



***CP Series***  
***Portable Radios***  
***Basic Service Manual***



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# SAFETY

## Product Safety and RF Exposure Compliance



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These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.



**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 is restricted to occupational use only to satisfy ICNIRP 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 6804110J47) to ensure compliance with RF energy exposure limits.

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

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## DOCUMENT HISTORY

The following major changes have been implemented in this manual since the previous edition:

Edition	Description	Date
6878421A01-A	Initial edition	Oct. 2008

## Notes

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## Table of Contents

<b>Copyright .....</b>	<b>i</b>
<b>Safety .....</b>	<b>ii</b>
<b>Document History .....</b>	<b>iii</b>
<b>Chapter 1 Model Charts and Test Specifications .....</b>	<b>1-1</b>
1.1 Radio Model Information.....	1-1
1.2 Model Chart for UHF2, 435–480 MHz .....	1-2
1.3 UHF2 Specifications .....	1-3
<b>Chapter 2 Theory Of Operation .....</b>	<b>2-1</b>
2.1 Introduction .....	2-1
2.2 Major Assemblies .....	2-1
2.2.1 Receiver.....	2-1
2.2.1.1 RX Front End.....	2-2
2.2.1.2 RX Back End .....	2-2
2.2.1.3 RX Squelch.....	2-2
2.2.2 Transmitter.....	2-3
2.2.3 Phase Lock Loop Synthesizer .....	2-4
2.2.4 RX Audio Circuit .....	2-5
2.2.5 TX Audio Circuit.....	2-6
2.2.6 Microcontroller .....	2-7
2.2.7 Power Supply.....	2-7
<b>Chapter 3 Test Equipment, Service Aids, and Service Tools.....</b>	<b>3-1</b>
3.1 Test Equipment.....	3-1
3.2 Service Aids .....	3-2
<b>Chapter 4 Performance Checks .....</b>	<b>4-1</b>
4.1 General .....	4-1
4.2 Power-Up Self Test.....	4-1
4.3 LCD/LED/Button/Volume Knob Test Mode.....	4-1
<b>Chapter 5 Radio Programming and Tuning .....</b>	<b>5-1</b>
5.1 Introduction .....	5-1
5.2 CPS Programming Setup .....	5-1
5.3 Radio-to-Radio Cloning .....	5-1
5.4 Radio Tuning Setup .....	5-2
5.4.1 Initial Test Equipment Control Settings.....	5-3
5.5 Transmitter Alignment Options .....	5-3
5.5.1 Transmit High Power Tuning .....	5-4

---

5.5.2	Transmit Low Power Tuning .....	5-5
5.5.3	Transmit Modulation Tuning .....	5-6
5.5.3.1	Transmit 12.5 kHz Modulation Tuning .....	5-6
5.5.3.2	Transmit 25 kHz Modulation Tuning .....	5-7
5.6	Receiver Tuning .....	5-8
5.6.1	Receive 12.5KHz-Band Normal Squelch Tuning .....	5-8
5.6.2	Receive 12.5KHz-Band Tight Squelch Tuning .....	5-9
5.6.3	Receive 25KHz-Band Normal Squelch Tuning .....	5-10
5.6.4	Receive 25KHz-Band Tight Squelch Tuning .....	5-11
5.7	Utilities .....	5-12
5.7.1	Program Serial No. ....	5-12
5.8	Front Panel Programming .....	5-13
5.8.1	Introduction .....	5-13
5.8.2	Dealer and User Configurations .....	5-13
5.8.2.1	Switching between Dealer and User Configurations .....	5-13
5.8.3	Entering Programming Mode .....	5-14
5.8.4	Exiting Programming Mode .....	5-14
5.8.5	Accessing Front Panel Programming Mode Parameters .....	5-14
5.8.6	Editing Front Panel Programming Mode Parameters .....	5-15
5.8.7	Factory Reset .....	5-22

## Chapter 6 Maintenance – CP1600/CP1660 ..... 6-1

6.1	Introduction .....	6-1
6.2	Preventive Maintenance .....	6-1
6.2.1	Inspection .....	6-1
6.2.2	Cleaning Procedures .....	6-1
6.3	Safe Handling of CMOS and LDMOS Devices .....	6-2
6.4	Disassembling and Reassembling the Radio – General .....	6-3
6.4.1	Radio Disassembly – Detailed .....	6-4
6.4.1.1	Front Housing From Chassis Disassembly .....	6-4
6.4.1.2	Chassis Assembly Disassembly .....	6-7
6.4.1.3	Front Circuit Board, Display Module and Keypad Disassembly .....	6-8
6.4.1.4	Speaker Disassembly .....	6-9
6.4.2	Radio Reassembly – Detailed .....	6-10
6.4.2.1	Speaker Reassembly .....	6-10
6.4.2.2	Front Circuit Board, Display Module and Keypad Reassembly .....	6-10
6.4.2.3	Chassis Assembly Reassembly .....	6-11
6.4.2.4	Chassis and Front Housing Reassembly .....	6-13
6.5	Torque List .....	6-13
6.6	Mechanical View and Parts List .....	6-14
6.6.1	CP1600/CP1660 Exploded View and Parts List .....	6-14

## Chapter 7 Maintenance – CP476/CP477/CP1300 ..... 7-1

7.1	Introduction .....	7-1
7.2	Preventive Maintenance .....	7-1
7.2.1	Inspection .....	7-1
7.2.2	Cleaning Procedures .....	7-1
7.3	Safe Handling of CMOS and LDMOS Devices .....	7-2
7.4	Disassembling and Reassembling the Radio – General .....	7-3
7.4.1	Radio Disassembly – Detailed .....	7-4
7.4.1.1	Front Housing From Chassis Disassembly .....	7-4

---

7.4.1.2	Chassis Assembly Disassembly .....	7-7
7.4.1.3	Front Circuit Board, Display Module and Keypad Disassembly .....	7-8
7.4.1.4	Speaker Disassembly .....	7-9
7.4.2	Radio Reassembly – Detailed .....	7-10
7.4.2.1	Speaker Reassembly.....	7-10
7.4.2.2	Front Circuit Board, Display Module and Keypad Reassembly .....	7-11
7.4.2.3	Chassis Assembly Reassembly.....	7-11
7.4.2.4	Chassis and Front Housing Reassembly.....	7-13
7.5	Torque List.....	7-14
7.6	Mechanical View and Parts List.....	7-14
7.6.1	CP476/CP477/CP1300 Exploded View and Parts List .....	7-14
<b>Chapter 8</b>	<b>Troubleshooting Tables .....</b>	<b>8-1</b>
8.1	Error Codes .....	8-1
8.2	Troubleshooting Table for Receiver.....	8-2
8.3	Troubleshooting Table for Transmitter.....	8-3
<b>Appendix A</b>	<b>Accessories .....</b>	<b>A-1</b>
<b>Appendix B</b>	<b>Warranty, Service Support, and Replacement Parts .....</b>	<b>B-1</b>
B.1	Scope of Manual.....	B-1
B.2	Warranty .....	B-1
B.2.1	Warranty Period and Return Instructions.....	B-1
B.2.2	After Warranty Period .....	B-1
B.2.3	Piece Parts .....	B-2
B.2.4	Technical Support.....	B-2
B.2.5	Further Assistance From Motorola .....	B-2
<b>Appendix C</b>	<b>Repair Procedures and Techniques — General.....</b>	<b>C-1</b>
<b>Glossary</b>	.....	<b>G-1</b>

## Notes

## List of Figures

Figure 2-1.	Receiver Block Diagram.....	2-1
Figure 2-2.	Transmitter Block Diagram.....	2-3
Figure 2-3.	PLL Synthesizer Block Diagram.....	2-4
Figure 2-4.	RX Audio Block Diagram.....	2-5
Figure 2-5.	TX Audio Block Diagram .....	2-6
Figure 3-1.	Programming/Test Cable (PMDN4077_R).....	3-3
Figure 3-2.	Cloning Cable (PMDN4076_R).....	3-3
Figure 3-3.	Wiring of the Connectors.....	3-3
Figure 4-1.	LCD Indication.....	4-1
Figure 5-1.	CPS Programming Setup .....	5-1
Figure 5-2.	Radio Tuning Setup.....	5-2
Figure 5-3.	Tx High Power Window (High Power).....	5-4
Figure 5-4.	Tx Low Power Window (Low Power).....	5-5
Figure 5-5.	Tx Modulation 12.5 kHz Window.....	5-6
Figure 5-6.	Tx Modulation 25 kHz Window.....	5-7
Figure 5-7.	Rx 12.5KHz-band Normal Squelch Tuning Window.....	5-8
Figure 5-8.	Rx 12.5KHz-band Tight Squelch Tuning Window .....	5-9
Figure 5-9.	Rx 25KHz-band Normal Squelch Tuning Window.....	5-10
Figure 5-10.	Rx 25KHz-band Tight Squelch Tuning Window .....	5-11
Figure 5-11.	Program Radio Serial No. Window.....	5-12
Figure 6-1.	Full Keypad Without Channel Knob Model.....	6-3
Figure 6-2.	Battery and Antenna Removal .....	6-4
Figure 6-3.	Knob Removal.....	6-5
Figure 6-4.	Chassis Removal .....	6-5
Figure 6-5.	Speaker Wire and Flexible Cable Connection.....	6-6
Figure 6-6.	Speaker Wire Removal .....	6-6
Figure 6-7.	Unlatch the Flexible Cable .....	6-7
Figure 6-8.	Sub-Circuit Board and Accessory Bracket Removal .....	6-7
Figure 6-9.	Main Circuit Board, O-ring and Battery Contact Seal Removal.....	6-8
Figure 6-10.	Front Circuit Board Removal .....	6-8
Figure 6-11.	LCD and Keypad Removal.....	6-9
Figure 6-12.	Speaker Removal.....	6-9
Figure 6-13.	Speaker Reassembly .....	6-10
Figure 6-14.	LCD and Keypad Reassembly .....	6-10
Figure 6-15.	Front Circuit Board Reassembly .....	6-11
Figure 6-16.	Main Circuit Board, O-ring and Battery Contact Seal Reassembly .....	6-12
Figure 6-17.	Sub Circuit Board and Accessory Bracket Reassembly .....	6-12
Figure 6-18.	Chassis Assembly and Front Housing Assembly Reassembly .....	6-13
Figure 6-19.	CP1600/CP1660 Radio Exploded View .....	6-14
Figure 7-1.	Limited Keypad Without Channel Knob Model.....	7-3
Figure 7-2.	Battery and Antenna Removal .....	7-4
Figure 7-3.	Knob Removal.....	7-5
Figure 7-4.	Chassis Removal .....	7-5
Figure 7-5.	Speaker Wire and Flexible Cable Connection.....	7-6
Figure 7-6.	Speaker Wire Removal .....	7-6
Figure 7-7.	Unlatch the Flexible Cable .....	7-7
Figure 7-8.	Sub-Circuit Board and Accessory Bracket Removal .....	7-7
Figure 7-9.	Main Circuit Board, O-ring and Battery Contact Seal Removal.....	7-8
Figure 7-10.	Front Circuit Board Removal .....	7-8
Figure 7-11.	LCD and Keypad Removal.....	7-9

Figure 7-12. Speaker Removal .....	7-10
Figure 7-13. Speaker Reassembly .....	7-10
Figure 7-14. LCD and Keypad Reassembly .....	7-11
Figure 7-15. Front Circuit Board Reassembly.....	7-11
Figure 7-16. Main Circuit Board, O-ring and Battery Contact Seal Reassembly .....	7-12
Figure 7-17. Sub Circuit Board and Accessory Bracket Reassembly.....	7-13
Figure 7-18. Chassis Assembly and Front Housing Assembly Reassembly .....	7-13
Figure 7-19. CP476/CP477/CP1300 – Exploded View.....	7-14

## List of Tables

Table 1-1.	Radio Model Number (Example: AZH03RDH8AA7) .....	1-1
Table 3-1.	Recommended Test Equipment.....	3-1
Table 3-2.	Service Aids .....	3-2
Table 4-1.	Radio Operation in Test Mode .....	4-1
Table 5-1.	Initial Equipment Control Settings .....	5-3
Table 5-2.	Transmit High/Low Power Level.....	5-3
Table 5-3.	Transmit Modulation Tuning .....	5-6
Table 5-4.	Receiver Squelch Tuning .....	5-8
Table 5-5.	Front Panel Programming Mode Parameters.....	5-15
Table 6-1.	Torque Chart .....	6-13
Table 7-1.	Torque Chart .....	7-14
Table 8-1.	Error Code Display .....	8-1
Table 8-2.	Receiver Troubleshooting Table .....	8-2
Table 8-3.	Transmitter Troubleshooting Table .....	8-3
Table C-1.	Lead Free Solder Wire Part Number List .....	C-1
Table C-2.	Lead Free Solder Paste Part Number List .....	C-1

## Related Publications

### APAC

CP476 Series Radios User Guide.....	6878079A01
CP477 Series Radios User Guide.....	6878076A01
CP1600/CP1660/ CP1300 Series Radios User Guide (English, Simplified Chinese, Indonesian, Korean).....	6878073A01
CP1600/CP1660/ CP1300 Series Radios Accessories Leaflet (English, Simplified Chinese, Indonesian, Korean).....	68007024009
CP Series Basic Service Manual .....	6878421A01
Product Safety and RF Exposure Booklet.....	6804110J47

## Notations Used in This Manual

Throughout the text in this publication, you will notice the use of the following notations. These notations are used to emphasize that safety hazards exist, and due care must be taken and observed.



**Note** An operational procedure, practice, or condition that is essential to emphasize.



**CAUTION** indicates a potentially hazardous situation which, if not avoided, might result in equipment damage.

## Notes

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# Chapter 1 Model Charts and Test Specifications

## 1.1 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 portable radio model number and its specific characteristics.

Table 1-1. Radio Model Number (Example: AZH03RDH8AA7)

Regional Prefix	Type of Unit	Model Series	Freq. Band	Power Level	Physical Packages	Channel Spacing	Protocol	Feature Level
AZ ↑ AZ = APAC	H ↑ H = Portable	03 ↑ 03 = CP Family Model Series	R UHF (435–480 MHz)  K VHF (136–174 MHz)  M 200MHz (216–223 MHz)  N 200MHz (245–247 MHz)  E 300MHz (350–390 MHz)  Q UHF (403–446 MHz)  S UHF (470–512 MHz)	D 4 W  B 1 W  C 2 W  E 5 W	H Limited Keypad without Channel Knob  F Limited Keypad with Channel Knob  K Full Keypad without Channel Knob  T Full Keypad RTTE Model  U Limited Keypad RTTE Model	8 12.5/25k  4 12.5k  6 20/25k  9 12.5/20/25k	AA  AA = Conventional ↑	7 No Front Panel Prog. with Scrambling  1 Fixed Freq. Tier 1  2 Fixed Freq. Tier 2  3 Fixed Freq. Tier 3  4 Fixed Freq. Tier 4  5 Fixed Freq. Tier 5  9 Front Panel Prog. with Scrambling

## 1.2 Model Chart for UHF2, 435–480 MHz

CP476/CP477/CP1300/CP1600/CP1660, UHF2, 435–480 MHz							
Model			Description				
AZH03RDK8AA9			CP1660 435–480M 4W 12.5/25K 99C FKP FPP SCR				
AZH03RDK4AA9			CP1660 435–480M 4W 12.5K 99C FKP FPP SCR				
AZH03RDK8AA7			CP1600 435–480M 4W 12.5/25K 99C FKP SCR				
AZH03RDH8AA7			CP1300 435–480M 4W 12.5/25K 99C LKP SCR				
AZH03RDH4AA7			CP1300 435–480M 4W 12.5K 99C LKP SCR				
AZH03RDH8AA3			CP477 477M 1W 12.5K 10C LKP				
AZH03RDH8AA2 AZH03RDH8AA2S			CP476 476–477M 4W 45C LKP CP476 476–477M 4W 45C LKP – AUS				
Item			Description				
X			PMUE3148_	CP1660 435–480M 4W 12.5/25K 99C FKP FPP SCR			
	X		PMUE3147_	CP1660 435–480M 4W 12.5K 99C FKP FPP SCR			
		X	PMUE3145_	CP1600 435–480M 4W 12.5/25K 99C FKP SCR			
			X	PMUE3144_			
				CP1300 435–480M 4W 12.5/25K 99C LKP SCR			
				X	PMUE3143_		
					CP1300 435–480M 4W 12.5K 99C LKP SCR		
					X	PMUE3141_	
						CP477 477M 1W 12.5K 10C LKP	
					X	PMUE3140_	
						CP476 476–477M 4W 45C LKP	
X				PMDE4008_R	435–480M 4W PCB – PMUE3148_AA		
	X			PMDE4022_R	435–480M 4W PCB – PMUE3147_AA		
		X		PMDE4018_R	435–480M 4W PCB – PMUE3145_AA		
			X	PMDE4014_R	435–480M 4W PCB – PMUE3144_AA		
			X	PMDE4011_R	435–480M 4W PCB – PMUE3144_AK		
				X	PMDE4017_R	435–480M 4W PCB – PMUE3143_AA	
				X	PMDE4020_R	477M 1W PCB – PMUE3141_AA	
				X	PMDE4021_R	476–477M 4W PCB – PMUE3140_AA	
X	X	X		PMDN4130_R	Front Circuit Board, FKP		
			X	X	X	PMDN4131_R	Front Circuit Board, LKP
X	X	X	X	X	X	PMDN4129_R	Sub Circuit Board, w/o Channel

X = Indicates compatibility with model(s)

## 1.3 UHF2 Specifications

### General

	UHF2		
Frequency:	435–480 MHz		
Channel Capacity:	10, 45, or 99 Channels		
Power Supply:	7.5 Volts ±20%		
Dimensions: (H x W x D) with High Capacity Li-Ion NiMH Std Li-Ion Std Batteries:	120 mm x 55 mm x 40.7 mm 120mm x 55mm x 36.5mm 120mm x 55mm x 35.5mm		
Weight: CP Series model with Battery: High Capacity Li-Ion NiMH Std Li-Ion Std	342.0g 394.5g 335.0g		
Average Battery Life @ (5-5-90 Duty Cycle): High Capacity Li-Ion NiMH Std Li-Ion Std	Capacity (mAh)	4 W	1 W
	2150 1300 1500	12 Hrs. 8 Hrs. 8 Hrs.	14 Hrs. 10 Hrs. 10 Hrs.

### Self-Quieter Frequencies

UHF2
444.01
446.44
446.45
456.01
456.02
460.00
468.01
468.02

### Transmitter

	UHF2	
RF Output NiMH @ 7.5 V:	Low 1 W	High 4 W
Frequency:	435–480 MHz	
Channel Spacing:	12.5/25 kHz	
Freq. Stability: (-30°C to +60°C)	0.00025%	
Spurs/Harmonics:	-36 dBm < 1 GHz -30 dBm > 1 GHz	
Audio Response: (from 6 dB/oct. Pre-emphasis, 300 to 3000 Hz)	+1, -3 dB	
Audio Distortion: @ 1000 Hz, 60% Rated Max. Dev.	<5%	
FM Noise:	<-40 dB	

### Receiver

	UHF2 12.5 kHz	UHF2 25kHz
Frequency:	435–480 MHz	
Sensitivity 12 dB EIA SINAD:	0.25 µV (typical)	
Adjacent Channel Selectivity:	-65 dB	-70 dB
Intermodulation:	-70 dB	
Freq. Stability (-30°C to +60°C):	0.00025%	
Spur Rejection:	-70 dB	
Image and 1/2 I-F Rejection:	-70 dB	
Audio Output @ <5% Distortion:	500 mW	

All specifications are subject to change without notice.

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**Notes**

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# Chapter 2 Theory Of Operation

## 2.1 Introduction

This chapter provides a basic theory of operation for the radio components.

## 2.2 Major Assemblies

- Main PCB – contains the RF circuits which comprises receiver, transmitter, phase-locked loop (PLL) frequency synthesizer, micro controller, power supply, audio and digital circuits.
- Display and Keypad PCB (Limited and Full Keypad models only) – 8 characters (14 segments star burst) and 10 icons with backlighting, liquid-crystal display (LCD)
- Volume Knob PCB – Rotary Volume Knob and 16-channel Knob (16 channel model only).

### 2.2.1 Receiver

The radio's receiver is a double conversion super heterodyne with 1st IF of 45.1 MHz and 2nd IF of 455 kHz.

UHF2 receiver design covers the frequency range of 435 to 480 MHz.

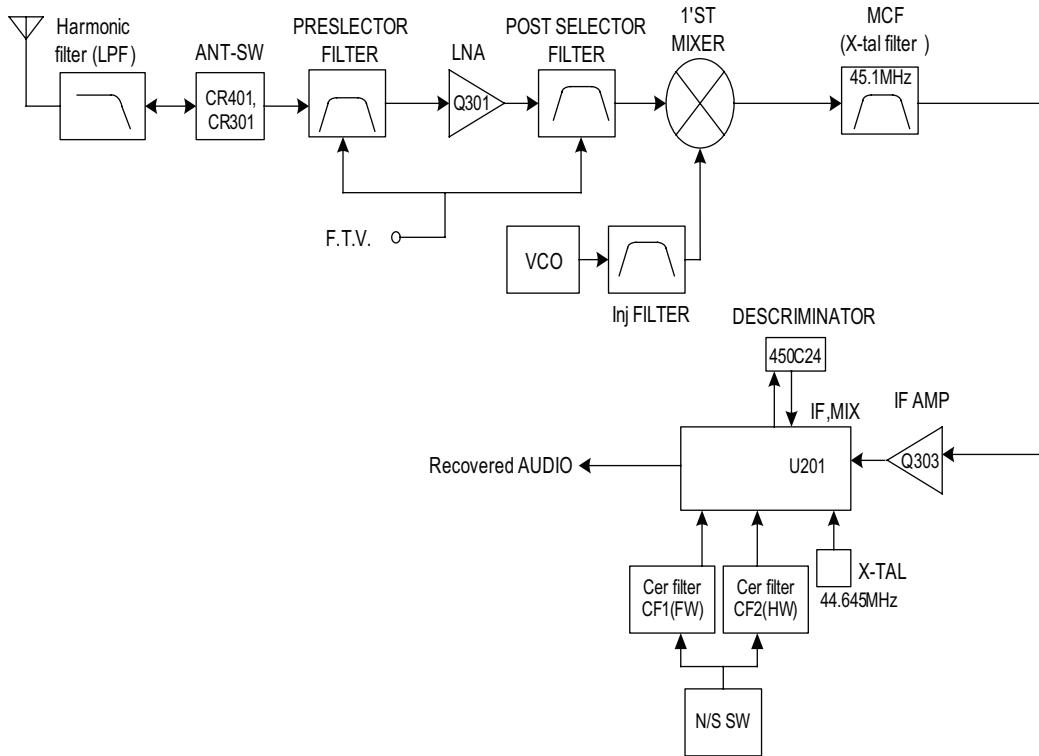


Figure 2-1. Receiver Block Diagram

### 2.2.1.1 RX Front End

Receiver Front-end consists of a low pass filter, a pre-selector filter, a low noise RF Amplifier and a Post-selector filter. Incoming RF signal from the antenna is applied through the Harmonics Low Pass Filter (L409–L411, C426–C429, C445–C446) and passes through the transmit/receive switch (CR301) and a varactor-tuned 2-pole pre-selector filter (L320, L324, C351, C361, CR314 and CR307) before routed to an RF amplifier (Q301). The pre-selector filter is an 8 step Band-shift filter, and the frequency shifting is controlled by variable capacitor diodes (CR314 and CR307) connected to the CPU. The filter output is coupled to a 13dB RF amplifier Q301 which outputs the RF signal to the post-selector filter (L323, L322, L328, C379, C354 and C355) which is also a band shift filter configured to provide steeper low-side attenuation. The 3 variable capacitors (CR313, CR304 and CR305) with 8 frequency steps are also controlled by the CPU.

### 2.2.1.2 RX Back End

RF signal from RX front-end is then directed to a Single Balanced Mixer (L329, L333, Q306, and Q307). 1st LO signal from VCO is filtered by an injection filter (L310, L331, C325–C327) to remove harmonics.

After passing through a pair of 45.1 MHz Crystal filter, the 1st IF signal is amplified by 15dB via an IF amp (Q303) and channeled to IF IC (U201) to be mixed thus producing the 2nd IF Frequency (455 kHz):

$$\text{1st IF (45.1 MHz)} - \text{2nd LO (44.645 MHz)} = \text{2nd IF (455 kHz)}$$

Depending on channel spacing, the 2nd IF frequency passes through the wide (CF1) and/or narrow (CF2) filters to eliminate undesired signals before being finally demodulated by demodulator in U201 with Recovered Audio as the final output.

### 2.2.1.3 RX Squelch

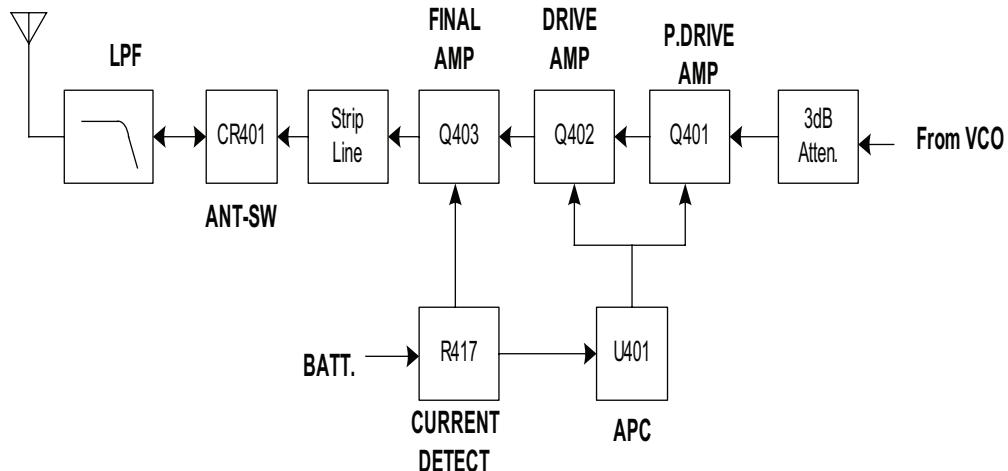
The mute (squelch) circuitry switches off the audio amplifier when no audio is detected from the recovered audio. The squelch circuit main components are U202 & U201.

U202 will adjust the squelch circuit sensitivity depending on Noise level from recovered audio. Noise level is amplified by internal amplifier of U201 to help U202 decide the squelch circuit sensitivity. If the noise level is over the set threshold, the microprocessor mutes the radio.

**Note** Perform squelch tuning after any RX part replacement. Refer Chapter 5.6: Receiver Tuning on page 5-8.

## 2.2.2 Transmitter

The radio's TX Power Amplifier system is a three stage amplifier which is able to amplify the VCO output up to the permitted maximum transmit power levels (UHF: 4W, VHF: 5W).



*Figure 2-2. Transmitter Block Diagram*

TX VCO output signal passes thru a 3dB, pie style resistor, attenuator before going into the TX power stage acting as isolation between the low power VCO and high power amps. The next stage consists of a pre-driver (Q401) and a drive amplifier (Q402). The -4 dBm TX RF signal from the attenuator is amplified to +25 dBm by the pre-driver and drive amp. This is followed by the final PA, an enhancement-mode N-channel MOSFET device (Q403), which provides a 12 dB gain.

The final PA draws current directly from the DC battery supply voltage input via L413.

The PA matching network consists of C416–C422 and a strip line, which matches the TX Power impedance to approximately 50 ohm. Antenna switch is shared between TX and RX circuit. In TX mode, PIN diodes (CR401, CR301) are forward biased which enable the High Power RF signal to pass through the antenna. In RX mode, both diodes are off. Signals applied to the antenna jack are routed, via the Harmonics LPF in to the RX circuit. The High Power RF Signal finally passes through a TX Low Pass Filter, a 7th order Chebyshev filter (L409–L411, C426–C429, C445–C446).

The APC (Auto Power Control) keeps the current supplied to Final PA (Q403) constant. Resistor, R417 is used for current sensing. The voltage difference ratio of R423 to R417 is amplified through U401 and passed to Q404 and Q405 to produce constant power output to the antenna. Do not exceed the maximum allowed bias voltage of the device.

**Note** Retune the TX Power if Final PA (Q403) is replaced. Refer Chapter 5.5: Transmitter Alignment Options on page 5-3.

## 2.2.3 Phase Lock Loop Synthesizer

The Phase Lock Loop (PLL) synthesizer subsystem consists of the reference oscillator (VCTCXO), VCO, PLL IC, Charge pump and Loop filter.

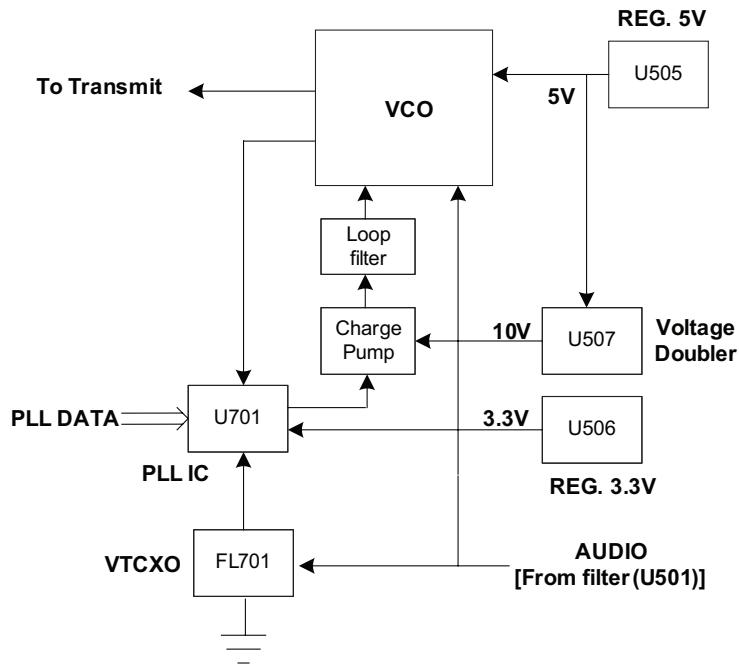


Figure 2-3. PLL Synthesizer Block Diagram

VCTCXO (Voltage Controlled Temperature Compensated crystal Oscillator) reference frequency (12.8 MHz) provides reference to PLL IC, with stability of +/-2.5PPM at -30° to +60°C. This reference frequency is divided to 6.25 kHz or 5 kHz by PLL IC. PLL IC outputs 2 Signals (P & R) depending on phase difference. A charge pump is used to charge these output signals from 0 – 3.3 V up to 0 – 10 V which is required to control the VCO. A voltage doubler (U507) converts 5 V to 10 V to supply the necessary voltage for a higher frequency resolution in VCO. The Loop filter is a Low Pass filter (C751–C754, R726–R728) to reduce the residual side-band noise of VCO Reference Frequency for the best signal-to-noise ratio. The VCO module contains both RX VCO and TX VCO, configured as Colpits oscillators and connects to DC power through cascaded buffers. Q705 and Q305 enable RX VCO when RX-EN is high. Q706 and Q503 enable TX VCO when TX-EN1 is high.

The input audio signal for TX VCO is from (U501-B) and applied to a variable capacitor diode (CR703) in TX VCO to be modulated into TX RF signal.

## 2.2.4 RX Audio Circuit

The RX audio circuit consists of Audio Processor IC, Audio amp, speakers & Sub-tone system.

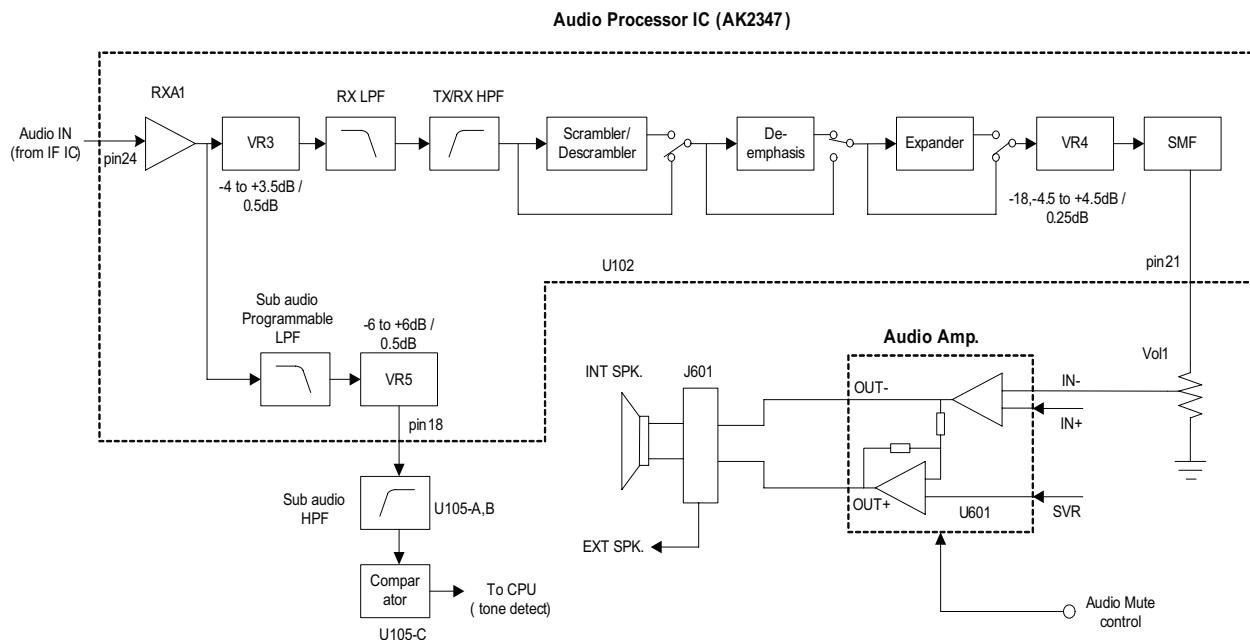


Figure 2-4. RX Audio Block Diagram

The RX Audio from U201 is channeled to Audio processor IC. VR3 controls the received demodulated signal level from -4.0 dB to +3.5 dB in 0.5 dB steps. RX LPF eliminates high-frequency audio components > 3 kHz. TX/RX HPF eliminates low-frequency audio components lower < 250Hz. Descrambler (if ON) inverts the spectrum distribution of audio signals with respect to scrambling frequency. De-emphasis (if ON) restores high-frequency component of audio signal which has been emphasized by the pre-emphasis circuit in transmitting radio. Expander (if ON) expands audio signal by 0.5 dB to restore the original signal compressed by transmitting radio. VR4 amplifies RX audio level by -18.0 dB, with -4.5 dB to +4.5 dB in 0.25 dB steps adjustment range. Smoothing filter (SMF) eliminates high-frequency and clock components, generated by ASIC.

Sub-audio Programmable LPF totally eliminates voice audio from Audio signal to extract sub-audio tone. VR5 regulates the output level of extracted sub-audio tone and sends it to a high pass filter (U105-A,B) with 4 selectable cut-off frequencies and finally passes through a comparator (U105-C), to square the signal and sends it to the MCU.

The output audio signal of Audio Processor IC is directed to volume control switch (SW/VOL1) which is controlled by user and is finally amplified by U601BTL Audio Amplifier to a sufficient level to drive either the external or internal speaker.

## 2.2.5 TX Audio Circuit

The TX audio circuit is comprised of microphones, LPF, Audio Processor IC, and TX Sub-tone system.

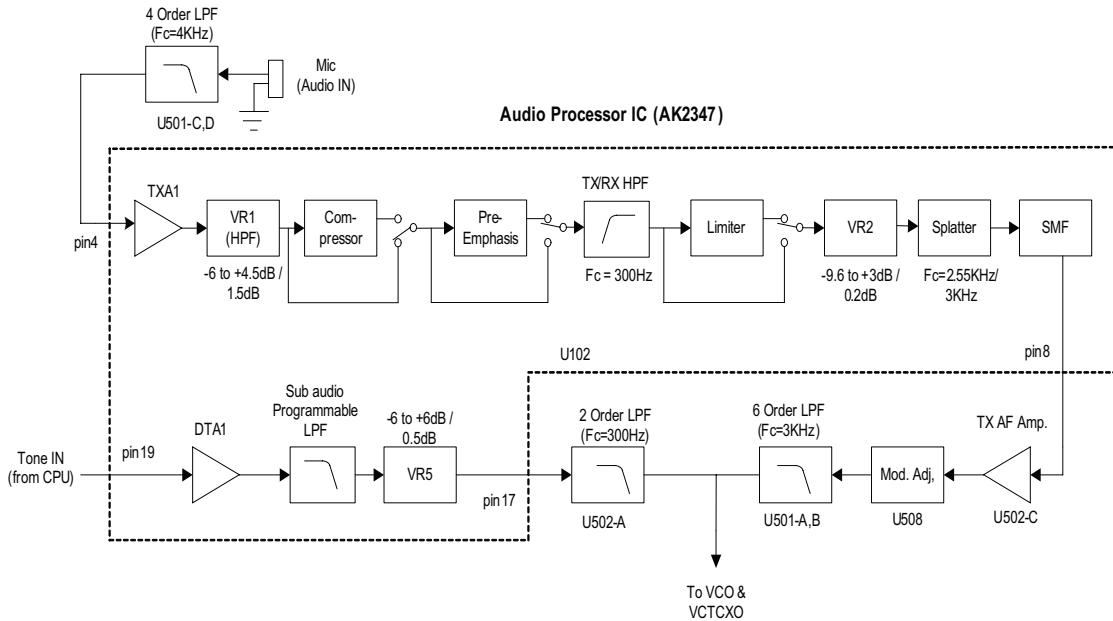


Figure 2-5. TX Audio Block Diagram

The TX audio enters the radio via the internal MIC or external MIC. This TX Audio is filtered through a 4th order 4 kHz Low-pass filter (U501-C & D) which prevents aliasing noise from ASIC. TX Audio enters the Audio Processor IC which is then directed to an internal Amplifier (TX A1) for gain adjustment of audio signal. A HPF (VR1) controls the input level of TX audio signal from -6.0 dB to +4.5 dB in 1.5 dB steps. A Compressor (if ON) compresses the amplitude of TX audio signal by 0.5 dB. A Pre-emphasis circuit (if ON) emphasizes the high frequency component of TX audio signal to improve Signal to Noise ratio before modulation. A shared High-pass filter (TX/RX HPF) eliminates low-frequency components <250 Hz from TX audio signal. A Limiter is used to limit the signal amplitude and suppress frequency deviation during modulation. VR2 controls the output level from -9.6 dB to +3.0 dB in 0.2 dB steps. A Splatter (LPF) eliminates high-frequency components >3 kHz. A Smoothing filter (SMF) eliminates high-frequency and clock components generated internally by ASIC.

For sub-tone data from CPU, DTA1 amplifies the signal, sends it through a Sub-audio Programmable LPF to eliminate components of DAT1 amplification, and finally the signal is regulated by VR5 from -6.0 dB to +6.0 dB in 0.5 dB steps. The final sub-tone data passes through a 2nd order LPF (U502-A) before it is mixed with TX Audio for modulation.

The processed TX audio signal from Audio Processor IC is amplified by TX audio frequency amplifier (U502-C) to increase limiting range and then adjusted to a proper level for modulation by U508. Final TX Audio signal passes through a 6th order 3 kHz low pass filter (U501-A & B) before sent to VCO for modulation.

**Note** Retune the TX modulation if U508 is replaced. Refer Chapter 5.5: Transmitter Alignment Options on page 5-3.

The output audio signal of Audio Processor IC is directed to volume control switch (SW/VOL1) controlled by user and is finally amplified by U601BTL Audio Amplifier to a sufficient level to drive either the external or internal speaker.

## 2.2.6 Microcontroller

The microprocessor or CPU includes Microprocessor (U101), EEPROM and support components. Radio operation is controlled by software in internal Flash ROM memory.

Radio parameters and customer specific information is stored in External EEPROM (U104). Pins 35 & 36 controls the Sub-PCB mounted LED indicators. PTT button (PB501) is linked to CPU via pin44. Side programmable buttons 1 & 2 (PB502 & PB503) is linked via pin 21 & 32, respectively. Customer Programming Software (CPS) connects to the radio via a USB Programming cable (PMDN4077\_R) through the microphone port (J601 pin 6) to pin 34 & 33 (PRG/CLONE\_RX & PRG/CLONE\_TX port). A 7.3728MHz clock signal (X-in) is provided by FL101 to CPU. A voltage divider system (R153&R154) is used by CPU to sense battery level.

## 2.2.7 Power Supply

There are 4 voltage supplies in this radio: SWB+, 3.3V, 5V & 10V.

SWB+ voltage is distributed to SW/Vol 1, Final PA (Q403 via R417) & APC circuit (U401)

The 3.3V regulated supply (U506) is applied to CPU (U101), EEPROM (U104), DTMF IC (U103), Audio processor IC (U102), microphone biasing circuit and LCD/keypad driver.

The 5.0V regulated source (U505) is distributed to RX back end circuit, RX/TX audio filters, 1/2 VCC generator, VCO (Q705, Q706), RX B+ (Q304), TXvB (Q407) & VCTCXO.

The 10.0V regulated source (U507) is solely applied for Charge pump use.

**Notes**

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# Chapter 3 Test Equipment, Service Aids, and Service Tools

## 3.1 Test Equipment

Table 3-1 lists test equipment required to service the radios.

*Table 3-1. Recommended Test Equipment*

Motorola Part No.	Description	Characteristics	Application
R2600 series	System analyzer	This item will substitute for items with an asterisk (*)	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1074A	Fluke 87 digital multi-meter	True RMS metering, 200 kHz frequency counter, 32-segment bar graph with backlit display	Digital voltmeter is recommended for AC/DC voltage and current measurements
	Fluke 85 RF probe	500 MHz, 30 VAC max	Use with Fluke 87 digital multi-meter for RF voltage measurements.
*R1377A	AC voltmeter	1 mV to 300 mV, 10 mega-ohm input impedance	Audio voltage measurements
R1611A	Dual channel 100 MHz oscilloscope (Agilent)	Two-channel, 100 MHz bandwidth, 200 M sample rate/sec, 2 MB memory/channel	Waveform measurements
S1339A	RF millivolt meter	100 µV to 3V RF, 10 kHz to 1 GHz frequency range	RF level measurements
*R1013B or *R1370A	SINAD meter or SINAD meter with RMS	Without RMS audio voltmeter or With RMS audio voltmeter	Receiver sensitivity measurements

### **3.2 Service Aids**

Table 3-2 lists service aids recommended for working on the CP Series Radios. 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 3-2. Service Aids*

<b>Motorola Part No.</b>	<b>Description</b>	<b>Application</b>
PMDN4038_R	Knob Remover/Chassis Opener	Used to remove the front cover assembly.
PMDN4039_R	Crab Eye Nut Opener	Used to remove the crab eye nut.
PMDN4040_R <sup>1</sup>	Radio Test Box	Enables communication between the radio, test equipment and the computer's USB port.
PMDN4041_R	RF Adapter	Adapts radio's antenna port to BNC cabling of test equipment.
PMDN4076_R	Radio to Radio Cloning Cable	Allows a radio to be duplicated from a master radio by transferring programmed data from the master radio to the other.
PMDN4077_R	Programming Cable	Used to program the radio through Customer Programming Software and Radio Tuner.
PMDN4079_R	GND Plate	Interconnects radio's chassis to RF Adaptor.
PMDN4080_R	Battery Eliminator	Interconnects radio to power supply.
PMVN4161_	Customer Programming Software on CD Rom	Program customer option and channel data.
PMVN4165_	Tuner on CD Rom	Only Motorola Service Centers or Authorized Motorola Service Dealers can perform this function.

**Note:** 1. Use PMDN4040BR or higher for Tuning the CP Series radios as PMDN4040AR cannot be used to perform this function.

## Programming/Test Cable

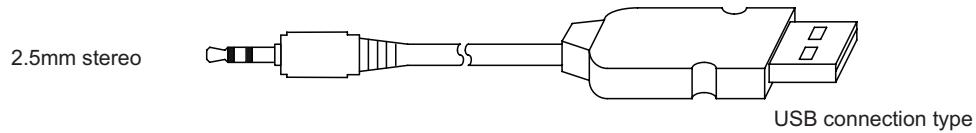


Figure 3-1. Programming/Test Cable (PMDN4077\_R)

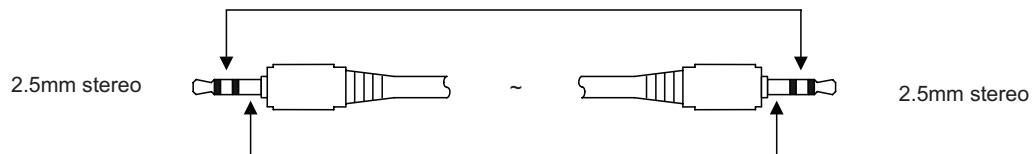


Figure 3-2. Cloning Cable (PMDN4076\_R)

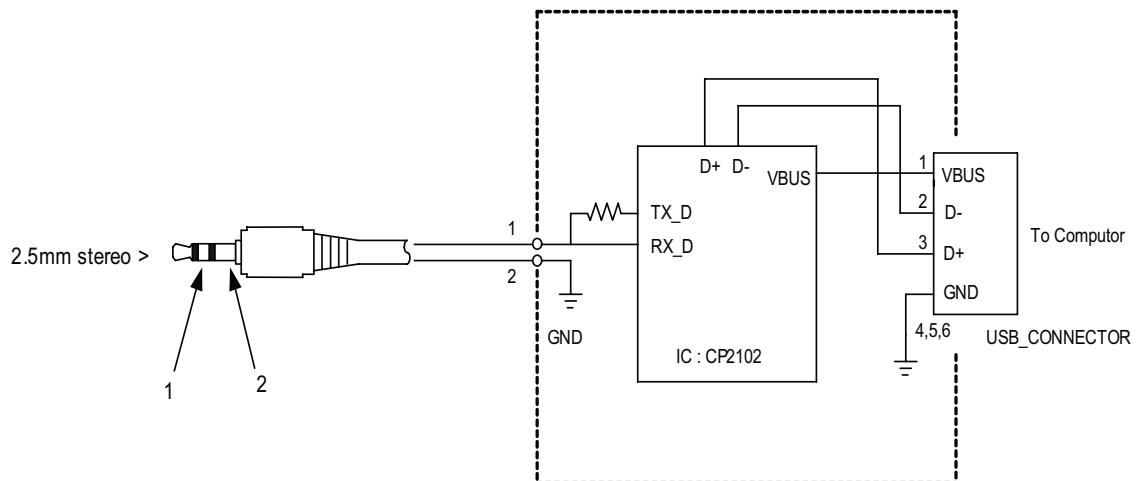


Figure 3-3. Wiring of the Connectors

**Notes**

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# Chapter 4 Performance Checks

## 4.1 General

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

## 4.2 Power-Up Self Test

Whenever the radio is turn on, it initiates a self-test routine which checks the RAM, EEPROM hardware and EEPROM checksum. If Self Test passes, the green LED flashes once and a Self-Test Pass Tone is generated. If unsuccessful, the red LED flashes rapidly and a Self-Test Fail Tone is heard.

## 4.3 LCD/LED/Button/Volume Knob Test Mode

1. Make sure the radio is turned off.
2. Turn on the radio and immediately press **P3** 3 times. The LED turns solid amber. The LCD displays the following indication (Figure 4-1) and the backlight is activated.



Figure 4-1. LCD Indication

3. The radio will operate as shown in table 4-1 if any key is pressed while in test mode.

Table 4-1. Radio Operation in Test Mode

Button	LED	LCD Indication	Backlight	Tone
<b>▶</b> , Right	Solid Green	RIGHT KEY	<ul style="list-style-type: none"><li>• ON when button is pressed.</li><li>• OFF following button released (after a short period of inactivity).</li></ul>	
<b>◀</b> , Left	Solid Red	LEFT KEY	- same as above -	

Table 4-1. Radio Operation in Test Mode (Continued)

Button	LED	LCD Indication	Backlight	Tone
SPB1 (Side Programmable Button 1)	OFF	SPBI	<ul style="list-style-type: none"> <li>ON when button is pressed.</li> <li>OFF after a short period of inactivity (even if the button is continuously being pressed).</li> <li>OFF when button is released.</li> </ul>	
SPB2 (Side Programmable Button 2)	OFF	SPB2	- same as above -	
<b>P1</b> , FPB1 (Front Programmable Button 1)	OFF	VOL--FPB1	- same as above -	Continuous tone; volume increases/decreases by turning the Volume Knob clockwise/ counterclockwise. <b>Note:</b> Press <b>P3</b> to turn continuous tone OFF.
<b>P2</b> , FPB2 (Front Programmable Button 2)	OFF	◀ ▶	- same as above -	
<b>P3</b> , FPB3 (Front Programmable Button 3)	OFF	VOL--FPB3	- same as above -	Continuous tone OFF if previously ON.
Numeric (Only Full Keypad Model)  1 2 (a b c) 3 (d e f) 4 (g h i) 5 (j k l) 6 (m n o) 7 (p q r s) 8 (t u v) 9 (w x y z) * (DEL) 0 # (✉)		ONE TWO THREE FOUR FIVE SIX SEVEN EIGHT NINE ASTERISK ZERO SHARP	<ul style="list-style-type: none"> <li>ON when button is pressed.</li> <li>OFF following button released (after a short period of inactivity).</li> </ul>	

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# Chapter 5 Radio Programming and Tuning

## 5.1 Introduction

This chapter provides an overview of the CP Series Customer Programming Software (CPS) and the CP/EP/P Tuner as designed for use in a Windows® 2000/XP/Vista environment. Both cover all the functions of the traditional Radio Service Software (RSS) package.

They are both available in the CPS CD-ROM (PMVN4161\_) and Entry Level Radio Tuner CD-ROM (PMVN4165\_).

## 5.2 CPS Programming Setup

Refer to online help files for the CPS Programming procedures. (See Figure 5-1 for CPS Programming Setup).

Program Cable PMDN4077\_R

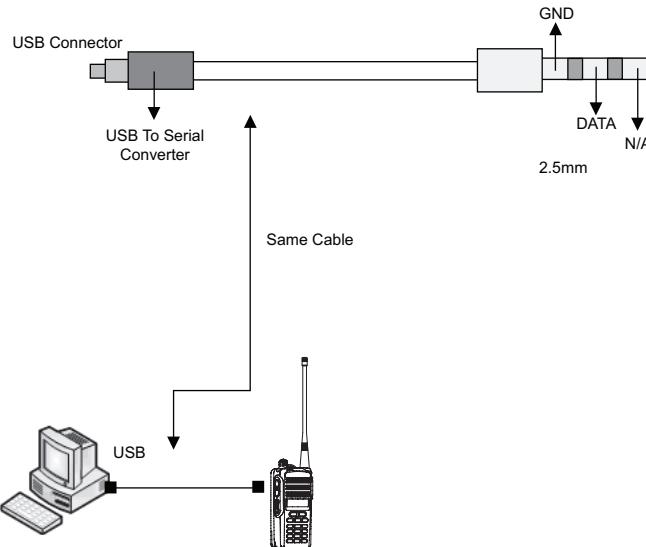


Figure 5-1. CPS Programming Setup

## 5.3 Radio-to-Radio Cloning

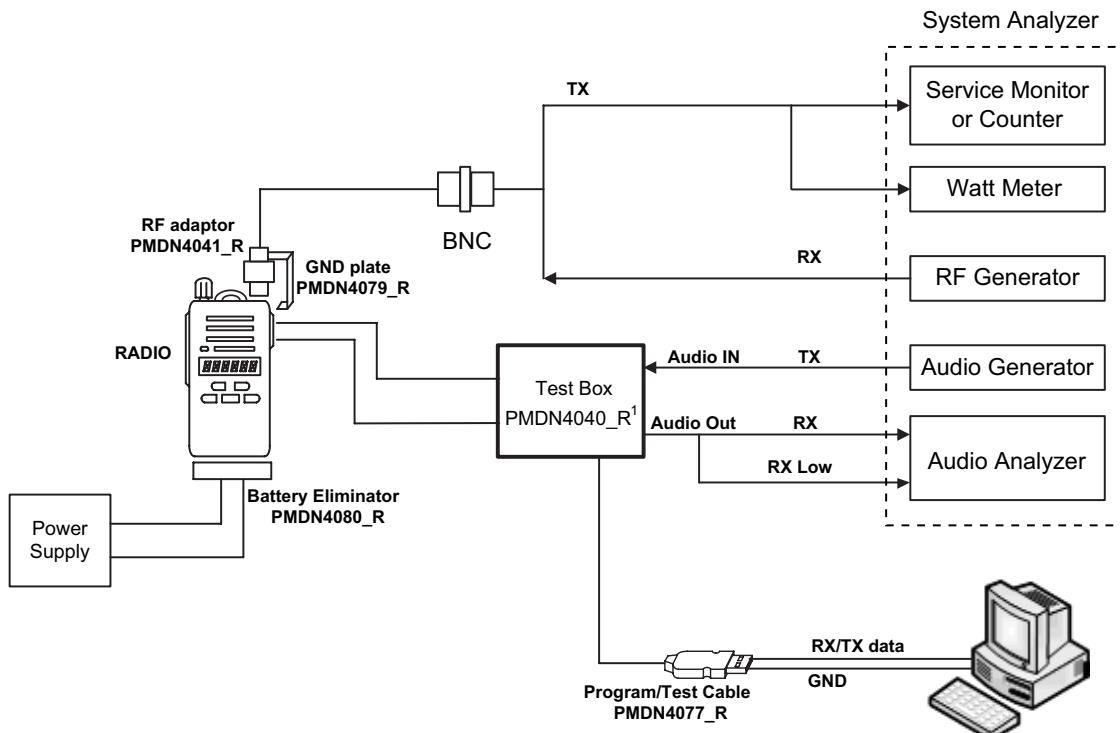
1. Cloning is the process of copying the content of one radio (source radio) into another radio (destination radio). Radio content refers to system-type features such as frequency, squelch type option, etc.
2. The cloning can be done only if all the following conditions are met:
  - a. The source radio's serial number cannot be blank.
  - b. The source radio and the destination radio must have the same model number.
  - c. The source radio and the destination radio must have an identical major codeplug version.
3. Radio functionality inherent in one radio cannot be cloned to another radio that does not contain the same functionality. Tuning and alignment information are not transferable and are not affected by cloning.

**Procedure:**

1. Turn source and destination radios off.
2. Connect cloning cable (PMDN4076\_R) to programming port of the two radios.
3. Turn on the destination radio.
4. Press and hold **P1** on the source radio and power up. "MASTER" and programming mode icon are displayed on the source radio and at the same time LED of the radio turns solid amber.
5. "SLAVE" and programming mode icon are displayed on the destination radio and at the same time LED of the radio turns solid amber.
6. During the cloning process, LED flashes in amber and source radio displays "CLONING" while destination radio displays "PROG ON".
7. When cloning is completed, the source and destination radios display "COMPLETE". To exit cloning mode, radios should be turn off.
8. Turn both radios off.
9. Disconnect the cloning cable from both radios and turn them on for normal operation.

## 5.4 Radio Tuning Setup

A Windows 2000/XP/Vista PC (personal computer) and Entry Level Radio Tuner are required to tune the radio. To perform the tuning procedures, the radio must be connected to the PC, Test box and Universal Test Set as shown in Figure 5-2 below. Refer to online help files for the tuning procedures.



**Note:** 1. Use PMDN4040BR or higher for Tuning the CP Series radios as PMDN4040AR cannot be used to perform this function.

Figure 5-2. Radio Tuning Setup

### 5.4.1 Initial Test Equipment Control Settings

The initial test equipment control settings are listed in Table 5-1.

*Table 5-1. Initial Equipment Control Settings*

Service Monitor	Test Set	Power Supply
Monitor Mode: Power Monitor	Impedance: 24 Ohm	Voltage: 7.5 Vdc
RF Attenuation: -70	Speaker/load: Load	DC on/standby: Standby
AM, CW, FM: FM	PTT: OFF	Volt Range: 0 – 10 V
Oscilloscope Source: Mod Oscilloscope Horizontal: 10 mSec/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: 3.0 A

## 5.5 Transmitter Alignment Options

**Note:** The maximum available power level given in the table below must NOT be exceeded. There are separate alignment procedures for High and Low power.

**Note:** When checking the RF power output of the radio with a test set, always use a pad of at least 30 dB attached to the radio end of the RF cable. This will avoid an RF mismatch and ensure a stable RF reading that will not change with varying lengths of connecting cable.

*Table 5-2. Transmit High/Low Power Level*

RF Band (MHz)	Model Number	High Power (W)	Low Power (W)
435–480M 4W 12.5/25K 99C FKP FPP SCR	_H03RDK8AA9	4.2 – 4.6 W	1.2 – 1.6 W
435–480M 4W 12.5K 99C FKP FPP SCR	_H03RDK4AA9	4.2 – 4.6 W	1.2 – 1.6 W
435–480M 4W 12.5/25K 99C FKP SCR	_H03RDK8AA7	4.2 – 4.6 W	1.2 – 1.6 W
435–480M 4W 12.5/25K 99C LKP SCR	_H03RDH8AA7	4.2 – 4.6 W	1.2 – 1.6 W
435–480M 4W 12.5K 99C LKP SCR	_H03RDH4AA7	4.2 – 4.6 W	1.2 – 1.6 W
477M 1W 12.5K 10C LKP	_H03RDH8AA3	Disabled	1.2 – 1.6 W
476–477M 4W 45C LKP	_H03RDH8AA2	4.2 – 4.6 W	1.2 – 1.6 W

### 5.5.1 Transmit High Power Tuning

1. Click the **Read** icon to initiate communication with the radio.
2. Under the **Alignment** menu, select **Tx Power**, then select **High** (Figure 5-3).
3. Press **PTT Toggle**. This will key up the radio at the 1st test frequency (F1).
4. Read the Transmit Power from the Service Monitor.
5. Adjust the High Power Level as shown in Table 5-2 on page 5-3 by using either the Left/Right arrows on the slider or Up/Down arrows on the Working Softpot box.
6. Press **PTT Toggle** to dekey the radio.
7. Goto the next frequency point by clicking on the Working Softpot value and press **PTT Toggle**.
8. Repeat steps 4–6 for the remaining test frequencies (F2–F5).
9. Press **Program** to commit the softpot values into the codeplug.
10. Exit the Transmit High Power function.
11. If the radio uses only high power channels, proceed to adjust modulation. If low power channels are used, perform Transmit Low Power Tuning as defined.

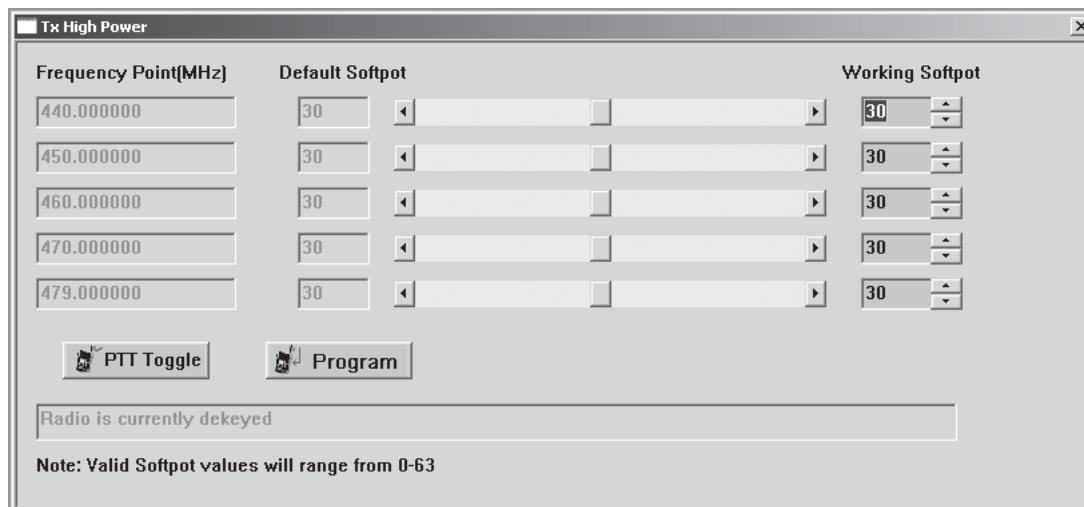


Figure 5-3. Tx High Power Window (High Power)

### 5.5.2 Transmit Low Power Tuning

1. Click the **Read** icon to initiate communication with the radio.
2. Under the **Alignment** menu, select **Tx Power**, then select **Low** (Figure 5-4).
3. Press **PTT Toggle**. This will key up the radio at the 1st test frequency (F1).
4. Read the Transmit Power from the Service Monitor.
5. Adjust the Low Power Level as shown in Table 5-2 on page 5-3 by using either the Left/Right arrows on the slider or Up/Down arrows on the Working Softpot box.
6. Press **PTT Toggle** to dekey the radio.
7. Goto the next frequency point by clicking on the Working Softpot value and press **PTT Toggle**.
8. Repeat steps 4–6 for the remaining test frequencies (F2–F5).
9. Press **Program** to commit the softpot values into the codeplug.
10. Exit the Transmit Low Power function.
11. Proceed to Adjust Modulation.

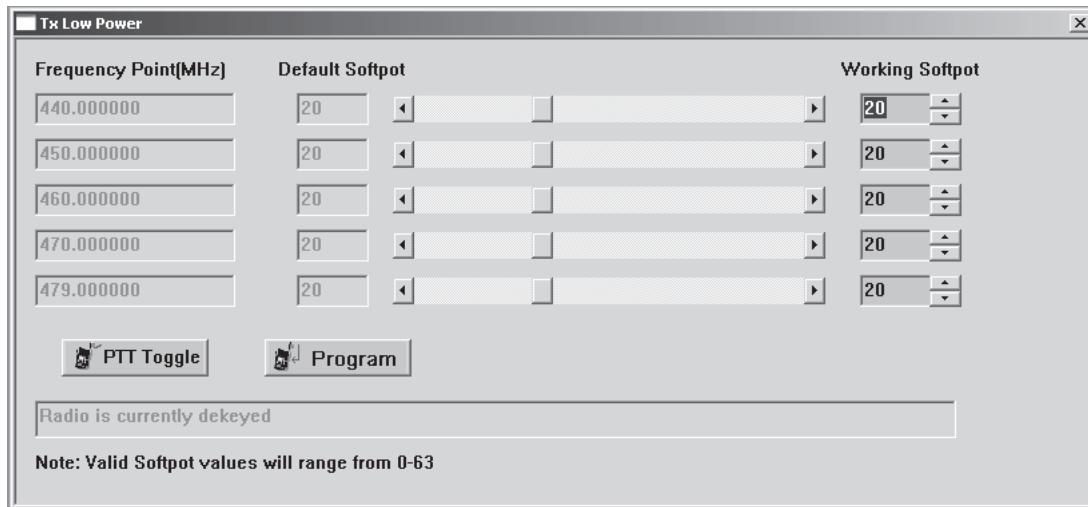


Figure 5-4. Tx Low Power Window (Low Power)

## 5.5.3 Transmit Modulation Tuning

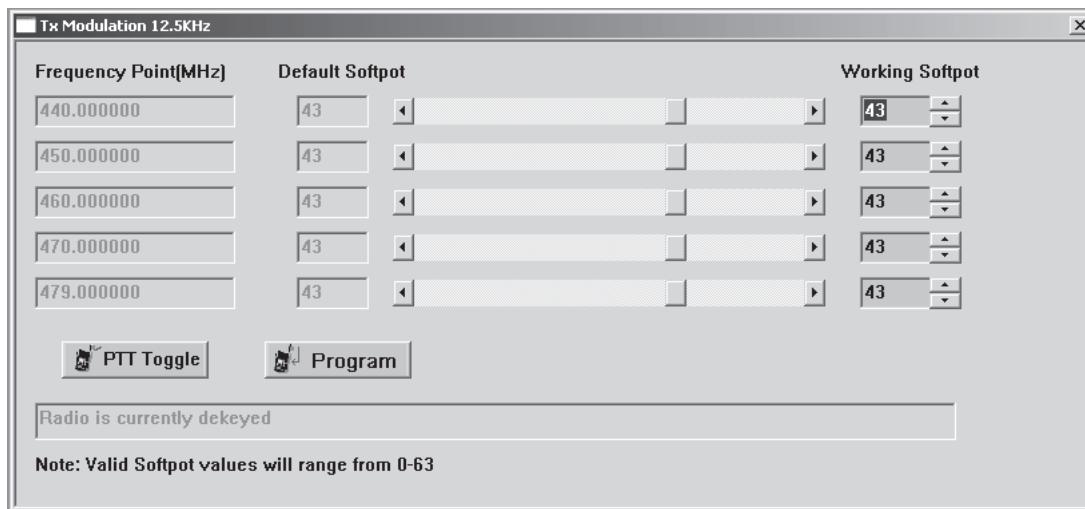
There are 2 variations of Transmit Modulation Tuning, namely 12.5 kHz and 25 kHz.

*Table 5-3. Transmit Modulation Tuning*

Channel Spacing (kHz)	Tuning Range (kHz)
12.5	$2.25 \pm 0.05$
25	$4.5 \pm 0.1$

### 5.5.3.1 Transmit 12.5 kHz Modulation Tuning

- Under the **Alignment** menu, select **Tx Modulation**, then select **Mod. 12.5 kHz** (Figure 5-5).
- Press **PTT Toggle**. This will key up the radio at the F1.
- Read the Modulation from the Service Monitor.
- Change the modulation setting until the Tx deviation value lies in the range of the 12.5 kHz channel (as shown in Table 5-3) by using either the Left/Right arrows on the slider or Up/Down arrows on the Working Softpot box.
- Press **PTT Toggle** to dekey the radio.
- Goto the next frequency point by clicking on the Working Softpot value and press **PTT Toggle**.
- Repeat steps 3–5 for the remaining test frequencies (F2–F5).
- Press **Program** to commit the softpot values into the codeplug.
- Exit the Transmit 12.5 kHz Modulation function.
- If 25 kHz channels are used, perform Transmit 25 kHz Modulation Tuning.



*Figure 5-5. Tx Modulation 12.5 kHz Window*

### 5.5.3.2 Transmit 25 kHz Modulation Tuning

1. Under the **Alignment** menu, select **Tx Modulation**, then select **Mod. 25 kHz** (Figure 5-6).
2. Press **PTT Toggle**. This will key up the radio at the F1.
3. Read the Modulation from the Service Monitor.
4. Change the modulation setting until the Tx deviation value lies in the range of the 25 kHz channel (as shown in Table 5-3) by using either the Left/Right arrows on the slider or Up/Down arrows on the Working Softpot box.
5. Press **PTT Toggle** to dekey the radio.
6. Goto the next frequency point by clicking on the Working Softpot value and press **PTT Toggle**.
7. Repeat steps 3–5 for the remaining test frequencies (F2–F5).
8. Press **Program** to commit the softpot values into the codeplug.
9. Exit the Transmit 25 kHz Modulation function.

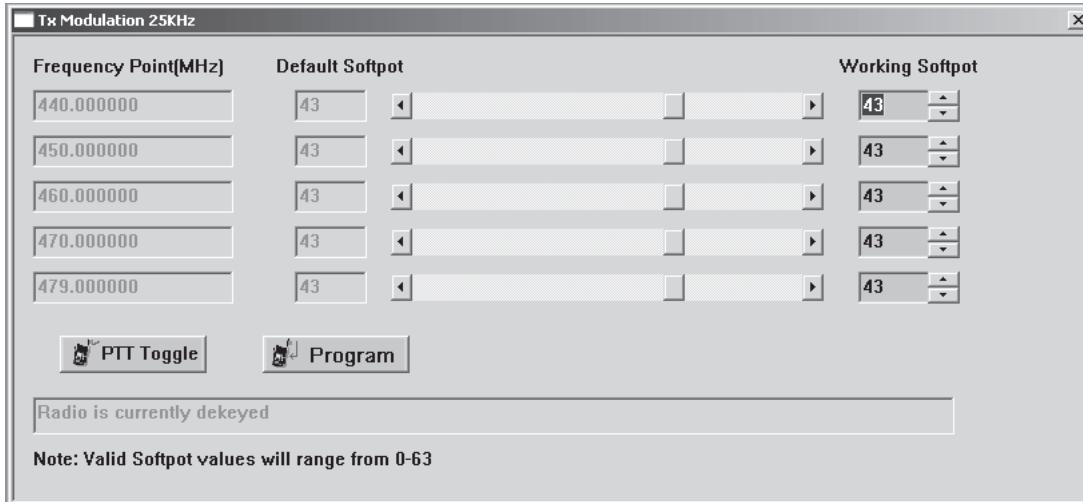


Figure 5-6. Tx Modulation 25 kHz Window

## 5.6 Receiver Tuning

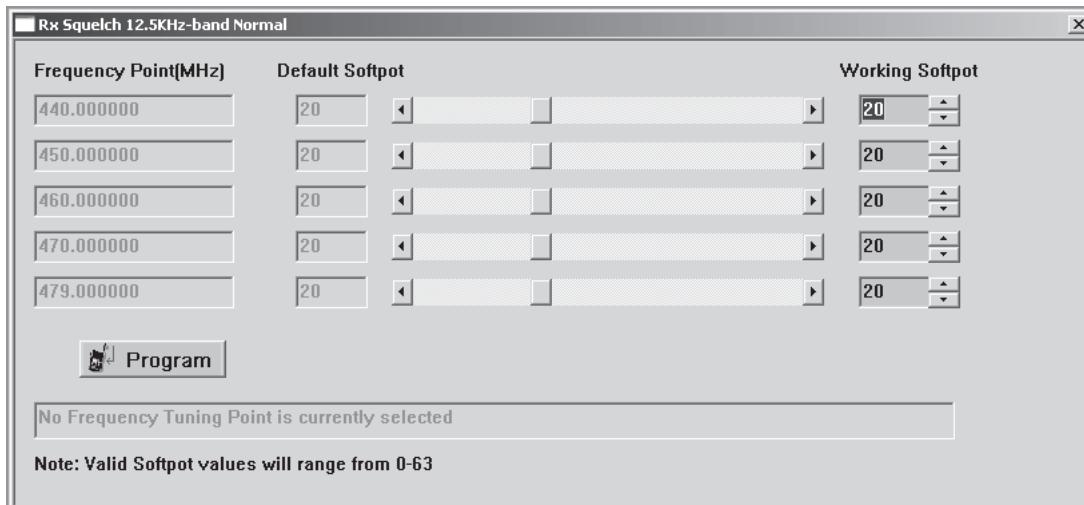
There are 4 variations of Receive Squelch Tuning: 12.5KHz-Band normal Channel Spacing, 12.5KHz-Band tight Channel Spacing, 25KHz-Band normal Channel Spacing and 25KHz-Band tight Channel Spacing.

*Table 5-4. Receiver Squelch Tuning*

Squelch Type	Tuning Range (dB)
Normal	6 – 8
Tight	15 – 17

### 5.6.1 Receive 12.5KHz-Band Normal Squelch Tuning

- Under the **Alignment** menu, select **Rx Squelch**, then select **Squelch 12.5KHz-band Normal**. (Figure 5-7).
- Apply a RF signal for current frequency point with minimum amplitude, -128 dBm (F1 being the first).
- Set softpot to minimum (0) and adjust the amplitude of RF signal to the range of normal squelch tuning (as shown in Table 5-4) on the test equipment.
- Adjust the softpot value by using either the Left/Right arrows on the slider or Up/Down arrows on the Working Softpot box until the radio is totally muted.
- Repeat steps 2–4 for F2–F5.
- Press **Program** to commit the softpot values into the codeplug.



*Figure 5-7. Rx 12.5KHz-band Normal Squelch Tuning Window*

### 5.6.2 Receive 12.5KHz-Band Tight Squelch Tuning

1. Under the **Alignment** menu, select **Rx Squelch**, then select **Squelch 12.5KHz-band Tight**. (Figure 5-8).
2. Apply a RF signal for current frequency point with minimum amplitude, -128 dBm (F1 being the first).
3. Set softpot to minimum (0) and adjust the amplitude of RF signal to the range of tight squelch tuning (as shown in Table 5-4) on the test equipment.
4. Adjust the softpot value by using either the Left/Right arrows on the slider or Up/Down arrows on the Working Softpot box until the radio is totally muted.
5. Repeat steps 2–4 for F2–F5.
6. Press **Program** to commit the softpot values into the codeplug.

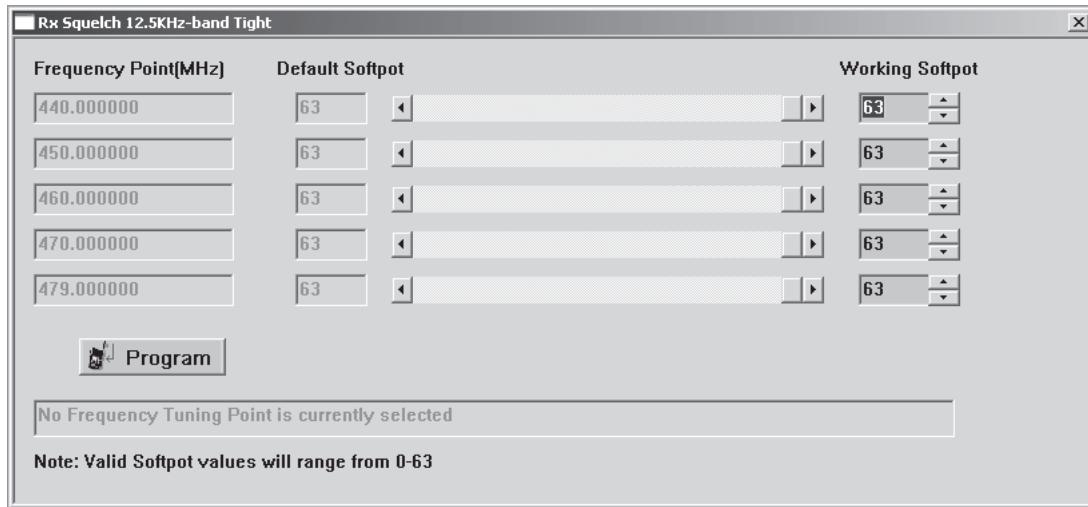


Figure 5-8. Rx 12.5KHz-band Tight Squelch Tuning Window

### 5.6.3 Receive 25KHz-Band Normal Squelch Tuning

1. Under the Alignment menu, select **Rx Squelch**, then select **Squelch 25KHz-band Normal**. (Figure 5-9).
2. Apply a RF signal for current frequency point with minimum amplitude, -128 dBm (F1 being the first).
3. Set softpot to minimum (0) and adjust the amplitude of RF signal to the range of normal squelch tuning (as shown in Table 5-4) on the test equipment.
4. Adjust the softpot value by using either the Left/Right arrows on the slider or Up/Down arrows on the Working Softpot box until the radio is totally muted.
5. Repeat steps 2–4 for F2–F5.
6. Press **Program** to commit the softpot values into the codeplug.

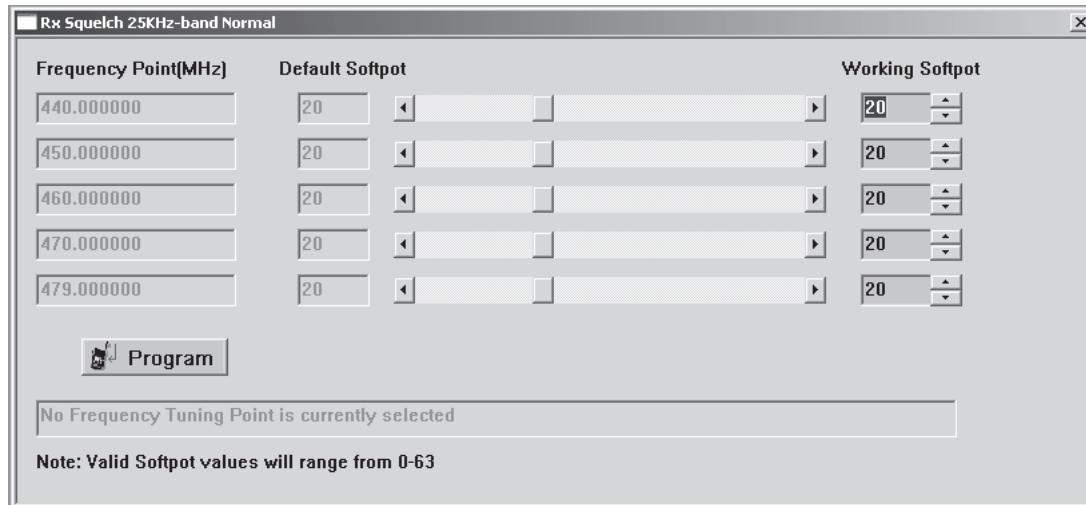


Figure 5-9. Rx 25KHz-band Normal Squelch Tuning Window

### 5.6.4 Receive 25KHz-Band Tight Squelch Tuning

1. Under the **Alignment** menu, select **Rx Squelch**, then select **Squelch 25KHz-band Tight**. (Figure 5-10).
2. Apply a RF signal for current frequency point with minimum amplitude, -128 dBm (F1 being the first).
3. Set softpot to minimum (0) and adjust the amplitude of RF signal to the range of tight squelch tuning (as shown in Table 5-4) on the test equipment.
4. Adjust the softpot value by using either the Left/Right arrows on the slider or Up/Down arrows on the Working Softpot box until the radio is totally muted.
5. Repeat steps 2–4 for F2–F5.
6. Press **Program** to commit the softpot values into the codeplug.

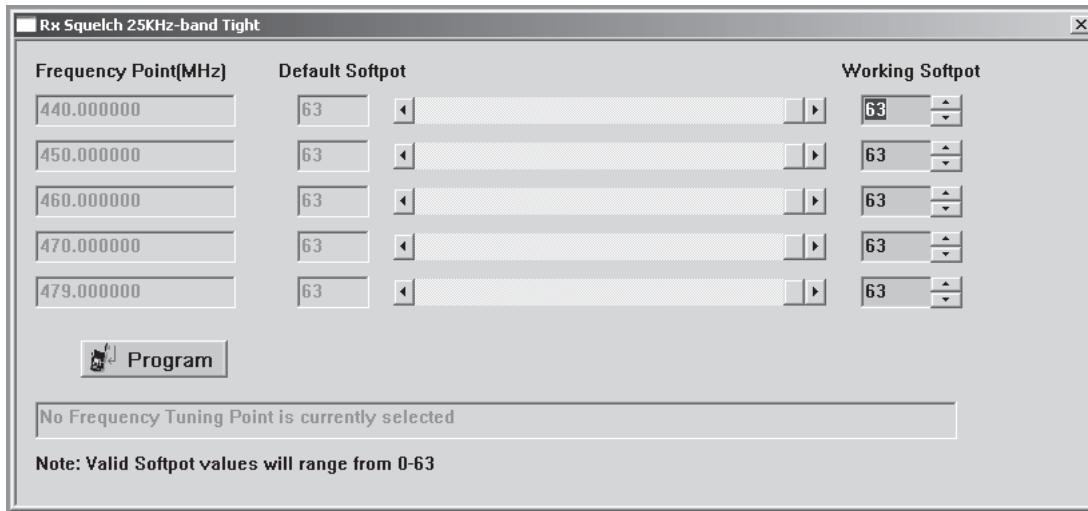


Figure 5-10. Rx 25KHz-band Tight Squelch Tuning Window

## 5.7 Utilities

### 5.7.1 Program Serial No.

The Program Serial No. option under the Utilities heading allow the radio serial number to be programmed. However, the serial number of a particular radio can only be programmed if it was originally blank. Only New Service Boards have a blank serial number. Once a new serial number is programmed into the board, it is NO longer changeable. If the serial number of the radio is not blank, access to the screen will be denied. The serial number programming screen is shown in Figure 5-11. For the new radio serial number to take effect, close the screen and then read the radio again.

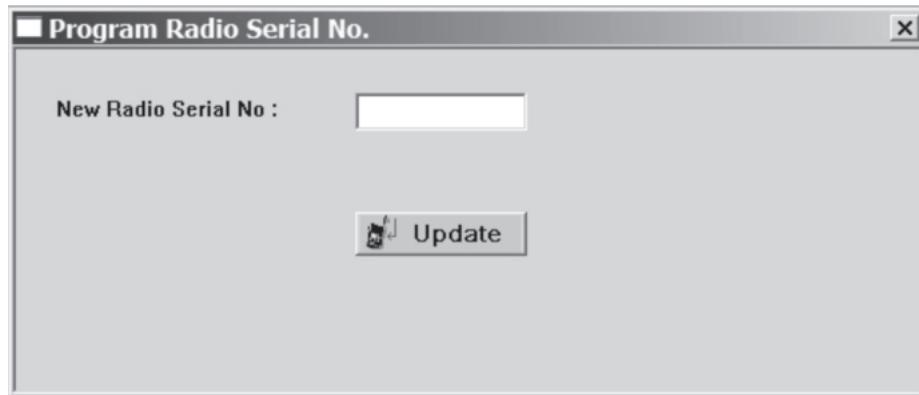


Figure 5-11. Program Radio Serial No. Window

## 5.8 Front Panel Programming

### 5.8.1 Introduction

To program your radio using the front panel, you need to enter Programming Mode in Dealer Configuration. This configuration/mode allows you to edit a number of features to enhance the use of this radio.

In user configuration, a user will have a limited choice to program the radio.

**Note** Some CP Series models do not have Dealer Configuration enabled. (CP Series radio with the following Regional Super Tanapa: PMUE3145\_AA, PMUE3144\_AA, PMUE3143\_AA, PMUE3141\_AA, and PMUE3140\_AA only have User Configuration enabled). Please use the CPS to program additional settings on the radio.

### 5.8.2 Dealer and User Configurations

Your radio is shipped out from the factory configured according to the User Configuration. In this configuration, users can only access a limited number of features. Channels and other radio settings can **ONLY** be programmed when the radio is operating in Dealer Configuration.

To prepare radios for the users, the dealer should:

1. Set the radio to Dealer Configuration (if the radio is configured in User Configuration).
2. Enter Programming Mode.
3. Program the radio with all the necessary parameters, according to the users' requirements.
4. Set the radio back to User Configuration.
5. Clone the radio's parameters to all the users' radios.

#### 5.8.2.1 Switching between Dealer and User Configurations

##### 5.8.2.1.1 From Dealer to User

1. Turn off the radio.
2. Press the Side Programmable Button 2 (bottom side programmable button) 5 times within 3 seconds after turning on the radio.
3. LCD will display the current front panel programming mode.
4. If the LCD does not display "USER",
  - a. Press Left-arrow or Right-arrow buttons to scroll to "USER" mode.
  - b. Press PTT to confirm "USER" mode selection.
  - c. The LCD displays "USER MODE ON" for a while before showing "USER".
5. Turn off the radio. The radio is now operating in USER MODE.

##### 5.8.2.1.2 From User to Dealer

1. Turn off the radio.
2. Press the Side Programmable Button 2 (bottom side programmable button) 5 times within 3 seconds after turning on the radio.
3. LCD will display the current front panel programming mode.

4. If the LCD does not display "DEALER",
  - a. Press Left-arrow or Right-arrow buttons to scroll to "DEALER" mode.
  - b. Press PTT to confirm "DEALER" mode selection.
  - c. The LCD displays "DEALER MODE ON" for a while before showing "DEALER".
5. Turn off the radio. The radio is now operating in DEALER MODE.

**Important** If the radio is to be given to the customer, **REMEMBER** to switch it back to operate in User Configuration.

### 5.8.3 Entering Programming Mode

Make sure the radio is turn off. Press Side Programmable Button 1 (top side programmable button), and turn ON the radio. A tone is heard, indicating that the radio is in Programming Mode. The indicator illuminates and the "BCKLIGHT" is displayed on the radio LCD.

### 5.8.4 Exiting Programming Mode

Turn off the radio to exit Programming Mode.

### 5.8.5 Accessing Front Panel Programming Mode Parameters

Press  or  to scroll through the parameters for each menu or sub-menu item, or  
Press **PTT** to select the menu or sub-menu item, or

Press Side Programmable Button 1 to either return to previous menu level or to exit the selection parameter without change.

### 5.8.6 Editing Front Panel Programming Mode Parameters

*Table 5-5. Front Panel Programming Mode Parameters*

Main Menu	1st Level Sub-Menu	2nd Level Sub-Menu	Setting	Remarks
BCLIGHT (Backlight)			AUTO TOGGLE	AUTO – Backlight Off if no keypress for more than 5 seconds. Pressing the Backlight button again prolongs illumination time. TOGGLE – Allows Backlight Button to toggle control the ON/OFF status of the backlight.
BATTERY	SAVER (Battery Saver)		OFF NORMAL ENHANCED	Helps to extend battery life. When enabled, turns off the radio receiver circuitry periodically when no activity is detected. NORMAL – turns off radio less frequently; select this to save battery when expecting to receive <i>Selective Call</i> or <i>Call Alert</i> . ENHANCED – turns off receiver for a longer duration; select this to maximize battery saving with no <i>Selective Call</i> or <i>Call Alert</i> .
	TYPE (Battery Type)		NIMH LI-ION H LI-ION	Type of battery radio uses. NIMH – Nickel Metal Hydride LI-ION – Lithium-Ion H LI-ION – High Capacity Lithium-Ion
ACCESORY (Accessory)	SPK GAIN (External Speaker Gain)		+2 +1 0 -1 -2	Volume Adjustment – External Speaker. +2: maximum external speaker gain -2: minimum external speaker gain
	MIC GAIN (External Microphone Gain)		+2 +1 0 -1 -2	Sensitivity Adjustment – External microphone. +2: maximum external microphone sensitivity gain -2: minimum external microphone sensitivity gain
	VOX GAIN (VOX Microphone Gain)		VERY HIGH HIGH MIDDLE LOW	VOX microphone sensitivity adjustment – VOX accessories VERYHIGH: maximum VOX microphone sensitivity gain. LOW: minimum VOX microphone sensitivity gain.
	VOX CH	CH-001 ... CH-099	ENABLE DISABLE	Enable or Disable VOX feature for the selected channel.
TONE VOL (Alert Tone Volume)			ON OFF	Selects the alert tone volume preference. OFF: no alert tone. ON: Alert tone is on.

*Table 5-5. Front Panel Programming Mode Parameters (Continued)*

Main Menu	1st Level Sub-Menu	2nd Level Sub-Menu	Setting	Remarks
PROG BTN (Programmable Button)	SIDE 1S (Side Button 1 – Short Press)		UNASSIGN (Unassigned) BCKLIGHT (Backlight) CH ALIAS (Channel Alias) PTT ID (PTT ID Enable) TPL/DPL (TPL/DPL Enable) PRIME CH (Prime Channel) POWER (Power Level) SCAN SQUELCH (Squelch Level) TALKARND (Talkaround) MONITOR PHONE (Phone Mode) SCM CODE (Scrambling Code Select) VOX (Voice Operated Transmit) RV BURST (Reverse Burst) SEL CALL (Selective Call) CL ALERT (Call Alert)	Program Side Button 1 – Short Press.
	SIDE 1L (Side Button 1 – Long Press)		UNASSIGN (Unassigned) BCKLIGHT (Backlight) CH ALIAS (Channel Alias) KEY LOCK (Keypad Lock) NUIS DEL (Nuisance Channel Delete) PTT ID (PTT ID Enable) TPL/DPL (TPL/DPL Enable) PRIME CH (Prime Channel) POWER (Power Level) SCAN SQUELCH (Squelch Level) TALKARND (Talkaround) STKY MONITOR (Sticky Monitor) PHONE (Phone Mode) SCRAMBLE (Scrambling Enable) SCM CODE (Scrambling Code Select) VOX (Voice Operated Transmit) RV BURST (Reverse Burst) SEL CALL (Selective Call) CL ALERT (Call Alert) VOL SET (Volume Set)	Program Side Button 1 – Long Press.
	SIDE 2S (Side Button 2 – Short Press)		- same as above -	Program Side Button 2 – Short Press.
	SIDE 2L (Side Button 2 – Long Press)		- same as above -	Program Side Button 2 – Long Press.
	FRONT 1S (Front Button 1 – Short Press)		- same as above -	Program Front Button 1 – Short Press.

Table 5-5. Front Panel Programming Mode Parameters (Continued)

Main Menu	1st Level Sub-Menu	2nd Level Sub-Menu	Setting	Remarks
	FRONT 1L (Front Button 1 – Long Press)		- same as above -	Program Front Button 1 – Long Press.
	FRONT 2S (Front Button 2 – Short Press)		- same as above -	Program Front Button 2 – Short Press.
	FRONT 2L (Front Button 2 – Long Press)		- same as above -	Program Front Button 2 – Long Press.
	FRONT 3S (Front Button 3 – Short Press)		- same as above -	Program Front Button 3 – Short Press.
	FRONT 3L (Front Button 3 – Long Press)		- same as above -	Program Front Button 3 – Long Press.
CHANNEL	ACTIVATE**	CH-001 ... CH-099	ENABLE DISABLE	Enable or disable a channel.
	ALIAS**	CH-001 ... CH-099	YYYYYYYYYY	Set alias for the channel.
	BANDWDTH** (Bandwidth)	CH-001 ... CH-099	12.5KHZ 25.0KHZ	Set channel bandwidth at 12.5 kHz or 25 kHz. The selection will depend on the bandwidth setting allowed for a particular mode
	RX FREQ** (Rx Frequency)	CH-001 ... CH-099	XXX. XXXX	Set receiving frequency (in MHz) for the current channel.
	TX FREQ** (Tx Frequency)	CH-001 ... CH-099	XXX. XXXX	Set transmitting frequency (in MHz) for the current channel.
	PL DSPLY** (PL Display Type)		FREQ CODE	PL display type – in frequency or code.
	RX PL** (Receive TPL/ DPL)	CH-001 ... CH-099	CSQ            CSQ TPL 067.0 ... 001 ... TPL 254.1      042 DPL 023    or    043 DPL 754        127 TPL 1            TPL 1 TPL 2            TPL 2 TPL 3            TPL 3	Receive PL • Frequency: CSQ, TPL 67.0 – TPL 254.1, DPL 023 – DPL 754, user defined TPL 1, user defined TPL 2, & user defined TPL 3  • Code: CSQ, 001 – 127, user defined TPL 1, user defined TPL 2, & user defined TPL 3
	TX PL** (Transmit TPL/ DPL)	CH-001 ... CH-099	CSQ            CSQ TPL 067.0    001 ... TPL 254.1    042 DPL 023    or    043 DPL 754       127 TPL 1           TPL 1 TPL 2           TPL 2 TPL 3           TPL 3	Transmit PL • Frequency: CSQ, TPL 67.0 – TPL 254.1, DPL 023 – DPL 754, user defined TPL 1, user defined TPL 2, & user defined TPL 3  • Code: CSQ, 001 – 127, user defined TPL 1, user defined TPL 2, & user defined TPL 3
	TPL 1**		067.0 067.1 ... 254.9 255.0	Non-standard private line (TPL) frequency. 67.0 Hz – 255.0 Hz with 0.1 Hz step.

Table 5-5. Front Panel Programming Mode Parameters (Continued)

Main Menu	1st Level Sub-Menu	2nd Level Sub-Menu	Setting	Remarks
	TPL 2**		067.0 067.1 ... 254.9 255.0	Non-standard private line (TPL) frequency. 67.0 Hz – 255.0 Hz with 0.1 Hz step.
	TPL 3**		067.0 067.1 ... 254.9 255.0	Non-standard private line (TPL) frequency. 67.0 Hz – 255.0 Hz with step size of 0.1 Hz.
	RXDPL TY** (RX DPL Type)	CH-001 ... CH-099	DPL INV DPL (Invert DPL)	Receive DPL Type – DPL or Invert DPL.
	TXDPL TY ** (TX DPL Type)	CH-001 ... CH-099	DPL INV DPL (Invert DPL)	Transmit DPL Type – DPL or Invert DP.
	RV BURST** (Reverse Burst)	CH-001 ... CH-099	NONE 180 240	Reverse burst setting – None, 180° or 240°.
	TOC** (Turn Off Code)	CH-001 ... CH-099	ENABLE DISABLE	Turn Off Code setting – enable or disable.
	SQUELCH (Squelch Level)	CH-001 ... CH-099	NORMAL TIGHT	NORMAL squelch level – receive weak signals. TIGHT squelch level – receive strong signals and eliminates unwanted noise.
	TIME OUT (Time Out Timer)		OFF 010 020 ... 590 600	Maximum duration (in seconds) the radio can transmit continuously.
	POWER** (Power Level)	CH-001 ... CH-099	HIGH LOW	Power level – High or Low.
	PRIME CH (Prime Channel)		OFF 001... 099	The channel that you wish to spend most of your time monitoring. The radio will always switch back to the Prime Channel if it is idle for more than the preprogrammed hang-time in other channels.
	PR CH HT** (Prime Channel Hang Time)		010 011... 059 060	Prime Channel Hang Time – duration the radio will stay in another channel before reverting back to the prime channel. 10 sec. – 60 sec. with step size of 1 sec.
	BCL** (Busy Channel Lockout)	CH-001 ... CH-099	ENABLE DISABLE	Busy channel lockout – enable or disable.
	COPY CH** (Copy Channel)	CH-001 ... CH-099	TO CH XXX	Copy setting of a channel to a new channel.
SIGNALNG** (Signaling)	PTT ID		XXXXXXXX	Set PTT ID.

Table 5-5. Front Panel Programming Mode Parameters (Continued)

Main Menu	1st Level Sub-Menu	2nd Level Sub-Menu	Setting	Remarks
	PTTID TY (PTT ID Type)		NONE PRE POST BOTH	PTT ID type – None, Pre, Post or Both.
	PTTID CH (PTT ID Channel)	CH-001 ... CH-099	ENABLE DISABLE	Set channel with PTT ID enabled.
	PTT TONE (PTT Side Tone)		NONE LONG SHORT	PTT side tone – No side tone, Long side tone or Short side tone.
	TXPRTIME (TX Pertime)		0000 0025... 3975 4000	Transmit pretime – duration radio waits, after a Push-to-Talk (PTT) button press, before transmitting the DTMF signaling. 0ms – 4000ms with step size of 25ms.
	IND ID (Individual ID)		XXXXXXXX	Set Individual ID.
	GRP ID (Group ID)		XXXXXXXX	Set Group ID.
	ALL ID		XXXXXXXX	Set All ID.
	ACK ID (Acknowledge ID)		XXXXXXXX	Set Acknowledge ID.
	ACK IND (Acknowledge for Individual Call)	CH-001 ... CH-099	ENABLE DISABLE	Set channel that enable Acknowledge ID transmission upon receiving Individual Call.
	SEL CAL (Selective Call Channel)	CH-001 ... CH-099	ENABLE DISABLE	Set channel that enable Selective Call transmission.
SCAN	CALL PL (PL Required for Call)	CH-001 ... CH-099	ENABLE DISABLE	Set channel that enable PL required for call feature. When enabled, the radio needs to receive a matching Call ID as well as a TPL/DPL code in order to unmute on the current channel.
	CL ALERT (Call Alert Channel)	CH-001 ... CH-099	ENABLE DISABLE	Set channel that enable Call Alert transmission.
	HANGTIME** (Scan Hang Time)		500 1000 ... 9500 10000	Scan hang time: 500ms – 10000ms with step size of 500ms.
	INT TIME** (Scan Interval Time)		750 1000 ... 4750 5000	Scan interval time: 750ms - 5000ms with step size of 250ms.
	LIST 1 (Scan List 1)	01-XXX 02-XXX ... 15-XXX 16-XXX\	--- 001 ... 099	Set Scan List 1 members. xxx – selected scan list member --- – no scan list member is selected

*Table 5-5. Front Panel Programming Mode Parameters (Continued)*

Main Menu	1st Level Sub-Menu	2nd Level Sub-Menu	Setting	Remarks
	LIST 2 (Scan List 2)	01-XXX 02-XXX ... 15-XXX 16-XXX\	— 001 ... 099	Set Scan List 2 members. xxx – selected scan list member --- – no scan list member is selected
	LIST 3 (Scan List 3)	01-XXX 02-XXX ... 15-XXX 16-XXX\	— 001 ... 099	Set Scan List 3 members. xxx – selected scan list member --- – no scan list member is selected
	LIST SEL (Scan List Select)	CH-001 ... CH-099	LIST1 (Scan List 1) LIST2 (Scan List 2) LIST3 (Scan List 3)	Set scan list for a selected channel.
	SCAN TYP (Scan Type Select)	CH-001 ... CH-099	NORMAL PRIORITY	Scan type for selected channel – Normal Scan, Priority Scan
	PRIORITY (Priority Channel Select)	LIST1 (Scan List 1)	— 001 ... 099	Set Priority Channel for Scan List 1. xxx – selected priority channel --- – no priority channel is selected
		LIST2 (Scan List 2)	— 001 ... 099	Set Priority Channel for Scan List 2. xxx – selected priority channel --- – no priority channel is selected
		LIST3 (Scan List 3)	— 001 ... 099	Set Priority Channel for Scan List 3. xxx – selected priority channel --- – no priority channel is selected
SCRMBLIN (Voice Inversion Scrambling)	CHANNEL (Scrambling Channel Select)	CH-001 ... CH-099	ENABLE DISABLE	Scrambling – Enable or disable
	CODE (Scrambling Code Select)		3.29 3.39	Scrambling code – 3.29 or 3.39.

Table 5-5. Front Panel Programming Mode Parameters (Continued)

Main Menu	1st Level Sub-Menu	2nd Level Sub-Menu	Setting	Remarks
PHONE *	ACC CODE (Access Code)		XXXXXXXX	Access code for phone – XXXXXXXX. Use radio keypad to enter up to 16 characters consisting of 0,1,2,3,4,5,6,7,8,9,#,*
	DEACCCODE (Deaccess Code)		XXXXXXXX	Deaccess code for phone – XXXXXXXX. Use radio keypad to enter up to 16 characters consisting of 0,1,2,3,4,5,6,7,8,9,#,*
	PHONE 01		NUMBER01	Set Phone No 1. Use radio keypad to enter up to 16 characters consisting of 0,1,2,3,4,5,6,7,8,9,#,* Note: NUMBER01 will appear if the phone list entry is empty.
			NAME 01	Set alias for Phone No 1. User can use radio keypad to enter up to 8 characters consisting of A – Z, 0 – 9, \, #, < >, *, +, -, /, - Note: NAME 01 will appear if the phone list entry is empty.
	ALIAS (Assigned name)	EDIT		Edit phone number – XXXXXXXX. Note: The alias will appear at 1st menu level if the phone list entry is not empty.
		DELETE		Delete the phone entry.
	PHONE XX (XX = 01 to 16)		NUMBERXX	Set Phone No X. User can use radio keypad to enter up to 16 characters consisting of 0,1,2,3,4,5,6,7,8,9,#,* Note: NUMBERXX will appear if the phone list entry is empty.
			NAMEXX	Set alias for Phone No X. User can use radio keypad to enter up to 8 characters consisting of A – Z, 0 – 9, \, #, < >, *, +, -, /, - Note: NAMEXX will appear if the phone list entry is empty.
CALL LST * (Call List)	ALIAS	EDIT	XXXXXXXX	Allows you to edit call ID. XXXXXXXX denotes the call ID numbers. Note: The alias will appear at 1st menu level if the call list entry is not empty. Selecting DELETE option will delete the call list entry.
	DELETE			
	CALL XX (XX= 01 to 16)		ID XX	Set call list ID X. Use radio keypad to enter up to 8 characters consisting of 0,1,2,3,4,5,6,7,8,9,#,* Note: ID XX will appear if the call list entry is empty.
			ALIAS XX	Set alias for call list ID X. Use radio keypad to enter up to 8 characters consisting of A - Z, 0 - 9, \, #, < >, *, +, -, /, - Note: Alias XX will appear if the call list entry is empty.

\* Applicable to Keypad Models only.

\*\* Only applicable to radio that supports Dealer Mode.

### 5.8.7 Factory Reset

This feature allows you to erase certain programmable parameters and restore the radio to the factory default settings. The radio, upon reset, clears all memory channels, and restores the default settings of radio wide parameters.

1. Set the radio in Dealer Configuration (if it is operating in User Configuration).
2. Press and hold Side Programming Button 2 and PTT button together, while turning on the radio.
3. A good key tone is heard and “FA RESET” is displayed on the LCD
4. Proceed to step 8 to Cancel Factory Reset.
5. Press . “YES” is displayed.
6. Press PTT to confirm Factory Reset. “RESET OP” is shown while factory reset operation is in progress.
7. Upon completion, “FACTORY RESET COMPLETED” is shown and the radio automatically turn off and on again. The radio is now restored to its default factory setting.
8. Press . “NO” is displayed.
9. Press PTT to confirm Cancellation. “CANCELLED” is shown and the radio automatically turn off, and on again.

**Note** Factory Reset function is only available for Software Mode 1 and Software Mode 2 radios.

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# **Chapter 6 Maintenance – CP1600/CP1660 (Full Keypad Models)**

## **6.1 Introduction**

This section 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
- Mechanical View and Parts List

## **6.2 Preventive Maintenance**

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

### **6.2.1 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.

### **6.2.2 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: 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 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).

## 6.3 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 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.

## 6.4 Disassembling and Reassembling the Radio – General

When disassembling and reassembling the radio, 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 and reassembling the radio (see Chapter 3 for a list of service aids):

- Phillips Screwdriver
- Flat Head Screwdriver
- Torque Driver
- Crab Eye Nut Opener (PMDN4039\_R)
- Chassis and Knob Opener (PMDN4038\_R)
- Tweezers

If a unit requires further testing or service than is customarily performed at the basic level, please send the unit to a Motorola Authorized Service Center listed in Appendix B.

**Note:** • Numbers in parentheses ( ) refer to item numbers in Figure 6-19, on page 6-14.

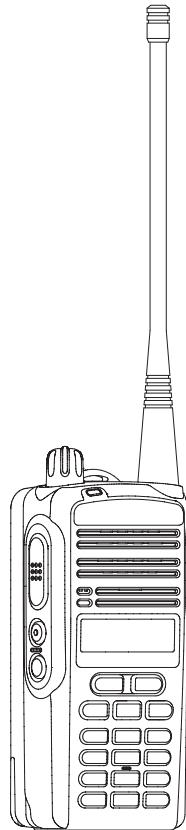
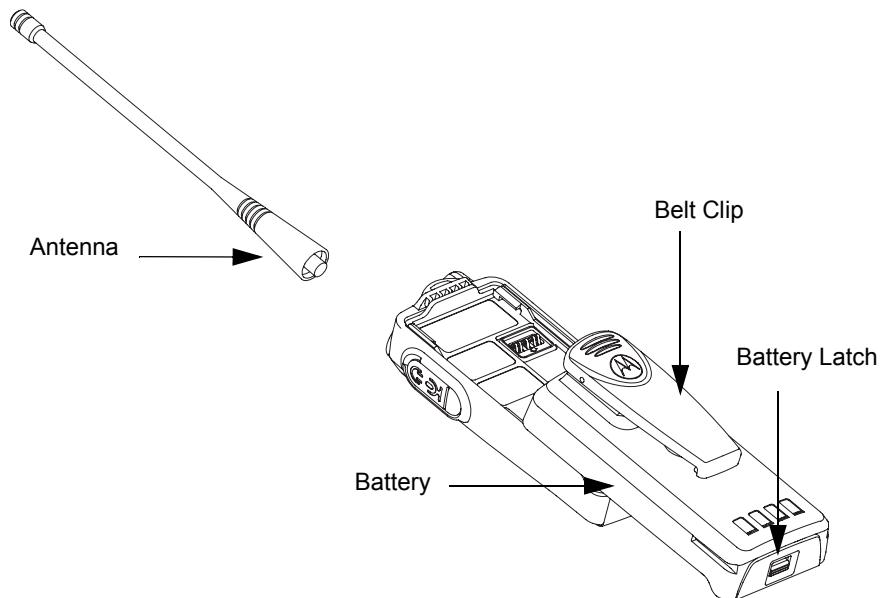


Figure 6-1. Full Keypad Without Channel Knob Model

## 6.4.1 Radio Disassembly – Detailed

### 6.4.1.1 Front Housing From Chassis Disassembly

1. Turn off the radio.
2. Remove the Battery (30):
  - a. Release the battery latch by moving it into the unlock position.
  - b. Slide the Battery downwards.
  - c. Remove the Battery from the radio.



*Figure 6-2. Battery and Antenna Removal*

3. Remove the Antenna (21) by turning it counterclockwise.

4. Remove the Volume Knob (7) from its shaft using the Chassis and Knob Opener. (Refer Figure 6-3).

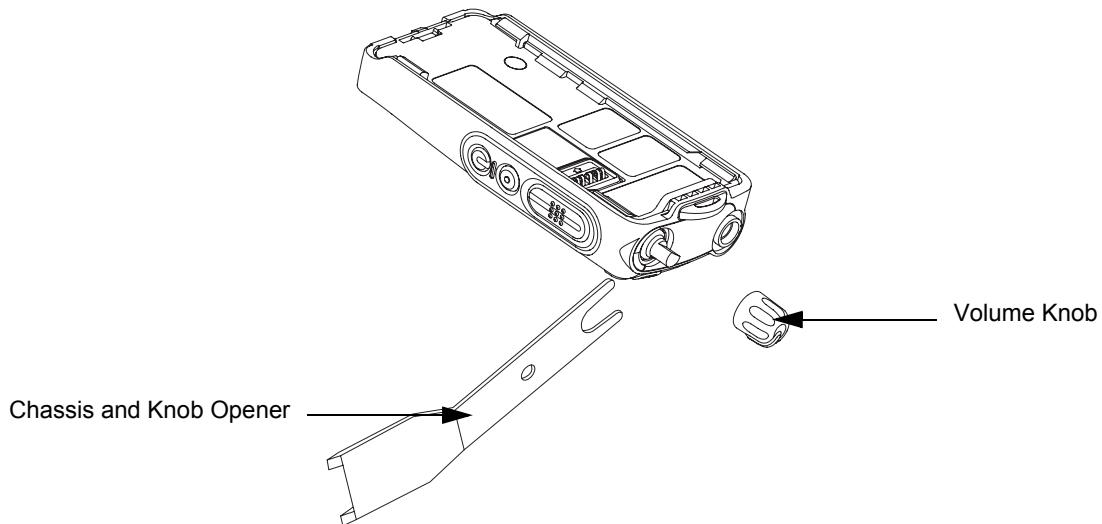


Figure 6-3. Knob Removal

**Note:** The Volume Knob can be turned clockwise and counterclockwise. However, it is designed to fit very tightly on the shaft.

5. Separate the Chassis (26) from the Front Housing Assembly (1):
  - a. Insert the Chassis and Knob Opener in between the thin retaining wall and the chassis at the bottom of the radio. Do not mar the O-ring sealing area on the housing.
  - b. Slowly pry the bottom of the chassis from the housing by pushing the Chassis and Knob Opener downwards, and prying the handle of the tool over and behind the base of the radio. This forces the thin inner plastic wall toward the base of the radio thus releasing the two chassis base tabs. (Refer Figure 6-4).

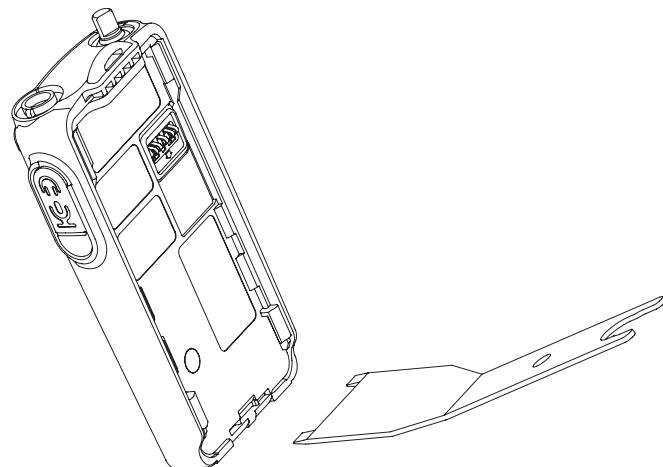


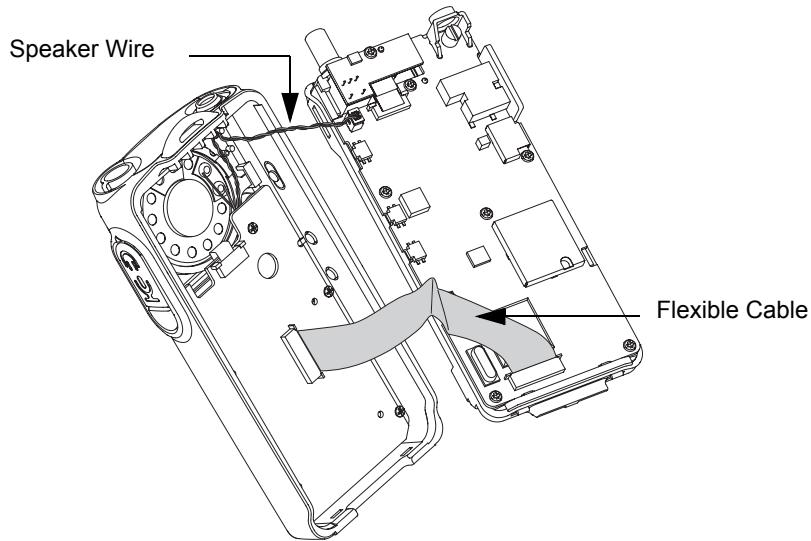
Figure 6-4. Chassis Removal



**CAUTION:** Marring the front cover O-ring sealing area will prevent the radio from sealing properly. If the O-ring (23) is damaged, replace it with a new one.

Caution

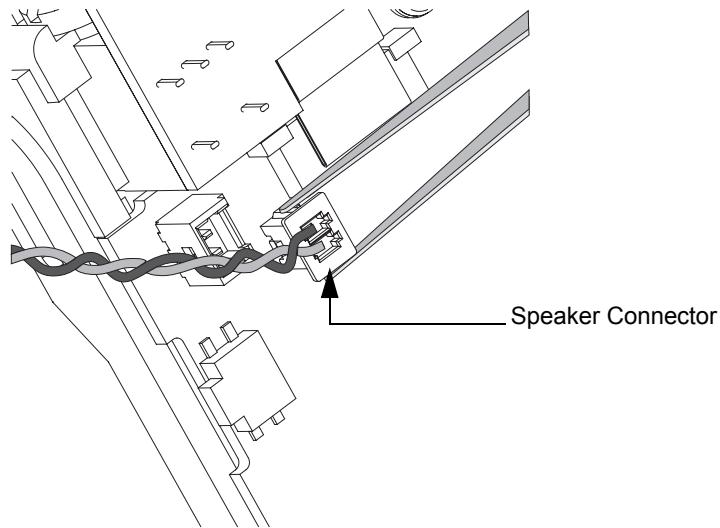
- c. Slide the rear chassis downwards, and away from the front housing. Be careful not to damage the Flexible Cable (38) and speaker wire underneath. (Refer Figure 6-5).



*Figure 6-5. Speaker Wire and Flexible Cable Connection*

**Note:** The speaker wire and flexible cable connector connecting the Front Housing Assembly (1) and the Chassis (26) prevent the two units from being completely separated

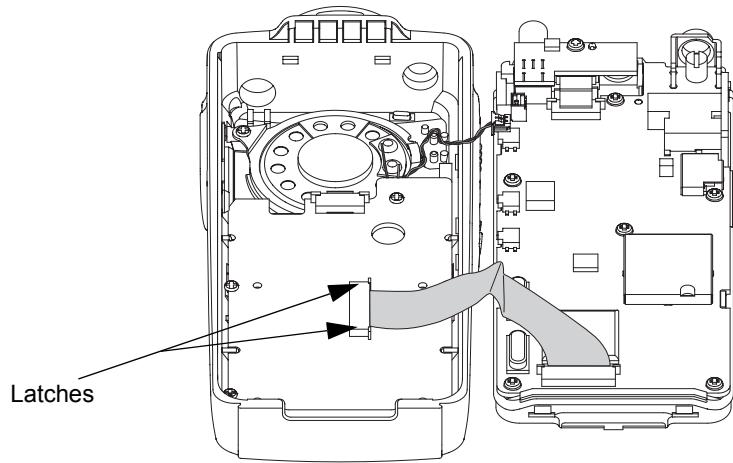
- d. Remove the speaker wire connector connecting the main circuit board and the internal speaker on the front housing with the tweezers. (Refer Figure 6-6)



*Figure 6-6. Speaker Wire Removal*

- e. Lay the front housing down. Rotate the chassis sideways from the Front Housing Assembly (1) and lay it down.

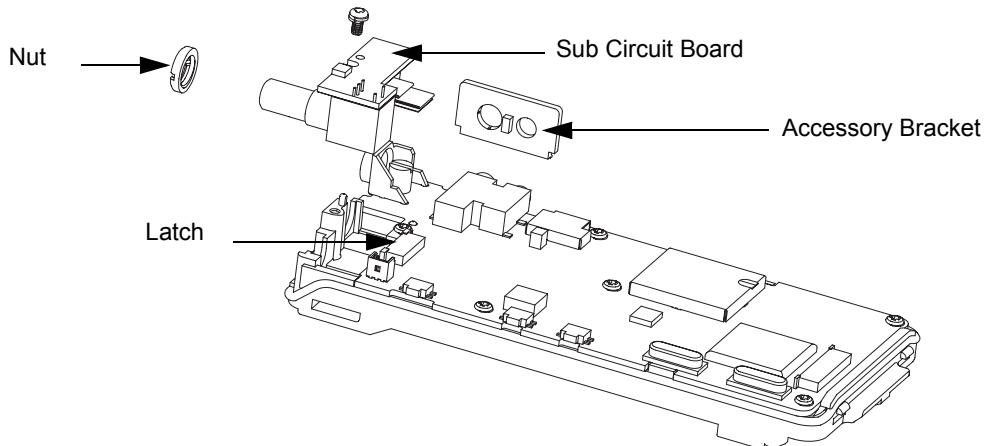
- f. Push the latches on the Front Circuit Board (40) sideways to the right to release the flexible cable from the connector. (Refer Figure 6-7).



*Figure 6-7. Unlatch the Flexible Cable*

#### 6.4.1.2 Chassis Assembly Disassembly

1. Remove the Accessory Bracket (34).
2. Remove the nut (16) on the On/Off Volume Knob Shaft with the Crab Eye Nut Opener.
3. Remove the screw holding the Sub Circuit Board (15) to the Chassis (26) with a Phillips screwdriver.
4. Push the latches on the Main Circuit Board (18) to release the Flexible Cable (38) from the connector.
5. Remove the Sub Circuit Board from the Chassis. (Refer Figure 6-8).



*Figure 6-8. Sub-Circuit Board and Accessory Bracket Removal*

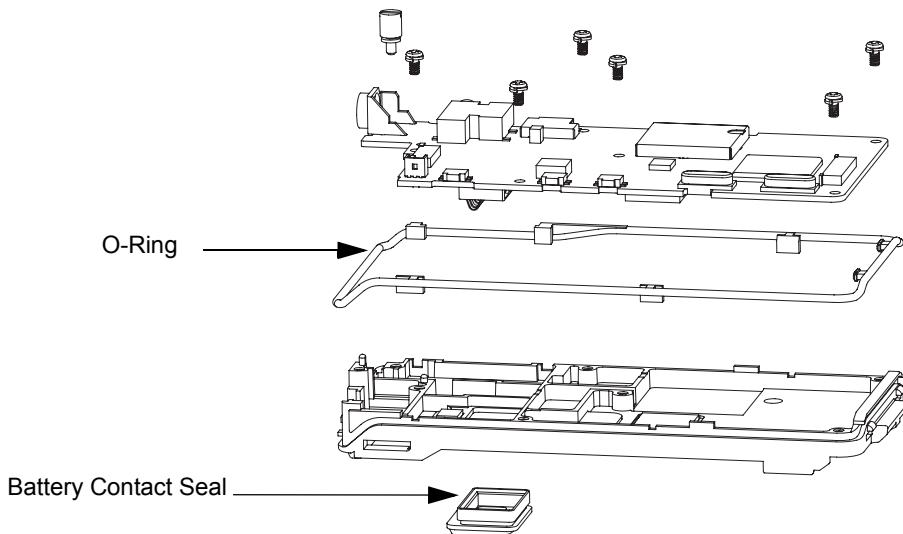
6. Remove the six screws (36) holding the Main Circuit Board to the Chassis with a Phillips screwdriver. Remove the RF Support Screw (19) with a flat head screwdriver.

7. Remove the Main Circuit Board from the Chassis.



**CAUTION: Refer to the CMOS CAUTION paragraph under Section 6.3 before removing the main board. Be sure to use ESD protection when handling the circuit boards.**

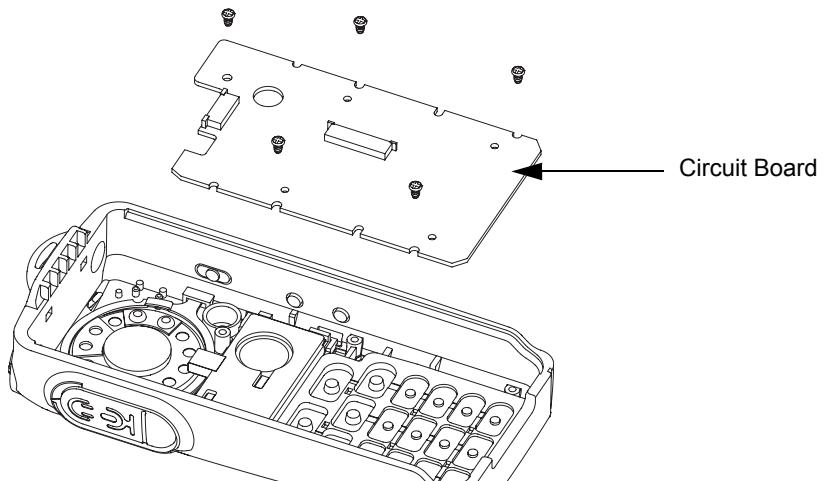
8. Remove the seven small O-ring retainers from their slots in the Chassis. Note the alignment of the retainers for reassembly.
9. Remove the O-ring (23) and the Battery Contact Seal (27). (Refer Figure 6-9).



*Figure 6-9. Main Circuit Board, O-ring and Battery Contact Seal Removal*

#### 6.4.1.3 Front Circuit Board, Display Module and Keypad Disassembly

1. Push the latches on the Front Circuit Board (40) to release the Liquid Crystal Display (LCD) flexible cable from the connector.
2. Remove the five screws holding the Front Circuit Board to the front housing with a Phillips screwdriver.
3. Remove the Front Circuit Board from the Front Housing. (Refer Figure 6-10).



*Figure 6-10. Front Circuit Board Removal*

4. Remove the LCD (37) and Keypad (42) from the Front Housing. (Refer Figure 6-11).

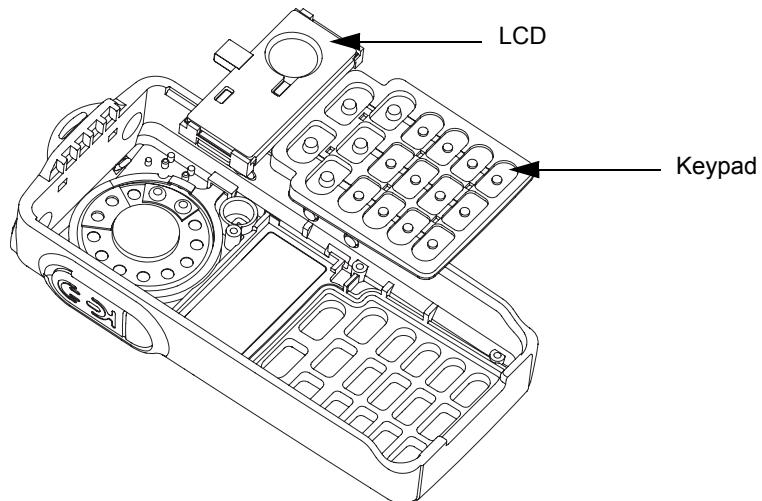


Figure 6-11. LCD and Keypad Removal

#### 6.4.1.4 Speaker Disassembly

1. Remove the screw holding the Speaker Retainer (10) to the Front Housing with a Phillips screwdriver.
2. Remove the Speaker Retainer from the Housing.

**Note: Be careful not to damage the Speaker Wire when removing the Retainer Bracket.**

3. Remove the Speaker from the Housing with a flat head screwdriver.
4. Remove the Speaker Insulator (11) from the speaker.
5. Remove the Speaker Felt (8) from the grille area (Refer Figure 6-12).

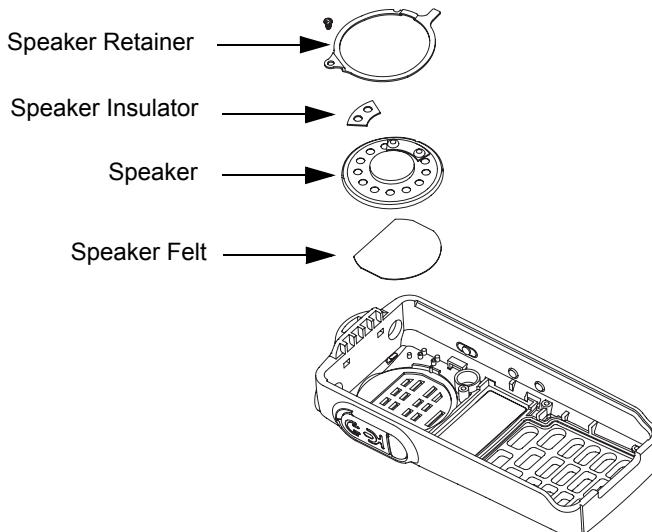


Figure 6-12. Speaker Removal

## 6.4.2 Radio Reassembly – Detailed

### 6.4.2.1 Speaker Reassembly

1. Place the Speaker Felt (8) onto the grille area.
2. Align the speaker wire at three o'clock position and push down the speaker until fully adhere onto the front housing.
3. Align the Speaker Insulator (11) at twelve o'clock position and push down until fully adhere onto the speaker.
4. Install the Speaker Retainer (10).
5. Tighten the Speaker Retainer to the housing with a Phillips screwdriver torque to 1.0 kgf – 1.2 kgf (Refer Table 6-1 on page 6-13 for torque in other units).

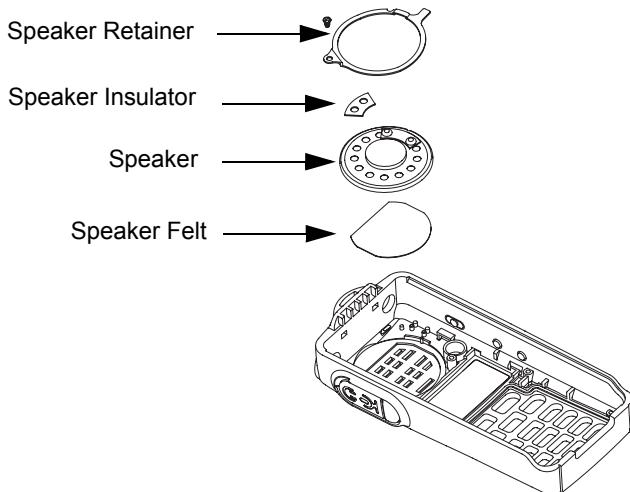


Figure 6-13. Speaker Reassembly

### 6.4.2.2 Front Circuit Board, Display Module and Keypad Reassembly

1. Place and align the LCD (37) onto the front housing.
2. Place and align the Keypad (42) onto the keypad slot. Apply force around the keypad and ensure the keypad sealing rib is perfectly seated onto the keypad slot. (Refer Figure 6-14).

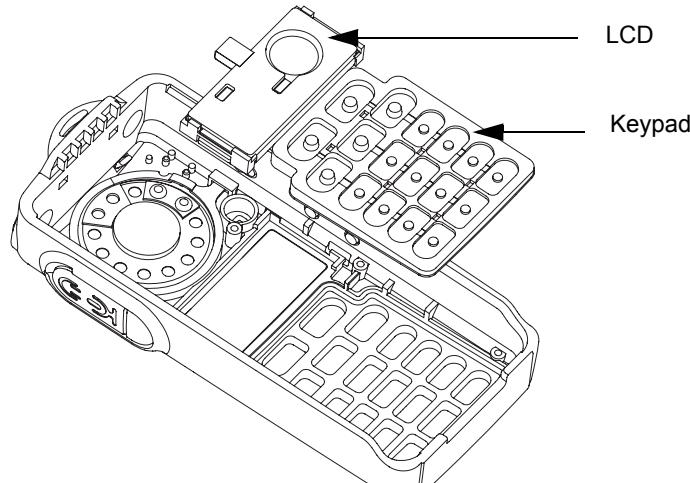
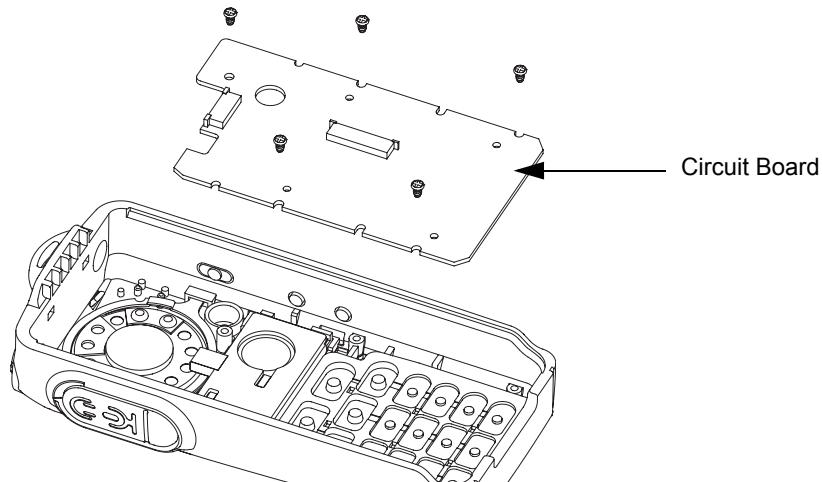


Figure 6-14. LCD and Keypad Reassembly

3. Place the Front Circuit Board (40) straight down on top of the LCD and keypad. Align the front circuit board to the four housing ribs. Press the top right edge of the front circuit board to ensure the microphone sealing rubber is fully seated in place.
4. Tighten the five screws holding the front circuit board with a Phillips screwdriver torque to 1.2 kgf – 1.5 kgf. (Refer Table 6-1 on page 6-13 for torque in other units).



*Figure 6-15. Front Circuit Board Reassembly*

5. Insert the LCD flexible cable into the connector on the front circuit board.
6. Push the latches into the connectors.

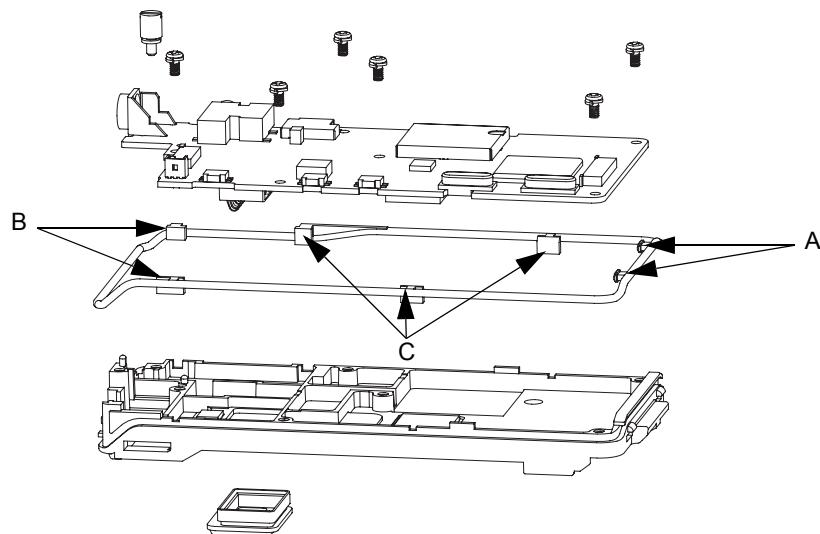
#### 6.4.2.3 Chassis Assembly Reassembly

1. Fit the Battery Contact Seal (27) onto the battery contact slot.
2. Fit the main O-ring (23) onto the chassis as follow:
  - a. Ensure that the main O-ring is not twisted. Untangle to original form if necessary.
  - b. Secure **A** into the bottom two notches on the chassis. (Refer Figure 6-16).
  - c. Fit the bottom section of the main O-ring around the bottom two grooves.
  - d. Insert **B** into the top two catches on the chassis.
  - e. Fit the top section of the main O-ring around the top two corners of the chassis.
  - f. Secure **C** into the remaining three notches on the chassis.
3. Place the main circuit board straight down on top of the chassis.

**Note:** Make sure the battery contact seal protrudes through the chassis and is not squeezed under the chassis. Ensure the O-ring is also not squeezed under main circuit board.

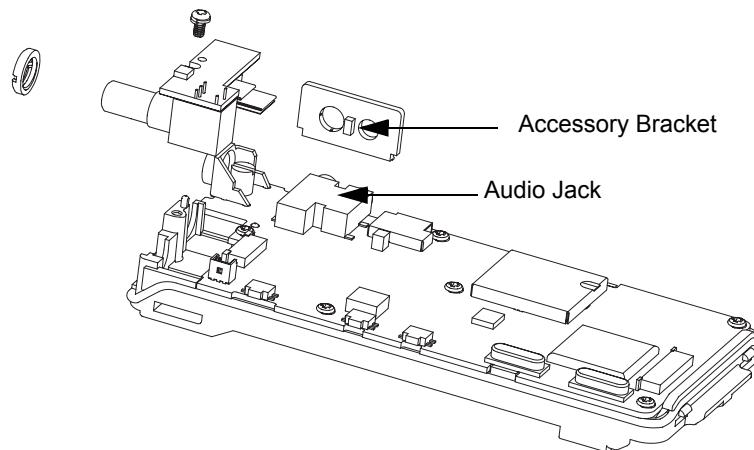
4. Tighten the six screws holding the main circuit board with a Phillips screwdriver torque to 2.2 kgf – 2.5 kgf. (Refer Table 6-1 on page 6-13 for torque in other units).

5. Tighten the RF Support Screw (19) with a flat head screw torque to 2.2 kgf – 2.5 kgf. (Refer Table 6-1 on page 6-13 for torque in other units).



*Figure 6-16. Main Circuit Board, O-ring and Battery Contact Seal Reassembly*

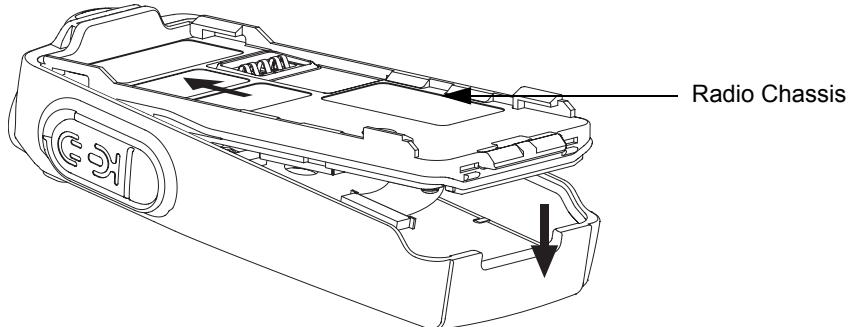
6. Insert the Sub Circuit Board Flexible Cable (14) into the respective connectors at the top of the main circuit board.
7. Push the latches into the connectors.
8. Place the sub circuit board straight down on top of the chassis.
9. Tighten the screw that is holding the sub circuit with a Phillips screwdriver torque to 2.2 kgf – 2.5 kgf. (Refer Table 6-1 on page 6-13 for torque in other units).
10. Tighten the nut on the On/Off Volume Knob Shaft with the Crab Eye Nut Opener.
11. Align and Insert the Accessory Bracket (34) into the audio jack hole. (Refer Figure 6-17).



*Figure 6-17. Sub Circuit Board and Accessory Bracket Reassembly*

#### 6.4.2.4 Chassis and Front Housing Reassembly

1. Assembly the Chassis Assembly to the Front Housing Assembly (1) as follow:
  - a. Lay the Chassis Assembly beside to the Front Housing Assembly.
  - b. Insert the Flexible Cable (38) from the main circuit board into the connector on the front circuit board.
  - c. Push the latches into the Front Housing Assembly.
  - d. Connect the speaker wire to the connector.
2. Slide the On/Off Volume Knob Shaft into the respective holes in the front cover.
3. Insert top chassis tabs into the recesses on the front cover and apply some force until the tabs are fully inserted.
4. Be sure the O-ring (23) is properly seated so that the radio is properly sealed.
5. Snap the bottom of the chassis into the front housing.
6. Reassemble the Knob (7), Dust Cover (41), Antenna (21), and Battery (30). (Refer Figure 6-18).



*Figure 6-18. Chassis Assembly and Front Housing Assembly Reassembly*

## 6.5 Torque List

Table 6-1 lists the various screws by part number and description, followed by the torque values in different units of measure. Torque all screws to the recommended value when assembling the radio.

*Table 6-1. Torque Chart*

Part Number	Description	Quantity	Torque		
			N·m	lb-in	kgf-cm
PMDN4099_R	Retainer, Speaker, with screw	1	0.11±0.01	0.95±0.09	1.10±0.10
PMDN4119_R	Screw, Tapping	5	0.13±0.01	1.17±0.13	1.35±0.15
PMDN4107_R	Screw, Machine	7	0.23±0.01	2.04±0.13	2.35±0.15
PMDN4114_R	Screw, RF Support	1	0.23±0.01	2.04±0.13	2.35±0.15

## 6.6 Mechanical View and Parts List

### 6.6.1 CP1600/CP1660 Exploded View and Parts List

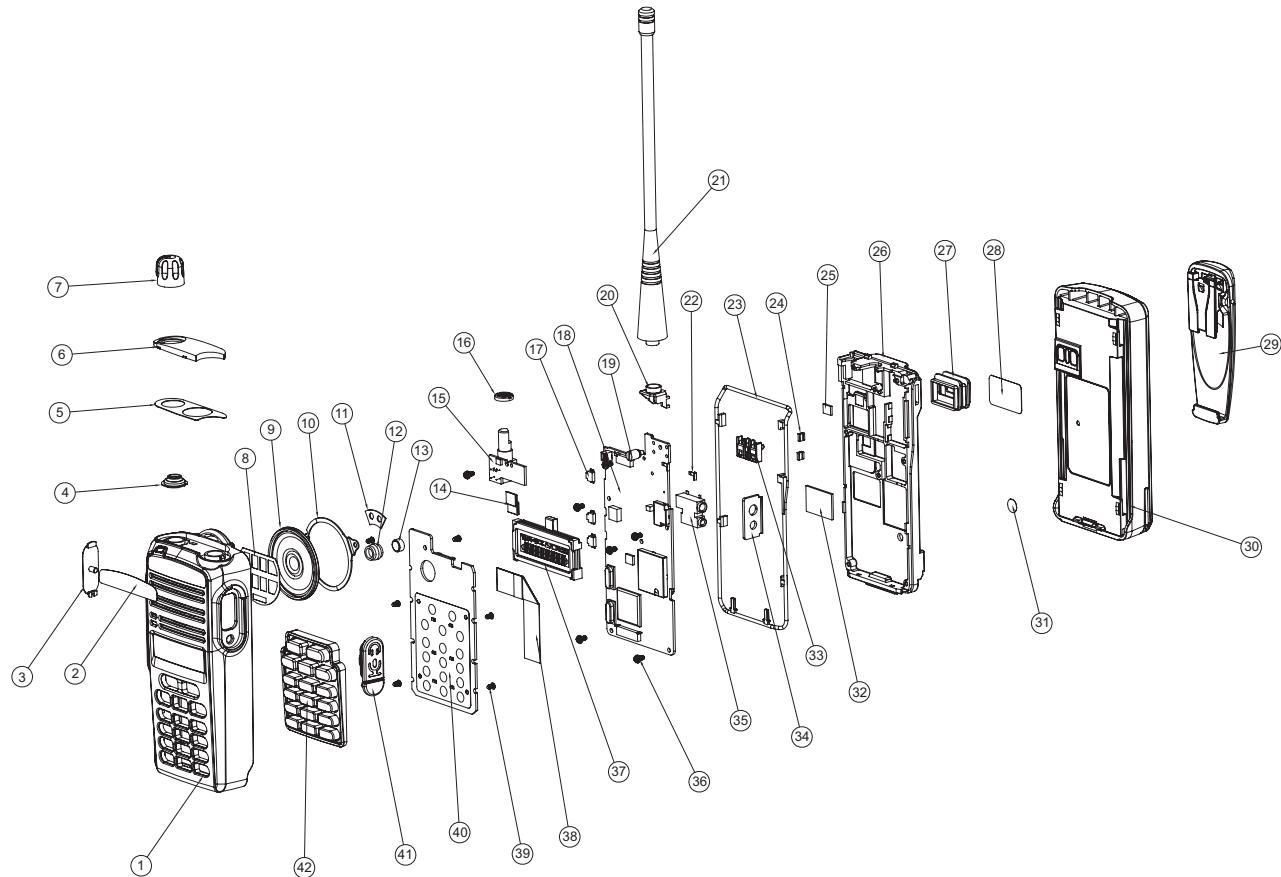


Figure 6-19. CP1600/CP1660 Radio Exploded View

Item	Motorola Kit Number	Description	Quantity
1	PMDN4087_R	Front Housing, Full Keypad	1
2	PMDN4094_R PMDN4093_R	Name Plate (CP1600) Name Plate (CP1660)	1
3	PMDN4124_R	Double Molded Cover, PTT	1
4	PMDN4090_R	Seal, Volume Knob	1
5	PMDN4088_R	Adhesive, Top Control	1
6	PMDN4104_R	Escutcheon, Top without Channel knob	1
7	PMDN4102_R	Knob, Volume	1
8	PMDN4100_R	Felt, Speaker	1
9	PMDN4067_R	Speaker	1
10	PMDN4099_R	Retainer, Speaker, with screw	1
11	PMDN4098_R	Insulator, Speaker	1
12	PMDN4135_R	Seal, Microphone	1
13	PMDN4139_R	Microphone	1
14	PMDN4111_R	Flexible Cable, Sub Circuit Board	1
15	PMDN4129_R	Sub Circuit Board, w/o Channel	1
16	PMDN4112_R	Crab-Eye Nut, Volume and Channel	1
17	PMDN4134_R	Switch, Tact	3
18*	PMDE4018_R PMDE4008_R PMDE4022_R	Main Circuit Board (CP1600 – PMUE3145_AA) Main Circuit Board (CP1660 – PMUE3148_AA) Main Circuit Board (CP1660 – PMUE3147_AA)	1
19	PMDN4114_R	Screw, RF Support	1
20	PMDN4138_R	Bracket, Antenna	1
21	See Appendix A	Antenna	1
22	PMDN4137_R	Finger Strip, PCB	1
23	PMDN4116_R	O-ring	1
24	PMDN4120_R	Finger Strip, Chassis	2
25	PMDN4121_R	Pad, Thermal	1
26	PMDN4122_R	Chassis	1
27	PMDN4105_R	Seal, Battery Contact	1
28	PMDN4110_R	Label, Caution	1
29	See Appendix A	Belt Clip	1
30	See Appendix A	Battery	1
31	PMDN4028_R	Tuning Hole Sticker (Small)	1
32	PMDN4106_R	Gel Pad, Ceramic Filter	1
33	0915184H01	Contact, Battery	1
34	PMDN4108_R	Bracket, Accessory	1
35	0980683Z01	Jack, Audio	1

Item	Motorola Kit Number	Description	Quantity
36	PMDN4107_R	Screw, Machine	7
37	PMDN4123_R	Module, Liquid Crystal Display	1
38	PMDN4109_R	Flexible Cable, Main Circuit Board	1
39	PMDN4119_R	Screw, Tapping	5
40‡	PMDN4130_R	Front Circuit Board, FKP	1
41	PMDN4113_R	Cover, Dust	1
42	PMDN4115_R	Keypad, Full Keypad	1

**Note:**

\*This kit consists of tact switch, antenna bracket, PCB finger strip, battery contact and audio jack.

‡This kit consists of microphone and microphone seal.

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# **Chapter 7 Maintenance – CP476/CP477/CP1300**

## **(Limited Keypad Models)**

### **7.1 Introduction**

This section 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
- Mechanical View and Parts List

### **7.2 Preventive Maintenance**

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

#### **7.2.1 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.

#### **7.2.2 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: 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 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).

## 7.3 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 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.

## 7.4 Disassembling and Reassembling the Radio – General

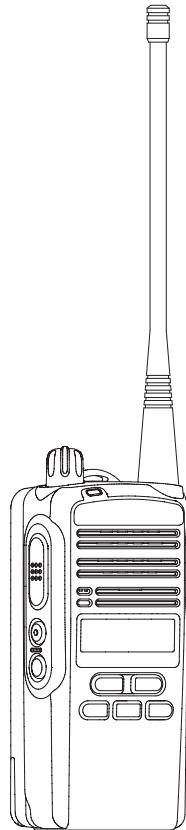
When disassembling and reassembling the radio, it is important to pay particular attention to the snaps and tabs, and how parts align with each other.

The following tools are required for disassembling and reassembling the radio (see Chapter 3 for a list of service aids):

- Phillips Screwdriver
- Flat Head Screwdriver
- Torque Driver
- Crab Eye Nut Opener (PMDN4039\_R)
- Chassis and Knob Opener (PMDN4038\_R)
- Tweezers

If a unit requires further testing or service than is customarily performed at the basic level, please send the unit to a Motorola Authorized Service Center listed in Appendix B.

**Note:** • Numbers in parentheses ( ) refer to item numbers in Figure 7-19, on page 7-14.

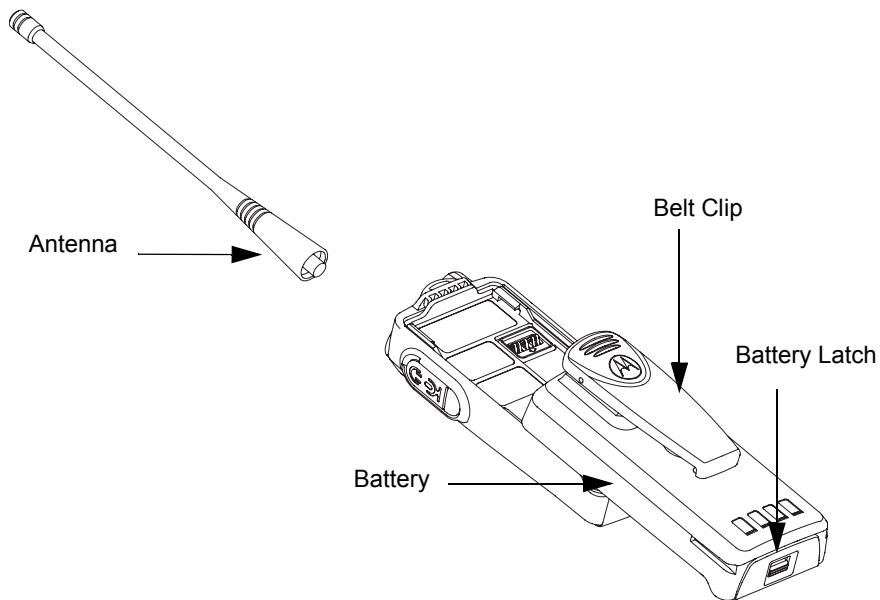


*Figure 7-1. Limited Keypad Without Channel Knob Model*

## 7.4.1 Radio Disassembly – Detailed

### 7.4.1.1 Front Housing From Chassis Disassembly

1. Turn off the radio.
2. Remove the Battery (30):
  - a. Release the battery latch by moving it into the unlock position.
  - b. Slide the Battery downwards.
  - c. Remove the Battery from the radio



*Figure 7-2. Battery and Antenna Removal*

3. Remove the Antenna (21) by turning it counterclockwise.

4. Remove the Volume Knob (7) from its shaft using the Chassis and Knob Opener. (Refer Figure 7-3.)

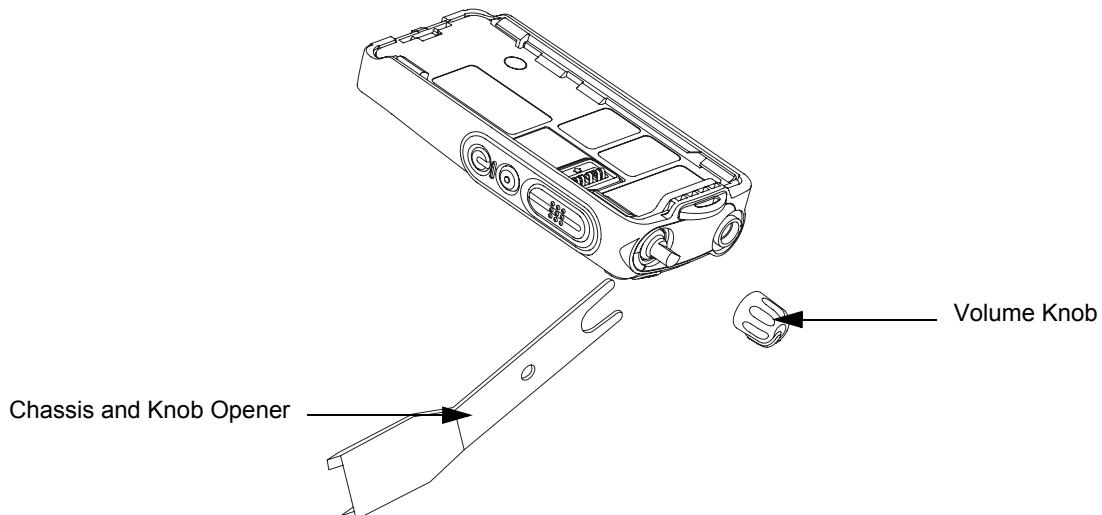


Figure 7-3. Knob Removal

**Note:** The Volume Knob can be turned clockwise and counterclockwise. However, it is designed to fit very tightly on the shaft.

5. Separate the Chassis (26) from the Front Housing Assembly (1):

- a. Insert the Chassis and Knob Opener in between the thin retaining wall and the chassis at the bottom of the radio. Do not mar the O-ring sealing area on the housing.
- b. Slowly pry the bottom of the chassis from the housing by pushing the Chassis and Knob Opener downwards, and prying the handle of the tool over and behind the base of the radio. This forces the thin inner plastic wall toward the base of the radio thus releasing the two chassis base tabs. (Refer Figure 7-4).

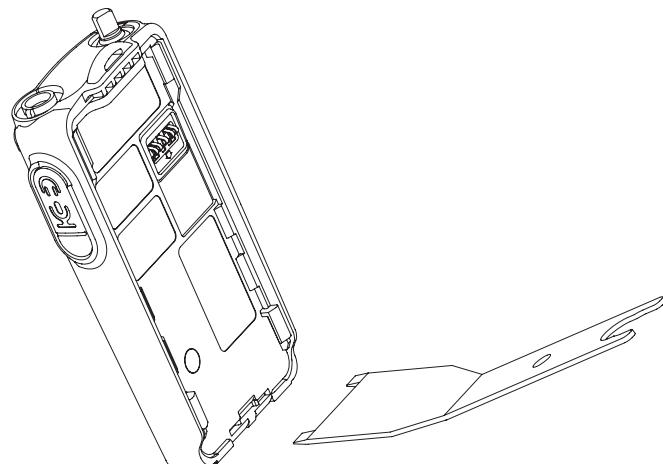


Figure 7-4. Chassis Removal



**CAUTION:** Marring the front cover O-ring sealing area will prevent the radio from sealing properly. If the O-ring (23) is damaged, replace it with a new one.

Caution

- c. Slide the rear chassis downwards, and away from the front housing. Be careful not to damage the Flexible Cable (38) and speaker wire underneath. (Refer Figure 7-5).

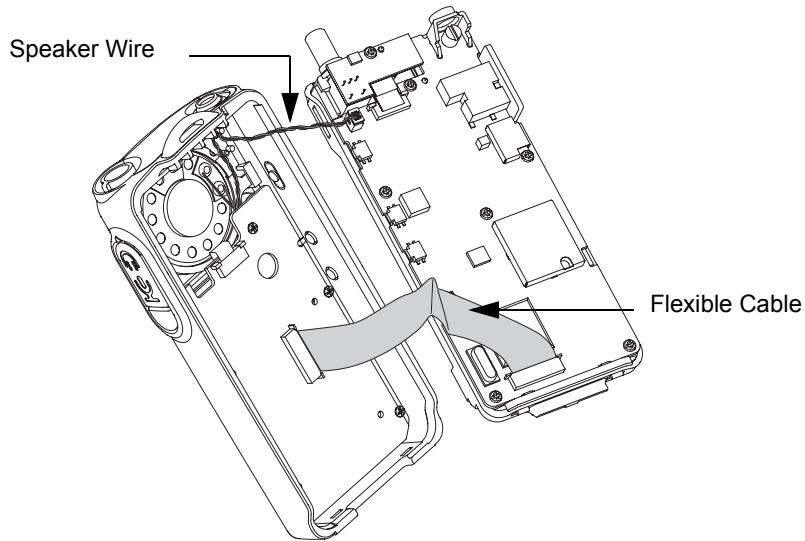


Figure 7-5. Speaker Wire and Flexible Cable Connection

**Note:** The speaker wire and flexible cable connector connecting the Front Housing Assembly (1) and the Chassis (26) prevent the two units from being completely separated

- d. Remove the speaker wire connector connecting the main circuit board and the internal speaker on the front housing with the tweezers. (Refer Figure 7-6).

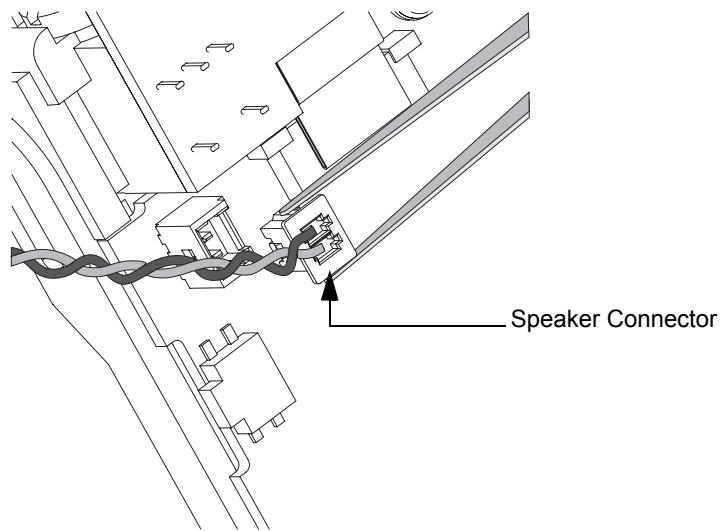
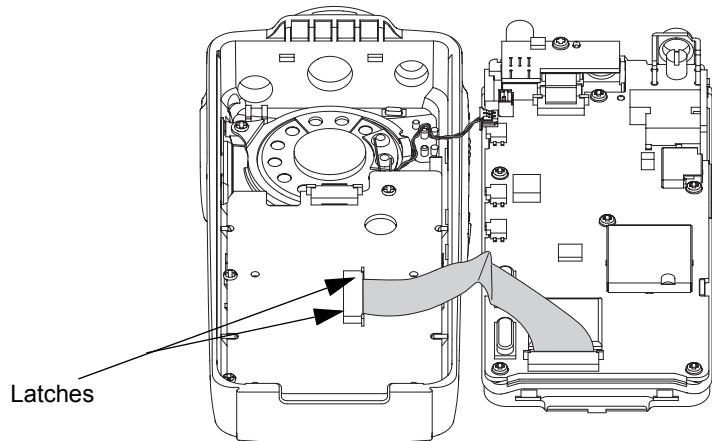


Figure 7-6. Speaker Wire Removal

- e. Lay the front housing down. Rotate the chassis sideways from the Front Housing Assembly (1) and lay it down.

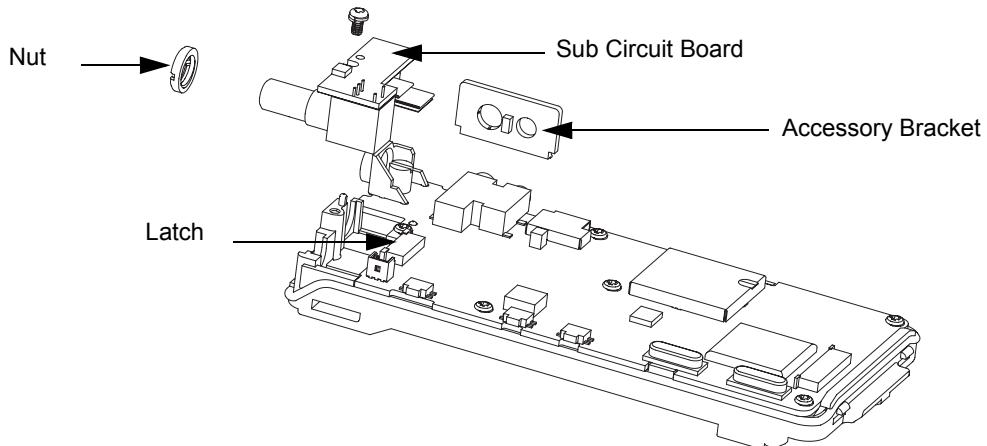
- f. Push the latches on the Front Circuit Board (40) sideways to the right to release the flexible cable from the connector. (Refer Figure 7-7).



*Figure 7-7. Unlatch the Flexible Cable*

#### 7.4.1.2 Chassis Assembly Disassembly

1. Remove the Accessory Bracket (34).
2. Remove the nut (16) on the On Off Volume Knob Shaft with the Crab Eye Nut Opener.
3. Remove the screw holding the Sub Circuit Board (15) to the Chassis (26) with a Phillips screwdriver.
4. Push the latches on the Main Circuit Board (18) to release the Flexible Cable (38) from the connector.
5. Remove the Sub Circuit Board from the Chassis. (Refer Figure 7-8).



*Figure 7-8. Sub-Circuit Board and Accessory Bracket Removal*

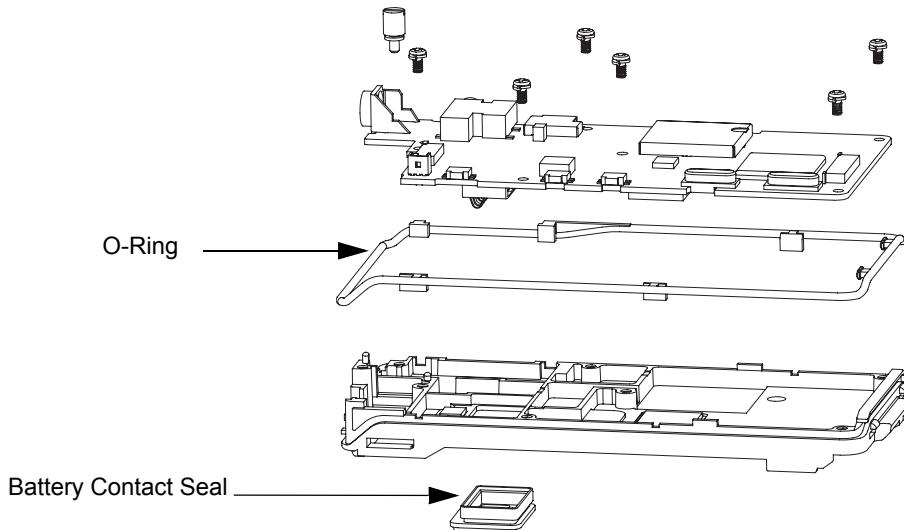
6. Remove the six screws (36) holding the Main Circuit Board to the Chassis with a Phillips screwdriver. Remove the RF Support Screw (19) with a flat head screwdriver.

7. Remove the Main Circuit Board from the Chassis.



**CAUTION: Refer to the CMOS CAUTION paragraph under Section 7.3 before removing the main board. Be sure to use ESD protection when handling the circuit boards.**

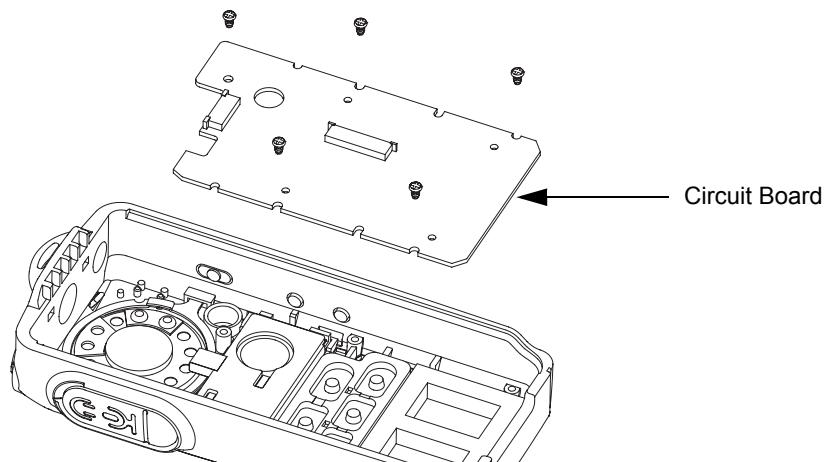
8. Remove the seven small O-ring retainers from their slots in the Chassis. Note the alignment of the retainers for reassembly.
9. Remove O-ring (23) and the Battery Contact Seal (27). (Refer Figure 7-9).



*Figure 7-9. Main Circuit Board, O-ring and Battery Contact Seal Removal*

#### 7.4.1.3 Front Circuit Board, Display Module and Keypad Disassembly

1. Push the latches on the Front Circuit Board (40) to release the Liquid Crystal Display (LCD) flexible cable from the connector.
2. Remove the five screws holding the Front Circuit Board to the front housing with a Phillips screwdriver.
3. Remove the Front Circuit Board from the Front Housing. (Refer Figure 7-10).



*Figure 7-10. Front Circuit Board Removal*

4. Remove the LCD (37) (38), Poron Pad (43) and Keypad (42) from the Front Housing.  
(Refer Figure 7-11).

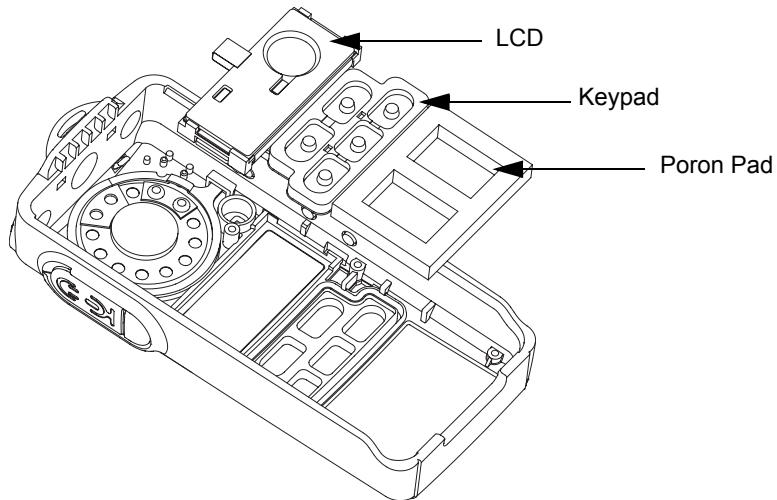


Figure 7-11. LCD and Keypad Removal

**Note:** The poron pad will be damaged during disassembly. A new poron pad is needed for reassembly.

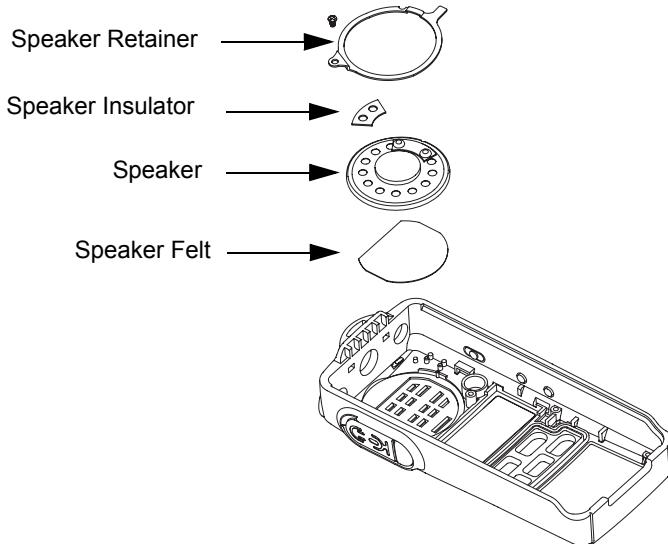
#### 7.4.1.4 Speaker Disassembly

1. Remove the screw holding the Speaker Retainer (10) to the Front Housing with a Phillips screwdriver.
2. Remove the Speaker Retainer from the Housing.

**Note:** Be careful not to damage the Speaker Wire when removing the Retainer Bracket.

3. Remove the Speaker from the Housing with a flat head screwdriver.
4. Remove the Speaker Insulator (11) from the speaker.

5. Remove the Speaker Felt (8) from the grille area (Refer Figure 7-12).

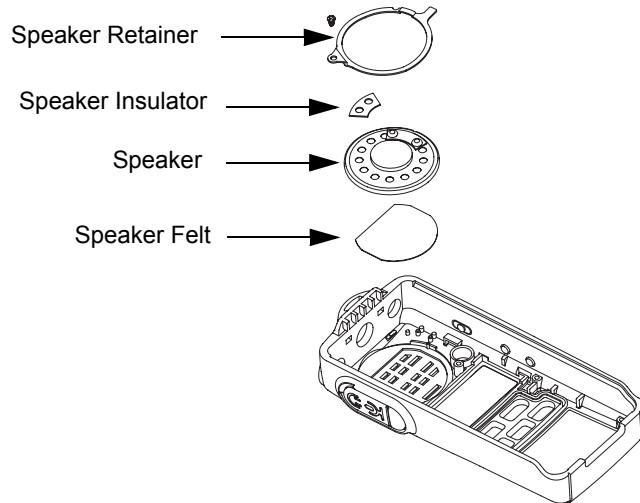


*Figure 7-12. Speaker Removal*

## 7.4.2 Radio Reassembly – Detailed

### 7.4.2.1 Speaker Reassembly

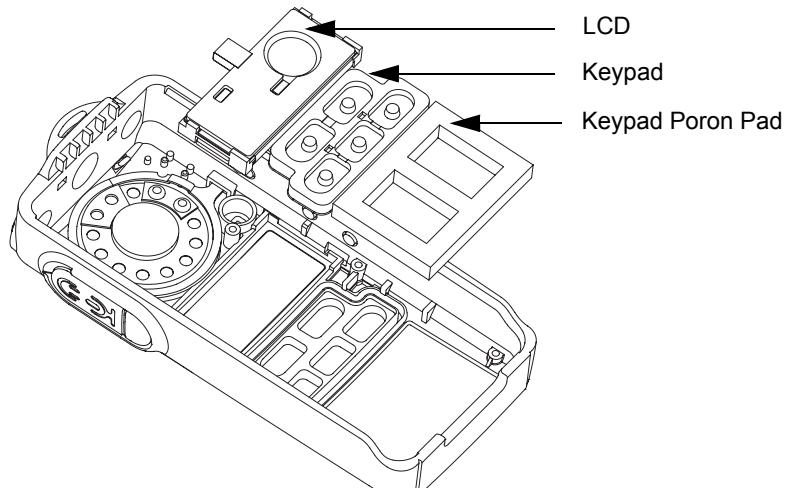
1. Place the Speaker Felt (8) onto the grille area.
2. Align the speaker wire at three o'clock position and push down the speaker until fully adhere onto the front housing.
3. Align the Speaker Insulator (11) at twelve o'clock position and push down until fully adhere onto the speaker.
4. Install the Speaker Retainer (10).
5. Tighten the Speaker Retainer to the housing with a Phillips screwdriver torque to 1.0 kgf – 1.2 kgf. (Refer Table 7-1 on page 7-14 for torque in other units)



*Figure 7-13. Speaker Reassembly*

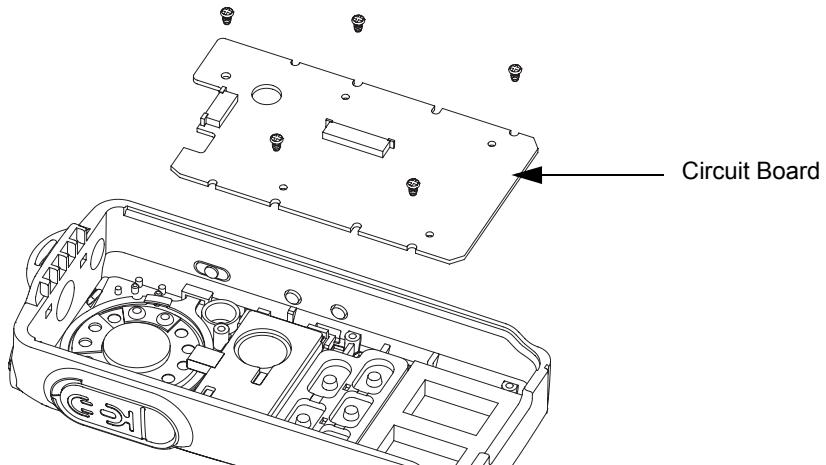
#### 7.4.2.2 Front Circuit Board, Display Module and Keypad Reassembly

1. Place and align the LCD (37) onto the front housing.
2. Place and align the Keypad (42) onto the keypad slot. Apply force around the keypad and ensure the keypad sealing rib is perfectly seated onto the keypad slot. (Refer Figure 7-14).



*Figure 7-14. LCD and Keypad Reassembly*

3. Place the Front Circuit Board (40) straight down on top of the LCD and keypad. Align the front circuit board to the four housing ribs. Press the top right edge of the front circuit board to ensure the microphone sealing rubber is fully seated in place.
4. Tighten the five screws holding the front circuit board with a Phillips screwdriver torque to 1.2 kgf – 1.5 kgf. (Refer Table 7-1 on page 7-14 for torque in other units).



*Figure 7-15. Front Circuit Board Reassembly*

5. Insert the LCD flexible cable into the connector on the front circuit board.
6. Push the latches into the connectors.

#### 7.4.2.3 Chassis Assembly Reassembly

1. Fit the Battery Contact Seal (27) onto the battery contact slot.
2. Fit the main O-ring (23) onto the chassis as follow:

- a. Ensure that the main O-ring is not twisted. Untangle to original form if necessary.
  - b. Secure **A** into the bottom two notches on the chassis. (Refer Figure 7-16).
  - c. Fit the bottom section of the main O-ring around the bottom two grooves.
  - d. Insert **B** into the top two catches on the chassis.
  - e. Fit the top section of the main O-ring around the top two corners of the chassis.
  - f. Secure **C** into the remaining three notches on the chassis.
3. Place the main circuit board straight down on top of the chassis.
- Note:** Make sure the battery contact seal protrudes through the chassis and is not squeezed under the chassis. Ensure the O-ring is also not squeezed under main circuit board.
4. Tighten the six screws holding the main circuit board with a Phillips screwdriver torque to 2.2 kgf – 2.5 kgf. (Refer Table 7-1 on page 7-14 for torque in other units).
  5. Tighten the RF Support Screw (19) with a flat head screw torque to 2.2 kgf – 2.5 kgf. (Refer Table 7-1 on page 7-14 for torque in other units).

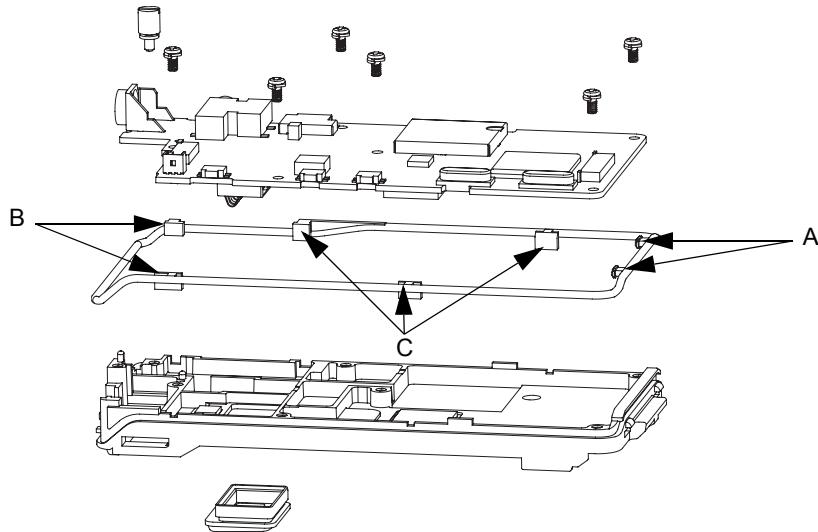


Figure 7-16. Main Circuit Board, O-ring and Battery Contact Seal Reassembly

6. Insert the Sub Circuit Board Flexible Cable (14) into the respective connectors at the top of the main circuit board.
7. Push the latches into the connectors.
8. Place the sub circuit board straight down on top of the chassis.
9. Tighten the screw that is holding the sub circuit with a Phillips screwdriver torque to 2.2 kgf – 2.5 kgf. (Refer Table 7-1 on page 7-14 for torque in other units).
10. Tighten the nut on the On/Off Volume Knob Shaft with the Crab Eye Nut Opener.

11. Align and Insert the Accessory Bracket (34) into the audio jack hole. (Refer Figure 7-17).

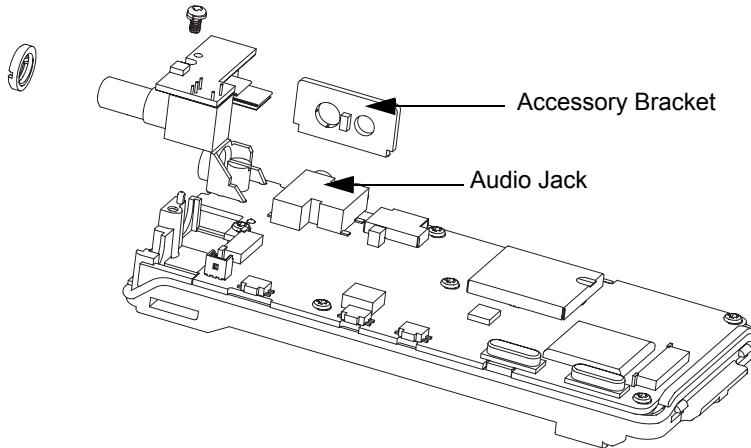


Figure 7-17. Sub Circuit Board and Accessory Bracket Reassembly

#### 7.4.2.4 Chassis and Front Housing Reassembly

1. Assembly the Chassis Assembly to the Front Housing Assembly (1) as follow:
  - a. Lay the Chassis Assembly beside to the Front Housing Assembly.
  - b. Insert the Flexible Cable (38) from the main circuit board into the connector on the front circuit board.
  - c. Push the latches into the Front Housing Assembly.
  - d. Connect the speaker wire to the connector.
2. Slide the On/Off Volume Knob Shaft into the respective holes in the front cover.
3. Insert top chassis tabs into the recesses on the front cover and apply some force until the tabs are fully inserted.
4. Be sure the O-ring (23) is properly seated so that the radio is properly sealed.
5. Snap the bottom of the chassis into the front housing.
6. Reassemble the Knob (7), Dust Cover (41), Antenna (21), and Battery (30). (Refer Figure 7-18).

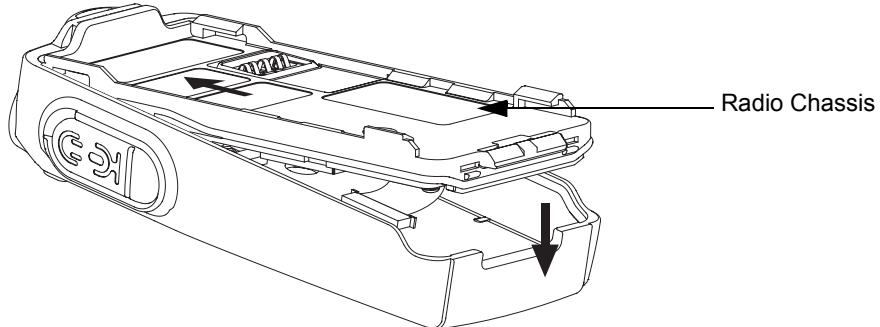


Figure 7-18. Chassis Assembly and Front Housing Assembly Reassembly

## 7.5 Torque List

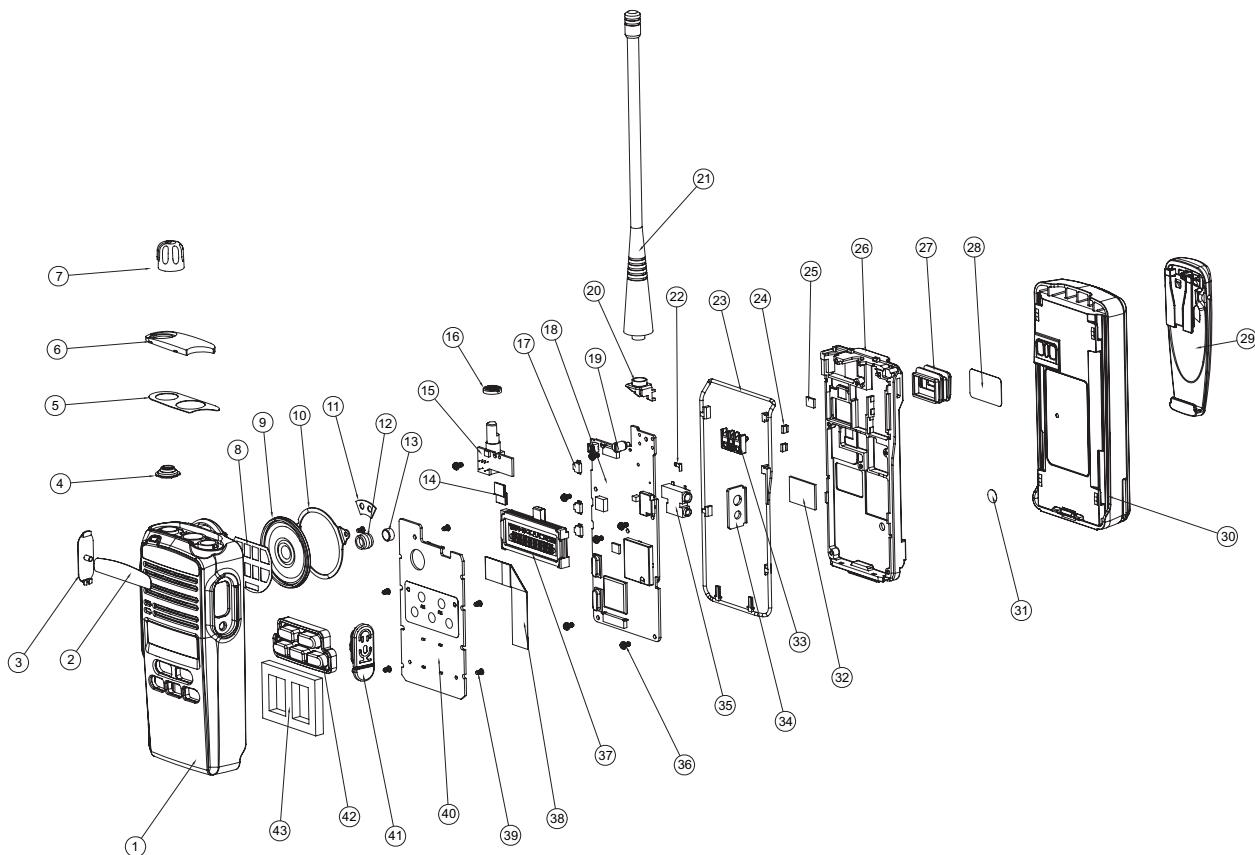
Table 7-1 lists the various screws by part number and description, followed by the torque values in different units of measure. Torque all screws to the recommended value when assembling the radio.

*Table 7-1. Torque Chart*

Part Number	Description	Quantity	Torque		
			N-m	lb-in	kgf-cm
PMDN4099_R	Retainer, Speaker, with screw	1	0.11±0.01	0.95±0.09	1.10±0.10
PMDN4119_R	Screw, Tapping	5	0.13±0.01	1.17±0.13	1.35±0.15
PMDN4107_R	Screw, Machine	7	0.23±0.01	2.04±0.13	2.35±0.15
PMDN4114_R	Screw, RF Support	1	0.23±0.01	2.04±0.13	2.35±0.15

## 7.6 Mechanical View and Parts List

### 7.6.1 CP476/CP477/CP1300 Exploded View and Parts List



*Figure 7-19. CP476/CP477/CP1300 – Exploded View*

Item	Motorola Kit Number	Description	Quantity
1	PMDN4097_R	Front Housing, Limited Keypad	1
2	PMDN4092_R PMDN4091_R PMDN4095_R	Name Plate (CP476) Name Plate (CP477) Name Plate (CP1300)	1
3	PMDN4124_R	Double Molded Cover, PTT	1
4	PMDN4090_R	Seal, Volume Knob	1
5	PMDN4088_R	Adhesive, Top Control	1
6	PMDN4104_R	Escutcheon, Top without Channel knob	1
7	PMDN4102_R	Knob, Volume	1
8	PMDN4100_R	Felt, Speaker	1
9	PMDN4067_R	Speaker	1
10	PMDN4099_R	Retainer, Speaker, with screw	1
11	PMDN4098_R	Insulator, Speaker	1
12	PMDN4135_R	Seal, Microphone	1
13	PMDN4139_R	Microphone	1
14	PMDN4111_R	Flexible Cable, Sub Circuit Board	1
15	PMDN4129_R	Sub Circuit Board, w/o Channel	1
16	PMDN4112_R	Crab-Eye Nut, Volume and Channel	1
17	PMDN4134_R	Switch, Tact	3
18*	PMDE4021_R PMDE4020_R PMDE4011_R PMDE4014_R PMDE4017_R	Main Circuit Board (CP476 – PMUE3140_AA) Main Circuit Board (CP477 – PMUE3141_AA) Main Circuit Board (CP1300 – PMUE3144_AK) Main Circuit Board (CP1300 – PMUE3144_AA) Main Circuit Board (CP1300 – PMUE3143_AA)	1
19	PMDN4114_R	Screw, RF Support	1
20	PMDN4138_R	Bracket, Antenna	1
21	See Appendix A	Antenna	1
22	PMDN4137_R	Finger Strip, PCB	1
23	PMDN4116_R	O-ring	1
24	PMDN4120_R	Finger Strip, Chassis	2
25	PMDN4121_R	Pad, Thermal	1
26	PMDN4122_R	Chassis	1
27	PMDN4105_R	Seal, Battery Contact	1
28	PMDN4110_R	Label, Caution	1
29	See Appendix A	Belt Clip	1
30	See Appendix A	Battery	1
31	PMDN4028_R	Tuning Hole Sticker (Small)	1
32	PMDN4106_R	Gel Pad, Ceramic Filter	1
33	0915184H01	Contact, Battery	1

Item	Motorola Kit Number	Description	Quantity
34	PMDN4108_R	Bracket, Accessory	1
35	0980683Z01	Jack, Audio	1
36	PMDN4107_R	Screw, Machine	7
37	PMDN4123_R	Module, Liquid Crystal Display	1
38	PMDN4109_R	Flexible Cable, Main Circuit Board	1
39	PMDN4119_R	Screw, Tapping	5
40‡	PMDN4131_R	Front Circuit Board, LKP	1
41	PMDN4113_R	Cover, Dust	1
42	PMDN4118_R	Keypad, Limited Keypad	1
43	PMDN4117_R	Pad, Poron	1

**Note:**

\*This kit consists of tact switch, antenna bracket, PCB finger strip, battery contact and audio jack.

‡This kit consists of microphone and microphone seal.

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# Chapter 8 Troubleshooting Tables

## 8.1 Error Codes

The radio performs cursory tests to determine if its basic electronics and software are in working order, during start-up and during operations. Problems detected during these tests are presented as error codes on the radio display. The presence of an error code should prompt the user that a problem exists and that a service technician should be contacted. Use Table 8-1 to aid in understanding particular error code display.

*Table 8-1. Error Code Display*

Error Code	Possible Causes	Corrective Action
PLLError	PLL Unlock Error – Radio cannot receive or transmit on the programmed frequencies.	Reprogram codeplug with correct version and retest radio. If message reoccurs, replace main board or send radio to nearest Motorola Service Centre
FATALERR	Radio Fatal Error – Codeplug is corrupted.	Reprogram codeplug with correct version and retest radio. If message reoccurs, replace main board or send radio to nearest Motorola Service Centre.
SLFTFAIL	Self Test Fail – Radio failed to initialize during start-up.	Retest the radio by turning it off then on again. If message reoccurs, replace main board or send radio to nearest Motorola Service Centre.
ERROR	Clone Error – Cloning between source and destination radios failed.	Check the connection between source and destination radios. Make sure follow the correct cloning procedures. If message reoccurs, send radio to nearest Motorola Service Centre.
TIME OUT	Time Out Error – No communication between source and destination radios during cloning.	Check the connection between source and destination radios. Make sure follow the correct cloning procedures. If message reoccurs, send radio to nearest Motorola Service Centre.
CS ERROR	Checksum Error	Reprogram codeplug.
TYPE ERR	Mismatch Radio Type Error – Different source and destination radio models.	Retest by connecting same source and destination radio model.
COMM ERR	Communication Error – Cloning between source and destination radios failed.	Check the connection between source and destination radios. Make sure follow the correct cloning procedures. If message reoccurs, send radio to nearest Motorola Service Centre.
No Display	Display module is not connected properly. Display module is damaged.	Check the connection between main board and display module. Replace with new display module.

## 8.2 Troubleshooting Table for Receiver

Table 8-2 lists the possible causes of, and corrections for, receiver problems.

*Table 8-2. Receiver Troubleshooting Table*

Symptom	Possible Causes	Corrective or Test (Measurements at Room Temperature)
Radio Dead; Display Does Not Turn On	1. Dead Battery.	Replace with charged battery.
	2. Blown Fuse	Send radio to nearest Motorola Service Centre.
	3. On/Off Switch	
	4. Regulators	
	5. Regulator fault	
Radio Dead; Display Turns On	Transceiver Board	Send radio to nearest Motorola Service Centre.
No Receive Audio, or Receiver Does Not Unmute	Programming	<p>1. Does the transmitted signal match the receiver configuration (PL, DPL, etc.)?</p> <p>2. With the monitor function enabled, can the radio be unmuted?</p>
Audio Distorted or Not Loud Enough	Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign it off by more than $\pm 150$ Hz (VHF), $\pm 500$ Hz (UHF)
RF Sensitivity Poor	1. Synthesizer Not on Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign it off by more than $\pm 150$ Hz (VHF), $\pm 500$ Hz (UHF)
	2. Antenna Switch/Connector	Send radio to nearest Motorola Service Centre.
	3. Receiver Front End Tuning	Check RF front-end tuning for optimum sensitivity using the tuner.
Radio Will Not Turn Off	Transceiver Board	Send radio to nearest Motorola Service Centre.

## 8.3 Troubleshooting Table for Transmitter

Table 8-3 lists the possible causes of, and corrections for, transmitter problems.

*Table 8-3. Transmitter Troubleshooting Table*

Symptom	Possible Causes	Corrective or Test (Measurements at Room Temperature)
No RF Power Out	1. Tx Power Level or Frequency	Check Tx power level and frequency programming (from tuner).
	2. No Injection To Power Amplifier	Send radio to nearest Motorola Service Centre.
	Antenna Switch/Connector	
No Modulation; Distortion Modulation	1. Programming	Check deviation and compensation settings using the tuner.
	2. Transceiver Board	Send radio to nearest Motorola Service Centre.
Bad Microphone Sensitivity	1. Check Deviation and Compensation	Realign if necessary.
	2. Microphone	Send radio to nearest Motorola Service Centre.
No/Low Signaling (PL, DPL, MDC)	1. Programming	Check programming.
	2. Transceiver Board	Send radio to nearest Motorola Service Centre.
Cannot Set Deviation Balance	Transceiver Board	Send radio to nearest Motorola Service Centre.

**Notes**

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## Appendix A    Accessories

### Antennas

#### VHF

HAD9338_R	VHF Heliflex Antenna (136 – 162 MHz)
HAD9742_	VHF Stubby Antenna, 9cm (146 – 162 MHz)
HAD9743_	VHF Stubby Antenna, 9cm (162 – 174 MHz)
NAD6502_R	VHF Heliflex Antenna (146 – 174 Mhz)
NAD6579_	VHF Whip Antenna (148 – 161 MHz)
PMAD4012_	VHF Stubby Antenna, 9cm (136 – 155 MHz)
PMAD4013_	VHF Stubby Antenna, 9cm (155 – 174 MHz)
PMAD4014_	VHF Antenna, 14cm (136 – 155 MHz)
PMAD4015_	VHF Antenna, 14cm (55 – 174 MHz)
PMAD4049_	VHF Helical Antenna (146 – 174 MHz)

#### UHF

NAE6483_R	UHF Whip Antenna, 16.5 cm (403 – 520 MHz)
PMAE4002_	UHF Stubby Antenna, 9 cm (403 – 433 MHz)
PMAE4003_	UHF Stubby Antenna, 9 cm (430 – 470 MHz)
PMAE4006_	UHF Antenna, 9 cm (465 – 495 MHz)
PMAE4007_	UHF Antenna, 9 cm (490 – 527 MHz)
PMAE4008_	UHF Whip Antenna,13 cm (470 – 530 MHz)
PMAE4014_	UHF Whip Antenna, 19 cm (403 – 425 MHz)
PMAE4016_	UHF Whip Antenna (403 – 520 MHz)

### Audio Accessories

AARLN4885_	Receive Only Earbud for Remote Speaker Microphone Only 3.5 mm Adapter
HMN9013_	Lightweight Single Muff Adjustable Headset with Swivel Boom Microphone
HMN9754_	2-Wire Surveillance Kit, with Microphone and PTT Combined, Beige
PMMN4008_	Remote Speaker Microphone (MagOne)
PMMN4013_	Remote Speaker Microphone with Ear Jack
PMMN4029_	Remote Speaker Microphone
PMLN4442_	Earbud with In-Line Microphone / PTT / VOX Switch (MagOne)
PMLN4443_	Ear Receiver with In-Line Microphone / PTT / VOX Switch (MagOne)
PMLN4444_	Earset with Boom Microphone and In-Line PTT/VOX Switch (MagOne)
PMLN4445_	Ultra-Light Headset with Boom Microphone and In-Line PTT/VOX Switch (MagOne)
PMLN4620_	D-Shell Earpiece (Remote Speaker Microphone Only) 3.5 mm Adapter
PMLN5001_	D-Style Earpiece with Microphone / PTT

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PMLN5003_	Retail Temple Transducer Headset
RLN4941_	Earpiece Receive Only with Translucent Tube
RLN6230_	High Noise Kit, Black (Includes Foam Earplugs with Acoustic Tube)
RLN6231_	High Noise Kit, Beige (Includes Foam Earplugs with Acoustic Tube)
RLN6232_	Low Noise Kit, Black (Includes Rubber Tips with Acoustic Tube)
RLN6241_	Low Noise Kit, Beige (Includes Rubber Tips with Acoustic Tube)
RLN6242_	Quick Disconnect Acoustic Tube
WADN4190_	Ear Receiver with Coil Cable (Remote Speaker Microphone Only) 3.5 mm Adapter

## Batteries

PMNN4080_R	Li-Ion High Capacity, 2150 mAH
PMNN4081_R	Li-Ion, 1500 mAH
PMNN4082_R	NiMH, 1300 mAH

## Belt Clip

HLN9844_	Spring Action Belt Clip, 2 inch
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## Carrying Accessories

PMLN5333_	Soft Leather Protective Case, FKP
PMLN5334_	Soft Leather Protective Case, LKP

## Chargers And Power Adapters

2571586S02	220 – 240 V, 10.8 W linear power supply with UK plug
2571586S03	220 – 240 V, 10.8 W linear power supply with EU plug
2571586S10	220 – 240 V, 10.8 W linear power supply with China plug
2571586S14	110 V 10.8 W linear power supply with US 2-pin plug
2571586S17	220 – 240 V, 10.8 W linear power supply with Korea plug
EPNN9286_	190 – 264 V switch mode power supply with EU plug
EPNN9294_	190 – 264 V switch mode power supply with Australia/ New Zealand plug
PMLN5228_	Tri-Chem Single Unit Charger base
PMLN5393_	Single Unit Charger kit with Korea 2-pin plug linear power supply
PMLN5394_	Single Unit Charger kit with UK 3-pin plug linear power supply
PMLN5395_	Single Unit Charger kit with Australia / New Zealand 2-pin plug switch mode power supply
PMLN5396_	Single Unit Charger kit with EU 2-pin plug linear power supply
PMLN5397_	Single Unit Charger kit with EU 2-pin plug switch mode power supply
PMLN5400_	Single Unit Charger kit with China 2-pin plug linear power supply
PMLN5406_	Single Unit Charger kit with US 2-pin plug linear power supply

**Note:** Certain accessories may not be available at the time of publication. For latest information on accessories, visit: <http://www.motorola.com/governmentandenterprise>.

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## **Appendix B      Warranty, Service Support, and Replacement Parts**

### **B.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 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 Product Safety and RF Exposure Compliance section in the front of this manual.

### **B.2    Warranty**

**Note:** Only Motorola Service Centers or Approved Motorola Service Dealers can perform these functions. Any tampering by non-authorized Motorola Service Centers voids the warranty of your radio. To find out more about Motorola and its approved Service Centers, please visit <http://www.motorola.com/businessandgovernment/public/functions/home/home.aspx>

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 authorized Motorola Dealer must be accompanied by a Warranty Claim Form. Warranty Claim Forms are obtained by contacting an Authorized Motorola Dealer.

#### **B.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 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.

#### **B.2.2    After Warranty Period**

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

1. Motorola's Managed Technical Services (MTS) offers a repair service to both end users and dealers at competitive prices.
2. MTS supplies individual parts and modules that can be purchased by dealers who are technically capable of performing fault analysis and repair.

### B.2.3 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's Managed Technical Services (MTS). 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 orders for parts/information should include the complete Motorola identification number. Request for help in identification of non-referenced spare parts should be directed to the Motorola's local area representation. 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. Orders for replacement parts which are listed in the "Parts List" section of this manual, should be placed directly on Motorola's local distribution organization or via Motorola Online (Extranet).

### B.2.4 Technical Support

Technical support is available to assist the dealer/distributor in resolving any malfunction which may be encountered. Initial contact should be by telephone wherever possible. When contacting Motorola Technical Support, be prepared to provide the product model number and the unit's serial number.

### B.2.5 Further Assistance From Motorola

You can also contact the Customer Help Desk through the following web address.

<http://www.motorola.com/governmentandenterprise>

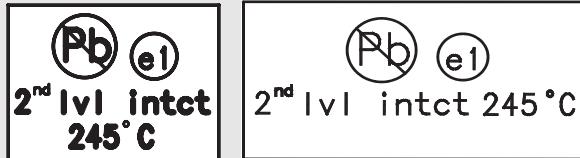
**Note:** Only Motorola Service Centers or Approved Motorola Service Dealers can perform these functions. Any tampering by non-authorized Motorola Service Centers voids the warranty of your radio. To find out more about Motorola and its approved Service Centers, please visit <http://www.motorola.com/businessandgovernment/public/functions/home/home.aspx>

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## Appendix C Repair Procedures and Techniques — General

**Note** Environmentally Preferred Products (EPP) (refer to the marking on the printed circuit boards - examples shown below) were developed and assembled using environmentally preferred components and solder assembly techniques that meet or exceed compliance to the European Union's ROHS and WEEE directives ([Waste Electrical and Electronic Equipment \(WEEE\) Directive 2002/96/EC](#) and [Restriction of Hazardous Substances \(ROHS\) Directive 2002/95/EC](#)). To maintain product compliance and reliability, use only the Motorola specified parts in this manual.

For the identification of lead (Pb) free assemblies, all EPP products will carry the EPP Marking, shown below, on the printed circuit board (PCB). This marking provides information to those performing assembly, servicing and recycling operation on this product, adhering to the JEDEC standard #97. The EPP Marking takes the form of a label or marking on the PCB.



Any rework or repair on Environmentally Preferred Products must be done using the appropriate lead-free solder wire and solder paste as stated in the following tables:

*Table C-1. Lead Free Solder Wire Part Number List*

Motorola Part Number	Alloy	Flux Type	Flux Content by Weight	Melting Point	Supplier Part number	Diameter	Weight
1088929Y01	95.5Sn/3.8Ag/0.7Cu	RMA Version	2.7-3.2%	217C	52171	0.015"	1lb spool

*Table C-2. Lead Free Solder Paste Part Number List*

Motorola Part Number	Manufacturer Part Number	Viscosity	Type	Composition & Percent Metal	Liquidus Temperature
10-856-74C03	NC-SMQ230	900-1000KCPs Brookfield(5rpm)	Type 3 (-325/+500)	95.5%Sn-3.8%Ag-0.7%Cu 89.3%	217 Degree C

### 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 Communications parts center listed in the "Piece Parts" section 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 connector pins:

- 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.

## Chip Components

Use the RLN4062 Hot-Air Repair Station for chip component replacement. Adjust the temperature control to 390 °C (735 °F), and adjust the airflow to a minimum setting. Airflow can vary due to component density.

- **To remove a chip component:**
  1. Use a hot-air hand piece and position the nozzle of the hand piece approximately 0.3 cm (1/8") above the component to be removed.
  2. Begin applying the hot air. Once the solder reflows, remove the component using a pair of tweezers.
  3. Using a solder wick and a soldering iron or a power desoldering station, remove the excess solder from the pads.
- **To replace a chip component using a soldering iron:**
  1. Select the appropriate micro-tipped soldering iron and apply fresh solder to one of the solder pads.
  2. Using a pair of tweezers, position the new chip component in place while heating the fresh solder.
  3. Once solder wicks onto the new component, remove the heat from the solder.
  4. Heat the remaining pad with the soldering iron and apply solder until it wicks to the component. If necessary, touch up the first side. All solder joints should be smooth and shiny.
- **To replace a chip component using hot air:**
  1. Use the hot-air hand piece and reflow the solder on the solder pads to smooth it.
  2. Apply a drop of solder paste flux to each pad.
  3. Using a pair of tweezers, position the new component in place.
  4. Position the hot-air hand piece approximately 0.3 cm (1/8") above the component and begin applying heat.
  5. Once the solder wicks to the component, remove the heat and inspect the repair. All joints should be smooth and shiny.

## Shields

Removing and replacing shields is recommended to be done with the Air Blower, BOSCH GHG 603 or equivalent.

- **To remove the shield:**
  1. Place the circuit board in the circuit board holder.
  2. Add solder paste flux around the base of the shield.

3. Position the heat-focus head onto the shield.
  4. Turn on the heater and wait until the shield lifts off the circuit board.
  5. Once the shield is off, turn off the heat, and grab the part with a pair of tweezers.
  6. Remove the circuit board from the circuit board holder.
- **To replace the shield:**
    1. Add solder to the shield if necessary, using a micro-tipped soldering iron.
    2. Next, rub the soldering iron tip along the edge of the shield to smooth out any excess solder. Use solder wick and a soldering iron to remove excess solder from the solder pads on the circuit board.
    3. Place the circuit board back in the circuit board holder.
    4. Place the shield on the circuit board using a pair of tweezers.
    5. Position the heat-focus head over the shield.
    6. Turn on the heater and wait for the solder to reflow.
    7. Once complete, turn off the heat, raise the heat-focus head and wait approximately one minute for the part to cool.
    8. Remove the circuit board and inspect the repair. No cleaning should be necessary.

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**Notes**

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## 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 Ratio).
ASFIC	Audio Signalling Filter Integrated Circuit
BKC	Bad Key Chirp
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
EPP	Environmental Preferred Product
Firmware	Software, or a software/hardware combination of computer programs and data, with a fixed logic configuration stores 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.
GKC	Good Key Chirp
ISW	Inbound Signalling Word: data transmitted on the control channel from a subscriber unit to the central control unit.
LH DATA	Longhorn Data: a bidirectional 0-5V, RS-232 line protocol 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.
MCU	Micro Controller Unit
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.
OMPAC	Over-Molded Pad-Array Carrier: a Motorola custom package, distinguished by the presence of solder balls on the bottom pads.
PC Board	Printed Circuit Board

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<b>Term</b>	<b>Definition</b>
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; 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.
RESET	Reset line: an input to the microcontroller that restarts execution.
RF PA	Radio Frequency Power Amplifier
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	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
TOT	Time-Out Timer: a timer that limits the length of a transmission.
TPL	Tone Private-line
µC	Microcontroller
µP	Microprocessor
UHF	Ultra High Frequency
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





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