel with the lower frequency. If there are no channels within plus or minus 0.5 MHz of F_{mid}, a tune-up PROM (programmable read-only memory) should be used on receive frequency F_{mid}. A procedure for tuning the receiver when a tune-up PROM is required, but is not available is provided at the end of this section. The widespace models do not require a tune-up PROM.

Step 4. Set the channel selector switch to the proper channel, as determined in the preceding step.

Step 5. Connect an ac voltmeter across the audio output of the radio set. The audio output must be terminated in either the recommended 2-ohm speaker/audio load (refer to test equipment list), or a 2-ohm resistor.

Step 6. Depress the squelch button and monitor button (if used), so that noise is heard in the speaker.

Step 7. Adjust the volume control until a comfortable noise level is obtained. If a 2-ohm load is used, adjust the volume control until an indication of approximately 1 volt is obtained across the load.

Step 8. Adjust L5 (quad coil) until maximum noise level is obtained from the speaker. Set the slugs of L01, L02, L03, RF1, RF2, RF3, RF4, and RF5 in accordance with the instructions provided in the graph of Figure 3.

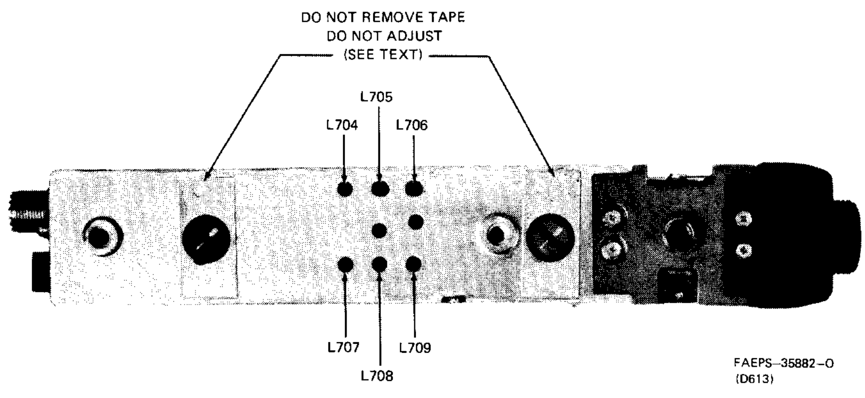

Figure 4. Widespace Single and Dual Front End Alignment Points

ALIGNMENT

Step 9. Connect a high input-impedance dc voltmeter to the INJ METER point (Figure 1) and set it to a low dc voltage range. Adjust coils L02, L01, and L03 (in this order) until a maximum dc voltage level (typically between 2.1 and 3.5 V dc) is obtained. Repeat the step until no further increase in dc voltage level can be obtained.

Step 10. Connect a signal generator to the antenna connector of the receiver and adjust the generator so that it will provide an on-frequency, unmodulated signal that is sufficiently strong to quiet the receiver. Connect a dc voltmeter to the RISE MTR test point (Figure 1) and set it to a low dc voltage range. Adjust coils RF1, RF2, RF3, RF4, and RF5 (in this order) until a maximum dc voltage indication is obtained. Adjust the signal generator, as required, to maintain the dc voltage between 2.5 and 3.5 V dc during tune-up. Repeat the step until no further increase in dc voltage level can be obtained. Proceed to the Receiver Adjustments Procedure paragraph in this section of the manual.

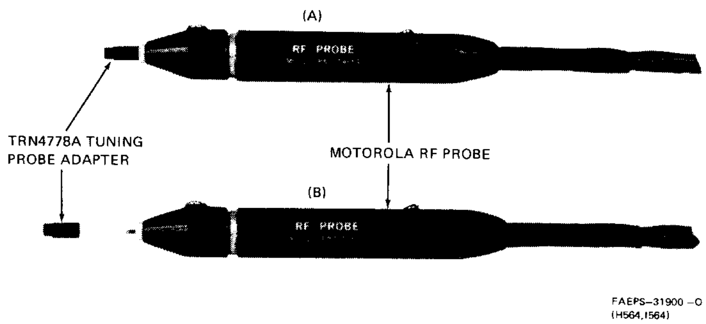

Figure 5. DVP MCX100 Alignment Probe
(A) RF Probe with Tuning Adapter in position
(B) RF Probe and Tuning Adapter separated

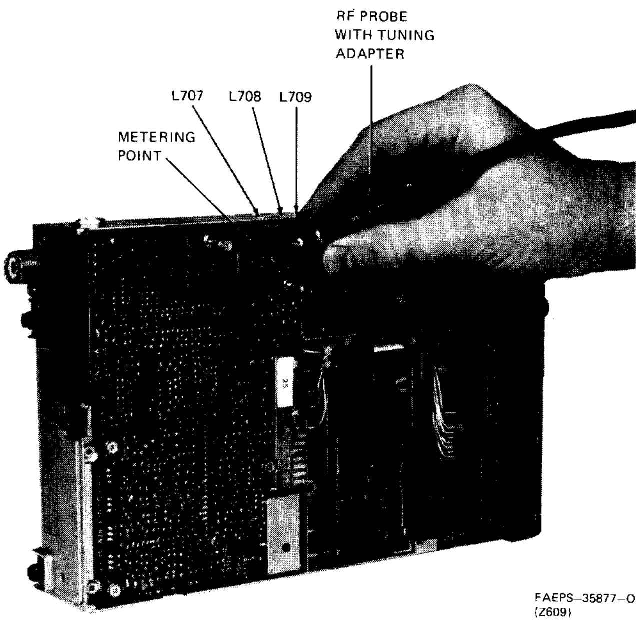

Figure 6. Main Board Side Tuning Probe Position (Widespace Single Front End and Widespace Dual Front End High Range)

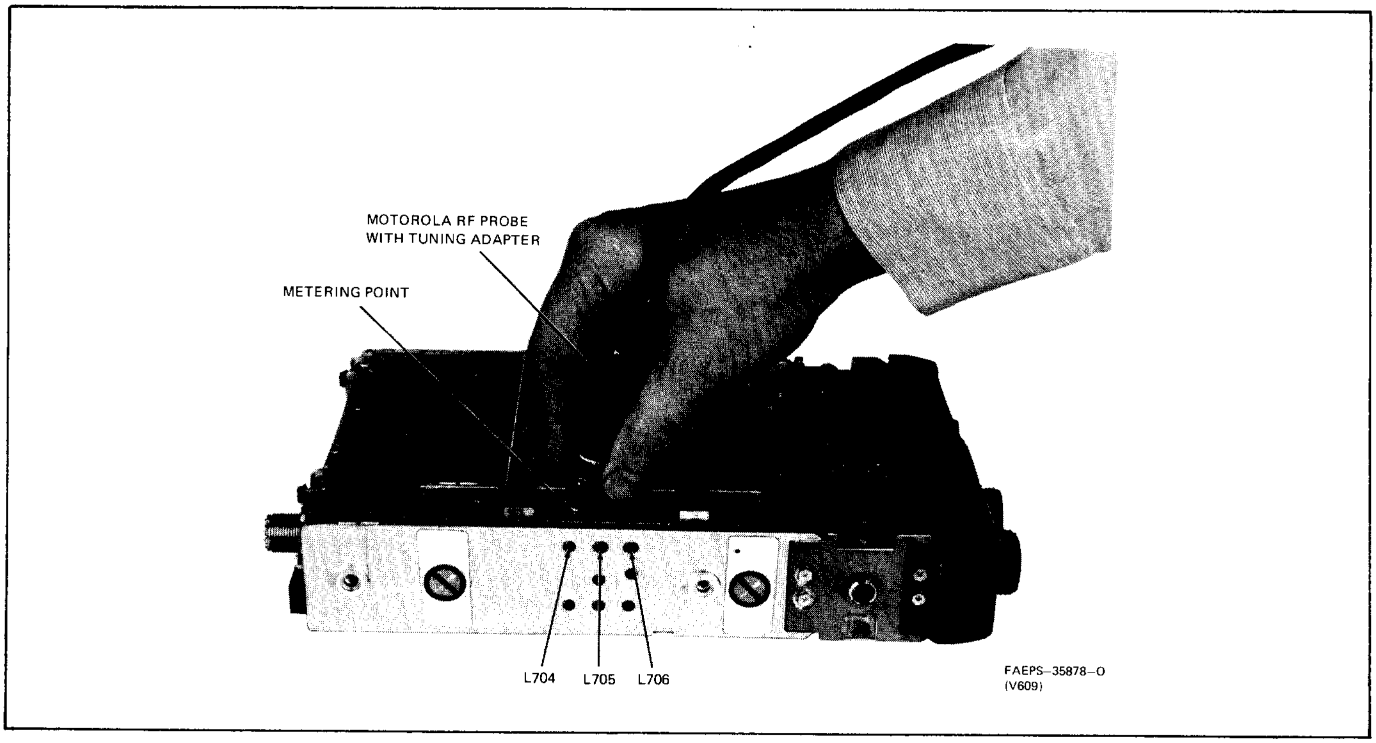

Figure 7. Synthesizer Side Tuning Probe Position (Widespace Dual Front End Low Range)

4.2 RF DECK ALIGNMENT PROCEDURE (WIDESPACE DUAL FRONT END TYPE)

In the following procedure, radios in the 136-to-162 MHz frequency range are referred to as Range 1 radio sets, and radios in the 146-to-174 MHz range are referred to as Range 2 radio sets. The terms high and low range refer to the ranges of the switched filters within the rf deck, the actual frequency ranges are determined by the requirements of the particular radio.

NOTE

The rf input coils (L701,L702,L703) of this type radio are covered with a strip of tape (refer to Figure 4). These coils are computer-set at the factory during assembly and **MUST NOT BE FIELD ADJUSTED**. If a replacement rf deck is purchased from Motorola, these coils will be preset by the factory. There should never be any reason to readjust these coils.

Step 1A. (Range 1 radios only) Carefully turn the slugs of coils L704, L705, L706, L707, L708, and L709 counterclockwise until the adjusting screws just protrude from the radio chassis wall.

Step 1B. (Range 2 radios only) Carefully turn the slugs of coils L704, L705, L706, L707, L708, and L709 clockwise until the adjusting screws are flush with the torque nut on the rf deck housing.

Step 2. Refer to label on the cover of the radio for tune-up frequencies for both high and low range switched filters. If the label is not supplied or is missing, contact your Motorola representative for information. The tune-up frequency is not necessarily the midpoint of the frequency range.

Step 3. Set the channel selector switch to any channel programmed into the radio.

Step 4. Connect an ac voltmeter across the audio output of the radio set. The audio output must be terminated in either the recommended 2-ohm speaker/audio load (refer to Table 1), or a 2-ohm resistor.

Step 5. Depress the squelch button and monitor button (if used), so that noise is heard in the speaker (if used).

Step 6. Adjust the volume control until a comfortable noise level is reached. If a 2-ohm load is used, adjust the volume control for an indication of approximately 1 volt across the load.

Step 7. Adjust L5 (quad coil) until maximum noise level is obtained from the speaker, or the highest reading on the voltmeter is obtained.

Step 8. Set the rf generator to the high range tune-up frequency, and set the channel selector to the *highest operating frequency*.

Step 9. Press the tuning probe adapter (Motorola No. TRN4778A) onto the probe of the rf voltmeter as shown in Figure 5.

Step 10. Place the radio into the position shown in Figure 6, and insert the test probe adapter tip through the HI RNG FLTR probe hole in the main board and into the tuning hole of the first cavity (L707) of the high range switched filter.

Step 11. Keep the probe in position, and turn L707 in (clockwise) for Range 1 radios or out (counterclockwise) for Range 2 radios until a peak in the voltmeter reading is obtained.

Step 12. Keep the probe in position, and turn L708 in the same direction (as in Step 11 for Range 1 or 2) until a dip in the voltmeter reading is obtained.

Step 13. Keep the probe in position, and turn L709 in the same direction (as in Step 11 for Range 1 or 2) until a peak in the voltmeter reading is obtained. The high range switched filter is now tuned.

Step 14. Set the signal generator to the low range tune-up frequency, and the channel selector switch to the *lowest operating frequency.*

Step 15. Place the radio in the position shown in Figure 7 and place the test probe adapter tip into the hole of the first cavity (L704) of the low range switched filter.

Step 16. Keep the probe in position and turn L704 in (clockwise) for Range 1 radios or out (counterclockwise) for Range 2 radios until a peak in the voltmeter reading is obtained.

Step 17. Keep the probe in position and turn L705 in the same direction (as in Step 16 for Range 1 or 2) until a dip in the voltmeter reading is obtained.

Step 18. Keep the probe in position, and turn L706 in the same direction (as in Step 16 for Range 1 or 2) until a peak in the voltmeter reading is obtained. Both switched filters are now tuned. Proceed to the Receiver Adjustments Procedure paragraph in this section of the manual.

4.3 RF DECK ALIGNMENT PROCEDURE (WIDESPACE SINGLE FRONT END TYPE)

Step 1. Carefully turn the slugs of coils L707, L708, and L709 clockwise until the adjusting screws are flush with the torque nut on the rf deck housing.

NOTE

The rf input coils (L701, L702, L703) and injection input coils (L710, L711, L712) of this type radio are covered with a strip of tape (refer to Figure 4). These coils are computer-set at the factory during assembly and **MUST NOT BE FIELD ADJUSTED**. If a replacement rf deck is purchased from Motorola, these coils will be preset by the factory. There should never be any reason to readjust these coils.

Step 2. Refer to label on the cover of the radio for tune-up frequency. If the label is not supplied or is missing, contact your Motorola representative for information. The tune-up frequency is not necessarily the midpoint of the frequency range.

Step 3. Set the channel selector switch to any channel programmed into the radio.

Step 4. Connect an ac voltmeter across the audio output of the radio set. The audio output must be terminated in either the recommended 2-ohm speaker/audio load (refer to Table 1), or a 2-ohm resistor.

Step 5. Depress the squelch button and monitor button (if used), so that noise is heard in the speaker (if used).

Step 6. Adjust the volume control until a comfortable noise level is reached. If a 2-ohm load is used, adjust the volume control for an indication of approximately 1 volt across the load.

Step 7. Adjust L5 (quad coil) until maximum noise level is obtained from the speaker, or the highest reading on the voltmeter is obtained.

Step 8. Set the rf generator to the tune-up frequency.

Step 9. Press the tuning probe adapter (Motorola No. TRN4778A) onto the probe of the rf voltmeter as shown in Figure 5.

Step 10. Place the radio into the position shown in Figure 6, and insert the test probe adapter tip through the HI RNG FLTR probe hole in the main board and into the tuning hole of the first cavity (L707) of the filter.

Step 11. Keep the probe in position and turn L707 in (clockwise) for Range 1 radios or out (counterclockwise) for Range 2 radios until a peak in the voltmeter reading is obtained.

Step 12. Keep the probe in position and turn L708 in the same direction (as in Step 11 for Range 1 or 2) until a dip in the voltmeter reading is obtained.

Step 13. Keep the probe in position and turn L709 in the same direction (as in Step 11 for Range 1 or 2) until a peak in the voltmeter reading is obtained. The filter is now tuned. Proceed to the Receiver Adjustments Procedure paragraph in this section of the manual.

4.4 RECEIVER ADJUSTMENTS PROCEDURE

NOTE

The following Receiver Adjustments Procedure is to be performed after the appropriate RF Deck Alignment Procedure is completed.

Step 1. Set the signal generator to provide an output of 1 mV at 1 kHz modulation at 3 kHz deviation. With the volume control set for a comfortable listening level, very slowly adjust L5 (quad coil) until a maximum tone level is obtained from the speaker (or a maximum indication across a 2-ohm load, if such a load is used).

Step 2. Set the generator to provide an unmodulated, on-frequency output signal that causes 10 dB of noise quieting.

Step 3. Turn R2103 (SQUELCH ADJ. potentiometer) fully counterclockwise and set the squelch pushbutton on the front panel to the OUT position.

Step 4. Turn R2103 clockwise until the speaker noise mutes; then *very slowly* turn it counterclockwise until the speaker noise just stays unmuted.

Step 5. Reduce the signal generator output level to zero and then *very slowly* increase it until the speaker unmutes. Verify that the noise quieting (at squelch opening) is between 9 and 11 dB.

Step 6. (For PL/DPL or *Select 5* radio sets only.) Using the signal generator, apply an on-frequency, unmodulated output signal that produces 23 dB of noise quieting. Adjust R1202 (BUSY LIGHT ADJ. potentiometer) until the busy light on the front panel just turns on.

Step 7. Check radio on all channels for 20 dB quieting sensitivity. The quieting level should not exceed 0.35 uV on any channel.

4.5 RECEIVER ALIGNMENT WITHOUT TUNE-UP PROM (SINGLE FRONT END MODELS ONLY)

NOTE

This receiver alignment procedure should be used if a tune-up PROM is required, but is not available.

Step 1. Turn the slugs of coils RF1, RF2, RF3, RF4, and RF5 clockwise until they reach the top of the coil forms.

Step 2. Carefully turn the slugs of coils L01, L02, and L03 clockwise until they touch the injection shield cover; then turn these slugs five full turns in a counterclockwise direction.

Step 3. Connect an ac voltmeter across the audio output of the radio set. The audio output must be terminated in either the recommended 2-ohm speaker/audio load (refer to test equipment list), or a 2-ohm resistor.

Step 4. Depress the squelch button and monitor button (if used), so that noise is heard in the speaker.

Step 5. Adjust the volume control until a comfortable noise level is obtained. If a 2-ohm load is used, adjust the volume control until an indication of approximately 1 volt is obtained across the load.

Step 6. Adjust L5 (quad coil) until maximum noise level is obtained from the speaker. Set the slugs of L01, L02, L03, RF1, RF2, RF3, RF4, and RF5 in accordance with the instructions provided in the graph of Figure 3.

Step 7. Select the receive channel with the lowest frequency with the channel selector switch.

Step 8. Connect a high input-impedance dc voltmeter to the INJ METER point (Figure 1) and set it to a low dc voltage range. Adjust coils L02, L01, and L03 (in this order) until a maximum dc voltage level (typically between 2.1 and 3.5 V dc) is obtained. Repeat the step until no further increase in dc voltage level can be obtained.

Step 9. Connect a signal generator to the antenna connector of the receiver and adjust the generator so that it will provide an on-frequency, unmodulated signal that is sufficiently strong to quiet the receiver. Connect a dc voltmeter to the RISE MTR test point (Figure 1) and set it to a low dc voltage range. Adjust coils RF1, RF2, RF3, RF4, and RF5 (in this order) until a maximum dc voltage indication is obtained. Adjust the signal generator, as required, to maintain the dc voltage between 2.5 and 3.5 V dc during tune-up. Repeat the step until no further increase in dc voltage level can be obtained.

Step 10. Select the receiver channel with the highest frequency. Connect a high-input-impedance dc voltmeter to the INJ METER point (Figure l) and set it to the appropriate low range. Noting the number of turns required, adjust L02, L01, and L03 in a clockwise direction (in this order) *only once* to obtain maximum dc voltage indication with each coil. (Some coils may not require any change.)

Step 11. Connect a dc voltmeter to the RISE MTR point (Figure l). Using a signal generator, apply an on-frequency, unmodulated signal of sufficient strength to quiet the receiver. Recording the number of turns required, adjust coils RF1, RF2, RF3, RF4, and RF5 in a clockwise direction (in the order listed) *only once* to obtain a maximum dc voltage indication with each coil (typically between 2.5 and 3.5 V). (Some coils may not require any change.) While performing the step, adjust the generator, as required, to maintain the dc voltage at the specified level (i.e., between 2.5 and 3.5 V dc).

Step 12. For any coil whose position was changed while performing Steps 10 and 11, turn the coil in question counterclockwise, the number of turns being *half* of those recorded in Steps 10 and 11.

Step 13. Set the signal generator to provide an output of 1 mV at 1 kHz modulation at 3 kHz deviation. With the volume control set for a comfortable listening level, very slowly adjust L5 (quad coil) until a maximum tone level is obtained from the speaker (or a maximum indication across a 2-ohm load, if such a load is used).

Step 14. Set the generator to provide an unmodulated, on-frequency output signal that causes 10 dB of noise quieting.

Step 15. Turn R2103 (SQUELCH ADJ. potentiometer) fully counterclockwise and set the squelch pushbutton on the front panel to the OUT position.

Step 16. Turn R2103 clockwise until the speaker noise mutes; then *very slowly* turn it counterclockwise until the speaker noise just stays unmuted.

Step 17. Reduce the signal generator output level to zero and then *very slowly* increase it until the speaker unmutes. Verify that the noise quieting (at squelch opening) is between 9 and 11 dB.

Step 18. (For PL/DPL or *Select 5* radio sets only.) Using the signal generator, apply an on-frequency, unmodulated output signal that produces 23 dB of noise quieting. Adjust R1202 (BUSY LIGHT ADJ. potentiometer) until the busy light on the front panel just turns on.

Step 19. Verify that 20 dB quieting is obtained on all the receive channels. *Slightly* adjust coils RF1, RF2, RF3, RF4, and RF5, if required, until all the receive channels are within the quieting sensitivity specification of 0.35 microvolts.

NOTE

Clockwise rotation of the coil slugs raises the tuning frequency, whereas a counterclockwise rotation lowers the tuning frequency.