ST7000 Basic Service Manual

MN002952A01-AH

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Copyrights

Disclaimer

Please note that certain features, facilities, and capabilities described in this document may not be applicable to or licensed for use on a specific system, or may be dependent upon the characteristics of a specific mobile subscriber unit or configuration of certain parameters. Please refer to your Motorola Solutions contact for further information.

Trademarks

European Union (EU) Waste of Electrical and Electronic Equipment (WEEE) directive

The European Union's WEEE directive requires that products sold into EU countries must have the crossed out trash bin label on the product (or the package in some cases).

As defined by the WEEE directive, this cross-out trash bin label means that customers and end-users in EU countries should not dispose of electronic and electrical equipment or accessories in household waste.

Customers or end-users in EU countries should contact their local equipment supplier representative or service centre for information about the waste collection system in their country.

Document History

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

Table 1: Document History

Edition	Description	Date
MN002952A01-AA	Initial edition	November 2016
MN002952A01-AB	• Changed 350–470 MHz to 380-430 MHz. • Updated ST7000 Series Model Specifications. • Updated Test Check List. • Added antenna in Accessories Replacement Parts List. • Updated Display Description.	March 2017
MN002952A01-AC	• Updated Sales Model Short Description. • Updated Sales Model Nomenclature.	April 2017
MN002952A01-AD	Updated Test Setup and Testing.	April 2017
MN002952A01-AE	Added 800 MHz model and updated 415 MHz and 465 MHz	August 2017
MN002952A01-AF	Added IFR 3901/IFR 3902/IFR 3920 configuration steps for Japan radios.	February 2019
MN002952A01-AG	Removed Motorola Solutions Propriety footer.	June 2019
MN002952A01-AH	Updated the EU contact in Service information	November 2019

Scope of this Manual

This manual contains information necessary to test and maintain the TETRA radio at the module level. It also contains information on radio assembling and disassembling.

Notations Used in This Manual

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

WARNING: WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or injury.

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

NOTICE: NOTICE indicates an operational procedure, practice, or condition that is essential to emphasize.

Safety Information

This chapter is an extract of the multilingual safety booklet publication. For the latest safety information, refer to the separate safety booklet delivered with your radio.

RF Energy Exposure and Product Safety Guide

> **CAUTION:** Before using this radio, read the guide enclosed with your radio which contains important operating instructions for safe usage and RF energy awareness and control for compliance with applicable standards and regulations.

Compliance with RF Exposure Standards

Your Motorola Solutions two-way radio is designed and tested to comply with various national and international standards and guidelines for human exposure to radio frequency electromagnetic energy.

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

- United States Federal Communications Commission (FCC), Code of Federal Regulations; 47 CFR et seq.

- FCC, OET Bulletin 65

- Institute of Electrical and Electronic Engineers (IEEE) C95.1

- International Commission on Non-Ionizing Radiation Protection (ICNIRP)

- Ministry of Health (Canada) Safety Code 6

- Industry Canada RSS-102

- Australian Communications Authority Radiocommunications Standard et seq.

- ANATEL ANNEX to Resolution No. 303 et seq.

This radio complies with the IEEE (FCC) and ICNIRP exposure limits for occupational/controlled RF exposure environments at operating duty factors of up to 50% talk-50% listen. The IEEE/ICNIRP authorizes this radio for occupational use only.

> **NOTICE:** The approved batteries, supplied with the portable radio, are rated for a 5-5-90 duty cycle (5% talk–5% listen–90% standby), even though this radio complies with IEEE/ICNIRP occupational exposure limits at usage factors of up to 50% talk.

In terms of measuring RF energy for compliance with these exposure guidelines, your radio generates measurable RF energy only while it is transmitting (during talking), not when it is receiving (listening) or in standby mode.

Federal Communication Commission (FCC) Regulations

The FCC rules require manufacturers to comply with the FCC RF energy exposure limits for two-way radios before they can be marketed in the U.S.

When two-way radios are used as a consequence of employment, the FCC requires users to be fully aware of and able to control their exposure to meet occupational requirements. The use of a product label directing users to specific user awareness information can facilitate exposure awareness. Your Motorola Solutions two-way radio has Exposure Product Label. Do not remove this RF Exposure Label from the device. Also, your Motorola Solutions user manual, or separate safety booklet includes information and operating instructions required to control your RF exposure and to satisfy compliance requirements.

RF Energy Exposure Awareness, Control Information, and Operational Instructions for Occupational Use

NOTICE: This radio is intended for use in occupational/controlled conditions where users have full knowledge of their exposure and can exercise control over their exposure to meet the occupational limits in FCC/ICNIRP and International standards. This radio device is NOT authorized for general population consumer use.

This two-way radio uses electromagnetic energy in the radio frequency (RF) spectrum to provide communications between two or more users over a distance. It uses radio frequency (RF) energy or radio waves to send and receive calls. RF energy is one form of electromagnetic energy. Other forms include, but are not limited to, sunlight and x-rays. RF energy, however, should not be confused with these other forms of electromagnetic energy, which when used improperly, can cause biological damage. High levels of x-rays, for example, can damage tissues and genetic material.

Experts in science, engineering, medicine, health, and industry work with organizations to develop standards for safe exposure to RF energy. These standards provide recommended levels of RF exposure for both workers and the general public. These recommended RF exposure levels include substantial margins of protection.

All Motorola Solutions two-way radios are designed, manufactured, and tested to ensure that they meet government-established RF exposure levels. In addition, manufacturers also recommend specific operating instructions to users of two-way radios. These instructions are important because they inform users about RF energy exposure and provide simple procedures on how to control it.

Refer to the following websites for more information on what RF energy exposure is and how to control your exposure to assure compliance with established RF exposure limits:

http://www.fcc.gov/oet/rfsafety/rf-faqs.html

http://www.osha.gov/SLTC/radiofrequencyradiation/index.html

RF Exposure Compliance and Control Guidelines

Always adhere to the following procedures to control RF exposure to yourself and others and also to comply to the occupational/controlled environment exposure limits.

- Do not remove the RF Exposure Label from the device.

- User awareness instructions should accompany device when transferred to other users.

- Do not use this device if it does not meet the operational requirements.

Operating Instructions

- Transmit no more than the rated duty factor of 50% of the time. To transmit (talk), push the Push-To-Talk (PTT) button. To receive calls, release the PTT button. It is important to transmit 50% of the time or less, because this radio generates measurable RF energy exposure only when transmitting.

- Hold the radio in a vertical position in front of the face with the microphone (and other parts of the radio including the antenna) at least 2.5 cm (one inch) away from the nose or lips. Keep the antenna away from the eye. Keeping the radio at a proper distance is important as RF exposure decreases with increasing distance from the antenna.

- When worn on the body, always place the radio in a Motorola Solutions-approved clip, holder, holster, case, or body harness. The use of non-Motorola Solutions-approved accessories may result in exposure levels exceeding the IEEE/ICNIRP occupational/controlled environment RF exposure limits.

Approved Accessories

Use only Motorola Solutions-approved supplied or replacement antennas, batteries, and accessories. Use of non-Motorola Solutions-approved antennas, batteries, and accessories may exceed IEEE/ ICNIRP RF exposure guidelines.

For a list of Motorola Solutions-approved antennas, batteries, and other accessories, contact your dealer or local Motorola Solutions contact. Your nearest dealer can be found at www.motorolasolutions.com.

Additional Information

For additional information on exposure requirements or other training information, visit http:// responsibility.motorolasolutions.com/index.php/downloads/dow07-rfexposureassessmentstand/

Intrinsically Safe Radio Information

A radio that has been approved for intrinsic safety has the Intrinsically Safe Approval Label attached to the radio. This label specifies the hazardous Class/Division/Group along with the part number of the battery that must be used.

The Intrinsically Safe Approval unit refers to a product that has been approved as intrinsically safe by an approval agency (such as FM Approvals, CSA, UL, CENELEC, or ATEX). It certifies that a particular product meets the applicable intrinsic safety standards for specific types of hazardous classified locations of the agency.

Operational Cautions for Intrinsic Safe Equipment

Radios must be shipped from the Motorola Solutions manufacturing facility with the hazardous atmosphere capability and the intrinsic safety approval labeling (FM, UL, CSA, CENELEC, or ATEX). Radios will not be upgraded to this capability and labeled once they have been shipped to the field.

A modification changes the hardware of the unit from its original design configuration. Only the original product manufacturer can modify the hardware.

⚠️ **WARNING:**

- Do not operate radio communications equipment in a hazardous atmosphere unless it is a type especially qualified (such as FM, UL, CSA, CENELEC, or ATEX approved). An explosion or fire may result.

- Do not operate a radio unit that has been approved as intrinsically safe product in a hazardous atmosphere if it has been physically damaged (for example, cracked housing). An explosion or fire may result.

- Do not replace or charge batteries in a hazardous atmosphere. Contact sparking may occur while installing or removing batteries and cause an explosion or fire.

- Do not replace or change accessories in a hazardous atmosphere. Contact sparking may occur while installing or removing accessories and cause an explosion or fire.

- Turn off the radio before removing or installing a battery or accessory.

- Do not disassemble an intrinsically safe product in any way that exposes the internal circuits of the unit.

- Failure to use an intrinsically safe approved battery or approved accessories for the radio unit may result in the dangerously unsafe condition of an unapproved radio combination being used in a hazardous location.

- Unauthorized or incorrect modification of the intrinsically safe approved product negates the approval rating of the product.

- Incorrect repair or relabeling of any intrinsically safe agency-approved radio could adversely affect the approval rating of the unit.

- Use of a radio that is not intrinsically safe in a hazardous atmosphere could result in serious injury or death.

Do Not Substitute Options or Accessories

The Motorola Solutions communications equipment certified as intrinsically safe by the approving agency (FM, UL, CSA, CENELEC, or ATEX) is tested as a complete system which consists of the listed agency approved portable, approved battery, and approved accessories or options, or both. This approved portable and battery combination must be strictly observed. There must be no substitution of items, even if the substitute has been previously approved with a different Motorola Solutions communications equipment unit. The approving agency (FM, UL, CSA, CENELEC, or ATEX) lists all the approved configurations.

The Intrinsically Safe Approval Label affixed to the radio refers to the intrinsically safe classification of that radio product, and the approved batteries that can be used with that system.

The manual part number referenced on the Intrinsically Safe Approval Label identifies the approved accessories and/or options that can be used with that portable radio unit.

Using a non-Motorola Solutions intrinsically safe battery and/or accessory with the Motorola Solutions approved radio unit voids the intrinsically safe approval of that radio unit.

Repair

A repair constitutes something done internally to the unit that would bring it back to its original condition.

Repairs for Motorola Solutions products with intrinsically safe approval are the responsibility of the user. Repairs to a Motorola Solutions FM approved radio product should only be done at a location that has been FM audited under the FM 3605 repairs and service standard. Contact Motorola Solutions for assistance regarding repairs and service of Motorola Solutions intrinsically safe equipment.

Items not considered as repairs are items in which an action is performed on a unit which does not require the outer casing of the unit to be opened in a manner which exposes the internal electrical circuits of the unit.

Electromagnetic Interference/Compatibility

If inadequately shielded, designed, or otherwise configured for electromagnetic compatibility, nearly every electronic device is susceptible to Electromagnetic Interference (EMI).

Facilities

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

Medical Devices

Pacemakers

The Advanced Medical Technology Association (AdvaMed) recommends that a minimum separation of 15 cm (6 in.) be maintained between a hand-held wireless radio and a pacemaker. These recommendations are consistent with those of the U.S. Food and Drug Administration. Persons with pacemakers should:

- ALWAYS keep the radio more than 15 cm from their pacemaker when the radio is turned ON.

- Not carry the radio in the breast pocket.

- Use the ear opposite the pacemaker to minimize the potential of interference.

- Turn the radio OFF immediately if you have any reason to suspect that interference is taking place.

Hearing Aids

Some digital wireless radios may interfere with some hearing aids. In the event of such interference, you may want to consult your hearing aid manufacturer to discuss alternatives.

Other Medical Devices

If you use any other personal medical device, consult the manufacturer of your device to determine if it is adequately shielded from RF energy. Your physician may be able to assist you in obtaining this information.

Aircraft

When instructed to do so, turn off your radio when on board an aircraft. Any use of a radio must be in accordance with applicable regulations per airline crew instructions.

$C\epsilon$ European Union Directives Conformance Statement

This product is in conformance with the TETRA (TErrestrial Trunked RAdio) standard. This product is in conformance with the requirements of the applicable EU Council Directives.

Use of Communication Devices While Driving

Always obey the laws and regulations on the use of radios in the area where you drive.

- Give full attention to driving and to the road.

- Use hands-free operation, if available.

- Pull off the road and park before making or answering a call if driving conditions or regulations so require.

Operational Warnings

⚠️ **WARNING:**

For vehicles with an air bag, refer to the manual of the vehicle manufacturer before installation of electronic equipment to avoid interference with air bag wiring.

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

Potentially Explosive Atmospheres (explosive atmospheres refers to hazard classified locations that may contain hazardous gas, vapors, or dusts)

Turn off your radio before entering any area with a potentially explosive atmosphere, unless it is a radio type especially qualified for use in such areas as "Intrinsically Safe" (such as Factory Mutual, CSA, UL, CENELEC, or ATEX approved). Do not remove, install, or charge batteries in such areas. Sparks in a potentially explosive atmosphere can cause an explosion or fire resulting in bodily injury or even death.

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

Blasting Caps And Blasting Areas

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

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

Operational Cautions

⚠️ **CAUTION:**

Antennas

Do not use any portable radio that has a damaged antenna. If a damaged antenna comes into contact with your skin, a minor burn can result.

Batteries

If a conductive material such as jewelry, keys, or beaded chains touch exposed battery terminals, it can cause property damage and/or bodily injury such as burns. The conductive material may complete an electrical circuit (short circuit) and become hot. Exercise care in handling any charged battery, particularly when placing it inside a pocket, purse, or other container with metal objects.

Warranty and Service Support

Motorola Solutions 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.

Warranty Period and Return Instructions

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

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

Prior to shipping any radio back to the appropriate Motorola Solutions warranty depot, please contact Customer Resources or your Motorola Solutions dealer, distributor or reseller. All returns must be accompanied by a Warranty Claim Form, available from your Customer Service representative or Motorola Online (MOL) or your Motorola Solutions dealer, distributor or reseller. Products should be shipped back in the original packaging, or correctly packaged to ensure no damage occurs in transit.

After Warranty Period

After the Warranty period, Motorola Solutions continues to support its products.

- Motorola Solutions Regional Radio Support Centers offer a repair service to both end users and dealers at competitive prices.

- Dealers who are technically capable of performing fault analysis and repair can purchase individual parts and modules from the Radio Products and Solutions Organization (RPSO).

Related EMEA Region Publications

This section contains part numbers and titles of related Europe, Middle East, and Africa (EMEA) region publications.

Table 2: Quick Start Guides

Part Number	Language
MN002961A01	en-US
MN002999A01	es-LA
MN003000A01	pt-BR
MN003001A01	ar-EG
MN003002A01	da-DK
MN003003A01	nl-NL
MN003004A01	fr-FR
MN003005A01	de-DE
MN003006A01	it-IT
MN003007A01	nb-NO
MN003008A01	pl-PL
MN003009A01	es-ES
MN003010A01	pt-PT
MN003011A01	sv-SE
MN003012A01	ru-RU
MN003013A01	uk-UA
MN003199A01	fi-FI
MN004977A01	ca-ES
MN005278A01	tr-TR

Table 3: User Manuals

Part Number	Description	Language
MN002958A01	ST7000 Feature User Guides	en-US
MN003015A01		en-US and es-LA
MN003016A01		en-US and pt-BR
MN003017A01		en-US and de-DE
MN002955A01	ST7000 Product Information	en-US

Table 4: Other Related Manuals

Part Number	Description	Language
MN002951A01	ST7000 Detailed Service Manual	en-US

Chapter 1

Model Information

This manual applies to the following ST7000, Class 3L, TETRA Handportable Terminal model:

Table 5: ST7000 Sales Models

Sales Model No.	Short Description
MDH67PCL6TZ5AN	ST7000 380–430 MHz PTM412DE
MDH67PCL6TZ5ANB	ST7000 380–430 MHz BULK PTM412DE

1.1

ST7000 Model Specifications

NOTICE: Specifications subject to change without notice.

The following are the model specifications for sales model as listed:
Sales Model No.:
  MDH67PCL6TZ5AN

  MDH67PCL6TZ5ANB

Table 6: General Specifications for 380–430 MHz Sales Models

GENERAL	
ETSI:	ETS 300 019-1-7
Type Number:	
380.0–430.0 MHz	PTM412DE
Temperature Range for Transceiver:	
Operating	-20 °C to +55 °C
Storage	-30 °C to +85 °C
Battery Types:	
Standard	Removable 2300 mAH IMPRES Li-Ion
Battery Voltage:	
Minimum	3.2 Vdc
Nominal	3.8 Vdc
Portable Dimensions: (HxWxD in mm)	107x60x19 mm with standard battery
	132x60x19 mm with antenna
Weight:	
With standard battery and stubby antenna	173 g

Table 7: Receiver Specifications for 380–430 MHz Sales Models

RECEIVER	
Receiver Type:	Class A and B
Frequency Range:	380.0–430.0 MHz
Channel Spacing:	25 kHz
Sensitivity (3.5%) BER:	-114 dBm (guaranteed)
	-116 dBm (typical)
Intermodulation:	(3.5%) BER
Interfering Signal Level	-47 dBm
Selectivity Blocking: (50–100 kHz)	(3.5%) BER
Interfering Signal Level	-40 dBm
Spurious Rejection:	(3.5%) BER
Interfering Signal Level	-45 dBm
Frequency Stability:	
Locked to Base	+100 Hz
Unlocked to Base	+1000 Hz
Audio Rated	1 W
Distortion at Rated Audio:	15% Max.

Table 8: Transmitter Specifications for 380–430 MHz Sales Models

TRANSMITTER	
Modulation Type:	π/4DQPSK
RF Power:	1.8 W
Frequency Range:	
TMO	380.0–430.0 MHz
DMO	380.0–430.0 MHz
Frequency Stability:	
Locked to Base:	+100 Hz
Unlocked to Base:	+1000 Hz
Spurious Emissions:	
Conducted	
30 MHz–1 GHz:	-36 dBm
1 GHz–12.75 GHz:	-30 dBm
Radiated	
30 MHz–1 GHz:	-36 dBm
1 GHz–12.75 GHz:	-30 dBm
Adjacent Channel Power (at ±25 kHz):	

TRANSMITTER	
Class 4 (1 W)	55 dBc
Class 3L (1.8 W)	60 dBc

1.2
Sales Model Nomenclature

Table 9: Model Numbering Scheme

Typical Model Number	AZ	H	6	7	P	C	L	6	T	Z	5	A	N
Position	0	1	2	3	4	5	6	7	8	9	10	11	12

Table 10: Sales Models – Description of Positions

Position	Description	Value
0	Applicable Region	AZ = Asia/Latin America Central Region (APAC/LACR)
		AN = Australia & New Zealand (ANZ)
		MD = Europe, Middle East, and Africa (EMEA)
1	Type of Unit	H = Hand-Held Portable
		M = Mobile Product
2	Model Series	67 = Motorola Solutions ST7000 Family
3		
4	Frequency Band	P = 380–430 MHz
		R = 415 MHz and 465 MHz
		U = 806–870 MHz
		NOTICE: Values given represent range only; they are not absolute.
5	Power Level	A = 0–0.7 W
		B = 0.7–0.9 W
		C = 1.0–3.9 W
		D = 4.0–5.0 W
		E = 5.1–6.0 W
		F = 6.1–10.0 W
6	Physical Packages	L = Limited Controls – Limited Display
7	Channel Spacing	1 = 5 kHz
		2 = 6.25 kHz
		3 = 10 kHz
		4 = 12.5 kHz
		5 = 15 kHz

Position	Description	Value
		6 = 25 kHz
		7 = 30 kHz
8	Primary Operation	N = Digital Front
		Q = Low Profile – Basic Display
		R = Digital Multi-Service
		T = TDMA Digital Dual Mode
9	Primary System Type	Z = Dimetra
10	Feature Level	1 = Basic
		2 = Limited Package
		3 = Limited Plus
		4 = Intermediate
		5 = Standard Package
		6 = Standard Plus
		7 = Expanded Package
		8 = Expanded Plus
		9 = Full Feature/Programmable
11	Version	Version Letter (Alpha) – Major Change
		Version Letter (Beta) – Major Change
12	Unique Model Variations	N = Standard Package

Overview

To achieve a high spectrum efficiency, the radio uses digital modulation technology and sophisticated voice-compression algorithm. The voice of the person speaking into the microphone is converted into a digital bit stream consisting of zeros (0) and ones (1).

This stream is then modulated into a radio frequency (RF) signal, which is transmitted over-the-air to another radio. The process is called digital modulation.

2.1
Digital Modulation Technology

The radio operates in dispatch and phone modes.

The radio also operates in Trunked Mode Operation (TMO) and Direct Mode Operation (DMO). It uses the π/4 DQPSK and Time Division Multiple Access (TDMA) digital technologies.

π/4DQPSK is a modulation technique that transmits information by altering the phase of the signal. Data is converted into complex symbols, which alter the RF signal and transmit the information. When the signal is received, the change in phase is converted back into symbols and then into the original data.

The system can accommodate 4-voice channels in the standard 25 kHz channel as used in the two-way radio. TDMA is used to allocate portions of the RF signal by dividing time into four slots, one for each unit.

Time allocation enables each unit to transmit its data information without interference from other transmitting units. Transmission from a unit or base station is accommodated in time-slot lengths of 15 ms and frame lengths of 60 ms. The TDMA technique requires sophisticated algorithms and a Digital Signal Processor (DSP) to perform voice compressions/decompressions and RF modulation/demodulation.

2.2
Voice Compression Technology

Voice is converted into a digital bit stream by sampling the voice at high rate and converting the samples into numbers, which are represented by bits.

Voice compression reduces the number of bits per second while maintaining the voice at an acceptable quality level. The radio uses a coding technique called Algebraic Code Excited Linear Prediction (ACELP). The compressed voice-data bits modulate the RF signal.

2.3
Transceiver

All radio circuitry are contained in the Digital/RF board and the keypad board.

The Digital/RF board is divided into the following sections.

- Digital
- Transmitter
- Receiver
- Frequency Generating

2.3.1
Digital Section

The digital section is based on a Dual Core System On a Chip (SoC) processor, a low-power Applications processor with dual core architecture based on Advanced RISC Machine (ARM) application core and Digital Signal Processor (DSP) core with floating point.

The dual-core architecture of the Dual Core Processor SoC provides benefits of both DSP and Reduced Instruction Set Computing (RISC) technologies.

The DSP performs modulation and de-modulation functions for the radio. It also performs Forward Error Correction and other correction algorithms for overcoming channel errors and Algebraic Code Excited Linear Prediction (ACELP) speech coding. It carries out linear 16-bit analog to digital conversions, audio filtering, and level amplification for the microphone audio input and the received audio output.

The power and audio section is based on the Power Management IC and includes power supplies, audio routing, microphone, and earpiece amplifiers. An external audio power amplifier is used for the loudspeaker.

2.3.2
Transmitter Path

The transmitter circuitry includes a linear class AB Power Amplifier (PA) for the linear modulation of the terminal. It includes a Cartesian Loop to enhance its transmitter linearity and reduce splattering power into adjacent channels.

The transmitter path consists of a Cartesian Loop that contains forward and feedback paths. The forward path includes the following items.

- Tx Power Control Integrated Circuit
- Balanced-Unbalanced Converter (BALUN)
- Attenuator
- Power Amplifier
- Coupler
- Antenna Switch

The loop feedback path includes the following items.

- Tx Power Control Integrated Circuit
- BALUN
- Attenuator
- Directional Coupler

2.3.3
Receiver Path

The receiver section in the radio is based on the DCR (Direct Conversion) technology. The main concept of this technology is down converting of the RF signal directly into a base band signal, skipping the intermediate stage of IF signal.

The receiver path includes the following items.

- Duplexer
- Antenna Switch
- RF Switches

- Off Channel Detector and Inverting Schmitt Trigger

- Balanced-Unbalanced Converter (BALUN)

- Limiter

- 2-bit 6/12/18 dB Step Attenuator

- Discrete Front Filter

- Low Noise Amplifier (LNA) integrated with Step Attenuator and Automatic Gain Control (AGC) continuous attenuation

- 13 dB (350 MHz) or 12 dB (800 MHz) of Gain with LNA Bypass Option

- Discrete Post-Selector Filter (350 MHz) or SAW Post-Selector Filter (800 MHz)

- RFIC for mixing

- Baseband filtering and internal 55 dB AGC continuous attenuation (inclusive of the internal 10 dB step attenuator) which consists of all the baseband receive chain and mixer.

2.3.4
Frequency Generating Section

The frequency generating section includes the following components.

- RFIC Fractional-N Synthesizer

- Reference Oscillator

- Loop Filter

- Voltage Multiplier

2.4
Bluetooth Section

The Bluetooth (BT) section includes the following main components.

- BT Antenna

- RF Connector

- Bandpass Filter

- Switch

- TCXO

- BT IC

2.5
Global Navigation Satellite System Section

The Global Navigation Satellite System (GNSS) section includes the following main components.

- GNSS Antenna

- Front Filters

- GNSS IC

Chapter 3

Programming the Radio

> **NOTICE:** For programming the radio, refer to *6802974C10 TETRA Customer Programming Software (CPS) Plus Start-up User Guide*.

Chapter 4

Test Setup and Testing

This chapter provides a general overview for testing Motorola Solutions radios.

⚠️ **CAUTION:** Any level 3 repairs can deeply affect the performance of the terminal and may cause a new tuning procedure. Certain authorized Motorola Solutions depots, where the appropriate test and tune equipment is available, applies this tuning procedure. The appropriate test and tune equipment is a special automated test equipment which is only available at some Motorola Solutions factories and Motorola Solutions repair centers.

📝 **NOTICE:** There may be some differences caused by the various software versions running on the testing equipment. Consult the user guides of the respective testing equipment for further details.

4.1
Typical Test Setup

Carry out the following instructions before testing:

- Check that you have a fully charged battery (not required when using Battery Eliminator and RF radio antenna adapter).

- To test the radio, a special Battery Eliminator (PS000230A01 for firmware MR16 and above; PS000241A01 for firmware MR16.5 and above) with RF Cable Kit (TL000100A01) and a SMA type RF Cable are required.

- Detach the antenna from the radio.

- Connect the RF Cable Kit at the rear side of your radio and fix it with the retainer by tightening the thumb screw.

- Connect the other side of the cable to the N-type RF Connector of the IFR using an N-type-to-SMA-adapter.

- Connect the power supply to the battery eliminator wires.

Figure 1: Battery Eliminator Overview

No.	Description
1	UART Communication Mode
2	USB/Normal Power ON Mode
3	Blank Board Flashing Mode
4	UART Connector

CAUTION: Connect the red (+) and black (-) wires of the battery eliminator to the respective positive and negative points of the power supply, and use the correct voltage (3.8 VDC, maximum 4.2 VDC). Failing to properly connect the wires would damage your radio and/or the power supply.

Figure 2: Typical Test Setup
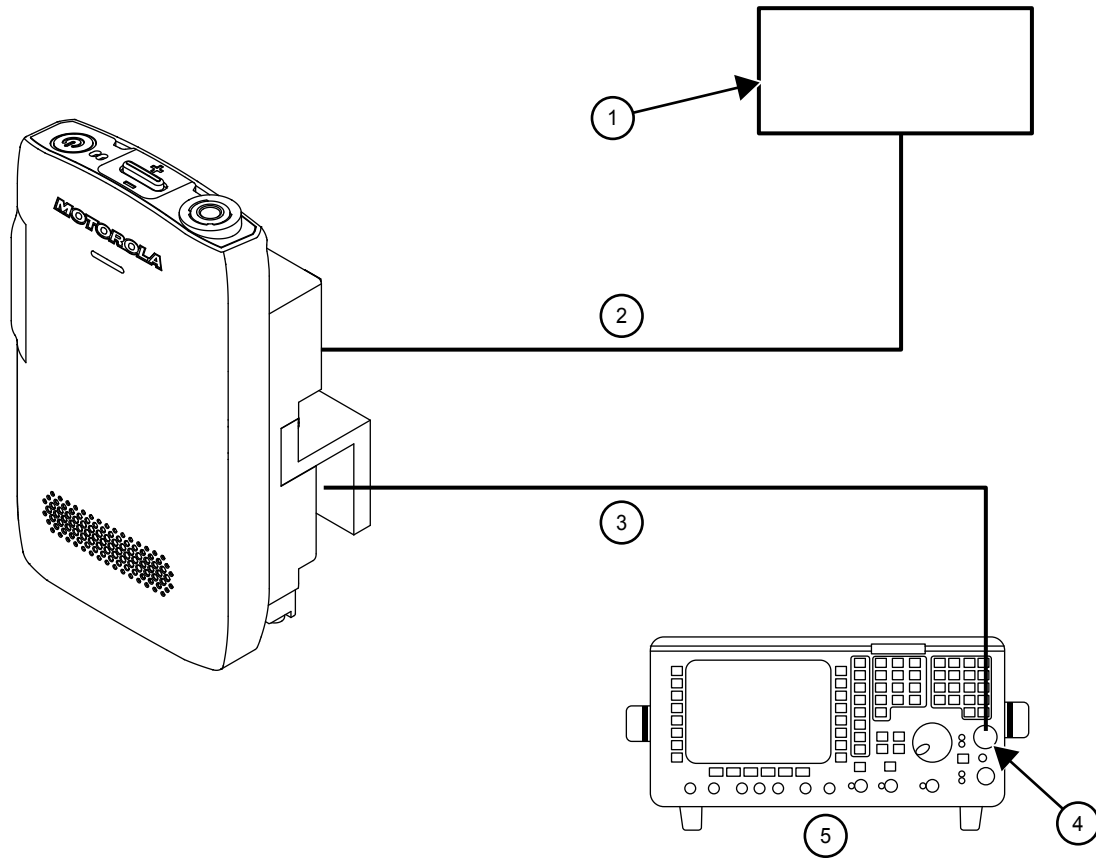
No.	Description
1	3.8 V Power Supply
2	Battery Eliminator connected to Power Supply
3	RF Cable
4	N-type RF Connector
5	IFR 39xx/IFR 2968

4.1.1
Assembly Procedures

Procedure:

1 Insert the bottom area of the battery eliminator into the compartment.

Figure 3: Battery Eliminator Insertion
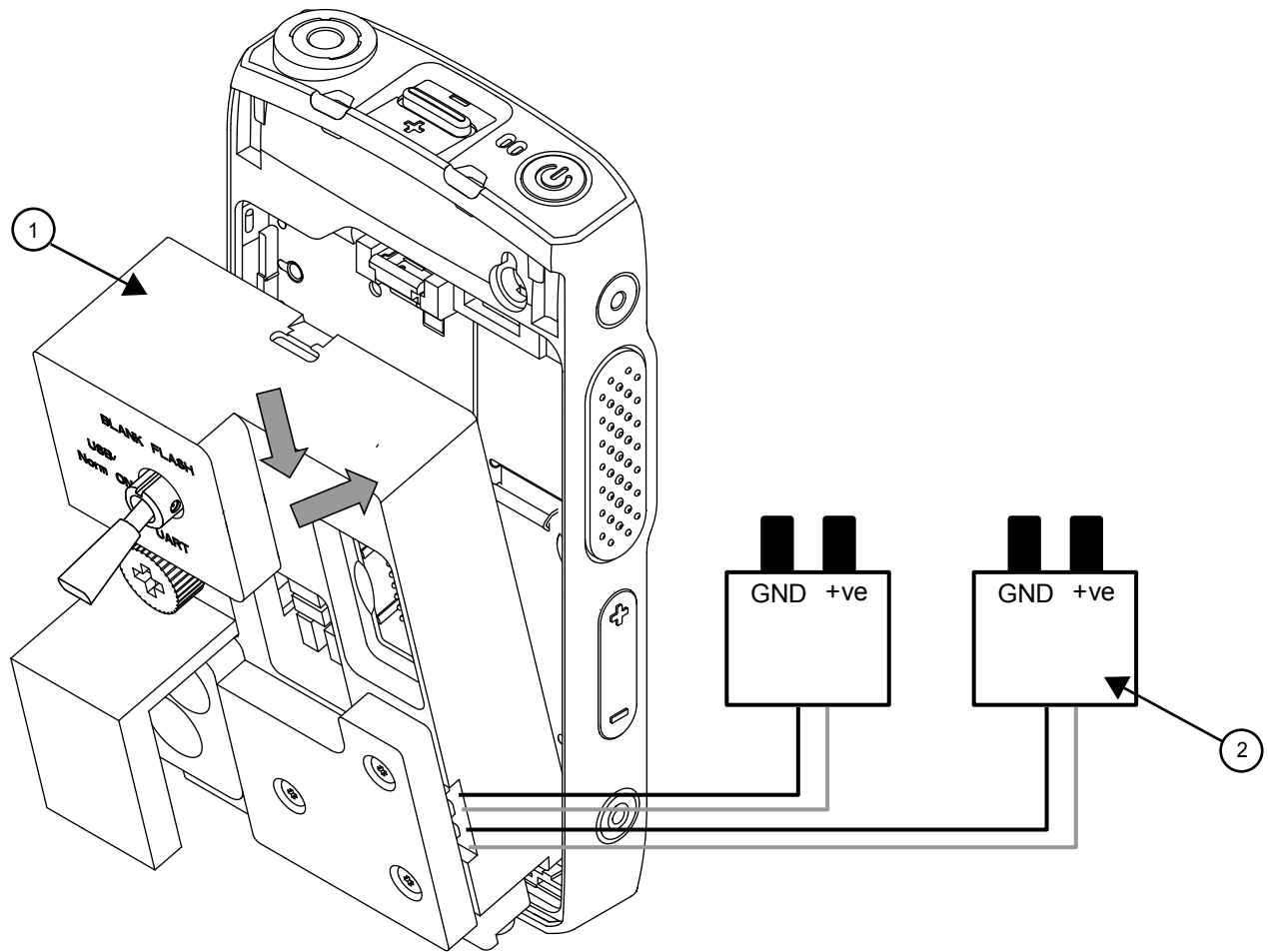
No.	Description
1	Battery Eliminator
2	Banana Plug

2 Press down the top area of the battery eliminator into the compartment until it clicks.

3 Remove the retainer by loosening the thumb screw.

⚠ **WARNING:**
Use the right RF cable kit for testing, else it damages the RF connector.

- RF Cable Kit TL000100A01 for RF testing.
- RF Cable Kit TL000068A01 for GPS testing.

4 Align the RF Cable Kit into the RF slot.

5 Insert the RF Cable Kit into the RF slot. A slight friction is felt when the RF Cable Kit is connected to the RF switch located inside the radio.

6 Push the RF plug deeper into the slot until it reached maximum depth.

7 Reassemble the retainer and tighten the thumb screw.

Figure 4: RF cable kit insertion
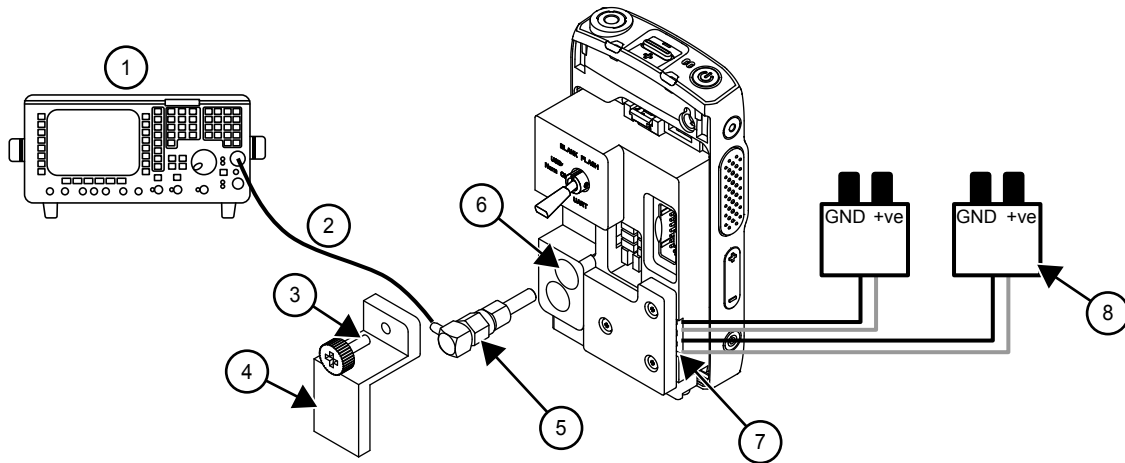
No.	Description
1	IFR 39xx/IFR 2968
2	RF Cable
3	Thumb Screw
4	Retainer
5	RF Cable (Part Number TL000100A01)
6	RF Plug Slot
7	Battery Eliminator
8	Banana Plug

4.1.2
Disassembly Procedures

Procedure:

1 Loosen the thumb screw.

2 Remove the retainer horizontally backward.

3 Remove the RF plug horizontally backward. Ensure that the RF plug is fully removed.

Figure 5: Removing RF Cable Kit
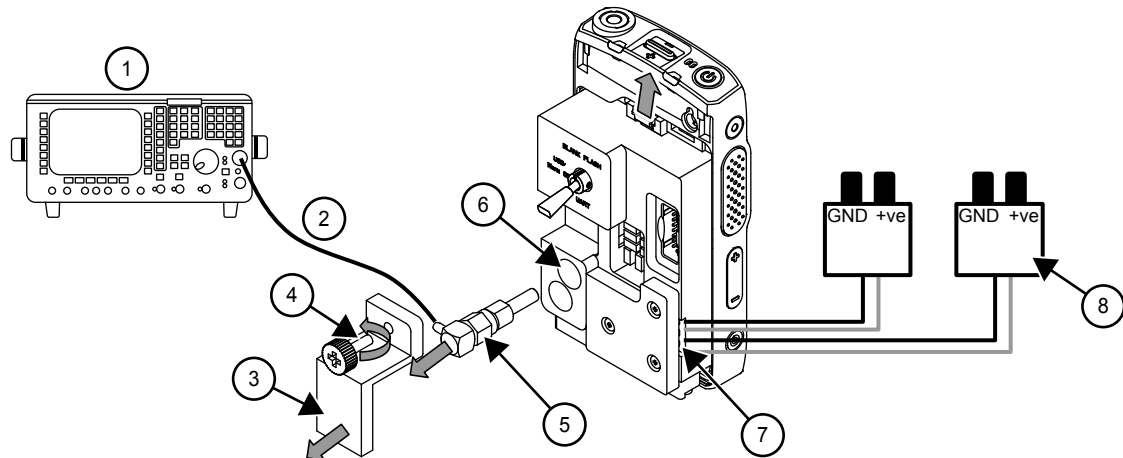
No.	Description
1	IFR 39xx/IFR 2968
2	RF Cable
3	Thumb Screw
4	Retainer
5	RF Cable (Part Number TL000100A01)
6	RF Plug Slot
7	Battery Eliminator
8	Banana Plug

4 Push up the battery latch. The battery eliminator is slightly ejected from the slot.

5 Pull the top part of the battery eliminator outward from the compartment.

Figure 6: Battery eliminator removal
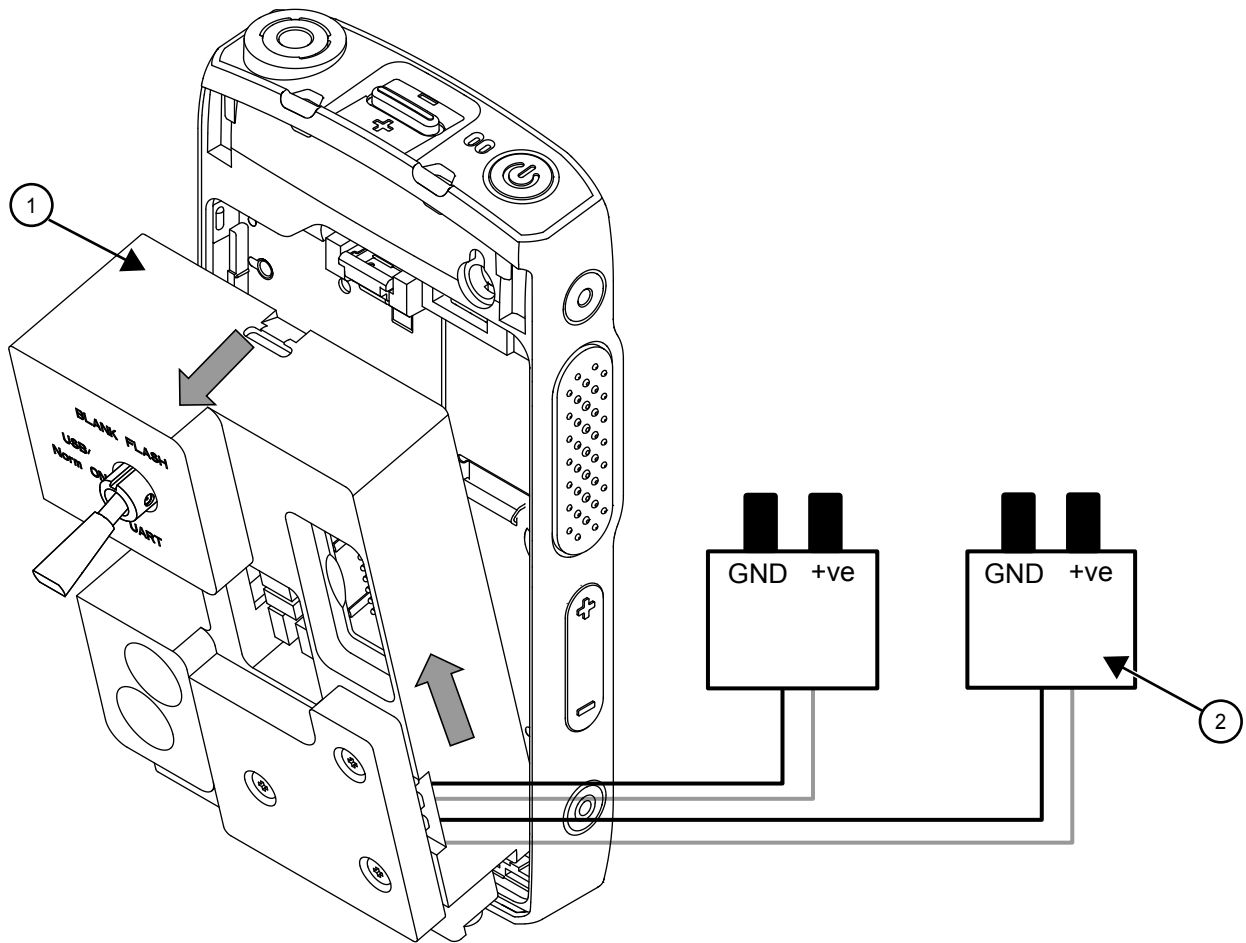
No.	Description
1	Battery Eliminator
2	Banana Plug

6 Fully remove the battery eliminator from the compartment.

Flashing Mode

This section lists the applicable flashing mode for the radio and its procedures.

• Blank Flash Mode

> **NOTICE:** Blank Board Flashing Mode is not supported and can only be performed at authorized Motorola Solutions Repair Center.

• USB-C/Norm Mode

• UART Mode

4.2.1
Connecting the Radio in Blank Flash Mode

The function of this mode is for blank board flashing.

Procedure:

1 Flip up the battery eliminator switch.

2 Connect the serial data cable to the PC.

3 To enter Boot Me mode, press the **On/OFF** button or connect the programming cable to the PC.

Figure 7: Connecting the Radio in Blank Flash Mode (1 of 2)
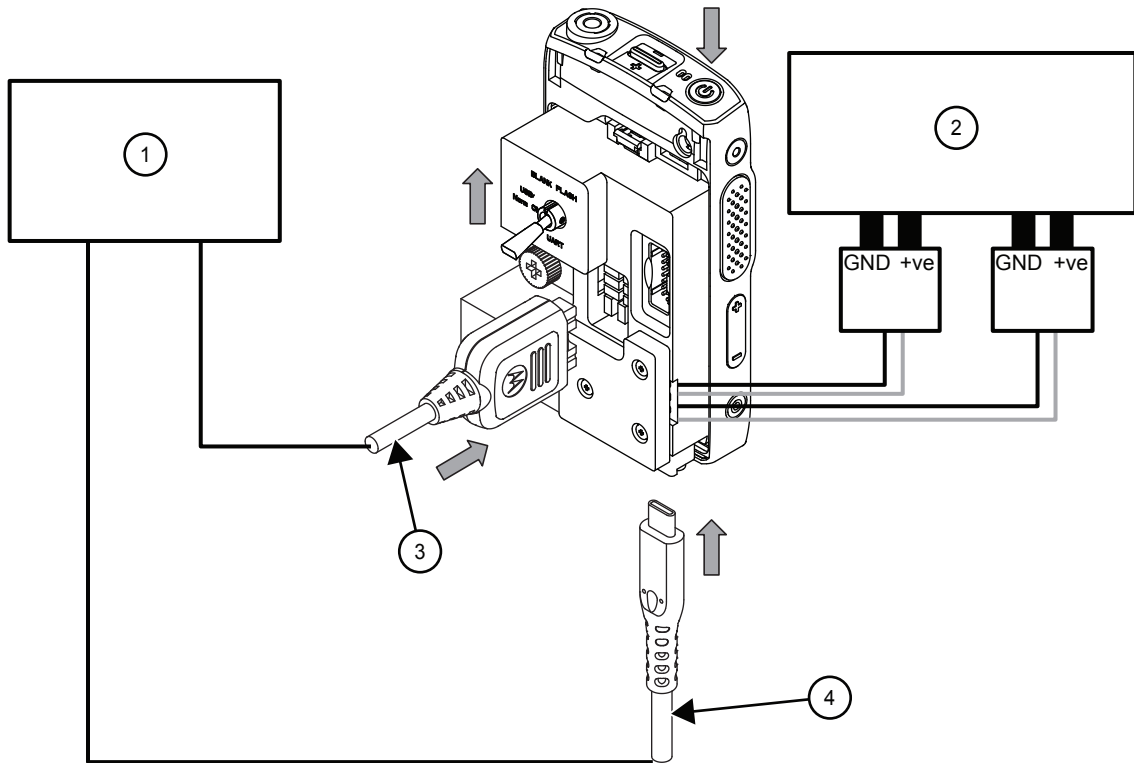
No.	Description
1	Personal Computer
2	Power Supply 3.8 V
3	Serial Data Cable
4	Programming Cable (USB Type-C)

4 Push the battery eliminator switch to the middle.

5 Ensure that the programming cable is connected to the radio and the PC.

6 Flash the software or firmware to the radio.

Figure 8: Connecting the Radio in Blank Flash Mode (2 of 2)
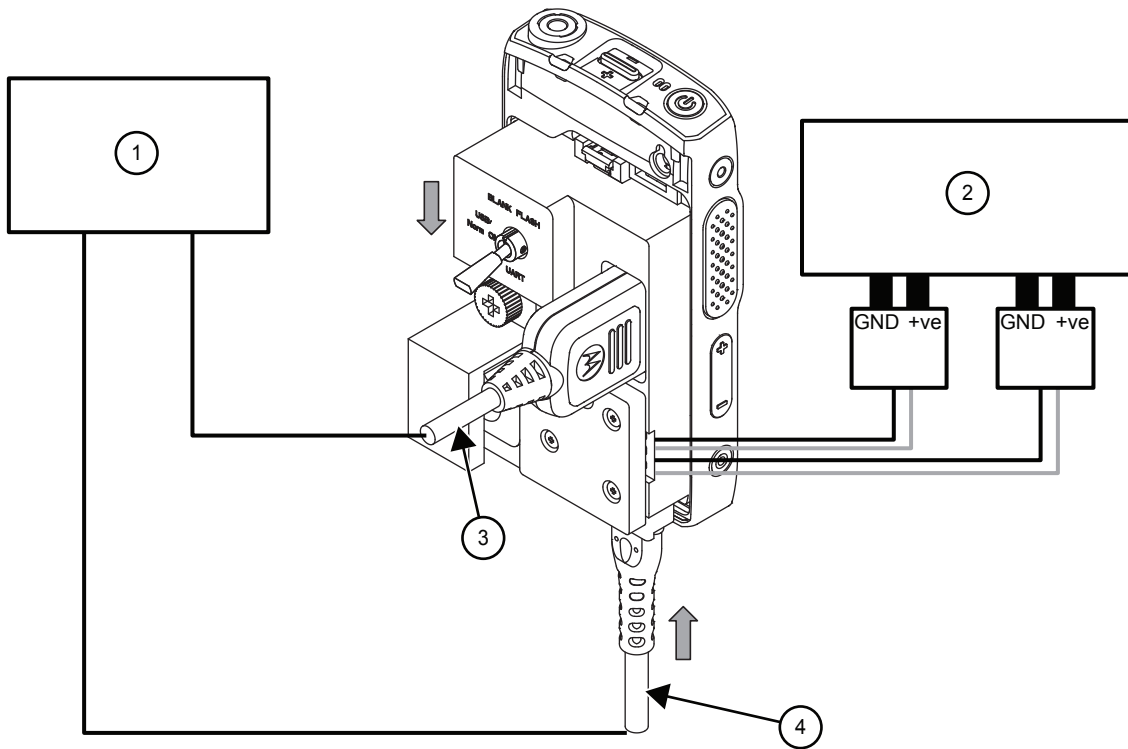
No.	Description
1	Personal Computer
2	Power Supply 3.8 V
3	Serial Data Cable
4	Programming Cable (USB Type-C)

4.2.2

Connecting the Radio in USB-C/Norm Mode

The function of this mode is for radio normal power-up and programming cable connection between the radio and the PC.

Procedure:

1 Push the switch to the middle.

2 Connect the radio and the PC with the programming cable.

3 Power on the radio.

Figure 9: Connecting the radio in USB-C/Norm mode
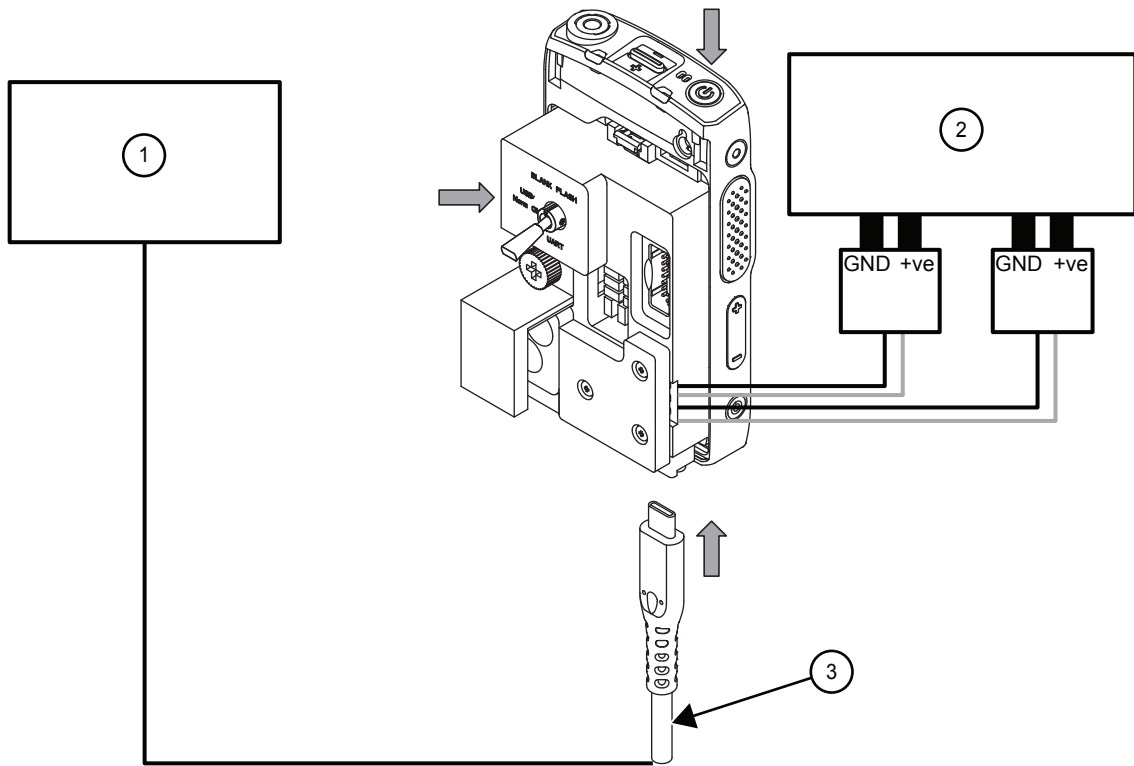
No.	Description
1	Personal Computer
2	Power Supply 3.8 V
3	Programming Cable (USB Type-C)

4.2.3

Connecting the Radio in UART Mode

Procedure:

1 Push down the switch.

2 Connect the radio and PC with the serial data cable.

3 Power on the radio.

Figure 10: Connecting the radio in UART mode
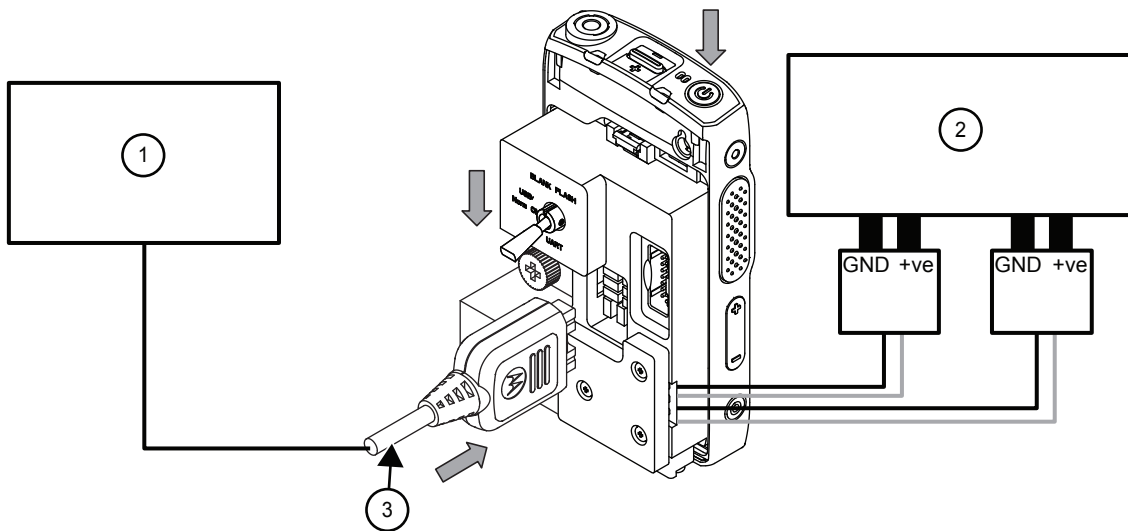
No.	Description
1	Personal Computer
2	Power Supply 3.8 V
3	Serial Data Cable

4.3

Test Check List

Table 12: Test Setup for 380–430 MHz Radio Models

The following table summarizes the required test setup for 380–430 MHz radio models.

Test Name	Test Setup	Radio Setup	Test Conditions	Limits
Base Station Registration	Control Channel	390.125 MHz	3605	TETRA 380+0MS
	Traffic Channel	390.125 MHz	3605	TETRA 380+0MS
	Time Slot	N/A	3	N/A
	Country Code	N/A	234	N/A
	Network Code	N/A	2392	N/A
	Base Color	N/A	1	N/A
	Location Area	N/A	22	N/A
	Min Rx Level	N/A	N/A	-110 dBm
	Max Tx Level	N/A	N/A	30.0 dBm (1 W radio)
				32.5 dBm (1.8 W radio)

Test Name	Test Setup	Radio Setup	Test Conditions	Limits
	Access Parameter	N/A	-53 dBm	N/A
	Mobile Power	30.0 dBm (1 W radio) 32.5 dBm (1.8 W radio)	N/A	N/A
	Burst Type	N/A	Normal	N/A
Transmitter Burst Power	RF Gen Level Burst Power	N/A	-90 dBm	30.5–34.5 dBm (1.8 W radio)
	Timing Error	N/A	N/A	±0.25 Symbols
	Vector Error	N/A	N/A	Max 10% RMS, 30% Peak
	Frequency Error	N/A	N/A	±100 Hz
Call Processing Talk Back	1 kHz Test Signal Group Mode	N/A	-50 dBm	N/A
Call Processing Call to Mobile	Private	4-digit random number and Send	N/A	28.0–32.0 dBm (1 W radio) 30.5–34.5 dBm (1.8 W radio)
	RF Gen Level Burst Power	N/A	-90 dBm	28.0–32.0 dBm (1 W radio) 30.5–34.5 dBm (1.8 W radio)
	Timing Error	N/A	N/A	±0.25 Symbols
	Vector Error	N/A	N/A	Max 10% RMS, 30% Peak
	Frequency Error	N/A	N/A	±100 Hz

4.3.1
Transmitter Tests

1   Power Burst (Control Range)

2   Power Profiles

3   Tx Burst Timing Error

4   Vector Error RMS and Peak

5   Tx Frequency Error

4.3.2
Call Processing Tests

1   Talk Back

2   Call to Mobile

4.3.3
Duplex Test

Digital Duplex Test (Tx)

Measurement Capabilities:

- Bar charts (Tx Power, Frequency Error, Vector Error RMS)

- Spectrum Analyzer

- Power Analyzer

- Vector Analyzer

- Vector Diagrams

4.4
Configuring IFR 3901/IFR 3902/IFR 3920 Setup

Use these procedures to configure the IFR 3901/IFR 3902/IFR 3920 setup.

Procedure:

1 Turn ON the IFR.

2 Press **CONFIG → CONFIG**. Select **System → TETRA → MS**.

3 Press **CONFIG → CONFIG**. Select **Configure → Channel Plan**.

4 Press **SELECT → TETRA 380+0MS**.

5 Press **CONFIG**. Select **System ID & Access Params**.

6 Enter `234` for Mobile Country Code (MCC). Press **Enter**.

7 Enter `2392` for Mobile Network Code (MNC). Press **Enter**.

8 Enter `1` for Base Station Color Code (BCC). Press **Enter**.

9 Enter `22` for Location Area Code (LA). Press **Enter**.

10 Enter `-110` for Min Rx Level For Access. Press **Enter**.

11 Enter `30` for Max Tx Level. Press **Enter**.

12 Enter `-53` for Access Parameter. Press **Enter**.

13 Press **CONFIG**. Select **Base Services**.

   NOTICE: You are entering base services setup. The displayed value are factory defaults and should not be changed.

```
Power On Registration: Required
Power Off De-registration: Required
Priority Cell: Yes
Minimum Mode Service: May Be Used
Migration: Supported
System Wide Services: Normal Mode
TETRA Voice Service: Supported
Circuit Mode Data Service: Supported
(Reserved): Available
TETRA Packet Data Service: Available
Air Interface Encryption: Not Available
Advanced Link: Not Supported
```

14 Press **CONFIG**. Select **Neighbor Cell Info**.

15 Verify that the following NEIGHBOUR CELL INFO values are displayed:

📝 **NOTICE:** The displayed values are factory defaults and should not be changed.

```
BROADCAST: Not Supported
BROADCAST INTERVAL: 5 s
NEIGHBOUR CELL CHANNEL: 3500
NEIGHBOUR CELL LOCATION AREA: 0017
NEIGHBOUR CELL IDENTIFIER: 01
SLOW RE-SELECT THRESHOLD ABOVE FAST: 10 dB
FAST RE-SELECT THRESHOLD: 10 dB
SLOW RE-SELECT HYSTERESIS: 10 dB
FAST RE-SELECT HYSTERESIS: 10 dB
```

16 Press **CONFIG**. Select **Call Timers & Trunking**.

17 Select **Transmission** for Trunking Type.

18 Select **Continuous** for Test Set Transmit Mode.

4.5
Configuring IFR 3901/IFR 3902/IFR 3920 Setup for Japan radios

Use these procedures to configure the IFR 3901/IFR 3902/IFR 3920 setup for Japan radios only.

Prerequisites: This setup depends on the firmware version of the IFR 3901/3902/3920, the firmware version of the radio, and the programmed parameters of the radio.

Procedure:

1 Turn ON the IFR.

2 Press **Config → Config**. Select **System → TETRA → MS**.

3 Press **Config → Config**. Select **Configure → Channel Plan**.

4 Press **Select → No Plan → New Plan**.

5 Enter the following parameters:

```
Channel Plan: JAPANUHF
Frequency Band: 4 (400.000 MHz)
Offset: 0 (+0kHz Offset)
Duplex Spacing: 5 (Reserved)
Reverse Operation: 0 (Normal)
Channel Block 1:
    Lowest Channel: 2400
    Highest Channel: 2580
    Lowest Channel Downlink Freq: 460.000 MHz
    Duplex Offset: 44.5 MHz
    Channel Spacing: 25 kHz
```

6 Press the **Save** button at the top left panel on the screen.

7 To use this channel plan, press **Config**. Select **Channel Plan → JAPANUHF**.

8 Press **Config → Config → Configure**. Select **System ID & Access Parameters**.

9 Enter the following parameters:

```
Mobile Country Code (MCC): 440
Mobile Network Code (MNC): 5101
Base Station Color Code (BCC): 1
Location Area Code (LA): 1
```

10 Press **Config → Config → Configure**. Select **Mobile Parameters**.

11 Enter the following parameters:

```
Short Subscriber Identity (SSI): (use fixed) 9999
Group Short Subscriber Identity (GSSI): (use fixed) 1001
Power Class: (use fixed) 4 (30.0dBm/1W)
Receiver Class: (use fixed) A
```

> **NOTICE:** The number for Short Subscriber Identity (SSI) and Group Short Subscriber Identity (GSSI) is based on the number key in the Codeplug of the radio.

12 Press **Config → Config → Configure**. Select **Call Types**.

13 Enter the following parameters:

```
Priority: 00 = Priority Not Defined
Calling Party SSI: 100
```

14 Press **Config → Config → Configure**. Select **Call Timers & Trunking**.

15 Enter the following parameters:

```
Trunking Type: Transmission
Simplex Traffic Channel Type: DL and UL TCH
Test Set Transmit Mode: Continuous
```

16 Leave the rest of the parameters in their default values.

17 Press **Config → Config → Configure**. Select **Neighbour Cell Info**.

18 Enter the following parameters:

```
Broadcast: Not supported
Broadcast Interval: 5 s
Neighbour Cell Channel: 3500
Neighbour Cell Location Area: 1
Neighbour Cell Identifier: 1
Slow Re-select Threshold Above Fast: 10 dB
Fast Re-select Threshold: 10 dB
Slow Re-select Hysteresis: 10 dB
Fast Re-select Hysteresis: 10 dB
```

19 Press **Config → Config → Configure**. Select **Base Service**.

20 Use the following default parameters:

```
POWER ON REGISTRATION: REQUIRED
POWER OFF DE-REGISTRATION: REQUIRED
PRIORITY CELL: YES
MINIMUM MODE SERVICE: NEVER USED
MIGRATION: SUPPORTED
SYSTEM WIDE SERVICE: NORMAL MODE
TETRA VOICE SERVICE: SUPPORTED
CIRCUIT MODE DATA SERVICE: NOT SUPPORTED
(RESERVED): NOT AVAILABLE
TETRA PACKET DATA SERVICE: NOT AVAILABLE
AIR INTERFACE ENCRYPTION: NOT AVAILABLE
ADVANCED LINK: NOT SUPPORTED
```

> **NOTICE:** Store these settings in the IFR to be recalled for future use.

4.6
Configuring IFR 2968 Setup

Use these procedures to configure the IFR 2968 setup.

Procedure:

1 Turn ON the IFR.

2 Press **Systems** Mode Key and wait until the digital system is initialized.

3 Press **Tetra Mobile → Setup**. Enter the System Parameters Screen.

4 Press **Channel Plan**.

5 Press **Tetra 380+0MS**.

The Control Channel automatically changes to `3600`, and Traffic Channel automatically changes to `3700`.

6 Press **Traffic Channel → Traffic Channel**. Check that the marker goes to Timeslot.

7 To change to Timeslot 3, press **3 → Traffic Channel**.

8 Press **Country Code**. Enter `234` and press **Country Code**.

9 Press **Network Code**. Enter `2392` and press **Network Code**.

10 Press **Base Color**. Enter `1` and press **Base Color**.

11 Press **More**.

12 Press **Location Area**. Enter `22` and press **Location Area**.

13 Press **More**.

14 Press **Min Rx Level**. Enter `-110 dBm` and press **Min Rx Level**.

15 Press **Max Tx Level**. Enter `30 dBm` and press **Max Tx Level**.

16 Press **Access Parameter**. Enter `-53 dBm` and press **Access Parameter**.

17 Press **Test Mode → Enable**.

18 Press **Base Service**.

> **NOTICE:** You are entering base services setup. The displayed value are factory defaults and should not be changed.

```
Power On Registration: Required
Power Off De-registration: Required
Priority Cell: Yes
Minimum Mode Service: May Be Used
Migration: Supported
System Wide Services: Normal Mode
```

19 Press **More**.

```
TETRA Voice Service: Supported
Circuit Mode Data Service: Supported
(Reserved): Available
SNDCP Service: Available
Air Interface Encryption: Not Available
Advanced Link: Not Supported
```

20 Press **Return**. Select **Neighbor Cell**.

21 Verify that the following NEIGHBOUR CELL INFO values are displayed:

> **NOTICE:** The displayed values are factory defaults and should not be changed.

```
BROADCAST: Not Required
BROADCAST INTERVAL: 5 s
NEIGHBOUR CELL CHANNEL: 3500
NEIGHBOUR CELL LOCATION AREA: 00017
NEIGHBOUR CELL IDENTIFIER: 01
SLOW RE-SELECT THRESHOLD ABOVE FAST: 10 dB
```

22 Press **More**.

```
FAST RE-SELECT THRESHOLD: 10 dB
SLOW RE-SELECT HYSTERESIS: 10 dB
FAST RE-SELECT HYSTERESIS: 10 dB
```

23 Press **Return**.

24 Press **Trunk Type** → **message Trunked** (Transmission).

25 Press **More**.

> 📝 **NOTICE:** The displayed values are factory defaults and should not be changed. It is not required to configure Call Types, Call Arial, and Messages.

26 Press **More**.

4.7
Configuring IFR 3901/IFR 3902/IFR 3920 Manual Screen Test

Use these procedures to configure the IFR 3901/IFR 3902/IFR 3920 manual screen test.

Procedure:

1 Press **TEST** → **TAB**.

2 Enter `3600` for Control Channel.

3 Enter `3700` for Traffic Channel.

4 Enter `3` for Slot.

5 Enter `-75` for RF Gen Level.

6 Select **Expected** → **30.0 dBm/1 W** for Mobile Power.

7 To select Tx Measurements, press **TAB**.

8 Press **Normal** for Burst.

The test equipment configuration setup is completed.

> 📝 **NOTICE:** The System Setup Configuration Data is saved even after the power is turned off. However, the Manual Test Setup is not saved.

4.8
Configuring IFR 2968 Manual Screen Test

Use these procedures to configure the IFR 2968 manual screen test.

Procedure:

1 Press **Manual** to enter the Manual Test screen.

2 Press **Control Channel**. Enter `3605` and press **Control Channel**.

(IFR 3605 = Rx 390.125000 MHz)

3 Press **Traffic Channel**. Enter `3605` and press **Traffic Channel**.

The marker goes to Timeslot.

4 Enter `3` and press **Traffic Channel**.

> 📝 **NOTICE:** The Traffic Channel number changes automatically after entering the Control Channel number.

5 Press **RF Gen Level**. Enter `-75` and press **dBm** → **RF Gen Level**.

6 Press **Mobile Power**. Enter `30 dBm/1 W`.

7 Press **Burst Type → Normal**.

The test equipment configuration setup is completed.

> **NOTICE:** The System Setup Configuration Data is saved even after the power is turned off. However, the Manual Test Setup is not saved.

4.9
RF Tests

This section lists the applicable RF Tests and its procedures for the radio.

4.9.1
Testing Receiver using IFR 3901/IFR 3902/IFR 3920

Prerequisites: This test requires programming the radio. Refer to TETRA Customer Programming Software (CPS) User Guide.

Procedure:

1 Turn ON the radio.

2 Do one of the following to enter the radio test page:

- Use CPS.

- Press **Menu/OK → Up → Down → Back**.

3 Check that registration and `ITSI ---/---: xxxx` is displayed on the IFR Operations/Status screen.

```
GROUP: XXXXXXX SELECTED
```

4.9.2
Testing Receiver using IFR 2968

Prerequisites: This test requires programming the radio. Refer to TETRA Customer Programming Software (CPS) User Guide.

Procedure:

1 Turn ON the radio.

The screen is Idle.

2 Do one of the following to enter the radio test page:

- Use CPS.

- Press **Menu/OK → Up → Down → Back**.

3 Check that registration and `ITSI ---/---: xxxx` is displayed on the IFR Manual Test screen.

```
STATUS: REGISTRATION (ITSI ATTCHED)
GSSI: XXXXXXX SELECTED
```

4.9.3
Testing Transmitter using IFR 3901/IFR 3902/IFR 3920

Procedure:

1 To select RF Settings, press **TAB**.

2 Enter `-90` for RF Gen level.

3 Switch ON the RF Gen.

4 Switch OFF the Pre Amp.

5 Press **PTT**.

> **NOTICE:** Press and hold the **PTT** to read the results.

Monitor the **Tx Measurement** window which displays the Power Profile, Burst Timing, Vector Peak, Vector RMS, Freq Error, and Residual Carrier.

```
Burst Power Required Results: 28.0-32.0 dBm (Class 4) or 30.5-34.5 dBm
(Class 3L)
Power Profile: Passed
Burst Timing: ± 0.25 Symbols
Vector Error: Max 10% RMS, Max 30% Peak, Max 5% residual
Frequency Error: ± 100 Hz
```

6 Press **TAB** to select Operations/Status.

7 Press **Call Mobile → Group Call → Cleardown**.

4.9.4
Testing Transmitter using IFR 2968

Procedure:

1 Press **RF Gen Level**. Enter `-90 dBm` and press **RF Gen Level**.

2 Press **PTT**.

> **NOTICE:** Press and hold the **PTT** to read the results.

Monitor the IFR Manual Test screen which displays the Power Profile, Burst Timing, Vector Peak, Vector RMS, Freq Error, and Residual Carrier.

```
Burst Power Required Results: 28.0-32.0 dBm (Class 4) or 30.5-34.5 dBm
(Class 3L)
Power Profile: Passed
Burst Timing: ± 0.25 Symbols
Vector Error: Max 10% RMS, Max 30% Peak, Max 5% residual
Frequency Error: ± 100 Hz
```

3 Press **Clear Down** to proceed with other tests.

4.10
Call Processing Tests

This section list the applicable Call Processing Tests and its procedures.

4.10.1
Talk Back using IFR 3901/IFR 3902/IFR 3920

Prerequisites: Ensure that the handset and test equipment are configured the same as given in the Transmitter Test before you start this test.

Procedure:

1 Press **Call Mobile → Group Call**.

2 Press **TALKBACK**.

3 Press **PTT** and speak into the microphone of the radio.

   The last 3 sec of the speech frames is heard after **PTT** is released.

4 Press **Test Sound** to provide the 1 kHz signal to the radio speaker.

   A 1 kHz tone is heard from the radio speaker for about 3 sec.

5 Press the **Silence** to mute the 1 kHz Audio Signal of the speaker.

6 Press **Clear Down**.

4.10.2
Talk Back using IFR 2968

Prerequisites: Ensure that handset and test equipment are configured the same as given in the Transmitter Test before you start this test.

Procedure:

1 Press **PTT** and speak into the microphone of the radio.

   The last 3 sec of the speech frames is heard after **PTT** is released.

2 Press **Test Sound** to provide the 1 kHz signal to the radio speaker.

   A 1 kHz tone from the radio speaker is heard for about 3 sec.

3 Press the **Silence** to mute the 1 kHz Audio Signal of the speaker.

4 Press **Clear Down**. Check that the `Cleardown Complete` status appears on the IFR Manual Test screen.

4.10.3
Call to Mobile

Procedure:

1 Press **Call Mobile** on the IFR.

2 Press **Private**.

   NOTICE: Select the type of call.

   The handset beeps.

3 Press **Abort Call**.

4 Repeat step 1 through step 3 for Phone and Emergency calls.

4.11

Digital Duplex Test (Tx) using IFR 3901/IFR 3902/IFR 3920

Procedure:

1 On the radio, press **Menu → Contact → Contact 1 → Send**.

The following results are displayed on the **Tx Measurements** window.

```
Burst Power Required Results: 28.0-32.0 dBm (Class 4) or 30.5-34.5 dBm
(Class 3L)
Power Profile: Passed
Burst Timing: ± 0.25 Symbols
Vector Error: Max 10% RMS, Max 30% Peak, Max 5% residual
Frequency Error: ± 100 Hz
```

2 Press **Call Mobile → Group Call → TALKBACK**.

3 Speak into the microphone of the handset.

You hear your speech (after a short delay) from the internal earpiece of the handset.

4 If you need more details, select ▼ at the Rx Measurement Window.

For...	Then...
Power Analyzer Graph	**a** Select **Power → Profile Full**. **b** To view the detail of Profile Full, select ☐ and press **Select**. **c** To minimize the window, press **Select**. **d** To view the rest of the power analyzer graphs, select any item under Power drop-down list.
Vector Analyzer Diagram	**a** Select **Mod Accuracy → Vector Error**. **b** To view the detail of Vector Error, select ☐, and press **Select**. **c** To minimize the window, press **Select**. **d** To view the rest of the vector analyzer graphs, select any item under Mod Accuracy drop-down list.

5 Press **End** on the handset.

4.12

Digital Duplex Test (Tx) using IFR 2968

Procedure:

1 On the radio, press **Menu → Contact → Contact 1 → Send**.

The following results are displayed on IFR Manual Test Screen.

```
Burst Power Required Results: 28.0-32.0 dBm (Class 4) or 30.5-34.5 dBm
(Class 3L)
```

```
Power Profile: Passed
Burst Timing: ± 0.25 Symbols
Vector Error: Max 10% RMS, Max 30% Peak, Max 5% residual
Frequency Error: ± 100 Hz
```

2 Speak into the microphone of the handset.

You hear your speech (after a short delay) from the internal earpiece of the handset.

> **NOTICE:** If you need more details, press **Duplex Test.**

3 Press **Duplex Test (Tx)**.

The Digital Duplex test results are displayed on the IFR screen providing you with the following bar charts measurement capabilities:

- Power
- Vector RMS
- Frequency Error

4 Perform one of the following actions:

For...	Then...
Power Analyzer Graph	**a** Press **power ana**. **b** Check that the power frame falls within the limits.
Spectrum Analyzer Diagram	**a** Press **spec ana**. **b** Monitor the Tx frequency.
Vector Analyzer Diagram	**a** Press **vector ana**. **b** Monitor the constellation diagram. **c** Press **vector diagram**. **d** Monitor the vector diagram. **e** To zoom in on the constellation, press **rotated vector**.

5 Press **End** on the handset.

4.13
Manual Mode Testing

When and where to use: Use these procedures to set up radio for DALT Mode testing.

Procedure:

1 Verify that the radio is turned OFF.

2 Press and hold **P2 Programmable** button and **PTT** simultaneously and press the **Power/Sleep/Wake** button for more than 5 seconds to enter DALT mode.

4.13.1
Testing in DALT Mode

These tests are covered in DALT mode.

NOTICE: Any key pressed causes the test to advance from one step to the next. You are to respond accordingly to the instructions on the screen.

Procedure:

Display Test

1 Display test. The display shows:

```
Display test
Press any key to proceed
```

2 Do the following:

Action	The display shows:
Press any key.	Horizontal red lines.
Press any key consecutively.	Horizontal red lines become thicker with every key press, until it becomes fully red.
Press any key.	Four colored rectangles.
Press any key consecutively.	Vertical green lines that become thicker with every key press, until it becomes fully green.
Press any key.	White screen.
Press any key.	Black screen.
Press any key.	Blue screen and `END LCD test!!!`

3 Press the corresponding key to proceed to the next test.

Battery Test

4 Battery Interface test. The display shows:

```
Battery Interface Test
Press any key to continue
```

5 Do the following:

Action	The display shows:

Press any key.	`Battery`
	`Interface Test`
	`PASSED`

6 Press the corresponding key to proceed to the next test.

SIM Card Test

7 SIM card test. The display shows:

```
SIM card test
Press any key to continue
```

NOTICE: Check SIM card presence for the SIM card version of radio.

8 Do the following:

Action	Result
Press any key.	If SIM card is detected in SIM slot, the display shows:

Action	Result
	SIM card PASSED Press Any key To Continue

9 Press the corresponding key to proceed to the next test.

Vibrator Test

10 The display shows:

Vibrator
Test

11 Do the following:

Action	Result
Press any key.	The display shows: Vibrator On The radio vibrates.

12 Press the corresponding key to proceed to the next test.

LEDs Test

13 The display shows:

LEDs
Test

14 Do the following:

Action	Result
Press any key.	The display shows: Red LED on LED Power Indicator lights up in red.
Press any key.	The display shows: Green LED on LED Power Indicator lights up in green.
Press any key.	The display shows: Amber LED on LED Power Indicator lights up in amber.
Press any key.	The display shows: CHRG Red LED on LED Power Indicator lights up in red.
Press any key.	The display shows: CHRG Green LED on LED Power Indicator lights up in green.
Press any key.	The display shows: CHRG Amber LED on LED Power Indicator lights up in amber.
Press any key.	The display shows:

Action	Result
	`Up LED on` The Up button of the radio is lit.
Press any key.	The display shows: `Down LED on` The Down button of the radio is lit.
Press any key.	The display shows: `Back LED on` The Back button of the radio is lit.
Press any key.	The display shows: `OK LED on` The OK button of the radio is lit.
Press any key.	The display shows: `All LEDs on` All LED of the radio are lit.

15 Press the corresponding key to proceed to the next test.

Accessory Connect Test

16 The display shows:

```
Accessory
Connect Test
```

17 Do the following:

Action	Result

Press any key.	The display shows:
	`Connect GCAI:`
	`1. Core Accy`
	`2. PHF to the radio`
	`and press any key`

Attach Core or PHF accessory to the 3.5 mm audio jack on the bottom left. Press any key.	The display shows:
	• For Core Accessory:
	`Core RSM connected`
	• For PHF Accessory:
	`GMOI RSM connected`
	• For PHF Earpiece:
	`GMOI Speaker connected`

18 Press the corresponding key to proceed to the next test.

Tones Test

19 The display shows:

```
Tones
Test
```

20 Do the following:

Action	Result
Press the corresponding key to continue.	The display shows: `Internal Speaker Tone Test` The speaker plays a continuous tone.
Press any key.	The display shows: `Internal Earpiece Tone Test` The internal earpiece plays a continuous tone.

Press any key.	The display shows:
	
	`Connect Stereo`
	`accessory`
	`to the radio`
	`(RSM connected)`

Attach accessory to the radio.	The display shows:
	
	`Stereo`
	`tone test`
	`Stereo Accy`
	`connected`
	The Stereo accessory plays a continuous tone.

Press any key.	The display shows:
	
	`Connect Mono`
	`accessory`
	`to the radio`
	`(RSM connected)`

Attach accessory to the radio.	The display shows:
	
	`Mono`
	`tone test`
	`Mono Accy`
	`connected`
	The Mono accessory plays a continuous tone.

21 Press the corresponding key to proceed to the next test.

Loopback Test

22 The display shows:

```
Loopback
Test
```

23 Do the following:

Action	Result
Press any key.	The display shows: `INT MIC to INT EAR Loopback Test`
Speak into the bottom microphone.	You hear your voice from the internal earpiece.

Press any key to continue.	The display shows:
	
	`Connect RSM`
	`to the radio`
	`(RSM connected)`

Action	Result

Attach RSM accessory to the radio.	The display shows:
	
	`TOP MIC to RSM`
	`Loopback Test`

Speak into the top micro-phone.	You hear your voice from the PHF (RSM connected) ear-piece.

Press any key to continue.	The display shows:
	
	`Connect RSM`
	`to the radio`
	`(RSM connected)`

Attach RSM accessory to the radio.	The display shows:
	
	`RSM MIC to INT EAR`
	`Loopback Test`
	`(RSM connected)`

Speak into the RSM micro-phone.	You hear your voice from the internal (RSM connected) ear-piece.

24 Press the corresponding key to proceed to the next test.

Keypad Test

25 The display shows:

```
Keypad
Test
```

26 Do the following:

Action	Result

Press any key.	The display shows:
	
	` Back to EXIT`
	`VOL UP     TG UP`
	`VOL DW      PWR`
	`  UP      TG DW`
	`  Ptt`
	`  DOWN`

Press the corresponding key to continue.	The respective display disappears every time you press a key. Continue until display is empty.

27 Press the corresponding key to proceed to the next test.

Navigation Button Test

28 The display shows:

```
Navigation
Test
```

29 Do the following:

Action	Result

Press any key.	The display shows:
	
	`** << >>**`
	`Press cap touch:`
	`Back for "<"`
	`UP and Down for "*"`
	`OK for ">"`

Action	Result
Press the corresponding key to continue.	The respective display disappears every time you press a key. Continue until display is empty.

30 Press the corresponding key to proceed to the next test.

Mandown Test

31 The display shows:

```
Mandown
Test
```

32 Do the following:

Action	Result

Press any key.	The display shows:
	```Gyro Sensor```
	```Test```

Place the radio horizontally on a flat surface.	A beep sounds after 10 seconds. Mandown angle detection feature is functional.

Press any key to continue.	The display shows:
	```No-Movement```
	```Mandown Test```

Place the radio in a stable position.	A beep sounds after 10 seconds. Mandown angle detection feature is functional.

33 Press the corresponding key to proceed to the next test.

Proximity Sensor Test

34 The display shows:

```
Proximity Sensor
Test
```

35 Do the following:

Action	Result

Press any key.	The display shows:
	```Cover PROX```
	```SENSOR```

Cover the proximity sensor with your finger. Press any key to continue.	The display shows:
	```Uncover PROX```
	```SENSOR```

Uncover the proximity sensor. Press any key to continue.	The display shows:
	• If passed:
	```PROX SENSOR```
	```TEST PASSED```
	• If failed:
	```PROX SENSOR```
	```TEST FAILED```

36 Press the corresponding key to proceed to the next test.

Bluetooth Test

37 The display shows:

```
Bluetooth
Test
```

38 Do the following:

Action	Result

Press any key.	The display shows:
	
	```BT test - pairing```
	```WAIT !!!```
	
	📝 **NOTICE:** Be prepared with supported Bluetooth accessories configured to pairing mode.

Wait for result.	The display shows pairing test result.
Press any key to continue.	The display shows pairing connection test result.

Press any key to continue.	The display shows:
	
	```BT microphone```
	```test - start```

Speak into the internal microphone.	You hear yourself in the paired Bluetooth audio speaker.

Press any key to continue.	The display shows:
	
	```BT speaker```
	```test - start```

Speak into the paired Bluetooth microphone.	You hear yourself in the internal speaker.

39 Press the corresponding key to proceed to the next test.

Tx Power Test

40 The display shows:

```
TX Power Class 3L test
```

41 Press the corresponding key to continue.

42 The display shows:

```
TX Power Class 4 test
```

43 Press the corresponding key to continue.

The display shows:

```
End Test
Press any key
to turn the
radio OFF
```

Test is completed. Press any key to turn the radio OFF.

4.13.2
Testing Charger Recognition

Procedure:

1 Turn the radio ON.

2 Connect the Rapid Travel Charger accessory connector to the handset. Check the following:

  • LCD display shows ```charger connected.```

- A beep is heard.

- Keypad back-light is turned ON.

- Charging icon is shown.

3 Connect the handset to the USB Charger. Check the following:

- PMOLED display shows `charger connected`.

- Three beeps are heard.

- Keypad back-light is turned ON.

- Charging icon is shown.

4 Connect the handset to the MUC Charger. Check the following:

- PMOLED display shows `charger connected`.

- A beep is heard.

- Keypad back-light is turned ON.

- Charging icon is shown.

5 Verify that the battery charger is in progress.

> **NOTICE:** The process advance is indicated on the Battery Strength icon.

6 Press the **Power ON/OFF**.

The radio turns OFF.

4.13.3
Proximity Sensor Calibration

Procedure:

1 Place device into the test jig.

2 Turn on the DUT and connect USB-C cable to the PC.

3 Download the *proximitySensorCalibrator.exe* file from:

- EMEA - https://emeaonline.motorolasolutions.com

Run the file customized for proximity sensor calibration. Select the COM port associated with DUT.

4 Select Read Proximity Sensor in the command option, then press **START**, with the DUT placed inside the jig. Take the reading as 10MM PROXIMITY COUNT.

5 Use the value of 10 mm PROXIMITY COUNT. Set the upper/lower threshold as shown in the following formula:

a Select **Set Proximity Sensor Threshold Upper/Lower** in the command option and press **START**.

Upper Threshold = 10 mm PROXIMITY COUNT + 250

Lower Threshold = 10 mm PROXIMITY COUNT + 200

Table 13: Specification for proximity sensor calibration

Test Parameter	Lower Limit	Upper Limit
Delta Proximity	150	400

Test Parameter	Lower Limit	Upper Limit
Offset Count (no gray card)	1900	3100
Offset Count (with gray card)	2050	3500
Upper threshold	2300	3750
Lower threshold	2250	3700

4.14

Captouch Button Calibration

If there is a severe loss in degradation, calibrate the threshold according to the documented percentage value of the detection.

Procedure:

1 Place radio on a flat surface area.

2 Start timer.

3 Execute TetraCom command `CAP_TOUCH READ REG_DIFFERENCE_COUNT_SENSOR0` to read different count repeatedly when the stylus moves close to touch the corresponding navigation button.

The command used in step 3 uses the **Up** button as the example (**Up** = `SENSOR0`).

> **NOTICE:** Ensure that the stylus touches the center of the capacitive touch button.

4 Take note of the timer reading when a value is observed (different count not 0). Continue recording the different count reading for ten samples and calculate the average reading.

5 Write the threshold setting for the button referencing to the percentage of the average different count value into the buffer using these commands.

```
CAP_TOUCH WRITE USER_TUNE_REG_BASE_THRESHOLD0 xx
CAP_TOUCH WRITE FACTORY_TUNE_REG_BASE_THRESHOLD0 xx
```

> **NOTICE:** First command initiates write buffer to store into the user codeplug, and second command stores as a backup tuning data. `xx` is the value to write into.
> Threshold setting:
> - **Up**: 65 %
> - **Down**: 67 %
> - **Back**: 68 %
> - **OK**: 70 %

Software returns `OK` upon successful execution.

6 Remove stylus from button when the timer hits 5 seconds relative to the time noted in step 4 of the observed different count value.

> **NOTICE:** Different count read within 5 seconds relative timing.

7 Repeat step 3 to step 6 for different button.

Sensor button referencing:

- **Up**: `SENSOR0`
- **Down**: `SENSOR6`

- **Back**: `SENSOR5`

- **OK**: `SENSOR3`

8 Execute command `CPPROG_CAP_TOUCH` to write the buffer value into the codeplug.

Radio firmware returns `CP_OK` indicating the new value has been written into the codeplug.

9 Execute command `CAP_TOUCH WRITE USER_CONFIGURATION_REGISTERS` to reset the captouch chipset and initialize with the new threshold value.

10 To verify the sensitivity of the configured threshold, perform functional test on the captouch buttons. Repeat step 1 to step 9 if the touch sensitivity is not satisfactory.

4.15

Service Flowchart

The service flowchart shows the expected results and their next required actions for the testing procedure of the radio.

Figure 11: Service Flowchart
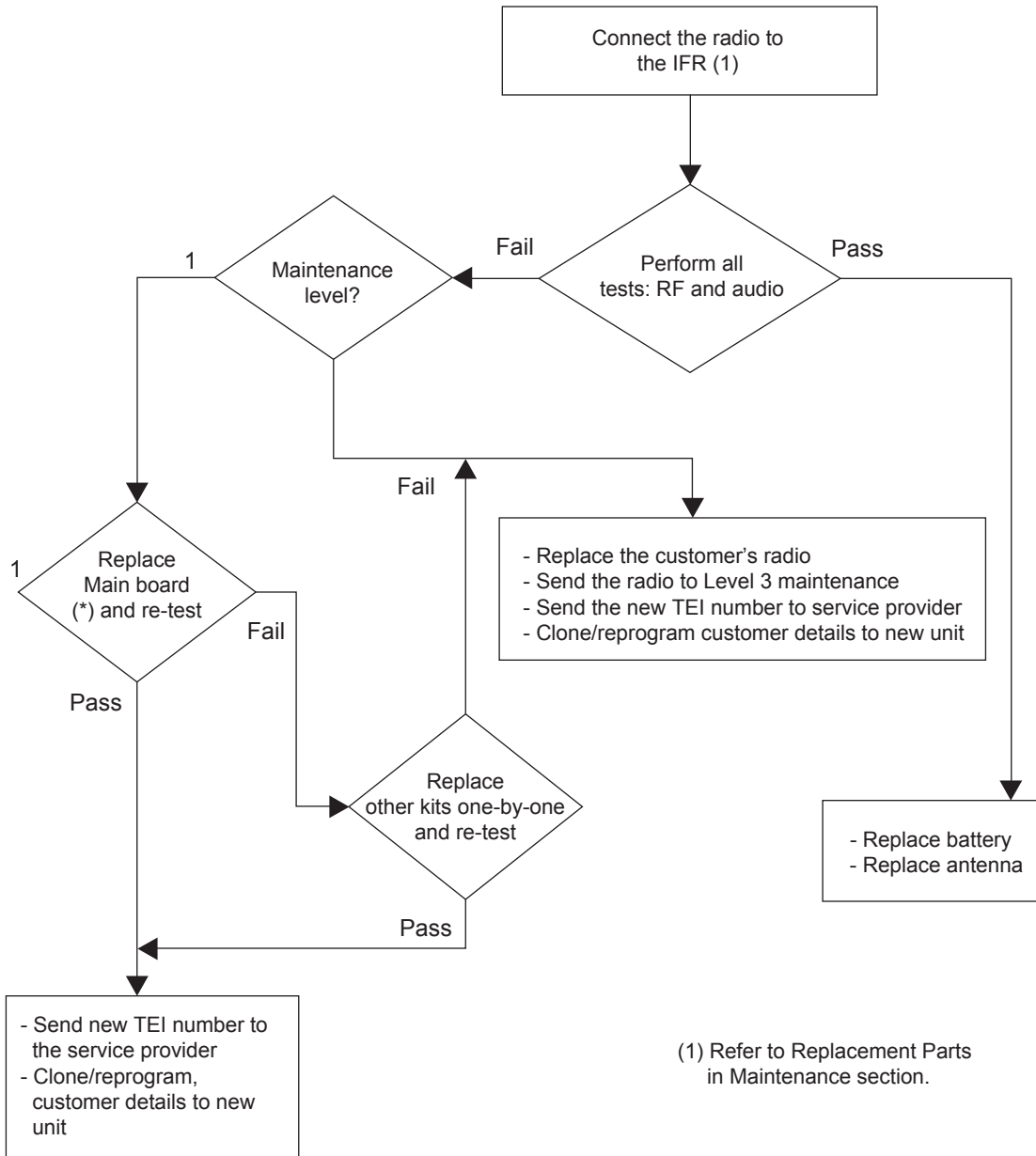
Chapter 5

Maintenance

This chapter provides information about the care and maintenance of this radioRSM.

5.1
Preventive Maintenance

Periodic visual inspection and cleaning are recommended.

Inspection

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

Cleaning Procedures

The following procedures describe the recommended cleaning agents and the methods to clean the external and internal surfaces of your radio.

External surfaces include the front cover, housing assembly, battery cover, and battery. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime.

> ⚠️ **CAUTION:** Use all chemicals as prescribed by the manufacturer. Follow all safety precautions as defined on the label or material safety data sheet.

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

> ✎ **NOTICE:**
> Only clean internal surfaces when your radio is disassembled for service or repair.

> Before any programming procedure and to ensure optimum performance of the bottom connectors, use a lint-free cloth applied with isopropyl alcohol (100% by volume) to clean the contact pads.

Cleaning External Plastic Surfaces

> 🛈 **IMPORTANT:** The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dish-washing detergent in water.

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

Cleaning Internal Circuit Boards and Components

> 🛈 **IMPORTANT:**
> The only factory recommended liquid for cleaning the printed circuit boards and their components is isopropyl alcohol (100% by volume).

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

Apply Isopropyl alcohol (100%) 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 your 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 it can cause the liquid to collect in unwanted places. After completing of the cleaning process, use a soft, absorbent, lint-less cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, front cover, or back cover.

5.2
Safe Handling of CMOS and LDMOS Devices

Complementary Metal Oxide Semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) 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/LDMOS circuits and are especially important in low humidity conditions. Do not attempt to disassemble your radio without referring to the following caution statement.

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

- Store and transport all CMOS/LDMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS/LDMOS 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/LDMOS device. It is recommended that you use a wrist strap, two ground cords, a table mat, a floor mat, electrostatic discharge (ESD) shoes, and an ESD chair.

- 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 Solutions part number 4280385A59.

- Do not wear nylon clothing while handling CMOS/LDMOS devices.

- Do not insert or remove CMOS/LDMOS devices with power applied. Check all power supplies used for testing CMOS/LDMOS devices to be certain that there are no voltage transients present.

- When straightening CMOS/LDMOS pins, provide ground straps for the apparatus used.

- When soldering, use a grounded soldering iron.

- Handle CMOS/LDMOS devices by the package and not by the leads. Before 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.

NOTICE: The radio has a vent port that allows pressure equalization in the device. The pressure equalization vent is located at the battery compartment. Do not touch the equalization vent.
Ensure no oily substance comes in contact with the vent. Do not poke the vent with any objects such as needles, tweezers, or screwdrivers. This could create a leak path into the device and lose the submergibility of the device.

5.3
General Repair Procedures and Techniques

Environmentally Preferred Products (EPP) were developed and assembled using environmentally preferred components and solder assembly techniques to comply with the European Union's Restriction of Hazardous Substances (ROHS 2) Directive 2011/65/EU and Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU. To maintain product compliance and reliability, use only the Motorola Solutions specified parts in this manual.

For the identification of lead (Pb) free assemblies, all EPP products carry the EPP Marking, shown in the following examples, 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 No. 97. The EPP Marking takes the form of a label or marking on the PCB.
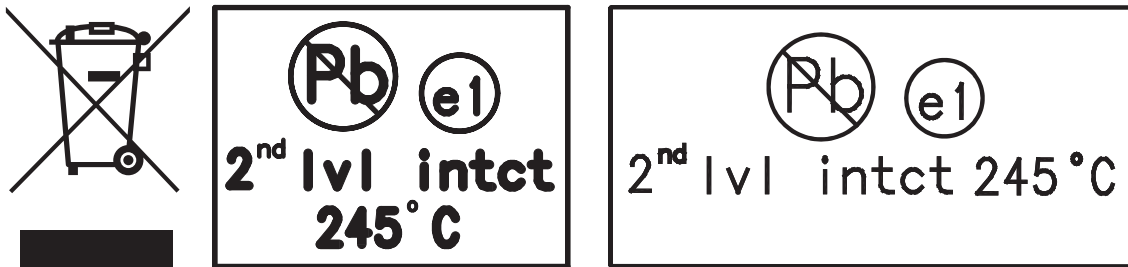
Any rework or repair on Environmentally Preferred Products must be done using the appropriate lead-free solder wire and lead-free solder paste as stated in the following tables:

Table 14: Lead Free Solder Wire Part Number List

Motorola Solutions 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%	217 °C	52171	0.015 in.	1 lb spool

Table 15: Lead Free Solder Paste Part Number List

Motorola Solutions Part Number	Manufacturer Part Number	Viscosity	Type	Composition and Percent Metal	Liquid Temperature
1085674C03	NC-SMQ230	900–1000KCPs Brookfield (5 rpm)	Type 3 (-325/+500)	(95.5%Sn-3.8%Ag-0.7%Cu) 89.3%	217 °C

Parts Replacement and Substitution

When damaged parts are replaced, identical parts must be used. If the identical replacement part is not locally available, check the parts list for the proper Motorola Solutions part number and order the part.

Rigid Circuit Boards

This family of radios use bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The plated-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 a connector:

- 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.

For soldering components with Hot-Air or infra red solder systems, check the user guide of your solder system to get information on solder temperature and time for the different housings of the integrated circuits and other components.

5.4
Pre-baking of Integrated Circuits

Electronic components are generally coated with plastic material which has the nature of not being waterproof. If kept unsealed, the components can absorb humidity.

When soldered to the board (especially with reflow techniques) the sudden change in temperature can cause fissures or cracks that can result in malfunction or damage.

To avoid this problem, these Moisture Sensitive (MS) components must be stored and shipped in a sealed wrapping (dry pack). Processing must take place only with dry components when uninterrupted dry storage can be guaranteed, otherwise the components must be pre-baked.

If a reflow procedure takes place close to MS components, the whole board must be pre-baked.

Table 16: Moisture Sensitivity Levels (MSL)

Part Number	MSL	Description
5166554A01	3	ADDAG
5186988J77	3	JAVELIN
5185956E43	2A	FLASH 16 MB
5185963A85	3	ABACUS AD9874
5166541A01	3	Patriot ROM3
5189233U61	3	PSRAM 4 MB
5199434A01	2	Serial SPI EEPROM

Part Number	Moisture Sensitivity Level (MSL)[1]	Description
51009877001[2]	3	RFIC, U200_W
5186988J77	3	Tx Power Control IC, U600_Y
5108683Y44[3]	3	TETRA PA, U702_Y, U703_Y, U704_Y[3]
IC000326A01	3	Power Management IC 4.1, U6010_B
51012475004	3	Dual Core Processor 2.3, U4020_A

---

[1] Out of dry package MSL:

- 1 – No dry pack required

- 2 – One year

- 3 – 168 hours

[2] New parts replacement. Use older parts until depletion.

[3] This part is offered for 800 MHz radio models only.

Part Number	Moisture Sensitivity Level (MSL)[1]	Description
51016003001	3	mDDR RAM, U4050_A
MM000157A01	3	FLASH, U4000_A

5.5
Level 1 and Level 2 Maintenance

This manual covers Level 1 and Level 2 Maintenance.

At Level 1 maintenance, you replace the terminal and/or accessories and send the faulty unified chassis and/or accessories to a higher level of maintenance. At Level 2 maintenance, a faulty kit is replaced.

5.6
Replacement Parts

Damaged parts must be replaced with identical replacement parts.

For complete information on ordering required parts and kits, contact your local customer service representative. The first column of the radio replacement parts list provides you with the call out number of the components as marked in.

5.6.1
Radio Replacement Parts List

The radio replacement parts list identifies all the serviceable components and part/kit numbers of the radio.

The table provides the part/kit numbers of the components shown in the following exploded view.

---

[1] Out of dry package MSL:

- 1 – No dry pack required
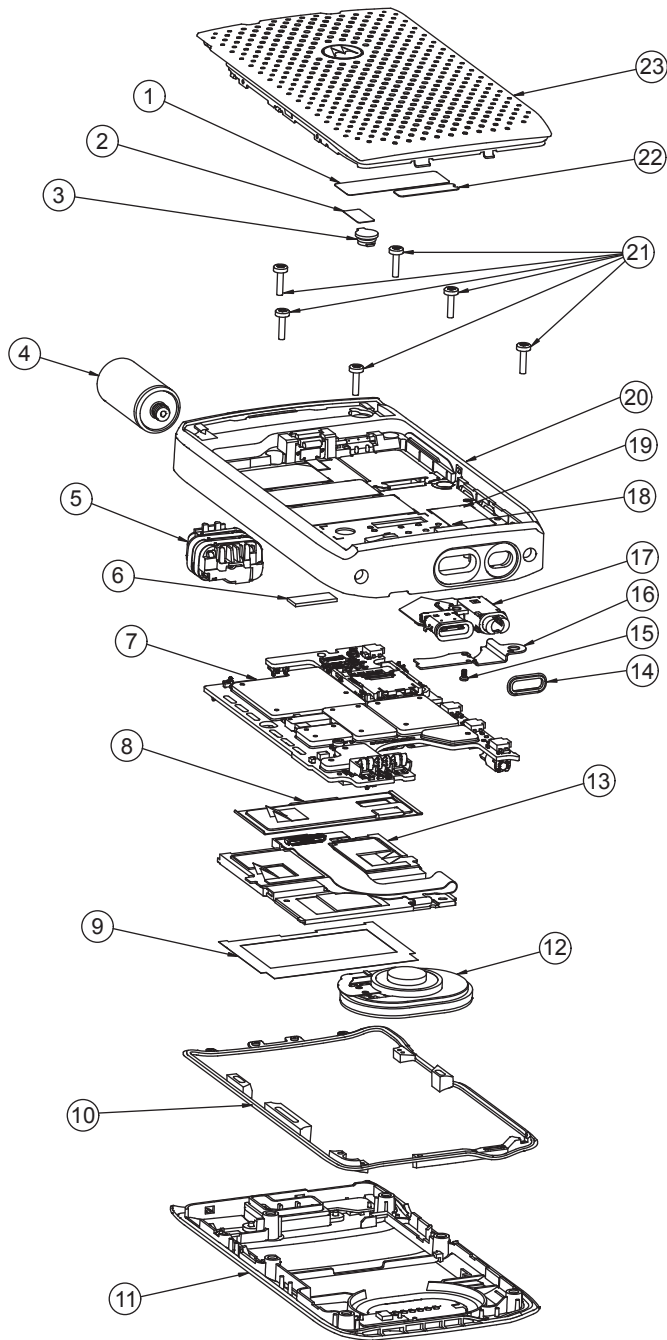
- 2 – One year

- 3 – 168 hours

Figure 12: Exploded View

Table 17: Radio Replacement Parts List

No. from Exploded View	Part/Kit Number	Description
1	LB000755A01	Test Point Label
2	LB000714A01	Tamper/Hologram Label
3	28012032001	Bluetooth/GPS RF Switch Seal
4	AN000168A01[4] [5] [6]	Stubby 25 mm Antenna (380–430 MHz)

No. from Exploded View	Part/Kit Number	Description
	AN000171A011[4]	Stubby 15 mm Antenna (800 MHz)
	AN000172A015[7]	Stubby 20 mm Antenna (415 MHz and 465 MHz), Japan
5	0104074J19[7]	Internal Antenna Module (Japan)
	0104075J11[4] [5] [6]	Internal Antenna Module (UHF)
	0104075J37[4]	Internal Antenna Module (800 MHz)
6	HW001186A01	Thermal Pad
7	See Table 30: Service Replacement Kit Matrix for Main Board (for EMEA) on page 88	Main PCB Kit
8	HW001235A01	Capacitive Touch Retainer with Contact Spring
9	HW001043A01	OLED Black Tape
10	SL000292A01	Main Seal
11	PMHN4368_	Front Housing Service Kit
12	PA001524A01	Speaker Flex Assembly
13	PMHN4367_	OLED Capacitive Touch-Proximity Module Assembly
14	SL000293A01	USB-C O-ring
15	FN000128A01	USB-C/Audio Jack Retainer Screw
16	HW001055A01	USB-C/Audio Jack Retainer
17	PA001406A01	USB-C/Audio Jack Flex Assembly
18	LB000762A01	Label, Cosmetic, USB-C/Audio Jack - BUMP
19	LB000923A01/A02	Label, Cosmetic, Battery Floor (SIM/Non-SIM)
20	PMHN4357_	Main Housing Kit (SIM)
	PMHN4358_	Main Housing Kit (Plain)
21	03012043002	Front Cover Screw
22	33012021015	Model Label
23	PMHN4359_	Battery Door Kit

[4] Available in APAC region only.
[5] Available in EMEA region only.
[6] Available in LACR region only.
[7] Available in Japan only.

5.6.2
Accessories Replacement Parts List

Choose from a variety of accessories designed, tested, and certified to optimize the performance of this radio.

Table 18: Antennas

Part Number	Description
AN000168A01	Stubby 25 mm (380–430 MHz)

Table 19: Antenna Rings

Part Number	Description
PMLN7636_	Antenna ID Band (Grey-pack of 10 pieces)
PMLN7637_	Antenna ID Band (Yellow-pack of 10 pieces)
PMLN7638_	Antenna ID Band (Red-pack of 10 pieces)
PMLN7639_	Antenna ID Band (Blue-pack of 10 pieces)
PMLN7640_	Antenna ID Band (Purple-pack of 10 pieces)

Table 20: Audio Accessories

Part Number	Description
PMLN7203_	Flexible-fit Swivel Earpiece with Boom Microphone (requires NNTN8191)
PMLN7540_	3.5 mm Ear Bud with In-line Microphone and Push-to-Talk
PMLN7541_	3.5 mm 2-Wire Earpiece with Translucent Tube

Table 21: Operations Critical Wireless Accessories

Part Number	Description
NNTN8191_	Operations Critical Wireless Push-To-Talk Pod. Power supply for charging this pod must be ordered separately.
NNTN8294_	Wireless Bluetooth Ear-bud with 11.5 inch Cable. Requires NNTN8191 Operations Critical Wireless Push-To-Talk Pod.
NNTN8433_	Completely Discreet Wireless Surveillance Kit. Includes Wireless Neck Loop Y-Adapter and Retention Hook, Completely Discreet Earpiece Kit and Wireless Push-to-Talk Pod.
NTN2572_	Operations Critical Wireless Earpiece with 12 inch Cable. Requires NNTN8191 Operations Critical Wireless Push-To-Talk Pod.
PMLN6463_	Bluetooth Kit with a Receive-only Earpiece and Bluetooth Pod

Table 22: Batteries and Chargers

Part Number	Description
PMNN4510_	IMPRES 2, 2300 mAh Li-Ion Slim Battery
PMPN4120_	12-Device Multi-Unit Charger with Japan Plug
PMPN4121_	12-Device Multi-Unit Charger with Euro Plug
PMPN4122_	12-Device Multi-Unit Charger with UK/HK Plug
PMPN4123_	12-Device Multi-Unit Charger with Australia/NZ Plug
PMPN4124_	12-Device Multi-Unit Charger with Argentina Plug
PMPN4125_	12-Device Multi-Unit Charger with China Plug
PMPN4126_	12-Device Multi-Unit Charger with Korea Plug
PMPN4127_	12-Device Multi-Unit Charger with Brazil Plug
PMPN4279_	12-Device Multi-Unit Charger with US Plug
PS000150A21	USB-C Wall Charger, US/Japan Plug
PS000150A22	USB-C Wall Charger, Euro Plug
PS000150A23	USB-C Wall Charger, UK/HK Plug
PS000150A24	USB-C Wall Charger, Australia/NZ Plug
PS000150A25	USB-C Wall Charger, Argentina Plug
PS000150A26	USB-C Wall Charger, China Plug
PS000150A27	USB-C Wall Charger, Korea Plug
PS000150A28	USB-C Wall Charger, Brazil Plug

Table 23: Carry Accessories

Part Number	Description
PMLN7510_	Carry Holster
PMLN7511_	Carry Sling

Table 24: Power Cords

Part Number	Description
3087791G01	Power Cord, US/NA
3087791G04	Power Cord, Europe
3087791G07	Power Cord, UK/HK
3087791G10	Power Cord, Australia/NZ
3087791G13	Power Cord, Argentina
3087791G16	Power Cord, Korea
3087791G20	Power Cord, Japan
3087791G22	Power Cord, Brazil
CB000199A01	Power Cord, China

Table 25: Power Supply

Part Number	Description
PS000212A01	201 W Power Supply

Table 26: Programming Cable

Part Number	Description
PMKN4122_	RS-232 Programming cable (set cable switch to FLASH)
PMKN4196_	USB-C to USB-A Radio Programming Cable

Table 27: Miscellaneous

Part Number	Description
HW001104A01	Battery Cover Removal Tool
PMHN4359_	Battery Cover

5.7

Radio Disassembly and Reassembly

Mechanical checks and self-tests should be performed on the unit at the basic level of service. To perform testing at the field level, it is sometimes necessary to remove the antenna and the housing from the unit.

NOTICE: Read each procedure thoroughly before performing the actual task.

5.7.1

Torque Specification Chart

Use the recommended torque value in this chart when fastening different parts of the radio.

Table 28: Torque Specification Chart

Description	Part/Kit	Quantity	Torque
USB-C/AJ Retainer Screw	FN000128A01	1	0.7±0.1 lb-in
Main Screw	03012043002	6	2.2±0.1 lb-in

5.7.2

Disassembling the Radio

Only Motorola Solutions Service Centers or Authorized Motorola Solutions Service Dealers can disassemble the radio for repair or maintenance.

Prerequisites: Prepare a torque screwdriver with 3 IP and 6 IP TORX Plus® bits.

5.7.2.1
Removing the Antenna

Procedure:

Unscrew the antenna counterclockwise until it is detached from the radio. The antenna must be removed each time the back housing is removed.

Figure 13: Removing the Antenna

5.7.2.2
Removing the Back Cover

Prerequisites: Prepare the Battery Cover Opener (part number HW001104A01).

Procedure:

1 Place the Battery Cover Opener at the top right and left corners of the battery cover. Twist the Battery Cover Opener to pry open the battery cover.

Figure 14: Removing the Battery Cover

2 Lift the battery cover.

5.7.2.3
Removing the Battery

Procedure:

Push the battery release button upward to release the battery from the radio.

Figure 15: Removing the Battery

5.7.2.4

Removing the Front Cover

Procedure:

1 Follow the sequence in Figure 16: Removing the Main Screws on page 76 to remove the screws. Use a torque screwdriver with 6 IP Torx Plus bit and unscrew in a counterclockwise direction.

Figure 16: Removing the Main Screws
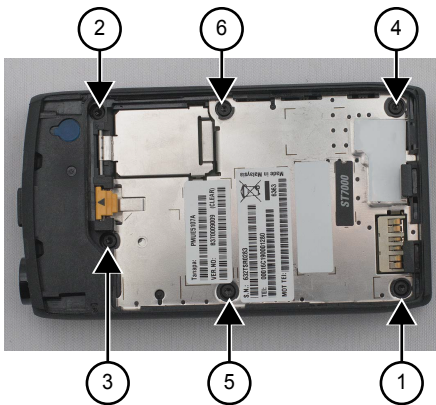
2 Take note of the two catches in Figure 17: Removing the Front Cover on page 76. Release the catches one at a time by pulling the front cover toward the bottom of the radio while lifting upward. A significant amount of force may be required to release the catches, but do not lift the front cover completely as a flex is attached to it.

Figure 17: Removing the Front Cover
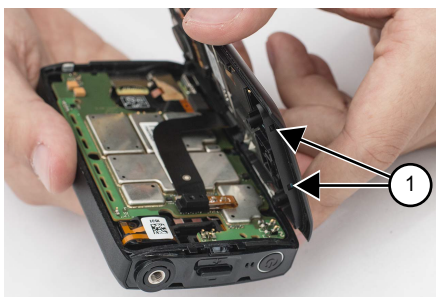
No.	Description
1	Catches

3 Detach the OLED Display Flex board-to-board connector.

Figure 18: Detaching the OLED Display Flex Board-to-Board Connector
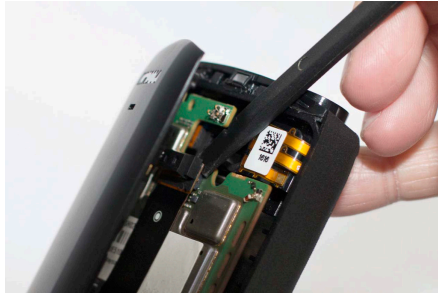
5.7.2.5

Removing the Main Board

Procedure:

1   Detach the USB-C/audio jack flex assembly board-to-board connector before carefully lifting the main board.

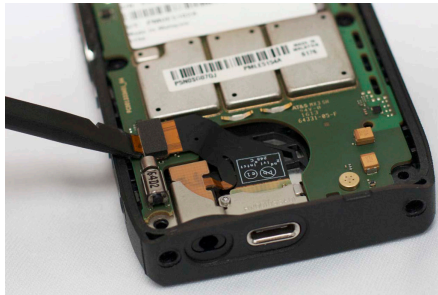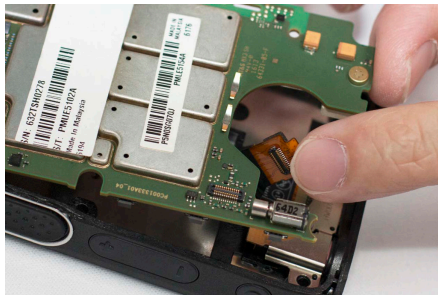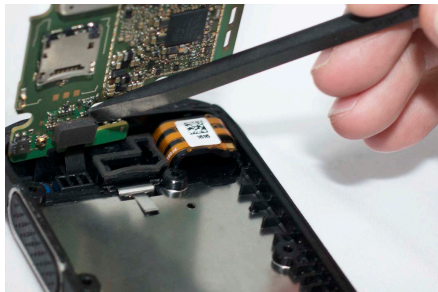**Figure 19: Detaching the USB Board-to-Board Flex Connector**

Figure 20: Removing the USB Board-to-Board Flex Connector from the Main Board

2   Detach the top flex board-to-board connector to remove the main board.

Figure 21: Removing the Main Board

5.7.2.6
Removing the Internal Antenna Module Assembly

Procedure:

Detach the internal antenna module assembly.

Figure 22: Detaching the Internal Antenna Module Assembly
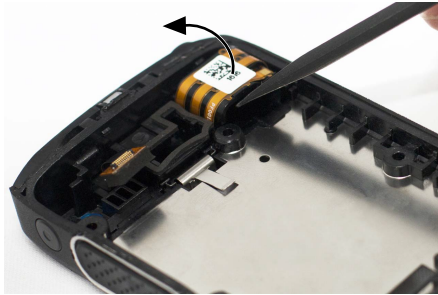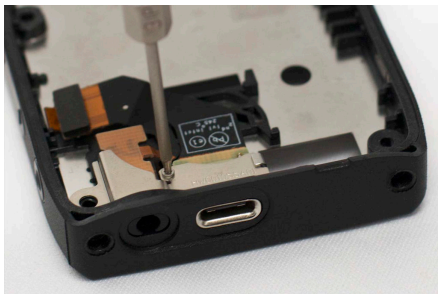

5.7.2.7
Removing the USB-C/Audio Jack Flex Assembly

Once the USB-C/audio jack flex assembly is removed, a new USB-C O-ring must be replaced.
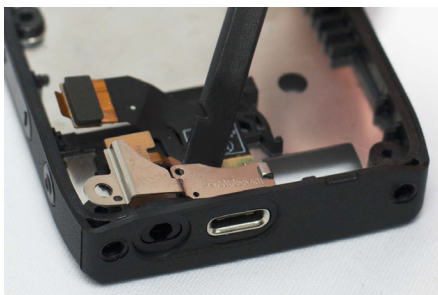
Procedure:

1 Use a torque screwdriver with 3 IP Torx Plus bit to unscrew the USB-C/audio jack metal retainer screw in a counterclockwise direction.

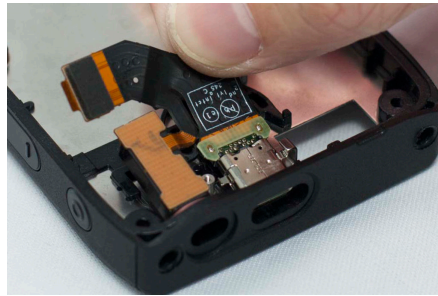**Figure 23: Removing the USB-C/Audio Jack Retainer Screw**

2 Lift the USB-C/audio jack metal retainer to remove it.

Figure 24: Removing the USB-C/Audio Jack Metal Retainer

3 Lift the USB-C/audio jack flex assembly to remove it.

Figure 25: Removing the USB-C/Audio Jack Flex Assembly

5.7.2.8
Removing the OLED Display Module Assembly

Procedure:

1 Push the plastic retention feature beyond the edge of the metal retainer to detach the OLED capacitive touch metal retainer.
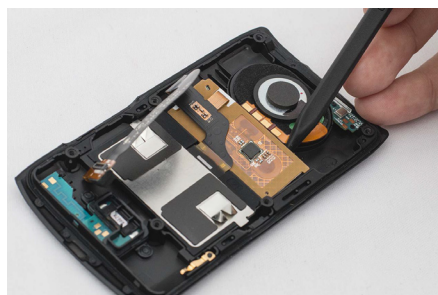
Figure 26: Detaching the Capacitive Touch Metal Retainer

2 Lift the capacitive touch metal retainer to remove it.

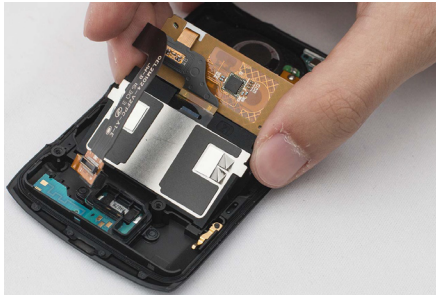**Figure 27: Removing the Capacitive Touch Metal Retainer**

3 Lift the OLED capacitive touch proximity module assembly to detach it.

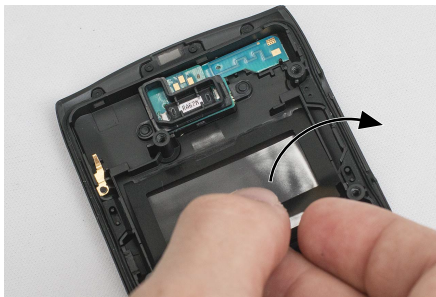**Figure 28: Detaching the OLED Capacitive Touch Proximity Module Assembly**

4 Lift the OLED display module assembly to remove it.

Figure 29: Removing the OLED Display Module Assembly

5 Remove the black tape as shown in Figure 30: Removing the Black Tape on page 80.

Figure 30: Removing the Black Tape

5.7.2.9
Removing the Main Seal

Once the main seal is removed, a new main seal must be replaced.

Procedure:

Lift the main seal to detach all retention features from the front housing. Remove the main seal.

Figure 31: Removing the Main Seal

5.7.3
Reassembling the Radio

Only Motorola Solutions Service Centers or Authorized Motorola Solutions Service Dealers can disassemble the radio for repair or maintenance.

Prerequisites: Prepare a torque screwdriver with 3 IP and 6 IP TORX Plus® bits.
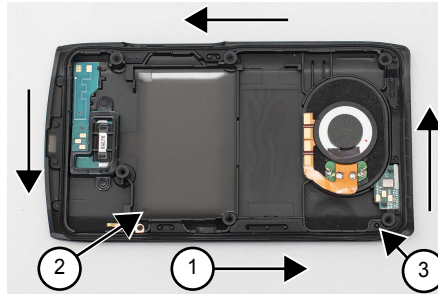
5.7.3.1
Attaching the Main Seal

Procedure:

Follow the sequence in Figure 32: Attaching the Main Seal on page 81 to insert the retention features of the main seal into the respective slots of the front housing.

Figure 32: Attaching the Main Seal

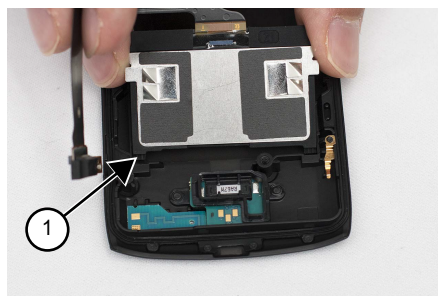| No.	Description
1	Installation sequence
2	Black tape
3	Retention features

5.7.3.2
Installing the OLED Display Module Assembly

Procedure:

1 Insert the OLED rubber jacket tabs into the slots on the front housing to assemble the OLED capacitive touch proximity module assembly.

Figure 33: Installing the OLED Display Module Assembly

No.	Description
1	Rubber jacket tabs

2 Press down the OLED capacitive touch module and the OLED display module assemblies to ensure that they are in place.

3 Insert the capacitive touch metal retainer and press it down firmly until it snaps in place below the plastic retention feature of the front housing.

Figure 34: Installing the Capacitive Touch Metal Retainer
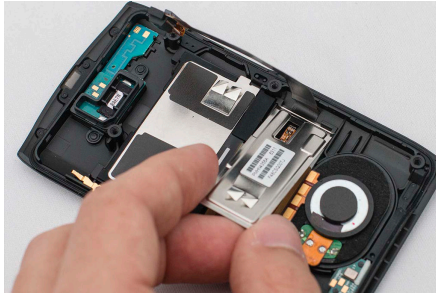
5.7.3.3
Installing the USB-C/Audio Jack Flex Assembly

Procedure:

1 Insert the USB-C/audio jack flex assembly with a new USB-C O-ring to the main housing slot.

Figure 35: Inserting the USB-C/Audio Jack Flex Assembly
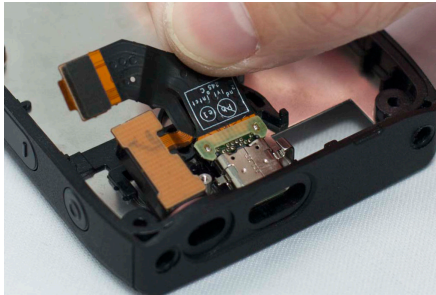
2 Insert the USB-C/audio jack metal retainer.

Figure 36: Inserting the USB-C/Audio Jack Metal Retainer
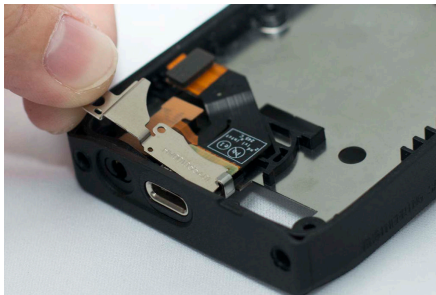
3 Use a torque screwdriver with 3 IP Torx Plus bit to fasten the USB-C/audio jack metal retainer screw in a clockwise direction.

Figure 37: Attaching the USB-C/Audio Jack Metal Retainer Screw

5.7.3.4
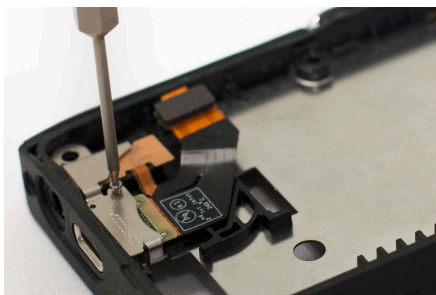# Installing the Internal Antenna Module Assembly

Procedure:

Insert the internal antenna module assembly and press it down firmly until it snaps in place.

Figure 38: Installing the Internal Antenna Module Assembly
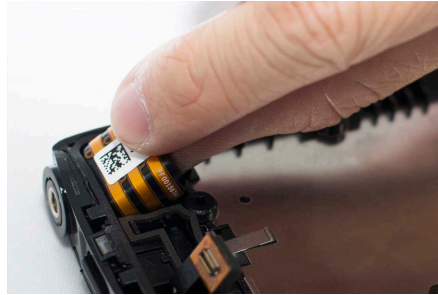
5.7.3.5
Installing the Main Board

Procedure:

1 Assemble the top flex board-to-board connector to the main PCB.

Figure 39: Installing the Top Flex Board-to-Board Connector
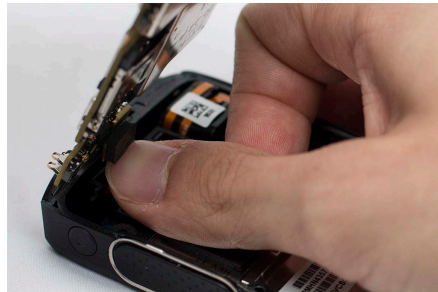
2 Lift the USB board-to-board flex connector and slot in the main PCB.

Figure 40: Inserting the Main PCB
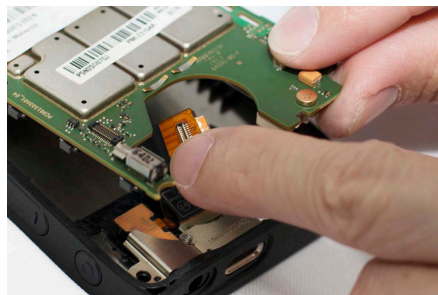
3 Attach the USB flex board-to-board connector to the main board.

Figure 41: Attaching the USB Flex Board-to-Board Connector
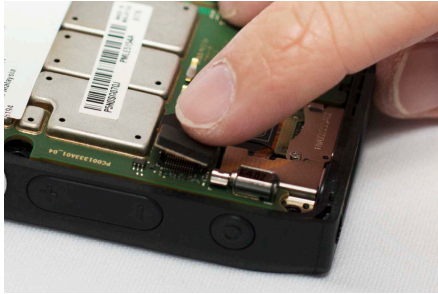
5.7.3.6
Installing the Front Cover

Procedure:

1 Attach the OLED display board-to-board connector to the main display board-to-board connector.

Figure 42: Attaching the OLED Display Board-to-Board Connector
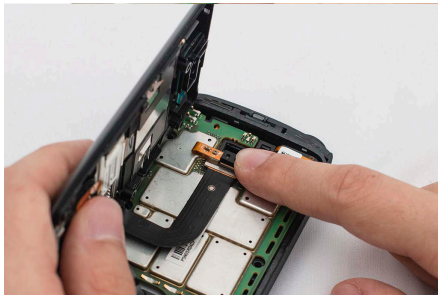
2 Align the bottom edges of the front cover and the main housing. Press down on the top area of the front cover to attach it to the two catches on the main housing.

Figure 43: Attaching the Front Cover

3 Follow the sequence in Figure 44: Attaching the Main Screws on page 85 to fasten the screws. Use a torque screwdriver with 6 IP Torx Plus bit and screw in a clockwise direction.

Figure 44: Attaching the Main Screws
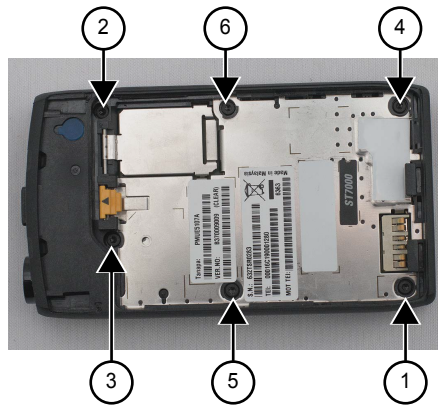
5.7.3.7
Inserting the Battery

Procedure:

1. Insert the battery into the battery compartment until the contacts align and the battery hooks in place.

    Figure 45: Inserting the Battery

2. Press the battery downward until it clicks.

5.7.3.8
Attaching the Back Cover

Procedure:

1. Insert the two fastening bridges at the bottom of the battery cover to the main housing slots.

    Figure 46: Inserting Fastening Bridges to the Main Housing Slots
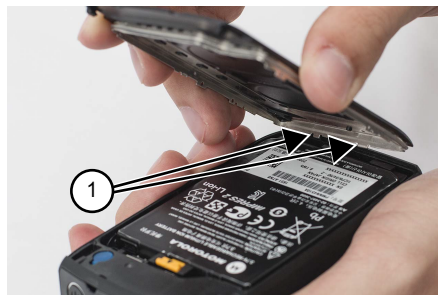
Call-out	Description
1	Fastening bridges

2 Press the battery cover down along the sides from the bottom to the top of the radio, to ensure that all retention features are engaged to the main housing.

Figure 47: Attaching the Battery Cover

5.7.3.9
Installing the Antenna

Procedure:

1 Insert the screw-in base of the antenna into the antenna terminal at the top of the radio.

2 Turn clockwise until tight.

Figure 48: Installing the Antenna

Appendix A

Service Information

Service for the radio is based on the substitution method; whereby a working part replaces a faulty one, providing quicker service to the customer. For example, if the controller board is faulty, it is replaced.

If the radio requires complete testing or servicing than that is available at field level, it is sent to the European Radio Service Center where it is serviced and returned to the Regional Service Center.

Level 1 and Level 2 Maintenance

This manual covers Level 1 and Level 2 Maintenance.

Level 1 Maintenance
  You replace the radio and/or accessories and send the faulty radio and/or accessories to a higher level of maintenance.

Level 2 Maintenance
  A radio board is replaced.

The radios are programmed at the factory. They cannot be tuned at the field service level.

Level 3 Maintenance

Level 3 maintenance can only be done at the Motorola Solutions Service Center/Depot. To find out more about Motorola Solutions Service Center, visit https://www.motorolasolutions.com/.

Replacement Parts

Damaged parts are replaced with identical replacement parts. For complete information on ordering required parts and kits, contact your local customer service representative.

A.1
Service Information

EMEA Technical Support Operations (TSO)

The EMEA Technical Support Operations (TSO) provides a remote Technical Support Service to help customers resolve technical issues and quickly restore networks and systems. This team of highly skilled professionals is available to customers with current service agreements in place that include the Technical Support Service. The TSO technical experts may be accessed through the Service Desk either electronically or using the listed telephone numbers. If you are unsure whether your current service agreement entitles you to benefit from this service, or if you would like more information about the Technical Support Service, contact your local customer support or account manager for further information.

Contact Details

Technical Requests: techsupport.emea@motorolasolutions.com

Repair Support: repair.emea@motorolasolutions.com

Contact Us: https://www.motorolasolutions.com/en_xu/support.html

Parts Identification and Ordering

If you need help in identifying non-referenced spare parts, direct a request to the Customer Care Organization of a local area Motorola Solutions representative. Orders for replacement parts, kits, and assemblies should be placed directly at the local distribution organization of Motorola Solutions or through the Extranet site Motorola Online at https://emeaonline.motorolasolutions.com.

However, you cannot order export-controlled products or spare parts such as TEA-related boards through Motorola Online. Send an order form with actual end-customer details by e-mail to your customer care team.

Your Input

Send questions and comments regarding user documentation to documentation@motorolasolutions.com.

A.2
Recommended Programming Equipment

Table 29: Recommended Programming Equipment

Name	Part Number
Customer CPS User Guide	6802974C10
Programming cable	PMKN4203_

A.3
Service Replacement Kit Matrix

The following kits consist of complete radio but exclude any accessories, battery, and antenna.

Table 30: Service Replacement Kit Matrix for Main Board (for EMEA)

Radio Version	Service Main Board Kit	Description
ST7000 380–430 MHz	PMUE5102_W[8]	ST7000 380–430 MHz CLR Mainboard
	PMUE5104_W[8]	ST7000 380–430 MHz TEA1 Mainboard
	PMUE5105_W[8]	ST7000 380–430 MHz TEA2 Mainboard
	PMUE5106_W[8]	ST7000 380–430 MHz TEA3 Mainboard
	PMUE5111_W[8]	ST7000 380–430 MHz TEA2 BSI Mainboard
	PMUE5112_W[8]	ST7000 380–430 MHz CLR AES128 Mainboard
	PMUE5113_W[8]	ST7000 380–430 MHz TEA1 AES128 Mainboard
	PMUE5114_W[8]	ST7000 380–430 MHz TEA2 AES128 Mainboard
	PMUE5115_W[8]	ST7000 380–430 MHz TEA3 AES128 Mainboard

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[8] For external customer ordering.

Radio Version	Service Main Board Kit	Description
	PMUE5116_W[8]	ST7000 380–430 MHz CLR AES256 Mainboard
	PMUE5117_W[8]	ST7000 380–430 MHz TEA1 AES256 Mainboard
	PMUE5118_W[8]	ST7000 380–430 MHz TEA2 AES256 Mainboard
	PMUE5119_W[8]	ST7000 380–430 MHz TEA3 AES256 Mainboard
	PMUE5102_Z[9]	ST7000 380–430 MHz CLR Mainboard PEN
	PMUE5107_Z[9]	ST7000 380–430 MHz CLR SIM Mainboard PEN

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[9] For internal Motorola Solutions ordering.

Glossary

Advanced RISC Machine (ARM) A processor architecture based on a 32-bit reduced instruction set (RISC) computer.

Air Interface Encryption (AIE) Provides confidentiality on the radio link over the air.

Algebraic Code Excited Linear Prediction A speech (or other audio signals) encoding algorithm where a limited set of pulses is distributed as excitation to linear prediction filter.

| **Abbreviation:** ACELP

Analog Refers to a continuously variable signal or a circuit or device designed to handle such signals.

Analog-to-Digital Converter A device that converts analog signals into digital data. Also known as codec.

| **Abbreviation:** ADC

Automatic Gain Control (AGC) A process or means by which gain is automatically adjusted in a specified manner as a function of a specified parameter, such as received signal level.

BALUN Balanced-unbalanced converter.

Band Frequencies allowed for a specific purpose.

Bluetooth (BT) A wireless protocol utilizing short-range communications over short distances.

CMOS Complementary Metal-Oxide Semiconductor

Co-uP Co-Processor

Customer Programming Software (CPS) Software with a graphical user interface containing the feature set of a radio.

Default A pre-defined set of parameters.

Differential Quadrature Phase Shift Keying (DQPSK) A sub-class of the QPSK methods of transmitting data. Rather than using the absolute value of phase (as in QPSK), only the difference between the current value of phase and the previous value of phase are used. By using phase differences, the implementation is simpler (since an absolute reference source is not required).

Digital Refers to data that is stored or transmitted as a sequence of discrete symbols from a finite set; most commonly this means binary data represented using electronic or electromagnetic signals.

Digital-to-Analog Converter A device that converts a digital value to a corresponding dc voltage value.

| **Abbreviation:** DAC

Digital Signal Processor (DSP) A special-purpose microprocessor that can perform math calculations very rapidly.

Electrically Erasable Programmable Read-Only Memory (EEPROM) Integrated circuit used to store data, which can be erased by electrical methods.

Federal Communications Commission (FCC) Regulates interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Columbia, and U.S. territories. It was established by the Communications Act of 1934 and operates as an independent U.S. government agency overseen by Congress. The commission is committed to being a responsive, efficient and effective agency capable of facing the technological and economic opportunities of the new millennium.

Frequency Number of times a complete electromagnetic-wave cycle occurs in a fixed unit of time (usually one second).

General-Purpose Input/Output (GPIO) Pins whose function is programmable.

Global Core Accessory Interface Motorola Solutions proprietary accessory port for use with Motorola Solutions approved cables. USB and RS232 styles supported.

| **Abbreviation:** GCAI

Global Navigation Satellite System A standard generic term for satellites orbiting the Earth to determine the geographical location. GNSS uses satellites from the GPS, GLONASS, Galileo, and BeiDou systems.

| **Abbreviation:** GNSS

Global Positioning System (GPS) System of 24 satellites that identify earth locations, launched by the U.S. Department of Defense. By triangulating signals from three of the satellites, a GPS receiving unit can pinpoint its current location anywhere on earth to within a few meters.

Input Output For computers, bi-directional input/output (I/O) ports couple the micro-controller to external devices. This interface can operate in parallel or serial form and is usually digital (0 to +5Vdc) logic. Parallel interfaces allow I/O data transfer of eight bits at a time to parallel ports on the micro-controller. The technology is typically used to transfer data between the micro-controller and the external logic it controls. Screen reader support enabled.

| **Abbreviation:** I/O

Integrated Circuit (IC) An assembly of interconnected components on a small semiconductor chip, usually made of silicon. One chip can contain millions of microscopic components and perform many functions.

integrated Terminal Management integrated Terminal Management in Motorola Solutions Dimetra radio systems.

| **Abbreviation:** iTM

Intermediate Frequency A range of frequent audio and radio frequencies.

| **Abbreviation:** IF

Joint Test Action Group Same as IEEE std 1149.1a, which defines signals and behavior for serial testing.

| **Abbreviation:** JTAG

kilohertz (kHz) One thousand cycles per second. Used especially as a radio-frequency unit.

LDMOS Laterally Diffused Metal Oxide Semiconductor

Light Emitting Diode (LED) An electronic device that lights up when electricity is passed through it.

Local Oscillator A tunable oscillator used in a radio or TV receiver to select a particular channel for reception.

| **Abbreviation:** LO

Low Noise Amplifier (LNA) The main amplifying unit in the receiver.

Low-Pass Filter A filter that passes only frequency components lower than a certain frequency.

| **Abbreviation:** LPF

Man Machine Interface (MMI) An interface that enables information to be passed between a human user and hardware or software components of a computer system.

Megahertz (MHz) One million cycles per second. Used especially as aradio-frequency unit.

Phase-locked Loop (PLL) A circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.

Printed Circuit Board (PC Board) A circuit manufactured so that many or all of the components are attached to a non-conductive

circuit board with copper strips on one or both sides to replace wires.

Programming Cable A cable that allows the computer to communicate directly with certain radios using USB.

Radio Frequency (RF) The portion of the electromagnetic spectrum between audio sound and infrared light (approximately 10 kHz to 10 GHz).

Radio Frequency Power Amplifier Amplifier having one or more active devices to amplify radio signals.

| **Abbreviation:** RFPA

Receiver Electronic device that amplifies RF signals. A receiver separates the audio signal from the RF carrier, amplifies it, and converts it back to the original sound waves.

Request-To-Send In General Packet Radio Service (GPRS), a handshaking signal used with some communication links to indicate that data is ready for transmission.

| **Abbreviation:** RTS

RESET Reset line; an input to the microcontroller that restarts execution.

Signal An electrically transmitted electromagnetic wave.

SLIM Slim Connector

Spectrum Frequency range within which radiation has specific characteristics.

Static Random Access Memory Static-RAM chip used for volatile, program/data memory.

| **Abbreviation:** SRAM

Subscriber Identity Module A smart card that holds subscriber information (including the authentication key) and is inserted into the radio to grant its personality.

| **Abbreviation:** SIM

System-On-a-Chip An integrated circuit with all the required circuitry and components of an electronic system on a single chip.

| **Abbreviation:** SoC

Time Division Multiple Access (TDMA) A channel access method to allow several users to share the same frequency channel by dividing the signal into different time slots

Transceiver Transmitter-receiver: A device that both transmits and receives analog or digital signals.

| **Abbreviation:** XCVR

Transmitter Electronic equipment that generates and amplifies an RF carrier signal, modulates the signal, and then radiates it into space.

Universal Serial Bus (USB) An external bus standard that supports data transfer rates of 12 Mbps.

Voltage Controlled Oscillator (VCO) An oscillator whereby the frequency of oscillation can be varied by changing a control voltage.