



Professional Series
Two-Way Radio Basic Service Manual

CDM1550•LS⁺

200 MHz
700 MHz

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PRODUCT SAFETY AND RF EXPOSURE COMPLIANCE



Caution

Before using this product, read the operating instructions for safe usage contained in the Product Safety and RF Exposure booklet enclosed with your radio.

ATTENTION!

This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements.

Before using this product, read the RF energy awareness information and operating instructions in the Product Safety and RF Exposure booklet enclosed with your radio (Motorola Publication part number 68P81095C99) to ensure compliance with RF energy exposure limits.

For a list of Motorola-approved antennas, batteries, and other accessories, visit the following web site which lists approved accessories: <http://www.motorola.com/cgiss/index.shtml>.

Chapter 1

Introduction

1.1 Scope of Manual

This manual is intended for use by service technicians familiar with similar types of equipment. It contains service information required for the equipment described in this document and is current as of the printing date. Changes which occur after the printing date will be incorporated in a complete Manual Revision or alternatively as additions.

Note: Before operating or testing these units, please read the Safety Information Section at the beginning of this manual.

1.2 Warranty and Service Support

Motorola offers support which includes: full exchange and/or repair of the product during the warranty period; and service/repair or spare parts support out of warranty. Any "return for exchange" or "return for repair" to an authorized Motorola Dealer must be accompanied by a Warranty Claim Form. Warranty Claim Forms are available from Authorized Motorola Dealers.

1.2.1 Warranty Period and Return Instructions

The terms and conditions of warranty are defined fully in the Motorola Dealer, Distributor or Reseller contract. These conditions may change from time to time, and the following subsections are for guidance purposes only.

In instances where the product is covered under a "return for replacement" or "return for repair" warranty, a check of the product should be performed prior to shipping the unit back to Motorola. This is to ensure that the product has been correctly programmed or has not been subjected to damage outside the terms of the warranty.

Prior to shipping any radio back to the appropriate Motorola warranty depot, please contact Technical Support. (See section 1.2.4 on page 1-3 of this chapter.) All returns must be accompanied by a Warranty Claim Form available from your Customer Resources representative. Products should be shipped back in the original packaging, or correctly packaged to ensure that no damage occurs in transit.

1.2.2 After Warranty Period

After the Warranty period, Motorola continues to support its products in two ways:

1. Motorola's Radio Parts and Service Group offers repair service to users and dealers at competitive prices.
2. The Motorola Accessories and Aftermarket Division (AAD) supplies individual parts and modules that can be purchased by dealers who are capable of performing fault analysis and repair.

1.2.3 Piece Parts Availability

Some replacement parts, spare parts, and/or product information can be ordered directly.

If...	It Means That...
A complete Motorola part number is assigned to the part, and it is not identified as Depot ONLY	The part is available from AAD.
No part number is assigned	The part is not normally available from Motorola.
The part number is appended with an asterisk	The part is serviceable by a Motorola Depot only.
A parts list is not included	Generally, no user-serviceable parts are available for that kit or assembly.

Parts Order Entry:

7:00 A.M. to 7:00 P.M. (Central Standard Time)
Monday through Friday (Chicago, U.S.A.)

To Order Parts:

1-800-422-4210, or 847-538-8023
1-800-826-1913, or 410-712-4907 (U.S. Federal Government)
TELEX: 280127
FAX: 1-847-538-8198
FAX: 1-410-712-4991 (U.S. Federal Government)
(U.S.A.) after hours or weekends:
1-800-925-4357

Motorola Parts

Accessories and Aftermarket Division
(United States and Canada)
Attention: Order Processing
2200 Galvin Dr.
Elgin, IL 60123

Parts Identification

1-800-422-4210 menu 3

1.2.4 Technical Support

Technical support is available to assist the dealer/distributor in resolving any malfunction which may be encountered. For service, contact the Service Depot in your area. If your area does not have a depot, please contact your Business Development Manager, Distributor, or contact Motorola Technical Support. When contacting Motorola Technical Support, keep the product **model number** and the unit's **serial number** handy.

For service, contact one of the following Depots. Please call and confirm your return before sending the unit to the depot for service.

Motorola Radio Support Center

3761 South Central Avenue
Rockford, IL 61102-4294
1-800-227-6772
1-815-489-1000

Motorola Toronto Service Center

400 Matheson Blvd. W,
Mississauga, Ontario, Canada L5R 3M1
1-800-543-3222
1-416-756-5841
1-888-331-9872 (Fax)

Motorola U.S. Federal Government Depot

4395 Nicole Drive
Lanham, MD 20706
1-800-969-6680
1-301-731-6676

1.3 Radio Model Information

The model number and serial number are located on a label attached to the back of your radio. You can determine the RF output power, frequency band, protocols, and physical packages. The example on the next page shows one mobile radio model number and its specific characteristics.

Table 1-1. Radio Model Number (Example: AAM25MHF4DP5AN)

	Type of Unit	Model Series	Freq. Band	Power Level	Physical Packages	Channel Spacing	Protocol	Feature Level	Model Revision	Model Package
AA ↑ AA = Motorola Internal Use	M ↑ M = Mobile	25	M (200 MHz) 5 (700 MHz)	H 1 to 25 W or 1 to 15 W	F CDM1550•LS+	4 12.5 kHz	DP PassPort	5 4 Chan., 64 Chan., 128 Chan.	A	N

Chapter 2

Maintenance

2.1 Introduction

This chapter provides details about the following:

- Preventive maintenance (inspection and cleaning)
- Safe handling of CMOS and LDMOS devices
- Disassembly and reassembly of the radio
- Installation of optional retrofit kit
- Installation of option boards

2.2 Preventive Maintenance

The radios do not require a scheduled preventive maintenance program; however, periodic visual inspection and cleaning is recommended.

2.2.1 Inspection

Check that the external surfaces of the radio are clean, and that all external controls and switches are functional. It is not recommended to inspect the interior electronic circuitry.

2.2.2 Cleaning Procedures

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the radio. External surfaces include the front cover, housing assembly, and battery case. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime.

Note: Internal surfaces should be cleaned only when the radio is disassembled for service or repair.

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water. The only factory recommended liquid for cleaning the printed circuit boards and their components is Isopropyl alcohol (100% by volume).



CAUTION: Certain chemicals and their vapors can have harmful effects on certain plastics. Avoid using aerosol sprays, tuner cleaners, and other chemicals.

Cleaning External Plastic Surface

Apply the 0.5% detergent-water solution sparingly with a stiff, non-metallic, short-bristled brush to work all loose dirt away from the radio. Use a soft, absorbent, lintless cloth or tissue to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

Cleaning Internal Circuit Boards and Components

Isopropyl alcohol (100%) may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the radio. Make sure that controls or tunable components are not soaked with alcohol. Do not use high-pressure air to hasten the drying process.

since this could cause the liquid to collect in unwanted places. After completing the cleaning process, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any Isopropyl alcohol to the frame, front cover, or back cover.

Note: Always use a fresh supply of alcohol and a clean container to prevent contamination by dissolved material (from previous usage).

2.3 Safe Handling of CMOS and LDMOS Devices



CAUTION: This radio contains static-sensitive devices. Do not open the radio unless you are properly grounded. Take the following precautions when working on this unit:

- Store and transport all CMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS devices into conventional plastic “snow” trays used for storage and transportation of other semiconductor devices.
- Ground the working surface of the service bench to protect the CMOS device. We recommend using the Motorola Static Protection Assembly (part number 0180386A82), which includes a wrist strap, two ground cords, a table mat, and a floor mat.
- Wear a conductive wrist strap in series with a 100k resistor to ground. (Replacement wrist straps that connect to the bench top covering are Motorola part number RSX-4015.)
- Do not wear nylon clothing while handling CMOS devices.
- Do not insert or remove CMOS devices with power applied. Check all power supplies used for testing CMOS devices to be certain that there are no voltage transients present.
- When straightening CMOS pins, provide ground straps for the apparatus used.
- When soldering, use a grounded soldering iron.
- If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

Complementary metal-oxide semiconductor (CMOS) devices are used in this family of radios, and are susceptible to damage by electrostatic or high voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, special precautions must be taken to prevent device damage during disassembly, troubleshooting, and repair.

Handling precautions are mandatory for CMOS circuits and are especially important in low humidity conditions. DO NOT attempt to disassemble the radio without first referring to the above CAUTION statement.

2.4 Repair Procedures and Techniques — General

Parts Replacement and Substitution

When damaged parts are replaced, identical parts should be used. If the identical replacement part is not locally available, check the parts list for the proper Motorola part number. Order parts from the nearest Motorola Communications parts center listed in Chapter 1, Introduction.

Rigid Circuit Boards

This family of radios uses bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The printed-through holes may interconnect multiple layers of the printed circuit. Therefore, exercise care to avoid pulling the plated circuit out of the hole.

When soldering near the 20-pin and 40-pin connectors:

- Avoid accidentally getting solder in the connector.
- Be careful not to form solder bridges between the connector pins.
- Examine your work closely for shorts due to solder bridges.

2.5 Disassembling and Reassembling the Radio — General

Since these radios may be disassembled and reassembled with the use of only six (board to casting) screws, it is important to pay particular attention to the snaps and tabs, and how parts align with each other.

The following tools are required for disassembling the radio:

- Small flat blade screwdriver
- TORX™ T20 screwdriver
- Dismantling Tool

If a unit requires more complete testing or service than is customarily performed at the basic level, send the unit to a Motorola Authorized Service Center. (See Chapter 1, Introduction for a list of regional service centers.)

The following disassembly procedures should be performed only if necessary.

2.6 Radio Disassembly — Detailed

The procedure to remove and replace a control head is similar for all models of radio. A typical procedure is therefore shown in the following.

2.6.1 Control Head Removal

1. Insert the dismantling tool in the groove between the control head and the radio assembly as shown in Figure 2-1.
2. Press on the dismantling tool until the snap connectors on the side of the control head release from the radio assembly.

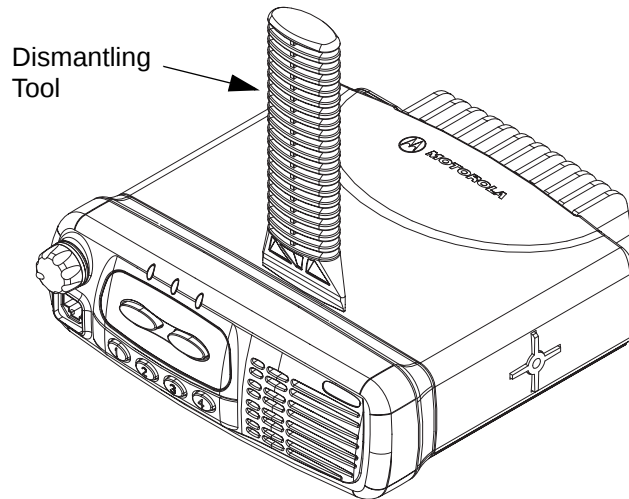


Figure 2-1. Typical Control Head Removal

3. Pull the control head away from the radio assembly as shown in Figure 2-2.

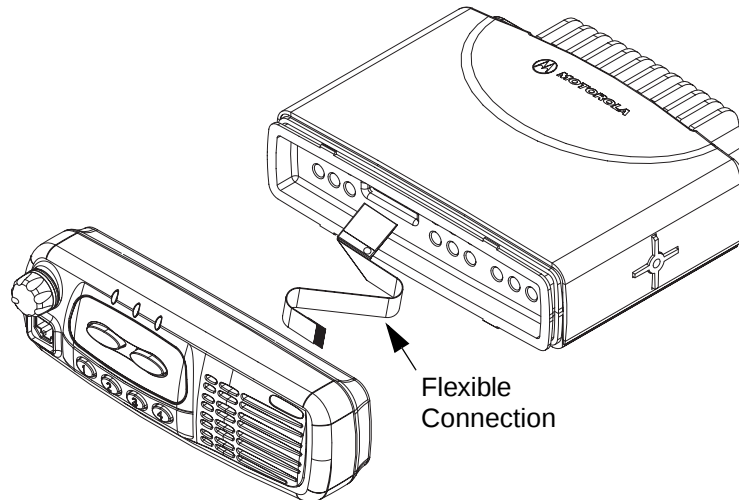


Figure 2-2. Flexible Connection Removal

4. Remove the flexible connection from the socket on the control head board.

2.6.2 Top Cover Removal

1. Insert the dismantling tool in the middle of the radio assembly side groove as shown in Figure 2-3.
2. Press on the dismantling tool until the snap connectors on the side of the cover release from the radio chassis.

3. Lift the top cover from the chassis.

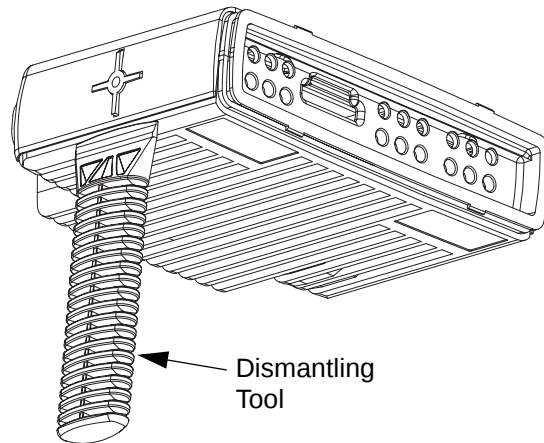


Figure 2-3. Top Cover Removal

2.6.3 Transceiver Board Removal

1. Remove six screws from the diecast cover using the T20 TORX™ driver as shown in Figure 2-4.
2. Lift the cover from the chassis.

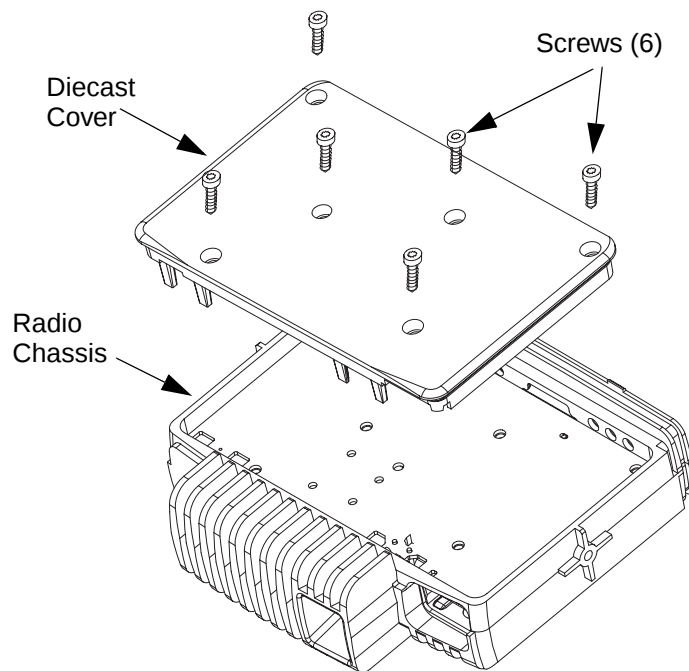


Figure 2-4. Diecast Cover Removal

3. Slowly lift the transceiver board on the edge at the front of the radio (the edge that mates with the control head) and pull gently toward the front of the radio as shown in Figure 2-5. Take care to slide the antenna connector and power connector out of the chassis towards the front.
4. Once the transceiver board is removed from the radio chassis, handle it per the procedure for "Safe Handling of CMOS and LDMOS Devices", Section 2.3. In addition, take care not to disturb the thermal pad material that may adhere to the devices that mate with the thermal pads located on the radio chassis. Do not disturb the thermal pad on the radio chassis as well. Also, do not disrupt the conductive bead gasket that is applied to the radio chassis walls.

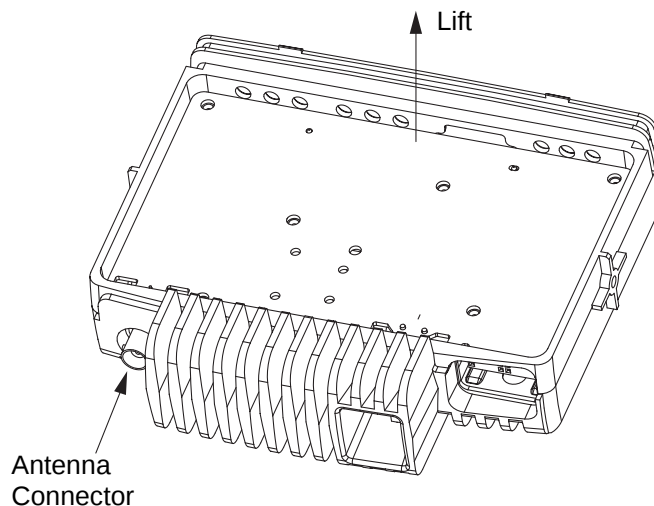


Figure 2-5. Transceiver Board Removal

2.6.4 Control Head Disassembly

1. Dismount the control head housing from the back housing, by inserting the dismantling tool in the groove between the two housings as shown in Figure 2-6.

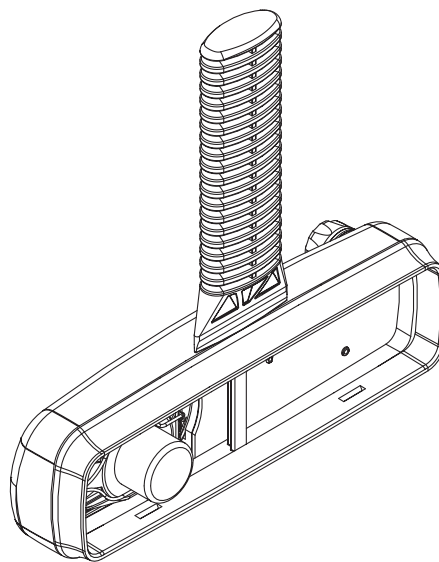


Figure 2-6. Control Head Back Housing Removal

2. Press the dismantling tool until the snap connectors on the side of the back housing release from the control head.

3. Disconnect the speaker socket and remove the speaker (Figure 2-7) with tube by stretching the control head housing and pulling out the tube.

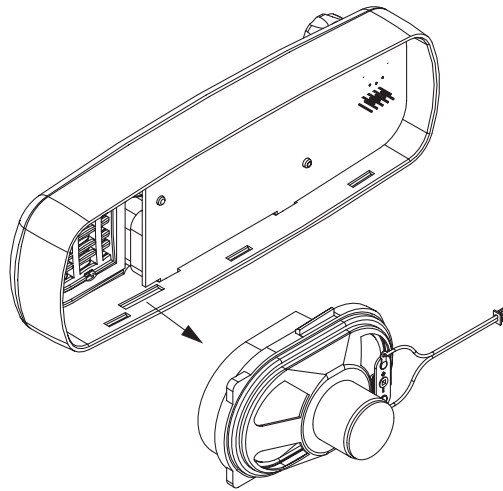


Figure 2-7. Speaker and Speaker Tube Removal

4. Remove the board from the control head housing by stretching the control head housing and pulling up on the board as shown in Figures 2-7 and 2-8. The knob will remain with the control head housing.

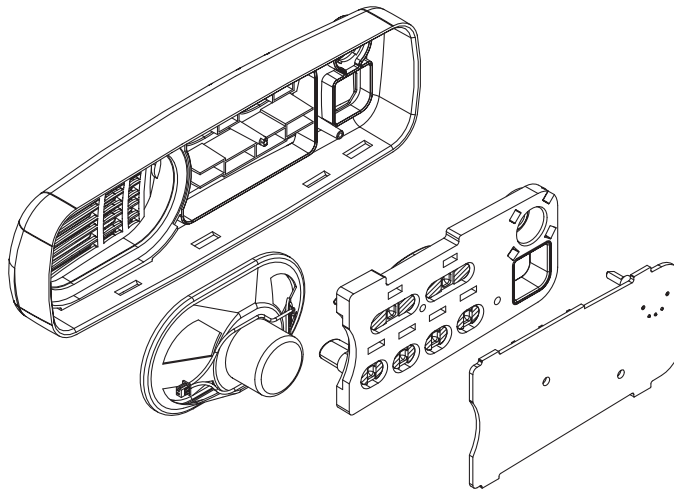


Figure 2-8. Board, Keypad and Speaker Removal

5. Remove the keypad from the control head housing by lifting up the rubber keypad.
6. Remove the display from the control head housing.

Note: DO NOT touch or contaminate the conductive pads on the under side of the keypad or the conductive contacts on the printed circuit board.

2.7 Radio Assembly

2.7.1 Control Head

1. Locate the display in the control head ensuring that the two cut-outs in the display are aligned with their corresponding indentations, then press the display into place.

Note: DO NOT touch or contaminate the conductive pads on the underside of the display.

2. Fit the rubber keypad onto the board ensuring that the on/off control and accessory connector on the board locate correctly with the cut-outs in the keypad.
3. On the board, rotate the on/off control spindle fully counter-clockwise.
4. Rotate the volume knob on the front housing counter-clockwise.
5. Align the board (with the rubber keypad attached) with the control head, inserting the on/off control spindle and accessory connector through the holes in the control head.
6. Ensure that the keypad, on/off control spindle and microphone connector are aligned with the control head then press the board into place until it clicks.
7. Insert the speaker and speaker tube with speaker into the control head and press it in until it clicks.
8. Connect the speaker connector to the board.

2.7.2 Radio Chassis and Transceiver Board

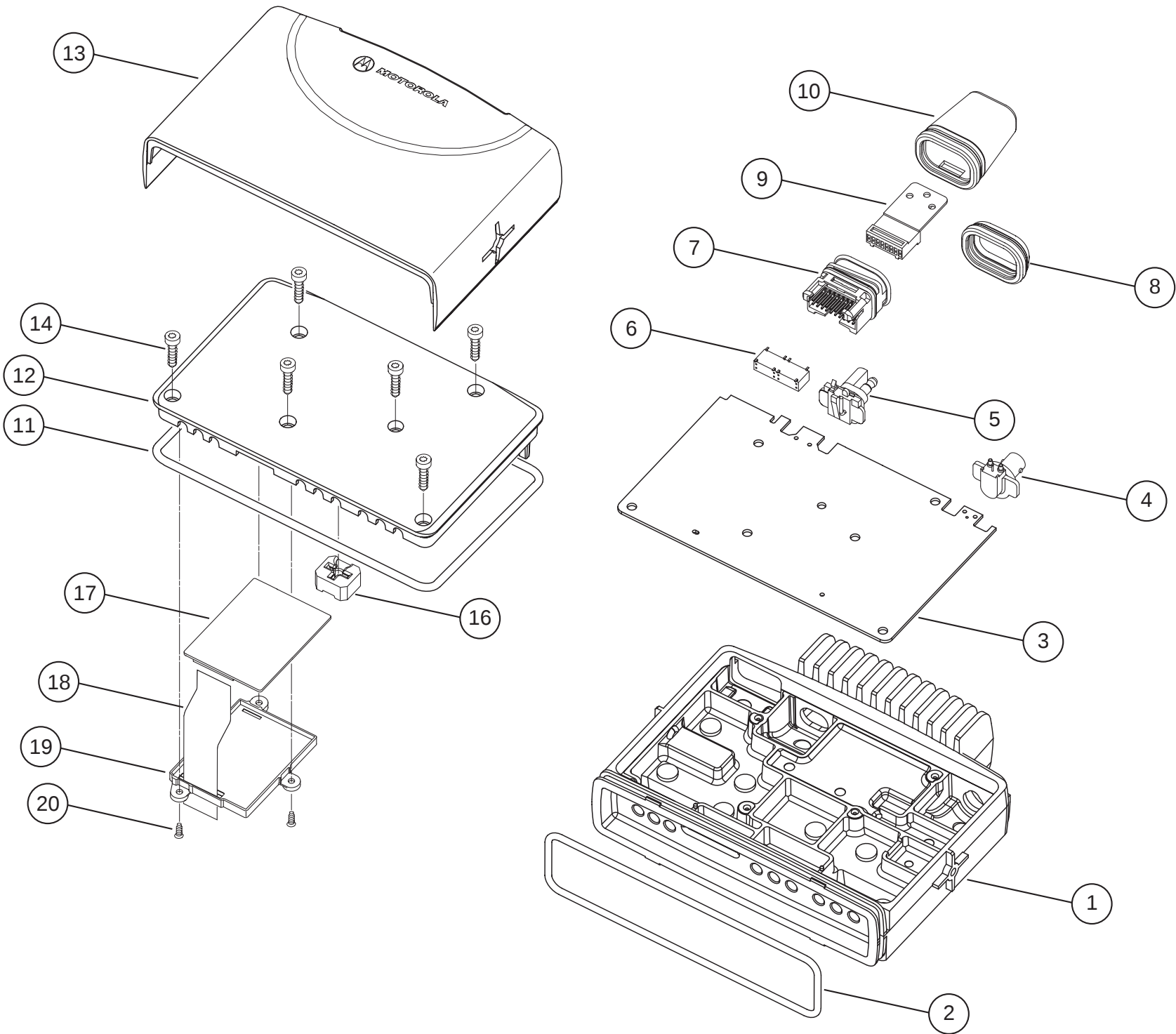
1. Inspect the transceiver board and if required reapply thermal grease to the heatsink area on the chassis and heat dissipating devices. You may have to scrap existing thermal pad from the chassis prior to applying the grease.
2. Insert the transceiver board at an angle (approximately 30°) into the chassis taking care to slide the antenna connector and accessory connector into their cut-outs in the chassis.
3. Lower the transceiver board onto the chassis and align the two locating holes in the board with the locating pins in the chassis.
4. Secure the cover to the chassis with the six screws previously removed.
5. Torque the six screws to 17 in-lbs (1.9 NM) using the T20 TORX™ driver. Begin with the two screws located in the middle of the chassis followed by the four outer screws. Since the screws usually take a set, torque the screws a second time to 17 in-lbs (1.9 NM) in the same order.
6. Refit the top cover over the assembled radio chassis. Press the cover down until it snaps into place.

2.7.3 Control Head Fitting

1. Align the "0" mark on the flex with the "0" mark on the chassis to the socket on the radio assembly as shown in Figure 2-2.
2. Check that the back housing o-ring seal is undamaged and fitted in the groove. Replace the seal if it is damaged (for more information, please see the exploded view diagrams and parts list in the following section).
3. Fit the back housing to the control head. Ensure that the tags on the back housing align with the snap catch grooves on the control head. Press the back housing into place until it snaps into place.
4. Check that the radio chassis o-ring seal is undamaged and fitted in the groove on the chassis assembly. Replace the seal if it is damaged.

2.8 Radio Assembly Exploded Mechanical View and Parts List

Item	Motorola Part Number	Description
1	2786082B02	Chassis 200 MHz
	2766521A01	Chassis 700 MHz
2	3202620Y01	Gasket, Controlhead
3		Main PCB (items 4, 5, and 8 included)
4	0986166B02	Antenna Connector with Gasket Mini UHF
5	0986165B01	Power Connector with Gasket
6	0986105B01	Connector, 20-Pin
7	2886122B02	Connector Assembly
8	3202607Y01	Gasket, Cover
9	1580922V01 (optional)	Connector, Housing
10	3202606Y01 (optional)	Gasket, Accessory Connector
11	3286085B01 (part of item 12, 200 MHz)	Gasket, Cover 200 MHz Models
	3286095B01 (part of item 12, 700 MHz)	Gasket, Cover 700 MHz Models
12	1586084B01	Cover, 200 MHz Models
	1566511A01	Cover, 700 MHz Models
13	1586083B01	Cover, Plastic 200 MHz Models
	1586170B01	Cover, Plastic 700 MHz Models
14	0310911A30 (M4)	Screw, T20, 6 used
16	7586187B01	Silicon Pressure Pad for LDMOS Power Devices, 200 MHz Models
	7586253Z01	Silicon Pressure Pad for LDMOS Power Devices, 700 MHz Models
17	0104015J14	PassPort Board
18	8480475Z03	Flex Controller - Keypad
19	0786183B01	Frame Option Board
20	0310943R55	Screw TT3x10 - 5x8



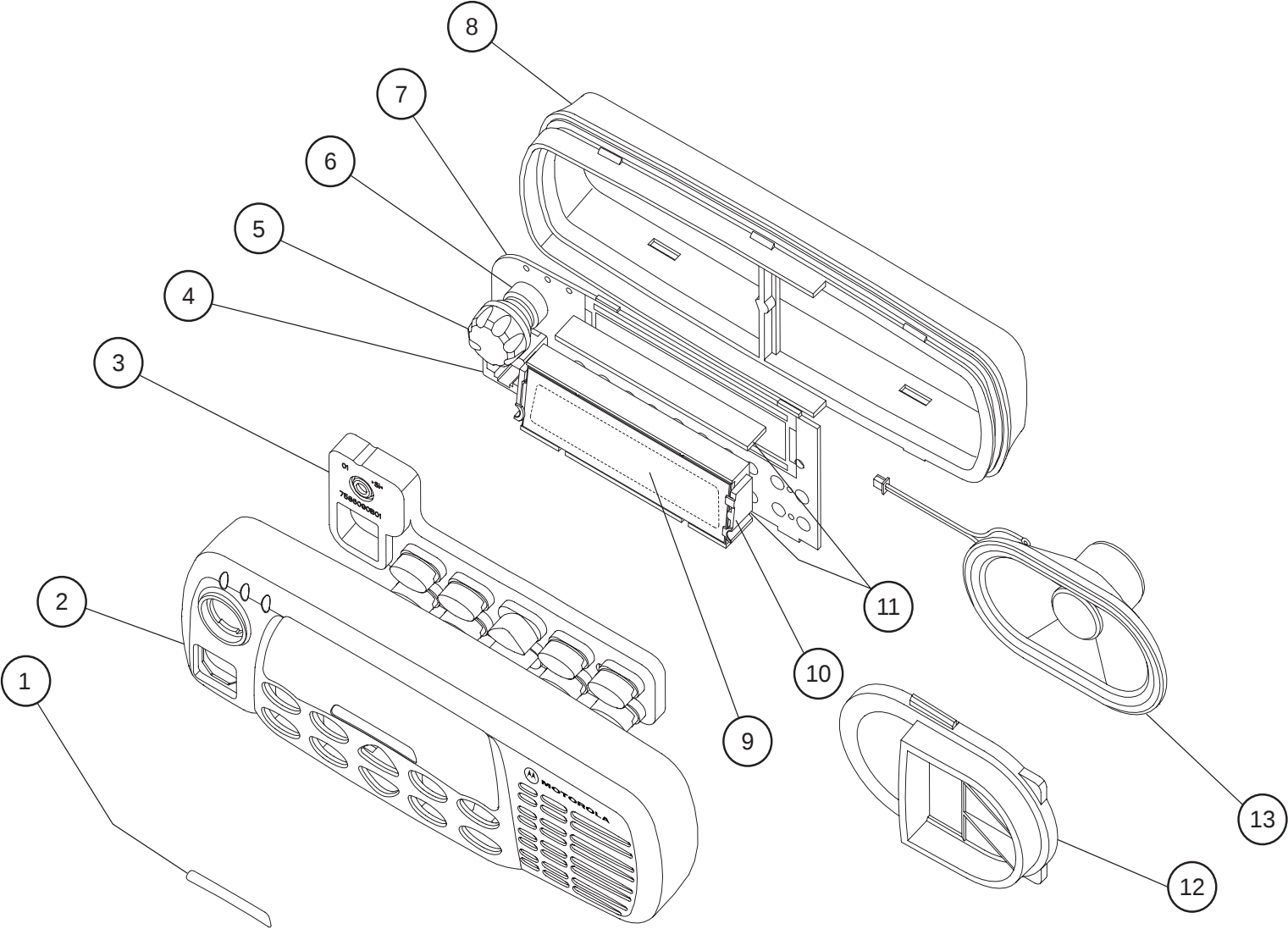
2.9 Radio Control Head Exploded Mechanical View and Parts List

Item	Motorola Part Number	Description
1	5486132B20 5486132B21	Nameplate - CDM1550•LS ⁺ , 200 MHz Nameplate - CDM1550•LS ⁺ , 700 MHz
2	1586088B01	Housing Front
3	7586091B02*	Keypad
4	2864287B01	10-Pin, Microphone Jack
5	3686098B02	Knob, Volume
6	1805911V01	Potentiometer
7	GLN7353A	PCB
8	1586093B02 [‡]	Back Housing
	3986218B01	Including Ground Clip
	3286094B01	Including O-ring
9	7286104B01	LCD Glass
10	0786099B01	Frame LCD
11	2886130B01 2886130B02	Connector, Elastomeric Connector, Elastomeric
12	3786107B01 [†]	Tube, Speaker
13	5086126B01 [†] 8486127B01	Speaker Flex, 12-Position Connector (not shown)

* Please refer to section 6.1.13 on page 6-5 in Chapter 6, Accessories for a complete list of part numbers for Keypad Buttons.

[‡] When using new Backhousing (1586093B02) for Control Head GCN6114A with PCB - GLN7353A (8486155B05), the grounding clips must be removed.

[†] Speaker (13) and Tube (12) are glued together using self-adhesive material. If replacement is required, it is recommended that both parts are ordered.



2.10 Service Aids

Table 2-1 lists service aids recommended for radio maintenance.

Table 2-1. Service Aids

Motorola Part No.	Description	Application
RLN4460	Portable Test Set	Enables connection to audio/accessory jack. Allows switching for radio testing.
HVN9025	Customer Programming Software (CPS) Tuner CD ROM. Includes PPCPS (PassPort Customer Programming Software).	Programs customer option and channel data. Tunes hardware parameters, front end, power, deviation, etc. Conventional, LTR, and PassPort products.
AARKN4081	Programming Cable with Internal RIB	Includes radio interface box (RIB) capability.
RLN4853	10 to 20 Pin Adapter	Used with RKN4081.
AARKN4083	Mobile Programming/Test Cable	Connects radio to RIB (RLN4008).
RLN4008	Radio Interface Box	Enables communications between radio and computer's serial communications adapter.
HLN8027	Mini UHF to BNC Adaptor	Adapts radio antenna port to BNC cabling of test equipment.
8180384J59	Chassis Eliminator, 200 MHz Models	
6666500A01	Chassis Eliminator, 700 MHz Models	
6686119B01	Dismantling Tool	Assists in the removal of radio control head.

2.11 Test Equipment

Table 2-2 lists test equipment required to service these and other two-way radios.

Note: While all of these items are available from Motorola, most are standard shop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 2-2. Recommended Test Equipment

Motorola Part No.	Description	Characteristics	Application
R2000, R2600 R2400, R2001, or R2590 with LTR trunking and PassPort [†]	Service Monitor	This monitor will substitute for items listed below with an asterisk *	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1049	Digital Multimeter		Two meters recommended for AC/DC voltage and current measurements
*S1100	Audio Oscillator	67 to 200Hz tones	Used with service monitor for injection of PL tones
*S1053, *SKN6009, *SKN6001	AC Voltmeter, Power Cable for meter, Test leads for meter	• 1 mV to 300 V • 10 MΩ input impedance	Audio voltage measurements
R1053	Dual-trace Oscilloscope	20 MHz bandwidth, 5 mV/cm - 20 V/cm	Waveform measurements
R1443A	Broadband Watt-meter		Transmitter power output measurements
S1339	RF Millivolt Meter	100 μ V to 3 VRF, 10 kHz to 1.2 GHz	RF level measurements
*R1013	SINAD Meter		Receiver sensitivity measurements
S1348 (prog)	DC Power Supply	0-20 Vdc, 0-20 Amps	Bench supply for 13.2Vdc

[†] For those customers that need to test the LTR functioning of their radio instead of the R2600, purchase the R2590 with LTR option.

2.12 Programming Test Cable Configuring and Wiring

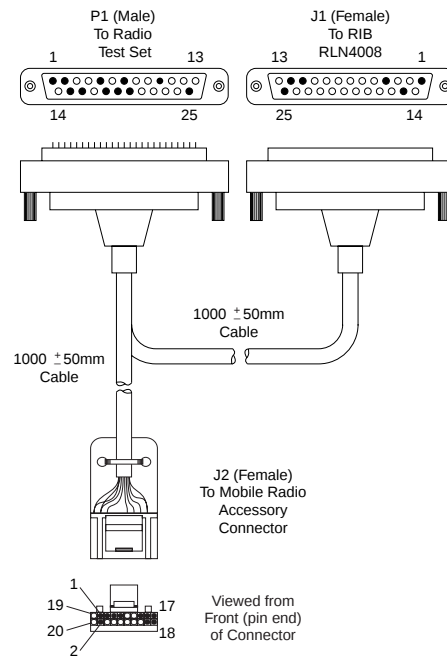


Figure 2-9. Programming/Test Cable AARKN4083_

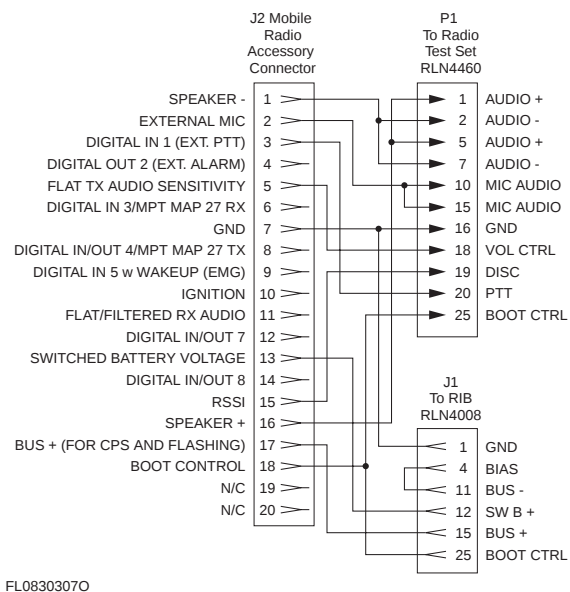


Figure 2-10. Pin Configuration of the Cable Side Connector

Notes

2.12 Programming Test Cable Configuring and Wiring

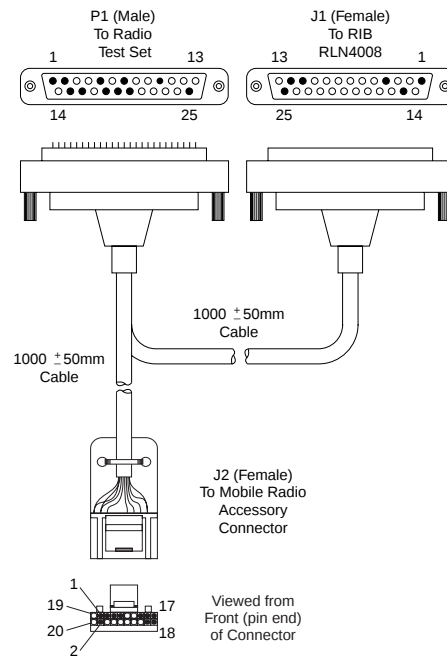


Figure 2-9. Programming/Test Cable AARKN4083_

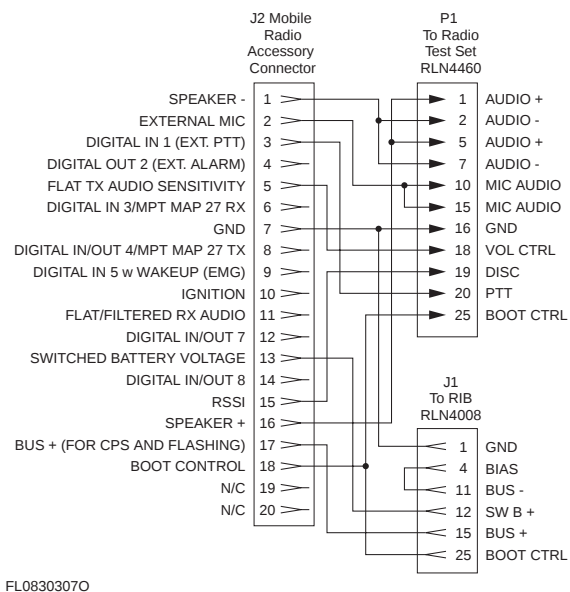


Figure 2-10. Pin Configuration of the Cable Side Connector

Notes

Chapter 3

Transceiver Performance Testing

3.1 General

These radios meet published specifications through their manufacturing process by utilizing high-accuracy laboratory-quality test equipment. The recommended field service equipment approaches the accuracy of the manufacturing equipment with few exceptions. This accuracy must be maintained in compliance with the manufacturer's recommended calibration schedule.

3.2 Setup

Supply voltage is provided using a 13.2 Vdc power supply. The equipment required for alignment procedures is connected as shown in the Radio Tuning Test Equipment Setup Diagram, Table 4-4.

Initial equipment control settings should be as indicated in Table 3-1. The remaining tables in this chapter contain the following related technical data:

Table 3-1. Table Chart

Table Number	Title
3-2	Initial Equipment Control Settings
3-3	Test Environments
3-4	Test Channel Spacing
3-5	Test Frequencies
3-6	Transmitter Performance Checks
3-7	Receiver Performance Checks

Table 3-2. Initial Equipment Control Settings

Service Monitor	Test Set	Power Supply
Monitor Mode: Power Monitor	Spkr set: A	Voltage: 13.2Vdc
RF Attn: -70	Spkr/load: Speaker	DC On/Standby: Standby
AM, CW, FM: FM	PTT: OFF	Volt Range: 10V
Oscilloscope Source: Mod Oscilloscope Horiz: 10mSec/Div Oscilloscope Vert: 2.5kHz/Div Oscilloscope Trig: Auto Monitor Image: Hi Monitor BW: Nar Monitor Squelch: mid CW Monitor Vol: 1/4 CW		Current: 2.5A

3.3 RF Test Mode

This test mode is for display radios only. When the radio is operating in its normal environment, the radio's microcontroller controls the RF channel selection, transmitter key-up, and receiver muting. However, when the unit is on the bench for testing, alignment, or repair, it is removed from its normal environment and cannot receive commands from its system. Therefore, the internal microcontroller does not key the transmitter or unmute the receiver. This prevents the use of a normal tuning procedure. To solve this problem, a special "test mode" is incorporated into the radio.

Note: The test mode procedure that follows assumes that the Customer Programming Software front panel access (FPA) screen has both the FPA and RF TEST boxes selected. Select from the programming screen to enable or disable certain features of the radio RF test mode.

- FPA entry not selected blocks all test modes.
- FPA entry selected and RF TEST not selected blocks RF test mode.
- FPA entry selected and RF TEST selected enables all test modes.

To enter test mode:

1. Turn the radio on.
2. Within ten seconds after the self-test is complete, press button **P2**, five times in succession.
3. After “CSQ CHXX SP25” appears in the display, the radio is on channel XX*, carrier squelch mode, 25 kHz channel spacing.
4. Each additional press of **P2** scrolls through to the next channel spacing and a corresponding set of tones is sounded, as shown in Table 3-4.

Note: Only 12.5 kHz operation is available on these models. Do not select 25 kHz or 20 kHz.

5. Pressing **P1** scrolls through and accesses test environments as shown in Table 3-3.
6. Pressing **P2** for three seconds switches the radio to the control head test mode. ‘**LCD Test**’ appears on the display.
7. Pressing **P1** causes the radio to turn on all the dots of the first character. Another **P1** press turns on all the dots of the next character and so on until the last character (character 14).
8. Pressing **P1** at the end of the LCD test activates the ‘Icon Test’. The next **P1** press turns on the first icon.
9. Pressing **P1** at the end of the Icon test activates the button test. Pressing any button (except P1) or any keypad button during the LCD test or Icon test immediately activates this test.
10. Pressing **P2** for 3 seconds in the control head test mode causes the radio to return to the RF test mode.

*XX = channel number (01 - 14)

Table 3-3. Test Environments

No. of Beeps	Description	Function
1	Carrier Squelch	RX: if carrier detected TX: mic audio
1	Tone Private-Line	RX: unsquelch if carrier and tone (192.8Hz) detected TX: mic audio + tone (192.8Hz)
2	Digital Private-Line	RX: unsquelch if carrier and digital code (131) detected TX: mic audio + digital code (131)
3	Dual-Tone multiple frequency	RX: unsquelch if carrier detected TX: selected DTMF tone pair
9	MDC1200 HSS	RX: unsquelch if carrier detected TX: 1500Hz tone
5	Unsquelch Open	RX: constant unsquelch TX: mic audio
11	CMP	RX: if carrier detected TX: mic audio
12	LLE	RX: if detected TX: mic audio

Table 3-4. Test Channel Spacing

Number of Beeps	Channel Spacing
1	25 kHz
2	12.5 kHz
3	20 kHz

Note: Only 12.5 kHz operation is available on these models. Do not select 25 kHz or 20 kHz.

Table 3-5. Test Frequencies

Test Mode	Test Channel Low Power	Test Channel High Power	200 MHz	700 MHz
TX	1	8	217.025	746.125
RX	1	8	217.025	746.125
TX	2	9	217.975	746.975
RX	2	9	217.975	746.975
TX	3	10	219.125	762.125
RX	3	10	219.125	762.125
TX	4	11	219.775	763.975
RX	4	11	219.775	763.975
TX	5	12	220.525	776.525
RX	5	12	220.525	763.975
TX	6	13	221.275	792.025
RX	6	13	221.275	763.975
TX	7	14	221.975	793.975
RX	7	14	221.975	763.975

Table 3-6. Transmitter Performance Checks

Test Name	Communications Analyzer	Radio	Test Set	Comment
Reference Frequency	Mode: PWR MON 4th channel test frequency* Monitor: Frequency error Input at RF In/Out	TEST MODE, Test Channel 4 carrier squelch	PTT to continuous (during the performance check)	Frequency error: ±150 Hz 200 MHz, ±450 Hz 700 MHz
Power RF	As above	As above	As above	25-29 W 200 MHz 15-17.4 W 700 MHz
Voice Modulation	Mode: PWR MON 4th channel test frequency* atten to -70, input to RF In/ Out Monitor: DVM, AC Volts Set 1kHz Mod Out level for 800mVrms at test set, 800mVrms at AC/DC test set jack	As above	As above, meter selector to mic	Deviation: 2.5 kHz Max. (12.5 kHz Ch. Sp)
Voice Modulation (internal)	Mode: PWR MON 4th channel test frequency* atten to -70, input to RF In/ Out	TEST MODE, Test Channel 4 carrier squelch output at antenna	Remove modulation input	Deviation: 2.5 kHz Max. (12.5 kHz Ch. Sp.)
High-Speed Data Modulation**	As above	TEST MODE, Test Channel 4 high speed output at antenna	PTT to continuous (during the performance check).	Deviation: 1.6-1.9 kHz (12.5 kHz Ch. Sp.)
DTMF Modulation	As above, 4th channel test frequency*	TEST MODE, Test Channel 4 DTMF output at antenna	As above	Deviation: 1.4-1.9 kHz (12.5 kHz Ch. Sp.)
PL/DPL Modulation	As above 4th channel test frequency* BW to narrow	TEST MODE, Test Channel 4 TPL DPL	As above	Deviation: 0.25-0.5 kHz (12.5 kHz Ch. Sp.)

* See Table 3-5

** MDC

Table 3-7. Receiver Performance Checks

Test Name	Communications Analyzer	Radio	Test Set	Comment
Rated Audio	Mode: GEN Output level: 1.0mV RF 4th channel test frequency* Mod: 1kHz tone at 3kHz deviation Monitor: DVM: AC Volts	TEST MODE Test Channel 4 carrier squelch	PTT to OFF (center), meter selector to Audio PA	Set volume control to 8Vrms
Distortion	As above, except to distortion	As above	As above	Distortion <5.0%
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12dB SINAD.	As above	PTT to OFF (center)	RF input to be <0.3 μ V (200 MHz) <0.35 μ V (700 MHz)
Noise Squelch Threshold (only radios with conventional system need to be tested)	RF level set to 1mV RF	As above	PTT to OFF (center), meter selection to Audio PA, spkr/ load to speaker	Set volume control to 3.16Vrms
	As above, except change fre- quency to a conventional sys- tem. Raise RF level from zero until radio unsquelches.	out of TEST MODE; select a conventional system	As above	Unsquelch to occur at <0.25 μ V. Preferred SINAD = 7-8dB

* See Table 3-5

Chapter 4

Radio Programming and Tuning Procedures

4.1 Introduction

This chapter provides an overview of the Customer Programming Software (CPS) and tuner program designed for use in a Windows® NT, Windows® 95, Windows® 98, Windows® 2000, and Windows® Millennium (ME), environment. These programs are available in separate kits as listed in Table 4-1. An installation instruction manual is also included with each kit.

Note: Refer to the appropriate program on-line help files for the programming procedures.

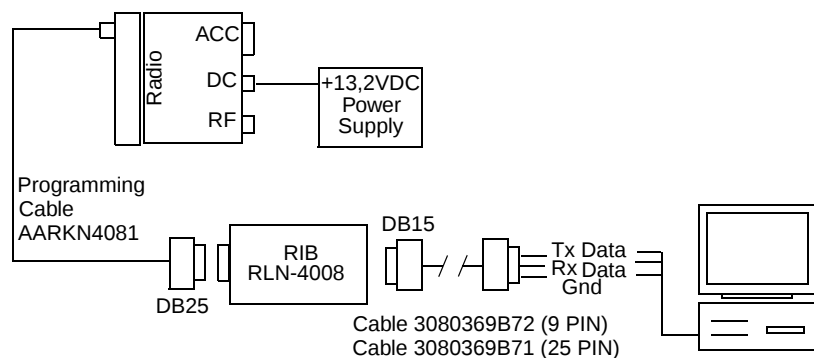
Table 4-1. Software Installation Kit Radio Tuning Setup

Description	Kit Number
Customer Programming Software (CPS+) CD Includes CPS and PPCPS	HVN9025_

4.2 CPS Programming Setup

The CPS programming setups, shown in Figures 4-1 through 4-3, are used to program the radio.

Note: Refer to the appropriate program on-line help files for detailed programming procedures.



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Figure 4-1. CPS Programming Setup with RIB

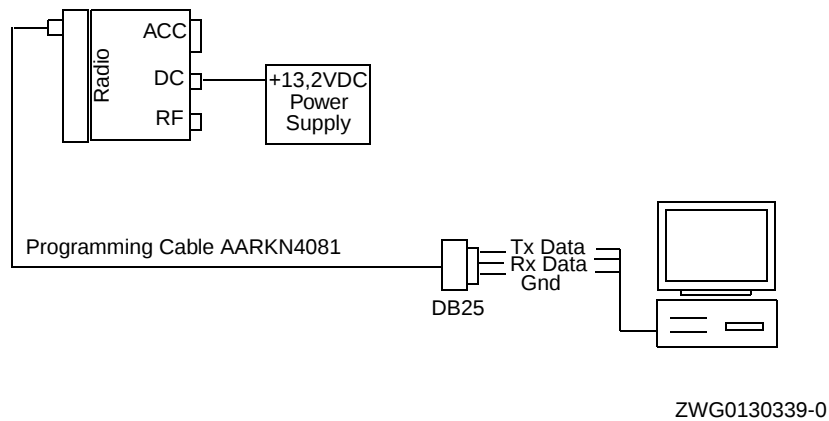


Figure 4-2. CPS Programming Setup Cable with Internal RIB

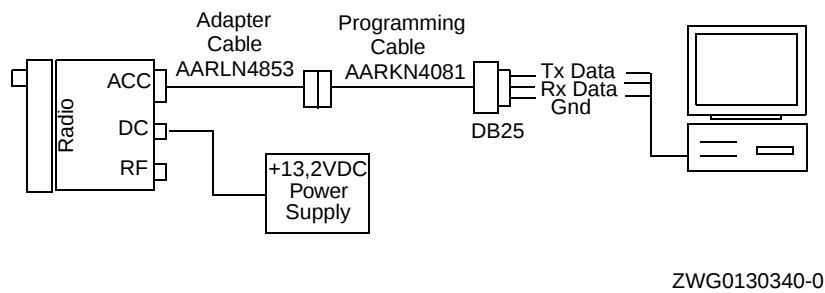
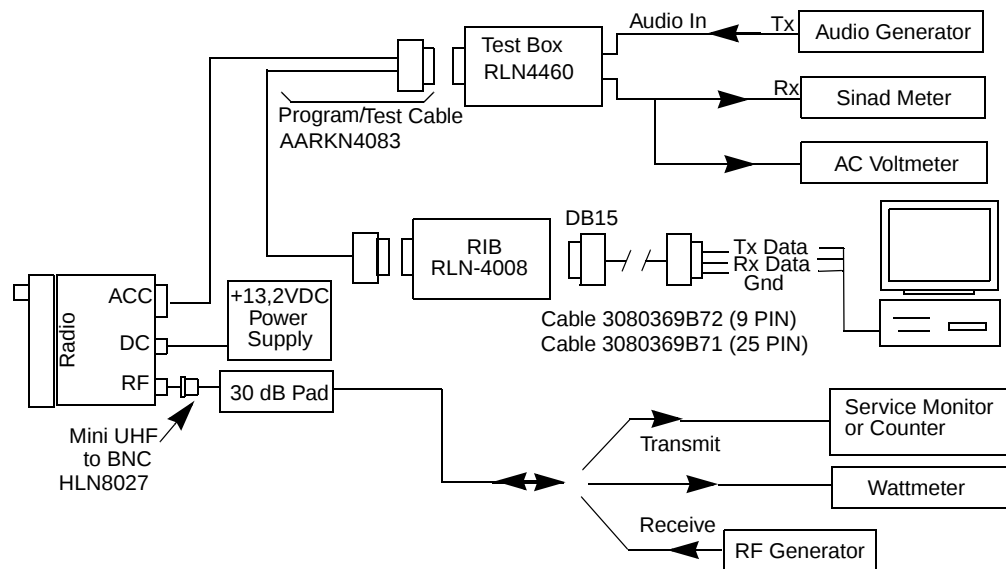


Figure 4-3. CPS Programming Setup Cable with Internal RIB and Rear Adapter Cable

4.3 Radio Tuning Setup

A personal computer (PC), a supported Windows[®] environment, and a tuner program are required to tune the radio. To perform the tuning procedures, the radio must be connected to the PC, radio interface box (RIB), and test equipment setup as shown in Figure 4-4.



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Figure 4-4. Radio Tuning Test Equipment Setup with External RIB

4.3.1 Initial Test Equipment Control Settings

The initial test equipment control settings are listed in Table 4-2.

Table 4-2. Initial Equipment Control Settings

Service Monitor	Test Set	Power Supply
Monitor Mode: Power Monitor	Speaker set: A	Voltage: 13.2Vdc
RF Attenuation: -70	Speaker/load: Speaker	DC on/standby: Standby
AM, CW, FM: FM	PTT: OFF	Volt Range: 20V
Oscilloscope Source: Mod Oscilloscope Horizontal: 10mSec/Div Oscilloscope Vertical: 2.5 kHz/Div Oscilloscope Trigger: Auto Monitor Image: Hi Monitor BW: Nar Monitor Squelch: mid CW Monitor Volume: 1/4 CW		Current: 20A

4.4 Transmitter Tuning

The following sub-sections contain the procedures to tune the radio transmitter. These procedures include:

- ▮ Power Amplifier (PA) Bias Tuning
- ▮ Reference Oscillator Warp
- ▮ DAC Tuning
- ▮ Transmit Power Tuning

- Power Amplifier (PA) Voltage Limit Tuning
- Modulation Balance Attenuation
- VCO Attenuation
- DTMF Deviation
- MDC1200 Deviation

4.4.1 Power Amplifier (PA) Bias Tuning

Note: 1. If using the regulated power supply RLN4510 to measure the current drawn by the radio, remember that the current meter terminals only measure the voltage drop across a 0.1ohm shunt resistor. Calculate the actual current being drawn by the radio by dividing the voltage drop across the resistor by 0.1. ($V= I \cdot R$).
2. Tuning must be performed only for High Power. The tuning screen will show up to three Toggle Bias buttons numbered 1, 2 and 3. Tuning must be started with the lowest bias number and continued until all bias points have been tuned.

Perform the PA Bias tuning procedure as follows:



CAUTION: To prevent damage to the PA, ensure that the antenna output is always terminated into a 50 Ohm load

1. Under the **Tx Align** menu, select **PA Bias**, and then **High Power**.
2. Measure/read the DC current drawn from the radio (varies from radio to radio). This value should typically range from 100-700mA. Record this value as **X**.
3. Press **Toggle Bias** button for the first bias to enable the PA bias softpot.
4. Increase softpot value to obtain **Y** until **Y - X** is within the range given for PA current in Table 4-3.
5. Press **Toggle Bias** for the first bias again to disable the PA bias softpot.
6. Repeat Steps 5-7 for the remaining **Toggle Bias** buttons.
7. Program the bias softpot values into the radio by pressing the **Program** button.
8. Exit the PA bias high power function.

Table 4-3. PA Bias Specifications*

RF Band	PA Type	PA Control Voltage Limit	Bias 1 Current	Bias 2 Current	Bias 3 Current
200 MHz	25 W	55 (dec)	100-150mA	450-550mA	Not Used
700 MHz	15 W	95 (dec)	100-150mA	475-525mA	Not Used

**These values are up-to-date as of the print date. For the latest values and procedures, refer to the Tuner online help.*

4.4.2 Reference Oscillator Warp

This procedure affects all deviation values such as DTMF and MDC1200 signaling as the frequency will drift if not warped properly.

Note:

1. Tuning of the PA BIAS must be performed first.
2. This operation should be performed prior to all other transmit tuning operations to minimize heating and the impact of warp on signaling operations.
3. If the output power level is too low to measure the frequency, tune the transmit power for the highest frequency first. However, if this is done, a wait period is required to allow the radio chassis to cool down to approximately 25 °C before setting the Reference Oscillator Warp.

Perform the oscillator warp procedure as follows:

1. Under the **Tx Align** menu, select **Reference Oscillator Warp**.
2. There is only one frequency point shown. This is always the last frequency point (F7).
3. Click on the slider thumb. Press **PTT Toggle** to key up the radio at the corresponding frequency point.
4. Monitor the transmit frequency.
5. Adjust the slider, spin, or edit control until the frequency is as close as possible to the indicated transmit frequency. Refer to values listed in Table 4-4T. Press **ENTER** to confirm the selection.
6. Dekey the radio by pressing **PTT Toggle**.
7. Program the warp value into the radio by pressing the **Program** button.
8. Exit the reference oscillator warp function.

Table 4-4. Reference Oscillator Warp Specifications*

RF Band	Target
200 MHz	±100 Hz
700 MHz	±150 Hz

**These values are up-to-date as of the print date. For the latest values and procedures, refer to the Tuner online help.*

4.4.3 DAC Tuning

- Note:**
1. Tuning of the PA BIAS must be performed first.
 2. This procedure must be performed before tuning the transmitter power.
 3. If any of the DAC values exceeds the range 20-200 or the value of DAC1 is greater than the value of DAC2, a warning message will be displayed.
 4. The DAC values will only be updated when the radio is keyed up. If the radio is not keyed up, any DAC value change will be ignored.

Perform the DAC tuning procedure as follows:

1. Under the **Tx Align** menu, select Transmit Power, then select **DAC**.
2. Press the **PTT Toggle** button to key up the radio.
3. Select **DAC1** by clicking on it's slider bar.
4. Measure the transmit power and compare it with the specification limits for **DAC1 Power** as defined in Table 4-5.
5. If the measured transmit power is outside the specification limits, adjust the slider, spin, or edit control until the transmit power is within the specification limits.
6. Repeat Steps 3 - 5 for **DAC2**.
7. Press **PTT Toggle** again to dekey the radio.
8. Exit the DAC tuning function.

Table 4-5. DAC1 & DAC2 Power Specifications*

RF Band	DAC1	DAC2
200 MHz	0.8-1.2 W	26.5-28.5 W
700 MHz	0.8-1.2 W	15.5-17.5 W

*These values are up-to-date as of the print date. For the latest values and procedures, refer to the Tuner online help.

4.4.4 Transmit Power Tuning

- Note:**
1. Tuning of the PA BIAS must be performed first.
 2. DAC Tuning must be performed first.
 3. **IMPORTANT:** To set the transmitter power for customer applications use the Customer Programming Software (CPS). The following procedure should only be performed if transmitter components have been changed or the radio does not transmit with the power set via the CPS. This tuning method is performed for multiple Transmit Power Tuning Channels.
 4. The power values displayed after opening the screen may have a small rounding offset.
 5. When checking the RF power output of the radio with a test set, always use a pad of at least 30dB attached to the radio end of the RF cable. This will avoid any RF mismatch and ensure a stable RF reading that will not change with varying lengths of connecting cable.

Perform the transmit high power tuning procedure as follows:

1. Under the **Tx Align** menu, select **Transmit Power**, then select **K and M Tuning**.
2. Select the **Power 1** box for the first frequency (F1).
3. Press **PTT Toggle** to key up the radio.

4. Observe the power level (W) displayed on the power meter. Record this value as **X**.
5. Key in the value **X** in the **Power 1** box.
6. Select the **Power 2** box for the first frequency (F1).
7. Observe the power level (W) displayed on the power meter. Record this value as **Y**.
8. Key in the value **Y** in the **Power 2** box.
9. Press **PTT Toggle** again to dekey the radio.
10. Repeat Steps 2-9 for frequency points 2 to 7.
11. Press **Program** to store all keyed in values into the radio.
12. Exit the K and M tuning function.

4.4.5 Power Amplifier (PA) Voltage Limit Tuning

- Note:**
1. Tuning of the transmit power must be performed first.
 2. This method automatically tunes all PA Voltage Limit Tuning Channels.

Perform the PA voltage limit tuning procedure as follows:

1. Under the **Tx Align** menu, select **PA Voltage Limit**.
2. Press **Auto Tune** and wait until all PA voltage limit softspots have been tuned.
3. Exit the PA voltage limit tuning function.

4.4.6 Modulation Balance Attenuation

- Note:**
1. When using test box RLN4460B/C, inject the signal into the radio at the **METER IN** terminal and set the **METER IN** selector switch to "VOL".
 2. Tuning of the transmit power and reference oscillator warp must be performed first.
 3. This tuning method is performed for multiple Modulation Balance Attenuation Tuning Channels.
 4. Compensation alignment balances the modulation sensitivity of the VCO and reference modulation (synthesizer low frequency port) lines. The compensation algorithm is critical to the operation of signaling schemes that have very low frequency components (i.e. DPL) and could result in distorted waveforms, if not adjusted properly.

Perform the modulation balance attenuation procedure as follows:

1. Under the **Tx Align** menu, select **Mod Balance Attn**.
2. Begin with the lowest frequency, i.e., the first frequency point from the top. Press **PTT Toggle** without selecting any slider control at the corresponding frequency point. This keys the radio up at the first frequency point.
3. Inject 80 Hz at 100mVrms.
4. Record the deviation obtained. Typical values should range from 3.5-5.5 kHz.
5. Inject 3 kHz at 100mVrms.
6. Change the modulation balance attenuation setting until the Tx deviation is as recorded in Step 4.
7. Inject 80 Hz at 100mVrms, and check the deviation again. If Tx deviation changes, note the reading and repeat Steps 5, 6, and 7 until the Tx deviation remains the same.
8. Press **PTT Toggle** to dekey the radio. Choose the next frequency, key up, then repeat Steps 3 to 7 until all seven tuning points are completed.
9. Program the softpot value by pressing the **Program** button.
10. Exit the modulation balance function.

4.4.7 VCO Attenuation

- Note:**
1. Tuning of the modulation balance must be accomplished first. The transmit deviation limit softpot sets the maximum deviation of the carrier. Although these models operate only at 12.5 kHz channel spacing, tuning is performed for both 12.5 kHz and 25 kHz channel spacing. Tuning for 25 kHz channel must be done first for all frequency points. Tuning for 12.5 kHz channel spacing determines only the offset to the previously tuned deviation for 25 kHz tuning channel spacing. For 12.5 kHz channel spacing, only F7 is used for tuning.
 2. When using test box RLN4460, set the METER OUT toggle switch to the “MIC PORT” position and METER OUT selector switch to “MIC”. Inject 1 kHz tone, and 800mVrms to AUDIO IN. The 800mVrms should be measured at the AC/DC METER.
 3. Depending on the radio model and the customer settings, the signal injected in accessory connector Pin 5 or the signal from an option board may be transmitted simultaneously with other signals, for example from the microphone or internally generated signaling. In this case the peak signal level is the sum of the individual signal's peak levels and can exceed the maximum allowed transmit deviation level. To prevent over deviation, the maximum deviation must be measured with both signals present and if the deviation still exceeds the range defined in Table 4-6, the VCO Attenuation must be re-tuned, so that the deviation stays in the tuning range with both signals present.
 4. Tuning of the modulation balance attenuation must be performed first.

Table 4-6. Deviation Specifications*

Band	Channel Spacing	Rated System Deviation	Deviation (kHz)
200 /700 MHz	12.5 kHz	2.5 kHz	2.2 – 2.3

**These values are up-to-date as of the print date. For the latest values and procedures, refer to the Tuner online help.*

4.4.8 VCO Attenuation (25 kHz)

Perform the 25 kHz VCO attenuation procedure as follows:

1. Under the **Tx Align** menu, select **VCO Attn. 25 kHz**.
2. Begin with the lowest frequency. Select the thumb of the slider at the lowest frequency point, then press the **PTT Toggle** button to key up the radio at the corresponding frequency point. The spin control can also be toggled via its up/down arrow buttons. The softpot value can also be typed into the edit control. Press **ENTER** to confirm the selection.
3. Inject 1 kHz at 800mVrms to the external microphone audio path.
4. Note the deviation obtained.
5. Adjust the slider, adjust the spin control or key in softpot values for the frequency point until the deviation is within the range as defined in the Table 4-6. Press **ENTER** to confirm the selection.
6. Press the **PTT Toggle** button to dekey radio. Choose the next frequency, key up, then repeat Steps 3-5 until all seven tuning points are completed.
7. Program the softpot value by pressing the **Program** button.
8. Exit the VCO attenuation 25 kHz function.

4.4.9 VCO Attenuation (12.5 kHz)

Note: Tuning of modulation balance attenuation and VCO attenuation for 25kHz channel spacing must be accomplished first.

Perform the 12.5 kHz VCO attenuation procedure as follows:

1. Under the **Tx Align** menu, select **VCO Attn. 12.5 kHz**.
2. Press **PTT Toggle** to key up the radio at F7.
3. Inject 1 kHz at 800mVrms to the external microphone audio path.
4. Note the deviation obtained.
5. Adjust the slider, adjust the spin control or key in softpot values for the frequency point until the deviation is within the range as defined in the Table 4-6. Press **ENTER** to confirm the selection.
6. Press **PTT Toggle** to dekey the radio.
7. Enter the softpot value into the radio by pressing the **Program** button.
8. Exit the VCO attenuation 12.5 kHz function.

4.4.10 DTMF Deviation Tuning

This tuning option controls the dual-tone, multi-frequency (DTMF) deviation.

Note: Modulation balancing and VCO attenuation must be performed prior to this tuning operation. Not doing so will result in the wrong deviation value being obtained while tuning the DTMF.

Perform the DTMF deviation tuning procedure as follows:

1. Under the **Tx Align** menu, select **DTMF Deviation**.
2. Press **PTT Toggle** to key the radio up. Monitor the deviation obtained.
3. Adjust the slider, spin, or edit control until a deviation of 3.0 – 3.7 kHz is obtained. Press **ENTER** to confirm the selection.
4. Press **PTT Toggle** again to dekey the radio.
5. Program the softpot value into the radio by pressing the **Program** button.
6. Exit the DTMF deviation function.

4.4.11 MDC1200 Deviation Tuning (MDC radios only)

This tuning option controls the MDC1200 Signaling deviation.

Note: Modulation balancing and VCO attenuation tuning must be performed prior to this tuning operation. Not doing so will result in the wrong deviation value being obtained while tuning this feature.

Perform the MDC1200 deviation tuning procedure as follows:

1. Under the **Tx Align** menu, select **MDC1200 Signaling**.
2. Press **PTT Toggle** to key the radio up. Monitor the deviation obtained.
3. Adjust the slider, spin or edit control until a deviation of about 3.25 – 3.75kHz is obtained. Press **ENTER** to confirm the selection.
4. Press **PTT Toggle** again to dekey the radio.
5. Program the softpot value into the radio by pressing the **Program** button.
6. Exit the MDC1200 deviation function.

4.5 Receiver Tuning

The following sub-sections contain the procedures to tune the radio receiver. These procedures include:

- Rated Volume
- Squelch Tuning Front End Filter Tuning

4.5.1 Rated Volume Tuning

Note: When using test box RLN4460B/C, the received audio output is taken from the AC/DC METER OUT terminals with the METER OUT rotary switch set to RX.

Perform the rated volume tuning procedure as follows:

1. Under the **Rx Align** menu, select **Rated Volume**.
2. Inject a -47dBm rf signal modulated with 1 kHz tone at the 60% rated deviation listed in Table 4-7.
3. Adjust the softpot value by using the slider, keying in the edit box (press **ENTER** to confirm the selection or send a softpot value), or via the spin controls. Repeat this until 3W(8Vrms) audio power is obtained. Press **Program** to commit the softpot value into the radio.
4. Exit the rated volume tuning function.

Table 4-7. Rated Volume Deviation Values

Channel Spacing	Rated System Deviation	Signal Generator Deviation
12.5 kHz	2.5 kHz	1.5 kHz

4.5.2 Squelch Tuning

Note: 1. Squelch tuning can only be accomplished after reference oscillator warping.

2. When using the test box RLN4460, the received audio output is taken from the AC/DC METER OUT terminals with the METER OUT rotary switch set to RX. It is recommended that rated volume tuning is performed so the correct 10dB SINAD level can be obtained.

3. This tuning method is performed for multiple squelch tuning channels and multiple channel spacings.

Perform the squelch tuning procedure as follows:

1. Under the **Rx Align** menu, select **Squelch Atten**. Select **Squelch Atten 12.5 kHz**.
2. Apply an RF signal modulated with a 1 kHz tone at 60% rated deviation listed in Table 4-8 for current frequency point (F1 being the first) of 10dB SINAD. That is, adjust the reference signal level until 10dB SINAD is obtained at the SINAD meter. Squelch tuning can either be done manually (see page 4-11 for procedure) or by auto squelch (see page 4-11 for procedure). To obtain 10dB, unmute the radio first by dragging the corresponding slider value to 1.

Table 4-8. Squelch Deviation Values

Channel Spacing	Rated System Deviation	Signal Generator Deviation
12.5 kHz	2.5 kHz	1.5 kHz

Manual Squelch Tuning:

3. Set softpot to its maximum value to mute the radio.
4. Adjust the softpot value by using the slider, keying in the edit box or using the spin controls. Press **ENTER** to confirm the selection. Do this until the radio is totally unmuted. Verify the squelch closing by inputting a signal level of 4dB lower than that of the 10dB SINAD level.
5. Repeat Step 2 and Steps 3-4 of Manual Squelch Tuning, for frequency points F2-F7.
6. Press **Program** to commit the softpot values into the radio.
7. Exit the squelch tuning function.

Auto Tune:

Note: Proceed with caution since this procedure automatically programs the softpot value into your radio.

When you press the **Auto Tune** button, the radio automatically returns an optimum squelch value.

After you press the button, the radio may need time to produce an optimal setting for the squelch attenuation. The following steps describe the auto tune process:

3. Select current frequency point (F1 being the first), then press **Auto Tune**.
4. Repeat Steps 2 and 3 of the Auto Tune section for frequency points F2-F7.

Notes

Chapter 5

Power Up Self-Test

5.1 Error Codes - Conventional Radios

Turning on the radio starts a self-test routine that checks the RAM, ROM checksum, EEPROM hardware, and EEPROM checksum. If these checks are successful, the radio generates two high-pitched self-test pass tones, or a musical tone (selected in CPS). If the self-test is not successful, one low-pitched tone is heard. Radios with displays are able to display the error codes. The displayed error codes and related corrections are listed in Table 5-1.

Table 5-1. Power Up Error Codes

If the error code displayed is...	then, there is a...	To correct the problem...
"RAM TST ERROR"	RAM test failure.	Retest the radio by turning it off and turning it on again. If message reoccurs, replace RAM (U0122).
"EEPRM HW ERROR"	Codeplug structure mismatch or non existence of codeplug.	Reprogram codeplug with correct version and retest radio. If message reoccurs, replace EEPROM (U0111).
"EEPRM CS ERROR"	Wrong codeplug checksum.	Reprogram codeplug.
No Display	Bad display module connection or damaged display module.	Check connection between main board and display module or replace with new display module.

5.2 Error Codes - PassPort

For the purpose of this document the phrase "PassPort Trunking Controller Board" and its acronym "PTCB" are used.

Table 5-2. Power-up Display Codes (PassPort Trunking Controller Board)

If the error code displayed is...	then, there is a...	To correct the problem...
ESN BAD	PTCB Defective.	Replace PTCB.
AppCode Fail	PTCB Firmware Defective.	Reprogram PTCB FLASH-ROM.
BackDoor		Turn radio off and restart.
ERR:Watchdog	Firmware Failure Resulted in Watch-dog Timer Interrupt.	Restart radio.
Unprogrammed	Programming is not correct	Use CPS and PPCPS to properly program radio and PTCB.
ERROR: NO PTG		Use PPCPS to program that Zone with a Primary Talk Group.

5.3 PassPort Tone Options

In order to provide more detailed information about the radio's state to a user or service technician various tones and display options are available.

One Tone option is a short low pitched tone that sounds whenever the radio loses contact for any reason with its registered PassPort site and begins to search for another site. This tone is enabled by the "Enable LOS Search Start Tone" option.

Service technicians who are determining system coverage and RSSI settings may want to be able to discriminate between the LOS (Loss of System) for complete loss of data from the site or when the site RSSI drops below required levels. A second tone following the first LOS Tone indicating that LOS was caused by complete LOS of PassPort data from the site and not low.

RSSI can be activated with the "Enable LOS CRC Search start tone" option.

Enable just the "Enable LOS Search start tone" option. Allow the radio to register. Turn off the Home repeater. The radio will sound a single tone and start to search. Turn on the Home repeater. Allow the radio to register. Remove the antenna. The radio will sound a single tone and start to search. Replace the antenna.

Enable the "Enable LOS CRC Search start tone" option. Allow the radio to register. Turn off the Home repeater. The radio will sound two tones and start to search. Turn on the Home repeater. Allow the radio to register. Remove the antenna. The radio will sound a single tone and start to search.

5.4 Special Diagnostic Functions

Some special diagnosis functions can be turned on "as needed" by accessing the "Service Menu". In order to enter this menu please proceed as follows:

- 1) Press the Menu Key. (You don't need to be registered).
- 2) Quickly press the  then the  key.
- 3) Service Menu appears on the screen.
- 4) Press  to select it.

A series of functions then become available to you as you scroll up and down. They are as follows:

PassPort ESN - Enter the Service Menu and using the Up/Dn keys scroll to "**PassPort ESN**". Press the Select key. Use the Up/Dn and Select Keys to activate or deactivate this function. This function momentarily displays the radio's PassPort Electronic Serial Number.

PassPort Information Report - Enter the Service Menu and using the Up/Dn keys scroll to "Report". Press the Select key. The display will sequentially show, the search method preference, the number of Near Neighbors from the last registered site neighbor list, All Neighbors, the total number of unique stored Neighbor frequencies and then display the known list of Neighbor Frequencies. The report will complete and the radio will search and re-register.

Monitor - This Service Menu option defeats PassPort coded squelch and allows a technician to hear all transmissions on the system. This function can be enabled or disabled using the PassPort CPS (PPCPS).

Show RSSI - Enter the Service Menu and using the Up/Dn keys scroll to "**Show RSSI**". Press the Select key. Use the Up/Dn and Select Keys to activate or deactivate this function. This diagnostic momentarily displays the ASID and RSSI of all received site IDLE messages in the format " WXXX-YYY-ZZZ " where W is a "-" on an Idle channel and a "+" on a busy one, XXX is the ASID of the site, YYY is the RSSI of the message just received and ZZZ is the current running average RSSI. This can be helpful in determining RSSI roaming settings. Also while this feature is enabled and the radio is searching, each new search frequency is momentarily displayed in order to track the radio's progress through the known frequencies.

Search Freq-(Enter Search Frequencies) - Enter the Service Menu and using the Up/Dn keys scroll to "**Search Freq**". Press the Select key. Using the numeric keys and Left (P1) key for backup/delete and the "*" key for the decimal point, enter the desired Search Frequency in MHz. Press the Select key when the entry is complete or the Escape/Exit Key to exit the function without entering a search frequency. After pressing the Select key the radio will exit the Menu mode and begin searching the entered frequency for a period of time equal to twice the initial search delay. This utility allows a new radio or a radio with an empty Neighbor List Almanac to search an initial frequency other than its Home Frequency or a Seed List Frequency. This can be helpful when programming and delivering a new radio to a customer in an area not served by a site on his Home Frequency.

Clear Almanac - (Clear Neighbor List Almanac): Enter the Service Menu and using the Up/ keys scroll to "**Clear Almanac**". Press the Select key. The stored Neighbor frequencies will be erased. This utility allows clearing obsolete Neighbor frequencies collected.

5.5 CPS/PPCPS Programming Setup

The CPS/PPCPS programming setup, shown in Figure 5-1, is used to program the radio codeplug.

Note: Refer to appropriate program on-line help files for the codeplug programming procedures.

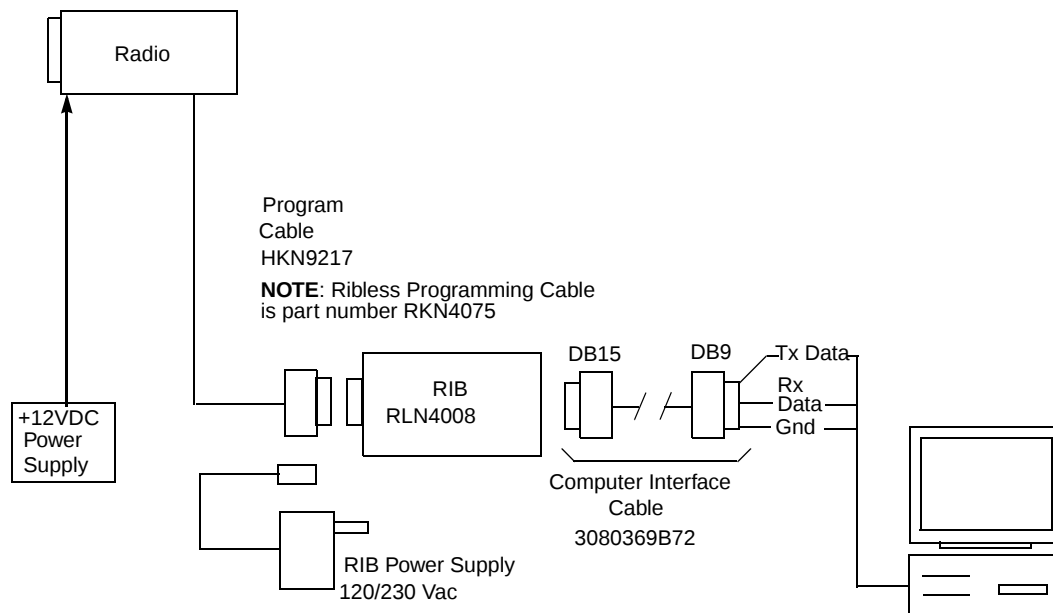


Figure 5-1. CPS/PPCPS Programming Setup

Chapter 6

Accessories

6.1 Accessories

To order, contact the Motorola Accessories & Aftermarket Division. For Contact Information, please see section 1.2.3 on page 1-2 of Chapter 1, Introduction.

6.1.1 Antennas

HKAD4001_	216-225 MHz, 1/4-Wave Roof Mount
HKAD4002_	216-225 MHz, 5/8-Wave Roof Mount
HAF4012_	Mini-U 746-794 MHz, 1/4-Wave Roof Mount

6.1.2 Mounting

GLN7317	Trunnion, High Profile Mounting
GLN7324_R	Trunnion, Low Profile Mounting
HLN8097	Slide Mount, Removable
RLN4779	Key Lock Mount
RLN4781	DIN Mounting Kit

6.1.3 Remote Mount

RLN4802	Remote Mount Kit, Control Head
RKN4077	Remote Mount Cable, 3m
RKN4078	Remote Mount Cable, 5m
RKN4079	Remote Mount Cable, 7m

6.1.4 Loudspeaker

RSN4001	External Speaker, 13W, 4 Ohms
HSN8145	External Speaker, 7.5W, 8 Ohms

6.1.5 Audio

AARMN4025	Microphone, Enhanced Compact
AARMN4026	Microphone, Enhanced Keypad
AARMN4038	Microphone, Heavy Duty
HMN3000	Microphone, Black Desk
AAREX4617	Handset, Telephone Style
HLN9073_R	Microphone Hang-Up Clip (all microphones)

6.1.6 Hands Free Operation

AARMN4027	Microphone, Visor Mounted
RLN4856	Footswitch PTT
RLN4857	Push-button PTT
RLN4858	Gooseneck PTT
RLN4836	Emergency Footswitch

6.1.7 Control Station Kits

HMN3000	Desk Microphone (Black)
GLN7326	Desktop Tray with Speaker
GLN7318	Desktop Tray without Speaker
HKN9088	Mobile Mini-U Antenna Adapter - 8 Ft. Cable
HPN4002_R	Power Supply and Cable

6.1.8 Installation

GKN6272	Relay Alarm and Cable, External
HLN9457	Accessory Connector Kit (includes 16 connector pins, [5] 8-inch wires with pins attached, and an extra housing)
6686119B01	Control Head Removal Tool
HKN4137	Standard 12V 10" Power Cable to Battery
HKN4192	12V 20 Ft. Power Cable to Battery
HKN9327	Ignition Switch Cable
HKN9557_R	PL259/Mini-U Antenna Adapter - 8" Cable

6.1.9 Service Aids

H5177	Portable/Mobile Programming Software (CPS) 3 Year Subscription Package - Includes CPS CD ROM Software: HVN9025 for the HT/EX500/CDM/MTX.LS Series and HVN9067 for MTX Series Privacy Plus. Includes HT/MTX Series Programming/Test Cable (AARKN4074). Also is compatible with RLN4460 used for radio testing. (HVN9025 is compatible with Windows® 95/98/2000/Millennium (ME)/Windows NT®. HVN9067 is compatible with Windows® 95/98/Windows NT®). Software requires a license agreement and is not intended for resale.
AARKN4081	Programming Cable with Internal RIB (direct connection from computer to radio microphone connector)
AARKN4083	Programming Cable (allows radio programming via rear accessory connector)
3080070N01	Programming Cable (connection from RIB to radio)
3080369B72	9 Pin PC to Radio Interface Box Cable (IBM AT or compatible)
RLN4460	Test Box for Portables and Mobiles
RLN4008	Radio Interface Box (RIB)
0180357A57	Wall Mounted Power Supply, 120V - used with RLN4008
RLN4853	10 to 20 Pin Adapter

6.1.10 Public Address

RLN5288_	Public Address Kit (includes RLN5289_ Interface Cable, HKN9473_ Power Cable, and RLN5290_ Public Address Switch Box)
HKN9323_	8 Ft. Public Address Speaker Cable
HKN9324_	15 Ft. Public Address Speaker Cable (one cable per speaker)
HSN1000_R	6 Watt Amplified External Speaker

6.1.11 Mobile Data Units Section

Terminals:	
RDN7367	Mobile Display Terminal with GPS - Mobile display terminal equipped with an Automatic Vehicle Location (AVL) device compatible with Global Positioning system (GPS).
RDN7368	Mobile Display Terminal - Mobile messaging device equipped with a data modem. This unit features a 4x40 backlit LCD display and the keypad allows users to send information to the dispatcher in response to base instructions.
RDN7369	Standalone Modem/GPS - Cost efficient Automatic Vehicle Location (AVL) device compatible with Global Positioning System (GPS).

RDN7738	Serial Breakout Unit (used in multiple applications that allow up to eight base modems to be connected).
RDN7365	Mobile Status Terminal - Mobile messaging device equipped with a data modem.
RDN7366	Mobile Status Terminal with GPS - Mobile status terminal equipped with an AVL.
RDN7738	Serial Breakout Unit (used in multiple applications that allow up to 8 base connections)
Radio Interface Cables: One radio interface cable is required with purchase of each hardware device	
RDN7370	3 Ft. Interface Cable with 16 Pin Connector
RDN7376	15 Ft. Interface Cable with 16 Pin Connector
RDN7739	3 Ft. Flying Cable (same as regular interface cable, but omits connectors).
RDN7740	15 Ft. Flying Cable (same as regular interface cable, but omits connectors).
Peripherals:	
RDN7371	Credit Card Reader - Card reader is used to perform automatic online credit card authorization transaction. Used with RDN7379 (credit card software).
RDN7373	Mobile Printer - The mobile printer provides users with a hard copy of the information transmitted from the base dispatch location.
Global Positioning System (GPS) Antennas: Antenna is required with purchase of any GPS unit	
RDN7372	Fixed Mount GPS Active Antenna
RDN7375	Magnetic Mount GPS Active Antenna
Software:	
RDN7374	Programming Software - Used for mobile data units.
RDN7377	Regional Map Software - Will allow up to 10 selected US counties.
RDN7378	AVL Messaging Status Software - Mapping software that provides the user with Automatic Vehicle Location to track vehicles along with message dispatch and status tracking capability.
RDN7379	Credit Card Software - Used with RDN7371 (credit card reader).
Miscellaneous:	
RDN7364	Radio Channel Card - A radio channel controller and modem that interface with the base radio. Required with every radio channel or wireless circuit used within the system.
RDN7380	Mobile Programming Hardware

6.1.12 Option Boards

0104015J14	LS ⁺ PassPort Option Board
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* Voice Storage included in the PassPort board.

6.1.13 Buttons

Customer Specific:	
RLN5324	Button Kit: Site, Roam, Mon, Scan, Call, Home, Phone.
RLN4831	Button Kit: Mon, Scan, Call, Home, Phone.
CDM1550•LS ⁺	
3886134B03	
3886134B04	
3886134B05	
3886134B06	
3886134B08	
3886134B09	
3886134B10	
3886134B12	
3886134B13	
3886134B14	
3886134B15	
3886134B16	
3886134B17	
3886134B18	
3886134B19	
3886134B20	
3886134B21	
3886134B22	
3886134B23	
3886134B24	

3886134B25	
3886134B26	
3886134B27	
3886134B28	
3886134B29	
3886134B30	
3886134B33	
3886134B37	
3886134B38	
3886134B39	
3886134B40	
3886134B42	
3886134B46	
3886134B54	
3886134B57	
3886134B80	
3886134B81	

Chapter 7

Model Chart and Test Specifications

7.1 200 MHz (LTR and PassPort)

Model	Description	CDM1550•LS⁺ Mobile Radio 200 MHz	
AAM25MH-F4DP5AN	CDM1550•LS ⁺ 200 MHz, 1-25 W		
	Item	Description	
X	PMUD1765_S	Board, CDM1550•LS ⁺ 200 MHz, 1-25 W	
X	GCN6114_	Control Head	
X	0104015J14	LS ⁺ PassPort Option Board	
X	AARMN4025_	Compact Microphone	
X	GLN7324_	Mounting Bracket	
	RLN5324_	Button Kit	
X	HKN4137_	15 A Standard Power Cable	
X	HKAD4001_	216-225 MHz, 1/4-Wave Roof Mount Antenna	
X	HKLN4193_	User Guide	

X = Indicates one of each is required.

7.2 700 MHz (LTR and PassPort)

Model	Description	CDM1550•LS⁺ Mobile Radio 700 MHz	
AAM255HF4DP5AN	CDM1550•LS ⁺ 700 MHz, 1-15 W		
	Item		Description
	X	PMUF1111_S	Board, CDM1550•LS ⁺ 700 MHz, 1-15 W
	X	GCN6114_	Control Head
	X	0104015J14	LS ⁺ PassPort Option Board
	X	AARMN4025_	Compact Microphone
	X	GLN7324_	Mounting Bracket
		RLN5324_	Button Kit
	X	HKN4137_	15 A Standard Power Cable
	X	HAF4012_	Mini-U 746-794 MHz, 1/4-Wave Roof Mount Antenna
	X	HKLN4193_	User Guide

X = Indicates one of each is required.

7.3 Specifications

General		
Specification	200 MHz	700 MHz
Model Numbers:	AAM25MHF4DP5AN	AAM255HF4DP5AN
Channel Capacity:	Trunking Zone 15 Trunking Talkgroup 16 (per zone) Conventional Channels 16	
Channel Spacing:	12.5 kHz	
Dimensions (H x W x L):	2.83 in. x 7.28 in. x 7.4 in. (72mm x 185mm x 188mm)	2.83 in. x 7.28 in. x 7.87 in. (72mm x 185mm x 200mm)
Weight:	3.15 lbs. (1.43 kg)	3.5 lbs. (1.59 kg)
Power Supply:	13.2Vdc (10.8 - 15.6 Vdc) negative vehicle ground	
Current Draing: Standby: Rx @ rated, external 8 ohms: Transmit:	0.3 A 1.5 A 7 A @ 25 W	0.3 A 1.5 A 7 A @ 15 W
FCC Description:	ABZ99FT3081	ABZ99FT5001

Mobile Military Standards 810 C, D, & E						
Applicable MIL-STD	810C		810D		810E	
	Methods	Procedure	Methods	Procedure	Method	Procedure
Low Pressure:	500.1	1	500.2	2	500.3	2
High Temperature:	501.1	1,2	501.2	1,2	501.3	1,2
Low Temperature	502.1	2	502.2	1,2	502.3	1,2
Temperature Shock:	503.1	1	503.2	1	505.3	1
Solar Radiation:	505.1	1	505.2	2	505.3	1
Rain:	506.1	1,2	506.2	1,2	506.3	1,2
Humidity:	507.1	2	507.2	2,3	507.3	2,3
Salt Fog:	509.1	1	509.2	1	509.3	1
Dust:	510.1	1	510.2	1	510.3	1
Vibration:	514.2	8,10	514.3	1	514.4	1
Shock:	516.2	1,2,5	516.3	1	516.4	1,4

Environmental Specifications

Operating Temperature	-30° C to +60° C
Storage Temperature	-55° C to +85° C
Thermal Shock	-40° C to +85 ° C
Humidity	95% RH @ 8 Hr.
ESD	IEC 801-2 KV
Water Intrusion	IP54
Packing Test	Impact Test

Transmitter

Specification	200 MHz	700 MHz
Frequency Range:	217-218 MHz (Talkaround) 219-220 MHz 220-221 MHz (Talkaround) 221-222 MHz	746-747 MHz (Talkaround) 762-764 MHz (Talkaround) 776-777 MHz 792-794 MHz
Power Output:	1-25W	1-15W
Frequency Stability: (-30°C to +60°C, 25°C Ref.)	±2.5 ppm	±1.5 ppm
Conducted/Radiated Emissions:	-16 dBm	-16 dBm (except -40 dBm from 1559-1610 MHz)
Adjacent Channel Coupled Power:	NA	Complies with 47 CFR 27.53 (d) (1)
Adjacent Channel Power	-70 dB	
Audio Response: (from 6 dB/oct. Pre-Emphasis, 300 to 3000Hz)	+1 to - 3 dB	
Audio Distortion: @ 1000 Hz, 60% Rated Maximum Deviation:	3% Typical	
Modulation Limiting:	±2.5 kHz @ 12.5 kHz	
FM Hum and Noise:	-40 dB Typical	
FM Modulation Designator:	11K0F3E	

Receiver		
Specification	200 Mhz	700 MHz
Frequency Range:	217-218 MHz 219-222 MHz	746-747 MHz 762-764 MHz
Sensitivity (12 dB SINAD):	0.3 μV (0.25 μV Typical)	0.35 μV (0.3 μV Typical)
Intermodulation:	75 dB	
Adjacent Channel Selectivity:	65 dB (EIA/TIA 603) 40 dB (EIA/TIA 603A)	
Spurious Rejection:	75 dB	
Rated Audio: (External audio w/4 ohm speaker):	3 W Internal 13 W External	
Audio Distortion @ Rated Audio:	3% Typical	
Hum and Noise:	-40 dB @ 12.5 kHz	
Audio Response: (from 6 dB/oct. De- Emphasis, 300-3000 Hz):	+1 dB to -3 dB	
Conducted Spurious Emission FCC Part 15:	-57 dBm <1 Ghz -47 dBm >1 Ghz	
Specifications subject to change without notice. All electrical specifications and methods refer to EIA/TIA 603 standards. CDM Series radios meet or exceed requirements of MIL STD 810 C, D, E.		

Glossary of Terms

Glossary of Terms

Term	Definition
ALC	Automatic Level Control: a circuit in the transmit RF path that controls RF power amplifier output, provides leveling over frequency and voltage, and protects against high VSWR (voltage standing wave ration).
ASF IC	Audio Signalling Filter Integrated Circuit with voice compander.
CD	Compact Disk.
CMP	Compression.
CPS	Customer Programming Software.
CSQ	Carrier Squelch.
DTMF	Dual-Tone Multifrequency.
DPL	Digital Private-Line™.
EEPROM	Electrically Erasable/Programmable Read-Only Memory: used by the radio to store its personality.
Firmware	Software, or a software/hardware combination of computer programs and data, with a fixed logic configuration stored in a read-only memory. Information cannot be altered or reprogrammed.
FGU	Frequency Generation Unit.
GaAs	Gallium Arsenide: a type of crystalline material used in some semiconductors.
ISW	Inbound Signalling Word: data transmitted on the control channel from a subscriber unit to the central control unit.
LCD	Liquid Crystal Display: a module used to display the radio's current operating channel or system and scan status.
LDMOS	Lateral Diffusion MOS.
LH DATA	Longhorn Data: a bidirectional 0-5V, RS-232 line that uses the microcontroller's integrated RS-232 asynchronous serial communications interface (SCI) peripheral.
LLE	Low Level Expander: slight amount of volume expansion; used to improve the signal to noise ratio.
LSH	Low-Speed Handshake: 150 baud digital data sent to the radio during trunked operation while receiving audio.
LTR	Trunked Signaling Protocol using low-speed data. Registered trademark of E.F. Johnson Company.
MDC	Motorola Data Communication.

Glossary of Terms

MRTI	Motorola Radio-Telephone Interconnect: a system that provides a repeater connection to the Public Switched Telephone Network (PSTN). The MRTI allows the radio to access the telephone network when the proper access code is received.
MSK	Minimum-Shift Keying
OMPAC	Over-Molded Pad-Array Carrier: a Motorola custom package, distinguished by the presence of solder balls on the bottom pads.
OSW	Outbound Signalling Word: data transmitted on the control channel from the central controller to the subscriber unit.
PassPort®	Enhanced trunking protocol developed by Trident DataCom Technologies, Inc. that links wide area dispatch networking.
PC Board	Printed Circuit Board
PL	Private-Line® tone squelch: a continuous sub-audible tone that is transmitted along with the carrier.
PLL	Phase-Locked Loop: a circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.
PPCPS	PassPort Customer Programming Software.
PTT	Push-To-Talk: the switch located on the left side of the radio which, when pressed, causes the radio to transmit.
RAM	Random Access Memory: the radio's RAM is loaded with a copy of the EEPROM data.
Registers	Short-term data-storage circuits within the microcontroller.
Repeater	Remote transmit/receive facility that retransmits received signals to improve communications coverage.
RESET	Reset line: an input to the microcontroller that restarts execution.
RF PA	Radio Frequency Power Amplifier
RIB	Radio Interface Box
ROM	Read Only Memory
RSSI	Received Signal-Strength Indicator: a dc voltage proportional to the received RF signal strength.
RPT/TA	Repeater/Talk-Around
Softpot	Software Potentiometer: a computer-adjustable electronic attenuator
Software	Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system
SPI (clock and data lines)	Serial Peripheral Interface: how the microcontroller communicates to modules and ICs through the CLOCK and DATA lines.

Glossary of Terms

Squelch	Muting of audio circuits when received signal levels fall below a pre-determined value
Standby Mode	An operating mode whereby the radio is muted but still continues to receive data
System Central Controller	Main control unit of the trunked dispatch system; handles ISW and OSW messages to and from subscriber units (see ISW and OSW).
System Select	The act of selecting the desired operating system with the system-select switch (also, the name given to this switch).
TOT	Time-Out Timer: a timer that limits the length of a transmission.
TPL	Tone Private-line
μC	Microcontroller
UHF	Ultra High Frequency
μP	Microprocessor
VCO	Voltage-Controlled Oscillator: an oscillator whereby the frequency of oscillation can be varied by changing a control voltage.
VCOBIC	Voltage-Controlled Oscillator Buffer Integrated Circuit
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio

Notes

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