



***CP185™***

***Portable Radios  
Basic Service Manual***



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| Disassembly Procedures   |          |            |         |           |       |           |               |                |                            |
| Alignment Procedures     |          |            |         |           |       |           |               |                |                            |
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# SAFETY

## Product Safety and RF Exposure Compliance



Caution

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 Quick Reference Card 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 Quick Reference Card enclosed with your radio (Motorola Publication part number 68007024011) 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/business>

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## DOCUMENT HISTORY

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

| <b>Edition</b> | <b>Description</b>                  | <b>Date</b> |
|----------------|-------------------------------------|-------------|
| 68007024004-A  | Initial edition                     | Oct. 2008   |
| 68007024004-B  | Added VHF 136 – 174 MHz information | Feb. 2009   |

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## Notes

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## Related Publications

### NAG

|                                                                          |             |
|--------------------------------------------------------------------------|-------------|
| CP185 Series Radios User Guide (English, French Canadian) .....          | 6878080A01  |
| CP185 Series Radios Quick Reference Card (English, French Canadian)..... | 68007024011 |
| CP185 Series Basic Service Manual.....                                   | 68007024004 |

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## 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.

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## Summary of Bands Available

Table below lists all the bands available in this manual. For details, please refer to the Model Charts section.

| Frequency Band | Bandwidth     | Power Level |
|----------------|---------------|-------------|
| UHF2           | 435 – 480 MHz | 2W or 4W    |
| VHF            | 136 – 174 MHz | 2W or 5W    |

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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:AAH03RDF8AA7AN)*

| Regional Prefix            | Type of Unit                  | Model Series                                  | Freq. Band                                                                   | Power Level                            | Physical Packages                            | Channel Spacing      | Protocol                            | Feature Level                                    | Version Letter | Unique Variation                      |
|----------------------------|-------------------------------|-----------------------------------------------|------------------------------------------------------------------------------|----------------------------------------|----------------------------------------------|----------------------|-------------------------------------|--------------------------------------------------|----------------|---------------------------------------|
| <b>AA</b><br>↑<br>AA = NAG | <b>H</b><br>↑<br>H = Portable | <b>03</b><br>↑<br>03 = CP Family Model Series | <b>R</b><br>UHF<br>(435 – 480 MHz)<br><br><b>K</b><br>VHF<br>(136 – 174 MHz) | <b>D</b><br>4 W<br><br><b>E</b><br>5 W | <b>F</b><br>Limited Keypad with Channel Knob | <b>8</b><br>12.5/25k | <b>AA</b><br>↑<br>AA = Conventional | <b>7</b><br>No Front Panel Prog. with Scrambling | <b>A</b>       | <b>N</b><br>↑<br>N = Standard Package |

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

| CP185, UHF2, 435 – 480 MHz |             |                                  |
|----------------------------|-------------|----------------------------------|
| Model                      |             | Description                      |
| AAH03RDF8AA7AN             |             | CP185 435 – 480M 4W 12.5/25K 16C |
|                            | Item        | Description                      |
| X                          | PMUE3139_   | CP185 435 – 480M 4W 12.5/25K 16C |
| X                          | PMDE4023_R  | 435 – 480M 4W PCB – PMUE3139_AN  |
| X                          | PMDN4131_R  | Front Circuit Board, LKP         |
| X                          | PMDN4128_R  | Sub Circuit Board, w Channel     |
| X                          | 68007024004 | Sub Circuit Board, w Channel     |

X = Indicates compatibility with model(s)

### 1.3 Model Chart for VHF, 136–174 MHz

| CP185, VHF, 136 – 174 MHz |             |                                     |
|---------------------------|-------------|-------------------------------------|
| Model                     |             | Description                         |
| AAH03KEF8AA7AN            |             | CP185 136 – 174M 5W 12.5/25K 16C    |
|                           | Item        | Description                         |
| X                         | PMUD2444_   | 136 – 174M 5W 12.5/25K 16CH         |
| X                         | PMDD4020_R  | 136 –174M 5W PCB – PMUD2444_AN      |
| X                         | PMDN4131_R  | Front Circuit Board, LKP            |
| X                         | PMDN4128_R  | Sub Circuit Board, w Channel        |
| X                         | 68007024004 | CP185 Series – Basic Service Manual |

X = Indicates compatibility with model(s)

## 1.4 UHF2 Specifications

### General

|                                                                                                     | UHF2                                                                       |         |         |
|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------|---------|
| Frequency:                                                                                          | 435 – 480 MHz                                                              |         |         |
| Channel Capacity:                                                                                   | 16 Channels                                                                |         |         |
| Power Supply:                                                                                       | 7.5 Volts $\pm$ 20%                                                        |         |         |
| Dimensions:<br>(H x W x D)<br>with<br>High Capacity Li-Ion<br>NiMH Std<br>Li-Ion Std<br>Batteries:  | 120 mm x 55 mm x 40.7 mm<br>120mm x 55mm x 36.5mm<br>120mm x 55mm x 35.5mm |         |         |
| Weight:<br>16 Channel Model<br>Batteries:<br>High Capacity Li-Ion<br>NiMH Std<br>Li-Ion Std         | 342.0g<br>394.5g<br>335.0g                                                 |         |         |
| Average Battery Life<br>@ (5-5-90 Duty<br>Cycle):<br>High Capacity Li-Ion<br>NiMH Std<br>Li-Ion Std | Capacity<br>(mAh)                                                          | 4 W     | 2 W     |
|                                                                                                     | 2150                                                                       | 12 Hrs. | 14 Hrs. |
|                                                                                                     | 1300                                                                       | 8 Hrs.  | 10 Hrs. |
|                                                                                                     | 1500                                                                       | 8 Hrs.  | 10 Hrs. |

### Self-Quieter Frequencies

| UHF2    |
|---------|
| 446.44  |
| 446.445 |
| 455.895 |
| 456.01  |
| 456.015 |
| 456.125 |
| 458.195 |
| 460     |
| 467.785 |
| 467.9   |
| 468.01  |
| 468.125 |
| 468.24  |
| 470     |
| 479.9   |

### Transmitter

|                                                                        | UHF2                               |             |
|------------------------------------------------------------------------|------------------------------------|-------------|
| RF Output<br>NiMH @ 7.5 V:                                             | Low<br>2 W                         | High<br>4 W |
| Frequency:                                                             | 435 – 480 MHz                      |             |
| Channel Spacing:                                                       | 12.5/25 kHz                        |             |
| Freq. Stability:<br>(-30°C to +60°C)                                   | 0.00025%                           |             |
| Spurs/Harmonics:                                                       | -36 dBm < 1 GHz<br>-30 dBm > 1 GHz |             |
| Audio Response:<br>(from 6 dB/oct.<br>Pre-emphasis, 300 to<br>3000 Hz) | +1, -3 dB                          |             |
| Audio Distortion:<br>@ 1000 Hz, 60%<br>Rated Max. Dev.                 | <5%                                |             |
| FM Noise:                                                              | <-40 dB                            |             |

### Receiver

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

All specifications are subject to change without notice.

## 1.5 VHF Specifications

### General

|                                                                                                     | VHF                                                                              |         |         |
|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------|---------|
| Frequency:                                                                                          | 136 – 174 MHz                                                                    |         |         |
| Channel Capacity:                                                                                   | 16 Channels                                                                      |         |         |
| Power Supply:                                                                                       | 7.5 Volts $\pm 20\%$                                                             |         |         |
| Dimensions:<br>(H x W x D)<br>with<br>High Capacity Li-Ion<br>NiMH Std<br>Li-Ion Std<br>Batteries:  | 120 mm x 55 mm x 40.7 mm<br>120 mm x 55 mm x 36.5 mm<br>120 mm x 55 mm x 35.5 mm |         |         |
| Weight:<br>model with Battery:<br>High Capacity Li-Ion<br>NiMH Std<br>Li-Ion Std                    | 342.0g<br>394.5g<br>335.0g                                                       |         |         |
| Average Battery Life<br>@ (5-5-90 Duty<br>Cycle):<br>High Capacity Li-Ion<br>NiMH Std<br>Li-Ion Std | Capacity<br>(mAh)                                                                | 5 W     | 2 W     |
|                                                                                                     | 2150                                                                             | 12 Hrs. | 14 Hrs. |
|                                                                                                     | 1300                                                                             | 8 Hrs.  | 10 Hrs. |
|                                                                                                     | 1500                                                                             | 8 Hrs.  | 10 Hrs. |

### Self-Quieten Frequencies

| VHF     |
|---------|
| 140     |
| 155.01  |
| 155.02  |
| 155.03  |
| 155.015 |
| 155.17  |
| 155.18  |
| 155.175 |
| 155.505 |
| 159.995 |
| 160     |
| 160.005 |
| 161.45  |
| 167.025 |
| 167.03  |
| 169.995 |
| 170     |
| 170.005 |
| 173.985 |
| 173.99  |

### Transmitter

|                                                                        | VHF                                |             |
|------------------------------------------------------------------------|------------------------------------|-------------|
| RF Output<br>NiMH @ 7.5 V:                                             | Low<br>2 W                         | High<br>5 W |
| Frequency:                                                             | 136 – 174 MHz                      |             |
| Channel Spacing:                                                       | 12.5/25 kHz                        |             |
| Freq. Stability:<br>(-30°C to +60°C)                                   | 0.00025%                           |             |
| Spurs/Harmonics:                                                       | -36 dBm < 1 GHz<br>-30 dBm > 1 GHz |             |
| Audio Response:<br>(from 6 dB/oct.<br>Pre-emphasis, 300 to<br>3000 Hz) | +1, -3 dB                          |             |
| Audio Distortion:<br>@ 1000 Hz, 60%<br>Rated Max. Dev.                 | <5%                                |             |
| FM Noise:                                                              | >-40 dB                            |             |

### Receiver

|                                      | VHF<br>12.5 kHz        | VHF<br>25 kHz |
|--------------------------------------|------------------------|---------------|
| Frequency:                           | 136 – 174 MHz          |               |
| Sensitivity<br>12 dB EIA SINAD:      | 0.25 $\mu$ V (typical) |               |
| Adjacent Channel<br>Selectivity:     | -65 dB                 | -70 dB        |
| Intermodulation:                     | -70 dB                 |               |
| Freq. Stability<br>(-30°C to +60°C): | 0.00025%               |               |
| Spur Rejection:                      | -70 dB                 |               |
| Image and 1/2 I-F<br>Rejection:      | -70 dB                 |               |
| Audio Output<br>@ <5% Distortion:    | 500 mW                 |               |

All specifications are subject to change without notice.

## 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 (PMDN4128AR) – Rotary Volume Knob and 16-channel Knob

#### 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 – 480 MHz.

VHF receiver design covers the frequency range of 136 – 174 MHz.

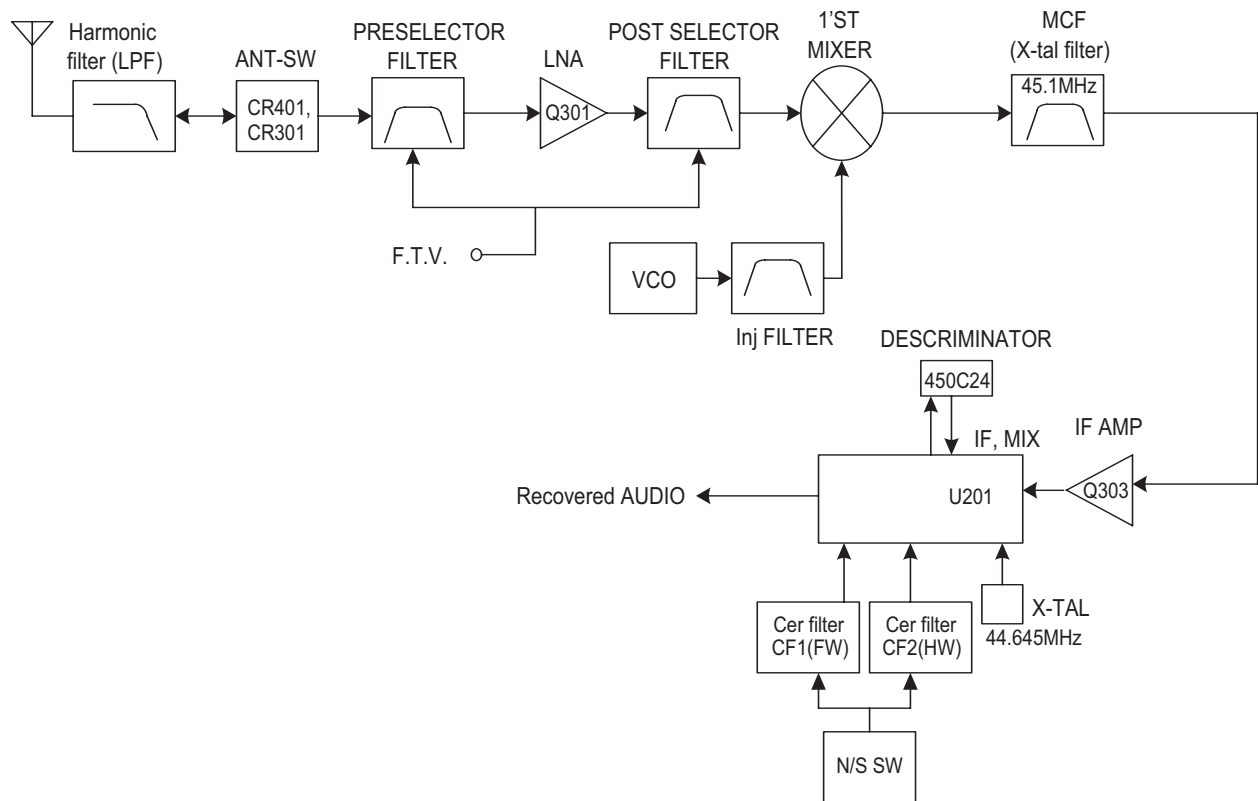


Figure 2-1. Receiver Block Diagram

### 2.2.1.1 RX Front End

**UHF2** : 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 13 dB 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.

**VHF** : Receiver Front-end consists of a low pass filter, a pre-selector filter, a low noise RF Amplifier, a Post-selector filter. Incoming RF signal from antenna is applied through the Harmonics Low Pass Filter (L409 – L411, C426 – C430, C445 – C446) and passes the transmit/receive switch (CR301) and a varactor-tuned 2-pole pre-selector filter (L301 – L304, C301, CR302, CR303, C304, C305, C307, C308) before routed to an RF amplifier (Q301). The pre-selector filter is a 6 step Band-shift filter, and the frequency shifting is controlled by variable capacitors diode's (CR302 & CR303) connected to the CPU. The filter output is coupled to a 13 dB RF amplifier Q301 which outputs the RF signal to the post-selector filter (L308, L309, L311, C315 and C354) which is also a band shift filter configured to provide steeper low-side attenuation. The 2 units of 6 step frequency variable capacitors (CR305, CR307) are also controlled by the CPU.

### 2.2.1.2 RX Back End

**UHF2** : 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 15 dB via an IF amp (Q303) and channeled to IF IC (U201) to be mixed thus producing the 2nd IF Frequency (455 kHz):

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

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.

**VHF** : 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, C326 and C333) to remove harmonics.

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

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

Depending on channel spacing, the 2nd IF frequency passes through wide (CF1) or narrow (CF2) filter 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 (UHF2: 4W, VHF: 5W).

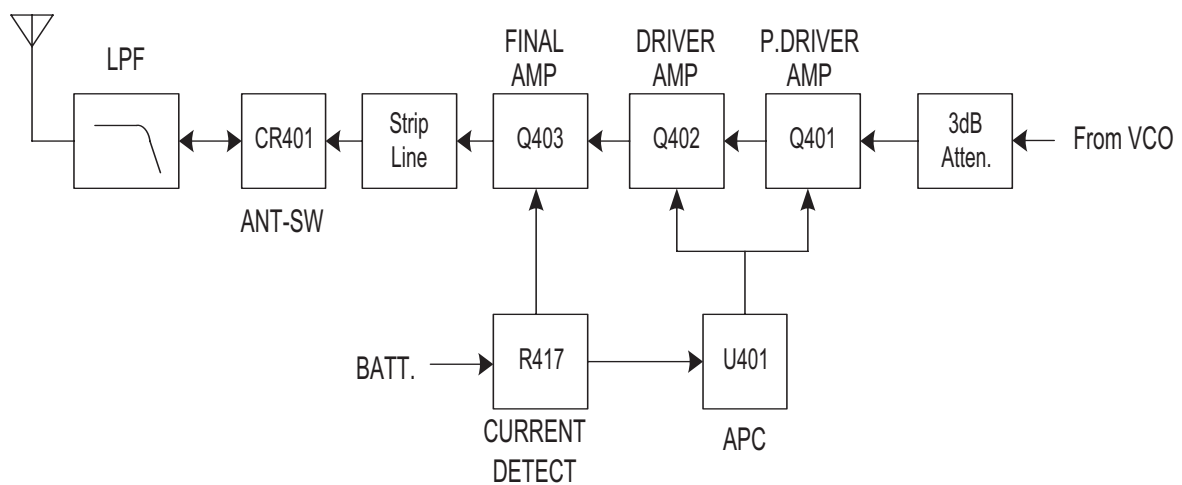


Figure 2-2. Transmitter Block Diagram

TX VCO output signal passes thru a 3 dB, 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 driver amplifier (Q402). The TX RF signal (UHF2 : -4 dBm, VHF : -3 dBm) from the attenuator is amplified to +25 dBm (UHF2) or +28 dBm (VHF) by the pre-driver and driver 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 (UHF2) or C417, C418, C420, C455 (VHF) 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.

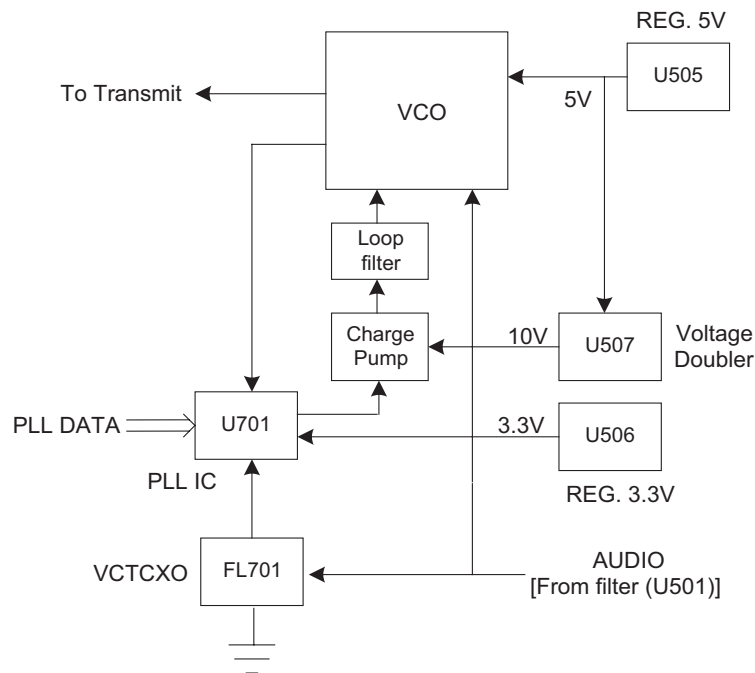


Figure 2-3. PLL Synthesizer Block Diagram

VCTCXO (Voltage Controlled Temperature Compensated crystal Oscillator) reference frequency (12.8 MHz) provides reference to PLL IC, with stability of  $\pm 2.5$ PPM at  $-30^{\circ}$  to  $+60^{\circ}$ 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 Collpits 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.

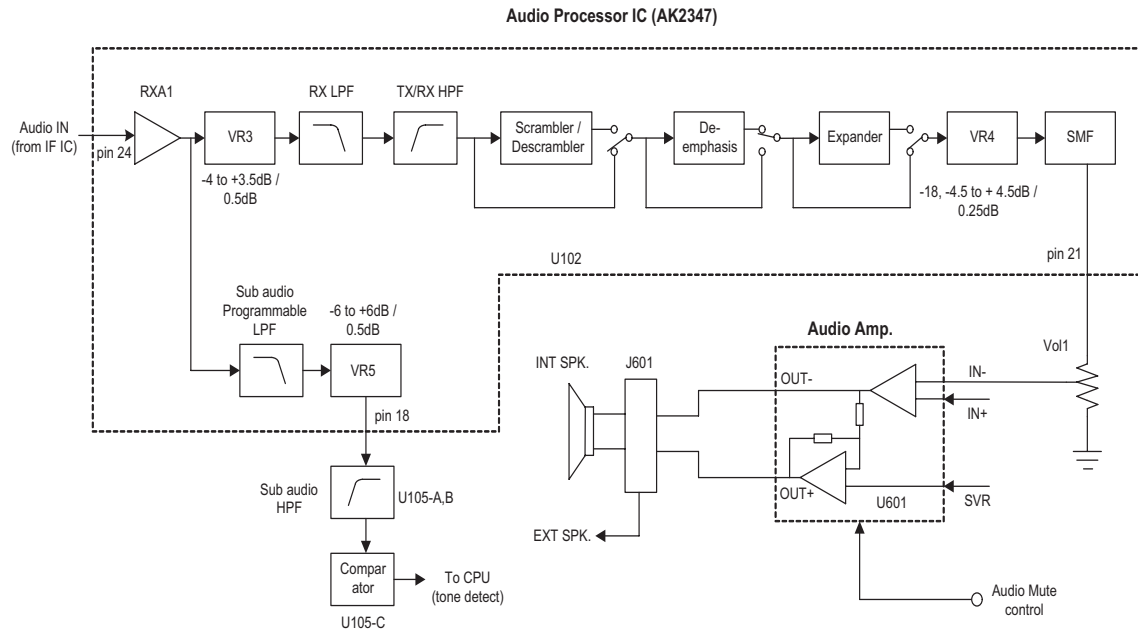


Figure 2-4. RX Audio Block Diagram

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.

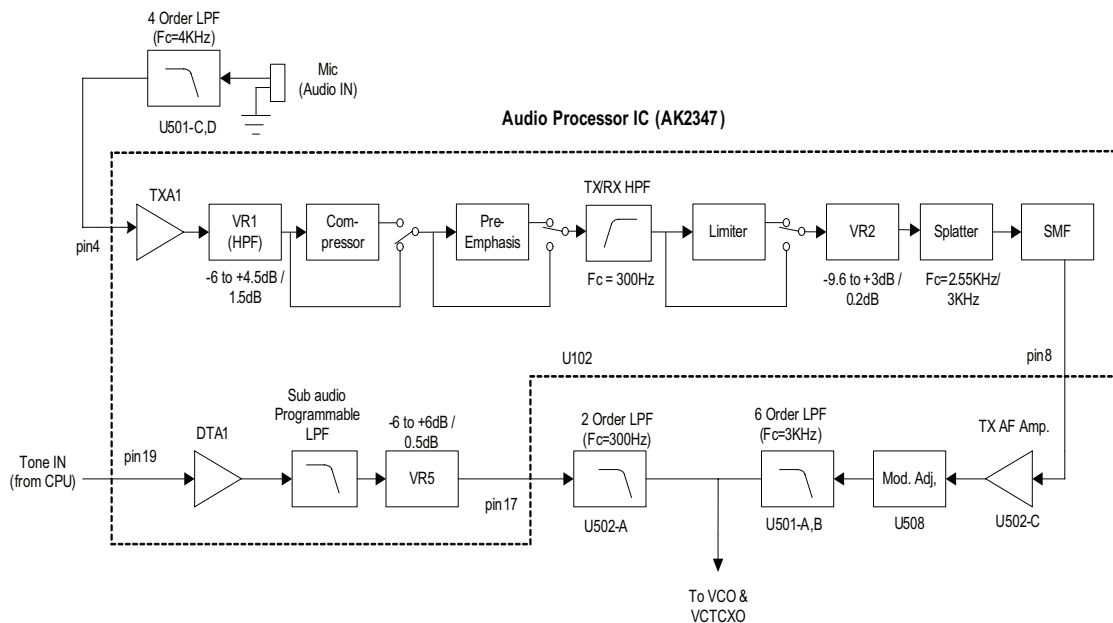


Figure 2-5. TX Audio Block Diagram

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 pin 44. 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 7.3728 MHz 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+, 3.3 V, 5 V & 10 V.

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

The 3.3 V 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 5.0 V 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 10.0 V 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 $\mu$ V to 3V RF, 10 kHz to 1 GHz frequency range                                   | RF level measurements                                                                       |
| *R1013B or<br>*R1370A | SINAD meter or<br>SINAD meter with RMS      | Without RMS audio voltmeter or<br>With RMS audio voltmeter                              | Receiver sensitivity measurements                                                           |

## 3.2 Service Aids

Table 3-2. lists service aids recommended for working on the CP185 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*

| Motorola Part No.       | Description                                          | Application                                                                                                             |
|-------------------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 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.                                                                                    |
| RVN5194_                | CP185 Series Customer Programming Software and Tuner | Program customer option and channel data, and also align and program the radio's parameters.                            |

**Note:** 1. Use PMDN4040BR or higher for tuning the CP185 Series radios as PMDN4040AR cannot be used to perform this function.

# Programming/Test Cable

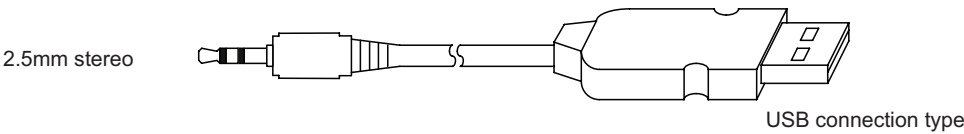


Figure 3-1. Programming/Test Cable (PMDN4077\_R)

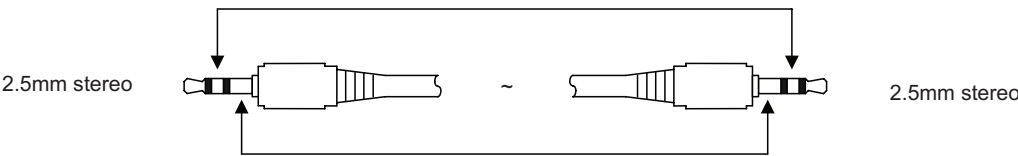


Figure 3-2. Cloning Cable (PMDN4076\_R)

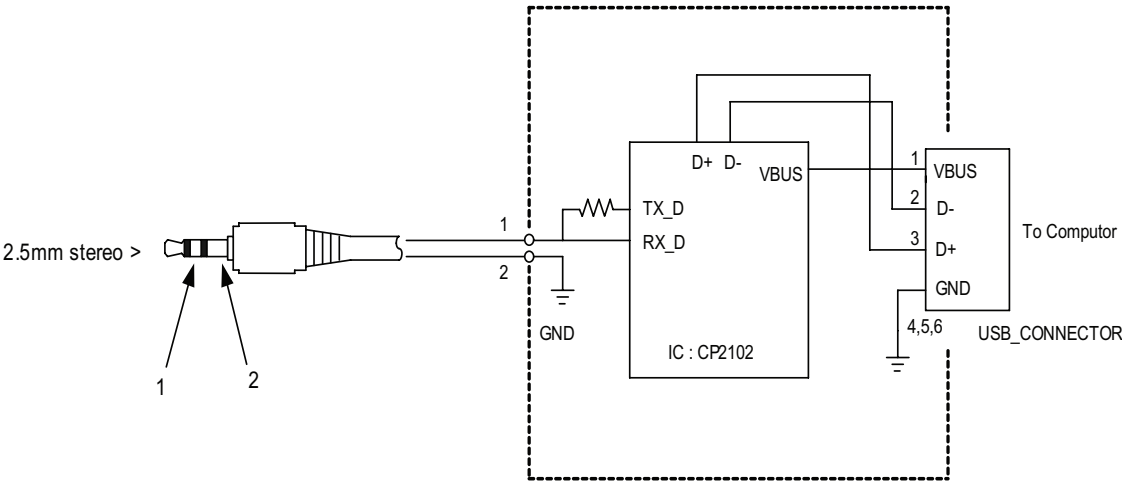


Figure 3-3. Wiring of the Connectors

## 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.

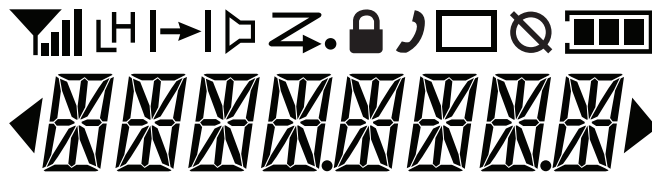


Figure 4-1. LCD Indication

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 |
|---------------------------------------------------------------------------------------------|-------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
|  , Right | Solid Green | RIGHTKEY       | <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> |      |
|  , Left  | Solid Red   | LEFT KEY       | – same as above –                                                                                                                                          |      |

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

| Button                                                                                                                      | LED         | LCD Indication                                                                      | Backlight                                                                                                                                                                                                                    | Tone                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SPB1<br>(Side Programmable Button 1)                                                                                        | OFF         | SPB1                                                                                | <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<br>(Side Programmable Button 2)                                                                                        | OFF         | SPB2                                                                                | – same as above –                                                                                                                                                                                                            |                                                                                                                                                                                                                                           |
|  , FPB1<br>(Front Programmable Button 1)   | OFF         | VOF--FPB1                                                                           | – same as above –                                                                                                                                                                                                            | Continuous tone; volume increases/decreases by turning the Volume Knob clockwise/counterclockwise.<br><b>Note:</b> Press  to turn continuous tone OFF. |
|  , FPB2<br>(Front Programmable Button 2) | OFF         | ◀ ▶                                                                                 | – same as above –                                                                                                                                                                                                            |                                                                                                                                                                                                                                           |
|  , FPB3<br>(Front Programmable Button 3) | OFF         | VOF--FPB3                                                                           | – same as above –                                                                                                                                                                                                            | Continuos tone OFF if previously ON.                                                                                                                                                                                                      |
| PTT Button<br>(Push-To-Talk Button)                                                                                         | Solid Amber |  | <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 CP185 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 CP185 Series CPS and Tuner CD-ROM (RVN5194\_).

### 5.2 CPS Programming Setup

Refer to online help files for the CPS Programming procedures.

(See Figure 5-1. CPS Programming Setup for CPS Programming Setup).

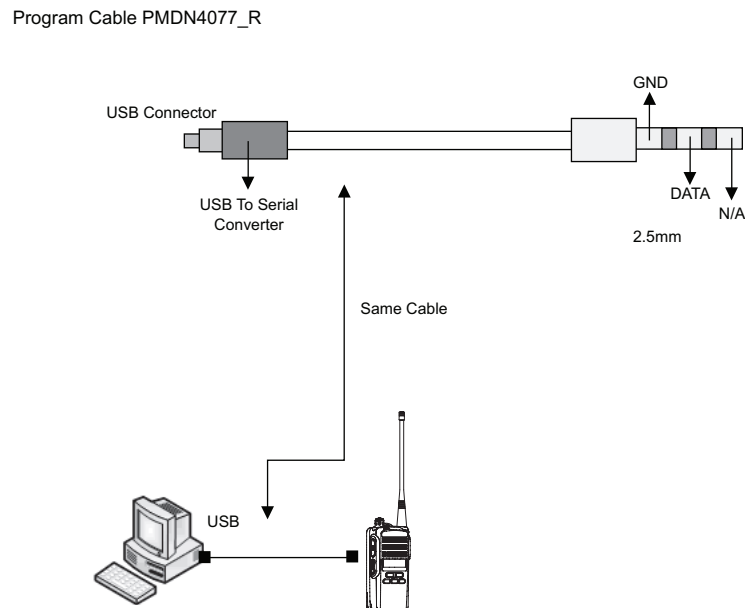


Figure 5-1. CPS Programming Setup

### 5.3 Radio-to-Radio Cloning

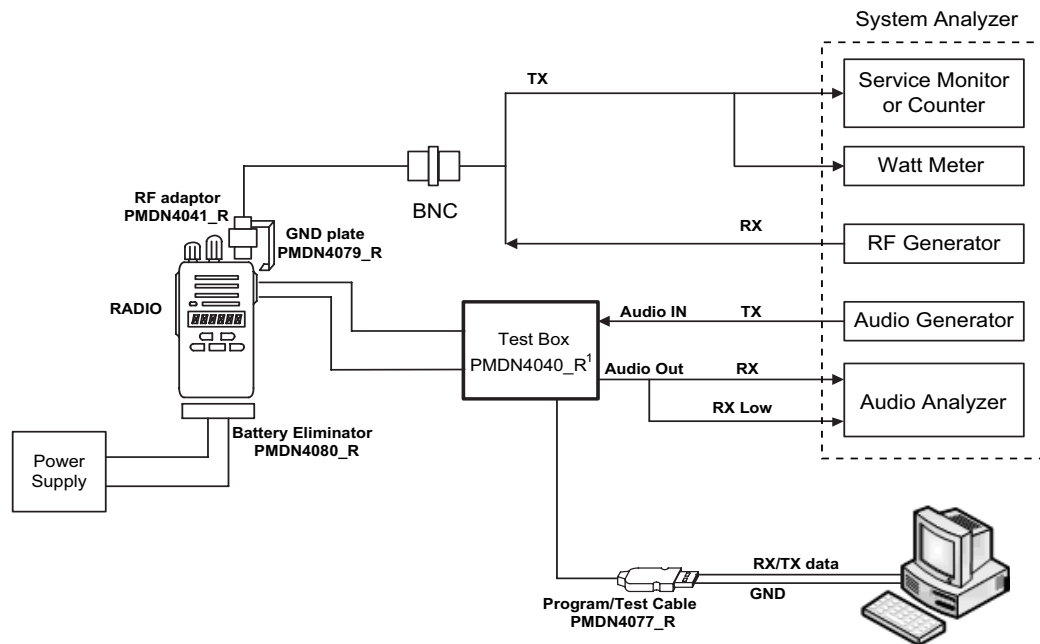
1. Cloning is the process of copying the content of one radio (source radio) into another radio (destination radio). Radio content refers to system-type features such as frequency, squelch type option, etc.
2. The cloning can be done only if all the following conditions are met:
  - a. The source radio's 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 5-4 below. Refer to online help files for the tuning procedures.



**Note:** 1. Use PMDN4040BR or higher for tuning the CP185 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<br>Oscilloscope Horizontal: 10 mSec/Div<br>Oscilloscope Vertical: 2.5 kHz/Div<br>Oscilloscope Trigger: Auto<br>Monitor Image: Hi<br>Monitor BW: Nar<br>Monitor Squelch: mid CW<br>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 12.5/25K16C UHF 2 | AAH03RDF8AA7_N | 4.2 – 4.6      | 2.2 – 2.6     |
| 136 – 174M 5W 12.5/25K 16CH     | AAH03KEF8AA7_N | 5.0 – 5.3      | 2.0 – 2.3     |

### 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. Tx High Power Window (High Power)).
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 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.

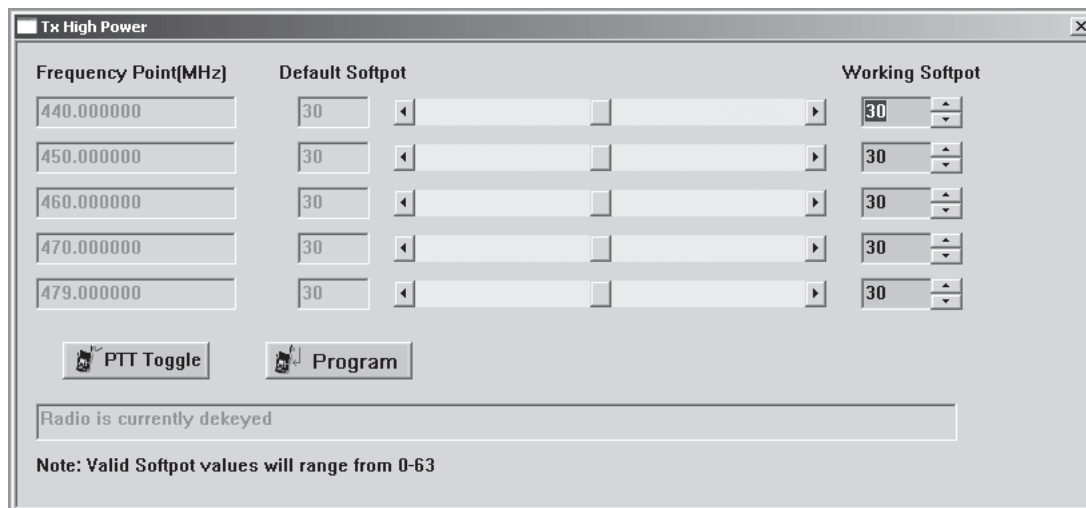


Figure 5-3. Tx High Power Window (High Power)

### 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. Tx Low Power Window (Low Power)).
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 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.

The screenshot shows the 'Tx Low Power' window with the following data:

| Frequency Point(MHz) | Default Softpot | Working Softpot |
|----------------------|-----------------|-----------------|
| 440.000000           | 20              | 20              |
| 450.000000           | 20              | 20              |
| 460.000000           | 20              | 20              |
| 470.000000           | 20              | 20              |
| 479.000000           | 20              | 20              |

Buttons: PTT Toggle, Program

Status: Radio is currently dekeyed

Note: Valid Softpot values will range from 0-63

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

1. Under the **Alignment** menu, select **Tx Modulation**, then select **Mod. 12.5 kHz** (Figure 5-5. Tx Modulation 12.5 kHz Window).
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 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.
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 12.5 kHz Modulation function.
10. If 25 kHz channels are used, perform Transmit 25 kHz Modulation Tuning.

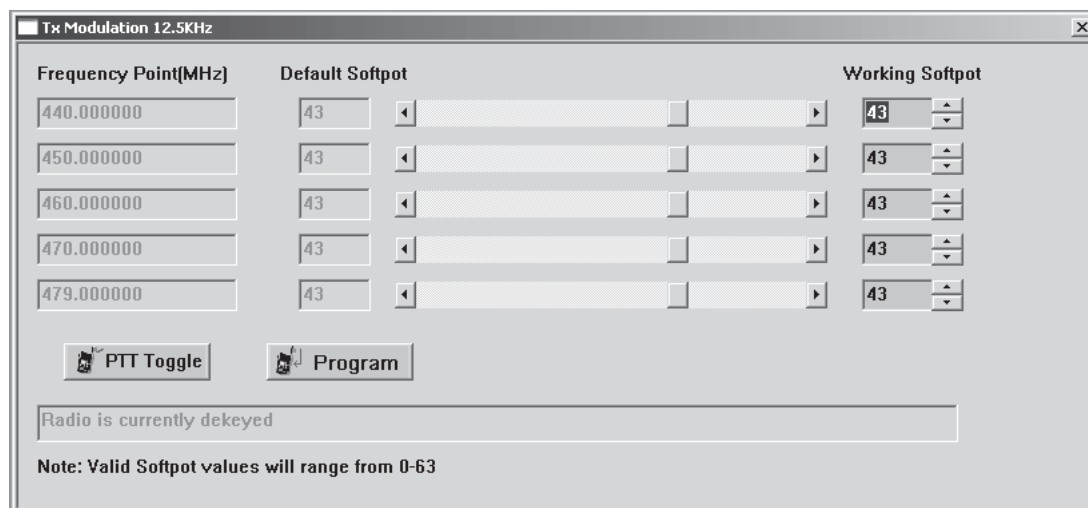


Figure 5-5. Tx Modulation 12.5 kHz Window

### 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. Tx Modulation 25 kHz Window).
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.

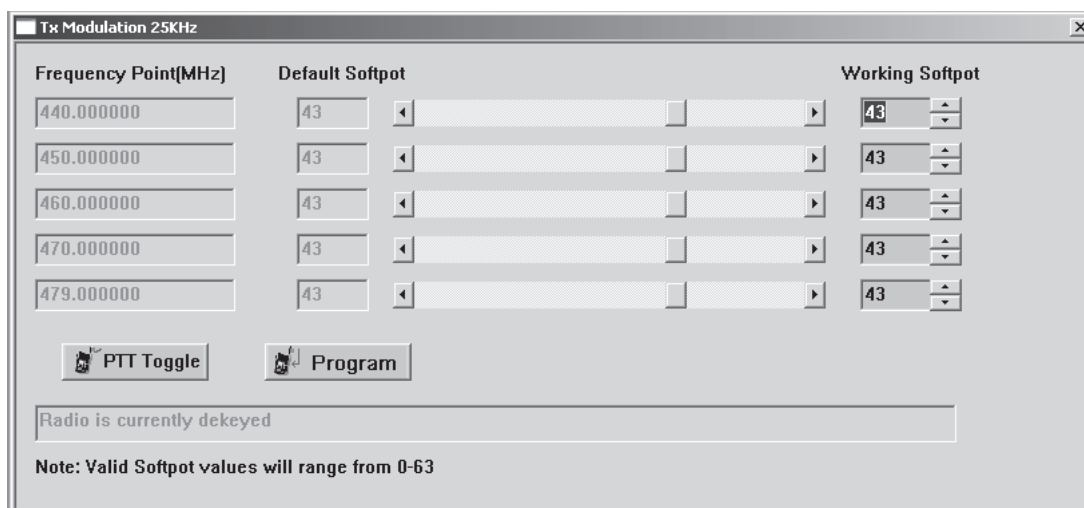


Figure 5-6. Tx Modulation 25 kHz Window

## 5.6 Receiver Tuning

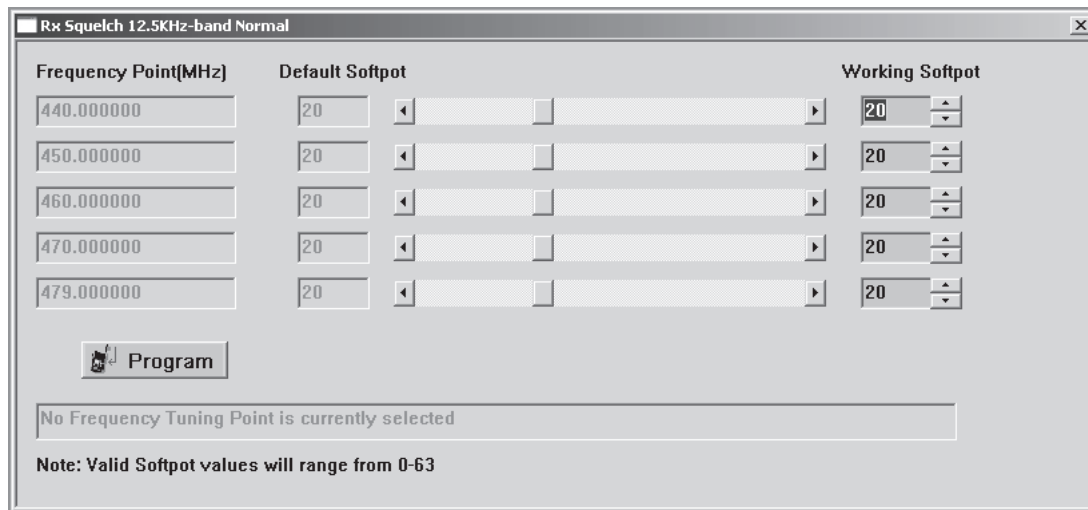
There are 4 variations of Receive Squelch Tuning: 12.5 kHz-Band Normal Squelch, 12.5 kHz-Band Tight Squelch, 25 kHz-Band Normal Squelch and 25 kHz-Band Tight Squelch.

*Table 5-4. Receiver Squelch Tuning*

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

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

1. Under the **Alignment** menu, select **Rx Squelch**, then select **Squelch 12.5 kHz-band Normal**. (Figure 5-7. Rx 12.5 kHz-band Normal Squelch Tuning Window).
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 5-7. Rx 12.5 kHz-band Normal Squelch Tuning Window*

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

1. Under the **Alignment** menu, select **Rx Squelch**, then select **Squelch 12.5 kHz-band Tight**. (Figure 5-8. Rx 12.5 kHz-band Tight Squelch Tuning Window).
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.

The screenshot shows a window titled "Rx Squelch 12.5kHz-band Tight". It contains a table with three columns: "Frequency Point(MHz)", "Default Softpot", and "Working Softpot". There are five rows of data. Below the table is a "Program" button. At the bottom, there is a status bar that says "No Frequency Tuning Point is currently selected" and a note: "Note: Valid Softpot values will range from 0-63".

| Frequency Point(MHz) | Default Softpot | Working Softpot |
|----------------------|-----------------|-----------------|
| 440.000000           | 63              | 63              |
| 450.000000           | 63              | 63              |
| 460.000000           | 63              | 63              |
| 470.000000           | 63              | 63              |
| 479.000000           | 63              | 63              |

**Program**

No Frequency Tuning Point is currently selected

Note: Valid Softpot values will range from 0-63

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

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

1. Under the **Alignment** menu, select **Rx Squelch**, then select **Squelch 25 kHz-band Normal**. (Figure 5-9. Rx 25 kHz-band Normal Squelch Tuning Window).
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.

| Frequency Point(MHz) | Default Softpot | Working Softpot |
|----------------------|-----------------|-----------------|
| 440.000000           | 20              | 20              |
| 450.000000           | 20              | 20              |
| 460.000000           | 20              | 20              |
| 470.000000           | 20              | 20              |
| 479.000000           | 20              | 20              |

**Program**

No Frequency Tuning Point is currently selected

Note: Valid Softpot values will range from 0-63

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

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

1. Under the **Alignment** menu, select **Rx Squelch**, then select **Squelch 25 kHz-band Tight**. (Figure 5-10. Rx 25 kHz-band Tight Squelch Tuning Window).
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.

The screenshot shows a software window titled "Rx Squelch 25KHz-band Tight". It contains a table with three columns: "Frequency Point(MHz)", "Default Softpot", and "Working Softpot". There are five rows of data, each representing a frequency point from 440.000000 to 479.000000 MHz. Each row has a "Default Softpot" value of 63 and a "Working Softpot" value of 63. Below the table is a "Program" button. At the bottom, there is a status bar that says "No Frequency Tuning Point is currently selected" and a note: "Note: Valid Softpot values will range from 0-63".

| Frequency Point(MHz) | Default Softpot | Working Softpot |
|----------------------|-----------------|-----------------|
| 440.000000           | 63              | 63              |
| 450.000000           | 63              | 63              |
| 460.000000           | 63              | 63              |
| 470.000000           | 63              | 63              |
| 479.000000           | 63              | 63              |

**Program**

No Frequency Tuning Point is currently selected

Note: Valid Softpot values will range from 0-63

Figure 5-10. Rx 25 kHz-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. Program Radio Serial No. Window. For the new radio serial number to take effect, close the screen and then read the radio again.

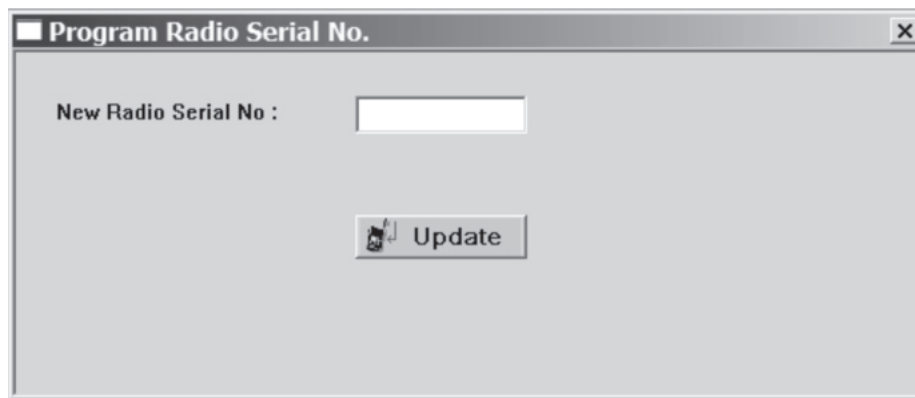


Figure 5-11. Program Radio Serial No. Window

## 5.8 Front Panel Feature and Button Configuration Mode

### 5.8.1 Introduction

This mode allows you to change the feature parameters to enhance the use of your radio.

**Note** Please use the CPS to program additional setting on the radio.

### 5.8.2 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.

### 5.8.3 Exiting Programming Mode

Turn off the radio to exit Programming Mode.

### 5.8.4 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.

### 5.8.5 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                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------|-------------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BCKLIGHT (Backlight)         |                                     |                      | AUTO<br>TOGGLE                                                                                                                                                          | AUTO – Backlight Off if no keypress for more than 5 seconds.<br>Pressing the Backlight button again prolongs illumination time.<br>TOGGLE – Allows Backlight Button to toggle control the ON/OFF status of the backlight.                                                                                                                                                                                                         |
| BATTERY                      | SAVER (Battery Saver)               |                      | OFF<br>NORMAL<br>ENHANCED                                                                                                                                               | Helps to extend battery life. When enabled, turns off the radio receiver circuitry periodically when no activity is detected.<br>NORMAL – turns off radio less frequently; select this to save battery when expecting to receive <i>Selective Call</i> or <i>Call Alert</i> .<br>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<br>LI-ION<br>H LI-ION                                                                                                                                              | Select type of battery radio uses.<br>NIMH – Nickel Metal Hydride<br>LI-ION – Lithium-Ion<br>H LI-ION – High Capacity Lithium-Ion                                                                                                                                                                                                                                                                                                 |
| ACCESSORY (Accessory)        | SPK GAIN (External Speaker Gain)    |                      | +2<br>+1<br>0<br>-1<br>-2                                                                                                                                               | Volume Adjustment – External Speaker .<br>+2: maximum external speaker gain<br>-2: minimum external speaker gain                                                                                                                                                                                                                                                                                                                  |
|                              | MIC GAIN (External Microphone Gain) |                      | +2<br>+1<br>0<br>-1<br>-2                                                                                                                                               | Sensitivity Adjustment – External microphone.<br>+2: maximum external microphone sensitivity gain<br>-2: minimum external microphone sensitivity gain                                                                                                                                                                                                                                                                             |
| TONE VOL (Alert Tone Volume) |                                     |                      | ON<br>OFF                                                                                                                                                               | Alert tone volume preference.<br>OFF: No alert tone.<br>ON: Alert tone is on.                                                                                                                                                                                                                                                                                                                                                     |
| CHANNEL                      | PL Display (PL Display Type)        |                      | FREQ<br>CODE                                                                                                                                                            | PL Display Type<br>•FREQ – frequency<br>•CODE – code                                                                                                                                                                                                                                                                                                                                                                              |
|                              | RX PL (Receive TPL/ DPL)            | CH-001 ...<br>CH-016 | CSQ      CSQ<br>TPL 067.0 ... 001 ...<br>TPL 254.1      042<br>DPL 023      or      043<br>DPL 754      127<br>TPL 1      TPL 1<br>TPL 2      TPL 2<br>TPL 3      TPL 3 | Receive PL<br>•Frequency: CSQ, TPL 67.0 – TPL 254.1, DPL 023 – DPL 754, user defined TPL 1, user defined TPL 2, & user defined TPL 3<br><br>•Code: CSQ, 001 – 127, user defined TPL 1, user defined TPL 2, & user defined TPL 3                                                                                                                                                                                                   |

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

| Main Menu                                   | 1st Level Sub-Menu                           | 2nd Level Sub-Menu                        | Setting                                                                                                                                                                | Remarks                                                                                                                                                                                                                                   |
|---------------------------------------------|----------------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | TX PL<br>(Transmit TPL/<br>DPL)              | CH-001 ...<br>CH-016                      | CSQ      CSQ<br>TPL 067.0    001 ...<br>TPL 254.1    042<br>DPL 023    or    043<br>DPL 754      127<br>TPL 1        TPL 1<br>TPL 2        TPL 2<br>TPL 3        TPL 3 | Transmit PL<br>•Frequency: CSQ, TPL 67.0 – TPL 254.1,<br>DPL 023 – DPL 754, user defined TPL 1, user<br>defined TPL 2, & user defined TPL 3<br><br>•Code: CSQ, 001 – 127, user defined TPL 1,<br>user defined TPL 2, & user defined TPL 3 |
|                                             | SQUELCH<br>(Squelch Level)                   | CH-001 ...<br>CH-016                      | NORMAL<br>TIGHT                                                                                                                                                        | NORMAL squelch level – receive weak signals.<br>TIGHT squelch level – receive strong signals and<br>eliminates unwanted noise.                                                                                                            |
|                                             | TIME OUT<br>(Time<br>Out Timer)              |                                           | OFF<br>010<br>020<br>...<br>590<br>600                                                                                                                                 | Maximum duration (in seconds) the radio can<br>transmit continuously.                                                                                                                                                                     |
| SCAN                                        | LIST 1<br>(Scan List 1)                      | 01-XXX<br>02-XXX ...<br>15-XXX<br>16-XXX\ | ---<br>001 ...<br>016                                                                                                                                                  | Set Scan List 1 members.<br>XXX – selected scan list member<br>--- – no scan list member is selected                                                                                                                                      |
|                                             | LIST SEL<br>(Scan List<br>Select)            | CH-001 ...<br>CH-016                      | LIST1 (Scan List 1)                                                                                                                                                    | Set scan list for a selected channel.                                                                                                                                                                                                     |
|                                             | SCAN TYP<br>(Scan Type<br>Select)            | CH-001 ...<br>CH-016                      | NORMAL<br>PRIORITY                                                                                                                                                     | Scan type for selected channel – Normal Scan,<br>Priority Scan                                                                                                                                                                            |
|                                             | PRIORITY<br>(Priority<br>Channel<br>Select)  | LIST1<br>(Scan List 1)                    | ---<br>...<br>XXX                                                                                                                                                      | Set Priority Channel for Scan List 1.<br>XXX – selected priority channel<br>--- – no priority channel is selected                                                                                                                         |
| SCRMBLIN<br>(Voice Inversion<br>Scrambling) | CHANNEL<br>(Scrambling<br>Channel<br>Select) | CH-001 ...<br>CH-016                      | ENABLE<br>DISABLE                                                                                                                                                      | Scrambling – Enable or disable                                                                                                                                                                                                            |
|                                             | CODE<br>(Scrambling<br>Code<br>Select)       |                                           | 3.29<br>3.39                                                                                                                                                           | Scrambling code – 3.29 or 3.39.                                                                                                                                                                                                           |

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## Chapter 6 Maintenance – CP185

### 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).



**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 6-15.

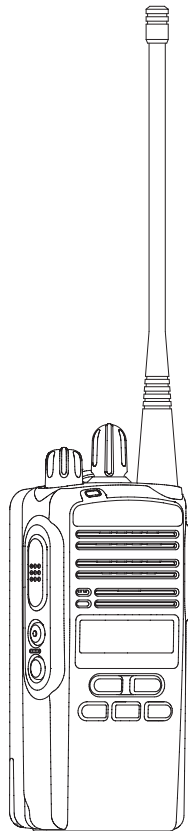


Figure 6-1. Limited Keypad With Channel Knob Model

## 6.4.1 Radio Disassembly – Detailed

### 6.4.1.1 Front Housing From Chassis Disassembly

1. Turn off the radio.
2. Remove the Battery (31):
  - a. Release the battery latch by moving it into the unlock position.
  - b. Slide the Battery downwards.
  - c. Remove the Battery from the radio.

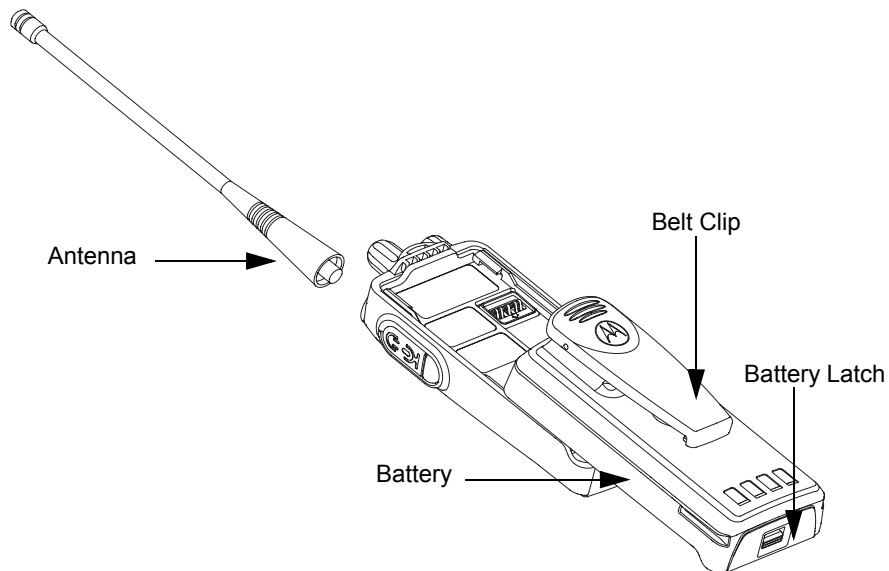


Figure 6-2. Battery and Antenna Removal

3. Remove the Antenna (22) by turning it counterclockwise.

4. Remove the Volume Knob (7) and Channel Knob (8) from their shafts using the Chassis and Knob Opener. (Refer Figure 6-3).

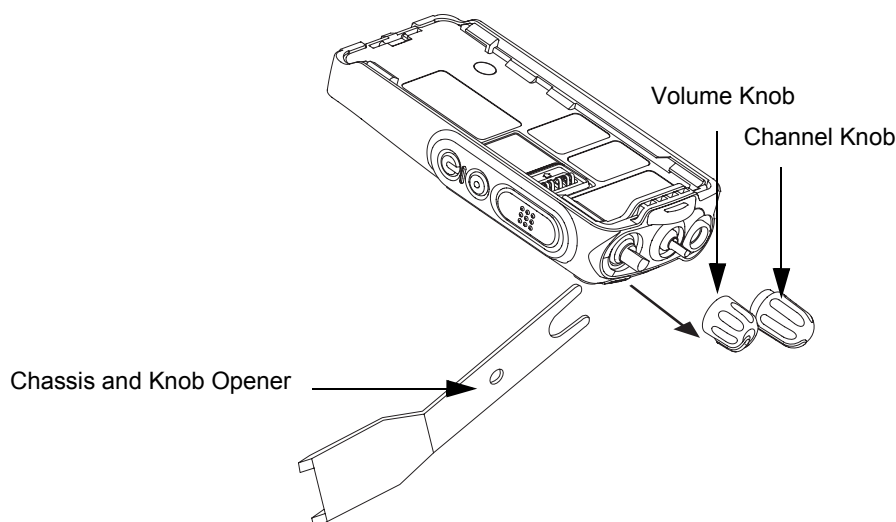


Figure 6-3. Knobs Removal

**Note:** Both knobs can be turned clockwise and counterclockwise. However, they are designed to fit very tightly on their shafts.

5. Separate the Chassis (27) 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).

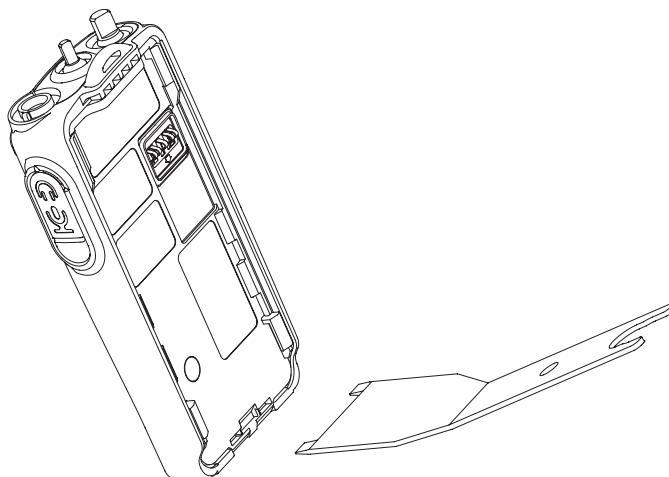


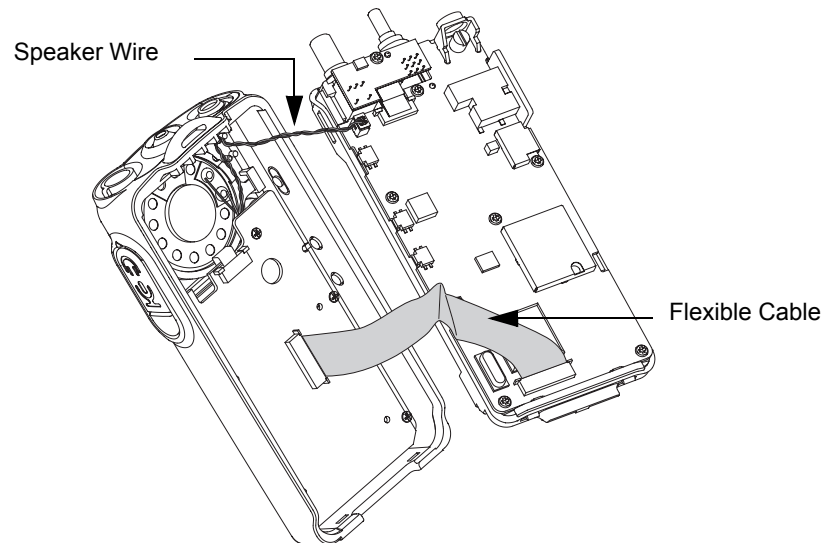
Figure 6-4. Chassis Removal



Caution

Marring the front cover O-ring sealing area will prevent the radio from sealing properly. If the O-ring (24) is damaged, replace it with a new one.

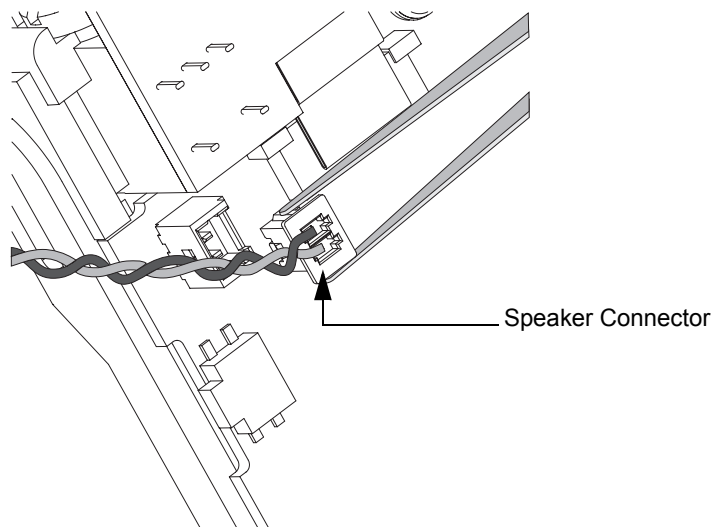
- c. Slide the rear chassis downwards, and away from the front housing. Be careful not to damage the Flexible Cable (39) and speaker wire underneath. (Refer Figure 6-5).



*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 (27) 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 (41) sideways to the right to release the flexible cable from the connector. (Refer Figure 6-7).

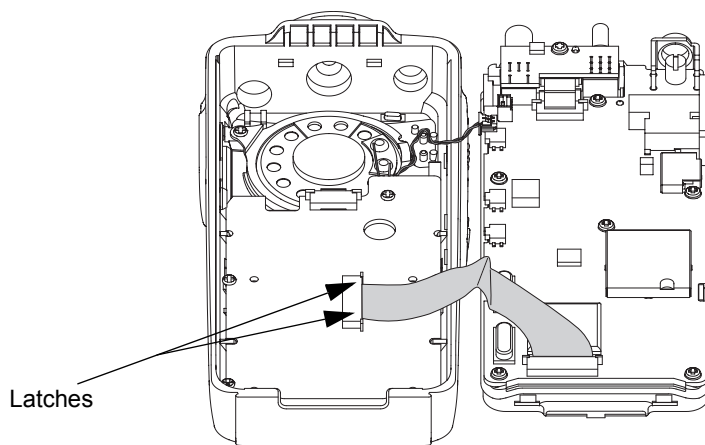


Figure 6-7. Unlatch the Flexible Cable

#### 6.4.1.2 Chassis Assembly Disassembly

1. Remove the Accessory Bracket (35).
2. Remove the nut (17) on the On/Off Volume Knob Shaft and Channel Knob Shaft with the Crab Eye Nut Opener.
3. Remove the screw holding the Sub Circuit Board (16) to the Chassis (27) with a Phillips screwdriver.
4. Push the latches on the Main Circuit Board (19) to release the Flexible Cable (39) from the connector.
5. Remove the Sub Circuit Board from the Chassis. (Refer Figure 6-8).

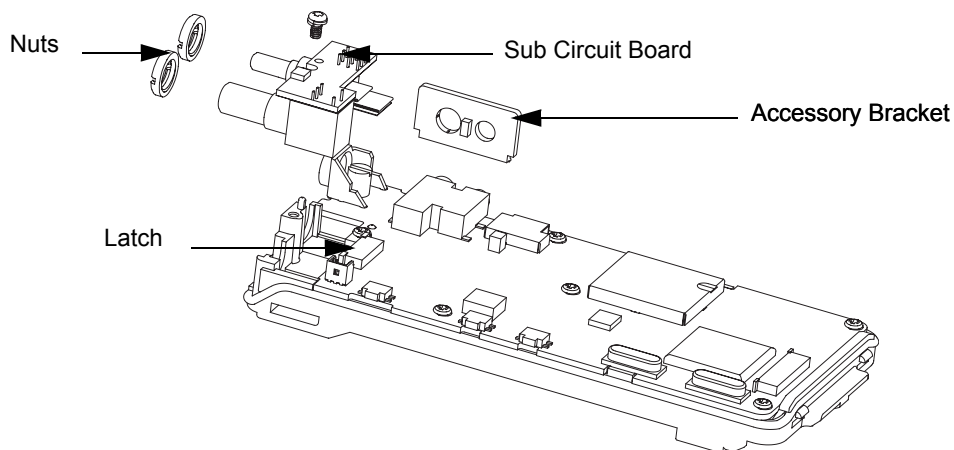


Figure 6-8. Sub-Circuit Board and Accessory Bracket Removal

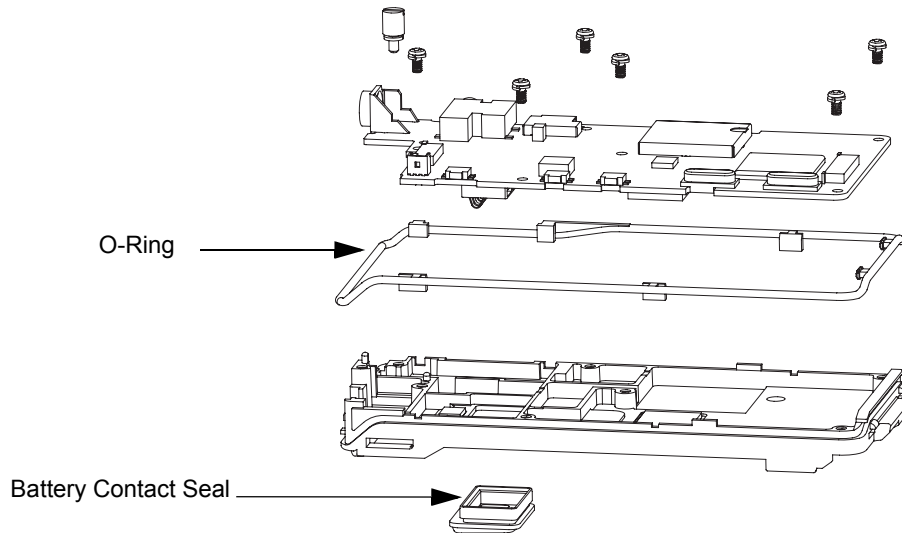
6. Remove the six screws (37) holding the Main Circuit Board to the Chassis with a Phillips screwdriver. Remove the RF Support Screw (20) with a flat head screwdriver.

7. Remove the Main Circuit Board from the Chassis.



**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.**

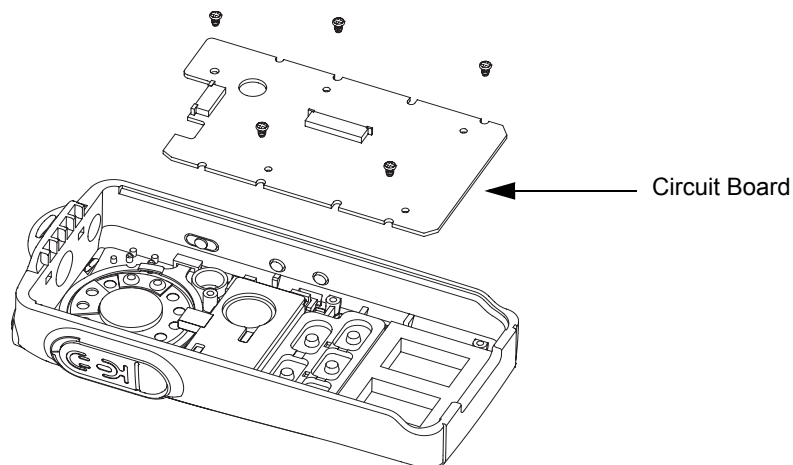
8. Remove the seven small O-ring retainers from their slots in the Chassis. Note the alignment of the retainers for reassembly.
9. Remove O-ring (24) and the Battery Contact Seal (28). (Refer Figure 6-9).



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

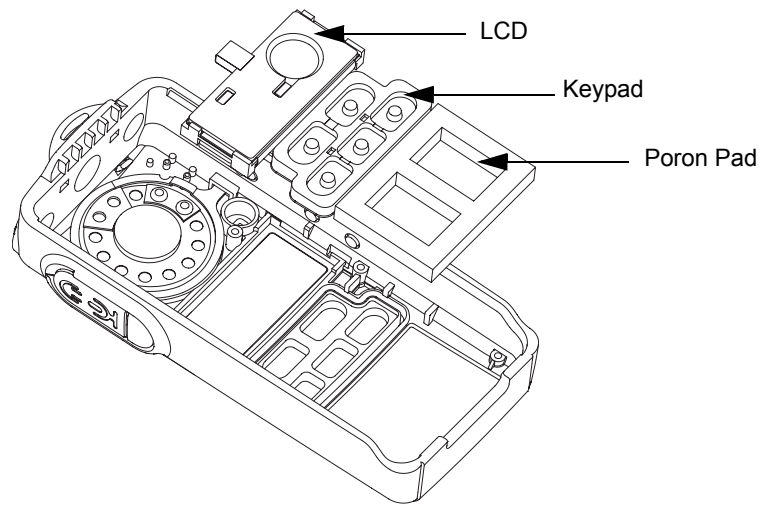
#### 6.4.1.3 Front Circuit Board, Display Module and Keypad Disassembly

1. Push the latches on the Front Circuit Board (41) 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 (38), Poron Pad (44) and Keypad (43) from the Front Housing.  
(Refer Figure 6-11).



*Figure 6-11. LCD and Keypad Removal*

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

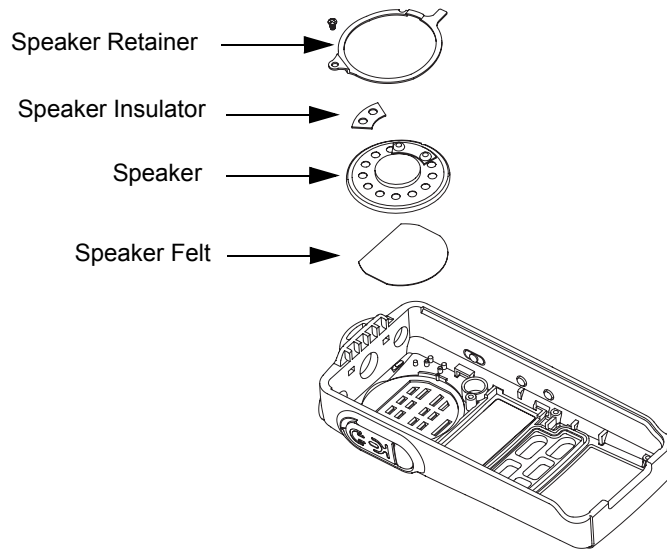
#### 6.4.1.4 Speaker Disassembly

1. Remove the screw holding the Speaker Retainer (11) 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 (12) from the speaker.

5. Remove the Speaker Felt (9) 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 (9) 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 (12) at twelve o'clock position and push down until fully adhere onto the speaker.
4. Install the Speaker Retainer (11).
5. Tighten the Speaker Retainer to the housing with a Phillips screwdriver torque to 0.86 lb-in – 1.04 lb-in. (Refer Table 6-1 on page 6-14 for torque in other units).

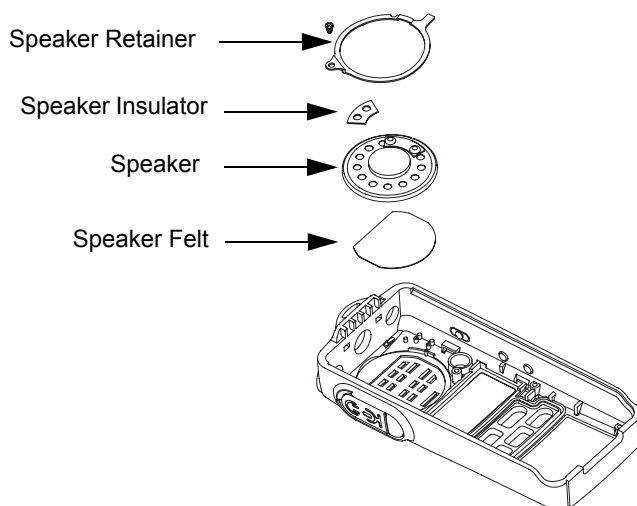


Figure 6-13. Speaker Reassembly

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

1. Place and align the LCD (38) onto the front housing.
2. Place and align the Keypad (43) 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).

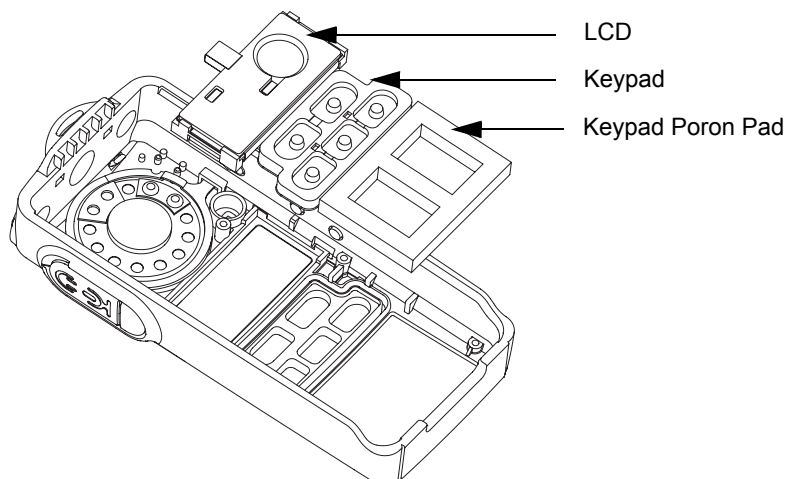


Figure 6-14. LCD and Keypad Reassembly

3. Place the Front Circuit Board (41) 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 1.04 lb-in – 1.30 lb-in. (Refer Table 6-1 on page 6-14 for torque in other units).

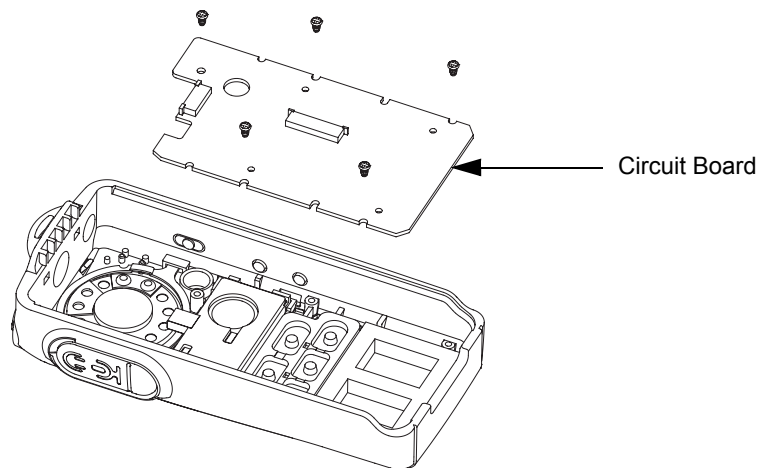


Figure 6-15. Front Circuit Board Reassembly

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

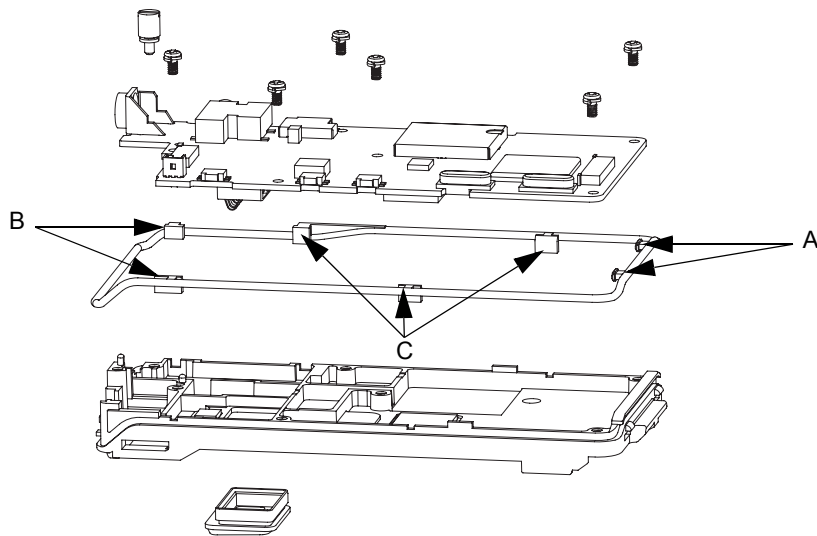
#### 6.4.2.3 Chassis Assembly Reassembly

1. Fit the Battery Contact Seal (28) onto the battery contact slot.
2. Fit the main O-ring (24) 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.

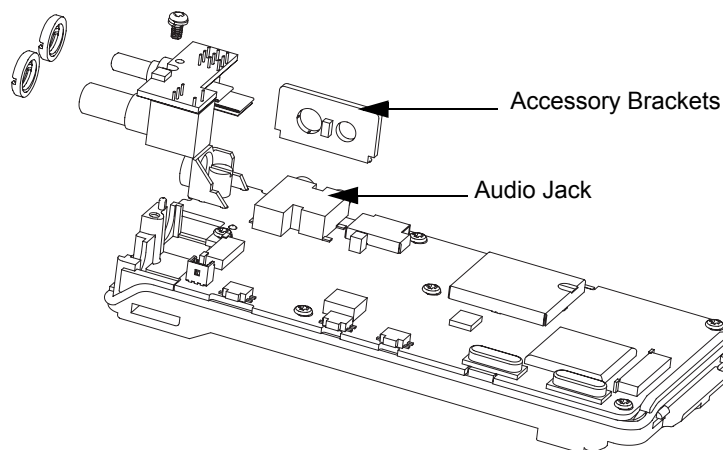
4. Tighten the six screws holding the main circuit board with a Phillips screwdriver torque to 1.91 lb-in – 2.17 lb-in. (Refer Table 6-1 on page 6-14 for torque in other units).

5. Tighten the RF Support Screw (20) with a flat head screw torque to 1.91 lb-in – 2.17 lb-in. (Refer Table 6-1 on page 6-14 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 (15) 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 1.91 lb-in – 2.17 lb-in. (Refer Table 6-1 on page 6-14 for torque in other units).
10. Tighten the two nuts on the On/Off Volume Knob and Channel Knob Shafts with the Crab Eye Nut Opener.
11. Align and Insert the Accessory Bracket (35) 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 (39) 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.

**Note:** For re-use Flexible Cable (39), please ensure that it is properly folded. For new Flexible Cable (39), please ensure pre-folded flexible cable was provided and used.

2. Slide the On/Off Volume Knob Shaft into their respective holes in the front cover.
3. Insert the 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 (24) is properly seated so that the radio is properly sealed.
5. Snap the bottom of the chassis into the front housing.
6. Reassemble the Knobs (7,8), Dust Cover (42), Antenna (22), and Battery (31). (Refer Figure 6-18).

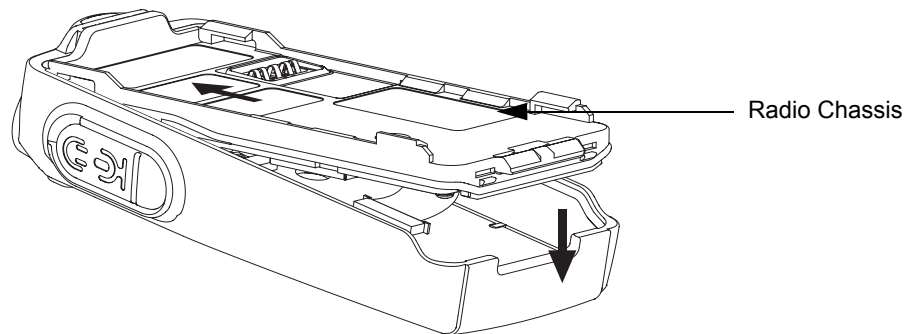


Figure 6-18. Chassis Assembly and Front Housing Assembly Reassembly

## 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 CP185 View and Parts List

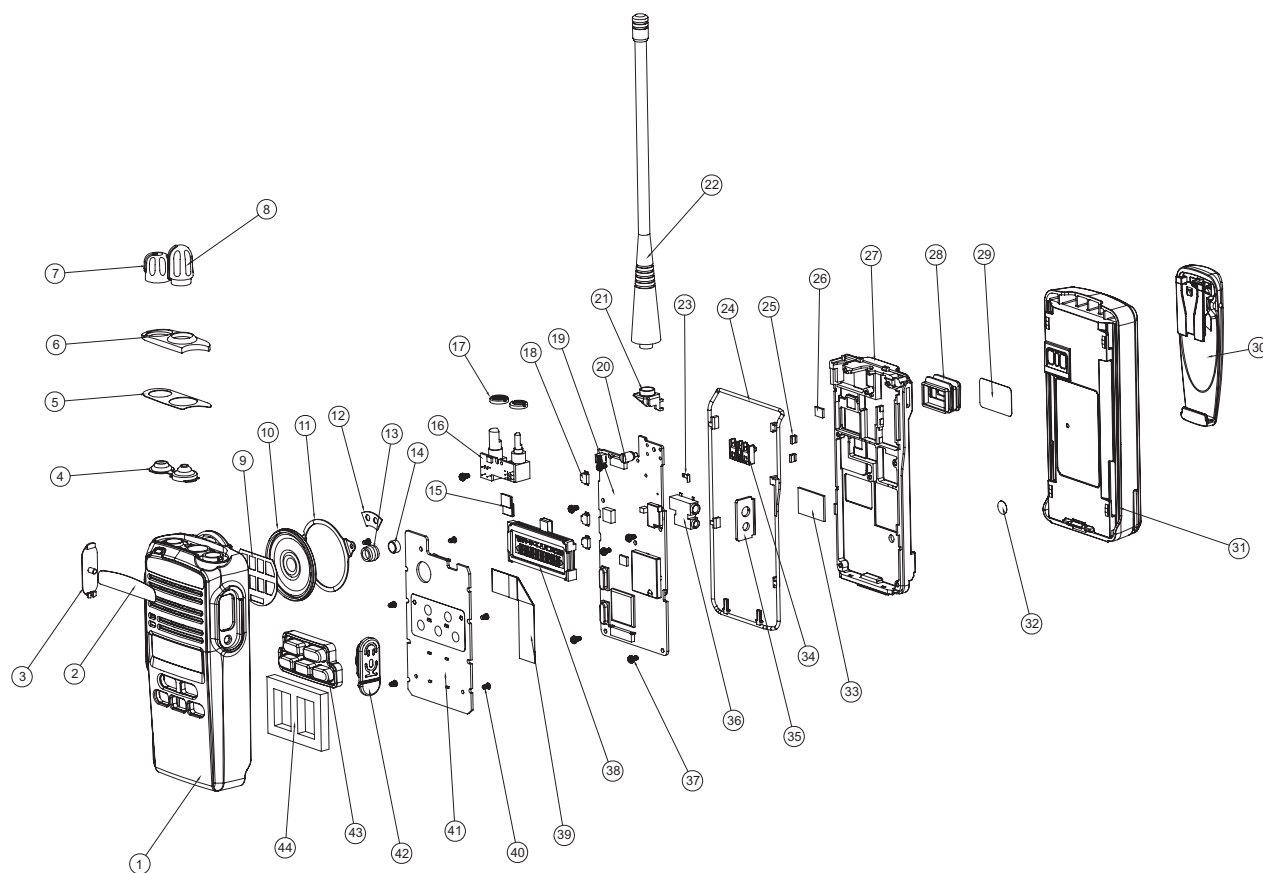


Figure 6-19. CP185 Exploded View

| Item | Motorola Kit Number      | Description                                                                          | Quantity |
|------|--------------------------|--------------------------------------------------------------------------------------|----------|
| 1    | PMDN4097_R               | Front Housing, Limited Keypad                                                        | 1        |
| 2    | PMDN4096_R               | Name Plate (CP185)                                                                   | 1        |
| 3    | PMDN4124_R               | Double Molded Cover, PTT                                                             | 1        |
| 4    | PMDN4089_R               | Seal, Volume and Channel Knob                                                        | 1        |
| 5    | PMDN4088_R               | Adhesive, Top Control                                                                | 1        |
| 6    | PMDN4103_R               | Escutcheon, Top                                                                      | 1        |
| 7    | PMDN4102_R               | Knob, Volume                                                                         | 1        |
| 8    | PMDN4101_R               | Knob, Channel                                                                        | 1        |
| 9    | PMDN4100_R               | Felt, Speaker                                                                        | 1        |
| 10   | PMDN4067_R               | Speaker                                                                              | 1        |
| 11   | PMDN4099_R               | Retainer, Speaker, with screw                                                        | 1        |
| 12   | PMDN4098_R               | Insulator, Speaker                                                                   | 1        |
| 13   | PMDN4135_R               | Seal, Microphone                                                                     | 1        |
| 14   | PMDN4139_R               | Microphone                                                                           | 1        |
| 15   | PMDN4111_R               | Flexible Cable, Sub Circuit Board                                                    | 1        |
| 16   | PMDN4128_R               | Sub Circuit Board, w Channel                                                         | 1        |
| 17   | PMDN4112_R               | Crab-Eye Nut, Volume and Channel                                                     | 2        |
| 18   | PMDN4134_R               | Switch, Tact                                                                         | 3        |
| 19*  | PMDE4023_R<br>PMDD4020_R | Main Circuit Board (CP185 – PMUE3139_AN)<br>Main Circuit Board (CP185 – PMUD2444_AN) | 1        |
| 20   | PMDN4114_R               | Screw, RF Support                                                                    | 1        |
| 21   | PMDN4138_R               | Bracket, Antenna                                                                     | 1        |
| 22   | See Appendix A           | Antenna                                                                              | 1        |
| 23   | PMDN4137_R               | Finger Strip, PCB                                                                    | 1        |
| 24   | PMDN4116_R               | O-ring                                                                               | 1        |
| 25   | PMDN4120_R               | Finger Strip, Chassis                                                                | 2        |
| 26   | PMDN4121_R               | Pad, Thermal                                                                         | 1        |
| 27   | PMDN4122_R               | Chassis                                                                              | 1        |
| 28   | PMDN4105_R               | Seal, Battery Contact                                                                | 1        |
| 29   | PMDN4110_R               | Label, Caution                                                                       | 1        |
| 30   | See Appendix A           | Belt Clip                                                                            | 1        |
| 31   | See Appendix A           | Battery                                                                              | 1        |
| 32   | PMDN4028_R               | Tuning Hole Sticker (Small)                                                          | 1        |
| 33   | PMDN4106_R               | Gel Pad, Ceramic Filter                                                              | 1        |
| 34   | 0915184H01               | Contact, Battery                                                                     | 1        |
| 35   | PMDN4108_R               | Bracket, Accessory                                                                   | 1        |
| 36   | 0980683Z01               | Jack, Audio                                                                          | 1        |

| Item | Motorola Kit Number | Description                        | Quantity |
|------|---------------------|------------------------------------|----------|
| 37   | PMDN4107_R          | Screw, Machine                     | 7        |
| 38   | PMDN4123_R          | Module, Liquid Crystal Display     | 1        |
| 39   | PMDN4109_R          | Flexible Cable, Main Circuit Board | 1        |
| 40   | PMDN4119_R          | Screw, Tapping                     | 5        |
| 41‡  | PMDN4131_R          | Front Circuit Board, LKP           | 1        |
| 42   | PMDN4113_R          | Cover, Dust                        | 1        |
| 43   | PMDN4118_R          | Keypad, Limited Keypad             | 1        |
| 44   | 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.

## Notes

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## Chapter 7 Troubleshooting Tables

### 7.1 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 7-1. to aid in understanding particular error code display.

*Table 7-1. 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.<br>Make sure follow the correct cloning procedures.<br>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.<br>Make sure follow the correct cloning procedures.<br>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.<br>Make sure follow the correct cloning procedures.<br>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.<br>Replace with new display module.                                                                                        |
| ERR-EEP    | EEPROM 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.                                    |

## 7.2 Troubleshooting Table for Receiver

Table 7-2. lists the possible causes of, and corrections for, receiver problems.

*Table 7-2. Receiver Troubleshooting Table*

| Symptom                                       | Possible Causes                 | Corrective or Test<br>(Measurements at Room Temperature)                                                                                                |
|-----------------------------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Radio Dead; Display Does Not Turn On          | 1. Dead Battery                 | Replace with charged battery.                                                                                                                           |
|                                               | 2. On/Off Switch                | Send radio to nearest Motorola Service Centre.                                                                                                          |
|                                               | 3. Regulators                   |                                                                                                                                                         |
|                                               | 4. 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                     | 1. Does the transmitted signal match the receiver configuration (PL, DPL, etc.)?<br><br>2. With the monitor function enabled, can the radio be unmuted? |
| 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.                                                                                                          |

## 7.3 Troubleshooting Table for Transmitter

Table 7-3. lists the possible causes of, and corrections for, transmitter problems.

*Table 7-3. Transmitter Troubleshooting Table*

| Symptom                              | Possible Causes                     | Corrective or Test<br>(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.               |
|                                      | 3. 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

|           |                                      |
|-----------|--------------------------------------|
| NAD6502_R | VHF Heliflex Antenna (146 – 174 Mhz) |
| PMAD4049_ | VHF Helical Antenna (146 – 174 MHz)  |

#### UHF

|           |                                           |
|-----------|-------------------------------------------|
| NAE6483_R | UHF Whip Antenna, 16.5 cm (403 – 520 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 Earpiece with Microphone and PTT Combined, Beige                      |
| RLN5317_   | 2-Wire Earpiece with Microphone and PTT Combined, Translucent Tube – Beige   |
| RLN5318_   | 2-Wire Earpiece with Microphone and PTT Combined, Translucent Tube – Black   |
| RLN4895_   | 2-Wire Earpiece with Microphone and PTT Combined, Black                      |
| 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             |
| 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 |
|----------|---------------------------------|

**Carrying Accessories**

|           |                                   |
|-----------|-----------------------------------|
| PMLN5334_ | Soft Leather Protective Case, LKP |
|-----------|-----------------------------------|

**Chargers And Power Adapters**

|            |                                                              |
|------------|--------------------------------------------------------------|
| EPNN9288_  | 90 – 264 V, SMPS with NA/LA country plug                     |
| PMLN5228_R | Tri-Chem Single Unit Charger base                            |
| PMLN5398_  | Single Unit Charger Base with switch mode power supply (Kit) |

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

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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.

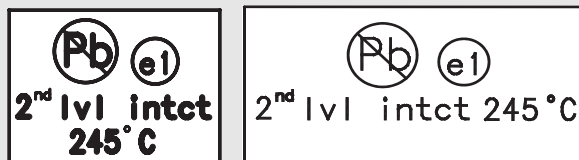
All orders for parts/information should include the complete Motorola identification number. Request for help in identification of non-referenced spare parts should be directed to the Motorola's local area representation. When damaged parts are replaced, identical parts should be used. If the identical 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).

## 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.

## 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   | Electrically 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                                                                                                                                                                                                                   |

| Term                       | Definition                                                                                                                                |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| PL                         | Private-Line <sup>®</sup> 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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