MOTOROLA

intelligence everywhere ™

Commercial Series
CM Radios

Basic Service Manual

6866545D11-O

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SAFETY INFORMATION

Read this information before using your radio.

PRODUCT SAFETY AND RF EXPOSURE FOR MOBILE TWO-WAY RADIOS INSTALLED IN VEHICLES OR AS FIXED SITE CONTROL STATIONS.

This document provides information and instructions for the safe and efficient operation of Motorola Mobile Two-Way Radios. The information provided in this document supersedes information contained in user guides published prior to **February 2002.**

COMPLIANCE WITH RF ENERGY EXPOSURE STANDARDS

Note: This Radio is intended for use in occupational/controlled applications, where users have been made aware of the potential for exposure and can exercise control over their exposure. This radio device is NOT authorized for general population, consumer or similar use.

This user safety booklet includes useful information about RF exposure and helpful instructions on how to control your RF exposures.

Your Motorola radio is designed and tested to comply with a number of national and international standards and guidelines regarding human exposure to radio frequency electromagnetic energy. **This radio complies with IEEE and ICNIRP exposure limits for occupational/controlled RF** exposure environments at usage factors of up to 50% talk–50% listen. In terms of measuring RF energy for compliance with the IEEE/ICNIRP exposure guidelines, your radio radiates measurable RF energy only while it is transmitting (during talking), not when it is receiving (listening) or in standby mode.

Your Motorola two-way radio complies with the following RF energy exposure standards and guidelines:

- United States Federal Communications Commission, Code of Federal Regulations; 47 CFR part 2 sub-part J
- American National Standards Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999 Edition
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6. Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz, 1999
- Australian Communications Authority Radiocommunications (Electromagnetic Radiation - Human Exposure) Standard 2001
- ANATEL, Brasil Regulatory Authority, Resolution 256 (April 11, 2001) "additional requirements for SMR, cellular and PCS product certification."

COMPLIANCE AND CONTROL GUIDELINES AND OPERATING INSTRUCTIONS FOR MOBILE TWO-WAY RADIOS INSTALLED IN VEHICLES

To control your exposure and ensure compliance with the occupational/controlled environment exposure limits, always adhere to the following procedures:

- To transmit (talk), push the Push-To-Talk (PTT) button; to receive, release the PTT button. Transmit only when people outside the vehicle are at least the minimum lateral distance away from a properly installed, externally-mounted antenna and from the vehicle body. Table 1 lists the minimum distance for bystanders in an uncontrolled environment from the transmitting antenna and from the vehicle body at several different ranges of rated radio power for mobile radios installed in a vehicle.

Table 1: Rated Power and Distances

Rated Power of Vehicle-Installed Mobile Two-Way Radio	Minimum Distance from Transmitting Antenna	Minimum Lateral Distance From Vehicle Body
Less than 7Watts	20 cm (8 Inches)	20 cm (8 Inches)
7 to 15 Watts	30.5 cm (1 Foot)	20 cm (8 Inches)
16 to 39 Watts	61 cm (2 Feet)	20 cm (8 Inches)
40 to 110 Watts	91.5 cm (3 Feet)	20 cm (8 Inches)

- Install mobile antennas at the centre of the roof and centre of the trunk deck. These mobile installation guidelines are limited to metal body vehicles. The antenna installation must additionally be in accordance with:
    a. The requirements of the antenna manufacturer/supplier
    b. Instructions in the Radio Installation Manual.
- Use only Motorola-approved supplied or replacement antenna. Use of non–Motorola - approved antennas, modifications, or attachments could damage the radio and may violate IEEE/ICNIRP regulations. For a list of Motorola-approved antennas, visit the following web site :

http://moleurope.comm.mot.com/member/commerce

For additional information on exposure requirements or other training information, visit http://www.motorola.com/rfhealth.

COMPLIANCE AND CONTROL GUIDELINES AND OPERATING INSTRUCTIONS FOR MOBILE TWO-WAY RADIOS INSTALLED AS FIXED SITE CONTROL STATIONS

If mobile radio equipment is installed at a fixed location and operated as a control station or as a fixed unit, the antenna installation must comply with the following requirements in order to ensure optimal performance and compliance with the RF energy exposure in the standards and guidelines listed above:

- The antenna must be mounted outside the building on the roof or a tower if at all possible.
- As with all fixed site antenna installations, it is the responsibility of the licensee to manage the site in accordance with applicable regulatory requirements and may require additional compliance actions such as site survey measurements, signage, and site access restrictions in order to insure that exposure limits are not exceeded.

ELECTROMAGNETIC INTERFERENCE/COMPATIBILITY

NOTE: Nearly every electronic device is susceptible to electromagnetic interference (EMI) if inadequately shielded, designed or otherwise configured for electromagnetic compatibility. It may be necessary to conduct compatibility testing to determine if any electronic equipment used in or around vehicles or near fixed site antenna is sensitive to external RF energy or if any procedures need to be followed to eliminate or mitigate the potential for interaction between the radio transmitter and the equipment or device.

Facilities

To avoid electromagnetic interference and/or compatibility conflicts, **turn off your radio in any facility where posted notices instruct you to do so**. Hospitals or health care facilities may be using equipment that is sensitive to external RF energy.

Vehicles

To avoid possible interaction between the radio transmitter and any vehicle electronic control modules, for example, ABS, engine, or transmission controls, the radio should be installed only by an experienced installer and that the following precautions be used when installing the radio:

1. Refer to the manufacturer's instructions or other technical bulletins or recommendations on radio installation.

2. Before installing the radio, determine the location of the electronic control modules and their harnesses in the vehicle.

3. 3. Route all radio wiring, including the antenna transmission line, as far away as possible from the electronic control units and associated wiring.

Driver Safety

Check the laws and regulations on the use of radios in the area where you drive. Always obey them. **When using your radio while driving, please:**

- Give full attention to driving and to the road.
- Pull off the road and park before making or answering a call if driving conditions so require.

OPERATIONAL WARNINGS

For Vehicles With An Air Bag

Do not mount or place a mobile radio in the area over an air bag or in the air bag deployment area. Air bags inflate with great force. If a radio is placed in the air bag deployment area and the air bag inflates, the radio may be propelled with great force and cause serious injury to occupants of the vehicle.

Potentially Explosive Atmospheres

Turn off your radio prior to entering any area with a potentially explosive atmosphere. Sparks in a potentially explosive atmosphere can cause an explosion or fire resulting in bodily injury or even death.

The areas with potentially explosive atmospheres referred to above include fuelling areas such as below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles, such as grain, dust or metal powders. Areas with potentially explosive atmospheres are often but not always posted.

Blasting Caps And Areas

To avoid possible interference with blasting operations, turn off your radio when you are near electrical blasting caps, in a blasting area, or in areas posted:
"Turn off two-way radio". Obey all signs and instructions.

For radios installed in vehicles fueled by liquefied petroleum gas, refer to the (U.S.) National Fire Protection Association standard, NFPA 58, for storage, handling, and/or container information. For a copy of the LP-gas standard, NFPA 58, contact the National Fire Protection Association, One Battery Park, Quincy, MA.

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Chapter 1

INTRODUCTION

1.0   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 and is current as of the printing date. Changes which occur after the printing date may be incorporated by a complete Manual revision or alternatively as additions.

NOTE   Before operating or testing these units, please read the Safety Information Section in the front of this manual.

2.0   Warranty and Service Support

Motorola offers long term support for its products. This support 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" by an authorised Motorola Dealer must be accompanied by a Warranty Claim Form. Warranty Claim Forms are obtained by contacting an Authorised Motorola Dealer.

2.1   Warranty Period and Return Instructions

The terms and conditions of warranty are defined fully in the Motorola Dealer or Distributor or Reseller contract. These conditions may change from time to time and the following notes 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 Customer Resources (Please see page 2 and page 3 in this Chapter). All returns must be accompanied by a Warranty Claim Form, available from your Customer Services representative. Products should be shipped back in the original packaging, or correctly packaged to ensure no damage occurs in transit.

2.2   After Warranty Period

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

1.   Motorola's Radio Aftermarket and Accessory Division (AAD) offers a repair service to both end users and dealers at competitive prices.

2.   AAD supplies individual parts and modules that can be purchased by dealers who are technically capable of performing fault analysis and repair.

2.3   European Radio Support Centre (ERSC)

The ERSC Customer Information Desk is available through the following service numbers:

Austria:	08 60 29 75 41	Italy:	80 08 77 387
Belgium:	08 00 72 471	Luxemburg:	08 00 23 27
Denmark:	80 88 05 72	Netherlands:	08 00 22 45 13
Finland:	08 00 11 49 910	Norway:	80 01 11 15
France:	08 00 90 30 90	Portugal:	08 00 84 95 70
Germany:	08 00 18 75 240	Spain:	90 09 84 902
Greece:	00 80 04 91 29 020	Sweden:	02 07 94 307
UK :	08 00 96 90 95	Switzerland:	08 00 55 30 82
Ireland:	18 00 55 50 21	Iceland:	80 08 147

Or dial the European Repair and Service Centre:

Tel: +49 30 6686 1555

Please use these numbers for repair enquiries only.

2.4   Piece Parts

Some replacement parts, spare parts, and/or product information can be ordered directly. If a complete Motorola part number is assigned to the part, it is available from Motorola Radio Aftermarket and Accessory Division (AAD). If no part number is assigned, the part is not normally available from Motorola. If the part number is appended with an asterisk, the part is serviceable by Motorola Depot only. If a parts list is not included, this generally means that no user-serviceable parts are available for that kit or assembly.

All part orders should be directed to :

> **Motorola GmbH**
> **Customer Care**
> **Am Borsigturm 130**
> **13507 Berlin**
> **Germany.**

2.5   Technical Support

Motorola Product Services is available to assist the dealer/distributors in resolving any malfunctions which may be encountered.

UK/Ireland - Richard Russell
Telephone: +44 (0) 1256 488 082
Fax: +44 01256 488 080
Email: BRR001@email.mot.com

Central/East Europe - Siggy Punzenberger
Telephone: +49 (0) 6128 70 2342
Fax: +49 (0) 6128 95 1096
Email: TFG003@email.mot.com

Scandinavia
Telephone: +46 8 735 9282
Fax: +46 8 735 9280
Email: C14749@email.mot.com

Germany -Customer Connect Team
Telephone: +49 (0) 6128 70 2248
Fax: +49 (0) 6128 95 1082
Email: cgiss.emea@europe.mot.com

France - Lionel Lhermitte
Telephone: +33 1 6929 5722
Fax: +33 1 6929 5904
Email: TXE037@email.mot.com

Italy - Ugo Gentile
Telephone: +39 0 2822 0325
Fax: +39 0 2822 0334
Email: C13864@email.mot.com

Africa & Middle East - Armand Roy
Telephone: +33 1 6929 5715
Fax: +33 1 6929 5778
Email: armand.roy@Motorola.com

3.0 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 below shows one mobile radio model number and its specific characteristics.

Table 1-1 Radio Model Number (Example: MDM50FNC9AN2_N)

	Type of Unit	Model Series	Freq. Band	Power Level	Physical Packages	Channel Spacing	Protocol	Feature Level	Model Revision	Model Package
MD ↑ **MD** = Motorola Internal Use	**M** ↑ **M** = Mobile	50	**F** Midband (66-88MHz) **J** VHF (136-162MHz) **K** VHF (142-174MHz)	**N** 1-25W	**C** CM140 CM340	**9** Programmable	**AA** Conventional MDC	**1** RF Connector: Mini-UHF	**A**	**N**
			Q UHF1 (403-430MHz) **R** UHF2 (438-470MHz) **S** UHF3 (465-495MHz)	**P** 25-40W **Q** 25-45W	**F** CM160 CM360		**AN** 5 Tone	**2** RF Connector: BNC		

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Chapter 2

MAINTENANCE

</div>

1.0   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.
- ❑   Repair procedures and techniques.
- ❑   Installation of Option Boards.

2.0   Preventive Maintenance

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

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   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 and housing assembly. 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 (70% by volume).

⚠   **CAUTION: The effects of certain chemicals and their vapors can have harmful results on certain plastics. Avoid using aerosol sprays, tuner cleaners, and other chemicals.**

Cleaning External Plastic Surfaces

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 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 of 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 top cover.

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

3.0   Safe Handling of CMOS and LDMOS Devices

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 following CAUTION statement.

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 4280385A59)

❏ 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.

4.0   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 and order the part from the nearest Motorola Parts centre listed in the "Piece Parts" section in Chapter 1 of this manual.

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 RF connector, potentiometer, 16-pin and 20-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.

5.0   Disassembling and Reassembling the Radio — General

Since these radios may be disassembled and reassembled with the use of only 14 (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/assembling the radio:

❑   Small flat blade screwdriver

❑   Phillips small 1# screwdriver

❑   TORX™ T9 screwdriver

❑   TORX™ T10 screwdriver

❑   Torque screwdriver set

❑   Torque spanner

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

The following disassembly procedures should be performed only if necessary:

6.0   Radio Disassembly - Detailed

The procedure to remove and replace a Control Head, Top Cover or Transceiver Board is similar for all models of radio. A typical procedure is therefore shown followed by specific disassembly procedures for Control Heads on radio models without a display and radio models fitted with a display.

6.1   Control Head Removal

NOTE   Ensure that the volume knob is in the OFF position before disassembling the radio.

Volume Knob Removal

1.   Insert the flat screwdriver between the control head plastic and the volume knob and push the volume knob upwards. See Figure 2-1.
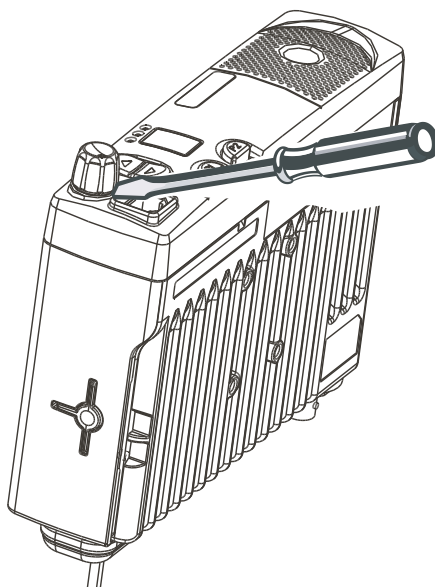
Figure 2-1 Volume Knob Removal.

2.   Insert the flat screw driver (4 mm maximum) into the slot and push the plastic up.
      Do the same with the second slot to free the control head from the chassis assembly. See Figure 2-2.
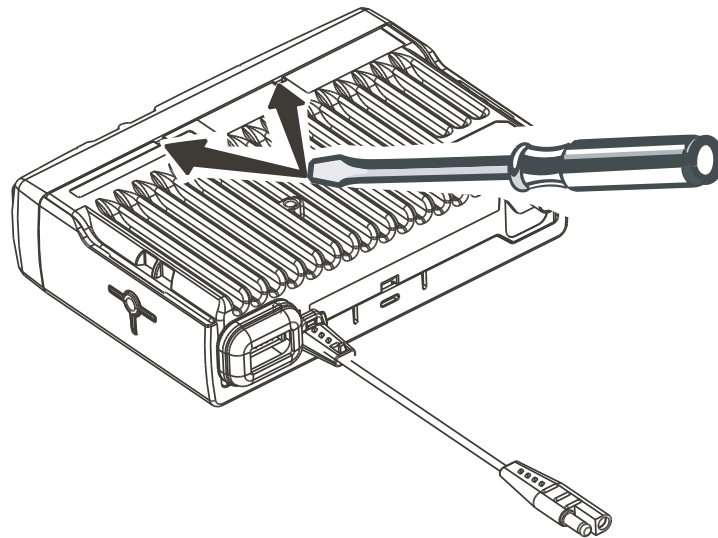
Figure 2-2 Control Head Removal

3. To free the head, disconnect the flat cable from the chassis assembly See Figure 2-3.
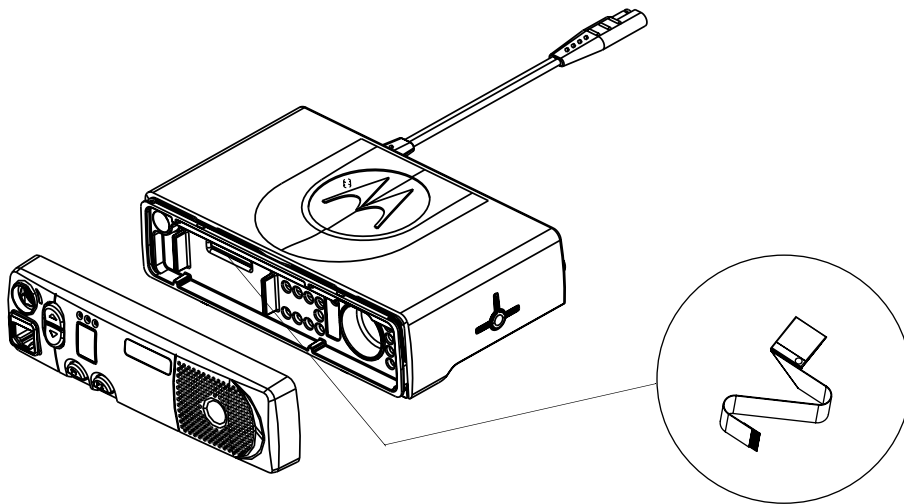
Figure 2-3 Flat Cable Removal

6.2   Top Cover Removal

1.   Place the radio in a vertical position as shown in Figure 2-4..
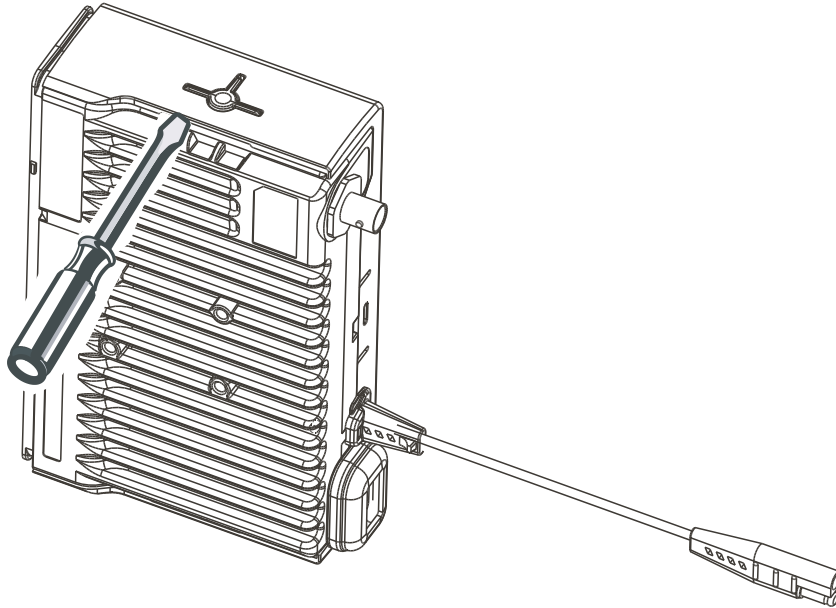
Figure 2-4 Top Cover Removal (Chassis Vertical).

2.   Insert the flat screw driver near the 'T' and push the plastic cover up until it pops over the 'T' mount boss. Perform the same function on the 'T' location on the other side of the chassis.

3.   Next place the radio in a horizontal position as shown in Figure 2-5 and insert the flat screw driver into the slot to release the upper cover.
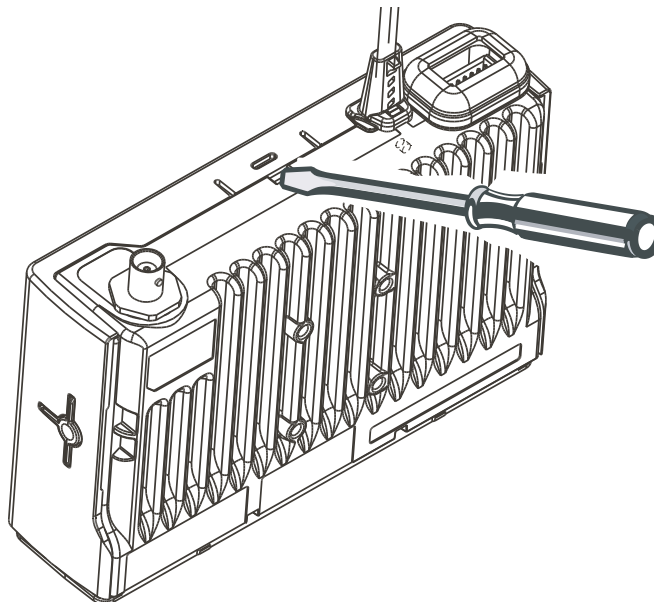
Figure 2-5 Top Cover Removal (Chassis Horizontal)

6.3   Main Shield Removal

1.   Insert the screw driver in the gap between the main shield and chassis (speaker cutout area) and push the shield up. See Figure 2-6.

2.   Lift the cover from the chassis.
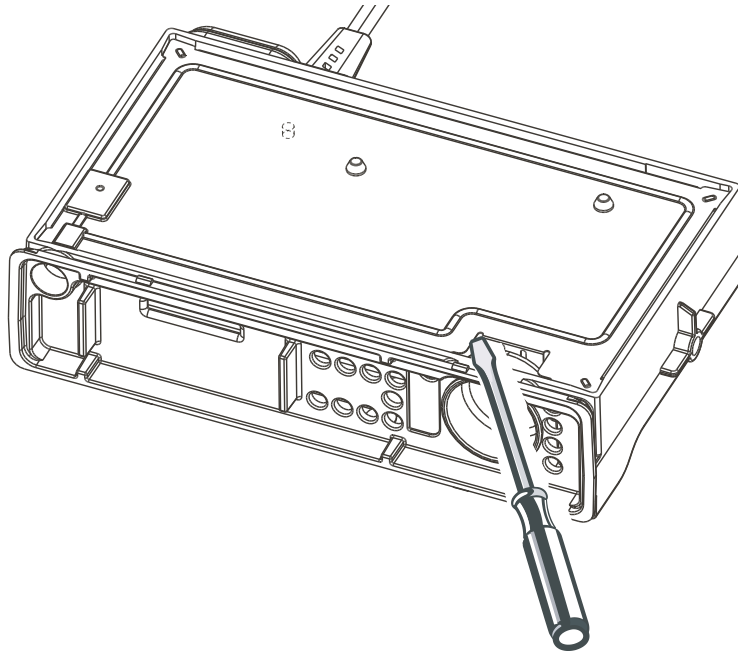
Figure 2-6 Main Shield Removal

6.4   PA Shield and DC Cable Removal

1.   Remove the three screws that attach the PA shield to PCB, and remove the PA shield.

2.   Remove the accessory Connector cap.

3.   Remove the two screws that attach the DC power cable to the PCB and pull it out from the side.
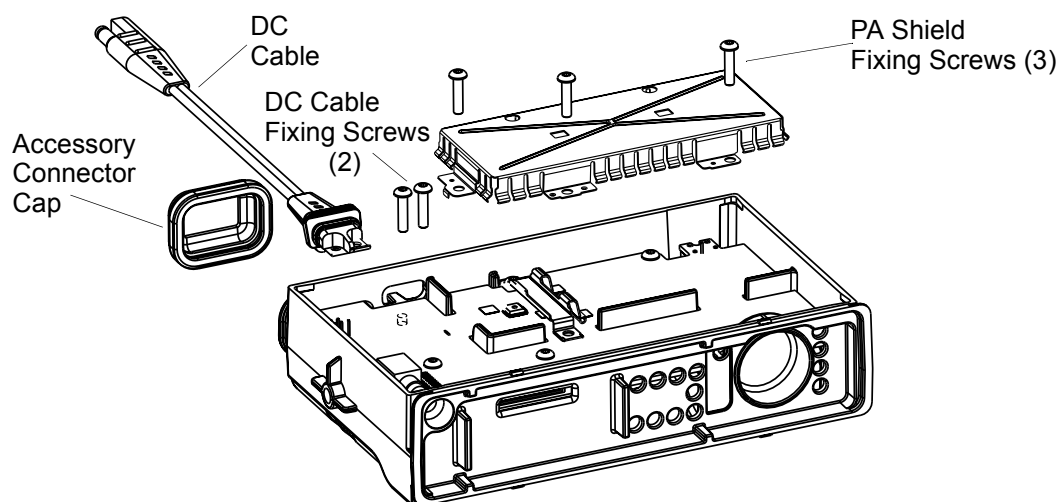
Figure 2-7 PA Shield and DC Cable Removal

6.5   PA Clip and Main PCB Removal

1.   Remove the screw that attaches the PA clip to the chassis. See Figure 2-8.

2.   Remove the PA clip.

3.   Remove all the screws that fix the PCB to the chassis.

4.   Loosen the M1.6 screw (about 3 to 4 turns) on the RF connector.

5.   Loosening this screw, enables you to unscrew the RF connector from outside.

6.   Carefully remove the main PCB in a diagonal manner.

NOTE   **It is recommended to grip the volume potentiometer and remove the PCB board**
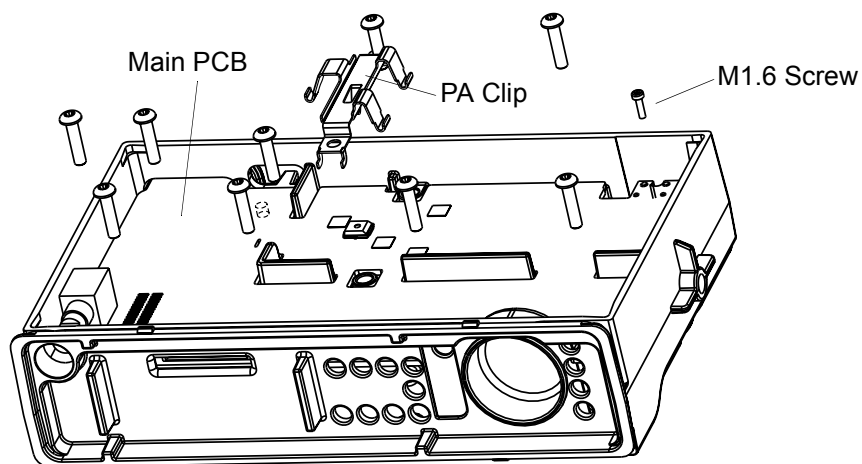
Figure 2-8 PA Clip and Main PCB Removal

6.6   Disassembly of Control Head - CM140/CM340

1.   Disconnect the flat cable from the Control Head PCB connector. See Figure 2-9

2.   Remove the keypad assembly from the control head housing by lifting it up from the face side.

3.   Disconnect the speaker socket and remove the speaker from the keypad assembly.

4.   Remove the pcb from the keypad assembly.

5.   Remove the LENs from the rubber keypad assembly.

| 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.** |

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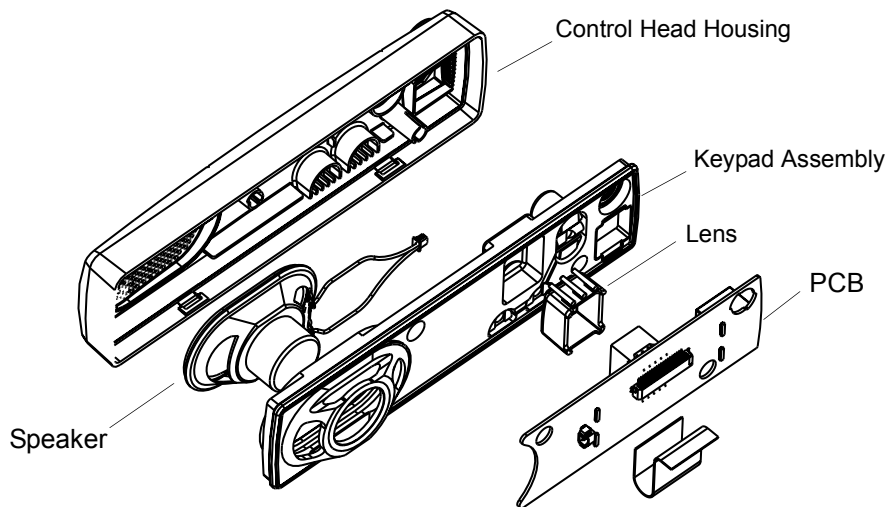
Figure 2-9 Control Head Housing Removal (CM140/CM340)

6.7   Disassembly of Control Heads - CM160 and CM360

1.   Disconnect the flat cable from the Control Head PCB connector. See Figure 2-10

2.   Remove the keypad assembly from the control head housing by lifting it up from the face side.

3.   Disconnect the speaker socket and remove the speaker from the keypad assembly.

4.   Remove the PCB from the keypad assembly.

5.   Remove the LCD assembly from the rubber keypad assembly.

NOTE   **DO NOT touch or contaminate the conductive pads on the under side of the keypad, the conductive contacts on the printed circuit board or the elastomeric connector.**
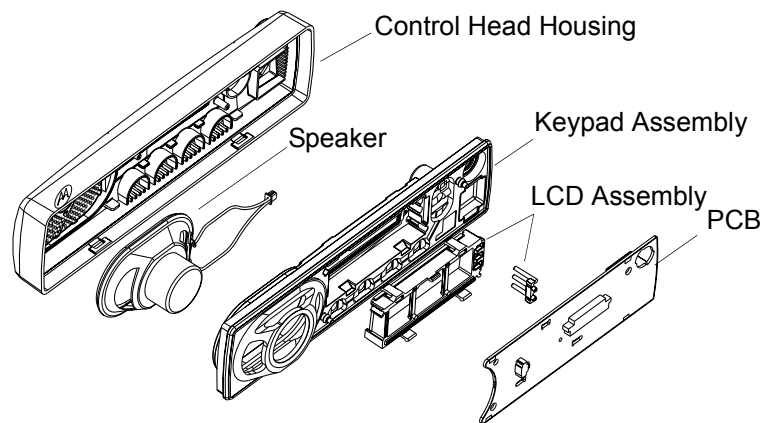
Figure 2-10 Control Head Housing Removal (CM160/CM360)

7.0   Radio Assembly

7.1   Chassis Assembly

1.   Ensure that the Fugi Poly Thermal Pad is on the small pedestal located on the PA compartment of the chassis.

2.   Verify that the potentiometer is soldered properly.

3.   Take the main PCB and smear thermal paste on LDMOS Power Amplifier, TO220, and Audio Power Amplifier.

4.   Slide the main board diagonally into the chassis.

5.   Assemble the O-ring on the RF connector and tighten it using Torque 22 lb.in.

6.   Tighten the RF connector security screw M1.6 using Torque 1.5 lb. (through the opening in the PCB).

7.   Tighten all eight screws (Torx T9).

8.   Take the Power Amplifier Clip and insert the leg-shape side into the opening groove located on the PCB. Tighten the screw using Torque 13 lb.in

9.   Take the PA Shield and place it on the PA compartment. Tighten the three screws using Torque 13 lb.in. Tighten the middle screw first, then the screw located on the left side, and lastly the screw located on the right side.

10. Insert the DC cable into the slot. Ensure that it is seated correctly on the chassis hook located below the DC cable. Attach it to the chassis and PCB by tightening the two screws using Torque 13 lb.in (Torx T10).

11. Take the main shield and place it on the chassis. Check that the corners of the main shield are seated properly on the corner supports.

12. Take the main seal and place it inside the top cover. Verify that the main seal is seated properly on its placement ribs and all around the groove.

13. Take the upper cover, place it properly on the chassis, and push it down. Three click sounds are heard from both sides and back.

7.2   Control Heads Assembly

1.   Assemble the Contol Heads by reversing the procedure for dis-assembly.

NOTE   Care should be taken not to touch or contaminate the conductive strip connectors and keypad conductors on the underside of the display and the elastomeric connectors (CM160/CM360 only).

7.3   Control Head Fitting

1.   Hold the Control Head in one hand and the chassis assembly in the other hand.

2.   Insert the flat cable into the main PCB connector through the slot in the chassis.

3.   Place the Control Head Assembly on the chassis assembly in a diagonal manner. Two clicking sounds are heard.

4.   Insert the Volume Knob into its groove and push it in.

5.   Place the cap of the accessory connector over the accessory pin.

7.4   Option Board Installation

1.   Follow the disassembly procedure in paragraphs 6.1 to 6.3.

2.   Remove and discard the 4xM3 screws holding the main pcb and replace with the 4 spacers provided. Torque the spacers to 10 lbs.

3.   Insert the jumper flex into the connector on the option board. Notice the orientation of the right-angle flex circuit.

4.   Insert the other end of the jumper flex into the connector on the main pcb.

5.   Fold the flex circuit under the option board.

6.   Position the option board over the spacers and retain using the 4xM2 screws provided.
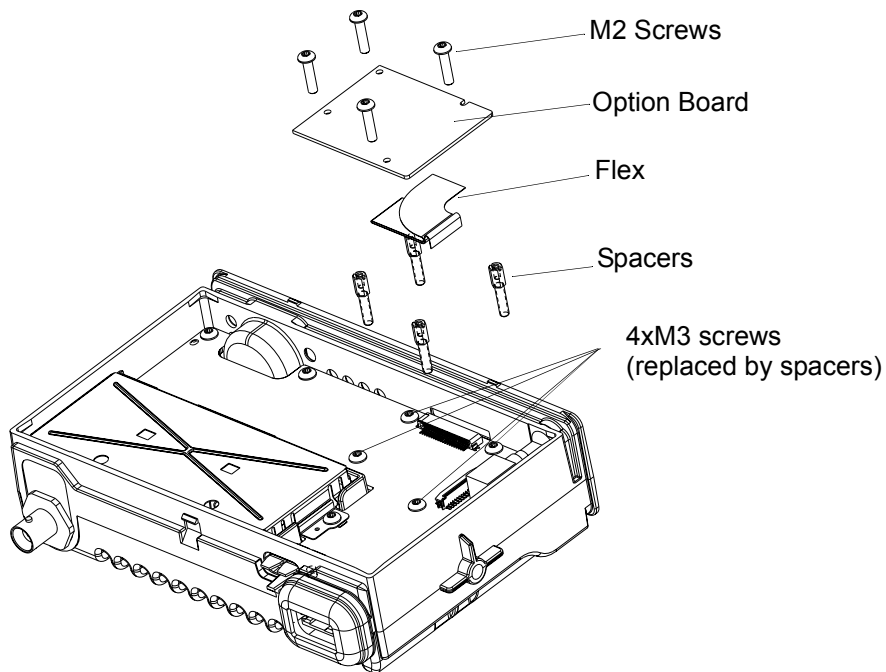
Figure 2-11 Option Board Installation

7.   With the option board correctly in place, the main shield and top cover can be assembled as detailed in paragraph 7.1 steps 11 to 13.

8.0 Radio Exploded Mechanical Views and Parts Lists

8.1 Radio Assembly - 25W Models
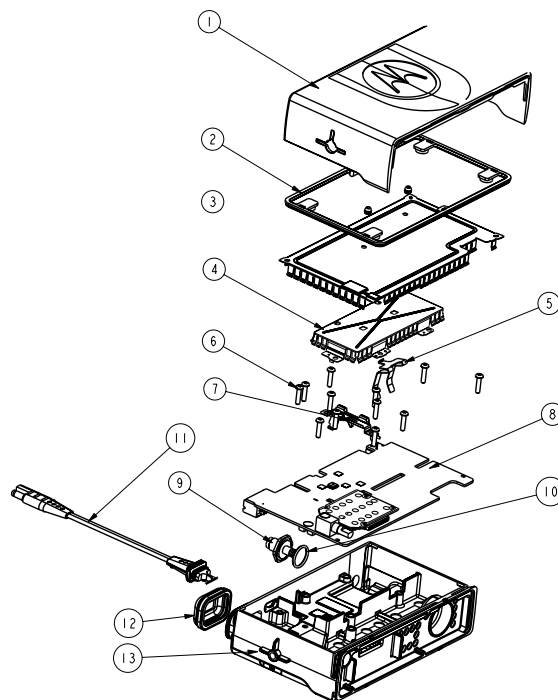
Figure 2-12 Radio Assembly - 25W Models

Table 2-1 Radio Assembly Parts List - 25W Models

Item No.	Description	Part Number
1	Upper Cover 25W	1589224U01
2	Main Seal	3289329U01
3	Main Shield	2689338U01
4	PA Shield	2689337U01
5	RF Connector Clip	4289561U01
6	Screw	0310943J12
7	PA Clip	0789352U01
8	VHF Main PCB UHF Main PCB Midband Main PCB	FLD6000A FLE6029A FUC1600A
9	Connector Jack: Mini UHF BNC	5802810C15 5802810C16
10	O-Ring	5802810C15
11	Power Cable Assembly	0189484U01
12	Cap, Accessory Connector	3202607Y01
13	Chassis 25W	2789223U01

8.2   Control Head - CM140/CM340
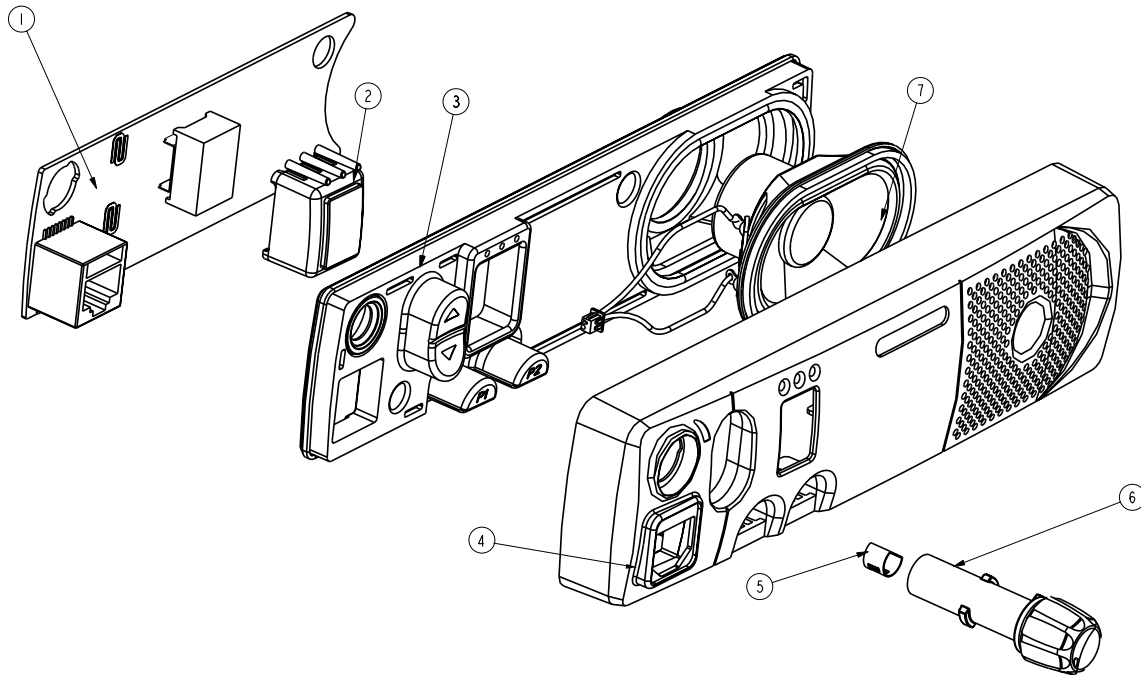
Figure 2-13 Control Head CM140/CM340

Table 2-2   Control Head CM140/CM340 Parts List

Item no	Description	Part No
1	Control Head PCB	FCN6288A
2	Lens	6189338U01
3	Keypad	7589330U01
4	Control Head Plastic	1589332U01
5	Knob Spring (part of knob - item 6)	
6	Knob, Volume	3689331U02
7	Speaker	5005156Z02
8	Flat Cable (not shown)	3089305U01

8.3 Control Head - CM160/CM360
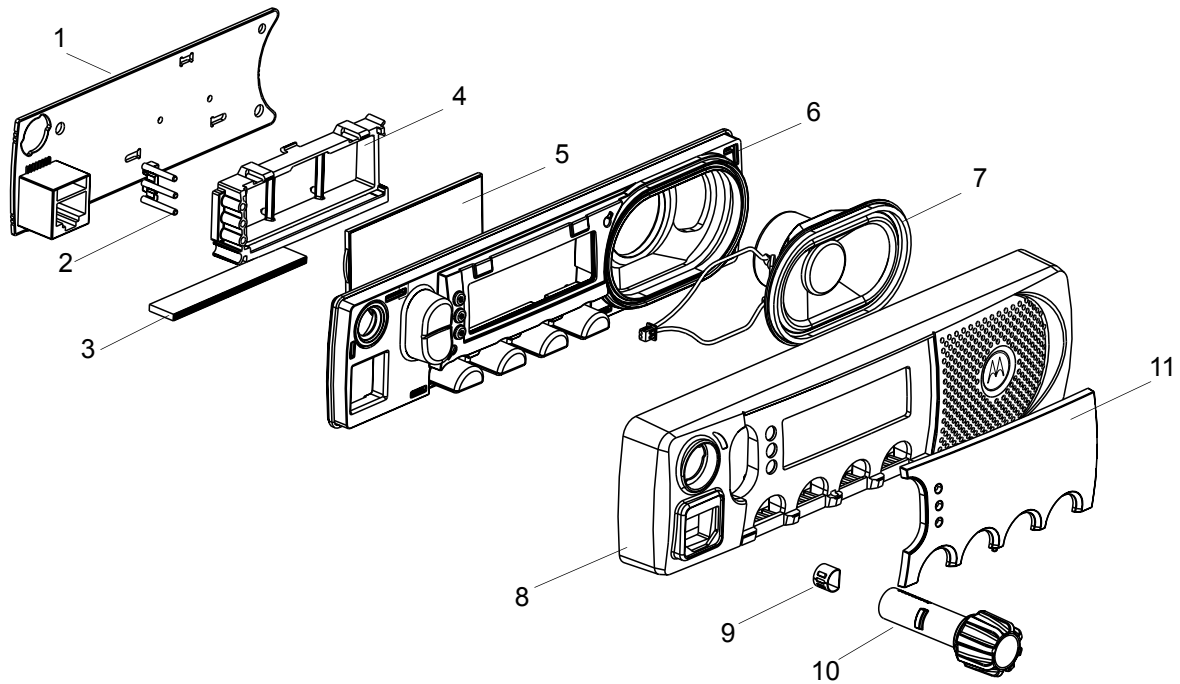
Figure 2-14 Control Head - CM160/CM360

Table 2-3   Control Head CM160/CM360 Parts List

Item no	Description	Part No.
1	Control Head PCB	FCN5523A
2	Light Guide	6189624U01
3	Elastomeric Connector	2802619S03
4	LCD Holder	0789623U01
5	LCD	7202421H33
6	Keypad	7589340U01
7	Speaker	5005156Z02
8	Control Head Plastic	1589333U01
9	Knob Spring (part of Knob - item 10)	
10	Knob	3689331U02
11	Lens: CM160 CM360	6189339U06 6189339U01
12	Flat Cable (Not Shown)	3089305U01

9.0   Service Aids

Table 2-4 lists the service aids recommended for working on the radio. While all of these items are available from Motorola, most are standard workshop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 2-4   Service Aids

Motorola Part No.	Description	Application
RLN4460_	Portable Test Set	Enables connection to audio/accessory jack. Allows switching for radio testing.
GMVN5034A	Customer Programming Software (CPS) and Tuner CDROM (MDC)	Programs customer options and channel data. Tunes hardware parameters, front end, power, deviation etc.
GMVN5033A	Customer Programming Software (CPS) and Tuner CDROM (5-Tone)	Programs customer options and channel data. Tunes hardware parameters, front end, power, deviation etc.
RKN4081_	Programming Cable with Internal RIB	Includes radio interface box (RIB) capability.
FKN8096_	Data/Flash Adapter	Used with RKN4081 (10 to 8 pin adapter for front Telco connector with CPS/Flash switch for programming/flashing only).
RKN4083_	Mobile Programming/Test Cable	Connects radio to RIB (RLN4008_) via rear accessory connector
FKN8113_	Adapter Cable	Used with RKN4083 (20 to 16 pin adapter for rear accessory connector).
GTF374_	Program Cable	Connects RIB to Radio microphone input.
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.
GPN6133_	Power Supply	Provides the radio with power when bench testing.
EPN4040_	Wall-Mounted Power Supply	Used to supply power to the RIB (UK).
EPN4041_	Wall-Mounted Power Supply	Used to supply power to the RIB (Euro).
8180384N64	Housing Eliminator (25W)	Test Fixture used to bench test the radio pcb.
3080369B71	Computer Interface Cable	Connects the RIB to the Computer (25-pin).
3080369B72	Computer Interface Cable	Connects the RIB to the Computer (9-pin) (Use for IBM PC AT - other IBM models use the B71 cable above).
6686119B01	Removal Tool	Assists in the removal of radio control head.

Table 2-4 Service Aids

Motorola Part No.	Description	Application
WADN4055A	Portable Soldering Station	Digitally controlled soldering iron.
6604008K01	0.4mm Replacement Tip	For WADN4055A Soldering iron.
6604008K02	0.8mm Replacement Tip	For WADN4055A Soldering iron.
0180386A82	Anti-static Grounding Kit	Used for all radio assembly/disassembly procedures.
6684253C72	Straight Prober	
6680384A98	Brush	
1010041A86	Solder (RMA type)	63/37, 0.5mm diameter, 2.2kg (1lb) spool.

10.0   Test Equipment

Table 2-5 lists test equipment required to service the radio and other two-way radios.

Table 2-5   Recommended Test Equipment

Motorola Part No.	Description	Characteristics	Application
R2600_NT	Comms System Analyzer (non MPT)	This monitor will substitute for items with an asterisk *	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1072_	Digital Multimeter		AC/DC voltage and current measurements
*R1377_	AC Voltmeter	100 μV to 300 V, 5Hz-1MHz, 10 Megohm input impedance	Audio voltage measurements
WADN4133	Delay Oscilloscope	2 Channel 40 MHz bandwidth, 5 mV/cm - 20 V/cm	Waveform measurements
R1440_ 0180305F17 0180305F31 0180305F40 RLN4610_ T1013_	Wattmeter, Plug-in Elements Plug-in Elements Plug-in Elements Carry case RF Dummy Load	Thruline 50-Ohm, ±5% accuracy 10W, 25 - 60 MHz 10W, 100 - 250 MHz 10W, 200 - 500 MHz Wattmeter and 6 elements	Transmitter power output measurements
S1339_	RF Millivolt Meter	100mV to 3 VRF, 10 kHz to 1.2 GHz	RF level measurements
R1011_/220V	220V Power Supply	0-40V, 0-40A	Programmable

11.0 Programming/Test Cable - RKN4083_
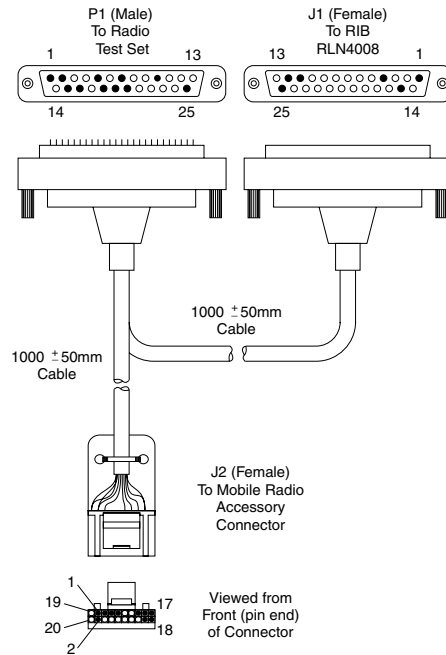
Note: Use with Adapter Cable FKN8113_

FLO830308-0

Figure 2-15 Programming/Test Cable
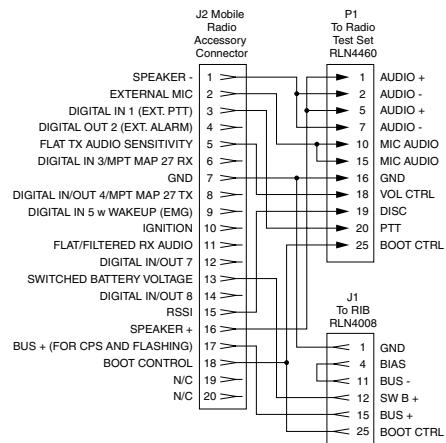
FLO830307-0

Figure 2-16 Pin Configuration of RKN4083

12.0   Adapter Cable - FKN8113_
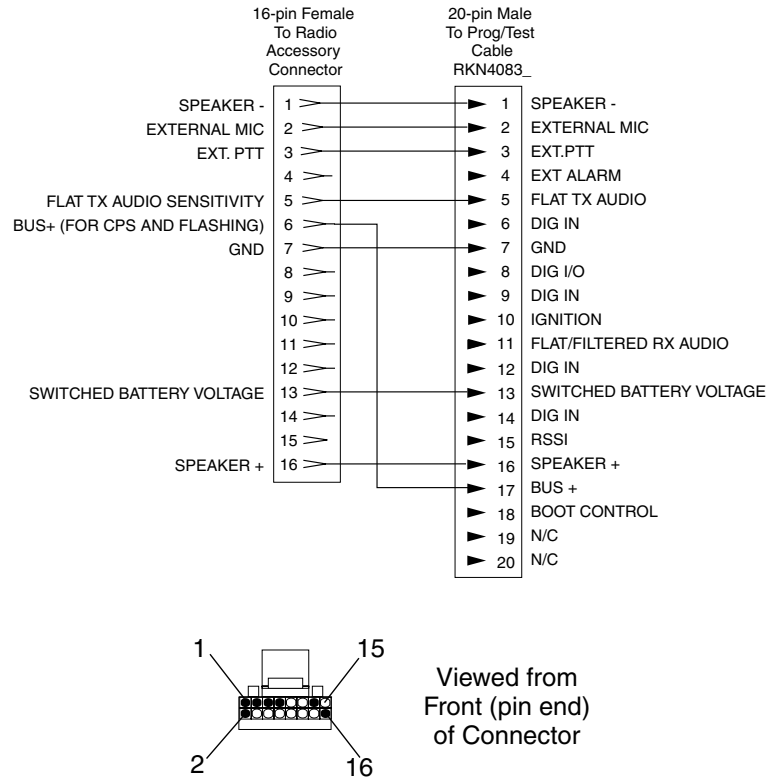
Figure 2-17 Pin Configuration of FKN8113

Chapter 3

TRANSCEIVER PERFORMANCE TESTING

1.0   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.

2.0   Setup

Supply voltage is provided using a 13.2Vdc power supply. The equipment required for alignment procedures is connected as shown in the Radio Tuning Test Setup Diagram, Chapter 4, Figure 4-6.

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 Number 5-Tone	MDC	Title
3-2	3-5	Test Environments
3-3	3-6	Test Channel Spacing
3-4	3-7	Test Frequencies
3-8		Transmitter Performance Checks
3-9		Receiver Performance Checks

Table 3-1   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: 20V
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: 20A

3.0   RF Test Mode (5-Tone Radios)

When the radio is operating in its normal environment, it is not possible to test all individual aspects of the transmitter and receiver performance. Therefore a special "test mode" is used to allow the service technician to perform certain functional tests on the product. A control head fuctional test mode is also available.

To enter test mode (CM360):

1.   Turn the radio on.

2.   Within less than one second of the power-up beep, press button **P2**, five times in succession.

3.   Six characters appear on the 8-character display, 'TT XX CC', where 'TT' indicates the test environment (Table 3.2), 'XX' indicates the channel number 1-14 (Table 3.4), and 'CC' indicates the channel spacing (Table 3.3). Test frequencies (channels) may be changed with use of the Up-Down button. Each additional press of **P2** will scroll through the remaining channel spacings supported.

4.   Pressing **P1** scrolls through and accesses test environments as shown in Table 3-2.

5.   Pressing **P2** for at least one second switches the radio to the control head test mode. '**LCD Test**' appears on the display.

6.   Pressing **P1** causes the radio to turn on all segments of the first character. A second **P1** press turns on all the segments of the second character and so on until all segments of all eight characters are illuminated.

7.   Pressing **P1** at the end of the LCD test activates the 'Icon & LED Test'. The next **P1** press turns on the first icon. Successive presses of **P1** cycle through all icons and finally the three LEDs.

8.   Pressing **P1** at the end of the 'Icon & LED Test' activates the button test. When a button is pressed a single beep is heard and another beep on each release of all four **P** buttons plus the Up-Down button.

9.   Pressing **P2** for at least one second in the control head test mode causes the radio to return to the RF test mode.

Note: The radio powers up on the last used test state i.e. the last used test environment and channel spacing, but always starts at channel 1.

To enter test mode (CM340):

1.   Turn the radio on.

2.   Within less than one second of the power-up beep, press button **P2**, five times in succession.

3.   The three LEDs will turn on and the single character segment display will indicate channel 1. As the display can only show 1 to 8, channels 1 to 7 are repeated with a dot on the display to indicate high power. Channels 1 to 7 with no dot represent low power (Table 3.4). An audio alert will sound to indicate the test environment.

4.   Pressing **P1** will scroll through the other 12 test environments with its associated audio beep. (Table 3.2)

5.   Press **P2** to scroll through the three supported channel spacings channel spacings supported (Table 3.3)

6.   Pressing **P2** for at least one second switches radio to the control head test mode. A beep will sound and the segment goes blank.

7.   Pressing **P1** will cycle scroll through the segment test, then the LED test and finally the HI/LO power segment indicator; a high pitched beep will also sound as P1 is pressed.

8. In this mode all buttons, when pressed and held, will emit a high pitched beep and another when the button is released to verify button functionality.

9. Pressing **P2** for at least one second will return the user to RF Test Mode

Note: The radio powers up on the last used test state i.e. the last used test environment, test channel, and channel spacing.

Table 3-2   Test Environments

No. of Beeps	Code 'TT' CM360	Description	Function
1 (high pitch)	SQ	Carrier Squelch (CSQ)	RX: unsquelch if carrier detected TX: mic audio
11	CP	CMP	RX: constant unsquelch TX: mic audio
12	LL	LLE	RX: constant unsquelch TX: mic audio
5	US	Unsquelch (UNSQ)	RX: constant unsquelch TX: mic audio
2	DP	Digital Private-Line (DPL)	RX: unsquelch if carrier and digital code (131) detected TX: mic audio + digital code (131)
1	TP	Tone Private-Line (TPL)	RX: unsquelch if carrier and tone (192.8Hz) detected TX: mic audio + tone (192.8Hz)
3	DT	Dual-Tone multiple frequency (DTMF)	RX: unsquelch if carrier detected TX: selected DTMF tone pair
9	M0	MPT 0	RX: unsquelch if carrier detected TX: 1200 baud with data "0"
10	M1	MPT 1	RX: unsquelch if carrier detected TX: 1200 baud with data "1"
4	M3	MPT 3	RX: speaker muted, high tone sounds when below sequence detected TX: 1200 baud with bit pattern "aa aa c4 d7 d2 90 49 f1 f1 bb f5 c7"
6	SC	Select 5 CCIR (SV-C)	RX: speaker muted, high tone sounds when below sequence detected TX: CCIR sequence 1124, 1275, 1446, 1640, 1860 Hz
7	SZ	Select 5 ZVEI (SV-Z)	RX: speaker muted, high tone sounds when below sequence detected TX: CCIR sequence 1060, 1270, 1530, 1830, 2200 Hz
8	EX	Data Mode (EXT)	RX: unsquelch if carrier detected TX: flat TX audio
13	BS	Base Station Mode (B-ST)	RX: constant unsquelch TX: mic audio

Table 3-3   Test Channel Spacing

Number of Beeps	Code 'CC' CM360	Channel Spacing
1	25	25 kHz
2	12	12.5 kHz
3	20	20 kHz

Table 3-4   Test Frequencies

Test Mode	Test Channel Low Power		Test Channel High Power		VHF2	UHF R1	UHF R2	MIDBAND
	CM360	CM340	CM360	CM340				
TX	01	1	08	1.	146.025	403.025	438.025	66.125
RX	01	1	08	1.	146.025	403.025	438.025	66.025
TX	02	2	09	2.	150.700	409.150	443.350	69.125
RX	02	2	09	2.	150.700	409.150	443.350	69.025
TX	03	3	10	3.	155.350	415.350	448.700	73.125
RX	03	3	10	3.	155.350	415.350	448.700	73.025
TX	04	4	11	4.	160.025	421.500	454.025	77.125
RX	04	4	11	4.	160.025	421.500	454.025	77.025
TX	05	5	12	5.	164.700	427.650	459.350	81.125
RX	05	5	12	5.	164.700	427.650	459.350	81.025
TX	06	6	13	6.	169.350	433.850	464.700	85.125
RX	06	6	13	6.	169.350	433.850	464.700	85.025
TX	07	7	14	7.	173.975	439.025	469.975	87.975
RX	07	7	14	7.	173.975	439.025	469.975	87.875

4.0   RF Test Mode (MDC Radios)

When the radio is operating in its normal environment, it is not possible to test all individual aspects of the transmitter and receiver performance. Therefore a special "test mode" is used to allow the service technician to perform certain functional tests on the product. A control head fuctional test mode is also available.

To enter test mode (display radios):

1. Turn the radio on.
2. Within ten seconds after the self test is complete, press button **P2**, five times in succession.
3. Channel number 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 are sounded.
5. Pressing **P1** scrolls through and accesses test environments as shown in Table 3-5.
6. Pressing **P2** for three seconds switches the radio to the control head test mode and zero appears on the display.
7. Pressing **P1** causes the radio to display the channel number "1". Another **P1** press causes the radio to display the next channel "2", and so on until channel "9".
8. Pressing **P1** at the end of the LCD test activates the 'LED Test'. The next **P1** press turns the LEDs and dot On/Off.
9. Pressing **P1** at the end of the LED 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 - 09)

Table 3-5   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

Table 3-6   Test Channel Spacing

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

Table 3-7   Test Frequencies

Test Mode	Test Channel Low Power		Test Channel High Power		VHF2	UHF R1	UHF R2
	CM160	CM140	CM160	CM140			
TX	01	1	08	8.	146.025	403.025	438.025
RX	01	1	08	8.	146.025	403.025	438.025
TX	02	2	09	9.	150.700	409.150	443.300
RX	02	2	09	9.	150.700	409.150	443.300
TX	03	3	10	0.	155.300	415.350	448.700
RX	03	3	10	0.	155.300	415.350	448.700
TX	04	4	11	1.	160.000	421.500	454.000
RX	04	4	11	1.	160.000	421.500	454.000
TX	05	5	12	2.	164.700	427.650	459.300
RX	05	5	12	2.	164.700	427.650	459.300
TX	06	6	13	3.	169.300	433.850	464.700
RX	06	6	13	3.	169.300	433.850	464.700
TX	07	7	14	4.	173.025	439.025	469.025
RX	07	7	14	4.	173.025	439.025	469.025

Table 3-8 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 VHF, ±150 Hz UHF ±150 Hz MB
Power RF	As above	As above	As above	1-25W
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). 4 kHz Max. (20 kHz Ch. Sp). 5 kHz Max. (25 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.). 4 kHz Max. (20 kHz Ch. Sp.). 5 kHz Max. (25 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: 1.5-2.0 kHz (12.5 kHz Ch. Sp.). 2.3-3.2 kHz (20 kHz Ch. Sp.). 3.0-4.0 kHz (25 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.). 2.3-3.0 kHz (20 kHz Ch. Sp.). 2.9-3.8 kHz (25 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.). 0.4-0.8 kHz (20 kHz Ch. Sp.) 0.5-1.0 kHz (25 kHz Ch. Sp.).

* See Tables 3-4 & 3.7

Table 3-9 Receiver 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 output at antenna	PTT to continuous (during the performance check)	Frequency error to be ±150 Hz VHF ±150 Hz UHF ±150 Hz MB
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 8.10Vrms
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 <0.3µV
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 frequency to a conventional system. Raise RF level from zero until radio unsquelches.	out of TEST MODE; select a conventional system	As above	Unsquelch to occur at <0.25µV. Preferred SINAD = 9-10dB

 * See Tables 3-4 & 3.7

<div align="right">

Chapter 4

RADIO TUNING AND PROGRAMMING

</div>

1.0   Introduction

This chapter provides an overview of the Customer Programming Software (CPS) and tuner program designed for use in a Windows 98/ME/NT/2000 environment. A CPS/Tuner Installation Manual (6866545D09) is included in this Product Manual.

NOTE	Refer to the CPS on-line help files for programming procedures.

<div align="center">

Table 4-1   Software Installation Kits Radio Tuning Setup

Description	Kit Number
5-Tone CPS (includes Global Tuner)	GMVN5033_
MDC CPS (includes Global Tuner)	GMVN5034_
Software Installation Manual	6866545D09_

</div>

2.0   CPS Programming/Flashing Setup with RIB

The CPS programming setup, shown in Figures 4-1 is used to program and flash the radio using the Radio front Telco connector.

Figure 4-1 CPS Programming/Flashing Setup with RIB

3.0   CPS Programming/Flashing Setup Ribless

The CPS programming setup, shown in Figures 4-2 is used to program and flash the radio using the Radio front Telco connector.
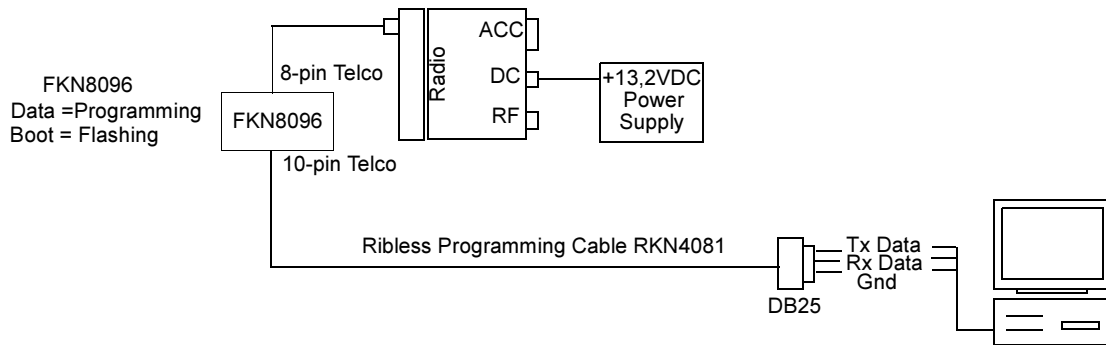
Figure 4-2 CPS Programming/Flashing Setup Cable with Internal RIB

4.0   CPS Programming Setup with RIB

The CPS programming setup, shown in Figures 4-3 is used to program the radio using the Radio front Telco connector.
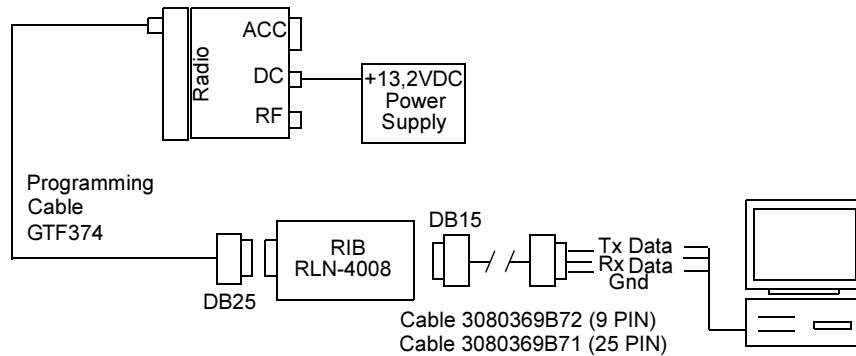
Figure 4-3 CPS Programming Setup with RIB

5.0 CPS Programming Setup with RIB

The CPS programming setup, shown in Figures 4-4 is used to program the radio using the Radio rear accessory connector.
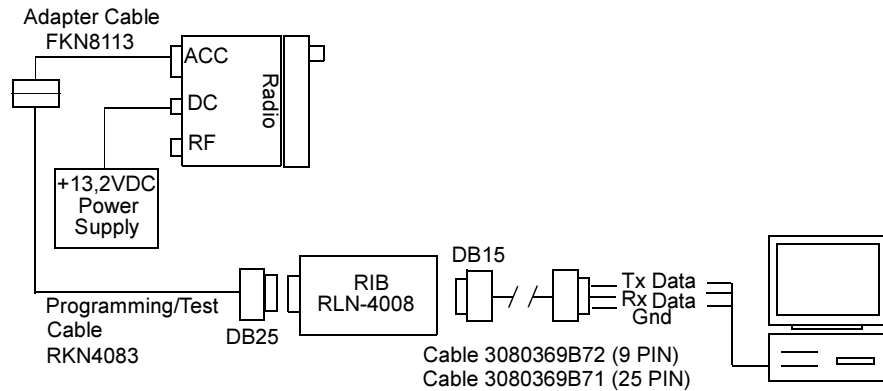
Figure 4-4 CPS Programming Setup Cable with RIB and Rear Adapter Cable

6.0 CPS Programming Setup with RIB

The CPS programming setup, shown in Figures 4-5 is used to program the radio using the Radio rear accessory connector.

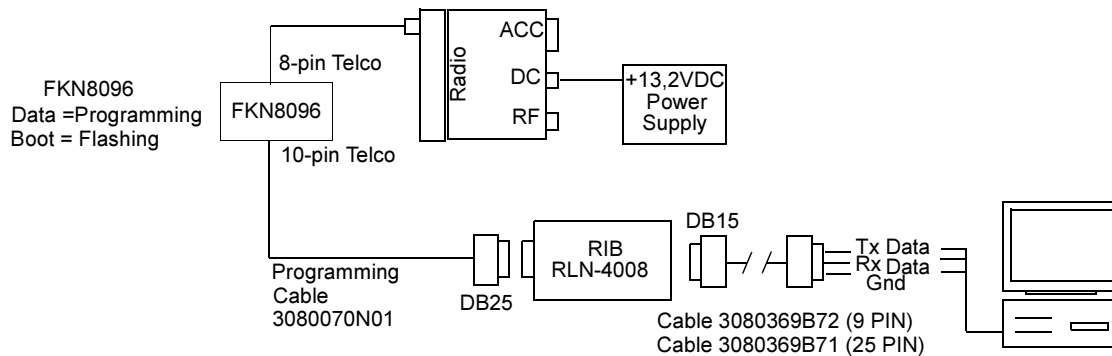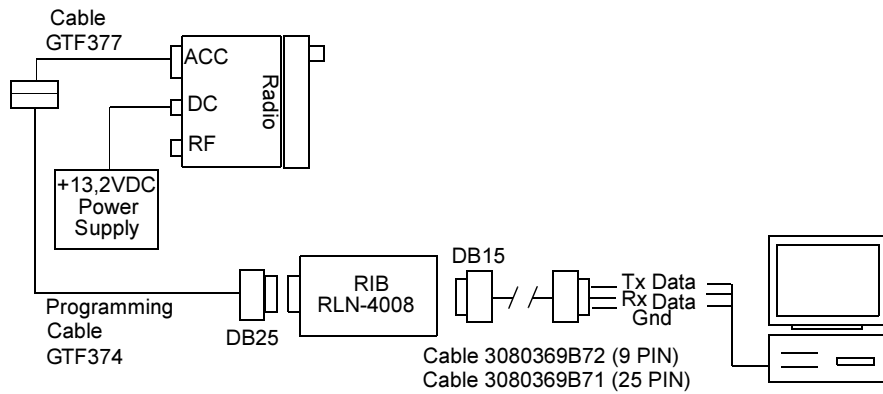**Figure 4-5** CPS Programming Setup Cable with RIB and Rear Adapter Cable

7.0   Radio Tuning Setup

A personal computer (PC), Windows 95/98/NT 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 4-6.
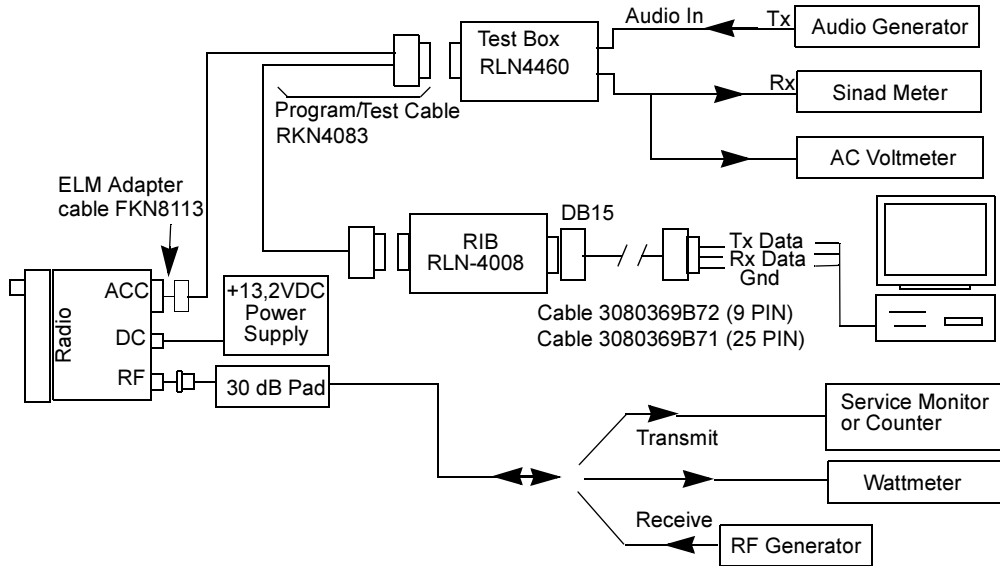
Figure 4-6 Radio Tuning Test Equipment Setup with External RIB

7.1   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

NOTE   Refer to Tuner on-line help files for tuning procedures.

POWER UP SELF-TEST

1.0   Error Codes (5-Tone Radios)

Turning on the radio starts a self-test routine that checks the radio functionality. If the checks are successful, the radio generates a high-pitched self-test pass tone. If the self-test is not successful, one low-pitched (300Hz) error tone is heard and the RED LED flashes several times to indicate the reason for the failure (see Table 5-1 below). After flashing the error code, the LED remains off for 5 seconds and then repeats the error code. The LED sequence and the error tone continue until the radio is switched off. Radios with displays are also able to display error codes. The meaning of the LED indication, the displayed error codes and the related corrections are listed in Table 5-1.

Table 5-1   Power-up Error Codes

If the error code displayed is…	The LED flashes...	then, there is a...	To correct the problem...
"Test 1 Failed"	Once	Hardware codeplug error, possibly codeplug structure mismatch or non-existant codeplug.	Reprogram codeplug. If message re-occurs, replace main board or return it to the nearest Motorola depot.
"Test 2 Failed"	Twice	Select 5 Application Vector corrupted.	Reprogram codeplug and retest the radio.
"Test 3 Failed"	Three times	Codeplug Checksum error.	Reprogram codeplug and retest the radio.
"Test 4 Failed"	Four times	Codeplug Version Error.	Reprogram codeplug using the correct version and retest the radio.
"Test 5 Failed"	- - - -	- - - -	Reserved
"Test 6 Failed"	Six times	RAM Checksum test failure.	Turn the radio off then on again. If the message re-occurs replace the main board or return it to the nearest Motorola depot.
"Test 7 Failed"	- - - -	- - - -	Reserved
"Test 8 Failed"	- - - -	- - - -	Reserved
300Hz Tone and Flashing LED.		Radio failure or invalid codeplug as described above.	Turn the radio off then on again. Confirm that there is a 300Hz fail tone and count the number of flashes made by the LED. Make the relevant correction as described above

2.0   Error Codes (MDC 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. If the self-test is not successful, one low-pitched tone is heard. Radios
with displays are able to display the error codes. Following are the possible errors and the related
corrections.

Table 5-2   Power Up Error Codes

Possible Errors	To correct the problem...
RAM test failure.	Retest the radio by turning it off and turning it on again. If bad tone reoccurs, replace RAM (U0122).
Codeplug structure mis-match or non existence of codeplug.	Reprogram codeplug with correct version and retest radio. If message reoccurs, replace EEPROM (U0111).
Wrong codeplug checksum.	Reprogram codeplug.

ACCESSORIES & CONNECTOR PIN FUNCTIONS

1.0 Accessories

To order, refer to Chapter 1 (paragraph 2.4 - 'Piece Parts') of this manual.

1.1 Antenna

RAD4198_	136 - 144 MHz 1/4 Wave Roof Mount - BNC
RAD4199_	144 - 152 MHz 1/4 Wave Roof Mount - BNC
RAD4200_	150.8 - 162 MHz 1/4 Wave Roof Mount - BNC
RAD4201_	162 - 174 MHz 1/4 Wave Roof Mount - BNC
RAE4151_	403 - 430 MHz 1/4 Wave Roof Mount - BNC
RAE4152_	450 - 470 MHz 1/4 Wave Roof Mount - BNC
RAE4154_	450 - 470 MHz 5dB Gain Roof Mount - BNC
RAC4000_RA	66 - 88 MHz 1/4 Wave Roof Mount - Mini UHF
RAC4000_MA	66 - 88 MHz 1/4 Wave Magnetic Mount - Mini UHF
5880367B28	BNC Adapter (for use with Mini UHF antenna)

1.2 Audio

HMN3413-	Compact Microphone
HMN1035_	Heavy Duty Microphone
HMN3000_	Black Desk Microphone
RMN5029_	Enhanced Keypad Microphone
RMN5018_	Mag One Microphone
RMN5019_	Mag One Keypad Microphone
MDREX4617_	Telephone Style Handset Kit
GMMN4065_	Visor Microphone (Omni Direction)
RSN4001_	External Speaker, 13 W
HSN8145_	External Speaker 7.5 W
HLN9073_	Microphone Hang-up Clip

1.3   Alarms and Accessories

RLN4586_	Footswitch with Remote PTT
RLN4857_	Pushbutton with Remote PTT
RLN4858_	Gooseneck PTT
RLN4836_	External PTT with Emergency Footswitch
HLN9328_	External Alarm Relay (used in conjunction with GLN7282)
GLN7282_	Buzzer Kit (used in conjunction with HLN9328)

1.4   Control Station

HPN4002_	Desktop Power Supply 1-25 W (not EMC approved)
HKN4139_	12V Power Cable to Battery (1-25 W)
HPN4001_	Desktop Power Supply 25-60 W (not EMC approved)
HKN9455_	Power Cable to Battery (25-60 W)
GPN6145_	Desktop Power Supply
GKN6266_	12V Cable to Radio, for use with GPN6145 Desktop Power Supply
RLN5390_	Desktop Tray with Speaker
RLN5391_	Desktop Tray without Speaker

1.5   Public Address

RLN5288_	Public Address Kit (includes switch box and cabling)
HKN9324_R	Speaker Cable for PA (15 ft.)
HSN1000	External Speaker, 6 W for public address

1.6   Cables

HKN9327	Ignition Switch Cable
HKN4137	Low Power Cable to Battery (1-25 W)
HKN4191	High Power Cable to Battery (25-60 W)
GMKN4084_	Speaker Extension Cable)

1.7   Peripherals

HLN3948_	Basic RICK (Repeater Interface Comm Kit)
HLN3333_	RICK (Repeater Interface Comm Kit)

1.8   Mounting

GLN7324_	Low Profile Mounting Bracket
GLN7317_	High Profile Mounting Bracket
FTN6083_	DIN Mount
GLN7341_	Removable Slide Mount
RLN4779_	Keylock Mounting Bracket

1.9   Programming

GTF374__	Programming Cable
GTF377__	Adapter Cable for GTF374
RKN4081_	Ribless Cable
FKN8096_	Adapter Cable for use with RKN4081
RKN4083_	Programming/Test Cable
FKN8113_	Adapter Cable for use with RKN4083
3080369B72	RS232 Cable 9-pin
3080369B71	RS232 Cable 25-pin
RLN4008_	Rib Box
RLN4460_	Test Box

2.0   Accessory Connector Pin Function

Pin	Function	Description
1	External Speaker (-)	Connect external 8 or 4 ohms speaker to pin 1 and 16. Caution: Bridge-type output. Neither pin 1 or 16 is grounded.
2	External Mic Audio	Input impedence:500 ohms 80 mV rms at 1 kHz for 60% deviation. This path is enabled when external mic PTT is keyed.
3	External Mic PTT	Put this pin low (less than 0.66 Vdc) to key transmitter and enable external mic audio path. This path is pulled low via a diode when front panel mic PTT is pulled low to allow sensing of mic PTT by accessory. This pin pulled high to 3.3 Vdc via 3.3k ohms
4	Programmable Output	Defaults to External Alarm. Provides an active high to 13.8 Vdc battery supply. maximum current: 0.25 amps.
5	Flat_TX_Audio Input	Input impedance: Greater than 35k ohms. The nominal input level is 150 mV rms for 60% deviation.
6	Bus+	Serial Communication Interface. On **MDC and P/L radios only,** this pin can be configured as a general purpose input by removing resistor R421.
7	Ground	Used as ground.
8	Programmable I/O	Input or output depending on dealer programming.
9	Emergency Input	When connecting the Emergency Footswitch between pin 9 and 7, the radio will sense the connection upon Power-up. Shorting this pin to Ground by pressing the switch when the radio is OFF, turns ON the radio in Emergency Mode. Shorting this pin to Ground by pressing the switch when the radio is ON, activates Emergency Mode. To turn OFF a radio that was turned ON by Emergency Footswitch (ON/OFF knob in OFF position) turn knob to ON and then to OFF position.
10	Ignition Sense	For optional 3-wire ignition control, connect this pin to the vehicle ignition-controlled voltage source for ignition-controlled radio ON/OFF. To resume NON ignition state, remove the battery connection for 10 seconds; remove the ignition connection from this pin and re-connect the battery connections.
11	Receive Audio Output	Programmable (using CPS in the RX Audio Type): 660mV rms (de-emphasized/muted) or 330mV rms (non de-emphasized muted. Minimum load resistance: 5k ohms
12	Programmable I/O	Input or Output
13	Switched B+	(Switched Battery Voltage) 13.8Vdc (500mA max.) when radio is ON
14	Programmable I/O	Input or Output
15	Internal Speaker	Connect to internal speaker (+) and by internal jumper to pin 16
16	External Speaker (+)	Connect external 8 or 4 ohms speaker to pins 1 and 16. CAUTION: Bridge type output. Neither pin 1 nor 16 is grounded.

3.0 Microphone Connector Pin Function

Pin	Function	Description
1	9.3V	Regulated 9.3V Supply (50mA max.)
2	Boot/DTMF Keypad Column	This pin function depends on the voltage applied to pin 3 (See pin 3, Hook description). When configured as "Boot", applying 5V to this pin will set the radio to Boot state. When configured as "DTMF Keypad Column", this pin will carry column voltages generated by the DTMF microphone (RMN5029).
3	Hook	When 0V is applied to this pin (mic on hook), pins 2 and 7 will be configured to "Column" and "Row". When no voltage is applied to this pin (mic off hook), this pin will read 2.7V, and pins 2 and 7 will be configured to "Column" and "Row". When 9.3V is applied to this pin (programming cables or Mag One mic RMN5018), pins 2 and 7 will be configured to "Boot" and "SCI".
4	Ground	Used as ground
5	Mic. Audio	Audio input impedance: 500 ohms 80 mV rms input (standard mic) or 1.8 mV rms (low cost mic) at 1 kHz for 60% deviation. This path is enabled when Mic. PTT (pin 6) is keyed
6	Mic. PTT	Microphone PTT is active low, so this port reads "0" when PTT is pressed and "1" when PTT is released. 10 K ohms internal pull up resistor to 9.3 V. Pulling low this pin will also pull low, via a diode, pin 3 (external MIC PTT) of the accessory connector.
7	SCI/DTMF Keypad Row	The function of this pin depends on the voltage applied to pin 3 (see pin 3 description). When configured as "SCI", serial communication with the radio is facilitated. When configured as "DTMF Keypad Row" this pin will carry new voltages generated by the DTMF mic (RMN5029)
8	Handset Rx Audio	Handset audio output provides de-emphasized, muted Rx audio. The source impedance is 10 ohms and the output level (open circuit) is controlled by the volume control setting.

MODEL CHART AND TEST SPECIFICATION

1.0   Model Chart (UHF1 403-440 MHz)

CM Series UHF1 403-440MHz					
Model					**Description**
MDM50QNC9AA2_N					CM140 403-440 MHz 1-25W 8-Ch
	MDM50QNC9AN2_N				CM340 403-440 MHz 1-25W 10-Ch
		MDM50QNF9AA2_N			CM160 403-440 MHz 1-25W 64-Ch
			MDM50QNF9AN2_N		CM360 403-440 MHz 1-25W 100-Ch
				Item	**Description**
X				PMUE2002_	S. Tanapa UHF1 25W 8 Ch BNC
	X			PMUE2023_	S. Tanapa UHF1 25W 10 Ch BNC
		X		PMUE2005_	S. Tanapa UHF1 25W 64 Ch BNC
			X	PMUE2025_	S. Tanapa UHF1 25W 100 Ch BNC
X	X	X	X	HKN4137_	Battery Power Cable
X	X			FCN6288_	Control Head
		X	X	FCN5523_	Control Head
X	X	X	X	RMN50188_ HMN3596_	Mag One Microphone Compact Microphone
X	X	X	X	GLN7324_	Low Profile Trunnion
X	X	X	X	6866546D02_	RTTE Leaflet
X	X	X	X	6866537D37_	Safety Leaflet
X				PMUE2029AS	Servicing Kit CM140
	X			PMUE2045AS	Servicing Kit CM340
		X		PMUE2031AS	Servicing Kit CM160
			X	PMUE2047AS	Servicing Kit CM360

X = Indicates one of each is required

2.0 Model Chart (UHF2 438-470 MHz)

CM Series UHF2 438-470MHz					
Model					**Description**
MDM50RNC9AA2_N					CM140 438-470 MHz 1-25W 8-Ch
	MDM50RNC9AN2_N				CM340 438-470 MHz 1-25W 10-Ch
		MDM50RNF9AA2_N			CM160 438-470 MHz 1-25W 64-Ch
			MDM50RNF9AN2_N		CM360 438-470 MHz 1-25W 100-Ch
				Item	**Description**
X				FUE1021_	S. Tanapa UHF2 25W 8 Ch BNC
	X			PMUE2019_	S. Tanapa UHF2 25W 10 Ch BNC
		X		PMUE1999_	S. Tanapa UHF2 25W 64 Ch BNC
			X	PMUE2021_	S. Tanapa UHF2 25W 100 Ch BNC
X	X			FCN6288_	Control Head
		X	X	FCN5523_	Control Head
X	X	X	X	HKN4137_	Battery Power Cable
X	X X	X	X	RMN50188_ HMN3596_	Mag One Microphone Compact Microphone
X	X	X	X	GLN7324_	Low Profile Trunnion
X	X	X	X	6866546D02_	RTTE Leaflet
X	X	X	X	6866537D37_	Safety Leaflet
X				FLE1621AS	Servicing Kit CM140
	X			PMUE2041AS	Servicing Kit CM340
		X		PMUE2027AS	Servicing Kit CM160
			X	PMUE2043AS	Servicing Kit CM360

X = Indicates one of each is required

3.0   Model Chart (VHF2 146-174 MHz)

CM Series VHF2 146-174MHz					
Model					**Description**
MDM50KNC9AA2_N					CM140 146-174 MHz 1-25W 8-Ch
	MDM50KNC9AN2_N				CM340 146-174 MHz 1-25W 10-Ch
		MDM50KNF9AA2_N			CM160 146-174 MHz 1-25W 64-Ch
			MDM50KNF9AN2_N		CM360 146-174 MHz 1-25W 100-Ch
				Item	**Description**
X				FUD1183_	S. Tanapa VHF2 25W 8 Ch BNC
	X			PMUD1879_	S. Tanapa VHF2 25W 10 Ch BNC
		X		PMUD1874_	S. Tanapa VHF2 25W 64 Ch BNC
			X	PMUD1881_	S. Tanapa VHF2 25W 100 Ch BNC
X	X			FCN6288_	Control Head
		X	X	FCN5523_	Control Head
X	X	X	X	HKN4137_	Battery Power Cable
X	X	X	X	RMN50188_ HMN3596_	Mag One Microphone Compact Microphone
X	X	X	X	GLN7324_	Low Profile Trunnion
X	X	X	X	6866546D02_	RTTE Leaflet
X	X	X	X	6866537D37_	Safety Leaflet
X				FLD1934AS	Servicing Kit CM140
	X			PMUD1889AS	Servicing Kit CM340
		X		PMUD1883AS	Servicing Kit CM160
			X	PMUD1891AS	Servicing Kit CM360

X = Indicates one of each is required

4.0   Model Chart (Midband 66-88 MHz)

CM Series Midband 66-88 MHz				
Model				**Description**
MDM50FNC9AN2_N				CM340 66-88 MHz 1-25W 10-Ch
	MDM50FNF9AN2_N			CM360 66-88 MHz 1-25W 100-Ch
		Item		**Description**
X			FUC1601_	S. Tanapa Midband 25W 10 Ch BNC
	X		FUC1603_	S. Tanapa Midband 25W 100 Ch BNC
X			FCN6288_	Control Head
	X		FCN5523_	Control Head
X	X		HKN4137_	Battery Power Cable
X	X		HMN3596_	Compact Microphone
X	X		GLN7324_	Low Profile Trunnion
X	X		6866546D02_	RTTE Leaflet
X	X		6866537D37_	Safety Leaflet
X			PMUC1033AS	Servicing Kit CM340
	X		FUC1605AS	Servicing Kit CM360

X = Indicates one of each is required

5.0   Model Chart (VHF2 146-174 MHz - High Power)

CM Series VHF2 146-174 MHz				
Model			**Description**	
MDM50KQC9AA2_N			CM140 146-174 MHz 25-45W 10-Ch	
	MDM50KQF9AA2_N		CM160 146-174 MHz 25-45W 100-Ch	
		Item	**Description**	
X		PMUD1848_	S. Tanapa VHF2 45W 10 Ch BNC	
	X	PMUD1894_	S. Tanapa VHF2 45W 100 Ch BNC	
X		FCN6288_	Control Head	
	X	FCN5523_	Control Head	
X	X	HKN4191_	Battery Power Cable	
X	X	RMN50188_	Mag One Microphone	
X	X	GLN7324_	Low Profile Trunnion	
X	X	6866546D02_	RTTE Leaflet	
X	X	6866537D37_	Safety Leaflet	
X		PMUD1885AS	Servicing Kit CM140	
	X	PMUD1887AS	Servicing Kit CM160	

X = Indicates one of each is required

6.0   Model Chart (UHF2 438-470 MHz - High Power)

CM Series UHF2 438-470 MHz				
Model			**Description**	
MDM50RPC9AA2_N			CM140 438-470 MHz 25-40W 10-Ch	
	MDM50RPF9AA2_N		CM160 438-470 MHz 25-40W 100-Ch	
		Item	**Description**	
X		PMUE2008_	S. Tanapa UHF2 40W 10 Ch BNC	
	X	PMUE2011_	S. Tanapa UHF2 40W 100 Ch BNC	
X		FCN6288_	Control Head	
	X	FCN5523_	Control Head	
X	X	HKN4191_	Battery Power Cable	
X	X	RMN50188_	Mag One Microphone	
X	X	GLN7324_	Low Profile Trunnion	
X	X	6866546D02_	RTTE Leaflet	
X	X	6866537D37_	Safety Leaflet	
X		PMUE2033AS	Servicing Kit CM140	
	X	PMUE2035AS	Servicing Kit CM160	

X = Indicates one of each is required

7.0   Specifications

General				
Specification	**VHF2**	**UHF1**	**UHF2**	**Midband**
Frequency Range:	146-174 MHz	403-440 MHz	438-470 MHz	66-88 MHz
Frequency Stability (-30°C to +60°C, 25°C Ref.)	±2.5 PPM	±2 PPM	±2 PPM	±5.0 PPM
Channel Capacity:	CM140 - 8 CM340 - 10 CM160 - 64 CM360 - 100			
Channel Spacing:	12.5/20/25 kHz			
Power Output:	1-25W, 25-45W	1-25W	1-25W, 25-40W	1-25W
Power Supply:	13.2Vdc (10.8 - 15.6 Vdc) negative vehicle ground			
Dimensions (L X W X H)	118mm X 169mm X 44mm			
Weight:	1.02 Kg			
Operating Temperature	-30 to 60 ^{o} C			
Storage temperature	-40 to 80° C			
Shock and Vibration	Meets MIL-STD 810-C,D&E and TIA/EIA 603			
Dust	Meets EN60529: IP54			
Humidity	Meets MIL-STD 810-C,D&E and TIA/EIA 603			

Transmitter				
Specification	**VHF2**	**UHF1**	**UHF2**	**Midband**
Frequency Stability:	+/- 2.5ppm			+/- 5ppm
Modulation Limiting:	±2.5 kHz @ 12.5 kHz ±4.0 kHz @ 20 kHz ±5.0 kHz @ 20/25 kHz			
Current Drain Transmit:	7A (25W)	8A (25W)		
FM Hum and Noise:	-40 dB@12.5 kHz -45 dB@ 20/25 kHz	-35 dB@12.5 kHz -40 dB@ 20/25 kHz		-40 dB@12.5 kHz -45 dB@ 20/25 kHz
Conducted/Radiated Emissions:	-36 dBm < 1 GHz -30 dBm > 1 GHz			
Adjacent Channel Power	-60dB @12.5, -70dB @ 20/25kHz			
Audio Response: (300 to 3000Hz)	+1, -3dB			
Audio Distortion: @ 1000 Hz, 60% Rated Maximum Deviation:	3% Typical			

Receiver				
Specification	**VHF2**	**UHF1**	**UHF2**	**Midband**
Sensitivity (12dBSINAD): (ETS)	0.35µV (12.5kHz) 0.30µV (25kHz) Typical			
Intermodulation : (ETS)	>65 dB			
Adjacent Channel Selectivity: (ETS)	75 dB @ 25 kHz 65 dB @ 12.5 kHz	70 dB @ 25 kHz 60 dB @ 12.5 kHz		
Spurious Rejection: (ETS)	75 dB	70 dB		
Rated Audio: (ETS) (Extended audio with 4 Ohm speaker)	4W Internal , 13W External			
Audio Distortion @ Rated Audio:	3% Typical			
Hum and Noise:	-40 dB @ 12.5 kHz -45 dB @ 20/25 kHz	-35 dB @ 12.5 kHz -40 dB @ 20/25 kHz		-40 dB @ 12.5 kHz -45 dB @ 20/25 kHz
Audio Response: (300 to 3000Hz)	+1, -3dB			
Conducted Spurious Emission per FCC Part 15:	-57 dBm <1 GHz -47 dBm >1 GHz			

GLOSSARY

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	Electronically 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.
MDC	Motorola Data Communication.
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.

OSW	Outbound Signalling Word: data transmitted on the control channel from the central controller to the subscriber unit.
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.
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.
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