APX™ TWO-WAY RADIOS

APX 1000
APX 2000
APX 4000
APX 4000Li
BASIC SERVICE MANUAL

Foreword

This manual covers all models of the ASTRO® APX™ 1000/APX™ 2000/APX™ 4000/APX™ 4000 Li digital portable radio, unless otherwise specified. It includes all the information necessary to maintain peak product performance and maximum working time, using levels 1 and 2 maintenance procedures. This level of service goes down to the board replacement level and is typical of some local service centers, self-maintained customers, and distributors.

For details on radio operation or component-level troubleshooting, refer to the applicable manuals available separately. A list of related publications is provided in the section, " Related Publications" on page vi.

Product Safety and RF Exposure Compliance

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

ATTENTION!

This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements. Before using this product, read the guide enclosed with your radio which contains important operating instructions for safe usage and RF energy awareness and control for compliance and applicable standards and regulations.

For a list of Motorola-approved antennas, batteries, and other accessories, visit the following web site: www.motorolasolutions.com/APX

Manual Revisions

Changes which occur after this manual is printed are described in FMRs (Florida Manual Revisions). These FMRs provide complete replacement pages for all added, changed, and deleted items, including pertinent parts list data, schematics, and component layout diagrams. To obtain FMRs, contact the Customer Care and Services Division (refer to "Appendix B Replacement Parts Ordering").

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ASTRO® APX 1000/ APX 2000/ APX 4000/ APX 4000Li Digital Portable Radios

Basic Service Manual

Contents

Document History

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

Edition	Description	Date
68012004056-A	Initial edition	Nov. 2011
68012004056-B	1) Added information for VHF and UHF2 • Model Chart and Specifications • Chapter 3: Basic Theory of Operation • Chapter 5: Performance Checks • Chapter 6: Radio Alignment Procedures	Feb. 2012
68012004056-C	1) Added information for 900 MHz, Model 1.5, APX 4000Li • Model Chart and Specifications • Chapter 3: Basic Theory of Operation • Chapter 5: Performance Checks • Chapter 6: Radio Alignment Procedures • Chapter 10: Exploded Views and Parts Lists	Nov. 2012
68012004056-D	1) Updated APX 4000Li Model 2 information • Model Chart 2) Updated Model Numbering Chart 3) Updated Chapter 4: Recommended Test Equipment and Service Aids. Changed CPS and Tuner software part no. 4) Updated Chapter 10: Exploded Views and Parts List	June 2013
68012004056-E	1) Updated Model Chart. 2) Updated Chapter 10: Exploded Views and Parts List	Nov. 2013
68012004056-F	1) Added information for Soldier Green • Model Chart and Specifications • Updated Chapter 10: Exploded Views and Parts List 2) Added information for APX 1000	Jun. 2014
68012004056-G	1) Added information for APX 1000 (900 MHz) 2) Added information for APX 2000/ APX 4000 Two Knobs 3) Added information for APX 1000 (VHF and UHF2) 3) APX 2000/ APX 4000/ APX 4000Li: Removed “Immersibility Test”, updated “Test Procedure” and removed item 21 (0402838X01) from “Exploded View” and “Exploded View Parts List”	Dec. 2014

Commercial Warranty

For details on the regional Motorola Service Centers, Replacement Parts Ordering and Technical Support assistance, refer to the relevant regions in the Appendix section of this manual.

Notes

ASTRO® APX® 2000/ APX® 4000/ APX® 4000 Li
Digital Portable Radios

Section 1

APX 2000/ APX 4000/ APX 4000Li

Notes

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Related Publications

APX 2000/APX 4000/APX 4000Li Digital Portable Radios Detailed Service Manual..............68012004061

List of Figures

Model Numbering, Charts, and Specifications

Portable Radio Model Numbering System

Typical Model Number:	H	5	1	K	G	D	9	P	W	5	A	N	S	P	0	1
Position:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Position 1 – Type of Unit
H = Hand-Held Portable

Positions 2 & 3 – Model Series
51 = APX 4000
52 = APX 2000

Position 4 - Frequency Band

A = Less than 29.7MHz	P = 336 to 410MHz
B = 29.7 to 35.99MHz	Q = 380 to 470MHz
C = 36 to 41.99MHz	R = 438 to 482MHz
D = 42 to 50MHz	S = 450 to 520MHz
F = 66 to 80MHz	T = Dual Band Capable
G = 74 to 90MHz	U = 764 to 870MHz
H = Product Specific	V = 825 to 870MHz
J = 136 to 162MHz	W = 896 to 941MHz
K = 136 to 174MHz	Y = 1.0 to 1.6GHz
L = 174 to 210MHz	Z = 1.5 to 2.0GHz
M = 190 to 235MHz	

Values given represent range only; they are not absolute.

Position 5 – Power Level
A = 0 to 0.7 Watts
B = 0.7 to 0.9 Watts
C = 1.0 to 3.9 Watts
D = 1.0 to 5.0 Watts
E = 5.1 to 6.0 Watts
F = 6.1 to 10 Watts
G = 0 to 6 Watts

Position 6 – Physical Packages
A = RF Modem Operation
B = Receiver Only
C = Standard Control; No Display
D = Standard Control; With Display
E = Limited Keypad; No Display
F = Limited Keypad; With Display
G = Full Keypad; No Display
H = Full Keypad; With Display
J = Limited Controls; No Display
K = Limited Controls; Basic Display
L = Limited Controls; Limited Display
M = Rotary Controls; Standard Display
N = Enhanced Controls; Enhanced Display
P = Low Profile; No Display
Q = Low Profile; Basic Display
R = Low Profile; Basic Display, Full Keypad

Position 7 – Channel Spacing

1 = 5kHz	5 = 15kHz
2 = 6.25kHz	6 = 20/25kHz
3 = 10kHz	7 = 30kHz
4 = 12.5kHz	9 = Variable/Programmable

Position 8 – Primary Operation
A = Conventional/Simplex
B = Conventional/Duplex
C = Trunked Twin Type
D = Dual Mode Trunked
E = Dual Mode Trunked/Duplex
F = Trunked Type I
G = Trunked Type II
H = FDMA* Digital Dual Mode
J = TDMA** Digital Dual Mode
K = Single Sideband
L = Global Positioning Satellite Capable
M = Amplitude Companded Sideband (ACSB)
P = Programmable

** FDMA = Frequency Division Multiple Access*
*** TDMA = Time Division Multiple Access*

Position 9 – Primary System Type
A = Conventional
B = Privacy Plus
C = Clear SMARTNET
D = Advanced Conventional Stat-Alert
E = Enhanced Privacy Plus
F = Nauganet 888 Series
G = Japan Specialized Mobile Radio (JSMR)
H = Multi-Channel Access (MCA)
J = CoveragePLUS
K = MPT1327* – Public
L = MPT1327* – Private
M = Radiocom
N = Tone Signalling
P = Binary Signalling
Q = Phonenet
W = Programmable
X = Secure Conventional
Y = Secure SMARTNET

** MPT = Ministry of Posts and Telecommunications*

Position 10 – Feature Level

1 = Basic	6 = Standard Plus
2 = Limited Package	7 = Expanded Package
3 = Limited Plus	8 = Expanded Plus
4 = Intermediate	9 = Full Feature/ Programmable
5 = Standard Package	

Position 11 – Version
Version Letter (Alpha) – Major Change

Position 12 – Unique Model Variations
C = Cenelec
N = Standard Package

Positions 13 – 16
SP Model Suffix

Notes

ASTRO APX 2000/APX 4000/APX 4000Li VHF Model Chart

MODEL DESCRIPTION:							VHF, APX 2000/APX 4000/APX 4000Li
Non-BT Models FCC ID:							AZ489FT3825
BT Models FCC ID:							AZ489FT3828
H52KDD9PW5AN							Model 1.5 APX2000, 136–174MHz, 1–5 Watts, Standard Control
	H51KDD9PW5AN						Model 1.5 APX4000 Li, 136–174MHz, 1–5 Watts, Standard Control
		H52KDF9PW6AN					Model 2 APX2000, 136–174MHz, 1–5 Watts, Limited Keypad
			H51KDF9PW6AN				Model 2 APX4000, 136–174MHz, 1–5 Watts, Limited Keypad
				H52KDH9PW7AN			Model 3 APX2000, 136–174MHz, 1–5 Watts, Full Keypad
					H51KDH9PW7AN		Model 3 APX4000, 136–174MHz, 1–5 Watts, Full Keypad
						ITEM NUMBER	DESCRIPTION
X	X					PMLN6448_	Assembly, Front Kit, Model 1.5
		X	X			PMLN5907_	Assembly, Front Kit, Model 2
				X	X	PMLN5903_	Assembly, Front Kit, Model 3
X	X	X	X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	X	X	X	42012056001	Retainer, Keypad
X	X					75012207001	Keypad, Model 1.5
		X	X			75012114003	Keypad, Model 2
				X	X	75012114001	Keypad, Model 3 (English)
				X	X	75012114002	Keypad, Model 3 (Chinese)
				X	X	75012114004	Keypad, Model 3 (Cyrillic)
				X	X	75012114005	Keypad, Model 3 (Arabic)
				X	X	75012114006	Keypad, Model 3 (Hebrew)
X	X					PMLN6458_	Assembly, Keypad Board, Model 1.5, Base
		X	X			PMLN6210_	Assembly, Keypad Board, Model 2, Base
		X	X			PMLN6211_	Assembly, Keypad Board, Model 2, Expanded
				X	X	PMLN6212_	Assembly, Keypad Board, Model 3, Base
				X	X	PMLN6209_	Assembly, Keypad Board, Model 3, Expanded
X	X					40012085001	Mylar with Metal Domes, Model 1.5 Keypad
		X	X			40012056002	Mylar with Metal Domes, Model 2 Keypad
				X	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	X	X	X	35012068001	Membrane, Back Mic
X	X	X	X	X	X	32012282001	Boot, Back Mic
X	X	X	X	X	X	64012022001	Backer, Back Mic
X	X	X	X	X	X	27012020002	Chassis
X	X	X	X	X	X	32012150001	Seal, Battery Contact
X	X	X	X	X	X	15012140001	Shroud
X	X	X	X	X	X	32012156001	O-ring, Main
X	X	X	X	X	X	PMLN6329_	WWP, Assembly, Main Board (VHF)*
X	X	X	X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	X	X	X	43012045001	Collar, Plastic
X	X	X	X	X	X	6071520M01	Coin Cell
		X	X	X	X	0104043J76	Assembly, Flex, Back-kit (Model 2 and Model 3)
X	X					0104055J99	Assembly, Flex, Back-kit (Model 1.5)
X	X	X	X	X	X	0104046J48	Assembly, Shield, Secondary
X	X	X	X	X	X	0386104Z04	Screw, Chassis
X	X	X	X	X	X	3286058L01	Seal, Vacuum Port

Note:
X *= Item Included.*
- *Refer* Appendix A for antennas, batteries and other applicable accessories.
- * *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
  - *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
  - *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
  - *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/APX 4000/APX 4000Li VHF Model Chart (Continued)

MODEL DESCRIPTION:							VHF, APX 2000/APX 4000/APX 4000Li
Non-BT Models FCC ID:							AZ489FT3825
BT Models FCC ID							AZ489FT3828
H52KDD9PW5AN							Model 1.5 APX2000, 136–174MHz, 1–5 Watts, Standard Control
	H51KDD9PW5AN						Model 1.5 APX4000 Li, 136–174MHz, 1–5 Watts, Standard Control
		H52KDF9PW6AN					Model 2 APX2000, 136–174MHz, 1–5 Watts, Limited Keypad
			H51KDF9PW6AN				Model 2 APX4000, 136–174MHz, 1–5 Watts, Limited Keypad
				H52KDH9PW7AN			Model 3 APX2000, 136–174MHz, 1–5 Watts, Full Keypad
					H51KDH9PW7AN		Model 3 APX4000, 136–174MHz, 1–5 Watts, Full Keypad
						ITEM NUMBER	**DESCRIPTION**
X	X	X	X	X	X	5478220A01	Label, Ventilation
		●	●	●	●	54012196001	Label, Front_NamePlate (Bluetooth Blue Dot – Expanded)
●	●	●	●	●	●	54012196002	Label, Front_NamePlate (Non-Bluetooth – Basic)
●		●		●		54012198001	Label, Back (APX 2000)
			●		●	54012198002	Label, Back (APX 4000)
	●					54012198003	Label, Back (APX 4000Li)
X	X	X	X	X	X	54012241001	Label, Bottom
●	●	●	●	●	●	54012255001	Label, Front, Color Talk Group
O	*O*	*O*	*O*	*O*	*O*	54012230001	Label, FM
X	X	X	X	X	X	36012020002	Knob, Multi Function
X	X	X	X	X	X	15012142001	Cover, Accessory-Connector
X	X	X	X	X	X	PMLN5997_	User Guide CD, APX 2000 and APX 4000

Note:
X *= Item Included.*
● *= Option available. Can be serviced in depot and ordered thru AAD.*
O *= Option available. Can be serviced in depot and orderable by FM qualified customers/dealers only. For APAC – Only FM label can be replaced and purchased by Motorola.*

- *Refer* Appendix A *for antennas, batteries and other applicable accessories.*

* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/APX 4000/APX 4000Li UHF1 Model Chart

MODEL DESCRIPTION:	**UHF1, APX 2000/APX 4000/APX 4000Li**
Non-BT Models FCC ID:	**AZ489FT4907**
BT Models FCC ID:	**AZ489FT4905**

Model	Description
H52QDD9PW5AN	**Model 1.5 APX2000, 380–470MHz, 1–5 Watts, Standard Control**
H51QDD9PW5AN	**Model 1.5 APX4000 Li, 380–470MHz, 1–5 Watts, Standard Control**
H52QDF9PW6AN	**Model 2 APX2000, 380–470MHz, 1–5 Watts, Limited Keypad**
H51QDF9PW6AN	**Model 2 APX4000, 380–470MHz, 1–5 Watts, Limited Keypad**
H52QDH9PW7AN	**Model 3 APX2000, 380–470MHz, 1–5 Watts, Full Keypad**
H51QDH9PW7AN	**Model 3 APX4000, 380–470MHz, 1–5 Watts, Full Keypad**

H52QDD9PW5AN	H51QDD9PW5AN	H52QDF9PW6AN	H51QDF9PW6AN	H52QDH9PW7AN	H51QDH9PW7AN	ITEM NUMBER	DESCRIPTION
X	X					PMLN6448_	Assembly, Front Kit, Model 1.5
		X	X			PMLN5907_	Assembly, Front Kit, Model 2
				X	X	PMLN5903_	Assembly, Front Kit, Model 3
X	X	X	X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	X	X	X	42012056001	Retainer, Keypad
X	X					75012207001	Keypad, Model 1.5
		X	X			75012114003	Keypad, Model 2
				X	X	75012114001	Keypad, Model 3 (English)
				X	X	75012114002	Keypad, Model 3 (Chinese)
				X	X	75012114004	Keypad, Model 3 (Cyrillic)
				X	X	75012114005	Keypad, Model 3 (Arabic)
				X	X	75012114006	Keypad, Model 3 (Hebrew)
X	X					PMLN6458_	Assembly, Keypad Board, Model 1.5, Base
		X	X			PMLN6210_	Assembly, Keypad Board, Model 2, Base
		X	X			PMLN6211_	Assembly, Keypad Board, Model 2, Expanded
				X	X	PMLN6212_	Assembly, Keypad Board, Model 3, Base
				X	X	PMLN6209_	Assembly, Keypad Board, Model 3, Expanded
X	X					40012085001	Mylar with Metal Domes, Model 1.5 Keypad
		X	X			40012056002	Mylar with Metal Domes, Model 2 Keypad
				X	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	X	X	X	35012068001	Membrane, Back Mic
X	X	X	X	X	X	32012282001	Boot, Back Mic
X	X	X	X	X	X	64012022001	Backer, Back Mic
X	X	X	X	X	X	27012020002	Chassis
X	X	X	X	X	X	32012150001	Seal, Battery Contact
X	X	X	X	X	X	15012140001	Shroud
X	X	X	X	X	X	32012156001	O-ring, Main
X	X	X	X	X	X	PMLN6214_	Assembly, Main Board (UHFr1)*
X	X	X	X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	X	X	X	43012045001	Collar, Plastic
X	X	X	X	X	X	6071520M01	Coin Cell
		X	X	X	X	0104043J76	Assembly, Flex, Back-kit (Model 2 and Model 3)
X	X					0104055J99	Assembly, Flex, Back-kit (Model 1.5)
X	X	X	X	X	X	0104046J48	Assembly, Shield, Secondary
X	X	X	X	X	X	0386104Z04	Screw, Chassis
X	X	X	X	X	X	3286058L01	Seal, Vacuum Port

Note:
X *= Item Included.*
- *Refer* Appendix A *for antennas, batteries and other applicable accessories.*

* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/APX 4000/APX 4000Li UHF1 Model Chart (Continued)

MODEL DESCRIPTION:							**UHF1, APX 2000/APX 4000/APX 4000Li**
Non-BT Models FCC ID:							**AZ489FT4907**
BT Models FCC ID:							**AZ489FT4905**
H52QDD9PW5AN							**Model 1.5 APX2000, 380–470MHz, 1–5 Watts, Standard Control**
	H51QDD9PW5AN						**Model 1.5 APX4000 Li, 380–470MHz, 1–5 Watts, Standard Control**
		H52QDF9PW6AN					**Model 2 APX2000, 380–470MHz, 1–5 Watts, Limited Keypad**
			H51QDF9PW6AN				**Model 2 APX4000, 380–470MHz, 1–5 Watts, Limited Keypad**
				H52QDH9PW7AN			**Model 3 APX2000, 380–470MHz, 1–5 Watts, Full Keypad**
					H51QDH9PW7AN		**Model 3 APX4000, 380–470MHz, 1–5 Watts, Full Keypad**
						ITEM NUMBER	**DESCRIPTION**
X	X	X	X	X	X	5478220A01	Label, Ventilation
		●	●	●	●	54012196001	Label, Front_NamePlate (Bluetooth Blue Dot – Expanded)
●	●	●	●	●	●	54012196002	Label, Front_NamePlate (Non-Bluetooth – Basic)
●		●		●		54012198001	Label, Back (APX 2000)
			●		●	54012198002	Label, Back (APX 4000)
	●					54012198003	Label, Back (APX 4000Li)
X	X	X	X	X	X	54012241001	Label, Bottom
●	●	●	●	●	●	54012255001	Label, Front, Color Talk Group
O	*O*	*O*	*O*	*O*	*O*	54012230001	Label, FM
X	X	X	X	X	X	36012020002	Knob, Multi Function
X	X	X	X	X	X	15012142001	Cover, Accessory-Connector
X	X	X	X	X	X	PMLN5997_	User Guide CD, APX 2000 and APX 4000

Note:
X *= Item Included.*
● *= Option available. Can be serviced in depot and ordered thru AAD.*
O *= Option available. Can be serviced in depot and orderable by FM qualified customers/dealers only. For APAC – Only FM label can be replaced and purchased by Motorola.*
- *Refer Appendix A for antennas, batteries and other applicable accessories.*

* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/APX 4000/APX 4000Li UHF2 Model Chart

MODEL DESCRIPTION:							**UHF2, APX 2000/APX 4000/APX 4000Li**
Non-BT Models FCC ID:							**AZ489FT4909**
BT Models FCC ID:							**AZ489FT4910**
H52SDD9PW5AN							**Model 1.5 APX2000, 450–520MHz, 1–5 Watts, Standard Control**
	H51SDD9PW5AN						**Model 1.5 APX4000 Li, 450–520MHz, 1–5 Watts, Standard Control**
		H52SDF9PW6AN					**Model 2 APX2000, 450–520MHz, 1–5 Watts, Limited Keypad**
			H51SDF9PW6AN				**Model 2 APX4000, 450–520MHz, 1–5 Watts, Limited Keypad**
				H52SDH9PW7AN			**Model 3 APX2000, 450–520MHz, 1–5 Watts, Full Keypad**
					H51SDH9PW7AN		**Model 3 APX4000, 450–520MHz, 1–5 Watts, Full Keypad**
						ITEM NUMBER	**DESCRIPTION**
X	X					PMLN6448_	Assembly, Front Kit, Model 1.5
		X	X			PMLN5907_	Assembly, Front Kit, Model 2
				X	X	PMLN5903_	Assembly, Front Kit, Model 3
X	X	X	X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	X	X	X	42012056001	Retainer, Keypad
X	X					75012207001	Keypad, Model 1.5
		X	X			75012114003	Keypad, Model 2
				X	X	75012114001	Keypad, Model 3 (English)
				X	X	75012114002	Keypad, Model 3 (Chinese)
				X	X	75012114004	Keypad, Model 3 (Cyrillic)
				X	X	75012114005	Keypad, Model 3 (Arabic)
				X	X	75012114006	Keypad, Model 3 (Hebrew)
X	X					PMLN6458_	Assembly, Keypad Board, Model 1.5, Base
		X	X			PMLN6210_	Assembly, Keypad Board, Model 2, Base
		X	X			PMLN6211_	Assembly, Keypad Board, Model 2, Expanded
				X	X	PMLN6212_	Assembly, Keypad Board, Model 3, Base
				X	X	PMLN6209_	Assembly, Keypad Board, Model 3, Expanded
X	X					40012085001	Mylar with Metal Domes, Model 1.5 Keypad
		X	X			40012056002	Mylar with Metal Domes, Model 2 Keypad
				X	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	X	X	X	35012068001	Membrane, Back Mic
X	X	X	X	X	X	32012282001	Boot, Back Mic
X	X	X	X	X	X	64012022001	Backer, Back Mic
X	X	X	X	X	X	27012020002	Chassis
X	X	X	X	X	X	32012150001	Seal, Battery Contact
X	X	X	X	X	X	15012140001	Shroud
X	X	X	X	X	X	32012156001	O-ring, Main
X	X	X	X	X	X	PMLN6328_	Assembly, Main Board (UHFr2)*
X	X	X	X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	X	X	X	43012045001	Collar, Plastic
X	X	X	X	X	X	6071520M01	Coin Cell
		X	X	X	X	0104043J76	Assembly, Flex, Back-kit (Model 2 and Model 3)
X	X					0104055J99	Assembly, Flex, Back-kit (Model 1.5)
X	X	X	X	X	X	0104046J48	Assembly, Shield, Secondary
X	X	X	X	X	X	0386104Z04	Screw, Chassis
X	X	X	X	X	X	3286058L01	Seal, Vacuum Port

Note:
X *= Item Included.*
- *Refer* Appendix A *for antennas, batteries and other applicable accessories.*

* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
  - *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
  - *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
  - *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/APX 4000/APX 4000Li UHF2 Model Chart (Continued)

MODEL DESCRIPTION:	**UHF2, APX 2000/APX 4000/APX 4000Li**
Non-BT Models FCC ID:	**AZ489FT4909**
BT Models FCC ID:	**AZ489FT4910**
H52SDD9PW5AN	**Model 1.5 APX2000, 450–520MHz, 1–5 Watts, Standard Control**
H51SDD9PW5AN	**Model 1.5 APX4000 Li, 450–520MHz, 1–5 Watts, Standard Control**
H52SDF9PW6AN	**Model 2 APX2000, 450–520MHz, 1–5 Watts, Limited Keypad**
H51SDF9PW6AN	**Model 2 APX4000, 450–520MHz, 1–5 Watts, Limited Keypad**
H52SDH9PW7AN	**Model 3 APX2000, 450–520MHz, 1–5 Watts, Full Keypad**
H51SDH9PW7AN	**Model 3 APX4000, 450–520MHz, 1–5 Watts, Full Keypad**

H52SDD9PW5AN	H51SDD9PW5AN	H52SDF9PW6AN	H51SDF9PW6AN	H52SDH9PW7AN	H51SDH9PW7AN	ITEM NUMBER	DESCRIPTION
X	X	X	X	X	X	5478220A01	Label, Ventilation
		●	●	●	●	54012196001	Label, Front_NamePlate (Bluetooth Blue Dot – Expanded)
●	●	●	●	●	●	54012196002	Label, Front_NamePlate (Non-Bluetooth – Basic)
●		●		●		54012198001	Label, Back (APX 2000)
			●		●	54012198002	Label, Back (APX 4000)
	●					54012198003	Label, Back (APX 4000Li)
X	X	X	X	X	X	54012241001	Label, Bottom
●	●	●	●	●	●	54012255001	Label, Front, Color Talk Group
O	*O*	*O*	*O*	*O*	*O*	54012230001	Label, FM
X	X	X	X	X	X	36012020002	Knob, Multi Function
X	X	X	X	X	X	15012142001	Cover, Accessory-Connector
X	X	X	X	X	X	PMLN5997_	User Guide CD, APX 2000 and APX 4000

Note:
X *= Item Included.*
● *= Option available. Can be serviced in depot and ordered thru AAD.*
O *= Option available. Can be serviced in depot and orderable by FM qualified customers/dealers only. For APAC – Only FM label can be replaced and purchased by Motorola.*
- *Refer* Appendix A *for antennas, batteries and other applicable accessories.*

* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
  - *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
  - *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
  - *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/APX 4000/APX 4000Li 700/800 MHz Model Chart

MODEL DESCRIPTION:	700–800, APX 2000/APX 4000/APX 4000Li
Non-BT Models FCC ID:	AZ489FT7050
BT Models FCC ID:	AZ489FT7049

Model	Description
H52UCD9PW5AN	Model 1.5 APX2000, 764–870MHz, 1.0–3.9 Watts, Standard Control
H51UCD9PW5AN	Model 1.5 APX4000 Li, 764–870MHz, 1.0–3.9 Watts, Standard Control
H52UCF9PW6AN	Model 2 APX2000, 764–870MHz, 1.0–3.9 Watts, Limited Keypad
H51UCF9PW6AN	Model 2 APX4000, 764–870MHz, 1.0–3.9 Watts, Limited Keypad
H52UCH9PW7AN	Model 3 APX2000, 764–870MHz, 1.0–3.9 Watts, Full Keypad
H51UCH9PW7AN	Model 3 APX4000, 764–870MHz, 1.0–3.9 Watts, Full Keypad

H52UCD9PW5AN	H51UCD9PW5AN	H52UCF9PW6AN	H51UCF9PW6AN	H52UCH9PW7AN	H51UCH9PW7AN	ITEM NUMBER	DESCRIPTION
X	X					PMLN6448_	Assembly, Front Kit, Model 1.5
		X	X			PMLN5907_	Assembly, Front Kit, Model 2
				X	X	PMLN5903_	Assembly, Front Kit, Model 3
		X				PMLN6848_	Assembly, Front Kit, Model 2, Soldier Green
				X		PMLN6849_	Assembly, Front Kit, Model 3, Soldier Green
X	X	X	X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	X	X	X	42012056001	Retainer, Keypad
X	X					75012207001	Keypad, Model 1.5
		X	X			75012114003	Keypad, Model 2
				X	X	75012114001	Keypad, Model 3 (English)
				X	X	75012114002	Keypad, Model 3 (Chinese)
				X	X	75012114004	Keypad, Model 3 (Cyrillic)
				X	X	75012114005	Keypad, Model 3 (Arabic)
				X	X	75012114006	Keypad, Model 3 (Hebrew)
X	X					PMLN6458_	Assembly, Keypad Board, Model 1.5, Base
		X	X			PMLN6210_	Assembly, Keypad Board, Model 2, Base
		X	X			PMLN6211_	Assembly, Keypad Board, Model 2, Expanded
				X	X	PMLN6212_	Assembly, Keypad Board, Model 3, Base
				X	X	PMLN6209_	Assembly, Keypad Board, Model 3, Expanded
X	X					40012085001	Mylar with Metal Domes, Model 1.5 Keypad
		X	X			40012056002	Mylar with Metal Domes, Model 2 Keypad
				X	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	X	X	X	35012068001	Membrane, Back Mic
X	X	X	X	X	X	32012282001	Boot, Back Mic
X	X	X	X	X	X	64012022001	Backer, Back Mic
X	X	X	X	X	X	27012020002	Chassis
X	X	X	X	X	X	32012150001	Seal, Battery Contact
X	X	X	X	X	X	15012140001	Shroud
X	X	X	X	X	X	32012156001	O-ring, Main
X	X	X	X	X	X	PMLN6213_	Assembly, Main Board (7_800)*
X	X	X	X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	X	X	X	43012045001	Collar, Plastic
X	X	X	X	X	X	6071520M01	Coin Cell
		X	X	X	X	0104043J76	Assembly, Flex, Back-kit (Model 2 and Model 3)
X	X					0104055J99	Assembly, Flex, Back-kit (Model 1.5)
X	X	X	X	X	X	0104046J48	Assembly, Shield, Secondary
X	X	X	X	X	X	0386104Z04	Screw, Chassis
X	X	X	X	X	X	3286058L01	Seal, Vacuum Port

Note:
X *= Item Included.*
- *Refer* Appendix A *for antennas, batteries and other applicable accessories.*

* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/APX 4000/APX 4000Li 700/800 MHz Model Chart (Continued)

MODEL DESCRIPTION:							**700–800, APX 2000/APX 4000/APX 4000Li**
Non-BT Models FCC ID:							**AZ489FT7050**
BT Models FCC ID:							**AZ489FT7049**
H52UCD9PW5AN							**Model 1.5 APX2000, 764–870MHz, 1.0–3.9 Watts, Standard Control**
	H51UCD9PW5AN						**Model 1.5 APX4000 Li, 764–870MHz, 1.0–3.9 Watts, Standard Control**
		H52UCF9PW6AN					**Model 2 APX2000, 764–870MHz, 1.0–3.9 Watts, Limited Keypad**
			H51UCF9PW6AN				**Model 2 APX4000, 764–870MHz, 1.0–3.9 Watts, Limited Keypad**
				H52UCH9PW7AN			**Model 3 APX2000, 764–870MHz, 1.0–3.9 Watts, Full Keypad**
					H51UCH9PW7AN		**Model 3 APX4000, 764–870MHz, 1.0–3.9 Watts, Full Keypad**
						ITEM NUMBER	**DESCRIPTION**
X	**X**	**X**	**X**	**X**	**X**	5478220A01	Label, Ventilation
		●	●	●	●	54012196001	Label, Front_NamePlate (Bluetooth Blue Dot – Expanded)
●	●	●	●	●	●	54012196002	Label, Front_NamePlate (Non-Bluetooth – Basic)
●		●		●		54012198001	Label, Back (APX 2000)
			●		●	54012198002	Label, Back (APX 4000)
	●					54012198003	Label, Back (APX 4000Li)
X	**X**	**X**	**X**	**X**	**X**	54012241001	Label, Bottom
●	●	●	●	●	●	54012255001	Label, Front, Color Talk Group
O	***O***	***O***	***O***	***O***	***O***	54012230001	Label, FM
X	**X**	**X**	**X**	**X**	**X**	36012020002	Knob, Multi Function
X	**X**	**X**	**X**	**X**	**X**	15012142001	Cover, Accessory-Connector
X	**X**	**X**	**X**	**X**	**X**	PMLN5997_	User Guide CD, APX 2000 and APX 4000

Note:
X *= Item Included.*
● *= Option available. Can be serviced in depot and ordered thru AAD.*
O *= Option available. Can be serviced in depot and orderable by FM qualified customers/dealers only. For APAC – Only FM label can be replaced and purchased by Motorola.*

- *Refer* Appendix A *for antennas, batteries and other applicable accessories.*

* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
  - *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
  - *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
  - *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 4000 900 MHz Model Chart

MODEL DESCRIPTION:			900 MHz, APX 4000
BT Models FCC ID:			AZ489FT5864
H51WCF9PW6AN			Model 2 APX4000, 896–941MHz, 1.0–3.9 Watts, Limited Keypad
	H51WCH9PW7AN		Model 3 APX4000, 896–941MHz, 1.0–3.9 Watts, Full Keypad
		ITEM NUMBER	DESCRIPTION
X		PMLN5907_	Assembly, Front Kit, Model 2
	X	PMLN5903_	Assembly, Front Kit, Model 3
X	X	0378212A02	Screw, Retainer, Keypad
X	X	42012056001	Retainer, Keypad
X		75012114003	Keypad, Model 2
	X	75012114001	Keypad, Model 3 (English)
	X	75012114002	Keypad, Model 3 (Chinese)
	X	75012114004	Keypad, Model 3 (Cyrillic)
	X	75012114005	Keypad, Model 3 (Arabic)
	X	75012114006	Keypad, Model 3 (Hebrew)
X		PMLN6211_	Assembly, Keypad Board, Model 2, Expanded
	X	PMLN6209_	Assembly, Keypad Board, Model 3, Expanded
X		40012056002	Mylar with Metal Domes, Model 2 Keypad
	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	0104059J61	Assembly, Flex, Back Mic
X	X	35012068001	Membrane, Back Mic
X	X	32012282001	Boot, Back Mic
X	X	64012022001	Backer, Back Mic
X	X	27012020002	Chassis
X	X	32012150001	Seal, Battery Contact
X	X	15012140001	Shroud
X	X	32012156001	O-ring, Main
X	X	PMLN7028_	Assembly, Main Board (900 MHz)*
X	X	7515719H02	Pad, Thermal, RF PA
X	X	43012045001	Collar, Plastic
X	X	6071520M01	Coin Cell
X	X	0104043J76	Assembly, Flex, Back-kit (Model 2 and Model 3)
X	X	0104046J48	Assembly, Shield, Secondary
X	X	0386104Z04	Screw, Chassis
X	X	3286058L01	Seal, Vacuum Port
X	X	5478220A01	Label, Ventilation
●	●	54012196001	Label, Front_NamePlate (Bluetooth Blue Dot – Expanded)
●	●	54012198002	Label, Back (APX 4000)
X	X	54012241001	Label, Bottom
●	●	54012255001	Label, Front, Color Talk Group
O	*O*	54012230001	Label, FM
X	X	36012020002	Knob, Multi Function
X	X	15012142001	Cover, Accessory-Connector
X	X	PMLN5997_	User Guide CD, APX 2000 and APX 4000

Note:
X *= Item Included.*
● *= Option available. Can be serviced in depot and ordered thru AAD.*
O *= Option available. Can be serviced in depot and orderable by FM qualified customers/dealers only. For APAC – Only FM label can be replaced and purchased by Motorola.*

- *Refer Appendix A for antennas, batteries and other applicable accessories.*

* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

Specifications for APX 2000/APX 4000/APX 4000Li VHF Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap:**	NNTN8129_*
or **Li-Ion High Cap:**	PMNN4424_
* FM Intrinsically Safe.	
Dimensions (H x W x D):	
Without Battery (Radio Only):	
H = 5.26" (133 mm)	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	
D[2] = 0.77" (19.6 mm) / 1.48" (37.5 mm)	
With Standard Battery:	
H = 5.26" (133 mm)	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	
D[2] = 1.47"(37.4mm) / 1.72"(43.6mm)	
With High Cap Battery:	
H = 5.26" (133mm)	
W[1] = 2.56"(65mm) / 2.37"(60.2mm)	
D[2] = 1.69"(42.9mm) / 1.93"(48.9mm)	
Note:	
H = Height; W = Width; D = Depth	
1 = (Width @ Top) / (Width @ PTT)	
2 = (Depth @ Bottom) / (Depth @ PTT)	
Weight: (w/o Antenna):	
Less Battery:	9.17 oz (260g)
With Li-Ion Standard:	14.47 oz (410g)
With Li-Ion High Cap:	14.81 oz (420g)

RECEIVER

Frequency Range:	136–174 MHz
Bandwidth:	38 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.216µV
Digital Sensitivity (typical)	
(1% BER):	0.285 µV
(5% BER):	0.188 µV
Intermodulation (typical):	-79 dB
Selectivity (typical):	
(25 kHz Channel):	-79.3 dB
(12.5 kHz Channel):	-70 dB
Spurious Rejection (typical):	-80.3 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	
	25 kHz -53.8 dB
	12.5 kHz -47 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	136–174 MHz
RF Power:	
136–174 MHz:	1–5 W
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -51 dB
	12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz
	20 kHz chnls ±4.0 kHz
	12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc
	12.5 kHz -68 dBc
Emissions Designators:	
11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 20K0F1E	

Specifications subject to change without notice.

Specifications for APX 2000/APX 4000/APX 4000Li UHF1 Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL	
Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	
	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap:**	NNTN8129_*
or **Li-Ion High Cap:**	PMNN4424_
* FM Intrinsically Safe.	
Dimensions (H x W x D):	
Without Battery (Radio Only):	
H = 5.26" (133 mm)	
W^1 = 2.56" (65 mm) / 2.37" (60.2 mm)	
D^2 = 0.77" (19.6 mm) / 1.48" (37.5 mm)	
With Standard Battery:	
H = 5.26" (133 mm)	
W^1 = 2.56" (65 mm) / 2.37" (60.2 mm)	
D^2 = 1.47"(37.4mm) / 1.72"(43.6mm)	
With High Cap Battery:	
H = 5.26" (133mm)	
W^1 = 2.56"(65mm) / 2.37"(60.2mm)	
D^2 = 1.69"(42.9mm) / 1.93"(48.9mm)	
Note:	
H = Height; W = Width; D = Depth	
1 = (Width @ Top) / (Width @ PTT)	
2 = (Depth @ Bottom) / (Depth @ PTT)	
Weight: (w/o Antenna):	
Less Battery:	9.17 oz (260g)
With Li-Ion Standard:	14.47 oz (410g)
With Li-Ion High Cap:	14.81 oz (420g)

RECEIVER	
Frequency Range:	380–470 MHz
Bandwidth:	90 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.234 µV
Digital Sensitivity (typical)	
(1% BER):	0.307 µV
(5% BER):	0.207 µV
Intermodulation (typical):	-77 dB
Selectivity (typical):	
(25 kHz Channel):	-77 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-80.3 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	
	25 kHz -50 dB
	12.5 kHz -45 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER	
Frequency Range:	380–470 MHz
RF Power:	
380–470 MHz:	1–5 W
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -51 dB
	12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz
	20 kHz chnls ±4 kHz
	12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc
	12.5 kHz -68 dBc
Emissions Designators:	
11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 20K0F1E	

Specifications subject to change without notice.

Specifications for APX 2000/APX 4000/APX 4000Li UHF2 Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	
	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap:**	NNTN8129_*
or **Li-Ion High Cap:**	PMNN4424_
* FM Intrinsically Safe.	

Dimensions (H x W x D):

Without Battery (Radio Only):
H = 5.26" (133 mm)
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)
D[2] = 0.77" (19.6 mm) / 1.48" (37.5 mm)

With Standard Battery:
H = 5.26" (133 mm)
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)
D[2] = 1.47"(37.4mm) / 1.72"(43.6mm)

With High Cap Battery:
H = 5.26" (133mm)
W[1] = 2.56"(65mm) / 2.37"(60.2mm)
D[2] = 1.69"(42.9mm) / 1.93"(48.9mm)

Note:
H = Height; W = Width; D = Depth
1 = (Width @ Top) / (Width @ PTT)
2 = (Depth @ Bottom) / (Depth @ PTT)

Weight: (w/o Antenna):	
Less Battery:	9.17 oz (260g)
With Li-Ion Standard:	14.47 oz (410g)
With Li-Ion High Cap:	14.81 oz (420g)

RECEIVER

Frequency Range:	450–520 MHz
Bandwidth:	70 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.234 µV
Digital Sensitivity (typical)	
(1% BER):	0.307 µV
(5% BER):	0.207 µV
Intermodulation (typical):	-77 dB
Selectivity (typical):	
(25 kHz Channel):	-77 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-80 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	
	25 kHz -53.5 dB
	12.5 kHz -47.4 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	450–520 MHz
RF Power:	
450–520 MHz:	1–5 W
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -51 dB
	12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz
	20 kHz chnls ±4 kHz
	12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -73 dBc
	12.5 kHz -68 dBc
Emissions Designators:	
11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 20K0F1E	

Specifications subject to change without notice.

Specifications for APX 2000/APX 4000/APX 4000Li 700/800 MHz Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1680 mA
Receive Current Drain (Rated Audio):	306 mA
Standby Current Drain:	137 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap:**	NNTN8129_*
or **Li-Ion High Cap:**	PMNN4424_

* FM Intrinsically Safe.

Dimensions (H x W x D):

Without Battery (Radio Only):
H = 5.26" (133 mm)
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)
D[2] = 0.77" (19.6 mm) / 1.48" (37.5 mm)

With Standard Battery:
H = 5.26" (133 mm)
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)
D[2] = 1.47"(37.4mm) / 1.72"(43.6mm)

With High Cap Battery:
H = 5.26" (133mm)
W[1] = 2.56"(65mm) / 2.37"(60.2mm)
D[2] = 1.69"(42.9mm) / 1.93"(48.9mm)

Note:
H = Height; W = Width; D = Depth
1 = (Width @ Top) / (Width @ PTT)
2 = (Depth @ Bottom) / (Depth @ PTT)

Weight: (w/o Antenna):	
Less Battery:	9.17 oz (260g)
With Li-Ion Standard:	14.47 oz (410g)
With Li-Ion High Cap:	14.81 oz (420g)

RECEIVER

Frequency Range:	
700 MHz:	764–776 MHz
800 MHz:	851–870 MHz
Bandwidth:	
700 MHz:	12 MHz
800 MHz:	19 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.266 µV
Digital Sensitivity (typical)	
(1% BER):	0.400 µV
(5% BER):	0.266 µV
Intermodulation (typical):	-75 dB
Selectivity (typical):	
(25 kHz Channel):	-76 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-76.6 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	
	25 kHz -53 dB
	12.5 kHz -47 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	
700 MHz:	764–776; 794–806 MHz
800 MHz:	806–825; 851–870 MHz
RF Power:	
700 MHz:	1–2.7 Watts
800 MHz:	1–3.0 Watts
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	
700 MHz:	±0.0001%
800 MHz:	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -50 dB
	12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5 kHz
	20 kHz chnls ±4 kHz
	12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc
	12.5 kHz -66 dBc

Emissions Designators:
11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 20K0F1E

Specifications subject to change without notice.

Specifications for APX 4000 900 MHz Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL	RECEIVER	TRANSMITTER
Temperature Range:	**Frequency Range:** 935–941 MHz	**Frequency Range:** 896–902 MHz
Operating: -30°C to +60°C		935–941 MHz
Storage: -40°C to +85°C	**Bandwidth:** 6 MHz	
		RF Power:
Power Supply:	**Analog Sensitivity (typical)**	1–**2.**5 W
Lithium-Ion Battery (Li-Ion)	**(12 dB SINAD):** 0.236μV	
		Frequency Stability (typical)
Battery Voltage:	**Digital Sensitivity (typical)**	**(-30 to +60°C; 25°C ref.):** ±0.0001%
Nominal: 7.5 Vdc	**(1% BER):** 0.33 μV	
Range: 6 to 9 Vdc	**(5% BER):** 0.222 μV	**Emission (typical conducted):** -75 dBc
Transmit Current Drain (Typical): 1580 mA	**Intermodulation (typical):** -75 dB	**FM Hum and Noise (typical)**
Receive Current Drain (Rated Audio): 306 mA		**(Companion Receiver):** 12.5 kHz -45 dB
Standby Current Drain: 137 mA	**Selectivity (typical):**	
	(12.5 kHz Channel): -67 dB	**Distortion (typical):** 1%
Recommended Battery:		
Li-Ion (Slim): NNTN8128_	**Spurious Rejection (typical):** -80 dB	**Modulation Limiting:** 12.5 kHz chnls ±2.5 kHz
or **Li-Ion High Cap:** NNTN8129_*		
or **Li-Ion High Cap:** PMNN4424_	**Frequency Stability**	**ACPR (typical):** **12.5 kHz -66 dBc**
* FM Intrinsically Safe.	**(-30+60°C; 25°C reference):** ±0.0001%	
		Emissions Designators:
Dimensions (H x W x D):	**Rated Audio:**	11K0F3E, 8K10F1D, 8K10F1E, 8K10F1W
Without Battery (Radio Only):	**Internal Speaker:** 500 mW	
H = 5.26" (133 mm)	**External Speaker:** 500 mW	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)		
D[2] = 0.77" (19.6 mm) / 1.48" (37.5 mm)	**FM Hum and Noise (typical):**	
With Standard Battery:	12.5 kHz -47 dB	
H = 5.26" (133 mm)		
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	**Distortion (typical):** 1 %	
D[2] = 1.47"(37.4mm) / 1.72"(43.6mm)		
With High Cap Battery:	**Channel Spacing:** 12.5 kHz	
H = 5.26" (133mm)		
W[1] = 2.56"(65mm) / 2.37"(60.2mm)		
D[2] = 1.69"(42.9mm) / 1.93"(48.9mm)		
Note:		
H = Height; W = Width; D = Depth		
1 = (Width @ Top) / (Width @ PTT)		
2 = (Depth @ Bottom) / (Depth @ PTT)		
Weight: (w/o Antenna):		
Less Battery: 9.17 oz (260g)		
With Li-Ion Standard: 14.47 oz (410g)		
With Li-Ion High Cap: 14.81 oz (420g)		

Specifications subject to change without notice.

Chapter 1 Introduction

This manual contains information needed for Levels One and Two radio servicing. Level One servicing consists of radio programming, radio alignment, knobs replacement, and installation and removal of the antenna, belt clip, battery, and universal connector cover. Level Two servicing covers disassembly and reassembly of the radio to replace circuit boards.

1.1 Manual Contents

Included in this manual is radio specification for the VHF (136–174 MHz), UHF1 (380–470 MHz), UHF2 (450–520 MHz), 700/800 MHz (764–870 MHz) and 900 MHz (896–941 MHz) frequency bands, a general description of ASTRO APX 2000/ APX 4000/ APX 4000Li models, recommended test equipment, service aids, radio alignment procedures, general maintenance recommendations, procedures for assembly and disassembly, and exploded views and parts lists.

1.2 Notations Used in This Manual

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

NOTE: An operational procedure, practice, or condition that is essential to emphasize.

Caution

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

WARNING

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

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or injury.

1.3 Radio Description

The ASTRO APX 2000/ APX 4000/ APX 4000Li radio provides improved voice quality across more coverage area. The digital process, called *embedded signaling*, intermixes system signaling information with digital voice, resulting in improved system reliability and the capability of supporting a multitude of advanced features.

ASTRO APX 2000/ APX 4000/ APX 4000Li radios are available in Single Display configuration. Table 1-1 describes their basic features.

Table 1-1. ASTRO APX 2000/ APX 4000/ APX 4000Li Basic Features

Feature	Standard Control (Model 1.5) (*)	Limited Keypad (Model 2)	Full Keypad (Model 3)
Display	• Full bitmap color LCD display • 3 lines of text x 14 characters • 1 line of icons • 1 menu line x 3 menus • White backlight	• Full bitmap color LCD display • 3 lines of text x 14 characters • 1 line of icons • 1 menu line x 3 menus • White backlight	• Full bitmap color LCD display • 3 lines of text x 14 characters • 1 line of icons • 1 menu line x 3 menus • White backlight
Keypad	• Backlight keypad • 3 soft keys	• Backlight keypad • 3 soft keys • 4 direction Navigation key • Home and Data buttons	• Backlight keypad • 3 soft keys • 4 direction Navigation key • 4x3 keypad • Home and Data buttons
Channel Capability	512	512	512
FLASHport Memory	64MB	64MB	64MB

NOTE: * Only applicable for APX 2000/ APX 4000Li.

1.4 FLASHport®

The ASTRO APX 2000/ APX 4000/ APX 4000Li radio utilizes Motorola's FLASHport technology. FLASHport makes it possible to add software that drives the radio's capabilities both at the time of purchase and later on. Previously, changing a radio's features and capabilities meant significant modifications or buying a new radio. But now, similar to how a computer can be loaded with different software, the radio's features and capabilities can be upgraded with FLASHport software.

Chapter 2 Basic Maintenance

This chapter describes the preventive maintenance and handling precautions. Each of these topics provides information vital to the successful operation and maintenance of the radio.

2.1 General Maintenance

In order to avoid operating outside the limits set by the FCC, align the ASTRO APX 2000/ APX 4000/ APX 4000Li radio's reference oscillator every time the radio is taken apart, or once per year, whichever comes first. (See Section 6.5.1). Periodic visual inspection and cleaning is also recommended.

2.1.1 Inspection

Check that the external surfaces of the radio are clean and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed.

2.1.2 Cleaning

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

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water.

Caution

Use all chemicals as prescribed by the manufacturer. Be sure to 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. Aerosol sprays, tuner cleaners, and other chemicals should be avoided.

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

2.2 Safe Handling of CMOS and LDMOS Devices

Complementary metal-oxide semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) devices, and other high-technology devices, are used in this family of radios. While the attributes of these devices are many, their characteristics make them susceptible to damage by electrostatic discharge (ESD) 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 this radio, and are especially important in low-humidity conditions.

Caution

- The APX 2000/ APX 4000/ APX 4000Li radio has a vent port that allows for pressure equalization in the radio. Never poke this vent with any objects, such as needles, tweezers, or screwdrivers. This could create a leak path into the radio and the radio's submergibility will be lost.
- The pressure equalization vent is located adjacent to the battery contact opening of the main chassis. Never touch the equalization vent. Ensure that no oily substances come in contact with this vent.
- The APX 2000/ APX 4000/ APX 4000Li radio is designed to be submerged to a maximum depth of six (6) feet, with a maximum submersion time of 2 hours per U.S. MIL-STD. Exceeding either maximum limit may result in damage to the radio.

If the radio battery contact area has been submerged in water, dry and clean the radio battery contacts before attaching a battery to the radio. Otherwise, the water could short-circuit the radio.

If the radio has been submerged in water, shake the radio briskly so that any water that is trapped inside the speaker grille and microphone port can be removed. Otherwise, the water will decrease the audio quality of the radio.

Chapter 3 Basic Theory of Operation

This chapter discusses the basic operational theory of the ASTRO APX 2000/ APX 4000 radio. The ASTRO APX 2000/ APX 4000 radio, which is a single-band synthesized radio, is available in the following frequency bands.

- VHF (136–174 MHz)
- UHF1 (380–470 MHz)
- UHF2 (450–520 MHz)
- 700/800 MHz (764–870 MHz)
- 900 MHz (896–941 MHz).

And the ASTRO APX 2000 M1.5, APX 4000Li M1.5 and APX 4000Li M2 is available in the following frequency bands.

- VHF (136–174 MHz)
- UHF1 (380–470 MHz)
- UHF2 (450–520 MHz)
- 700/800 MHz (764–870 MHz)

All ASTRO APX 2000/ APX 4000/ APX4000 Li radios besides the radios with 900 MHz are capable of analog operation (12.5 kHz or 25 kHz bandwidths), ASTRO mode (digital) operation (12.5 kHz only), X2-TDMA mode (25 kHz only) and Phase 2 TDMA mode (12.5 kHz only).

For radios with 900 MHz, they support analog operation (12.5 kHz only), ASTRO mode (digital) operation (12.5 kHz only), and Phase 2 TDMA mode (12.5 kHz only).

NOTE: The APX 2000 M1.5, APX 4000Li M1.5 and APX 4000Li M2 radio do not support any Global Positioning System (GPS), Bluetooth, MACE and Accelerometer functions. As such, disregard all references to the functions mentioned above in “Chapter 3 Basic Theory of Operation”.

3.1 Major Assemblies

The ASTRO APX 2000/ APX 4000/ APX4000 Li radio includes the following major assemblies (See Figure 3-1.):

- **Main Board –** Contains all transmit, receive, and frequency generation circuitry, including the digital receiver back-end IC and the reference oscillator. The main board also contains a dual core processor, which includes both the microcontroller unit (MCU) and a digital signal processor (DSP) core, the processors's memory devices, an audio and power supply support integrated circuit (IC), a digital support IC, external power amplifier as well as combination Global Positioning System (GPS) and Bluetooth 2.1 IC and front end circuitry.
- **Keypad Board** – Contains a Type III secure IC, Bluetooth controller (AVR IC) and a 3-axes digital accelerometer.
- **Control Top** – Contains a Multi-Function knob, a push button switch used for Emergency call and a light bar. The control top also includes TX/RX LED that is solid amber upon receive, red on PTT, and blinks amber on secure TX/RX.
- **Main Display** – 160 pixels x 90 pixels, transflective color LCD.
- **Keypad**
  - Standard Control (M1.5) Keypad version has 3 soft keys
  - Limited Keypad Version has 3 soft keys, 4 direction Navigation key, Home and Data buttons
  - Full Keypad Version has 3 soft keys, 4 direction Navigation key, 3x4 alphanumeric keypad, Home and Data buttons.

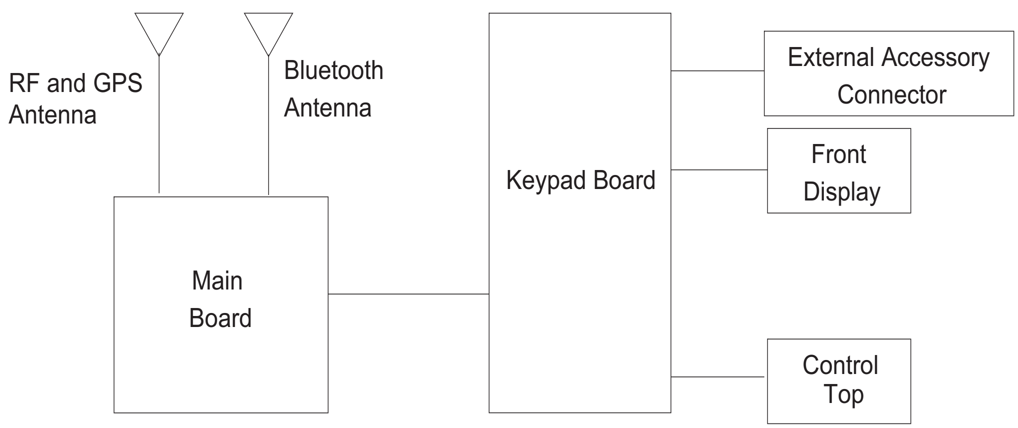

Figure 3-1. APX 2000/APX 4000/APX 4000Li Overall Block Diagram

3.2 Analog Mode of Operation

This section provides an overview of the analog mode receive and transmit theory of operation.

3.2.1 Receiving

The RF signal is received at the antenna and is routed through the Harmonic Filter, followed by the Antenna Switch and finally the 15dB Step Attenuator IC. The latter contains a switchable attenuator that is enabled at predetermined RF power thresholds present at the antenna port. See Figure 3-2., Figure 3-3, Figure 3-4and Figure 3-5.

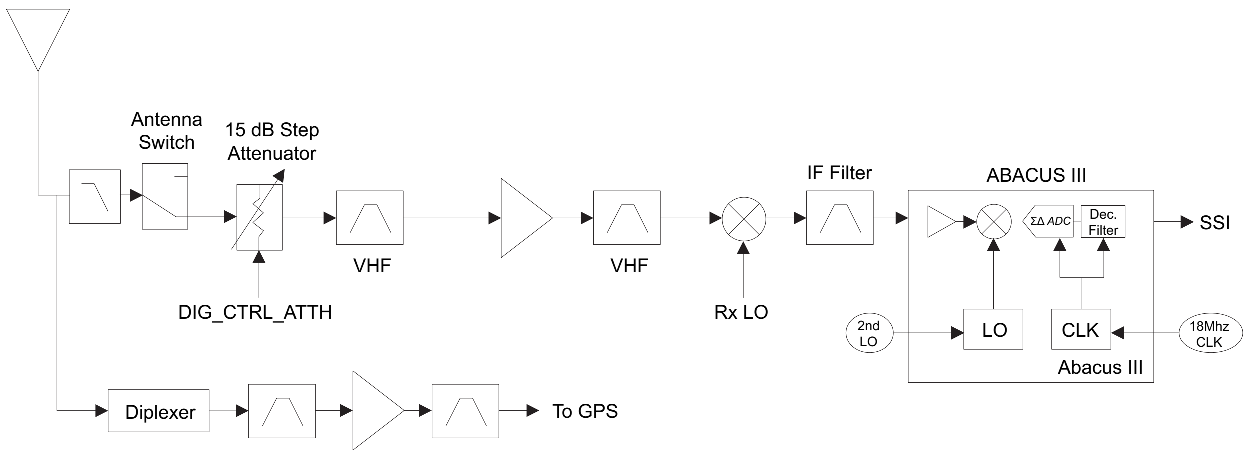

Figure 3-2. Receiver Block Diagram (VHF)

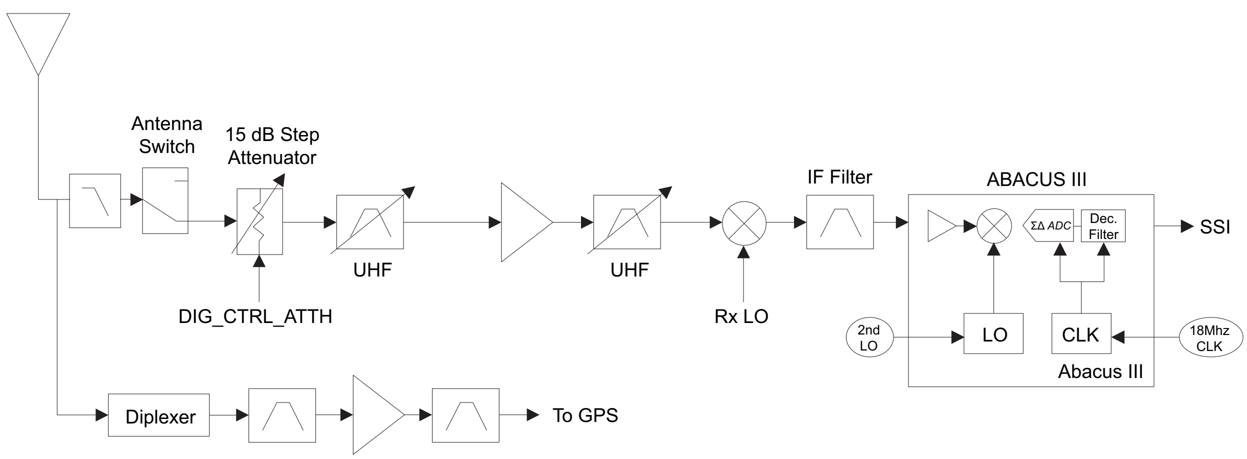

Figure 3-3. Receiver Block Diagram (UHF1/UHF2)

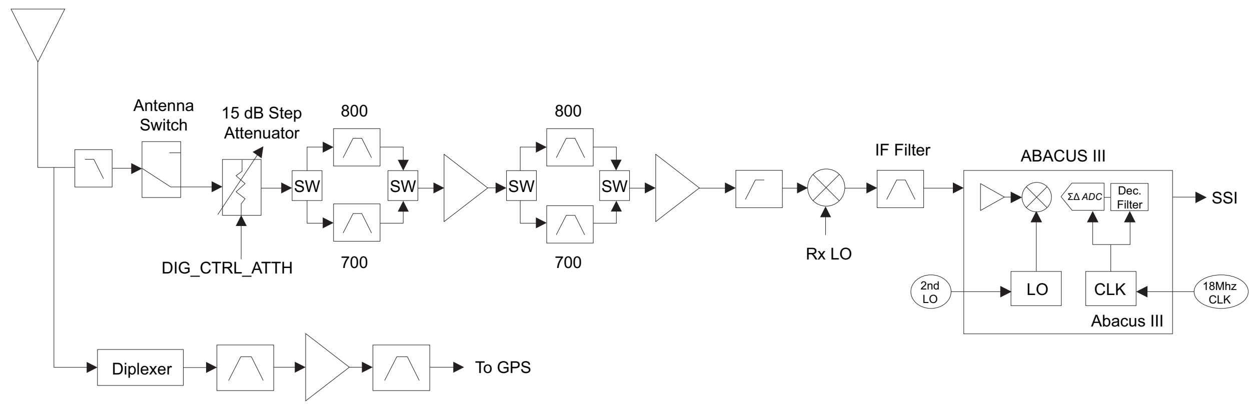

Figure 3-4. Receiver Block Diagram (700/800 MHz)

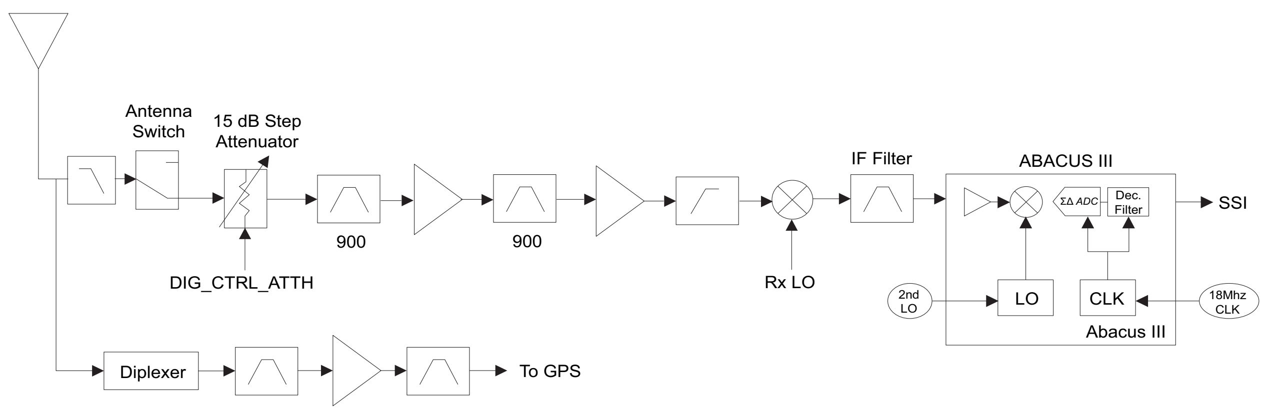

Figure 3-5. Receiver Block Diagram (900 MHz)

3.2.1.1 GPS

The GPS signal is tapped at the antenna port via a series resonant network (diplexer) which provides a very low capacitive load to the transceiver. The diplexer circuitry provides rejection to radio band signals up to ~1GHz which serves as isolation between the radio RF and GPS signal paths. The GPS signal is filtered though a GPS SAW filter - LNA – Saw filter chain before going into the TI GPS IC for processing.

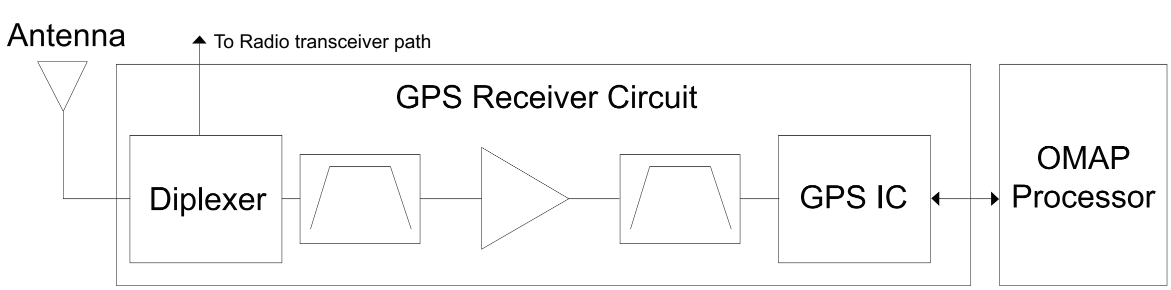

Figure 3-6. GPS Diagram

3.2.1.2 VHF Front-End

From the 15 dB Step Attenuator, a VHF signal is routed to the first pre-selector filter followed by an LNA and a second pre-selector filter. Both filters are discrete and tunable designs and are used to band limit the incoming energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the second pre-selector filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.3 UHF1/UHF2 Front-End

From the 15 dB Step Attenuator, a UHF1/UHF2 signal is routed to the first pre-selector filter followed by an LNA and a second pre-selector filter. Both filters are discrete and tunable designs and are used to band limit the incoming energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the second pre-selector filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.4 700/800 MHz Front-End

From the 15 dB Step Attenuator, a 700/800 MHz band signal is routed to the first band SPST switch which selects the 700 or the 800 band signal and routes it to the appropriate first pre-selector filter. A second band select switch selects the output of the appropriate filter and applies it to an LNA followed by a similar pre-selector filter/ band-select switch circuit. The signal is then routed to a second LNA whose output is applied to a discrete image filter. Both preselector filters are Surface Acoustic Wave designs used to band limit the received energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the discrete image filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.5 900 MHz Front-End

From the 15 dB Step Attenuator, the 900 MHz band signal is routed to the pre-selector filter. The output of the prefilter is applied to the first LNA followed by a similar filter as the pre-selector filter. The signal is then routed to a second LNA whose output is applied to a discrete image filter. Both pre and post selector filters are Surface Acoustic Wave designs used to band limit the received energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the discrete image filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.6 Analog To Digital Converter

The ADC IC's front end down converts the first IF to a second IF, a 2.25 MHz signal. The second IF is sampled at 18 MHz, a signal generated by an integrated clock synthesizer. The sampled signal is decimated by a factor of 900 to 20 kHz and converted to SSI format at the ADC's output. The Serial Synchronous Interface (SSI) serial data waveform is composed of a 16 bit in-phase word (I) followed by a 16 bit Quadrature word (Q). A 20 kHz Frame Synch and a 1.2 MHz clock waveform are used to synchronize the SSI IQ data transfer to the Digital Signal Processor IC (OMAP) for post-processing and demodulation.

3.2.2 Transmitting

When the radio is transmitting, microphone audio is digitized and then processed by the DSP and sent to the Trident IC (see Figure 3-7, Figure 3-8, Figure 3-9 and Figure 3-10) via the SSI interface. The Trident IC processes the SSI data for application to the voltage controlled oscillator as a modulation signal.

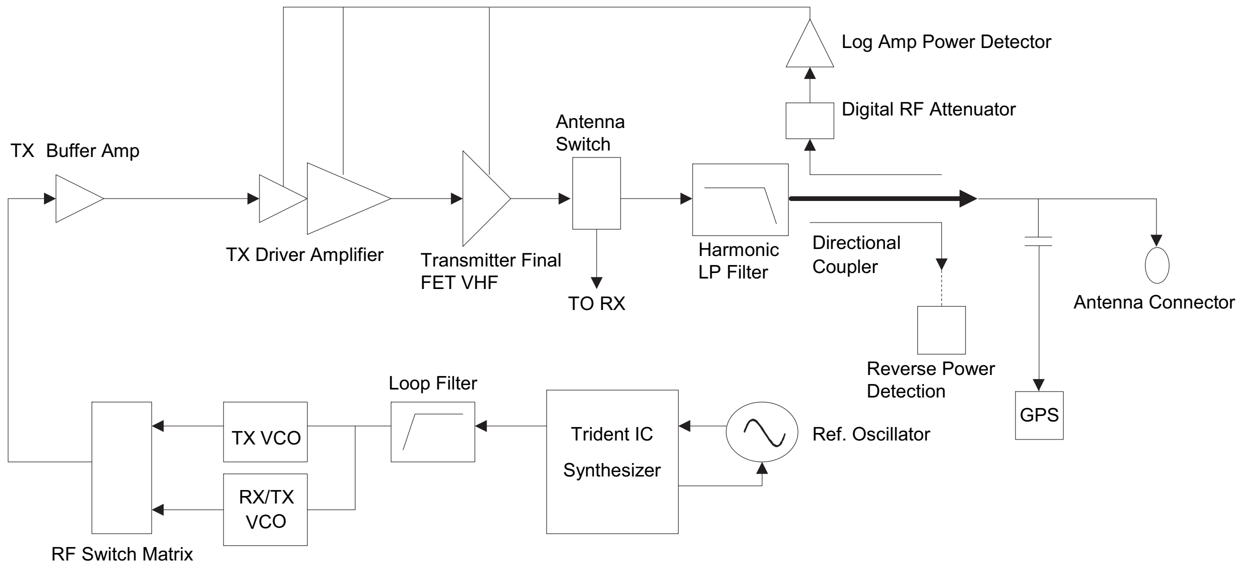

Figure 3-7. Transmitter (VHF) Block Diagram

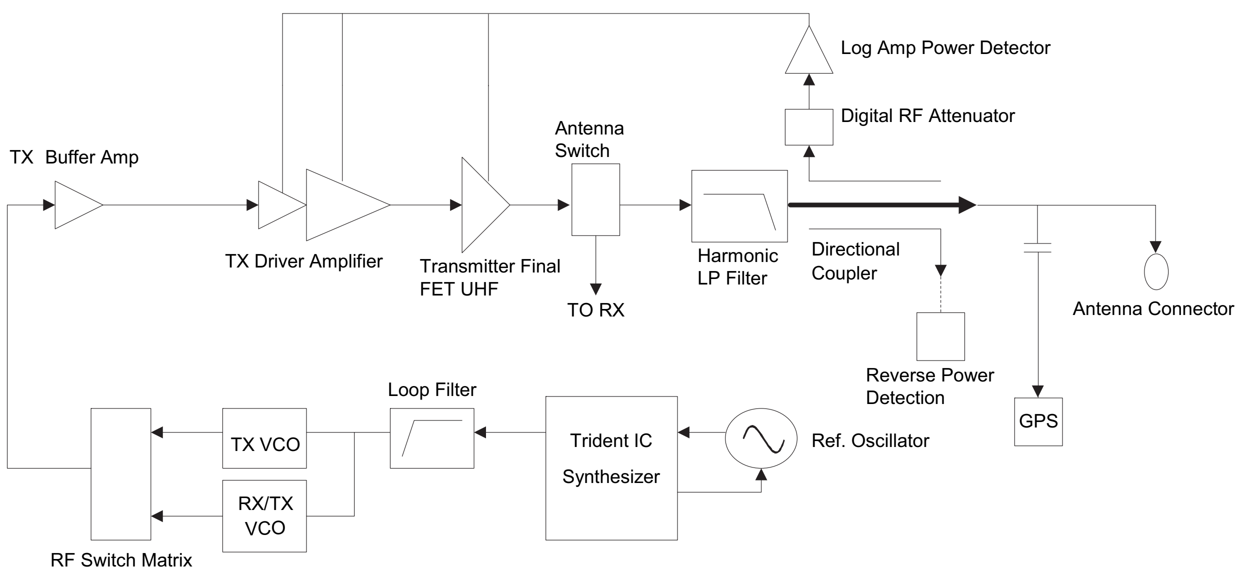

Figure 3-8. Transmitter (UHF1/UHF2) Block Diagram

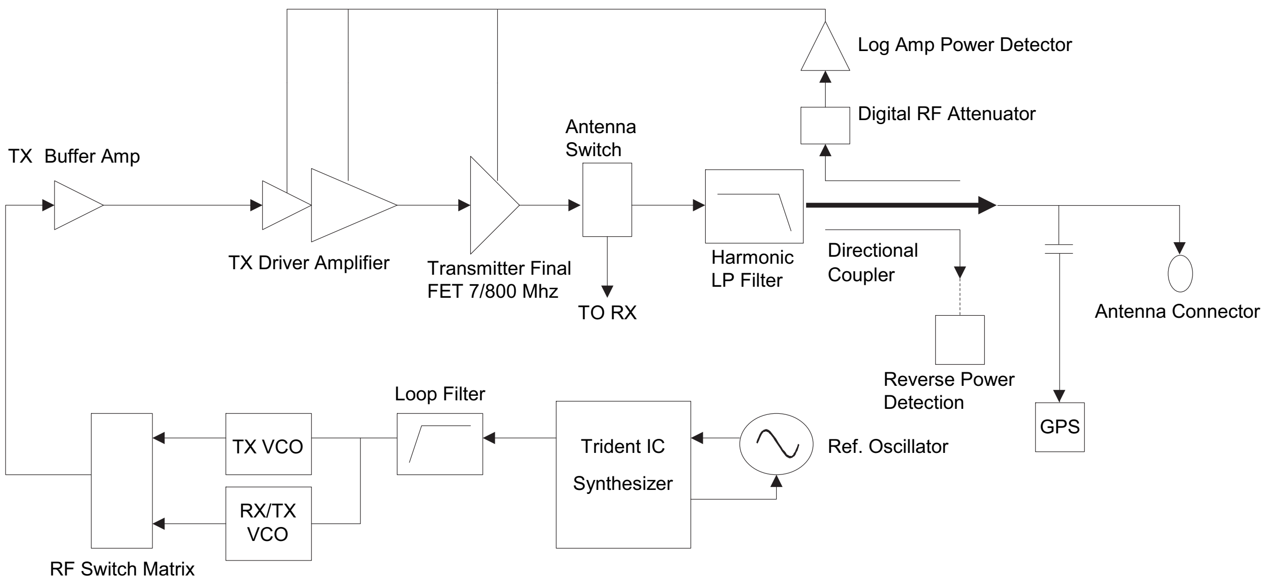

Figure 3-9. Transmitter (700/800 MHz) Block Diagram

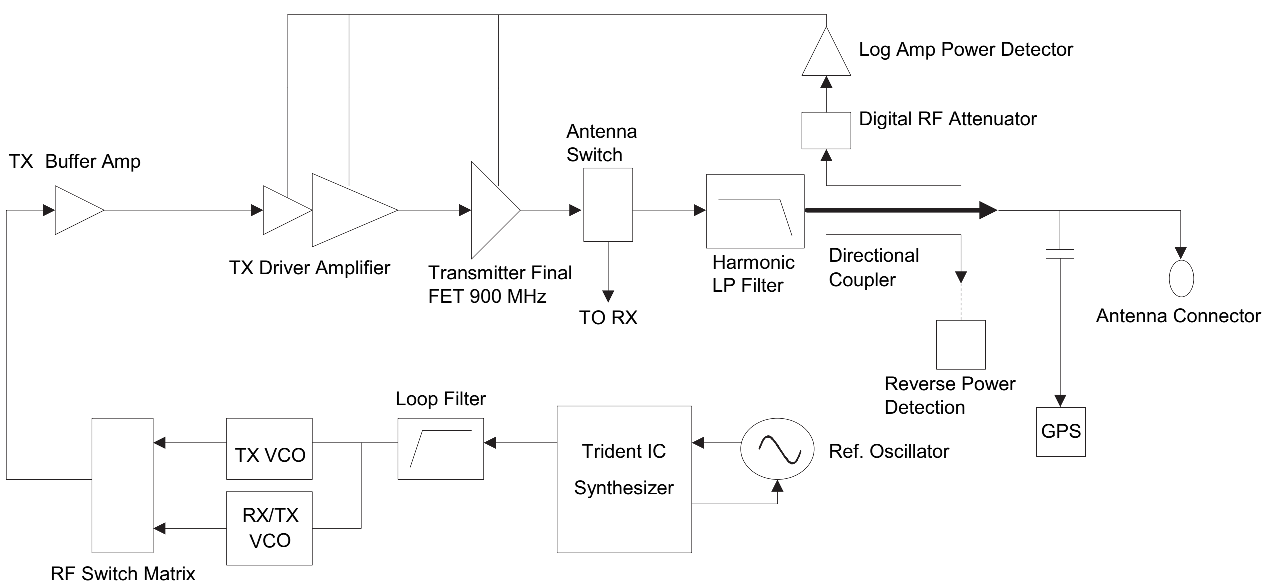

Figure 3-10. Transmitter (900 MHz) Block Diagram

3.2.2.1 VHF Transmit

Once a VHF frequency for transmit has been selected, the Trident IC and the accompanying logic circuitry will enable the voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the VHF Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The Log Amp power detector Monitors the output of the directional coupler and adjusts the control voltages to the driver amplifier and final power amplifier. Finally, the RF signal is routed to the main antenna.

3.2.2.2 UHF1/UHF2 Transmit

Once a UHF frequency for transmit has been selected, the Trident IC and the accompanying logic circuitry will enable the voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the UHF1/UHF2 Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The Log Amp power detector Monitors the output of the directional coupler and adjusts the control voltages to the driver amplifier and final power amplifier. Finally, the RF signal is routed to the main antenna.

3.2.2.3 700/800 MHz Transmit

Once a 700/800 MHz frequency for transmit has been selected, the Trident IC and accompanying logic circuitry enable the correct voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the 7800 Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The Log Amp power detector Monitors the output of the directional coupler and adjusts the control voltages to the driver amplifier and the discrete final power amplifier. Finally, the RF signal is routed to the main antenna.

3.2.2.4 900 MHz Transmit

Once a 900 MHz frequency for transmit has been selected, the Trident IC and accompanying logic circuitry enable the correct voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the 900 MHz Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The Log Amp power detector Monitors the output of the directional coupler and adjusts the control voltages to the driver amplifier and the discrete final power amplifier. Finally, the RF signal is routed to the main antenna.

3.3 Digital (ASTRO) Mode of Operation

In the ASTRO (digital) mode of operation, the transmitted or received signal is limited to a discrete set of frequency deviation levels. The receiver handles an ASTRO-mode signal identically to an analog-mode signal, up to the point where the DSP decodes the received data. In the ASTRO receive mode, the DSP uses a different algorithm to recover data.

In the ASTRO transmit mode, microphone audio is processed identically to an analog mode, with the exception of the algorithm the DSP uses to encode the information. Using this algorithm, transmitter FM deviation is limited to discrete levels.

3.4 Controller Section

The controller section (See Figure 3-11.) comprises of five functional sections that are split among two boards, which are the main and keypad boards. The main functional section consists of a dual core ARM and DSP controller, an encryption processor (MACE), Flash memory, and a Double Data Rate Synchronous Dynamic Random Access Memory (DDR SDRAM) and CPLD for GPIO expander multiple clock generation and SSI interface for the radio system. The Power and Clocks section includes a power management IC (MAKO) and various external switching regulators, and three clock sources (12 MHz and 24.576 MHz) from which all other controller digital clocks are derived. The Audio section has a CODEC and a class-D audio power amplifier that provides the radio with a microphone and speaker design. The User Interface section provides communication and control to the main Liquid Crystal Displays (LCD) on the radio, as well as a keypad and a side connector interface conforming to GCAI (Global Communications Accessory Interface) specifications. The GPS and Bluetooth section comprises of a Global Positioning Satellite(GPS) and Bluetooth combo chipset on the main board, and an AVR Bluetooth controller IC, SDRAM, LF wakeup IC and Accelerometer IC on the keypad board. The MACE IC is located on the keypad board.

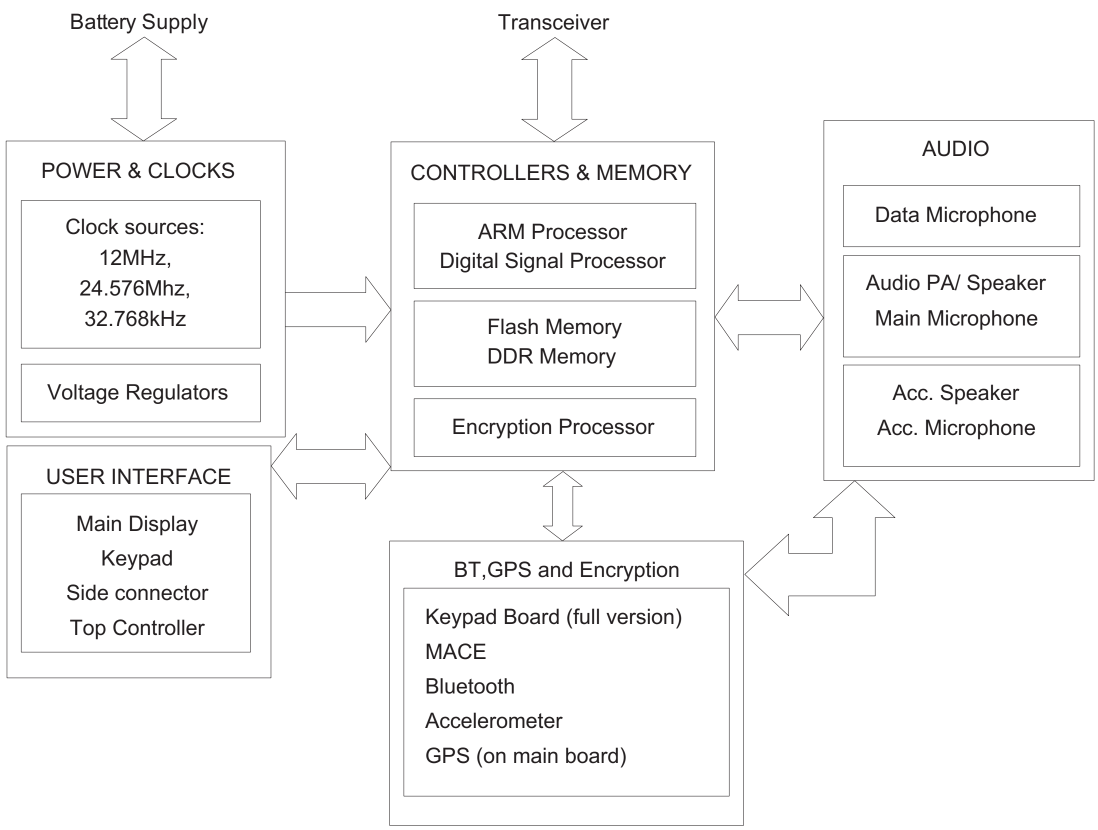

Figure 3-11. Controller Block Diagram

The ARM controller core of the OMAP processor handles the power up sequence of all devices, including firmware upgrades, and all operating system tasks that are associated with FLASH and SDRAM memories and user interface communication. The FLASH memory (64 MB) is required to store the firmware, tuning, and Codeplug settings, which upon initialization get read and stored into SDRAM (32MB) for execution. The ARM and DSP core jointly control and configure audio, wireless and RF devices linked to the Serial Peripheral Interface (SPI) and Synchronous Serial Interface (SSI) buses to enable radio FM and optional wireless communication protocols. For encryption, a separate ARM processor is used (MACE) to encode and decode encryption packets coming in from the main OMAP processor through the SSI interface. Its firmware is flashed via the main processor during an upgrade request to its internal FLASH memory. The MACE encryption processor is located on the keypad board.

The power and most clocks to the controller devices are provided by the MAKO IC and external switching and linear regulators on board. A Complex Programmable Logic Array (CPLD) IC divides the 24.576 MHz clock from MAKO to source OMAP's 32 kHz Real Time Clock, and MACE's 4 MHz main clock. OMAP's main clock is supplied externally from an on board 12 MHz crystal.

The radio has two internal microphones and an internal speaker, as well as available microphone and speaker connections for external accessories. The internal 4 Ohm speaker is located on the same side as the main display and keypad of the radio. The internal speaker is driven by a Class D audio amplifier located on the main board that is capable of delivering a rated power of 0.5 W. The external accessory speaker is driven by a Class AB audio amplifier on the MAKO IC that is capable of delivering 0.5 W of power into a 16 Ohm as a minimum load. Both speaker paths use the CODEC for volume control and to convert the audio signal from digital to analog. Both internal and external microphones use the CODEC's ADC to deliver digital audio samples to the DSP controller.

The user interface block consists of a main display, a keypad, top controls and the accessory side connector. The side connector (Universal Connector) provides audio, USB, RS232 communication for accessories. All signals to and from the connector go through the internal keypad board before reaching the microcontroller and other devices on the main board.

The radio also has integrated feature of Global Positioning System (GPS) and Bluetooth with Man-down feature (depending on radio model) (see Figure 3-12). The GPS and Bluetooth Combo RF chipset (NL5500) is located on the Main board together with the GPS/RF Diplexer circuitry and Bluetooth Front-End circuitry. The GPS receiver section of the GPS/BT combination IC interfaces with the OMAP processor through a dedicated UART port. The GPS receiver also has a dedicated reset controlled solely by the OMAP processor. The GPS/Bluetooth IC (NL5500) taps the GPS signal from transceiver path and processes the location information before relaying to the OMAP processor via UART lines. The clock supplies to NL5500 included a 26MHz TCXO and 32kHz clock from CPLD.

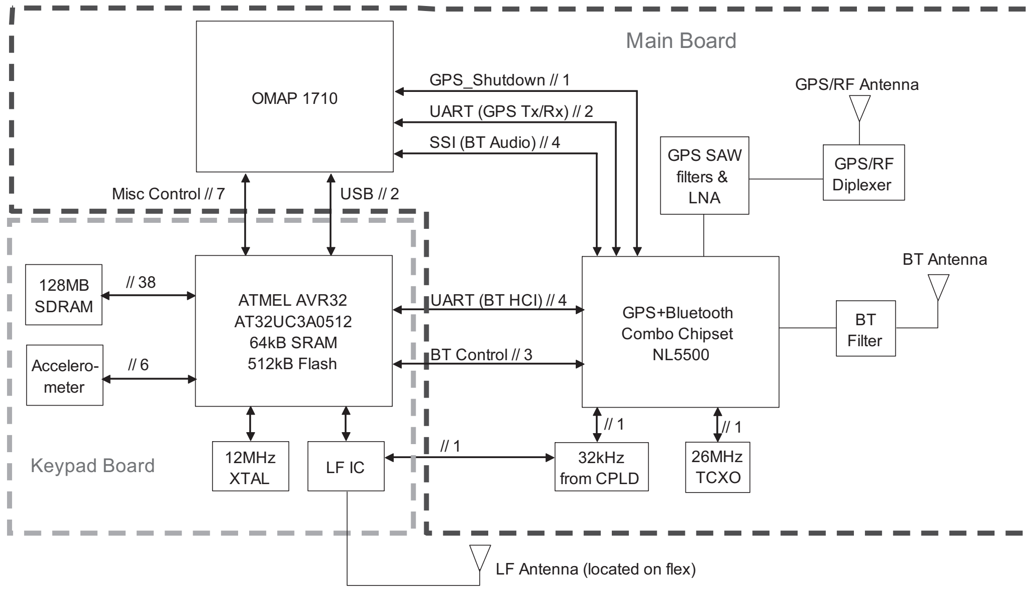

Figure 3-12. GPS/Bluetooth/Accelerometer Block Diagram

3.4.1 Radio with Mace Expanded Keypad Board

In addition to the Mace features, the Expanded Keypad Board consists of a 3-axes digital accelerometer and the Bluetooth Controller IC (AVR) together with LF Wakeup IC (AS3930A) for Secure Pairing.

The radio also has the ability to connect to a wireless Bluetooth audio headset. This feature is implemented using a combination Bluetooth/GPS integrated circuit (NL5500 IC) located on the Main board. An optional accessory headset can connect using a low-data rate GFSK modulated signal hopping on 79 x 1 MHz wide Bluetooth channels from 2402 MHz to 2480 MHz in the ISM band. Each APX accessory that is capable of Bluetooth communication will have its own unique Bluetooth address. Bluetooth uses a frequency hopping spread spectrum (FHSS) technique to spread the RF power across the spectrum to reduce the interference and spectral power density. The frequency hopping allows the channel to change up to 1600 times a second (625 µs time slot) based on a pseudo random sequence. If a packet is not received on one channel, the packet will be retransmitted on another channel. The Bluetooth IC sends data to the AVR32 processor that is also located on the keypad board over an HCI UART link. The AVR32 processor communicates to the OMAP processor on the main board through a dedicated USB port.

The Bluetooth feature is accompanied by a Low-Frequency (LF) detection circuit that is also located on the keypad board. The LF circuit provides the ability of a secure pairing connection with a Bluetooth accessory. Once a radio has the Bluetooth feature enabled, a user can tap their LF enabled Bluetooth audio accessory with the radio at the pairing spot to establish a secure Bluetooth connection. The LF circuit uses a 125 kHz radiated signal to communicate the secure pairing information between the Bluetooth accessory and low-frequency receiver. The low-frequency receiver is programmed by the AVR32 processor through a dedicated SPI bus and transfers the pairing data through a dedicated UART.

There is a digital accelerometer on the keypad board that detects the 3-axis force of gravity which can be used to determine the radio's orientation. The accelerometer's position is communicated to the AVR32 processor through a SPI bus.

Notes

Chapter 4 Recommended Test Equipment and Service Aids

This chapter provides lists of recommended test equipment and service aids, as well as information on field programming equipment that can be used in servicing and programming ASTRO APX 2000/ APX 4000/ APX 4000Li radios.

4.1 Recommended Test Equipment

The list of equipment contained in Table 4-1 includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specifically for servicing this family of radios. The “Characteristics” column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola model listed is either a unique item or no substitution is recommended.

Table 4-1. Recommended Test Equipment

Equipment	Characteristics	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	General Dynamics R2670	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital RMS Multimeter *	100 µV to 300 V 5 Hz to 1 MHz 10 Mega Ohm Impedance	Fluke 179 or equivalent (www.fluke.com)	AC/DC voltage and current measurements. Audio voltage measurements
RF Signal Generator *	100 MHz to 1 GHz -130 dBm to +10 dBm FM Modulation 0 kHz to 10 kHz Audio Frequency 100 Hz to 10 kHz	Agilent N5181A (www.agilent.com), Ramsey RSG1000B (www.ramseyelectronics.com, or equivalent	Receiver measurements
Oscilloscope *	2 Channel 50 MHz Bandwidth 5 mV/div to 20 V/div	Leader LS8050 (www.leaderusa.com), Tektronix TDS1001b (www.tektronix.com), or equivalent	Waveform measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 9240 (www.boonton.com) or equivalent	Waveform measurements
Power Supply	0 V to 32 V 0 A to 20 A	B&K Precision 1790 (www.bkprecision.com) or equivalent	Voltage supply

4.2 Service Aids

Refer to Table 4-2 for a listing and description of the service aids designed specifically for servicing this family of radios. These kits and/or parts are available from the Radio Products and Solutions Organization offices listed in "Appendix B Replacement Parts Ordering" . While all of these items are available from Motorola, most are standard shop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 4-2. Service Aids

Motorola Part Number	Description	Application
66012028001	Chassis Opener	To disassemble chassis from housing
66012031001	Battery Adapter	Used in place of battery to connect radio to an external power supply.
66012030001	Vacuum Test Fixture	To connect the vacuum/pressure hose to the radio.
NLN9839_	Vacuum Pump Kit	Vacuum pump with gauge and vacuum hose. Requires Vacuum Test Fixture (66012030001).
5880384G68	SMA to BNC Adapter	Adapts radio's antenna port to BNC cabling of test equipment.
RVN5224_	Customer Programming Software (CPS) and Tuner Software	CPS allows customer-specific programming of modes and features. Tuner software required to perform alignment of radio parameters.
PMKN4012B	Programming Cable	To program the radio through Customer Programming Software and Tuner Software.
PMKN4013C	Programming/Service Cable	To program and service the radio through Customer Programming Software and Tuner Software.
RLN4460_	Portable Test Set	For radio performance checks. Connects to radio's universal connector and allows remote switching and signal injection/ outputs for test equipment measurements.

NOTE: Do not place an order for the Programming Cable (PMKN4012A/PMKN4013B) as it is not compatible with the APX 2000/ APX 4000/ APX 4000Li radio.

4.3 Field Programming

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the online help in the Customer Programming Software (CPS) for complete field programming information.

Chapter 5 Performance Checks

This chapter covers performance checks used to ensure that the ASTRO APX 2000/ APX 4000/ APX 4000Li radio meets published specifications. The recommended test equipment listed in the previous section approaches the accuracy of the manufacturing equipment, with a few exceptions. Accuracy of the test equipment must be maintained in compliance with the manufacturer's recommended calibration schedule. Checks should be performed if radio performance degradation is suspected.

5.1 Test Equipment Setup

Supply voltage can be connected from the battery eliminator. The equipment required for the performance checks is connected as shown in Figure 5-1.

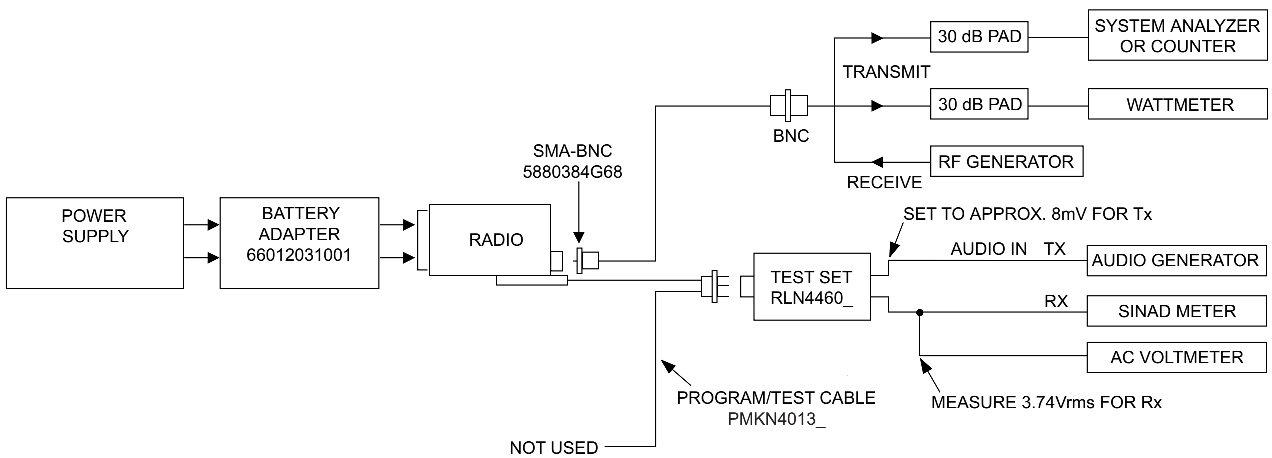

Figure 5-1. Performance Checks Test Setup

Initial equipment control settings should be as indicated in Table 5-1 and should be the same for all performance checks and alignment procedures, except as noted.

Table 5-1. Initial Equipment Control Settings

<table>
<tr><th>System Analyzer</th><th>Test Set</th><th>Power Supply</th></tr>
<tr><td>Monitor Mode: Standard*</td><td>Spkr/Load: Speaker</td><td>Voltage: 7.5 Vdc</td></tr>
<tr><td rowspan="4">Receiver Checks
RF Control: GEN
Output Level: -47 dBm
Modulation: 1 kHz tone @3 kHz deviation
Frequency: Set to selected radio RX frequency
Meter: AC Volts

Transmitter Checks
RF Control: Monitor
Frequency: Set to selected radio TX frequency
Meter: RF Display
Modulation Type: FM
Attenuation: 20 dB</td><td>PTT: OFF (center)</td><td>DC On/Standby: Standby</td></tr>
<tr><td>Meter Out: RX</td><td>Volt Range: 10 Vdc</td></tr>
<tr><td>Opt Sel: ON</td><td rowspan="2">Current: 2.5 Amps</td></tr>
<tr><td></td></tr>
</table>

* *Use “PROJ 25 STD” if testing ASTRO Conventional channels.*

5.2 Display Radio Test Mode

This section provides instructions for performing tests in display radio test mode.

5.2.1 Access the Test Mode

To enter the display radio test mode:

1. Turn the radio on.
2. Within 10 seconds, press **Side Button 2** five times in succession.

   The radio shows a series of displays that give information regarding various version numbers and subscriber specific information. The displays are described in Table 5-2.

Table 5-2. Test-Mode Displays

Name of Display	Description	Appears
Service	The literal string indicates the radio has entered test mode.	Always
Host version	The version of host firmware is displayed.	Always
DSP version	The version of DSP firmware is displayed.	Always
Secure version	Version of the encryption software	When the radio is secure equipped
KG1 algorithms name (Encryption Type 1)	Type of encryption being used	When the radio is secure equipped
KG2 algorithms name (Encryption Type 2)	Type of encryption being used	When the radio is secure equipped and 2 or more algorithms are loaded
KG3 algorithms name (Encryption Type 3)	Type of encryption being used	When the radio is secure equipped and 3 or more algorithms are loaded
KG4 algorithms name (Encryption Type 4)	Type of encryption being used	When the radio is secure equipped and 4 or more algorithms are loaded
KG5 algorithms name (Encryption Type 5)	Type of encryption being used	When the radio is secure equipped and 5 or more algorithms are loaded
KG6 algorithms name (Encryption Type 6)	Type of encryption being used	When the radio is secure equipped and 6 or more algorithms are loaded
Model number	The radio's model number, as programmed in the codeplug	Always
Serial number	The radio's serial number, as programmed in the codeplug	Always
ESN	The radio's unique electronic serial number	Always
ROM Size	The memory capacity of the host FLASH part	Always

Table 5-2. Test-Mode Displays (Continued)

Name of Display	Description	Appears
FLASHcode	The FLASH codes as programmed in the codeplug	Always
RF band 1	The radio's operating frequency	Always
Tuning Ver	Version of Tuning codeplug	Always
Proc Ver	Version of Processor	Always
Option Board Type	Type of Keypad board being used	When the radio has an Option Board/Expanded Keypad Board.
Option Board Serial Number	Serial number of the Keypad board is displayed	When the radio has an Expanded Keypad Board.
Option Board Bluetooth Addr	Bluetooth Address of the Keypad board is displayed	When the radio has an Expanded Keypad Board.
Option Board Sw Version	Software version of the Keypad Board is displayed	When the radio has an Expanded Keypad Board.
Exp Board Type	Type of Keypad Board is displayed	When the radio has a Keypad Board.

NOTE: All displays are temporary and will expire without any user intervention. If information is longer than the physical length of the radio's display, the information will wrap around to the next display. After the last display, "RF TEST" is displayed.

To freeze any of the displays, press the left arrow on the 4-Way Navigation Button. To resume automatic scrolling, press the right arrow on the 4-Way Navigation Button. To rapidly scroll forward through the displays, continue pressing the right arrow. You cannot scroll backwards.

NOTE: Press the **Top Side Button** (Purple button) to advance the test environments from "RF TEST", "CH TEST", "RGB TEST" then press the
Top Button (Orange button) to confirm selection. Press any other buttons to advance the test.

Once a test is carried out, restart the radio to proceed to another test.

3. Do one of the following:
   - Press the **Top Side Button** to stop the displays and toggle between RF test mode and the Control Top and Keypad test mode. The test mode menu "CH TEST" is displayed, indicating that you have selected the Control Top and Keypad test mode. Go to Section "5.2.3 Control Top and Keypad Test Mode" on page 1:5-7.

     NOTE: Each press of the **Top Side Button** (Purple button) scrolls through "RF TEST", "CH TEST" and "RGB TEST".
   - Press the **Top Button** (Orange button) to stop the displays and put the radio into the RF test mode. The test mode menu, "1 CSQ", is displayed, indicating test frequency 1, Carrier SQuelch mode. Go to Section "5.2.2 RF Test Mode" below.

     NOTE: Once your radio is in a particular test mode, you must turn off the radio and turn it back on again to access the other test mode.

5.2.2 RF Test Mode

When the ASTRO APX 2000/ APX 4000 radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting, according to the customer codeplug configuration. However, when the unit is on the bench for testing, alignment, or repair, it must be removed from its normal environment using a special routine, called **RF TEST MODE**.

While in RF test mode:

- Each additional press of **Side Button 2** advances to the next test channel. (Refer to Table 5-3.and Table 5-4)
- Pressing **Side Button 1** scrolls through and accesses the test environments shown in Table 5-5.
- Pressing **Top Side Button** scrolls through the Tx Deviation Frequency.

NOTE: Transmit into a load when keying a radio under test.

Table 5-3. Test Frequencies (MHz) – VHF, UHF1, UHF2

Test Channel	VHF		UHF1		UHF2	
	RX	TX	RX	TX	RX	TX
F1	136.075	136.025	380.075	380.025	450.075	450.025
F2	142.075	142.125	390.075	390.025	460.075	460.025
F3	154.275	154.225	400.075	400.025	471.075	471.025
F4	160.175	160.125	411.075	411.025	484.925	484.975
F5	168.125	168.075	424.975	424.925	485.075	485.025
F6	173.925	173.975	435.075	435.025	495.075	495.025
F7	–	–	445.075	445.000	506.075	506.025
F8	–	–	445.075005	445.000005	519.925	519.975
F9	–	–	457.075	457.025	–	–
F10	–	–	469.975	469.925	–	–

Table 5-4. Test Frequencies (MHz)– 700/800 MHz, 900 MHz

Test Channel	700/800 MHz		900 MHz	
	RX	TX	RX	TX
F1	764.0625	764.0125	935.0625	896.0125
F2	769.0625	769.0125	938.0625	899.0125
F3	775.9375	775.9875	940.9875	901.9875
F4	851.0625	794.0125	935.0625	935.0125
F5	860.0625	809.0125	938.0625	938.0125
F6	869.9375	823.9875	940.9875	940.9375
F7	851.0625	851.0125	–	–
F8	860.0625	860.0125		–
F9	869.9375	869.8875	–	–
F10	–	–	–	–

Table 5-5. Test Environments

Display	Description	Function
CSQ	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
TPL	Tone Private-Line	RX: unsquelch if carrier and tone (192.8 Hz) detected TX: mic audio + tone (192.8 Hz)
AST	ASTRO	RX: none TX: Digital Voice***
USQ	Carrier Unsquelch	RX: unsquelch always TX: mic audio

****All deviation values are based on deviation tuning of this mode.*

5.2.3 Control Top and Keypad Test Mode

This test mode is used to verify proper operation of all radio buttons and switches if a failure is suspected.

5.2.3.1 Control Top Checks

To perform the control top checks:

1. Press and hold the **Top Button** (Orange button); the radio icons are displayed, and the LED lights amber and lightbar LED light green.
2. Release the **Top Button**; "**148/0**" appears, which indicates that the **Top Button** is in the open position. Your radio is now in the Control Top and Keypad test mode.
3. Press the **Top Button** again; "**148/1**" appears, which indicates that the **Top Button** is in the closed position.
4. Rotate the **Volume Control**; "**11/0**" through "**11/255**" appear. The display values may vary slightly at the upper and lower limits. Press gives "**91/1**", release gives "**91/0**".
5. Press the **Top Side Button**; "**96/1**" appears; release, "**96/0**" appears.
6. Press **Side Button 1**; "**97/1**" appears; release, "**97/0**" appears.
7. Press **Side Button 2**; "**98/1**" appears; release, "**98/0**" appears.
8. Press the **PTT Button**; "**1/1**" appears; release, "**1/0**" appears.

5.2.4 RGB Test Mode

To perform the RGB Color Test:

1. Press and release **Top Button** (Orange button)
2. Press any key; Crosstalk test patterns appears.
3. Press any key; White color test appears.
4. Press any key; Red color horizontal lines appears.
5. Press any key until all 13 red color horizontal lines appears.
6. Press any key; Green color vertical line appears.
7. Press any key until all 13 green color vertical lines appears.
8. Press any key; Black color test appears.
9. Press any key; Blue color test appears.
10. Press any key; Vendor specific display test appears.
11. Press any key; "**Test completed**" appears.

5.3 Receiver Performance Checks

The following tables outline the performance checks for the receiver.

Table 5-6. Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check)	**VHF:** ±2 ppm (272–348 Hz) **UHF1:** ±2 ppm **UHF2:** ±2 ppm **700/800 MHz:** ±1.5ppm (1146–1305 Hz) **900 MHz:** ±1.5ppm
Rated Audio	**RF Control:** Gen **Output Level:** -47 dBm **Freq:** Selected radio RX freq. **Mod:** 1 kHz tone @ 3 kHz dev. **Meter:** AC Volts	As above	**PTT** to OFF (center)	Set volume control to 3.74 Vrms
Distortion	As above, except **Meter:** Ext Dist.	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except **Meter:** SINAD	As above	As above	RF input to be < 0.35 μV
Noise Squelch Threshold (only radios with conventional system need to be tested)	Set as for rated audio check	Out of TEST MODE; select a conventional system	As above	Set volume control to 3.74 Vrms. Set RF level to -130 dBm and raise until radio unsquelches. Unsquelch to occur at < 0.25 μV. Preferred SINAD = 6-8 dB.

* *See* Table 5-5.

*Table 5-7. Receiver Tests for ASTRO Conventional Channels**

Test Name	System Analyzer	Radio	Test Set	Comments
Bit Error rate (BER) Floor	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code:** 1011 Hz PAT	Radio Tuner Software (Bit Error Rate screen) is required	**PTT** to OFF (center)	BER < 0.01% (Use test setup shown in Figure 6-1)
Reference Sensitivity	As above; lower the output level until 5% BER is obtained	As above	As above	Output level < 0.35 µV (-116 dBm) (Use test setup shown in Figure 6-1)
Audio Output Distortion	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code:** 1011 Hz PAT **Meter:** Ext. Distortion	Radio Tuner Software not used; **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to OFF (center) Meter selector to **Audio PA** Spkr/Load to **Speaker**	Distortion < 3.0%
Residual Audio Noise Ratio	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code**: A) 1011 Hz PAT B) Silence PAT **Meter:** AC Volts	As above	As above	Residual Audio Noise Ratio -45 dB

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

5.4 Transmitter Performance Checks

The following tables outline the performance checks for the transmitter.

Table 5-8. Transmitter Performance Checks – APX 2000/ APX 4000/ APX 4000Li

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check).	**VHF:** ±2 ppm (272–348 Hz) **UHF1:** ±2 ppm **UHF2:** ±2 ppm **700/800 MHz:** ±1.5ppm (1146–1305 Hz) **900 MHz:** ±1.5ppm
RF Power	As above	As above	As above	**VHF**: 1–5 Watt **UHF1**: 1–5 Watt **UHF2**: 1–5 Watt **700**: 1–2.7 Watt **800**: 1–3 Watt **900**: 1–2.5 Watt
Voice Modulation (external)	As above. Set fixed 1 kHz audio level to 400 mV.	As above	As above	Deviation: (12.5 kHz) ≥ 2.1 kHz, but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz, but ≤ 5.0 kHz
Voice Modulation (internal)	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	As above	Remove modulation input. **PTT** to OFF (center)	Press **PTT** button on radio. Say “four” loudly into the radio mic. Measure deviation: (12.5 kHz) ≥ 2.1 kHz but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz but ≤ 5.0 kHz
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	As above	Conventional coded squelch personality (clear mode operation) or TPL channel (test mode*)	**PTT** to continuous (during the performance check)	Deviation: (12.5 kHz) ≥ 375 Hz but ≤ 500 Hz (25 kHz) ≥ 500 Hz but ≤ 1000 Hz
Secure Modulation (radios with conventional, secure mode, talkaround operation only)	As above	Programmed conventional channel (secure mode operation) Load key into radio.	As above	Deviation: ≥ 3.7 kHz but ≤ 4.3 kHz

* *See Table 5-5.*

Table 5-9. Transmitter Tests for ASTRO Conventional Channels – APX 2000/ APX 4000/ APX 4000Li

Test Name	System Analyzer	Radio	Test Set	Comments
RF Power	**Mode:** Proj 25 Std **RF Control:** Monitor **Meter:** RF Display	Radio Tuner Software not used. **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to continuous (during measurement).	**VHF**: 1–5 Watt **UHF1**: 1–5 Watt **UHF2**: 1–5 Watt **700**: 1–2.7 Watt **800**: 1–3 Watt **900**: 1–2.5 Watt
Frequency Error	As above	As above	As above	Error ≤ ±1.0 kHz
Frequency Deviation	As above	Radio Tuner Software (Transmitter Test Pattern screen) is required) **High use:** Symbol Rate PAT **Low use:** Low Symbol Rate P	**PTT** to OFF (center)	D_{HIGH} ≥ 2.543 kHz but ≤ 3.110 kHz D_{LOW} ≥ 0.841 kHz but ≤ 1.037 kHz (Use test setup shown in Figure 6-1)

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

Notes

Chapter 6 Radio Alignment Procedures

This chapter describes both receiver and transmitter radio alignment procedures.

6.1 Test Setup

A personal computer (PC) and tuner software are required to align the radio. Refer to the applicable manual for installation and setup procedures for the software. To perform the alignment procedures, the radio must be connected to the PC and to a universal test set. The radio alignment test setup is shown in Figure 6-1.

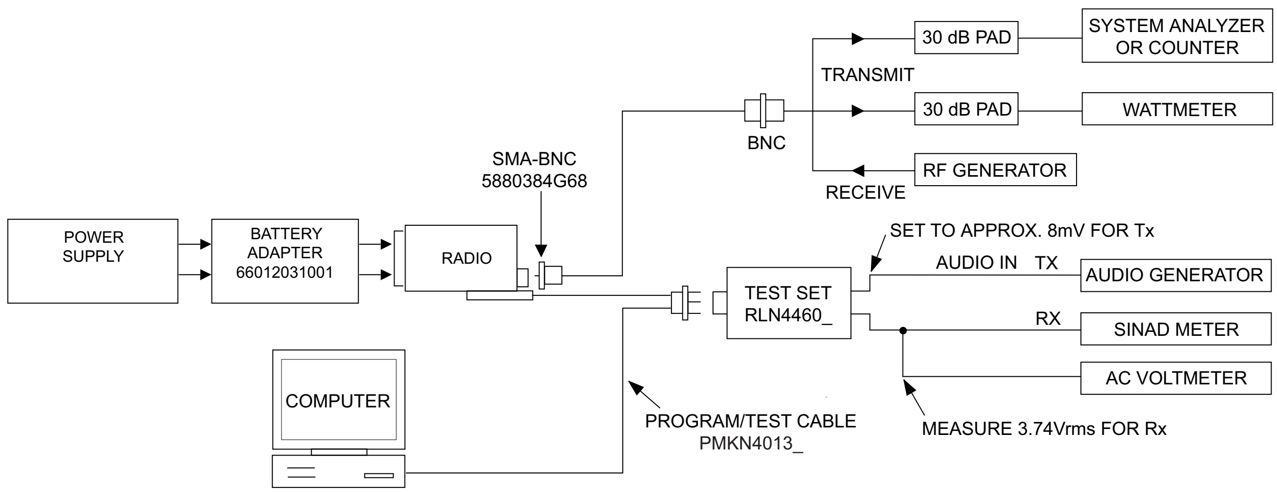

Figure 6-1. Radio Alignment Test Setup

Caution

These radio alignment procedures should only be attempted by qualified service personnel. Failure to perform alignment procedures properly may result in seriously degraded radio or system performance.

6.2 Tuner Main Menu

Select **Tuner** from the **START** menu by clicking **Start › Program Files › Motorola › ASTRO 25 Products › ASTRO 25 Tuner**. To read the radio, use the F**ile › Read Device** menu or click on Read Device. Figure 6-2 illustrates how the alignment screens are organized. To access a screen, double-click on the desired screen name in the **Tuner** menu.

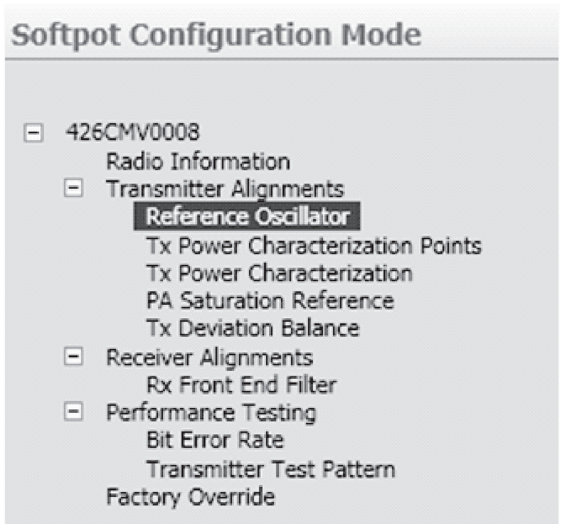

Figure 6-2. Tuner Software Main Menu

IMPORTANT: Tuning should follow the order of the Tuning tree view in descending order from top to bottom

6.3 Softpot

The alignment screens introduce the concept of the “softpot,” an analog **SOFT**ware-controlled **POT**entiometer used for adjusting all transceiver alignment controls.

Caution

DO NOT switch radios in the middle of any alignment procedure. Always left-click the **Close** button on the screen to return to the Main Menu screen before disconnecting the radio. Improper exits from the alignment screens might leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

Each alignment screen provides the ability to increase or decrease the softpot value by using a slider, or by entering the new value from the keyboard directly into the box. The slider bar indicates the current softpot value; see Figure 6-3.

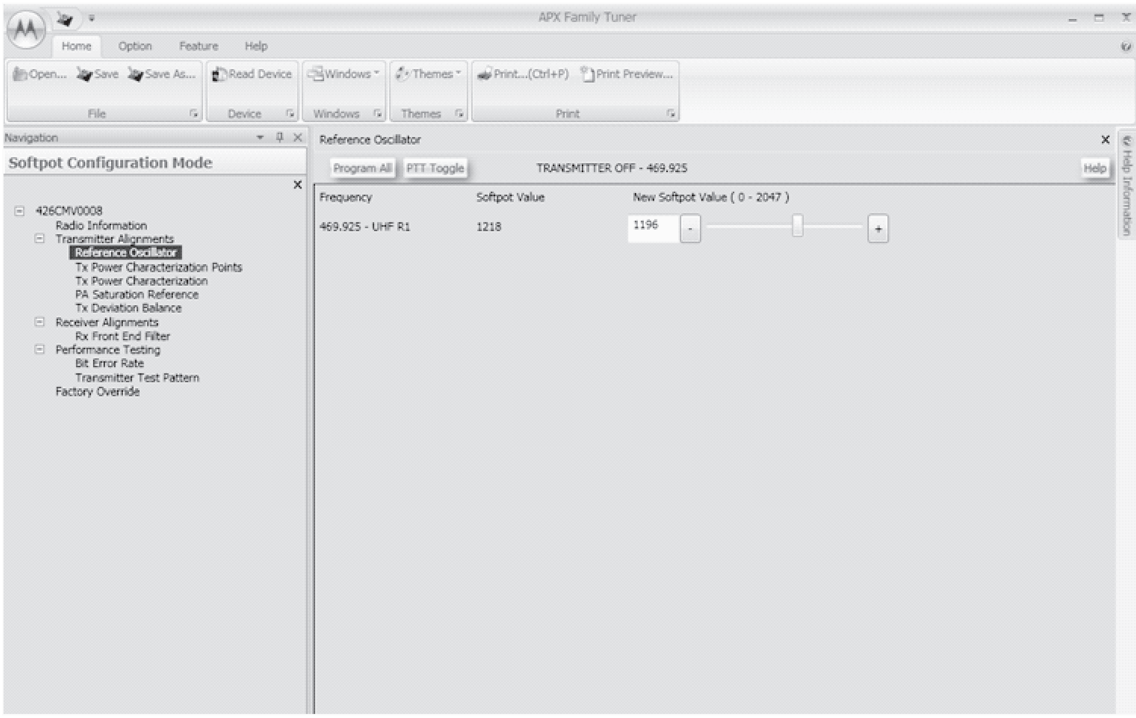

Figure 6-3. Typical Softpot Screen

Adjusting the softpot value sends information to the radio to increase (or decrease) the voltage in the corresponding circuit. For example, left-clicking the UP spin button in the New Softpot Value scroll box on the **Reference Oscillator** screen instructs the radio's microcomputer to increase the voltage across a varactor in the reference oscillator, which increases the frequency.

In ALL cases, the softpot value is just a relative number corresponding to a digital-to-analog (D/A) generated voltage in the radio.

Perform the following procedures in the sequence indicated.

NOTE: Some of the following screens may vary depending upon the radio under test and the version of tuner software you are using. Refer to the software's online help.

Caution

When keying the radio during a test, always transmit into a dummy load.

6.4 Radio Information

Figure 6-4 shows a typical Radio Information screen. This screen is informational only and cannot be directly changed.

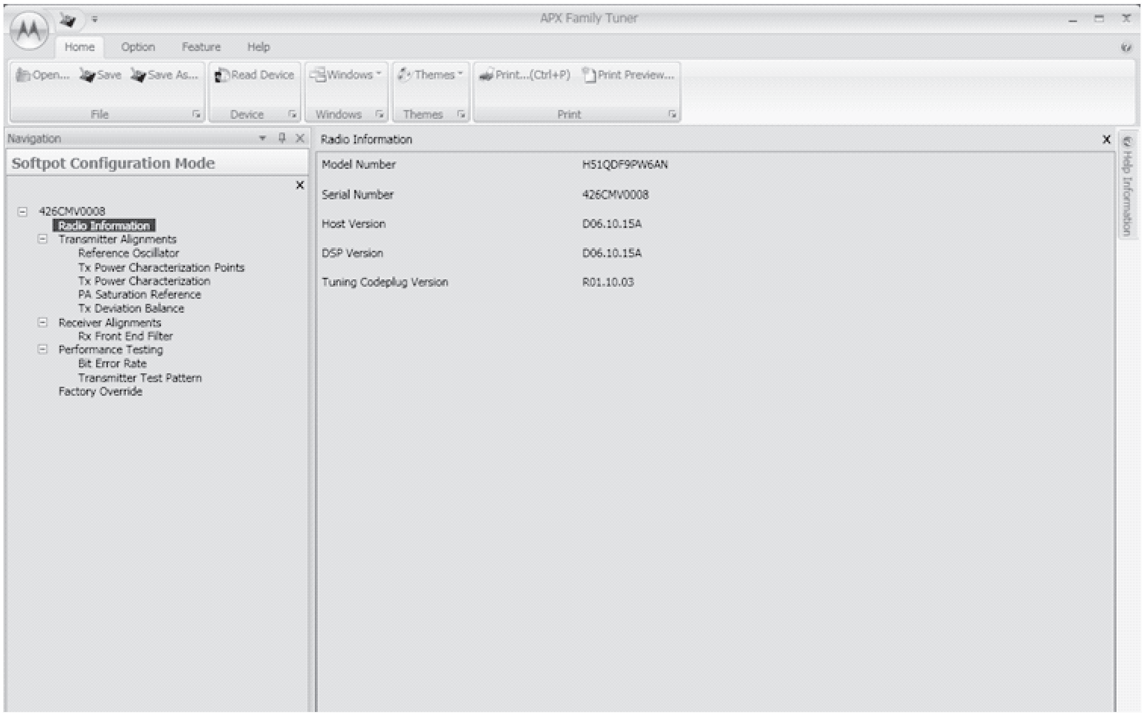

Figure 6-4. Radio Information Screen

6.5 Transmitter Alignments

6.5.1 Reference Oscillator Alignment

Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment will result not only in poor operation, but also in a misaligned radio that will interfere with other users operating on adjacent channels. For this reason, the reference oscillator should be checked every time the radio is serviced, or once a year, whichever comes first. The frequency counter used for this procedure must have a stability of 0.1 ppm (or better).

NOTE: Reference oscillator alignment is required after replacing (or servicing) the transceiver board.

This test can be done with either the R-2670 Communication Analyzer or the 8901_ Modulation Analyzer.

- Initial setup using the R-2670 Communication Analyzer:
  - RF Control: Monitor
  - B/W: WB
  - Freq: CPS frequency under test
  - Attenuation: 20dB
  - Mon RF in: RF I/O
  - Meter: RF Display
  - Mode: STD
  - Input Level: uV or W
  - Display: Bar Graphs
  - Squelch: Mid-range or adjust as necessary
- Initial setup using the 8901_ Series Modulation Analyzer:
  - Press the green **Automatic Operation** button on the analyzer.
  - Press the **FREQ** key.
  - Type **7.1** followed by **SPCL** button to set the 8901B_ modulation analyzer for maximum accuracy.

To align the reference oscillator:

Select the **Reference Oscillator** alignment screen. See Figure 6-5, Figure 6-6, Figure 6-7, Figure 6-8 and Figure 6-9.

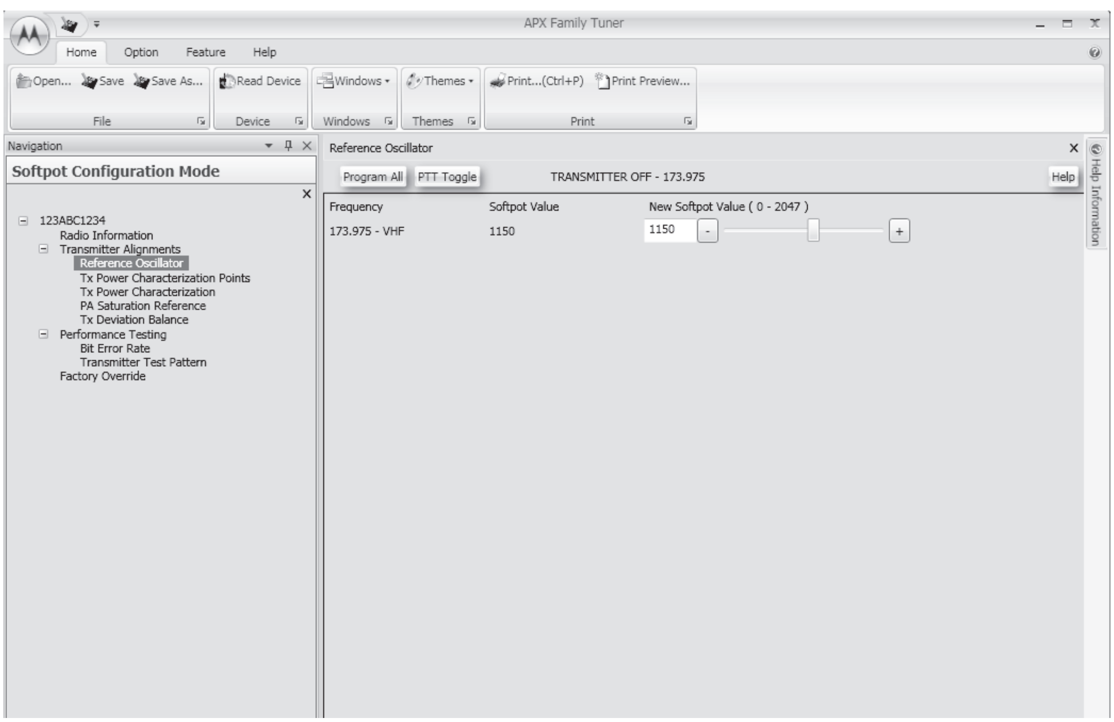

Figure 6-5. Reference Oscillator Alignment Screen (VHF)

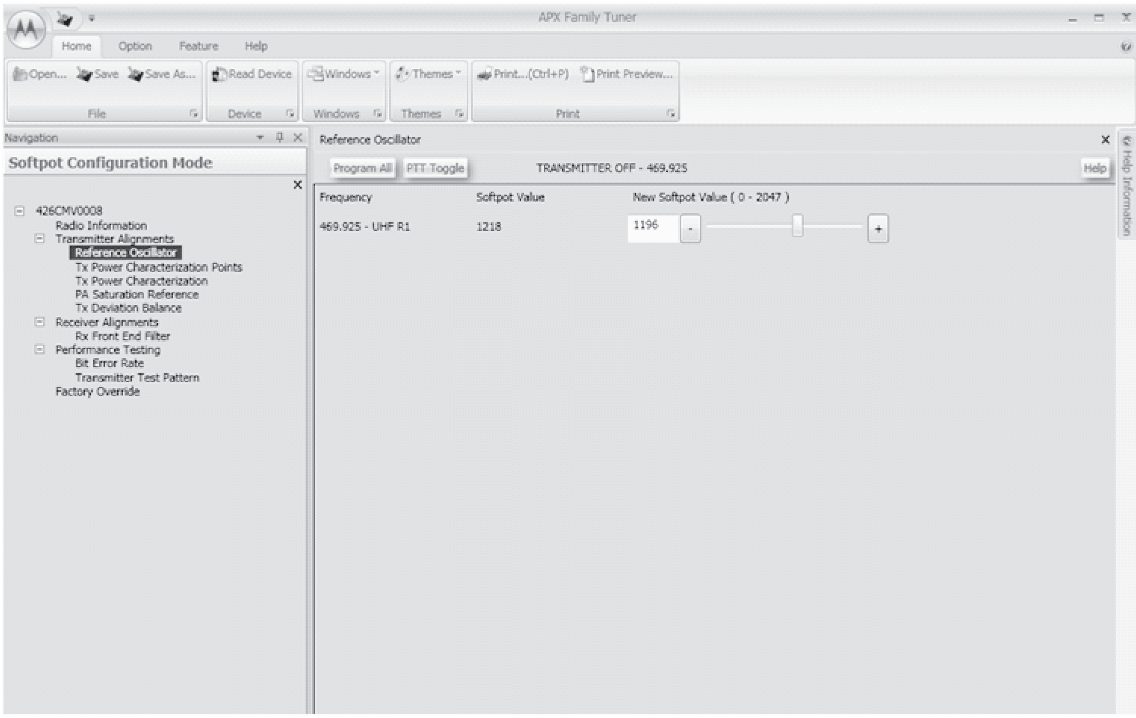

Figure 6-6. Reference Oscillator Alignment Screen (UHF1)

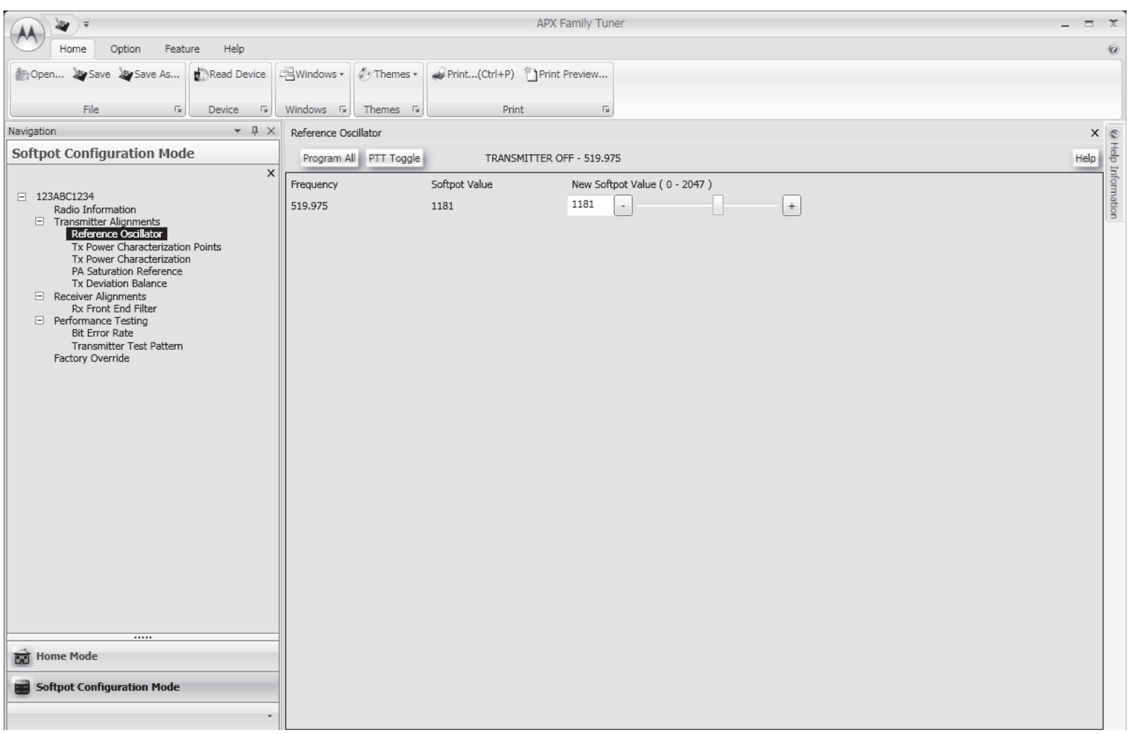

Figure 6-7. Reference Oscillator Alignment Screen (UHF2)

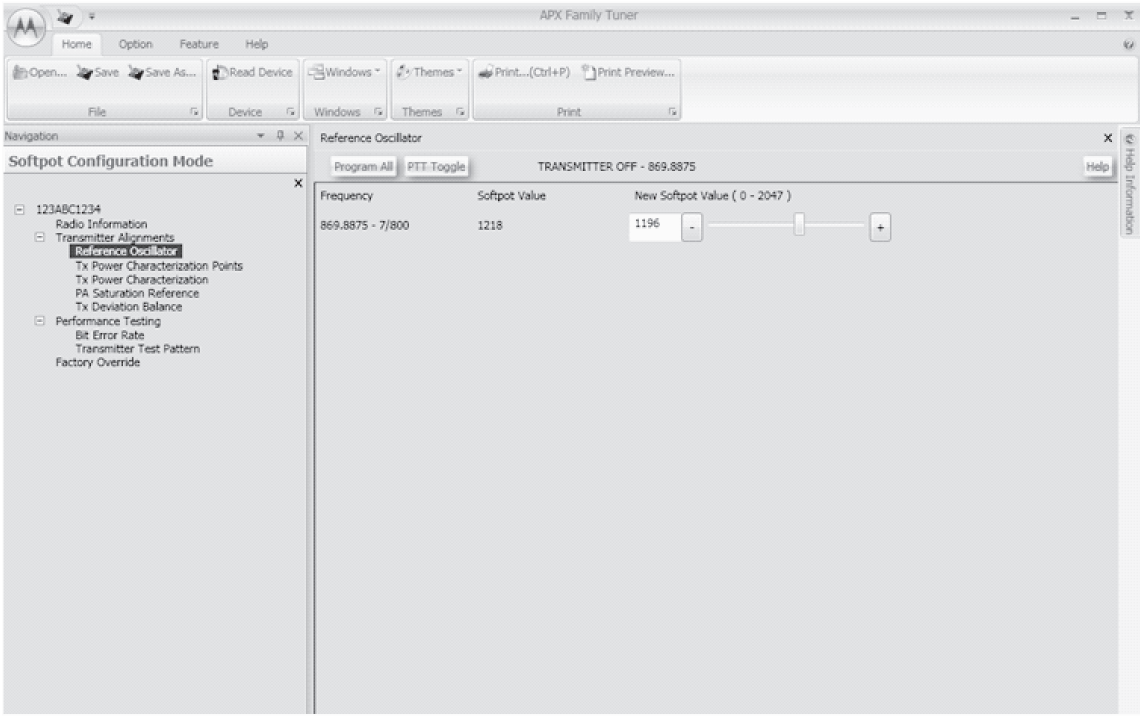

Figure 6-8. Reference Oscillator Alignment Screen (700/800 MHz)

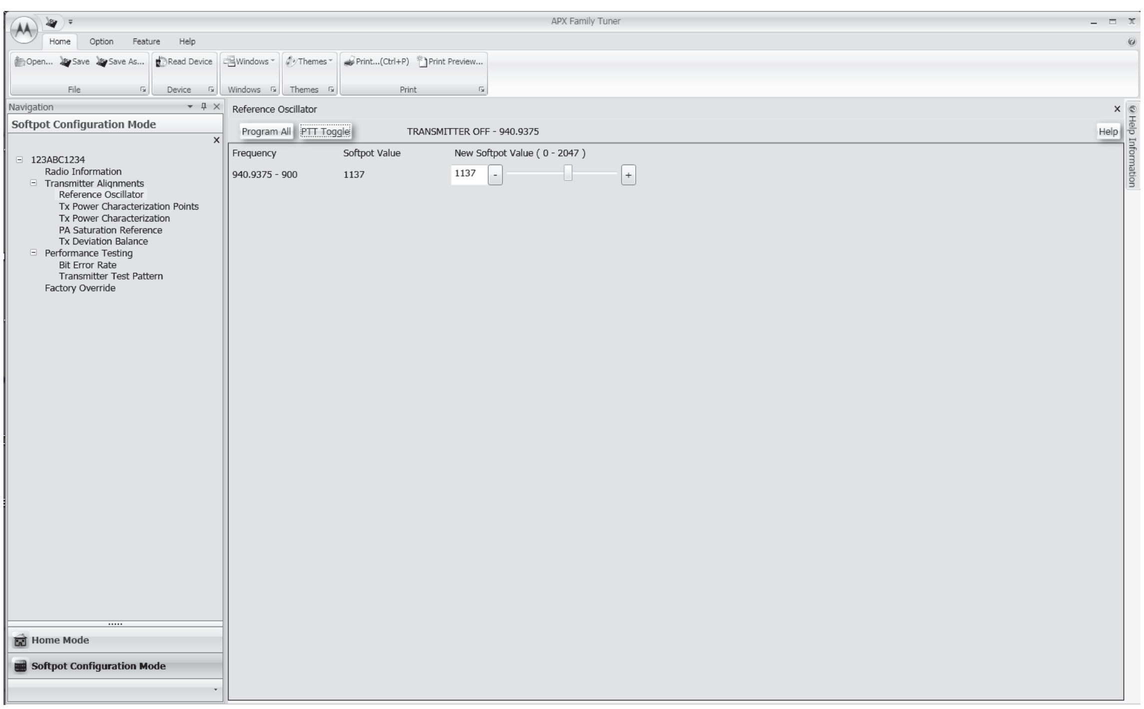

Figure 6-9. Reference Oscillator Alignment Screen (900 MHz)

1. Make sure the Communication Analyzer is in **Manual** mode.

   VHF
   - Set the base frequency to 173.975 MHz

   UHF1
   - Set the base frequency to 469.925 MHz

   UHF2
   - Set the base frequency to 519.975 MHz

   700/800 MHz
   - Set the base frequency to 869.8875 MHz

   900 MHz
   - Set the base frequency to 940.9375 MHz

2. Adjust the reference oscillator's softpot value with the slider until the measured value is as close as possible to the frequency shown on the screen. See Table 6-1.

   NOTE: Increases the slider decreases the frequency and vice versa.

Table 6-1. Reference Oscillator Alignment

Band	Target
VHF	±100 Hz
UHF1	±100 Hz
UHF2	±100 Hz
700/800 MHz	±100 Hz
900 MHz	±100 Hz

3. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.
4. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

6.5.2 Power Characterization Points

Tuning of the radio is done through **Power Characterization Points** tuning screen.

1. Select the **TX Power Characterization Points** alignment screen. See Figure 6-10, Figure 6-11, Figure 6-12, Figure 6-13 and Figure 6-14.
2. Set power supply voltage and current limit.
3. Adjust softpot value by manipulating the slider bar, incrementing the "New Softpot Value" text box, or directly entering the desired value into the "New Softpot Value" text box until the rated power is indicated on the service Monitor. For rated power refer to the help text in the Tuner.
4. Repeat step 2 to 3 for all frequencies.
5. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

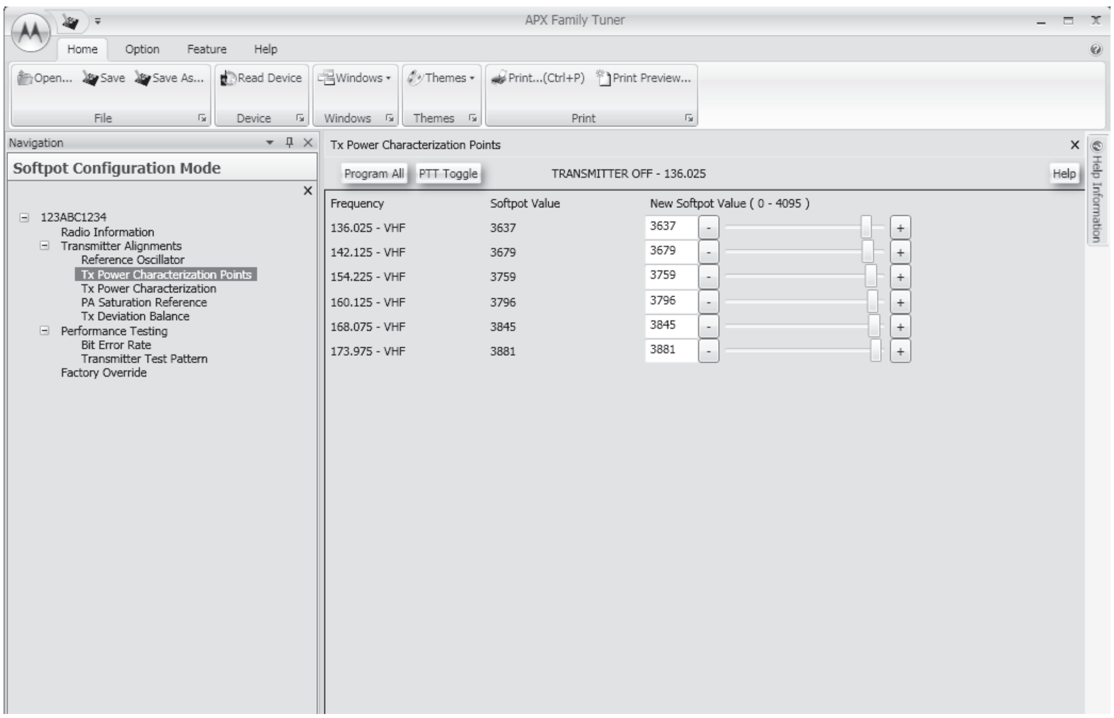

Figure 6-10. Transmit Power Characterization Points Alignment Screen (VHF)

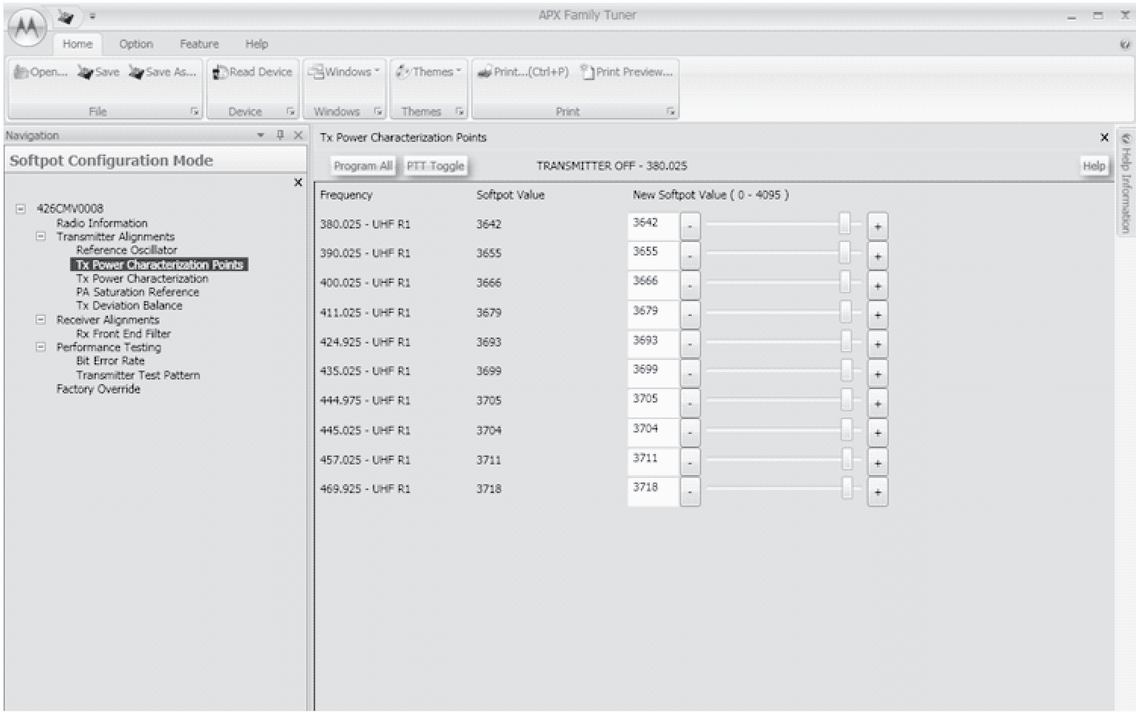

Figure 6-11. Transmit Power Characterization Points Alignment Screen (UHF1)

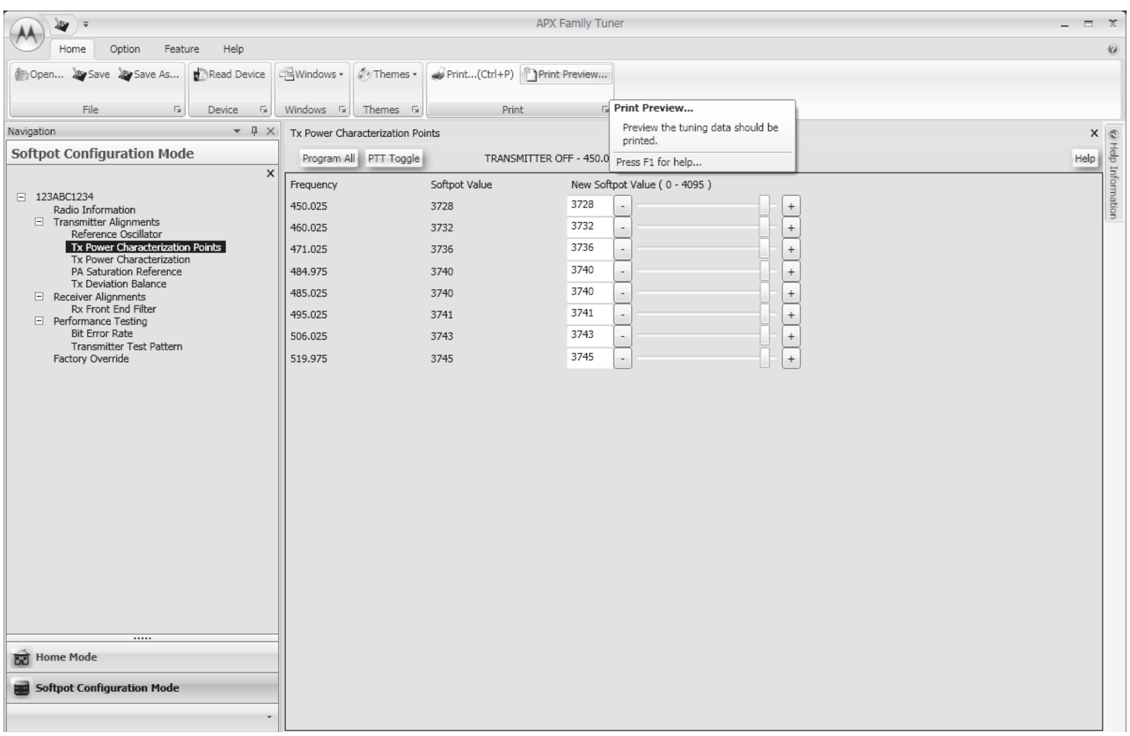

Figure 6-12. Transmit Power Characterization Points Alignment Screen (UHF2)

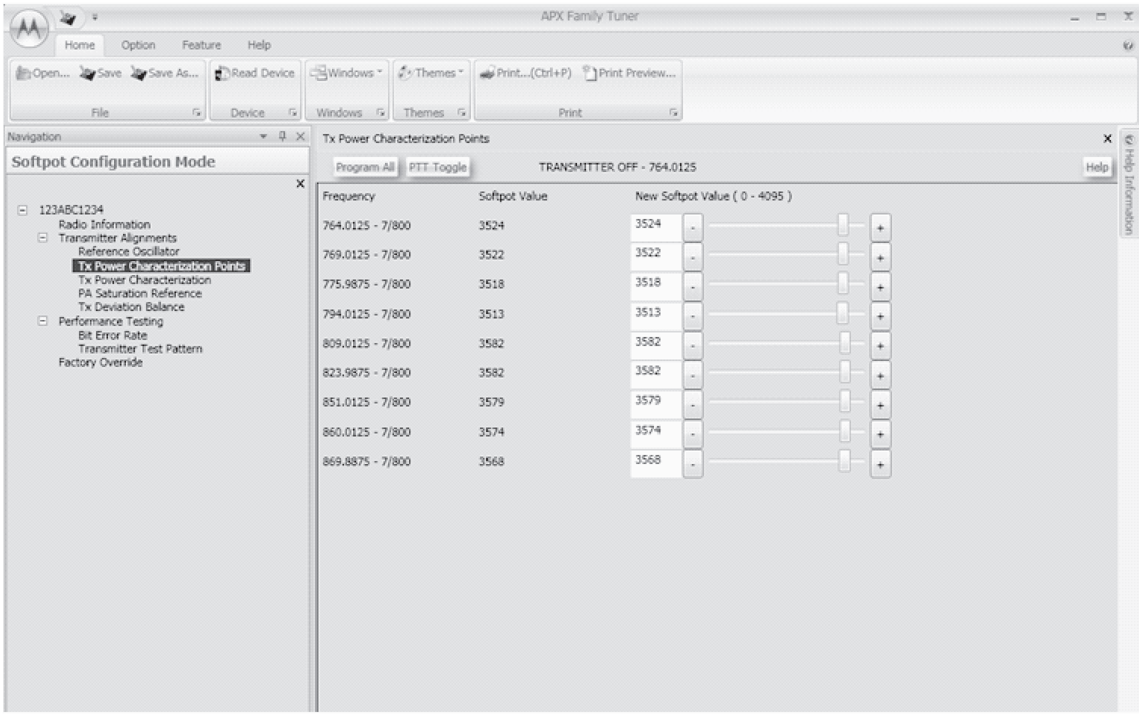

Figure 6-13. Transmit Power Characterization Points Alignment Screen (700/800 MHz)

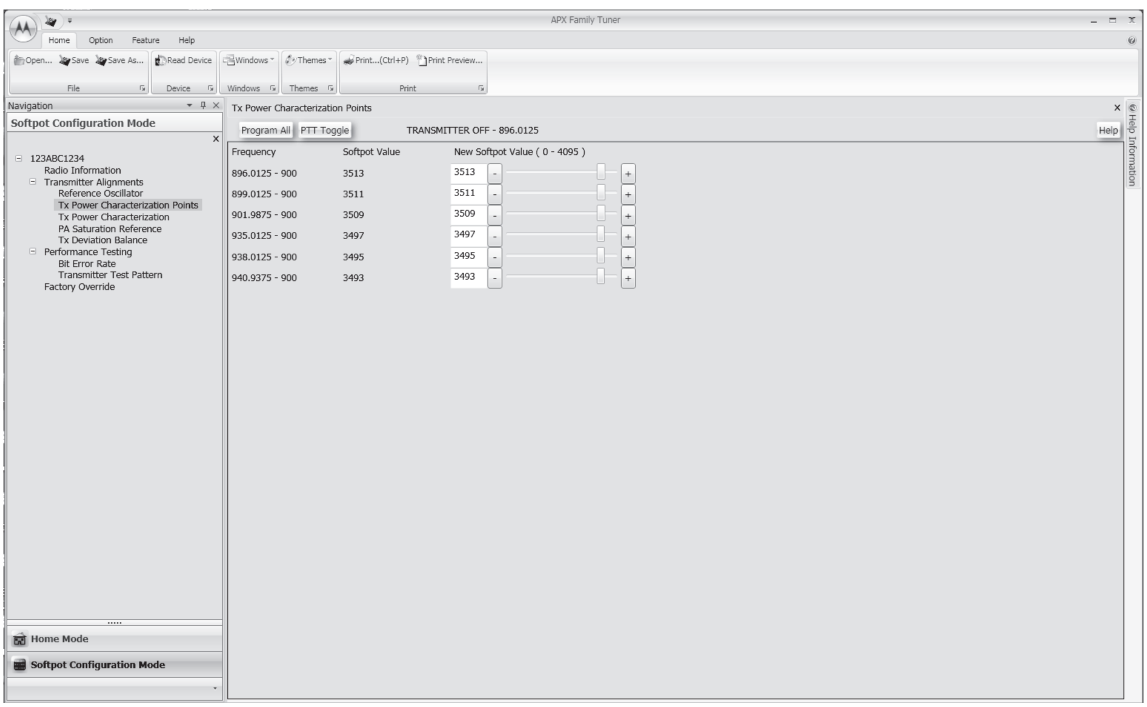

Figure 6-14. Transmit Power Characterization Points Alignment Screen (900 MHz)

6.5.3 Power Characterization Tuning

Tuning of the radio is done through **Power Characterization** tuning screen.

IMPORTANT: Power Characterization Tuning Points must be tuned before tuning Power Characterization Tuning.

NOTE: a.The longer the RF cable, the more the attenuation of the power reading.

b.Use a standard 50 ohm cable.

c. Remember to set the Communication Analyzer to baseband power.

1. Select the **TX Power Characterization** alignment screen. The screen indicates the transmit power to be used. See Figure 6-15, Figure 6-16, Figure 6-17, Figure 6-18 and Figure 6-19.
2. Left-click the box under “Measure Power 1” for the desired frequency field. (The selected box is highlighted).
3. Click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
4. Measure the transmit power of the radio with a service Monitor.
5. Input the transmit power in watts using two decimal places into the highlighted “Measure Power 1” box.
6. Left-click the box under “Measure Power 2” box for the same frequency field. (The selected box is highlighted).
7. Measure the transmit power of the radio with a service Monitor.
8. Input the transmit power in watts using two decimal places into the highlighted “Measure Power 2” box.
9. Repeat step 2 to 8 for all frequencies.
10. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

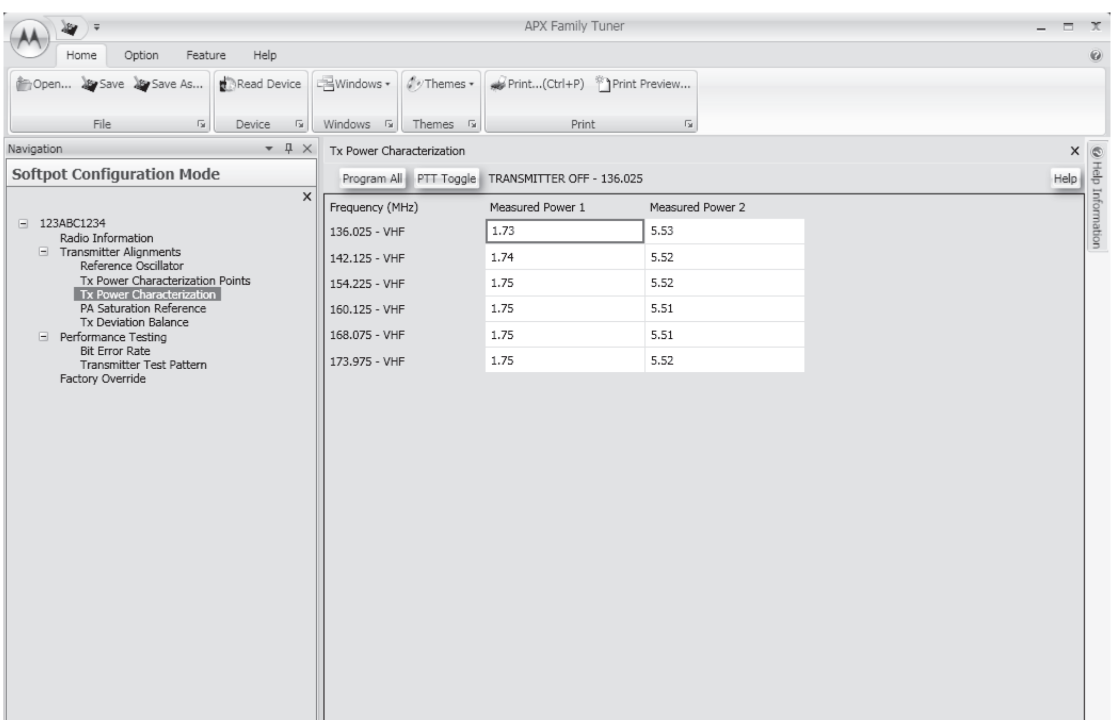

Figure 6-15. Transmit Power Characterization Alignment Screen (VHF)

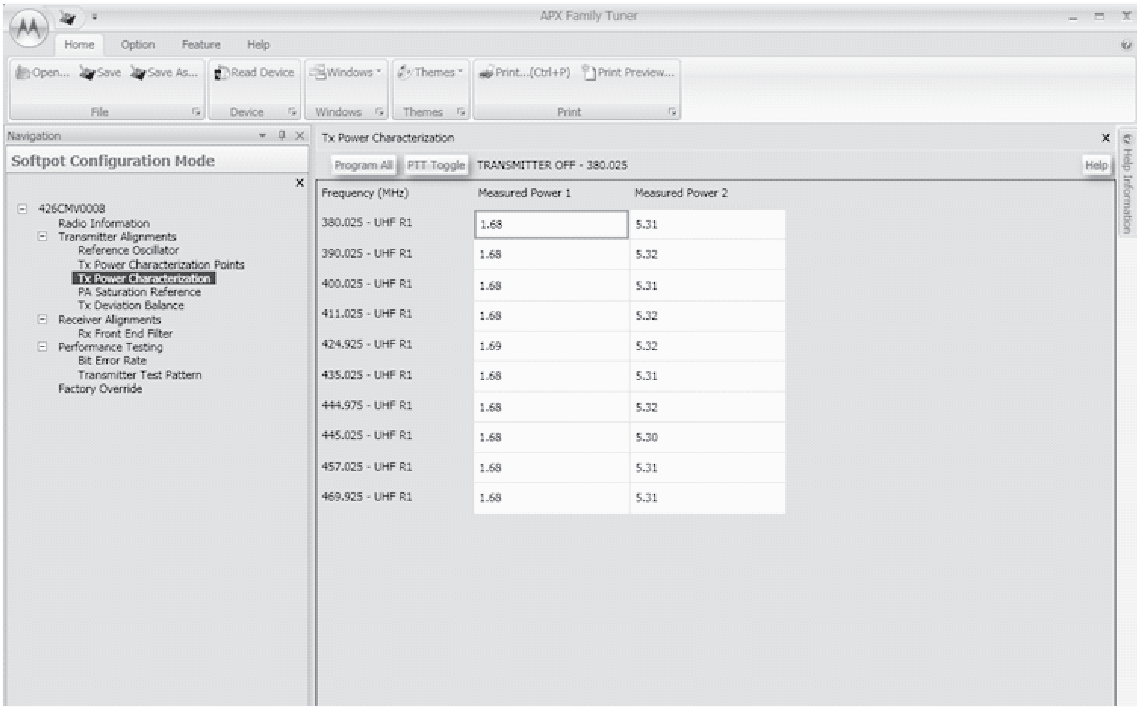

Figure 6-16. Transmit Power Characterization Alignment Screen (UHF1)

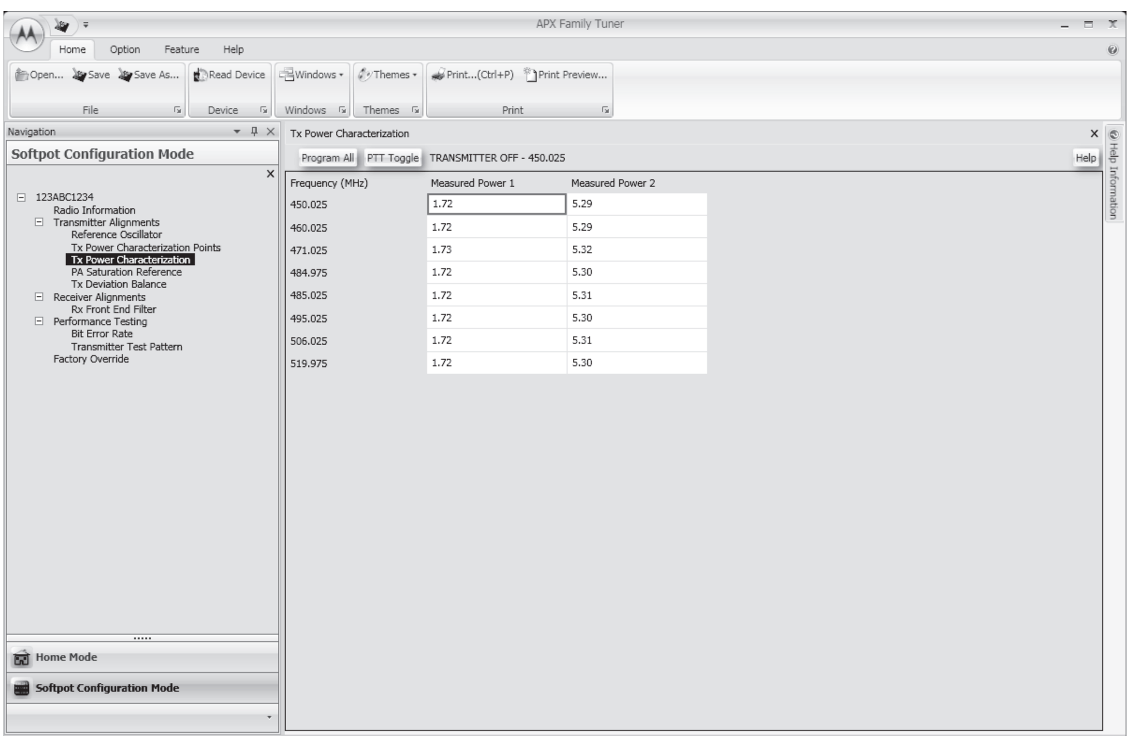

Figure 6-17. Transmit Power Characterization Alignment Screen (UHF2)

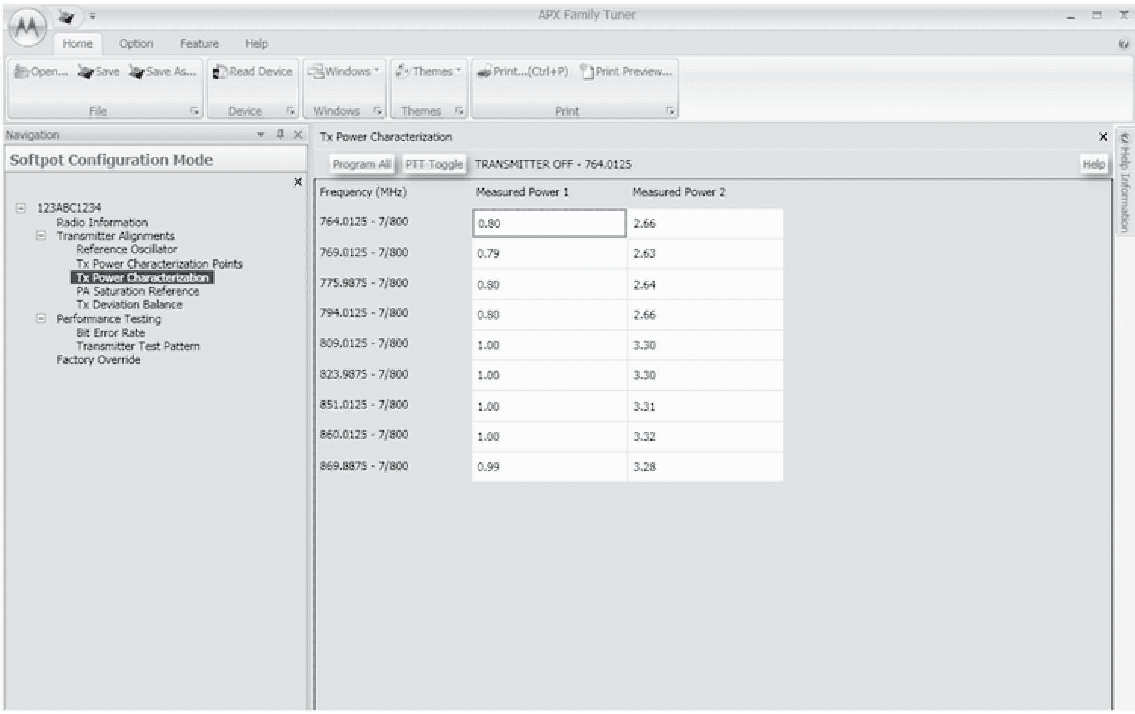

Figure 6-18. Transmit Power Characterization Alignment Screen (700/800 MHz)

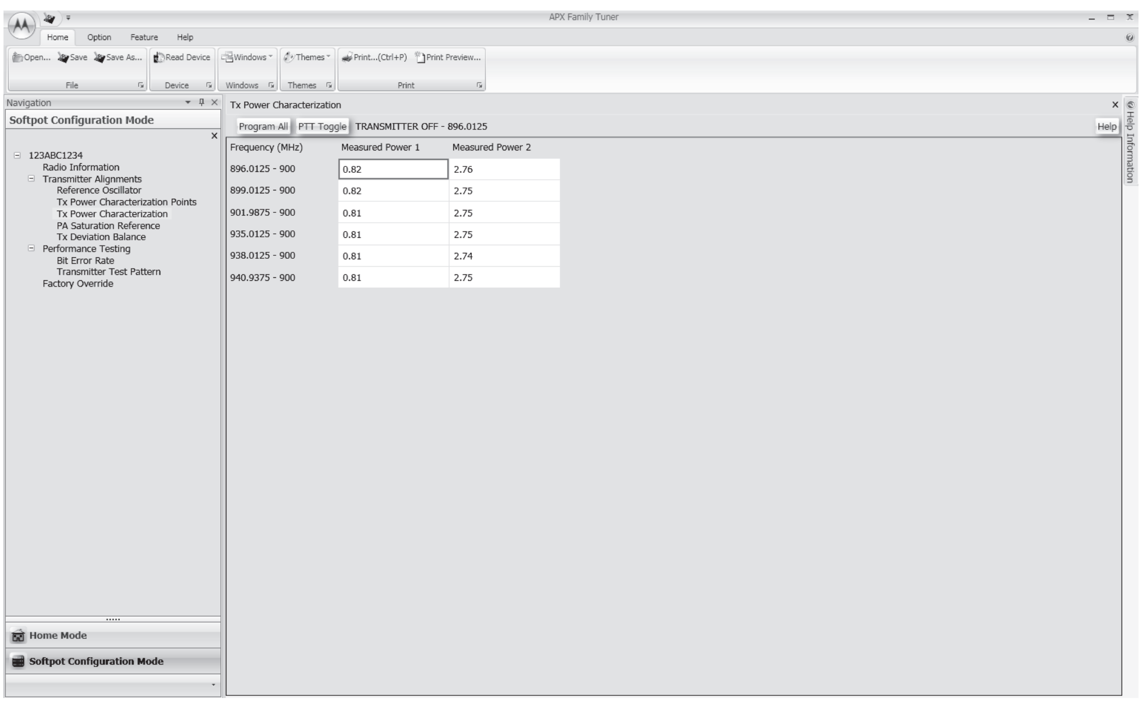

Figure 6-19. Transmit Power Characterization Alignment Screen (900 MHz)

6.5.4 PA Saturation Reference Tuning

Tuning is done through **PA Saturation Referencing** screen.

1. Select the **PA Saturation Reference** alignment screen. The screen indicates the transmit frequencies to be used. See Figure 6-20, Figure 6-21, Figure 6-22, Figure 6-23 and Figure 6-24.
2. In Manual Mode, set the service Monitor to the desired frequency (as shown in the frequency list in the PA Saturation Reference alignment screen).
3. Adjust the PA Saturation Reference softpot value with the slider until the radio transmits as close as possible to the rated power. For rated power refer to the help text in the Tuner.
4. Left-click the slider of the frequency selected (should be the same frequency as step 2).
5. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
6. Repeat step 2 to 5 for all frequencies.
7. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

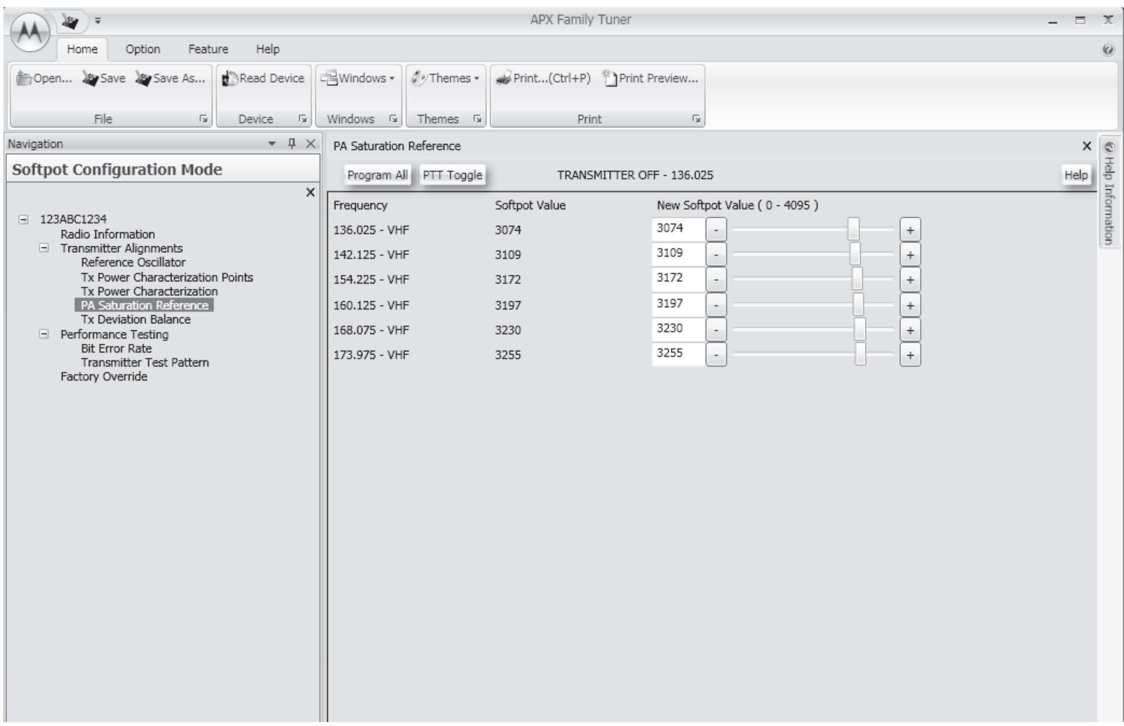

Figure 6-20. PA Saturation Referencing Alignment Screen (VHF)

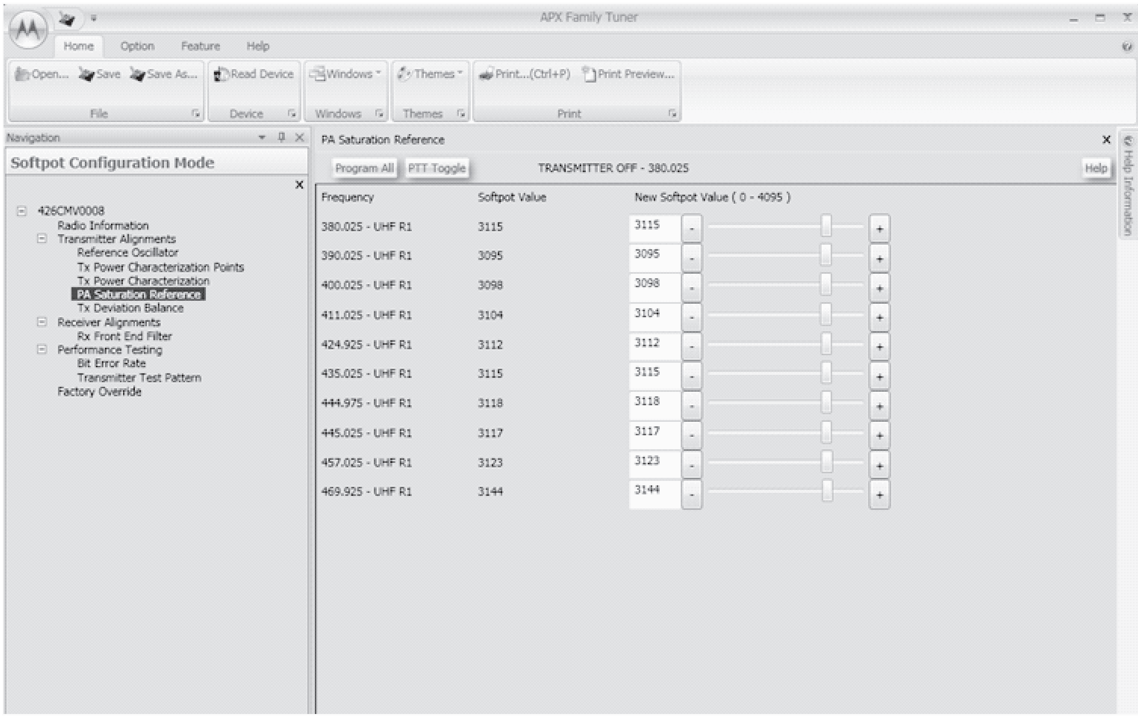

Figure 6-21. PA Saturation Referencing Alignment Screen (UHF1)

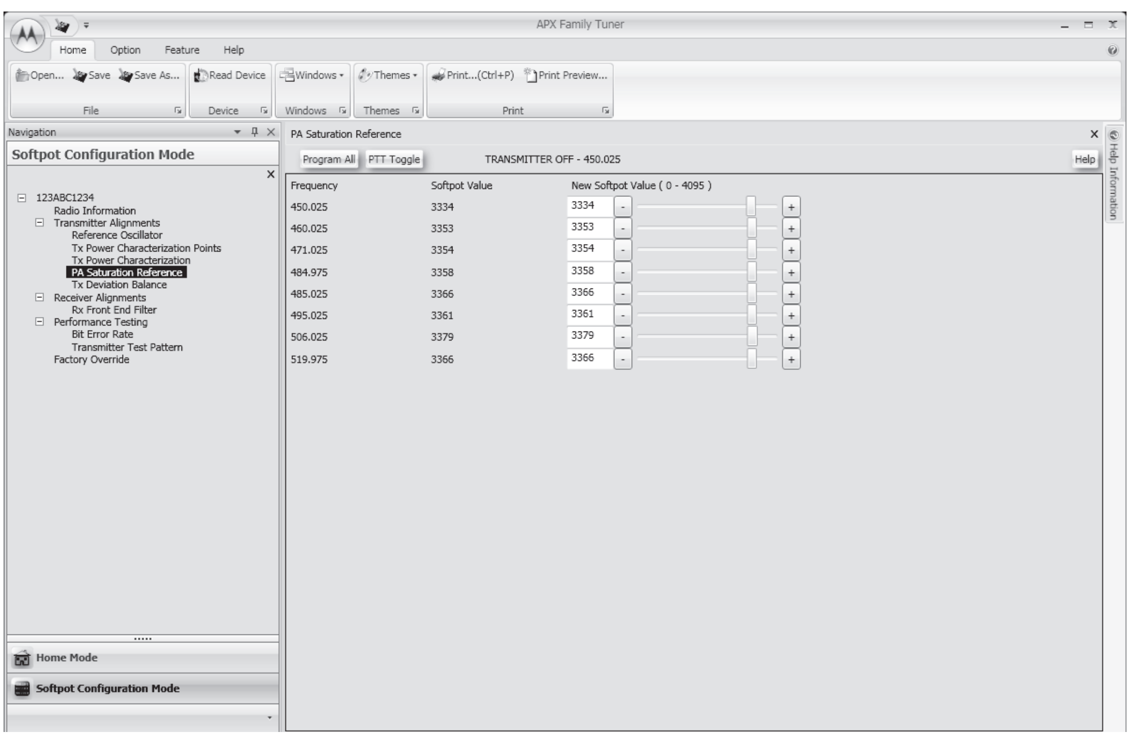

Figure 6-22. PA Saturation Referencing Alignment Screen (UHF2)

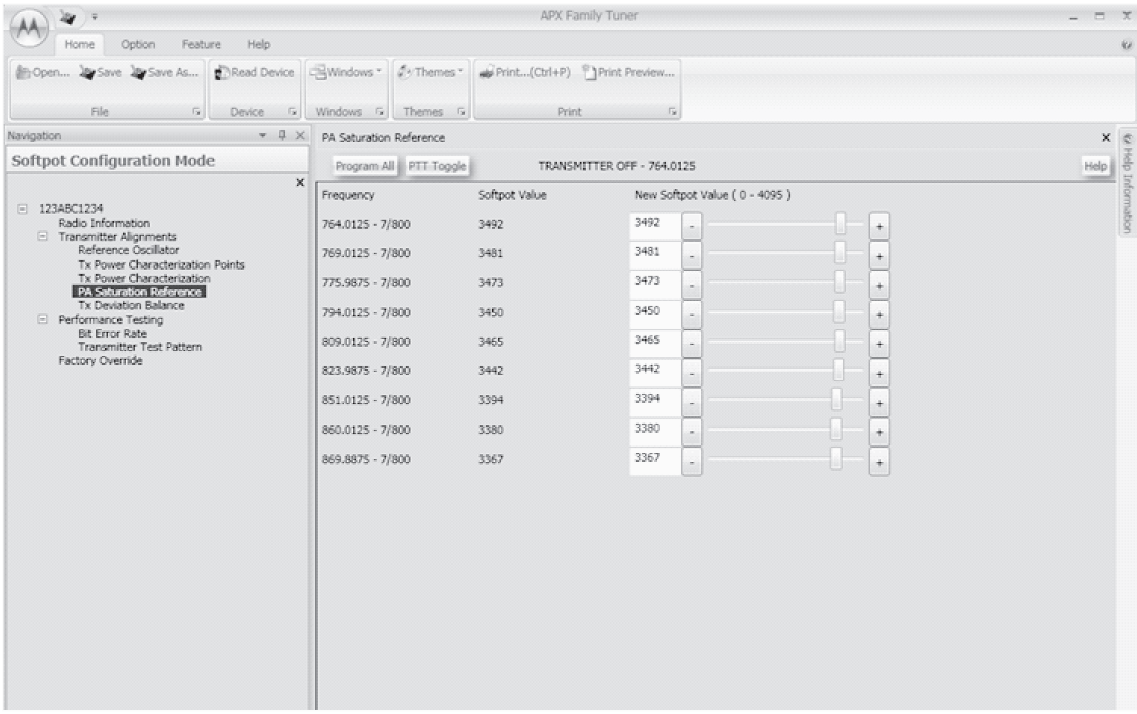

Figure 6-23. PA Saturation Referencing Alignment Screen (700/800 MHz)

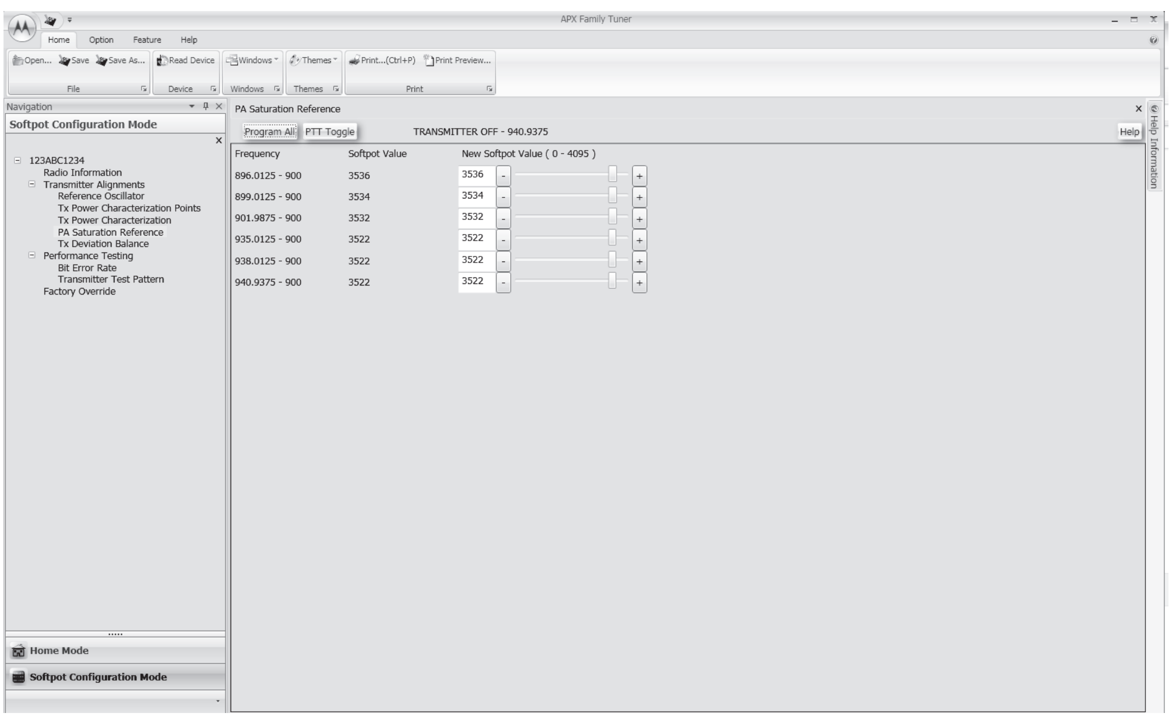

Figure 6-24. PA Saturation Referencing Alignment Screen (900 MHz)

6.5.5 Transmit Deviation Balance Alignment

This alignment procedure balances the modulation contributions of the low- and high-frequency portions of a baseband signal. Proper alignment is critical to the operation of signalling schemes that have very low frequency components (for example, DPL) and could result in distorted waveforms if improperly adjusted.

This procedure needs to be performed at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone.

NOTE: This alignment is required after replacing (or servicing) the main board.

Proper alignment requires a modulation analyzer or meter with a frequency response to less than 10 Hz modulating frequency. The modulation analyzer settings during this test should be set for average deviation, a 15 kHz low-pass filter, no de-emphasis, and no high-pass filter, if these settings are supported.

This alignment can be done with either the R-2670 Communication Analyzer or the 8901_ Series Modulation Analyzer. The method of choice is the R-2670 analyzer.

1. Initial setup using the R-2670 Communication Analyzer:
   - Connect a BNC cable between the “DEMOD OUT” port and the “VERT/SINAD DIST/DMM COUNTER IN” port on the R-2670.
   - Press the **SPF** key on the R-2670 to display the “SPECIAL FUNCTIONS MENU.” Move the cursor to “High Pass,” and select 5 Hz on the soft key menu. Select 20 kHz for the “Low Pass” setting.
   - In the “RF Control” section of the R-2670, move the cursor to the “B/W” setting and select “WIDE +/- 100 kHz” on the soft key menu.
   - Place the R-2670 cursor in the “Display” zone. Select “AC VOLTS” on the soft key menu. Move the cursor to the “Range” setting and select “AUTO.”
2. Initial setup using the 8901_ Series Modulation Analyzer:
   - Press the **FM MEASUREMENT** button. (The “*Error 0input level too low”* indication is normal until an input signal is applied.)
   - Simultaneously press the **Peak –** and **Peak +** buttons. Both LEDs on the buttons should light.
   - Press the 15 kHz LP filter key.
3. Select the **TX Deviation Balance** alignment screen. The screen indicates the transmit frequencies to be used. See Figure 6-25, Figure 6-26, Figure 6-27, Figure 6-28 and Figure 6-29.
4. In the "RF Control" section of the R2670, set the service Monitor to the desired frequency (as shown in the frequency list in the TX Deviation Balance alignment screen).
5. Left-click the **PTT Tone: Low** button.
6. Left-click the slider of the frequency selected (should be the same frequency as step 4).
7. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
8. Measure and Record the Low Tone Tx Deviation value from the 8901_ Series Analyzer or the AC voltage value from the R2670.
9. Left-click the **PTT Tone: High** button.
10. Adjust the softpot value until the measured deviation/voltage, when using the high tone, is within +/- 1.5% of the value observed when using the Low Tone.

11. Left-click the **PTT Toggle** to de-key the radio.
12. Repeat the steps 4 to 10 for all frequencies.
13. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

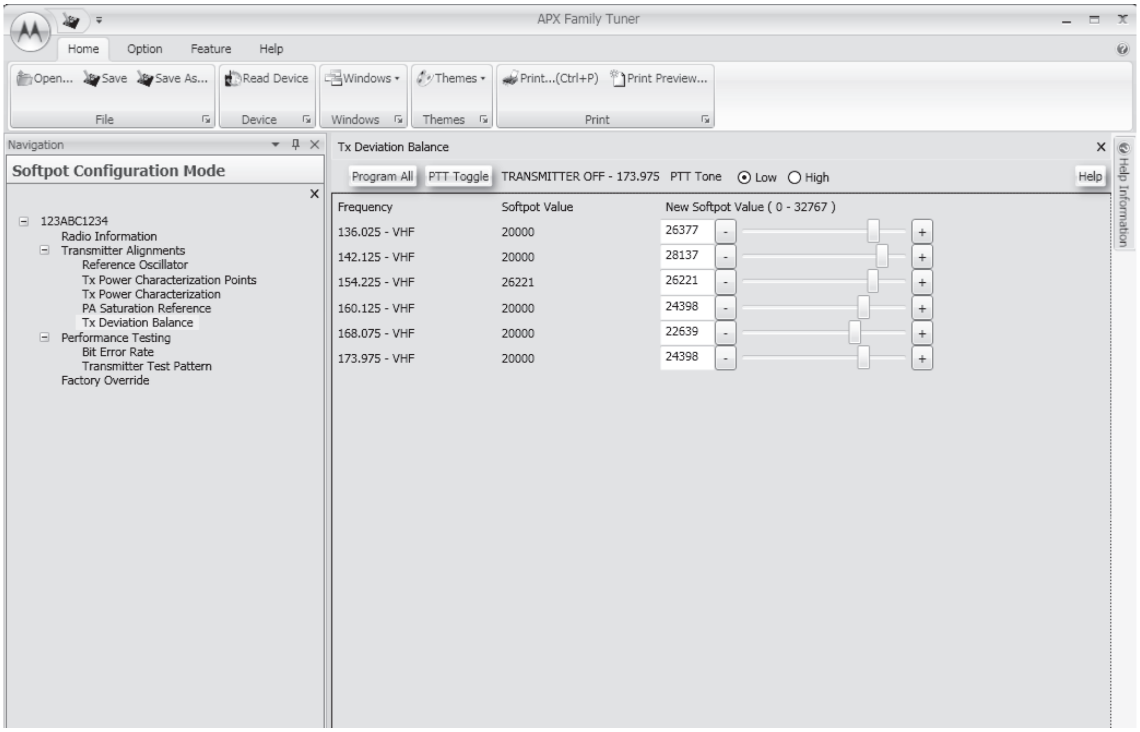

Figure 6-25. Transmit Deviation Balance Alignment Screen (VHF)

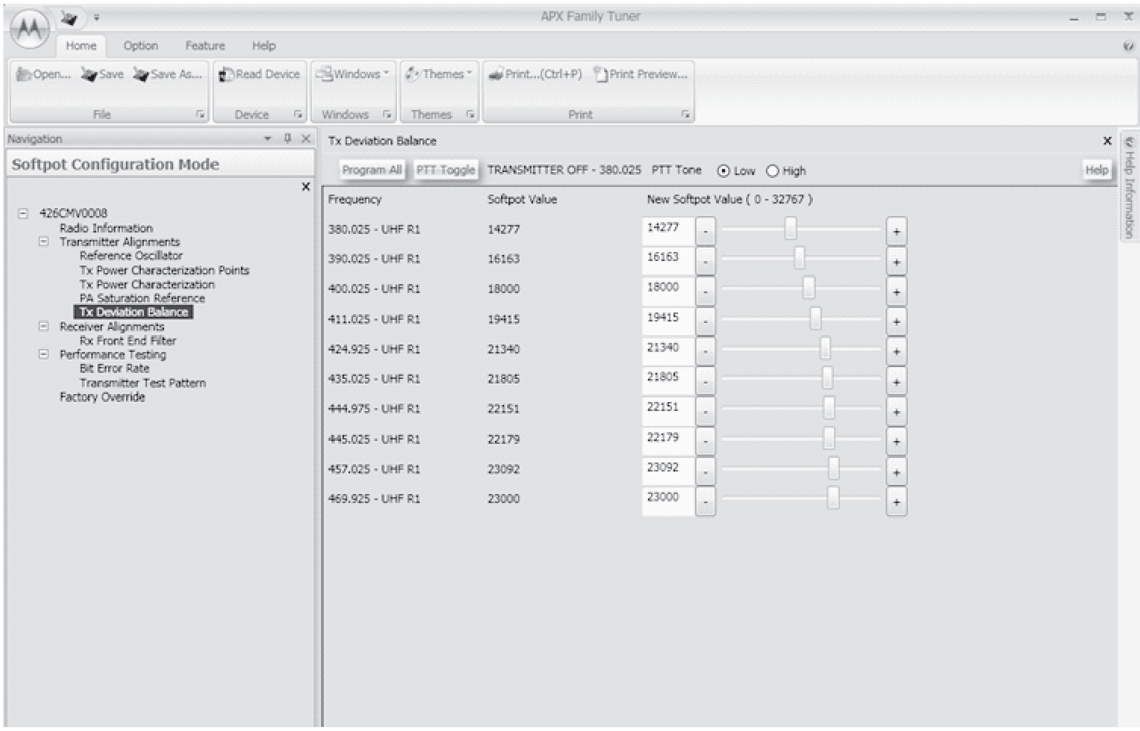

Figure 6-26. Transmit Deviation Balance Alignment Screen (UHF1)

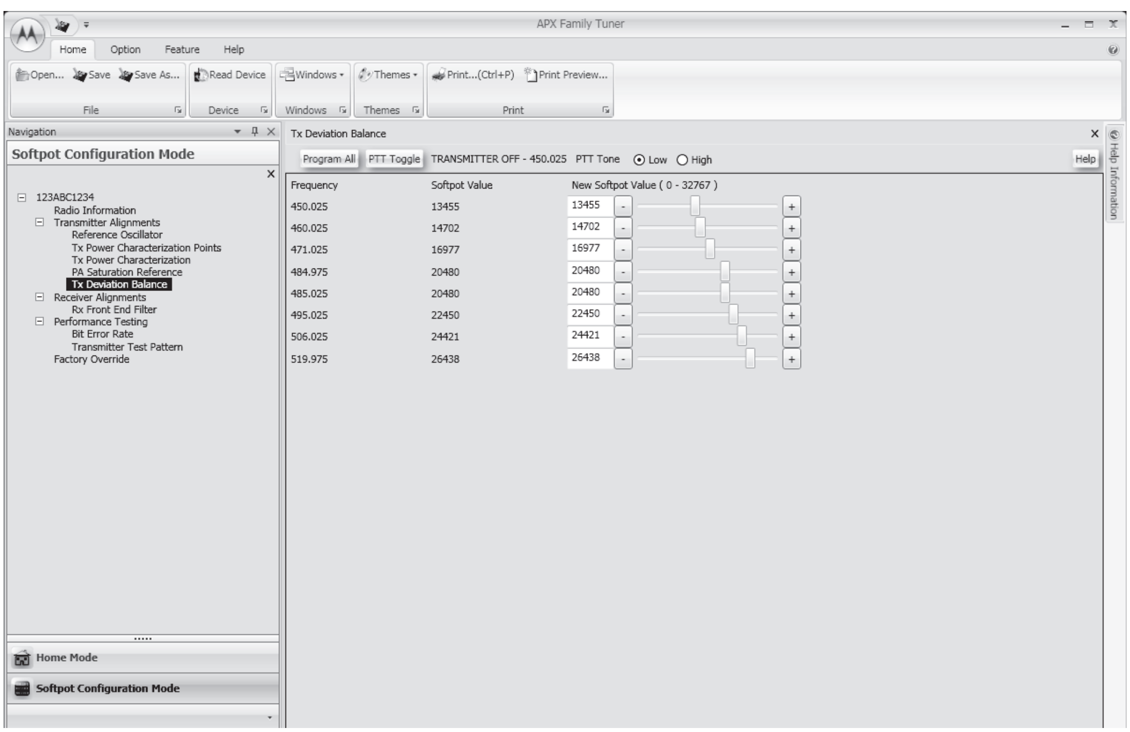

Figure 6-27. Transmit Deviation Balance Alignment Screen (UHF2)

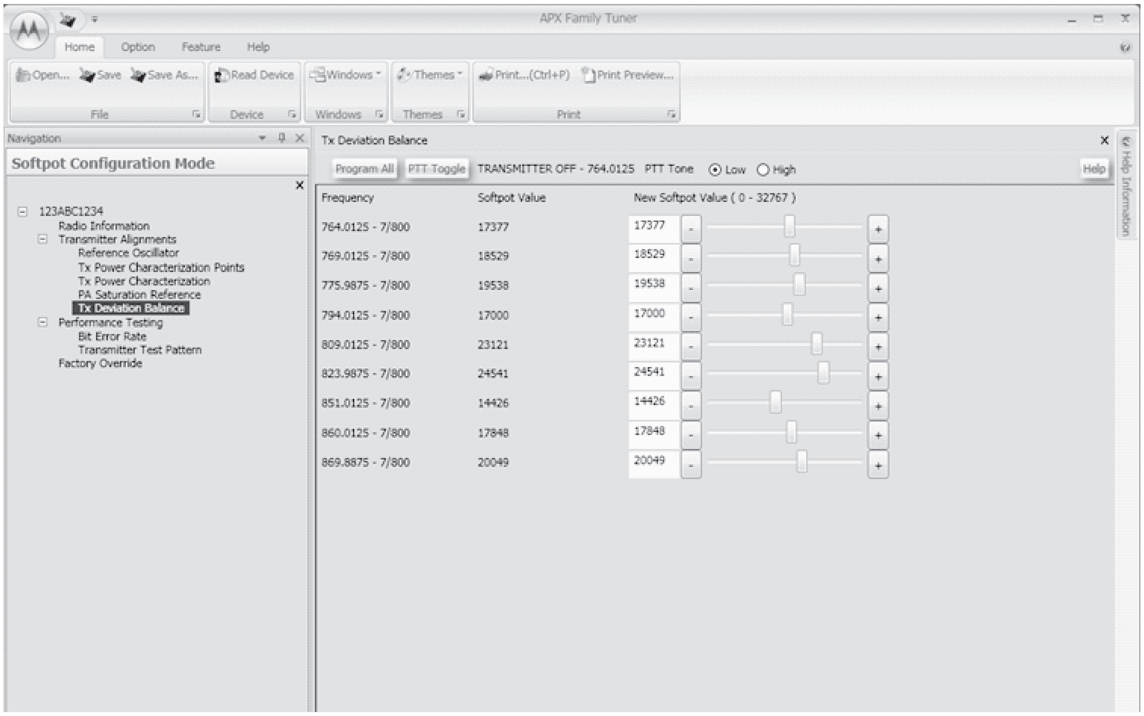

Figure 6-28. Transmit Deviation Balance Alignment Screen (700/800 MHz)

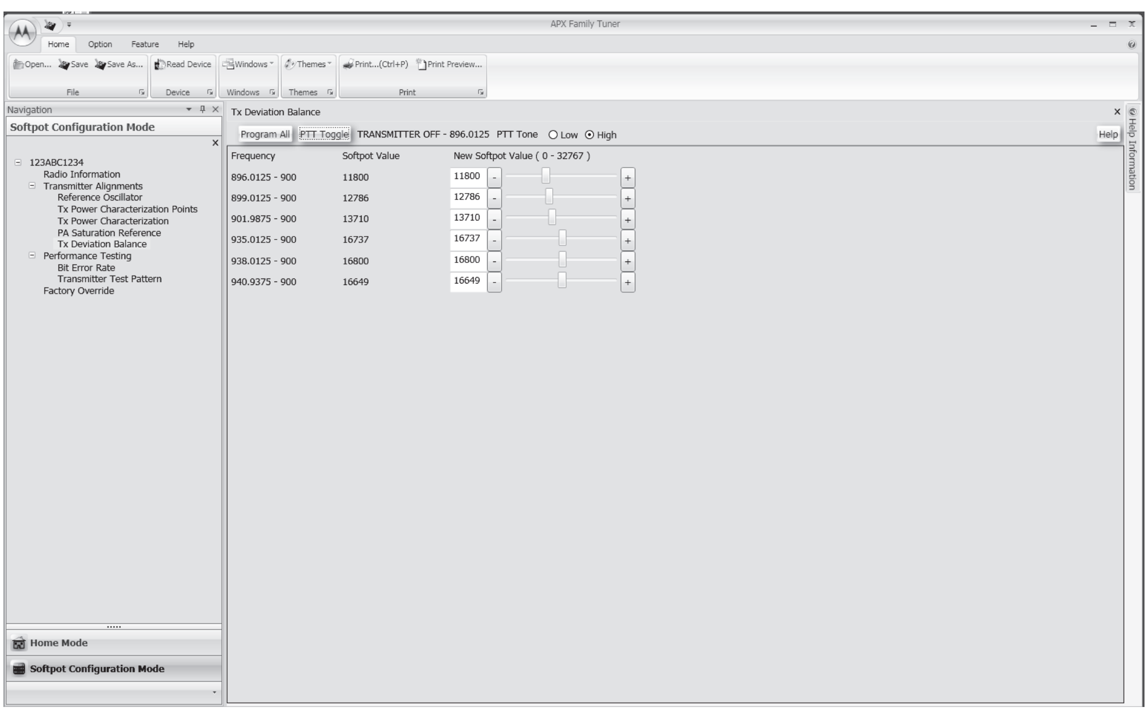

Figure 6-29. Transmit Deviation Balance Alignment Screen (900 MHz)

6.6 Front End Filter Alignment

Caution

This procedure should only be attempted by qualified service technicians.

The alignment procedure adjusts the front end receiver bandpass filters for the best receiver sensitivity and selectivity. This procedure should be performed for all test frequencies to allow for proper software interpolation of frequencies between the test frequencies in the band (see Figure 6-30).

NOTE: Rx Front End Filter Alignment is required after replacing (or servicing) the transceiver board.

6.6.1 Procedure for UHF 1 and UHF2 (Auto Tune)

Tuning of the radio is done through **Rx Front End Filter** tuning screen

1. Select the **Rx Front End Filter** alignment screen. See Figure 6-30.
2. Click on the slider or the "New Softpot Value" text box to select which frequency to tune.
3. Apply RF test signal input with no modulation at -90 dBm on the Test Signal Frequency displayed at the top of the screen.
4. Left-click the **Autotune** button.
5. Repeat step 2 to 4 for all frequencies.
6. Left-click the **Program All** button on the screen to save the tuned values in the radio.

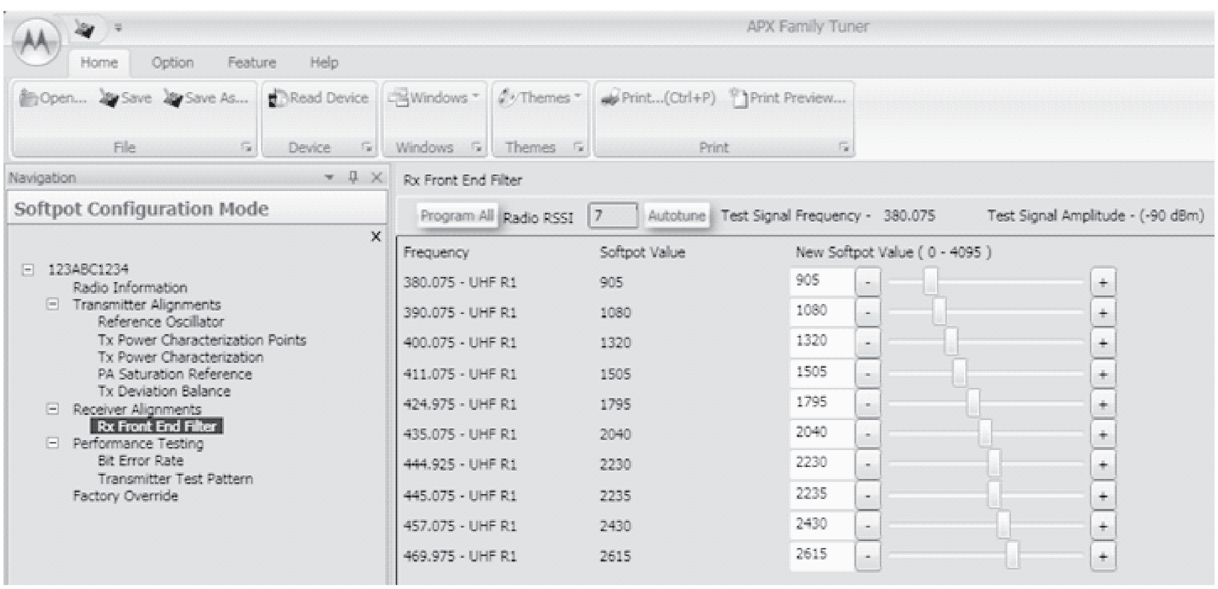

Figure 6-30. Front End Filter Alignment Screen (UHF1)

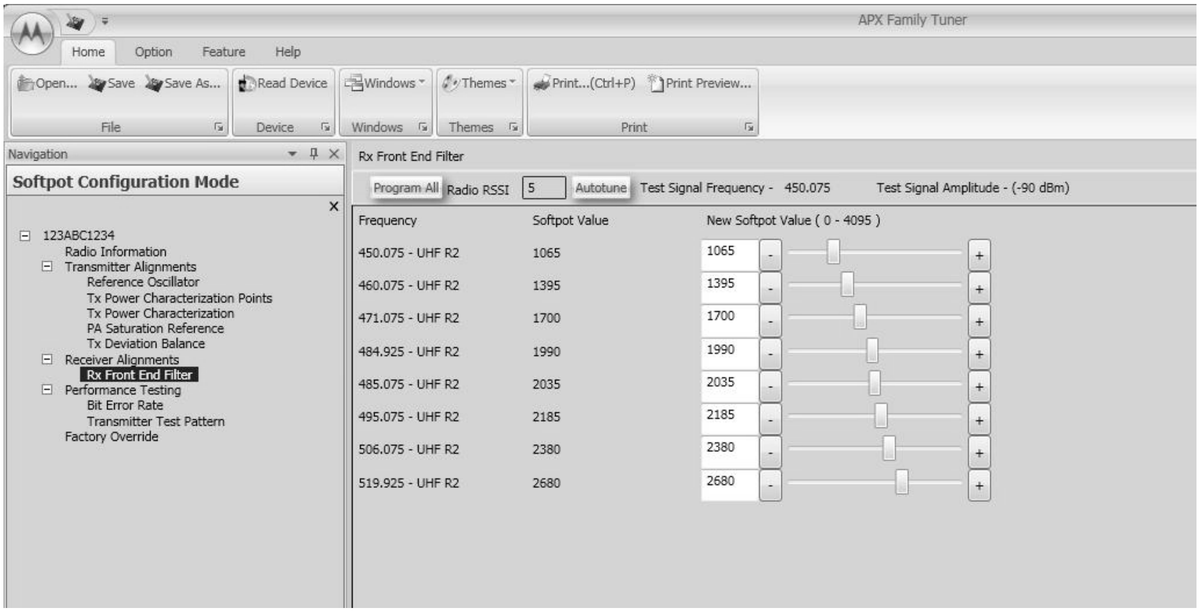

Figure 6-31. Front End Filter Alignment Screen (UHF2)

6.7 Performance Testing

6.7.1 Bit Error Rate

This section describes the Bit Error Rate (BER) test of the radio's receiver at a desired frequency (see Figure 6-32, Figure 6-33, Figure 6-34, Figure 6-35 and Figure 6-36).

6.7.1.1 Bit Error Rate Fields

Set up the R2670 Communication Analyzer as follows:

1. Connect the RF Input port of the radio under test to the RF IN/OUT port of the R2670 Service Monitor.
2. Set up the R2670 Service Monitor:
   - In the Display Zone, select PROJ 25 STD mode and set the meter to RF DISPLAY.
   - In the RF Zone, configure the analyzer as follows:

RF Control:	Generate
Preset:	B/W: NB
Freq:	Test frequency (Ex: 851.0625 MHz)
Output Level:	-50.0 dBm
Gen RF Out:	RF I/O

   - In the Audio Zone, select the 1011 Hz PAT code and set the deviation to "PROJ25Dev: 2.83 kHz ~".

The bit error rate screen contains the following fields:

- **Rx Frequency**:
  This field selects the Receive Frequency directly in MHz.

- **Test Pattern**:
  This field selects the Digital test pattern to be received by the radio. Choices are: Standard Tone Test Pattern (Framed 1011), F2 1031, Standard Interface Test Pattern (CCITT V.52) and Phase 2 Digital (1031 Hz) Test Pattern.
- **Modulation Type**:
  This field represents the digital modulation type of the incoming signal on which BER is to be calculated.
- **Continuous Operation**:
  This field allows the user the option to repeat the BER test indefinitely. A selection of Yes will cause the radio to calculate BER on a continuous basis and update the results on this screen after each integration time. A selection of No will cause the BER test to execute for only one sample of the integration time and then update the display.
- **Audio**:
  This field allows the user to select the audio output during a test. Selecting Internal will cause the radio's built-in speaker to unmute to any signals at the desired frequency which are present during the test. Selecting External will route the same signal to the radio's accessory connector audio output. Selecting Mute will disable the audio output.

NOTE: There will be **no audio** option available for APX 2000/APX 4000/APX 4000Li when performing a Bit Error Rate Test.

- **BER Integration Time**:
  BER Integration Time carries with Test Pattern Type.
- Number of Frames
  Number of Frames over which bit error result are accumulated to produce the result.

NOTE: When **Continuous Operation = Yes**, all fields will be grayed out while the test is in progress. They will be enabled when the STOP button is pressed.

When **Continuous Operation = No**, a wait cursor will be displayed while the test is in progress and return to normal when the test is done.

3. Press **Start/Stop** button to begin or end BER testing.

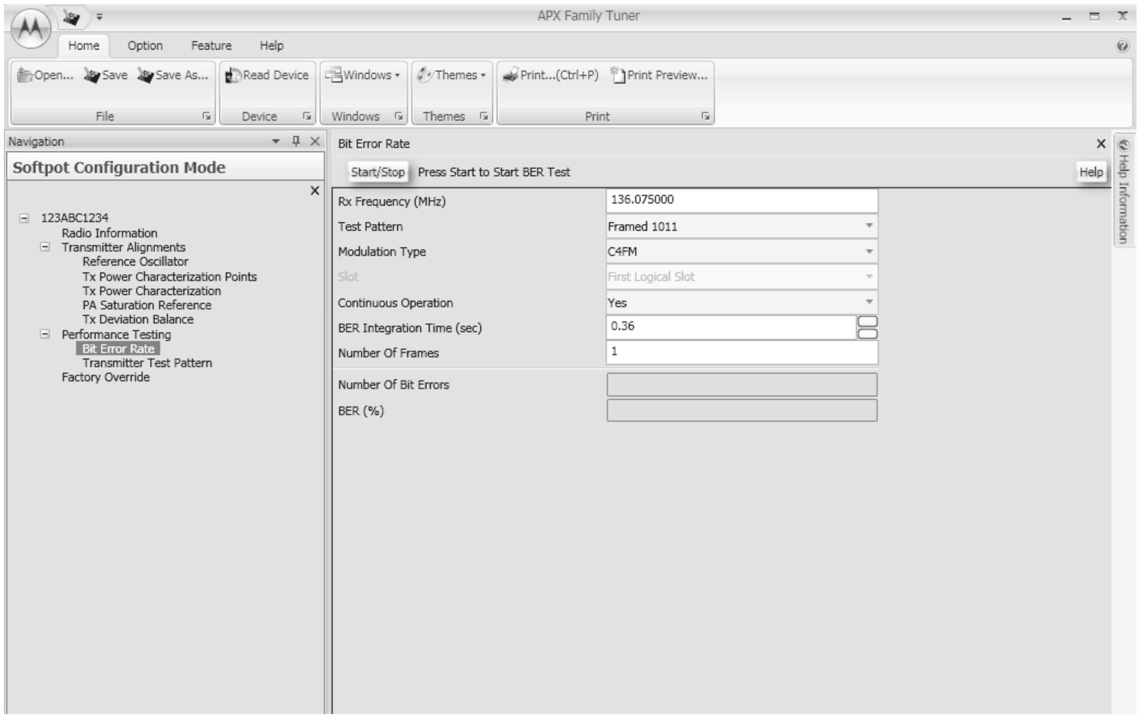

Figure 6-32. Bit Error Rate Screen (VHF)

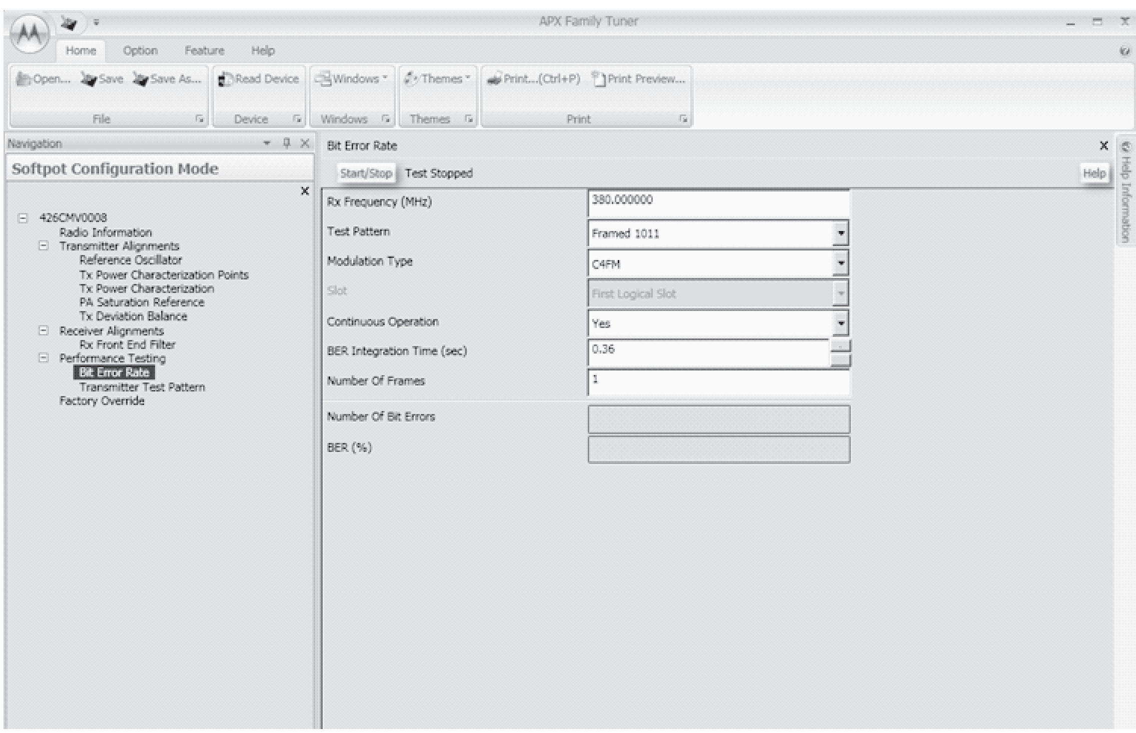

Figure 6-33. Bit Error Rate Screen (UHF1)

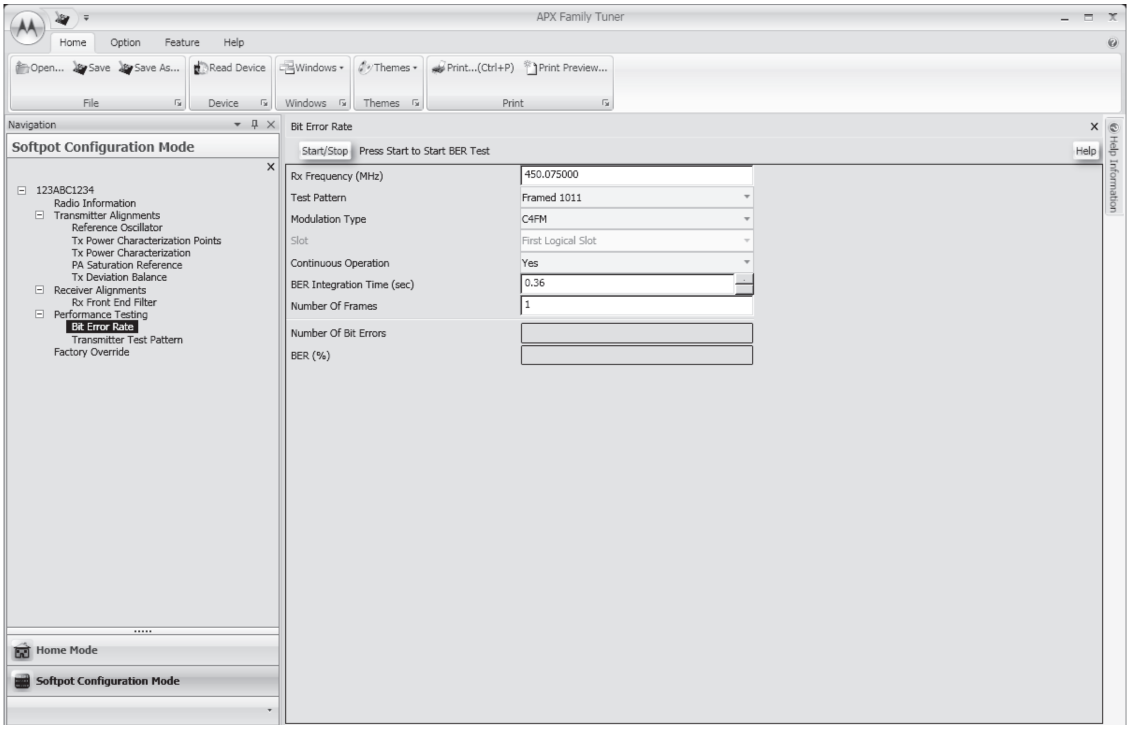

Figure 6-34. Bit Error Rate Screen (UHF2)

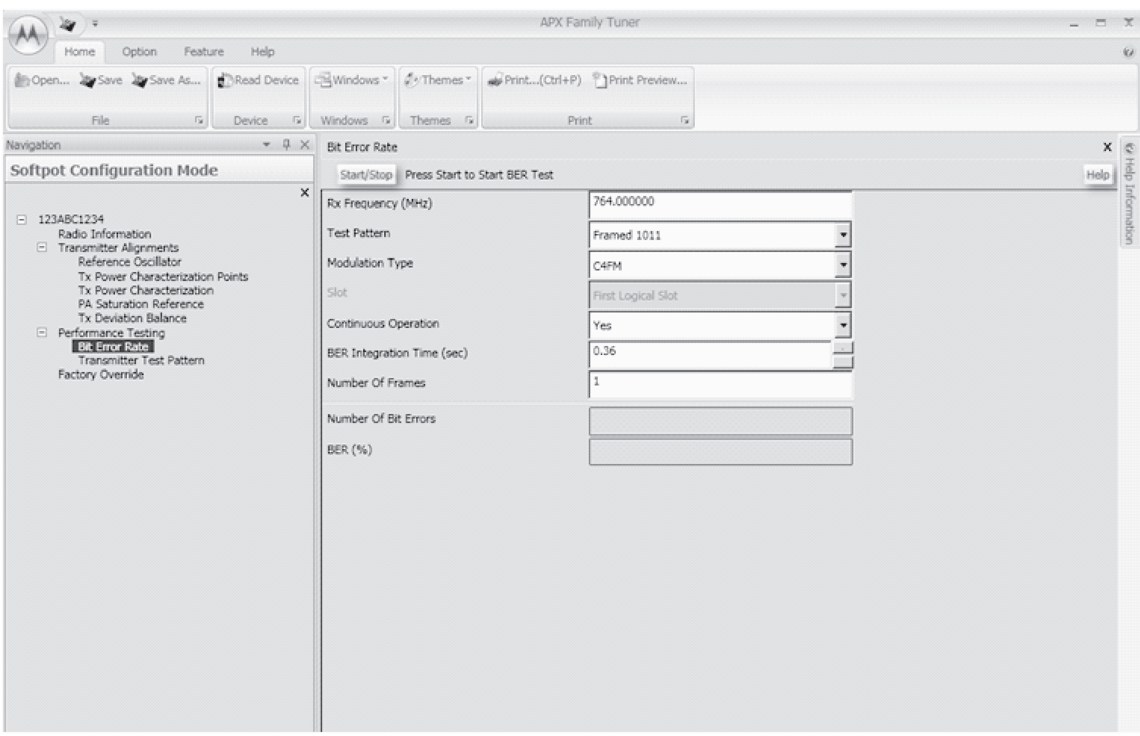

Figure 6-35. Bit Error Rate Screen (700/800 MHz)

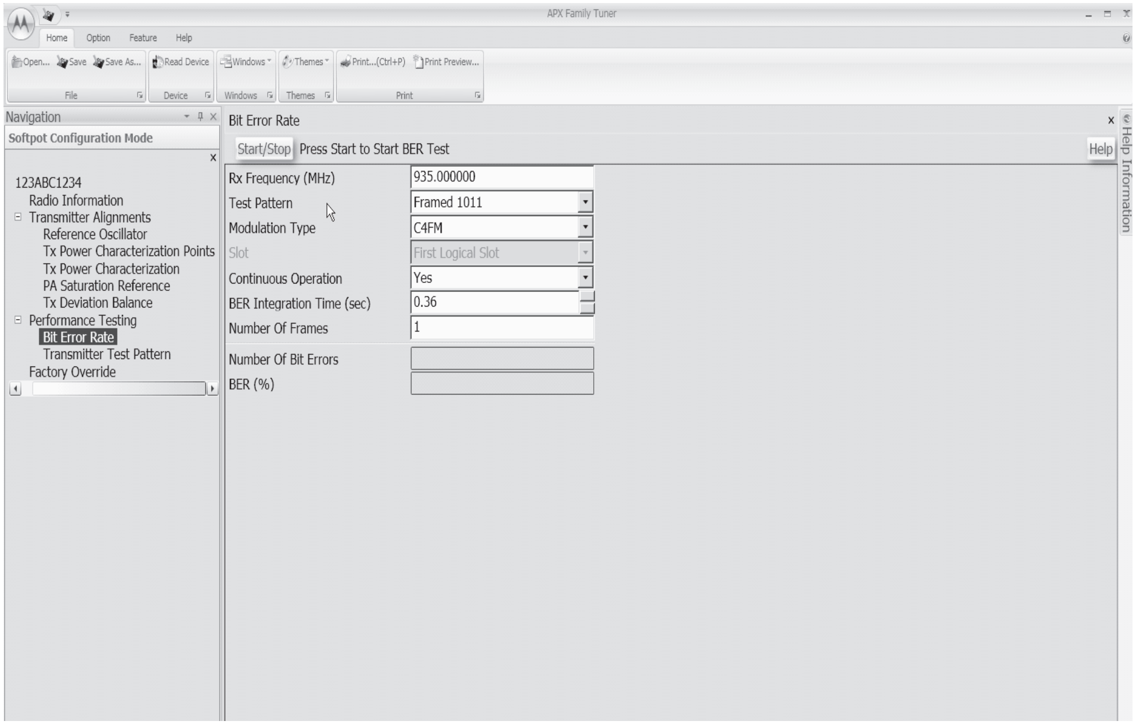

Figure 6-36. Bit Error Rate Screen (900 MHz)

6.7.2 Transmitter Test Pattern

The Transmitter Test Pattern test is used to transmit specific test patterns at a desired frequency so that the user can perform tests on the radio's transmitter (see Figure 6-37, Figure 6-38, Figure 6-39, Figure 6-40 and Figure 6-41).

6.7.2.1 Transmitter Test Fields

This screen contains the following fields:

- **Tx Frequency**:
  This field selects the Transmit Frequency directly in MHz.
- **Channel Spacing**:
  This field allows the user to select the desired transmit deviation in kHz.
- **Test Pattern Type**:
  This field represents the type of test pattern which will be transmitted by the radio when **PTT TOGGLE** button is pressed.

NOTE: Channel Spacing and Test Pattern Type fields will be grayed out while the radio is transmitting.

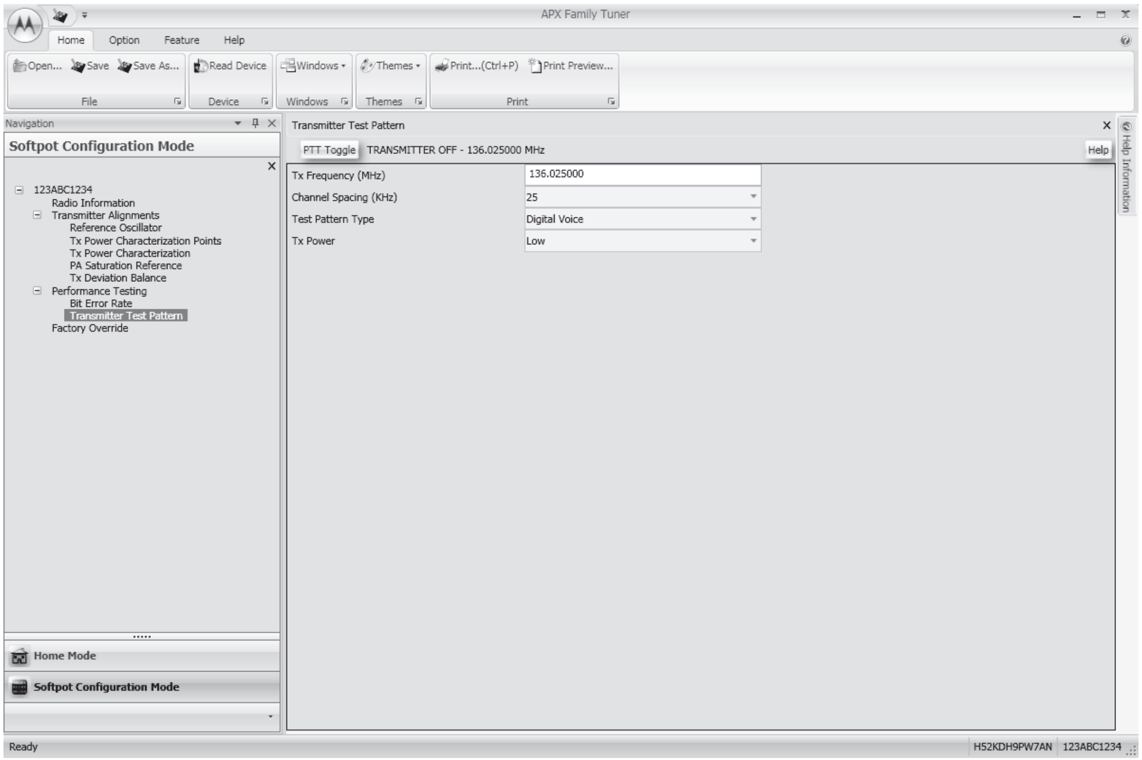

Figure 6-37. Transmitter Test Pattern Screen (VHF)

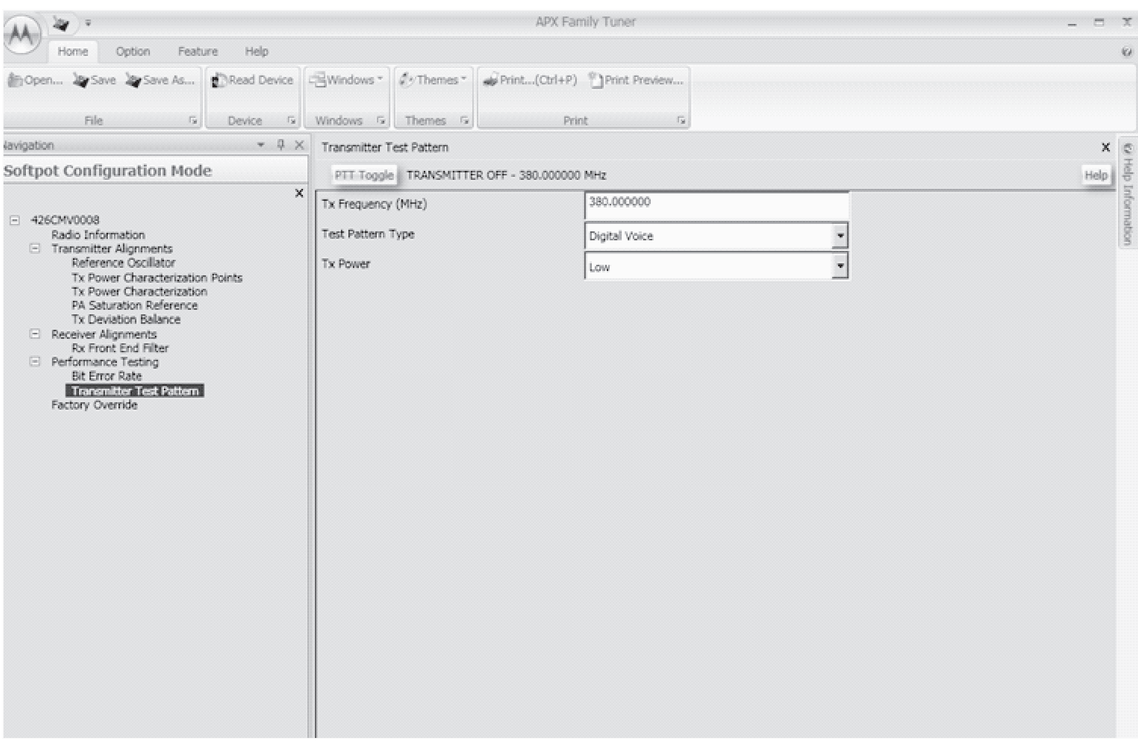

Figure 6-38. Transmitter Test Pattern Screen (UHF1)

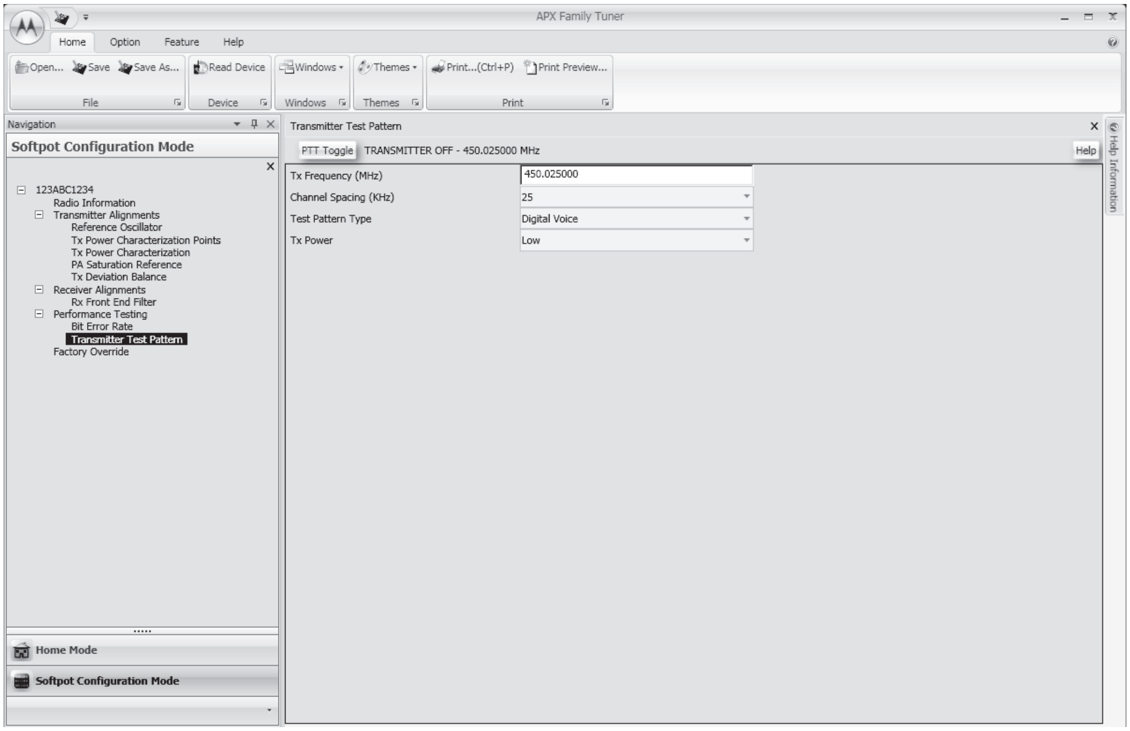

Figure 6-39. Transmitter Test Pattern Screen (UHF2)

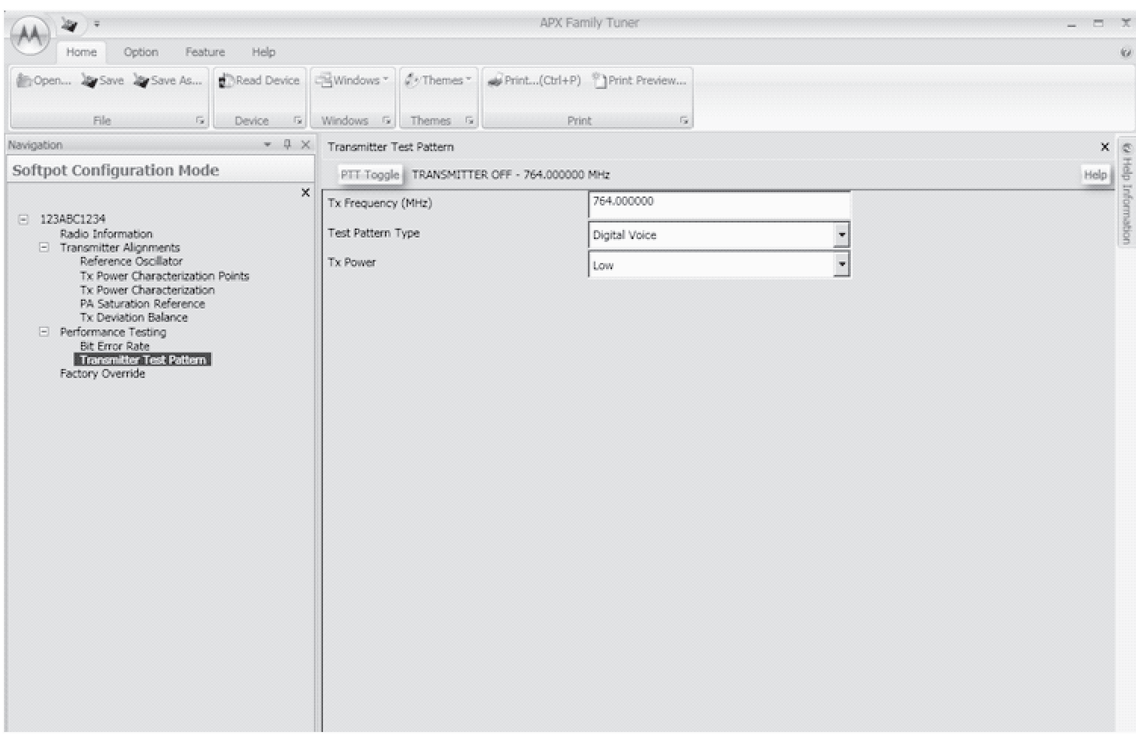

Figure 6-40. Transmitter Test Pattern Screen (700/800 MHz)

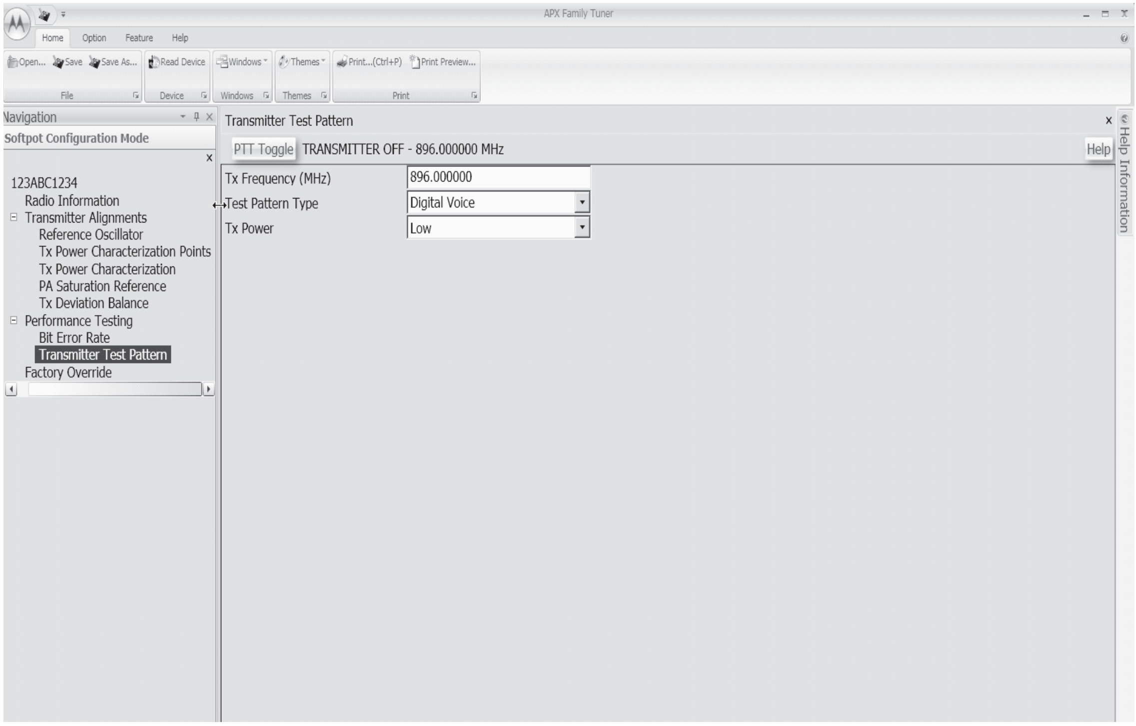

Figure 6-41. Transmitter Test Pattern Screen (900 MHz)

Chapter 7 Encryption

This chapter provides procedures for using the encryption capability of your radio. The following procedures are outlined:

- Loading an encryption key
- Selecting an encryption key
- Selecting an Index
- Erasing an encryption key

7.1 Load an Encryption Key

Keys will be loaded from the KVL to the radio in either clear or encrypted form depending on the configuration of the CPS parameter "KVL – FIPS Level 3 Approved Mode". If the parameter is disabled, keys will be sent in clear form; if the parameter is enabled, keys will be sent to the radio in encrypted form.

NOTE: A KVL3000 Plus with software version R03.52.45 or greater must be used to load keys to a radio with "KVL – FIPS Level 3 Approved Mode" enabled.

To load an encryption key:

1. Refer to the key-variable loader (KVL) manual for equipment connections and setup.
2. Attach the KVL to the radio. "KEYLOADING" is shown on the main display of a configured radio. All other radio functions, except for power down, backlight, and volume, are locked out.
3. Refer to the KVL manual for how to load the encryption keys into the radio.
4. When the key is loaded successfully, you will hear:
   - On single-key radios – a short tone.
   - On multikey radios – an alternating tone.

The secure kits for APX 2000/ APX 4000 are identified by the following kit numbers:

Table 7-1. Kit Numbers for Secure-Enabled Keypad Boards

Kit Number	Description
NNTN8314A	ADP KIT w/ Bluetooth M2
NNTN8313A	ADP w/ Bluetooth M3
NNTN8310A	ADP/DVP-XL w/ Bluetooth M2
NNTN8317A	ADP/DVP-XL KIT w/ Bluetooth M3
NNTN8311A	ADP/AES w/ Bluetooth M2
NNTN8316A	ADP/AES KIT w/Bluetooth M3
NNTN8312A	ADP/DES/DES-XL/DES-OFB KIT w/ Bluetooth M2
NNTN8315A	ADP/DES/DES-XL/DES-OFB KIT w/ Bluetooth M3

7.2 Multikey Feature

This feature allows the radio to be equipped with multiple encryption keys. It can support two or more encryption algorithms simultaneously (e.g., AES and DES-XL).

- **Conventional Multikey** – The encryption keys can be tied (strapped), on a one-per-channel basis. In addition, the radio can have operator-selectable keys, operator-selectable indices, and operator-selectable key erasure. If talkgroups are enabled in conventional, then the encryption keys are strapped to the talkgroups.
- **Trunked Multikey** – If the radio is used for both conventional and trunked applications, strap the encryption keys for trunking on a per- talkgroup or announcement group basis. In addition, a different key can be strapped to other features; for example, dynamic regrouping, failsoft, or emergency talkgroup. The radio can have operator-selectable key erasure.

7.3 Select an Encryption Key

You can select an encryption key using either the menu or the keypad.

7.3.1 Use the Menu

To select an encryption key using the menu:

1. Press ▶ until the display shows "Key".
2. Press (•), (••), or (•••) directly below "Key". The display shows the last user-selected and -stored encryption key.
3. Press ▲ or ▼ to scroll through the list of encryption keys.

   NOTE: If a deleted key is selected, "ERASED KEY" will be displayed.
4. Press (•), (••), or (•••) directly below the desired menu.
   - SEL = saves the newly selected key and returns to the home display.
5. Press 🏠, the **PTT** button, or (•), (••), or (•••) directly below "Exit", or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows "KEY FAIL" and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows "ILLEGAL KEY" and the radio sounds a momentary illegal key tone.

7.3.2 Use the Keypad

To select an encryption key using the keypad:

1. Press ▶ until the display shows "Key".
2. Press (•), (••), or (•••) directly below "Key". The display shows the last user-selected and -stored encryption key.
3. Using the keypad, enter the number of the desired key.

   NOTE: If a deleted key is selected, "ERASED KEY" will be displayed.

4. Press (•), (••), or (•••) directly below the desired menu.
   - SEL = saves the newly selected key and returns to the home display.
5. Press ⌂, the **PTT** button, or (•), (••), or (•••) directly below "Exit", or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows "KEY FAIL" and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows "ILLEGAL KEY" and the radio sounds a momentary illegal key tone.

7.4 Select an Encryption Index

This feature lets the user select one or more groups of several encryption keys from among the available keys stored in the radio. For example, the radio could have a group of three keys structured to one index, and another group of three different keys structured to another index. Changing indices makes the radio automatically switch from one set of keys to the other. Every channel to which one of the original keys was tied will now have the equivalent new key instead.

7.4.1 Use the Menu

To select an index using the menu:

1. Press ▶ until the display shows "KSet".
2. Press (•), (••), or (•••) directly below "KSet". The display shows the last user-selected and -stored index.
3. Press ▲ or ▼ to scroll through the list of encryption keys.

   NOTE: If a deleted key is selected, "ERASED KEY" will be displayed.

4. Press (•), (••), or (•••) directly below the desired menu.
   - SEL = saves the newly selected key and returns to the home display.
5. Press ⌂, the **PTT** button, or (•), (••), or (•••) directly below "Exit", or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows "KEY FAIL" and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows "ILLEGAL KEY" and the radio sounds a momentary illegal key tone.

7.4.2 Use the Keypad

To select an index using the keypad:

1. Press ▶ until the display shows “KSet”.
2. Press (•), (••), or (•••) directly below “KSet”. The display shows the last user-selected and -stored index.
3. Using the keypad, enter the number of the desired key.

   NOTE: If a deleted key is selected, “ERASED KEY” will be displayed.
4. Press (•), (••), or (•••) directly below the desired menu.
   - SEL = saves the newly selected key and returns to the home display.
5. Press ⌂, the **PTT** button, or (•), (••), or (•••) directly below “Exit”, or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows “KEY FAIL” and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows “ILLEGAL KEY” and the radio sounds a momentary illegal key tone.

7.5 Erase an Encryption Key

This section describes two methods for erasing an encryption key.

7.5.1 Method 1 – Key Zeroization (Multikey Only)

To zeroize an encryption key:

1. Press ▶ until the display shows “Eras”.
2. Press (•), (••), or (•••) directly below “Eras”. The display shows the last user-selected and -stored encryption key.
3. Press ▲ or ▼ to scroll through the list of encryption keys.
4. Select single encryption key or all encrytion keys deletion from the “OPTN” menu.
5. Press ⌂, the **PTT** button, or (•), (••), or (•••) directly below “Exit”, or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows “KEY FAIL” and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows “ILLEGAL KEY” and the radio sounds a momentary illegal key tone.

7.5.2 Method 2 – All Keys Erased

To erase all encryption keys at one time:

With the radio on, press and hold the **Top Side** button and, while holding this button down, press the **Top** button.

NOTE: **DO NOT** press the **Top** button before pressing the **Top Side** button unless you are in an emergency situation. This sends an emergency alarm.

Before the keys are erased, the display shows “PLEASE WAIT”.

When all the encryption keys have been erased, the display shows “ALL KEYS ERASED”.

Chapter 8 Disassembly/Reassembly Procedures

This chapter provides detailed procedures for disassembling/reassembling and ensuring submergibility of the APX 2000/ APX 4000/ APX 4000Li radios. When performing these procedures, refer to "Chapter 10: Exploded Views and Parts Lists" and the diagrams that accompany the text. Items in parentheses ( ) throughout this chapter refer to item numbers in the exploded view diagrams and their associated parts lists.

This chapter also has procedures for removing and installing the APX 2000/ APX 4000/ APX 4000Li radio's standard accessories.

8.1 APX 2000/ APX 4000/ APX 4000Li Exploded View (Main Subassemblies)

Caution

When servicing electronics, always ensure that you are properly grounded with antistatic grounding system approved for electronics handling.

This section contains the APX 2000/ APX 4000/ APX 4000Li radio partially exploded views.

NOTES:

- Refer to Figure 8-1, the Partial Exploded View, and Table 8-1, the Partial Exploded View Parts List.
- Letters in parentheses ( ) refer to item letters in Figure 8-1 and Table 8-1.

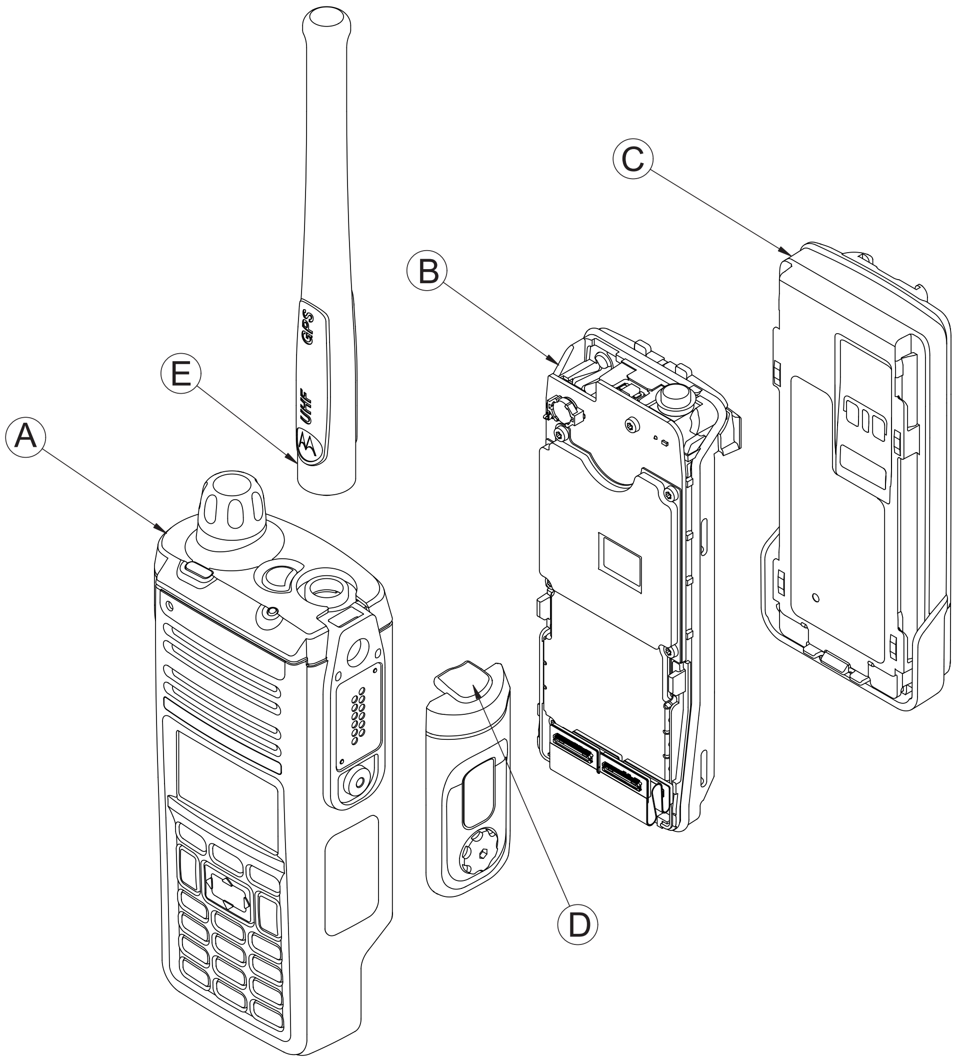

Figure 8-1. APX 2000/ APX 4000/ APX 4000Li Partial Exploded View

Table 8-1. APX 2000/ APX 4000/ APX 4000Li Partial Exploded View Parts List

Item Letter	Description	Exploded View and Parts List
A	Front Kit Assembly	Refer Figure 10-1.
B	Back Kit Assembly	Refer Figure 10-2.
C	Battery Assembly	Refer Figure 10-2.
D	Accessory-Connector Cover Assembly	Refer Figure 10-1.
E	Antenna Assembly	Refer Figure 10-1.

8.2 Required Tools and Supplies

Table 8-2. Required Tools and Supplies

Tools	Motorola Part Number	Supplier	Supplier Part Number	Remarks
Chassis Opener	66012028001	Motorola	–	To remove chassis from housing.
Bit, Torx T6	–	–	–	For speaker retainer, back kit (chassis) and keypad retainer.
Driver, Torque	–	–	–	–
Black stick	–	Hexacon Electric Co.	MA-800G	For keypad rubber mushroom rib assembly and disassembly.
Round stick	–	Brusia	BE-MO-14383	For microphone membrane assembly.
Allen wrench	–	–	–	To loosen accessory-connector cover thumb screw (if thumb screw is too tight).
Anti-static ground kit	–	–	–	To place radio and components during disassembly and reassembly.
Vacuum Pump kit	NLN9839	Motorola	–	For vacuum test. Requires 66012030001 Vacuum Test Fixture.
Vacuum Test Fixture	66012030001	Brusia	BE-MO-14512	To connect the vacuum/pressure hose of the Vacuum Pump Kit to the radio.
Vacuum Cup	66012040001	Brusia	PISCO VPC10RSE4B	To enhance sealing when the vacuum test fixture is connected to the radio.

8.3 Fastener Torque Chart

Table 8-3 lists the various fasteners by part number and description, followed by the torque values and the location where used. Torque all fasteners to the recommended value when assembling the radio.

Table 8-3. Required Tools and Supplies

Motorola Part Number	Description	Repair Torque (in-lbs)
0386104Z04	Speaker retainer and Chassis screw	3.0
0378212A02	Keypad Retainer screw	1.2
02012016001	Rotary Switch Spanner nut	4.5

8.4 Radio Disassembly

This section contains instructions for disassembling the radio's main subassemblies.

Prepare the radio for disassembly:

- Turn off the radio by pressing on the MFK (22) and hold the MFK (Multi Function Knob) until the radio display shows “Power off?”. Press the Menu Select button below and select Yes to power off.
- Remove the antenna, the battery, the Accessory-Connector cover (14), the Bottom Label (17) and any other accessory connected to the radio.

8.4.1 Remove Battery (48)

WARNING	**To avoid a possible explosion:** • **DO NOT charge, remove, or attach the battery in an area labeled “hazardous atmosphere.”** • **DO NOT discard batteries in a fire.**

Caution	If the radio is programmed for volatile-key retention, encryption keys will be retained for approximately 30 seconds after battery removal.

NOTE: The Motorola-approved battery shipped with the APX 2000/ APX 4000/ APX 4000Li radio is uncharged. Prior to using a new battery, charge it per the recommended procedure for the battery.

1. With the radio turned off, lift up the latch located at the bottom of the battery.

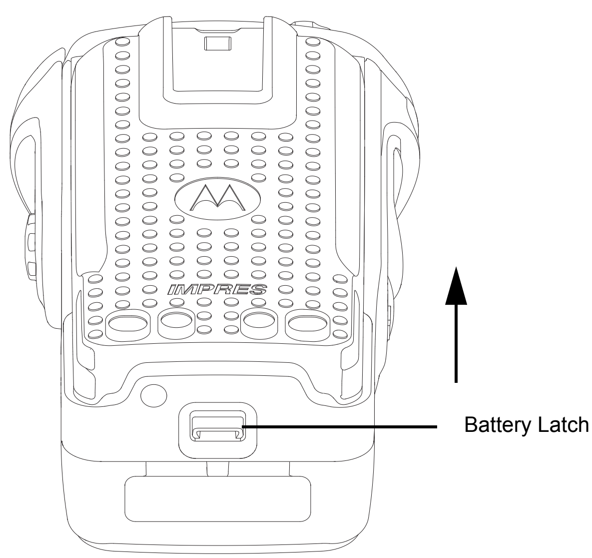

Figure 8-2. Lifting up the latch

2. While lifting the latch, remove the battery by sliding it out as shown.

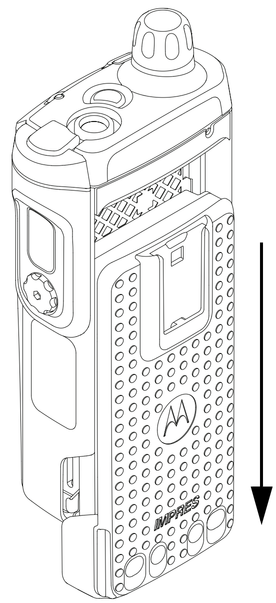

Figure 8-3. Removing the Battery

8.4.2 Remove Antenna (23)

1. With the radio turned off, turn the antenna counter-clockwise to remove it from the radio.

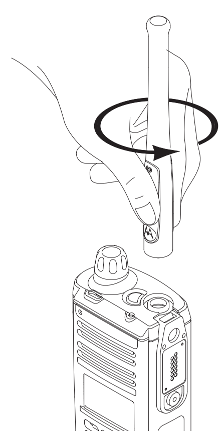

Figure 8-4. Removing the Antenna

8.4.3 Remove Multi Function Knob (22)

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis Opener, grasp the Multi Function Knob and pull it upward, until it is free from its shaft.

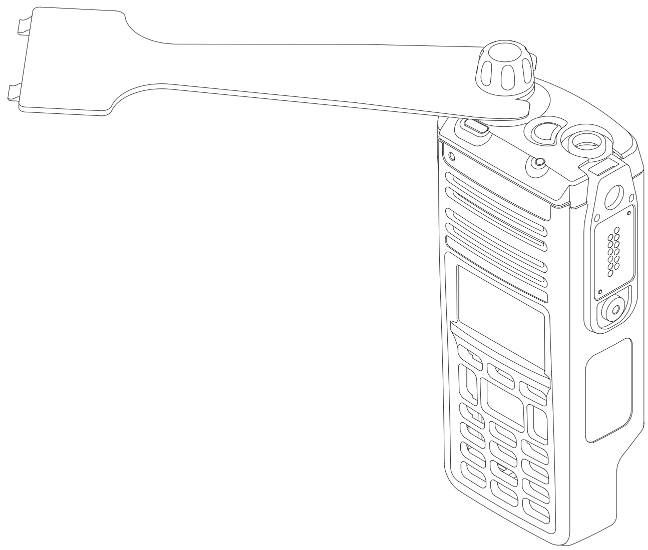

Figure 8-5. Removing the Multi Function Knob

8.4.4 Remove Accessory-Connector Cover (14)

Caution	When the accessory connector is not in use, keep it covered with the Accessory-Connector Cover.

1. Unscrew the thumb screw. If the screw is too tight, use an Allen wrench.

   NOTE: Do not remove the screw. It should remain captive in the cover.

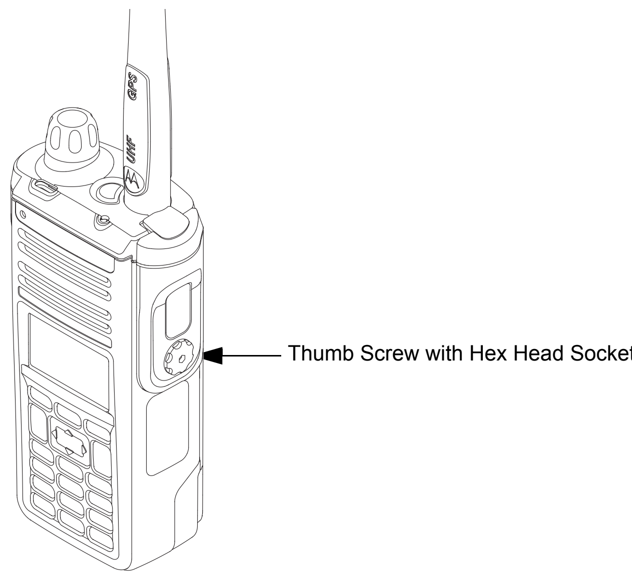

Figure 8-6. Removing the Thumb Screw

2. Slightly swing the Accessory-Connector Cover away from radio before sliding it upward to disengage the hook.
3. Pull the Accessory-Connector Cover away from the radio.

8.4.5 Removal of the Back Kit Assembly (B)

This section contains instructions for disassembling the radio.

8.4.5.1 Removal of the Chassis (41)

1. With the Battery removed, disengage the Chassis (41) using the Chassis Opener as shown in Figure 8-7.

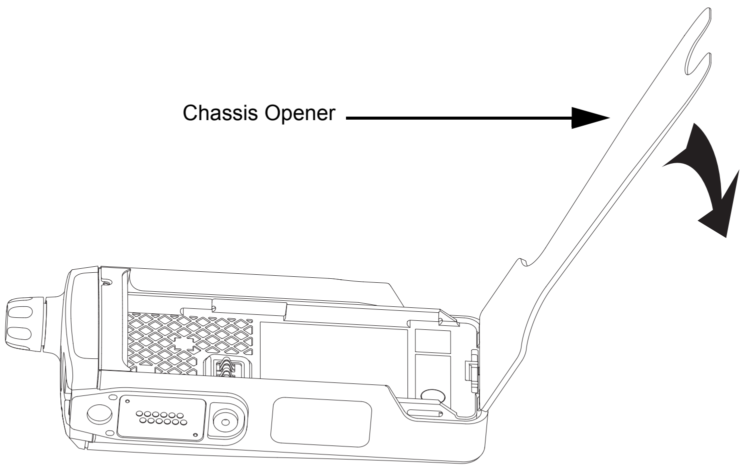

Figure 8-7. Disengage the Chassis

NOTE: The Vacuum Port seal (43) and the Ventilation Label (44) must be removed each time the Chassis is removed (for leak test).

2. After the Chassis (41) is disengaged, slide the chassis assembly down and lift it away from the Front Kit (A) and lay both sub-assemblies on the anti-static mat (part of anti-static ground kit) as shown in Figure 8-8.

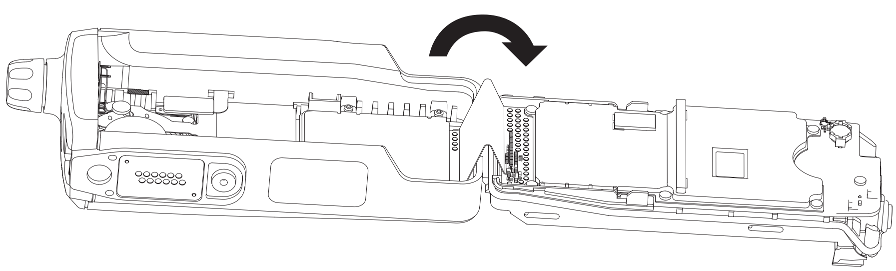

Figure 8-8. Remove the Chassis Assembly

8.4.5.2 Removal of the Secondary Shield Assembly (32)

1. Remove the chassis screws (30) as shown in Figure 8-9.

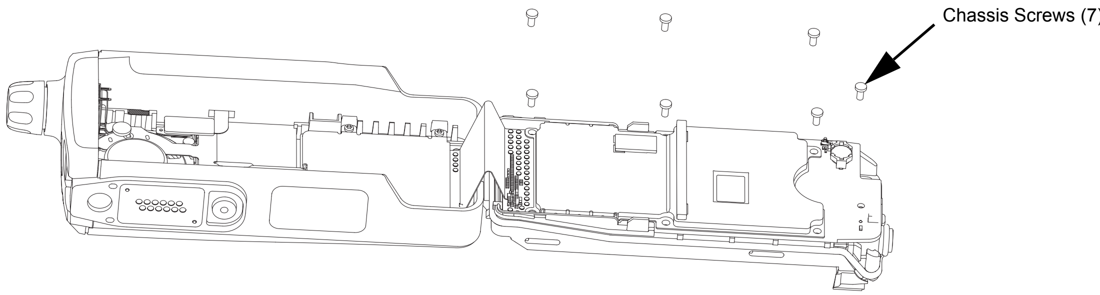

Figure 8-9. Remove the chassis screws

2. With the chassis screws removed, lift the Secondary Shield Assembly (32) out from the Chassis (41) as shown in Figure 8-10.

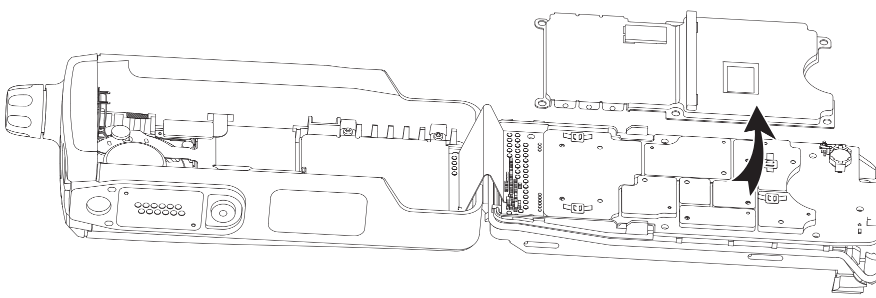

Figure 8-10. Remove the Secondary Shield Assembly

8.4.5.3 Removal of the Main Board(33)

1. Remove the Main O-Ring (36) at the antenna holder as shown in Figure 8-11.

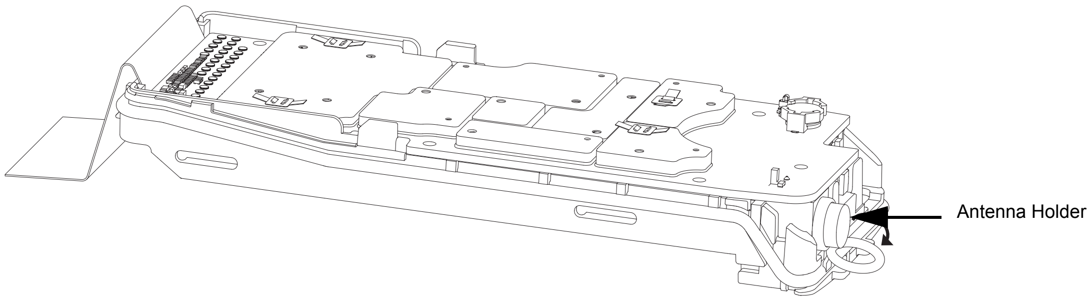

Figure 8-11. Remove the Main O-Ring at the antenna holder

2. Lift up the Main Board (33) from the Chassis (41) towards the Front Housing (16) and gently unplug the connectors from the Back Kit Flex (31) to remove the Main Board as shown in Figure 8-12. and Figure 8-13 respectively.

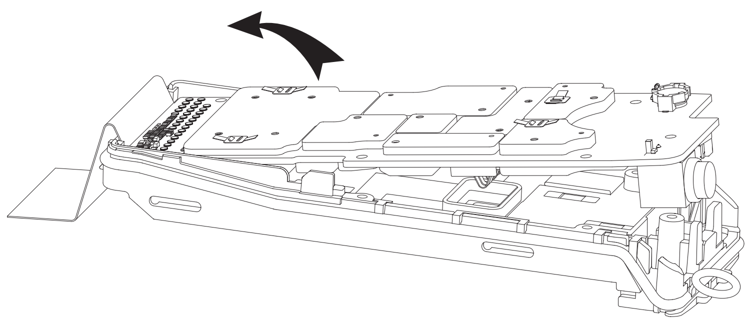

Figure 8-12. Lift up the Main Board from the Chassis

Caution	When separating the small interconnects, care is needed to avoid damage to the interconnect and surrounding on-board components.

Caution	Place the Main Board on the anti-static mat or in a clean and ESD safe area to avoid electrical damage to the electronics. Replace the Thermal Pad (10) whenever the Main Board is removed.

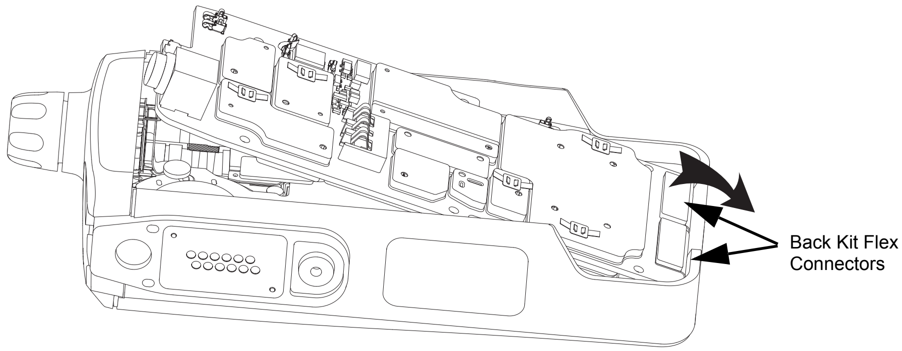

Figure 8-13. Unplug the Back Kit Flex connectors

8.4.5.4 Removal of the Shroud (47)

1. Place the black stick into the opening below the Shroud (47) to aid the disengagement of the Shroud. With the black stick still in place, slide the Shroud downwards at both sides to remove the Shroud from the Chassis (41).

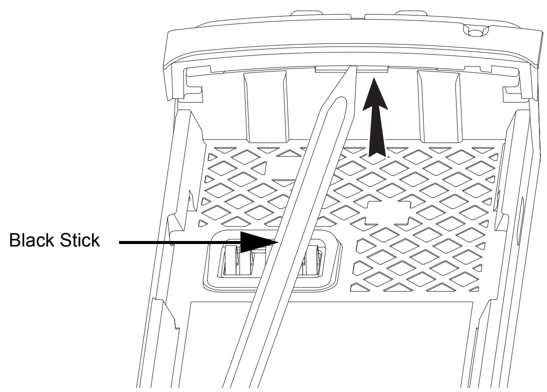

Figure 8-14. Disengage the Shroud

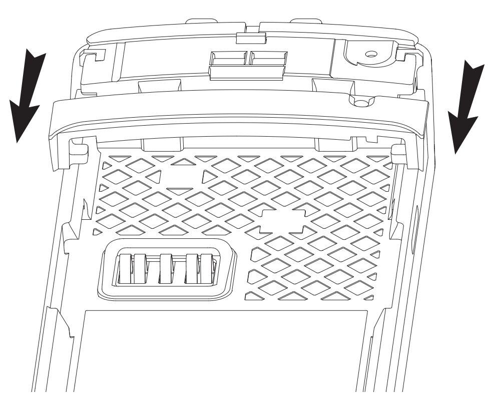

Figure 8-15. Remove the Shroud

8.4.5.5 Removal of the Keypad Retainer (28)

1. With the Back Kit Flex (34) connectors unplugged from the Main Board (33) as shown in Figure 8-13., remove the Keypad Retainer Screws (29) as shown in Figure 8-16.

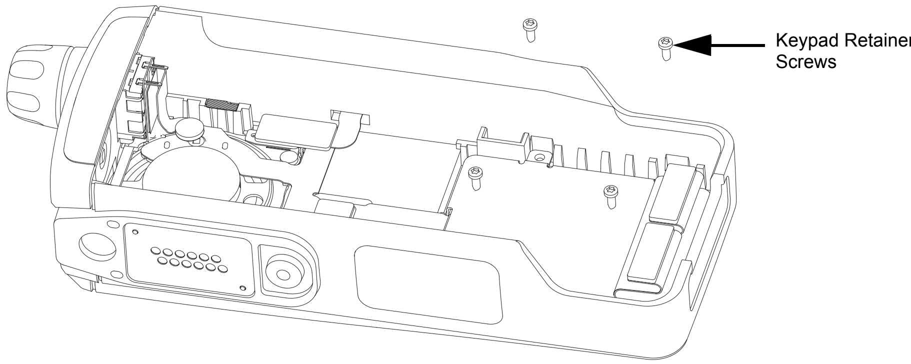

Figure 8-16. Remove the Keypad Retainer Screws

2. Lift out the Keypad Retainer (28) from the Front Housing (16) as shown in Figure 8-17.

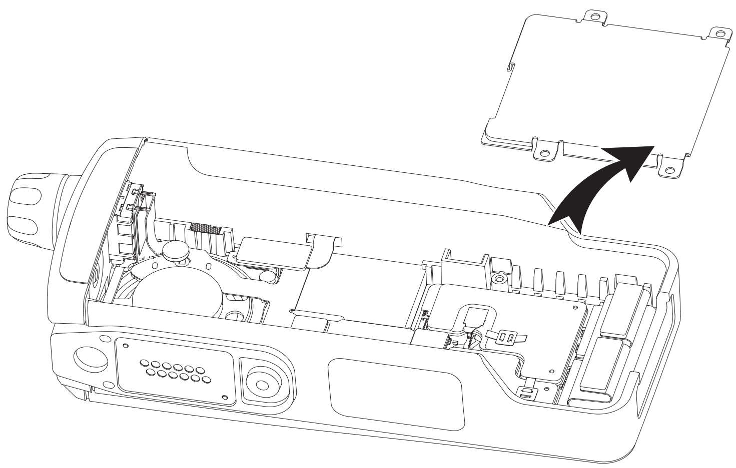

Figure 8-17. Remove the Keypad Retainer

8.4.5.6 Removal of the Keypad Board (27)

1. With the Keypad Retainer (28) removed, gently unplug the connectors of the Front Kit flex (2) and Back Kit Flex (31) to remove the Keypad Board (27) as shown in Figure 8-18.

Caution	When separating the flex and small interconnects, care is needed to avoid damage to the interconnect and surrounding on-board components

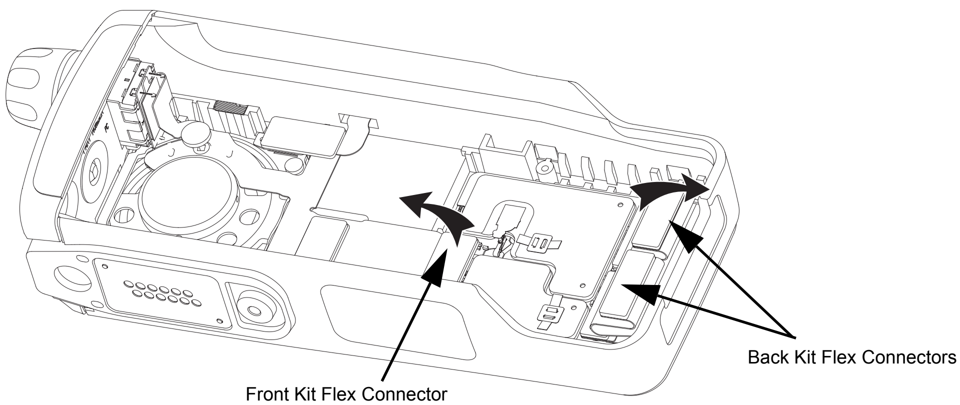

Figure 8-18. Unplug the Front Kit Flex and Back Kit Flex Connectors

2. With the connectors unplugged, gently lift the Keypad Board (27) out of the Front Housing (16) with the aid of the black stick as shown in Figure 8-18.

Caution	When lifting the Keypad Board with the black stick, care is needed to avoid piercing and damage to the Keypad.

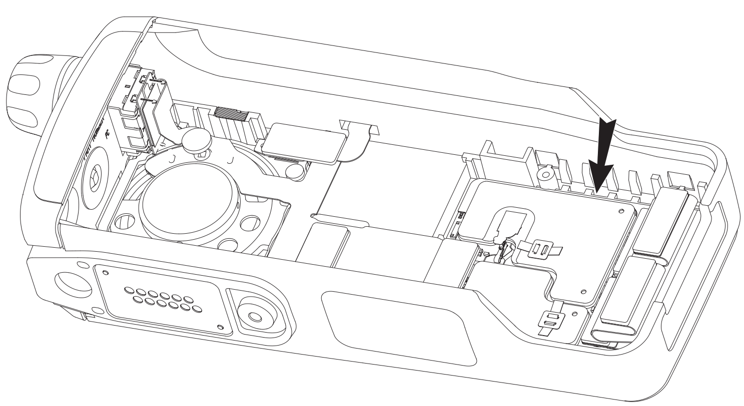

Figure 8-19. Remove the Keypad Board

8.4.5.7 Removal of the Keypad (25)

1. With the Keypad Board (27) removed, gently press the Keypad (25) from the front of the Front Housing (16) with fingers or with the aid of the back of the black stick to disengage the Keypad from the rib as shown in Figure 8-20.

Caution	When disengaging and removing the Keypad, care is needed to avoid tearing and damange to the Keypad.

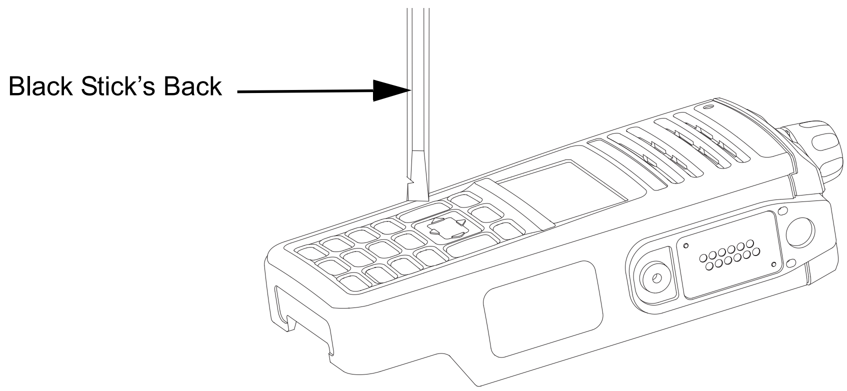

Figure 8-20. Disengage the Keypad

2. With the Keypad (25) disengaged from the rib, gently lift it out from the Front Housing (16).

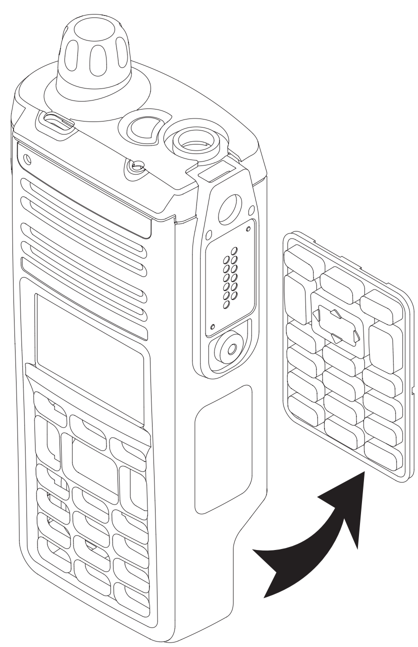

Figure 8-21. Remove the Keypad

8.4.6 Removal of the Front Kit Assembly (A)

1. Complete the steps in Section 8.4.5.1. and Section 8.4.5.5. through Section 8.4.5.7.
2. With the steps completed, the Front Kit Assembly (A) is obtained.

8.5 Serviceable Components of the Main Sub-Assemblies

8.5.1 Servicing Main Board Assembly

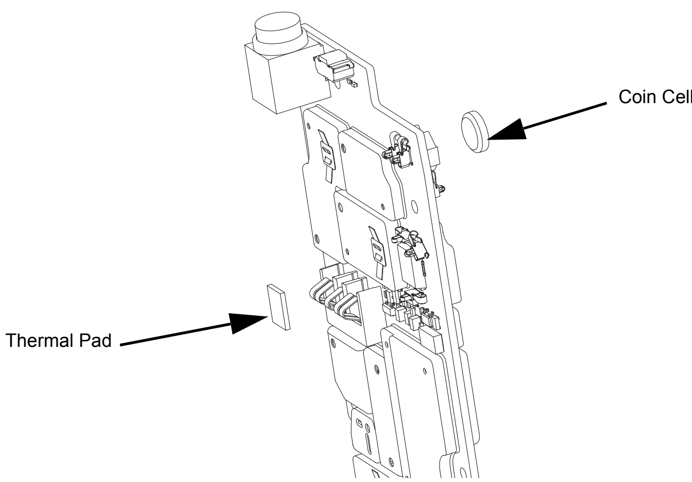

Figure 8-22. Serviceable Components – Main Board Assembly

8.5.1.1 Servicing Coin Cell:

1. Complete steps from Section 8.4.5.1. through Section 8.4.5.3.
2. Remove the coin cell with the Black Stick.

NOTE: Make sure the positive side is facing upwards.

3. Press the new coin cell into the battery carrier until it is secured and fully snapped into place.

8.5.1.2 Servicing Thermal Pad:

1. Complete steps from Section 8.4.5.1. through Section 8.4.5.3.
2. Carefully peel off the pad.
3. Ensure there is no debris or residue left on the amplifier's surface.
4. Replace with new Thermal Pad.
5. Peel the liner off the new pad and place in the respective location. Make sure the bottom surface of the pad is mating with the top surface of the amplifier.
6. Apply slight pressure to activate the adhesive.

Caution

Thermal pad should always be replaced when the Main board assembly is removed.

8.5.2 Servicing Chassis Assembly

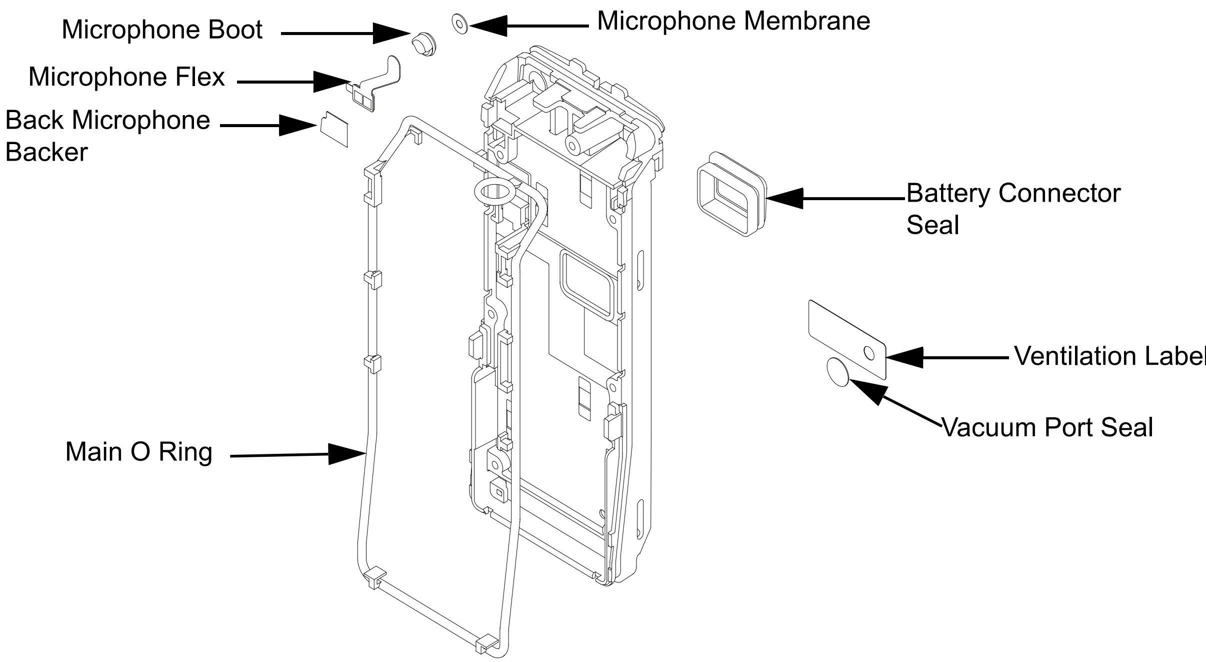

Figure 8-23. Serviceable Components – Chassis Assembly

8.5.2.1 Servicing Ventilation Label:

1. Complete steps in Section 8.4.
2. Carefully peel off the label.
3. Use the Black Stick to help remove any difficult sections of the label.
4. Clean the area once the label is removed to ensure it is free from adhesive and debris.
5. Peel the new label off its backer and place in the respective location.
6. Apply slight pressure to set the adhesive.

Caution

Ventilation label should always be replaced when back kit assembly is removed.

8.5.2.2 Servicing Vacuum Port Seal:

1. Complete steps in Section 8.4.
2. Carefully peel off the seal.
3. Use the Black Stick to help remove any difficult sections of the seal.
4. Clean the area once the seal is removed to ensure it is free of adhesive and debris.
5. Peel the new seal of its backer and place it in the respective location.
6. Apply slight pressure for approximately 30 seconds to activate the adhesive.

Caution

Vacuum port seal should always be replaced when back kit assembly is removed.

8.5.2.3 Servicing Battery Contact Seal:

1. Complete steps from Section 8.4.5.1. through Section 8.4.5.3.
2. Pinch the Battery Contact Seal inwards and remove it from the chassis opening.
3. Slot the new Battery Contact Seal until it is properly seated onto the Chassis surface.

8.5.2.4 Servicing Main O Ring:

1. Complete steps from Section 8.4.5.1. through Section 8.4.5.3.
2. Remove the Main O Ring with the aid of a Black Stick.
3. Replace the new Main O Ring into the groove provided in the Chassis.
4. Ensure that the seal is set properly and not stretched.

8.5.2.5 Servicing Microphone Boot:

NOTE: When servicing Microphone Boot, the Microphone Membrane part will also need to be replaced.

1. Gently remove the Back Microphone Backer (50) with the help of a Black Stick.
2. Carefully remove the microphone assembly out of the chassis opening.
3. With the aid of a Black Stick, dislodge the Microphone Boot and carefully slide out the microphone cartridge. Make sure the flex is not stretched. Ensure nothing comes in contact with the microphone while changing to a new Microphone Boot.
4. Press inward the new Microphone Boot to open up the clearance for the microphone assembly. Fit in the microphone cartridge. Make sure the flex is not stretched.
5. Ensure the microphone cartridge is seated properly within the Microphone Boot.
6. Ensure the Microphone Boot is correctly seated within the chassis opening.
7. Follow Section 8.5.2.6. (steps 4 to 6) to complete assembling and placing the Microphone Membrane.

8.5.2.6 Servicing Microphone Membrane:

1. Carefully remove the Microphone Membrane from the chassis opening using the Black Stick.
2. Use the pointed tip of the Black Stick to scrap off pieces of adhesives after removing the membrane.
3. Use a cotton bud dipped in IPA Cleaning Solvent to clean the area to remove remaining adhesive and debris.
4. Ensure the Microphone is seated properly within the Microphone Boot opening.
5. Remove the new Microphone Membrane from its backer.
6. Ensure that the area is dry (solvent fully evaporated) before carefully placing the new Microphone Membrane. The membrane needs to be centered on the surface of the microphone boss area on the Chassis. Ensure that the membrane is flat with no ripples or folds. Press down firmly, applying slight pressure to activate the adhesive using the Round Stick.
7. Ensure that the Microphone Boot is seated correctly within the chassis opening.
8. With the Microphone Boot seated in the chassis, carefully place the Back Microphone Backer (50) to cover the microphone opening.

8.5.3 Servicing Main Housing

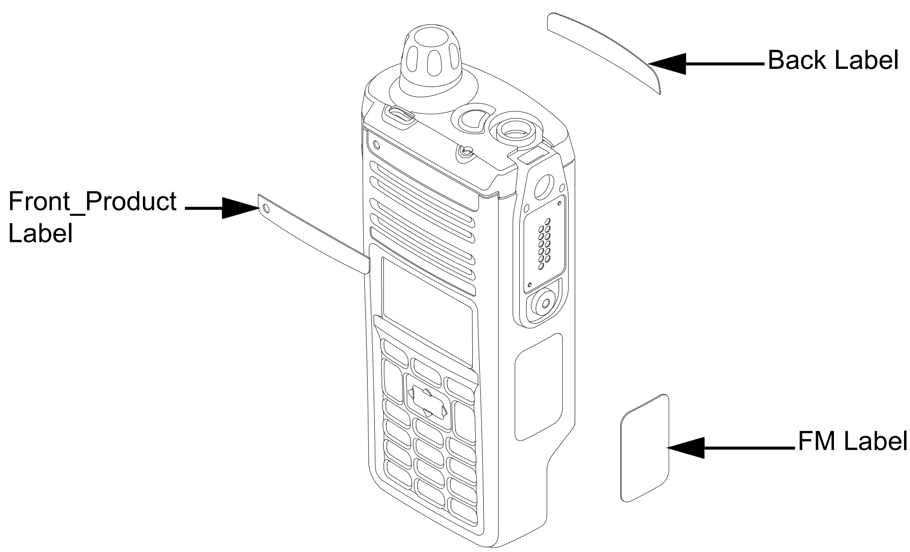

Figure 8-24. Serviceable Components – Main Housing

8.5.3.1 Servicing Front_Product Label

NOTE: There is no need to remove any component in order to service the Front_Product Label.

1. Scrap off the Front_Product Label with the Black Stick.
2. Clean the area once the Front_Product Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the label.

8.5.3.2 Servicing Back Label

NOTE: There is no need to remove any component in order to service the Back Label.

1. Scrap off the Back Label with the Black Stick.
2. Clean the area once the Back Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the label.

8.5.3.3 Servicing FM Label

NOTE: There is no need to remove any component in order to service the FM Label.

1. Scrap off the FM Label with the Black Stick.
2. Clean the area once the FM Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the label.

Caution

Refer to qualified service personnel and service shops to service the FM Label.

8.5.4 Servicing Multi Function Knob

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis Opener, grasp the Multi Function Knob and pull it upward, until it is free from its shaft.
3. Replace the knob with a new one by aligning the D-shaped part of the shaft with the D-shaped hole on the Multi Function Knob. Press the knob into place.

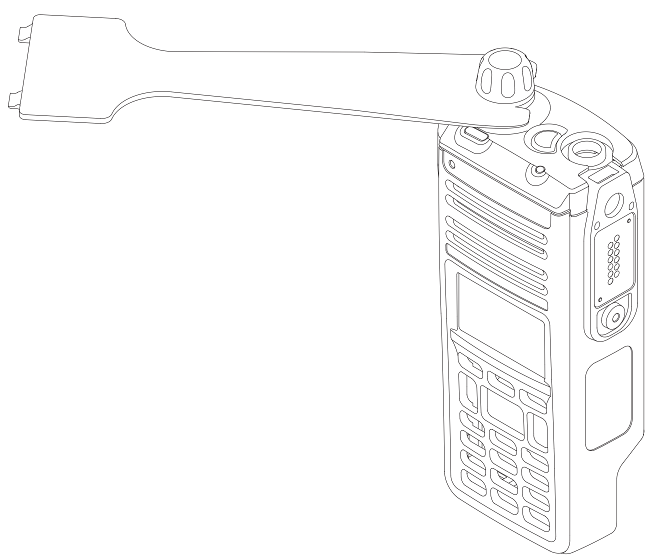

Figure 8-25. Servicing the Multi Function Knob

8.6 Radio Reassembly

This section contains instructions for reassembling the radio.

8.6.1 Reassemble the Main Board (33)

1. Plug in the connectors of the Back Kit Flex (31) onto the Main Board (33). With the Back Kit Flex connected to the Main Board, place the Main Board into the Chassis (41) as shown in Figure 8-26.

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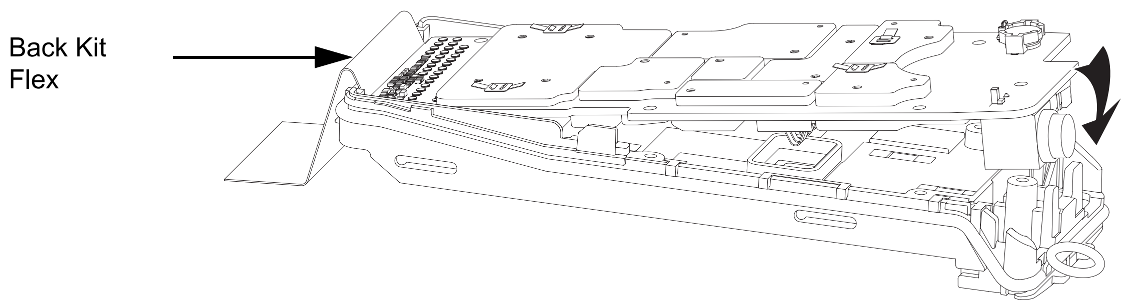

Figure 8-26. Assemble the RF Board

NOTE: Plug in the connectors at the side of the Back Kit Flex which reads “To Main Board”. Ensure that the Battery Contact Seal (42) does not pinch and the tabs of the Main O-Ring are held in place when assembling the Main Board into the Chassis.

2. With the Main Board (33) seated in the Chassis (41), gently assemble the Main O-Ring (36) to the Antenna Holder as shown in Figure 8-28.

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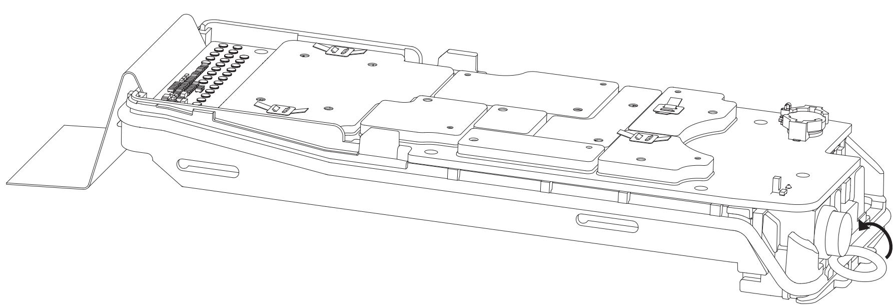

Figure 8-27. Assemble the Main O-Ring at Antenna Holder

8.6.2 Reassemble the Secondary Shield Assembly (32)

1. With the Main Board (33) assembled, place the Secondary Shield Assembly (32) onto the Main Board.

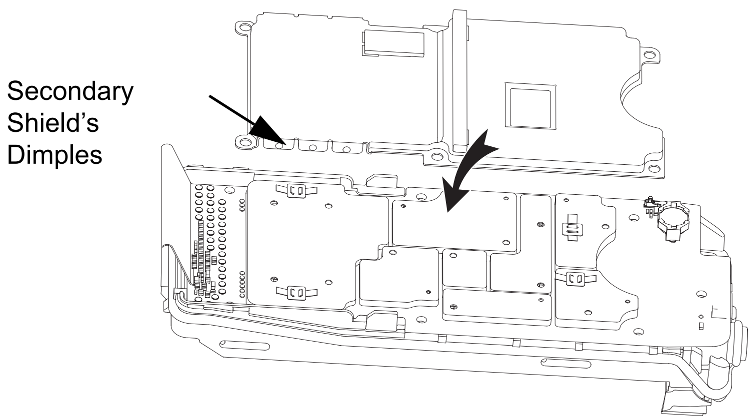

Figure 8-28. Assemble the Secondary Shield Assembly

2. Torque all seven Chassis Screws (30) with a Torx IP6 Bit and a Torque Driver to 3.0 in-lbf in the sequence as shown in Figure 8-29.

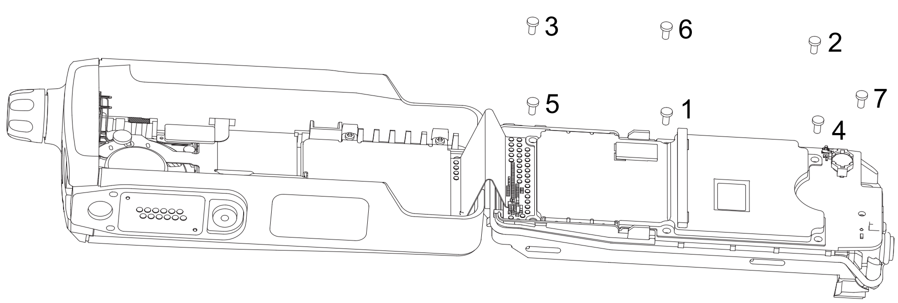

Figure 8-29. Torque in the Chassis Screws

8.6.3 Reassemble the Keypad (25)

NOTE: Please order keypad with required language.

1. Place the Keypad (25) into the Front Housing (16) and gently flush the mushroom rib at the edges of the Keypad into the Front Housing with the aid of the back of the Black Stick.

Caution	When flushing the Keypad, care is needed to avoid damage to the Keypad. Ensure that the Keypad is fully flushed to prevent leakage.

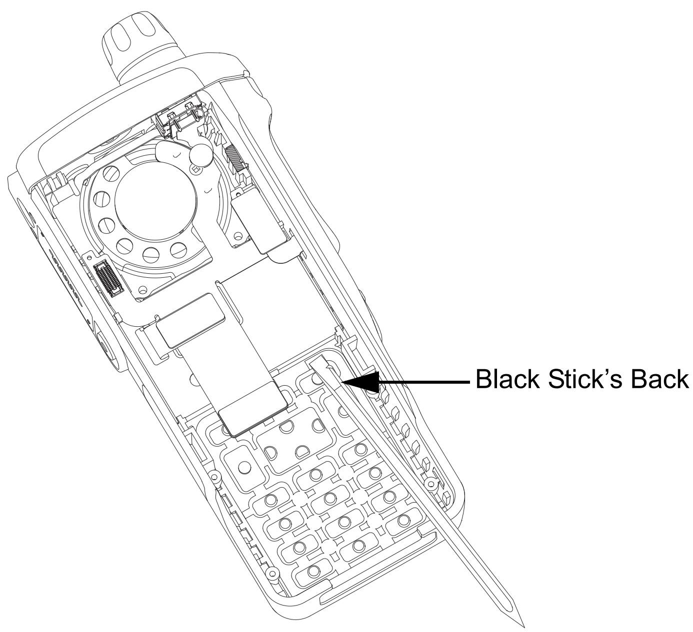

Figure 8-30. Assemble the Keypad

8.6.4 Reassemble the Keypad Board (27)

1. With the Keypad (25) assembled, place the Keypad Board (27) into the Front Housing (16).
2. Plug in the connector of the Front Kit Flex (2) as shown in Figure 8-32.

Caution	When plugging in the connectors, care is needed to avoid damage to the interconnect and surrounding on-board components.

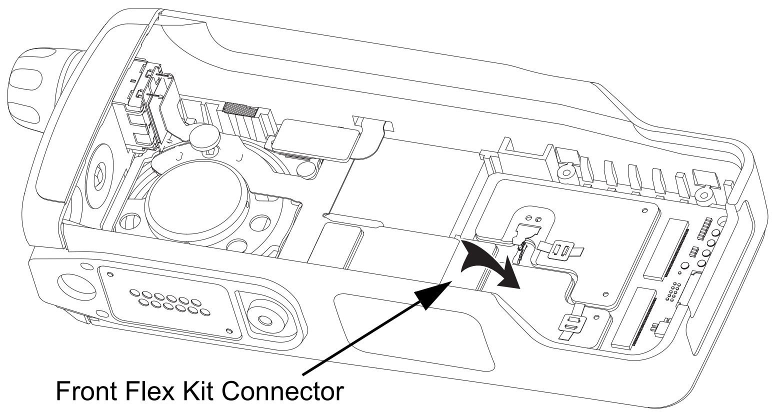

Figure 8-31. Plug in the Front Kit Flex Connector

3. Complete steps in Section 8.6.1. through Section 8.6.3.
4. Gently plug in the connectors of the Back Kit Flex (31) to the Keypad Board as shown in Figure 8-32.

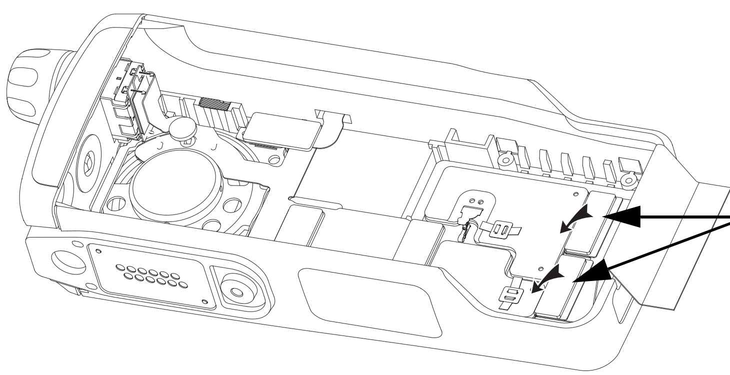

Figure 8-32. Plug in the Back Kit Flex Connectors

NOTE: Plug in the connectors at the side of the Back Kit Flex which reads “To Keypad Board”.

8.6.5 Reassemble the Keypad Retainer (28)

1. Place the Keypad Retainer (28) over the Keypad Board (27) in the Front Housing (16) as shown in Figure 8-33.

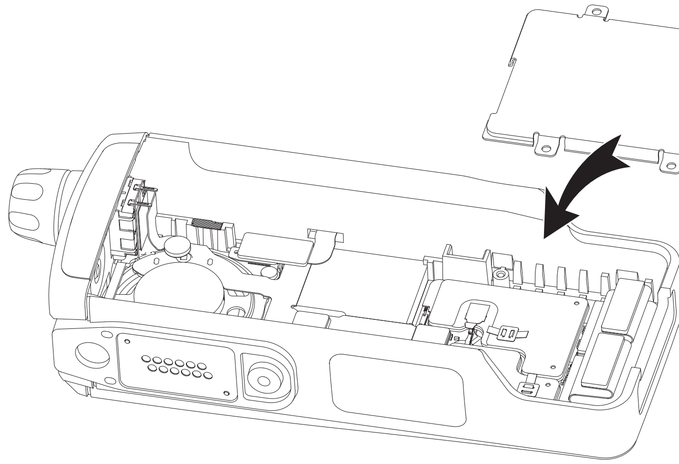

Figure 8-33. Place Keypad Retainer over the Keypad Board

2. Torque all four keypad retainer screws (29) with a Torx IP6 Bit and a Torque Driver to 1.2 in-lbf in the sequence as shown in Figure 8-34.

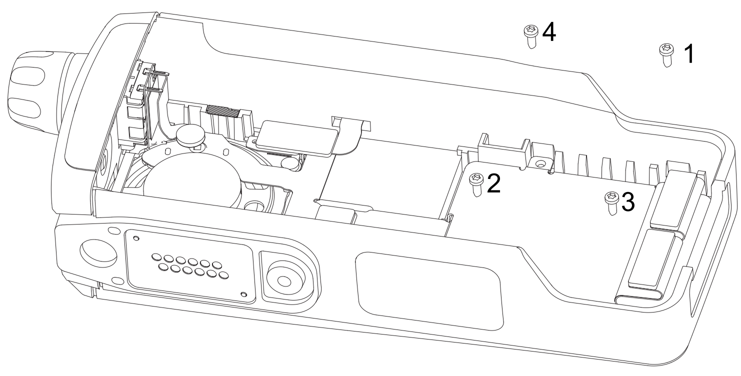

Figure 8-34. Torque in the Keypad Retainer Screws

8.6.6 Reassemble the Shroud (47)

1. Slide the Shroud (47) into the Chassis' frame until the latch clicks into place as shown in Figure 8-35.

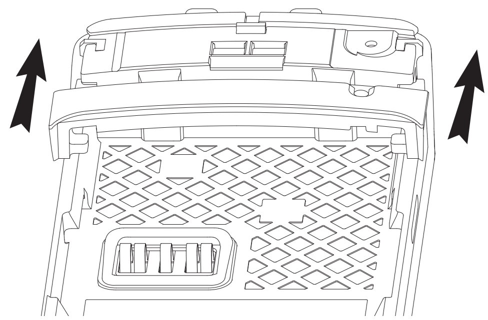

Figure 8-35. Assemble the Shroud

8.6.7 Reassemble the Main Subassemblies (A and B)

1. Complete the steps in Section 8.6.1. through Section 8.6.5.
2. Slide the Chassis assembly into the Front Housing as shown in Figure 8-36.

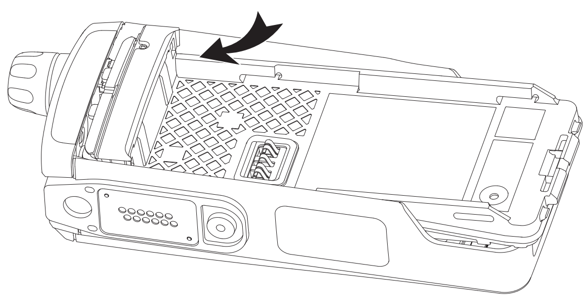

Figure 8-36. Slide chassis assembly into Front Housing

3. With the Chassis assembly fully slided in, press down the bottom part of the Chassis to lock the two subassemblies (A and B) together as shown in Figure 8-37.

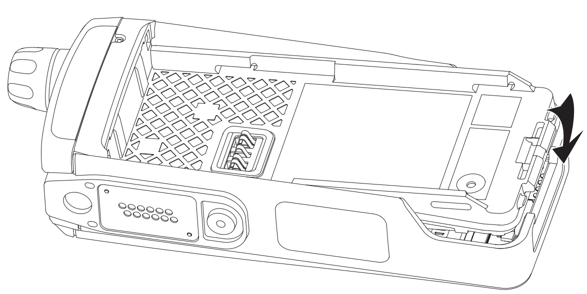

Figure 8-37. Assemble Back Kit and Front Kit together

8.6.8 Reassemble the Accessory-Connector Cover (14)

1. Insert the hooked end of the cover into the pocket. Engage the hook beneath the undercut and swing the cover down onto the radio. Ensure the cover is seated properly and the screw is aligned into the threaded hole.

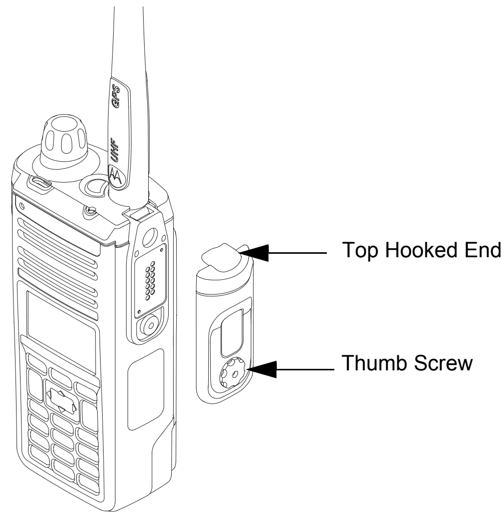

Figure 8-38. Engaging Hook and Seating Cover

2. Hand tighten the thumb screw clockwise until secured.

   NOTE: Do not overtighten the screw. The screw should be snugged and does not allow the cover to move.

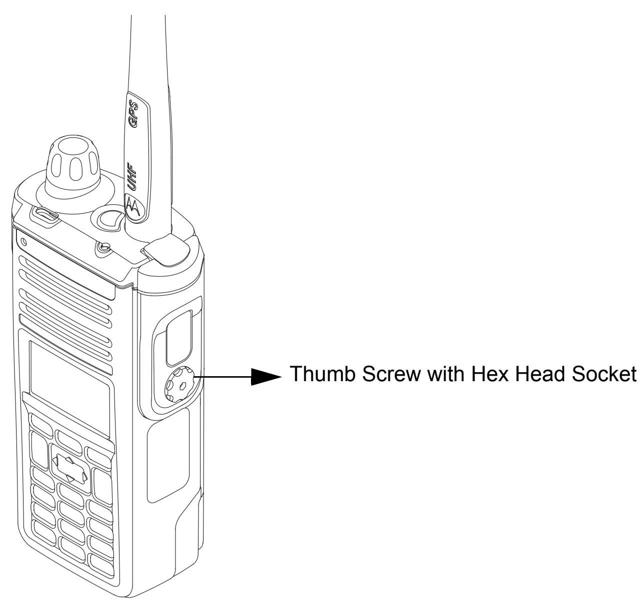

Figure 8-39. Securing the Cover

8.6.9 Reassemble Multi Function Knob (22)

1. Align the D-shaped part of the shaft with the D-shaped hole on the Multi Function knob. Press the knob into place.

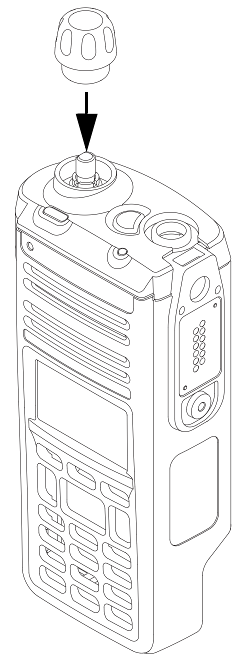

Figure 8-40. Reassemble the Multi Function Knob

8.6.10 Reassemble the Antenna (23)

1. With the radio turned off, turn the antenna clockwise to attach it to the radio.

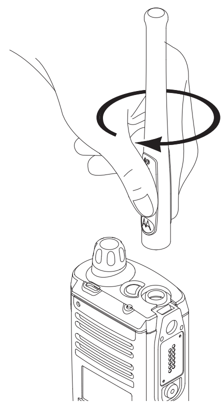

Figure 8-41. Attaching the Antenna

8.6.11 Reassemble the Vacuum Port Seal (43), Ventilation Label (44) and Bottom Label (17)

1. Adhere and gently press the Vacuum Port Seal (43) on the chassis' recess as shown in Figure 8-42. Press the Vacuum Port Seal (43) for 30 seconds.

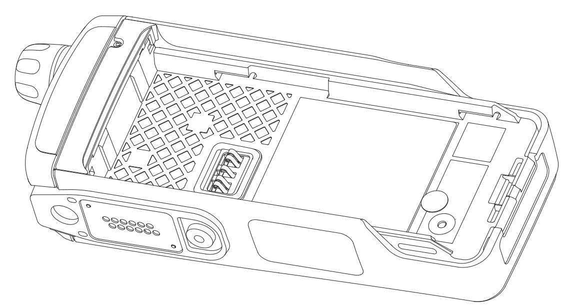

Figure 8-42. Assemble the Vacuum Port Seal

2. With the Vacuum Port Seal assembled, adhere the Ventilation Label (44) on the chassis' recess as shown in Figure 8-44. Press the Ventilation Label (Port Seal area) (44) for 10 seconds.

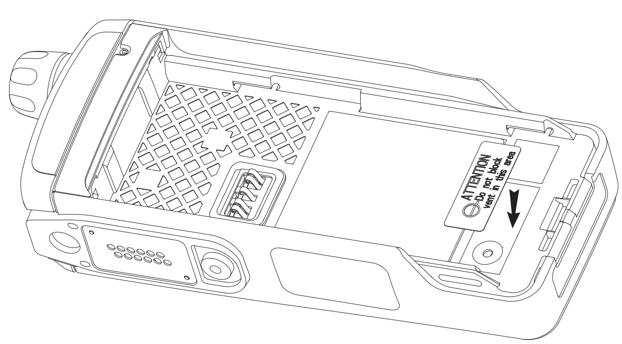

Figure 8-43. Assemble the Ventilation Label

3. Adhere the Bottom Label (17) on the recess at the bottom of the Front Housing as shown in Figure 8-44.

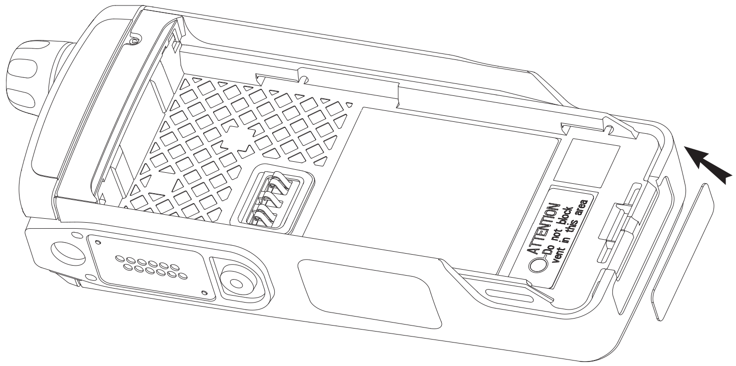

Figure 8-44. Assemble the Bottom Label

8.6.12 Reassemble the Battery (48)

1. With the radio turned off, slide up the battery into the radio's frame until the bottom latch clicks into place as shown in Figure 8-45.

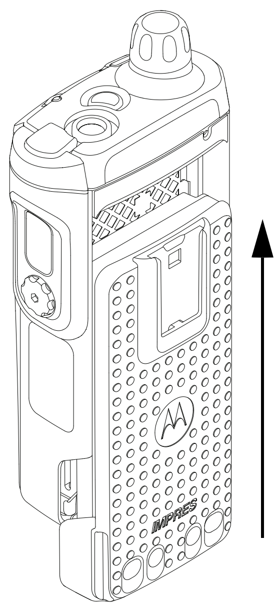

Figure 8-45. Attaching Battery – Slide into Position

8.7 Ensuring Radio Submergibility

This section discusses radio submergibility concerns, tests, and disassembly and reassembly of ASTRO APX 2000/ APX 4000/ APX 4000Li radios.

8.7.1 Standards

ASTRO APX 2000/ APX 4000/ APX 4000Li radio models meet the stringent requirements of IP67, which require the radio to maintain watertight integrity when immersed in one (1) metre water for 30 minutes.

8.7.2 Servicing

APX 2000/ APX 4000/ APX 4000Li radios shipped from the Motorola factory have passed vacuum testing and should not be disassembled. If disassembly is necessary, refer to qualified service personnel and service shops capable of restoring the watertight integrity of the radio.

Caution

It is strongly recommended that maintenance of the radio be deferred to qualified service personnel and service shops. This is of paramount importance as irreparable damage to the radio can result from service by unauthorized persons. If disassembly is necessary, unauthorized attempts to repair the radio may void any existing warranties or extended performance agreements with Motorola. It is also recommended that submergibility be checked annually by qualified service personnel.

8.7.3 Water Exposure

If the radio is exposed to water, shake the radio to remove the excess water from the speaker grille and microphone ports areas before operating; otherwise, the sound may be distorted until the water has evaporated, or is dislodged from these areas.

8.7.4 Specialized Test Equipment

This section summarizes the specialized test equipment necessary for testing the integrity of ASTRO APX 2000/ APX 4000/ APX 4000Li radios.

To ensure that the radio is truly a watertight unit, special testing, test procedures, and specialized test equipment are required. The special testing involves a vacuum check of the radio and pressure testing (troubleshooting) for water leaks if the vacuum check fails. The specialized test equipment is needed to perform the vacuum check and pressure testing, if required.

8.7.4.1 Vacuum Pump Kit NLN9839_

The Vacuum Pump Kit includes a Vacuum Pump with gauge and a Vacuum Hose. The Vacuum Test Fixture (p/n 66012030001) which connects the vacuum pump to the radio, must be ordered separately.

8.7.5 Disassembly

Disassemble the radio according to Section 8.4.

8.7.6 Reassembly

Caution	Do not reassemble the radio without first performing the following preliminary inspection procedure.

To reassemble the radio:

1. Inspect the Main O-Ringon the Chassis (41) for any damage or foreign material.
2. Inspect the Battery Contact Seal (42) on the Main Board Assembly (41) for any damage.
3. Inspect the mating seal surfaces on the Chassis (41) for all of the above seals for damage or foreign material that might prevent the seals from sealing properly.

Continue reassembling the radio according to Section 8.6. Tighten all hardware that was loosened or removed.

8.7.7 Vacuum Test

The Vacuum Test uses a Vacuum Pump to create a negative pressure condition inside the radio. The gauge measures this pressure and is used to Monitor any pressure changes in the radio. A properly sealed, watertight radio should have minimal change in pressure during the test.

Before starting the vacuum test:

- Remove the battery and antenna.
- Remove the Vacuum Port Seal (43) and Ventilation Label (44) that cover the Vacuum port.

NOTE: Refer to the exploded view diagrams and parts lists found in "Chapter 10: Exploded Views and Parts Lists".

8.7.7.1 Vacuum Tool Setup

1. Attach one end of the hose to the Vacuum Pump. Attach the other side of the hose to the Vacuum Test Fixture (66012030001)
2. Tool Leak Test:
   - i. Block the open end of the Vacuum Test Fixture.
   - ii. Pull the knob on the Vacuum Pump to create vacuum.
   - iii. Pump at least 15 inHg.
   - iv. Watch the gauge for a minute. If there is any loss of vacuum, repair or replace the tool.
3. Ensure that the seal is attached to the Vacuum Test Fixture.

NOTE: The actual reading of the gauge at this point is not important; it is important that the gauge pointer remained steady, indicating that there are no vacuum leaks in the pump.

8.7.7.2 Test Procedure

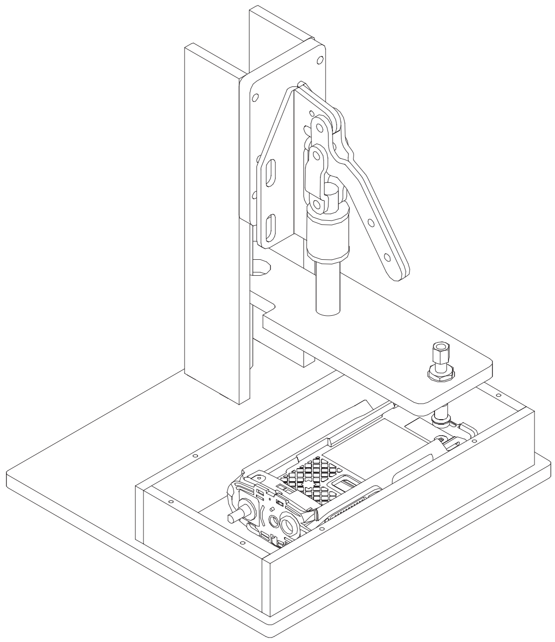

Figure 8-46. Attaching Vacuum Test Fixture

1. Place the radio in the vacuum test fixture. Ensure the radio position is lay perfectly into the mold.
2. Pull the knob on the Vacuum Pump to create vacuum. The vacuum test pressure should be 6.6 inHg.

Caution

Ensure that the vacuum pressure NEVER exceeds 7 inHg. The radio has pressure sensitive components that can be damaged if the pressure exceeds this limit.

3. Observe the gauge for approximately 2 minutes.
   - If the needle falls less than 0.5 inHg, the radio passes the vacuum test.
     i. If the seal passes this inspection, this radio is approved for submergibility. No additional testing is required.
     ii. Replace the vacuum port seal and ventilation label as described in the reassembly procedures.
   - If the needle falls more than 0.5 inHg, the radio fails the vacuum test and the radio might leak if submerged. Additional troubleshooting of the radio is required.

8.7.8 Troubleshooting Leak Areas

Before repairing any leak, first read all of the steps within the applicable section. This will help to eliminate unnecessary disassembly and reassembly of a radio with multiple leaks.

NOTES: All disassembly and reassembly methods can be found in Section 8.4. and Section 8.6.

8.7.8.1 Seal Interfaces

- If leak occurs at one or more of the seal interfaces, disassemble the component(s) and inspect the interfaces to determine if there is any damage. If no damage is observed, re-assemble the radio as directed.
- If damage has occurred, replacement parts will be needed.

8.7.8.2 Battery Contact Seal

- If leak occurs due to damage to the Battery Contact Seal (42), it will need to be replaced.

8.7.8.3 Front Housing

- If leak occurs through anywhere on the Front Housing, replace the Front Kit Assembly (A).

8.7.8.4 Keypad

- If leak occurs through the keypad (25), replace it.

8.7.8.5 Chassis

- If leak occurs through the Main O-Ring (36), it will need to be replaced.
- If leak occurs elsewhere on the Chassis (41), it will need to be replaced.

Notes

Chapter 9 Basic Troubleshooting

This section of the manual contains troubleshooting charts and error codes that will help you to isolate a problem. Level one and two troubleshooting will support only radio alignment, programming, battery replacement, and knob replacement, and circuit board replacement.

Component-level service information can be found in the "ASTRO APX 2000/ APX 4000/ APX 4000Li Portable Radios Detailed Service Manual," Motorola publication number 68012004061

9.1 Power-Up Error Codes

When the radio is turned on (power-up), the radio performs self-tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio's display. For non-display radios, the problem will be presented at power-up by a single, low-frequency tone. The radio should be sent to the depot if cycling power and reprogramming the code plug do not solve the problem. The presence of an error should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors will inhibit user operation; non-fatal errors will not. Use Table 9-1 to aid in understanding particular power-up error code displays.

Table 9-1. Power-Up Error Code Displays

Error Code	Description	Corrective Action
01/02	FLASH ROM Codeplug Checksum Non-Fatal Error	Reprogram the codeplug
01/12	Security Partition Checksum Non-Fatal Error	Send radio to depot
01/81	Host ROM Checksum Fatal Error	Send radio to depot
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug
01/84	External EEPROM Blank (or SLIC failure) Fatal Error	Send radio to depot
01/88	External RAM Fatal Error – **Note:** Not a checksum failure	Send radio to depot
01/90	General Hardware Failure Fatal Error	Turn the radio off, then on
01/92	Security Partition Checksum Fatal Error	Send radio to depot
01/93	FLASHport Authentication Code Failure	Send radio to depot
01/94	Internal EEPROM Blank Fatal Error.	Send radio to depot
01/98	Internal RAM Fail Fatal Error	Send radio to depot
01/A0	ABACUS Tune Failure Fatal Error	Send radio to depot
01/A2	Tuning Codeplug Checksum Fatal Error	Send radio to depot
02/81	DSP ROM Checksum Fatal Error	Send radio to depot

Table 9-1. Power-Up Error Code Displays (Continued)

Error Code	Description	Corrective Action
02/88	DSP RAM Fatal Error – **Note:** Not a checksum failure	Turn the radio off, then on
02/90	General DSP Hardware Failure (DSP startup message not received correctly)	Turn the radio off, then on
09/10	Secure Hardware Error	Turn the radio off, then on
09/90	Secure Hardware Fatal Error	Turn the radio off, then on
Hardware board absent/ Hardware board absent then Man-Down Hw error	Keypad board is not connected properly to the radio	Ensure the Keypad board is fixed in place
15/10	External Accessory Non-Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
15/90	External Accessory Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
1E/10	Collaborative device is connected to the radio but the collaborative feature is not enabled in the codeplug.	Contact your Motorola Sales Representative/Partner on how to add Collaborative feature to your radios.
Note: *If the corrective action does not fix the failure, send the radio to the depot.*		

9.2 Operational Error Codes

During radio operation, the radio performs dynamic tests to determine if the radio is working properly. Problems detected during these tests are presented as error codes on the radio's display. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 9-2 to aid in understanding particular operational error codes.

Table 9-2. Operational Error Code Displays

Error Code	Description	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	1. Reprogram external codeplug 2. Send radio to depot
FAIL 002	Selected Mode/Zone Codeplug Checksum Error	Reprogram external codeplug

9.3 Receiver Troubleshooting

Table 9-3 lists the possible causes of, and corrections for, receiver problems.

Table 9-3. Receiver Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements at Room Temperature)
Radio Dead; Display Does Not Turn On	1. Dead Battery	Replace with charged battery
	2. Blown Fuse	Send radio to depot
	3. On/Off Switch	
	4. Regulators	
Radio Dead; Display Turns On	1. Keypad Board	Send radio to depot
	2. Main Board	
Radio On; Front Display Off	High operating temperature (above 80°C)	Allow radio to return to normal operating temperature.
No Receive Audio, or Receiver Does Not Unmute	Programming	1. Check if transmitted signal matches the receiver configuration (PL, DPL, etc.) 2. Check if radio able to unmute with Monitor function enabled
Audio Distorted or Not Loud Enough	Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
RF Sensitivity Poor	1. Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
	2. Antenna Switch/ Connector	Send radio to depot
	3. Receiver Front-End Tuning	Check RF front-end tuning for optimum sensitivity using the tuner
Radio Will Not Turn Off	Main Board	Send radio to depot

9.4 Transmitter Troubleshooting

Table 9-4 lists the possible causes of, and corrections for, transmitter problems.

Table 9-4. Transmitter Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No RF Power Out	1. TX Power Level or Frequency	Check TX power level and frequency programming (from tuner)
	2. No Injection To Power Amplifier	Send radio to depot
	3. Antenna Switch/Connector	
No Modulation; Distorted Modulation	1. Programming	Check deviation and compensation settings using the tuner
	2. Main Board	Send radio to depot
Bad Microphone Sensitivity	1. Check Deviation and Compensation	Realign if necessary
	2. Microphone	Send radio to depot
No/Low signaling (PL, DPL, MDC)	1. Programming	Check programming
	2. Main Board	Send radio to depot
Cannot Set Deviation Balance	Main Board	Send radio to depot

9.5 Encryption Troubleshooting

Table 9-5 lists the possible causes of, and corrections for, encryption problems.

Table 9-5. Encryption Troubleshooting Chart

Symptom	Possible Cause	Corrective Action
No "KEYLOADING" on Radio Display When Keyloading Cable is Attached to the Radio Side Connector	1. Defective Keyload Cable	Send radio to depot
	2. Defective Radio	
Keyloader Displays "FAIL"	1. Wrong Keyloader Type	Use correct keyloader type. Refer to Keyloader User Guide for more information
	2. Bad Keyloader	Try another keyloader
	3. Defective Radio	Send radio to depot

Chapter 10 Exploded Views and Parts Lists

This chapter contains exploded views and associated parts lists for the ASTRO APX 2000/ APX 4000/ APX 4000Li digital portable radios. The following table lists the exploded views for the radio in different configurations:

Table 10-1. APX 2000/ APX 4000/ APX 4000Li Exploded Views and Controller Kit

10.1 APX 2000/ APX 4000/ APX 4000Li Front Kit Exploded View

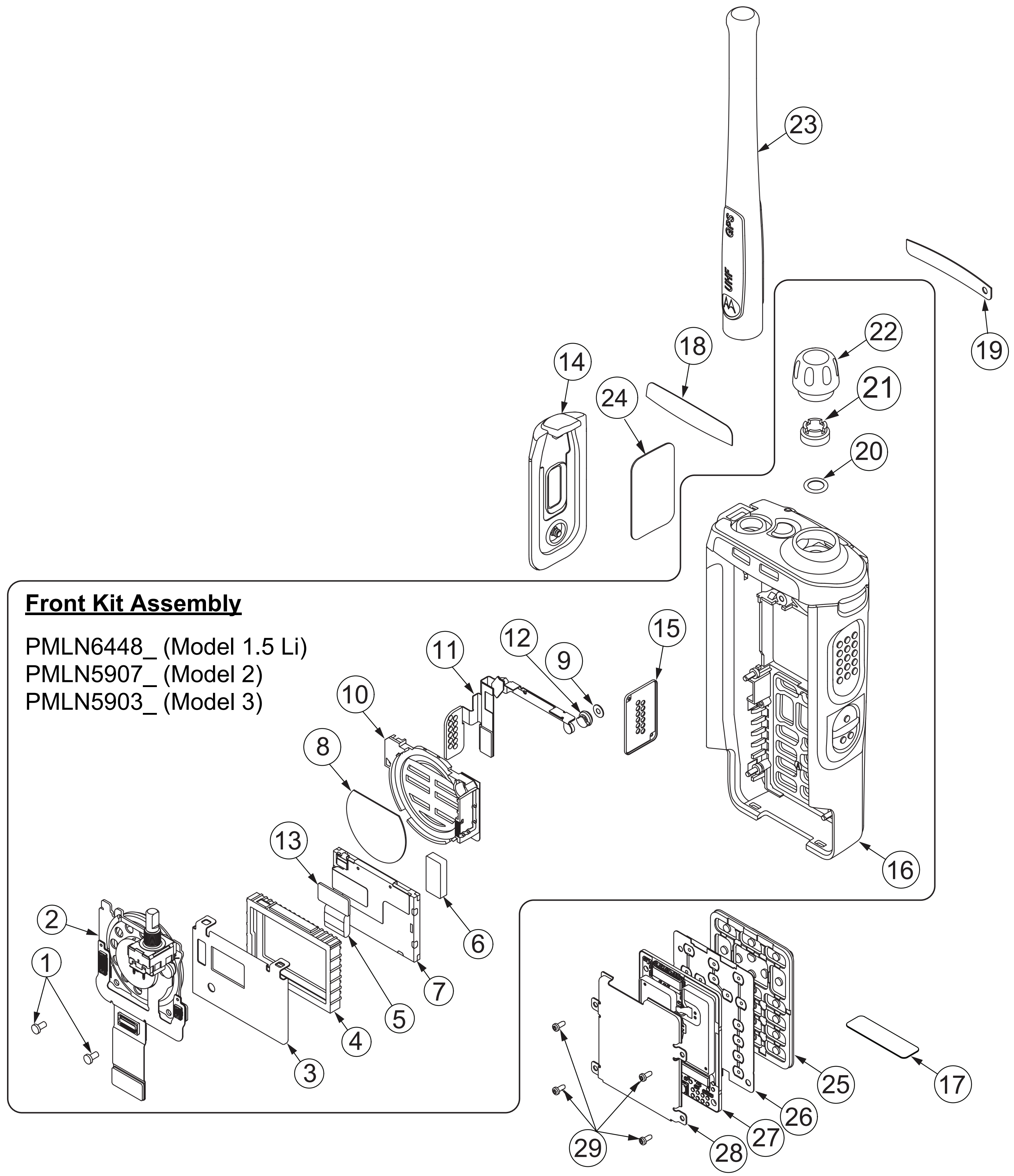

Figure 10-1. APX 2000/ APX 4000/ APX 4000Li Front Kit Exploded View

10.2 APX 2000/ APX 4000/ APX 4000Li Front Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
1††	**0386104Z04**	Screw, Retainer, Speaker
2†	**0104043J28**	Assembly, Flex, Front Kit
3†	**42012055001**	Retainer, LCD
4†	**75012121001**	Boot, LCD
5†	**75012125001**	Pad, Conductive, LCD-Mod to Retainer, LCD
6†	**75012189001**	Pad, Spacer
7†	**72012015001**	Module, LCD
8†	**35012069002**	Mesh, Speaker
9†	**35012068001**	Membrane, Front Mic
10†	**85012039003**	Assembly, Bluetooth Antenna & Speaker Holder
11†	**0104058J94**	Flex, GCAI & LEDs
12†	**32012282001**	Boot, Front Mic
13†	**75012116001**	Pad, Poron, 60pin Receptacle
14	**15012142001**	Cover, Accessory-Connector
15†	**33012027001**	Escutcheon, GCAI
16†	**0104056J82** **0104055J81** **0104055J80** **0104062J72** **0104062J73**	Assembly, Front Housing Kit (Model 1.5) Assembly, Front Housing Kit (Model 2) Assembly, Front Housing Kit (Model 3) Assembly, Front Housing Kit (Model 2 Soldier Green) Assembly, Front Housing Kit (Model 3 Soldier Green)
17	**54012241001**	Label, Bottom
18	**54012198001** **54012198002** **54012198003**	Label, Back (APX 2000) Label, Back (APX 4000) Label, Back (APX 4000Li)
19	**54012196001** **54012196002**	Label, Front_Product (Bluetooth Blue Dot-Expanded Model) Label, Front_Product (Non-Bluetooth-Basic Model)
20†	**32012152001**	O-ring, Switch, Rotary
21†	**02012016001**	Nut, Rotary Switch
22††	**36012020002**	Knob, Multi Function
23	**PMAE4065_** **NAF5085_** **NAR6593_** **NAR6595_** **FAF5259_** **FAF5260_** **PMAF4008_**	Antenna UHF/GPS Antenna Whip 700/800/GPS Antenna VHF/GPS Antenna 1/4 Wave 700/800 MHz Stubby/GPS Antenna,UHF_R1 Plus GPS Stubby Antenna, Assembly Antenna,UHF_R2 Plus GPS Stubby Antenna, Assembly Antenna, 900/GPS
24†††	**54012230001**	Label, FM
25†††††	**75012114001** **75012114002** **75012114003** **75012114004** **75012114005** **75012114006** **75012207001**	Keypad, Model 3 (English) Keypad, Model 3 (Chinese) Keypad, Model 2 Keypad, Model 3 (Cyrillic) Keypad, Model 3 (Arabic) Keypad, Model 3 (Hebrew) Keypad, Model 1.5
26	**40012056001** **40012056002** **40012085001**	Mylar with Metal Domes, Keypad (Model 3) Mylar with Metal Domes, Keypad (Model 2) Mylar with Metal Domes, Keypad (Model 1.5)
27††††	**PMCN4026_** **PMCN4027_** **PMCN4028_** **PMCN4029_** **PMCN4033_**	Assembly, Keypad Board (Model 3, Expanded) Assembly, Keypad Board (Model 3, Base) Assembly, Keypad Board (Model 2, Expanded) Assembly, Keypad Board (Model 2, Base) Assembly, Keypad Board (Model 1.5, Base)
28	**42012056001**	Retainer, Keypad
29	**0378212A02**	Screw, Retainer, Keypad

NOTE:

†. Items cannot be ordered individually. They are included in the Assembly, Front-Kit – PMLN5907_ (Model 2), PMLN5903_ (Model 3), PMLN6448_(Model 1.5 Li), PMLN6848_(Model 2 Soldier Green) and PMLN6849_(Model 3 Soldier Green). Refer to the Model Charts on pages xi, xiii, xv, xvii or xix.

††. Items can be ordered individually, but they are included in their respective kits (if ordered).

†††. For APAC, item can only be ordered by authorized Motorola Service Center.

††††. Items cannot be ordered individually. They are included in their respective kits (if ordered). Refer to the Model Charts on pages xi, xiii, xv, xvii or xix.

Note Assembly, Front-Kit – PMLN5907_ (Model 2), PMLN5903_ (Model 3), PMLN6448_(Model 1.5 Li), PMLN6848_(Model 2 Soldier Green) and PMLN6849_(Model 3 Soldier Green) include items #1-13, 15-16, and 20-22

†††††. Order keypad with the required language.

10.3 APX 2000/ APX 4000/ APX 4000Li Back Kit Exploded View

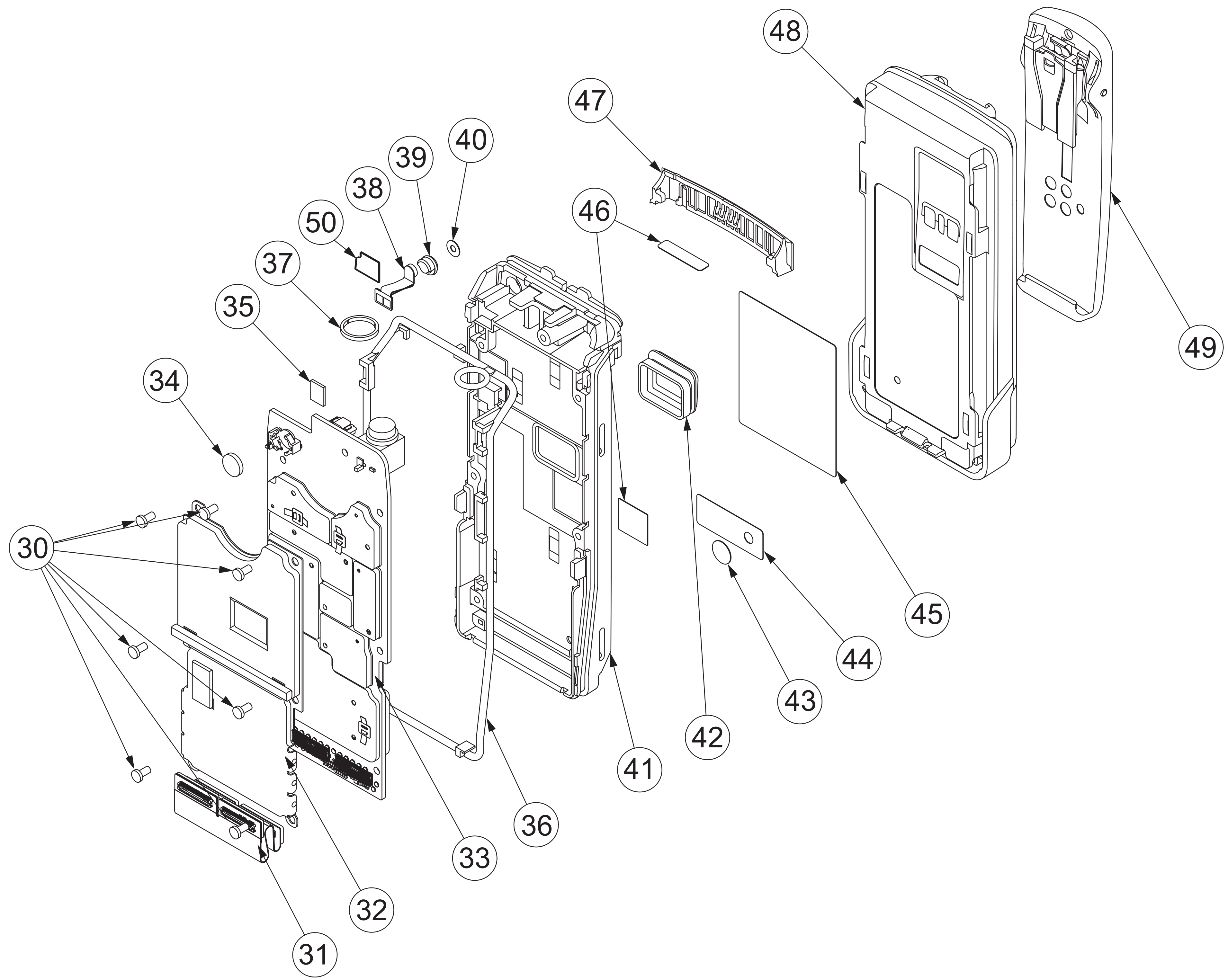

Figure 10-2. APX 2000/ APX 4000/ APX 4000Li Back Kit Exploded View

10.4 APX 2000/ APX 4000/ APX 4000Li Back Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
30	**0386104Z04**	Screw, Chassis
31	**0104043J76** **0104055J99**	Assembly, Flex, Back-kit (Model 2 and Model 3) Assembly, Flex, Back-kit (Model 1.5)
32	**0104046J48**	Shield, Secondary Assembly
33†	**PMLD4490_** **PMLE4720_** **PMLE4721_** **PMLF4089_** **PMLF4097_**	Assembly, Main Board (VHF) Assembly, Main Board (UHF_R1) Assembly, Main Board (UHF_R2) Assembly, Main Board (700/800 MHz) Assembly, Main Board (900 MHz)
34	**6071520M01**	Cell, Coin
35	**7515719H02**	Pad, Thermal, RF PA
36	**32012156001**	O-ring, Main
37	**43012045001**	Collar, Plastic
38	**0104059J61**	Assembly, Flex, Back Mic
39	**32012282001**	Boot, Back Mic
40	**35012068001**	Membrane, Back Mic
41	**27012020002**	Chassis
42	**32012150001**	Seal, Battery Contact
43	**3286058L01**	Seal, Vacuum Port
44	**5478220A01**	Label, Ventilation
45††	**54012242001**	Label, FCC
46††	**33012034001**	Label, ITID
47	**15012140001**	Shroud
48	**NNTN8129_** **NNTN8128_** **PMNN4424_**	Battery, Hi-Cap (FM, 2300 mAH) Battery, Standard (non-FM, 1900 mAH) Battery, Hi-Cap (non-FM, 2300 mAH)
49	**PMLN4651_** **PMLN7008_**	Clip, Belt (2”) Clip, Belt (2.5”)
50	**64012022001**	Back Microphone Backer

NOTE:

†. Items cannot be ordered individually. They are included in their respective kits (if ordered). Refer to the Model Charts on pages xi, xiii, xv, xvii or xix.

††. Item is not orderable.

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ASTRO® APX® 1000
Digital Portable Radios

Section 2
(VHF, UHF1, UHF2, 700/800 MHz)

APX 1000

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Model Numbering, Charts, and Specifications

Portable Radio Model Numbering System

Typical Model Number:	H	8	4	K	G	D	9	P	W	5	A	N	S	P	0	1
Position:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Position 1 – Type of Unit
H = Hand-Held Portable

Positions 2 & 3 – Model Series
84 = APX 1000

Position 4 - Frequency Band

A = Less than 29.7MHz
B = 29.7 to 35.99MHz
C = 36 to 41.99MHz
D = 42 to 50MHz
F = 66 to 80MHz
G = 74 to 90MHz
H = Product Specific
J = 136 to 162MHz
K = 136 to 174MHz
L = 174 to 210MHz
M = 190 to 235MHz
P = 336 to 410MHz
Q = 380 to 470MHz
R = 438 to 482MHz
S = 450 to 520MHz
T = Dual Band Capable
U = 764 to 870MHz
V = 825 to 870MHz
W = 896 to 941MHz
Y = 1.0 to 1.6GHz
Z = 1.5 to 2.0GHz

Values given represent range only; they are not absolute.

Position 5 – Power Level
A = 0 to 0.7 Watts
B = 0.7 to 0.9 Watts
C = 1.0 to 3.9 Watts
D = 1.0 to 5.0 Watts
E = 5.1 to 6.0 Watts
F = 6.1 to 10 Watts
G = 0 to 6 Watts

Position 6 – Physical Packages
A = RF Modem Operation
B = Receiver Only
C = Standard Control; No Display
D = Standard Control; With Display
E = Limited Keypad; No Display
F = Limited Keypad; With Display
G = Full Keypad; No Display
H = Full Keypad; With Display
J = Limited Controls; No Display
K = Limited Controls; Basic Display
L = Limited Controls; Limited Display
M = Rotary Controls; Standard Display
N = Enhanced Controls; Enhanced Display
P = Low Profile; No Display
Q = Low Profile; Basic Display
R = Low Profile; Basic Display, Full Keypad

Position 7 – Channel Spacing
1 = 5kHz
2 = 6.25kHz
3 = 10kHz
4 = 12.5kHz
5 = 15kHz
6 = 20/25kHz
7 = 30kHz
9 = Variable/Programmable

Position 8 – Primary Operation
A = Conventional/Simplex
B = Conventional/Duplex
C = Trunked Twin Type
D = Dual Mode Trunked
E = Dual Mode Trunked/Duplex
F = Trunked Type I
G = Trunked Type II
H = FDMA* Digital Dual Mode
J = TDMA** Digital Dual Mode
K = Single Sideband
L = Global Positioning Satellite Capable
M = Amplitude Companded Sideband (ACSB)
P = Programmable

** FDMA = Frequency Division Multiple Access*
*** TDMA = Time Division Multiple Access*

Position 9 – Primary System Type
A = Conventional
B = Privacy Plus
C = Clear SMARTNET
D = Advanced Conventional Stat-Alert
E = Enhanced Privacy Plus
F = Nauganet 888 Series
G = Japan Specialized Mobile Radio (JSMR)
H = Multi-Channel Access (MCA)
J = CoveragePLUS
K = MPT1327* – Public
L = MPT1327* – Private
M = Radiocom
N = Tone Signalling
P = Binary Signalling
Q = Phonenet
W = Programmable
X = Secure Conventional
Y = Secure SMARTNET

** MPT = Ministry of Posts and Telecommunications*

Position 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

Position 11 – Version
Version Letter (Alpha) – Major Change

Position 12 – Unique Model Variations
C = Cenelec
N = Standard Package

Positions 13 – 16
SP Model Suffix

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ASTRO APX 1000 VHF Model Chart

MODEL DESCRIPTION:				**VHF, APX 1000**
FCC ID:				**AZ489FT3834**
H84KDD9PW5AN				**Model 1.5 APX1000, 136–174MHz, 1–5 Watts, Standard Control**
	H84KDF9PW6AN			**Model 2 APX1000, 136–174MHz, 1–5 Watts, Limited Keypad**
		H84KDH9PW7AN		**Model 3 APX1000,136–174MHz, 1–5 Watts, Full Keypad**
			ITEM NUMBER	**DESCRIPTION**
X			PMLN6654_	Assembly, Front Kit, Model 1.5, APX 1000
	X		PMLN6805_	Assembly, Front Kit, Model 2, APX 1000
		X	PMLN6645_	Assembly, Front Kit, Model 3, APX 1000
X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	42012056001	Retainer, Keypad
X			75012207001	Keypad, Model 1.5
	X		75012114003	Keypad, Model 2
		X	75012114001	Keypad, Model 3 (English)
		X	75012114002	Keypad, Model 3 (Chinese)
		X	75012114004	Keypad, Model 3 (Cyrillic)
X	X	X	0104059J56	Assembly, Flex, Keypad
X			PMCN4036A	Assembly, Keypad Board, Model 1.5, Base, APX 1000
	X		PMCN4040A	Assembly, Keypad Board, Model 2, Base, APX 1000
		X	PMCN4037A	Assembly, Keypad Board, Model 3, Base, APX 1000
X			40012085001	Mylar with Metal Domes, Model 1.5 Keypad
	X		40012056002	Mylar with Metal Domes, Model 2 Keypad
		X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	75012224001	Conductive Pad, Keypad Retainer
X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	35012068001	Membrane, Back Mic
X	X	X	32012282001	Boot, Back Mic
X	X	X	64012022001	Backer, Back Mic
X	X	X	27012020002	Chassis
X	X	X	32012150001	Seal, Battery Contact
X	X	X	15012140001	Shroud
X	X	X	32012156001	O-ring, Main
X	X	X	PMLN6798_	Main Board, APX 1000 (VHF)*
X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	43012045001	Collar, Plastic
X	X	X	6071520M01	Coin Cell
X	X	X	HW000071A01	EMI Absorber
X	X	X	0386104Z03	Screw, Chassis (APX 1000)
X	X	X	3286058L01	Seal, Vacuum Port
X	X	X	5478220A01	Label, Ventilation
•	•	•	54012196002	Label, Front_NamePlate (APX 1000)
•	•	•	54012198004	Label, Back (APX 1000)
X	X	X	54012241001	Label, Bottom
X	X	X	36012020002	Knob, Multi Function
X	X	X	15012142001	Cover, Accessory-Connector
X	X	X	PMLN7029_	User Guide CD, APX 1000

Note:
X *= Item Included.*
• *= Option available. Can be serviced in depot and ordered thru AAD.*
• *Refer Appendix A for antennas, batteries and other applicable accessories.*
* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, 2 or 3 radio.*

ASTRO APX 1000 UHF1 Model Chart

MODEL DESCRIPTION:				UHF1, APX 1000
FCC ID:				AZ489FT4917
H84QDD9PW5AN				Model 1.5 APX 1000, 380–470MHz, 1–5 Watts, Standard Control
	H84QDF9PW6AN			Model 2 APX 1000, 380–470MHz, 1–5 Watts, Limited Keypad
		H84QDH9PW7AN		Model 3 APX 1000, 380–470MHz, 1–5 Watts, Full Keypad
			ITEM NUMBER	DESCRIPTION
X			PMLN6654_	Assembly, Front Kit, Model 1.5, APX 1000
	X		PMLN6805_	Assembly, Front Kit, Model 2, APX 1000
		X	PMLN6645_	Assembly, Front Kit, Model 3, APX 1000
X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	42012056001	Retainer, Keypad
X			75012207001	Keypad, Model 1.5
	X		75012114003	Keypad, Model 2
		X	75012114001	Keypad, Model 3 (English)
		X	75012114002	Keypad, Model 3 (Chinese)
		X	75012114004	Keypad, Model 3 (Cyrillic)
		X	75012114005	Keypad, Model 3 (Arabic)
		X	75012114006	Keypad, Model 3 (Hebrew)
X	X	X	0104059J56	Assembly, Flex, Keypad
X			PMCN4036A	Assembly, Keypad Board, Model 1.5, Base, APX 1000
	X		PMCN4040A	Assembly, Keypad Board, Model 2, Base, APX 1000
		X	PMCN4037A	Assembly, Keypad Board, Model 3, Base, APX 1000
X			40012085001	Mylar with Metal Domes, Model 1.5 Keypad
	X		40012056002	Mylar with Metal Domes, Model 2 Keypad
		X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	75012224001	Conductive Pad, Keypad Retainer
X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	35012068001	Membrane, Back Mic
X	X	X	32012282001	Boot, Back Mic
X	X	X	64012022001	Backer, Back Mic
X	X	X	27012020002	Chassis
X	X	X	32012150001	Seal, Battery Contact
X	X	X	15012140001	Shroud
X	X	X	32012156001	O-ring, Main
X	X	X	PMLN6797_	Main Board, APX 1000 (UHF1)*
X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	43012045001	Collar, Plastic
X	X	X	6071520M01	Coin Cell
X	X	X	HW000071A01	EMI Absorber
X	X	X	0386104Z10	Screw, Chassis (APX 1000)
X	X	X	3286058L01	Seal, Vacuum Port
X	X	X	5478220A01	Label, Ventilation
●	●	●	54012196002	Label, Front_NamePlate (APX 1000)
●	●	●	54012198004	Label, Back (APX 1000)
X	X	X	54012241001	Label, Bottom
X	X	X	36012020002	Knob, Multi Function
X	X	X	15012142001	Cover, Accessory-Connector
X	X	X	PMLN7029_	User Guide CD, APX 1000

Note:
X *= Item Included.*
• = Option available. Can be serviced in depot and ordered thru AAD.
• Refer Appendix A for antennas, batteries and other applicable accessories.
** The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, 2 or 3 radio.*

ASTRO APX 1000 UHF2 Model Chart

MODEL DESCRIPTION:				UHF2, APX 1000
FCC ID:				AZ489FT4920
H84SDD9PW5AN				Model 1.5 APX1000, 450–520MHz, 1–5 Watts, Standard Control
	H84SDF9PW6AN			Model 2 APX1000, 450–520MHz, 1–5 Watts, Limited Keypad
		H84SDH9PW7AN		Model 3 APX1000, 450–520MHz, 1–5 Watts, Full Keypad
			ITEM NUMBER	DESCRIPTION
X			PMLN6654_	Assembly, Front Kit, Model 1.5, APX 1000
	X		PMLN6805_	Assembly, Front Kit, Model 2, APX 1000
		X	PMLN6645_	Assembly, Front Kit, Model 3, APX 1000
X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	42012056001	Retainer, Keypad
X			75012207001	Keypad, Model 1.5
	X		75012114003	Keypad, Model 2
		X	75012114001	Keypad, Model 3 (English)
		X	75012114002	Keypad, Model 3 (Chinese)
X	X	X	0104059J56	Assembly, Flex, Keypad
X			PMCN4036A	Assembly, Keypad Board, Model 1.5, Base, APX 1000
	X		PMCN4040A	Assembly, Keypad Board, Model 2, Base, APX 1000
		X	PMCN4037A	Assembly, Keypad Board, Model 3, Base, APX 1000
X			40012085001	Mylar with Metal Domes, Model 1.5 Keypad
	X		40012056002	Mylar with Metal Domes, Model 2 Keypad
		X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	75012224001	Conductive Pad, Keypad Retainer
X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	35012068001	Membrane, Back Mic
X	X	X	32012282001	Boot, Back Mic
X	X	X	64012022001	Backer, Back Mic
X	X	X	27012020002	Chassis
X	X	X	32012150001	Seal, Battery Contact
X	X	X	15012140001	Shroud
X	X	X	32012156001	O-ring, Main
X	X	X	PMLN6799_	Main Board, APX 1000 (UHF2)*
X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	43012045001	Collar, Plastic
X	X	X	6071520M01	Coin Cell
X	X	X	HW000071A01	EMI Absorber
X	X	X	0386104Z03	Screw, Chassis (APX 1000)
X	X	X	3286058L01	Seal, Vacuum Port
X	X	X	5478220A01	Label, Ventilation
•	•	•	54012196002	Label, Front_NamePlate (APX 1000)
•	•	•	54012198004	Label, Back (APX 1000)
X	X	X	54012241001	Label, Bottom
X	X	X	36012020002	Knob, Multi Function
X	X	X	15012142001	Cover, Accessory-Connector
X	X	X	PMLN7029_	User Guide CD, APX 1000

Note:
X *= Item Included.*
• *= Option available. Can be serviced in depot and ordered thru AAD.*
• *Refer Appendix A for antennas, batteries and other applicable accessories.*
* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
  - *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
  - *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
  - *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, 2 or 3 radio.*

ASTRO APX 1000 700/800 MHz Model Chart

MODEL DESCRIPTION:				700/800, APX 1000
FCC ID:				AZ489FT7057
H84UCD9PW5AN				Model 1.5 APX 1000, 700MHz (1.0–2.5 W) / 800MHz (1.0–3.0 W), Standard Control
	H84UCF9PW6AN			Model 2 APX 1000, 700MHz (1.0–2.5 W) / 800MHz (1.0–3.0 W), Limited Keypad
		H84UCH9PW7AN		Model 3 APX 1000, 700MHz (1.0–2.5 W) / 800MHz (1.0–3.0 W), Full Keypad
			ITEM NUMBER	DESCRIPTION
X			PMLN6654_	Assembly, Front Kit, Model 1.5, APX 1000
	X		PMLN6805_	Assembly, Front Kit, Model 2, APX 1000
		X	PMLN6645_	Assembly, Front Kit, Model 3, APX 1000
X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	42012056001	Retainer, Keypad
X			75012207001	Keypad, Model 1.5
	X		75012114003	Keypad, Model 2
		X	75012114001	Keypad, Model 3 (English)
		X	75012114002	Keypad, Model 3 (Chinese)
		X	75012114004	Keypad, Model 3 (Cyrillic)
		X	75012114005	Keypad, Model 3 (Arabic)
		X	75012114006	Keypad, Model 3 (Hebrew)
X	X	X	0104059J56	Assembly, Flex, Keypad
X			PMCN4036A	Assembly, Keypad Board, Model 1.5, Base, APX 1000
	X		PMCN4040A	Assembly, Keypad Board, Model 2, Base, APX 1000
		X	PMCN4037A	Assembly, Keypad Board, Model 3, Base, APX 1000
X			40012085001	Mylar with Metal Domes, Model 1.5 Keypad
	X		40012056002	Mylar with Metal Domes, Model 2 Keypad
		X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	75012224001	Conductive Pad, Keypad Retainer
X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	35012068001	Membrane, Back Mic
X	X	X	32012282001	Boot, Back Mic
X	X	X	64012022001	Backer, Back Mic
X	X	X	27012020002	Chassis
X	X	X	32012150001	Seal, Battery Contact
X	X	X	15012140001	Shroud
X	X	X	32012156001	O-ring, Main
X	X	X	PMLN6796_	Main Board, APX 1000 (7/800MHz)*
X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	43012045001	Collar, Plastic
X	X	X	6071520M01	Coin Cell
X	X	X	HW000071A01	EMI Absorber
X	X	X	0386104Z10	Screw, Chassis (APX 1000)
X	X	X	3286058L01	Seal, Vacuum Port
X	X	X	5478220A01	Label, Ventilation
•	•	•	54012196002	Label, Front_NamePlate (APX 1000)
•	•	•	54012198004	Label, Back (APX 1000)
X	X	X	54012241001	Label, Bottom
X	X	X	36012020002	Knob, Multi Function
X	X	X	15012142001	Cover, Accessory-Connector
X	X	X	PMLN7029_	User Guide CD, APX 1000

Note:
X *= Item Included.*
• *= Option available. Can be serviced in depot and ordered thru AAD.*
• *Refer Appendix A for antennas, batteries and other applicable accessories.*
* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, 2, or 3 radio.*

Specifications for APX 1000 VHF Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap (2300 mAh):**	PMNN4424_*
or **Li-Ion High Cap (2700 mAh):**	PMNN4448_
* FM Intrinsically Safe.	
Dimensions (H x W x D):	
Without Battery (Radio Only):	
H = 5.26" (133 mm)	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	
D[2] = 0.77" (19.6 mm) / 1.48" (37.5 mm)	
With Standard Battery:	
H = 5.26" (133 mm)	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	
D[2] = 1.47"(37.4mm) / 1.72"(43.6mm)	
With High Cap Battery:	
H = 5.26" (133mm)	
W[1] = 2.56"(65mm) / 2.37"(60.2mm)	
D[2] = 1.69"(42.9mm) / 1.93"(48.9mm)	
Note:	
H = Height; W = Width; D = Depth	
1 = (Width @ Top) / (Width @ PTT)	
2 = (Depth @ Bottom) / (Depth @ PTT)	
Weight: (w/o Antenna):	
Less Battery:	8.47 oz (240g)
With Li-Ion Standard:	13.76 oz (390g)
With Li-Ion High Cap (2300 mAh):	14.11 oz (400g)
With Li-Ion High Cap (2700 mAh):	14.11 oz (400g)

RECEIVER

Frequency Range:	136–174 MHz
Bandwidth:	38 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.216µV
Digital Sensitivity (typical)	
(1% BER):	0.277 µV
(5% BER):	0.188 µV
Intermodulation (typical):	-79.5 dB
Selectivity (typical):	
(25 kHz Channel):	-76 dB
(12.5 kHz Channel):	-70 dB
Spurious Rejection (typical):	-79.3 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	25 kHz -51 dB
	12.5 kHz -45 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	136–174 MHz
RF Power:	
136–174 MHz:	1–5 W
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -47 dB
	12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz
	20 kHz chnls ±4.0 kHz
	12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc
	12.5 kHz -68 dBc
Emissions Designators:	11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W

Specifications subject to change without notice.

Specifications for APX 1000 UHF1 Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap (2300 mAh):**	PMNN4424 _
or **Li-Ion High Cap (2700 mAh):**	PMNN4448_
Dimensions (H x W x D):	
Without Battery (Radio Only):	
H = 5.26" (133 mm)	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	
D[2] = 0.77" (19.6 mm) / 1.48" (37.5 mm)	
With Standard Battery:	
H = 5.26" (133 mm)	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	
D[2] = 1.47"(37.4mm) / 1.72"(43.6mm)	
With High Cap Battery:	
H = 5.26" (133mm)	
W[1] = 2.56"(65mm) / 2.37"(60.2mm)	
D[2] = 1.69"(42.9mm) / 1.93"(48.9mm)	
Note:	
H = Height; W = Width; D = Depth	
1 = (Width @ Top) / (Width @ PTT)	
2 = (Depth @ Bottom) / (Depth @ PTT)	
Weight: (w/o Antenna):	
Less Battery:	8.47 oz (240g)
With Li-Ion Standard:	13.76 oz (390g)
With Li-Ion High Cap: (2300 mAh):	14.11 oz (400g)
With Li-Ion High Cap: (2700 mAh):	14.11 oz (400g)

RECEIVER

Frequency Range:	380–470 MHz
Bandwidth:	90 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.234 µV
Digital Sensitivity (typical)	
(1% BER):	0.307 µV
(5% BER):	0.207 µV
Intermodulation (typical):	-77 dB
Selectivity (typical):	
(25 kHz Channel):	-76 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-80.3 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	25 kHz -50 dB 12.5 kHz -45 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	380–470 MHz
RF Power:	
380–470 MHz:	1–5 W
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -47 dB 12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz 20 kHz chnls ±4 kHz 12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc 12.5 kHz -68 dBc
Emissions Designators:	11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W

Specifications subject to change without notice.

Specifications for APX 1000 UHF2 Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL	
Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap (2300 mAh):**	PMNN4424_*
or **Li-Ion High Cap (2700 mAh):**	PMNN4448_
* FM Intrinsically Safe.	
Dimensions (H x W x D):	
Without Battery (Radio Only):	
H = 5.26" (133 mm)	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	
D[2] = 0.77" (19.6 mm) / 1.48" (37.5 mm)	
With Standard Battery:	
H = 5.26" (133 mm)	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	
D[2] = 1.47"(37.4mm) / 1.72"(43.6mm)	
With High Cap Battery:	
H = 5.26" (133mm)	
W[1] = 2.56"(65mm) / 2.37"(60.2mm)	
D[2] = 1.69"(42.9mm) / 1.93"(48.9mm)	
Note:	
H = Height; W = Width; D = Depth	
1 = (Width @ Top) / (Width @ PTT)	
2 = (Depth @ Bottom) / (Depth @ PTT)	
Weight: (w/o Antenna):	
Less Battery:	8.47 oz (240g)
With Li-Ion Standard:	13.76 oz (390g)
With Li-Ion High Cap (2300 mAh):	14.11 oz (400g)
With Li-Ion High Cap (2700 mAh):	14.11 oz (400g)

RECEIVER	
Frequency Range:	450–520 MHz
Bandwidth:	70 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.234 µV
Digital Sensitivity (typical)	
(1% BER):	0.307 µV
(5% BER):	0.207 µV
Intermodulation (typical):	-77 dB
Selectivity (typical):	
(25 kHz Channel):	-76 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-80.3 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	25 kHz -50 dB 12.5 kHz -45 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER	
Frequency Range:	450–520 MHz
RF Power:	
450–520 MHz:	1–5 W
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -47 dB 12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz 20 kHz chnls ±4 kHz 12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc 12.5 kHz -68 dBc
Emissions Designators:	
11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W	

Specifications subject to change without notice.

Specifications for APX 1000 700/800 MHz Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1680 mA
Receive Current Drain (Rated Audio):	306 mA
Standby Current Drain:	137 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap (2300 mAh):**	PMNN4424_
or **Li-Ion High Cap (2700 mAh):**	PMNN4448_
Dimensions (H x W x D):	
Without Battery (Radio Only):	
H = 5.26" (133 mm)	
W^1 = 2.56" (65 mm) / 2.37" (60.2 mm)	
D^2 = 0.77" (19.6 mm) / 1.48" (37.5 mm)	
With Standard Battery:	
H = 5.26" (133 mm)	
W^1 = 2.56" (65 mm) / 2.37" (60.2 mm)	
D^2 = 1.47"(37.4mm) / 1.72"(43.6mm)	
With High Cap Battery:	
H = 5.26" (133mm)	
W^1 = 2.56"(65mm) / 2.37"(60.2mm)	
D^2 = 1.69"(42.9mm) / 1.93"(48.9mm)	
Note:	
H = Height; W = Width; D = Depth	
1 = (Width @ Top) / (Width @ PTT)	
2 = (Depth @ Bottom) / (Depth @ PTT)	
Weight: (w/o Antenna):	
Less Battery:	8.47 oz (240g)
With Li-Ion Standard:	13.76 oz (390g)
With Li-Ion High Cap: (2300 mAh):	14.11 oz (400g)
With Li-Ion High Cap: (2700 mAh):	14.11 oz (400g)

RECEIVER

Frequency Range:	
700 MHz:	764–776 MHz
800 MHz:	851–870 MHz
Bandwidth:	
700 MHz:	12 MHz
800 MHz:	19 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.250 µV
Digital Sensitivity (typical)	
(1% BER):	0.400 µV
(5% BER):	0.250 µV
Intermodulation (typical):	-75 dB
Selectivity (typical):	
(25 kHz Channel):	-76 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-76.6 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	25 kHz -53 dB
	12.5 kHz -47 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	
700 MHz:	764–776; 794–806 MHz
800 MHz:	806–824; 851–870 MHz
RF Power:	
700 MHz:	1–2.5 Watts
800 MHz:	1–3.0 Watts
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	
700 MHz:	±0.0001%
800 MHz:	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -47 dB
	12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5 kHz
	20 kHz chnls ±4 kHz
	12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc
	12.5 kHz -66 dBc
Emissions Designators:	
11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W	

Specifications subject to change without notice.

Chapter 1 Introduction

This manual contains information needed for Levels One and Two radio servicing. Level One servicing consists of radio programming, radio alignment, knobs replacement, and installation and removal of the antenna, belt clip, battery, and universal connector cover. Level Two servicing covers disassembly and reassembly of the radio to replace circuit boards.

1.1 Manual Contents

Included in this manual is radio specification for the VHF (136–174 MHz), UHF1 (380–470 MHz), UHF2 (450–520 MHz) and 700/800 MHz (764–870 MHz) frequency bands, a general description of ASTRO APX 1000 models, recommended test equipment, service aids, radio alignment procedures, general maintenance recommendations, procedures for assembly and disassembly, and exploded views and parts lists.

1.2 Notations Used in This Manual

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

NOTE: An operational procedure, practice, or condition that is essential to emphasize.

Caution

CAUTION indicates a potentially hazardous situation which, if not avoided, <u>might</u> result in equipment damage.

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, <u>could</u> result in death or injury.

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, <u>will</u> result in death or injury.

1.3 Radio Description

The ASTRO APX 1000 radio provides improved voice quality across more coverage area. The digital process, called *embedded signaling*, intermixes system signaling information with digital voice, resulting in improved system reliability and the capability of supporting a multitude of advanced features.

ASTRO APX 1000 radios are available in Single Display configuration. Table 1-1 describes their basic features.

Table 1-1. ASTRO APX 1000 Basic Features

Feature	Standard Control (Model 1.5)	Limited Keypad (Model 2)	Full Keypad (Model 3)
Display	•Full bitmap color LCD display •3 lines of text x 14 characters •1 line of icons •1 menu line x 3 menus •White backlight		
Keypad	• Backlight keypad • 3 soft keys	• Backlight keypad • 3 soft keys • 4 direction Navigation key • Home and Data buttons	• Backlight keypad • 3 soft keys • 4 direction Navigation key • 4x3 keypad • Home and Data buttons • Full DTMF keypad
Channel Capability	512		
FLASHport Memory	64MB		

1.4 FLASHport®

The ASTRO APX 1000 radio utilizes Motorola's FLASHport technology. FLASHport makes it possible to add software that drives the radio's capabilities both at the time of purchase and later on. Previously, changing a radio's features and capabilities meant significant modifications or buying a new radio. But now, similar to how a computer can be loaded with different software, the radio's features and capabilities can be upgraded with FLASHport software.

Chapter 2 Basic Maintenance

This chapter describes the preventive maintenance and handling precautions. Each of these topics provides information vital to the successful operation and maintenance of the radio.

2.1 General Maintenance

In order to avoid operating outside the limits set by the FCC, align the ASTRO APX 1000 radio's reference oscillator every time the radio is taken apart, or once per year, whichever comes first. (See Section 6.5.1). Periodic visual inspection and cleaning is also recommended.

2.1.1 Inspection

Check that the external surfaces of the radio are clean and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed.

2.1.2 Cleaning

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

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water.

Caution

Use all chemicals as prescribed by the manufacturer. Be sure to 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. Aerosol sprays, tuner cleaners, and other chemicals should be avoided.

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

2.2 Safe Handling of CMOS and LDMOS Devices

Complementary metal-oxide semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) devices, and other high-technology devices, are used in this family of radios. While the attributes of these devices are many, their characteristics make them susceptible to damage by electrostatic discharge (ESD) 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 this radio, and are especially important in low-humidity conditions.

Caution

- The APX 1000 radio has a vent port that allows for pressure equalization in the radio. Never poke this vent with any objects, such as needles, tweezers, or screwdrivers. This could create a leak path into the radio and the radio's splash protection reliability will be lost.
- The pressure equalization vent is located adjacent to the battery contact opening of the main chassis. Never touch the equalization vent. Ensure that no oily substances come in contact with this vent.
- Do not submerge the radio as this results in damage to the radio.
- If water is observed on the battery contact area, dry and clean the radio battery contacts before attaching a battery to the radio. Otherwise, the water could short-circuit the radio.
- If water is observed on the speaker grille area, shake the radio well so that any water that is trapped inside the speaker grille and microphone port can be removed. Otherwise, the water will decrease the audio quality of the radio.

Chapter 3 Basic Theory of Operation

This chapter discusses the basic operational theory of the ASTRO APX 1000 radio. The ASTRO APX 1000 radio, which is a single-band synthesized radio, is available in the following frequency bands.

- VHF (136–174 MHz)
- UHF1 (380–470 MHz)
- UHF2 (450–520 MHz)
- 700/800 MHz (764–870 MHz).

All ASTRO APX 1000 radios are capable of analog operation (12.5 kHz or 25 kHz bandwidths), ASTRO mode (digital) operation (12.5 kHz only), X2-TDMA mode (25 kHz only) and Phase 2 TDMA mode (12.5 kHz only).

NOTE: The APX 1000 M1.5, M2 and M3 radio support Global Positioning System (GPS) but do not support Bluetooth, MACE and Accelerometer functions. As such, disregard all references to the functions mentioned above in “Chapter 3 Basic Theory of Operation”.

3.1 Major Assemblies

The ASTRO APX 1000 radio includes the following major assemblies (See Figure 3-1.):

- **Main Board –** Contains all transmit, receive, and frequency generation circuitry, including the digital receiver back-end IC and the reference oscillator. The main board also contains a dual core processor, which includes both the microcontroller unit (MCU) and a digital signal processor (DSP) core, the processors's memory devices, an audio and power supply support integrated circuit (IC), a digital support IC, external power amplifier as well as combination Global Positioning System (GPS) and front end circuitry.
- **Control Top** – Contains a Multi-Function knob, a push button switch used for Emergency call and a light bar. The control top also includes TX/RX LED that is solid amber upon receive, red on PTT, and blinks amber on secure TX/RX.
- **Main Display** – 160 pixels x 90 pixels, transflective color LCD.
- **Keypad**
  - Standard Control (M1.5) Keypad version has 3 soft keys
  - Limited Keypad Version has 3 soft keys, 4 direction Navigation key, Home and Data buttons
  - Full Keypad Version has 3 soft keys, 4 direction Navigation key, 3x4 alphanumeric keypad, Home and Data buttons.

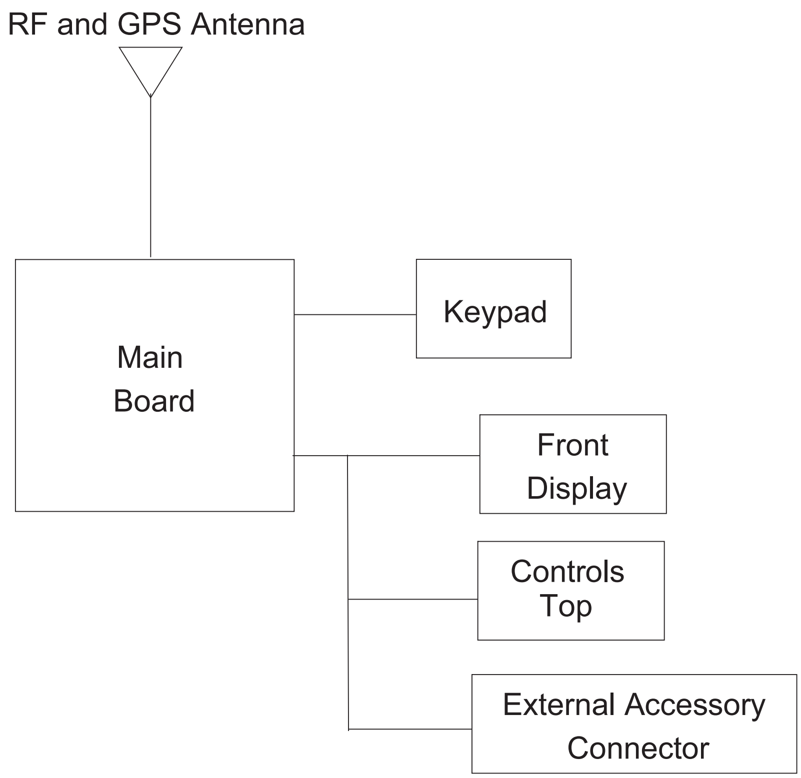

Figure 3-1. APX 1000 Overall Block Diagram

3.2 Analog Mode of Operation

This section provides an overview of the analog mode receive and transmit theory of operation.

3.2.1 Receiving

The RF signal is received at the antenna and is routed through the Harmonic Filter, followed by the Antenna Switch and finally the 15dB Step Attenuator IC. The latter contains a switchable attenuator that is enabled at predetermined RF power thresholds present at the antenna port. See Figure 3-2., Figure 3-3 and Figure 3-4.

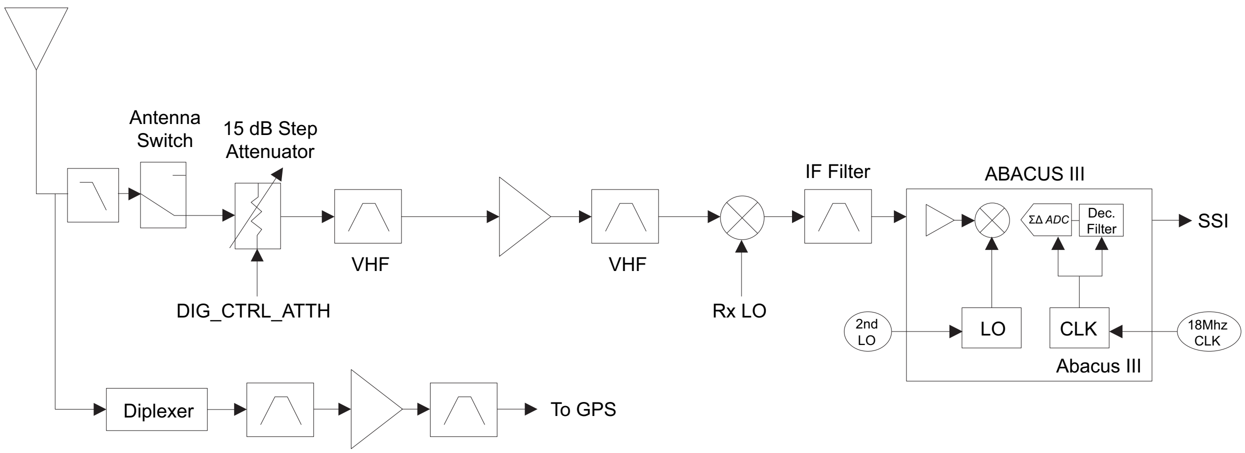

Figure 3-2. Receiver Block Diagram (VHF)

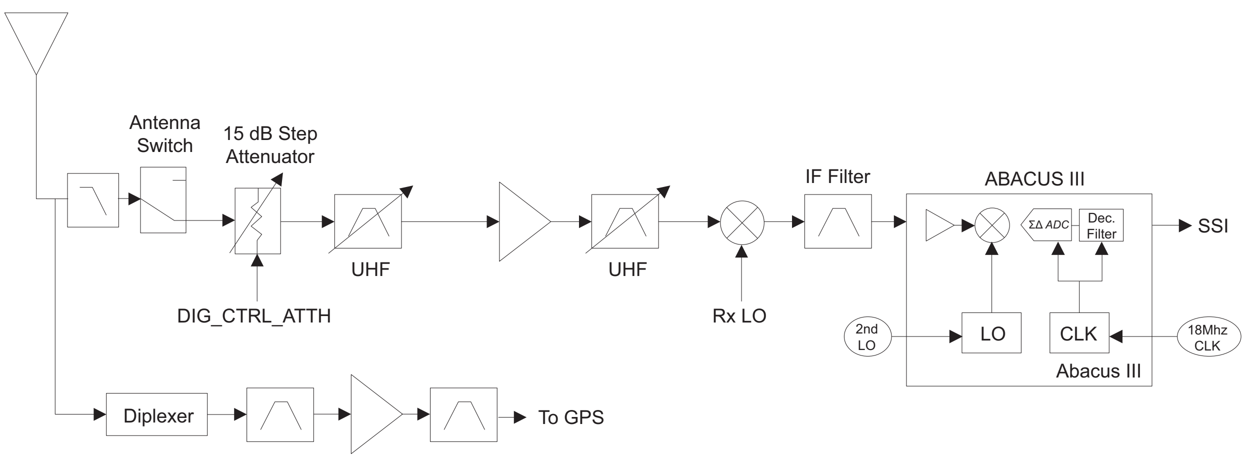

Figure 3-3. Receiver Block Diagram (UHF1/UHF2)

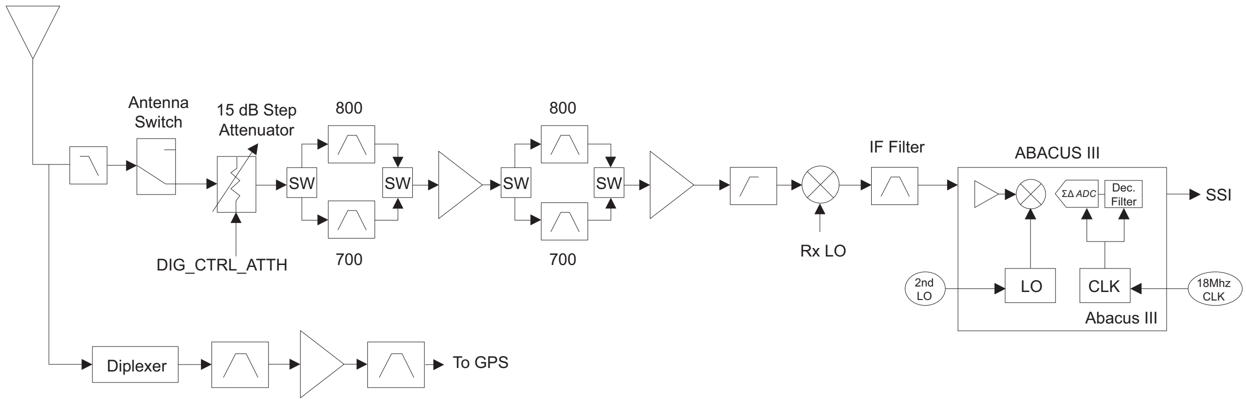

Figure 3-4. Receiver Block Diagram (700/800 MHz)

3.2.1.1 GPS

The GPS signal is tapped at the antenna port via a series resonant network (diplexer) which provides a very low capacitive load to the transceiver. The diplexer circuitry provides rejection to radio band signals up to ~1GHz which serves as isolation between the radio RF and GPS signal paths. The GPS signal is filtered though a GPS SAW filter - LNA – Saw filter chain before going into the TI GPS IC for processing.

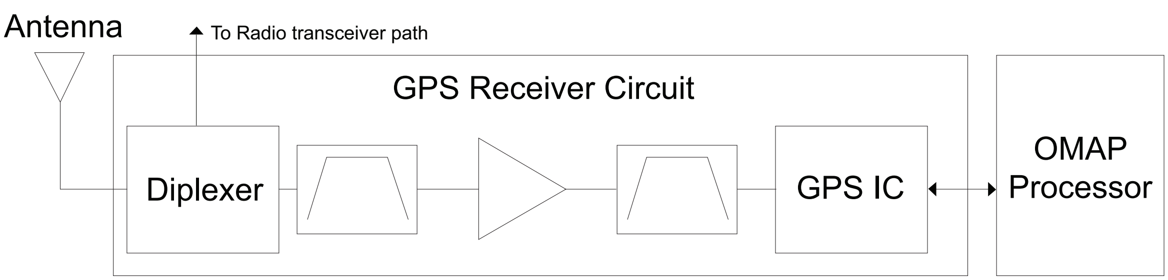

Figure 3-5. GPS Diagram

3.2.1.2 VHF Front-End

From the 15 dB Step Attenuator, a VHF signal is routed to the first pre-selector filter followed by an LNA and a second pre-selector filter. Both filters are discrete and tunable designs and are used to band limit the incoming energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the second pre-selector filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.3 UHF1/UHF2 Front-End

From the 15 dB Step Attenuator, a UHF1/UHF2 signal is routed to the first pre-selector filter followed by an LNA and a second pre-selector filter. Both filters are discrete and tunable designs and are used to band limit the incoming energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the second pre-selector filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.4 700/800 MHz Front-End

From the 15 dB Step Attenuator, a 700/800 MHz band signal is routed to the first band SPST switch which selects the 700 or the 800 band signal and routes it to the appropriate first pre-selector filter. A second band select switch selects the output of the appropriate filter and applies it to an LNA followed by a similar pre-selector filter/ band-select switch circuit. The signal is then routed to a second LNA whose output is applied to a discrete image filter. Both preselector filters are Surface Acoustic Wave designs used to band limit the received energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the discrete image filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.5 Analog To Digital Converter

The ADC IC's front end down converts the first IF to a second IF, a 2.25 MHz signal. The second IF is sampled at 18 MHz, a signal generated by an integrated clock synthesizer. The sampled signal is decimated by a factor of 900 to 20 kHz and converted to SSI format at the ADC's output. The Serial Synchronous Interface (SSI) serial data waveform is composed of a 16 bit in-phase word (I) followed by a 16 bit Quadrature word (Q). A 20 kHz Frame Synch and a 1.2 MHz clock waveform are used to synchronize the SSI IQ data transfer to the Digital Signal Processor IC (OMAP) for post-processing and demodulation.

3.2.2 Transmitting

When the radio is transmitting, microphone audio is digitized and then processed by the DSP and sent to the Trident IC (see Figure 3-6) via the SSI interface. The Trident IC processes the SSI data for application to the voltage controlled oscillator as a modulation signal.

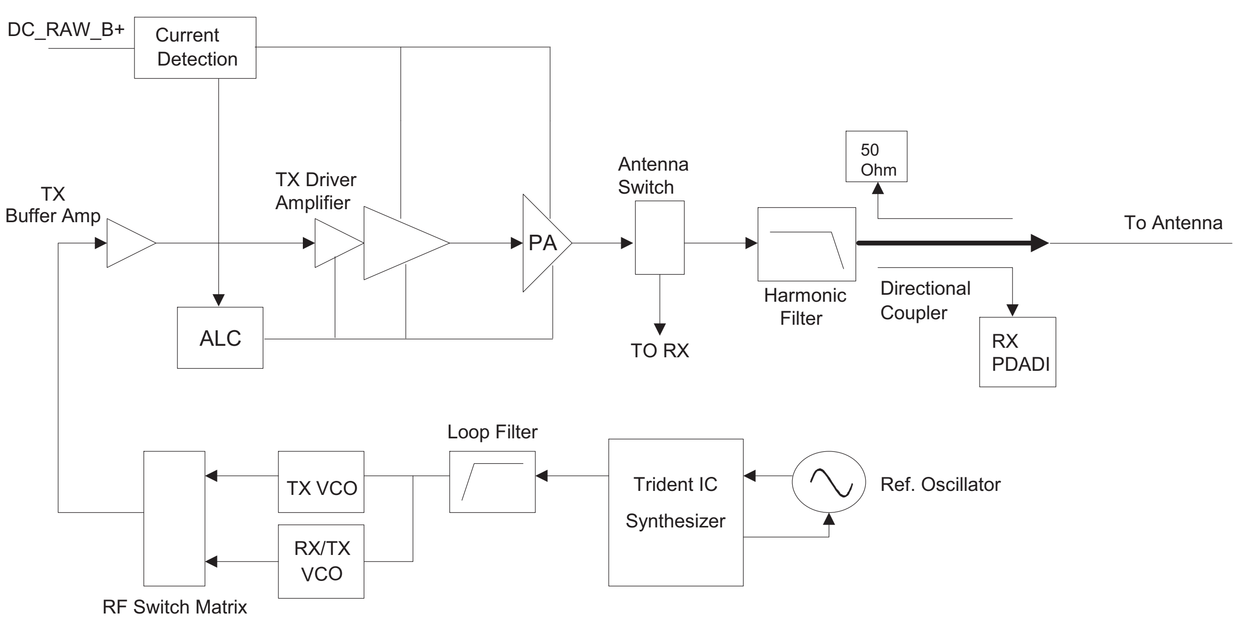

Figure 3-6. Transmitter Block Diagram

3.2.2.1 VHF

Once a VHF frequency for transmit has been selected, the Trident IC and the accompanying logic circuitry will enable the voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the VHF Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The current detection circuit will be Monitored the current drain of driver amplifier and final power amplifier and feedback to ALC circuitry to adjusts the control voltages to the driver amplifier and final power amplifier. Finally, the RF signal is routed to the main antenna.

3.2.2.2 UHF1/UHF2 Transmit

Once a UHF frequency for transmit has been selected, the Trident IC and the accompanying logic circuitry will enable the voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the UHF1 Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The current detection circuit will be Monitored the current drain of driver amplifier and final power amplifier and feedback to ALC circuitry to adjusts the control voltages to the driver amplifier and final power amplifier. Finally, the RF signal is routed to the main antenna.

3.2.2.3 700/800 MHz Transmit

Once a 700/800 MHz frequency for transmit has been selected, the Trident IC and accompanying logic circuitry enable the correct voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the 7800 Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The current detection circuit will be Monitored the current drain of driver amplifier and final power amplifier and feedback to ALC circuitry to adjusts the control voltages to the driver amplifier and final power amplifier. Finally, the RF signal is routed to the main antenna.

3.3 Digital (ASTRO) Mode of Operation

In the ASTRO (digital) mode of operation, the transmitted or received signal is limited to a discrete set of frequency deviation levels. The receiver handles an ASTRO-mode signal identically to an analog-mode signal, up to the point where the DSP decodes the received data. In the ASTRO receive mode, the DSP uses a different algorithm to recover data.

In the ASTRO transmit mode, microphone audio is processed identically to an analog mode, with the exception of the algorithm the DSP uses to encode the information. Using this algorithm, transmitter FM deviation is limited to discrete levels.

3.4 Controller Section

The controller section (See Figure 3-7.) comprises of five functional sections that are split among two boards, which are the main and keypad boards. The main functional section consists of a dual core ARM and DSP controller, Flash memory, and a Double Data Rate Synchronous Dynamic Random Access Memory (DDR SDRAM) and CPLD for GPIO expander multiple clock generation and SSI interface for the radio system. The Power and Clocks section includes a power management IC (MAKO) and various external switching regulators, and three clock sources (12 MHz and 24.576 MHz) from which all other controller digital clocks are derived. The Audio section has a CODEC and a class-D audio power amplifier that provides the radio with a microphone and speaker design. The User Interface section provides communication and control to the main Liquid Crystal Displays (LCD) on the radio, as well as a keypad and a side connector interface conforming to GCAI (Global Communications Accessory Interface) specifications.

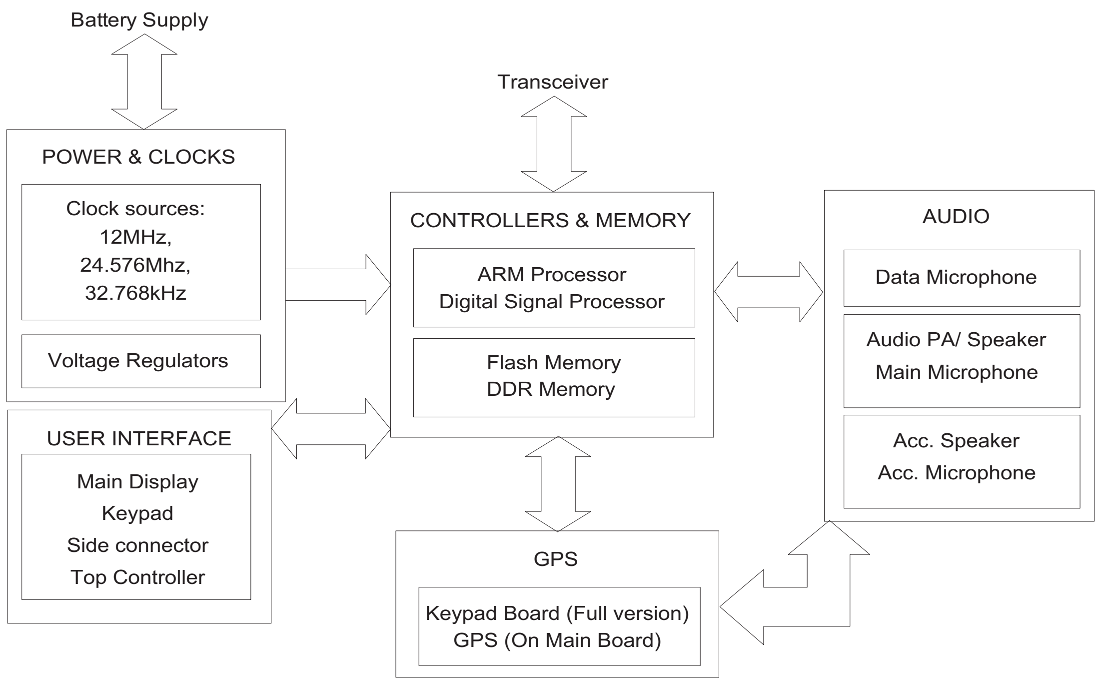

Figure 3-7. Controller Block Diagram

The ARM controller core of the OMAP processor handles the power up sequence of all devices, including firmware upgrades, and all operating system tasks that are associated with FLASH and SDRAM memories and user interface communication. The FLASH memory (64 MB) is required to store the firmware, tuning, and Codeplug settings, which upon initialization get read and stored into SDRAM (32MB) for execution. The ARM and DSP core jointly control and configure audio, wireless and RF devices linked to the Serial Peripheral Interface (SPI) and Synchronous Serial Interface (SSI) buses to enable radio FM and optional wireless communication protocols.

The power and most clocks to the controller devices are provided by the MAKO IC and external switching and linear regulators on board. A Complex Programmable Logic Array (CPLD) IC divides the 24.576 MHz clock from MAKO to source OMAP's 32 kHz Real Time Clock. OMAP's main clock is supplied externally from an on board 12 MHz crystal.

The radio has two internal microphones and an internal speaker, as well as available microphone and speaker connections for external accessories. The internal 4 Ohm speaker is located on the same side as the main display and keypad of the radio. The internal speaker is driven by a Class D audio amplifier located on the main board that is capable of delivering a rated power of 0.5 W. The external accessory speaker is driven by a Class AB audio amplifier on the MAKO IC that is capable of delivering 0.5 W of power into a 16 Ohm as a minimum load. Both speaker paths use the CODEC for volume control and to convert the audio signal from digital to analog. Both internal and external microphones use the CODEC's ADC to deliver digital audio samples to the DSP controller.

The user interface block consists of a main display, a keypad, top controls and the accessory side connector. The side connector (Universal Connector) provides audio, USB, RS232 communication for accessories. All signals to and from the connector go through the internal keypad board before reaching the microcontroller and other devices on the main board.

Chapter 4 Recommended Test Equipment and Service Aids

This chapter provides lists of recommended test equipment and service aids, as well as information on field programming equipment that can be used in servicing and programming ASTRO APX 1000 radios.

4.1 Recommended Test Equipment

The list of equipment contained in Table 4-1 includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specifically for servicing this family of radios. The “Characteristics” column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola model listed is either a unique item or no substitution is recommended.

Table 4-1. Recommended Test Equipment

Equipment	Characteristics	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	Aeroflex 3920 (www.aeroflex.com), R-2670 Communication Analyzer, 8901_ Modulation Analyzer (www.agilent.com) or equivalent	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital RMS Multimeter *	100 μV to 300 V 5 Hz to 1 MHz 10 Mega Ohm Impedance	Fluke 179 or equivalent (www.fluke.com)	AC/DC voltage and current measurements. Audio voltage measurements
RF Signal Generator *	100 MHz to 1 GHz -130 dBm to +10 dBm FM Modulation 0 kHz to 10 kHz Audio Frequency 100 Hz to 10 kHz	Agilent N5181A (www.agilent.com), Ramsey RSG1000B (www.ramseyelectronics.com, or equivalent	Receiver measurements
Oscilloscope *	2 Channel 50 MHz Bandwidth 5 mV/div to 20 V/div	Leader LS8050 (www.leaderusa.com), Tektronix TDS1001b (www.tektronix.com), or equivalent	Waveform measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 9240 (www.boonton.com) or equivalent	Waveform measurements
Power Supply	0 V to 32 V 0 A to 20 A	B&K Precision 1790 (www.bkprecision.com) or equivalent	Voltage supply
Power Meter and Sensor	5% accuracy 100MHz to 500MHz 50 Watts	Bird 43 Thruline Watt Meter (www.bird-electronic.com) or equivalent	Transmitter power output measurements

4.2 Service Aids

Refer to Table 4-2 for a listing and description of the service aids designed specifically for servicing this family of radios. These kits and/or parts are available from the Radio Products and Solutions Organization offices listed in "Appendix B Replacement Parts Ordering". While all of these items are available from Motorola, most are standard shop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 4-2. Service Aids

Motorola Part Number	Description	Application
66012028001	Chassis Opener	To disassemble chassis from housing
66012031001	Battery Adapter	Used in place of battery to connect radio to an external power supply.
5880384G68	SMA to BNC Adapter	Adapts radio's antenna port to BNC cabling of test equipment.
RVN5224_	Customer Programming Software (CPS) and Tuner Software	CPS allows customer-specific programming of modes and features. Tuner software required to perform alignment of radio parameters.
PMKN4012B	Programming Cable	To program the radio through Customer Programming Software and Tuner Software.
PMKN4013C	Programming/Service Cable	To program and service the radio through Customer Programming Software and Tuner Software.
RLN4460_	Portable Test Set	For radio performance checks. Connects to radio's universal connector and allows remote switching and signal injection/ outputs for test equipment measurements.

NOTE: Do not place an order for the Programming Cable (PMKN4012A/PMKN4013B) as it is not compatible with the APX 1000 radio.

4.3 Field Programming

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the online help in the Customer Programming Software (CPS) for complete field programming information.

Chapter 5 Performance Checks

This chapter covers performance checks used to ensure that the ASTRO APX 1000 radio meets published specifications. The recommended test equipment listed in the previous section approaches the accuracy of the manufacturing equipment, with a few exceptions. Accuracy of the test equipment must be maintained in compliance with the manufacturer's recommended calibration schedule. Checks should be performed if radio performance degradation is suspected.

5.1 Test Equipment Setup

Supply voltage can be connected from the battery eliminator. The equipment required for the performance checks is connected as shown in Figure 5-1.

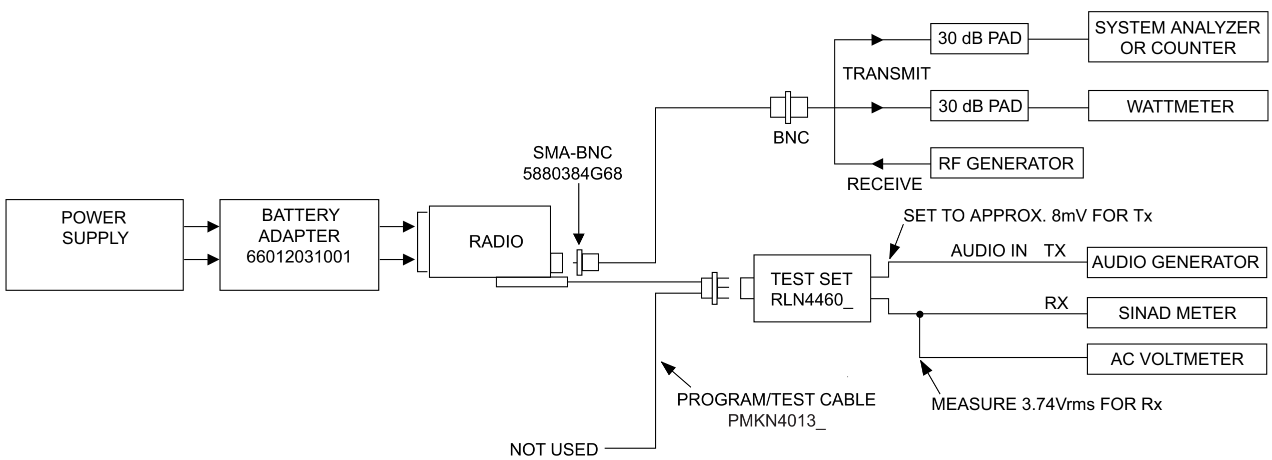

Figure 5-1. Performance Checks Test Setup

Initial equipment control settings should be as indicated in Table 5-1 and should be the same for all performance checks and alignment procedures, except as noted.

Table 5-1. Initial Equipment Control Settings

<table>
<tr><th>System Analyzer</th><th>Test Set</th><th>Power Supply</th></tr>
<tr><td>Monitor Mode: Standard*</td><td>Spkr/Load: Speaker</td><td>Voltage: 7.5 Vdc</td></tr>
<tr><td rowspan="4">Receiver Checks
RF Control: GEN
Output Level: -47 dBm
Modulation: 1 kHz tone @3 kHz deviation
Frequency: Set to selected radio RX frequency
Meter: AC Volts

Transmitter Checks
RF Control: Monitor
Frequency: Set to selected radio TX frequency
Meter: RF Display
Modulation Type: FM
Attenuation: 20 dB</td><td>PTT: OFF (center)</td><td>DC On/Standby: Standby</td></tr>
<tr><td>Meter Out: RX</td><td>Volt Range: 10 Vdc</td></tr>
<tr><td>Opt Sel: ON</td><td rowspan="2">Current: 2.5 Amps</td></tr>
<tr><td></td></tr>
</table>

* *Use “PROJ 25 STD” if testing ASTRO Conventional channels.*

5.2 Display Radio Test Mode

This section provides instructions for performing tests in display radio test mode.

5.2.1 Access the Test Mode

To enter the display radio test mode:

1. Turn the radio on.
2. Within 10 seconds, press **Side Button 2** five times in succession.

   The radio shows a series of displays that give information regarding various version numbers and subscriber specific information. The displays are described in Table 5-2.

Table 5-2. Test-Mode Displays

Name of Display	Description	Appears
Service	The literal string indicates the radio has entered test mode.	Always
Host version	The version of host firmware is displayed.	Always
DSP version	The version of DSP firmware is displayed.	Always
Model number	The radio's model number, as programmed in the codeplug	Always
Serial number	The radio's serial number, as programmed in the codeplug	Always
ESN	The radio's unique electronic serial number	Always
ROM Size	The memory capacity of the host FLASH part	Always
FLASHcode	The FLASH codes as programmed in the codeplug	Always
RF band 1	The radio's operating frequency	Always
Tuning Ver	Version of Tuning codeplug	Always
Proc Ver	Version of Processor	Always
Option Board Type	Type of Keypad board being used	When the radio has an Option Board/Expanded Keypad Board.
Option Board Serial Number	Serial number of the Keypad board is displayed	When the radio has an Expanded Keypad Board.
Option Board Sw Version	Software version of the Keypad Board is displayed	When the radio has an Expanded Keypad Board.
Exp Board Type	Type of Keypad Board is displayed	When the radio has a Keypad Board.

NOTE: All displays are temporary and will expire without any user intervention. If information is longer than the physical length of the radio's display, the information will wrap around to the next display. After the last display, "**RF TEST**" is displayed.

To freeze any of the displays, press the left arrow on the 4-Way Navigation Button. To resume automatic scrolling, press the right arrow on the 4-Way Navigation Button. To rapidly scroll forward through the displays, continue pressing the right arrow. You cannot scroll backwards.

NOTE: Press the **Top Side Button** (Purple button) to advance the test environments from "**RF TEST**", "**CH TEST**", "**RGB TEST**" then press the **Top Button** (Orange button) to confirm selection. Press any other buttons to advance the test.

Once a test is carried out, restart the radio to proceed to another test.

3. Do one of the following:
   - Press the **Top Side Button** to stop the displays and toggle between RF test mode and the Control Top and Keypad test mode. The test mode menu "**CH TEST**" is displayed, indicating that you have selected the Control Top and Keypad test mode. Go to Section 5.2.3.

     NOTE: Each press of the **Top Side Button** (Purple button) scrolls through "**RF TEST**", "**CH TEST**" and "**RGB TEST**".

   - Press the **Top Button** (Orange button) to stop the displays and put the radio into the RF test mode. The test mode menu, "**1 CSQ**", is displayed, indicating test frequency 1, Carrier SQuelch mode. Go to Section Section 5.2.2.

     NOTE: Once your radio is in a particular test mode, you must turn off the radio and turn it back on again to access the other test mode.

5.2.2 RF Test Mode

When the ASTRO APX 1000 radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting, according to the customer codeplug configuration. However, when the unit is on the bench for testing, alignment, or repair, it must be removed from its normal environment using a special routine, called **RF TEST MODE**.

While in RF test mode:

- Each additional press of **Side Button 2** advances to the next test channel. (Refer to Table 5-3.)
- Pressing **Side Button 1** scrolls through and accesses the test environments shown in Table 5-4.
- Pressing **Top Side Button** scrolls through the Tx Deviation Frequency.

NOTE: Transmit into a load when keying a radio under test.

Table 5-3. Test Frequencies (MHz) – VHF, UHF1, UHF2, 700/800 MHz

Test Channel	VHF		UHF1		UHF2		700/800 MHz	
	RX	TX	RX	TX	RX	TX	RX	TX
F1	136.075	136.025	380.075	380.025	450.075	450.025	764.0625	764.0125
F2	142.075	142.125	390.075	390.025	460.075	460.025	769.0625	769.0125
F3	154.275	154.225	400.075	400.025	471.075	471.025	775.9375	775.9875
F4	160.175	160.125	411.075	411.025	484.925	484.975	851.0625	794.0125
F5	168.125	168.075	424.975	424.925	485.075	485.025	860.0625	809.0125
F6	173.925	173.975	435.075	435.025	495.075	495.025	869.9375	823.9875
F7	–	–	445.075	445.000	506.075	506.025	851.0625	851.0125
F8	–	–	445.075005	445.000005	519.925	519.975	860.0625	860.0125
F9	–	–	457.075	457.025	–	–	869.9375	869.8875
F10	–	–	469.975	469.925	–	–	–	–

Table 5-4. Test Environments

Display	Description	Function
CSQ	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
TPL	Tone Private-Line	RX: unsquelch if carrier and tone (192.8 Hz) detected TX: mic audio + tone (192.8 Hz)
AST	ASTRO	RX: none TX: Digital Voice***
USQ	Carrier Unsquelch	RX: unsquelch always TX: mic audio

****All deviation values are based on deviation tuning of this mode.*

5.2.3 Control Top and Keypad Test Mode

This test mode is used to verify proper operation of all radio buttons and switches if a failure is suspected.

5.2.3.1 Control Top Checks

To perform the control top checks:

1. Press and hold the **Top Button** (Orange button); the radio icons are displayed, and the LED lights amber and lightbar LED light green.
2. Release the **Top Button**; “148/0” appears, which indicates that the **Top Button** is in the open position. Your radio is now in the Control Top and Keypad test mode.
3. Press the **Top Button** again; “148/1” appears, which indicates that the **Top Button** is in the closed position.
4. Rotate the **Volume Control**; “11/0” through “11/255” appear. The display values may vary slightly at the upper and lower limits. Press gives “91/1”, release gives “91/0”.
5. Press the **Top Side Button**; “96/1” appears; release, “96/0” appears.
6. Press **Side Button 1**; “97/1” appears; release, “97/0” appears.
7. Press **Side Button 2**; “98/1” appears; release, “98/0” appears.
8. Press the **PTT Button**; “1/1” appears; release, “1/0” appears.

5.2.4 RGB Test Mode

To perform the RGB Color Test:

1. Press and release **Top Button** (Orange button)
2. Press any key; Crosstalk test patterns appears.
3. Press any key; White color test appears.
4. Press any key; Red color horizontal lines appears.
5. Press any key until all 13 red color horizontal lines appears.
6. Press any key; Green color vertical line appears.
7. Press any key until all 13 green color vertical lines appears.
8. Press any key; Black color test appears.
9. Press any key; Blue color test appears.
10. Press any key; Vendor specific display test appears.
11. Press any key; "`Test completed`" appears.

5.3 Receiver Performance Checks

The following tables outline the performance checks for the receiver.

Table 5-5. Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check)	**VHF:** ±2 ppm (272–348 Hz) **UHF1:** ±2 ppm **UHF2:** ±2 ppm **700/800 MHz:** ±1.5ppm (1146–1305 Hz)
Rated Audio	**RF Control:** Gen **Output Level:** -47 dBm **Freq:** Selected radio RX freq. **Mod:** 1 kHz tone @ 3 kHz dev. **Meter:** AC Volts	As above	**PTT** to OFF (center)	Set volume control to 3.74 Vrms
Distortion	As above, except **Meter:** Ext Dist.	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except **Meter:** SINAD	As above	As above	RF input to be < 0.35 μV
Noise Squelch Threshold (only radios with conventional system need to be tested)	Set as for rated audio check	Out of TEST MODE; select a conventional system	As above	Set volume control to 3.74 Vrms. Set RF level to -130 dBm and raise until radio unsquelches. Unsquelch to occur at < 0.25 μV. Preferred SINAD = 6-8 dB.

* *See* Table 5-4 on page 1:5-5.

*Table 5-6. Receiver Tests for ASTRO Conventional Channels**

Test Name	System Analyzer	Radio	Test Set	Comments
Bit Error rate (BER) Floor	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code:** 1011 Hz PAT	Radio Tuner Software (Bit Error Rate screen) is required	**PTT** to OFF (center)	BER < 0.01% (Use test setup shown in Figure 6-1)
Reference Sensitivity	As above; lower the output level until 5% BER is obtained	As above	As above	Output level < 0.35 μV (-116 dBm) (Use test setup shown in Figure 6-1)
Audio Output Distortion	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code:** 1011 Hz PAT **Meter:** Ext. Distortion	Radio Tuner Software not used; **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to OFF (center) Meter selector to **Audio PA** Spkr/Load to **Speaker**	Distortion < 3.0%
Residual Audio Noise Ratio	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code**: A) 1011 Hz PAT B) Silence PAT **Meter:** AC Volts	As above	As above	Residual Audio Noise Ratio -45 dB

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

5.4 Transmitter Performance Checks

The following tables outline the performance checks for the transmitter.

Table 5-7. Transmitter Performance Checks – APX 1000

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check).	**VHF:** ±2 ppm (272–348 Hz) **UHF1:** ±2 ppm **UHF2:** ±2 ppm **700/800 MHz:** ±1.5ppm (1146–1305 Hz)
RF Power	As above	As above	As above	**VHF**: 1–5 Watt **UHF1**: 1–5 Watt **UHF2**: 1–5 Watt **700**: 1–2.5 Watt **800**: 1–3 Watt
Voice Modulation (external)	As above. Set fixed 1 kHz audio level to 400 mV.	As above	As above	Deviation: (12.5 kHz) ≥ 2.1 kHz, but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz, but ≤ 5.0 kHz
Voice Modulation (internal)	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	As above	Remove modulation input. **PTT** to OFF (center)	Press **PTT** button on radio. Say “four” loudly into the radio mic. Measure deviation: (12.5 kHz) ≥ 2.1 kHz but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz but ≤ 5.0 kHz
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	As above	Conventional coded squelch personality (clear mode operation) or TPL channel (test mode*)	**PTT** to continuous (during the performance check)	Deviation: (12.5 kHz) ≥ 375 Hz but ≤ 500 Hz (25 kHz) ≥ 500 Hz but ≤ 1000 Hz

* *See Table 5-4.*

Table 5-8. Transmitter Tests for ASTRO Conventional Channels – APX 1000

Test Name	System Analyzer	Radio	Test Set	Comments
RF Power	**Mode:** Proj 25 Std **RF Control:** Monitor **Meter:** RF Display	Radio Tuner Software not used. **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to continuous (during measurement).	**VHF**: 1–5 Watt **UHF1**: 1–5 Watt **UHF2**: 1–5 Watt **700**: 1–2.5 Watt **800**: 1–3 Watt
Frequency Error	As above	As above	As above	Error ≤ ±1.0 kHz
Frequency Deviation	As above	Radio Tuner Software (Transmitter Test Pattern screen) is required) **High use:** Symbol Rate PAT **Low use:** Low Symbol Rate P	**PTT** to OFF (center)	D_{HIGH} ≥ 2.543 kHz but ≤ 3.110 kHz D_{LOW} ≥ 0.841 kHz but ≤ 1.037 kHz (Use test setup shown in Figure 6-1)

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

Chapter 6 Radio Alignment Procedures

This chapter describes both receiver and transmitter radio alignment procedures.

6.1 Test Setup

A personal computer (PC) and tuner software are required to align the radio. Refer to the applicable manual for installation and setup procedures for the software. To perform the alignment procedures, the radio must be connected to the PC and to a universal test set. The radio alignment test setup is shown in Figure 6-1.

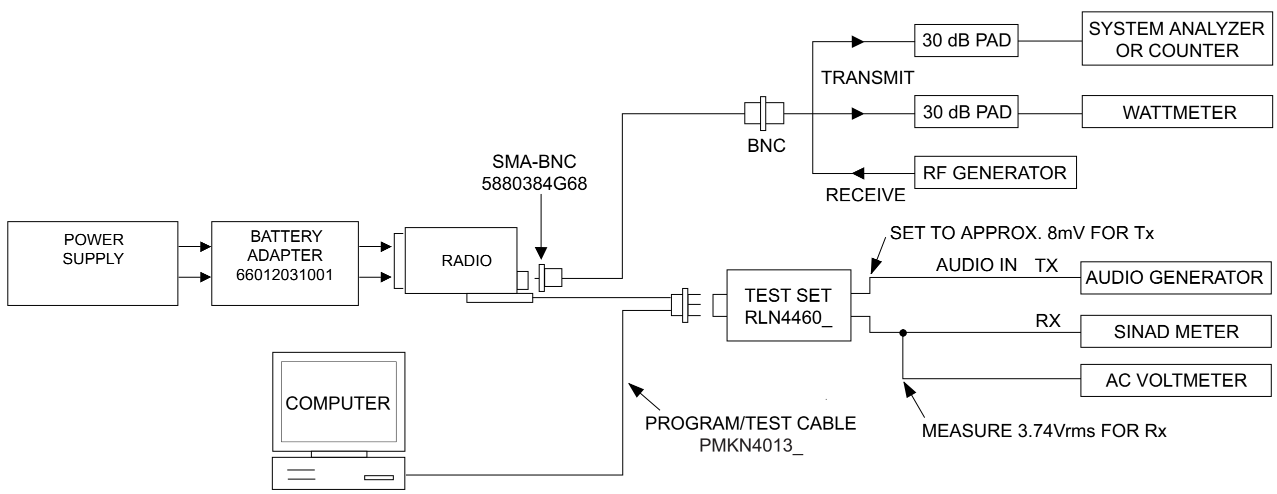

Figure 6-1. Radio Alignment Test Setup

Caution	These radio alignment procedures should only be attempted by qualified service personnel. Failure to perform alignment procedures properly may result in seriously degraded radio or system performance.

6.2 Tuner Main Menu

Select **Tuner** from the **START** menu by clicking **Start › Program Files › Motorola › ASTRO 25 Products › ASTRO 25 Tuner**. To read the radio, use the F**ile › Read Device** menu or click on Read Device. Figure 6-2 illustrates how the alignment screens are organized. To access a screen, double-click on the desired screen name in the **Tuner** menu.

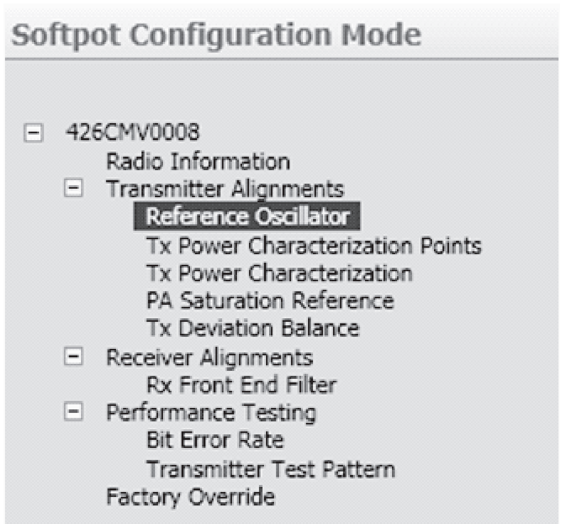

Figure 6-2. Tuner Software Main Menu

IMPORTANT: Tuning should follow the order of the Tuning tree view in descending order from top to bottom

6.3 Softpot

The alignment screens introduce the concept of the “softpot,” an analog **SOFT**ware-controlled **POT**entiometer used for adjusting all transceiver alignment controls.

Caution	DO NOT switch radios in the middle of any alignment procedure. Always left-click the **Close** button on the screen to return to the Main Menu screen before disconnecting the radio. Improper exits from the alignment screens might leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

Each alignment screen provides the ability to increase or decrease the softpot value by using a slider, or by entering the new value from the keyboard directly into the box. The slider bar indicates the current softpot value; see Figure 6-3.

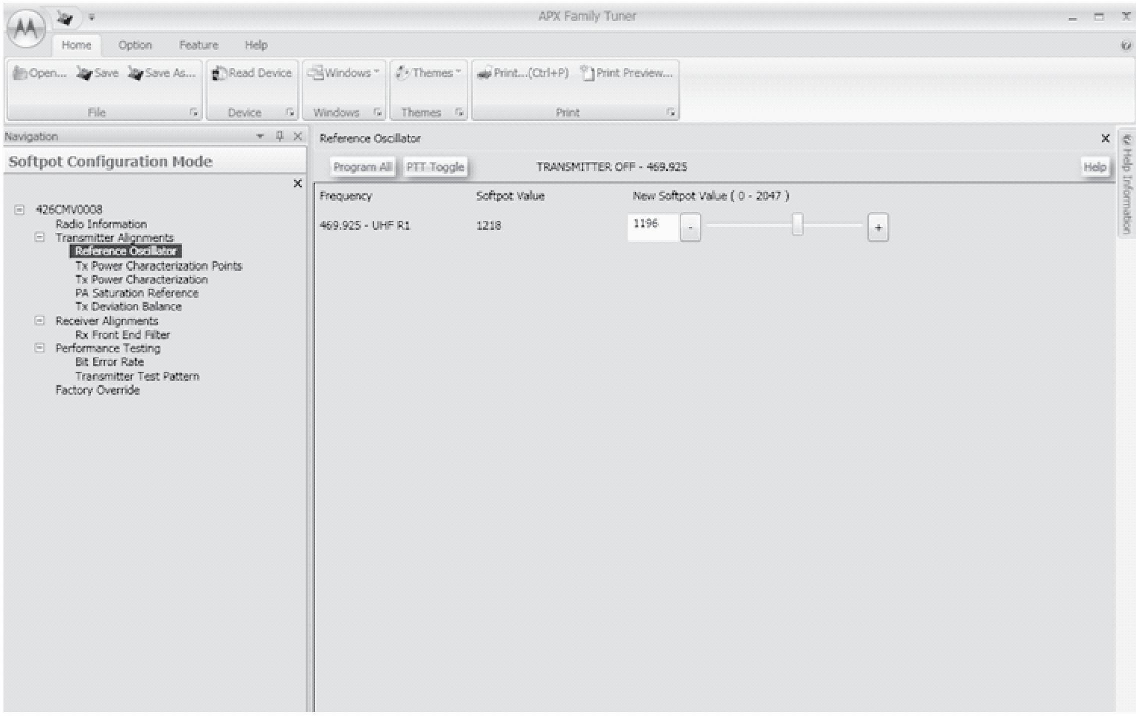

Figure 6-3. Typical Softpot Screen

Adjusting the softpot value sends information to the radio to increase (or decrease) the voltage in the corresponding circuit. For example, left-clicking the UP spin button in the New Softpot Value scroll box on the **Reference Oscillator** screen instructs the radio's microcomputer to increase the voltage across a varactor in the reference oscillator, which increases the frequency.

In ALL cases, the softpot value is just a relative number corresponding to a digital-to-analog (D/A) generated voltage in the radio.

Perform the following procedures in the sequence indicated.

NOTE: Some of the following screens may vary depending upon the radio under test and the version of tuner software you are using. Refer to the software's online help.

Caution

When keying the radio during a test, always transmit into a dummy load.

6.4 Radio Information

Figure 6-4 shows a typical Radio Information screen. This screen is informational only and cannot be directly changed.

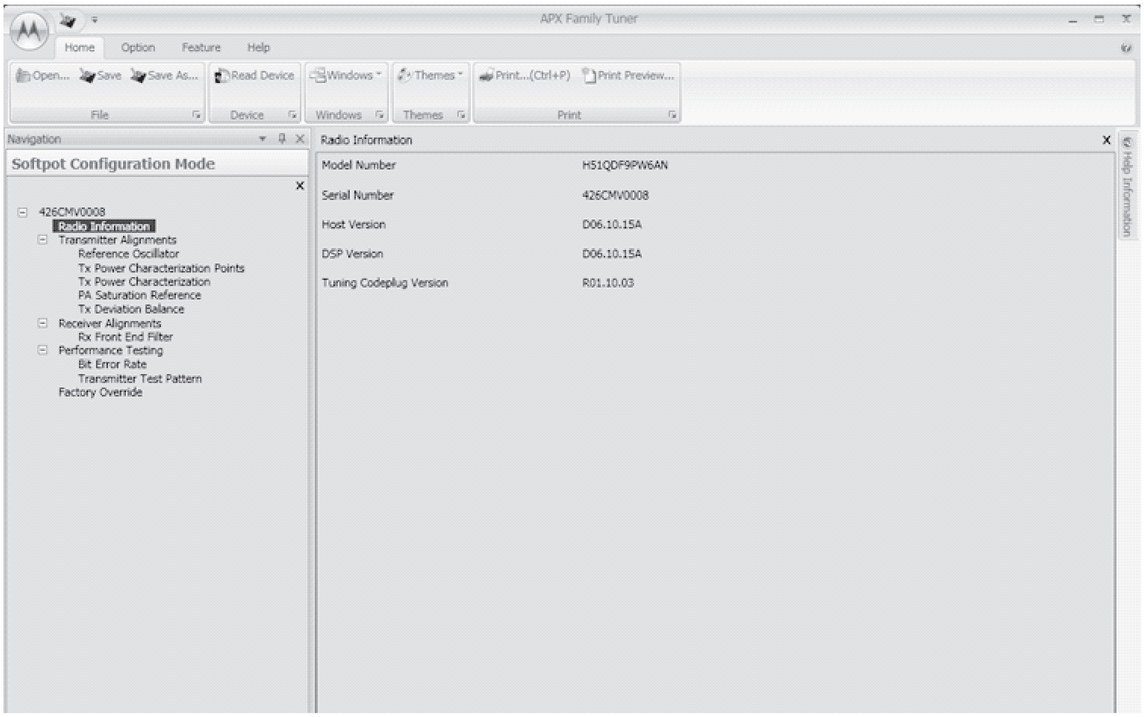

Figure 6-4. Radio Information Screen

6.5 Transmitter Alignments

6.5.1 Reference Oscillator Alignment

Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment will result not only in poor operation, but also in a misaligned radio that will interfere with other users operating on adjacent channels. For this reason, the reference oscillator should be checked every time the radio is serviced, or once a year, whichever comes first. The frequency counter used for this procedure must have a stability of 0.1 ppm (or better).

NOTE: Reference oscillator alignment is required after replacing (or servicing) the transceiver board.

This test can be done with either the R-2670 Communication Analyzer or the 8901_ Modulation Analyzer.

- Initial setup using the R-2670 Communication Analyzer:
  - RF Control: Monitor
  - B/W: WB
  - Freq: CPS frequency under test
  - Attenuation: 20dB
  - Mon RF in: RF I/O
  - Meter: RF Display
  - Mode: STD
  - Input Level: uV or W
  - Display: Bar Graphs
  - Squelch: Mid-range or adjust as necessary
- Initial setup using the 8901_ Series Modulation Analyzer:
  - Press the green **Automatic Operation** button on the analyzer.
  - Press the **FREQ** key.
  - Type **7.1** followed by **SPCL** button to set the 8901B_ modulation analyzer for maximum accuracy.

To align the reference oscillator:

Select the **Reference Oscillator** alignment screen. See Figure 6-5, Figure 6-6, Figure 6-7 and Figure 6-8.

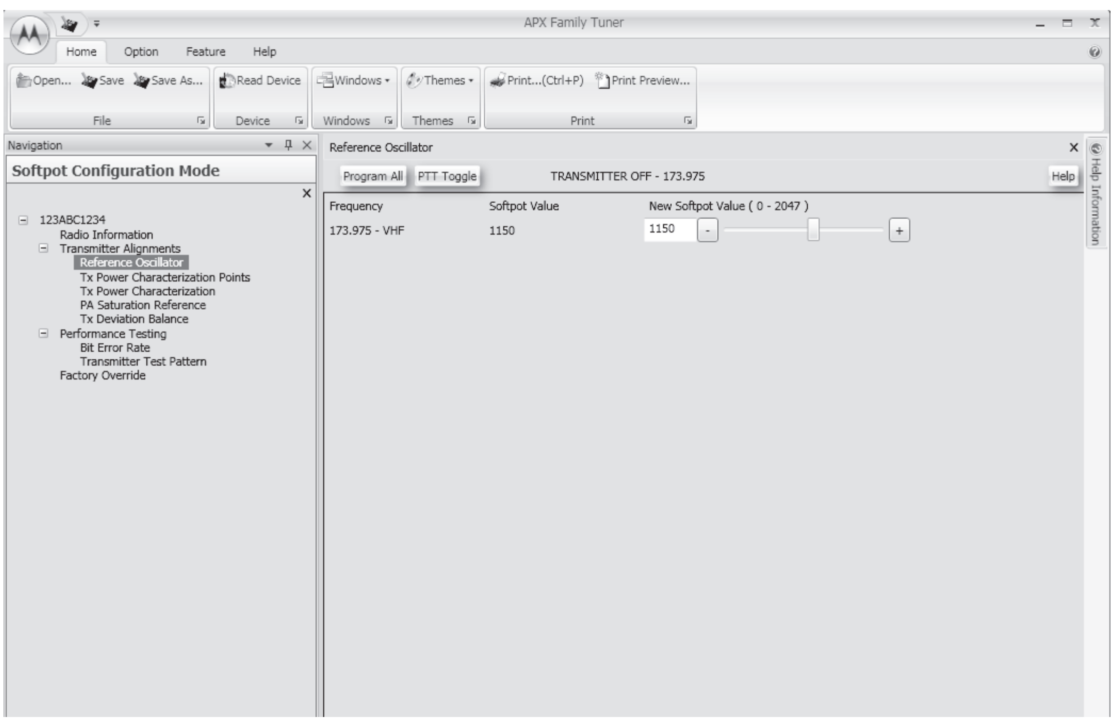

Figure 6-5. Reference Oscillator Alignment Screen (VHF)

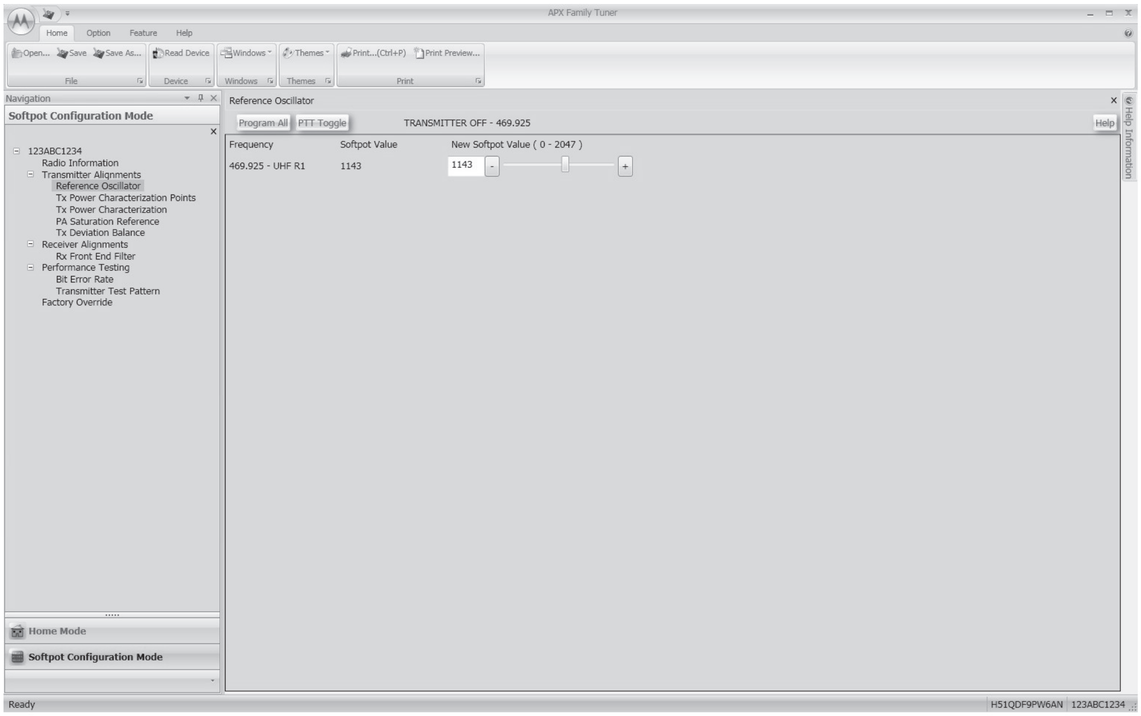

Figure 6-6. Reference Oscillator Alignment Screen (UHF1)

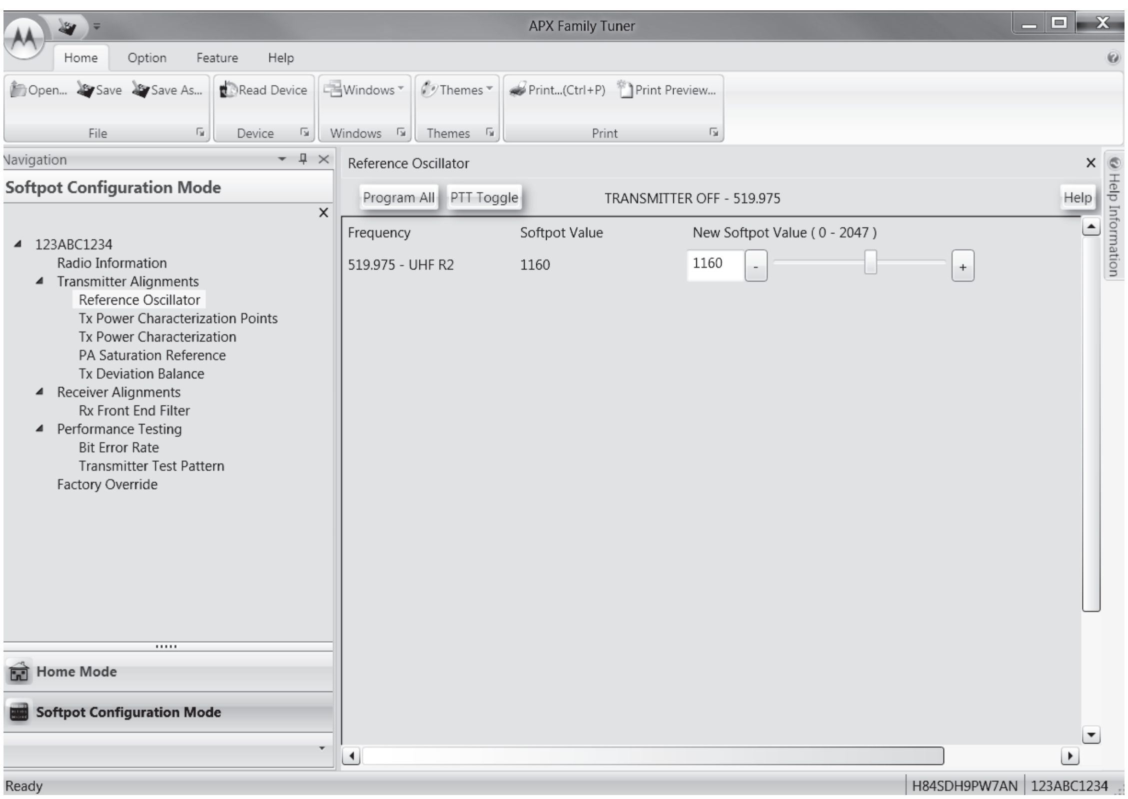

Figure 6-7. Reference Oscillator Alignment Screen (UHF2)

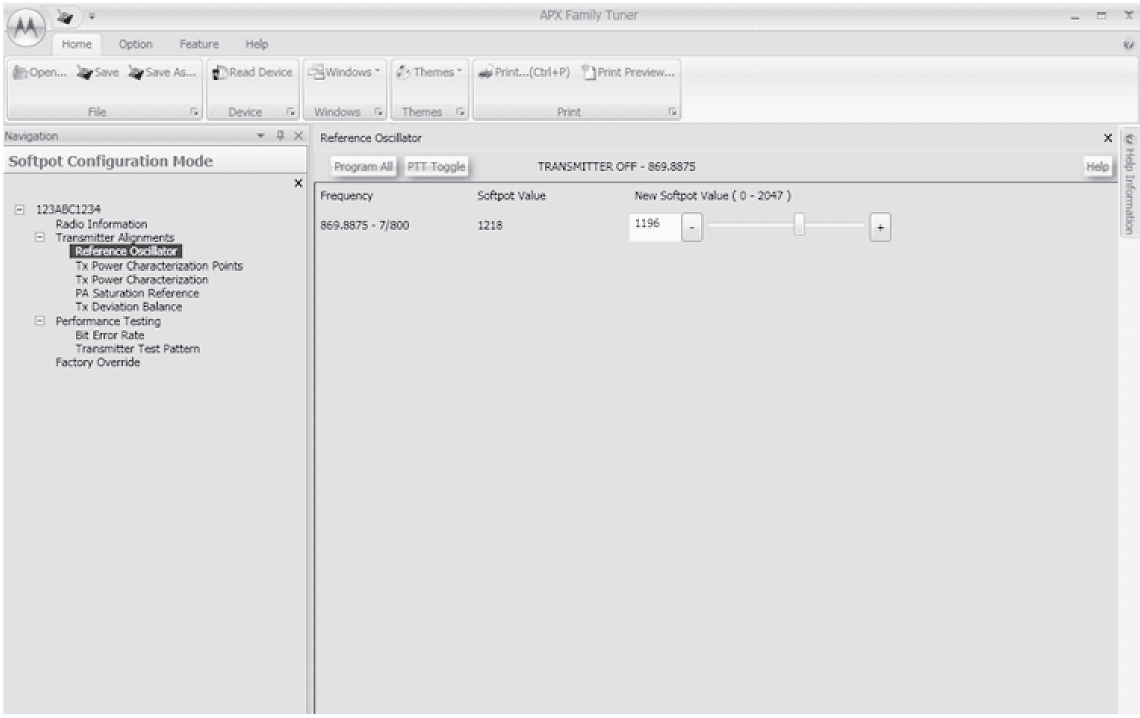

Figure 6-8. Reference Oscillator Alignment Screen (700/800 MHz)

1. Make sure the Communication Analyzer is in **Manual** mode.

   <u>VHF</u>
   - Set the base frequency to 173.925 MHz

   <u>UHF1</u>
   - Set the base frequency to 469.925 MHz

   <u>UHF2</u>
   - Set the base frequency to 519.975 MHz

   <u>700/800 MHz</u>
   - Set the base frequency to 869.8875 MHz

2. Adjust the reference oscillator's softpot value with the slider until the measured value is as close as possible to the frequency shown on the screen. See Table 6-1.

   NOTE: Increases the slider decreases the frequency and vice versa.

Table 6-1. Reference Oscillator Alignment

Band	Target
VHF	±100 Hz
UHF1	±100 Hz
UHF2	±100 Hz
700/800 MHz	±100 Hz

3. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.
4. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

6.5.2 Power Characterization Points

Tuning of the radio is done through **Power Characterization Points** tuning screen.

1. Select the **TX Power Characterization Points** alignment screen. See Figure 6-9, Figure 6-10, Figure 6-11 and Figure 6-12.
2. Set power supply voltage and current limit.
3. Adjust softpot value by manipulating the slider bar, incrementing the "New Softpot Value" text box, or directly entering the desired value into the "New Softpot Value" text box until the rated power is indicated on the service Monitor. For rated power refer to the help text in the Tuner.
4. Repeat the steps 2 and 3 for all frequencies.
5. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

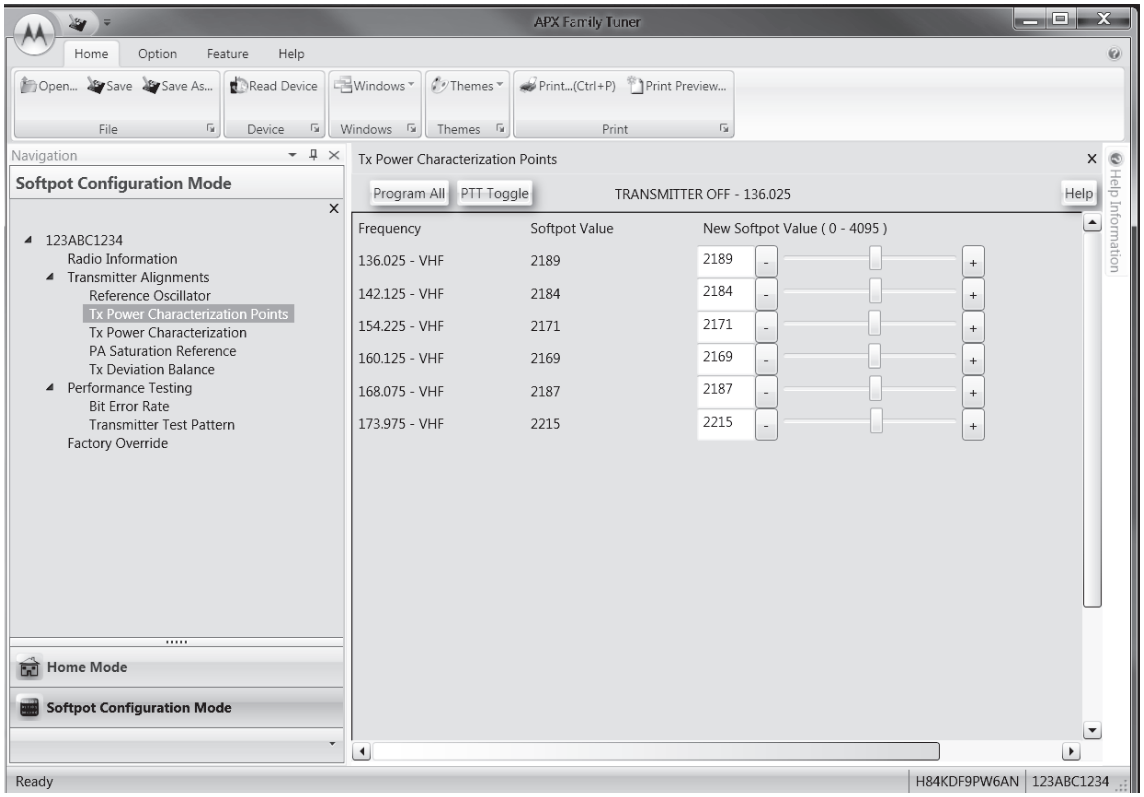

Figure 6-9. Transmit Power Characterization Points Alignment Screen (VHF)

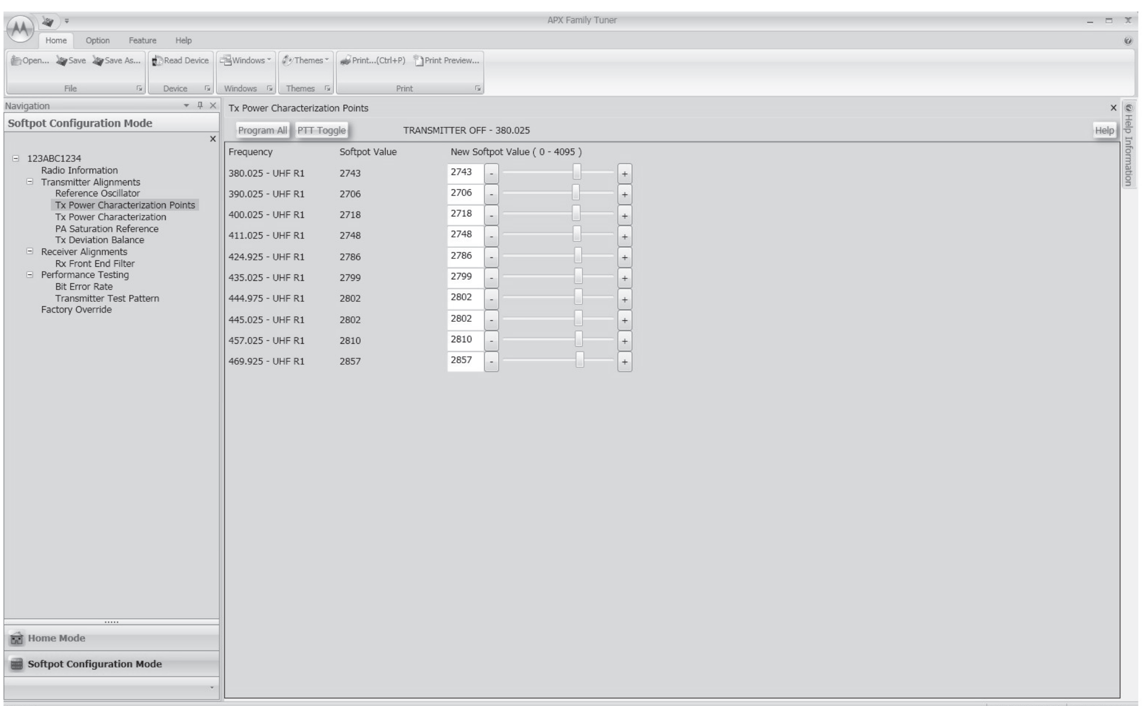

Figure 6-10. Transmit Power Characterization Points Alignment Screen (UHF1)

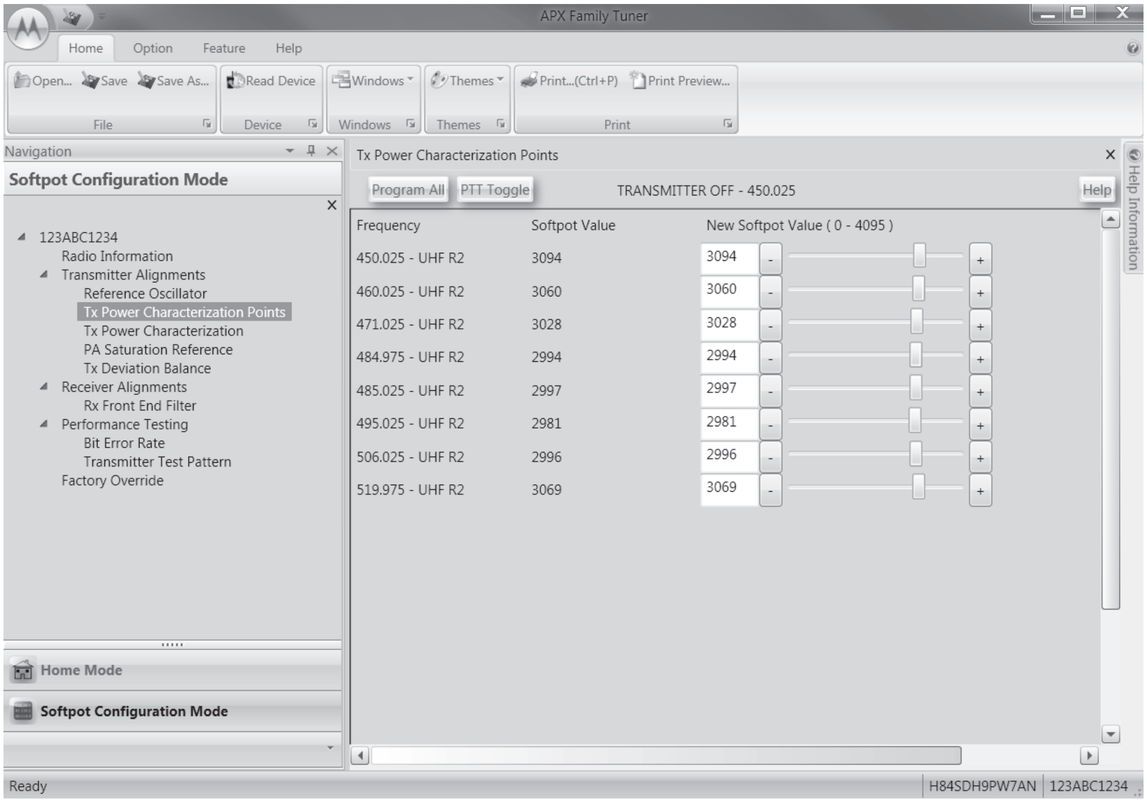

Figure 6-11. Transmit Power Characterization Points Alignment Screen (UHF2)

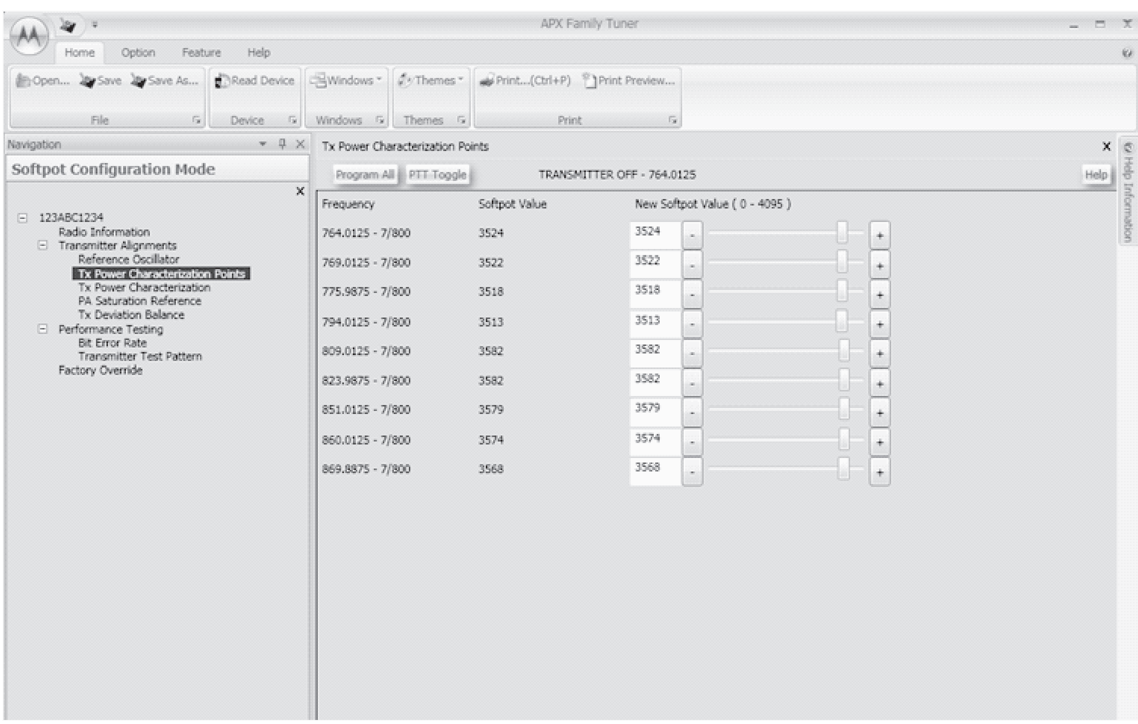

Figure 6-12. Transmit Power Characterization Points Alignment Screen (700/800MHz)

6.5.3 Power Characterization Tuning

Tuning of the radio is done through **Power Characterization** tuning screen.

IMPORTANT: Power Characterization Tuning Points must be tuned before tuning Power Characterization Tuning.

NOTE: a.The longer the RF cable, the more the attenuation of the power reading.

b.Use a standard 50 ohm cable.

c. Remember to set the Communication Analyzer to baseband power.

1. Select the **TX Power Characterization** alignment screen. The screen indicates the transmit power to be used. See Figure 6-13, Figure 6-14, Figure 6-15 and Figure 6-16.
2. Left-click the box under “Measure Power 1” for the desired frequency field. (The selected box is highlighted).
3. Click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
4. Measure the transmit power of the radio with a service Monitor.
5. Input the transmit power in watts using two decimal places into the highlighted “Measure Power 1” box.
6. Left-click the box under “Measure Power 2” box for the same frequency field. (The selected box is highlighted).
7. Measure the transmit power of the radio with a service Monitor.
8. Input the transmit power in watts using two decimal places into the highlighted “Measure Power 2” box.
9. Repeat steps 2 to 8 for all frequencies.
10. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

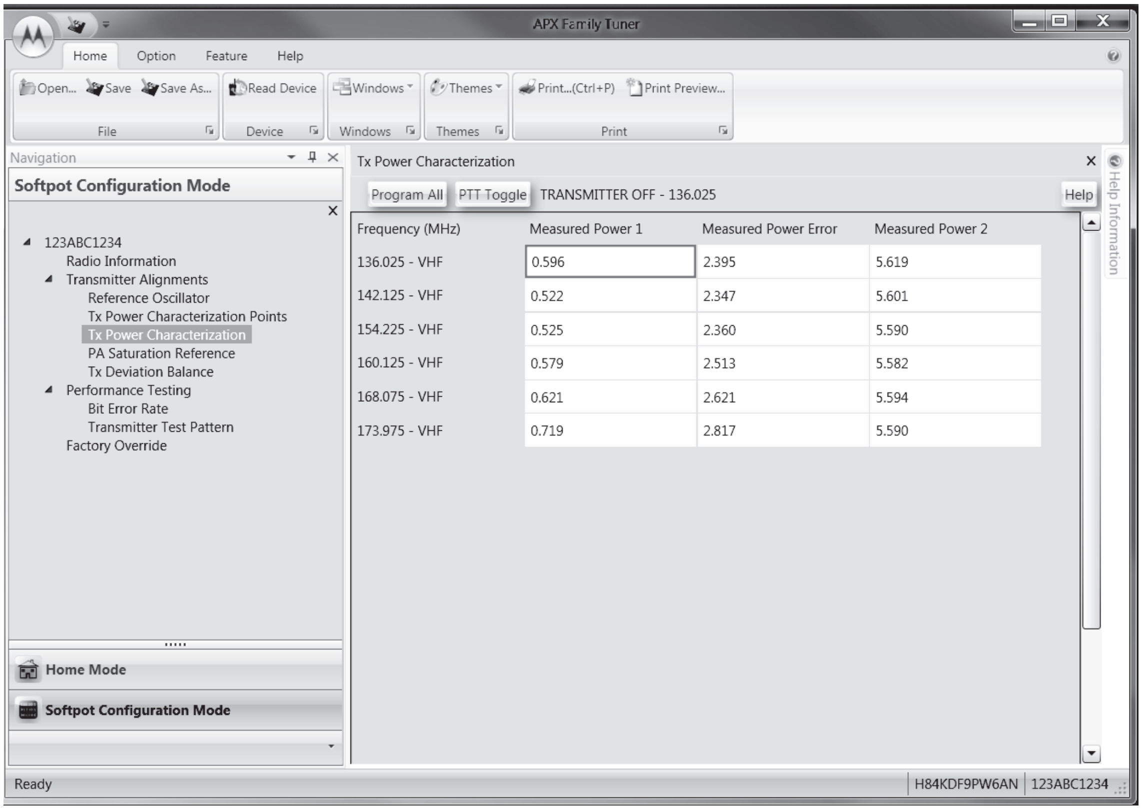

Figure 6-13. Transmit Power Characterization Alignment Screen (VHF)

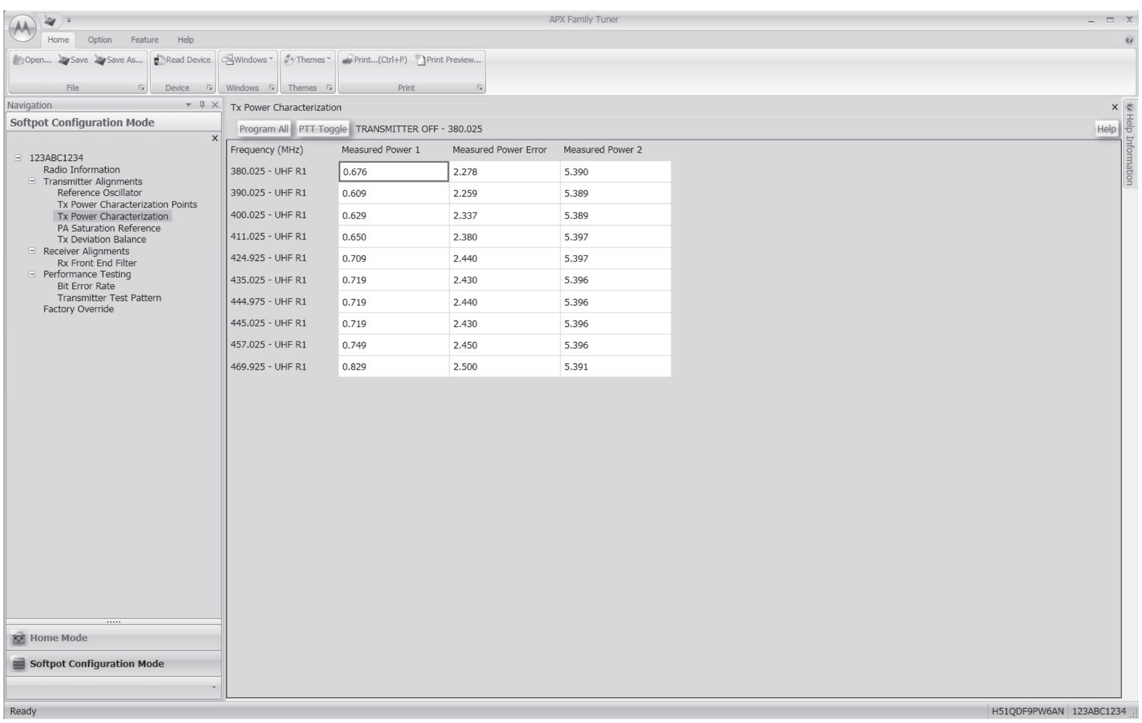

Figure 6-14. Transmit Power Characterization Alignment Screen (UHF1)

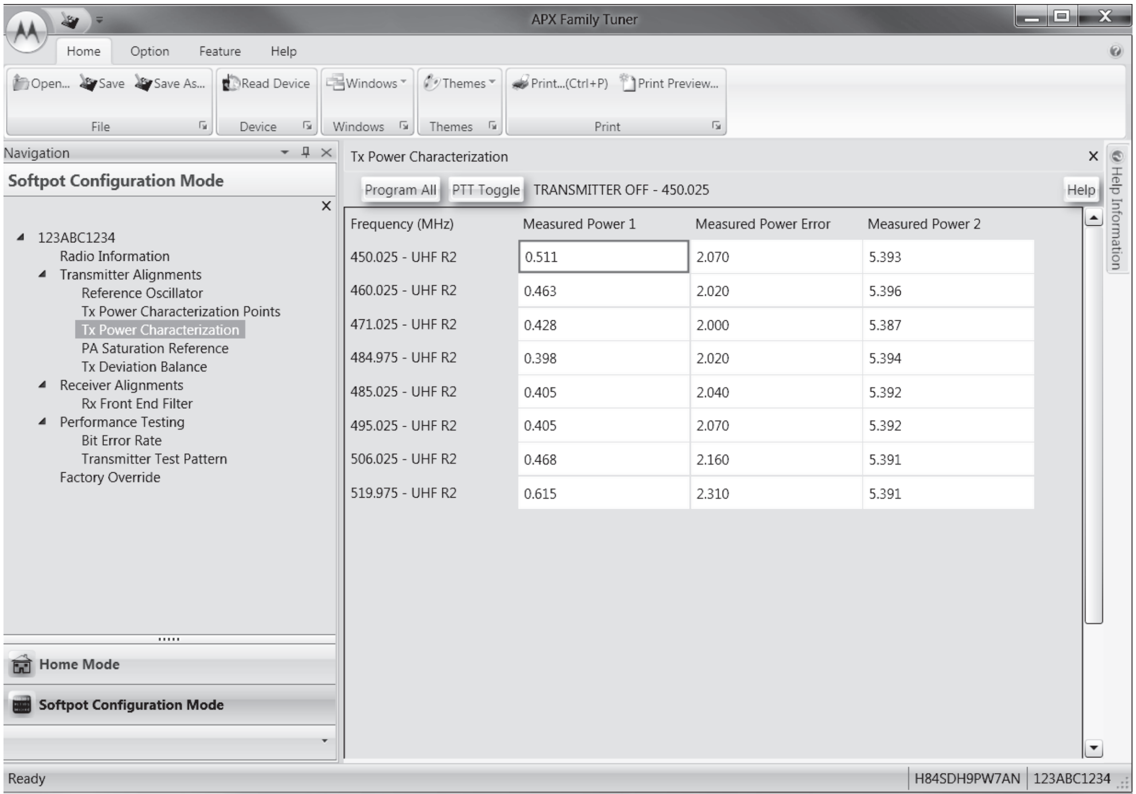

Figure 6-15. Transmit Power Characterization Alignment Screen (UHF2)

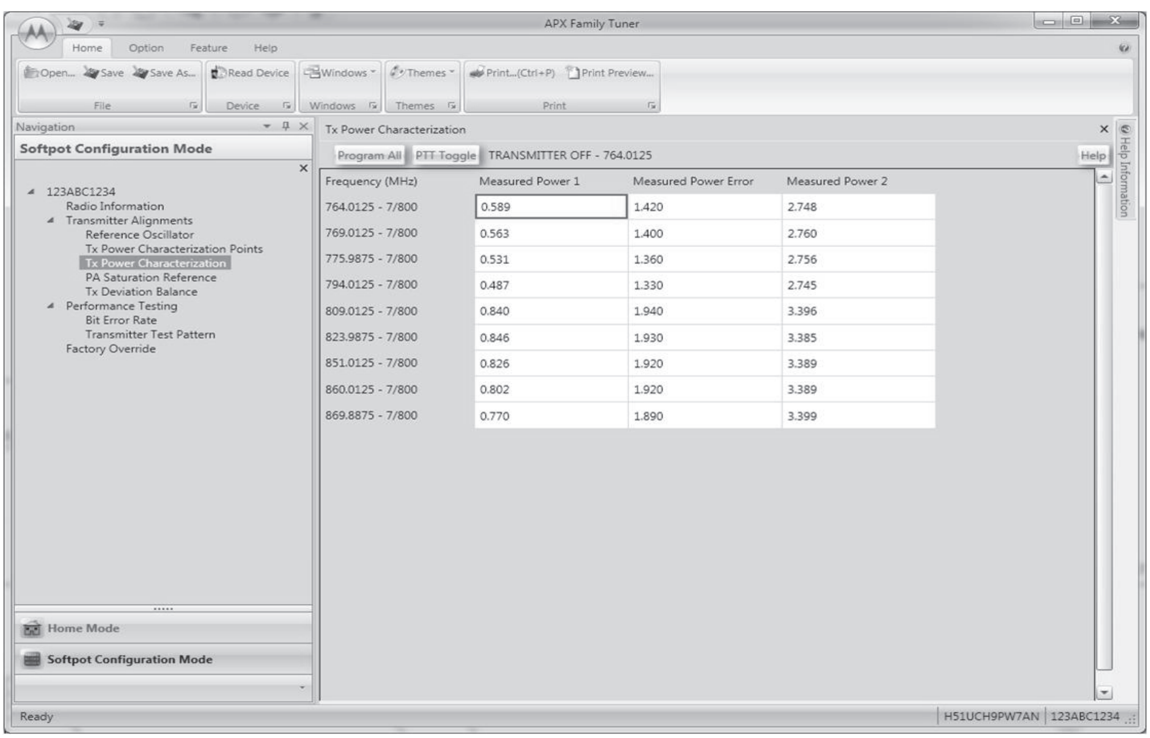

Figure 6-16. Transmit Power Characterization Alignment Screen (700/800 MHz)

6.5.4 Transmit Deviation Balance Alignment

This alignment procedure balances the modulation contributions of the low- and high-frequency portions of a baseband signal. Proper alignment is critical to the operation of signalling schemes that have very low frequency components (for example, DPL) and could result in distorted waveforms if improperly adjusted.

This procedure needs to be performed at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone.

NOTE: This alignment is required after replacing (or servicing) the main board.

Proper alignment requires a modulation analyzer or meter with a frequency response to less than 10 Hz modulating frequency. The modulation analyzer settings during this test should be set for average deviation, a 15 kHz low-pass filter, no de-emphasis, and no high-pass filter, if these settings are supported.

This alignment can be done with either the R-2670 Communication Analyzer or the 8901_ Series Modulation Analyzer. The method of choice is the R-2670 analyzer.

1. Initial setup using the R-2670 Communication Analyzer:
   - Connect a BNC cable between the “DEMOD OUT” port and the “VERT/SINAD DIST/DMM COUNTER IN” port on the R-2670.
   - Press the **SPF** key on the R-2670 to display the “SPECIAL FUNCTIONS MENU.” Move the cursor to “High Pass,” and select 5 Hz on the soft key menu. Select 20 kHz for the “Low Pass” setting.
   - In the “RF Control” section of the R-2670, move the cursor to the “B/W” setting and select “WIDE +/- 100 kHz” on the soft key menu.
   - Place the R-2670 cursor in the “Display” zone. Select “AC VOLTS” on the soft key menu. Move the cursor to the “Range” setting and select “AUTO.”
2. Initial setup using the 8901_ Series Modulation Analyzer:
   - Press the **FM MEASUREMENT** button. (The “*Error 0input level too low”* indication is normal until an input signal is applied.)
   - Simultaneously press the **Peak –** and **Peak +** buttons. Both LEDs on the buttons should light.
   - Press the 15 kHz LP filter key.
3. Select the **TX Deviation Balance** alignment screen. The screen indicates the transmit frequencies to be used. See Figure 6-17, Figure 6-18, Figure 6-19 and Figure 6-20.
4. In the "RF Control" section of the R2670, set the service Monitor to the desired frequency (as shown in the frequency list in the TX Deviation Balance alignment screen).
5. Left-click the **PTT Tone: Low** button.
6. Left-click the slider of the frequency selected (should be the same frequency as step 4).
7. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
8. Measure and Record the Low Tone Tx Deviation value from the 8901_ Series Analyzer or the AC voltage value from the R2670.
9. Left-click the **PTT Tone: High** button.
10. Adjust the softpot value until the measured deviation/voltage, when using the high tone, is within +/- 1.5% of the value observed when using the Low Tone.
11. Left-click the **PTT Toggle** to de-key the radio.

12. Repeat the steps 4 to 10 for all frequencies.
13. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

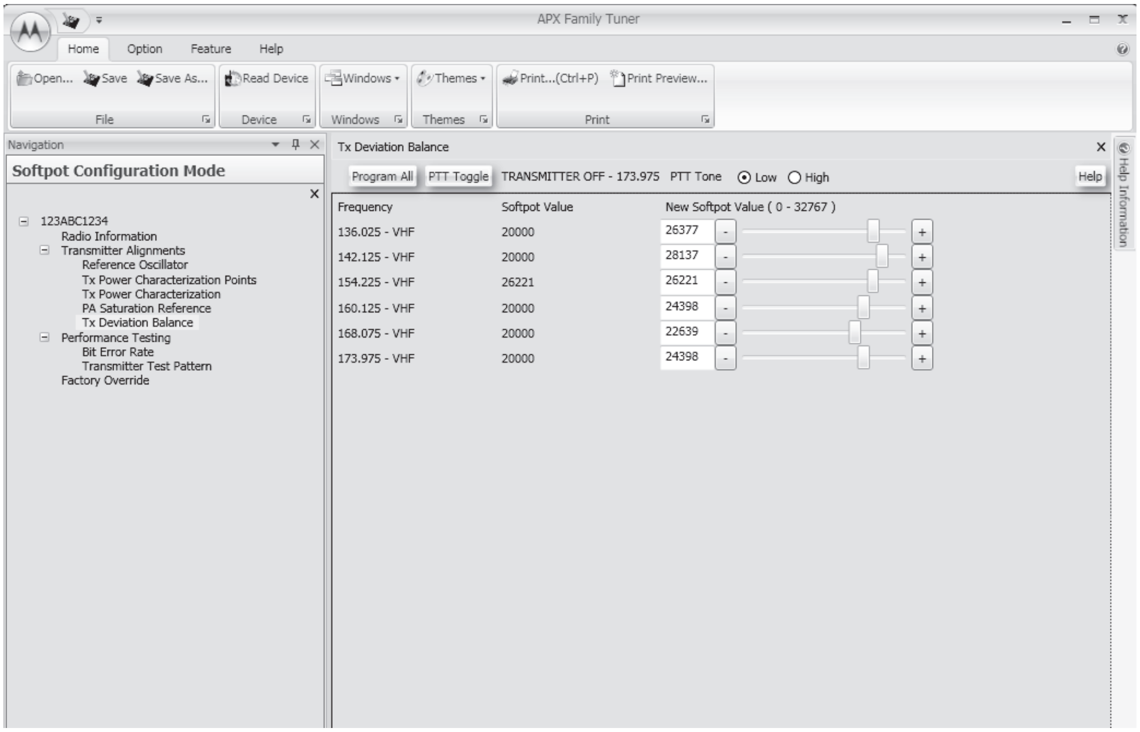

Figure 6-17. Transmit Deviation Balance Alignment Screen (VHF)

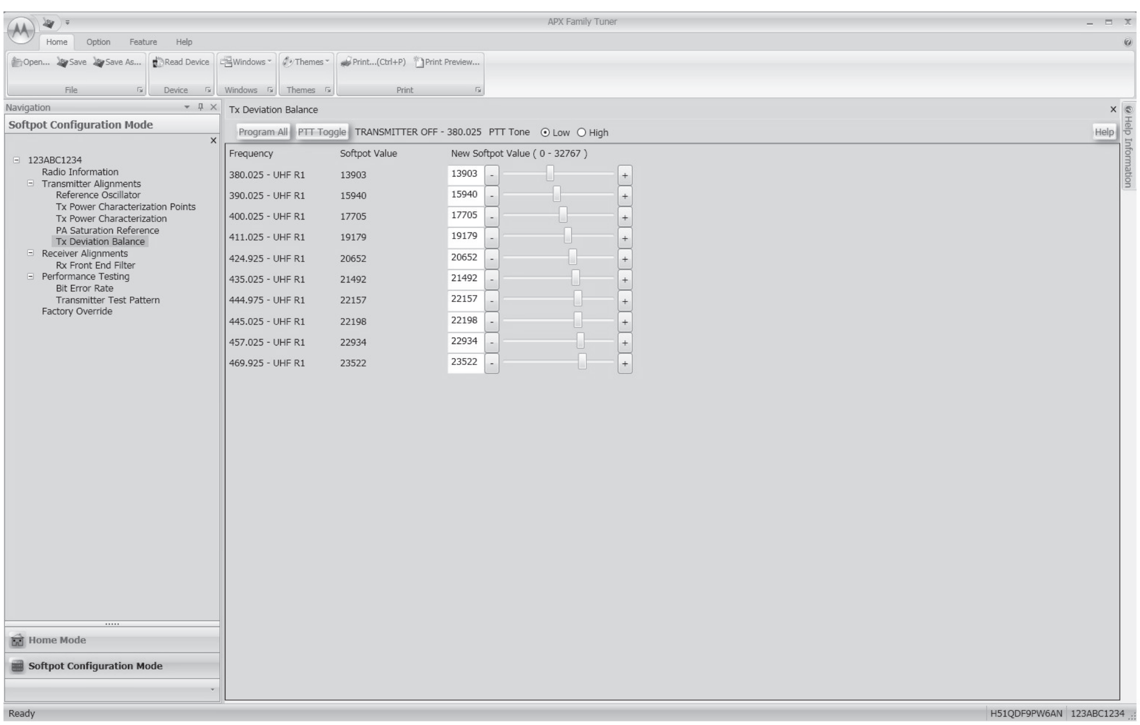

Figure 6-18. Transmit Deviation Balance Alignment Screen (UHF1)

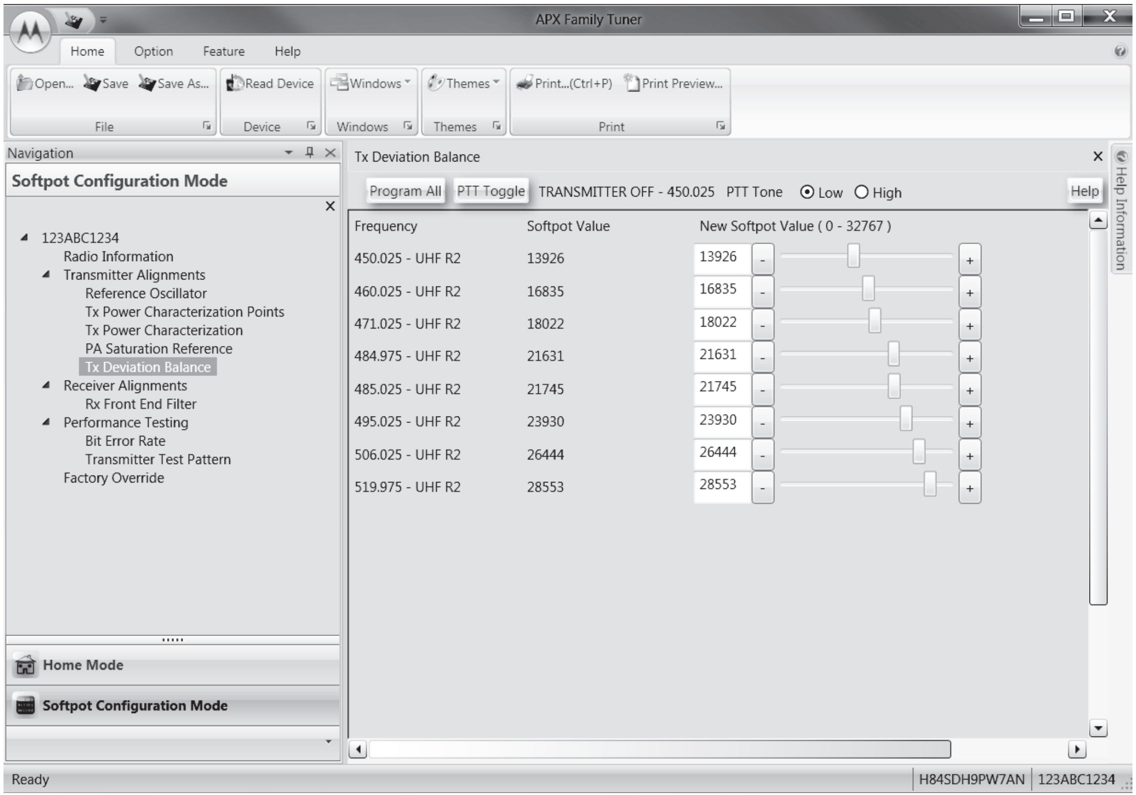

Figure 6-19. Transmit Deviation Balance Alignment Screen (UHF2)

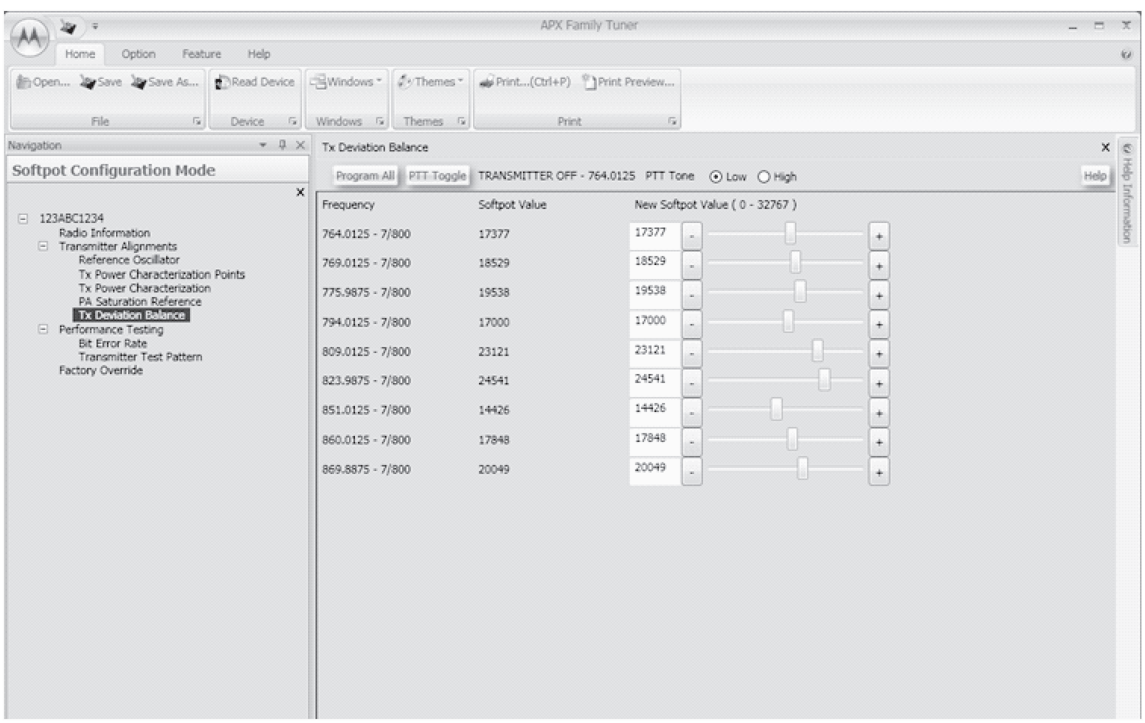

Figure 6-20. Transmit Deviation Balance Alignment Screen (700/800 MHz)

6.6 Front End Filter Alignment

Caution

This procedure should only be attempted by qualified service technicians.

The alignment procedure adjusts the front end receiver bandpass filters for the best receiver sensitivity and selectivity. This procedure should be performed for all test frequencies to allow for proper software interpolation of frequencies between the test frequencies in the band (see Figure 6-21 and Figure 6-22).

NOTE: Rx Front End Filter Alignment is required after replacing (or servicing) the transceiver board.

6.6.1 Procedure for UHF1/ UHF2 (Auto Tune)

Tuning of the radio is done through **Rx Front End Filter** tuning screen

1. Select the **Rx Front End Filter** alignment screen. See Figure 6-21 and Figure 6-22.
2. Click on the slider or the "New Softpot Value" text box to select which frequency to tune.
3. Apply RF test signal input with no modulation at -90 dBm on the Test Signal Frequency displayed at the top of the screen.
4. Left-click the **Autotune** button.
5. Repeat the steps 2–4 for all frequencies.
6. Left-click the **Program All** button on the screen to save the tuned values in the radio.

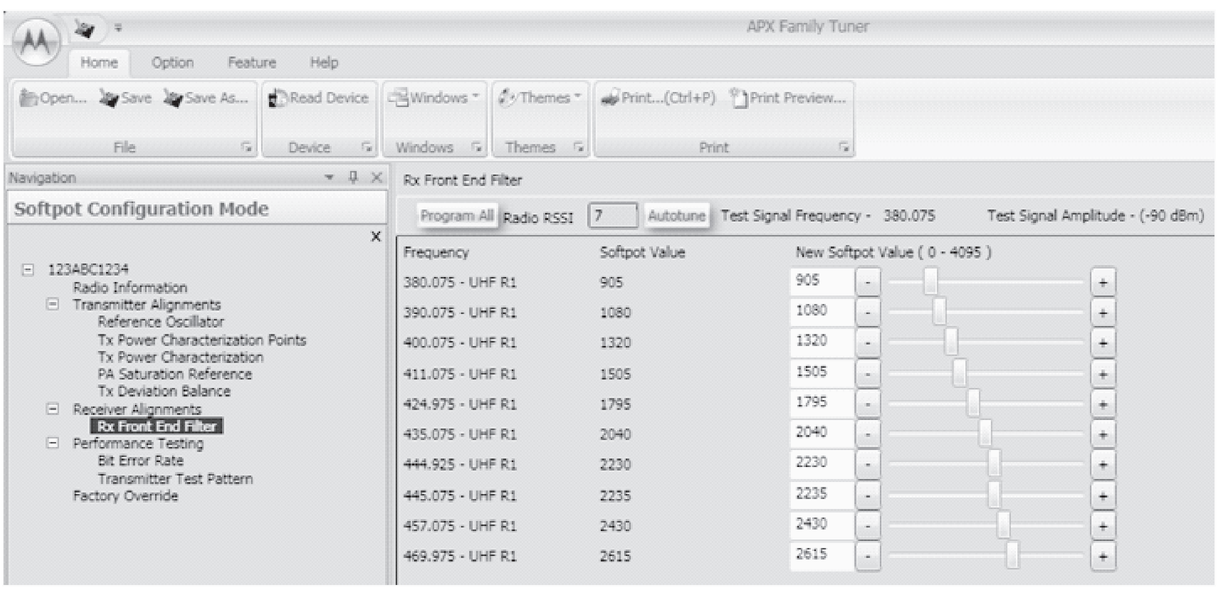

Figure 6-21. Front End Filter Alignment Screen (UHF1)

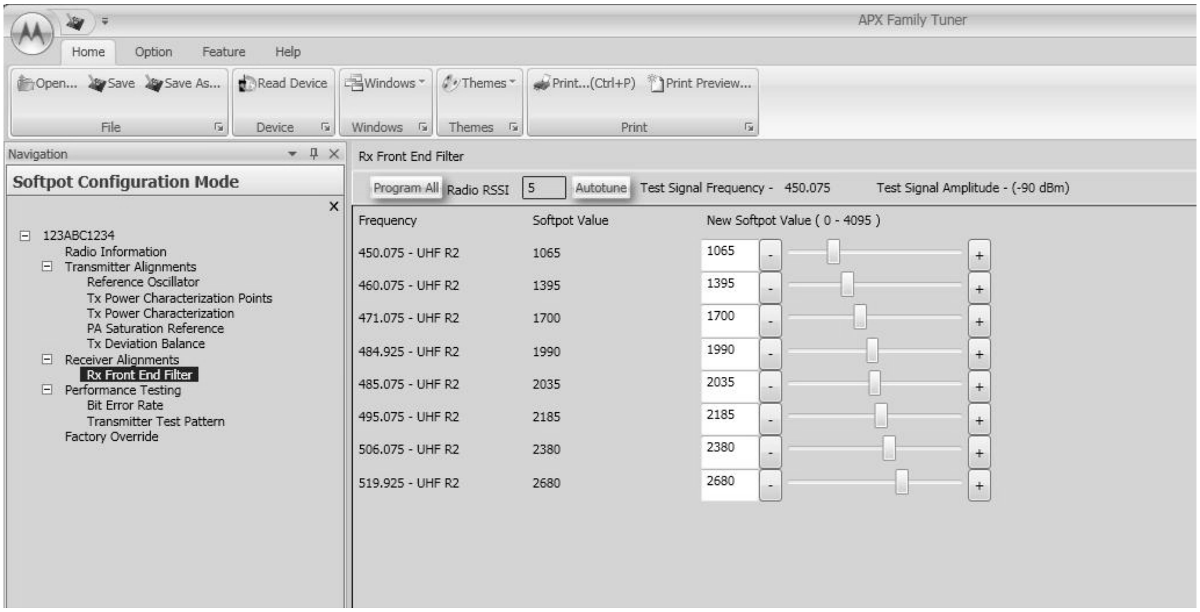

Figure 6-22. Front End Filter Alignment Screen (UHF2)

6.7 Performance Testing

6.7.1 Bit Error Rate

This section describes the Bit Error Rate (BER) test of the radio's receiver at a desired frequency (see Figure 6-23, Figure 6-24, Figure 6-25 and Figure 6-26).

6.7.1.1 Bit Error Rate Fields

Set up the R2670 Communication Analyzer as follows:

1. Connect the RF Input port of the radio under test to the RF IN/OUT port of the R2670 Service Monitor.
2. Set up the R2670 Service Monitor:
   - In the Display Zone, select PROJ 25 STD mode and set the meter to RF DISPLAY.
   - In the RF Zone, configure the analyzer as follows:

RF Control:	Generate
Preset:	B/W: NB
Freq:	Test frequency (Ex: 851.0625 MHz)
Output Level:	-50.0 dBm
Gen RF Out:	RF I/O

   - In the Audio Zone, select the 1011 Hz PAT code and set the deviation to "PROJ25Dev: 2.83 kHz ~".

The bit error rate screen contains the following fields:

- **Rx Frequency**:
  This field selects the Receive Frequency directly in MHz.

- **Test Pattern**:
  This field selects the Digital test pattern to be received by the radio. Choices are: Standard Tone Test Pattern (Framed 1011), F2 1031, Standard Interface Test Pattern (CCITT V.52) and Phase 2 Digital (1031 Hz) Test Pattern.
- **Modulation Type**:
  This field represents the digital modulation type of the incoming signal on which BER is to be calculated.
- **Continuous Operation**:
  This field allows the user the option to repeat the BER test indefinitely. A selection of Yes will cause the radio to calculate BER on a continuous basis and update the results on this screen after each integration time. A selection of No will cause the BER test to execute for only one sample of the integration time and then update the display.
- **Audio**:
  This field allows the user to select the audio output during a test. Selecting Internal will cause the radio's built-in speaker to unmute to any signals at the desired frequency which are present during the test. Selecting External will route the same signal to the radio's accessory connector audio output. Selecting Mute will disable the audio output.

NOTE: There will be **no audio** option available for APX 1000 when performing a Bit Error Rate Test.

- **BER Integration Time**:
  BER Integration Time carries with Test Pattern Type.
- Number of Frames
  Number of Frames over which bit error result are accumulated to produce the result.

NOTE: When **Continuous Operation = Yes**, all fields will be grayed out while the test is in progress. They will be enabled when the STOP button is pressed.

When **Continuous Operation = No**, a wait cursor will be displayed while the test is in progress and return to normal when the test is done.

3. Press **Start/Stop** button to begin or end BER testing.

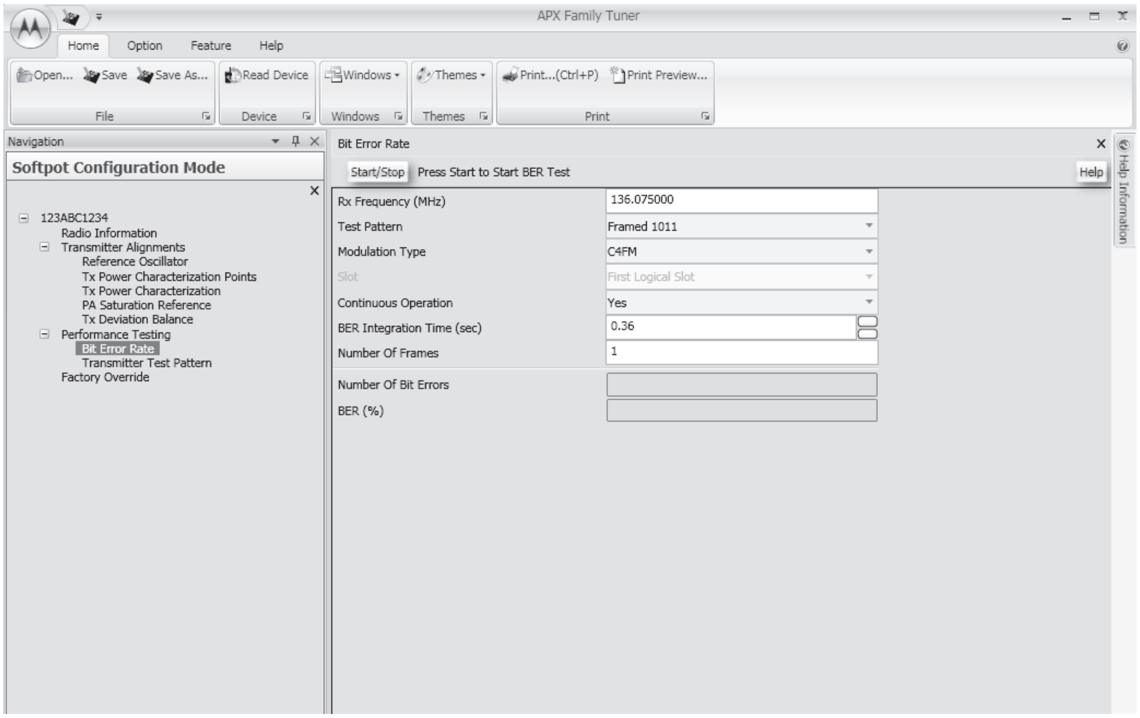

Figure 6-23. Bit Error Rate Screen (VHF)

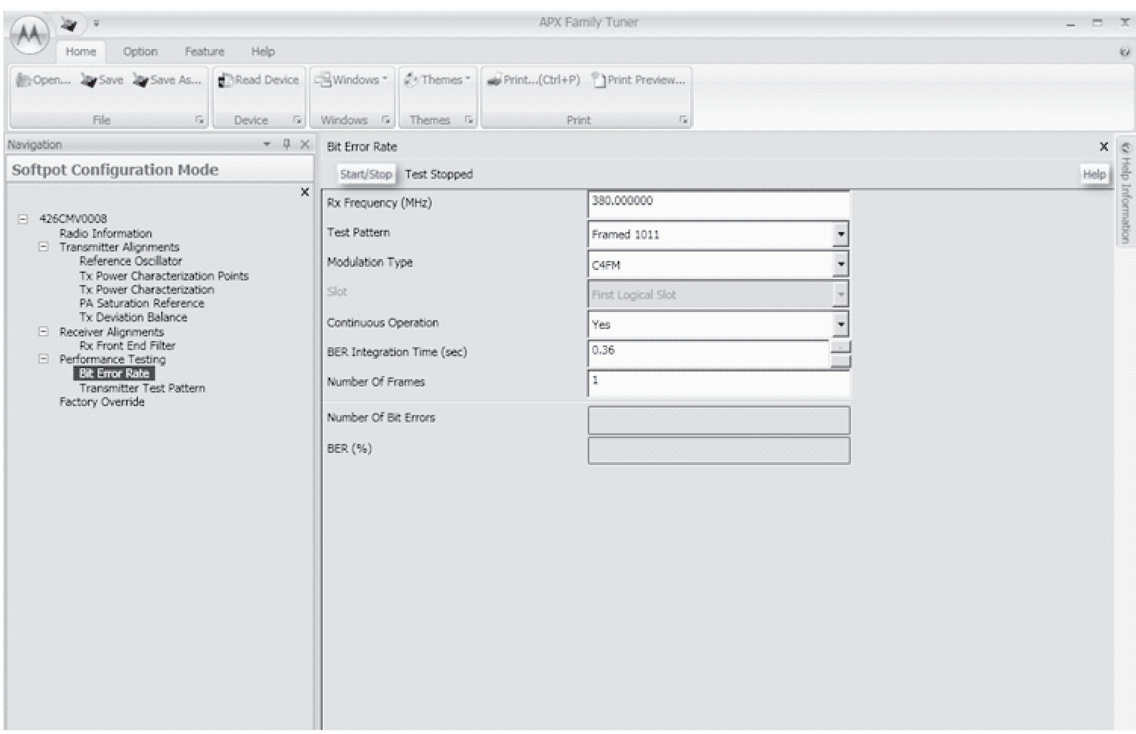

Figure 6-24. Bit Error Rate Screen (UHF1)

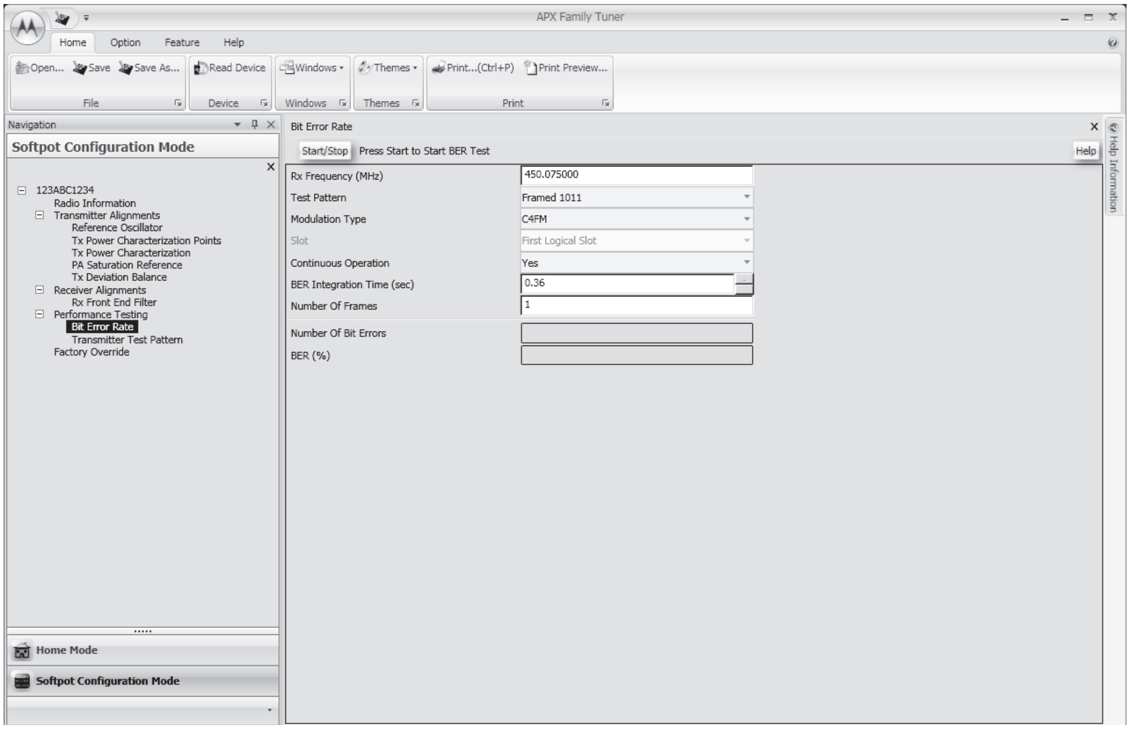

Figure 6-25. Bit Error Rate Screen (UHF2)

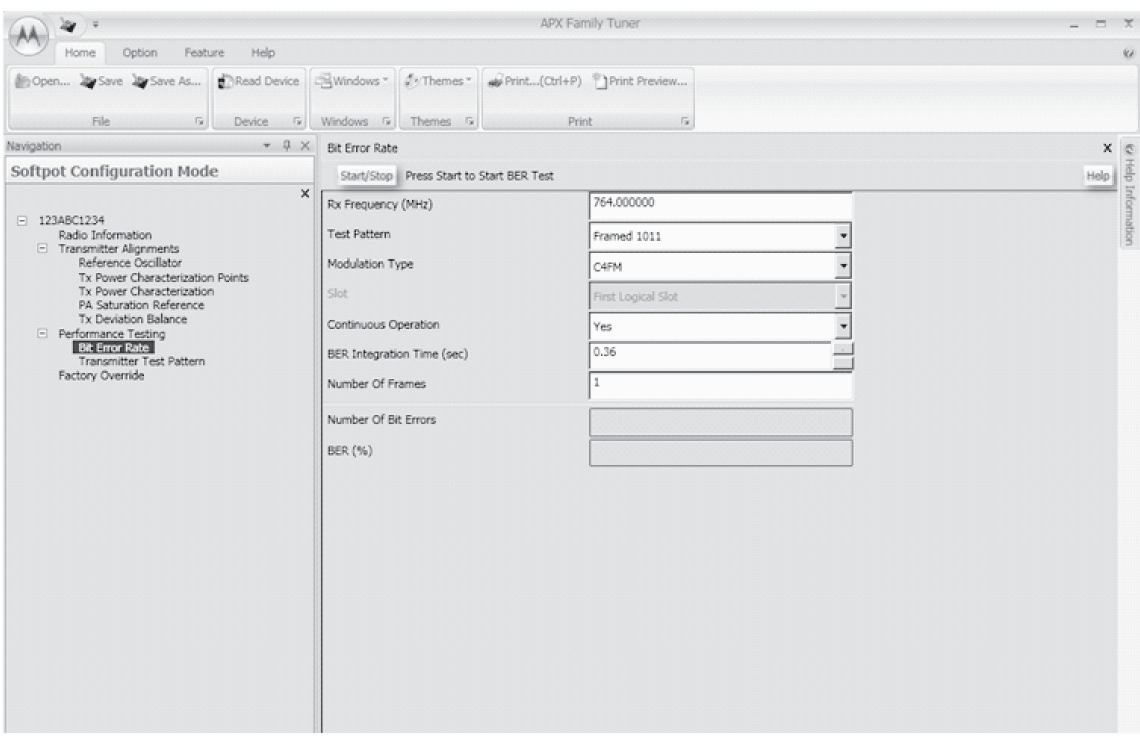

Figure 6-26. Bit Error Rate Screen (700/800 MHz)

6.7.2 Transmitter Test Pattern

The Transmitter Test Pattern test is used to transmit specific test patterns at a desired frequency so that the user can perform tests on the radio's transmitter (see Figure 6-27, Figure 6-28, Figure 6-29 and Figure 6-30).

6.7.2.1 Transmitter Test Fields

This screen contains the following fields:

- **Tx Frequency**:
  This field selects the Transmit Frequency directly in MHz.
- **Channel Spacing**:
  This field allows the user to select the desired transmit deviation in kHz.
- **Test Pattern Type**:
  This field represents the type of test pattern which will be transmitted by the radio when **PTT TOGGLE** button is pressed.

NOTE: Channel Spacing and Test Pattern Type fields will be grayed out while the radio is transmitting.

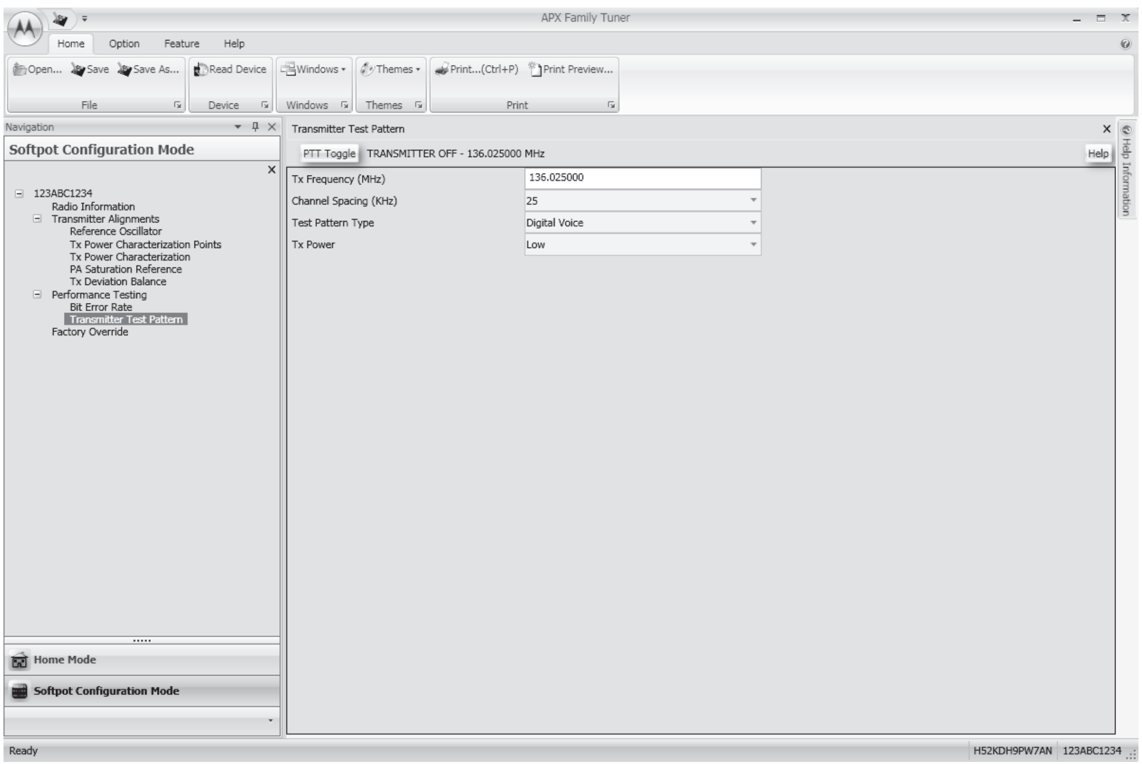

Figure 6-27. Transmitter Test Pattern Screen (VHF)

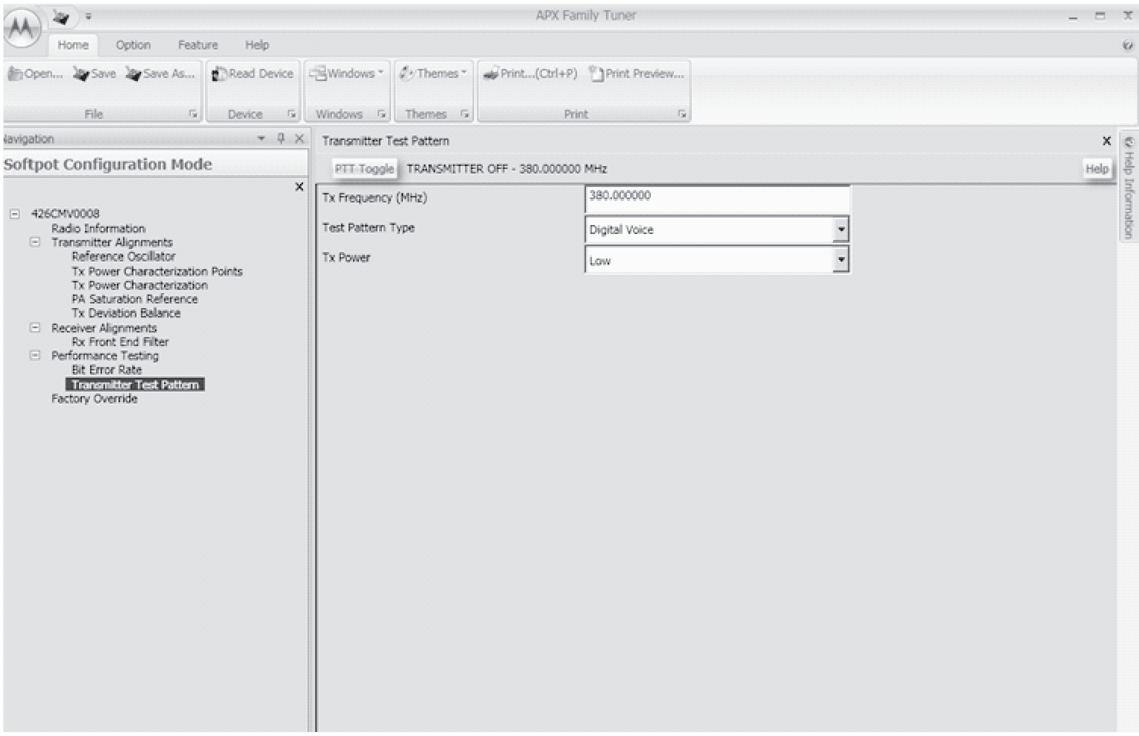

Figure 6-28. Transmitter Test Pattern Screen (UHF1)

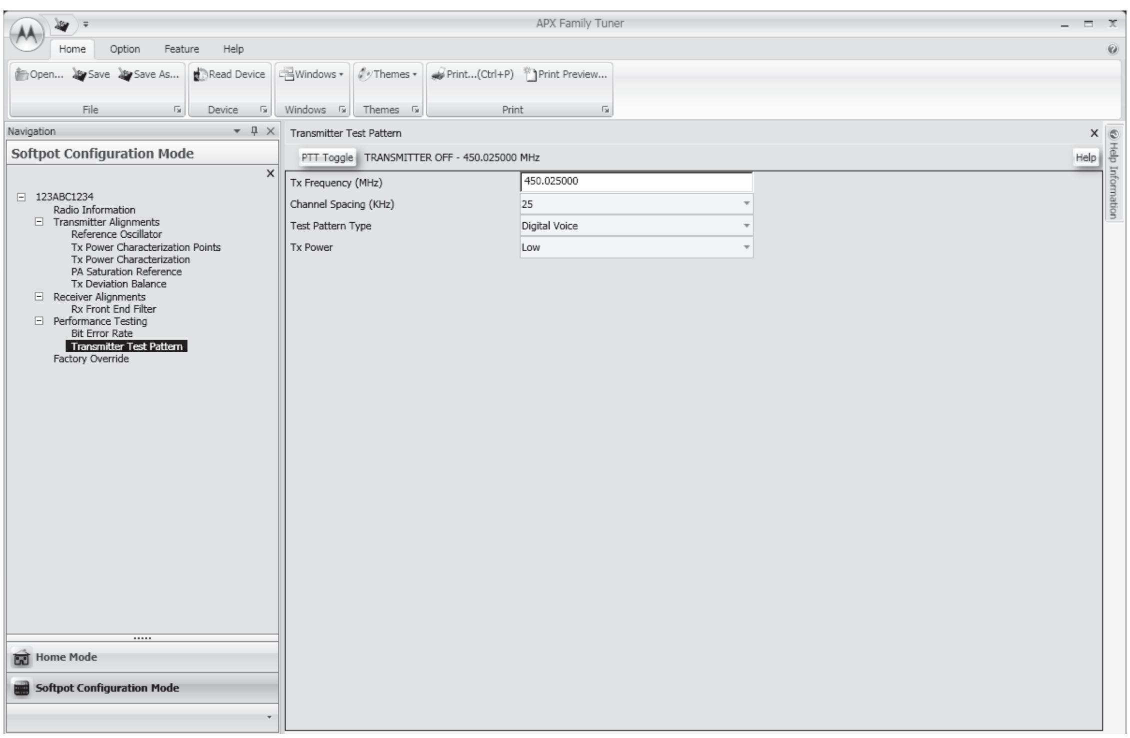

Figure 6-29. Transmitter Test Pattern Screen (UHF2)

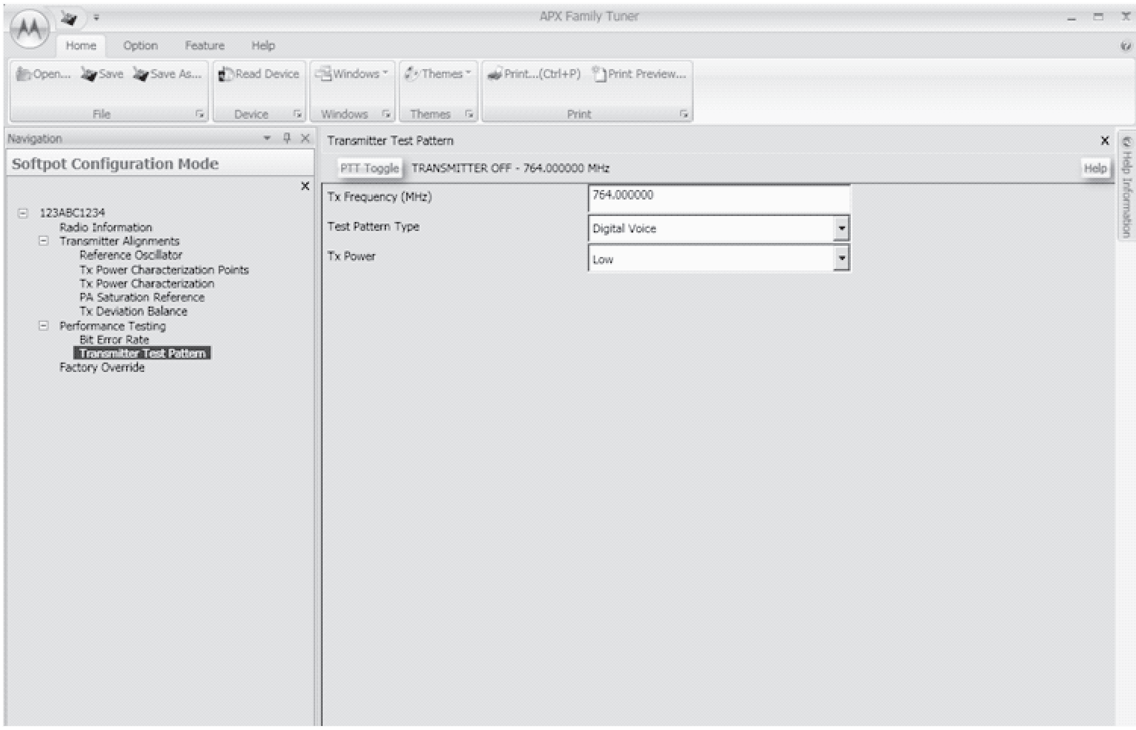

Figure 6-30. Transmitter Test Pattern Screen (700/800 MHz)

Chapter 7 Disassembly/Reassembly Procedures

This chapter provides detailed procedures for disassembling/reassembling and ensuring reliable splash protection of the APX 1000 radios. When performing these procedures, refer to "Chapter 9: Exploded Views and Parts Lists" and the diagrams that accompany the text. Items in parentheses ( ) throughout this chapter refer to item numbers in the exploded view diagrams and their associated parts lists.

This chapter also has procedures for removing and installing the APX 1000 radio's standard accessories.

7.1 APX 1000 Exploded View (Main Subassemblies)

Caution	When servicing electronics, always ensure that you are properly grounded with antistatic grounding system approved for electronics handling.

This section contains the APX 1000 radio partially exploded views.

NOTES:

- Refer to Figure 7-1, the Partial Exploded View, and Table 7-1, the Partial Exploded View Parts List.
- Letters in parentheses ( ) refer to item letters in Figure 7-1 and Table 7-1.

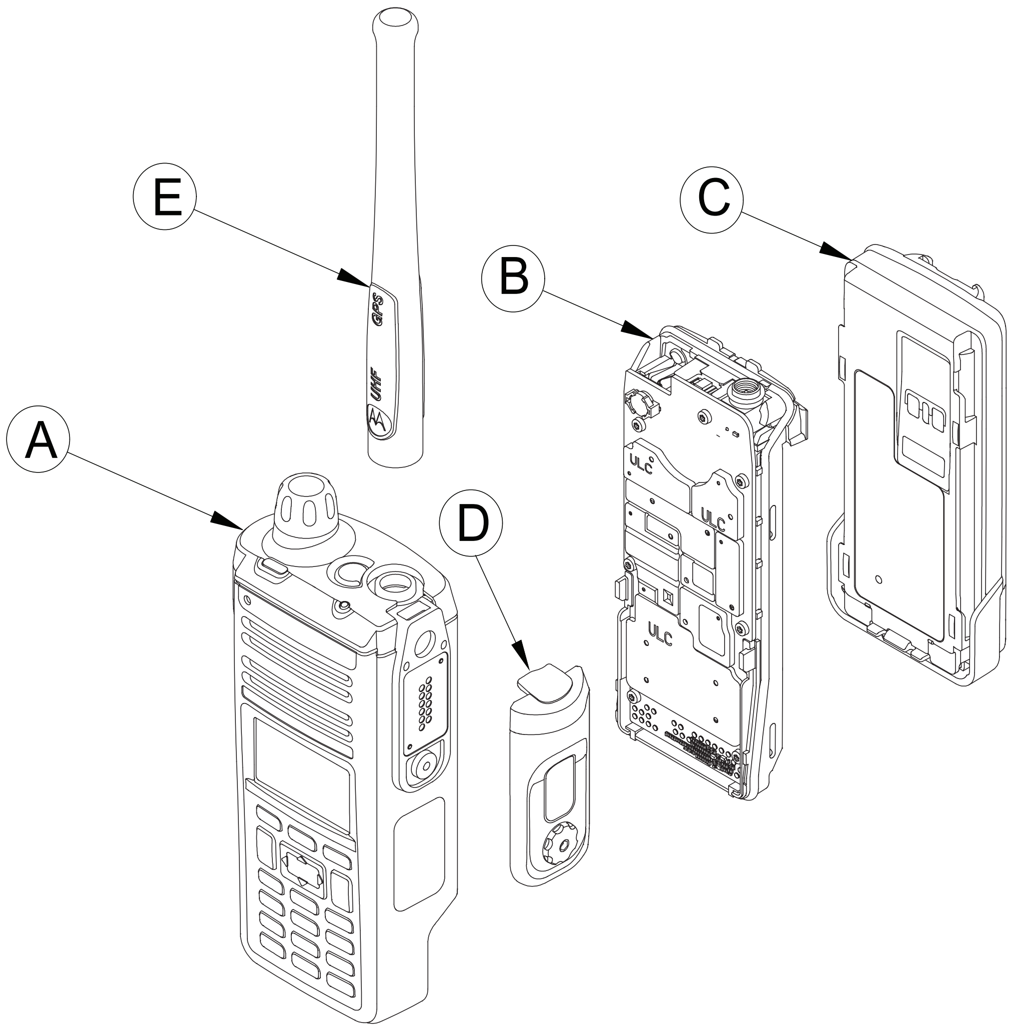

Figure 7-1. APX 1000 Partial Exploded View

Table 7-1. APX 1000 Partial Exploded View Parts List

Item Letter	Description	Exploded View and Parts List
A	Front Kit Assembly	Refer Figure 9-1.
B	Back Kit Assembly	Refer Figure 9-2.
C	Battery Assembly	Refer Figure 9-2.
D	Accessory-Connector Cover Assembly	Refer Figure 9-1.
E	Antenna Assembly	Refer Figure 9-1.

7.2 Required Tools and Supplies

Table 7-2. Required Tools and Supplies

Tools	Motorola Part Number	Supplier	Supplier Part Number	Remarks
Chassis Opener	66012028001	Motorola	–	To remove chassis from housing.
Bit, Torx T6	–	–	–	For back kit (chassis) and keypad retainer.
Driver, Torque	–	–	–	–
Black stick	–	Hexacon Electric Co.	MA-800G	For keypad rubber mushroom rib assembly and disassembly.
Round stick	–	Brusia	BE-MO-14383	For microphone membrane assembly.
Allen wrench	–	–	–	To loosen accessory-connector cover thumb screw (if thumb screw is too tight).

7.3 Fastener Torque Chart

Table 7-3 lists the various fasteners by part number and description, followed by the torque values and the location where used. Torque all fasteners to the recommended value when assembling the radio.

Table 7-3. Fastener Torque Chart

Motorola Part Number	Description	Repair Torque (in-lbs)
0386104Z10	Chassis Screw	3.7
0378212A02	Keypad Retainer screw	1.2

7.4 Radio Disassembly

This section contains instructions for disassembling the radio's main subassemblies.

Prepare the radio for disassembly:

- Turn off the radio by pressing on the MFK (6) and hold the MFK (Multi Function Knob) until the radio display shows “Power off?”. Press the Menu Select button below and select Yes to power off.
- Remove the antenna, the battery, the Accessory-Connector cover (1), the Bottom Label (3) and any other accessory connected to the radio.

7.4.1 Remove Battery (33)

WARNING

To avoid a possible explosion:
- **DO NOT charge, remove, or attach the battery in an area labeled “hazardous atmosphere.”**
- **DO NOT discard batteries in a fire.**

Caution

If the radio is programmed for volatile-key retention, encryption keys will be retained for approximately 30 seconds after battery removal.

NOTE: The Motorola-approved battery shipped with the APX 1000 radio is uncharged. Prior to using a new battery, charge it per the recommended procedure for the battery.

1. With the radio turned off, lift up the latch located at the bottom of the battery.

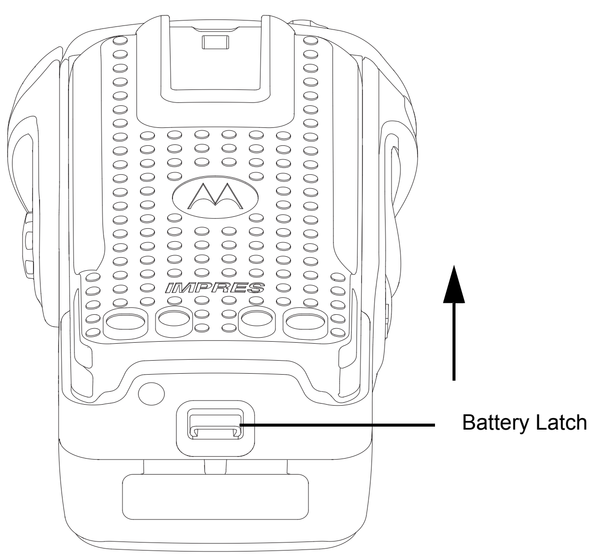

Figure 7-2. Lifting up the battery latch

2. While lifting the latch, remove the battery by sliding it out as shown.

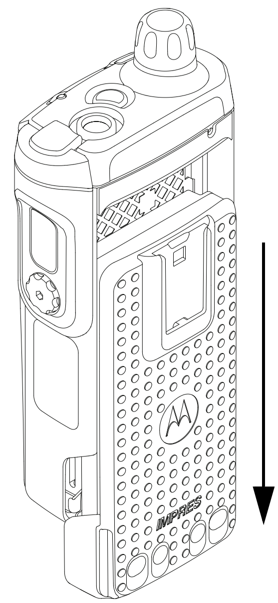

Figure 7-3. Removing the Battery

7.4.2 Remove Antenna (7)

1. With the radio turned off, turn the antenna counter-clockwise to remove it from the radio.

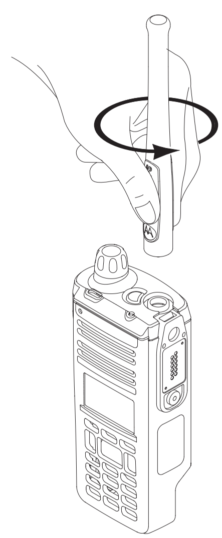

Figure 7-4. Removing the Antenna

7.4.3 Remove Multi Function Knob (6)

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis Opener, grasp the Multi Function Knob and pull it upward, until it is free from its shaft.

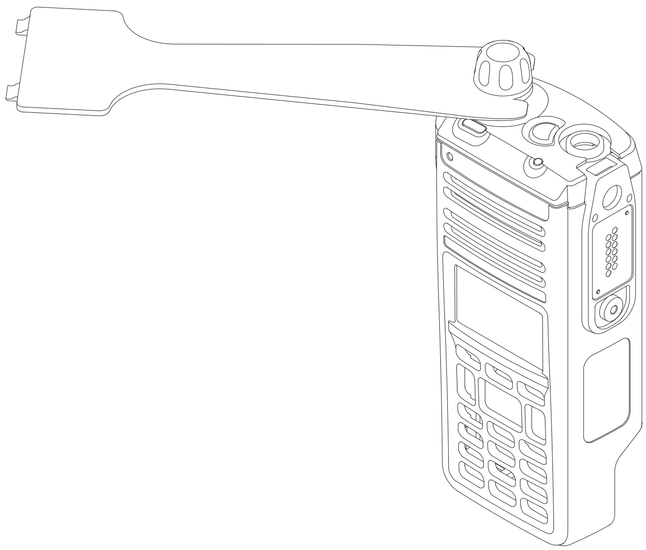

Figure 7-5. Removing the Multi Function Knob

7.4.4 Remove Accessory-Connector Cover (1)

Caution	When the accessory connector is not in use, keep it covered with the Accessory-Connector Cover.

1. Unscrew the thumb screw. If the screw is too tight, use an Allen wrench.

   NOTE: Do not remove the screw. It should remain captive in the cover.

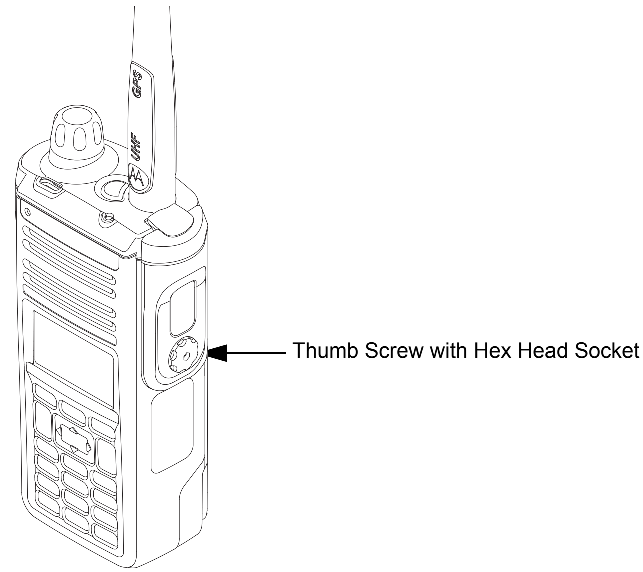

Figure 7-6. Removing the Thumb Screw

2. Slightly swing the Accessory-Connector Cover (1) away from radio before sliding it upward to disengage the hook feature.
3. Pull the Accessory-Connector Cover away from the radio.

7.4.5 Removal of the Back Kit Assembly (B)

This section contains instructions for disassembling the radio.

7.4.5.1 Removal of the Chassis (26)

1. With the Battery removed, disengage the Chassis (26) using the Chassis Opener as shown in Figure 7-7.

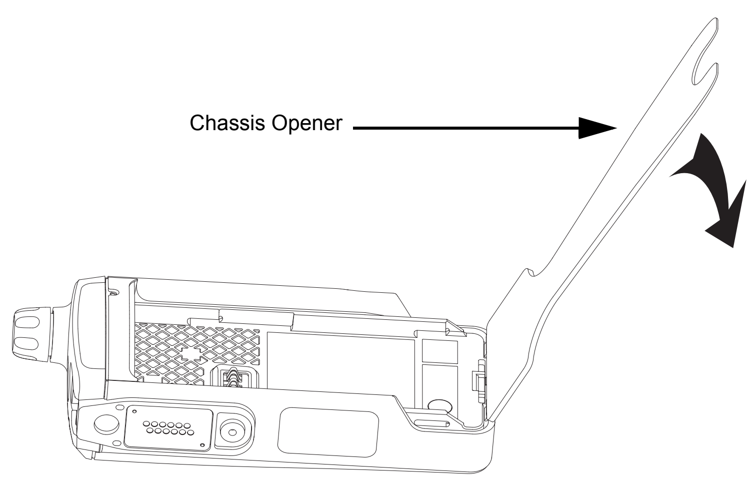

Figure 7-7. Disengage the Chassis

NOTE: The Vacuum Port seal (27) and the Ventilation Label (28) must be removed each time the Chassis is removed (for leak test).

2. After the Chassis (26) is disengaged, slide the chassis assembly down and lift it away from the Front Kit (A) and lay both sub-assemblies on the anti-static mat (part of anti-static ground kit) as shown in Figure 7-8.

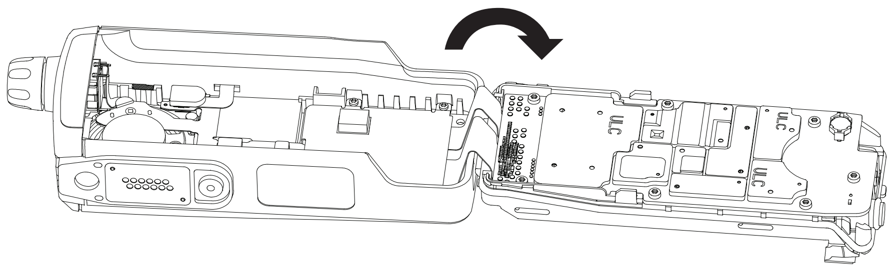

Figure 7-8. Remove the Chassis Assembly

7.4.5.2 Removal of the Chassis Screws (15)

1. Remove the black chassis screws (15) as shown in Figure 7-9.

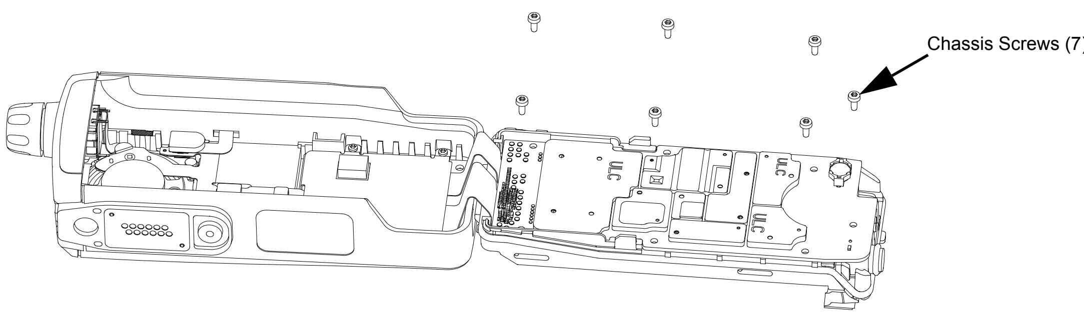

Figure 7-9. Remove the chassis screws

7.4.5.3 Removal of the Main Board(16)

1. Remove the Main O-Ring (25) at the antenna holder as shown in Figure 7-10.

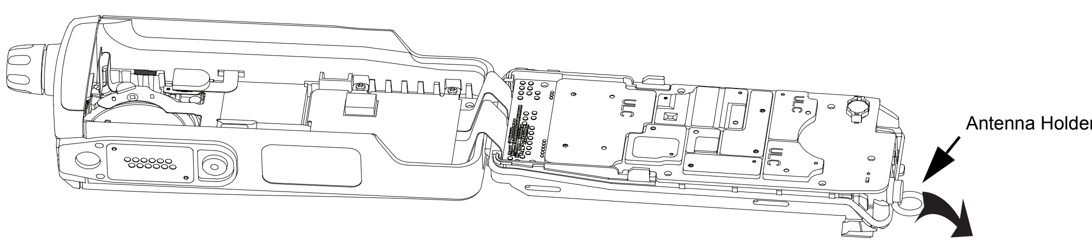

Figure 7-10. Remove the Main O-Ring at the antenna holder

2. Lift up the Main Board (16) from the Chassis (26) towards the Front Housing (2) and gently unplug the connectors from the Front Kit Flex and Keypad Flex (11) to remove the Main Board as shown in Figure 7-11. and Figure 7-12 respectively.

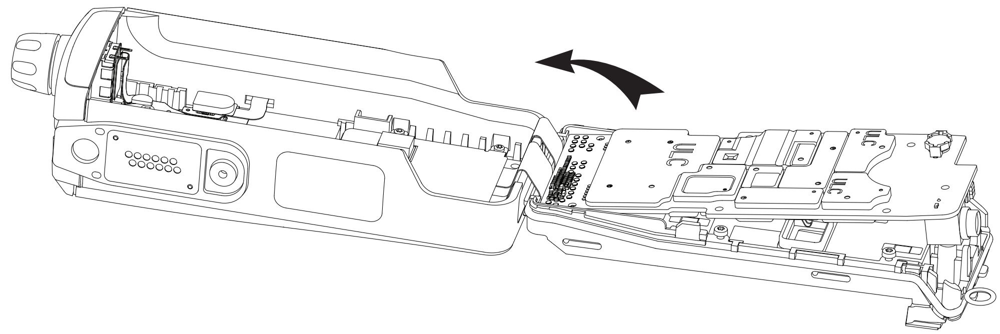

Figure 7-11. Lift up the Main Board from the Chassis

Caution	When separating the small interconnects, care is needed to avoid damage to the interconnect and surrounding on-board components.

Caution	Place the Main Board on the anti-static mat or in a clean and ESD safe area to avoid electrical damage to the electronics. Replace the Thermal Pad (19) whenever the Main Board is removed.

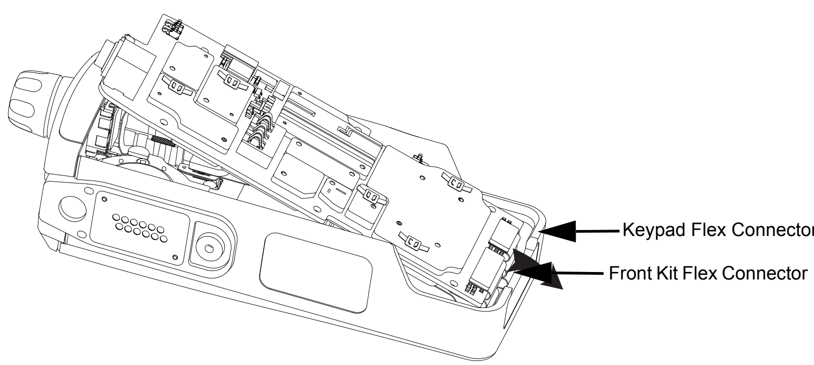

Figure 7-12. Unplug the connectors on the Front Kit Flex and Keypad Flex

7.4.5.4 Removal of the Shroud (32)

1. Place the black stick into the opening below the Shroud (32) to aid the disengagement of the Shroud. With the black stick still in place, slide the Shroud downwards at both sides to remove the Shroud from the Chassis (26).

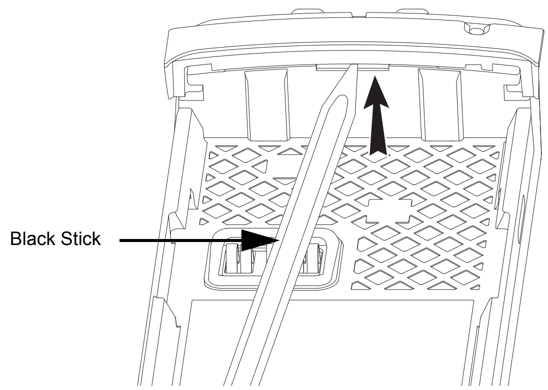

Figure 7-13. Disengage the Shroud

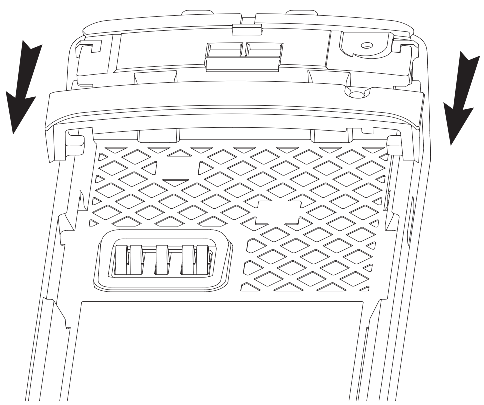

Figure 7-14. Remove the Shroud

7.4.5.5 Removal of the Keypad Retainer (12)

1. Remove the four Keypad Retainer Screws (13) as shown in Figure 7-15.

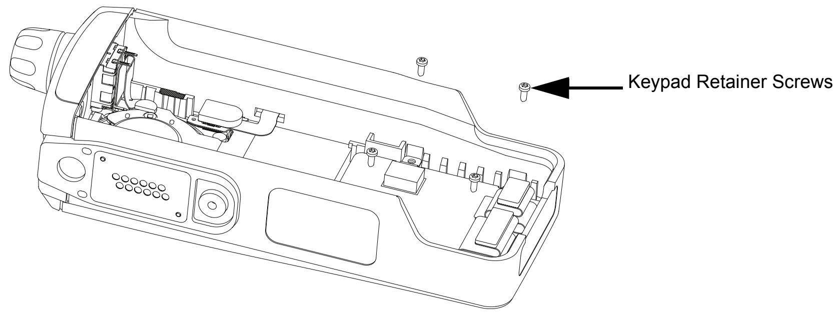

Figure 7-15. Remove the Keypad Retainer Screws

2. Lift out the Keypad Retainer (12) from the Front Housing (2) as shown in Figure 7-16.

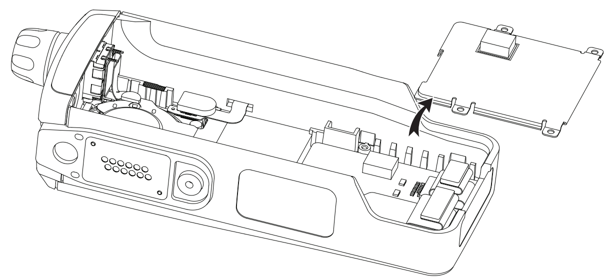

Figure 7-16. Remove the Keypad Retainer

7.4.5.6 Removal of the Keypad Board (10) and Keypad Flex (11)

1. With the Keypad Retainer (12) removed, gently detach the Keypad Flex (11) from the Keypad Board (10) as shown in Figure 7-17.

> **Caution**
>
> When separating the flex and small interconnects, care is needed to avoid damage to the interconnect and surrounding on-board components

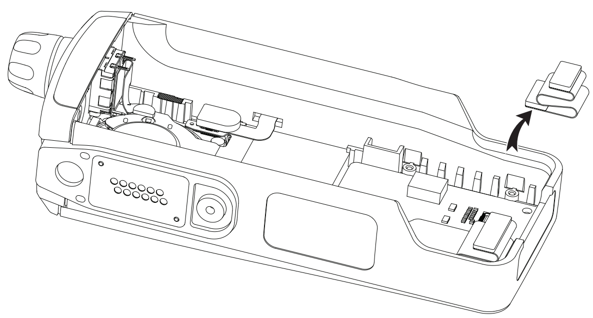

Figure 7-17. Detach the Keypad Flex from Keypad Board

2. With the Keypad Flex (11) detached, gently lift the end of the Front Kit Flex to make way for the Keypad Board (10). With the aid of the back of the black stick, gently lift the Keypad Board (10) from the Front Housing (2) as shown in Figure 7-18.

> **Caution**
>
> When lifting the Front Kit Flex, care is needed to avoid excessive bending and damage to the Flex.

> **Caution**
>
> When lifting the Keypad Board with the black stick, care is needed to avoid piercing and damage to the Keypad.

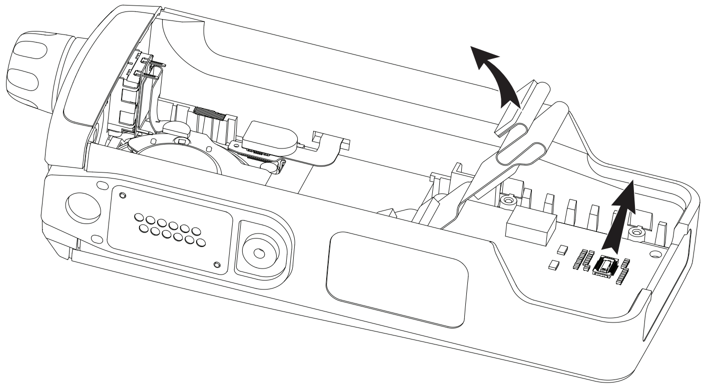

Figure 7-18. Remove the Keypad Board

7.4.5.7 Removal of the Keypad (8)

1. With the Keypad Board (10) removed, gently press the Keypad (8) from the front of the Front Housing (2) with fingers or with the aid of the back of the black stick to disengage the Keypad from the rib as shown in Figure 7-19.

Caution	When disengaging and removing the Keypad, care is needed to avoid tearing and damange to the Keypad.

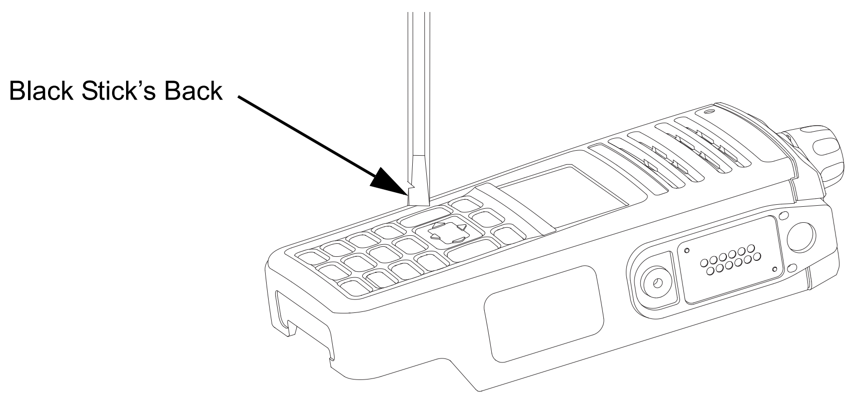

Figure 7-19. Disengage the Keypad

2. With the Keypad (8) disengaged from the rib, gently lift it out from the Front Housing (2).

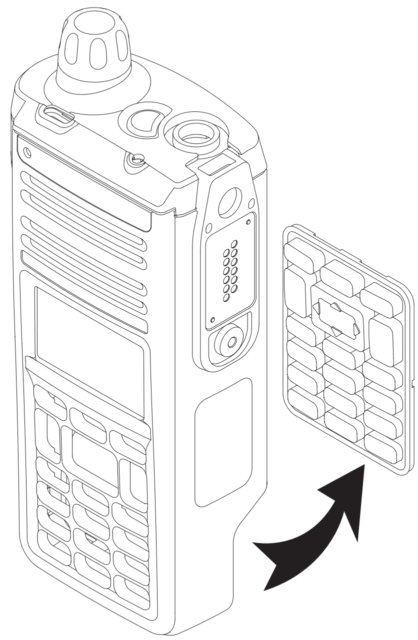

Figure 7-20. Remove the Keypad

7.4.6 Removal of the Front Kit Assembly (A)

1. Complete the steps in Section 7.4.5.1. and Section 7.4.5.5. through Section 7.4.5.7.

2. With the steps completed, the Front Kit Assembly (A) is obtained.

7.5 Serviceable Components of the Main Sub-Assemblies

7.5.1 Servicing Main Board Assembly

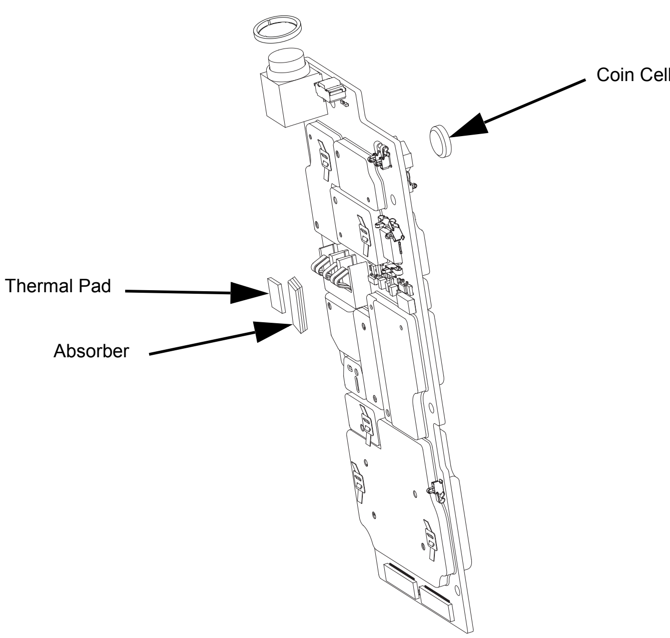

Figure 7-21. Serviceable Components – Main Board Assembly

7.5.1.1 Servicing Coin Cell:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Remove the coin cell with the Black Stick.

NOTE: Make sure the positive side is facing upwards.

3. Press the new coin cell into the battery carrier until it is secured and fully snapped into place.

7.5.1.2 Servicing Thermal Pad:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Carefully peel off the pad.
3. Ensure there is no debris or residue left on the amplifier’s surface.
4. Replace with new Thermal Pad.
5. Peel the liner off the new pad and place in the respective location. Make sure the bottom surface of the pad is mating with the top surface of the amplifier.
6. Apply slight pressure to activate the adhesive.

Caution

Thermal pad should always be replaced when the Main board assembly is removed.

7.5.1.3 Servicing Absorber:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Carefully peel off the Absorber.
3. Ensure there is no debris or residue left on the board surface.
4. Replace with the new Absorber.
5. Peel the liner off the new absorber and place in the respective location. Make sure it is not placed outside the legend printed on the board.
6. Apply slight pressure to activate the adhesive.

Caution

Absorber should always be placed within the white rectangular legend printed on the board.

Caution

Absorber should always be replaced when the Main Board assembly is removed.

7.5.2 Servicing Chassis Assembly

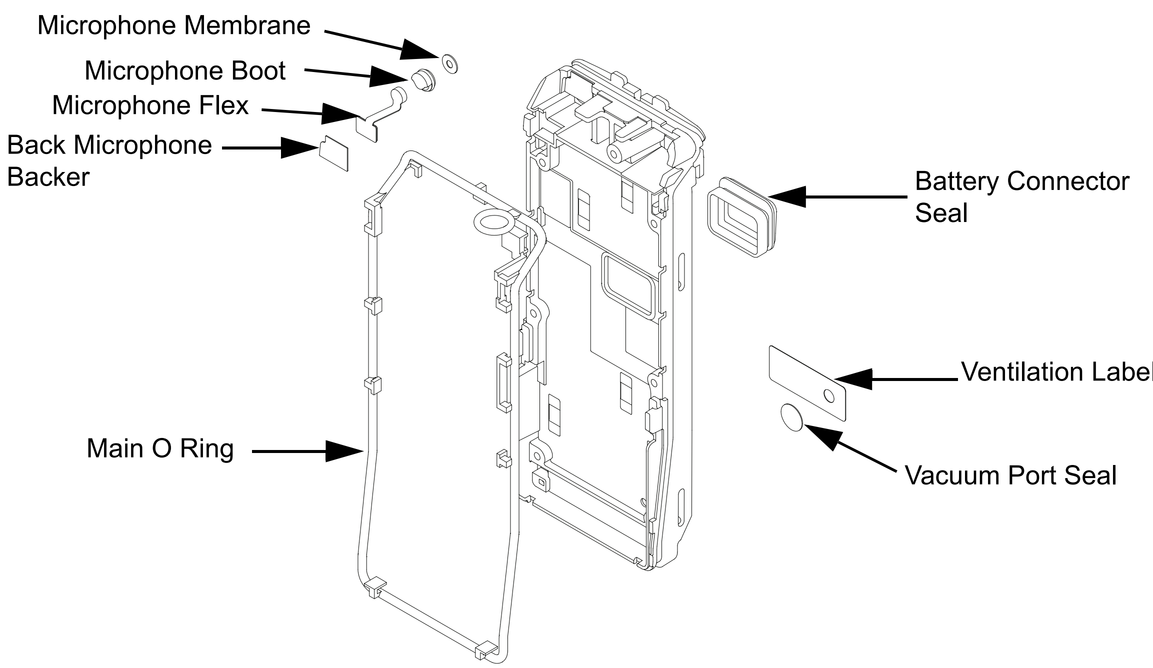

Figure 7-22. Serviceable Components – Chassis Assembly

7.5.2.1 Servicing Ventilation Label:

1. Complete steps in Section 7.4.
2. Carefully peel off the label.
3. Use the Black Stick to help remove any difficult sections of the label.
4. Clean the area once the label is removed to ensure it is free from adhesive and debris.
5. Peel the new label off its backer and place in the respective location.
6. Apply slight pressure to set the adhesive.

Caution	Ventilation label should always be replaced when back kit assembly is removed.

7.5.2.2 Servicing Vacuum Port Seal:

1. Complete steps in Section 7.4.
2. Carefully peel off the seal.
3. Use the Black Stick to help remove any difficult sections of the seal.
4. Clean the area once the seal is removed to ensure it is free of adhesive and debris.
5. Peel the new seal of its backer and place it in the respective location.
6. Apply slight pressure for approximately 30 seconds to activate the adhesive.

Caution

Vacuum port seal should always be replaced when back kit assembly is removed.

7.5.2.3 Servicing Battery Contact Seal:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Pinch the Battery Contact Seal inwards and remove it from the chassis opening.
3. Slot the new Battery Contact Seal until it is properly seated onto the Chassis surface.

7.5.2.4 Servicing Main O Ring:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Remove the Main O Ring with the aid of a Black Stick.
3. Replace the new Main O Ring into the groove provided in the Chassis.
4. Ensure that the seal is set properly and not stretched.

7.5.2.5 Servicing Microphone Boot:

NOTE: When servicing Microphone Boot, the Microphone Membrane part will also need to be replaced.

1. Gently remove the Back Microphone Backer (24) with the help of a Black Stick.
2. Carefully remove the microphone assembly out of the chassis opening.
3. With the aid of a Black Stick, dislodge the Microphone Boot and carefully slide out the microphone cartridge. Make sure the flex is not stretched. Ensure nothing comes in contact with the microphone while changing to a new Microphone Boot.
4. Press inward the new Microphone Boot to open up the clearance for the microphone assembly. Fit in the microphone cartridge. Make sure the flex is not stretched.
5. Ensure the microphone cartridge is seated properly within the Microphone Boot.
6. Ensure the Microphone Boot is correctly seated within the chassis opening.
7. Follow Section 7.5.2.6. (steps 4 to 6) to complete assembling and placing the Microphone Membrane.

7.5.2.6 Servicing Microphone Membrane:

1. Carefully remove the Microphone Membrane from the chassis opening using the Black Stick.
2. Use the pointed tip of the Black Stick to scrap off pieces of adhesives after removing the membrane.
3. Use a cotton bud dipped in IPA Cleaning Solvent to clean the area to remove remaining adhesive and debris.
4. Ensure the Microphone is seated properly within the Microphone Boot opening.
5. Remove the new Microphone Membrane from its backer.
6. Ensure that the area is dry (solvent fully evaporated) before carefully placing the new Microphone Membrane. The membrane needs to be centered on the surface of the microphone boss area on the Chassis. Ensure that the membrane is flat with no ripples or folds. Press down firmly, applying slight pressure to activate the adhesive using the Round Stick.
7. Ensure that the Microphone Boot is seated correctly within the chassis opening.
8. With the Microphone Boot seated in the chassis, carefully place the Back Microphone Backer (24) to cover the microphone opening.

7.5.3 Servicing Main Housing

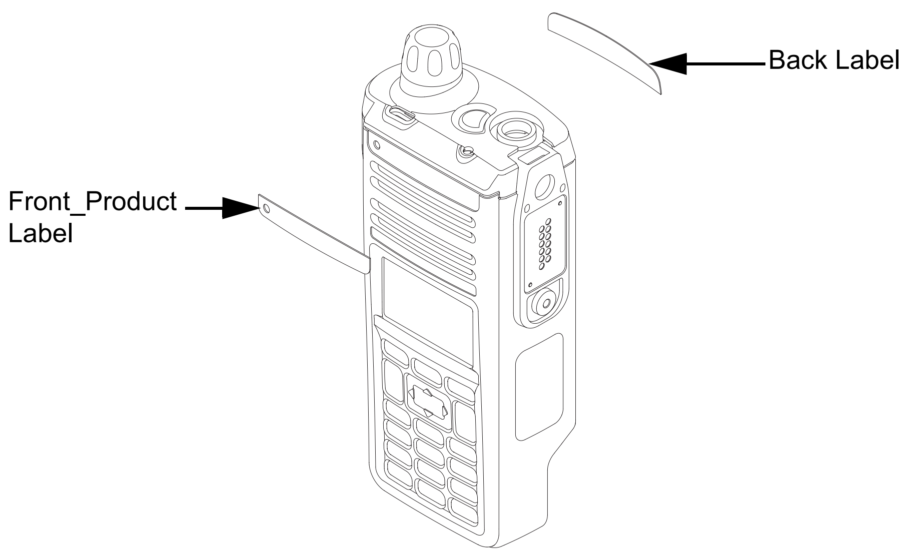

Figure 7-23. Serviceable Components – Main Housing

7.5.3.1 Servicing Front_Product Label

NOTE: There is no need to remove any component in order to service the Front_Product Label.

1. Scrap off the Front_Product Label with the Black Stick.
2. Clean the area once the Front_Product Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the label.

7.5.3.2 Servicing Back Label

NOTE: There is no need to remove any component in order to service the Back Label.

1. Scrap off the Back Label with the Black Stick.
2. Clean the area once the Back Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the label.

7.5.4 Servicing Multi Function Knob

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis Opener, grasp the Multi Function Knob and pull it upward, until it is free from its shaft.
3. Replace the knob with a new one by aligning the D-shaped part of the shaft with the D-shaped hole on the Multi Function Knob. Press the knob into place.

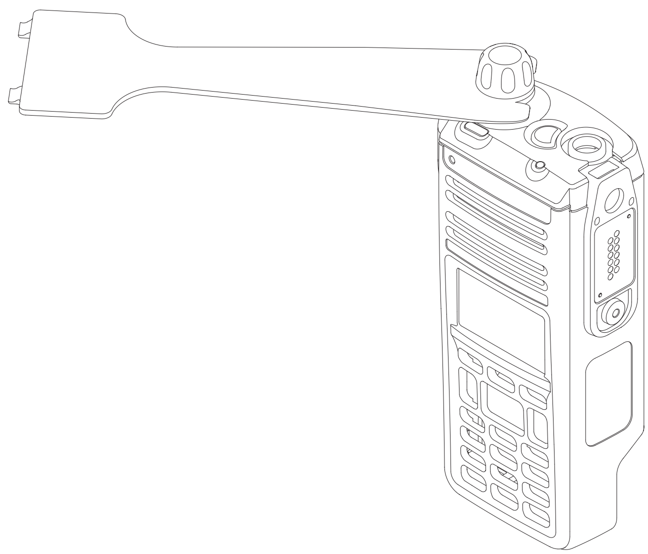

Figure 7-24. Servicing the Multi Function Knob

7.6 Radio Reassembly

This section contains instructions for reassembling the radio.

7.6.1 Reassemble the Keypad (8)

1. Gently lift the end of the Front Kit Flex to make way for the Keypad (8).

Caution	While lifting the Front Kit Flex, care is needed to avoid excessive bending and damage to the Flex.

2. Place the Keypad (8) into the Front Housing (2) and gently flush the mushroom rib at the edges of the Keypad into the Front Housing with the aid of the back of the Black Stick.

Caution	When flushing the Keypad, care is needed to avoid damage to the Keypad. Ensure that the Keypad is fully flushed to prevent leakage.

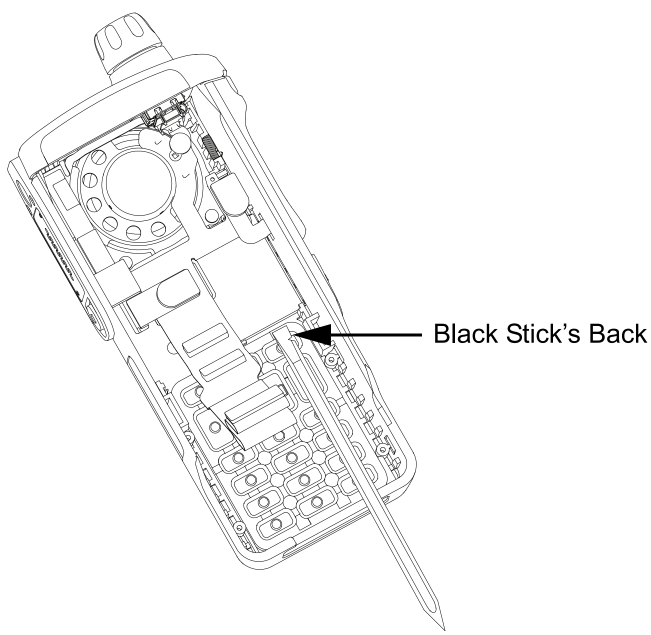

Figure 7-25. Assemble the Keypad

7.6.2 Reassemble the Keypad Board (10) and Keypad Flex (11)

1. With the Keypad (8) assembled, gently lift the Front Kit Flex and place the Keypad Board (10) into the Front Housing.

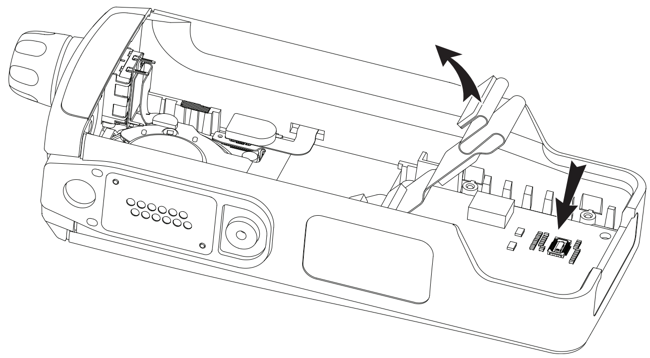

Figure 7-26. Plug in the Front Kit Flex Connector

2. Gently rest the Front Kit Flex onto the Keypad Board (10).
3. Place the Keypad Flex (11) in position and gently plug the Keypad Flex connector to the Keypad Board.

NOTE: Plug in the connector at the side of the Keypad Flex which reads “To Keypad Board”.

Caution	When plugging in the connectors, care is needed to avoid damage to the interconnect and surrounding on-board components.

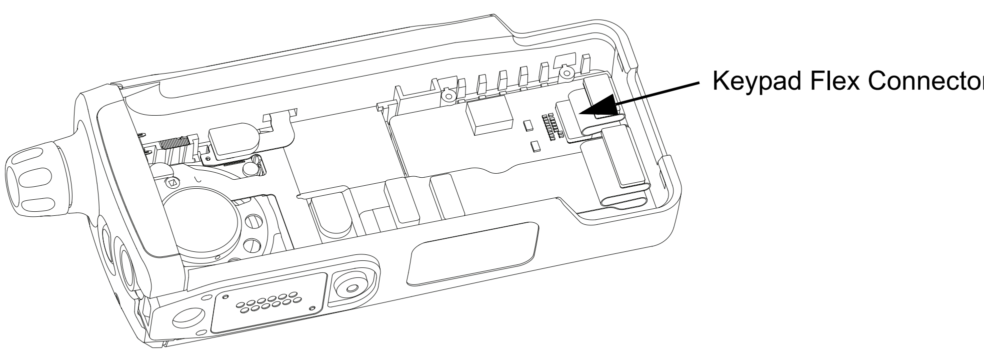

Figure 7-27. Rest the Front Kit Flex and plug in the Keypad Flex Connector

7.6.3 Reassemble the Keypad Retainer (12)

1. Place the Keypad Retainer (12) over the Keypad Board (10) in the Front Housing (2) as shown in Figure 7-28.

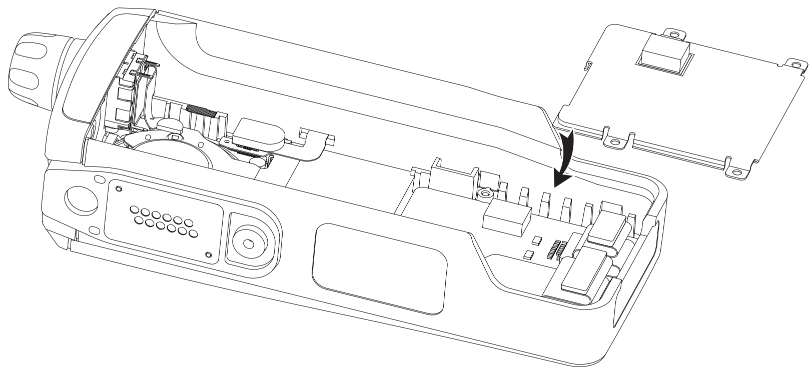

Figure 7-28. Place Keypad Retainer over the Keypad Board

2. Torque all four keypad retainer screws (13) with a Torx IP6 Bit and a Torque Driver to 1.2 in-lbf in the sequence as shown in Figure 7-29.

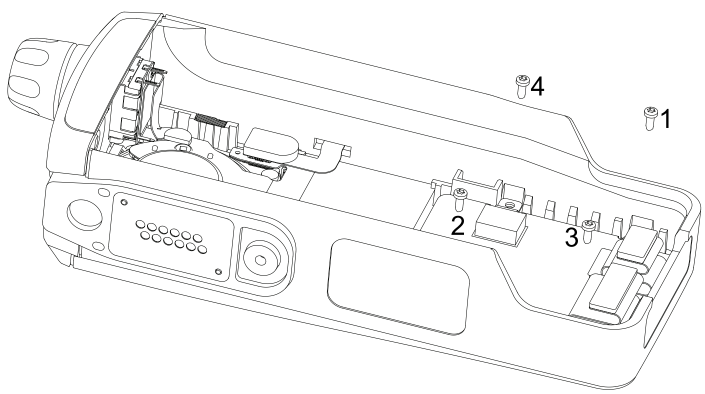

Figure 7-29. Torque in the Keypad Retainer Screws

7.6.4 Reassemble the Main Board (16)

1. Plug in the connectors from the Keypad Flex (11) and the Front Kit Flex onto the Main Board (16). With both the flexes connected to the Main Board, place the Main Board into the Chassis (25) as shown in Figure 7-30.

.

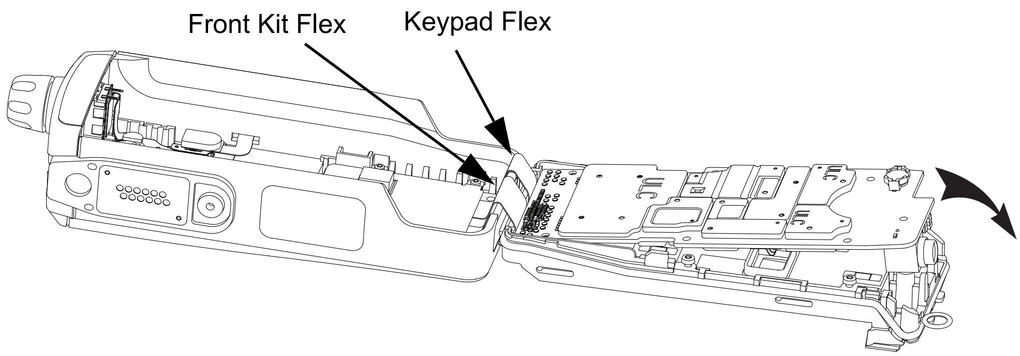

Figure 7-30. Assemble the RF Board

NOTE: Plug in the connectors at the side of the Keypad Flex which reads “To Main Board”. Ensure that the Battery Contact Seal (28) does not pinch and the tabs of the Main O-Ring are held in place when assembling the Main Board onto the Chassis.

2. With the Main Board (16) seated in the Chassis (25), gently assemble the Main O-Ring (24) to the Antenna Holder as shown in Figure 7-31.

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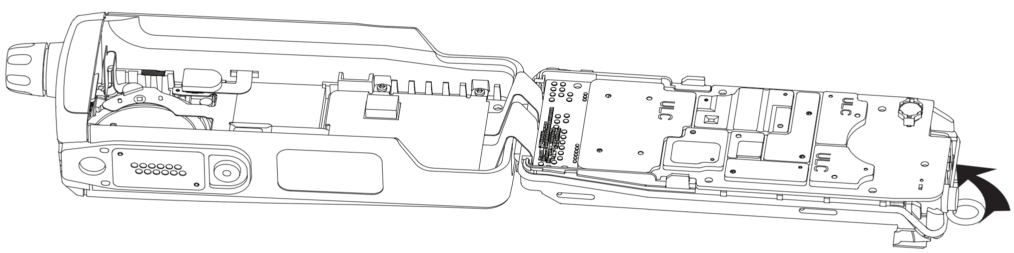

Figure 7-31. Assemble the Main O-Ring at Antenna Holder

3. Torque all seven Chassis Screws (15) with a Torx IP6 Bit and a Torque Driver to 3.7 in-lbf in the sequence as shown in Figure 7-32.

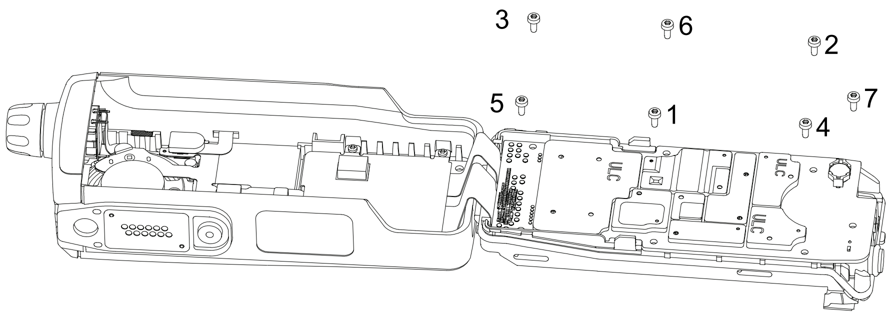

Figure 7-32. Torque in the Keypad Retainer Screws

7.6.5 Reassemble the Shroud (32)

1. Slide the Shroud (32) into the Chassis' frame until the latch clicks into place as shown in Figure 7-33.

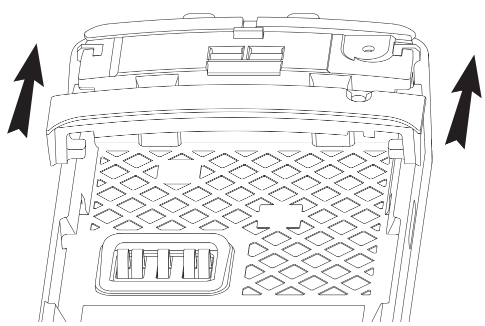

Figure 7-33. Assemble the Shroud

7.6.6 Reassemble the Main Subassemblies (A and B)

1. Complete the steps in Section 7.6.1. through Section 7.6.3.
2. Slide the Chassis assembly into the Front Housing as shown in Figure 7-34.

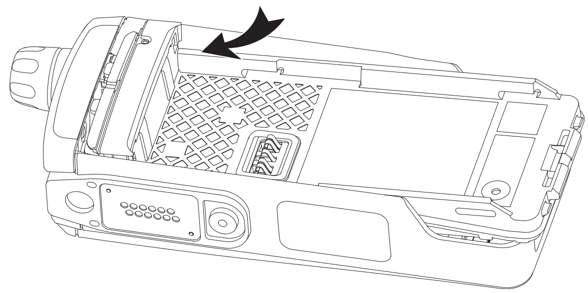

Figure 7-34. Slide chassis assembly into Front Housing

3. With the Chassis assembly fully slided in, press down the bottom part of the Chassis to lock the two subassemblies (A and B) together as shown in Figure 7-35.

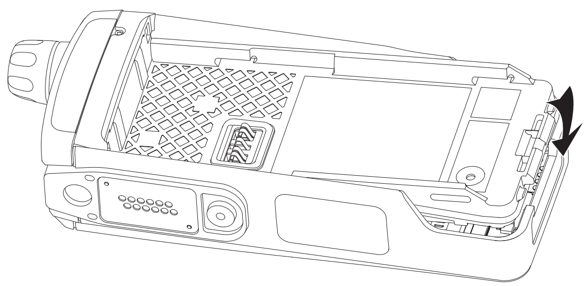

Figure 7-35. Assemble Back Kit and Front Kit together

7.6.7 Reassemble the Accessory-Connector Cover (1)

1. Insert the hooked end of the cover into the pocket. Engage the hook beneath the undercut and swing the cover down onto the radio. Ensure the cover is seated properly and the screw is aligned into the threaded hole.

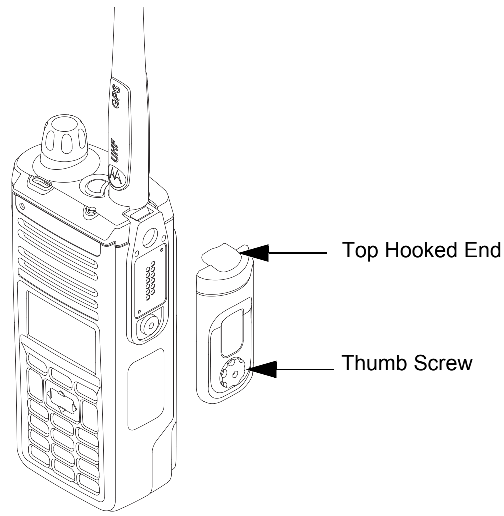

Figure 7-36. Engaging Hook and Seating Cover

2. Hand tighten the thumb screw clockwise until secured.

   NOTE: Do not overtighten the screw. The screw should be snugged and does not allow the cover to move.

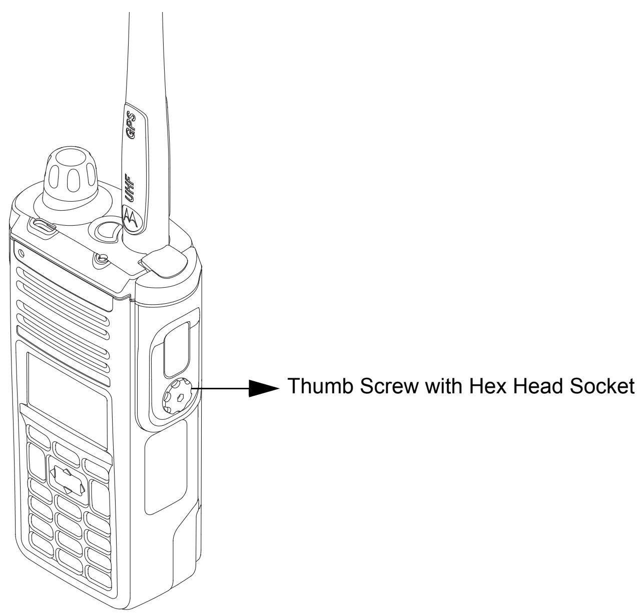

Figure 7-37. Securing the Cover

7.6.8 Reassemble Multi Function Knob (6)

1. Align the D-shaped part of the shaft with the D-shaped hole on the Multi Function knob. Press the knob into place.

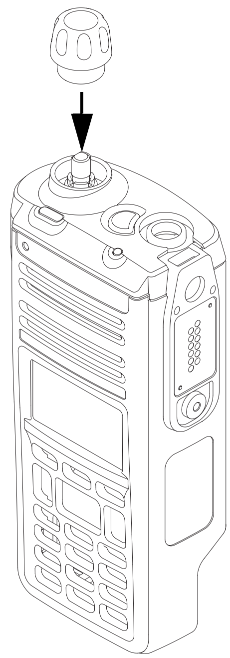

Figure 7-38. Reassemble the Multi Function Knob

7.6.9 Reassemble the Antenna (7)

1. With the radio turned off, turn the antenna clockwise to attach it to the radio.

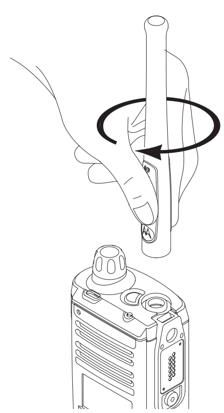

Figure 7-39. Attaching the Antenna

7.6.10 Reassemble the Vacuum Port Seal (27), Ventilation Label (28) and Bottom Label (3)

1. Adhere and gently press the Vacuum Port Seal (27) on the chassis' recess as shown in Figure 7-40.

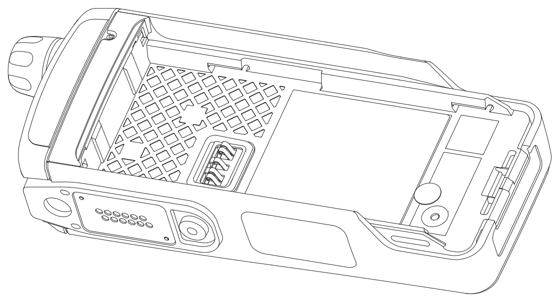

Figure 7-40. Assemble the Vacuum Port Seal

2. With the Vacuum Port Seal assembled, adhere the Ventilation Label (28) on the chassis' recess as shown in Figure 7-42.

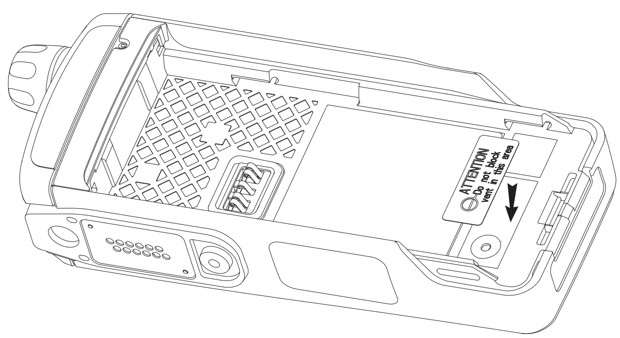

Figure 7-41. Assemble the Ventilation Label

3. Adhere the Bottom Label (3) on the recess at the bottom of the Front Housing as shown in Figure 7-42.

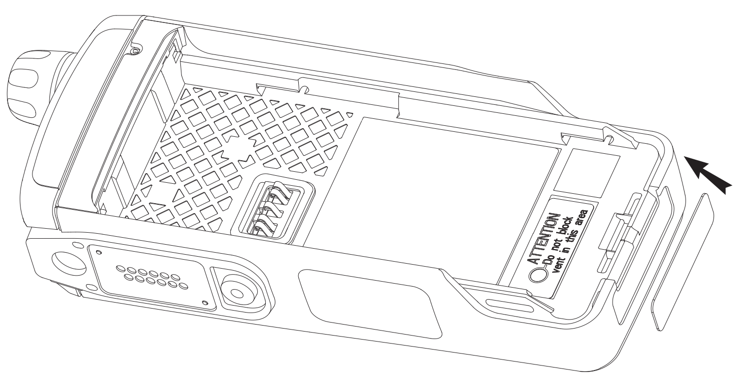

Figure 7-42. Assemble the Bottom Label

7.6.11 Reassemble the Battery (33)

1. With the radio turned off, slide up the battery into the radio's frame until the bottom latch clicks into place as shown in Figure 7-43.

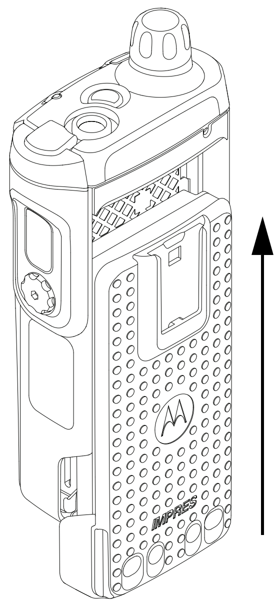

Figure 7-43. Attaching Battery – Slide into Position

7.7 Ensuring Reliable Splash Protection

This section discusses disassembly and reassembly of ASTRO APX 1000 radios and concerns in ensuring a reliable splash protection against liquid.

7.7.1 Standards

ASTRO APX 1000 radio model meet the requirements of IP54, which require the radio to maintain water protection integrity when subjected to splashing of water with volumetric flow up to 10 liters per minute at pressure of 80–100 kPa from any direction for 5 minutes.

7.7.2 Servicing

APX 1000 radios shipped from the Motorola factory should not be disassembled to maintain its splash protection integrity. If disassembly is necessary, refer to qualified service personnel and service shops capable of restoring the splash protection integrity of the radio.

Caution

It is strongly recommended that maintenance of the radio be deferred to qualified service personnel and service shops. This is of paramount importance as irreparable damage to the radio can result from service by unauthorized persons. If disassembly is necessary, unauthorized attempts to repair the radio may void any existing warranties or extended performance agreements with Motorola.

7.7.3 Water Exposure

If the radio is exposed to water, shake the radio to remove the excess water from the speaker grille and microphone ports areas before operating; otherwise, the sound may be distorted until the water has evaporated, or is dislodged from these areas.

Caution

Do not submerge the radio into water.

7.7.4 Disassembly

Disassemble the radio according to Section 7.4.

7.7.5 Reassembly

Caution	Do not reassemble the radio without first performing the following preliminary inspection procedure.

Before reassembling the radio:

1. Inspect the Main O-Ring on the Chassis (26) for any damage or foreign material.
2. Inspect the Battery Contact Seal (29) on the Main Board Assembly (16) for any damage.
3. Inspect the mating seal surfaces on the Chassis (26) for all of the above seals for damage or foreign material that might prevent the seals from sealing properly.

Continue reassembling the radio according to Section 7.6. Tighten all hardware that was loosened or removed.

Notes

Chapter 8 Basic Troubleshooting

This section of the manual contains troubleshooting charts and error codes that will help you to isolate a problem. Level one and two troubleshooting will support only radio alignment, programming, battery replacement, and knob replacement, and circuit board replacement.

Component-level service information can be found in the “ASTRO APX 1000 Portable Radios Detailed Service Manual,” Motorola publication number 68012004061.

8.1 Power-Up Error Codes

When the radio is turned on (power-up), the radio performs self-tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio’s display. For non-display radios, the problem will be presented at power-up by a single, low-frequency tone. The radio should be sent to the depot if cycling power and reprogramming the code plug do not solve the problem. The presence of an error should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors will inhibit user operation; non-fatal errors will not. Use Table 8-1 to aid in understanding particular power-up error code displays.

Table 8-1. Power-Up Error Code Displays

Error Code	Description	Corrective Action
01/02	FLASH ROM Codeplug Checksum Non-Fatal Error	Reprogram the codeplug
01/12	Security Partition Checksum Non-Fatal Error	Send radio to depot
01/81	Host ROM Checksum Fatal Error	Send radio to depot
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug
01/84	External EEPROM Blank (or SLIC failure) Fatal Error	Send radio to depot
01/88	External RAM Fatal Error – **Note:** Not a checksum failure	Send radio to depot
01/90	General Hardware Failure Fatal Error	Turn the radio off, then on
01/92	Security Partition Checksum Fatal Error	Send radio to depot
01/93	FLASHport Authentication Code Failure	Send radio to depot
01/94	Internal EEPROM Blank Fatal Error.	Send radio to depot
01/98	Internal RAM Fail Fatal Error	Send radio to depot
01/A0	ABACUS Tune Failure Fatal Error	Send radio to depot
01/A2	Tuning Codeplug Checksum Fatal Error	Send radio to depot
02/81	DSP ROM Checksum Fatal Error	Send radio to depot

Table 8-1. Power-Up Error Code Displays (Continued)

Error Code	Description	Corrective Action
02/88	DSP RAM Fatal Error – **Note:** Not a checksum failure	Turn the radio off, then on
02/90	General DSP Hardware Failure (DSP startup message not received correctly)	Turn the radio off, then on
Hardware board absent	Keypad board is not connected properly to the radio	Ensure the Keypad board is fixed in place
15/10	External Accessory Non-Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
15/90	External Accessory Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
1E/10	Collaborative device is connected to the radio but the collaborative feature is not enabled in the codeplug.	Contact your Motorola Sales Representative/Partner on how to add Collaborative feature to your radios.
Note: *If the corrective action does not fix the failure, send the radio to the depot.*		

8.2 Operational Error Codes

During radio operation, the radio performs dynamic tests to determine if the radio is working properly. Problems detected during these tests are presented as error codes on the radio's display. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 8-2 to aid in understanding particular operational error codes.

Table 8-2. Operational Error Code Displays

Error Code	Description	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	1. Reprogram external codeplug 2. Send radio to depot
FAIL 002	Selected Mode/Zone Codeplug Checksum Error	Reprogram external codeplug

8.3 Receiver Troubleshooting

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

Table 8-3. Receiver Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements at Room Temperature)
Radio Dead; Display Does Not Turn On	1. Dead Battery	Replace with charged battery
	2. Blown Fuse	Send radio to depot
	3. On/Off Switch	
	4. Regulators	
Radio Dead; Display Turns On	1. Keypad Board	Send radio to depot
	2. Main Board	
Radio On; Front Display Off	High operating temperature (above 80°C)	Allow radio to return to normal operating temperature.
No Receive Audio, or Receiver Does Not Unmute	Programming	1. Check if transmitted signal matches the receiver configuration (PL, DPL, etc.) 2. Check if radio able to unmute with Monitor function enabled
Audio Distorted or Not Loud Enough	Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
RF Sensitivity Poor	1. Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
	2. Antenna Switch/ Connector	Send radio to depot
	3. Receiver Front-End Tuning	Check RF front-end tuning for optimum sensitivity using the tuner
Radio Will Not Turn Off	Main Board	Send radio to depot

8.4 Transmitter Troubleshooting

Table 8-4 lists the possible causes of, and corrections for, transmitter problems.

Table 8-4. Transmitter Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No RF Power Out	1. TX Power Level or Frequency	Check TX power level and frequency programming (from tuner)
	2. No Injection To Power Amplifier	Send radio to depot
	3. Antenna Switch/Connector	
No Modulation; Distorted Modulation	1. Programming	Check deviation and compensation settings using the tuner
	2. Main Board	Send radio to depot
Bad Microphone Sensitivity	1. Check Deviation and Compensation	Realign if necessary
	2. Microphone	Send radio to depot
No/Low signaling (PL, DPL, MDC)	1. Programming	Check programming
	2. Main Board	Send radio to depot
Cannot Set Deviation Balance	Main Board	Send radio to depot

Chapter 9 Exploded Views and Parts Lists

This chapter contains exploded views and associated parts lists for the ASTRO APX 1000 digital portable radios. The following table lists the exploded views for the radio in different configurations:

Table 9-1. APX 1000 Exploded Views and Controller Kit

9.1 APX 1000 Front Kit Exploded View

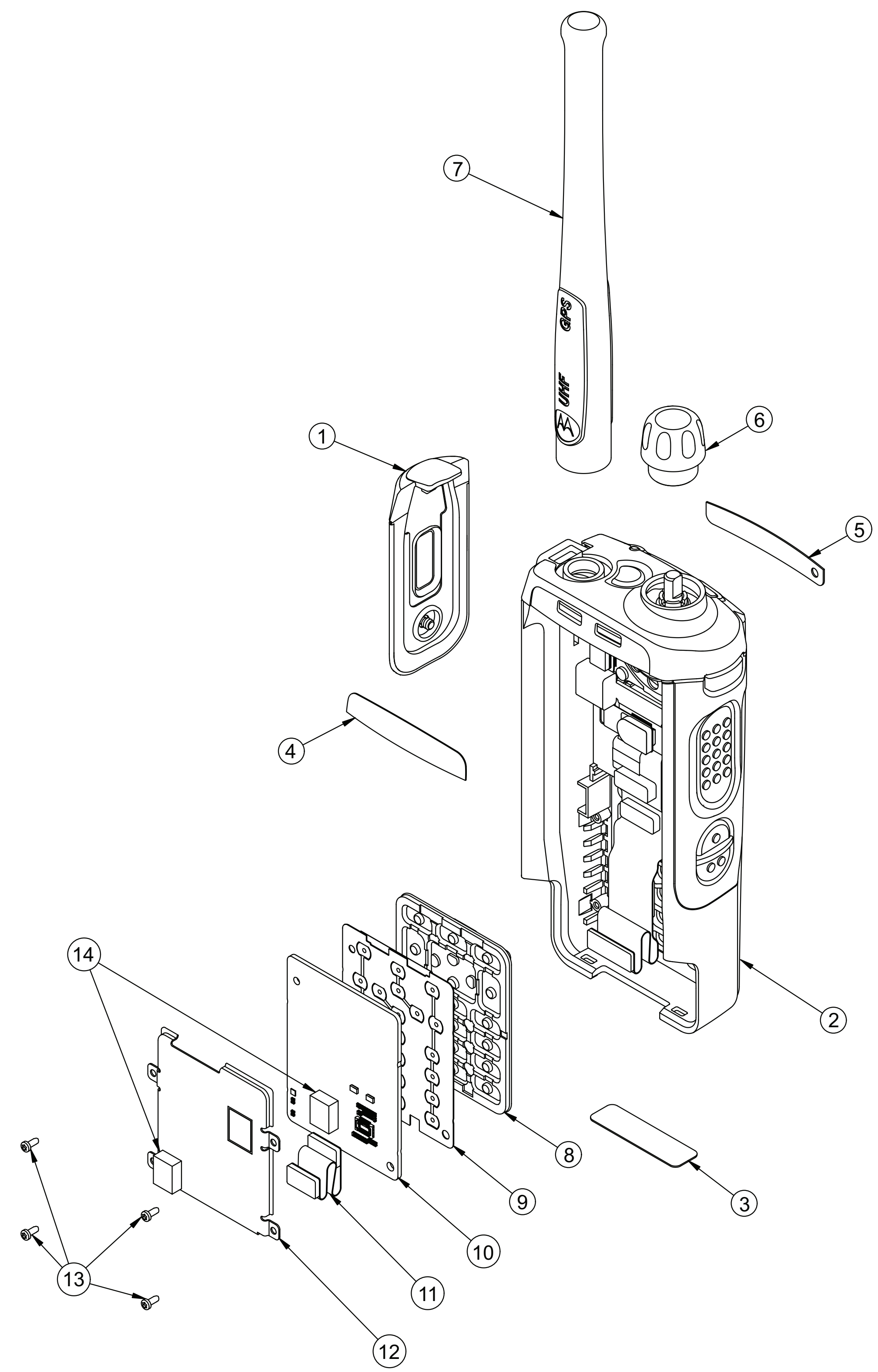

Figure 9-1. APX 1000 Front Kit Exploded View

9.2 APX 1000 Front Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
1	**15012142001**	Cover, Accessory-Connector
2†	**0104059J79** **0104061J96** **0104059J78**	Assembly, Front Housing Kit (Model 1.5) Assembly, Front Housing Kit (Model 2) Assembly, Front Housing Kit (Model 3)
3	**54012241001**	Label, Bottom
4††	**54012198004**	Label, Back (APX 1000)
5††	**54012196002**	Label, Front_Product
6††	**36012020002**	Knob, Multi Function
7	**PMAE4065_** **NAF5085_** **NAR6593_** **NAR6595_** **FAF5259_** **FAF5260_** **PMAF4008_**	Antenna UHF/GPS Antenna Whip 700/800/GPS Antenna VHF/GPS Antenna 1/4 Wave 700/800 MHz Stubby/GPS Antenna,UHF_R1 Plus GPS Stubby Antenna Antenna,UHF_R2 Plus GPS Stubby Antenna Antenna, 900/GPS
8†††	**75012114001** **75012114002** **75012114003** **75012114004** **75012114005** **75012114006** **75012207001**	Keypad, Model 3 (English) Keypad, Model 3 (Chinese) Keypad, Model 2 Keypad, Model 3 (Cyrillic) Keypad, Model 3 (Arabic) Keypad, Model 3 (Hebrew) Keypad, Model 1.5
9††	**40012056001** **40012056002** **40012085001**	Mylar with Metal Domes, Keypad (Model 3) Mylar with Metal Domes, Keypad (Model 2) Mylar with Metal Domes, Keypad (Model 1.5)
10††	**PMCN4037_** **PMCN4040_** **PMCN4036_**	Assembly, Keypad Board (Model 3) Assembly, Keypad Board (Model 2) Assembly, Keypad Board (Model 1.5)
11††	**0104059J56**	Assembly, Keypad Flex (APX 1000)
12††	**42012056001**	Retainer, Keypad
13††	**0378212A02**	Screw, Retainer, Keypad
14††	**75012224001**	Conductive Pad, Keypad Retainer

NOTE:

†. Items cannot be ordered individually. They are included in the Assembly, Front-Kit – PMLN6805_ (Model 2), PMLN6645 _ (Model 3) and PMLN6654_(Model 1.5). Refer to the Model Charts on pages xi, xii, xiii and xiv.

††. Items can be ordered individually, but they are included in their respective kits (if ordered).

†††. Item can be ordered individually, but Keypad with Part No. 75012114001, 75012114003 and 75012207001 are also included in PMLN6645_, PMLN6805_ and PMLN6654_ respectively.

9.3APX 1000 Back Kit Exploded View

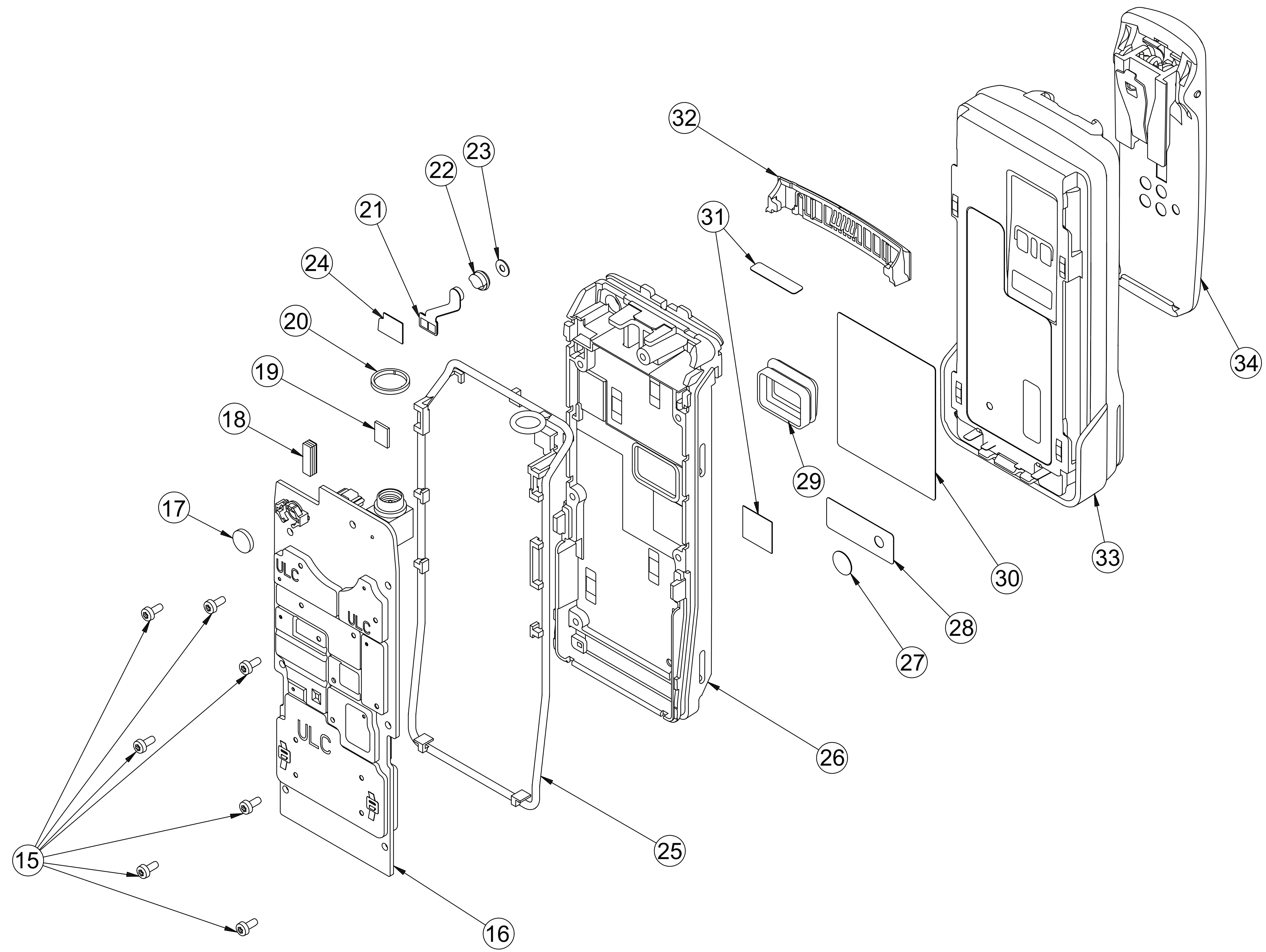

Figure 9-2. APX 1000 Back Kit Exploded View

9.4 APX 1000 Back Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
15	**0386104Z10**	Screw, Chassis
16†	**PMLD4613_** **PMLE4952_** **PMLF4123_** **PMLE4970_**	Assembly, Main Board (VHF) Assembly, Main Board (UHF_R1) Assembly, Main Board (700/800 MHz) Assembly, Main Board (UHF_R2)
17	**6071520M01**	Cell, Coin
18	**HW000071A01**	Absorber
19	**7515719H02**	Pad, Thermal, RF PA
20	**43012045001**	Collar, Plastic
21	**0104059J61**	Assembly, Flex, Back Mic
22	**32012282001**	Boot, Back Mic
23	**35012068001**	Membrane, Back Mic
24	**64012022001**	Back Microphone Backer
25	**32012156001**	O-ring, Main
26	**27012020002**	Chassis
27	**3286058L01**	Seal, Vacuum Port
28	**5478220A01**	Label, Ventilation
29	**32012150001**	Seal, Battery Contact
30††	**54012242001**	Label, FCC
31††	**33012034001**	Label, ITID
32	**15012140001**	Shroud
33	**NNTN8128_** **PMNN4424_** **PMNN4448_**	Battery, Standard (non-FM, 1900 mAH) Battery, Hi-Cap (non-FM, 2300 mAH) Battery, Hi-Cap (non-FM, 2700 mAH)
34	**PMLN4651_** **PMLN7008_**	Clip, Belt (2") Clip, Belt (2.5")

NOTE:

†. Items cannot be ordered individually. They are included in their respective kits (if ordered). Refer to the Model Charts on pages xi, xii, xiii and xiv.

††. Item is not orderable.

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ASTRO® APX® 1000
Digital Portable Radios

Section 3
(900 MHz)

APX 1000

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Notes

Model Numbering, Charts, and Specifications

Portable Radio Model Numbering System

Typical Model Number:	H	8	4	K	G	D	9	P	W	5	A	N	S	P	0	1
Position:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Position 1 – Type of Unit

H = Hand-Held Portable

Positions 2 & 3 – Model Series

84 = APX 1000

Position 4 - Frequency Band

A = Less than 29.7MHz	P = 336 to 410MHz
B = 29.7 to 35.99MHz	Q = 380 to 470MHz
C = 36 to 41.99MHz	R = 438 to 482MHz
D = 42 to 50MHz	S = 450 to 520MHz
F = 66 to 80MHz	T = Dual Band Capable
G = 74 to 90MHz	U = 764 to 870MHz
H = Product Specific	V = 825 to 870MHz
J = 136 to 162MHz	W = 896 to 941MHz
K = 136 to 174MHz	Y = 1.0 to 1.6GHz
L = 174 to 210MHz	Z = 1.5 to 2.0GHz
M = 190 to 235MHz	

Values given represent range only; they are not absolute.

Position 5 – Power Level

A = 0 to 0.7 Watts
B = 0.7 to 0.9 Watts
C = 1.0 to 3.9 Watts
D = 1.0 to 5.0 Watts
E = 5.1 to 6.0 Watts
F = 6.1 to 10 Watts
G = 0 to 6 Watts

Position 6 – Physical Packages

A = RF Modem Operation
B = Receiver Only
C = Standard Control; No Display
D = Standard Control; With Display
E = Limited Keypad; No Display
F = Limited Keypad; With Display
G = Full Keypad; No Display
H = Full Keypad; With Display
J = Limited Controls; No Display
K = Limited Controls; Basic Display
L = Limited Controls; Limited Display
M = Rotary Controls; Standard Display
N = Enhanced Controls; Enhanced Display
P = Low Profile; No Display
Q = Low Profile; Basic Display
R = Low Profile; Basic Display, Full Keypad

Position 7 – Channel Spacing

1 = 5kHz	5 = 15kHz
2 = 6.25kHz	6 = 20/25kHz
3 = 10kHz	7 = 30kHz
4 = 12.5kHz	9 = Variable/Programmable

Position 8 – Primary Operation

A = Conventional/Simplex
B = Conventional/Duplex
C = Trunked Twin Type
D = Dual Mode Trunked
E = Dual Mode Trunked/Duplex
F = Trunked Type I
G = Trunked Type II
H = FDMA* Digital Dual Mode
J = TDMA** Digital Dual Mode
K = Single Sideband
L = Global Positioning Satellite Capable
M = Amplitude Companded Sideband (ACSB)
P = Programmable

** FDMA = Frequency Division Multiple Access*
*** TDMA = Time Division Multiple Access*

Position 9 – Primary System Type

A = Conventional
B = Privacy Plus
C = Clear SMARTNET
D = Advanced Conventional Stat-Alert
E = Enhanced Privacy Plus
F = Nauganet 888 Series
G = Japan Specialized Mobile Radio (JSMR)
H = Multi-Channel Access (MCA)
J = CoveragePLUS
K = MPT1327* – Public
L = MPT1327* – Private
M = Radiocom
N = Tone Signalling
P = Binary Signalling
Q = Phonenet
W = Programmable
X = Secure Conventional
Y = Secure SMARTNET

** MPT = Ministry of Posts and Telecommunications*

Position 10 – Feature Level

1 = Basic	6 = Standard Plus
2 = Limited Package	7 = Expanded Package
3 = Limited Plus	8 = Expanded Plus
4 = Intermediate	9 = Full Feature/ Programmable
5 = Standard Package	

Position 11 – Version

Version Letter (Alpha) – Major Change

Position 12 – Unique Model Variations

C = Cenelec
N = Standard Package

Positions 13 – 16

SP Model Suffix

Notes

ASTRO APX 1000 900 MHz Model Chart

MODEL DESCRIPTION:		**900 MHz, APX 1000**
BT Models FCC ID:		**AZ489FT5864**
H84WCF9PW6AN		**Model 2 APX1000, 896–941MHz, 1.0–3.9 Watts, Limited Keypad**
	ITEM NUMBER	**DESCRIPTION**
X	PMLN5907_	Assembly, Front Kit, Model 2
X	0378212A02	Screw, Retainer, Keypad
X	42012056001	Retainer, Keypad
X	75012114003	Keypad, Model 2
X	PMLN6210_	Assembly, Keypad Board, Model 2, Base
X	40012056002	Mylar with Metal Domes, Model 2 Keypad
X	0104059J61	Assembly, Flex, Back Mic
X	35012068001	Membrane, Back Mic
X	32012282001	Boot, Back Mic
X	64012022001	Backer, Back Mic
X	27012020002	Chassis
X	32012150001	Seal, Battery Contact
X	15012140001	Shroud
X	32012156001	O-ring, Main
X	PMLN7028_	Assembly, Main Board (900 MHz)*
X	7515719H02	Pad, Thermal, RF PA
X	43012045001	Collar, Plastic
X	6071520M01	Coin Cell
X	0104043J76	Assembly, Flex, Back-kit (Model 2)
X	0104046J48	Assembly, Shield, Secondary
X	0386104Z04	Screw, Chassis
X	3286058L01	Seal, Vacuum Port
X	5478220A01	Label, Ventilation
●	54012196002	Label, Front_NamePlate (Non-Bluetooth – Basic)
●	54012198004	Label, Back (APX 1000)
X	54012241001	Label, Bottom
●	54012255001	Label, Front, Color Talk Group
X	36012020002	Knob, Multi Function
X	15012142001	Cover, Accessory-Connector
X	PMLN7029_	User Guide CD, APX 1000

Note:
X *= Item Included.*
● *= Option available. Can be serviced in depot and ordered thru AAD.*
• *Refer Appendix A for antennas, batteries and other applicable accessories.*
* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model II, or III radio.*

Specifications for APX 1000 900 MHz Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL	RECEIVER	TRANSMITTER
Temperature Range:	**Frequency Range:** 935–941 MHz	**Frequency Range:** 896–902 MHz
Operating: -30°C to +60°C		935–941 MHz
Storage: -40°C to +85°C	**Bandwidth:** 6 MHz	
		RF Power:
Power Supply:	**Analog Sensitivity (typical)**	1–**2.**5 W
Lithium-Ion Battery (Li-Ion)	**(12 dB SINAD):** 0.236µV	
		Frequency Stability (typical)
Battery Voltage:	**Digital Sensitivity (typical)**	**(-30 to +60°C; 25°C ref.):** ±0.0001%
Nominal: 7.5 Vdc	**(1% BER):** 0.33 µV	
Range: 6 to 9 Vdc	**(5% BER):** 0.222 µV	**Emission (typical conducted):** -75 dBc
Transmit Current Drain (Typical): 1580 mA	**Intermodulation (typical):** -75 dB	**FM Hum and Noise (typical)**
Receive Current Drain (Rated Audio): 306 mA		**(Companion Receiver):** 12.5 kHz -45 dB
Standby Current Drain: 137 mA	**Selectivity (typical):**	
	(12.5 kHz Channel): -67 dB	**Distortion (typical):** 1%
Recommended Battery:		
Li-Ion (Slim): NNTN8128_	**Spurious Rejection (typical):** -80 dB	**Modulation Limiting:** 12.5 kHz chnls ±2.5 kHz
or **Li-Ion High Cap:** NNTN8129_*		
or **Li-Ion High Cap:** PMNN4424_	**Frequency Stability**	**ACPR (typical):** **12.5 kHz -66 dBc**
* FM Intrinsically Safe.	**(-30+60°C; 25°C reference):** ±0.0001%	
		Emissions Designators:
Dimensions (H x W x D):	**Rated Audio:**	11K0F3E, 8K10F1D, 8K10F1E, 8K10F1W
Without Battery (Radio Only):	**Internal Speaker:** 500 mW	
H = 5.26" (133 mm)	**External Speaker:** 500 mW	
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)		
D[2] = 0.77" (19.6 mm) / 1.48" (37.5 mm)	**FM Hum and Noise (typical):**	
With Standard Battery:	12.5 kHz -47 dB	
H = 5.26" (133 mm)		
W[1] = 2.56" (65 mm) / 2.37" (60.2 mm)	**Distortion (typical):** 1 %	
D[2] = 1.47"(37.4mm) / 1.72"(43.6mm)		
With High Cap Battery:	**Channel Spacing:** 12.5 kHz	
H = 5.26" (133mm)		
W[1] = 2.56"(65mm) / 2.37"(60.2mm)		
D[2] = 1.69"(42.9mm) / 1.93"(48.9mm)		
Note:		
H = Height; W = Width; D = Depth		
1 = (Width @ Top) / (Width @ PTT)		
2 = (Depth @ Bottom) / (Depth @ PTT)		
Weight: (w/o Antenna):		
Less Battery: 9.17 oz (260g)		
With Li-Ion Standard: 14.47 oz (410g)		
With Li-Ion High Cap: 14.81 oz (420g)		

Specifications subject to change without notice.

Chapter 1 Introduction

This manual contains information needed for Levels One and Two radio servicing. Level One servicing consists of radio programming, radio alignment, knobs replacement, and installation and removal of the antenna, belt clip, battery, and universal connector cover. Level Two servicing covers disassembly and reassembly of the radio to replace circuit boards.

1.1 Manual Contents

Included in this manual is radio specification for the 900 MHz (896–941 MHz) frequency bands, a general description of ASTRO APX1000 models, recommended test equipment, service aids, radio alignment procedures, general maintenance recommendations, procedures for assembly and disassembly, and exploded views and parts lists.

1.2 Notations Used in This Manual

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

NOTE: An operational procedure, practice, or condition that is essential to emphasize.

Caution

CAUTION indicates a potentially hazardous situation which, if not avoided, <u>might</u> result in equipment damage.

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, <u>could</u> result in death or injury.

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, <u>will</u> result in death or injury.

1.3 Radio Description

The ASTRO APX1000 radio provides improved voice quality across more coverage area. The digital process, called *embedded signaling*, intermixes system signaling information with digital voice, resulting in improved system reliability and the capability of supporting a multitude of advanced features.

ASTRO APX1000 radios are available in Single Display configuration. Table 1-1 describes their basic features.

Table 1-1. ASTRO APX1000 Basic Features

Feature	Limited Keypad (Model 2)
Display	•Full bitmap color LCD display •3 lines of text x 14 characters •1 line of icons •1 menu line x 3 menus •White backlight
Keypad	• Backlight keypad • 3 soft keys • 4 direction Navigation key • Home and Data buttons
Channel Capability	512
FLASHport Memory	64MB

NOTE: * Only applicable for APX1000.

1.4 FLASHport®

The ASTRO APX1000 radio utilizes Motorola’s FLASHport technology. FLASHport makes it possible to add software that drives the radio’s capabilities both at the time of purchase and later on. Previously, changing a radio’s features and capabilities meant significant modifications or buying a new radio. But now, similar to how a computer can be loaded with different software, the radio’s features and capabilities can be upgraded with FLASHport software.

Chapter 2 Basic Maintenance

This chapter describes the preventive maintenance and handling precautions. Each of these topics provides information vital to the successful operation and maintenance of the radio.

2.1 General Maintenance

In order to avoid operating outside the limits set by the FCC, align the ASTRO APX 1000 radio's reference oscillator every time the radio is taken apart, or once per year, whichever comes first. (See Section 6.5.1). Periodic visual inspection and cleaning is also recommended.

2.1.1 Inspection

Check that the external surfaces of the radio are clean and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed.

2.1.2 Cleaning

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

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water.

Caution	Use all chemicals as prescribed by the manufacturer. Be sure to 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. Aerosol sprays, tuner cleaners, and other chemicals should be avoided.

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

2.2 Safe Handling of CMOS and LDMOS Devices

Complementary metal-oxide semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) devices, and other high-technology devices, are used in this family of radios. While the attributes of these devices are many, their characteristics make them susceptible to damage by electrostatic discharge (ESD) 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 this radio, and are especially important in low-humidity conditions.

Caution

- The APX 1000 radio has a vent port that allows for pressure equalization in the radio. Never poke this vent with any objects, such as needles, tweezers, or screwdrivers. This could create a leak path into the radio and the radio's splash protection reliability will be lost.
- The pressure equalization vent is located adjacent to the battery contact opening of the main chassis. Never touch the equalization vent. Ensure that no oily substances come in contact with this vent.
- Do not submerge the radio as this results in damage to the radio.
- If water is observed on the battery contact area, dry and clean the radio battery contacts before attaching a battery to the radio. Otherwise, the water could short-circuit the radio.
- If water is observed on the speaker grille area, shake the radio well so that any water that is trapped inside the speaker grille and microphone port can be removed. Otherwise, the water will decrease the audio quality of the radio.

Chapter 3 Basic Theory of Operation

This chapter discusses the basic operational theory of the ASTRO APX 1000 radio. The ASTRO APX 1000 radio, which is a single-band synthesized radio, is available in the 900 MHz (896–941 MHz) frequency band.

All ASTRO APX 1000 radios with 900 MHz frequency support analog operation (12.5 kHz only), ASTRO mode (digital) operation (12.5 kHz only), and Phase 2 TDMA mode (12.5 kHz only).

NOTE: The APX 1000 M2 radio do not support any Global Positioning System (GPS), Bluetooth, MACE and Accelerometer functions. As such, disregard all references to the functions mentioned above in "Chapter 3 Basic Theory of Operation".

3.1 Major Assemblies

The ASTRO APX1000 radio includes the following major assemblies (See Figure 3-1.):

- **Main Board –** Contains all transmit, receive, and frequency generation circuitry, including the digital receiver back-end IC and the reference oscillator. The main board also contains a dual core processor, which includes both the microcontroller unit (MCU) and a digital signal processor (DSP) core, the processors's memory devices, an audio and power supply support integrated circuit (IC), a digital support IC, external power amplifier as well as combination Global Positioning System (GPS) and Bluetooth 2.1 IC and front end circuitry.
- **Keypad Board** – Contains a Type III secure IC, Bluetooth controller (AVR IC) and a 3-axes digital accelerometer.
- **Control Top** – Contains a Multi-Function knob, a push button switch used for Emergency call and a light bar. The control top also includes TX/RX LED that is solid amber upon receive, red on PTT, and blinks amber on secure TX/RX.
- **Main Display** – 160 pixels x 90 pixels, transflective color LCD.
- **Keypad**
  - Standard Control Keypad version has 3 soft keys
  - Limited Keypad Version has 3 soft keys, 4 direction Navigation key, Home and Data buttons
  - Full Keypad Version has 3 soft keys, 4 direction Navigation key, 3x4 alphanumeric keypad, Home and Data buttons.

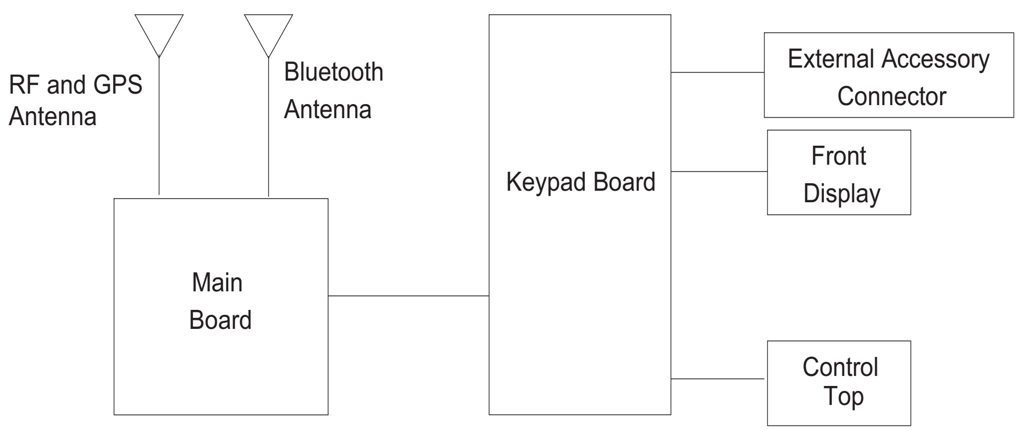

Figure 3-1. APX 1000 Overall Block Diagram

3.2 Analog Mode of Operation

This section provides an overview of the analog mode receive and transmit theory of operation.

3.2.1 Receiving

The RF signal is received at the antenna and is routed through the Harmonic Filter, followed by the Antenna Switch and finally the 15dB Step Attenuator IC. The latter contains a switchable attenuator that is enabled at predetermined RF power thresholds present at the antenna port. See Figure 3-2.

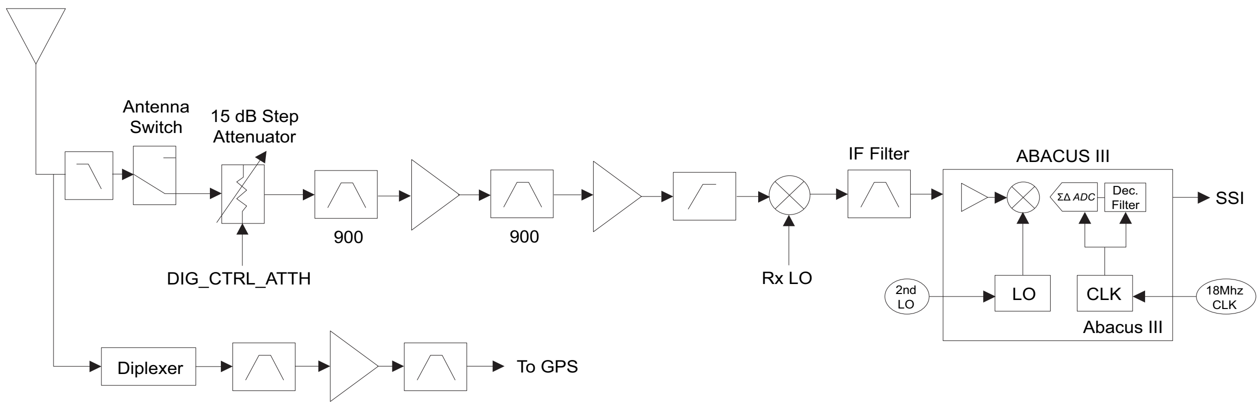

Figure 3-2. Receiver Block Diagram (900 MHz)

3.2.1.1 GPS

The GPS signal is tapped at the antenna port via a series resonant network (diplexer) which provides a very low capacitive load to the transceiver. The diplexer circuitry provides rejection to radio band signals up to ~1GHz which serves as isolation between the radio RF and GPS signal paths. The GPS signal is filtered though a GPS SAW filter - LNA – Saw filter chain before going into the TI GPS IC for processing.

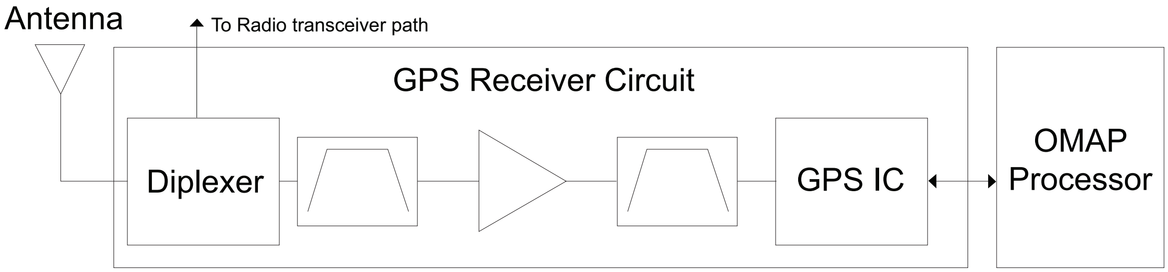

Figure 3-3. GPS Diagram

3.2.1.2 900 MHz Front-End

From the 15 dB Step Attenuator, the 900 MHz band signal is routed to the pre-selector filter. The output of the prefilter is applied to the first LNA followed by a similar filter as the pre-selector filter. The signal is then routed to a second LNA whose output is applied to a discrete image filter. Both pre and post selector filters are Surface Acoustic Wave designs used to band limit the received energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the discrete image filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.3 Analog To Digital Converter

The ADC IC's front end down converts the first IF to a second IF, a 2.25 MHz signal. The second IF is sampled at 18 MHz, a signal generated by an integrated clock synthesizer. The sampled signal is decimated by a factor of 900 to 20 kHz and converted to SSI format at the ADC's output. The Serial Synchronous Interface (SSI) serial data waveform is composed of a 16 bit in-phase word (I) followed by a 16 bit Quadrature word (Q). A 20 kHz Frame Synch and a 1.2 MHz clock waveform are used to synchronize the SSI IQ data transfer to the Digital Signal Processor IC (OMAP) for post-processing and demodulation.

3.2.2 Transmitting

When the radio is transmitting, microphone audio is digitized and then processed by the DSP and sent to the Trident IC (see Figure 3-4) via the SSI interface. The Trident IC processes the SSI data for application to the voltage controlled oscillator as a modulation signal.

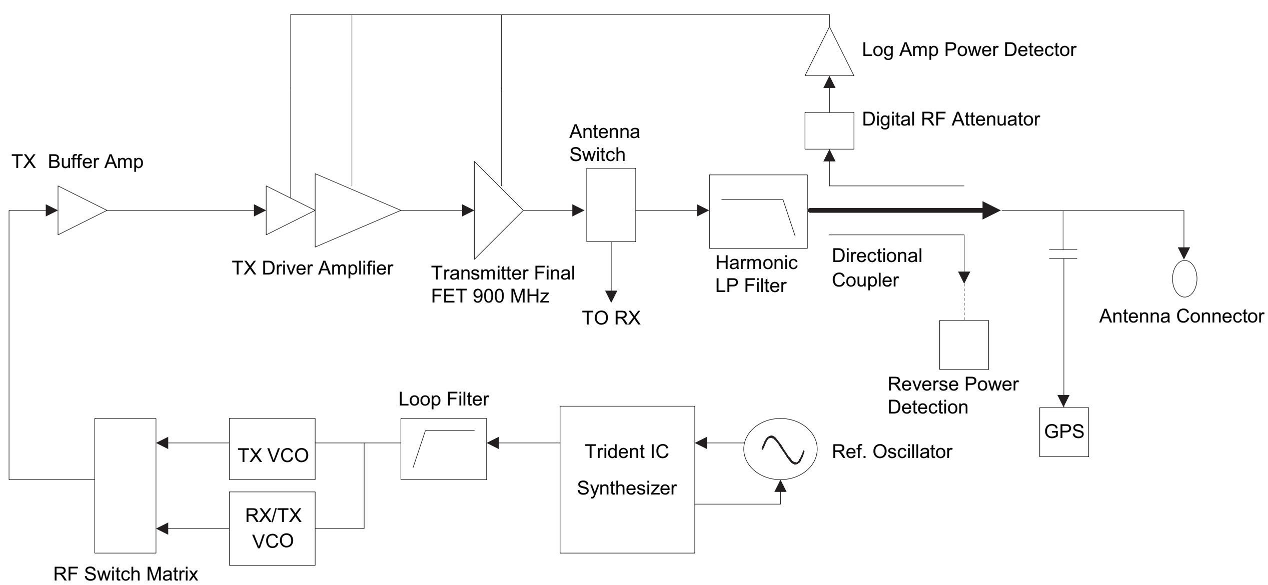

Figure 3-4. Transmitter (900 MHz) Block Diagram

3.2.2.1 900 MHz Transmit

Once a 900 MHz frequency for transmit has been selected, the Trident IC and accompanying logic circuitry enable the correct voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the 900 MHz Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The Log Amp power detector Monitors the output of the directional coupler and adjusts the control voltages to the driver amplifier and the discrete final power amplifier. Finally, the RF signal is routed to the main antenna.

3.3 Digital (ASTRO) Mode of Operation

In the ASTRO (digital) mode of operation, the transmitted or received signal is limited to a discrete set of frequency deviation levels. The receiver handles an ASTRO-mode signal identically to an analog-mode signal, up to the point where the DSP decodes the received data. In the ASTRO receive mode, the DSP uses a different algorithm to recover data.

In the ASTRO transmit mode, microphone audio is processed identically to an analog mode, with the exception of the algorithm the DSP uses to encode the information. Using this algorithm, transmitter FM deviation is limited to discrete levels.

3.4 Controller Section

The controller section (See Figure 3-5.) comprises of five functional sections that are split among two boards, which are the main and keypad boards. The main functional section consists of a dual core ARM and DSP controller, an encryption processor (MACE), Flash memory, and a Double Data Rate Synchronous Dynamic Random Access Memory (DDR SDRAM) and CPLD for GPIO expander multiple clock generation and SSI interface for the radio system. The Power and Clocks section includes a power management IC (MAKO) and various external switching regulators, and three clock sources (12 MHz and 24.576 MHz) from which all other controller digital clocks are derived. The Audio section has a CODEC and a class-D audio power amplifier that provides the radio with a microphone and speaker design. The User Interface section provides communication and control to the main Liquid Crystal Displays (LCD) on the radio, as well as a keypad and a side connector interface conforming to GCAI (Global Communications Accessory Interface) specifications. The GPS and Bluetooth section comprises of a Global Positioning Satellite(GPS) and Bluetooth combo chipset on the main board, and an AVR Bluetooth controller IC, SDRAM, LF wakeup IC and Accelerometer IC on the keypad board. The MACE IC is located on the keypad board.

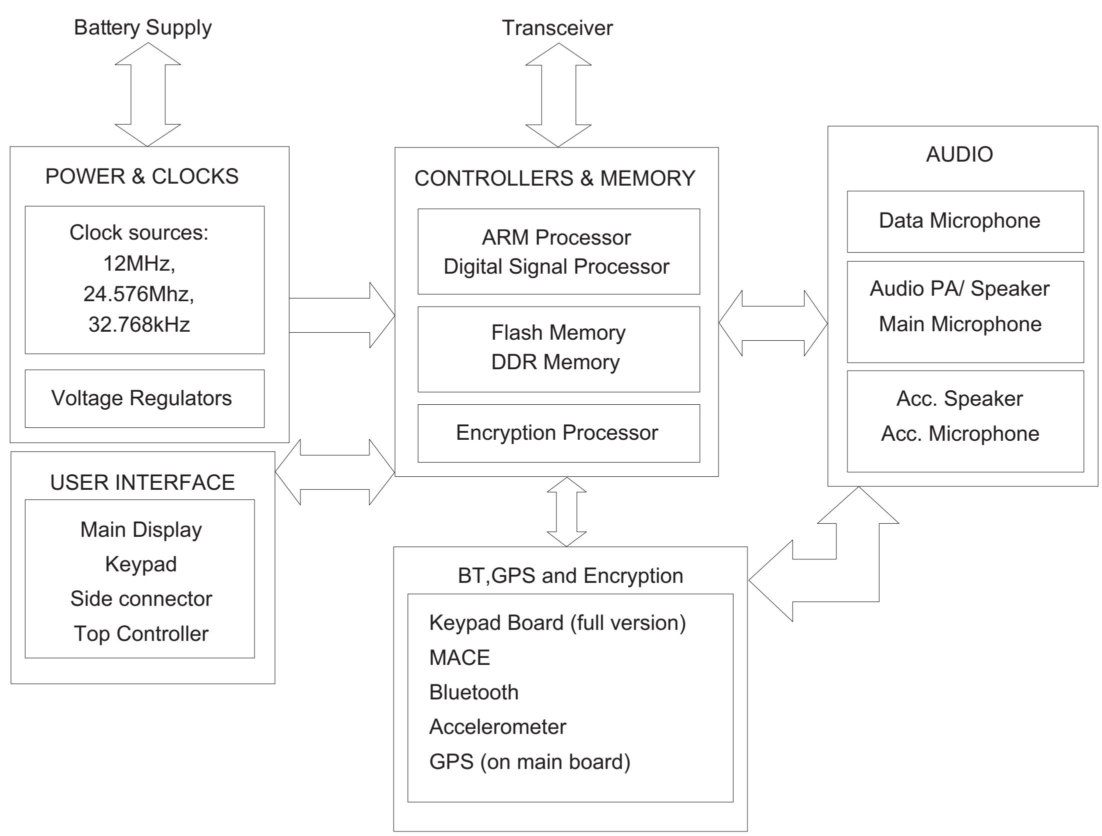

Figure 3-5. Controller Block Diagram

The ARM controller core of the OMAP processor handles the power up sequence of all devices, including firmware upgrades, and all operating system tasks that are associated with FLASH and SDRAM memories and user interface communication. The FLASH memory (64 MB) is required to store the firmware, tuning, and Codeplug settings, which upon initialization get read and stored into SDRAM (32MB) for execution. The ARM and DSP core jointly control and configure audio, wireless and RF devices linked to the Serial Peripheral Interface (SPI) and Synchronous Serial Interface (SSI) buses to enable radio FM and optional wireless communication protocols. For encryption, a separate ARM processor is used (MACE) to encode and decode encryption packets coming in from the main OMAP processor through the SSI interface. Its firmware is flashed via the main processor during an upgrade request to its internal FLASH memory. The MACE encryption processor is located on the keypad board.

The power and most clocks to the controller devices are provided by the MAKO IC and external switching and linear regulators on board. A Complex Programmable Logic Array (CPLD) IC divides the 24.576 MHz clock from MAKO to source OMAP's 32 kHz Real Time Clock, and MACE's 4 MHz main clock. OMAP's main clock is supplied externally from an on board 12 MHz crystal.

The radio has two internal microphones and an internal speaker, as well as available microphone and speaker connections for external accessories. The internal 4 Ohm speaker is located on the same side as the main display and keypad of the radio. The internal speaker is driven by a Class D audio amplifier located on the main board that is capable of delivering a rated power of 0.5 W. The external accessory speaker is driven by a Class AB audio amplifier on the MAKO IC that is capable of delivering 0.5 W of power into a 16 Ohm as a minimum load. Both speaker paths use the CODEC for volume control and to convert the audio signal from digital to analog. Both internal and external microphones use the CODEC's ADC to deliver digital audio samples to the DSP controller.

The user interface block consists of a main display, a keypad, top controls and the accessory side connector. The side connector (Universal Connector) provides audio, USB, RS232 communication for accessories. All signals to and from the connector go through the internal keypad board before reaching the microcontroller and other devices on the main board.

The radio also has integrated feature of Global Positioning System (GPS) and Bluetooth with Man-down feature (depending on radio model) (see Figure 3-6). The GPS and Bluetooth Combo RF chipset (NL5500) is located on the Main board together with the GPS/RF Diplexer circuitry and Bluetooth Front-End circuitry. The GPS receiver section of the GPS/BT combination IC interfaces with the OMAP processor through a dedicated UART port. The GPS receiver also has a dedicated reset controlled solely by the OMAP processor. The GPS/Bluetooth IC (NL5500) taps the GPS signal from transceiver path and processes the location information before relaying to the OMAP processor via UART lines. The clock supplies to NL5500 included a 26MHz TCXO and 32kHz clock from CPLD.

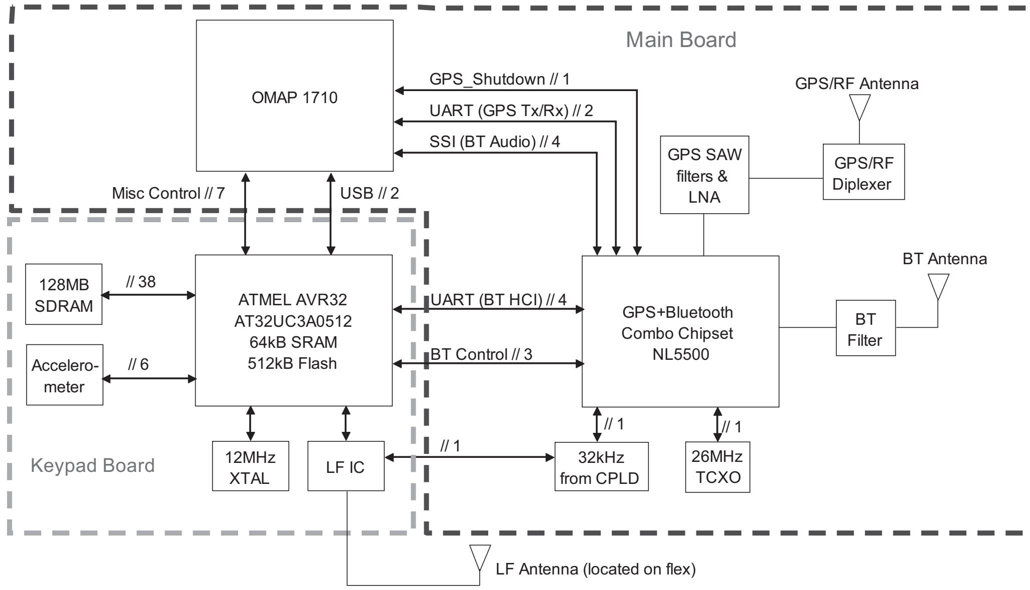

Figure 3-6. GPS/Bluetooth/Accelerometer Block Diagram

3.4.1 Radio with Mace Expanded Keypad Board

In addition to the Mace features, the Expanded Keypad Board consists of a 3-axes digital accelerometer and the Bluetooth Controller IC (AVR) together with LF Wakeup IC (AS3930A) for Secure Pairing.

The radio also has the ability to connect to a wireless Bluetooth audio headset. This feature is implemented using a combination Bluetooth/GPS integrated circuit (NL5500 IC) located on the Main board. An optional accessory headset can connect using a low-data rate GFSK modulated signal hopping on 79 x 1 MHz wide Bluetooth channels from 2402 MHz to 2480 MHz in the ISM band. Each APX accessory that is capable of Bluetooth communication will have its own unique Bluetooth address. Bluetooth uses a frequency hopping spread spectrum (FHSS) technique to spread the RF power across the spectrum to reduce the interference and spectral power density. The frequency hopping allows the channel to change up to 1600 times a second (625 µs time slot) based on a pseudo random sequence. If a packet is not received on one channel, the packet will be retransmitted on another channel. The Bluetooth IC sends data to the AVR32 processor that is also located on the keypad board over an HCI UART link. The AVR32 processor communicates to the OMAP processor on the main board through a dedicated USB port.

The Bluetooth feature is accompanied by a Low-Frequency (LF) detection circuit that is also located on the keypad board. The LF circuit provides the ability of a secure pairing connection with a Bluetooth accessory. Once a radio has the Bluetooth feature enabled, a user can tap their LF enabled Bluetooth audio accessory with the radio at the pairing spot to establish a secure Bluetooth connection. The LF circuit uses a 125 kHz radiated signal to communicate the secure pairing information between the Bluetooth accessory and low-frequency receiver. The low-frequency receiver is programmed by the AVR32 processor through a dedicated SPI bus and transfers the pairing data through a dedicated UART.

There is a digital accelerometer on the keypad board that detects the 3-axis force of gravity which can be used to determine the radio's orientation. The accelerometer's position is communicated to the AVR32 processor through a SPI bus.

Notes

Chapter 4 Recommended Test Equipment and Service Aids

This chapter provides lists of recommended test equipment and service aids, as well as information on field programming equipment that can be used in servicing and programming ASTRO APX 1000 radios.

4.1 Recommended Test Equipment

The list of equipment contained in Table 4-1 includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specifically for servicing this family of radios. The “Characteristics” column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola model listed is either a unique item or no substitution is recommended.

Table 4-1. Recommended Test Equipment

Equipment	Characteristics	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	General Dynamics R2670	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital RMS Multimeter *	100 µV to 300 V 5 Hz to 1 MHz 10 Mega Ohm Impedance	Fluke 179 or equivalent (www.fluke.com)	AC/DC voltage and current measurements. Audio voltage measurements
RF Signal Generator *	100 MHz to 1 GHz -130 dBm to +10 dBm FM Modulation 0 kHz to 10 kHz Audio Frequency 100 Hz to 10 kHz	Agilent N5181A (www.agilent.com), Ramsey RSG1000B (www.ramseyelectronics.com, or equivalent	Receiver measurements
Oscilloscope *	2 Channel 50 MHz Bandwidth 5 mV/div to 20 V/div	Leader LS8050 (www.leaderusa.com), Tektronix TDS1001b (www.tektronix.com), or equivalent	Waveform measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 9240 (www.boonton.com) or equivalent	Waveform measurements
Power Supply	0 V to 32 V 0 A to 20 A	B&K Precision 1790 (www.bkprecision.com) or equivalent	Voltage supply

4.2 Service Aids

Refer to Table 4-2 for a listing and description of the service aids designed specifically for servicing this family of radios. These kits and/or parts are available from the Radio Products and Solutions Organization offices listed in "Appendix B Replacement Parts Ordering". While all of these items are available from Motorola, most are standard shop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 4-2. Service Aids

Motorola Part Number	Description	Application
66012028001	Chassis Opener	To disassemble chassis from housing
66012031001	Battery Adapter	Used in place of battery to connect radio to an external power supply.
5880384G68	SMA to BNC Adapter	Adapts radio's antenna port to BNC cabling of test equipment.
RVN5224_	Customer Programming Software (CPS) and Tuner Software	CPS allows customer-specific programming of modes and features. Tuner software required to perform alignment of radio parameters.
PMKN4012B	Programming Cable	To program the radio through Customer Programming Software and Tuner Software.
PMKN4013C	Programming/Service Cable	To program and service the radio through Customer Programming Software and Tuner Software.
RLN4460_	Portable Test Set	For radio performance checks. Connects to radio's universal connector and allows remote switching and signal injection/ outputs for test equipment measurements.

NOTE: Do not place an order for the Programming Cable (PMKN4012A/PMKN4013B) as it is not compatible with the APX 1000 radio.

4.3 Field Programming

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the online help in the Customer Programming Software (CPS) for complete field programming information.

Chapter 5 Performance Checks

This chapter covers performance checks used to ensure that the ASTRO APX 1000 radio meets published specifications. The recommended test equipment listed in the previous section approaches the accuracy of the manufacturing equipment, with a few exceptions. Accuracy of the test equipment must be maintained in compliance with the manufacturer's recommended calibration schedule. Checks should be performed if radio performance degradation is suspected.

5.1 Test Equipment Setup

Supply voltage can be connected from the battery eliminator. The equipment required for the performance checks is connected as shown in Figure 5-1.

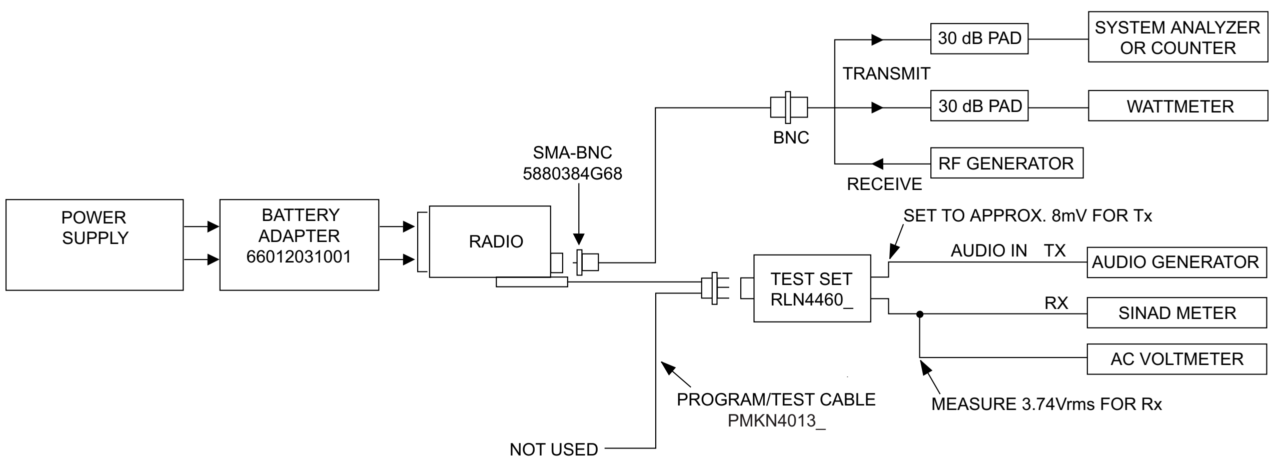

Figure 5-1. Performance Checks Test Setup

Initial equipment control settings should be as indicated in Table 5-1 and should be the same for all performance checks and alignment procedures, except as noted.

Table 5-1. Initial Equipment Control Settings

System Analyzer	Test Set	Power Supply
Monitor Mode: Standard*	**Spkr/Load:** Speaker	**Voltage:** 7.5 Vdc
Receiver Checks **RF Control:** GEN **Output Level:** -47 dBm **Modulation:** 1 kHz tone @3 kHz deviation **Frequency:** Set to selected radio RX frequency **Meter:** AC Volts Transmitter Checks **RF Control:** Monitor **Frequency:** Set to selected radio TX frequency **Meter:** RF Display **Modulation Type:** FM **Attenuation:** 20 dB	**PTT:** OFF (center) **Meter Out:** RX **Opt Sel:** ON	**DC On/Standby:** Standby **Volt Range:** 10 Vdc **Current:** 2.5 Amps

* *Use "PROJ 25 STD" if testing ASTRO Conventional channels.*

5.2 Display Radio Test Mode

This section provides instructions for performing tests in display radio test mode.

5.2.1 Access the Test Mode

To enter the display radio test mode:

1. Turn the radio on.
2. Within 10 seconds, press **Side Button 2** five times in succession.

   The radio shows a series of displays that give information regarding various version numbers and subscriber specific information. The displays are described in Table 5-2.

Table 5-2. Test-Mode Displays

Name of Display	Description	Appears
Service	The literal string indicates the radio has entered test mode.	Always
Host version	The version of host firmware is displayed.	Always
DSP version	The version of DSP firmware is displayed.	Always
Secure version	Version of the encryption software	When the radio is secure equipped
KG1 algorithms name (Encryption Type 1)	Type of encryption being used	When the radio is secure equipped
KG2 algorithms name (Encryption Type 2)	Type of encryption being used	When the radio is secure equipped and 2 or more algorithms are loaded
KG3 algorithms name (Encryption Type 3)	Type of encryption being used	When the radio is secure equipped and 3 or more algorithms are loaded
KG4 algorithms name (Encryption Type 4)	Type of encryption being used	When the radio is secure equipped and 4 or more algorithms are loaded
KG5 algorithms name (Encryption Type 5)	Type of encryption being used	When the radio is secure equipped and 5 or more algorithms are loaded
KG6 algorithms name (Encryption Type 6)	Type of encryption being used	When the radio is secure equipped and 6 or more algorithms are loaded
Model number	The radio's model number, as programmed in the codeplug	Always
Serial number	The radio's serial number, as programmed in the codeplug	Always
ESN	The radio's unique electronic serial number	Always
ROM Size	The memory capacity of the host FLASH part	Always

Table 5-2. Test-Mode Displays (Continued)

Name of Display	Description	Appears
FLASHcode	The FLASH codes as programmed in the codeplug	Always
RF band 1	The radio's operating frequency	Always
Tuning Ver	Version of Tuning codeplug	Always
Proc Ver	Version of Processor	Always
Option Board Type	Type of Keypad board being used	When the radio has an Option Board/Expanded Keypad Board.
Option Board Serial Number	Serial number of the Keypad board is displayed	When the radio has an Expanded Keypad Board.
Option Board Bluetooth Addr	Bluetooth Address of the Keypad board is displayed	When the radio has an Expanded Keypad Board.
Option Board Sw Version	Software version of the Keypad Board is displayed	When the radio has an Expanded Keypad Board.
Exp Board Type	Type of Keypad Board is displayed	When the radio has a Keypad Board.

NOTE: All displays are temporary and will expire without any user intervention. If information is longer than the physical length of the radio's display, the information will wrap around to the next display. After the last display, "**RF TEST**" is displayed.

To freeze any of the displays, press the left arrow on the 4-Way Navigation Button. To resume automatic scrolling, press the right arrow on the 4-Way Navigation Button. To rapidly scroll forward through the displays, continue pressing the right arrow. You cannot scroll backwards.

NOTE: Press the **Top Side Button** (Purple button) to advance the test environments from "**RF TEST**", "**CH TEST**", "**RGB TEST**" then press the
Top Button (Orange button) to confirm selection. Press any other buttons to advance the test.

Once a test is carried out, restart the radio to proceed to another test.

3. Do one of the following:
   - Press the **Top Side Button** to stop the displays and toggle between RF test mode and the Control Top and Keypad test mode. The test mode menu "**CH TEST**" is displayed, indicating that you have selected the Control Top and Keypad test mode. Go to Section 5.2.3.

     NOTE: Each press of the **Top Side Button** (Purple button) scrolls through "**RF TEST**", "**CH TEST**" and "**RGB TEST**".
   - Press the **Top Button** (Orange button) to stop the displays and put the radio into the RF test mode. The test mode menu, "**1 CSQ**", is displayed, indicating test frequency 1, Carrier SQuelch mode. Go to Section 5.2.2.

     NOTE: Once your radio is in a particular test mode, you must turn off the radio and turn it back on again to access the other test mode.

5.2.2 RF Test Mode

When the ASTRO APX 1000 radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting, according to the customer codeplug configuration. However, when the unit is on the bench for testing, alignment, or repair, it must be removed from its normal environment using a special routine, called **RF TEST MODE**.

While in RF test mode:

- Each additional press of **Side Button 2** advances to the next test channel. (Refer to Table 5-3)
- Pressing **Side Button 1** scrolls through and accesses the test environments shown in Table 5-4.
- Pressing **Top Side Button** scrolls through the Tx Deviation Frequency.

NOTE: Transmit into a load when keying a radio under test.

Table 5-3. Test Frequencies (MHz)– 900 MHz

Test Channel	900 MHz	
	RX	TX
F1	935.0625	896.0125
F2	938.0625	899.0125
F3	940.9875	901.9875
F4	935.0625	935.0125
F5	938.0625	938.0125
F6	940.9875	940.9375
F7	–	–
F8		–
F9	–	–
F10	–	–

Table 5-4. Test Environments

Display	Description	Function
CSQ	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
TPL	Tone Private-Line	RX: unsquelch if carrier and tone (192.8 Hz) detected TX: mic audio + tone (192.8 Hz)
AST	ASTRO	RX: none TX: Digital Voice***
USQ	Carrier Unsquelch	RX: unsquelch always TX: mic audio

****All deviation values are based on deviation tuning of this mode.*

5.2.3 Control Top and Keypad Test Mode

This test mode is used to verify proper operation of all radio buttons and switches if a failure is suspected.

5.2.3.1 Control Top Checks

To perform the control top checks:

1. Press and hold the **Top Button** (Orange button); the radio icons are displayed, and the LED lights amber and lightbar LED light green.
2. Release the **Top Button**; "148/0" appears, which indicates that the **Top Button** is in the open position. Your radio is now in the Control Top and Keypad test mode.
3. Press the **Top Button** again; "148/1" appears, which indicates that the **Top Button** is in the closed position.
4. Rotate the **Volume Control**; "11/0" through "11/255" appear. The display values may vary slightly at the upper and lower limits. Press gives "91/1", release gives "91/0".
5. Press the **Top Side Button**; "96/1" appears; release, "96/0" appears.
6. Press **Side Button 1**; "97/1" appears; release, "97/0" appears.
7. Press **Side Button 2**; "98/1" appears; release, "98/0" appears.
8. Press the **PTT Button**; "1/1" appears; release, "1/0" appears.

5.2.4 RGB Test Mode

To perform the RGB Color Test:

1. Press and release **Top Button** (Orange button)
2. Press any key; Crosstalk test patterns appears.
3. Press any key; White color test appears.
4. Press any key; Red color horizontal lines appears.
5. Press any key until all 13 red color horizontal lines appears.
6. Press any key; Green color vertical line appears.
7. Press any key until all 13 green color vertical lines appears.
8. Press any key; Black color test appears.
9. Press any key; Blue color test appears.
10. Press any key; Vendor specific display test appears.
11. Press any key; "`Test completed`" appears.

5.3 Receiver Performance Checks

The following tables outline the performance checks for the receiver.

Table 5-5. Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check)	**900 MHz:** ±1.5ppm
Rated Audio	**RF Control:** Gen **Output Level:** -47 dBm **Freq:** Selected radio RX freq. **Mod:** 1 kHz tone @ 3 kHz dev. **Meter:** AC Volts	As above	**PTT** to OFF (center)	Set volume control to 3.74 Vrms
Distortion	As above, except **Meter:** Ext Dist.	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except **Meter:** SINAD	As above	As above	RF input to be < 0.35 μV
Noise Squelch Threshold (only radios with conventional system need to be tested)	Set as for rated audio check	Out of TEST MODE; select a conventional system	As above	Set volume control to 3.74 Vrms. Set RF level to -130 dBm and raise until radio unsquelches. Unsquelch to occur at < 0.25 μV. Preferred SINAD = 6-8 dB.

* *See* Table 5-4.

*Table 5-6. Receiver Tests for ASTRO Conventional Channels**

Test Name	System Analyzer	Radio	Test Set	Comments
Bit Error rate (BER) Floor	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code:** 1011 Hz PAT	Radio Tuner Software (Bit Error Rate screen) is required	**PTT** to OFF (center)	BER < 0.01% (Use test setup shown in Figure 6-1)
Reference Sensitivity	As above; lower the output level until 5% BER is obtained	As above	As above	Output level < 0.35 µV (-116 dBm) (Use test setup shown in Figure 6-1)
Audio Output Distortion	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code:** 1011 Hz PAT **Meter:** Ext. Distortion	Radio Tuner Software not used; **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to OFF (center) Meter selector to **Audio PA** Spkr/Load to **Speaker**	Distortion < 3.0%
Residual Audio Noise Ratio	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code**: A) 1011 Hz PAT B) Silence PAT **Meter:** AC Volts	As above	As above	Residual Audio Noise Ratio -45 dB

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

5.4 Transmitter Performance Checks

The following tables outline the performance checks for the transmitter.

Table 5-7. Transmitter Performance Checks – APX1000

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check).	**900 MHz:** ±1.5ppm
RF Power	As above	As above	As above	**900 MHz**: 1–2.5 Watt
Voice Modulation (external)	As above. Set fixed 1 kHz audio level to 400 mV.	As above	As above	Deviation: (12.5 kHz) ≥ 2.1 kHz, but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz, but ≤ 5.0 kHz
Voice Modulation (internal)	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	As above	Remove modulation input. **PTT** to OFF (center)	Press **PTT** button on radio. Say “four” loudly into the radio mic. Measure deviation: (12.5 kHz) ≥ 2.1 kHz but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz but ≤ 5.0 kHz
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	As above	Conventional coded squelch personality (clear mode operation) or TPL channel (test mode*)	**PTT** to continuous (during the performance check)	Deviation: (12.5 kHz) ≥ 375 Hz but ≤ 500 Hz (25 kHz) ≥ 500 Hz but ≤ 1000 Hz
Secure Modulation (radios with conventional, secure mode, talkaround operation only)	As above	Programmed conventional channel (secure mode operation) Load key into radio.	As above	Deviation: ≥ 3.7 kHz but ≤ 4.3 kHz

* *See* Table 5-4.

Table 5-8. Transmitter Tests for ASTRO Conventional Channels – APX 1000

Test Name	System Analyzer	Radio	Test Set	Comments
RF Power	**Mode:** Proj 25 Std **RF Control:** Monitor **Meter:** RF Display	Radio Tuner Software not used. **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to continuous (during measurement).	**900 MHz**: 1–2.5 Watt
Frequency Error	As above	As above	As above	Error ≤ ±1.0 kHz
Frequency Deviation	As above	Radio Tuner Software (Transmitter Test Pattern screen) is required) **High use:** Symbol Rate PAT **Low use:** Low Symbol Rate P	**PTT** to OFF (center)	D_{HIGH} ≥ 2.543 kHz but ≤ 3.110 kHz D_{LOW} ≥ 0.841 kHz but ≤ 1.037 kHz (Use test setup shown in Figure 6-1)

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

Chapter 6 Radio Alignment Procedures

This chapter describes both receiver and transmitter radio alignment procedures.

6.1 Test Setup

A personal computer (PC) and tuner software are required to align the radio. Refer to the applicable manual for installation and setup procedures for the software. To perform the alignment procedures, the radio must be connected to the PC and to a universal test set. The radio alignment test setup is shown in Figure 6-1.

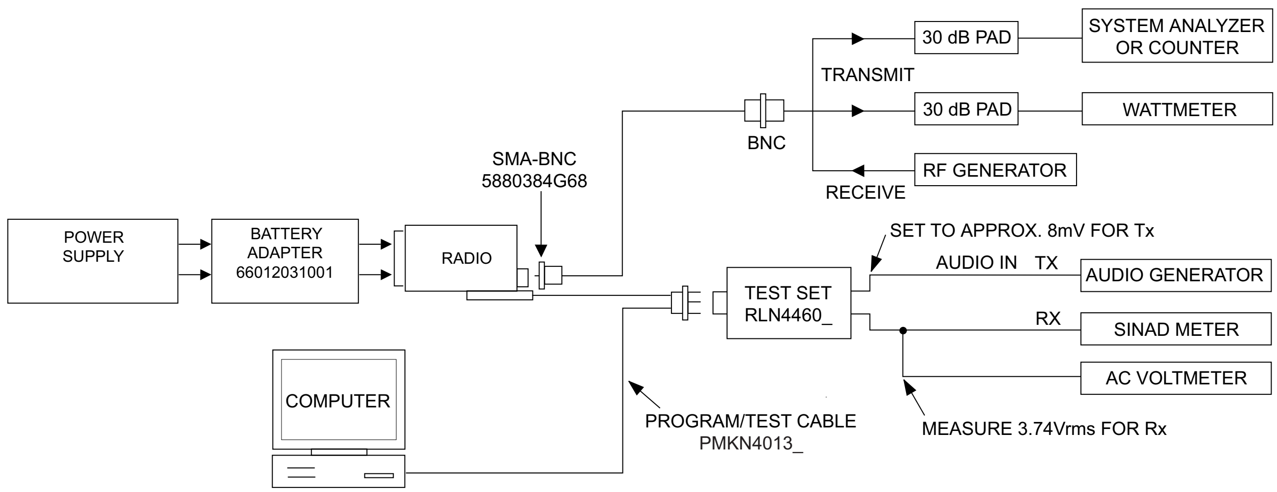

Figure 6-1. Radio Alignment Test Setup

These radio alignment procedures should only be attempted by qualified service personnel. Failure to perform alignment procedures properly may result in seriously degraded radio or system performance.

6.2 Tuner Main Menu

Select **Tuner** from the **START** menu by clicking **Start › Program Files › Motorola › ASTRO 25 Products › ASTRO 25 Tuner**. To read the radio, use the F**ile › Read Device** menu or click on Read Device. Figure 6-2 illustrates how the alignment screens are organized. To access a screen, double-click on the desired screen name in the **Tuner** menu.

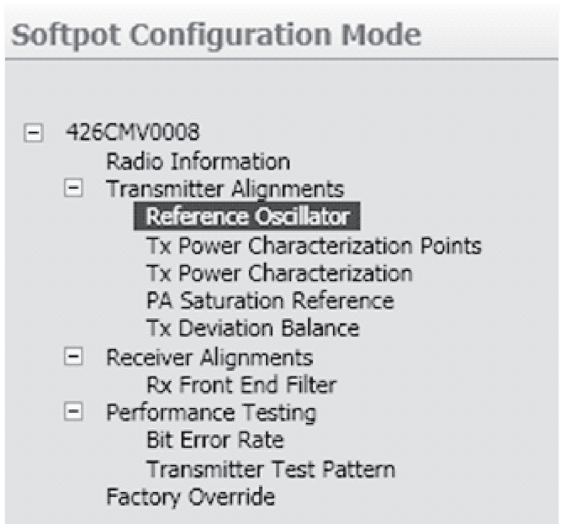

Figure 6-2. Tuner Software Main Menu

IMPORTANT: Tuning should follow the order of the Tuning tree view in descending order from top to bottom

6.3 Softpot

The alignment screens introduce the concept of the “softpot,” an analog **SOFT**ware-controlled **POT**entiometer used for adjusting all transceiver alignment controls.

Caution	DO NOT switch radios in the middle of any alignment procedure. Always left-click the **Close** button on the screen to return to the Main Menu screen before disconnecting the radio. Improper exits from the alignment screens might leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

Each alignment screen provides the ability to increase or decrease the softpot value by using a slider, or by entering the new value from the keyboard directly into the box. The slider bar indicates the current softpot value; see Figure 6-3.

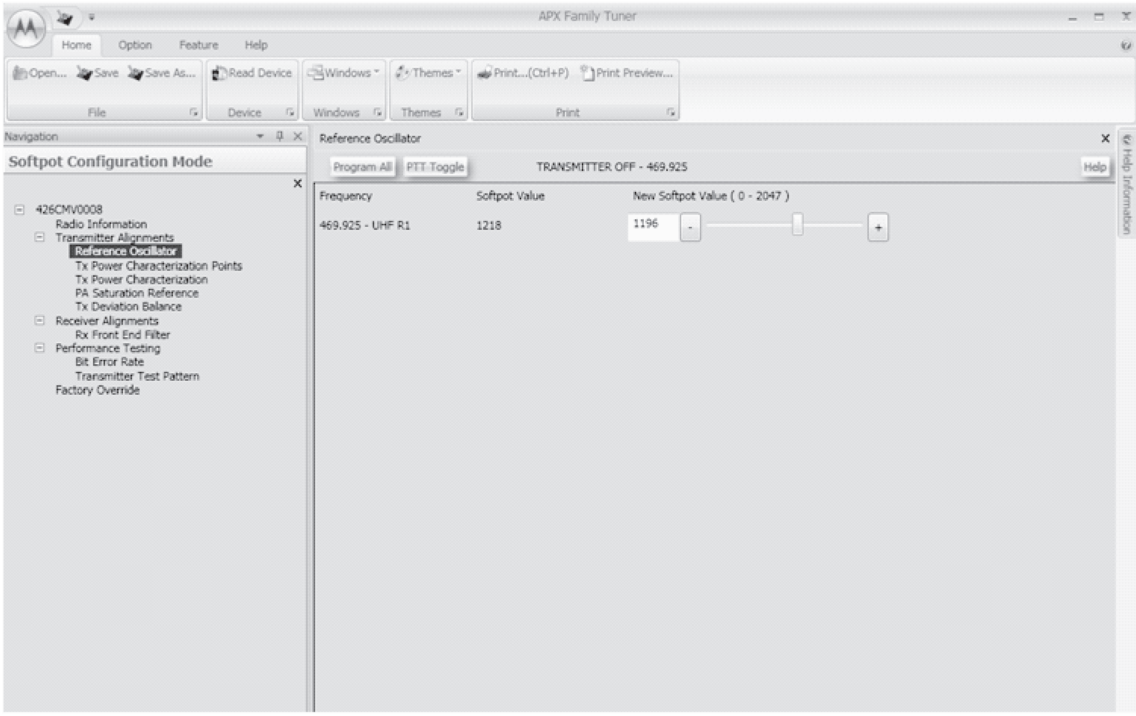

Figure 6-3. Typical Softpot Screen

Adjusting the softpot value sends information to the radio to increase (or decrease) the voltage in the corresponding circuit. For example, left-clicking the UP spin button in the New Softpot Value scroll box on the **Reference Oscillator** screen instructs the radio's microcomputer to increase the voltage across a varactor in the reference oscillator, which increases the frequency.

In ALL cases, the softpot value is just a relative number corresponding to a digital-to-analog (D/A) generated voltage in the radio.

Perform the following procedures in the sequence indicated.

NOTE: Some of the following screens may vary depending upon the radio under test and the version of tuner software you are using. Refer to the software's online help.

Caution	When keying the radio during a test, always transmit into a dummy load.

6.4 Radio Information

Figure 6-4 shows a typical Radio Information screen. This screen is informational only and cannot be directly changed.

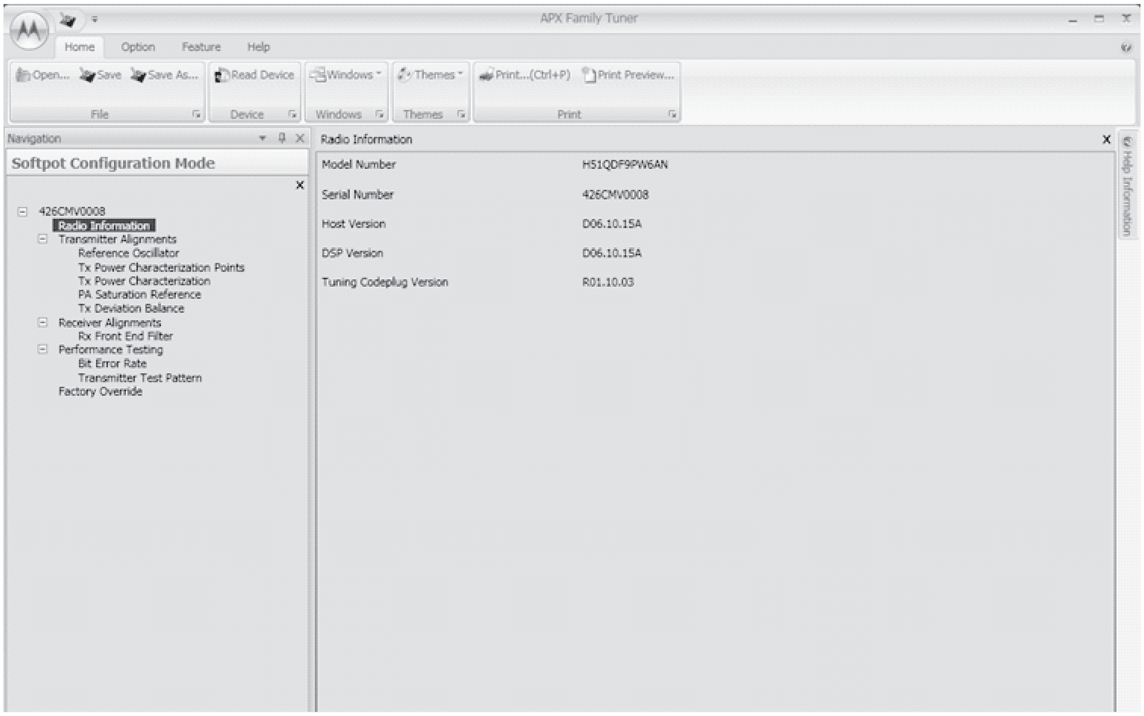

Figure 6-4. Radio Information Screen

6.5 Transmitter Alignments

6.5.1 Reference Oscillator Alignment

Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment will result not only in poor operation, but also in a misaligned radio that will interfere with other users operating on adjacent channels. For this reason, the reference oscillator should be checked every time the radio is serviced, or once a year, whichever comes first. The frequency counter used for this procedure must have a stability of 0.1 ppm (or better).

NOTE: Reference oscillator alignment is required after replacing (or servicing) the transceiver board.

This test can be done with either the R-2670 Communication Analyzer or the 8901_ Modulation Analyzer.

- Initial setup using the R-2670 Communication Analyzer:
  - RF Control: Monitor
  - B/W: WB
  - Freq: CPS frequency under test
  - Attenuation: 20dB
  - Mon RF in: RF I/O
  - Meter: RF Display
  - Mode: STD
  - Input Level: uV or W
  - Display: Bar Graphs
  - Squelch: Mid-range or adjust as necessary
- Initial setup using the 8901_ Series Modulation Analyzer:
  - Press the green **Automatic Operation** button on the analyzer.
  - Press the **FREQ** key.
  - Type **7.1** followed by **SPCL** button to set the 8901B_ modulation analyzer for maximum accuracy.

To align the reference oscillator:

Select the **Reference Oscillator** alignment screen. See Figure 6-5.

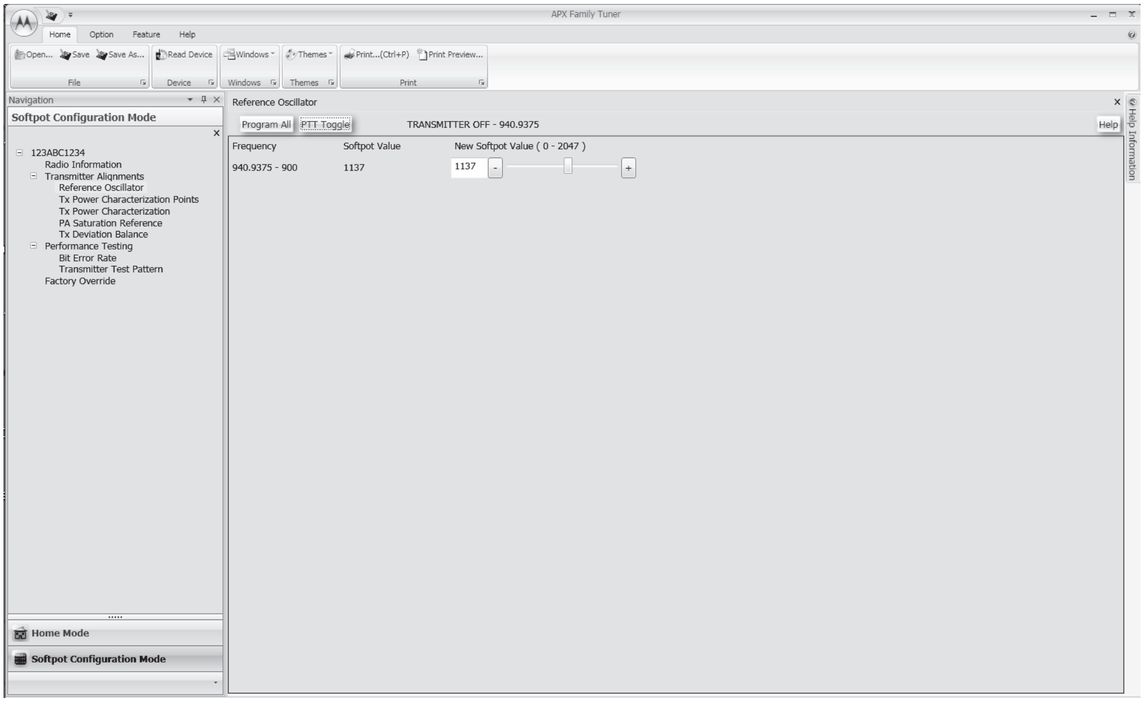

Figure 6-5. Reference Oscillator Alignment Screen (900 MHz)

1. Make sure the Communication Analyzer is in **Manual** mode.

   900 MHz

   - Set the base frequency to 940.9375 MHz

2. Adjust the reference oscillator's softpot value with the slider until the measured value is as close as possible to the frequency shown on the screen. See Table 6-1.

   NOTE: Increases the slider decreases the frequency and vice versa.

Table 6-1. Reference Oscillator Alignment

Band	Target
900 MHz	±100 Hz

3. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.
4. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

6.5.2 Power Characterization Points

Tuning of the radio is done through **Power Characterization Points** tuning screen.

1. Select the **TX Power Characterization Points** alignment screen. See Figure 6-6.
2. Set power supply voltage and current limit.
3. Adjust softpot value by manipulating the slider bar, incrementing the "New Softpot Value" text box, or directly entering the desired value into the "New Softpot Value" text box until the rated power is indicated on the service Monitor. For rated power refer to the help text in the Tuner.
4. Repeat the steps 2 and 3 for all frequencies.
5. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

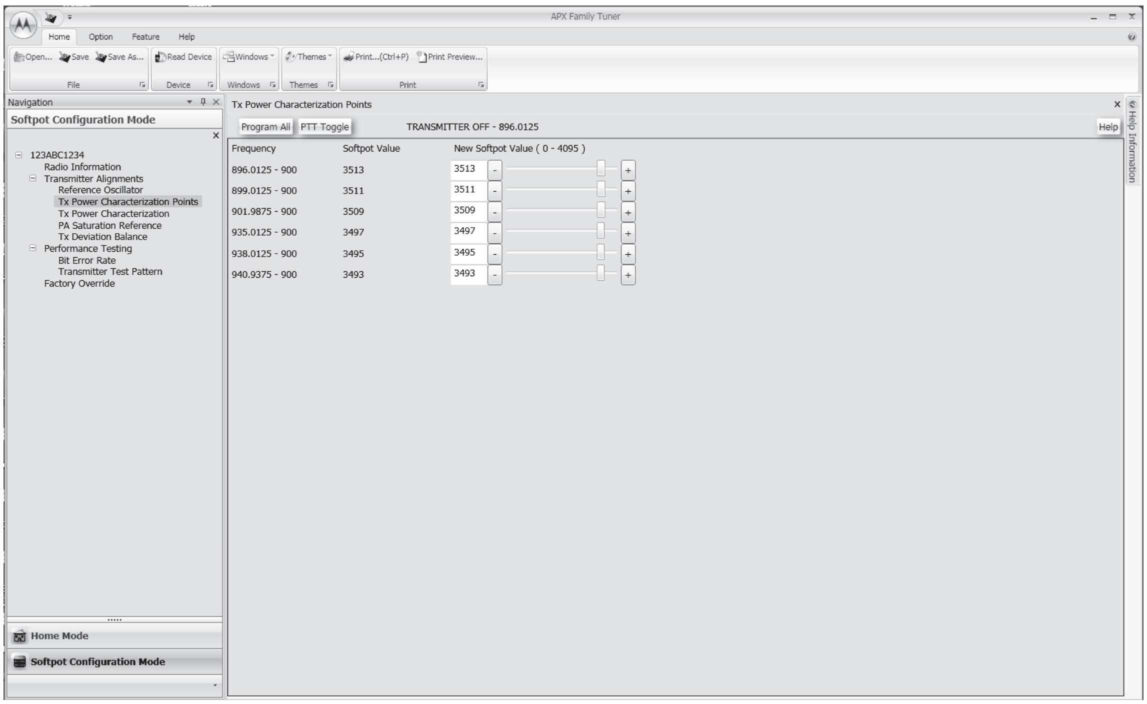

Figure 6-6. Transmit Power Characterization Points Alignment Screen (900MHz)

6.5.3 Power Characterization Tuning

Tuning of the radio is done through **Power Characterization** tuning screen.

IMPORTANT: Power Characterization Tuning Points must be tuned before tuning Power Characterization Tuning.

NOTE: a.The longer the RF cable, the more the attenuation of the power reading.

b.Use a standard 50 ohm cable.

c. Remember to set the Communication Analyzer to baseband power.

1. Select the **TX Power Characterization** alignment screen. The screen indicates the transmit power to be used. See Figure 6-7.
2. Left-click the box under "Measure Power 1" for the desired frequency field. (The selected box is highlighted).
3. Click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
4. Measure the transmit power of the radio with a service Monitor.
5. Input the transmit power in watts using two decimal places into the highlighted "Measure Power 1" box.
6. Left-click the box under "Measure Power 2" box for the same frequency field. (The selected box is highlighted).
7. Measure the transmit power of the radio with a service Monitor.
8. Input the transmit power in watts using two decimal places into the highlighted "Measure Power 2" box.
9. Repeat steps 2 to 8 for all frequencies.
10. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

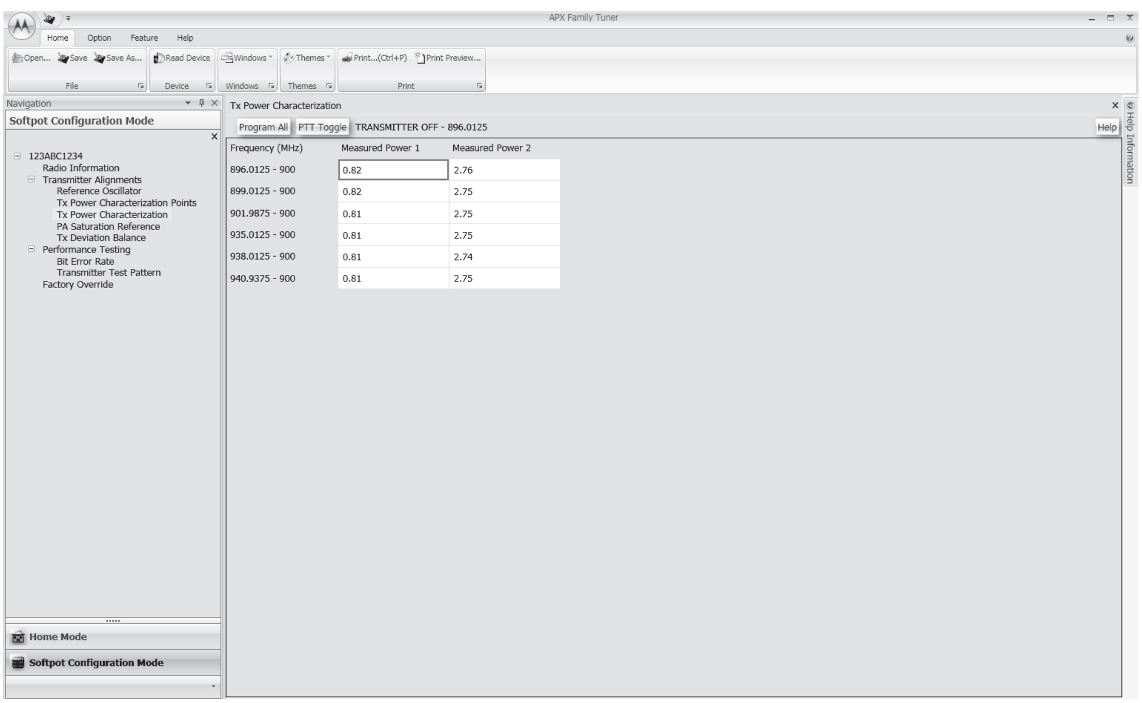

Figure 6-7. Transmit Power Characterization Alignment Screen (900 MHz)

6.5.4 PA Saturation Reference Tuning

Tuning is done through **PA Saturation Referencing** screen.

1. Select the **PA Saturation Reference** alignment screen. The screen indicates the transmit frequencies to be used. See Figure 6-8.
2. In Manual Mode, set the service Monitor to the desired frequency (as shown in the frequency list in the PA Saturation Reference alignment screen).
3. Adjust the PA Saturation Reference softpot value with the slider until the radio transmits as close as possible to the rated power. For rated power refer to the help text in the Tuner.
4. Left-click the slider of the frequency selected (should be the same frequency as step 2).
5. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
6. Repeat the steps 2 to 5 for all frequencies.
7. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

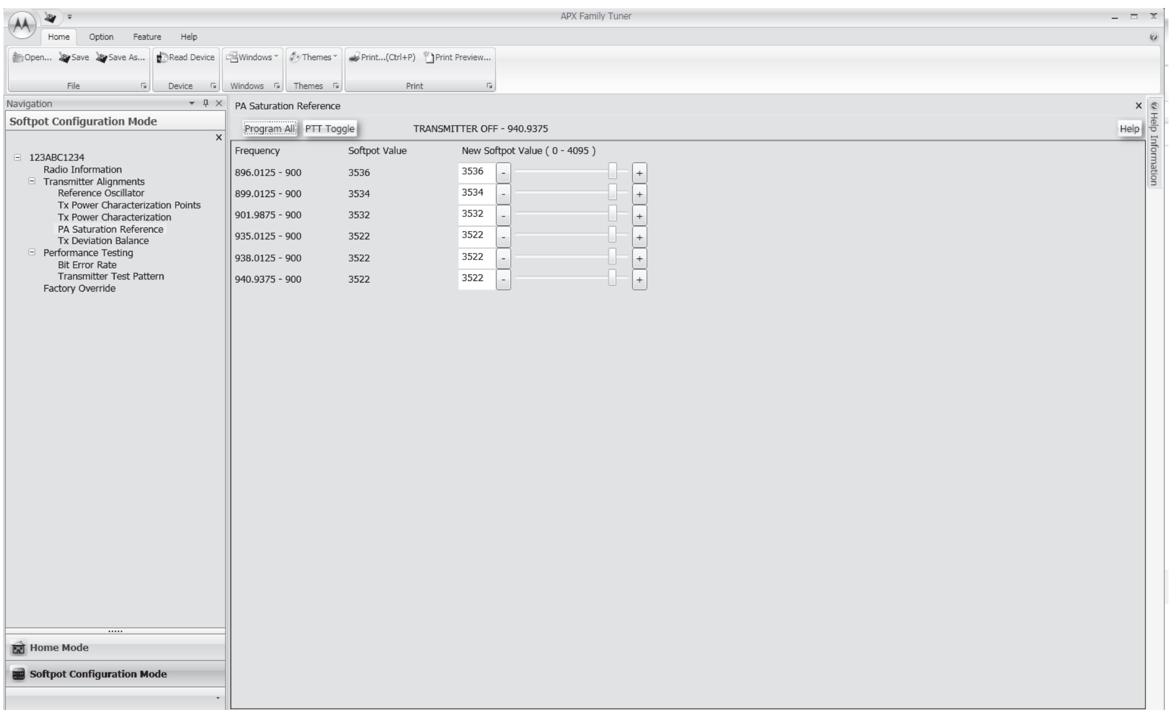

Figure 6-8. PA Saturation Referencing Alignment Screen (900 MHz)

6.5.5 Transmit Deviation Balance Alignment

This alignment procedure balances the modulation contributions of the low- and high-frequency portions of a baseband signal. Proper alignment is critical to the operation of signalling schemes that have very low frequency components (for example, DPL) and could result in distorted waveforms if improperly adjusted.

This procedure needs to be performed at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone.

NOTE: This alignment is required after replacing (or servicing) the main board.

Proper alignment requires a modulation analyzer or meter with a frequency response to less than 10 Hz modulating frequency. The modulation analyzer settings during this test should be set for average deviation, a 15 kHz low-pass filter, no de-emphasis, and no high-pass filter, if these settings are supported.

This alignment can be done with either the R-2670 Communication Analyzer or the 8901_ Series Modulation Analyzer. The method of choice is the R-2670 analyzer.

1. Initial setup using the R-2670 Communication Analyzer:
   - Connect a BNC cable between the “DEMOD OUT” port and the “VERT/SINAD DIST/DMM COUNTER IN” port on the R-2670.
   - Press the **SPF** key on the R-2670 to display the “SPECIAL FUNCTIONS MENU.” Move the cursor to “High Pass,” and select 5 Hz on the soft key menu. Select 20 kHz for the “Low Pass” setting.
   - In the “RF Control” section of the R-2670, move the cursor to the “B/W” setting and select “WIDE +/- 100 kHz” on the soft key menu.
   - Place the R-2670 cursor in the “Display” zone. Select “AC VOLTS” on the soft key menu. Move the cursor to the “Range” setting and select “AUTO.”
2. Initial setup using the 8901_ Series Modulation Analyzer:
   - Press the **FM MEASUREMENT** button. (The “*Error 0input level too low”* indication is normal until an input signal is applied.)
   - Simultaneously press the **Peak –** and **Peak +** buttons. Both LEDs on the buttons should light.
   - Press the 15 kHz LP filter key.
3. Select the **TX Deviation Balance** alignment screen. The screen indicates the transmit frequencies to be used. See Figure 6-9.
4. In the "RF Control" section of the R2670, set the service Monitor to the desired frequency (as shown in the frequency list in the TX Deviation Balance alignment screen).
5. Left-click the **PTT Tone: Low** button.
6. Left-click the slider of the frequency selected (should be the same frequency as step 4).
7. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
8. Measure and Record the Low Tone Tx Deviation value from the 8901_ Series Analyzer or the AC voltage value from the R2670.
9. Left-click the **PTT Tone: High** button.
10. Adjust the softpot value until the measured deviation/voltage, when using the high tone, is within +/- 1.5% of the value observed when using the Low Tone.

11. Left-click the **PTT Toggle** to de-key the radio.
12. Repeat the steps 4 to 10 for all frequencies.
13. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

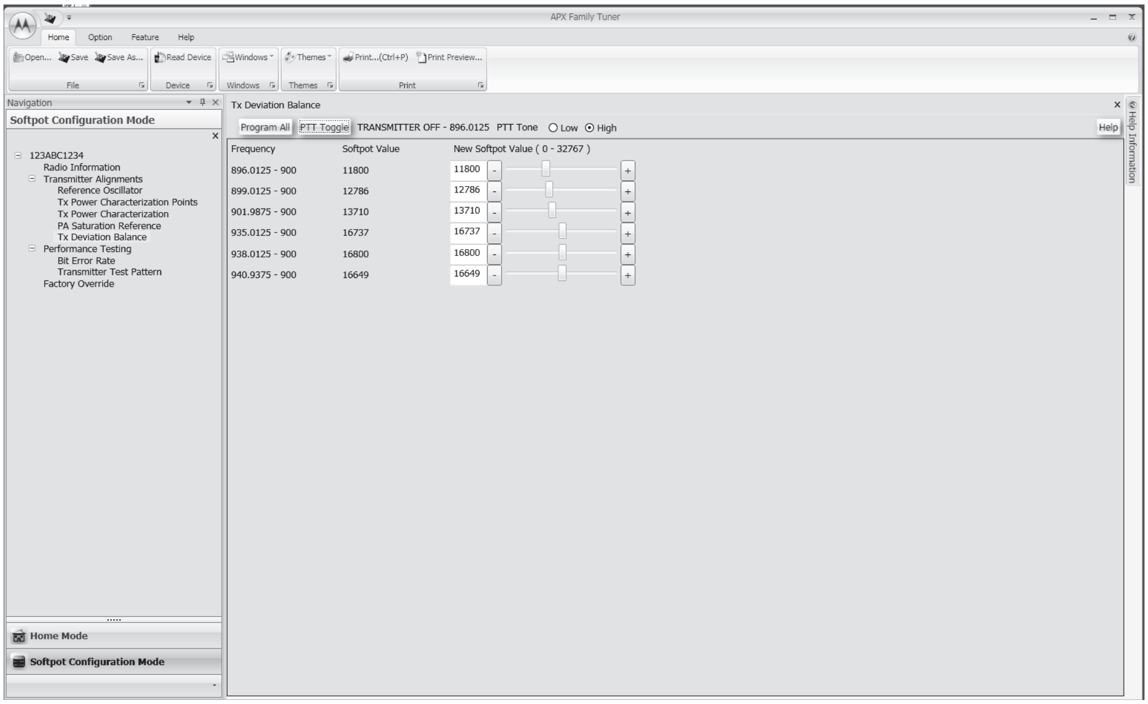

Figure 6-9. Transmit Deviation Balance Alignment Screen (900 MHz)

6.6 Performance Testing

6.6.1 Bit Error Rate

This section describes the Bit Error Rate (BER) test of the radio's receiver at a desired frequency (see Figure 6-10).

6.6.1.1 Bit Error Rate Fields

Set up the R2670 Communication Analyzer as follows:

1. Connect the RF Input port of the radio under test to the RF IN/OUT port of the R2670 Service Monitor.
2. Set up the R2670 Service Monitor:
   - In the Display Zone, select PROJ 25 STD mode and set the meter to RF DISPLAY.
   - In the RF Zone, configure the analyzer as follows:

RF Control:	Generate
Preset:	B/W: NB
Freq:	Test frequency (Ex: 851.0625 MHz)
Output Level:	-50.0 dBm
Gen RF Out:	RF I/O

   - In the Audio Zone, select the 1011 Hz PAT code and set the deviation to “PROJ25Dev: 2.83 kHz ~”.

The bit error rate screen contains the following fields:

- **Rx Frequency**:
  This field selects the Receive Frequency directly in MHz.
- **Test Pattern**:
  This field selects the Digital test pattern to be received by the radio. Choices are: Standard Tone Test Pattern (Framed 1011), F2 1031, Standard Interface Test Pattern (CCITT V.52) and Phase 2 Digital (1031 Hz) Test Pattern.
- **Modulation Type**:
  This field represents the digital modulation type of the incoming signal on which BER is to be calculated.
- **Continuous Operation**:
  This field allows the user the option to repeat the BER test indefinitely. A selection of Yes will cause the radio to calculate BER on a continuous basis and update the results on this screen after each integration time. A selection of No will cause the BER test to execute for only one sample of the integration time and then update the display.
- **Audio**:
  This field allows the user to select the audio output during a test. Selecting Internal will cause the radio's built-in speaker to unmute to any signals at the desired frequency which are present during the test. Selecting External will route the same signal to the radio's accessory connector audio output. Selecting Mute will disable the audio output.

NOTE: There will be **no audio** option available for APX 1000 when performing a Bit Error Rate Test.

- **BER Integration Time**:
  BER Integration Time carries with Test Pattern Type.
- Number of Frames
  Number of Frames over which bit error result are accumulated to produce the result.

NOTE: When **Continuous Operation = Yes**, all fields will be grayed out while the test is in progress. They will be enabled when the STOP button is pressed.

When **Continuous Operation = No**, a wait cursor will be displayed while the test is in progress and return to normal when the test is done.

3. Press **Start/Stop** button to begin or end BER testing.

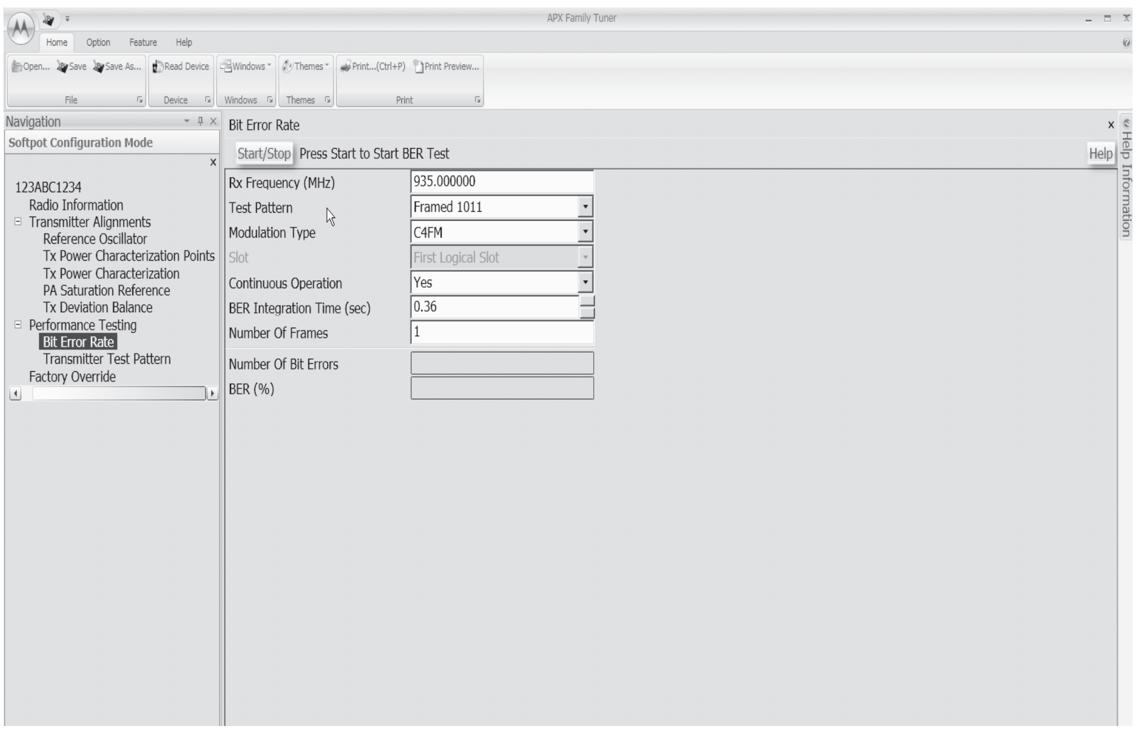

Figure 6-10. Bit Error Rate Screen (900 MHz)

6.6.2 Transmitter Test Pattern

The Transmitter Test Pattern test is used to transmit specific test patterns at a desired frequency so that the user can perform tests on the radio's transmitter (see Figure 6-11).

6.6.2.1 Transmitter Test Fields

This screen contains the following fields:

- **Tx Frequency**:
  This field selects the Transmit Frequency directly in MHz.
- **Channel Spacing**:
  This field allows the user to select the desired transmit deviation in kHz.
- **Test Pattern Type**:
  This field represents the type of test pattern which will be transmitted by the radio when **PTT TOGGLE** button is pressed.

NOTE: Channel Spacing and Test Pattern Type fields will be grayed out while the radio is transmitting.

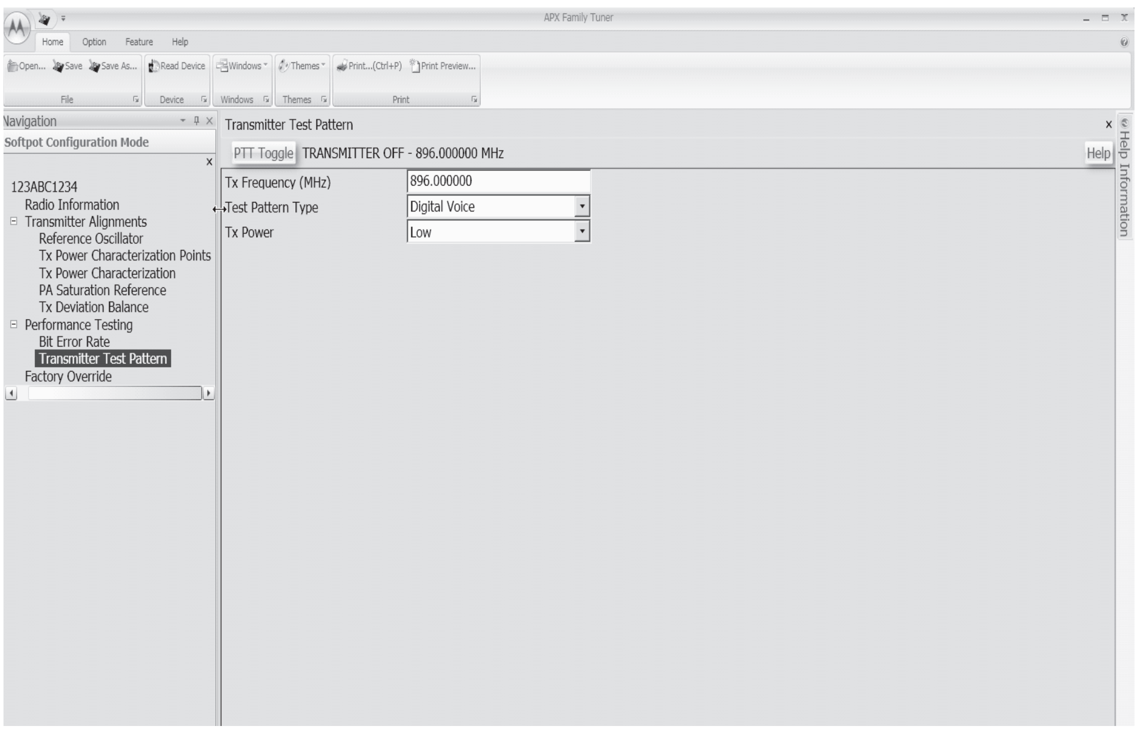

Figure 6-11. Transmitter Test Pattern Screen (900 MHz)

Chapter 7 Disassembly/Reassembly Procedures

This chapter provides detailed procedures for disassembling/reassembling and ensuring reliable splash protection of the APX 1000 radios. When performing these procedures, refer to “Chapter 9: Exploded Views and Parts Lists” and the diagrams that accompany the text. Items in parentheses ( ) throughout this chapter refer to item numbers in the exploded view diagrams and their associated parts lists.

This chapter also has procedures for removing and installing the APX 1000 radio’s standard accessories.

7.1 APX 1000 Exploded View (Main Subassemblies)

Caution	When servicing electronics, always ensure that you are properly grounded with antistatic grounding system approved for electronics handling.

This section contains the APX 1000 radio partially exploded views.

NOTES:

- Refer to Figure 7-1, the Partial Exploded View, and Table 7-1, the Partial Exploded View Parts List.
- Letters in parentheses ( ) refer to item letters in Figure 7-1 and Table 7-1.

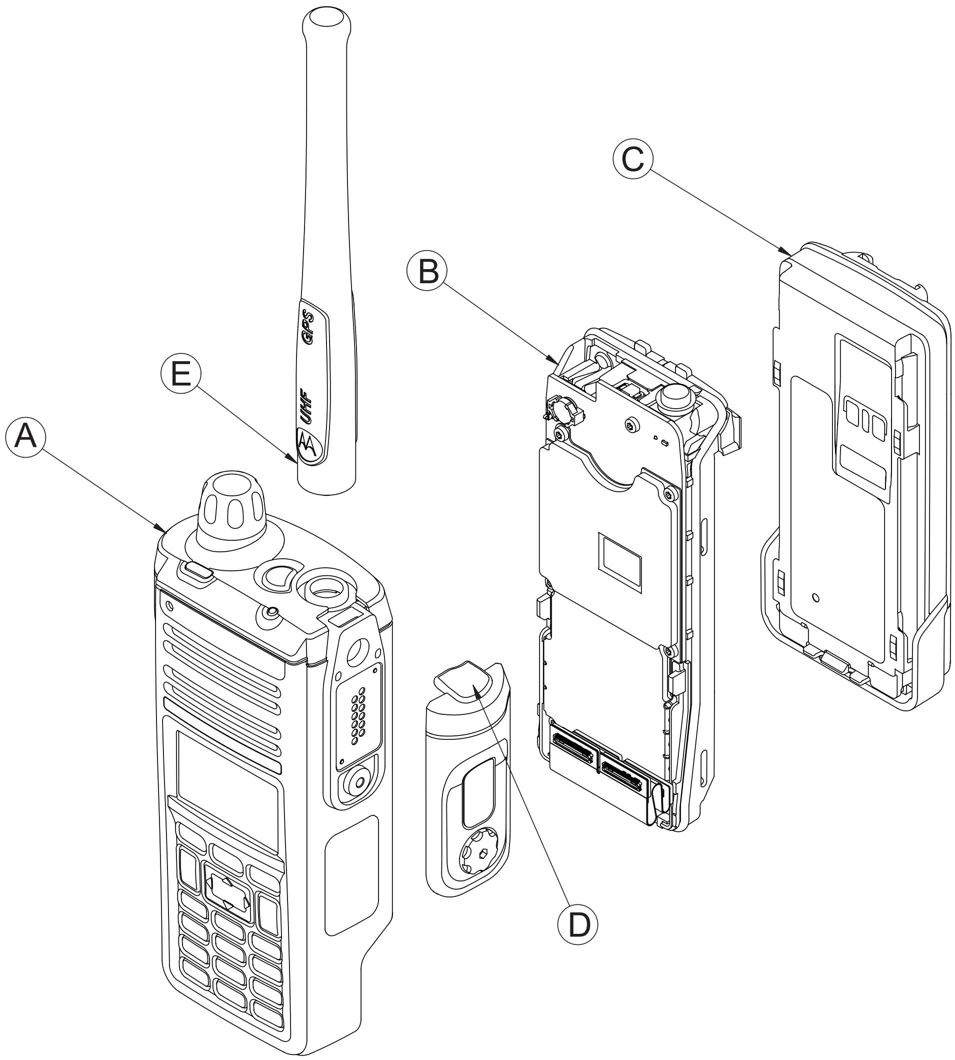

Figure 7-1. APX 1000 Partial Exploded View

Table 7-1. APX 1000 Partial Exploded View Parts List

Item Letter	Description	Exploded View and Parts List
A	Front Kit Assembly	Refer Figure 9-1.
B	Back Kit Assembly	Refer Figure 9-2.
C	Battery Assembly	Refer Figure 9-2.
D	Accessory-Connector Cover Assembly	Refer Figure 9-1.
E	Antenna Assembly	Refer Figure 9-1.

7.2 Required Tools and Supplies

Table 7-2. Required Tools and Supplies

Tools	Motorola Part Number	Supplier	Supplier Part Number	Remarks
Chassis Opener	66012028001	Motorola	–	To remove chassis from housing.
Bit, Torx T6	–	–	–	For back kit (chassis) and keypad retainer.
Driver, Torque	–	–	–	–
Black stick	–	Hexacon Electric Co.	MA-800G	For keypad rubber mushroom rib assembly and disassembly.
Round stick	–	Brusia	BE-MO-14383	For microphone membrane assembly.
Allen wrench	–	–	–	To loosen accessory-connector cover thumb screw (if thumb screw is too tight).

7.3 Fastener Torque Chart

Table 7-3 lists the various fasteners by part number and description, followed by the torque values and the location where used. Torque all fasteners to the recommended value when assembling the radio.

Table 7-3. Fastener Torque Chart

Motorola Part Number	Description	Repair Torque (in-lbs)
0386104Z04	Speaker retainer and Chassis screw	3.0
0378212A02	Keypad Retainer screw	1.2
02012016001	Rotary Switch Spanner nut	4.5

7.4 Radio Disassembly

This section contains instructions for disassembling the radio's main subassemblies.

Prepare the radio for disassembly:

- Turn off the radio by pressing on the MFK (22) and hold the MFK (Multi Function Knob) until the radio display shows “Power off?”. Press the Menu Select button below and select Yes to power off.
- Remove the antenna, the battery, the Accessory-Connector cover (14), the Bottom Label (17) and any other accessory connected to the radio.

7.4.1 Remove Battery (47)

WARNING

To avoid a possible explosion:
- **DO NOT charge, remove, or attach the battery in an area labeled “hazardous atmosphere.”**
- **DO NOT discard batteries in a fire.**

Caution

If the radio is programmed for volatile-key retention, encryption keys will be retained for approximately 30 seconds after battery removal.

NOTE: The Motorola-approved battery shipped with the APX 1000 radio is uncharged. Prior to using a new battery, charge it per the recommended procedure for the battery.

1. With the radio turned off, lift up the latch located at the bottom of the battery.

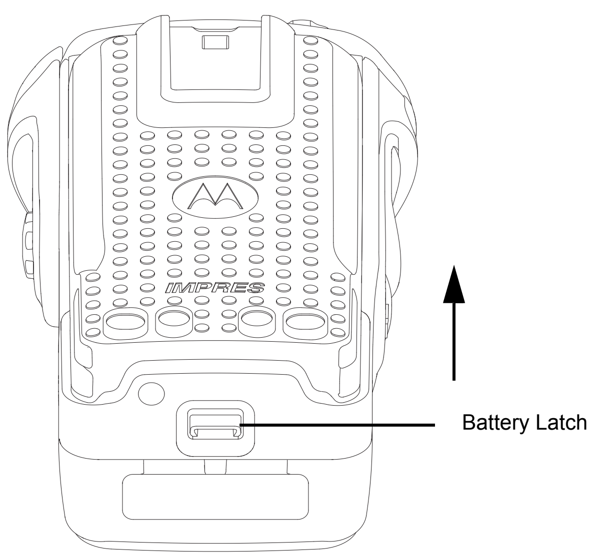

Figure 7-2. Lifting up the latch

2. While lifting the latch, remove the battery by sliding it out as shown.

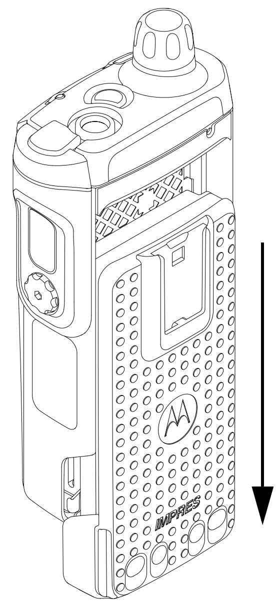

Figure 7-3. Removing the Battery

7.4.2 Remove Antenna (23)

1. With the radio turned off, turn the antenna counter-clockwise to remove it from the radio.

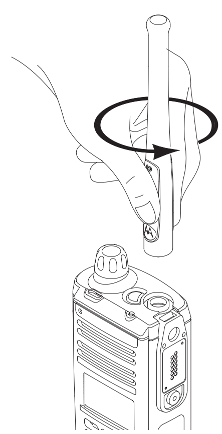

Figure 7-4. Removing the Antenna

7.4.3 Remove Multi Function Knob (22)

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis Opener, grasp the Multi Function Knob and pull it upward, until it is free from its shaft.

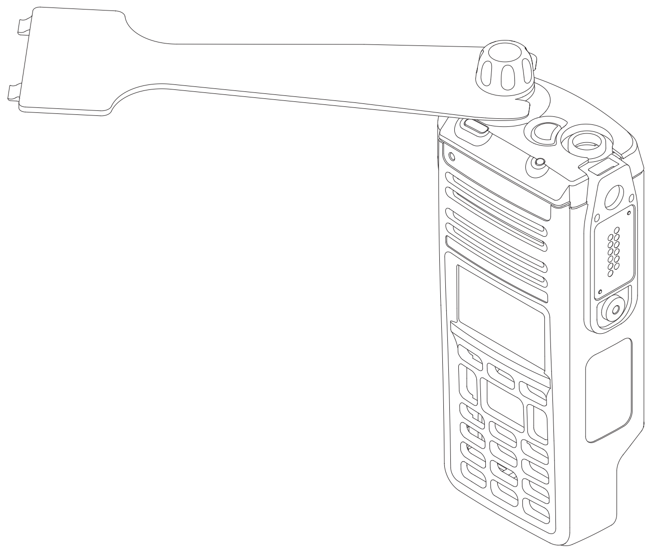

Figure 7-5. Removing the Multi Function Knob

7.4.4 Remove Accessory-Connector Cover (14)

Caution	When the accessory connector is not in use, keep it covered with the Accessory-Connector Cover.

1. Unscrew the thumb screw. If the screw is too tight, use an Allen wrench.

   NOTE: Do not remove the screw. It should remain captive in the cover.

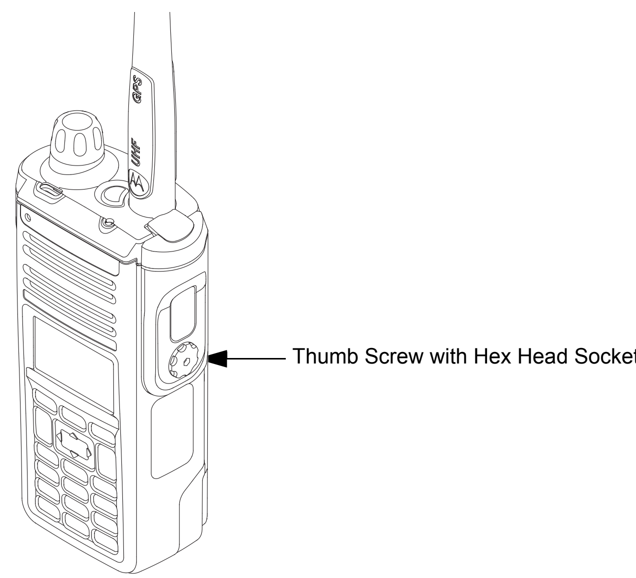

Figure 7-6. Removing the Thumb Screw

2. Slightly swing the Accessory-Connector Cover away from radio before sliding it upward to disengage the hook.
3. Pull the Accessory-Connector Cover away from the radio.

7.4.5 Removal of the Back Kit Assembly (B)

This section contains instructions for disassembling the radio.

7.4.5.1 Removal of the Chassis (40)

1. With the Battery removed, disengage the Chassis (40) using the Chassis Opener as shown in Figure 7-7.

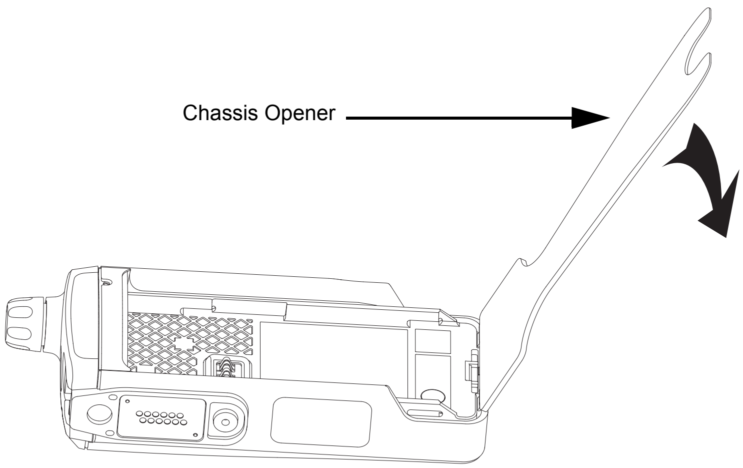

Figure 7-7. Disengage the Chassis

NOTE: The Vacuum Port seal (42) and the Ventilation Label (43) must be removed each time the Chassis is removed (for leak test).

2. After the Chassis (40) is disengaged, slide the chassis assembly down and lift it away from the Front Kit (A) and lay both sub-assemblies on the anti-static mat (part of anti-static ground kit) as shown in Figure 7-8.

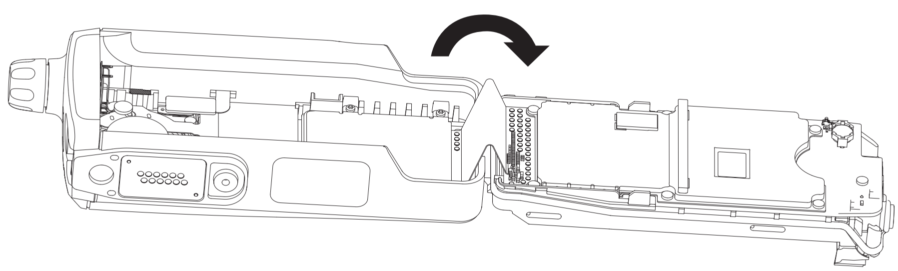

Figure 7-8. Remove the Chassis Assembly

7.4.5.2 Removal of the Secondary Shield Assembly (31)

1. Remove the chassis screws (29) as shown in Figure 7-9.

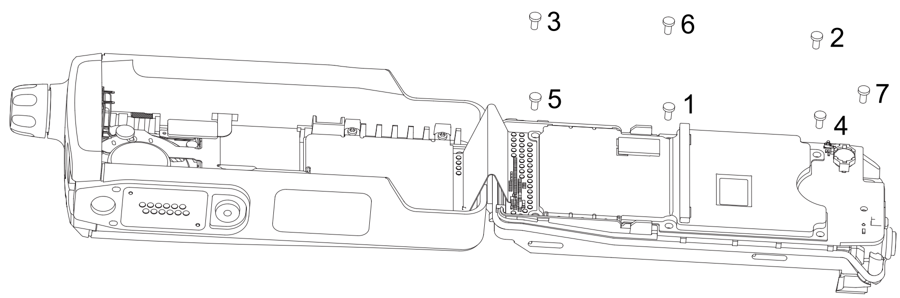

Figure 7-9. Remove the chassis screws

2. With the chassis screws removed, lift the Secondary Shield Assembly (31) out from the Chassis (40) as shown in Figure 7-10.

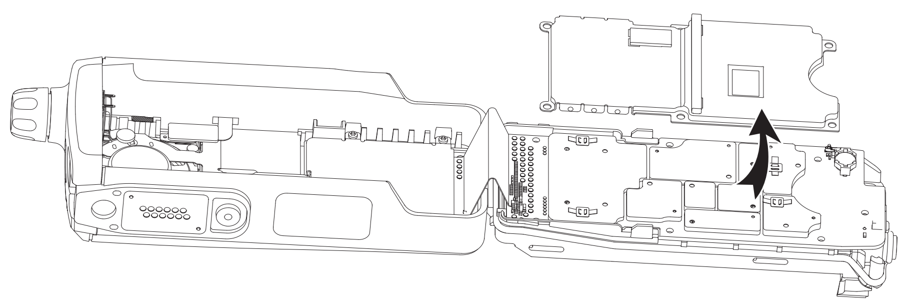

Figure 7-10. Remove the Secondary Shield Assembly

7.4.5.3 Removal of the Main Board (32)

1. Remove the Main O-Ring (35) at the antenna holder as shown in Figure 7-11.

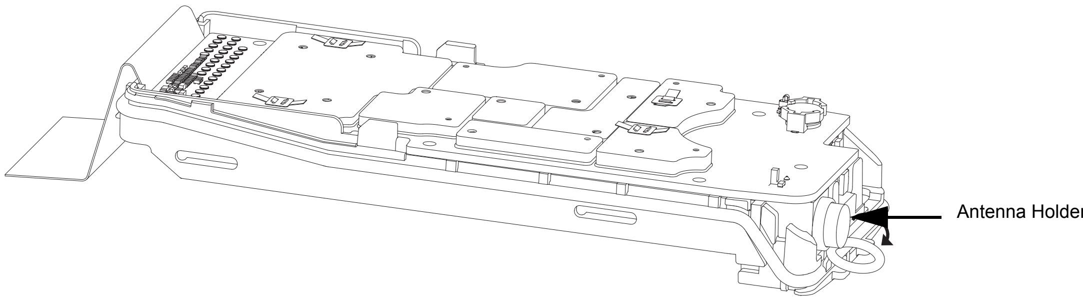

Figure 7-11. Remove the Main O-Ring at the antenna holder

2. Lift up the Main Board (32) from the Chassis (40) towards the Front Housing (16) and gently unplug the connectors from the Back Kit Flex (30) to remove the Main Board as shown in Figure 7-12. and Figure 7-13 respectively.

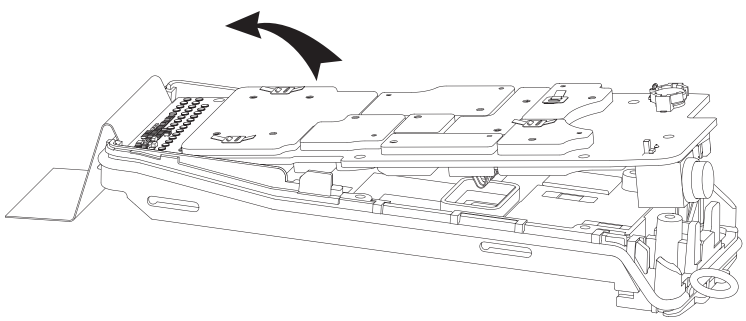

Figure 7-12. Lift up the Main Board from the Chassis

Caution	When separating the small interconnects, care is needed to avoid damage to the interconnect and surrounding on-board components.

Caution	Place the Main Board on the anti-static mat or in a clean and ESD safe area to avoid electrical damage to the electronics. Replace the Thermal Pad (10) whenever the Main Board is removed.

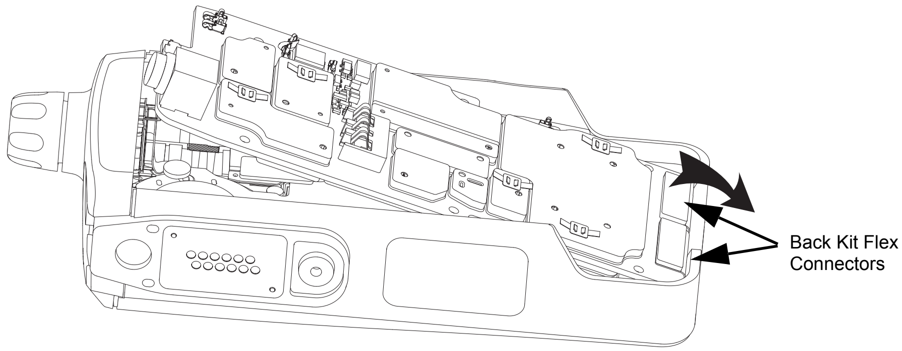

Figure 7-13. Unplug the Back Kit Flex connectors

7.4.5.4 Removal of the Shroud (46)

1. Place the black stick into the opening below the Shroud (46) to aid the disengagement of the Shroud. With the black stick still in place, slide the Shroud downwards at both sides to remove the Shroud from the Chassis (40).

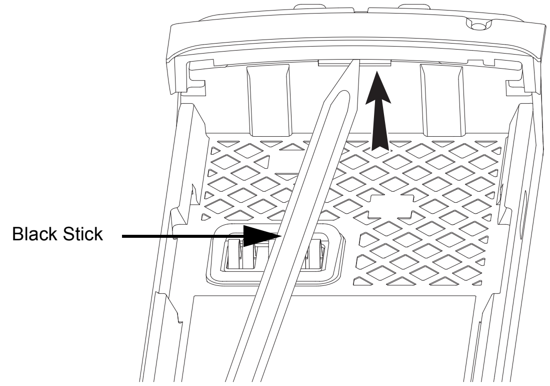

Figure 7-14. Disengage the Shroud

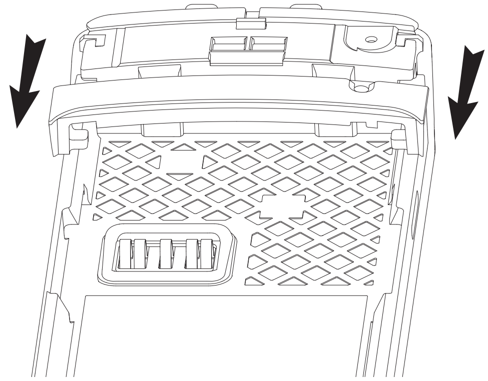

Figure 7-15. Remove the Shroud

7.4.5.5 Removal of the Keypad Retainer (27)

1. With the Back Kit Flex (33) connectors unplugged from the Main Board (32) as shown in Figure 7-13., remove the Keypad Retainer Screws (28) as shown in Figure 7-16.

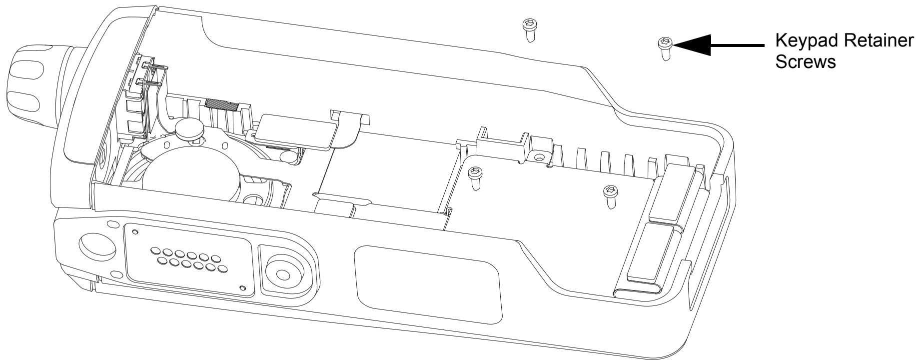

Figure 7-16. Remove the Keypad Retainer Screws

2. Lift out the Keypad Retainer (27) from the Front Housing (16) as shown in Figure 7-17.

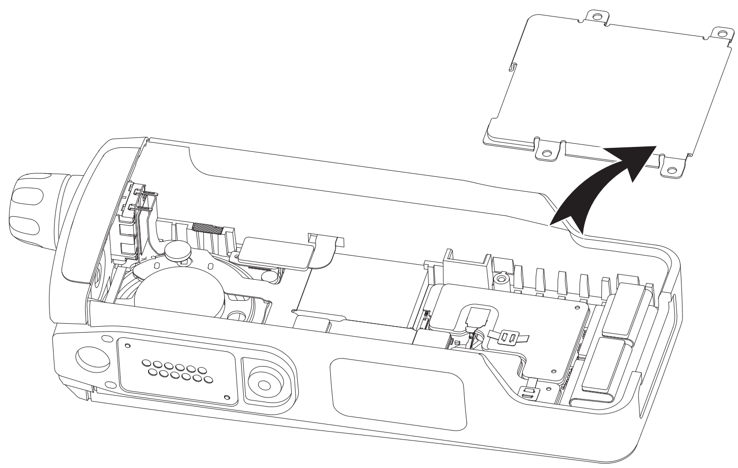

Figure 7-17. Remove the Keypad Retainer

7.4.5.6 Removal of the Keypad Board (26)

1. With the Keypad Retainer (27) removed, gently unplug the connectors of the Front Kit flex (2) and Back Kit Flex (30) to remove the Keypad Board (26) as shown in Figure 7-18.

Caution

When separating the flex and small interconnects, care is needed to avoid damage to the interconnect and surrounding on-board components

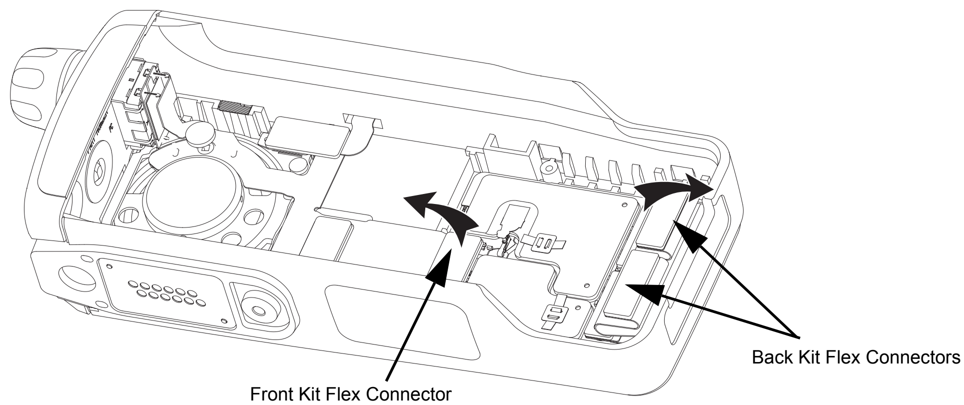

Figure 7-18. Unplug the Front Kit Flex and Back Kit Flex Connectors

2. With the connectors unplugged, gently lift the Keypad Board (26) out of the Front Housing (16) with the aid of the black stick as shown in Figure 7-19.

Caution

When lifting the Keypad Board with the black stick, care is needed to avoid piercing and damage to the Keypad.

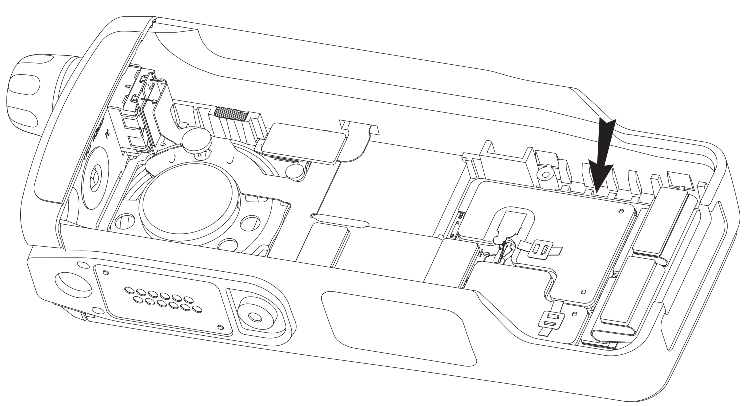

Figure 7-19. Remove the Keypad Board

7.4.5.7 Removal of the Keypad (24)

1. With the Keypad Board (26) removed, gently press the Keypad (24) from the front of the Front Housing (16) with fingers or with the aid of the back of the black stick to disengage the Keypad from the rib as shown in Figure 7-20.

Caution	When disengaging and removing the Keypad, care is needed to avoid tearing and damange to the Keypad.

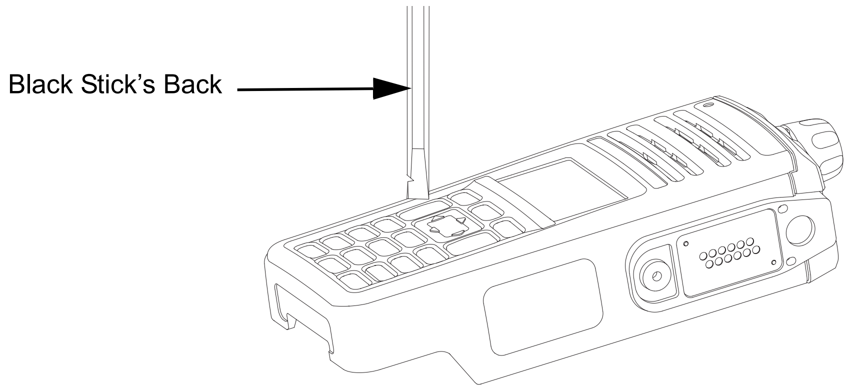

Figure 7-20. Disengage the Keypad

2. With the Keypad (24) disengaged from the rib, gently lift it out from the Front Housing (16).

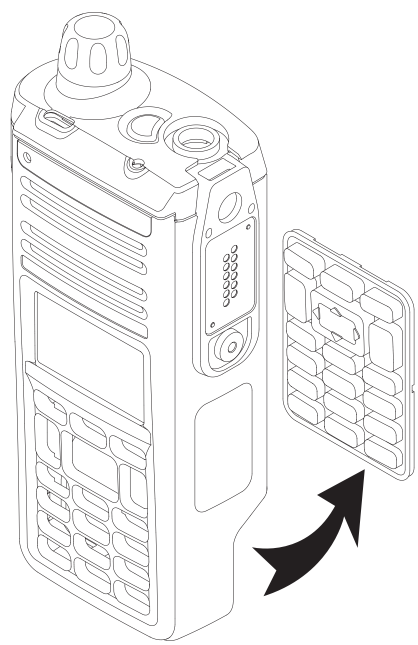

Figure 7-21. Remove the Keypad

7.4.6 Removal of the Front Kit Assembly (A)

1. Complete the steps in Section 7.4.5.1. and Section 7.4.5.5. through Section 7.4.5.7.

2. With the steps completed, the Front Kit Assembly (A) is obtained.

7.5 Serviceable Components of the Main Sub-Assemblies

7.5.1 Servicing Main Board Assembly

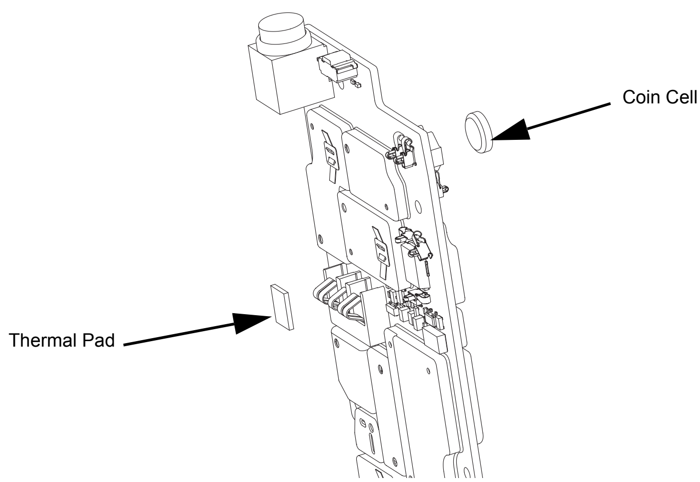

Figure 7-22. Serviceable Components – Main Board Assembly

7.5.1.1 Servicing Coin Cell:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Remove the coin cell with the Black Stick.

NOTE: Make sure the positive side is facing upwards.

3. Press the new coin cell into the battery carrier until it is secured and fully snapped into place.

7.5.1.2 Servicing Thermal Pad:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Carefully peel off the pad.
3. Ensure there is no debris or residue left on the amplifier’s surface.
4. Replace with new Thermal Pad.
5. Peel the liner off the new pad and place in the respective location. Make sure the bottom surface of the pad is mating with the top surface of the amplifier.
6. Apply slight pressure to activate the adhesive.

Caution

Thermal pad should always be replaced when the Main board assembly is removed.

7.5.2 Servicing Chassis Assembly

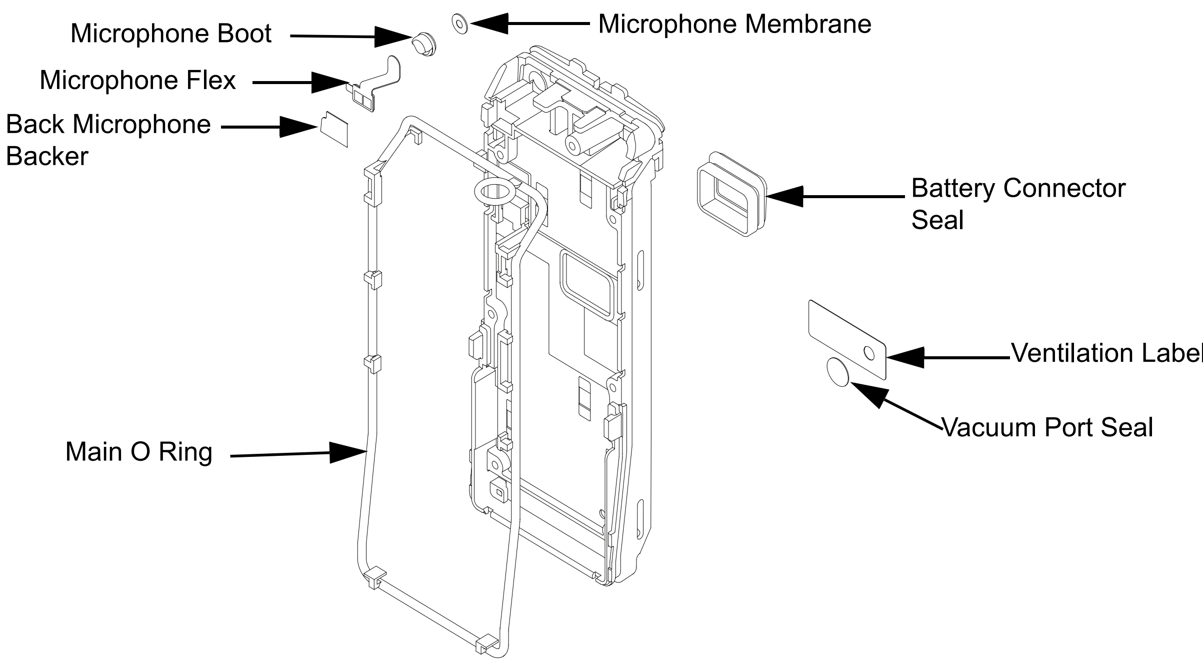

Figure 7-23. Serviceable Components – Chassis Assembly

7.5.2.1 Servicing Ventilation Label:

1. Complete steps in Section 7.4.
2. Carefully peel off the label.
3. Use the Black Stick to help remove any difficult sections of the label.
4. Clean the area once the label is removed to ensure it is free from adhesive and debris.
5. Peel the new label off its backer and place in the respective location.
6. Apply slight pressure to set the adhesive.

Caution

Ventilation label should always be replaced when back kit assembly is removed.

7.5.2.2 Servicing Vacuum Port Seal:

1. Complete steps in Section 7.4.
2. Carefully peel off the seal.
3. Use the Black Stick to help remove any difficult sections of the seal.
4. Clean the area once the seal is removed to ensure it is free of adhesive and debris.
5. Peel the new seal of its backer and place it in the respective location.
6. Apply slight pressure for approximately 30 seconds to activate the adhesive.

> **Caution**
>
> Vacuum port seal should always be replaced when back kit assembly is removed.

7.5.2.3 Servicing Battery Contact Seal:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Pinch the Battery Contact Seal inwards and remove it from the chassis opening.
3. Slot the new Battery Contact Seal until it is properly seated onto the Chassis surface.

7.5.2.4 Servicing Main O Ring:

1. Complete steps from Section 7.4.5.1. through Section 7.4.5.3.
2. Remove the Main O Ring with the aid of a Black Stick.
3. Replace the new Main O Ring into the groove provided in the Chassis.
4. Ensure that the seal is set properly and not stretched.

7.5.2.5 Servicing Microphone Boot:

NOTE: When servicing Microphone Boot, the Microphone Membrane part will also need to be replaced.

1. Gently remove the Back Microphone Backer (49) with the help of a Black Stick.
2. Carefully remove the microphone assembly out of the chassis opening.
3. With the aid of a Black Stick, dislodge the Microphone Boot and carefully slide out the microphone cartridge. Make sure the flex is not stretched. Ensure nothing comes in contact with the microphone while changing to a new Microphone Boot.
4. Press inward the new Microphone Boot to open up the clearance for the microphone assembly. Fit in the microphone cartridge. Make sure the flex is not stretched.
5. Ensure the microphone cartridge is seated properly within the Microphone Boot.
6. Ensure the Microphone Boot is correctly seated within the chassis opening.
7. Follow Section 7.5.2.6. (steps 4 to 6) to complete assembling and placing the Microphone Membrane.

7.5.2.6 Servicing Microphone Membrane:

1. Carefully remove the Microphone Membrane from the chassis opening using the Black Stick.
2. Use the pointed tip of the Black Stick to scrap off pieces of adhesives after removing the membrane.
3. Use a cotton bud dipped in IPA Cleaning Solvent to clean the area to remove remaining adhesive and debris.
4. Ensure the Microphone is seated properly within the Microphone Boot opening.
5. Remove the new Microphone Membrane from its backer.
6. Ensure that the area is dry (solvent fully evaporated) before carefully placing the new Microphone Membrane. The membrane needs to be centered on the surface of the microphone boss area on the Chassis. Ensure that the membrane is flat with no ripples or folds. Press down firmly, applying slight pressure to activate the adhesive using the Round Stick.
7. Ensure that the Microphone Boot is seated correctly within the chassis opening.
8. With the Microphone Boot seated in the chassis, carefully place the Back Microphone Backer (49) to cover the microphone opening.

7.5.3 Servicing Main Housing

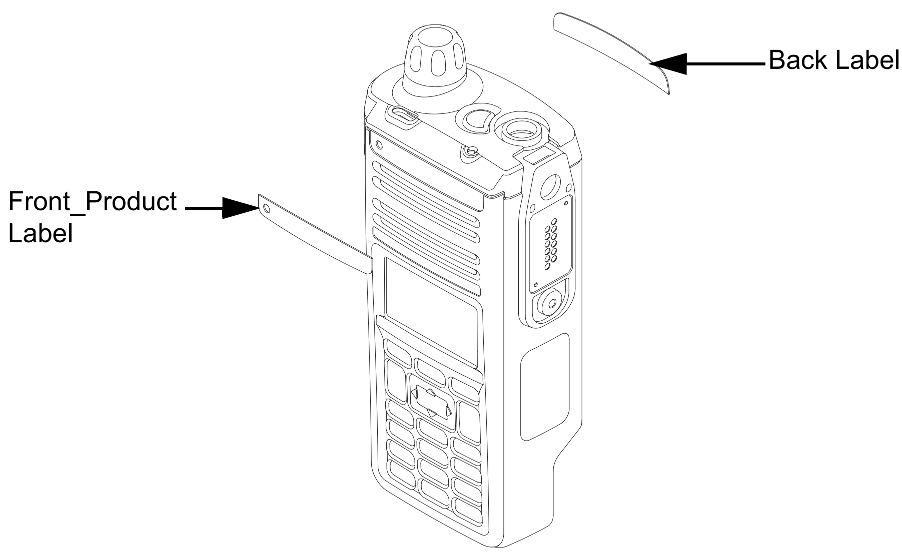

Figure 7-24. Serviceable Components – Main Housing

7.5.3.1 Servicing Front_Product Label

NOTE: There is no need to remove any component in order to service the Front_Product Label.

1. Scrap off the Front_Product Label with the Black Stick.
2. Clean the area once the Front_Product Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the label.

7.5.3.2 Servicing Back Label

NOTE: There is no need to remove any component in order to service the Back Label.

1. Scrap off the Back Label with the Black Stick.
2. Clean the area once the Back Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the label.

7.5.4 Servicing Multi Function Knob

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis Opener, grasp the Multi Function Knob and pull it upward, until it is free from its shaft.
3. Replace the knob with a new one by aligning the D-shaped part of the shaft with the D-shaped hole on the Multi Function Knob. Press the knob into place.

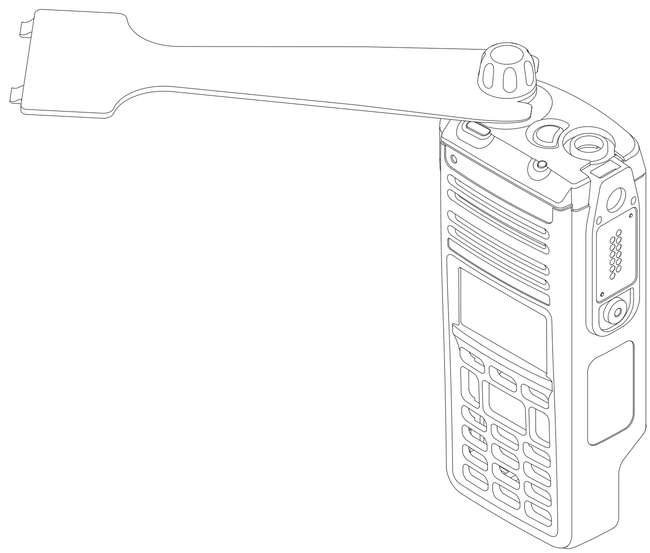

Figure 7-25. Servicing the Multi Function Knob

7.6 Radio Reassembly

This section contains instructions for reassembling the radio.

7.6.1 Reassemble the Main Board (32)

1. Plug in the connectors of the Back Kit Flex (30) onto the Main Board (32). With the Back Kit Flex connected to the Main Board, place the Main Board into the Chassis (40) as shown in Figure 7-26.

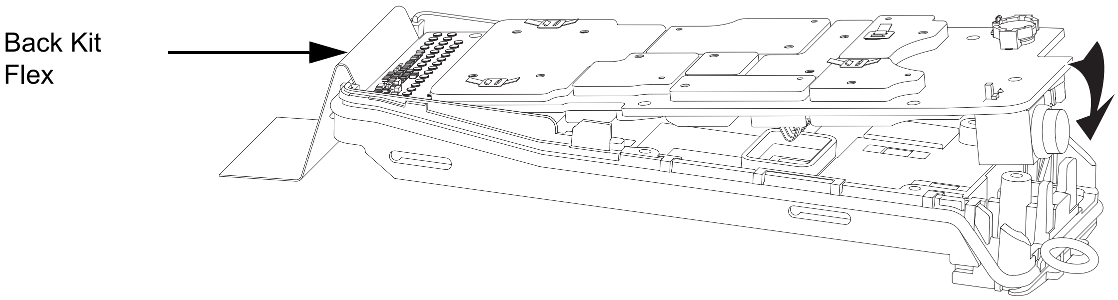

Figure 7-26. Assemble the RF Board

NOTE: Plug in the connectors at the side of the Back Kit Flex which reads “To Main Board”. Ensure that the Battery Contact Seal (41) does not pinch and the tabs of the Main O-Ring are held in place when assembling the Main Board into the Chassis.

2. With the Main Board (32) seated in the Chassis (40), gently assemble the Main O-Ring (35) to the Antenna Holder as shown in Figure 7-27.

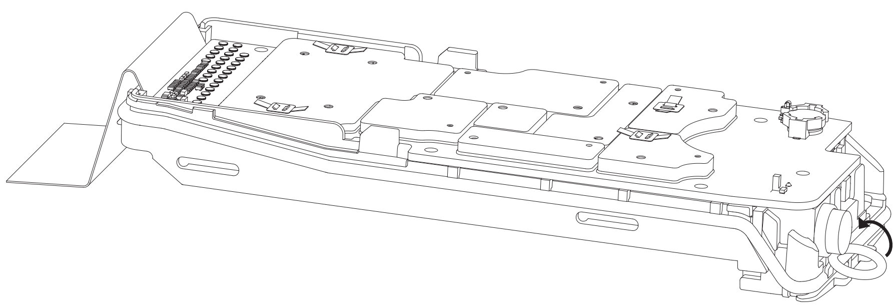

Figure 7-27. Assemble the Main O-Ring at Antenna Holder

7.6.2 Reassemble the Secondary Shield Assembly (31)

1. With the Main Board (32) assembled, place the Secondary Shield Assembly (31) onto the Main Board.

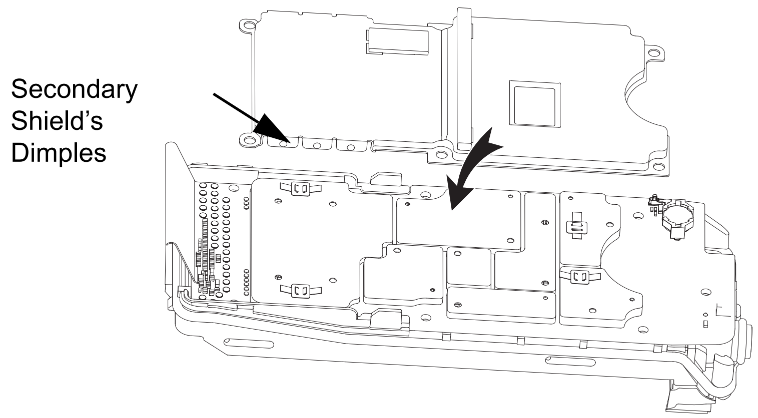

Figure 7-28. Assemble the Secondary Shield Assembly

2. Torque all seven Chassis Screws (29) with a Torx IP6 Bit and a Torque Driver to 3.0 in-lbf in the sequence as shown in Figure 7-29.

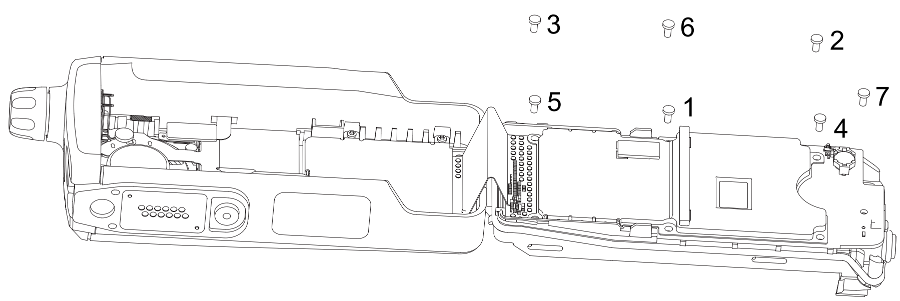

Figure 7-29. Torque in the Chassis Screws

7.6.3 Reassemble the Keypad (24)

1. Place the Keypad (24) into the Front Housing (16) and gently flush the mushroom rib at the edges of the Keypad into the Front Housing with the aid of the back of the Black Stick.

> **Caution**
>
> When flushing the Keypad, care is needed to avoid damage to the Keypad.
>
> Ensure that the Keypad is fully flushed to prevent leakage.

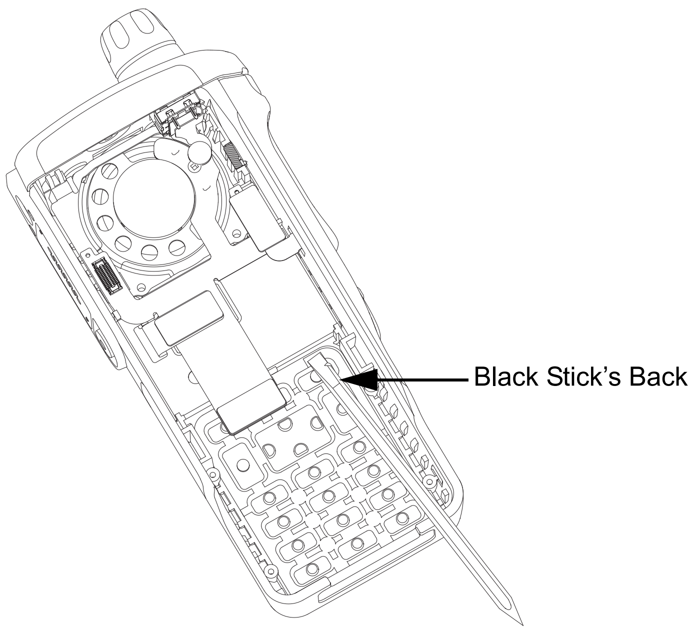

Figure 7-30. Assemble the Keypad

7.6.4 Reassemble the Keypad Board (26)

1. With the Keypad (24) assembled, place the Keypad Board (26) into the Front Housing (16).
2. Plug in the connector of the Front Kit Flex (2) as shown in Figure 7-31.

> **Caution**
>
> When plugging in the connectors, care is needed to avoid damage to the interconnect and surrounding on-board components.

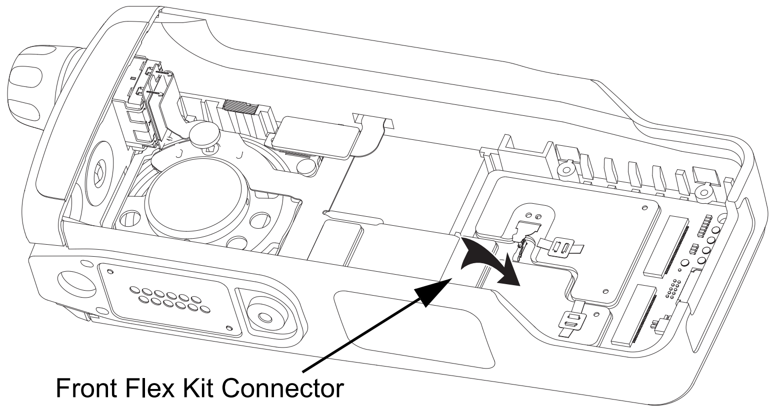

Figure 7-31. Plug in the Front Kit Flex Connector

3. Complete steps in Section 7.6.1. through Section 7.6.3.
4. Gently plug in the connectors of the Back Kit Flex (30) to the Keypad Board as shown in Figure 7-32.

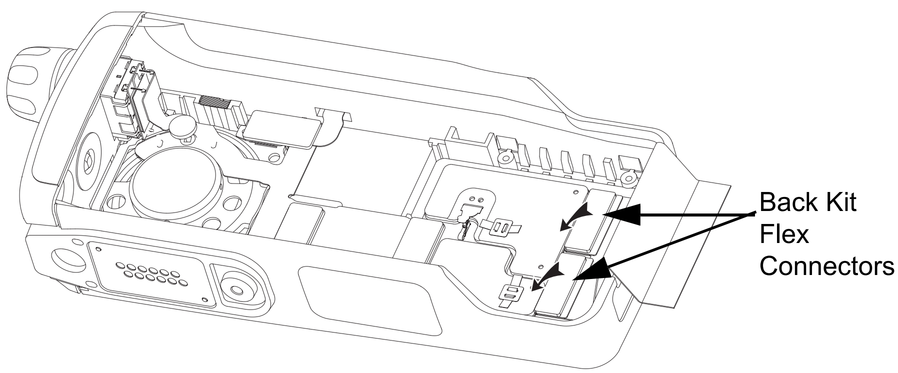

Figure 7-32. Plug in the Back Kit Flex Connectors

NOTE: Plug in the connectors at the side of the Back Kit Flex which reads “To Keypad Board”.

7.6.5 Reassemble the Keypad Retainer (27)

1. Place the Keypad Retainer (27) over the Keypad Board (26) in the Front Housing (16) as shown in Figure 7-33.

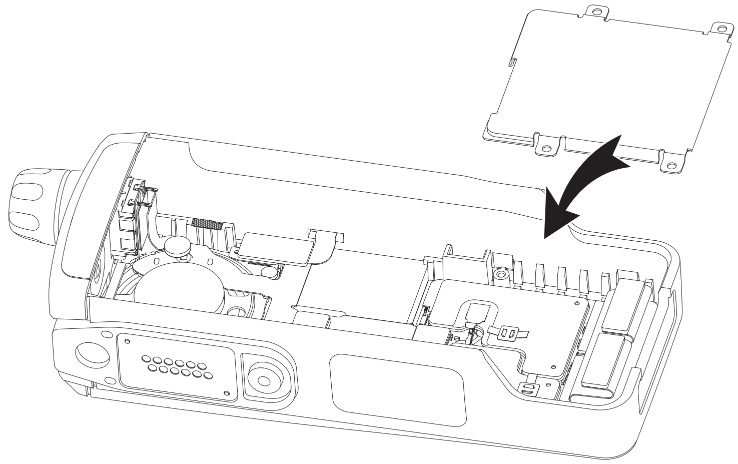

Figure 7-33. Place Keypad Retainer over the Keypad Board

2. Torque all four keypad retainer screws (28) with a Torx IP6 Bit and a Torque Driver to 1.2 in-lbf in the sequence as shown in Figure 7-34.

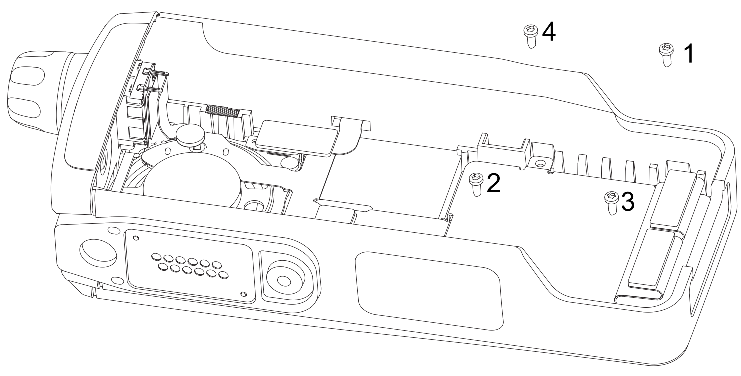

Figure 7-34. Torque in the Keypad Retainer Screws

7.6.6 Reassemble the Shroud (46)

1. Slide the Shroud (46) into the Chassis' frame until the latch clicks into place as shown in Figure 7-35.

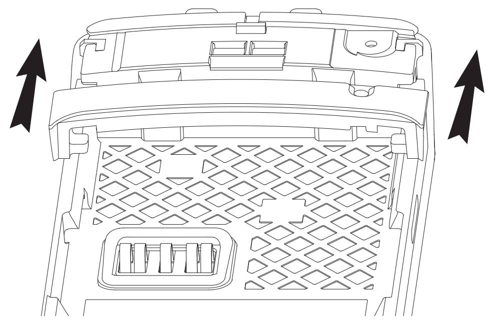

Figure 7-35. Assemble the Shroud

7.6.7 Reassemble the Main Subassemblies (A and B)

1. Complete the steps in Section 7.6.1. through Section 7.6.5.
2. Slide the Chassis assembly into the Front Housing as shown in Figure 7-36.

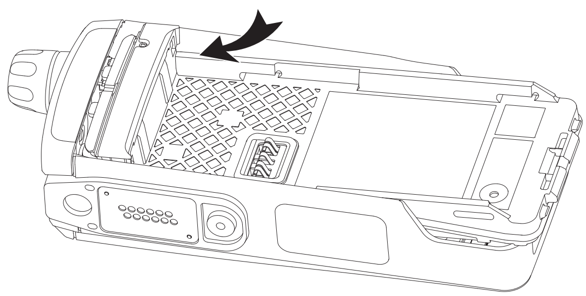

Figure 7-36. Slide chassis assembly into Front Housing

3. With the Chassis assembly fully slided in, press down the bottom part of the Chassis to lock the two subassemblies (A and B) together as shown in Figure 7-37.

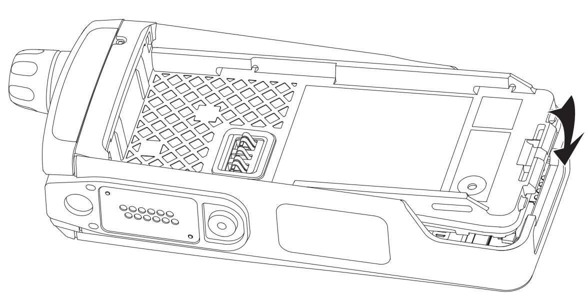

Figure 7-37. Assemble Back Kit and Front Kit together

7.6.8 Reassemble the Accessory-Connector Cover (14)

1. Insert the hooked end of the cover into the pocket. Engage the hook beneath the undercut and swing the cover down onto the radio. Ensure the cover is seated properly and the screw is aligned into the threaded hole.

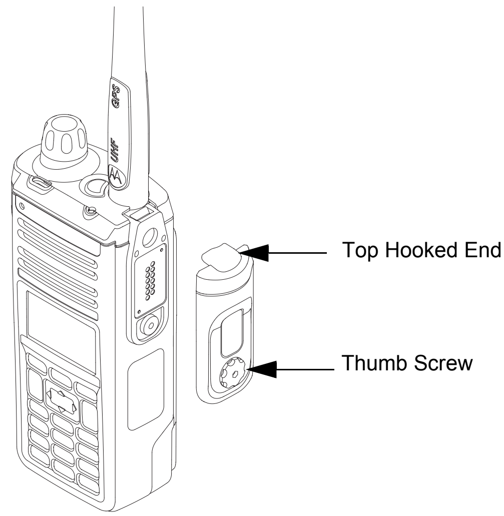

Figure 7-38. Engaging Hook and Seating Cover

2. Hand tighten the thumb screw clockwise until secured.

   NOTE: Do not overtighten the screw. The screw should be snugged and does not allow the cover to move.

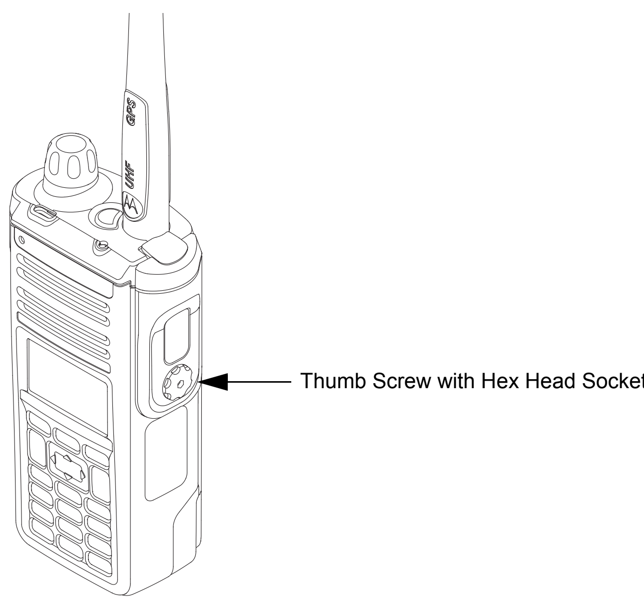

Figure 7-39. Securing the Cover

7.6.9 Reassemble Multi Function Knob (22)

1. Align the D-shaped part of the shaft with the D-shaped hole on the Multi Function knob. Press the knob into place.

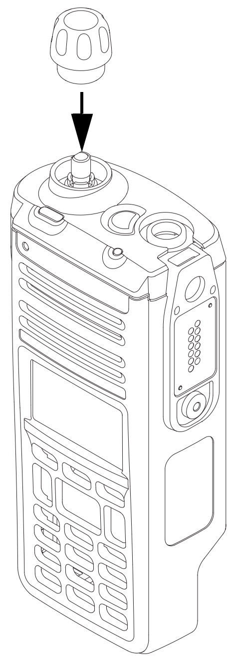

Figure 7-40. Reassemble the Multi Function Knob

7.6.10 Reassemble the Antenna (23)

1. With the radio turned off, turn the antenna clockwise to attach it to the radio.

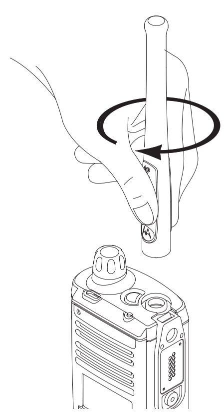

Figure 7-41. Attaching the Antenna

7.6.11 Reassemble the Vacuum Port Seal (42), Ventilation Label (43) and Bottom Label (17)

1. Adhere and gently press the Vacuum Port Seal (42) on the chassis' recess as shown in Figure 7-42.

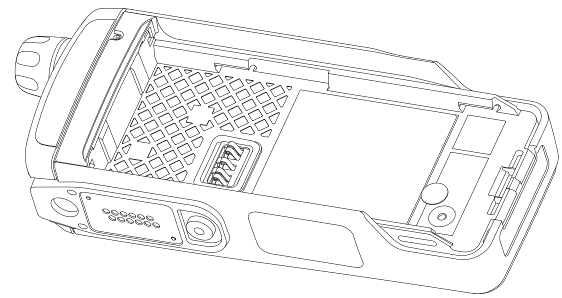

Figure 7-42. Assemble the Vacuum Port Seal

2. With the Vacuum Port Seal assembled, adhere the Ventilation Label (43) on the chassis' recess as shown in Figure 7-43.

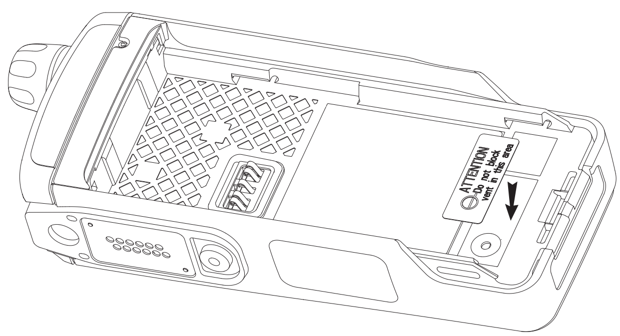

Figure 7-43. Assemble the Ventilation Label

3. Adhere the Bottom Label (17) on the recess at the bottom of the Front Housing as shown in Figure 7-44.

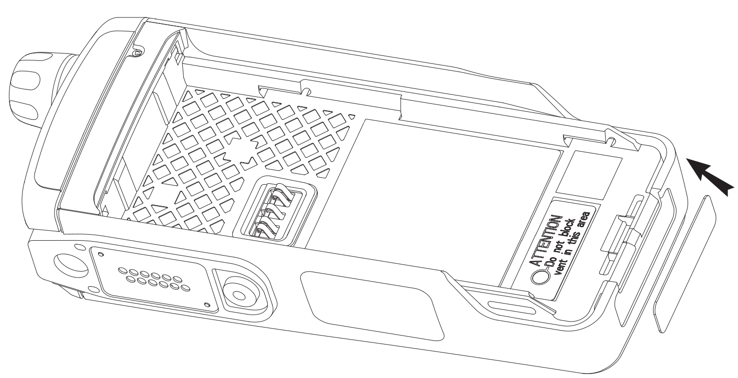

Figure 7-44. Assemble the Bottom Label

7.6.12 Reassemble the Battery (47)

1. With the radio turned off, slide up the battery into the radio’s frame until the bottom latch clicks into place as shown in Figure 7-45.

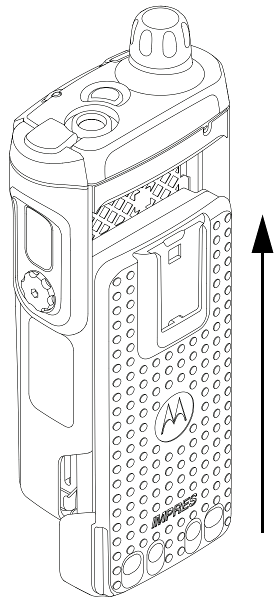

Figure 7-45. Attaching Battery – Slide into Position

7.7 Ensuring Reliable Splash Protection

This section discusses disassembly and reassembly of ASTRO APX 1000 radios and concerns in ensuring a reliable splash protection against liquid.

7.7.1 Standards

ASTRO APX 1000 radio model meet the requirements of IP54, which require the radio to maintain water protection integrity when subjected to splashing of water with volumetric flow up to 10 liters per minute at pressure of 80–100 kPa from any direction for 5 minutes.

7.7.2 Servicing

APX 1000 radios shipped from the Motorola factory should not be disassembled to maintain its splash protection integrity. If disassembly is necessary, refer to qualified service personnel and service shops capable of restoring the splash protection integrity of the radio.

Caution

It is strongly recommended that maintenance of the radio be deferred to qualified service personnel and service shops. This is of paramount importance as irreparable damage to the radio can result from service by unauthorized persons. If disassembly is necessary, unauthorized attempts to repair the radio may void any existing warranties or extended performance agreements with Motorola.

7.7.3 Water Exposure

If the radio is exposed to water, shake the radio to remove the excess water from the speaker grille and microphone ports areas before operating; otherwise, the sound may be distorted until the water has evaporated, or is dislodged from these areas.

Caution

Do not submerge the radio into water.

7.7.4 Disassembly

Disassemble the radio according to Section 7.4.

7.7.5 Reassembly

Caution

Do not reassemble the radio without first performing the following preliminary inspection procedure.

Before reassembling the radio:

1. Inspect the Main O-Ring on the Chassis (26) for any damage or foreign material.
2. Inspect the Battery Contact Seal (29) on the Main Board Assembly (16) for any damage.
3. Inspect the mating seal surfaces on the Chassis (26) for all of the above seals for damage or foreign material that might prevent the seals from sealing properly.

Continue reassembling the radio according to Section 7.6. Tighten all hardware that was loosened or removed.

Notes

Chapter 8 Basic Troubleshooting

This section of the manual contains troubleshooting charts and error codes that will help you to isolate a problem. Level one and two troubleshooting will support only radio alignment, programming, battery replacement, and knob replacement, and circuit board replacement.

Component-level service information can be found in the “ASTRO APX 1000 Portable Radios Detailed Service Manual,” Motorola publication number 68012004061.

8.1 Power-Up Error Codes

When the radio is turned on (power-up), the radio performs self-tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio’s display. For non-display radios, the problem will be presented at power-up by a single, low-frequency tone. The radio should be sent to the depot if cycling power and reprogramming the code plug do not solve the problem. The presence of an error should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors will inhibit user operation; non-fatal errors will not. Use Table 8-1 to aid in understanding particular power-up error code displays.

Table 8-1. Power-Up Error Code Displays

Error Code	Description	Corrective Action
01/02	FLASH ROM Codeplug Checksum Non-Fatal Error	Reprogram the codeplug
01/12	Security Partition Checksum Non-Fatal Error	Send radio to depot
01/81	Host ROM Checksum Fatal Error	Send radio to depot
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug
01/84	External EEPROM Blank (or SLIC failure) Fatal Error	Send radio to depot
01/88	External RAM Fatal Error – **Note:** Not a checksum failure	Send radio to depot
01/90	General Hardware Failure Fatal Error	Turn the radio off, then on
01/92	Security Partition Checksum Fatal Error	Send radio to depot
01/93	FLASHport Authentication Code Failure	Send radio to depot
01/94	Internal EEPROM Blank Fatal Error.	Send radio to depot
01/98	Internal RAM Fail Fatal Error	Send radio to depot
01/A0	ABACUS Tune Failure Fatal Error	Send radio to depot
01/A2	Tuning Codeplug Checksum Fatal Error	Send radio to depot
02/81	DSP ROM Checksum Fatal Error	Send radio to depot

Table 8-1. Power-Up Error Code Displays (Continued)

Error Code	Description	Corrective Action
02/88	DSP RAM Fatal Error – **Note:** Not a checksum failure	Turn the radio off, then on
02/90	General DSP Hardware Failure (DSP startup message not received correctly)	Turn the radio off, then on
09/10	Secure Hardware Error	Turn the radio off, then on
09/90	Secure Hardware Fatal Error	Turn the radio off, then on
Hardware board absent/ Hardware board absent then Man-Down Hw error	Keypad board is not connected properly to the radio	Ensure the Keypad board is fixed in place
15/10	External Accessory Non-Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
15/90	External Accessory Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
1E/10	Collaborative device is connected to the radio but the collaborative feature is not enabled in the codeplug.	Contact your Motorola Sales Representative/Partner on how to add Collaborative feature to your radios.
Note: *If the corrective action does not fix the failure, send the radio to the depot.*		

8.2 Operational Error Codes

During radio operation, the radio performs dynamic tests to determine if the radio is working properly. Problems detected during these tests are presented as error codes on the radio's display. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 8-2 to aid in understanding particular operational error codes.

Table 8-2. Operational Error Code Displays

Error Code	Description	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	1. Reprogram external codeplug 2. Send radio to depot
FAIL 002	Selected Mode/Zone Codeplug Checksum Error	Reprogram external codeplug

8.3 Receiver Troubleshooting

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

Table 8-3. Receiver Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements at Room Temperature)
Radio Dead; Display Does Not Turn On	1. Dead Battery	Replace with charged battery
	2. Blown Fuse	Send radio to depot
	3. On/Off Switch	
	4. Regulators	
Radio Dead; Display Turns On	1. Keypad Board	Send radio to depot
	2. Main Board	
Radio On; Front Display Off	High operating temperature (above 80°C)	Allow radio to return to normal operating temperature.
No Receive Audio, or Receiver Does Not Unmute	Programming	1. Check if transmitted signal matches the receiver configuration (PL, DPL, etc.) 2. Check if radio able to unmute with Monitor function enabled
Audio Distorted or Not Loud Enough	Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
RF Sensitivity Poor	1. Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
	2. Antenna Switch/ Connector	Send radio to depot
	3. Receiver Front-End Tuning	Check RF front-end tuning for optimum sensitivity using the tuner
Radio Will Not Turn Off	Main Board	Send radio to depot

8.4 Transmitter Troubleshooting

Table 8-4 lists the possible causes of, and corrections for, transmitter problems.

Table 8-4. Transmitter Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No RF Power Out	1. TX Power Level or Frequency	Check TX power level and frequency programming (from tuner)
	2. No Injection To Power Amplifier	Send radio to depot
	3. Antenna Switch/Connector	
No Modulation; Distorted Modulation	1. Programming	Check deviation and compensation settings using the tuner
	2. Main Board	Send radio to depot
Bad Microphone Sensitivity	1. Check Deviation and Compensation	Realign if necessary
	2. Microphone	Send radio to depot
No/Low signaling (PL, DPL, MDC)	1. Programming	Check programming
	2. Main Board	Send radio to depot
Cannot Set Deviation Balance	Main Board	Send radio to depot

Chapter 9 Exploded Views and Parts Lists

This chapter contains exploded views and associated parts lists for the ASTRO APX 1000 digital portable radios. The following table lists the exploded views for the radio in different configurations:

Table 9-1. APX 1000 Exploded Views and Controller Kit

9.1 APX 1000 Front Kit Exploded View

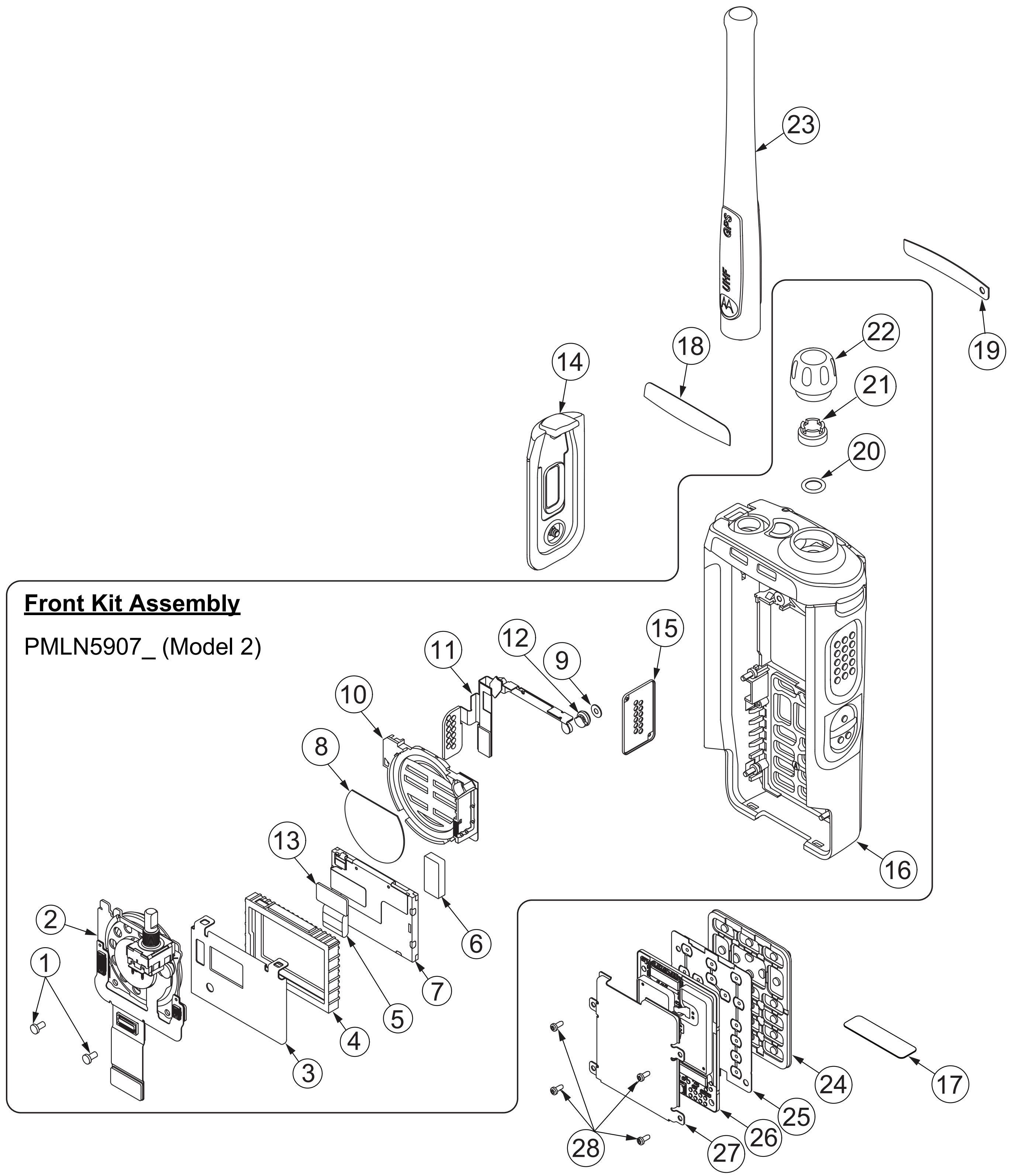

Figure 9-1. APX 1000 Front Kit Exploded View

9.2 APX 1000 Front Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
1††	**0386104Z04**	Screw, Retainer, Speaker
2†	**0104043J28**	Assembly, Flex, Front Kit
3†	**42012055001**	Retainer, LCD
4†	**75012121001**	Boot, LCD
5†	**75012125001**	Pad, Conductive, LCD-Mod to Retainer, LCD
6†	**75012189001**	Pad, Spacer
7†	**72012015001**	Module, LCD
8†	**35012069002**	Mesh, Speaker
9†	**35012068001**	Membrane, Front Mic
10†	**85012039003**	Assembly, Bluetooth Antenna & Speaker Holder
11†	**0104058J94**	Flex, GCAI & LEDs
12†	**32012282001**	Boot, Front Mic
13†	**75012116001**	Pad, Poron, 60pin Receptacle
14	**15012142001**	Cover, Accessory-Connector
15†	**33012027001**	Escutcheon, GCAI
16†	**0104055J81**	Assembly, Front Housing Kit (Model 2)
17	**54012241001**	Label, Bottom
18	**54012198004**	Label, Back (APX 1000)
19	**54012196002**	Label, Front_Product (Non-Bluetooth-Basic Model)
20†	**32012152001**	O-ring, Switch, Rotary
21†	**02012016001**	Nut, Rotary Switch
22††	**36012020002**	Knob, Multi Function
23	**PMAF4008_**	Antenna, 900/GPS
24	**75012114003**	Keypad, Model 2
25	**40012056002**	Mylar with Metal Domes, Keypad (Model 2)
26†††	**PMCN4029_**	Assembly, Keypad Board (Model 2, Base)
27	**42012056001**	Retainer, Keypad
28	**0378212A02**	Screw, Retainer, Keypad

NOTE:

†. Items cannot be ordered individually. They are included in the Assembly, Front-Kit – PMLN5907_ (Model 2). Refer to the Model Charts on page xi.

††. Items can be ordered individually, but they are included in their respective kits (if ordered).

†††. Items cannot be ordered individually. They are included in their respective kits (if ordered). Refer to the Model Charts on pages xi.

Note Assembly, Front-Kit – PMLN5907_ (Model 2) include items #1-13, 15-16, and 20-22

9.3 APX 1000 Back Kit Exploded View

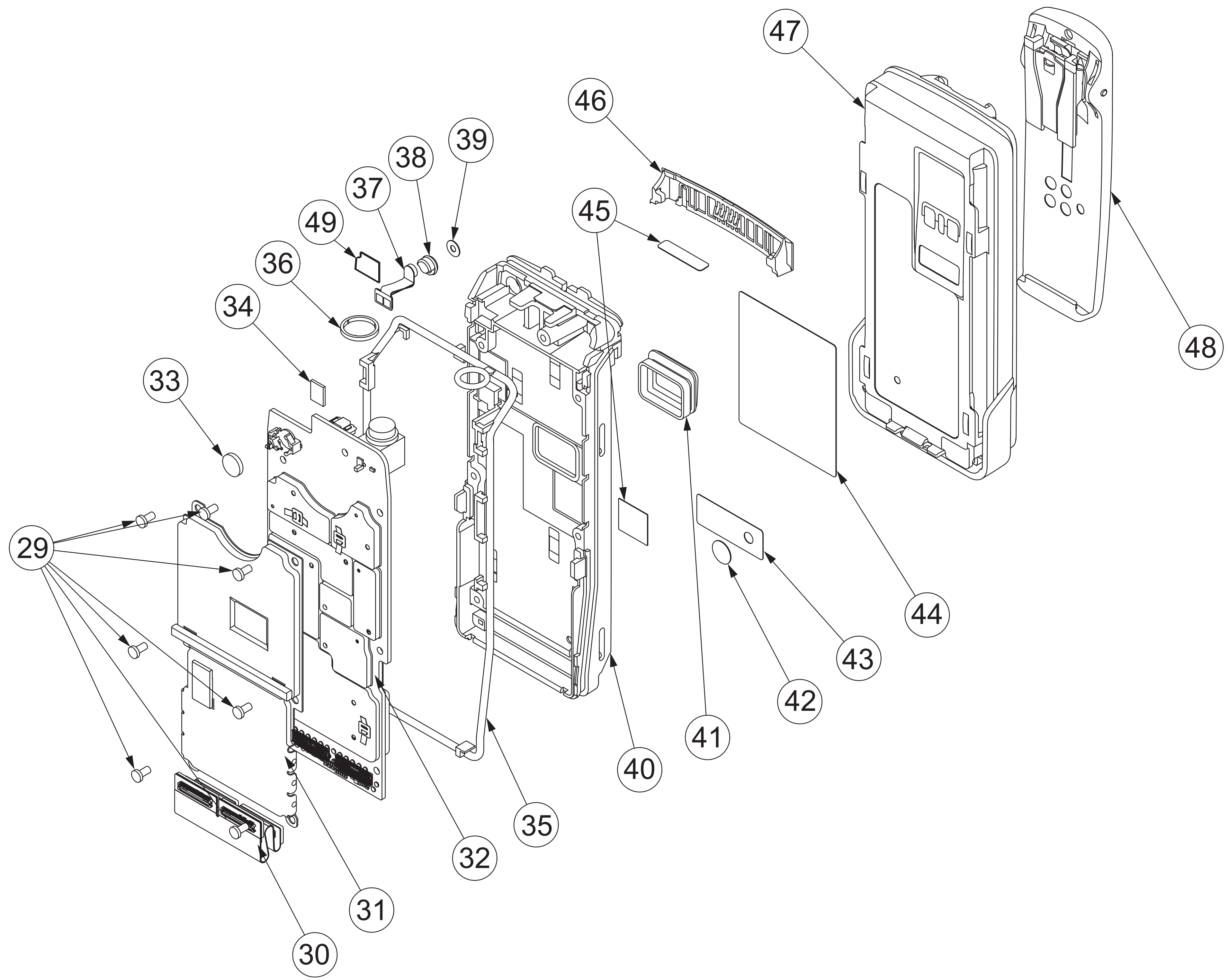

Figure 9-2. APX 1000 Back Kit Exploded View

9.4 APX 1000 Back Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
29	**0386104Z04**	Screw, Chassis
30	**0104043J76**	Assembly, Flex, Back-kit (Model 2)
31	**0104046J48**	Shield, Secondary Assembly
32†	**PMLF4097_**	Assembly, Main Board (900 MHz)
33	**6071520M01**	Cell, Coin
34	**7515719H02**	Pad, Thermal, RF PA
35	**32012156001**	O-ring, Main
36	**43012045001**	Collar, Plastic
37	**0104059J61**	Assembly, Flex, Back Mic
38	**32012282001**	Boot, Back Mic
39	**35012068001**	Membrane, Back Mic
40	**27012020002**	Chassis
41	**32012150001**	Seal, Battery Contact
42	**3286058L01**	Seal, Vacuum Port
43	**5478220A01**	Label, Ventilation
44††	**54012242001**	Label, FCC
45††	**33012034001**	Label, ITID
46	**15012140001**	Shroud
47	**NNTN8129_** **NNTN8128_** **PMNN4424_**	Battery, Hi-Cap (FM, 2300 mAH) Battery, Standard (non-FM, 1900 mAH) Battery, Hi-Cap (non-FM, 2300 mAH)
48	**PMLN4651_** **PMLN7008_**	Clip, Belt (2”) Clip, Belt (2.5”)
49	**64012022001**	Back Microphone Backer

NOTE:

†. Items cannot be ordered individually. They are included in their respective kits (if ordered). Refer to the Model Charts on page xi.

††. Item is not orderable.

Notes

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Notes

ASTRO® APX® APX® 2000/ APX® 4000
Digital Portable Radios

Section 4

APX 2000/ APX 4000 (Two Knobs)

Notes

Table of Contents

List of Tables

List of Figures

Model Numbering, Charts, and Specifications

Portable Radio Model Numbering System

Typical Model Number:	H	5	1	K	G	D	9	P	W	5	A	N	S	P	0	1
Position:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Position 1 – Type of Unit

H = Hand-Held Portable

Positions 2 & 3 – Model Series

51 = APX 4000
52 = APX 2000

Position 4 - Frequency Band

A = Less than 29.7MHz	P = 336 to 410MHz
B = 29.7 to 35.99MHz	Q = 380 to 470MHz
C = 36 to 41.99MHz	R = 438 to 482MHz
D = 42 to 50MHz	S = 450 to 520MHz
F = 66 to 80MHz	T = Dual Band Capable
G = 74 to 90MHz	U = 764 to 870MHz
H = Product Specific	V = 825 to 870MHz
J = 136 to 162MHz	W = 896 to 941MHz
K = 136 to 174MHz	Y = 1.0 to 1.6GHz
L = 174 to 210MHz	Z = 1.5 to 2.0GHz
M = 190 to 235MHz	

Values given represent range only; they are not absolute.

Position 5 – Power Level

A = 0 to 0.7 Watts
B = 0.7 to 0.9 Watts
C = 1.0 to 3.9 Watts
D = 1.0 to 5.0 Watts
E = 5.1 to 6.0 Watts
F = 6.1 to 10 Watts
G = 0 to 6 Watts

Position 6 – Physical Packages

A = RF Modem Operation
B = Receiver Only
C = Standard Control; No Display
D = Standard Control; With Display
E = Limited Keypad; No Display
F = Limited Keypad; With Display
G = Full Keypad; No Display
H = Full Keypad; With Display
J = Limited Controls; No Display
K = Limited Controls; Basic Display
L = Limited Controls; Limited Display
M = Rotary Controls; Standard Display
N = Enhanced Controls; Enhanced Display
P = Low Profile; No Display
Q = Low Profile; Basic Display
R = Low Profile; Basic Display, Full Keypad

Position 7 – Channel Spacing

1 = 5kHz	5 = 15kHz
2 = 6.25kHz	6 = 20/25kHz
3 = 10kHz	7 = 30kHz
4 = 12.5kHz	9 = Variable/Programmable

Position 8 – Primary Operation

A = Conventional/Simplex
B = Conventional/Duplex
C = Trunked Twin Type
D = Dual Mode Trunked
E = Dual Mode Trunked/Duplex
F = Trunked Type I
G = Trunked Type II
H = FDMA* Digital Dual Mode
J = TDMA** Digital Dual Mode
K = Single Sideband
L = Global Positioning Satellite Capable
M = Amplitude Companded Sideband (ACSB)
P = Programmable

** FDMA = Frequency Division Multiple Access*
*** TDMA = Time Division Multiple Access*

Position 9 – Primary System Type

A = Conventional
B = Privacy Plus
C = Clear SMARTNET
D = Advanced Conventional Stat-Alert
E = Enhanced Privacy Plus
F = Nauganet 888 Series
G = Japan Specialized Mobile Radio (JSMR)
H = Multi-Channel Access (MCA)
J = CoveragePLUS
K = MPT1327* – Public
L = MPT1327* – Private
M = Radiocom
N = Tone Signalling
P = Binary Signalling
Q = Phonenet
W = Programmable
X = Secure Conventional
Y = Secure SMARTNET

** MPT = Ministry of Posts and Telecommunications*

Position 10 – Feature Level

1 = Basic	6 = Standard Plus
2 = Limited Package	7 = Expanded Package
3 = Limited Plus	8 = Expanded Plus
4 = Intermediate	9 = Full Feature/ Programmable
5 = Standard Package	

Position 11 – Version

Version Letter (Alpha) – Major Change

Position 12 – Unique Model Variations

C = Cenelec
N = Standard Package

Positions 13 – 16

SP Model Suffix

Notes

ASTRO APX 2000/ APX 4000 (Two Knobs) VHF Model Chart

MODEL DESCRIPTION:					136–174 MHz, APX 4000_2000
FCC ID:					AZ489FT3828
H51KDF9PW6AN					APX 4000 Model 2 VHF
	H52KDF9PW6AN				APX 2000 Model 2 VHF
		H51KDH9PW7AN			APX 4000 Model 3 VHF
			H52KDH9PW7AN		APX 2000 Model 3 VHF
				ITEM NUMBER	DESCRIPTION
●	●			PMLN6807_	Assembly, Front Kit, Model 2, yellow
●	●			PMLN6824_	Assembly, Front Kit, Model 2, black
		●	●	PMLN6806_	Assembly, Front Kit, Model 3, yellow
		●	●	PMLN6823_	Assembly, Front Kit, Model 3, black
X	X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	X	BR000082A01	Retainer, Keypad
X	X			KP000017A02	Keypad, Model 2
		●	●	KP000017A01	Keypad, Model 3 (English)
		●	●	KP000017A03	Kyepad, Model 3 (Chinese)
X	X			PMLN7225_	Assembly, Keypad Board, Model 2
		X	X	PMLN7226_	Assembly, Keypad Board, Model 3
X	X			ST000137A01	Mylar with Metal Domes, Model 2 Keypad
		X	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	X	35012068001	Membrane, Back Mic
X	X	X	X	32012282001	Boot, Back Mic
X	X	X	X	64012022001	Backer, Back Mic
X	X	X	X	CH000067A01	Chassis
X	X	X	X	32012150001	Seal, Battery Contact
X	X	X	X	HN000165A01	Shroud,Yellow
X	X	X	X	HN000165A02	Shroud,Black
X	X	X	X	32012156001	O-ring, Main
X	X	X	X	PMLN7222_	Assembly, Main Board (VHF)*
X	X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	X	43012045001	Collar, Plastic
X	X	X	X	6071520M01	Coin Cell
X	X	X	X	0104063J03	Assembly, Flex, Back-kit
X	X	X	X	0104046J48	Assembly, Shield, Secondary
X	X	X	X	0386104Z04	Screw, Chassis
X	X	X	X	3286058L01	Seal, Vacuum Port
X	X	X	X	5478220A01	Label, Ventilation
X	X	X	X	LB000084A01	Label, Front
●		●		LB000238A01	Label, Back, APX4000
●		●		LB000238A02	Label, Back, APX4000R
	●		●	LB000238A03	Label, Back, APX2000
	●		●	LB000238A04	Label, Back, APX2000R
X	X	X	X	LB000073A01	Label, Bottom, Blank
O		O		LB000073A02	Label, Bottom, UL (APX 4000, APX 4000R)
	O		O	LB000073A03	Label, Bottom, UL (APX 2000, APX 2000R)
●	●	●	●	LB000085A01	Label, Reflective
X	X	X	X	HW000256A01	Volume Knob
X	X	X	X	HW000254A01	Channel Knob
X	X	X	X	SL000106A01	Torque Adder
X	X	X	X	FN000083A01	Screw, Top bezel
X	X	X	X	KP000014A01	Monitor button
X	X	X	X	FN000080A01	Nut, Volume Switch Spanner

ASTRO APX 2000/ APX 4000 (Two Knobs) VHF Model Chart (Continued)

MODEL DESCRIPTION:					136–174 MHz, APX 4000_2000
FCC ID:					AZ489FT3828
H51KDF9PW6AN					APX 4000 Model 2 VHF
	H52KDF9PW6AN				APX 2000 Model 2 VHF
		H51KDH9PW7AN			APX 4000 Model 3 VHF
			H52KDH9PW7AN		APX 2000 Model 3 VHF
				ITEM NUMBER	DESCRIPTION
●	●	●	●	HN000161A01	Bezel, Top Control (Yellow)
●	●	●	●	HN000161A02	Bezel, Top Control (Black)
●	●	●	●	HN000164A01	Accessory-Connector Cover, Yellow
●	●	●	●	HN000164A02	Accessory-Connector Cover, Black
X	X	X	X	PMLN5997_	User Guide CD, APX 2000 and APX 4000

Note:
X *= Item Included.*
• *Option available. Can be serviced in depot and ordered thru AAD.*
O *Option available. Can be serviced in depot and orderable by UL qualified customers/dealers only. For APAC – Only UL label can be replaced and purchased by Motorola.*
• *Refer* Appendix A for antennas, batteries and other applicable accessories.
***** *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/ APX 4000 (Two Knobs) UHF1 Model Chart

MODEL DESCRIPTION:					**380–470 MHz, APX 4000_2000**
FCC ID:					**AZ489FT4905**
H51QDF9PW6AN					**APX 4000 Model 2 UHF1**
	H52QDF9PW6AN				**APX 2000 Model 2 UHF1**
		H51QDH9PW7AN			**APX 4000 Model 3 UHF1**
			H52QDH9PW7AN		**APX 2000 Model 3 UHF1**
				ITEM NUMBER	**DESCRIPTION**
●	●			PMLN6807_	Assembly, Front Kit, Model 2, Yellow
●	●			PMLN6824_	Assembly, Front Kit, Model 2, Black
		●	●	PMLN6806_	Assembly, Front Kit, Model 3, Yellow
		●	●	PMLN6823_	Assembly, Front Kit, Model 3, Black
X	X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	X	BR000082A01	Retainer, Keypad
X	X			KP000017A02	Keypad, Model 2
		●	●	KP000017A01	Keypad, Model 3 (English)
		●	●	KP000017A03	Kyepad, Model 3 (Chinese)
X	X			PMLN7225_	Assembly, Keypad Board, Model 2
		X	X	PMLN7226_	Assembly, Keypad Board, Model 3
X	X			ST000137A01	Mylar with Metal Domes, Model 2 Keypad
		X	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	X	35012068001	Membrane, Back Mic
X	X	X	X	32012282001	Boot, Back Mic
X	X	X	X	64012022001	Backer, Back Mic
X	X	X	X	CH000067A01	Chassis
X	X	X	X	32012150001	Seal, Battery Contact
X	X	X	X	HN000165A01	Shroud,Yellow
X	X	X	X	HN000165A02	Shroud,Black
X	X	X	X	32012156001	O-ring, Main
X	X	X	X	PMLN7223_	Assembly, Main Board (UHF1)*
X	X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	X	43012045001	Collar, Plastic
X	X	X	X	6071520M01	Coin Cell
X	X	X	X	0104063J03	Assembly, Flex, Back-kit
X	X	X	X	0104046J48	Assembly, Shield, Secondary
X	X	X	X	0386104Z04	Screw, Chassis
X	X	X	X	3286058L01	Seal, Vacuum Port
X	X	X	X	5478220A01	Label, Ventilation
X	X	X	X	LB000084A01	Label, Front
●		●		LB000238A01	Label, Back, APX4000
●		●		LB000238A02	Label, Back, APX4000R
	●		●	LB000238A03	Label, Back, APX2000
	●		●	LB000238A04	Label, Back, APX2000R
X	X	X	X	LB000073A01	Label, Bottom, Blank
O		O		LB000073A02	Label, Bottom, UL (APX 4000, APX 4000R)
	O		O	LB000073A03	Label, Bottom, UL (APX 2000, APX 2000R)
●	●	●	●	LB000085A01	Label, Reflective
X	X	X	X	HW000256A01	Volume Knob
X	X	X	X	HW000254A01	Channel Knob
X	X	X	X	SL000106A01	Torque Adder
X	X	X	X	FN000083A01	Screw, Top bezel
X	X	X	X	KP000014A01	Monitor button
X	X	X	X	FN000080A01	Nut, Volume Switch Spanner

ASTRO APX 2000/ APX 4000 (Two Knobs) UHF1 Model Chart (Continued)

MODEL DESCRIPTION:					136–174MHz, APX 4000_2000
FCC ID:					AZ489FT4905
H51QDF9PW6AN					APX 4000 Model 2 UHF1
	H52QDF9PW6AN				APX 2000 Model 2 UHF1
		H51QDH9PW7AN			APX 4000 Model 3 UHF1
			H52QDH9PW7AN		APX 2000 Model 3 UHF1
				ITEM NUMBER	DESCRIPTION
●	●	●	●	HN000161A01	Bezel, Top Control (Yellow)
●	●	●	●	HN000161A02	Bezel, Top Control (Black)
●	●	●	●	HN000164A01	Accessory-Connector Cover, Yellow
●	●	●	●	HN000164A02	Accessory-Connector Cover, Black
X	X	X	X	PMLN5997_	User Guide CD, APX 2000 and APX 4000

Note:
X *= Item Included.*
• *Option available. Can be serviced in depot and ordered thru AAD.*
O *Option available. Can be serviced in depot and orderable by UL qualified customers/dealers only. For APAC – Only UL label can be replaced and purchased by Motorola.*
• *Refer* Appendix A for antennas, batteries and other applicable accessories.
***** *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/ APX 4000 (Two Knobs) UHF2 Model Chart

MODEL DESCRIPTION:					**450–520MHz, APX 4000_2000**
FCC ID:					**AZ489FT4910**
H51SDF9PW6AN					**APX 4000 Model 2 UHF2**
	H52SDF9PW6AN				**APX 2000 Model 2 UHF2**
		H51SDH9PW7AN			**APX 4000 Model 3 UHF2**
			H52SDH9PW7AN		**APX 2000 Model 3 UHF2**
				ITEM NUMBER	**DESCRIPTION**
●	●			PMLN6807_	Assembly, Front Kit, Model 2, Yellow
●	●			PMLN6824_	Assembly, Front Kit, Model 2, Black
		●	●	PMLN6806_	Assembly, Front Kit, Model 3, Yellow
		●	●	PMLN6823_	Assembly, Front Kit, Model 3, Black
X	X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	X	BR000082A01	Retainer, Keypad
X	X			KP000017A02	Keypad, Model 2
		●	●	KP000017A01	Keypad, Model 3 (English)
		●	●	KP000017A03	Kyepad, Model 3 (Chinese)
X	X			PMLN7225_	Assembly, Keypad Board, Model 2
		X	X	PMLN7226_	Assembly, Keypad Board, Model 3
X	X			ST000137A01	Mylar with Metal Domes, Model 2 Keypad
		X	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	X	35012068001	Membrane, Back Mic
X	X	X	X	32012282001	Boot, Back Mic
X	X	X	X	64012022001	Backer, Back Mic
X	X	X	X	CH000067A01	Chassis
X	X	X	X	32012150001	Seal, Battery Contact
X	X	X	X	HN000165A01	Shroud,Yellow
X	X	X	X	HN000165A02	Shroud,Black
X	X	X	X	32012156001	O-ring, Main
X	X	X	X	PMLN7224_	Assembly, Main Board (UHF2)*
X	X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	X	43012045001	Collar, Plastic
X	X	X	X	6071520M01	Coin Cell
X	X	X	X	0104063J03	Assembly, Flex, Back-kit
X	X	X	X	0104046J48	Assembly, Shield, Secondary
X	X	X	X	0386104Z04	Screw, Chassis
X	X	X	X	3286058L01	Seal, Vacuum Port
X	X	X	X	5478220A01	Label, Ventilation
X	X	X	X	LB000084A01	Label, Front
●		●		LB000238A01	Label, Back, APX4000
●		●		LB000238A02	Label, Back, APX4000R
	●		●	LB000238A03	Label, Back, APX2000
	●		●	LB000238A04	Label, Back, APX2000R
X	X	X	X	LB000073A01	Label, Bottom, Blank
O		O		LB000073A02	Label, Bottom, UL(APX4000, APX4000R)
	O		O	LB000073A03	Label, Bottom, UL(APX2000, APX2000R)
●	●	●	●	LB000085A01	Label, Reflective
X	X	X	X	HW000256A01	Volume Knob
X	X	X	X	HW000254A01	Channel Knob
X	X	X	X	SL000106A01	Torque Adder
X	X	X	X	FN000083A01	Screw, Top bezel
X	X	X	X	KP000014A01	Monitor button
X	X	X	X	FN000080A01	Nut, Volume Switch Spanner

ASTRO APX 2000/ APX 4000 (Two Knobs) UHF2 Model Chart (Continued)

MODEL DESCRIPTION:					450–520MHz, APX 4000_2000
FCC ID:					AZ489FT4910
H51SDF9PW6AN					APX 4000 Model 2 UHF2
	H52SDF9PW6AN				APX 2000 Model 2 UHF2
		H51SDH9PW7AN			APX 4000 Model 3 UHF2
			H52SDH9PW7AN		APX 2000 Model 3 UHF2
				ITEM NUMBER	DESCRIPTION
●	●	●	●	HN000161A01	Bezel, Top Control (Yellow)
●	●	●	●	HN000161A02	Bezel, Top Control (Black)
●	●	●	●	HN000164A01	Accessory-Connector Cover, Yellow
●	●	●	●	HN000164A02	Accessory-Connector Cover, Black
X	X	X	X	PMLN5997_	User Guide CD, APX 2000 and APX 4000

Note:
X *= Item Included.*
• *Option available. Can be serviced in depot and ordered thru AAD.*
O *Option available. Can be serviced in depot and orderable by UL qualified customers/dealers only. For APAC – Only UL label can be replaced and purchased by Motorola.*
• *Refer* Appendix A for antennas, batteries and other applicable accessories.
***** *The radio's model number and FLASHcode are required when placing an order for the Main Board.*

- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

ASTRO APX 2000/ APX 4000 (Two Knobs) 700/800 MHz Model Chart

MODEL DESCRIPTION:					764–870 MHz,APX 4000_2000
FCC ID:					AZ489FT7049
H51UCF9PW6AN					APX 4000 Model 2 7/800
	H52UCF9PW6AN				APX 2000 Model 2 7/800
		H51UCH9PW7AN			APX 4000 Model 3 7/800
			H52UCH9PW7AN		APX 2000 Model 3 7/800
				ITEM NUMBER	DESCRIPTION
●	●			PMLN6807_	Assembly, Front Kit, Model 2, yellow
●	●			PMLN6824_	Assembly, Front Kit, Model 2, black
		●	●	PMLN6806_	Assembly, Front Kit, Model 3, yellow
		●	●	PMLN6823_	Assembly, Front Kit, Model 3, black
X	X	X	X	0378212A02	Screw, Retainer, Keypad
X	X	X	X	BR000082A01	Retainer, Keypad
X	X			KP000017A02	Keypad, Model 2
		●	●	KP000017A01	Keypad, Model 3 (English)
		●	●	KP000017A03	Kyepad, Model 3 (Chinese)
X	X			PMLN7225_	Assembly, Keypad Board, Model 2
		X	X	PMLN7226_	Assembly, Keypad Board, Model 3
X	X			ST000137A01	Mylar with Metal Domes, Model 2 Keypad
		X	X	40012056001	Mylar with Metal Domes, Model 3 Keypad
X	X	X	X	0104059J61	Assembly, Flex, Back Mic
X	X	X	X	35012068001	Membrane, Back Mic
X	X	X	X	32012282001	Boot, Back Mic
X	X	X	X	64012022001	Backer, Back Mic
X	X	X	X	CH000067A01	Chassis
X	X	X	X	32012150001	Seal, Battery Contact
X	X	X	X	HN000165A01	Shroud,Yellow
X	X	X	X	HN000165A02	Shroud,Black
X	X	X	X	32012156001	O-ring, Main
X	X	X	X	PMLN7227_	Assembly, Main Board (7_800)*
X	X	X	X	7515719H02	Pad, Thermal, RF PA
X	X	X	X	43012045001	Collar, Plastic
X	X	X	X	6071520M01	Coin Cell
X	X	X	X	0104063J03	Assembly, Flex, Back-kit
X	X	X	X	0104046J48	Assembly, Shield, Secondary
X	X	X	X	0386104Z04	Screw, Chassis
X	X	X	X	3286058L01	Seal, Vacuum Port
X	X	X	X	5478220A01	Label, Ventilation
X	X	X	X	LB000084A01	Label, Front
●		●		LB000238A01	Label, Back, APX4000
●		●		LB000238A02	Label, Back, APX4000R
	●		●	LB000238A03	Label, Back, APX2000
	●		●	LB000238A04	Label, Back, APX2000R
X	X	X	X	LB000073A01	Label, Bottom, Blank
O		O		LB000073A02	Label, Bottom, UL(APX4000, APX4000R)
	O		O	LB000073A03	Label, Bottom, UL(APX2000, APX2000R)
●	●	●	●	LB000085A01	Label, Reflective
X	X	X	X	HW000256A01	Volume Knob
X	X	X	X	HW000254A01	Channel Knob
X	X	X	X	SL000106A01	Torque Adder
X	X	X	X	FN000083A01	screw, Top bezel
X	X	X	X	KP000014A01	Monitor button
X	X	X	X	FN000080A01	Nut, Volume Switch Spanner

ASTRO APX 2000/ APX 4000 (Two Knobs) 700/800 MHz Model Chart (Continued)

MODEL DESCRIPTION:					764–870 MHz,APX 4000_2000
FCC ID:					AZ489FT7049
H51UCF9PW6AN					APX 4000 Model 2 7/800
	H52UCF9PW6AN				APX 2000 Model 2 7/800
		H51UCH9PW7AN			APX 4000 Model 3 7/800
			H52UCH9PW7AN		APX 2000 Model 3 7/800
				ITEM NUMBER	DESCRIPTION
●	●	●	●	HN000161A01	Bezel, Top Control (Yellow)
●	●	●	●	HN000161A02	Bezel, Top Control (Black)
●	●	●	●	HN000164A01	Accessory-Connector Cover, Yellow
●	●	●	●	HN000164A02	Accessory-Connector Cover, Black
X	X	X	X	PMLN5997_	User Guide CD, APX2000 and APX4000

Note:
X *= Item Included.*
• *Option available. Can be serviced in depot and ordered thru AAD.*
O *Option available. Can be serviced in depot and orderable by UL qualified customers/dealers only. For APAC – Only UL label can be replaced and purchased by Motorola.*
• *Refer* Appendix A for antennas, batteries and other applicable accessories.
* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a Model 1.5, 2 or 3 radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4012B or PMKN4013C) and the CPS to read a Model 1.5, II, or III radio.*

Specifications for APX 2000/ APX 4000 (Two Knobs) VHF Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap:**	NNTN8129_*
or **Li-Ion High Cap:**	PMNN4424_
or **IMPRES Li-Ion High Cap Battery (TIA4950):**	NNTN8560_
* FM Intrinsically Safe.	
Dimensions (H x W x D):	
Without Battery (Radio Only):	H = 5.42" (137.7 mm) W[1] = 2.62" (66.55 mm)/ 2.42" (61.4 mm) D[2] = 0.82" (20.90mm)/ 1.41" (35.75 mm)
With Standard Battery:	H = 5.42" (137.7 mm) W[1] = 2.62" (66.55 mm)/ 2.42"(61.4 mm) D[2] = 1.54"(39.10 mm)/ 1.73" (44.02 mm)
With High Cap Battery/ IMPRESS High Cap Battery (TIA4950):	H = 5.42" (137.7 mm) W[1] = 2.62" (66.55 mm)/ 2.42" (61.4 mm) D[2] = 1.75" (44.40 mm)/ 1.94" (49.32 mm)
Note:	H = Height; W = Width; D = Depth 1 = (Width @ Top) / (Width @ PTT) 2 = (Depth @ Bottom) / (Depth @ PTT)
Weight: (w/o antenna):	
Less Battery:	10.05 oz (285g)
With Li-Ion Standard:	15.34 oz (435g)
With Li-Ion High Cap:	15.70 oz (445g)
With IMPRES Li-Ion High Cap Battery (TIA4950):	17.46 oz (495g)

RECEIVER

Frequency Range:	136–174 MHz
Bandwidth:	38 MHz
Analog Sensitivity (typical) (12 dB SINAD):	0.216μV
Digital Sensitivity (typical)	
(1% BER):	0.285 μV
(5% BER):	0.188 μV
Intermodulation (typical):	-79 dB
Selectivity (typical):	
(25 kHz Channel):	-79.3 dB
(12.5 kHz Channel):	-70 dB
Spurious Rejection (typical):	-80.3 dB
Frequency Stability (-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	25 kHz -53.8 dB 12.5 kHz -47 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	136–174 MHz
RF Power:	
136–174 MHz:	1–5 W
Frequency Stability (typical) (-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical) (Companion Receiver):	25 kHz -51 dB 12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz 20 kHz chnls ±4.0 kHz 12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc 12.5 kHz -68 dBc
Emissions Designators:	11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 20K0F1E

Specifications subject to change without notice.

Specifications for APX 2000/ APX 4000 (Two Knobs) UHF1 Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap:**	NNTN8129_*
or **Li-Ion High Cap:**	PMNN4424_
or **IMPRES Li-Ion High Cap Battery (TIA4950):**	NNTN8560_

* FM Intrinsically Safe.

Dimensions (H x W x D):

Without Battery (Radio Only):
H = 5.42" (137.7 mm)
W[1] = 2.62" (66.55 mm)/ 2.42" (61.4 mm)
D[2] = 0.82" (20.90mm)/ 1.41" (35.75 mm)

With Standard Battery:
H = 5.42" (137.7 mm)
W[1] = 2.62" (66.55 mm)/ 2.42"(61.4 mm)
D[2] = 1.54"(39.10 mm)/ 1.73" (44.02 mm)

With High Cap Battery/ IMPRESS High Cap Battery (TIA4950):
H = 5.42" (137.7 mm)
W[1] = 2.62" (66.55 mm)/ 2.42" (61.4 mm)
D[2] = 1.75" (44.40 mm)/ 1.94" (49.32 mm)

Note:
H = Height; W = Width; D = Depth
1 = (Width @ Top) / (Width @ PTT)
2 = (Depth @ Bottom) / (Depth @ PTT)

Weight: (w/o antenna):	
Less Battery:	10.05 oz (285g)
With Li-Ion Standard:	15.34 oz (435g)
With Li-Ion High Cap:	15.70 oz (445g)
With IMPRES Li-Ion High Cap Battery (TIA4950):	17.46 oz (495g)

RECEIVER

Frequency Range:	380–470 MHz
Bandwidth:	90 MHz
Analog Sensitivity (typical) (12 dB SINAD):	0.234 µV
Digital Sensitivity (typical)	
(1% BER):	0.307 µV
(5% BER):	0.207 µV
Intermodulation (typical):	-77 dB
Selectivity (typical):	
(25 kHz Channel):	-77 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-80.3 dB
Frequency Stability (-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	25 kHz -50 dB 12.5 kHz -45 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	380–470 MHz
RF Power:	
380–470 MHz:	1–5 W
Frequency Stability (typical) (-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical) (Companion Receiver):	25 kHz -51 dB 12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz 20 kHz chnls ±4 kHz 12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc 12.5 kHz -68 dBc
Emissions Designators:	11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 20K0F1E

Specifications subject to change without notice.

Specifications for APX 2000/ APX 4000 (Two Knobs) UHF2 Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1960 mA
Receive Current Drain (Rated Audio):	293 mA
Standby Current Drain:	133 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap:**	NNTN8129_*
or **Li-Ion High Cap:**	PMNN4424_
or **IMPRES Li-Ion High Cap Battery (TIA4950):**	NNTN8560_
* FM Intrinsically Safe.	
Dimensions (H x W x D):	
Without Battery (Radio Only):	
H = 5.42" (137.7 mm)	
W[1] = 2.62" (66.55 mm)/ 2.42" (61.4 mm)	
D[2] = 0.82" (20.90mm)/ 1.41" (35.75 mm)	
With Standard Battery:	
H = 5.42" (137.7 mm)	
W[1] = 2.62" (66.55 mm)/ 2.42"(61.4 mm)	
D[2] = 1.54"(39.10 mm)/ 1.73" (44.02 mm)	
With High Cap Battery/ IMPRESS High Cap Battery (TIA4950):	
H = 5.42" (137.7 mm)	
W[1] = 2.62" (66.55 mm)/ 2.42" (61.4 mm)	
D[2] = 1.75" (44.40 mm)/ 1.94" (49.32 mm)	
Note: H = Height; W = Width; D = Depth 1 = (Width @ Top) / (Width @ PTT) 2 = (Depth @ Bottom) / (Depth @ PTT)	
Weight: (w/o antenna):	
Less Battery:	10.05 oz (285g)
With Li-Ion Standard:	15.34 oz (435g)
With Li-Ion High Cap:	15.70 oz (445g)
With IMPRES Li-Ion High Cap Battery (TIA4950):	17.46 oz (495g)

RECEIVER

Frequency Range:	450–520 MHz
Bandwidth:	70 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.234 μV
Digital Sensitivity (typical)	
(1% BER):	0.307 μV
(5% BER):	0.207 μV
Intermodulation (typical):	-77 dB
Selectivity (typical):	
(25 kHz Channel):	-77 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-80 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	25 kHz -53.5 dB 12.5 kHz -47.4 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	450–520 MHz
RF Power:	
450–520 MHz:	1–5 W
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -51 dB 12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5.0 kHz 20 kHz chnls ±4 kHz 12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -73 dBc 12.5 kHz -68 dBc
Emissions Designators:	11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 20K0F1E

Specifications subject to change without notice.

Specifications for APX 2000/ APX 4000 (Two Knobs) 700/800 MHz Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL

Temperature Range:	
Operating:	-30°C to +60°C
Storage:	-40°C to +85°C
Power Supply:	Lithium-Ion Battery (Li-Ion)
Battery Voltage:	
Nominal:	7.5 Vdc
Range:	6 to 9 Vdc
Transmit Current Drain (Typical):	1680 mA
Receive Current Drain (Rated Audio):	306 mA
Standby Current Drain:	137 mA
Recommended Battery:	
Li-Ion (Slim):	NNTN8128_
or **Li-Ion High Cap:**	NNTN8129_*
or **Li-Ion High Cap:**	PMNN4424_
or **IMPRES Li-Ion High Cap Battery (TIA4950):**	NNTN8560_
* FM Intrinsically Safe.	

Dimensions (H x W x D):

Without Battery (Radio Only):
H = 5.42" (137.7 mm)
W[1] = 2.62" (66.55 mm)/ 2.42" (61.4 mm)
D[2] = 0.82" (20.90mm)/ 1.41" (35.75 mm)

With Standard Battery:
H = 5.42" (137.7 mm)
W[1] = 2.62" (66.55 mm)/ 2.42"(61.4 mm)
D[2] = 1.54"(39.10 mm)/ 1.73" (44.02 mm)

With High Cap Battery/ IMPRESS High Cap Battery (TIA4950):
H = 5.42" (137.7 mm)
W[1] = 2.62" (66.55 mm)/ 2.42" (61.4 mm)
D[2] = 1.75" (44.40 mm)/ 1.94" (49.32 mm)

Note:
H = Height; W = Width; D = Depth
1 = (Width @ Top) / (Width @ PTT)
2 = (Depth @ Bottom) / (Depth @ PTT)

Weight: (w/o antenna):	
Less Battery:	10.05 oz (285g)
With Li-Ion Standard:	15.34 oz (435g)
With Li-Ion High Cap:	15.70 oz (445g)
With IMPRES Li-Ion High Cap Battery (TIA4950):	17.46 oz (495g)

RECEIVER

Frequency Range:	
700 MHz:	764–776 MHz
800 MHz:	851–870 MHz
Bandwidth:	
700 MHz:	12 MHz
800 MHz:	19 MHz
Analog Sensitivity (typical)	
(12 dB SINAD):	0.266 μV
Digital Sensitivity (typical)	
(1% BER):	0.400 μV
(5% BER):	0.266 μV
Intermodulation (typical):	-75 dB
Selectivity (typical):	
(25 kHz Channel):	-76 dB
(12.5 kHz Channel):	-67 dB
Spurious Rejection (typical):	-76.6 dB
Frequency Stability	
(-30+60°C; 25°C reference):	±0.0001%
Rated Audio:	
Internal Speaker:	500 mW
External Speaker:	500 mW
FM Hum and Noise (typical):	25 kHz -53 dB 12.5 kHz -47 dB
Distortion (typical):	1 %
Channel Spacing:	12.5/25 kHz

TRANSMITTER

Frequency Range:	
700 MHz:	764–776; 794–806 MHz
800 MHz:	806–825; 851–870 MHz
RF Power:	
700 MHz:	1–2.7 Watts
800 MHz:	1–3.0 Watts
Frequency Stability (typical)	
(-30 to +60°C; 25°C ref.):	
700 MHz:	±0.0001%
800 MHz:	±0.0001%
Emission (typical conducted):	-75 dBc
FM Hum and Noise (typical)	
(Companion Receiver):	25 kHz -50 dB 12.5 kHz -45 dB
Distortion (typical):	1%
Modulation Limiting:	25 kHz chnls ±5 kHz 20 kHz chnls ±4 kHz 12.5 kHz chnls ±2.5 kHz
ACPR (typical):	25 kHz -72 dBc 12.5 kHz -66 dBc
Emissions Designators:	11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 20K0F1E

Specifications subject to change without notice.

Chapter 1 Introduction

This manual contains information needed for Levels One and Two radio servicing. Level One servicing consists of radio programming, radio alignment, knobs replacement, and installation and removal of the antenna, belt clip, battery, and universal connector cover. Level Two servicing covers disassembly and reassembly of the radio to replace circuit boards.

1.1 Manual Contents

Included in this manual is radio specification for the VHF (136–174 MHz), UHF1 (380–470 MHz), UHF2 (450–520 MHz) and 700/800 MHz (764–870 MHz) frequency bands, a general description of ASTRO APX 2000/ APX 4000 (Two Knobs) models, recommended test equipment, service aids, radio alignment procedures, general maintenance recommendations, procedures for assembly and disassembly, and exploded views and parts lists.

1.2 Notations Used in This Manual

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

NOTE: An operational procedure, practice, or condition that is essential to emphasize.

Caution

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

WARNING

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

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or injury.

1.3 Radio Description

The ASTRO APX 2000/ APX 4000 (Two Knobs) radio provides improved voice quality across more coverage area. The digital process, called *embedded signaling*, intermixes system signaling information with digital voice, resulting in improved system reliability and the capability of supporting a multitude of advanced features.

ASTRO APX 2000/ APX 4000 (Two Knobs) radios are available in Single Display configuration. Table 1-1 describes their basic features.

Table 1-1. ASTRO APX 2000/ APX 4000 (Two Knobs) Basic Features

Feature	Limited Keypad (Model 2)	Full Keypad (Model 3)
Display	• Full bitmap color LCD display • 3 lines of text x 14 characters • 1 line of icons • 1 menu line x 3 menus • White backlight	• Full bitmap color LCD display • 3 lines of text x 14 characters • 1 line of icons • 1 menu line x 3 menus • White backlight
Keypad	• Backlight keypad • 3 soft keys • 4 direction Navigation key • Home and Data buttons	• Backlight keypad • 3 soft keys • 4 direction Navigation key • 4x3 keypad • Home and Data buttons
Channel Capability	512	512
FLASHport Memory	64MB	64MB

NOTE: * Only applicable for APX 2000.

1.4 FLASHport®

The ASTRO APX 2000/ APX 4000 (Two Knobs) radio utilizes Motorola's FLASHport technology. FLASHport makes it possible to add software that drives the radio's capabilities both at the time of purchase and later on. Previously, changing a radio's features and capabilities meant significant modifications or buying a new radio. But now, similar to how a computer can be loaded with different software, the radio's features and capabilities can be upgraded with FLASHport software.

Chapter 2 Basic Maintenance

This chapter describes the preventive maintenance and handling precautions. Each of these topics provides information vital to the successful operation and maintenance of the radio.

2.1 General Maintenance

In order to avoid operating outside the limits set by the FCC, align the ASTRO APX 2000/ APX 4000 (Two Knobs) radio's reference oscillator every time the radio is taken apart, or once per year, whichever comes first. (See Section 6.5.1). Periodic visual inspection and cleaning is also recommended.

2.1.1 Inspection

Check that the external surfaces of the radio are clean and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed.

2.1.2 Cleaning

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

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water.

Caution

Use all chemicals as prescribed by the manufacturer. Be sure to 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. Aerosol sprays, tuner cleaners, and other chemicals should be avoided.

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

2.2 Safe Handling of CMOS and LDMOS Devices

Complementary metal-oxide semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) devices, and other high-technology devices, are used in this family of radios. While the attributes of these devices are many, their characteristics make them susceptible to damage by electrostatic discharge (ESD) 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 this radio, and are especially important in low-humidity conditions.

Caution

- The APX 2000/ APX 4000 (Two Knobs) radio has a vent port that allows for pressure equalization in the radio. Never poke this vent with any objects, such as needles, tweezers, or screwdrivers. This could create a leak path into the radio and the radio's submergibility will be lost.
- The pressure equalization vent is located adjacent to the battery contact opening of the main chassis. Never touch the equalization vent. Ensure that no oily substances come in contact with this vent.
- The APX 2000/ APX 4000 (Two Knobs) radio is designed to be submerged to a maximum depth of six (6) feet, with a maximum submersion time of 2 hours per U.S. MIL-STD. Exceeding either maximum limit may result in damage to the radio.

If the radio battery contact area has been submerged in water, dry and clean the radio battery contacts before attaching a battery to the radio. Otherwise, the water could short-circuit the radio.

If the radio has been submerged in water, shake the radio briskly so that any water that is trapped inside the speaker grille and microphone port can be removed. Otherwise, the water will decrease the audio quality of the radio.

Chapter 3 Basic Theory of Operation

This chapter discusses the basic operational theory of the ASTRO APX 2000/ APX 4000 (Two Knobs) radio. The ASTRO APX 2000/ APX 4000 (Two Knobs) radio, which is a single-band synthesized radio, is available in the following frequency bands.

- VHF (136–174 MHz)
- UHF1 (380–470 MHz)
- UHF2 (450–520 MHz)
- 700/800 MHz (764–870 MHz).

And the ASTRO APX 2000 M1.5 is available in the following frequency bands.

- VHF (136–174 MHz)
- UHF1 (380–470 MHz)
- UHF2 (450–520 MHz)
- 700/800 MHz (764–870 MHz)

All ASTRO APX 2000/ APX 4000 (Two Knobs) radios are capable of analog operation (12.5 kHz or 25 kHz bandwidths), ASTRO mode (digital) operation (12.5 kHz only), X2-TDMA mode (25 kHz only) and Phase 2 TDMA mode (12.5 kHz only).

NOTE: The APX 2000 M1.5 radio do not support any Global Positioning System (GPS), Bluetooth, MACE and Accelerometer functions. As such, disregard all references to the functions mentioned above in “Chapter 3 Basic Theory of Operation”.

3.1 Major Assemblies

The ASTRO APX 2000/ APX 4000 (Two Knobs) radio includes the following major assemblies (See Figure 3-1.):

- **Main Board –** Contains all transmit, receive, and frequency generation circuitry, including the digital receiver back-end IC and the reference oscillator. The main board also contains a dual core processor, which includes both the microcontroller unit (MCU) and a digital signal processor (DSP) core, the processors's memory devices, an audio and power supply support integrated circuit (IC), a digital support IC, external power amplifier as well as combination Global Positioning System (GPS) and Bluetooth 2.1 IC and front end circuitry.
- **Keypad Board** – Contains a Type III secure IC, Bluetooth controller (AVR IC) and a 3-axes digital accelerometer.
- **Control Top** – Contains a Multi-Function knob, a push button switch used for Emergency call and a light bar. The control top also includes TX/RX LED that is solid amber upon receive, red on PTT, and blinks amber on secure TX/RX.
- **Main Display** – 160 pixels x 90 pixels, transflective color LCD.
- **Keypad**
  - Limited Keypad Version has 3 soft keys, 4 direction Navigation key, Home and Data buttons
  - Full Keypad Version has 3 soft keys, 4 direction Navigation key, 3x4 alphanumeric keypad, Home and Data buttons.

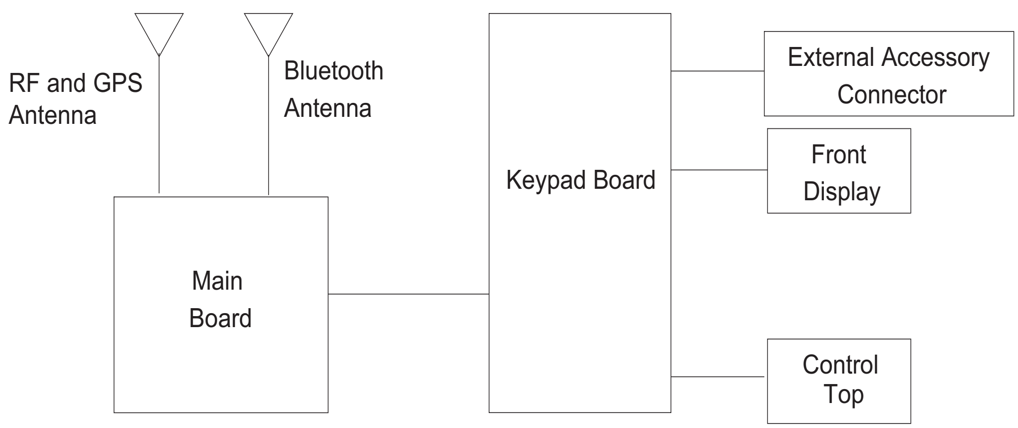

Figure 3-1. APX 2000/ APX 4000 (Two Knobs) Overall Block Diagram

3.2 Analog Mode of Operation

This section provides an overview of the analog mode receive and transmit theory of operation.

3.2.1 Receiving

The RF signal is received at the antenna and is routed through the Harmonic Filter, followed by the antenna Switch and finally the 15dB Step Attenuator IC. The latter contains a switchable attenuator that is enabled at predetermined RF power thresholds present at the antenna port. See Figure 3-2., Figure 3-3 and Figure 3-4.

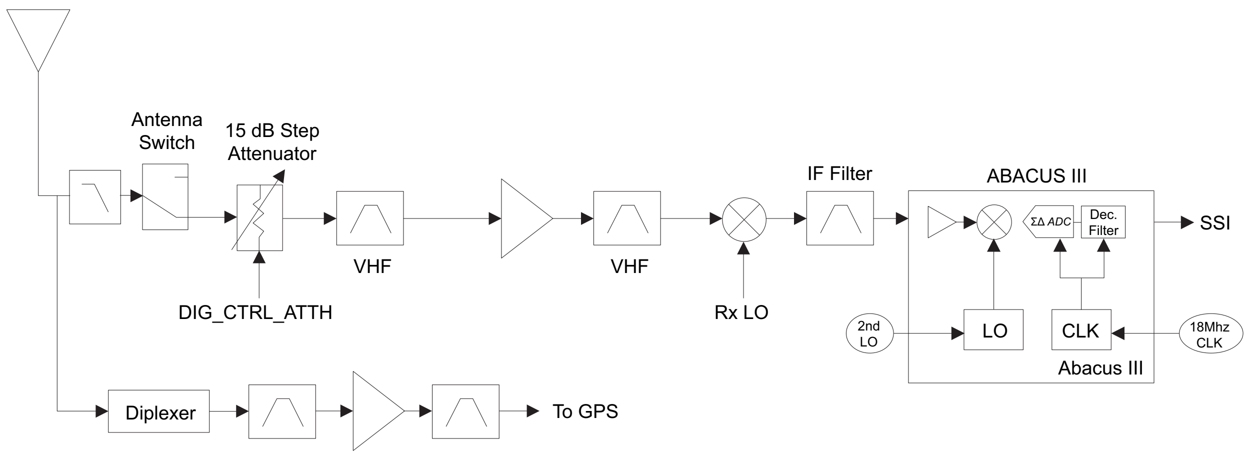

Figure 3-2. Receiver Block Diagram (VHF)

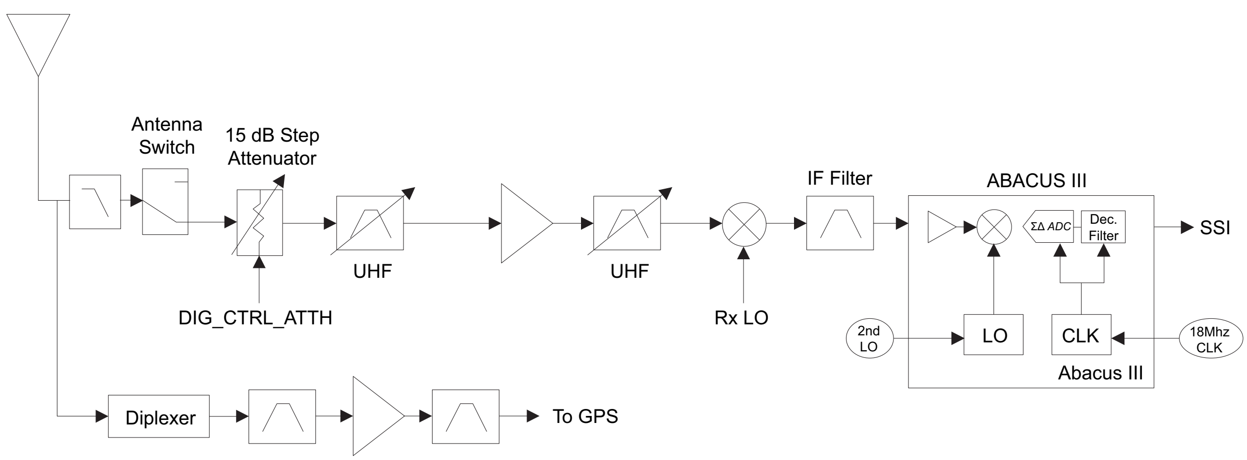

Figure 3-3. Receiver Block Diagram (UHF1/UHF2)

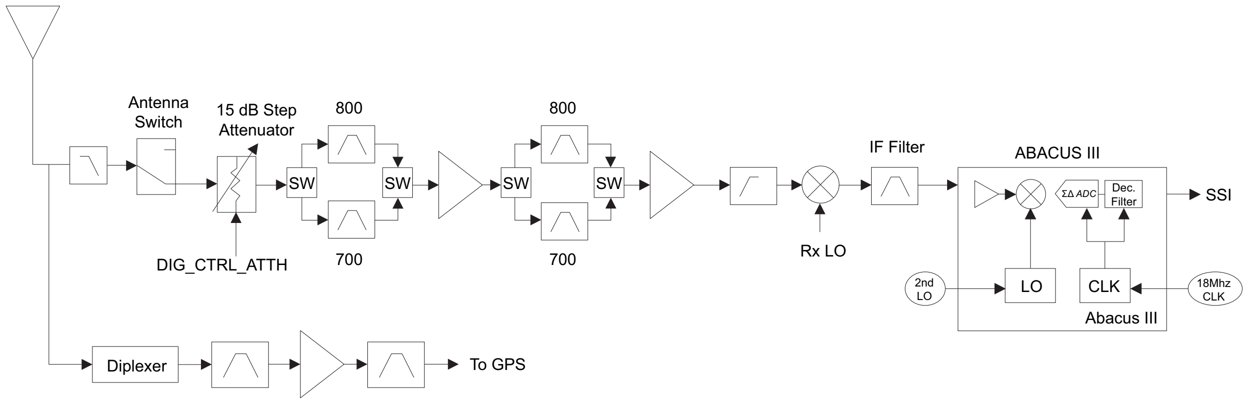

Figure 3-4. Receiver Block Diagram (700/800 MHz)

3.2.1.1 GPS

The GPS signal is tapped at the antenna port via a series resonant network (diplexer) which provides a very low capacitive load to the transceiver. The diplexer circuitry provides rejection to radio band signals up to ~1GHz which serves as isolation between the radio RF and GPS signal paths. The GPS signal is filtered though a GPS SAW filter - LNA – Saw filter chain before going into the TI GPS IC for processing.

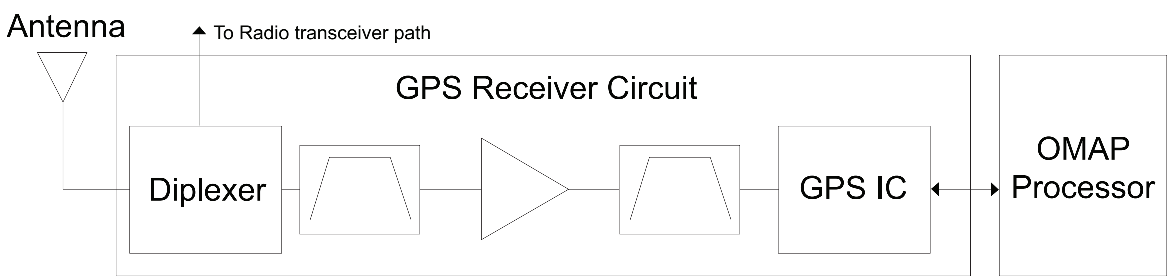

Figure 3-5. GPS Diagram

3.2.1.2 VHF Front-End

From the 15 dB Step Attenuator, a VHF signal is routed to the first pre-selector filter followed by an LNA and a second pre-selector filter. Both filters are discrete and tunable designs and are used to band limit the incoming energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the second pre-selector filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.3 UHF1/UHF2 Front-End

From the 15 dB Step Attenuator, a UHF1/UHF2 signal is routed to the first pre-selector filter followed by an LNA and a second pre-selector filter. Both filters are discrete and tunable designs and are used to band limit the incoming energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the second pre-selector filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.4 700/800 MHz Front-End

From the 15 dB Step Attenuator, a 700/800 MHz band signal is routed to the first band SPST switch which selects the 700 or the 800 band signal and routes it to the appropriate first pre-selector filter. A second band select switch selects the output of the appropriate filter and applies it to an LNA followed by a similar pre-selector filter/ band-select switch circuit. The signal is then routed to a second LNA whose output is applied to a discrete image filter. Both preselector filters are Surface Acoustic Wave designs used to band limit the received energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the discrete image filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.5 Analog To Digital Converter

The ADC IC's front end down converts the first IF to a second IF, a 2.25 MHz signal. The second IF is sampled at 18 MHz, a signal generated by an integrated clock synthesizer. The sampled signal is decimated by a factor of 900 to 20 kHz and converted to SSI format at the ADC's output. The Serial Synchronous Interface (SSI) serial data waveform is composed of a 16 bit in-phase word (I) followed by a 16 bit Quadrature word (Q). A 20 kHz Frame Synch and a 1.2 MHz clock waveform are used to synchronize the SSI IQ data transfer to the Digital Signal Processor IC (OMAP) for post-processing and demodulation.

3.2.2 Transmitting

When the radio is transmitting, microphone audio is digitized and then processed by the DSP and sent to the Trident IC (see Figure 3-6, Figure 3-7 and Figure 3-8) via the SSI interface. The Trident IC processes the SSI data for application to the voltage controlled oscillator as a modulation signal.

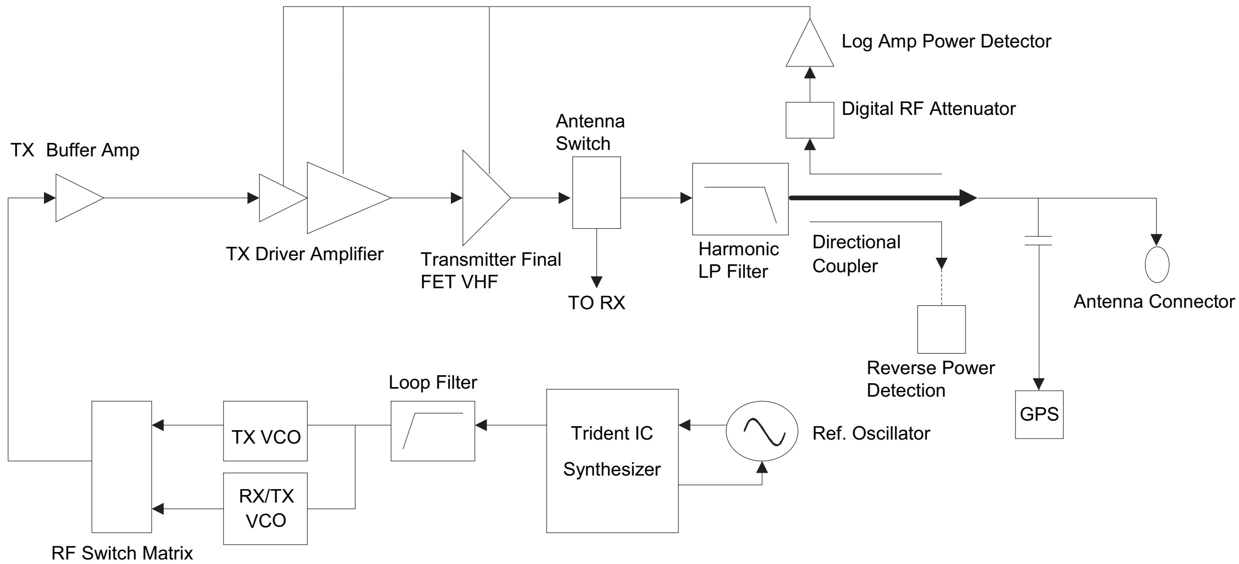

Figure 3-6. Transmitter (VHF) Block Diagram

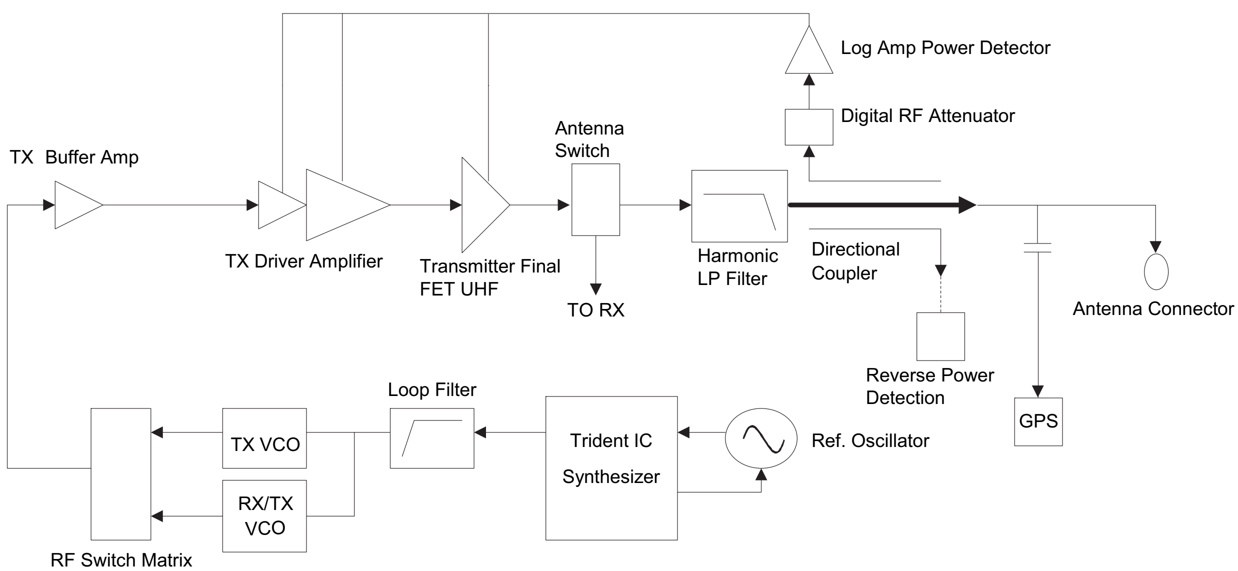

Figure 3-7. Transmitter (UHF1/UHF2) Block Diagram

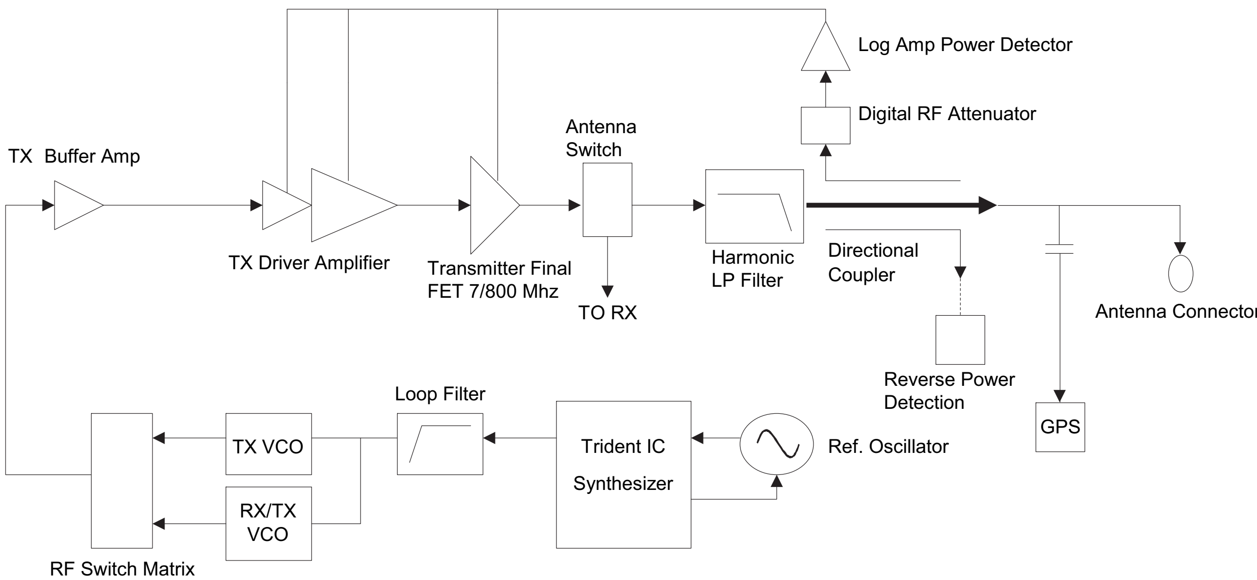

Figure 3-8. Transmitter (700/800 MHz) Block Diagram

3.2.2.1 VHF Transmit

Once a VHF frequency for transmit has been selected, the Trident IC and the accompanying logic circuitry will enable the voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the VHF Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The Log Amp power detector Monitors the output of the directional coupler and adjusts the control voltages to the driver amplifier and final power amplifier. Finally, the RF signal is routed to the main antenna.

3.2.2.2 UHF1/UHF2 Transmit

Once a UHF frequency for transmit has been selected, the Trident IC and the accompanying logic circuitry will enable the voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the UHF1/UHF2 Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The Log Amp power detector Monitors the output of the directional coupler and adjusts the control voltages to the driver amplifier and final power amplifier. Finally, the RF signal is routed to the main antenna.

3.2.2.3 700/800 MHz Transmit

Once a 700/800 MHz frequency for transmit has been selected, the Trident IC and accompanying logic circuitry enable the correct voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the 7800 Driver amplifier and then to the discrete final power amplifier. The signal now goes through the antenna switch which routes the power to the harmonic filter which will filter out the harmonics of the carrier signal and then passes through a directional coupler. The Log Amp power detector Monitors the output of the directional coupler and adjusts the control voltages to the driver amplifier and the discrete final power amplifier. Finally, the RF signal is routed to the main antenna.

3.3 Digital (ASTRO) Mode of Operation

In the ASTRO (digital) mode of operation, the transmitted or received signal is limited to a discrete set of frequency deviation levels. The receiver handles an ASTRO-mode signal identically to an analog-mode signal, up to the point where the DSP decodes the received data. In the ASTRO receive mode, the DSP uses a different algorithm to recover data.

In the ASTRO transmit mode, microphone audio is processed identically to an analog mode, with the exception of the algorithm the DSP uses to encode the information. Using this algorithm, transmitter FM deviation is limited to discrete levels.

3.4 Controller Section

The controller section (See Figure 3-9.) comprises of five functional sections that are split among two boards, which are the main and keypad boards. The main functional section consists of a dual core ARM and DSP controller, an encryption processor (MACE), Flash memory, and a Double Data Rate Synchronous Dynamic Random Access Memory (DDR SDRAM) and CPLD for GPIO expander multiple clock generation and SSI interface for the radio system. The Power and Clocks section includes a power management IC (MAKO) and various external switching regulators, and three clock sources (12 MHz and 24.576 MHz) from which all other controller digital clocks are derived. The Audio section has a CODEC and a class-D audio power amplifier that provides the radio with a microphone and speaker design. The User Interface section provides communication and control to the main Liquid Crystal Displays (LCD) on the radio, as well as a keypad and a side connector interface conforming to GCAI (Global Communications Accessory Interface) specifications. The GPS and Bluetooth section comprises of a Global Positioning Satellite(GPS) and Bluetooth combo chipset on the main board, and an AVR Bluetooth controller IC, SDRAM, LF wakeup IC and Accelerometer IC on the keypad board. The MACE IC is located on the keypad board.

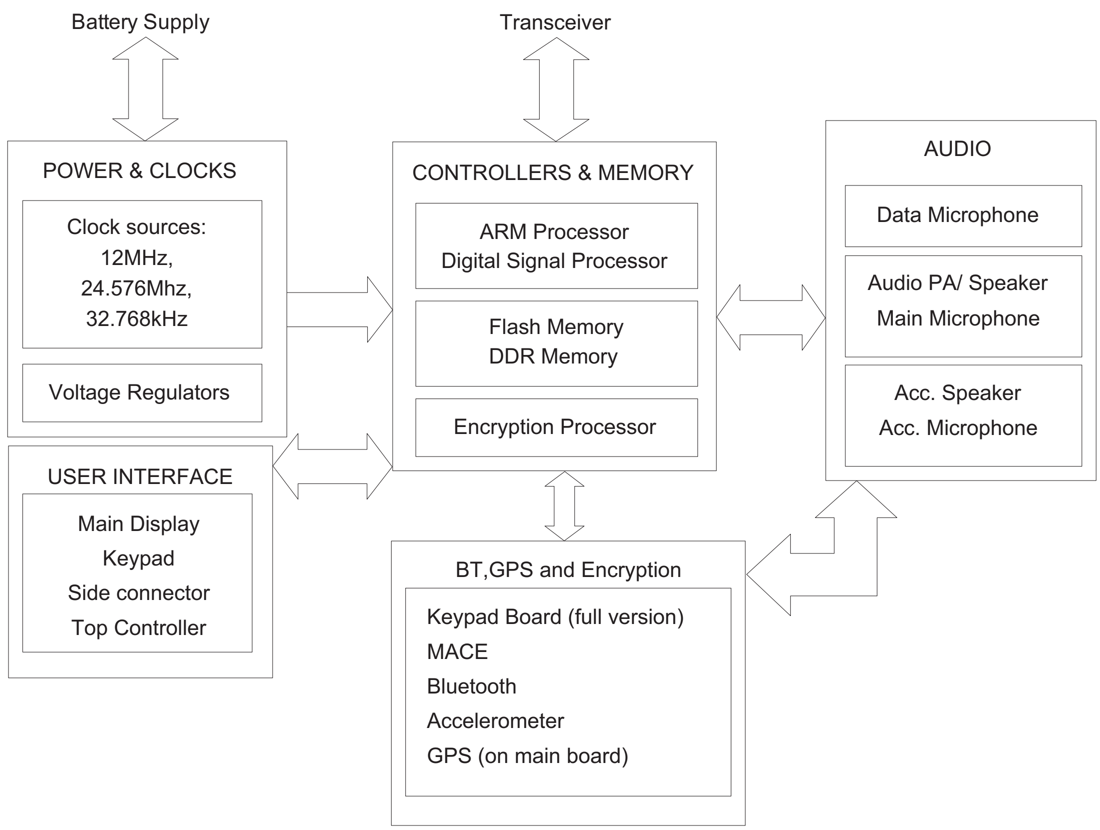

Figure 3-9. Controller Block Diagram

The ARM controller core of the OMAP processor handles the power up sequence of all devices, including firmware upgrades, and all operating system tasks that are associated with FLASH and SDRAM memories and user interface communication. The FLASH memory (64 MB) is required to store the firmware, tuning, and Codeplug settings, which upon initialization get read and stored into SDRAM (32MB) for execution. The ARM and DSP core jointly control and configure audio, wireless and RF devices linked to the Serial Peripheral Interface (SPI) and Synchronous Serial Interface (SSI) buses to enable radio FM and optional wireless communication protocols. For encryption, a separate ARM processor is used (MACE) to encode and decode encryption packets coming in from the main OMAP processor through the SSI interface. Its firmware is flashed via the main processor during an upgrade request to its internal FLASH memory. The MACE encryption processor is located on the keypad board.

The power and most clocks to the controller devices are provided by the MAKO IC and external switching and linear regulators on board. A Complex Programmable Logic Array (CPLD) IC divides the 24.576 MHz clock from MAKO to source OMAP's 32 kHz Real Time Clock, and MACE's 4 MHz main clock. OMAP's main clock is supplied externally from an on board 12 MHz crystal.

The radio has two internal microphones and an internal speaker, as well as available microphone and speaker connections for external accessories. The internal 4 Ohm speaker is located on the same side as the main display and keypad of the radio. The internal speaker is driven by a Class D audio amplifier located on the main board that is capable of delivering a rated power of 0.5 W. The external accessory speaker is driven by a Class AB audio amplifier on the MAKO IC that is capable of delivering 0.5 W of power into a 16 Ohm as a minimum load. Both speaker paths use the CODEC for volume control and to convert the audio signal from digital to analog. Both internal and external microphones use the CODEC's ADC to deliver digital audio samples to the DSP controller.

The user interface block consists of a main display, a keypad, top controls and the accessory side connector. The side connector (Universal Connector) provides audio, USB, RS232 communication for accessories. All signals to and from the connector go through the internal keypad board before reaching the microcontroller and other devices on the main board.

The radio also has integrated feature of Global Positioning System (GPS) and Bluetooth with Man-down feature (depending on radio model) (see Figure 3-10). The GPS and Bluetooth Combo RF chipset (NL5500) is located on the Main board together with the GPS/RF Diplexer circuitry and Bluetooth Front-End circuitry. The GPS receiver section of the GPS/BT combination IC interfaces with the OMAP processor through a dedicated UART port. The GPS receiver also has a dedicated reset controlled solely by the OMAP processor. The GPS/Bluetooth IC (NL5500) taps the GPS signal from transceiver path and processes the location information before relaying to the OMAP processor via UART lines. The clock supplies to NL5500 included a 26MHz TCXO and 32kHz clock from CPLD.

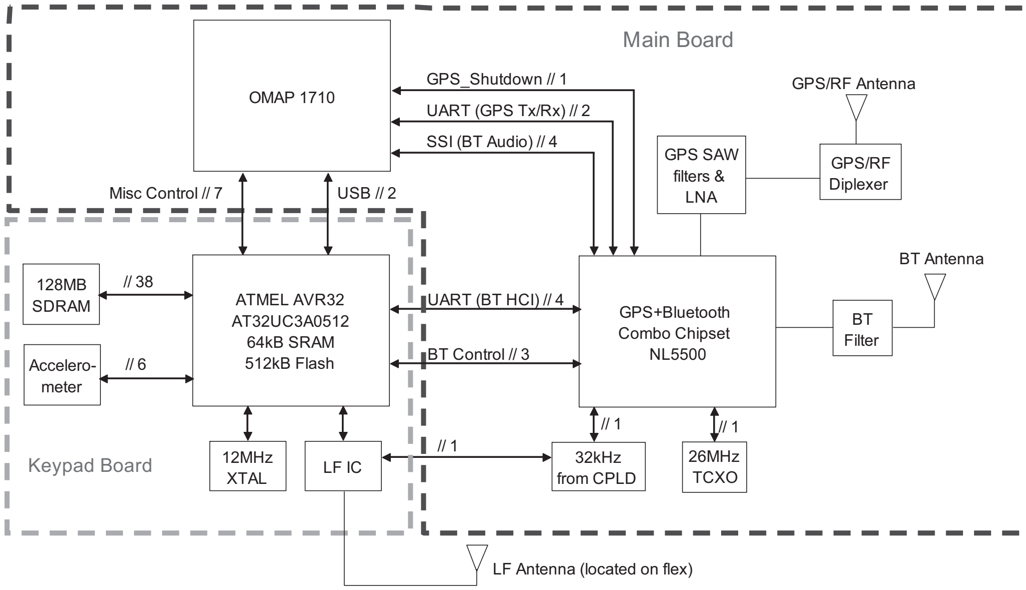

Figure 3-10. GPS/Bluetooth/Accelerometer Block Diagram

3.4.1 Radio with Mace Expanded Keypad Board

In addition to the Mace features, the Expanded Keypad Board consists of a 3-axes digital accelerometer and the Bluetooth Controller IC (AVR) together with LF Wakeup IC (AS3930A) for Secure Pairing.

The radio also has the ability to connect to a wireless Bluetooth audio headset. This feature is implemented using a combination Bluetooth/GPS integrated circuit (NL5500 IC) located on the Main board. An optional accessory headset can connect using a low-data rate GFSK modulated signal hopping on 79 x 1 MHz wide Bluetooth channels from 2402 MHz to 2480 MHz in the ISM band. Each APX accessory that is capable of Bluetooth communication will have its own unique Bluetooth address. Bluetooth uses a frequency hopping spread spectrum (FHSS) technique to spread the RF power across the spectrum to reduce the interference and spectral power density. The frequency hopping allows the channel to change up to 1600 times a second (625 µs time slot) based on a pseudo random sequence. If a packet is not received on one channel, the packet will be retransmitted on another channel. The Bluetooth IC sends data to the AVR32 processor that is also located on the keypad board over an HCI UART link. The AVR32 processor communicates to the OMAP processor on the main board through a dedicated USB port.

The Bluetooth feature is accompanied by a Low-Frequency (LF) detection circuit that is also located on the keypad board. The LF circuit provides the ability of a secure pairing connection with a Bluetooth accessory. Once a radio has the Bluetooth feature enabled, a user can tap their LF enabled Bluetooth audio accessory with the radio at the pairing spot to establish a secure Bluetooth connection. The LF circuit uses a 125 kHz radiated signal to communicate the secure pairing information between the Bluetooth accessory and low-frequency receiver. The low-frequency receiver is programmed by the AVR32 processor through a dedicated SPI bus and transfers the pairing data through a dedicated UART.

There is a digital accelerometer on the keypad board that detects the 3-axis force of gravity which can be used to determine the radio's orientation. The accelerometer's position is communicated to the AVR32 processor through a SPI bus.

Chapter 4 Recommended Test Equipment and Service Aids

This chapter provides lists of recommended test equipment and service aids, as well as information on field programming equipment that can be used in servicing and programming ASTRO APX 2000/ APX 4000 (Two Knobs) radios.

4.1 Recommended Test Equipment

The list of equipment contained in Table 4-1 includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specifically for servicing this family of radios. The "Characteristics" column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola model listed is either a unique item or no substitution is recommended.

Table 4-1. Recommended Test Equipment

Equipment	Characteristics	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	General Dynamics R2670	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital RMS Multimeter *	100 µV to 300 V 5 Hz to 1 MHz 10 Mega Ohm Impedance	Fluke 179 or equivalent (www.fluke.com)	AC/DC voltage and current measurements. Audio voltage measurements
RF Signal Generator *	100 MHz to 1 GHz -130 dBm to +10 dBm FM Modulation 0 kHz to 10 kHz Audio Frequency 100 Hz to 10 kHz	Agilent N5181A (www.agilent.com), Ramsey RSG1000B (www.ramseyelectronics.com, or equivalent	Receiver measurements
Oscilloscope *	2 Channel 50 MHz Bandwidth 5 mV/div to 20 V/div	Leader LS8050 (www.leaderusa.com), Tektronix TDS1001b (www.tektronix.com), or equivalent	Waveform measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 9240 (www.boonton.com) or equivalent	Waveform measurements
Power Supply	0 V to 32 V 0 A to 20 A	B&K Precision 1790 (www.bkprecision.com) or equivalent	Voltage supply

4.2 Service Aids

Refer to Table 4-2 for a listing and description of the service aids designed specifically for servicing this family of radios. These kits and/or parts are available from the Radio Products and Solutions Organization offices listed in "Appendix B Replacement Parts Ordering". While all of these items are available from Motorola, most are standard shop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 4-2. Service Aids

Motorola Part Number	Description	Application
66012031001	Battery Adapter	Used in place of battery to connect radio to an external power supply.
NTN4265_	Pressure Pump Kit	For pressure test.
NLN9839_	Vacuum Pump Kit	Vacuum pump with gauge and vacuum hose.
5880384G68	SMA to BNC Adapter	Adapts radio's antenna port to BNC cabling of test equipment.
RVN5224_	Customer Programming Software (CPS) and Tuner Software	CPS allows customer-specific programming of modes and features. Tuner software required to perform alignment of radio parameters.
PMKN4012B	Programming Cable	To program the radio through Customer Programming Software and Tuner Software.
PMKN4013C	Programming/Service Cable	To program and service the radio through Customer Programming Software and Tuner Software.
RLN4460_	Portable Test Set	For radio performance checks. Connects to radio's universal connector and allows remote switching and signal injection/outputs for test equipment measurements.
PMLN7204A	Chassis/Knob Opener	To remove chassis and knob from housing.
TL000063A01	Volume Switch Spanner Nut opener	For Volume Switch Spanner Nut.
TL000059A01	Vacuum Test Fixture	To connect the vacuum/pressure hose of the Vacuum Pump Kit to the radio.
TL000061A01	Vacuum Cap	To enhance sealing when the vacuum test fixture is connected to the radio.
TL000062A01	Pressure test fixture	To connect the vacuum/pressure hose of the Pressure Pump Kit to the radio

NOTE: Do not place an order for the Programming Cable (PMKN4012A/PMKN4013B) as it is not compatible with the APX 2000/ APX 4000 (Two Knobs) radio.

4.3 Field Programming

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the online help in the Customer Programming Software (CPS) for complete field programming information.

Chapter 5 Performance Checks

This chapter covers performance checks used to ensure that the ASTRO APX 2000/ APX 4000 (Two Knobs) radio meets published specifications. The recommended test equipment listed in the previous section approaches the accuracy of the manufacturing equipment, with a few exceptions. Accuracy of the test equipment must be maintained in compliance with the manufacturer's recommended calibration schedule. Checks should be performed if radio performance degradation is suspected.

5.1 Test Equipment Setup

Supply voltage can be connected from the battery eliminator. The equipment required for the performance checks is connected as shown in Figure 5-1.

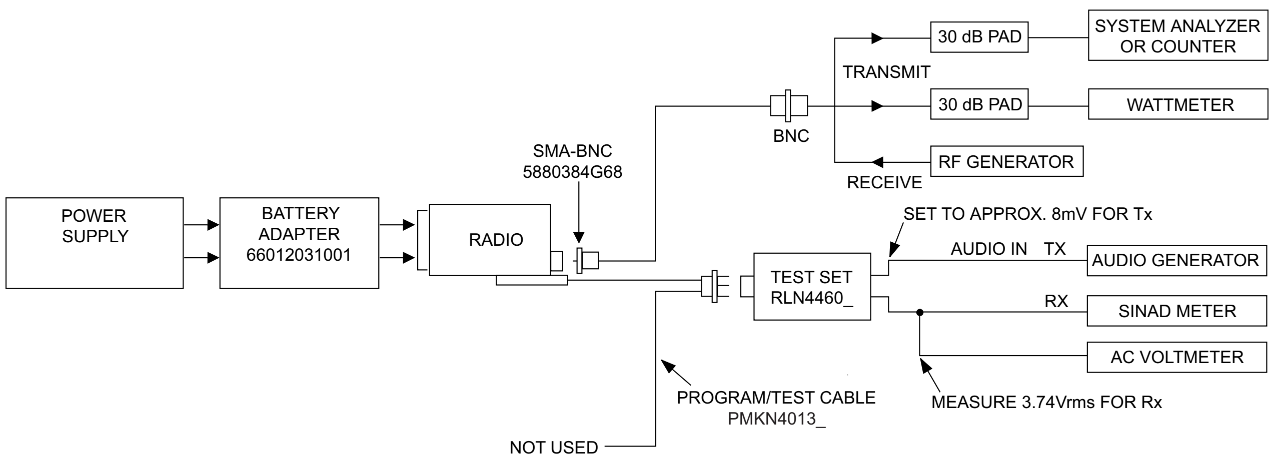

Figure 5-1. Performance Checks Test Setup

Initial equipment control settings should be as indicated in Table 5-1 and should be the same for all performance checks and alignment procedures, except as noted.

Table 5-1. Initial Equipment Control Settings

<table>
<tr><th>System Analyzer</th><th>Test Set</th><th>Power Supply</th></tr>
<tr><td>Monitor Mode: Standard*</td><td>Spkr/Load: Speaker</td><td>Voltage: 7.5 Vdc</td></tr>
<tr><td rowspan="4">Receiver Checks
RF Control: GEN
Output Level: -47 dBm
Modulation: 1 kHz tone @3 kHz deviation
Frequency: Set to selected radio RX frequency
Meter: AC Volts

Transmitter Checks
RF Control: Monitor
Frequency: Set to selected radio TX frequency
Meter: RF Display
Modulation Type: FM
Attenuation: 20 dB</td><td>PTT: OFF (center)</td><td>DC On/Standby: Standby</td></tr>
<tr><td>Meter Out: RX</td><td>Volt Range: 10 Vdc</td></tr>
<tr><td>Opt Sel: ON</td><td rowspan="2">Current: 2.5 Amps</td></tr>
<tr><td></td></tr>
</table>

* *Use "PROJ 25 STD" if testing ASTRO Conventional channels.*

5.2 Display Radio Test Mode

This section provides instructions for performing tests in display radio test mode.

5.2.1 Access the Test Mode

To enter the display radio test mode:

1. Turn the radio on.
2. Within 10 seconds, press **Side Button 2** five times in succession.

   The radio shows a series of displays that give information regarding various version numbers and subscriber specific information. The displays are described in Table 5-2.

Table 5-2. Test-Mode Displays

Name of Display	Description	Appears
Service	The literal string indicates the radio has entered test mode.	Always
Host version	The version of host firmware is displayed.	Always
DSP version	The version of DSP firmware is displayed.	Always
Secure version	Version of the encryption software	When the radio is secure equipped
KG1 algorithms name (Encryption Type 1)	Type of encryption being used	When the radio is secure equipped
KG2 algorithms name (Encryption Type 2)	Type of encryption being used	When the radio is secure equipped and 2 or more algorithms are loaded
KG3 algorithms name (Encryption Type 3)	Type of encryption being used	When the radio is secure equipped and 3 or more algorithms are loaded
KG4 algorithms name (Encryption Type 4)	Type of encryption being used	When the radio is secure equipped and 4 or more algorithms are loaded
KG5 algorithms name (Encryption Type 5)	Type of encryption being used	When the radio is secure equipped and 5 or more algorithms are loaded
KG6 algorithms name (Encryption Type 6)	Type of encryption being used	When the radio is secure equipped and 6 or more algorithms are loaded
Model number	The radio's model number, as programmed in the codeplug	Always
Serial number	The radio's serial number, as programmed in the codeplug	Always
ESN	The radio's unique electronic serial number	Always
ROM Size	The memory capacity of the host FLASH part	Always

Table 5-2. Test-Mode Displays (Continued)

Name of Display	Description	Appears
FLASHcode	The FLASH codes as programmed in the codeplug	Always
RF band 1	The radio's operating frequency	Always
Tuning Ver	Version of Tuning codeplug	Always
Proc Ver	Version of Processor	Always
Option Board Type	Type of Keypad board being used	When the radio has an Option Board/Expanded Keypad Board.
Option Board Serial Number	Serial number of the Keypad board is displayed	When the radio has an Expanded Keypad Board.
Option Board Bluetooth Addr	Bluetooth Address of the Keypad board is displayed	When the radio has an Expanded Keypad Board.
Option Board Sw Version	Software version of the Keypad Board is displayed	When the radio has an Expanded Keypad Board.
Exp Board Type	Type of Keypad Board is displayed	When the radio has a Keypad Board.

NOTE: All displays are temporary and will expire without any user intervention. If information is longer than the physical length of the radio's display, the information will wrap around to the next display. After the last display, "**RF TEST**" is displayed.

To freeze any of the displays, press the left arrow on the 4-Way Navigation Button. To resume automatic scrolling, press the right arrow on the 4-Way Navigation Button. To rapidly scroll forward through the displays, continue pressing the right arrow. You cannot scroll backwards.

NOTE: Press the **Top Side Button** (Purple button) to advance the test environments from "**RF TEST**", "**CH TEST**", "**RGB TEST**" then press the **Top Button** (Orange button) to confirm selection. Press any other buttons to advance the test.

Once a test is carried out, restart the radio to proceed to another test.

3. Do one of the following:
   - Press the **Top Side Button** to stop the displays and toggle between RF test mode and the Control Top and Keypad test mode. The test mode menu "**CH TEST**" is displayed, indicating that you have selected the Control Top and Keypad test mode. Go to Section "5.2.3 Control Top and Keypad Test Mode" on page 1:5-7.

     NOTE: Each press of the **Top Side Button** (Purple button) scrolls through "**RF TEST**", "**CH TEST**" and "**RGB TEST**".

   - Press the **Top Button** (Orange button) to stop the displays and put the radio into the RF test mode. The test mode menu, "**1 CSQ**", is displayed, indicating test frequency 1, Carrier SQuelch mode. Go to Section "5.2.2 RF Test Mode" below.

     NOTE: Once your radio is in a particular test mode, you must turn off the radio and turn it back on again to access the other test mode.

5.2.2 RF Test Mode

When the ASTRO APX 2000/ APX 4000 radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting, according to the customer codeplug configuration. However, when the unit is on the bench for testing, alignment, or repair, it must be removed from its normal environment using a special routine, called **RF TEST MODE**.

While in RF test mode:

- Each additional press of **Side Button 2** advances to the next test channel. (Refer to Table 5-3.and Table 5-4)
- Pressing **Side Button 1** scrolls through and accesses the test environments shown in Table 5-5.
- Pressing **Top Side Button** scrolls through the Tx Deviation Frequency.

NOTE: Transmit into a load when keying a radio under test.

Table 5-3. Test Frequencies (MHz) – VHF, UHF1, UHF2

Test Channel	VHF		UHF1		UHF2	
	RX	TX	RX	TX	RX	TX
F1	136.075	136.025	380.075	380.025	450.075	450.025
F2	142.075	142.125	390.075	390.025	460.075	460.025
F3	154.275	154.225	400.075	400.025	471.075	471.025
F4	160.175	160.125	411.075	411.025	484.925	484.975
F5	168.125	168.075	424.975	424.925	485.075	485.025
F6	173.925	173.975	435.075	435.025	495.075	495.025
F7	–	–	445.075	445.000	506.075	506.025
F8	–	–	445.075005	445.000005	519.925	519.975
F9	–	–	457.075	457.025	–	–
F10	–	–	469.975	469.925	–	–

Table 5-4. Test Frequencies (MHz)– 700/800 MHz

Test Channel	700/800 MHz	
	RX	TX
F1	764.0625	764.0125
F2	769.0625	769.0125
F3	775.9375	775.9875
F4	851.0625	794.0125
F5	860.0625	809.0125
F6	869.9375	823.9875
F7	851.0625	851.0125
F8	860.0625	860.0125
F9	869.9375	869.8875
F10	–	–

Table 5-5. Test Environments

Display	Description	Function
CSQ	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
TPL	Tone Private-Line	RX: unsquelch if carrier and tone (192.8 Hz) detected TX: mic audio + tone (192.8 Hz)
AST	ASTRO	RX: none TX: Digital Voice***
USQ	Carrier Unsquelch	RX: unsquelch always TX: mic audio

****All deviation values are based on deviation tuning of this mode.*

5.2.3 Control Top and Keypad Test Mode

This test mode is used to verify proper operation of all radio buttons and switches if a failure is suspected.

5.2.3.1 Control Top Checks

To perform the control top checks:

1. Press and hold the **Top Button** (Orange button); the radio icons are displayed, and the LED lights amber and lightbar LED light green.
2. Release the **Top Button**; “148/0” appears, which indicates that the **Top Button** is in the open position. Your radio is now in the Control Top and Keypad test mode.
3. Press the **Top Button** again; “148/1” appears, which indicates that the **Top Button** is in the closed position.
4. Rotate the **Volume Control**; “2/0” through “2/255” appear. The display values may vary slightly at the upper and lower limits.
5. Rotate the 16-Position Select Switch; “4/0” through “4/15” appears, which indicates that the selector switch is in mode/zone position 1 through 16.
6. Press the **Top Side Button**; “96/1” appears; release, “96/0” appears.
7. Press **Side Button 1**; “97/1” appears; release, “97/0” appears.
8. Press **Side Button 2**; “98/1” appears; release, “98/0” appears.
9. Press the **PTT Button**; “1/1” appears; release, “1/0” appears.

5.2.4 RGB Test Mode

To perform the RGB Color Test:

1. Press and release **Top Button** (Orange button)
2. Press any key; Crosstalk test patterns appears.
3. Press any key; White color test appears.
4. Press any key; Red color horizontal lines appears.
5. Press any key until all 13 red color horizontal lines appears.
6. Press any key; Green color vertical line appears.
7. Press any key until all 13 green color vertical lines appears.
8. Press any key; Black color test appears.
9. Press any key; Blue color test appears.
10. Press any key; Vendor specific display test appears.
11. Press any key; "Test completed" appears.

5.3 Receiver Performance Checks

The following tables outline the performance checks for the receiver.

Table 5-6. Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check)	**VHF:** ±2 ppm (272–348 Hz) **UHF1:** ±2 ppm **UHF2:** ±2 ppm **700/800 MHz:** ±1.5ppm (1146–1305 Hz)
Rated Audio	**RF Control:** Gen **Output Level:** -47 dBm **Freq:** Selected radio RX freq. **Mod:** 1 kHz tone @ 3 kHz dev. **Meter:** AC Volts	As above	**PTT** to OFF (center)	Set volume control to 3.74 Vrms
Distortion	As above, except **Meter:** Ext Dist.	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except **Meter:** SINAD	As above	As above	RF input to be < 0.35 µV
Noise Squelch Threshold (only radios with conventional system need to be tested)	Set as for rated audio check	Out of TEST MODE; select a conventional system	As above	Set volume control to 3.74 Vrms. Set RF level to -130 dBm and raise until radio unsquelches. Unsquelch to occur at < 0.25 µV. Preferred SINAD = 6-8 dB.

* *See Table 5-5.*

*Table 5-7. Receiver Tests for ASTRO Conventional Channels**

Test Name	System Analyzer	Radio	Test Set	Comments
Bit Error rate (BER) Floor	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code:** 1011 Hz PAT	Radio Tuner Software (Bit Error Rate screen) is required	**PTT** to OFF (center)	BER < 0.01% (Use test setup shown in Figure 6-1)
Reference Sensitivity	As above; lower the output level until 5% BER is obtained	As above	As above	Output level < 0.35 µV (-116 dBm) (Use test setup shown in Figure 6-1)
Audio Output Distortion	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code:** 1011 Hz PAT **Meter:** Ext. Distortion	Radio Tuner Software not used; **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to OFF (center) Meter selector to **Audio PA** Spkr/Load to **Speaker**	Distortion < 3.0%
Residual Audio Noise Ratio	**Mode:** Proj 25 Std **RF Control:** Gen **Output Level:** -47 dBm **Proj 25 Dev:** 2.83 kHz **Code**: A) 1011 Hz PAT B) Silence PAT **Meter:** AC Volts	As above	As above	Residual Audio Noise Ratio -45 dB

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

5.4 Transmitter Performance Checks

The following tables outline the performance checks for the transmitter.

Table 5-8. Transmitter Performance Checks – APX 2000/ APX 4000 (Two Knobs)

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check).	**VHF:** ±2 ppm (272–348 Hz) **UHF1:** ±2 ppm **UHF2:** ±2 ppm **700/800 MHz:** ±1.5ppm (1146–1305 Hz)
RF Power	As above	As above	As above	**VHF**: 1–5 Watt **UHF1**: 1–5 Watt **UHF2**: 1–5 Watt **700**: 1–2.7 Watt **800**: 1–3 Watt
Voice Modulation (external)	As above. Set fixed 1 kHz audio level to 400 mV.	As above	As above	Deviation: (12.5 kHz) ≥ 2.1 kHz, but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz, but ≤ 5.0 kHz
Voice Modulation (internal)	**RF Control:** Monitor **Meter:** RF Display **Display:** Bar Graphs **Freq:** Selected radio TX freq.	As above	Remove modulation input. **PTT** to OFF (center)	Press **PTT** button on radio. Say “four” loudly into the radio mic. Measure deviation: (12.5 kHz) ≥ 2.1 kHz but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz but ≤ 5.0 kHz
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	As above	Conventional coded squelch personality (clear mode operation) or TPL channel (test mode*)	**PTT** to continuous (during the performance check)	Deviation: (12.5 kHz) ≥ 375 Hz but ≤ 500 Hz (25 kHz) ≥ 500 Hz but ≤ 1000 Hz
Secure Modulation (radios with conventional, secure mode, talkaround operation only)	As above	Programmed conventional channel (secure mode operation) Load key into radio.	As above	Deviation: ≥ 3.7 kHz but ≤ 4.3 kHz

* *See Table 5-5.*

Table 5-9. Transmitter Tests for ASTRO Conventional Channels – APX 2000/ APX 4000 (Two Knobs)

Test Name	System Analyzer	Radio	Test Set	Comments
RF Power	**Mode:** Proj 25 Std **RF Control:** Monitor **Meter:** RF Display	Radio Tuner Software not used. **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to continuous (during measurement).	**VHF**: 1–5 Watt **UHF1**: 1–5 Watt **UHF2**: 1–5 Watt **700**: 1–2.7 Watt **800**: 1–3 Watt **900**: 1–2.5 Watt
Frequency Error	As above	As above	As above	Error ≤ ±1.0 kHz
Frequency Deviation	As above	Radio Tuner Software (Transmitter Test Pattern screen) is required) **High use:** Symbol Rate PAT **Low use:** Low Symbol Rate P	**PTT** to OFF (center)	D_{HIGH} ≥ 2.543 kHz but ≤ 3.110 kHz D_{LOW} ≥ 0.841 kHz but ≤ 1.037 kHz (Use test setup shown in Figure 6-1)

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

Notes

Chapter 6 Radio Alignment Procedures

This chapter describes both receiver and transmitter radio alignment procedures.

6.1 Test Setup

A personal computer (PC) and tuner software are required to align the radio. Refer to the applicable manual for installation and setup procedures for the software. To perform the alignment procedures, the radio must be connected to the PC and to a universal test set. The radio alignment test setup is shown in Figure 6-1.

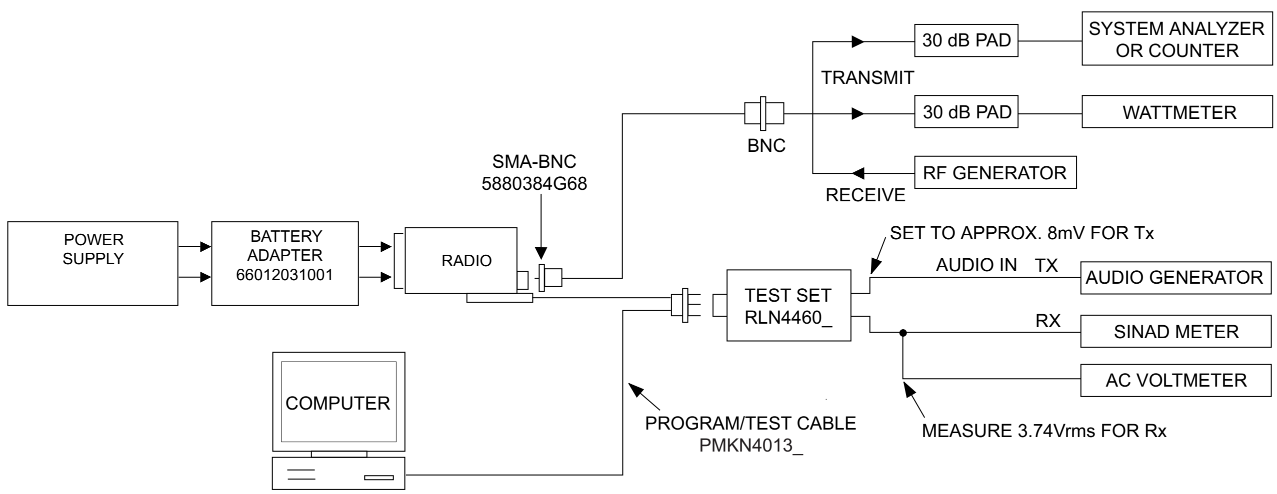

Figure 6-1. Radio Alignment Test Setup

Caution

These radio alignment procedures should only be attempted by qualified service personnel. Failure to perform alignment procedures properly may result in seriously degraded radio or system performance.

6.2 Tuner Main Menu

Select **Tuner** from the **START** menu by clicking **Start › Program Files › Motorola › ASTRO 25 Products › ASTRO 25 Tuner**. To read the radio, use the F**ile › Read Device** menu or click on Read Device. Figure 6-2 illustrates how the alignment screens are organized. To access a screen, double-click on the desired screen name in the **Tuner** menu.

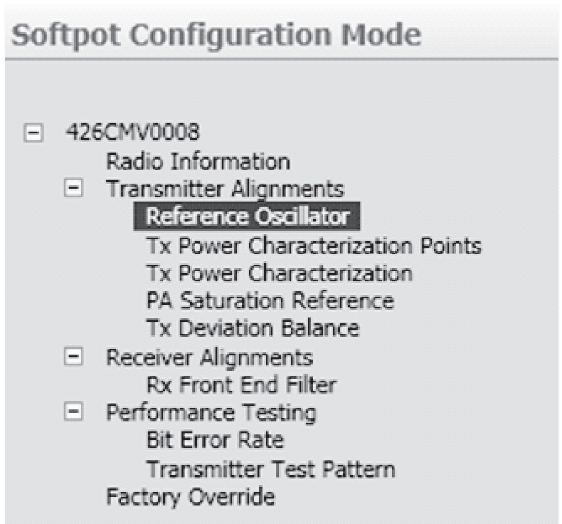

Figure 6-2. Tuner Software Main Menu

IMPORTANT: Tuning should follow the order of the Tuning tree view in descending order from top to bottom

6.3 Softpot

The alignment screens introduce the concept of the “softpot,” an analog **SOFT**ware-controlled **POT**entiometer used for adjusting all transceiver alignment controls.

Caution	DO NOT switch radios in the middle of any alignment procedure. Always left-click the **Close** button on the screen to return to the Main Menu screen before disconnecting the radio. Improper exits from the alignment screens might leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

Each alignment screen provides the ability to increase or decrease the softpot value by using a slider, or by entering the new value from the keyboard directly into the box. The slider bar indicates the current softpot value; see Figure 6-3.

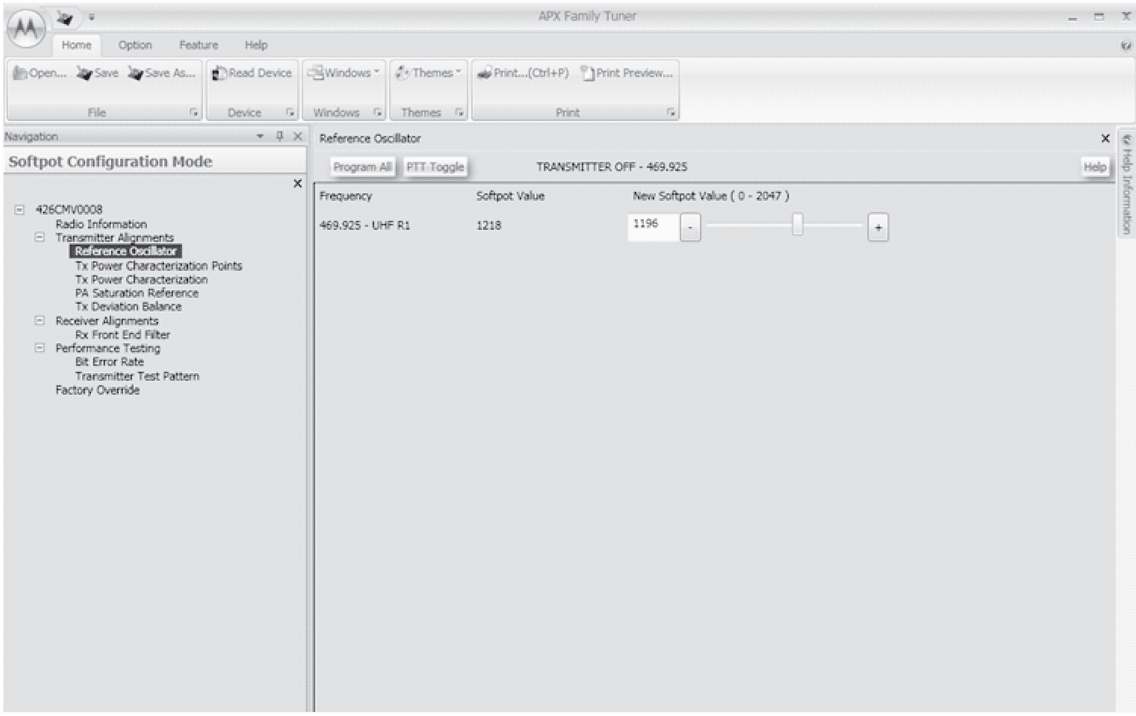

Figure 6-3. Typical Softpot Screen

Adjusting the softpot value sends information to the radio to increase (or decrease) the voltage in the corresponding circuit. For example, left-clicking the UP spin button in the New Softpot Value scroll box on the **Reference Oscillator** screen instructs the radio's microcomputer to increase the voltage across a varactor in the reference oscillator, which increases the frequency.

In ALL cases, the softpot value is just a relative number corresponding to a digital-to-analog (D/A) generated voltage in the radio.

Perform the following procedures in the sequence indicated.

NOTE: Some of the following screens may vary depending upon the radio under test and the version of tuner software you are using. Refer to the software's online help.

Caution	When keying the radio during a test, always transmit into a dummy load.

6.4 Radio Information

Figure 6-4 shows a typical Radio Information screen. This screen is informational only and cannot be directly changed.

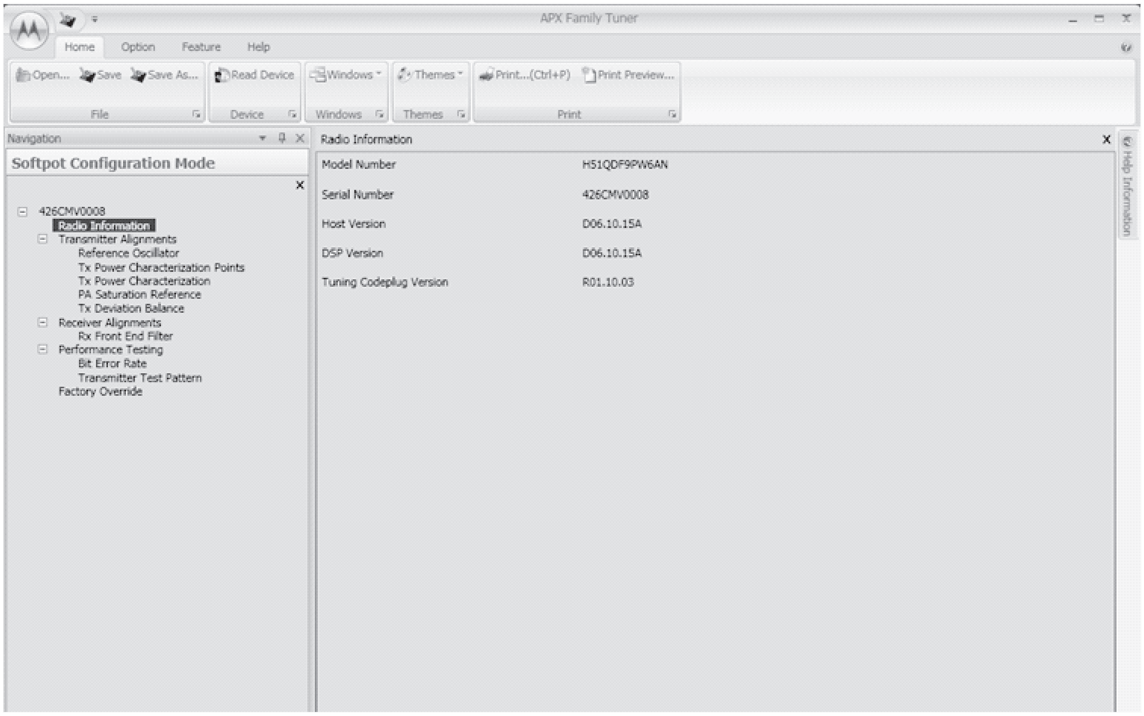

Figure 6-4. Radio Information Screen

6.5 Transmitter Alignments

6.5.1 Reference Oscillator Alignment

Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment will result not only in poor operation, but also in a misaligned radio that will interfere with other users operating on adjacent channels. For this reason, the reference oscillator should be checked every time the radio is serviced, or once a year, whichever comes first. The frequency counter used for this procedure must have a stability of 0.1 ppm (or better).

NOTE: Reference oscillator alignment is required after replacing (or servicing) the transceiver board.

This test can be done with either the R-2670 Communication Analyzer or the 8901_ Modulation Analyzer.

- Initial setup using the R-2670 Communication Analyzer:
  - RF Control: Monitor
  - B/W: WB
  - Freq: CPS frequency under test
  - Attenuation: 20dB
  - Mon RF in: RF I/O
  - Meter: RF Display
  - Mode: STD
  - Input Level: uV or W
  - Display: Bar Graphs
  - Squelch: Mid-range or adjust as necessary
- Initial setup using the 8901_ Series Modulation Analyzer:
  - Press the green **Automatic Operation** button on the analyzer.
  - Press the **FREQ** key.
  - Type **7.1** followed by **SPCL** button to set the 8901B_ modulation analyzer for maximum accuracy.

To align the reference oscillator:

Select the **Reference Oscillator** alignment screen. See Figure 6-5, Figure 6-6, Figure 6-7 and Figure 6-8.

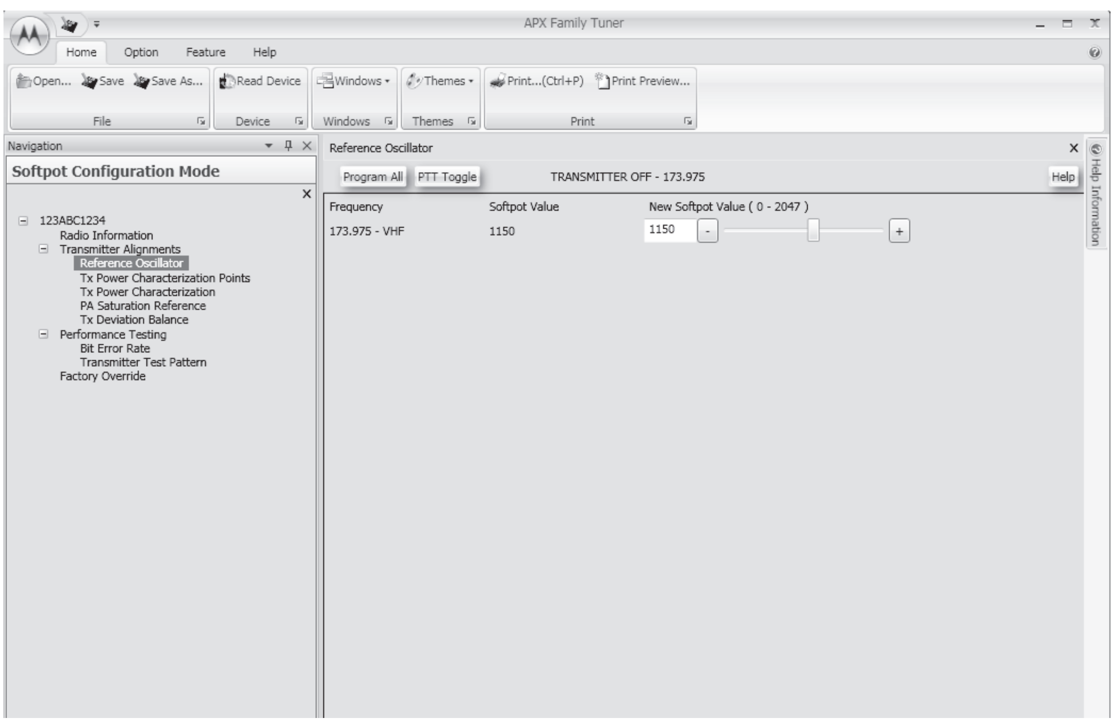

Figure 6-5. Reference Oscillator Alignment Screen (VHF)

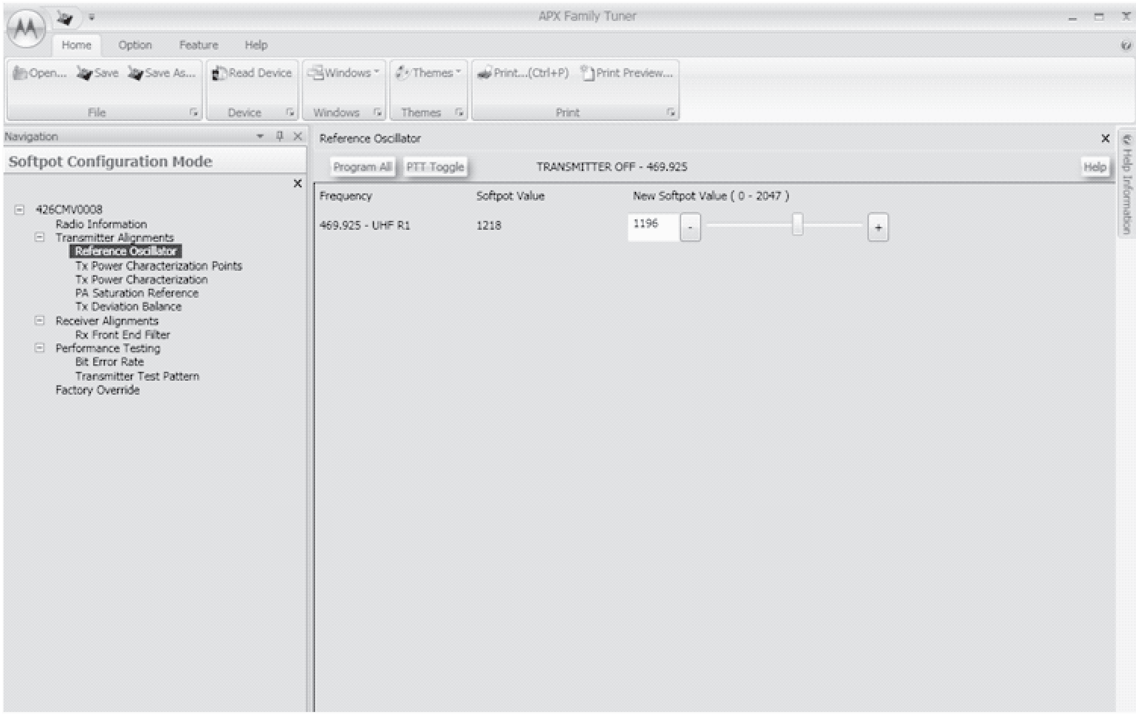

Figure 6-6. Reference Oscillator Alignment Screen (UHF1)

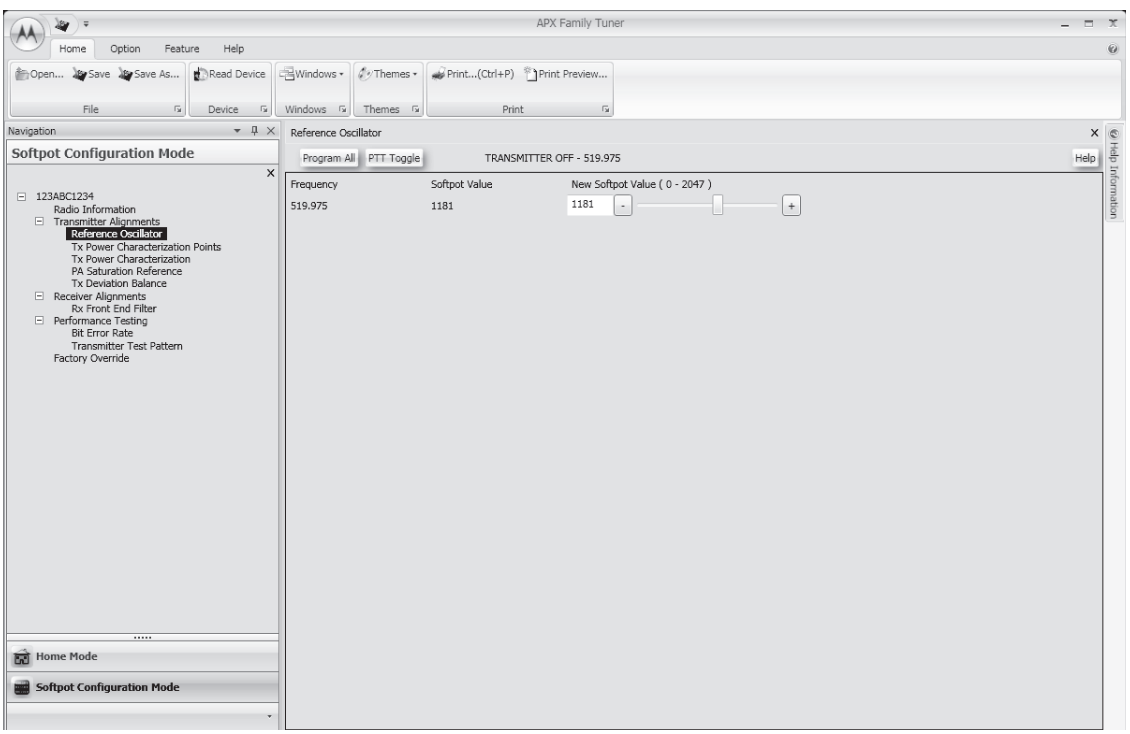

Figure 6-7. Reference Oscillator Alignment Screen (UHF2)

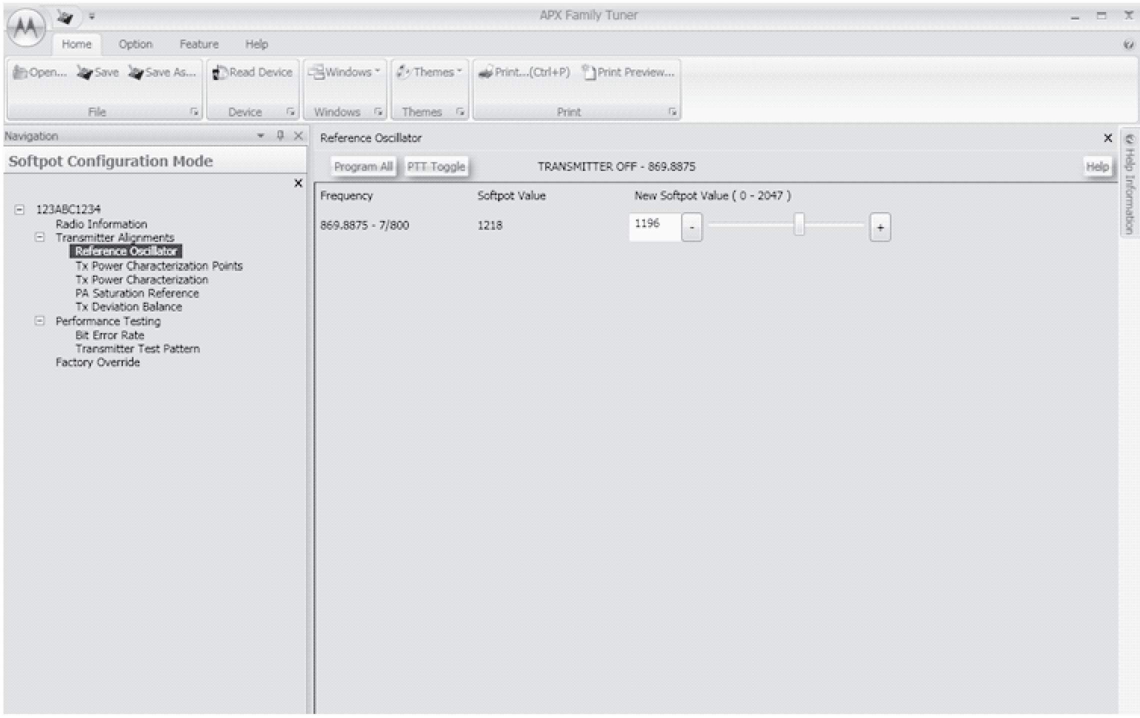

Figure 6-8. Reference Oscillator Alignment Screen (700/800 MHz)

1. Make sure the Communication Analyzer is in **Manual** mode.

   <u>VHF</u>

   - Set the base frequency to 173.975 MHz

   <u>UHF1</u>

   - Set the base frequency to 469.925 MHz

   <u>UHF2</u>

   - Set the base frequency to 519.975 MHz

   <u>700/800 MHz</u>

   - Set the base frequency to 869.8875 MHz

2. Adjust the reference oscillator's softpot value with the slider until the measured value is as close as possible to the frequency shown on the screen. See Table 6-1.

   NOTE: Increases the slider decreases the frequency and vice versa.

Table 6-1. Reference Oscillator Alignment

Band	Target
VHF	±100 Hz
UHF1	±100 Hz
UHF2	±100 Hz
700/800 MHz	±100 Hz

3. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.
4. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

6.5.2 Power Characterization Points

Tuning of the radio is done through **Power Characterization Points** tuning screen.

1. Select the **TX Power Characterization Points** alignment screen. See Figure 6-9, Figure 6-10, Figure 6-11 and Figure 6-12.
2. Set power supply voltage and current limit.
3. Adjust softpot value by manipulating the slider bar, incrementing the "New Softpot Value" text box, or directly entering the desired value into the "New Softpot Value" text box until the rated power is indicated on the service Monitor. For rated power refer to the help text in the Tuner.
4. Repeat the steps 2 and 3 for all frequencies.
5. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

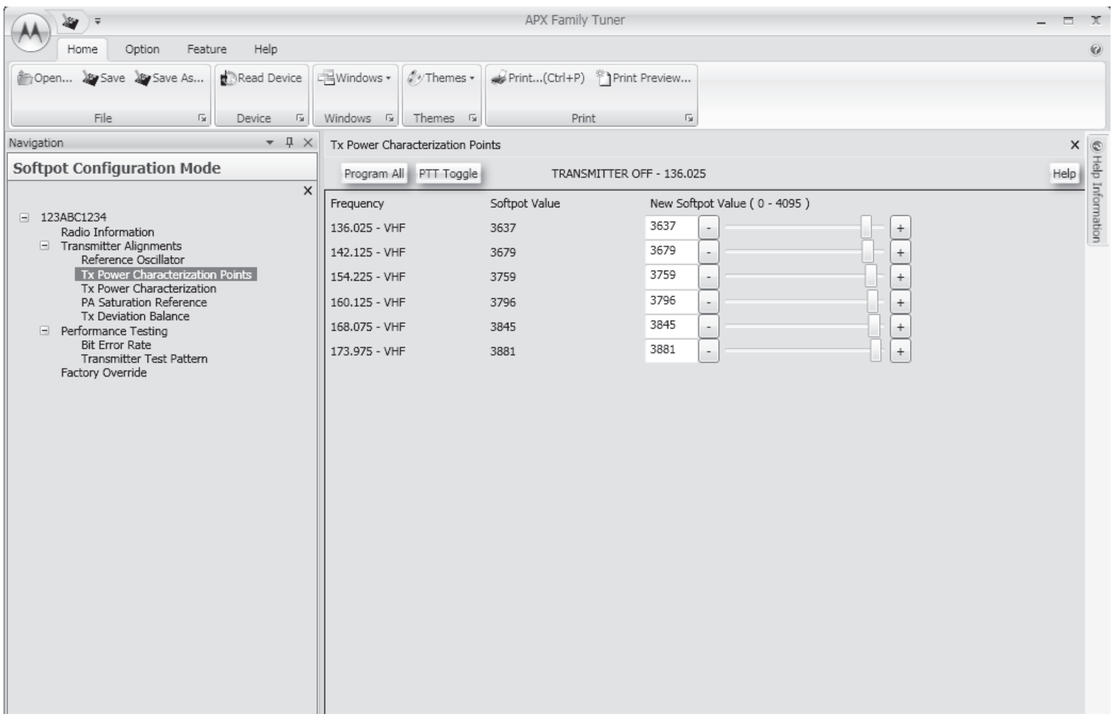

Figure 6-9. Transmit Power Characterization Points Alignment Screen (VHF)

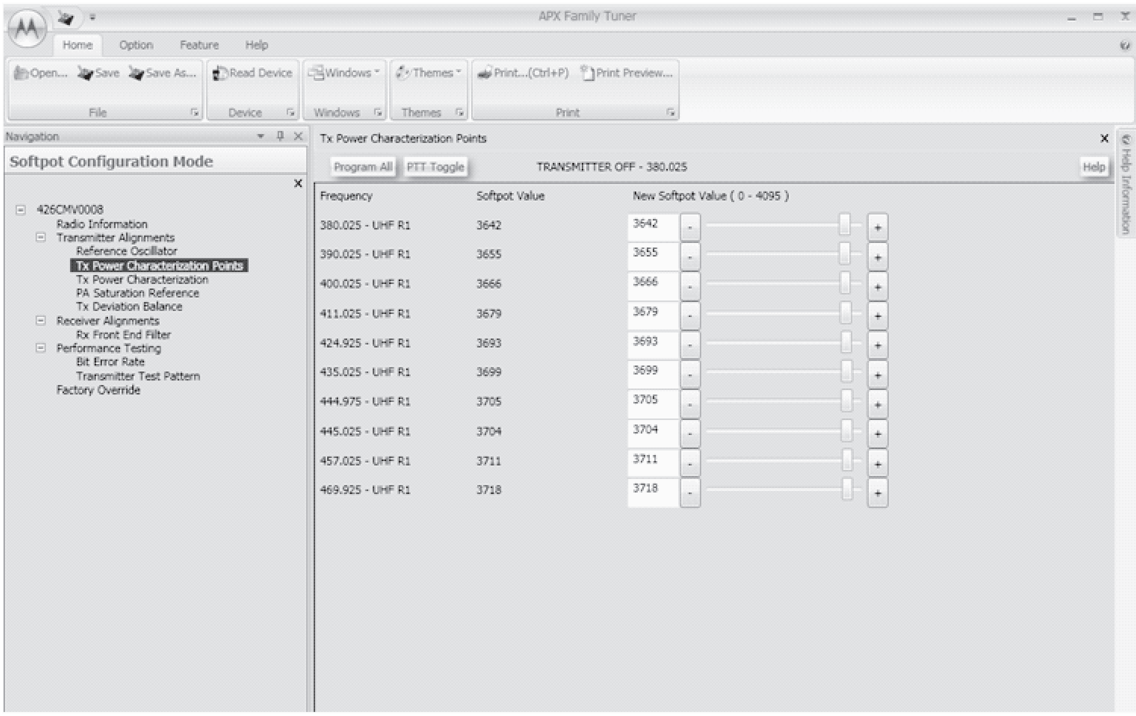

Figure 6-10. Transmit Power Characterization Points Alignment Screen (UHF1)

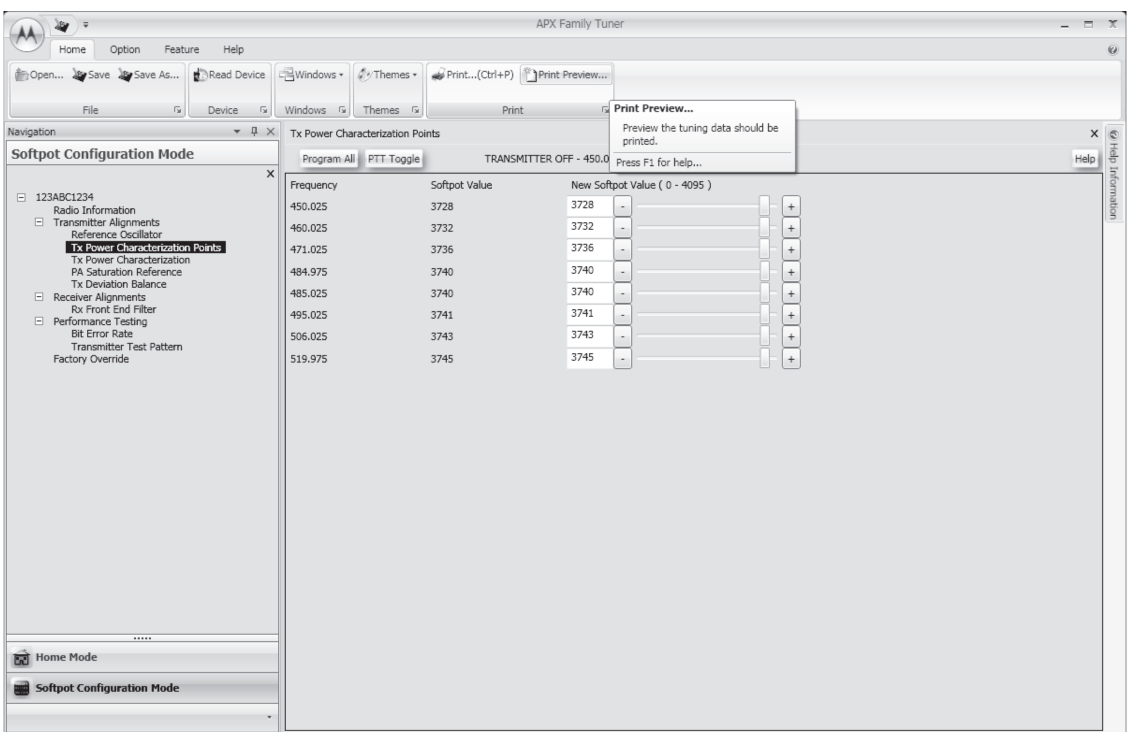

Figure 6-11. Transmit Power Characterization Points Alignment Screen (UHF2)

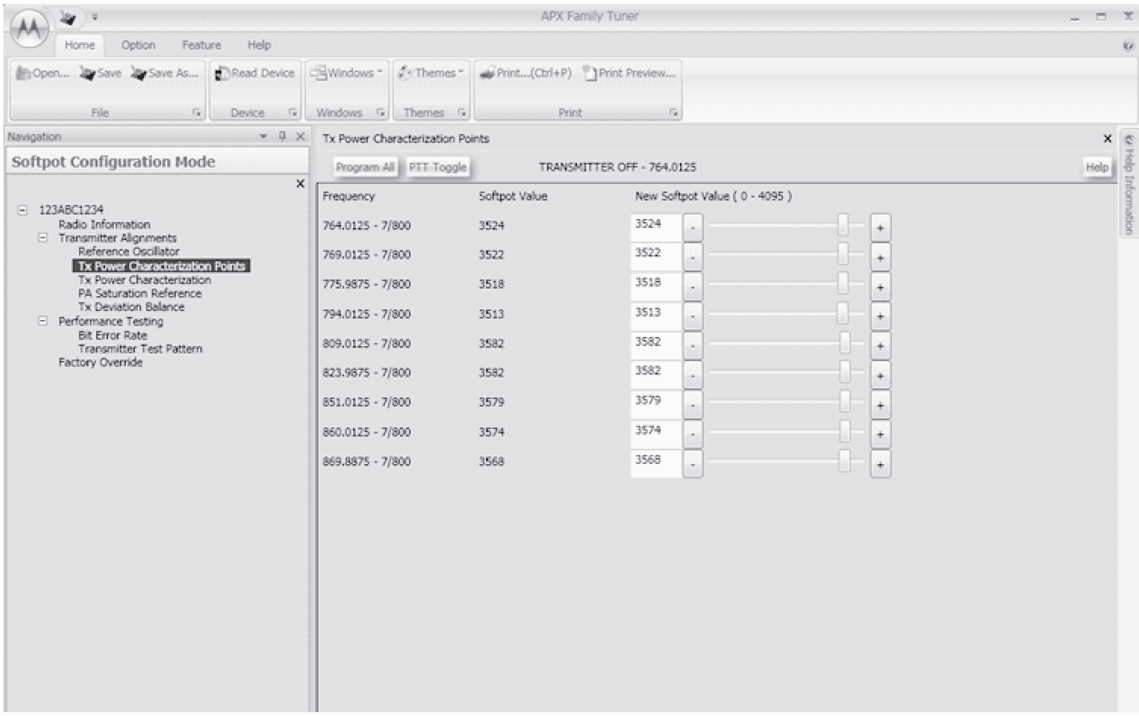

Figure 6-12. Transmit Power Characterization Points Alignment Screen (700/800 MHz)

6.5.3 Power Characterization Tuning

Tuning of the radio is done through **Power Characterization** tuning screen.

IMPORTANT: Power Characterization Tuning Points must be tuned before tuning Power Characterization Tuning.

NOTE: a.The longer the RF cable, the more the attenuation of the power reading.

b.Use a standard 50 ohm cable.

c. Remember to set the Communication Analyzer to baseband power.

1. Select the **TX Power Characterization** alignment screen. The screen indicates the transmit power to be used. See Figure 6-13, Figure 6-14, Figure 6-15 and Figure 6-16.
2. Left-click the box under “Measure Power 1” for the desired frequency field. (The selected box is highlighted).
3. Click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
4. Measure the transmit power of the radio with a service Monitor.
5. Input the transmit power in watts using two decimal places into the highlighted “Measure Power 1” box.
6. Left-click the box under “Measure Power 2” box for the same frequency field. (The selected box is highlighted).
7. Measure the transmit power of the radio with a service Monitor.
8. Input the transmit power in watts using two decimal places into the highlighted “Measure Power 2” box.

9. Repeat steps 2 to 8 for all frequencies.
10. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

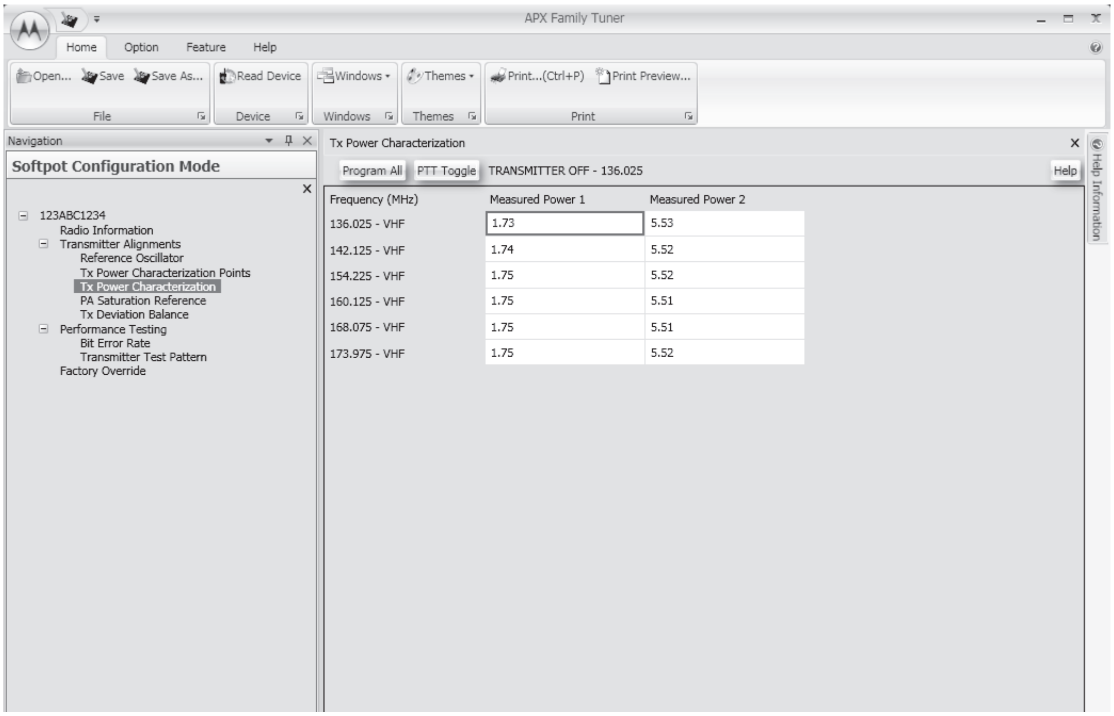

Figure 6-13. Transmit Power Characterization Alignment Screen (VHF)

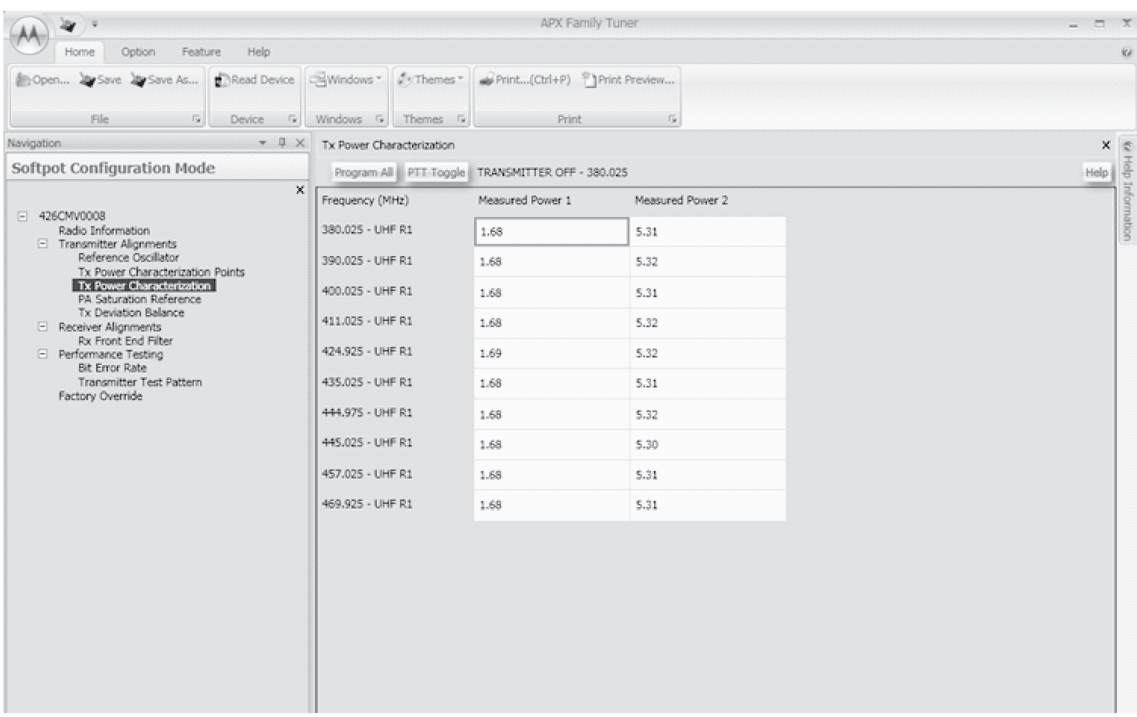

Figure 6-14. Transmit Power Characterization Alignment Screen (UHF1)

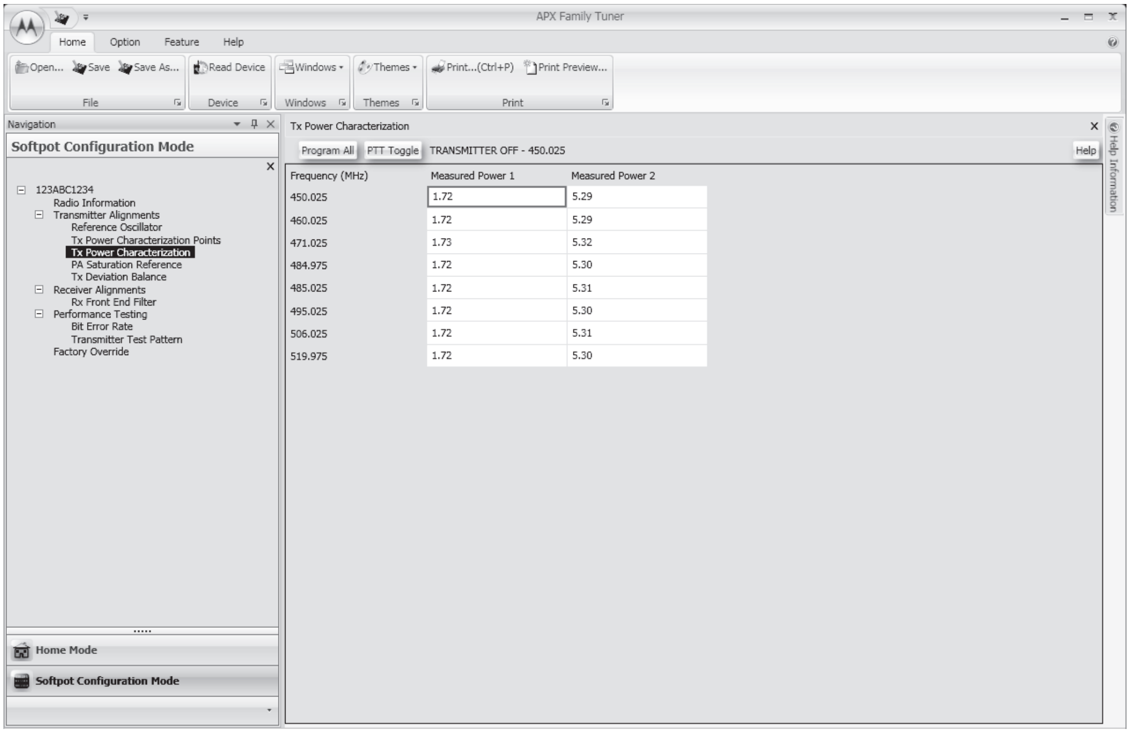

Figure 6-15. Transmit Power Characterization Alignment Screen (UHF2)

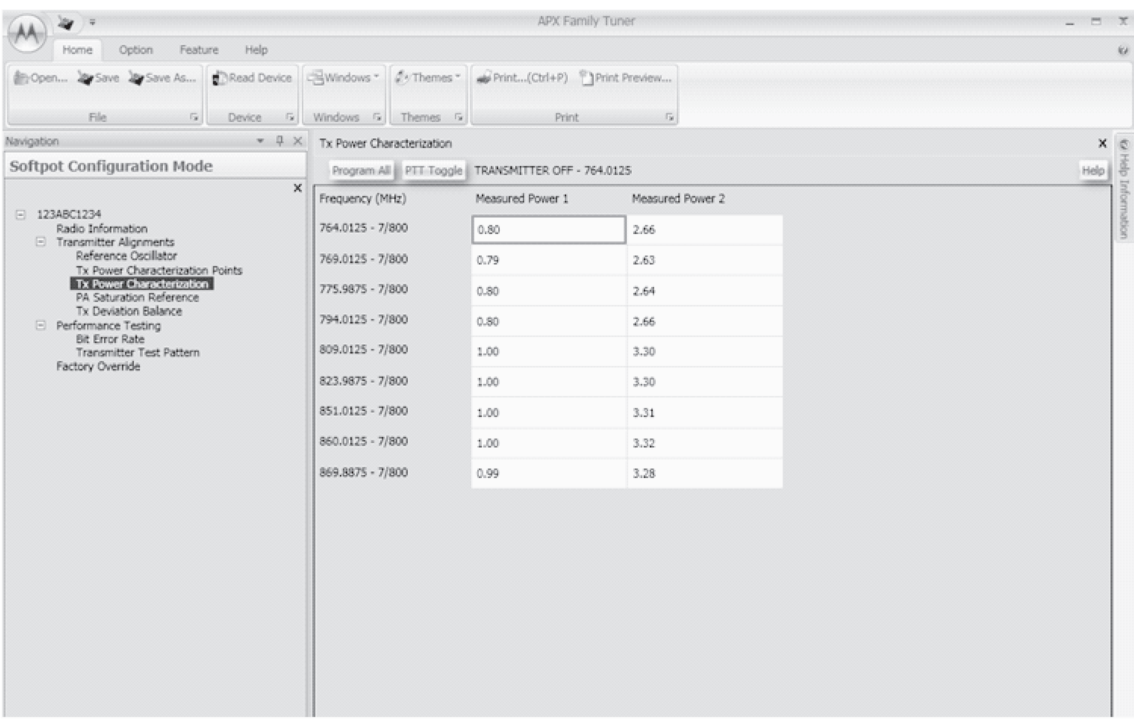

Figure 6-16. Transmit Power Characterization Alignment Screen (700/800 MHz)

6.5.4 PA Saturation Reference Tuning

Tuning is done through **PA Saturation Referencing** screen.

1. Select the **PA Saturation Reference** alignment screen. The screen indicates the transmit frequencies to be used. See Figure 6-17, Figure 6-18, Figure 6-19 and Figure 6-20.
2. In Manual Mode, set the service Monitor to the desired frequency (as shown in the frequency list in the PA Saturation Reference alignment screen).
3. Adjust the PA Saturation Reference softpot value with the slider until the radio transmits as close as possible to the rated power. For rated power refer to the help text in the Tuner.
4. Left-click the slider of the frequency selected (should be the same frequency as step 2).
5. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
6. Repeat the steps 2 to 5 for all frequencies.
7. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

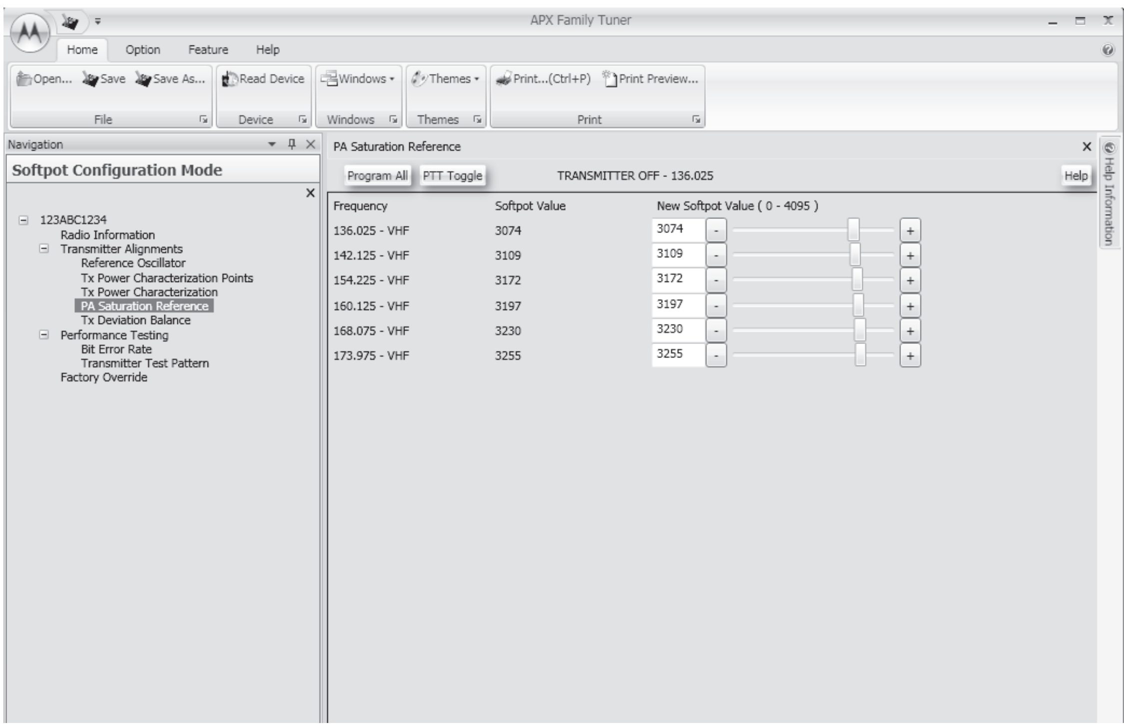

Figure 6-17. PA Saturation Referencing Alignment Screen (VHF)

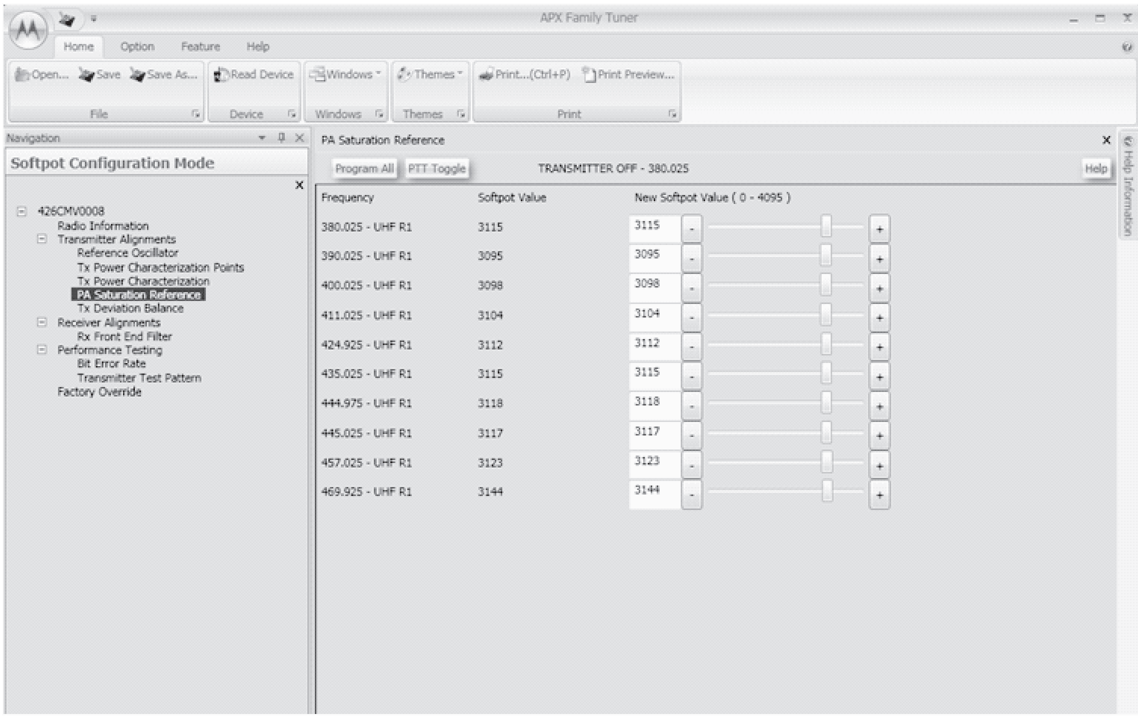

Figure 6-18. PA Saturation Referencing Alignment Screen (UHF1)

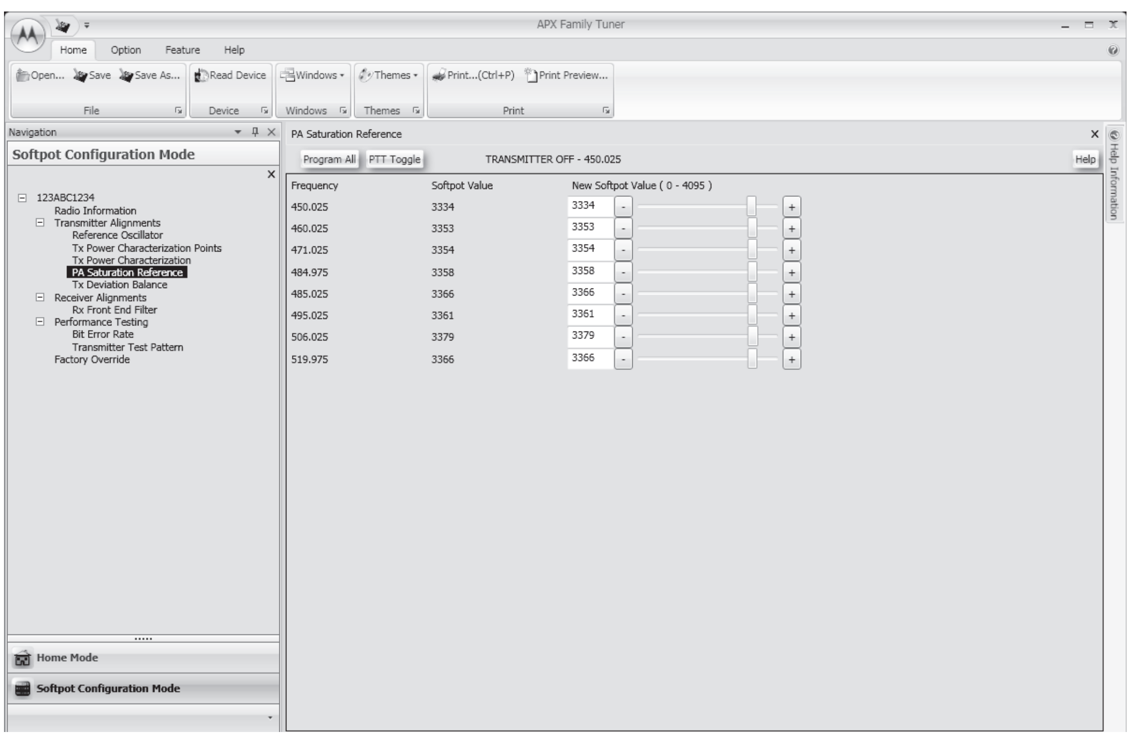

Figure 6-19. PA Saturation Referencing Alignment Screen (UHF2)

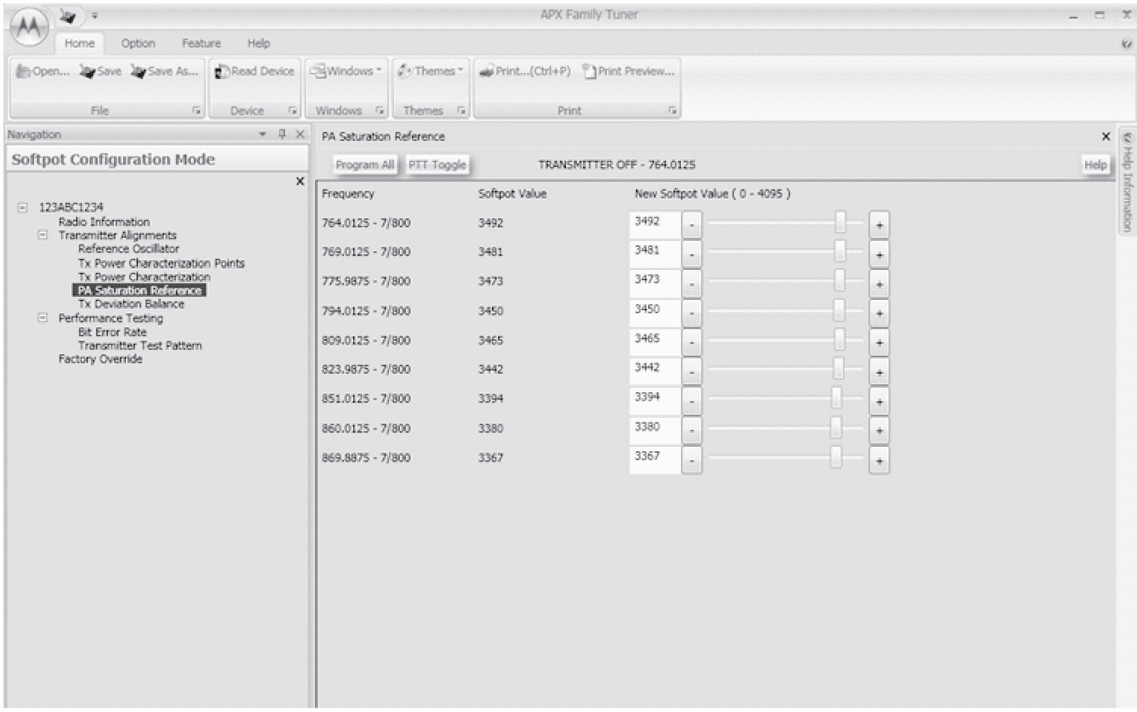

Figure 6-20. PA Saturation Referencing Alignment Screen (700/800 MHz)

6.5.5 Transmit Deviation Balance Alignment

This alignment procedure balances the modulation contributions of the low- and high-frequency portions of a baseband signal. Proper alignment is critical to the operation of signalling schemes that have very low frequency components (for example, DPL) and could result in distorted waveforms if improperly adjusted.

This procedure needs to be performed at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone.

NOTE: This alignment is required after replacing (or servicing) the main board.

Proper alignment requires a modulation analyzer or meter with a frequency response to less than 10 Hz modulating frequency. The modulation analyzer settings during this test should be set for average deviation, a 15 kHz low-pass filter, no de-emphasis, and no high-pass filter, if these settings are supported.

This alignment can be done with either the R-2670 Communication Analyzer or the 8901_ Series Modulation Analyzer. The method of choice is the R-2670 analyzer.

1. Initial setup using the R-2670 Communication Analyzer:
   - Connect a BNC cable between the “DEMOD OUT” port and the “VERT/SINAD DIST/DMM COUNTER IN” port on the R-2670.
   - Press the **SPF** key on the R-2670 to display the “SPECIAL FUNCTIONS MENU.” Move the cursor to “High Pass,” and select 5 Hz on the soft key menu. Select 20 kHz for the “Low Pass” setting.

- In the “RF Control” section of the R-2670, move the cursor to the “B/W” setting and select “WIDE +/- 100 kHz” on the soft key menu.
- Place the R-2670 cursor in the “Display” zone. Select “AC VOLTS” on the soft key menu. Move the cursor to the “Range” setting and select “AUTO.”

2. Initial setup using the 8901_ Series Modulation Analyzer:
   - Press the **FM MEASUREMENT** button. (The “*Error 0input level too low”* indication is normal until an input signal is applied.)
   - Simultaneously press the **Peak –** and **Peak +** buttons. Both LEDs on the buttons should light.
   - Press the 15 kHz LP filter key.
3. Select the **TX Deviation Balance** alignment screen. The screen indicates the transmit frequencies to be used. See Figure 6-21, Figure 6-22, Figure 6-23 and Figure 6-24.
4. In the "RF Control" section of the R2670, set the service Monitor to the desired frequency (as shown in the frequency list in the TX Deviation Balance alignment screen).
5. Left-click the **PTT Tone: Low** button.
6. Left-click the slider of the frequency selected (should be the same frequency as step 4).
7. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
8. Measure and Record the Low Tone Tx Deviation value from the 8901_ Series Analyzer or the AC voltage value from the R2670.
9. Left-click the **PTT Tone: High** button.
10. Adjust the softpot value until the measured deviation/voltage, when using the high tone, is within +/- 1.5% of the value observed when using the Low Tone.
11. Left-click the **PTT Toggle** to de-key the radio.
12. Repeat the steps 4 to 10 for all frequencies.
13. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

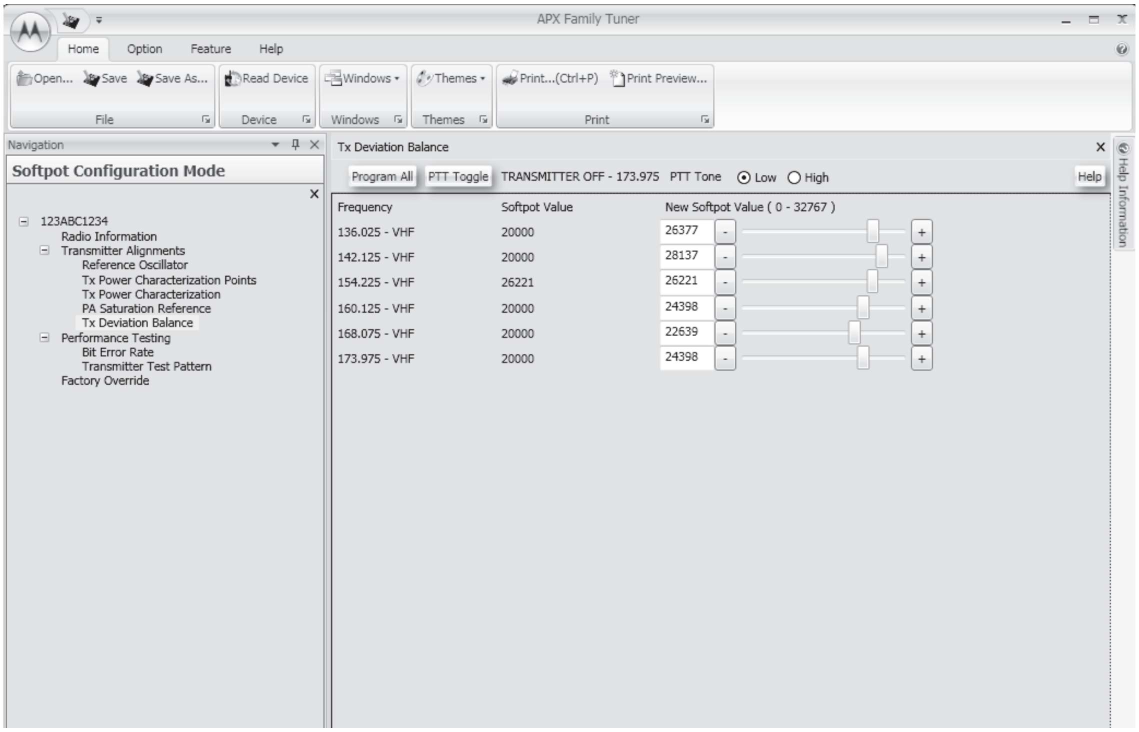

Figure 6-21. Transmit Deviation Balance Alignment Screen (VHF)

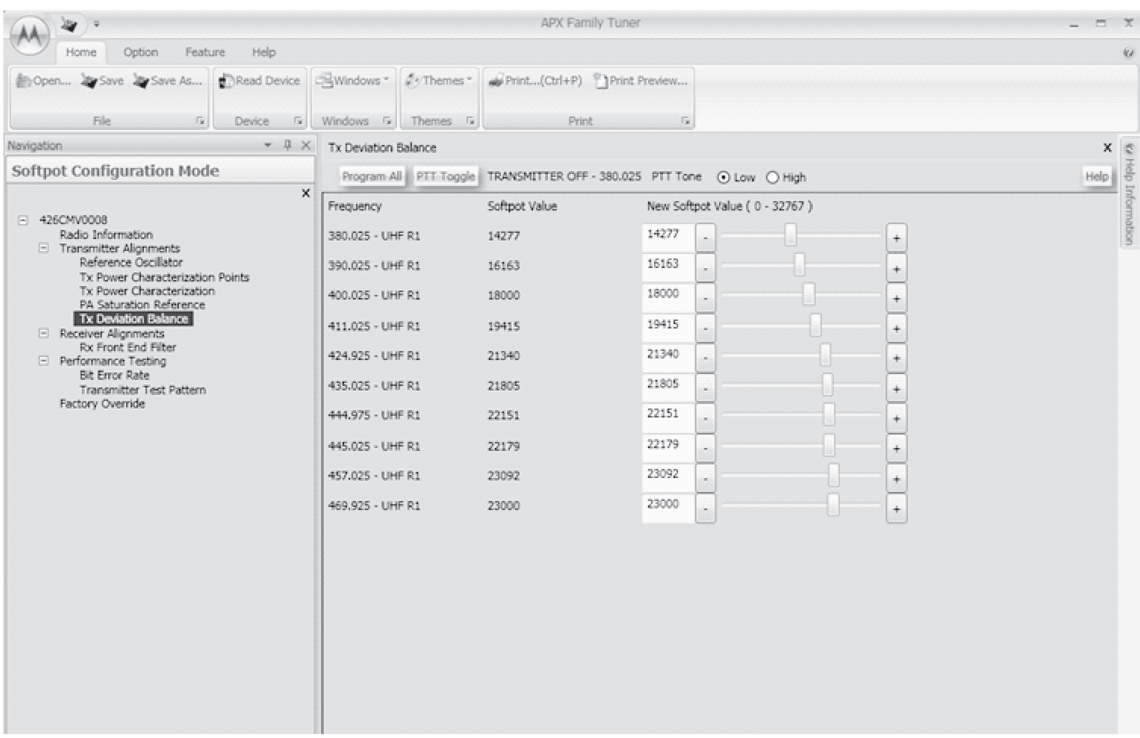

Figure 6-22. Transmit Deviation Balance Alignment Screen (UHF1)

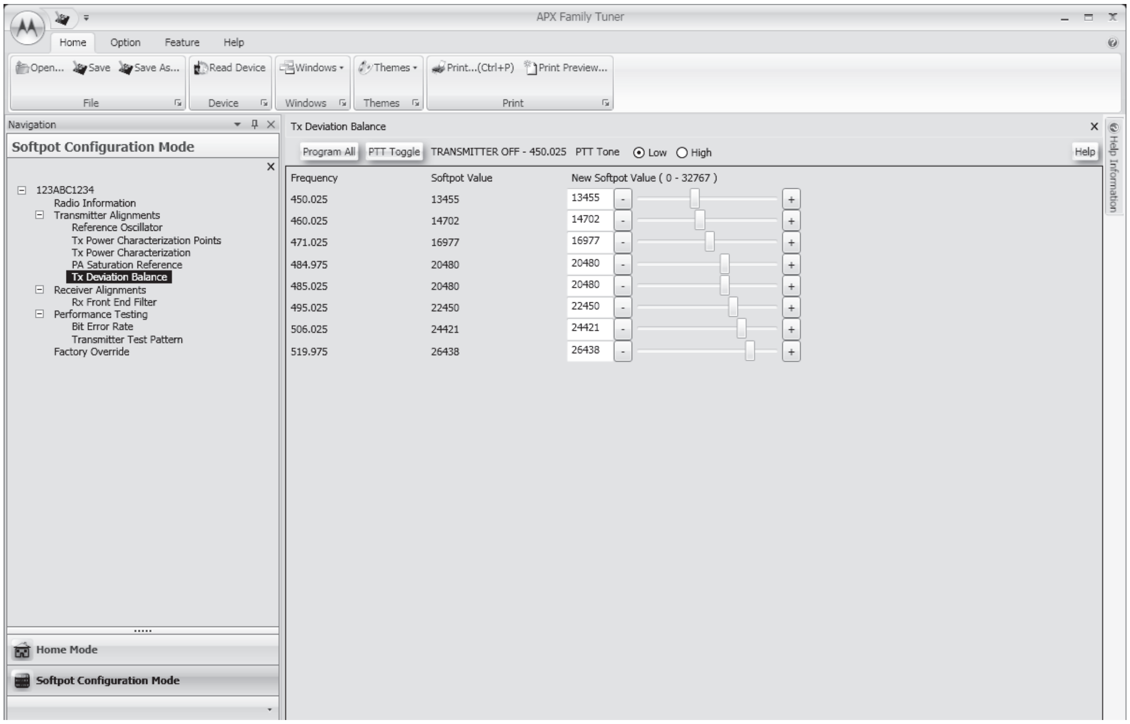

Figure 6-23. Transmit Deviation Balance Alignment Screen (UHF2)

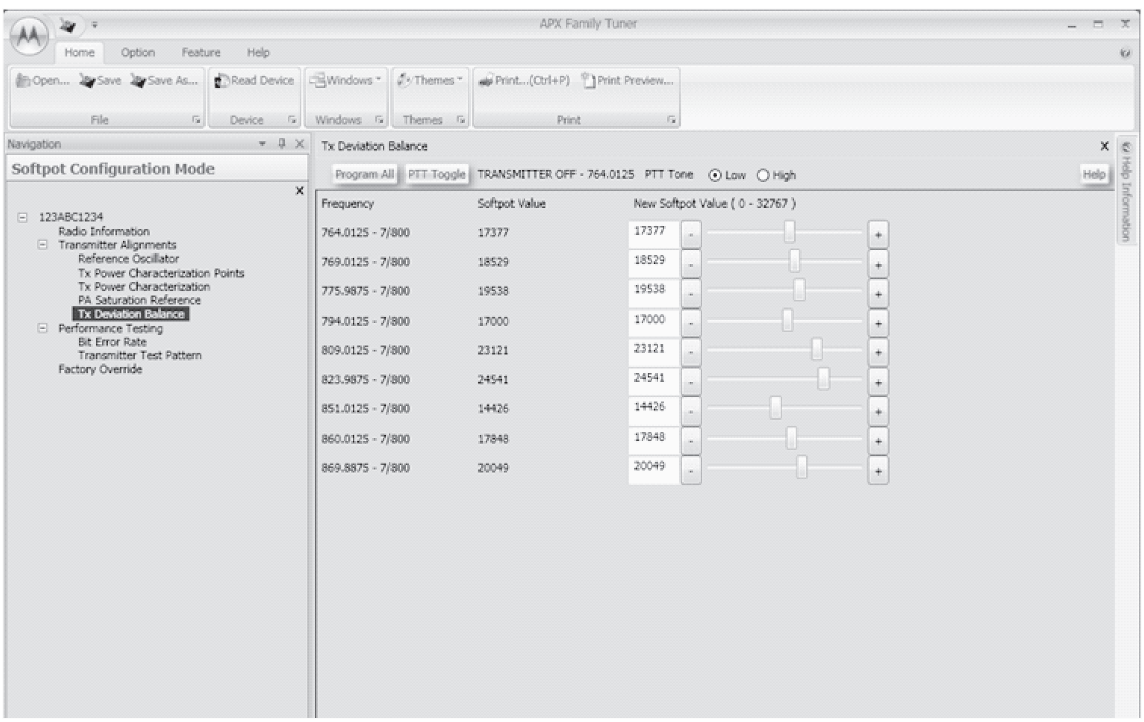

Figure 6-24. Transmit Deviation Balance Alignment Screen (700/800 MHz)

6.6 Front End Filter Alignment

Caution

This procedure should only be attempted by qualified service technicians.

The alignment procedure adjusts the front end receiver bandpass filters for the best receiver sensitivity and selectivity. This procedure should be performed for all test frequencies to allow for proper software interpolation of frequencies between the test frequencies in the band (see Figure 6-25 and Figure 6-26).

NOTE: Rx Front End Filter Alignment is required after replacing (or servicing) the transceiver board.

6.6.1 Procedure for UHF 1 and UHF2 (Auto Tune)

Tuning of the radio is done through **Rx Front End Filter** tuning screen

1. Select the **Rx Front End Filter** alignment screen. See Figure 6-25 and Figure 6-26.
2. Click on the slider or the "New Softpot Value" text box to select which frequency to tune.
3. Apply RF test signal input with no modulation at -90 dBm on the Test Signal Frequency displayed at the top of the screen.
4. Left-click the **Autotune** button.
5. Repeat the steps 2–4 for all frequencies.
6. Left-click the **Program All** button on the screen to save the tuned values in the radio.

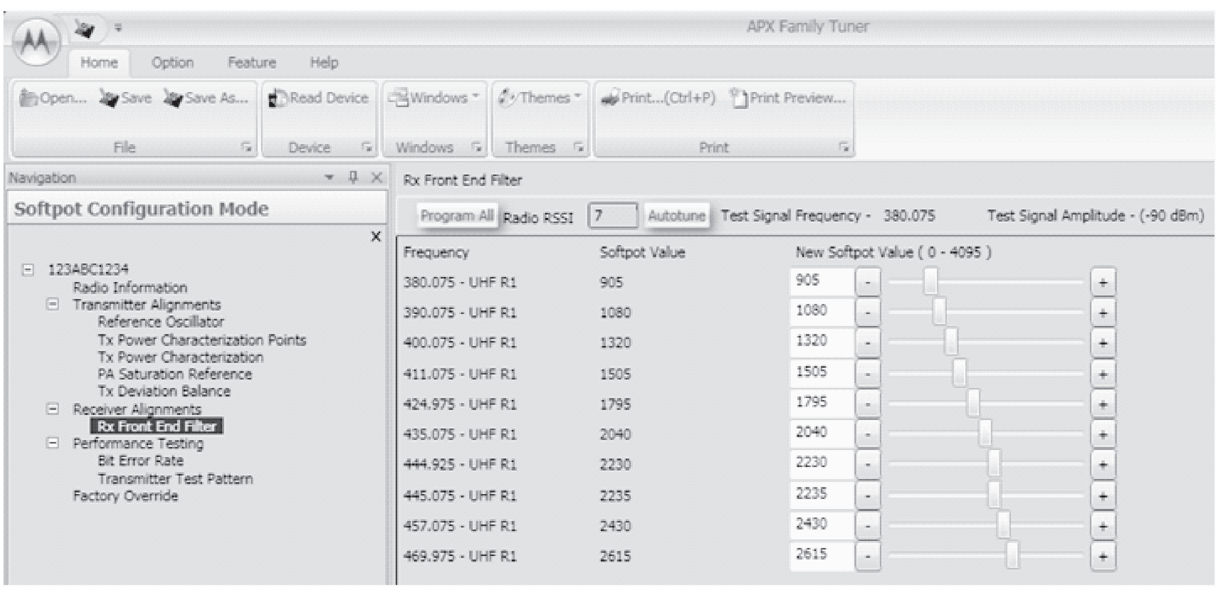

Figure 6-25. Front End Filter Alignment Screen (UHF1)

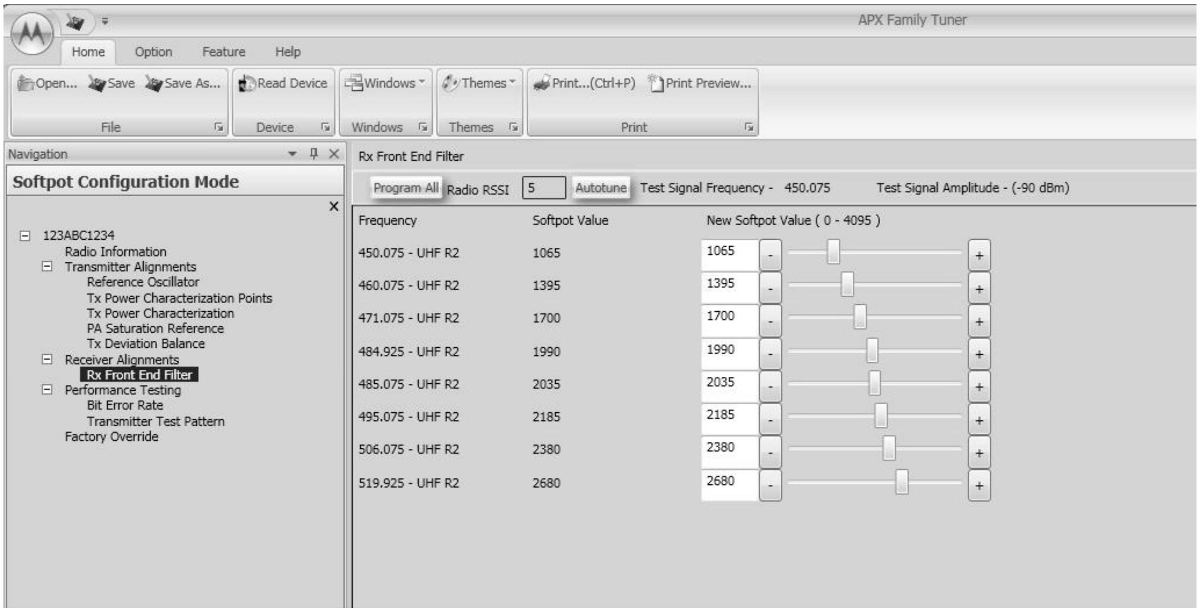

Figure 6-26. Front End Filter Alignment Screen (UHF2)

6.7 Performance Testing

6.7.1 Bit Error Rate

This section describes the Bit Error Rate (BER) test of the radio's receiver at a desired frequency (see Figure 6-27, Figure 6-28, Figure 6-29 and Figure 6-30).

6.7.1.1 Bit Error Rate Fields

Set up the R2670 Communication Analyzer as follows:

1. Connect the RF Input port of the radio under test to the RF IN/OUT port of the R2670 Service Monitor.
2. Set up the R2670 Service Monitor:
   - In the Display Zone, select PROJ 25 STD mode and set the meter to RF DISPLAY.
   - In the RF Zone, configure the analyzer as follows:

RF Control:	Generate
Preset:	B/W: NB
Freq:	Test frequency (Ex: 851.0625 MHz)
Output Level:	-50.0 dBm
Gen RF Out:	RF I/O

   - In the Audio Zone, select the 1011 Hz PAT code and set the deviation to “PROJ25Dev: 2.83 kHz ~”.

The bit error rate screen contains the following fields:

- **Rx Frequency**:
  This field selects the Receive Frequency directly in MHz.

- **Test Pattern**:
  This field selects the Digital test pattern to be received by the radio. Choices are: Standard Tone Test Pattern (Framed 1011), F2 1031, Standard Interface Test Pattern (CCITT V.52) and Phase 2 Digital (1031 Hz) Test Pattern.
- **Modulation Type**:
  This field represents the digital modulation type of the incoming signal on which BER is to be calculated.
- **Continuous Operation**:
  This field allows the user the option to repeat the BER test indefinitely. A selection of Yes will cause the radio to calculate BER on a continuous basis and update the results on this screen after each integration time. A selection of No will cause the BER test to execute for only one sample of the integration time and then update the display.
- **Audio**:
  This field allows the user to select the audio output during a test. Selecting Internal will cause the radio's built-in speaker to unmute to any signals at the desired frequency which are present during the test. Selecting External will route the same signal to the radio's accessory connector audio output. Selecting Mute will disable the audio output.

NOTE: There will be **no audio** option available for APX 2000/ APX 4000 (Two Knobs) when performing a Bit Error Rate Test.

- **BER Integration Time**:
  BER Integration Time carries with Test Pattern Type.
- Number of Frames
  Number of Frames over which bit error result are accumulated to produce the result.

NOTE: When **Continuous Operation = Yes**, all fields will be grayed out while the test is in progress. They will be enabled when the STOP button is pressed.

When **Continuous Operation = No**, a wait cursor will be displayed while the test is in progress and return to normal when the test is done.

3. Press **Start/Stop** button to begin or end BER testing.

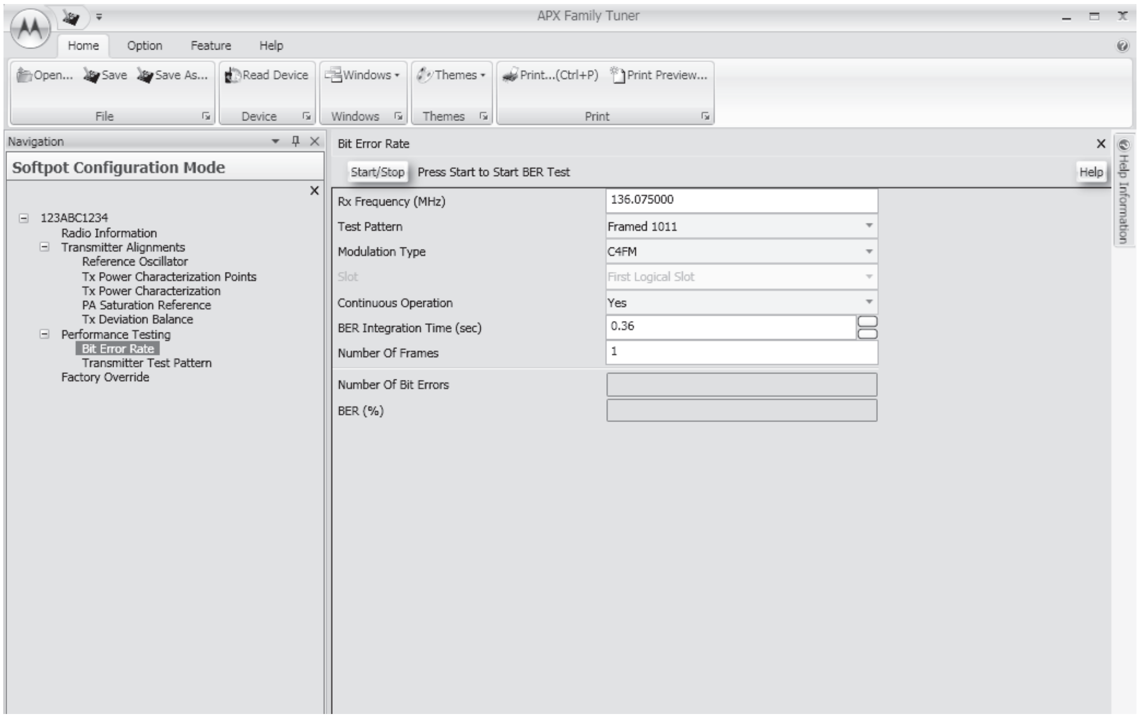

Figure 6-27. Bit Error Rate Screen (VHF)

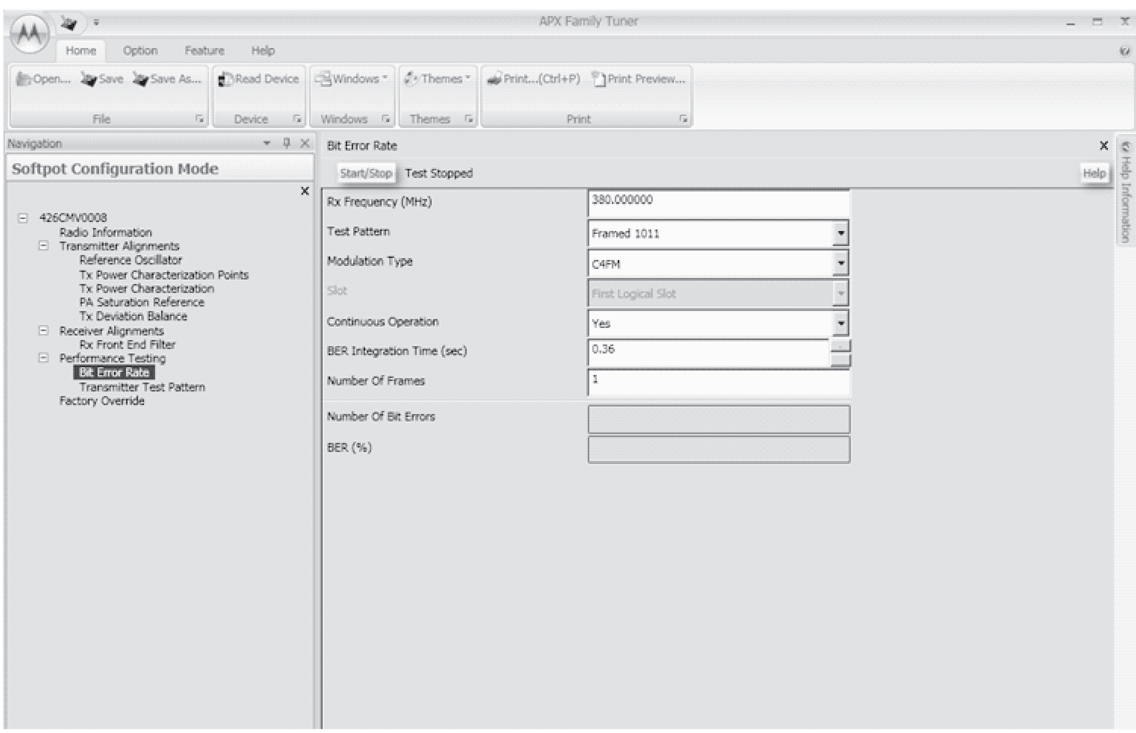

Figure 6-28. Bit Error Rate Screen (UHF1)

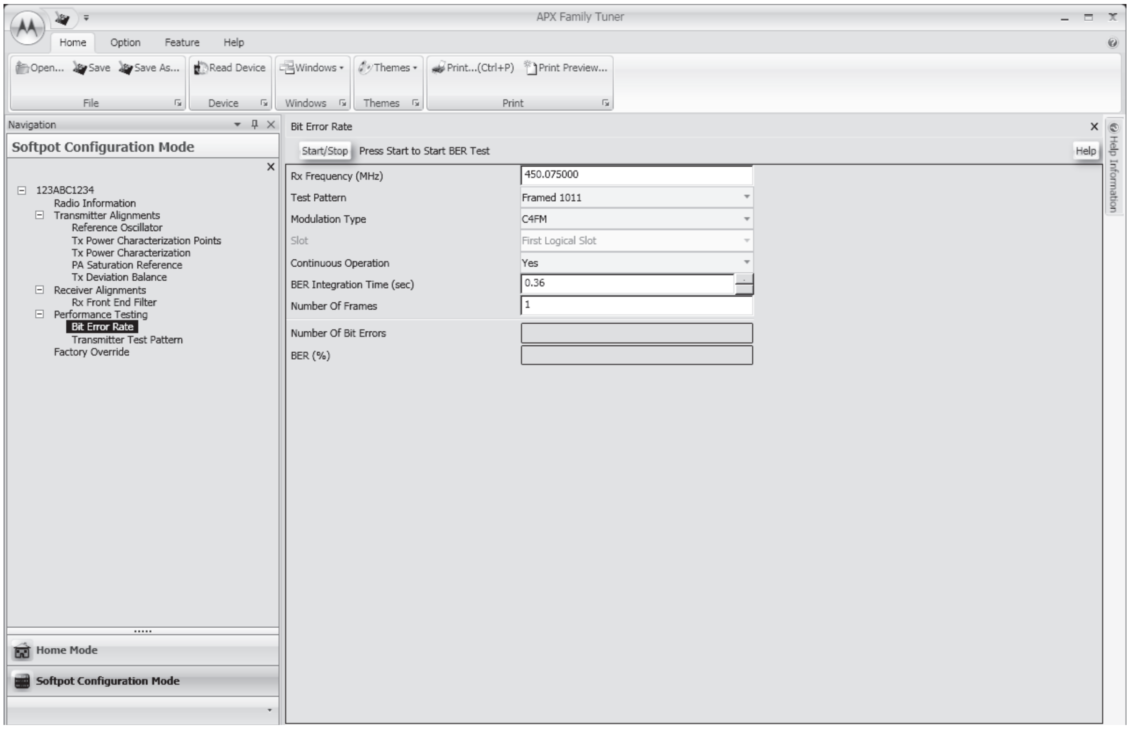

Figure 6-29. Bit Error Rate Screen (UHF2)

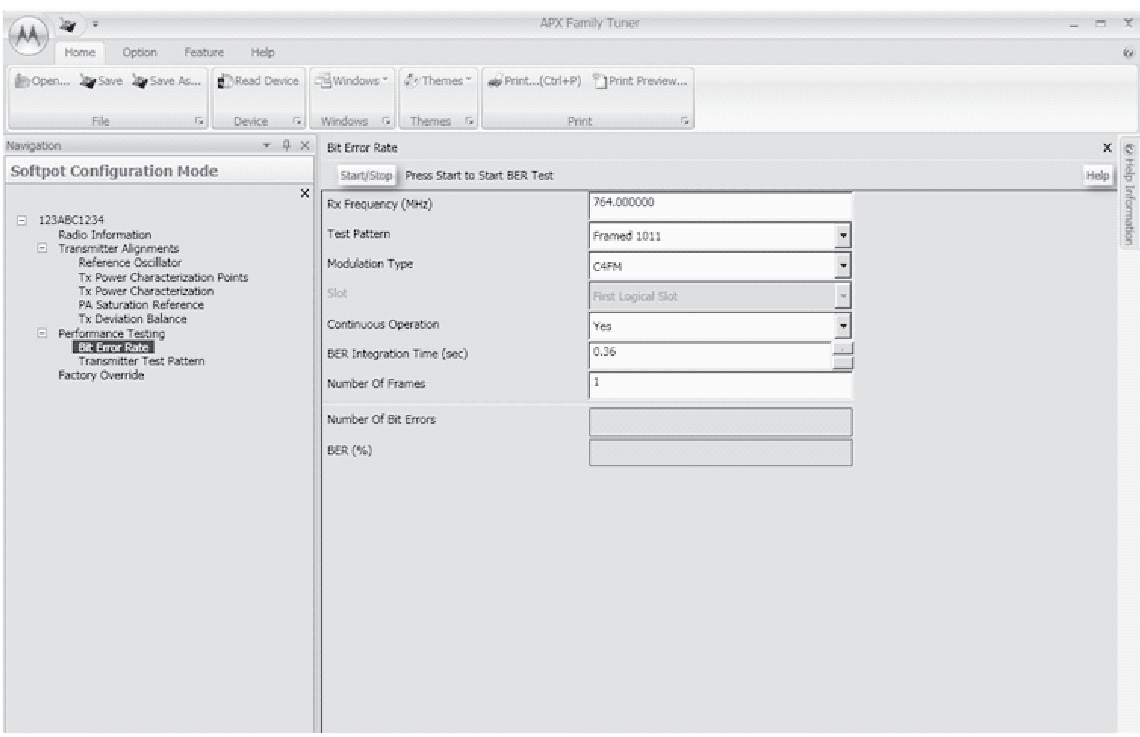

Figure 6-30. Bit Error Rate Screen (700/800 MHz)

6.7.2 Transmitter Test Pattern

The Transmitter Test Pattern test is used to transmit specific test patterns at a desired frequency so that the user can perform tests on the radio's transmitter (see Figure 6-31, Figure 6-32, Figure 6-33 and Figure 6-34).

6.7.2.1 Transmitter Test Fields

This screen contains the following fields:

- **Tx Frequency**:
  This field selects the Transmit Frequency directly in MHz.
- **Channel Spacing**:
  This field allows the user to select the desired transmit deviation in kHz.
- **Test Pattern Type**:
  This field represents the type of test pattern which will be transmitted by the radio when **PTT TOGGLE** button is pressed.

NOTE: Channel Spacing and Test Pattern Type fields will be grayed out while the radio is transmitting.

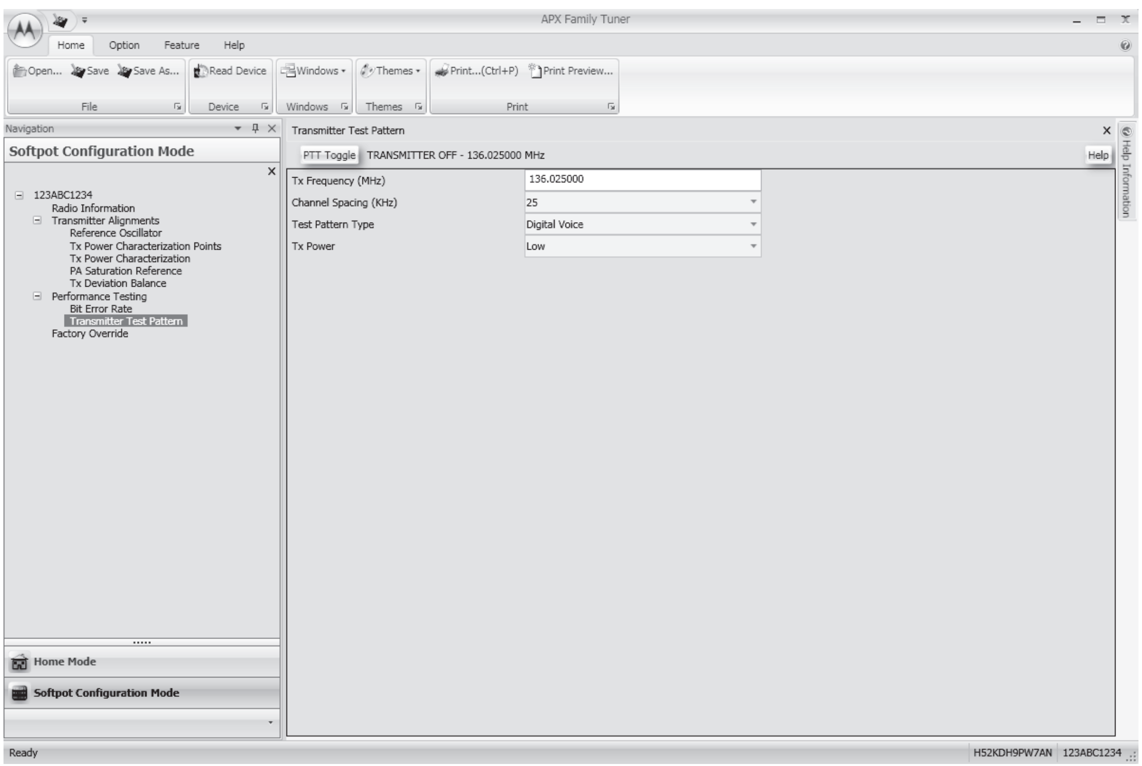

Figure 6-31. Transmitter Test Pattern Screen (VHF)

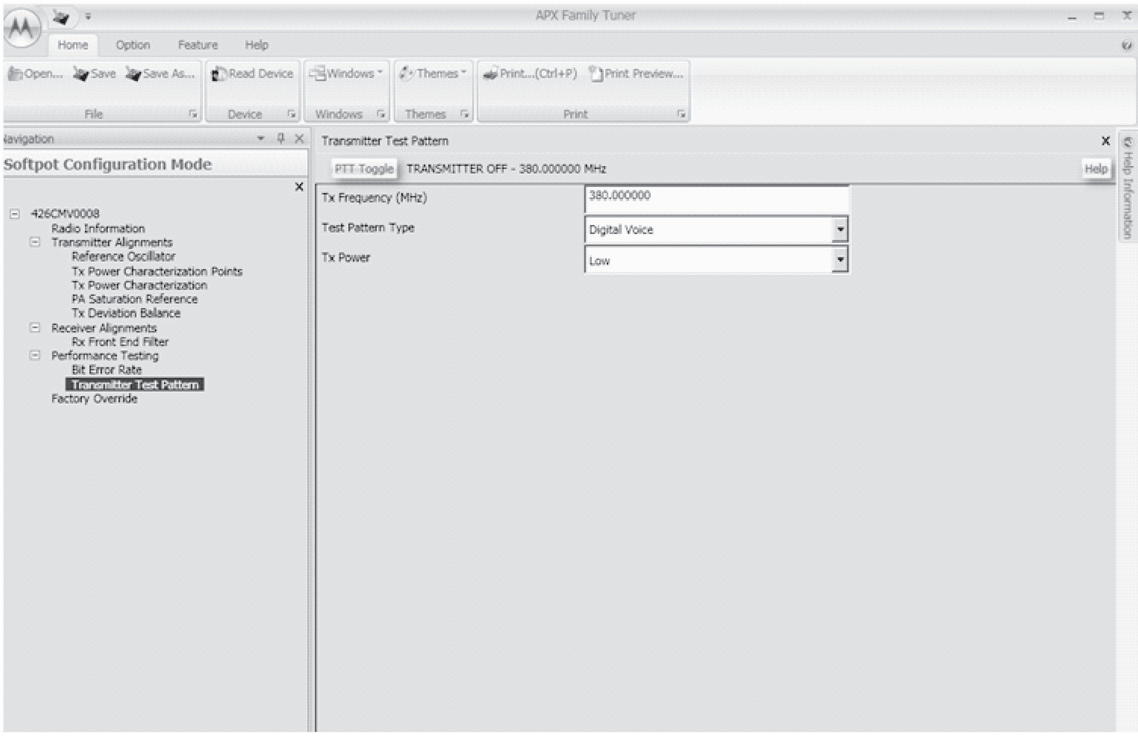

Figure 6-32. Transmitter Test Pattern Screen (UHF1)

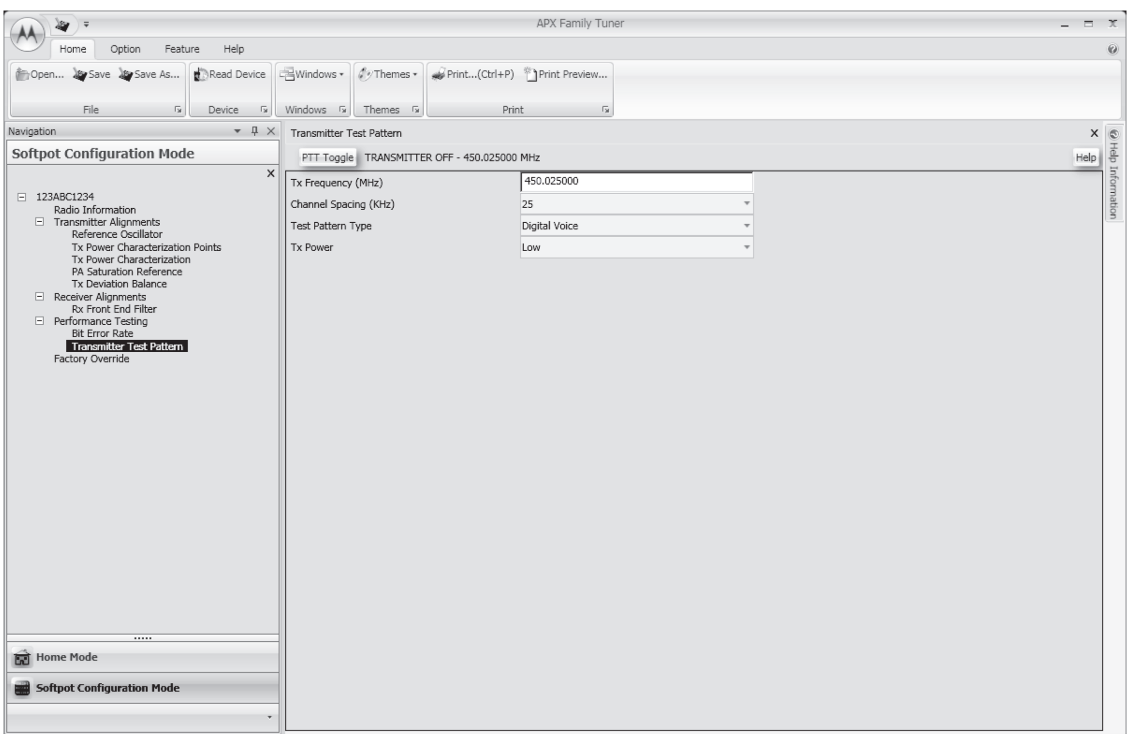

Figure 6-33. Transmitter Test Pattern Screen (UHF2)

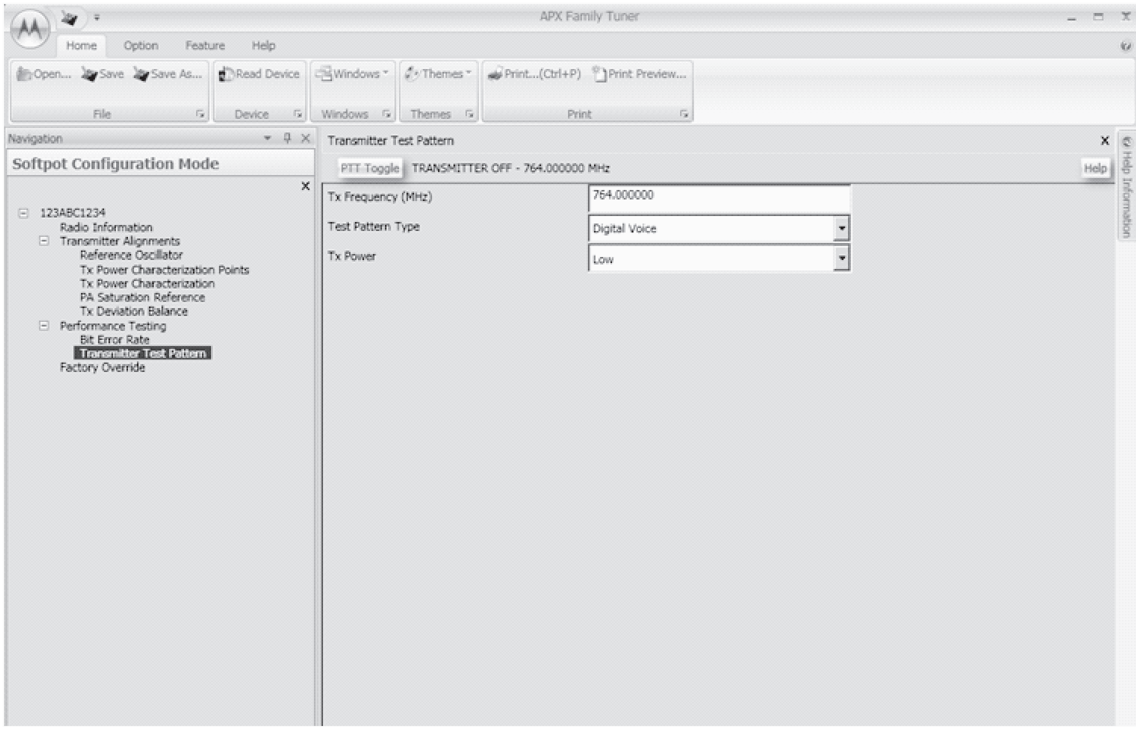

Figure 6-34. Transmitter Test Pattern Screen (700/800 MHz)

Notes

Chapter 7 Encryption

This chapter provides procedures for using the encryption capability of your radio. The following procedures are outlined:

- Loading an encryption key
- Selecting an encryption key
- Selecting an Index
- Erasing an encryption key

7.1 Load an Encryption Key

Keys will be loaded from the KVL to the radio in either clear or encrypted form depending on the configuration of the CPS parameter "KVL – FIPS Level 3 Approved Mode". If the parameter is disabled, keys will be sent in clear form; if the parameter is enabled, keys will be sent to the radio in encrypted form.

NOTE: A KVL3000 Plus with software version R03.52.45 or greater must be used to load keys to a radio with "KVL – FIPS Level 3 Approved Mode" enabled.

To load an encryption key:

1. Refer to the key-variable loader (KVL) manual for equipment connections and setup.
2. Attach the KVL to the radio. "KEYLOADING" is shown on the main display of a configured radio. All other radio functions, except for power down, backlight, and volume, are locked out.
3. Refer to the KVL manual for how to load the encryption keys into the radio.
4. When the key is loaded successfully, you will hear:
   - On single-key radios – a short tone.
   - On multikey radios – an alternating tone.

The secure kits for APX 2000/ APX 4000 (Two Knobs) are identified by the following kit numbers:

Table 7-1. Kit Numbers for Secure-Enabled Keypad Boards (Model 2)

Kit Number	Description
NNTN8791A	ADP/LOcalized Enabled Encryption, Model 2
NNTN8792A	ADP/DVP-XL/Localized Enabled Encryption, Model 2
NNTN8793A	ADP/AES/DES/DES-XL/DES-OFB/Localized Enabled Encryption, Model 2
NNTN8794A	ADP/DES/DES-XL/DES-OFB/CFX-256 Enabledconfigurable Encryption, Model 2
NNTN8795A	ADP/AES/Localized Enabled Encryption, Model 2
NNTN8796A	ADP/AES/DVP-XL/Localized Enabled Encryption, Model 2
NNTN8797A	ADP/CFX-256 Configurable Encryption, Model 2
NNTN8798A	ADP/DVP-XL/CFX-256 Configurable Encryption, Model 2
NNTN8799A	ADP/AES/DES/DES-XL/DES-OFB/CFX-256 Configurable Encryption, Model 2

Table 7-1. Kit Numbers for Secure-Enabled Keypad Boards (Model 2) (Continued)

Kit Number	Description
NNTN8800A	ADP/DES/DES-XL/DES-OFB/CFX-256 Configurableconfigurable Encryption, Model 2
NNTN8801A	ADP/AES/CFX-256 Configurable Encryption, Model 2
NNTN8802A	ADP/AES/DVP-XL/CFX-256 Configurable Encryption, Model 2
NNTN8753A	ADP/DVP-XL KIT W/ Bluetooth, Model 2
NNTN8755A	ADP/AES KIT W/Bluetooth, Model 2
NNTN8757A	ADP/DES/DES-XL/DES-OFB KIT W/ Bluetooth, Model 2
NNTN8752A	ADP KIT W/ Bluetooth, Model 2

Table 7-2. Kit Numbers for Secure-Enabled Keypad Boards (Model 3)

Kit Number	Description
NNTN8779A	ADP/Localized Enabled Encryption, Model 3
NNTN8780A	ADP/DVP-XL/Localized Enabled Encryption, Model 3
NNTN8781A	ADP/AES/DES/DES-XL/DES-OFB/Localized Enabled Encryption, Model 3
NNTN8782A	ADP/DES/DES-XL/DES-OFB/CFX-256 Enabled configurable Encryption, Model 3
NNTN8783A	ADP/AES/Localized Enabled Encryption, Model 3
NNTN8784A	ADP/AES/DVP-XL/Localized Enabled Encryption, Model 3
NNTN8785A	ADP/CFX-256 Configurable Encryption, Model 3
NNTN8786A	ADP/DVP-XL/CFX-256 Configurable Encryption, Model 3
NNTN8787A	ADP/AES/DES/DES-XL/DES-OFB/CFX-256 Configurable Encryption, Model 3
NNTN8788A	ADP/DES/DES-XL/DES-OFB/CFX-256 Configurableconfigurable Encryption, Model 3
NNTN8789A	ADP/AES/CFX-256 Configurable Encryption, Model 3
NNTN8790A	ADP/AES/DVP-XL/CFX-256 Configurable Encryption, Model 3
NNTN8751A	ADP W/ Bluetooth, Model 3
NNTN8758A	ADP/DES/DES-XL/DES-OFB KIT W/ Bluetooth, Model 3
NNTN8756A	ADP/AES KIT W/Bluetooth, Model 3
NNTN8754A	ADP/DVP-XL KIT W/ Bluetooth, Model 3

7.2 Multikey Feature

This feature allows the radio to be equipped with multiple encryption keys. It can support two or more encryption algorithms simultaneously (e.g., AES and DES-XL).

- **Conventional Multikey** – The encryption keys can be tied (strapped), on a one-per-channel basis. In addition, the radio can have operator-selectable keys, operator-selectable indices, and operator-selectable key erasure. If talkgroups are enabled in conventional, then the encryption keys are strapped to the talkgroups.
- **Trunked Multikey** – If the radio is used for both conventional and trunked applications, strap the encryption keys for trunking on a per- talkgroup or announcement group basis. In addition, a different key can be strapped to other features; for example, dynamic regrouping, failsoft, or emergency talkgroup. The radio can have operator-selectable key erasure.

7.3 Select an Encryption Key

You can select an encryption key using either the menu or the keypad.

7.3.1 Use the Menu

To select an encryption key using the menu:

1. Press ▶ until the display shows "Key".
2. Press (•), (••), or (•••) directly below "Key". The display shows the last user-selected and -stored encryption key.
3. Press ▲ or ▼ to scroll through the list of encryption keys.

   NOTE: If a deleted key is selected, "ERASED KEY" will be displayed.
4. Press (•), (••), or (•••) directly below the desired menu.
   - SEL = saves the newly selected key and returns to the home display.
5. Press (home), the **PTT** button, or (•), (••), or (•••) directly below "Exit", or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows "KEY FAIL" and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows "ILLEGAL KEY" and the radio sounds a momentary illegal key tone.

7.3.2 Use the Keypad

To select an encryption key using the keypad:

1. Press ▶ until the display shows “Key”.
2. Press (•), (••), or (•••) directly below “Key”. The display shows the last user-selected and -stored encryption key.
3. Using the keypad, enter the number of the desired key.

   NOTE: If a deleted key is selected, “ERASED KEY” will be displayed.

4. Press (•), (••), or (•••) directly below the desired menu.
   - SEL = saves the newly selected key and returns to the home display.
5. Press ⌂, the **PTT** button, or (•), (••), or (•••) directly below “Exit”, or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows “KEY FAIL” and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows “ILLEGAL KEY” and the radio sounds a momentary illegal key tone.

7.4 Select an Encryption Index

This feature lets the user select one or more groups of several encryption keys from among the available keys stored in the radio. For example, the radio could have a group of three keys structured to one index, and another group of three different keys structured to another index. Changing indices makes the radio automatically switch from one set of keys to the other. Every channel to which one of the original keys was tied will now have the equivalent new key instead.

7.4.1 Use the Menu

To select an index using the menu:

1. Press ▶ until the display shows “KSet”.
2. Press (•), (••), or (•••) directly below “KSet”. The display shows the last user-selected and -stored index.
3. Press ▲ or ▼ to scroll through the list of encryption keys.

   NOTE: If a deleted key is selected, “ERASED KEY” will be displayed.

4. Press (•), (••), or (•••) directly below the desired menu.
   - SEL = saves the newly selected key and returns to the home display.
5. Press ⌂, the **PTT** button, or (•), (••), or (•••) directly below “Exit”, or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows “KEY FAIL” and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows “ILLEGAL KEY” and the radio sounds a momentary illegal key tone.

7.4.2 Use the Keypad

To select an index using the keypad:

1. Press ▶ until the display shows "KSet".
2. Press (•), (••), or (•••) directly below "KSet". The display shows the last user-selected and -stored index.
3. Using the keypad, enter the number of the desired key.

   NOTE: If a deleted key is selected, "ERASED KEY" will be displayed.

4. Press (•), (••), or (•••) directly below the desired menu.
   - SEL = saves the newly selected key and returns to the home display.
5. Press ⌂, the **PTT** button, or (•), (••), or (•••) directly below "Exit", or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows "KEY FAIL" and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows "ILLEGAL KEY" and the radio sounds a momentary illegal key tone.

7.5 Erase an Encryption Key

This section describes two methods for erasing an encryption key.

7.5.1 Method 1 – Key Zeroization (Multikey Only)

To zeroize an encryption key:

1. Press ▶ until the display shows "Eras".
2. Press (•), (••), or (•••) directly below "Eras". The display shows the last user-selected and -stored encryption key.
3. Press ▲ or ▼ to scroll through the list of encryption keys.
4. Select single encryption key or all encrytion keys deletion from the "OPTN" menu.
5. Press ⌂, the **PTT** button, or (•), (••), or (•••) directly below "Exit", or turn the **Multi-function** knob to exit this menu.
   - If the selected key is erased, the display shows "KEY FAIL" and the radio sounds a momentary keyfail tone.
   - If the selected key is not allowed, the display shows "ILLEGAL KEY" and the radio sounds a momentary illegal key tone.

7.5.2 Method 2 – All Keys Erased

To erase all encryption keys at one time:

With the radio on, press and hold the **Top Side** button and, while holding this button down, press the **Top** button.

NOTE: **DO NOT** press the **Top** button before pressing the **Top Side** button unless you are in an emergency situation. This sends an emergency alarm.

Before the keys are erased, the display shows "PLEASE WAIT".

When all the encryption keys have been erased, the display shows "ALL KEYS ERASED".

Notes

Chapter 8 Disassembly/Reassembly Procedures

This chapter provides detailed procedures for disassembling/reassembling and ensuring submergibility of the APX 2000/ APX 4000 (Two Knobs) radios. When performing these procedures, refer to “Chapter 10: Exploded Views and Parts Lists” and the diagrams that accompany the text. Items in parentheses ( ) throughout this chapter refer to item numbers in the exploded view diagrams and their associated parts lists.

This chapter also has procedures for removing and installing the APX 2000/ APX 4000 (Two Knobs) radio’s standard accessories.

8.1 APX 2000/ APX 4000 (Two Knobs) Exploded View (Main Subassemblies)

Caution	When servicing electronics, always ensure that you are properly grounded with antistatic grounding system approved for electronics handling.

This section contains the APX 2000/ APX 4000 (Two Knobs) radio partially exploded views.

NOTES:

- Refer to Figure 8-1, the Partial Exploded View, and Table 8-1, the Partial Exploded View Parts List.
- Letters in parentheses ( ) refer to item letters in Figure 8-1 and Table 8-1.

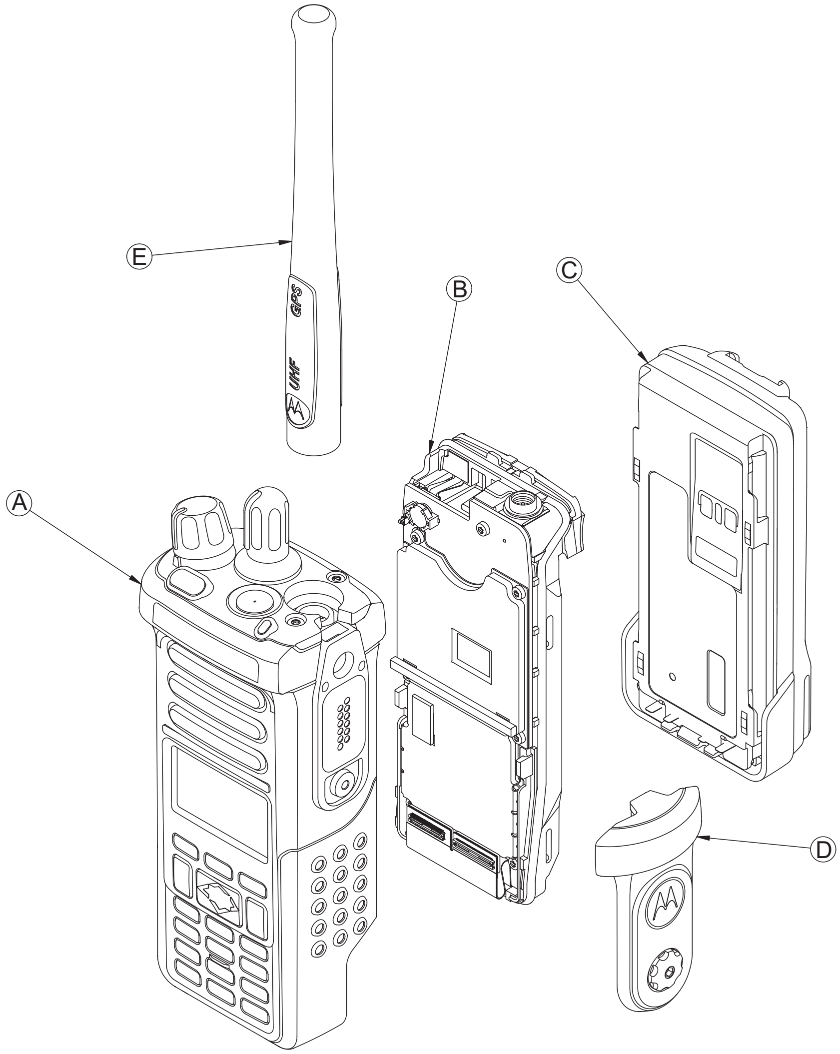

Figure 8-1. APX 2000/ APX 4000 (Two Knobs) Partial Exploded View

Table 8-1. APX 2000/ APX 4000 (Two Knobs) Partial Exploded View Parts List

Item Letter	Description	Exploded View and Parts List
A	Front Kit Assembly	Refer Figure 10-1.
B	Back Kit Assembly	Refer Figure 10-2.
C	Battery Assembly	Refer Figure 10-2.
D	Accessory-Connector Cover Assembly	Refer Figure 10-1.
E	Antenna Assembly	Refer Figure 10-1.

8.2 Required Tools and Supplies

Table 8-2. Required Tools and Supplies

Tools	Motorola Part Number	Supplier	Supplier Part Number	Remarks
Chassis/Knob Opener	PMLN7204A	Horizon Land Sdn. Bhd.	14-8973	To remove chassis and knob from housing.
Bit, Torx T6	–	–	–	For speaker retainer, back kit (chassis) and keypad retainer.
Bit, Torx T8	–	–	–	For top bezel screw.
Volume Switch Spanner Nut opener	TL000063A01	Brusia	BE-MO-143828	For Volume Switch Spanner Nut.
Driver, Torque	–	–	–	–
Black Stick	–	Hexacon Electric Co.	MA-800G	For keypad rubber mushroom rib assembly and disassembly.
Round Stick	–	Brusia	BE-MO-14383	For microphone membrane assembly.
Allen Wrench	–	–	–	To loosen accessory-connector cover thumb screw (if thumb screw is too tight).
ESD Table Mat	–	–	–	To place radio and components during disassembly and reassembly.
Vacuum Pump kit	NLN9839_	Motorola	–	For vacuum test.
Vacuum Test Fixture	TL000059A01	Brusia	BE-MO-141326	To connect the vacuum/pressure hose of the Vacuum Pump Kit to the radio.
Vacuum Cap	TL000061A01	Brusia	VP6RSE	To enhance sealing when the vacuum test fixture is connected to the radio.
Pressure Test Fixture	TL000062A01	Brusia	BE-MO-143143	To connect the vacuum/pressure hose of the Pressure Pump Kit to the radio.
Pressure Pump Kit	NTN4265_	Motorola	–	For pressure test.

8.3 Fastener Torque Chart

Table 8-3 lists the various fasteners by part number and description, followed by the torque values and the location where used. Torque all fasteners to the recommended value when assembling the radio.

Table 8-3. Fastener Torque Chart

Motorola Part Number	Description	Repair Torque (in-lbs)
0386104Z04	Speaker retainer (1)	4.6
0386104Z04	Chassis screw (42)	3
0378212A02	Keypad retainer screw (33)	1.2
FN000080A01	Nut, Volume Switch Spanner (25)	8
0275000H02	Nut, Switch Spanner (6)	8
FN000083A01	Top Bezel screw (23)	8

8.4 Radio Disassembly

This section contains instructions for disassembling the radio's main subassemblies.

Prepare the radio for disassembly:

- Turn off the radio by turning the Volume Knob (27) clockwise until a click sound is heard.
- Remove the antenna, the battery, the Accessory-Connector cover (36), the Bottom Label (39) and any other accessory connected to the radio.

8.4.1 Remove Battery (61)

WARNING

To avoid a possible explosion:
- **DO NOT charge, remove, or attach the battery in an area labeled "hazardous atmosphere."**
- **DO NOT discard batteries in a fire.**

Caution

If the radio is programmed for volatile-key retention, encryption keys will be retained for approximately 30 seconds after battery removal.

NOTE: The Motorola-approved battery shipped with the APX 2000/ APX 4000 (Two Knobs) radio is uncharged. Prior to using a new battery, charge it per the recommended procedure for the battery.

1. With the radio turned off, lift up the latch located at the bottom of the battery.

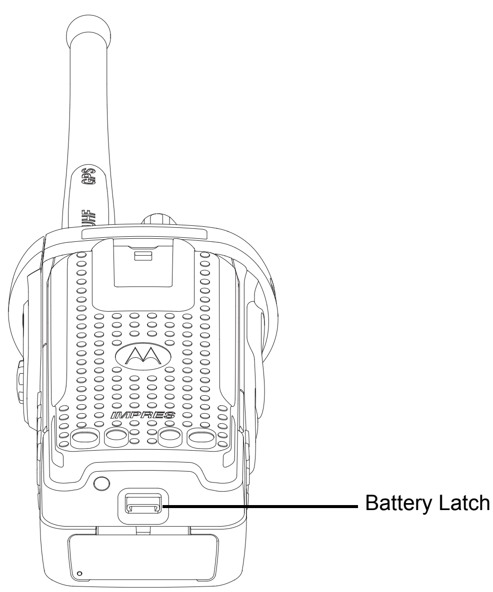

Figure 8-2. Lifting up the latch

2. While lifting the latch, remove the battery by sliding it out as shown.

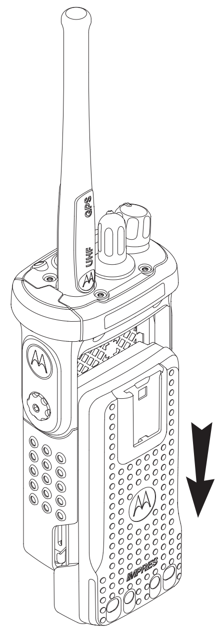

Figure 8-3. Removing the Battery

8.4.2 Remove Antenna (40)

1. With the radio turned off, turn the antenna counter-clockwise to remove it from the radio.

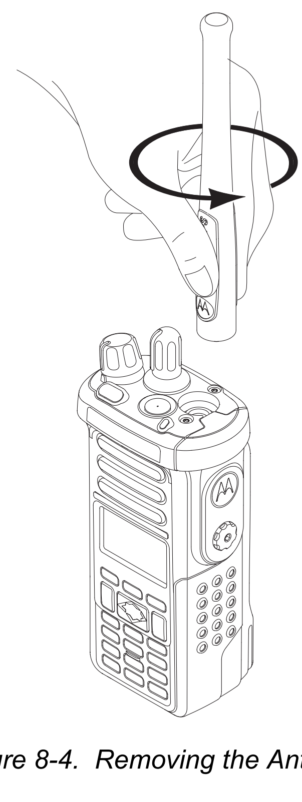

Figure 8-4. Removing the Antenna

8.4.3 Remove Volume Knob and Channel Knob (27)(28)

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis/Knob opener (P/N: PMLN7204A), grasp the Volume Knob and pull it upward, until it is free from its shaft.
3. Repeat Step 1 and 2 to remove the Channel Knob.

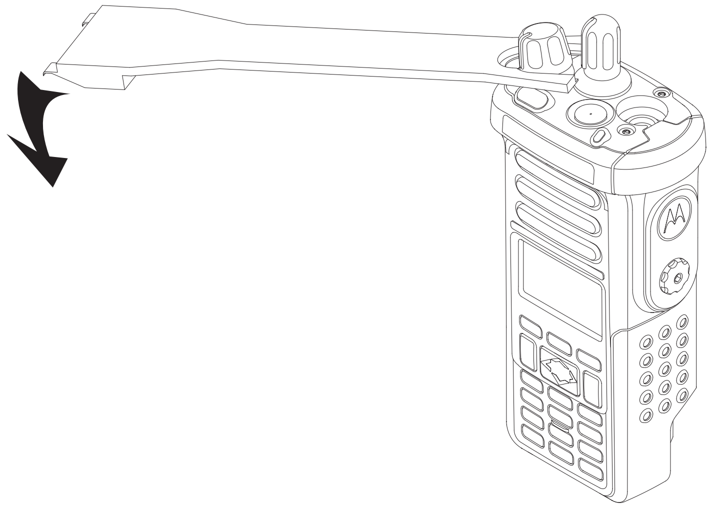

Figure 8-5. Removing the Volume Knob

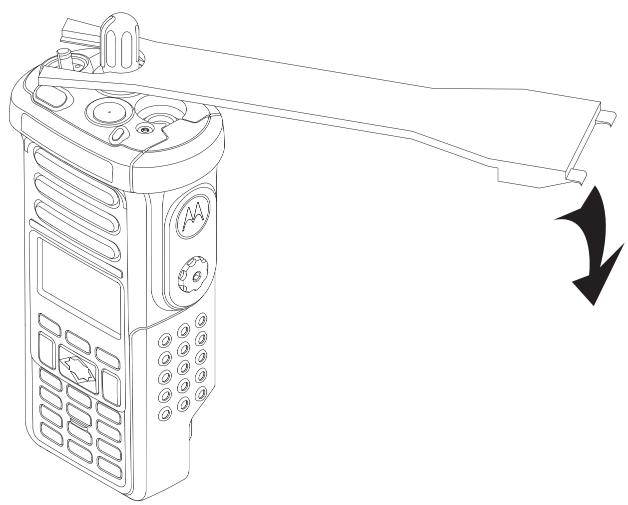

Figure 8-6. Removing the Channel Knob

8.4.4 Remove Accessory-Connector Cover (38)

Caution

When the accessory connector is not in use, keep it covered with the Accessory-Connector Cover (38).

1. Unscrew the thumb screw. If the screw is too tight, use an Allen wrench.

   NOTE: Do not remove the screw. It should remain captive in the cover.

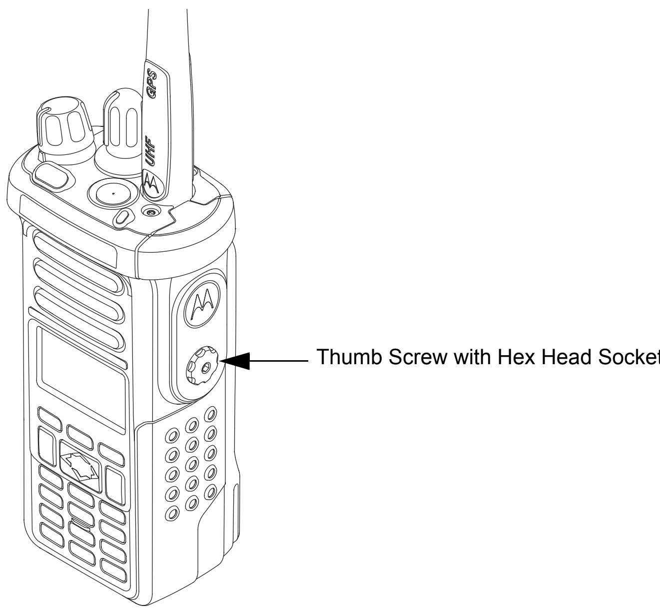

Figure 8-7. Removing the Thumb Screw

2. Slightly swing the Accessory-Connector Cover away from radio before sliding it upward to disengage the hook.
3. Pull the Accessory-Connector Cover away from the radio.

8.4.5 Remove Top Bezel (20)

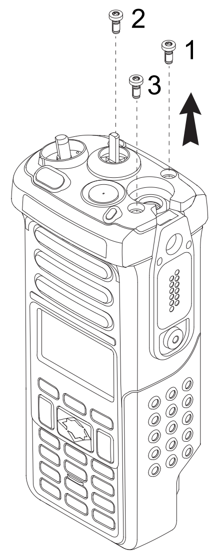

Figure 8-8. Unscrew the screws

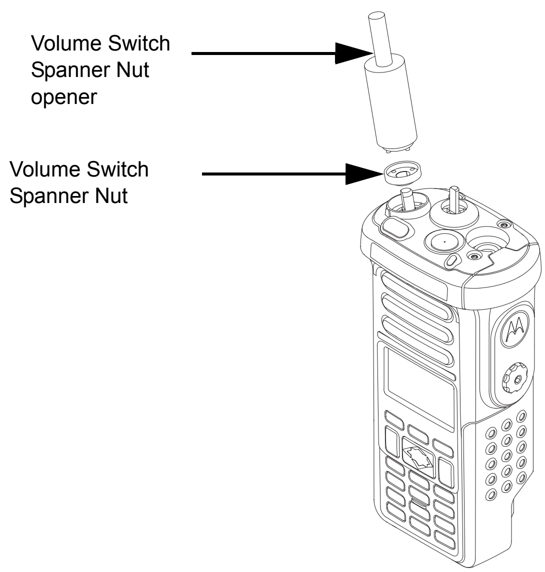

Figure 8-9. Removing the Volume Switch Spanner Nut

1. Unscrew the three screws with Torx IP8 Bit.
2. Remove the Volume Switch Spanner Nut using the Volume Switch Spanner Nut opener (P/N: TL000063A01).

8.4.6 Removal of the Back Kit Assembly (B)

This section contains instructions for disassembling the radio.

8.4.6.1 Removal of the Chassis (54)

1. With the Battery removed, disengage the Chassis (54) using the Chassis/Knob opener (P/N: PMLN7204A) as shown in Figure 8-10.

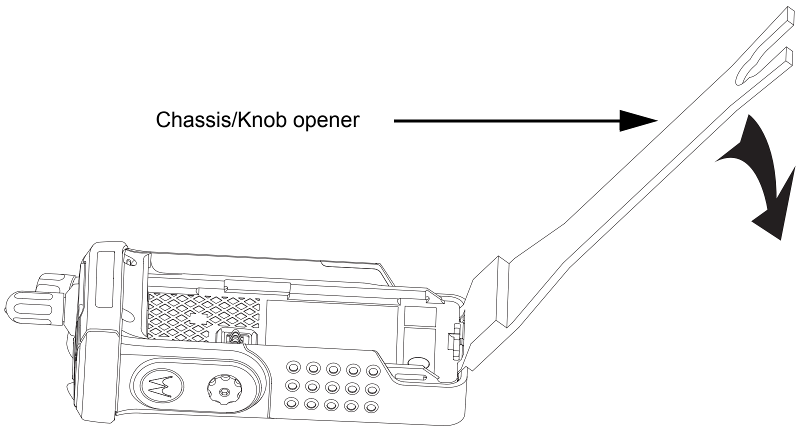

Figure 8-10. Disengage the Chassis

NOTE: The Vacuum Port seal (56) and the Ventilation Label (57) must be removed each time the Chassis is removed (for leak test).

2. After the Chassis (54) is disengaged, slide the chassis assembly down and lift it away from the Front Kit (A) and lay both sub-assemblies on the ESD table mat as shown in Figure 8-11.

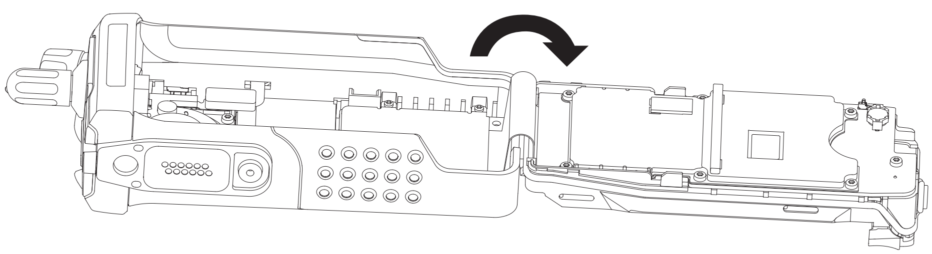

Figure 8-11. Remove the Chassis Assembly

8.4.6.2 Removal of the Secondary Shield Assembly (44)

1. Remove the chassis screws (42) with Torx IP6 Bit as shown in Figure 8-12.

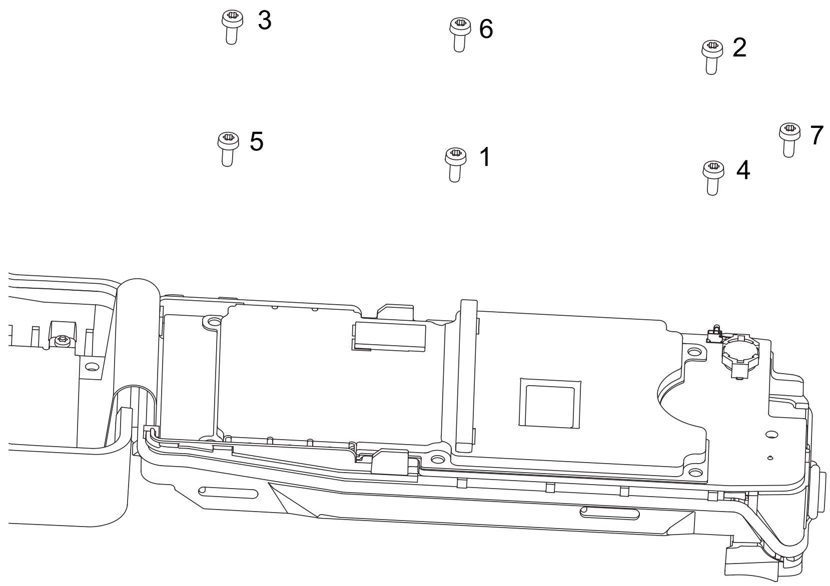

Figure 8-12. Remove the Chassis Screws

2. With the chassis screws removed, lift the Secondary Shield Assembly (44) out from the Chassis (54) as shown in Figure 8-13.

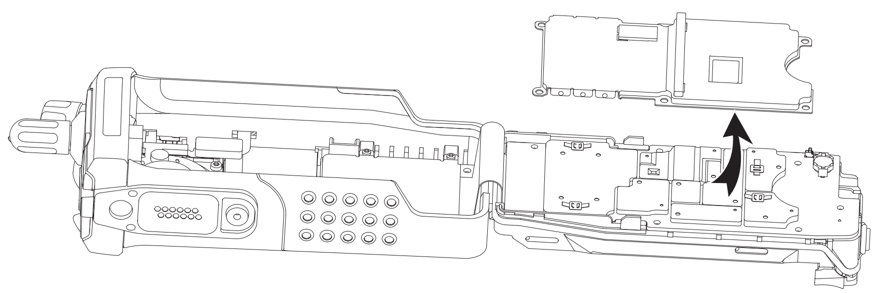

Figure 8-13. Remove the Secondary Shield Assembly

8.4.6.3 Removal of the Main Board (45)

1. Remove the Main O-Ring (48) at the antenna holder as shown in Figure 8-14.

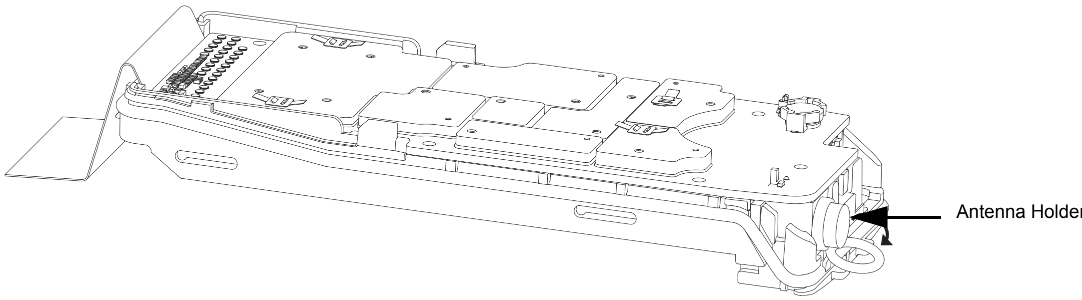

Figure 8-14. Remove the Main O-Ring at the antenna holder

2. Lift up the Main Board (45) from the Chassis (54) towards the Front Housing (19) and gently unplug the connectors from the Back Kit Flex (43) to remove the Main Board as shown in Figure 8-15. and Figure 8-16 respectively.

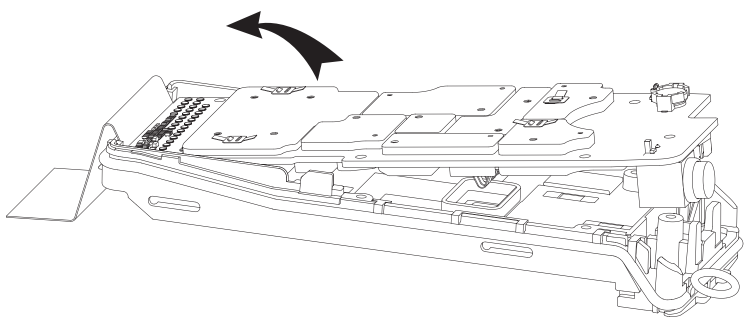

Figure 8-15. Lift up the Main Board from the Chassis

Caution	When separating the small interconnects, care is needed to avoid damage to the interconnect and surrounding on-board components.

Caution	Place the Main Board on the anti-static mat or in a clean and ESD safe area to avoid electrical damage to the electronics. Replace the Thermal Pad (47) whenever the Main Board is removed.

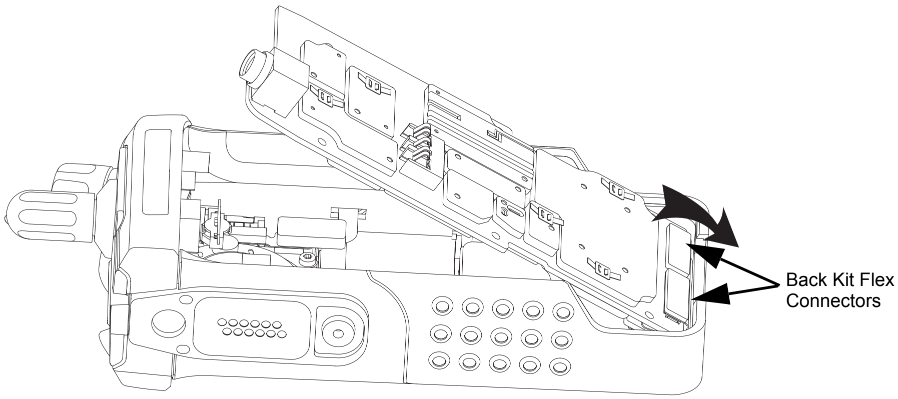

Figure 8-16. Unplug the Back Kit Flex connectors

8.4.6.4 Removal of the Shroud (60)

1. Place the black stick into the opening below the Shroud (60) to aid the disengagement of the Shroud. With the black stick still in place, slide the Shroud downwards at both sides to remove the Shroud from the Chassis (54).

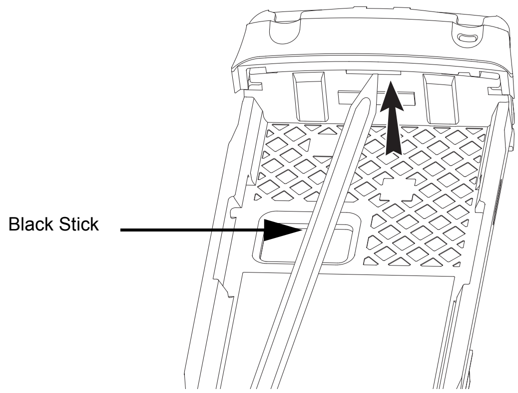

Figure 8-17. Disengage the Shroud

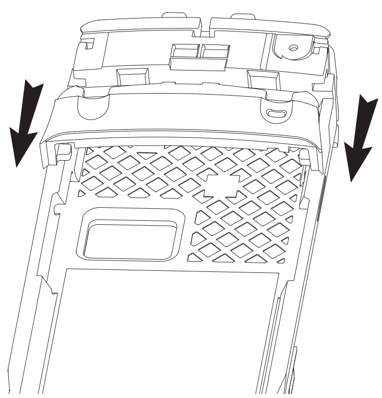

Figure 8-18. Remove the Shroud

8.4.6.5 Removal of the Keypad Retainer (34)

1. With the Back Kit Flex (43) connectors unplugged from the Main Board (45) as shown in Figure 8-16., remove the Keypad Retainer Screws (33) with Torx IP6 Bit as shown in Figure 8-19.

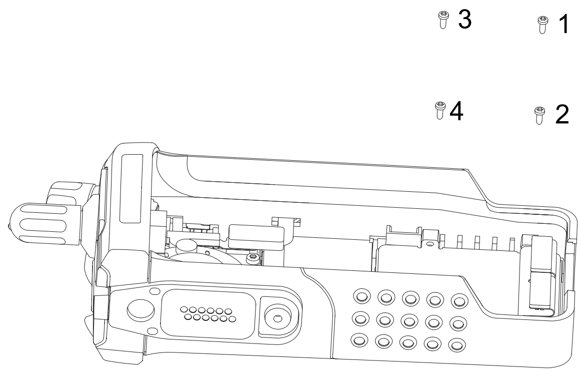

Figure 8-19. Remove the Keypad Retainer Screws

2. Lift out the Keypad Retainer (34) from the Front Housing (19) as shown in Figure 8-20.

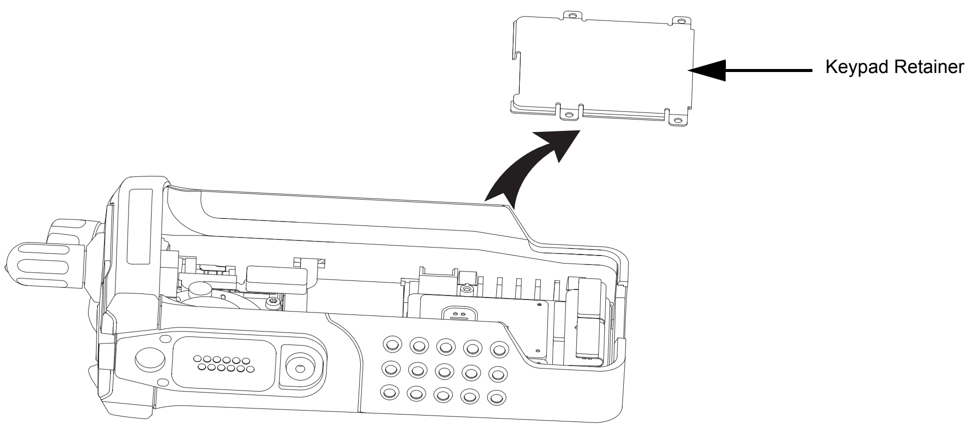

Figure 8-20. Remove the Keypad Retainer

8.4.6.6 Removal of the Keypad Board (35)

1. With the Keypad Retainer (34) removed, gently unplug the connectors of the Front Kit flex (3) and Back Kit Flex (43) to remove the Keypad Board (35) as shown in Figure 8-21.

Caution	When separating the flex and small interconnects, care is needed to avoid damage to the interconnect and surrounding on-board components

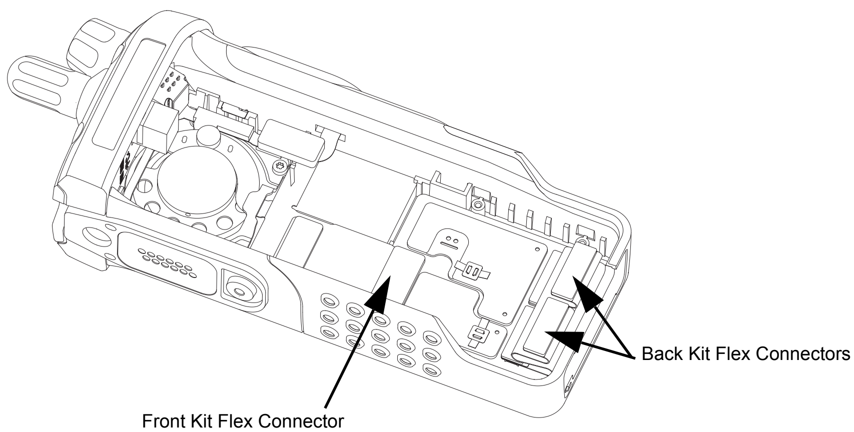

Figure 8-21. Unplug the Front Kit Flex and Back Kit Flex Connectors

2. With the connectors unplugged, gently lift the Keypad Board (35) out of the Front Housing (19) with the aid of the black stick as shown in Figure 8-22.

Caution	When lifting the Keypad Board (35) with the black stick, care is needed to avoid piercing and damage to the Keypad.

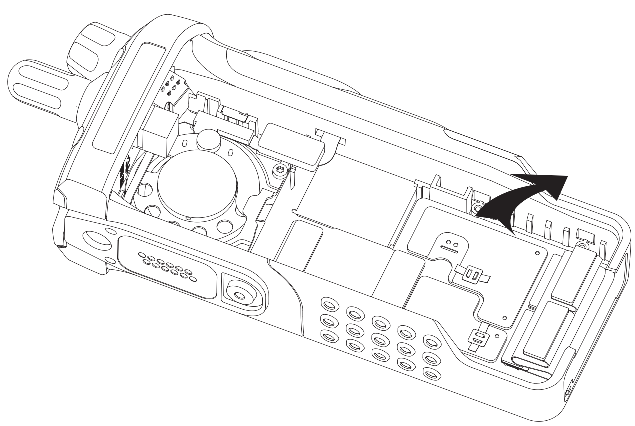

Figure 8-22. Remove the Keypad Board

8.4.6.7 Removal of the Keypad (37)

1. With the Keypad Board (35) removed, gently press the Keypad (37) from the front of the Front Housing (19) with fingers or with the aid of the back of the black stick to disengage the Keypad from the rib as shown in Figure 8-23.

> **Caution**
>
> When disengaging and removing the Keypad, care is needed to avoid tearing and damange to the Keypad.

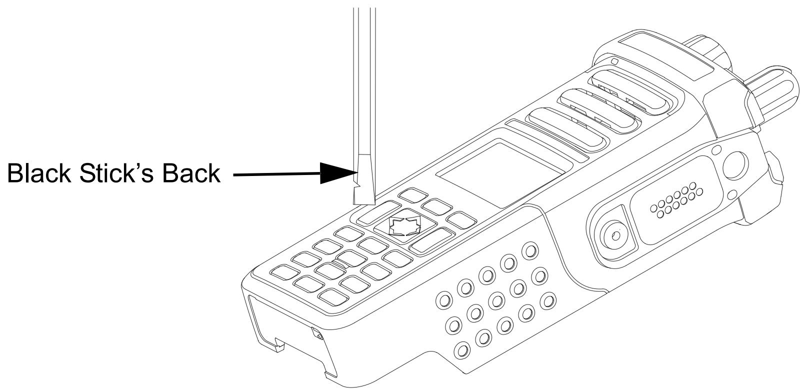

Figure 8-23. Disengage the Keypad

2. With the Keypad (37) disengaged from the rib, gently lift it out from the Front Housing (19).

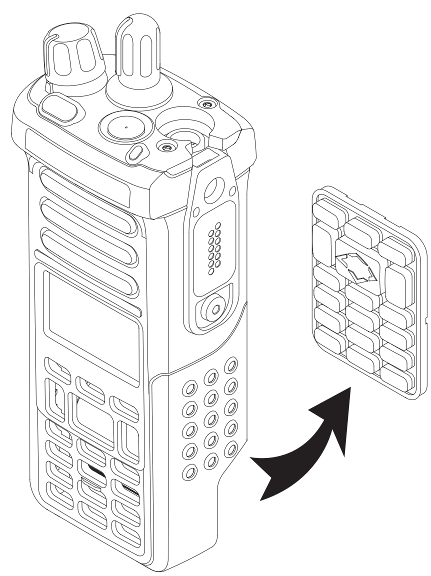

Figure 8-24. Remove the Keypad

8.4.7 Removal of the Front Kit Assembly (A)

1. Complete the steps in Section 8.4.6.1. and Section 8.4.6.5. through Section 8.4.6.7.

2. With the steps completed, the Front Kit Assembly (A) is obtained.

8.5 Serviceable Components of the Main Sub-Assemblies

8.5.1 Servicing Main Board Assembly

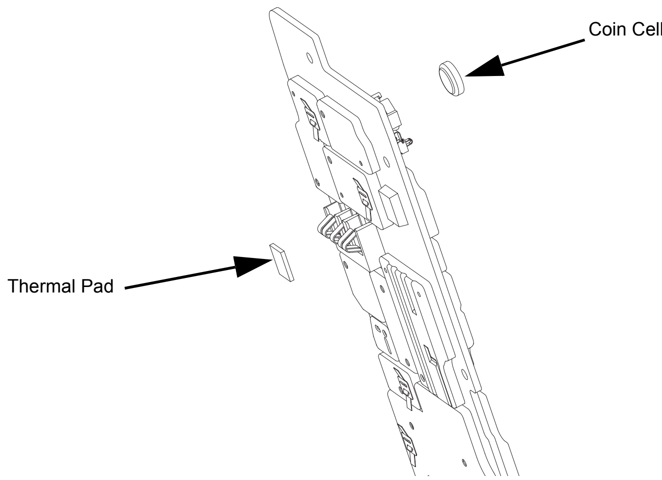

Figure 8-25. Serviceable Components – Main Board Assembly

8.5.1.1 Servicing Coin Cell:

1. Complete steps from Section 8.4.6.1. through Section 8.4.6.3.
2. Remove the coin cell with the Black Stick.

NOTE: Make sure the positive side is facing upwards.

3. Press the new coin cell into the battery carrier until it is secured and fully snapped into place.

8.5.1.2 Servicing Thermal Pad:

1. Complete steps from Section 8.4.6.1. through Section 8.4.6.3.
2. Carefully peel off the pad.
3. Ensure there is no debris or residue left on the amplifier's surface.
4. Replace with new Thermal Pad.
5. Peel the liner off the new pad and place in the respective location. Make sure the bottom surface of the pad is mating with the top surface of the amplifier.
6. Apply slight pressure to activate the adhesive.

Thermal pad should always be replaced when the Main board assembly is removed.

8.5.2 Servicing Chassis Assembly

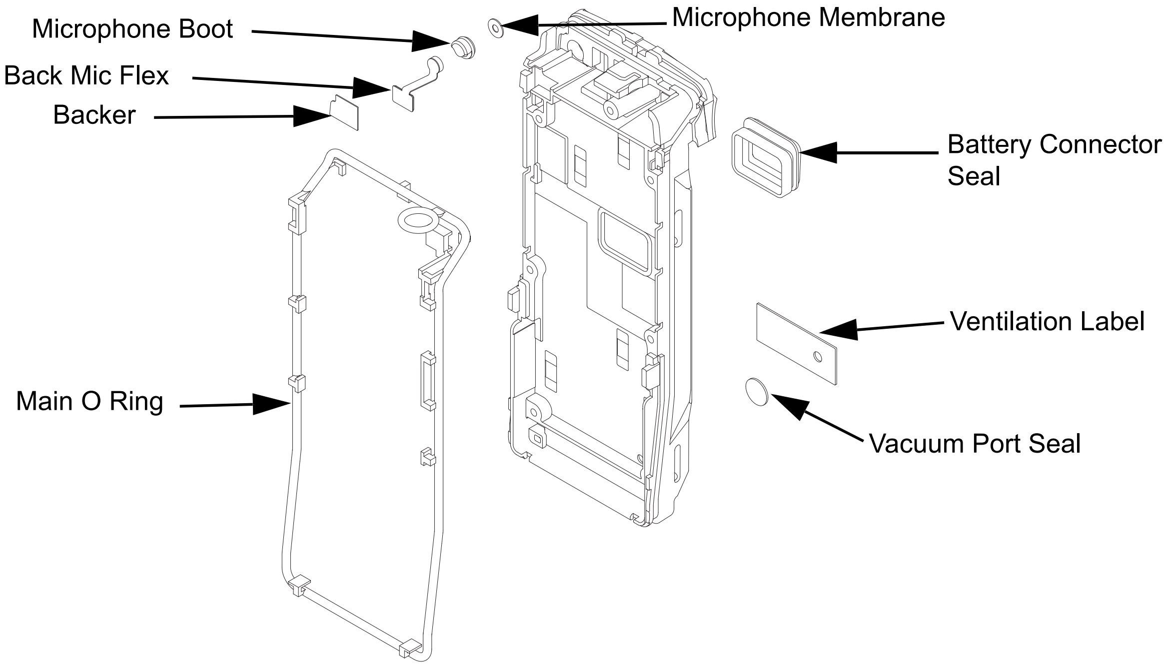

Figure 8-26. Serviceable Components – Chassis Assembly

8.5.2.1 Servicing Ventilation Label:

1. Complete steps in Section 8.4.
2. Carefully peel off the label.
3. Use the Black Stick to help remove any difficult sections of the label.
4. Clean the area once the label is removed to ensure it is free from adhesive and debris.
5. Peel the new label off its backer and place in the respective location.
6. Apply slight pressure for 10 seconds to set the adhesive.

> **Caution**
>
> Ventilation label should always be replaced when back kit assembly is removed.

8.5.2.2 Servicing Vacuum Port Seal:

1. Complete steps in Section 8.4.
2. Carefully peel off the seal.
3. Use the Black Stick to help remove any difficult sections of the seal.
4. Clean the area once the seal is removed to ensure it is free of adhesive and debris.
5. Peel the new seal of its backer and place it in the respective location.
6. Apply slight pressure for approximately 30 seconds to activate the adhesive.

Caution: Vacuum port seal should always be replaced when back kit assembly is removed.

8.5.2.3 Servicing Battery Contact Seal:

1. Complete steps from Section 8.4.6.1. through Section 8.4.6.3.
2. Pinch the Battery Contact Seal inwards and remove it from the chassis opening.
3. Slot the new Battery Contact Seal until it is properly seated onto the Chassis surface.

8.5.2.4 Servicing Main O Ring:

1. Complete steps from Section 8.4.6.1. through Section 8.4.6.3.
2. Remove the Main O Ring with the aid of a Black Stick.
3. Replace the new Main O Ring into the groove provided in the Chassis.
4. Ensure that the seal is set properly and not stretched.

8.5.2.5 Servicing Microphone Boot:

NOTE: When servicing Microphone Boot, the Microphone Membrane part will also need to be replaced.

1. Carefully remove the microphone assembly out of the chassis opening.
2. With the aid of a Black Stick, dislodge the Microphone Boot and carefully slide out the microphone cartridge. Make sure the flex is not stretched. Ensure nothing comes in contact with the microphone while changing to a new Microphone Boot.
3. Press inward the new Microphone Boot to open up the clearance for the microphone assembly. Fit in the microphone cartridge. Make sure the flex is not stretched.
4. Ensure the microphone cartridge is seated properly within the Microphone Boot.
5. Ensure the Microphone Boot is correctly seated within the chassis opening.
6. Follow Section 8.5.2.6. (steps 4 to 6) to complete assembling and placing the Microphone Membrane.

8.5.2.6 Servicing Microphone Membrane:

1. Carefully remove the Microphone Membrane from the chassis opening using the Black Stick.
2. Use the pointed tip of the Black Stick to scrap off pieces of adhesives after removing the membrane.
3. Use a cotton bud dipped in IPA Cleaning Solvent to clean the area to remove remaining adhesive and debris.
4. Ensure the Microphone is seated properly within the Microphone Boot opening.
5. Remove the new Microphone Membrane from its backer.
6. Ensure that the area is dry (solvent fully evaporated) before carefully placing the new Microphone Membrane. The membrane needs to be centered on the surface of the microphone boss area on the Chassis. Ensure that the membrane is flat with no ripples or folds. Press down firmly, applying slight pressure to activate the adhesive using the Round Stick.
7. Ensure that the Microphone Boot is seated correctly within the chassis opening.

8.5.3 Servicing Main Housing

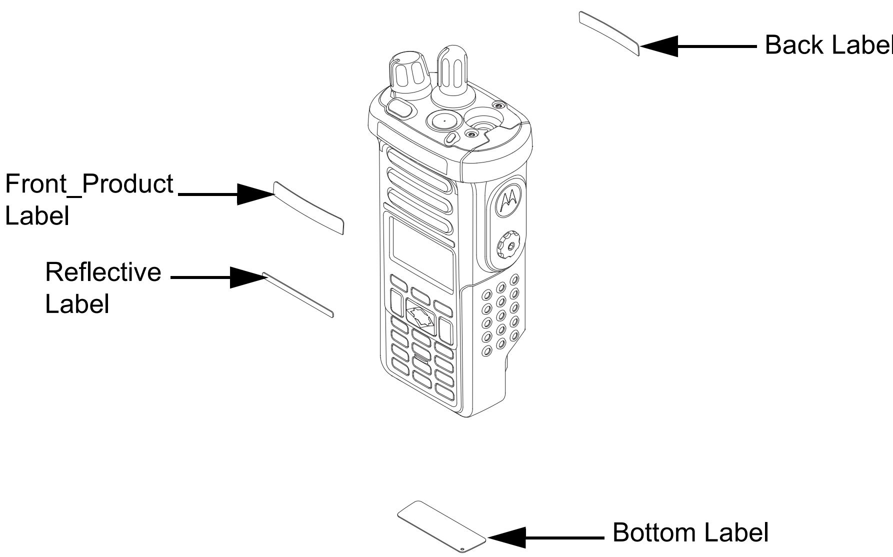

Figure 8-27. Serviceable Components – Main Housing

8.5.3.1 Servicing Front_Product Label

NOTE: There is no need to remove any component in order to service the Front_Product Label.

1. Scrap off the Front_Product Label with the Black Stick.
2. Clean the area once the Front_Product Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the new replacement label for 10 seconds.

8.5.3.2 Servicing Back Label

NOTE: There is no need to remove any component in order to service the Back Label.

1. Scrap off the Back Label with the Black Stick.
2. Clean the area once the Back Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the new replacement label for 10 seconds.

8.5.3.3 Servicing Bottom Label

NOTE: There is no need to remove any component in order to service the Bottom Label.

1. Scrap off the Bottom Label with the Black Stick.
2. Clean the area once the Bottom Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the new replacement label for 10 seconds.

Caution

Refer to qualified service personnel and service shops to service the Bottom Label with UL certification.

8.5.3.4 Servicing Reflective Label

NOTE: There is no need to remove any component in order to service the Reflective Label.

1. Scrap off the Reflective Label with the Black Stick.
2. Clean the area once the Reflective Label is completely removed to ensure it is free of adhesive and debris.
3. Remove the label off its backer and place it in the recess.
4. Press the new replacement label for 10 seconds.

8.5.4 Servicing Volume Knob

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis/Knob opener (P/N: PMLN7204A), grasp the Volume Knob and pull it upward, until it is free from its shaft as shown in Figure 8-28.
3. Remove the Torque Adder from Volume Knob.
4. Align the Torque Adder to the replace Volume Knob as shown in Figure 8-29. (Marked as 1)
5. Align the D-shaped part of the shaft with the D-shaped hole on the Volume knob as shown in Figure 8-29. (Marked as 2) Press the knob into place.

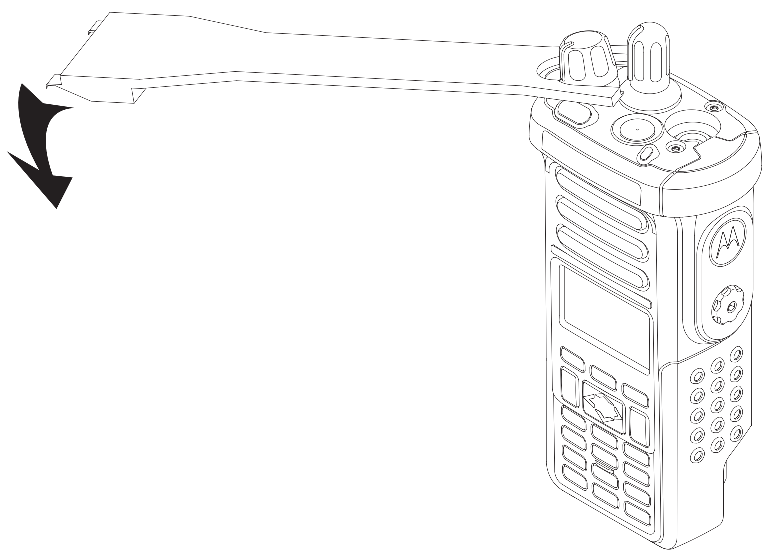

Figure 8-28. Servicing the Volume Knob

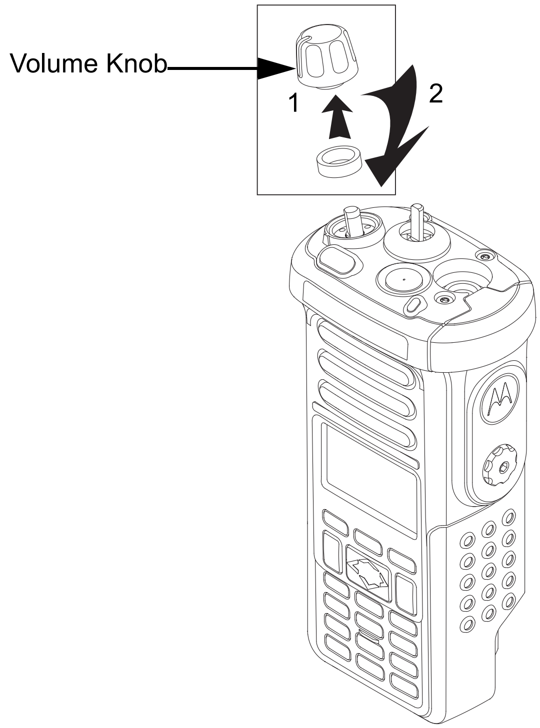

Figure 8-29. Align D-shaped part of the shaft with the D-shaped hole

8.5.5 Servicing Channel Knob

1. Hold the radio with the top facing upward and the front of the radio facing you.
2. With the Chassis/Knob opener (P/N: PMLN7204A), grasp the Channel Knob and pull it upward, until it is free from its shaft as shown in Figure 8-30.
3. Replace the knob with a new one by aligning the D-shaped part of the shaft with the D-shaped hole on the Channel Knob as shown in Figure 8-31. Press the knob into place.

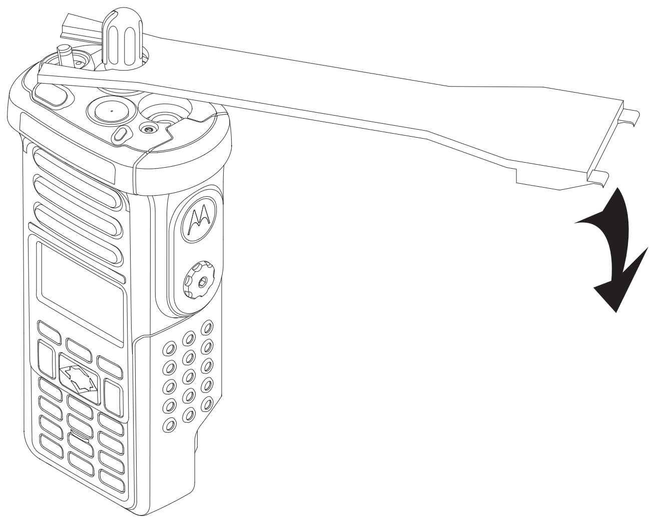

Figure 8-30. Servicing the Channel Knob

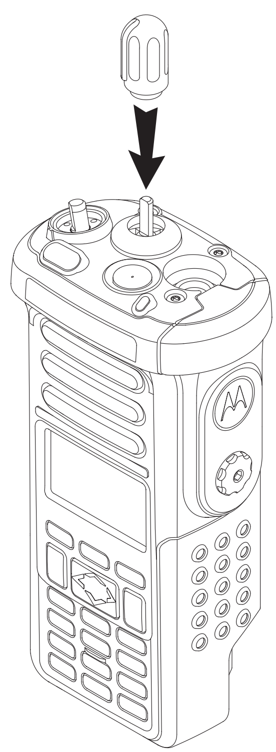

Figure 8-31. Align D-shaped part of the shaft with the D-shaped hole

8.5.6 Servicing Top Bezel and Monitor Button

1. Complete steps in Section 8.4.5. to remove the Top Bezel.
2. Replace the new Top Bezel with new Monitor Button as shown in Figure 8-32.
3. Complete steps in Section 8.6.8. to tighten the Top Bezel.

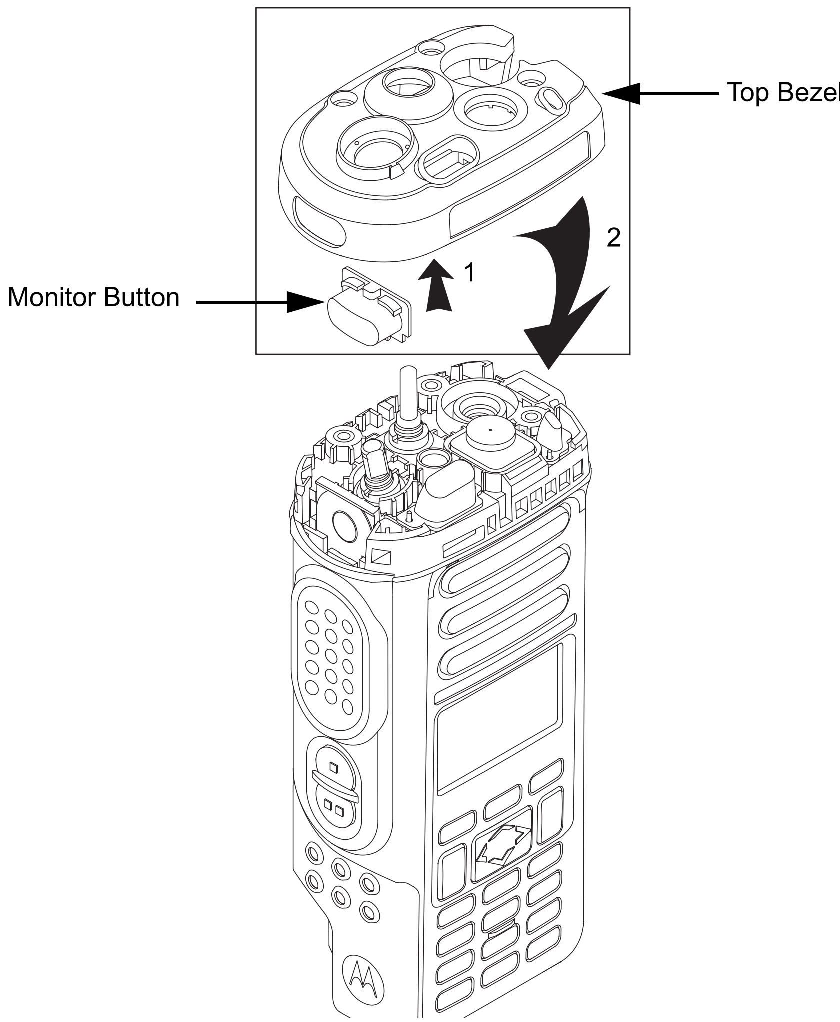

Figure 8-32. Replacing the new Top Bezel with new Monitor Button

8.6 Radio Reassembly

This section contains instructions for reassembling the radio.

8.6.1 Reassemble the Main Board (45)

1. Plug in the connectors of the Back Kit Flex (43) onto the Main Board (45). With the Back Kit Flex connected to the Main Board, place the Main Board into the Chassis (54) as shown in Figure 8-33.

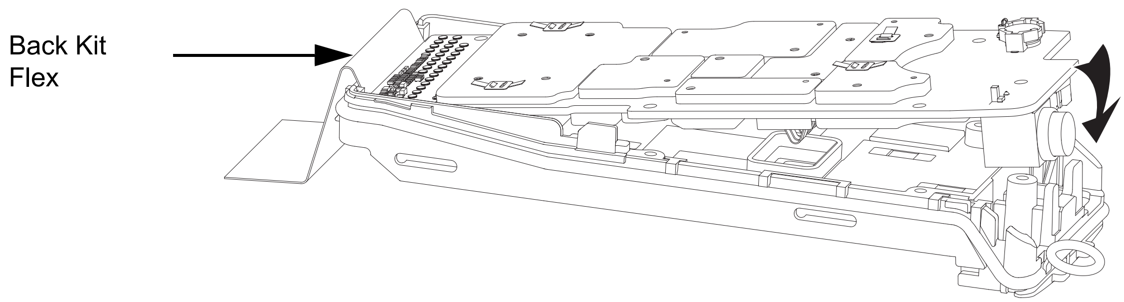

Figure 8-33. Assemble the RF Board

NOTE: Plug in the connectors at the side of the Back Kit Flex which reads “To Main Board”. Ensure that the Battery Contact Seal (55) does not pinch and the tabs of the Main O-Ring are held in place when assembling the Main Board into the Chassis.

2. With the Main Board (45) seated in the Chassis (54), gently assemble the Main O-Ring (48) to the Antenna Holder as shown in Figure 8-35.

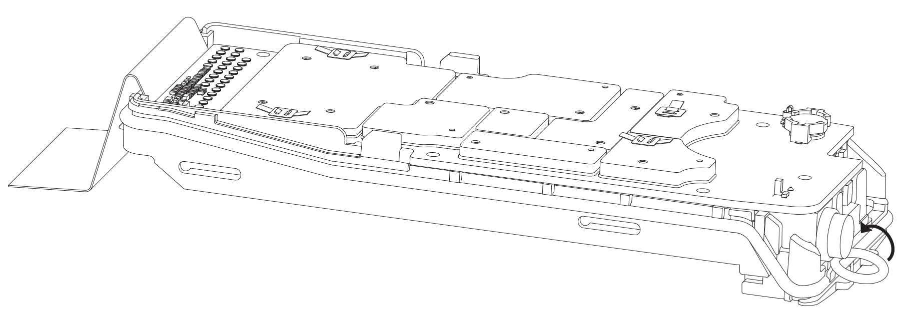

Figure 8-34. Assemble the Main O-Ring at Antenna Holder

8.6.2 Reassemble the Secondary Shield Assembly (44)

1. With the Main Board (45) assembled, place the Secondary Shield Assembly (44) onto the Main Board.

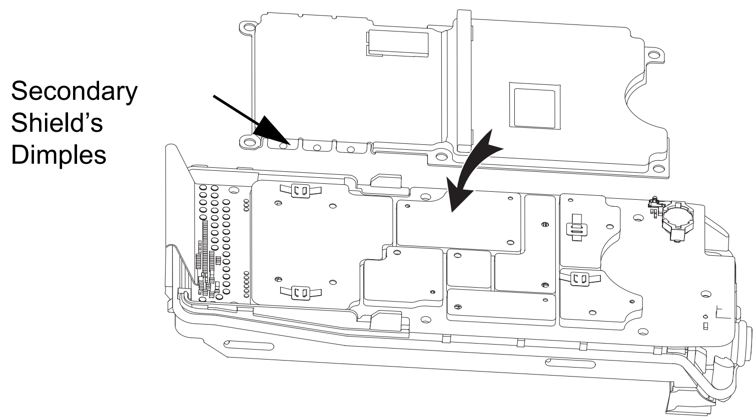

Figure 8-35. Assemble the Secondary Shield Assembly

2. Torque all seven Chassis Screws (42) with a Torx IP6 Bit and a Torque Driver to 3.0 in-lbf in the sequence as shown in Figure 8-36.

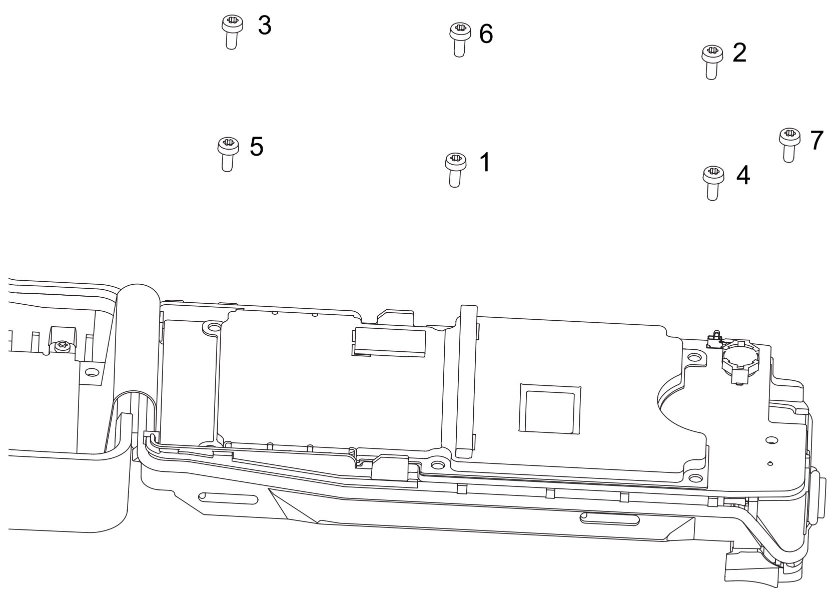

Figure 8-36. Torque in the Chassis Screws

8.6.3 Reassemble the Keypad (37)

NOTE: Please order keypad with required language.

1. Place the Keypad (37) into the Front Housing (19) and gently flush the mushroom rib at the edges of the Keypad into the Front Housing with the aid of the back of the Black Stick.

Caution

When flushing the Keypad, care is needed to avoid damage to the Keypad.

Ensure that the Keypad is fully flushed to prevent leakage.

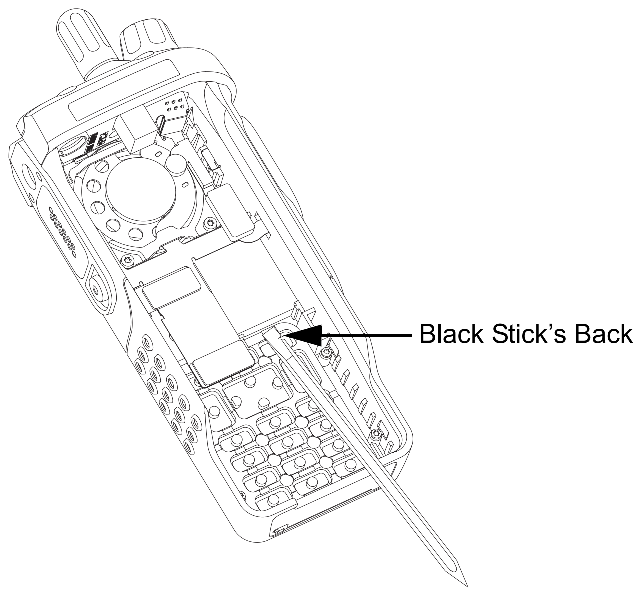

Figure 8-37. Assemble the Keypad

8.6.4 Reassemble the Keypad Board (35)

1. Complete steps in Section 8.6.1. through Section 8.6.3.
2. With the Keypad (37) assembled, place the Keypad Board (35) into the Front Housing (19).
3. Plug in the connector of the Front Kit Flex (3) as shown in Figure 8-39.

Caution	When plugging in the connectors, care is needed to avoid damage to the interconnect and surrounding on-board components.

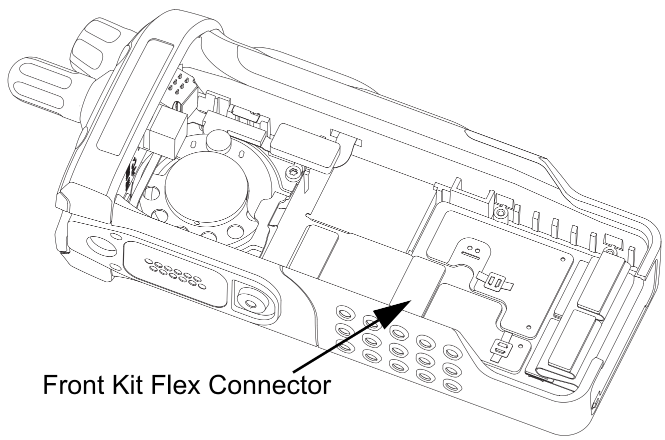

Figure 8-38. Plug in the Front Kit Flex Connector

4. Gently plug in the connectors of the Back Kit Flex (43) to the Keypad Board (35) as shown in Figure 8-39.

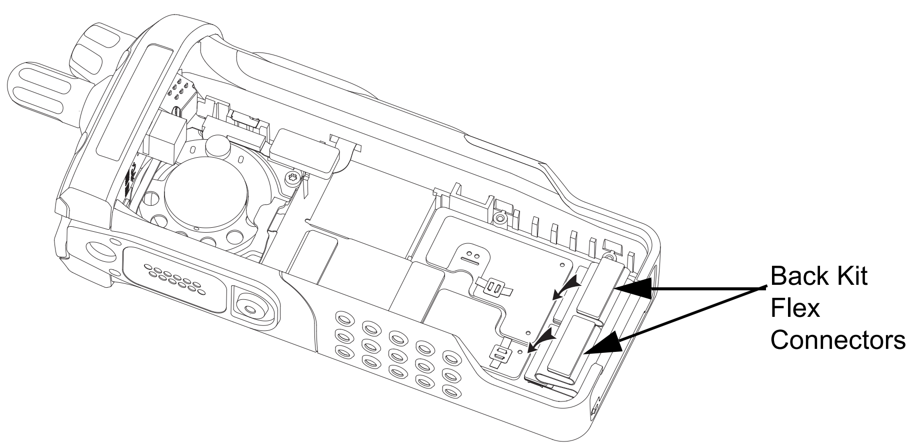

Figure 8-39. Plug in the Back Kit Flex Connectors

NOTE: Plug in the connectors at the side of the Back Kit Flex which reads “To Keypad Board”.

8.6.5 Reassemble the Keypad Retainer (34)

1. Place the Keypad Retainer (34) over the Keypad Board (35) in the Front Housing (19) as shown in Figure 8-40.

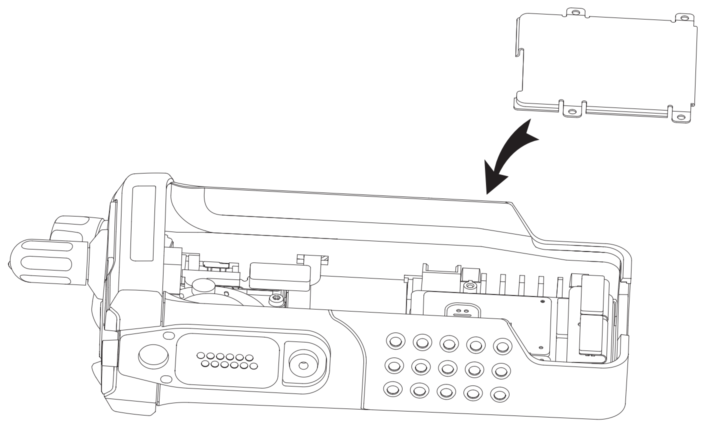

Figure 8-40. Place Keypad Retainer over the Keypad Board

2. Torque all four keypad retainer screws (33) with a Torx IP6 Bit and a Torque Driver to 1.2 in-lbf in the sequence as shown in Figure 8-41.

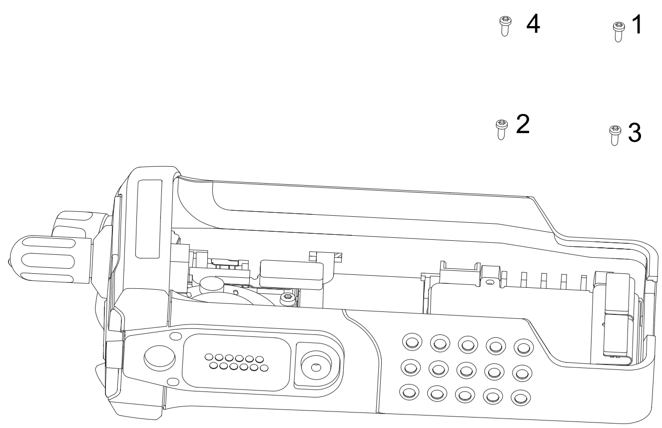

Figure 8-41. Torque in the Keypad Retainer Screws

8.6.6 Reassemble the Shroud (60)

1. Slide the Shroud (60) into the Chassis' frame until the latch clicks into place as shown in Figure 8-42.

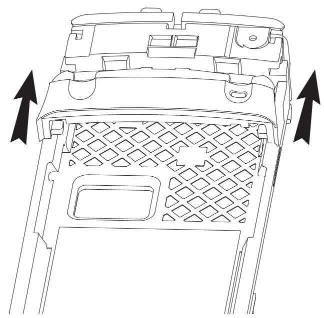

Figure 8-42. Assemble the Shroud

8.6.7 Reassemble the Main Subassemblies (A and B)

1. Complete the steps in Section 8.6.1. through Section 8.6.6.
2. Slide the Chassis assembly into the Front Housing as shown in Figure 8-43.

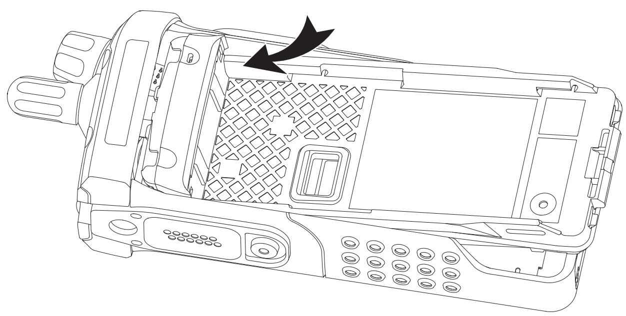

Figure 8-43. Slide chassis assembly into Front Housing

3. With the Chassis assembly fully slided in, press down the bottom part of the Chassis to lock the two subassemblies (A and B) together as shown in Figure 8-44.

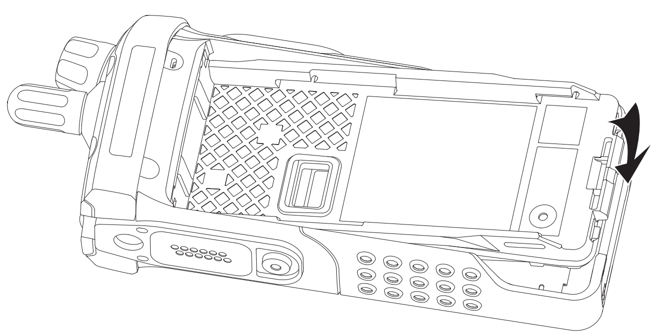

Figure 8-44. Assemble Back Kit and Front Kit together

8.6.8 Reassemble the Top Bezel

1. Locate the top bezel and tighten the three screws with a Torx IP8 Bit and a Torque Driver to 8 in-lbf as shown in Figure 8-45.
2. Tighten the Volume Switch nut with 8 in-lbf as shown in Figure 8-46.

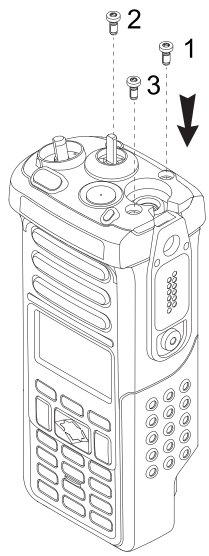

Figure 8-45. Tighten the Screws

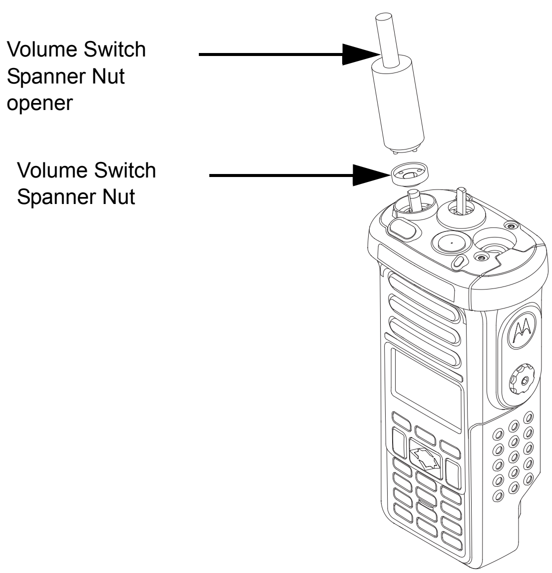

Figure 8-46. Tighten the Volume Switch Spanner Nut

8.6.9 Reassemble Volume Knob and Channel Knob (27)(28)

1. Align torque adder to the Volume Knob.
2. Align the D-shaped part of the shaft with the D-shaped hole on the Volume Knob and Channel Knob. Press the knobs into place.

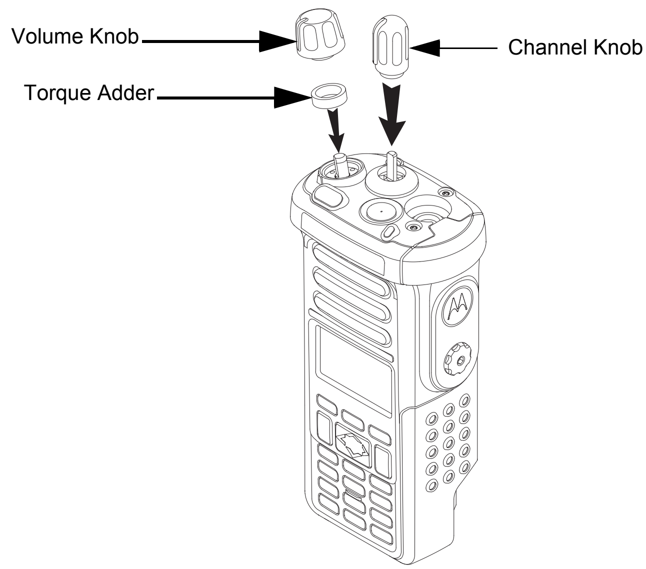

Figure 8-47. Reassemble the Volume Knob and Channel Knob

8.6.10 Reassemble the Accessory-Connector Cover (38)

1. Insert the hooked end of the cover into the pocket. Engage the hook beneath the undercut and swing the cover down onto the radio. Ensure the cover is seated properly and the screw is aligned into the threaded hole.

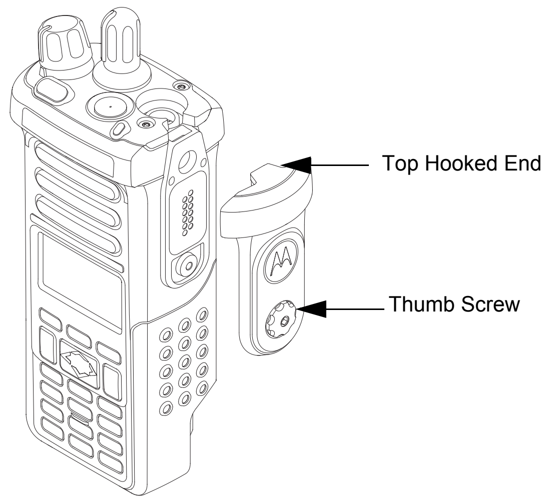

Figure 8-48. Engaging Hook and Seating Cover

2. Hand tighten the thumb screw clockwise until secured.

   NOTE: Do not overtighten the screw. The screw should be snugged and does not allow the cover to move.

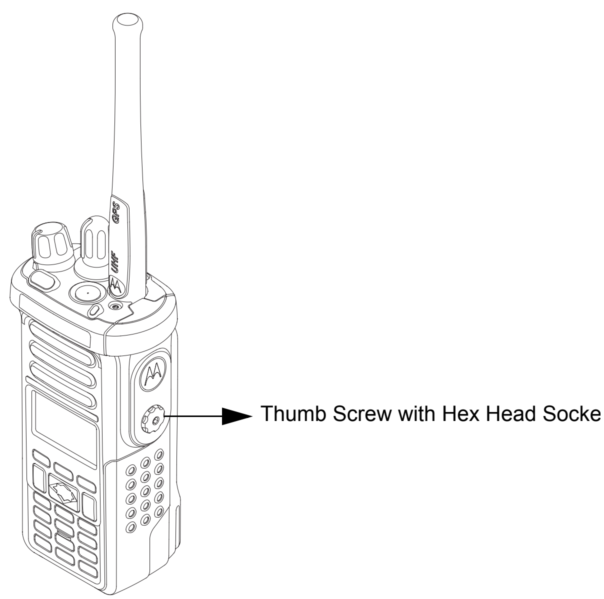

Figure 8-49. Securing the Cover

8.6.11 Reassemble the Antenna (40)

1. With the radio turned off, turn the antenna clockwise to attach it to the radio.

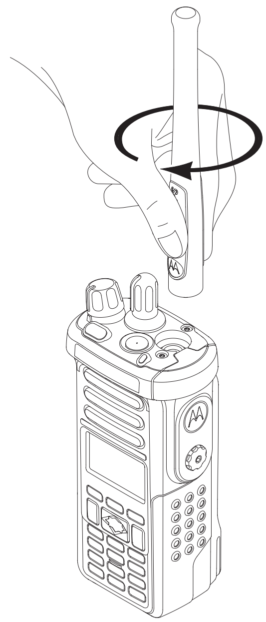

Figure 8-50. Attaching the Antenna

8.6.12 Reassemble the Vacuum Port Seal (56), Ventilation Label (57) and Bottom Label (39)

1. Adhere and gently press the new Vacuum Port Seal (56) on the chassis' recess as shown in Figure 8-51. Press the new Vacuum Port Seal (56) for 30 seconds.

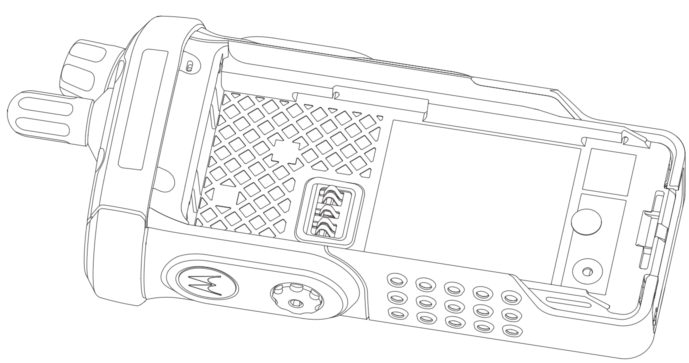

Figure 8-51. Assemble the Vacuum Port Seal

2. With the Vacuum Port Seal assembled, adhere the new Ventilation Label (57) on the chassis' recess as shown in Figure 8-53. Press the new Ventilation Label (Port Seal area) (57) for 10 seconds.

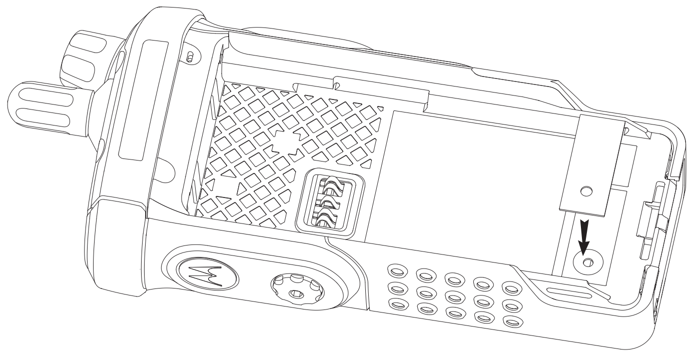

Figure 8-52. Assemble the Ventilation Label

3. Adhere the new Bottom Label (39) on the recess at the bottom of the Front Housing as shown in Figure 8-53.

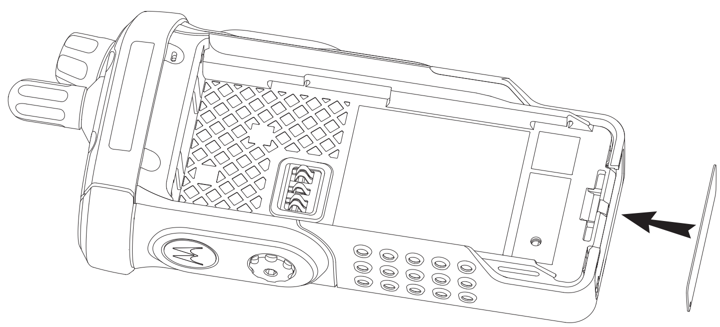

Figure 8-53. Assemble the Bottom Label

8.6.13 Reassemble the Battery (61)

1. With the radio turned off, slide up the battery into the radio's frame until the bottom latch clicks into place as shown in Figure 8-54.

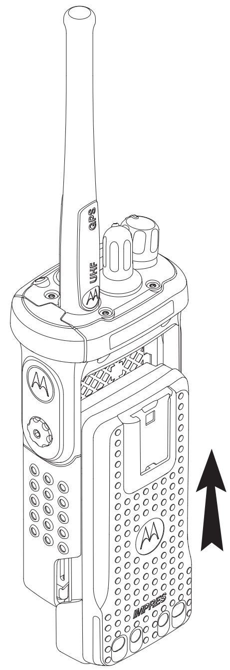

Figure 8-54. Attaching Battery – Slide into Position

8.7 Ensuring Radio Submergibility

This section discusses radio submergibility concerns, tests, and disassembly and reassembly of ASTRO APX 2000/ APX 4000 (Two Knobs) radios.

8.7.1 Standards

ASTRO APX 2000/ APX 4000 (Two Knobs) radio models meet the stringent requirements of IP67, which require the radio to maintain watertight integrity when immersed in one (1) metre water for 30 minutes.

8.7.2 Servicing

APX 2000/ APX 4000 (Two Knobs) radios shipped from the Motorola factory have passed vacuum testing and should not be disassembled. If disassembly is necessary, refer to qualified service personnel and service shops capable of restoring the watertight integrity of the radio.

Caution

It is strongly recommended that maintenance of the radio be deferred to qualified service personnel and service shops. This is of paramount importance as irreparable damage to the radio can result from service by unauthorized persons. If disassembly is necessary, unauthorized attempts to repair the radio may void any existing warranties or extended performance agreements with Motorola. It is also recommended that submergibility be checked annually by qualified service personnel.

8.7.3 Water Exposure

If the radio is exposed to water, shake the radio to remove the excess water from the speaker grille and microphone ports areas before operating; otherwise, the sound may be distorted until the water has evaporated, or is dislodged from these areas.

8.7.4 Specialized Test Equipment

This section summarizes the specialized test equipment necessary for testing the integrity of ASTRO APX 2000/ APX 4000 (Two Knobs) radios.

To ensure that the radio is truly a watertight unit, special testing, test procedures, and specialized test equipment are required. The special testing involves a vacuum check of the radio and pressure testing (troubleshooting) for water leaks if the vacuum check fails. The specialized test equipment is needed to perform the vacuum check and pressure testing, if required.

8.7.4.1 Vacuum Pump Kit NLN9839_

The Vacuum Pump Kit includes a Vacuum Pump with gauge and a Vacuum Hose. The Vacuum Test Fixture (P/N: TL000059A01) which connects the vacuum pump to the radio, must be ordered separately.

8.7.5 Disassembly

Disassemble the radio according to Section 8.4.

8.7.6 Reassembly

Caution	Do not reassemble the radio without first performing the following preliminary inspection procedure.

To reassemble the radio:

1. Inspect the Main O-Ringon the Chassis (54) for any damage or foreign material.
2. Inspect the Battery Contact Seal (55) on the Main Board Assembly (45) for any damage.
3. Inspect the mating seal surfaces on the Chassis (54) for all of the above seals for damage or foreign material that might prevent the seals from sealing properly.

Continue reassembling the radio according to Section 8.6. Tighten all hardware that was loosened or removed.

8.7.7 Vacuum Test

The Vacuum Test uses a Vacuum Pump to create a negative pressure condition inside the radio. The gauge measures this pressure and is used to Monitor any pressure changes in the radio. A properly sealed, watertight radio should have minimal change in pressure during the test.

Before starting the vacuum test:

- Remove the battery and antenna.
- Remove the Vacuum Port Seal (56) and Ventilation Label (57) that cover the Vacuum port.

NOTE: Refer to the exploded view diagrams and parts lists found in “Chapter 10: Exploded Views and Parts Lists” .

8.7.7.1 Vacuum Tool Setup

1. Attach one end of the hose to the Vacuum Pump. Attach the other side of the hose to the Vacuum Test Fixture (P/N: TL000059A01).
2. Tool Leak Test:
   i. Block the open end of the Vacuum Test Fixture.
   ii. Pull the knob on the Vacuum Pump to create vacuum.
   iii. Pump at least 15 in Hg.
   iv. Watch the gauge for a minute. If there is any loss of vacuum, repair or replace the tool.
3. Ensure that the seal is attached to the Vacuum Test Fixture.

NOTE: The actual reading of the gauge at this point is not important; it is important that the gauge pointer remained steady, indicating that there are no vacuum leaks in the pump.

8.7.7.2 Test Procedure

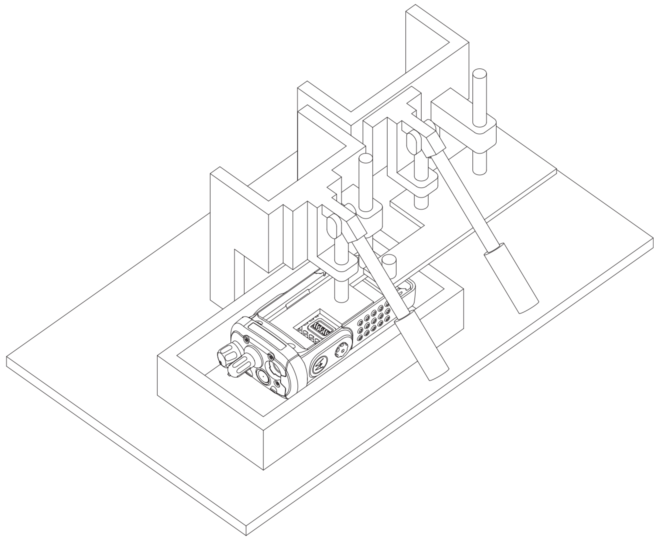

Figure 8-55. Attaching Vacuum Test Fixture

1. Place the radio in the Vacuum Test Fixture. Ensure the radio position is lay perfectly into the mould.
2. Pull the knob on the Vacuum Pump to create vacuum. The vacuum test pressure should be 6.6 in Hg.

Caution

Ensure that the vacuum pressure NEVER exceeds 7 in Hg. The radio has pressure sensitive components that can be damaged if the pressure exceeds this limit.

3. Observe the gauge for approximately 2 minutes.
   - If the needle falls less than 0.5 in Hg, the radio passes the vacuum test.
     i. If the seal passes this inspection, this radio is approved for submergibility. No additional testing is required.
     ii. Replace the vacuum port seal and ventilation label as described in the reassembly procedures.
   - If the needle falls more than 0.5 in Hg, the radio fails the vacuum test and the radio might leak if submerged. Additional troubleshooting of the radio is required.

8.7.8 Pressure Test (using NTN4265_)

Pressure testing the radio is necessary only if the radio has failed the vacuum test. Do not perform the test until the vacuum test has been completed. Pressure test involves creating sealed condition inside the radio, submerging the radio in water, and observing the radio for a stream of bubbles (leak). Since all areas of the radio are being checked, observe the entire unit carefully for the possibility of multiple leaks before completing this test.

NOTES: When Radio is placed under the water there will be some air trapped which will be released. This is not a failure.

Refer to the exploded view diagrams and parts lists found in “Chapter 10: Exploded Views and Parts Lists” .

To conduct the pressure test:

1. Observe is there is any torn on the Main O-ring and battery contact seal.
2. Ensure that the front kit and back kits are assembled properly.
3. Attach the pressure test fixture onto the vacuum port of the radio as shown in Figure 8-56.
4. Attach one end of the hose to the pressure pump. Attach the other side of the hose to the pressure test fixture (P/N: TL000062A01).
5. Operate the pump until the gauge reads approximately 1 psig.

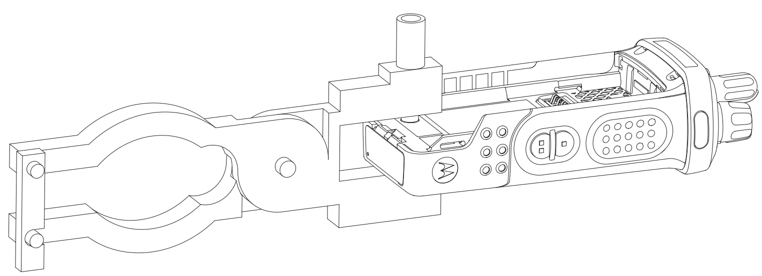

Figure 8-56. Attaching Pressure Test Fixture

6. Maintain the pressure around 1 psig and submerge the radio in a water-filled container.

Caution	Pressure must remain between 0.5 psig and 1.5 psig. Pressure lower than 0.5 psig may allow water into the radio, which will damage the radio.

Caution	Ensure that the pressure NEVER exceeds 1.5 psig. The radio has pressure sensitive components that can be damaged if the pressure exceeds this limit.

7. Watch for any continous series of bubbles. A steady stream of bubbles indicate a sign of leakage.

Caution	Some accumulation of air may be entrapped in the main housing which may cause a false diagnosis of a leak. Ensure there is a steady stream of bubbles before concluding there is a leak.

8. Note all of the seal areas that show signs of leakage. Rotate the radio to view all sides to pinpoint the problem(s) to one (or more) of the following areas:
   - Seal Interfaces
   - Battery Contact Seal
   - Front Housing, including the Top Bezel
   - Chassis
9. Remove the radio from the water container and dry the radio thoroughly. Be especially careful to dry the area around the vacuum Port and the battery contact seal area.

Caution	To avoid equipment damage, keep the area inside the Battery contact pocket is dry before assembling battery.

10. See Section 8.7.9..

8.7.9 Troubleshooting Leak Areas

Before repairing any leak, first read all of the steps within the applicable section. This will help to eliminate unnecessary disassembly and reassembly of a radio with multiple leaks.

NOTES: All disassembly and reassembly methods can be found in Section 8.4. and Section 8.6.

8.7.9.1 Seal Interfaces

- If leak occurs at one or more of the seal interfaces, disassemble the component(s) and inspect the interfaces to determine if there is any damage. If no damage is observed, re-assemble the radio as directed.
- If damage has occurred, replacement parts will be needed.

8.7.9.2 Battery Contact Seal

- If leak occurs due to damage to the Battery Contact Seal (55), it will need to be replaced.

8.7.9.3 Front Housing

- If leak occurs through anywhere on the Front Housing, replace the Front Kit Assembly (A).

8.7.9.4 Keypad

- If leak occurs through the keypad (37), replace it.

8.7.9.5 Chassis

- If leak occurs through the Main O-Ring (48), it will need to be replaced.
- If leak occurs elsewhere on the Chassis (54), it will need to be replaced.

Notes

Chapter 9 Basic Troubleshooting

This section of the manual contains troubleshooting charts and error codes that will help you to isolate a problem. Level one and two troubleshooting will support only radio alignment, programming, battery replacement, and knob replacement, and circuit board replacement.

Component-level service information can be found in the “ASTRO APX 2000/ APX 4000 (Two Knobs) Portable Radios Detailed Service Manual,” Motorola publication number 68012004061.

9.1 Power-Up Error Codes

When the radio is turned on (power-up), the radio performs self-tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio’s display. For non-display radios, the problem will be presented at power-up by a single, low-frequency tone. The radio should be sent to the depot if cycling power and reprogramming the code plug do not solve the problem. The presence of an error should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors will inhibit user operation; non-fatal errors will not. Use Table 9-1 to aid in understanding particular power-up error code displays.

Table 9-1. Power-Up Error Code Displays

Error Code	Description	Corrective Action
01/02	FLASH ROM Codeplug Checksum Non-Fatal Error	Reprogram the codeplug
01/12	Security Partition Checksum Non-Fatal Error	Send radio to depot
01/81	Host ROM Checksum Fatal Error	Send radio to depot
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug
01/84	External EEPROM Blank (or SLIC failure) Fatal Error	Send radio to depot
01/88	External RAM Fatal Error – **Note:** Not a checksum failure	Send radio to depot
01/90	General Hardware Failure Fatal Error	Turn the radio off, then on
01/92	Security Partition Checksum Fatal Error	Send radio to depot
01/93	FLASHport Authentication Code Failure	Send radio to depot
01/94	Internal EEPROM Blank Fatal Error.	Send radio to depot
01/98	Internal RAM Fail Fatal Error	Send radio to depot
01/A0	ABACUS Tune Failure Fatal Error	Send radio to depot
01/A2	Tuning Codeplug Checksum Fatal Error	Send radio to depot
02/81	DSP ROM Checksum Fatal Error	Send radio to depot

Table 9-1. Power-Up Error Code Displays (Continued)

Error Code	Description	Corrective Action
02/88	DSP RAM Fatal Error – **Note:** Not a checksum failure	Turn the radio off, then on
02/90	General DSP Hardware Failure (DSP startup message not received correctly)	Turn the radio off, then on
09/10	Secure Hardware Error	Turn the radio off, then on
09/90	Secure Hardware Fatal Error	Turn the radio off, then on
Hardware board absent/ Hardware board absent then Man-Down Hw error	Keypad board is not connected properly to the radio	Ensure the Keypad board is fixed in place
15/10	External Accessory Non-Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
15/90	External Accessory Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
1E/10	Collaborative device is connected to the radio but the collaborative feature is not enabled in the codeplug.	Contact your Motorola Sales Representative/Partner on how to add Collaborative feature to your radios.
***Note:** If the corrective action does not fix the failure, send the radio to the depot.*		

9.2 Operational Error Codes

During radio operation, the radio performs dynamic tests to determine if the radio is working properly. Problems detected during these tests are presented as error codes on the radio's display. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 9-2 to aid in understanding particular operational error codes.

Table 9-2. Operational Error Code Displays

Error Code	Description	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	1. Reprogram external codeplug 2. Send radio to depot
FAIL 002	Selected Mode/Zone Codeplug Checksum Error	Reprogram external codeplug

9.3 Receiver Troubleshooting

Table 9-3 lists the possible causes of, and corrections for, receiver problems.

Table 9-3. Receiver Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements at Room Temperature)
Radio Dead; Display Does Not Turn On	1. Dead Battery	Replace with charged battery
	2. Blown Fuse	Send radio to depot
	3. On/Off Switch	
	4. Regulators	
Radio Dead; Display Turns On	1. Keypad Board	Send radio to depot
	2. Main Board	
Radio On; Front Display Off	High operating temperature (above 80°C)	Allow radio to return to normal operating temperature.
No Receive Audio, or Receiver Does Not Unmute	Programming	1. Check if transmitted signal matches the receiver configuration (PL, DPL, etc.) 2. Check if radio able to unmute with Monitor function enabled
Audio Distorted or Not Loud Enough	Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
RF Sensitivity Poor	1. Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
	2. Antenna Switch/ Connector	Send radio to depot
	3. Receiver Front-End Tuning	Check RF front-end tuning for optimum sensitivity using the tuner
Radio Will Not Turn Off	Main Board	Send radio to depot

9.4 Transmitter Troubleshooting

Table 9-4 lists the possible causes of, and corrections for, transmitter problems.

Table 9-4. Transmitter Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No RF Power Out	1. TX Power Level or Frequency	Check TX power level and frequency programming (from tuner)
	2. No Injection To Power Amplifier	Send radio to depot
	3. Antenna Switch/Connector	
No Modulation; Distorted Modulation	1. Programming	Check deviation and compensation settings using the tuner
	2. Main Board	Send radio to depot
Bad Microphone Sensitivity	1. Check Deviation and Compensation	Realign if necessary
	2. Microphone	Send radio to depot
No/Low signaling (PL, DPL, MDC)	1. Programming	Check programming
	2. Main Board	Send radio to depot
Cannot Set Deviation Balance	Main Board	Send radio to depot

9.5 Encryption Troubleshooting

Table 9-5 lists the possible causes of, and corrections for, encryption problems.

Table 9-5. Encryption Troubleshooting Chart

Symptom	Possible Cause	Corrective Action
No “KEYLOADING” on Radio Display When Keyloading Cable is Attached to the Radio Side Connector	1. Defective Keyload Cable	Send radio to depot
	2. Defective Radio	
Keyloader Displays “FAIL”	1. Wrong Keyloader Type	Use correct keyloader type. Refer to Keyloader User Guide for more information
	2. Bad Keyloader	Try another keyloader
	3. Defective Radio	Send radio to depot

Chapter 10 Exploded Views and Parts Lists

This chapter contains exploded views and associated parts lists for the ASTRO APX 2000/ APX 4000 (Two Knobs) digital portable radios. The following table lists the exploded views for the radio in different configurations:

Table 10-1. APX 2000/ APX 4000 (Two Knobs) Exploded Views and Controller Kit

10.1 APX 2000/ APX 4000 (Two Knobs) Front Kit Exploded View

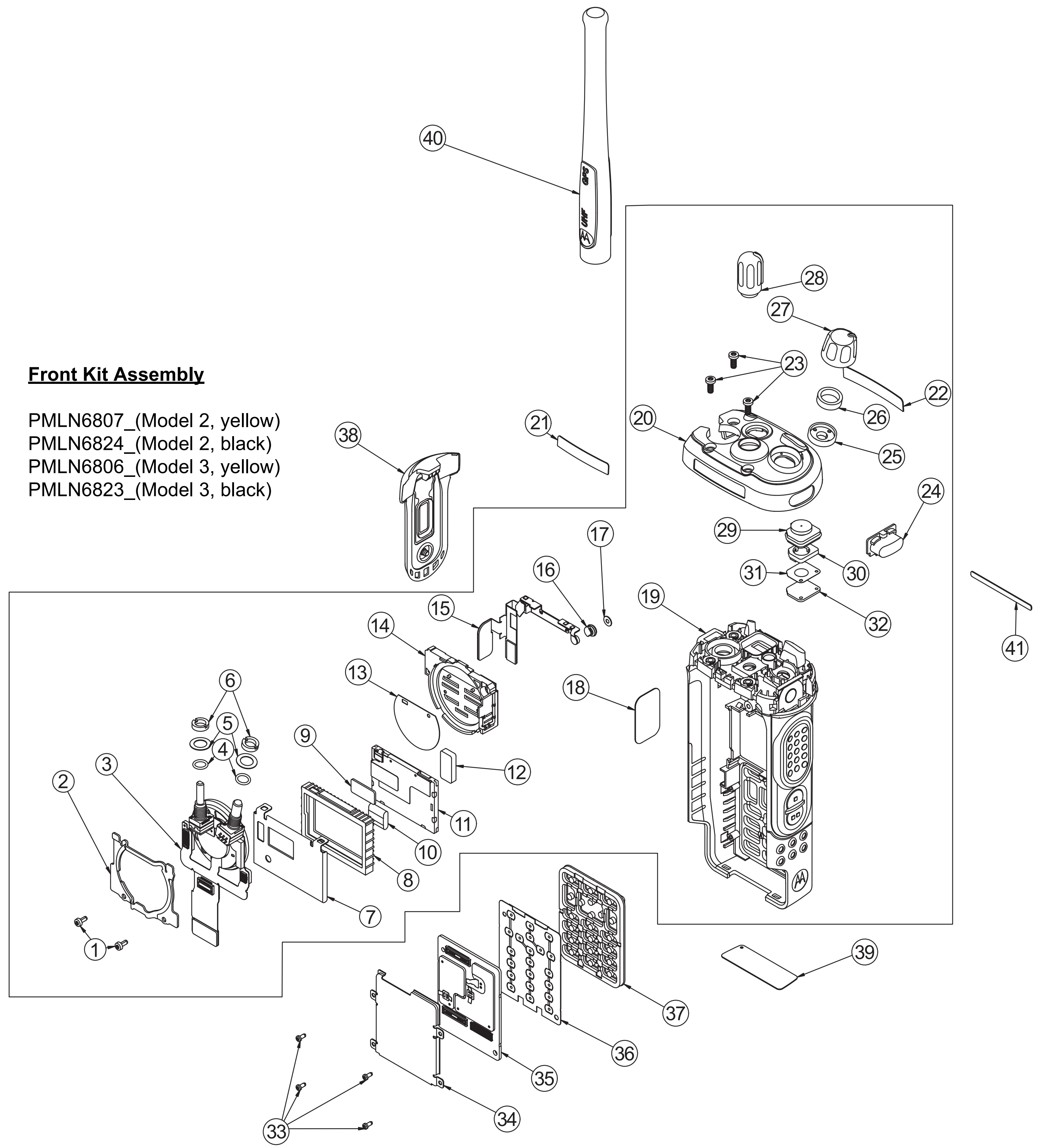

Figure 10-1. APX 2000/ APX 4000 (Two Knobs) Front Kit Exploded View

10.2 APX 2000/ APX 4000 (Two Knobs) Front Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
1††	**0386104Z04**	Screw, Retainer, Speaker
2†	**HW000100A01**	Retainer, Speaker
3†	**0104062J02**	Assembly, Flex, Front Kit
4†	**3275033C02**	O-ring
5†	**0402838X01**	Washer, Vol / Channel, 3 waves
6†	**0275000H02**	Nut, Switch Spanner
7†	**42012055001**	Retainer, LCD
8†	**75012121001**	Boot, LCD
9†	**75012116001**	Pad, Poron, 60pin Receptacle
10†	**75012125001**	Pad, Conductive, LCD-Mod to Retainer, LCD
11†	**72012015001**	Module, LCD
12†	**75012189001**	Pad, Spacer
13†	**HW000098A01**	Mesh, Speaker
14†	**AN000025A01**	Assembly, Bluetooth Antenna
15†	**0104062J03**	Flex, GCAI & LEDs
16†	**32012282001**	Boot, Front Mic
17†	**35012068001**	Membrane, Front Mic
18†	**13012035001**	Escutcheon, GCAI
19†	**HN000137A01** **HN000137A02** **HN000137A03** **HN000137A04**	Assembly, Front Housing Kit (Model 3,yellow) Assembly, Front Housing Kit (Model 3,black) Assembly, Front Housing Kit (Model 2,yellow) Assembly, Front Housing Kit (Model 2,black)
20††	**HN000161A01** **HN000161A02**	Bezel, Top Control (Yellow) Bezel, Top Control (Black)
21	**LB000238A01** **LB000238A02** **LB000238A03** **LB000238A04**	Label, Back, APX 4000 Label, Back, APX 4000R Label, Back, APX 2000 Label, Back, APX 2000R
22††	**LB000084A01**	Label, Front
23††	**FN000083A01**	Screw, Top bezel
24††	**KP000014A01**	Monitor button
25††	**FN000080A01**	Nut, Volume Switch Spanner
26††	**SL000106A01**	Torque Adder
27††	**HW000256A01**	Knob, volume
28††	**HW000254A01**	Knob, channel
29†	**KP000016A01**	Emergency Button
30†	**BR000083A01**	Plastic Holder, Emergency
31†	**ST000075A01**	Mylar Assembly, Emergency
32†	**PMLN7067_**	PCB Assembly, Emergency Button
33	**0378212A02**	Screw, Retainer, Keypad
34	**BR000082A01**	Retainer, Keypad
35††††	**PMCN4049_** **PMCN4048_**	Assembly, Keypad Board (Model 3, Expanded) Assembly, Keypad Board (Model 2, Expanded)
36	**40012056001** **ST000137A01**	Mylar with Metal Domes, Keypad (Model 3) Mylar with Metal Domes, Keypad (Model 2)
37†††††	**KP000017A01** **KP000017A03** **KP000017A02**	Keypad, Model 3 (English) Keypad, Model 3 (Chinese) Keypad, Model 2
38	**HN000164A01** **HN000164A02**	Accessory-Connector Cover, GCAI Kit, Yellow Accessory-Connector Cover, GCAI Kit, Black
39†††	**LB000073A01** **LB000073A02** **LB000073A03**	Label, Bottom, Blank Label, Bottom, UL (APX 4000, APX 4000R) Label, Bottom, UL (APX 2000, APX 2000R)
40	**PMAE4065_** **NAF5085_** **NAR6593_** **NAR6595_** **FAF5259_** **FAF5260_**	Antenna UHF/GPS Antenna Whip 700/800/GPS Antenna VHF/GPS Antenna 1/4 Wave 700/800 MHz Stubby/GPS Antenna, UHF_R1 Plus GPS Stubby Antenna, Assembly Antenna, UHF_R2 Plus GPS Stubby Antenna, Assembly
41	**LB000085A01**	Reflective Label

NOTE:

†. Items cannot be ordered individually. They are included in the Assembly, Front-Kit – PMLN6807_(Model 2 Yellow), PMLN6824_(Model 2 Black), PMLN6806_(Model 3 Yellow) and PMLN6823_(Model 3 Black). Refer to the Model Charts on pages xi, xiii, xv or xvii.

††. Items can be ordered individually, but they are included in their respective kits (if ordered).

†††. For APAC, item can only be ordered by authorized Motorola Service Center.

††††. Items cannot be ordered individually. They are included in their respective kits (if ordered). Refer to the Model Charts on pages xi, xiii, xv or xvii.

†††††. Order keypad with the required language.

10.3APX 2000/ APX 4000 (Two Knobs) Back Kit Exploded View

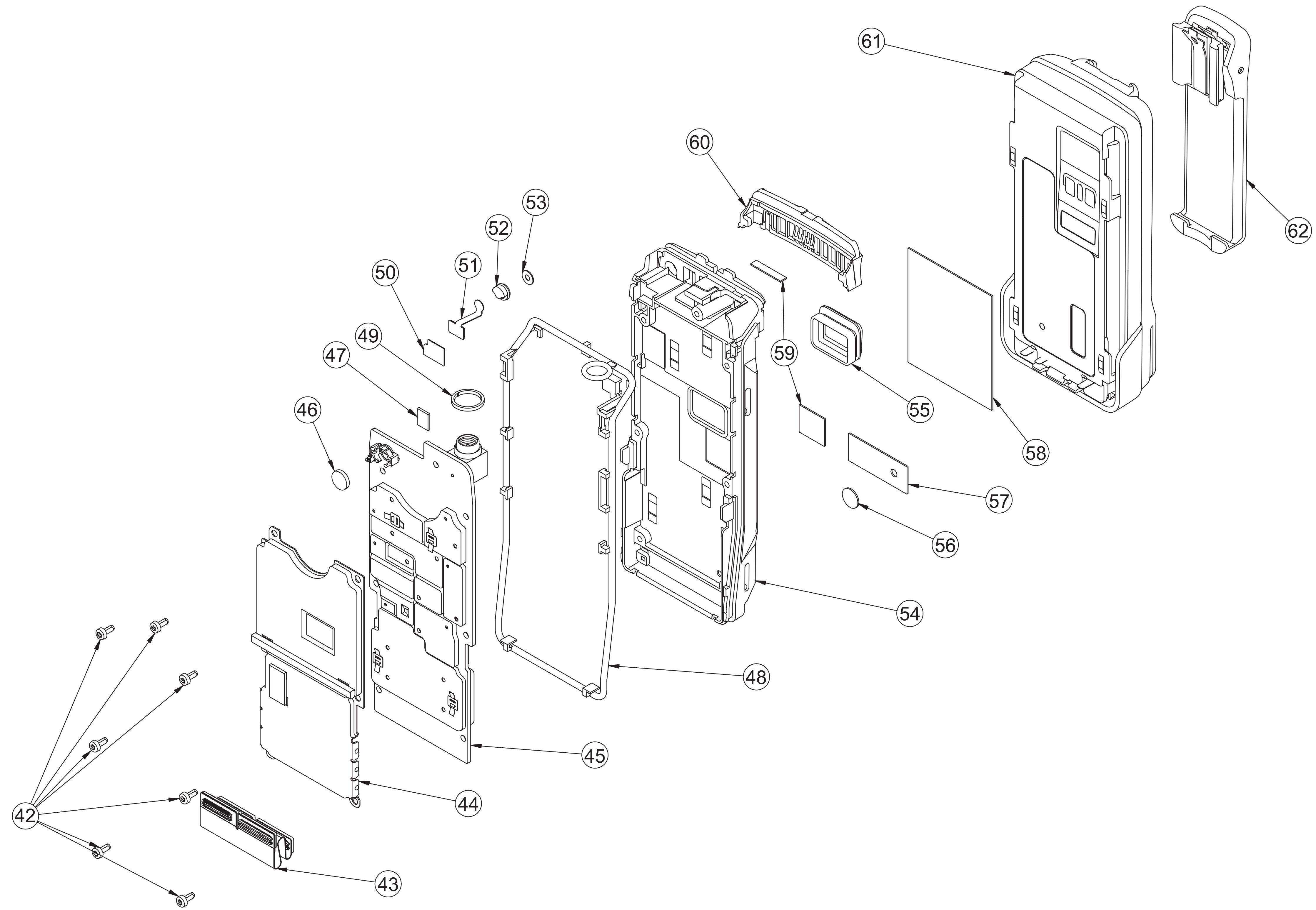

Figure 10-2. APX 2000/ APX 4000 (Two Knobs) Back Kit Exploded View

10.4 APX 2000/ APX 4000 (Two Knobs) Back Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
42	0386104Z04	Screw, Chassis
43	0104063J03	Assembly, Flex, Back-kit
44	0104046J48	Shield, Secondary Assembly
45†	PMLF4141_ PMLD4694_ PMLE5025_ PMLE5026_	Assy, PCB, Main 7/800 MHz Assy, PCB, Main VHF Assy, PCB, Main U1 Assy, PCB, U2
46	6071520M01	Cell, Coin
47	7515719H02	Pad, Thermal, RF PA
48	32012156001	O-ring, Main
49	43012045001	Collar, Plastic
50	64012022001	Back Mic Backer
51	0104059J61	Assembly, Flex, Back Mic
52	32012282001	Boot, Back Mic
53	35012068001	Membrane, Back Mic
54	CH000067A01	Chassis
55	32012150001	Seal, Battery Contact
56	3286058L01	Seal, Vacuum Port
57	5478220A01	Label, Ventilation
58††	54012242001	Label, FCC
59††	33012034001	Label, ITID
60	HN000165A01 HN000165A02	Shroud, Yellow Shroud, Black
61	NNTN8129_ NNTN8128_ PMNN4424_ PMNN4448_ NNTN8560_	Battery, Hi-Cap (FM, 2300 mAH) Battery, Standard (non-FM, 1900 mAH) Battery, Hi-Cap (non-FM, 2300 mAH) Battery, Hi-Cap (Non-IS, 2700 mAH) IMPRES Li-Ion High Cap Battery (TIA4950)
62	PMLN4651_ PMLN7008_	Clip, Belt (2") Clip, Belt (2.5")

NOTE:

†. Items cannot be ordered individually. They are included in their respective kits (if ordered). Refer to the Model Charts on pages xi, xiii, xv or xvii.

††. Item is not orderable.

Notes

ASTRO® APX® 1000/ APX® 2000/ APX® 4000/ APX® 4000 Li
Digital Portable Radios

Section 5

Appendices

Notes

Appendix A Accessories

Motorola provides the following approved optional accessories to improve the productivity of the APX 1000 portable radio.

For a complete list of Motorola-approved antennas, batteries, and other accessories, visit the following web site: http://www.motorolasolutions.com/APX

Notes

Appendix B EMEA Warranty, Service and Technical Support

B.1 Warranty and Service Support

MOTOROLA SOLUTIONS, INC. (“MOTOROLA”) offers long term support for its products. This support includes full exchange and/or repair of the product during the warranty period, and service/ repair or spare parts support out of warranty. Any "return for exchange" or "return for repair" by an authorized Motorola Dealer must be accompanied by a Warranty Claim Form. Warranty Claim Forms are obtained by contacting an Authorized Motorola Dealer.

B.1.1 Warranty Period and Return Instructions

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

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

Prior to shipping any radio back to the appropriate Motorola warranty depot, please contact Customer Resources (Please see page B-3). All returns must be accompanied by a Warranty Claim Form, available from your Customer Services representative. Products should be shipped back in the original packaging, or correctly packaged to ensure no damage occurs in transit.

B.1.2 After Warranty Period

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

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

B.2 European Radio Support Centre (ERSC)

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

Austria:	08 00 29 75 41	Italy:	80 08 77 387
Belgium:	08 00 72 471	Luxemburg:	08 00 23 27
Denmark:	80 88 58 80	Netherlands:	08 00 22 45 13
Finland:	08 00 11 49 910	Norway:	80 01 11 15
France:	08 00 90 30 90	Portugal:	08 00 84 95 70
Germany:	08 00 18 75 240	Spain:	90 09 84 902
Greece:	00 80 04 91 29 020	Sweden:	02 07 94 307
UK :	08 00 96 90 95	Switzerland:	08 00 55 30 82
Ireland:	18 00 55 50 21	Iceland:	80 08 147

Or dial the European Repair and Service Centre:
Tel: +49 30 6686 1555
Fax: +49 30 6686 1579
Email: ERSC@motorolasolutions.com

Please use these numbers for repair enquiries only.

B.3 Piece Parts

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

Orders for replacement parts, kits and assemblies should be placed directly on Motorola's local distribution/dealer organisation or via Motorola Online at: http://www.motorola.com/emeaonline

* The Radio Products and Solutions Organization (RPSO) was formerly known as the Radio Products Services Division (RPSD) and/or the Accessories and Aftermarket Division (AAD).

B.4 Technical Support

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

North Europe – Stephen Woodrow
Telephone: +44 (0) 1256 488 082
Fax: +44 01256 488 080
Email: CSW066@motorolasolutions.com

Russia and Belarus – Andrey Nagornykh
Telephone: +7 495 787 8910
Fax: +7 495 785 0185
Email: MWCB47@motorolasolutions.com

Middle East and Africa – Wayne Holmes
Telephone: +49 (0)6126 957 6237
Fax: +49 (0)6126 957 6826
Email: wayne.holmes@motorolasolutions.com

France – Armand Roy
Telephone: +33 1 6935 7868
Fax: +33 1 6935 7808
Email: armand.roy@motorolasolutions.com

Central and East Europe – Siggy Punzenberger
Telephone: +49 (0) 6128 70 2342
Fax: +49 (0) 6128 95 1096
Email: TFG003@motorolasolutions.com

Germany – Customer Connect Team
Telephone: +49 (0) 30 6686 1539
Fax: +49 (0) 30 6686 1916
Email: ESSC@motorolasolutions.com

Italy – Ugo Gentile
Telephone: +39 0 2822 0325
Fax: +39 0 2822 0334
Email: C13864@motorolasolutions.com

France – Laurent Irrmann
Telephone: +33 1 6935 7866
Fax: +33 1 6935 7808
Email: laurent.irrmann@motorolasolutions.com

B.5 Further Assistance From Motorola

You can also contact the Customer Help Desk through the following web address.
http://www.motorola.com/Business/US-EN/Pages/Contact_Us

Notes

Appendix C LACR Replacement Parts Ordering and Motorola Service Centers

C.1 Commercial Warranty

Limited Warranty

MOTOROLA COMMUNICATION PRODUCTS

I. What This Warranty Covers And For How Long

MOTOROLA SOLUTIONS, INC. (“MOTOROLA”) warrants the MOTOROLA manufactured Communication Products listed below (“Product”) against material defects in material and workmanship under normal use and service for the period of time from the date of purchase as scheduled below:

ASTRO APX 1000/ APX 2000/ APX 4000 (Two Knobs)/ APX 4000Li Digital Portable Units	Three (3) Years
Product Accessories	One (1) Year

Motorola will at its option and at no charge either repair the defective Product (with new or reconditioned parts), replace it (with a new or reconditioned Product), or refund the purchase price of the defective Product during the warranty period provided it is returned before the expiration of the warranty period and in accordance with the terms of this warranty. Replaced Product, parts or boards are warranted for the balance of the original applicable warranty period. All replaced Product, parts of boards shall become the property of MOTOROLA.

This express limited warranty is extended by MOTOROLA to the original end user purchasing the Product for commercial, industrial or governmental use only and is not assignable or transferable to any other party. This is the complete warranty for the Product manufactured by MOTOROLA. MOTOROLA assumes no obligations or liability for additions or modifications to this warranty unless made in writing and signed by an officer of MOTOROLA. Unless made in a separate agreement between MOTOROLA and the original purchaser, MOTOROLA does not warrant the installation, maintenance or service of the Product.

MOTOROLA is not responsible in any way for any ancillary equipment not furnished by MOTOROLA which is attached to or used in connection with the Product, or for operation of the Product with any ancillary equipment, and all such equipment is expressly excluded from this warranty. Because each system which may use the Product is unique, MOTOROLA disclaims liability for range, coverage, or operation of the system in part or as a whole under this warranty.

II. General Provisions

This warranty sets forth the full extent of MOTOROLA'S responsibilities regarding the Product. Repair, replacement or refund of the purchase price, at MOTOROLA'S option, is the exclusive remedy. THIS WARRANTY IS THE COMPLETE WARRANTY FOR THE PRODUCT AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES. MOTOROLA DISCLAIMS ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY COMMERCIAL LOSS; INCONVIENCE; LOSS OF USE, TIME, DATA, GOOD WILL, REVENUES, PROFITS OR SAVINGS; OR OTHER SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES IN ANY WAY RELATED TO OR ARISING FROM THE SALE OR USE OF THE PRODUCT.

III. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location before the expiration of the warranty period. Warranty service will be provided by Motorola through one of its authorized warranty service locations. If you first contact the company which sold you the Product, it can facilitate your obtaining warranty service. You can also open a *Contact Us* case on Motorola Online (http://www.motorolasolutions.com/businessonline).

IV. What This Warranty Does Not Cover

This warranty does not cover:

A. Defects or damage resulting from use of the Product in other than its normal customary or authorized manner.

B. Defects or damage from misuse, accident, liquid, lightning, neglect or act of God.

C. Defects or damage from testing, maintenance, installation, alteration, modification, or adjustment not provided or authorized in writing by MOTOROLA.

D. Breakage or damage to antennas unless caused directly by defects in material or workmanship.

E. A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola supplied equipment) which adversely affect performance of the Product or interfere with Motorola's normal warranty inspection and testing of the Product to verify any warranty claim.

F. Product which has had the serial number removed or made illegible.

G. Freight costs to ship the product to the repair depot.

H. Batteries (because they carry their own separate limited warranty) or consumables.

I. Customer’s failure to comply with all applicable industry and OSHA standards.

J. A Product which, due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA’s published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.

K. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.

L. Normal and customary wear and tear.

V. Governing Law

This Warranty is governed by the laws of the State of Illinois, USA.

C.2 Replacement Parts Ordering

C.2.1 Basic Ordering Information

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

C.2.2 Motorola Online

Motorola Online users can access our online catalog at http://www.motorolasolutions.com/businessonline

To register for online access:

- Have your Motorola Customer number available.
- Please go to http://www.motorolasolutions.com/businessonline and click on “Sign Up Now.”
- Complete form and submit it.
- Contact your BDM to complete set-up and it will be done within 24 to 48 hours.

C.3 Motorola Service Centers

C.3.1 Servicing Information

If a unit requires further complete testing, knowledge and/or details of component level troubleshooting or service than is customarily performed at the basic level, please send the radio to a Motorola Service Center as listed below.

C.3.2 Motorola de México, S.A.

Bosques de Alisos 125
Col. Bosques de las Lomas CP 05120
México D.F.
México
Tel: +52-55-5257-6700

C.3.3 Motorola de Colombia, Ltd.

Carrera 98 No. 25G-20 Of 105
Bogota
Colombia
Tel: +57-1-602-2111

Notes

Appendix D NAG Replacement Parts Ordering and Motorola Service Centers

D.1 Commercial Warranty

Limited Warranty

MOTOROLA COMMUNICATION PRODUCTS

I. What This Warranty Covers And For How Long

MOTOROLA SOLUTIONS, INC. (“MOTOROLA”) warrants the MOTOROLA manufactured Communication Products listed below (“Product”) against material defects in material and workmanship under normal use and service for the period of time from the date of purchase as scheduled below:

ASTRO APX 1000/ APX 2000/ APX 4000 (Two Knobs)/ APX 4000Li Digital Portable Units	One (1) Year
Product Accessories	One (1) Year

Motorola will at its option and at no charge either repair the defective Product (with new or reconditioned parts), replace it (with a new or reconditioned Product), or refund the purchase price of the defective Product during the warranty period provided it is returned before the expiration of the warranty period and in accordance with the terms of this warranty. Replaced Product, parts or boards are warranted for the balance of the original applicable warranty period. All replaced Product, parts of boards shall become the property of MOTOROLA.

This express limited warranty is extended by MOTOROLA to the original end user purchasing the Product for commercial, industrial or governmental use only and is not assignable or transferable to any other party. This is the complete warranty for the Product manufactured by MOTOROLA. MOTOROLA assumes no obligations or liability for additions or modifications to this warranty unless made in writing and signed by an officer of MOTOROLA. Unless made in a separate agreement between MOTOROLA and the original purchaser, MOTOROLA does not warrant the installation, maintenance or service of the Product.

MOTOROLA is not responsible in any way for any ancillary equipment not furnished by MOTOROLA which is attached to or used in connection with the Product, or for operation of the Product with any ancillary equipment, and all such equipment is expressly excluded from this warranty. Because each system which may use the Product is unique, MOTOROLA disclaims liability for range, coverage, or operation of the system in part or as a whole under this warranty.

II. General Provisions

This warranty sets forth the full extent of MOTOROLA'S responsibilities regarding the Product. Repair, replacement or refund of the purchase price, at MOTOROLA'S option, is the exclusive remedy. THIS WARRANTY IS THE COMPLETE WARRANTY FOR THE PRODUCT AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES. MOTOROLA DISCLAIMS ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY COMMERCIAL LOSS; INCONVIENCE; LOSS OF USE, TIME, DATA, GOOD WILL, REVENUES, PROFITS OR SAVINGS; OR OTHER SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES IN ANY WAY RELATED TO OR ARISING FROM THE SALE OR USE OF THE PRODUCT.

III. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location before the expiration of the warranty period. Warranty service will be provided by Motorola through one of its authorized warranty service locations. If you first contact the company which sold you the Product, it can facilitate your obtaining warranty service. You can also open a *Contact Us* case on Motorola Online (http://www.motorolasolutions.com/businessonline).

IV. What This Warranty Does Not Cover

This warranty does not cover:

A. Defects or damage resulting from use of the Product in other than its normal customary or authorized manner.

B. Defects or damage from misuse, accident, liquid, lightning, neglect or act of God.

C. Defects or damage from testing, maintenance, installation, alteration, modification, or adjustment not provided or authorized in writing by MOTOROLA.

D. Breakage or damage to antennas unless caused directly by defects in material or workmanship.

E. A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola supplied equipment) which adversely affect performance of the Product or interfere with Motorola's normal warranty inspection and testing of the Product to verify any warranty claim.

F. Product which has had the serial number removed or made illegible.

G. Freight costs to ship the product to the repair depot.

H. Batteries (because they carry their own separate limited warranty) or consumables.

I. Customer’s failure to comply with all applicable industry and OSHA standards.

J. A Product which, due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA’s published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.

K. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.

L. Normal and customary wear and tear.

V. Governing Law

This Warranty is governed by the laws of the State of Illinois, USA.

D.2 Replacement Parts Ordering

D.2.1 Basic Ordering Information

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

D.2.2 Motorola Online

Motorola Online users can access our online catalog at

http://motorola.com/businessonline

To register for online access, please call 1-800-422-4210 (for U.S. and Canada Service Centers only). International customers can obtain assistance at http://motorola.com/businessonline

D.2.3 Mail Orders

Mail orders are only accepted by the US Federal Government Markets Division (USFGMD).

Motorola
7031 Columbia Gateway Drive
3rd Floor - Order Processing
Columbia, MD 21046
U.S.A.

D.2.4 Telephone Orders

Radio Products and Solutions Organization*
(United States and Canada)
7:00 AM to 7:00 PM (Central Standard Time)
Monday through Friday (Chicago, U.S.A.)
1-800-422-4210
1-847-538-8023 (United States and Canada)

U.S. Federal Government Markets Division (USFGMD)
1-877-873-4668
8:30 AM to 5:00 PM (Eastern Standard Time)

D.2.5 Fax Orders

Radio Products and Solutions Organization*
(United States and Canada)
1-800-622-6210
1-847-576-3023 (United States and Canada)

USFGMD
(Federal Government Orders)
1-800-526-8641 (For Parts and Equipment Purchase Orders)

D.2.6 Parts Identification

Radio Products and Solutions Organization*
(United States and Canada)
1-800-422-4210

D.2.7 Product Customer Service

Radio Products and Solutions Organization (United States and Canada)
1-800-927-2744

* The Radio Products and Solutions Organization (RPSO) was formerly known as the Radio Products Services Division (RPSD) and/or the Accessories and Aftermarket Division (AAD).

D.3 Motorola Service Centers

D.3.1 Servicing Information

If a unit requires further complete testing, knowledge and/or details of component level troubleshooting or service than is customarily performed at the basic level, please send the radios to a Motorola Service Center as listed below.

D.3.2 Motorola Service Center

Motorola Repair
2214 Galvin Drive
Elgin, IL 60123
Tel: 1-800-221-7144

D.3.3 Motorola Federal Technical Center

10105 Senate Drive
Lanham, MD 20706
Tel: 1-800-969-6680
Fax: 1-800-784-4133

D.3.4 Motorola Canadian Technical Logistics Center

Motorola Canada Ltd.
8133 Warden Avenue
Markham, Ontario, L6G 1B3
Tel: 1-800-543-3222
Fax: 1-888-331-9872 or 1-905-948-5970

Appendix E Asia-Pacific Warranty, Service and Technical Support

E.1 Replacement Parts Ordering

Some replacement parts, spare parts, and/or product information can be ordered directly. While parts may be assigned with a Motorola part number, this does not guarantee that they are available from Motorola Radio Products and Solutions Organization (RPSO). Some parts may have become obsolete and no longer available in the market due to cancellations by the supplier. If no Motorola part number is assigned, the part is normally not available from Motorola, or is not a user-serviceable part.

Orders for replacement parts should be placed directly on Motorola Online. For Level 2 maintenance, only Motorola Service Centers can perform these functions. Any tampering by nonauthorized Motorola Service Centers voids the warranty of your radio. To find out more about Motorola Service Centers, please visit http://www.motorolasolutions.com

E.2 Warranty Period and Return Instructions

The terms and conditions of warranty are defined fully in the Motorola Dealer or Distributor or Reseller contract. These conditions may change from time to time and the following notes are for guidance purposes only. In instances where the product is covered under a "return for replacement" or "return for repair" warranty, a check of the product should be performed prior to shipping the unit back to Motorola. This is to ensure that the product has been correctly programmed or has not been subjected to damage outside the terms of the warranty.

Prior to shipping any radio back to the appropriate Motorola warranty depot, please contact Customer Resources or your Motorola 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 dealer, distributor or reseller. Products should be shipped back in the original packaging, or correctly packaged to ensure no damage occurs in transit.

ASTRO APX 1000/ APX 2000/ APX 4000 (Two Knobs)/ APX 4000Li Digital Portable Units	One (1) Year
Product Accessories	One (1) Year

E.3 Motorola Service Centers

E.3.1 Servicing Information

If a unit requires further complete testing, knowledge and/or details of component level troubleshooting or service than is customarily performed at the basic level, please send the radios to a Motorola Service Center as listed below.

E.3.2 Motorola Solutions Singapore Pte. Ltd.

c/o Azure Engineering,
49 Jalan Pemimpin,
#03-11 APS Industrial Building,
Singapore 577203

Contact: Mareen Phua
E-mail: mareen@azure.com.sg
Tel: +65-6352-6383
Enquiry: Tay Yong Hock
E-mail: yonghock.tay@motorolasolutions.com

E.3.3 Motorola Solutions Sdn. Bhd.

Level 14, Persoft Tower,
No. 68, Pesiaran Tropicana,
47410 Petaling Jaya,
Selangor Darul Ehsan,
Malaysia

Contact: Koh Tiong Eng
E-mail: A21001@motorolasolutions.com
Tel: +603-7809-0000

E.3.4 PT. Motorola Solutions Indonesia

30th Floor, Gedung BRI II, Suite 3001,
Jl. Jend. Sudirman Kav. 44-46,
Jakarta 10210,
Indonesia.

Contact: Eko Haryanto
E-mail: Eko.Haryanto@motorolasolutions.com
Tel: +62-21-3043-5239

E.3.5 Motorola Solutions (Thailand) Ltd.

142 Two Pacific Place Suite 2201,
3220 Sukhumvit Road,
Klongtoey,
Bangkok 10110.

Contact: Nitas Vatanasupapon
E-mail: Nitas@motorolasolutions.com
Tel: +662-653-220
Fax: +668-254-5922

E.3.6 Motorola Solutions India Pvt. Ltd.

C/o Communication Test Design India Private Limited,
#4, 5 Maruthi Industrial Estate,
Rajapalya, Hoodi Village,
Bangalore – 560048,
India.

Contact: K. Umamaheswari
E-mail: umamaheshwari@motorolasolutions.com
Tel: +91-9844218850

E.3.7 Motorola Solutions (China) Co. Ltd.

No. 1 East of Wang Jing Road,
Chao Yang District,
Beijing, 100102,
P.R. China

Contact: Sophy Wang
E-mail: C18170@motorolasolutions.com
Tel: +86-10-8473-2106

E.3.8 Motorola Solutions Asia Pacific Ltd.

Unit 1807–1812, 18/F, Two Harbourfront,
22 Tak Fung Street,
Hunghom, Kowloon,
Hong Kong.

Contact: Judy Leung
E-mail: Judy.Leung@motorolasolutions.com
Tel: 852-2966-4823

E.3.9 Motorola Communications Philippines, Inc.

Unit 2102, One Global Place Building,
5th Ave., Bonifacio Global City,
Taguig, Philippines 1634.

Contact: Arthur Nieves
E-mail: Arthur.Nieves@motorolasolutions.com
Tel: +632 858-7500
Fax: +632 841-0681

E.3.10 Motorola Solutions Korea, Inc.

9th Floor, Hibrand Building,
215, Yangjae-Dong, Seocho-Gu,
Seoul, 137-924,
Korea.

Contact: KS Kwak
E-mail: r45321@motorolasolutions.com
Tel: +822-3497-3649

E.3.11 Motorola Solutions Taiwan, Ltd.

8F, No. 9, Songgao Rd.,
Taipei 110,
Taiwan (R.O.C.)

Contact: Michael Chou
E-mail: ftpe239@motorolasolutions.com
Tel: +886-2-8729 8000

E.3.12 Motorola Solutions Australia Pty. Ltd.

10 Wesley Court,
Tally Ho Business Park,
East Burwood Victoria 3151,
Australia.

E-mail: servicecentre.au@motorolasolutions.com

Glossary

This glossary contains an alphabetical listing of terms and their definitions that are applicable to ASTRO portable and mobile subscriber radio products.

Term	Definition
A/D	*See analog-to-digital conversion.*
Abacus IC	A custom integrated circuit providing a digital receiver intermediate frequency (IF) backend.
active channel	A channel that has traffic on it.
ACK	Acknowledgment of communication.
ADC	*See analog-to-digital converter.*
ADDAG	*See Analog-to-Digital, Digital-to-Analog and Glue.*
analog	Refers to a continuously variable signal or a circuit or device designed to handle such signals. *See also digital.*
Analog-to-Digital, Digital-to-Analog and Glue	An integrated circuit designed to be an interface between the radio's DSP, which is digital, and the analog transmitter and receiver ICs.
analog-to-digital conversion	Conversion of an instantaneous dc voltage level to a corresponding digital value. *See also D/A.*
analog-to-digital converter	A device that converts analog signals into digital data. *See also DAC.*
ASTRO 25 trunking	Motorola standard for wireless digital trunked communications.
ASTRO conventional	Motorola standard for wireless analog or digital conventional communications.
automatic level control	A circuit in the transmit RF path that controls RF power amplifier output, provides leveling over frequency and voltage, and protects against high VSWR.
autoscan	A feature that allows the radio to automatically scan the members of a scan list.
band	Frequencies allowed for a specific purpose.
BGA	*See ball grid array.*
ball grid array	A type of IC package characterized by solder balls arranged in a grid that are located on the underside of the package.
Call Alert	Privately paging an individual by sending an audible tone.

Term	Definition
carrier squelch	Feature that responds to the presence of an RF carrier by opening or unmuting (turning on) a receiver's audio circuit. A squelch circuit silences the radio when no signal is being received so that the user does not have to listen to “noise.”
central controller	A software-controlled, computer-driven device that receives and generates data for the trunked radios assigned to it. It Monitors and directs the operations of the trunked repeaters.
channel	A group of characteristics, such as transmit/receive frequency pairs, radio parameters, and encryption encoding.
CMOS	Complementary metal-oxide semiconductor.
CODEC	*See coder/decoder.*
coded squelch	Used on conventional channels to ensure that the receiver hears only those communications intended for the receiver.
codeplug	Firmware that contains the unique personality for a system or device. A codeplug is programmable and allows changes to system and unit parameters. *See also firmware.*
coder/decoder	A device that encodes or decodes a signal.
control channel	In a trunking system, one of the channels that is used to provide a continuous, two-way/data-communications path between the central controller and all radios on the system.
conventional	Typically refers to radio-to-radio communications, sometimes through a repeater. Frequencies are shared with other users without the aid of a central controller to assign communications channels. *See also trunking.*
conventional scan list	A scan list that includes only conventional channels.
CPS	*See Customer Programming Software.*
cursor	A visual tracking marker (a blinking line) that indicates a location on a display.
Customer Programming Software	Software with a graphical user interface containing the feature set of an ASTRO radio. *See also RSS.*
D/A	*See digital-to-analog conversion.*
DAC	*See digital-to-analog converter.*
deadlock	Displayed by the radio after three failed attempts to unlock the radio.The radio must be powered off and on prior to another attempt.
default	A pre-defined set of parameters.

Term	Definition
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. *See also analog.*
digital-to-analog conversion	Conversion of a digital signal to a voltage that is proportional to the input value. *See also A/D.*
digital-to-analog converter	A device that converts digital data into analog signals. *See also ADC.*
Digital Private Line	A type of digital communications that utilizes privacy call, as well as memory channel and busy channel lock out to enhance communication efficiency.
digital signal processor	A microcontroller specifically designed for performing the mathematics involved in manipulating analog information, such as sound, that has been converted into a digital form. DSP also implies the use of a data compression technique.
digital signal processor code	Object code executed by the Digital Signal Processor in an ASTRO subscriber radio. The DSP is responsible for computation-intensive tasks, such as decoding ASTRO signaling.
dispatcher	An individual who has radio-system management duties and responsibilities.
DPL	*See Digital Private Line. See also PL.*
DSP	*See digital signal processor.*
DSP code	*See digital signal processor code.*
dynamic regrouping	A feature that allows the dispatcher to temporarily reassign selected radios to a single special channel so they can communicate with each other.
EEPOT	Electrically Programmable Digital Potentiometer.
EEPROM	*See Electrically Erasable Programmable Read-Only Memory.*
Electrically Erasable Programmable Read-Only Memory	A special type of PROM that can be erased by exposing it to an electrical charge. An EEPROM retains its contents even when the power is turned off.
Failsoft	A backup system that allows communication in a non-trunked, conventional mode if the trunked system fails.
FCC	Federal Communications Commission.

Term	Definition
firmware	Code executed by an embedded processor such as the Host or DSP in a subscriber radio. This type of code is typically resident in non-volatile memory and as such is more difficult to change than code executed from RAM.
FGU	*See frequency generation unit.*
flash	A non-volatile memory device similar to an EEPROM. Flash memory can be erased and reprogrammed in blocks instead of one byte at a time.
FLASHcode	A 13-digit code which uniquely identifies the System Software Package and Software Revenue Options that are enabled in a particular subscriber radio. FLASHcodes are only applicable for radios which are upgradeable through the FLASHport process.
FLASHport	A Motorola term that describes the ability of a radio to change memory. Every FLASHport radio contains a FLASHport EEPROM memory chip that can be software written and rewritten to, again and again.
FMR	*See Florida Manual Revision.*
Florida Manual Revision	A publication that provides supplemental information for its parent publication before it is revised and reissued.
frequency	Number of times a complete electromagnetic-wave cycle occurs in a fixed unit of time (usually one second).
frequency generation unit	This unit generates ultra-stable, low-phase noise master clock and other derived synchronization clocks that are distributed throughout the communication network.
General-Purpose Input/Output	Pins whose function is programmable.
GPIO	*See General-Purpose Input/Output.*
hang up	Disconnect.
home display	The first information display shown after a radio completes its self test.
host code	Object code executed by the host processor in an ASTRO subscriber radio. The host is responsible for control-oriented tasks such as decoding and responding to user inputs.
IC	*See integrated circuit.*
IF	Intermediate Frequency.
IMBE	A sub-band, voice-encoding algorithm used in ASTRO digital voice.
inbound signaling word	Data transmitted on the control channel from a subscriber unit to the central control unit.

Term	Definition
integrated circuit	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.
ISW	*See inbound signaling word.*
key-variable loader	A device used to load encryption keys into a radio.
kHz	*See kilohertz.*
kilohertz	One thousand cycles per second. Used especially as a radio-frequency unit.
KVL	*See key-variable loader.*
LCD	*See liquid-crystal display.*
LDMOS	Laterally Diffused Metal Oxide Semiconductor.
LED	*See LED.*
light emitting diode	An electronic device that lights up when electricity is passed through it.
liquid-crystal display	An LCD uses two sheets of polarizing material with a liquid-crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them.
LO	Local oscillator.
low-speed handshake	150-baud digital data sent to the radio during trunked operation while receiving audio.
LSH	*See low-speed handshake.*
Master In Slave Out	SPI data line from a peripheral to the MCU.
Master Out Slave In	SPI data line from the MCU to a peripheral.
MCU	*See microcontroller unit.*
MDC	Motorola Digital Communications.
menu entry	A software-activated feature shown at the bottom of the display. Selection of a feature is controlled by the programming of the buttons on the side of the radio.
MHz	*See Megahertz.*
Megahertz	One million cycles per second. Used especially as a radio-frequency unit.
microcontroller unit	Also written as µC. A microprocessor that contains RAM and ROM components, as well as communications and programming components and peripherals.
MISO	*See Master In Slave Out.*

Term	Definition
mode	A programmed combination of operating parameters; for example, a channel or talkgroup.
mode slaving	A radio programmed to automatically provide the proper operation for a given selected mode.
Monitoring	Used in conventional operation where the programmed Monitor button is pressed to listen to another user who is active on a channel. This prevents one user from interfering with another user’s conversation.
MOSI	*See Master Out Slave In.*
MFK	Multi Function Knob
multiplexer	An electronic device that combines several signals for transmission on some shared medium (e.g., a telephone wire).
MUX	*See multiplexer.*
Network Access Code	Network Access Code (NAC) operates on digital channels to reduce voice channel interference between adjacent systems and sites.
NiCd	Nickel-cadmium.
NiMH	Nickel-metal-hydride.
non-tactical/revert	The user will talk on a preprogrammed emergency channel. The emergency alarm is sent out on this same channel.
OMPAC	*See over-molded pad-array carrier.*
open architecture	A controller configuration that utilizes a microprocessor with extended ROM, RAM, and EEPROM.
oscillator	An electronic device that produces alternating electric current and commonly employs tuned circuits and amplifying components.
OSW	*See outbound signaling word.*
OTAR	*See over-the-air rekeying.*
outbound signaling word	Data transmitted on the control channel from the central controller to the subscriber unit.
over-molded pad-array carrier	A Motorola custom IC package, distinguished by the presence of solder balls on the bottom pads.
over-the-air rekeying	Allows the dispatcher to remotely reprogram the encryption keys in the radio.
PA	Power amplifier.
page	A one-way alert with audio and/or display messages.
paging	One-way communication that alerts the receiver to retrieve a message.

Term	Definition
PC Board	Printed Circuit Board. Also referred to as a PCB.
personality	A set of unique features specific to a radio.
phase-locked loop	A circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.
PL	*See private-line tone squelch.*
PLL	*See phase-locked loop.*
preprogrammed	A software feature that has been activated by a qualified radio technician.
Private (Conversatiion) Call	A feature that lets you have a private conversation with another radio user in the group.
private-line tone squelch	A continuous sub-audible tone that is transmitted along with the carrier. *See also DPL.*
programmable	A radio control that can have a radio feature assigned to it.
Programmable Read-Only Memory	A memory chip on which data can be written only once. Once data has been written onto a PROM, it remains there forever.
PROM	*See Programmable Read-Only Memory.*
PTT	*See Push-to-Talk.*
Push-to-Talk	The switch or button usually located on the left side of the radio which, when pressed, causes the radio to transmit. When the PTT is released, the unit returns to receive operation.
radio frequency	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.
Radio Interface Box	A service aid used to enable communications between a radio and the programming software.
Radio Service Software	DOS-based software containing the feature set of an ASTRO radio. *See also CPS.*
random access memory	A type of computer memory that can be accessed randomly; that is, any byte of memory can be accessed without touching the preceding bytes.
RAM	*See random access memory.*
read-only memory	A type of computer memory on which data has been prerecorded. Once data has been written onto a ROM chip, it cannot be removed and can only be read.

Term	Definition
real-time clock	A module that keeps track of elapsed time even when a computer is turned off.
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.
registers	Short-term data-storage circuits within the microcontroller unit or programmable logic IC.
repeater	Remote transmit/receive facility that re-transmits received signals in order to improve communications range and coverage (conventional operation).
repeater/talkaround	A conventional radio feature that permits communication through a receive/transmit facility, which re-transmits received signals in order to improve communication range and coverage.
RESET	Reset line: an input to the microcontroller that restarts execution.
RF	*See radio frequency.*
RF PA	*See radio frequency power amplifier.*
RIB	*See Radio Interface Box.*
ROM	*See read-only memory.*
RPCIC	Regulator/power control IC.
RPT/TA	*See repeater/talkaround.*
RSS	*See Radio Service Software.*
RSSI	Received Signal Strength Indicator.
RTC	*See real-time clock.*
RX	Receive.
RX DATA	Recovered digital data line.
SAP	*See Serial Audio CODEC Port.*
SCI IN	Serial Communications Interface Input line.
selective call	A feature that allows you to call a selected individual, intended to provide privacy and to eliminate the annoyance of having to listen to conversations of no interest to you.
selective switch	Any digital P25 traffic having the correct Network Access Code and the correct talkgroup.
Serial Audio CODEC Port	SSI to and from the GCAP II IC CODEC used to transfer transmit and receive audio data.

Term	Definition
Serial Communication Interface Input Line	A full-duplex (receiver/transmitter) asynchronous serial interface.
SCI IN	*See Serial Communication Interface Input Line.*
Serial Peripheral Interface	How the microcontroller communicates to modules and ICs through the CLOCK and DATA lines.
signal	An electrically transmitted electromagnetic wave.
Signal Qualifier mode	An operating mode in which the radio is muted, but still continues to analyze receive data to determine RX signal type.
softpot	*See software potentiometer.*
software	Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system.
software potentiometer	A computer-adjustable electronic attenuator.
spectrum	Frequency range within which radiation has specific characteristics.
SPI	*See Serial Peripheral Interface.*
squelch	Muting of audio circuits when received signal levels fall below a pre-determined value. With carrier squelch, all channel activity that exceeds the radio's preset squelch level can be heard.
SRAM	*See static RAM.*
SRIB	Smart Radio Interface Box. *See RIB.*
SSI	*See Synchronous Serial Interface.*
Standby mode	An operating mode in which the radio is muted but still continues to Monitor data.
static RAM	A type of memory used for volatile, program/data memory that does not need to be refreshed.
status calls	Pre-defined text messages that allow the user to send a conditional message without talking.
Synchronous Serial Interface	DSP interface to peripherals that consists of a clock signal line, a frame synchronization signal line, and a data line.
system central controllers	Main control unit of the trunked dispatch system; handles ISW and OSW messages to and from subscriber units *(See ISW and OSW)*.
system select	The act of selecting the desired operating system with the system-select switch (also, the name given to this switch).

Term	Definition
tactical/non-revert	The user will talk on the channel that was selected before the radio entered the emergency state.
TalkAround	Bypassing a repeater and talking directly to another unit for local unit-to-unit communications.
talkgroup	An organization or group of radio users who communicate with each other using the same communications path.
talkgroup scan list	A scan list that can include both talkgroups (trunked) and channels (conventional).
thin small-outline package	A type of dynamic random-access memory (DRAM) package that is commonly used in memory applications.
time-out timer	A timer that limits the length of a transmission.
tone	A continuous, sub-audible tone transmitted with the carrier.
TOT	*See time-out timer.*
transceiver	Transmitter-receiver. A device that both transmits and receives analog or digital signals. Also abbreviated as XCVR.
transmitter	Electronic equipment that generates and amplifies an RF carrier signal, modulates the signal, and then radiates it into space.
trunking	The automatic sharing of communications paths between a large number of users. Allows users to share a smaller number of frequencies because a repeater or communications path is assigned to a talkgroup for the duration of a conversation. *See also conventional.*
trunking priority Monitor scan list	A scan list that includes talkgroups that are all from the same trunking system.
TSOP	*See thin small-outline package.*
TX	Transmit.
UART	*See also Universal Asynchronous Receiver Transmitter.*
UHF	Ultra-High Frequency.
USK	Unique shadow key.
Universal Asynchronous Receiver Transmitter	A microchip with programming that controls a computer's interface to its attached serial devices.
Universal Connector	Interface point for all accessories to the radio.
Universal Serial Bus	An external bus standard that supports data transfer rates of 12 Mbps.
USB	*See Universal Connector.*

Term	Definition
VCO	*See voltage-controlled oscillator.*
vector sum excited linear predictive coding	A voice-encoding technique used in ASTRO digital voice.
VOCON	*See vocoder/controller.*
vocoder	An electronic device for synthesizing speech by implementing a compression algorithm particular to voice. *See also voice encoder.*
vocoder/controller	A PC board that contains an ASTRO radio's microcontroller, DSP, memory, audio and power functions, and interface support circuitry.
voice encoder	The DSP-based system for digitally processing analog signals, and includes the capabilities of performing voice compression algorithms or voice encoding. *See also vocoder.*
voltage-controlled oscillator	An oscillator in which the frequency of oscillation can be varied by changing a control voltage.

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Notes

MOTOROLA

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