APX™ TWO-WAY RADIOS

APX 3000

BASIC SERVICE MANUAL

Foreword

This manual covers all models of the ASTRO® APX®3000 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” .

Product Safety and RF Exposure Compliance

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

For a list of Motorola-approved antennas, batteries, and other accessories, visit the following web site which lists approved accessories: 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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Notes

Document History

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

Edition	Description	Date
68012007044-A	Initial edition	Nov. 2012
68012007044-B	Updated Model chart for 700/800 MHz and serviceable components table.Added in Servicing Shroud Label, NFC flex and lightpipe to section 8.5.2.5	Jan. 2013
68012007044-C	Added in UHF2 & VHF	Jun. 2013

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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 defects in material and workmanship under normal use and service for a period of time from the date of purchase as scheduled below:

ASTRO APX 3000 Digital Portable Units	One (1) Year
Product Accessories	One (1) Year

Motorola, at its option, will at no charge either repair the Product (with new or reconditioned parts), replace it (with a new or reconditioned Product), or refund the purchase price of the Product during the warranty period provided it is returned in accordance with the terms of this warranty. Replaced parts or boards are warranted for the balance of the original applicable warranty period. All replaced parts of Product shall become the property of MOTOROLA.

This express limited warranty is extended by MOTOROLA to the original end user purchaser 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 end user purchaser, MOTOROLA does not warrant the installation, maintenance or service of the Product.

MOTOROLA cannot be 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 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 GIVEN IN LIEU OF ALL OTHER EXPRESS WARRANTIES. IMPLIED WARRANTIES, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED TO THE DURATION OF THIS LIMITED WARRANTY. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY LOSS OF USE, LOSS OF TIME, INCONVENIENCE, COMMERCIAL LOSS, LOST PROFITS OR SAVINGS OR OTHER INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE SUCH PRODUCT, TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW.

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SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LIMITATION ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATION OR EXCLUSIONS MAY NOT APPLY.

This warranty gives specific legal rights, and there may be other rights which may vary from state to state.

IV. 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, also, deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location. 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 call Motorola at 1-888-567-7347 US/Canada.

V. What This Warranty Does Not Cover

A. Defects or damage resulting from use of the Product in other than its normal and customary manner.

B. Defects or damage from misuse, accident, water, or neglect.

C. Defects or damage from improper testing, operation, maintenance, installation, alteration, modification, or adjustment.

D. Breakage or damage to antennas unless caused directly by defects in material 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. Rechargeable batteries if:

H. any of the seals on the battery enclosure of cells are broken or show evidence of tampering.

I. the damage or defect is caused by charging or using the battery in equipment or service other than the Product for which it is specified.

J. Freight costs to the repair depot.

K. 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 certification labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.

L. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.

M. Normal and customary wear and tear.

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MOTOROLA will defend, at its own expense, any suit brought against the end user purchaser to the extent that it is based on a claim that the Product or parts infringe a United States patent, and MOTOROLA will pay those costs and damages finally awarded against the end user purchaser in any such suit which are attributable to any such claim, but such defense and payments are conditioned on the following:

A. that MOTOROLA will be notified promptly in writing by such purchaser of any notice of such claim;

B. that MOTOROLA will have sole control of the defense of such suit and all negotiations for its settlement or compromise; and

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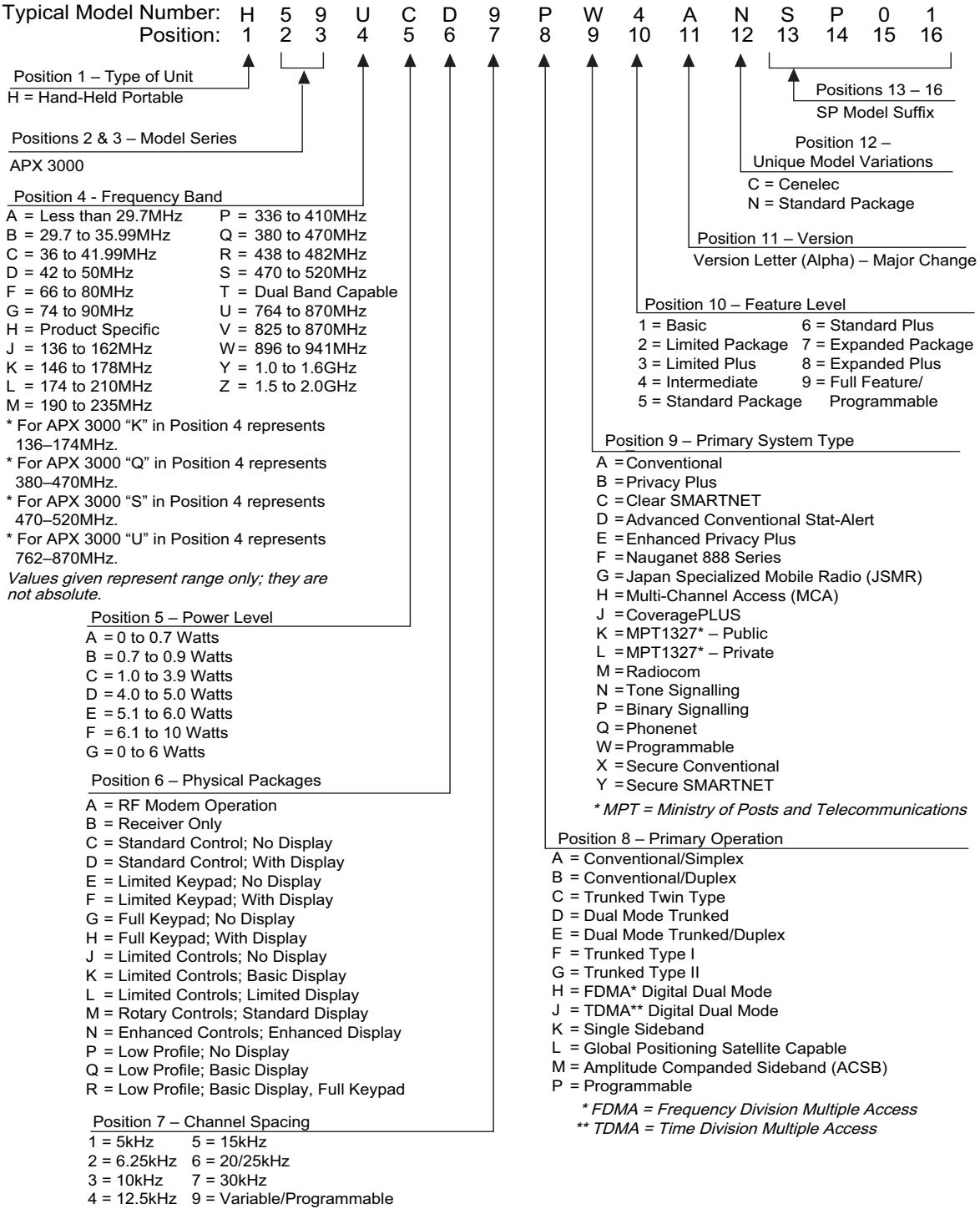
VII. Governing Law

This Warranty is governed by the laws of the State of Illinois, USA.

Notes

Model Numbering, Charts, and Specifications

Portable Radio Model Numbering System



Notes

ASTRO APX 3000 UHF1 Model Chart

	Model Number: H59QDD9PW4AN BT Models FCC ID: AZ489FT4911 MODEL DESCRIPTION: APX COVERT UHF1 MODEL 1 PORTABLE	
	ITEM NUMBER	**DESCRIPTION**
X	0104052J79	Front Housing Kit (APX 3000)
X	0104052J59	Assy, Flex, Top Control
X	41012013001	Spring, Switch, Rotary
X	07012048001	Bracket, Top Control
X	0104052J80	Back Housing Kit (APX 3000)
X	0104052J74	Assy, Flex, NFC
X	75012184001	Pad, Poron, BTB, 12pin, Plug, NFC
X	27012023001	Chassis
X	54012285001	Label, Chassis Left
X	54012285002	Label, Chassis Right
X	61012070001	Lightpipe, LEDs
X	15012209001	Shroud
X	54012276001	Label, Shroud
X	54012253001	Bluetooth Pairing Indication Label
X	32012212001	Main Seal
X	32012150001	Seal, Battery Contact
X	6071520M01	Batt Coin 3V LI Rechargeable
X	26012242001	Shield, Secondary
X	0386104Z04	Screw Chassis
X	3286058L01	Seal, Vacuum Port
X	43012045001	Collar, Plastic
X	75012182001	Pad, Thermal & Conductive
X	54012298001	Label, Gore Port
X	MLE4858_	RF Board Kit UHF1
●	54012279001	Label, FM
●	54012283002	Label, FM Approved Logo (Bottom)
●	54012283001	Label, Bottom Blank
●	15012210001	GCAI, Dust Cover
X	PMLN6408_	User Guide CD, APX 3000

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

ASTRO APX 3000 UHF2 Model Chart

Model Number: H59SDD9PW4AN BT Models FCC ID: AZ489FT4912 MODEL DESCRIPTION: APX COVERT UHF2 MODEL 1 PORTABLE		
	ITEM NUMBER	DESCRIPTION
X	0104052J79	Front Housing Kit (APX 3000)
X	0104052J59	Assy, Flex, Top Control
X	41012013001	Spring, Switch, Rotary
X	07012048001	Bracket, Top Control
X	0104052J80	Back Housing Kit (APX 3000)
X	0104052J74	Assy, Flex, NFC
X	75012184001	Pad, Poron, BTB, 12pin, Plug, NFC
X	27012023001	Chassis
X	54012285001	Label, Chassis Left
X	54012285002	Label, Chassis Right
X	61012070001	Lightpipe, LEDs
X	15012209001	Shroud
X	54012276001	Label, Shroud
X	54012253001	Bluetooth Pairing Indication Label
X	32012212001	Main Seal
X	32012150001	Seal, Battery Contact
X	6071520M01	Batt Coin 3V LI Rechargeable
X	26012242001	Shield, Secondary
X	0386104Z04	Screw Chassis
X	3286058L01	Seal, Vacuum Port
X	43012045001	Collar, Plastic
X	75012182001	Pad, Thermal & Conductive
X	54012298001	Label, Gore Port
X	MLE4912_	RF Board Kit UHF2
●	54012279001	Label, FM
●	54012283002	Label, FM Approved Logo (Bottom)
●	54012283001	Label, Bottom Blank
●	15012210001	GCAI, Dust Cover
X	PMLN6408_	User Guide CD, APX 3000

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

ASTRO APX 3000 VHF Model Chart

Model Number: BT Models FCC ID: MODEL DESCRIPTION:		H59KGD9PW4AN AZ489FT3830 APX COVERT VHF MODEL 1 PORTABLE
	ITEM NUMBER	DESCRIPTION
X	0104052J79	Front Housing Kit (APX 3000)
X	0104052J59	Assy, Flex, Top Control
X	41012013001	Spring, Switch, Rotary
X	07012048001	Bracket, Top Control
X	0104052J80	Back Housing Kit (APX 3000)
X	0104052J74	Assy, Flex, NFC
X	75012184001	Pad, Poron, BTB, 12pin, Plug, NFC
X	27012023001	Chassis
X	54012285001	Label, Chassis Left
X	54012285002	Label, Chassis Right
X	61012070001	Lightpipe, LEDs
X	15012209001	Shroud
X	54012276001	Label, Shroud
X	54012253001	Bluetooth Pairing Indication Label
X	32012212001	Main Seal
X	32012150001	Seal, Battery Contact
X	6071520M01	Batt Coin 3V LI Rechargeable
X	26012242001	Shield, Secondary
X	0386104Z04	Screw Chassis
X	3286058L01	Seal, Vacuum Port
X	43012045001	Collar, Plastic
X	75012182001	Pad, Thermal & Conductive
X	54012298001	Label, Gore Port
X	MLD4565_	RF Board Kit VHF
●	54012279001	Label, FM
●	54012283002	Label, FM Approved Logo (Bottom)
●	54012283001	Label, Bottom Blank
●	15012210001	GCAI, Dust Cover
X	PMLN6408_	User Guide CD, APX 3000

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

ASTRO APX 3000 700–800 MHz Model Chart

Model Number: H59UCD9PW4AN FCC ID: AZ489FT5860 MODEL DESCRIPTION: APX COVERT 700/800 MHZ MODEL 1 PORTABLE		
	ITEM NUMBER	**DESCRIPTION**
X	0104052J79	Front Housing Kit (APX 3000)
X	0104052J59	Assy, Flex, Top Control
X	41012013001	Spring, Switch, Rotary
X	07012048001	Bracket, Top Control
X	0104052J80	Back Housing Kit (APX 3000)
X	0386104Z04	Screw Chassis
X	0104052J74	Assy, Flex, NFC
X	75012184001	Pad, Poron, BTB, 12pin, Plug, NFC
X	27012023001	Chassis
X	54012285001	Label, Chassis Left
X	54012285002	Label, Chassis Right
X	61012070001	Lightpipe, LEDs
X	15012209001	Shroud
X	54012276001	Label, Shroud
X	54012253001	Bluetooth Pairing Indication Label
X	32012212001	Main Seal
X	32012150001	Batt Coin 3V Li Rechargeable
X	6071520M01	Seal, Battery Contact
X	26012242001	Shield, Secondary
X	3286058L01	Seal, Vacuum Port
X	43012045001	Collar, Plastic
X	75012182001	Pad, Thermal & Conductive
X	54012298001	Label, Gore Port
X	MLF4094_	RF Board Kit 700/800 MHz
●	54012279001	Label, FM
●	54012283002	Label, FM Approved Logo (Bottom)
●	54012283001	Label, Bottom Blank
●	15012210001	GCAI, Dust Cover
X	PMLN6408_	User Guide CD, APX3000

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

Specifications for APX 3000 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): 334 mA
Standby Current Drain: 133 mA

Recommended Battery:
- **Li-Ion (Ultra Slim):** NNTN8305_
- *or* **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" (133mm)
  W[1] = 2.56" (65mm) / 2.37" (60.2mm)
  D[2] = 0.77" (19.6mm) / 1.48" (37.5mm)
- **With Standard Battery:**
  H = 5.26" (133mm)
  W[1] = 2.56" (65mm) / 2.37" (60.2mm)
  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)

FCC ID:
AZ489FT4911

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:
- **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 3000 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): 338 mA
Standby Current Drain: 133 mA

Recommended Battery:
- **Li-Ion (Ultra Slim):** NNTN8305_
- *or* **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" (133mm)
  W[1] = 2.56" (65mm) / 2.37" (60.2mm)
  D[2] = 0.77" (19.6mm) / 1.48" (37.5mm)
- **With Standard Battery:**
  H = 5.26" (133 mm)
  W[1] = 2.56" (65mm) / 2.37" (60.2mm)
  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)

FCC ID:
AZ489FT4911

RECEIVER

Frequency Range: 450–520 MHz

Bandwidth: 70 MHz

Analog Sensitivity (typical)
- **(12 dB SINAD):** 0.224 µV

Digital Sensitivity (typical)
- **(1% BER):** 0.305 µV
- **(5% BER):** 0.205 µV

Intermodulation (typical): -78 dB

Selectivity (typical):
- **(25 kHz Channel):** -78 dB
- **(12.5 kHz Channel):** -68 dB

Spurious Rejection (typical): -80.3 dB

Frequency Stability
- **(-30+60°C; 25°C reference):** ±0.0001%

Rated Audio:
- **External Speaker:** 500 mW

FM Hum and Noise (typical):
25 kHz -51 dB
12.5 kHz -46 dB

Distortion (typical): 1 %

Channel Spacing: 12.5/25 kHz

TRANSMITTER

Frequency Range: 450–520 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 -53 dB
  12.5 kHz -47 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 3000 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): 1950 mA
Receive Current Drain (Rated Audio): 330 mA
Standby Current Drain: 133 mA

Recommended Battery:
Li-Ion (Ultra Slim): NNTN8305_
or **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 = 5.57" (141.5 mm)
W1 = 2.37" (60.1 mm) / 2.35" (59.8mm)
D2 = 1.07"(27.03mm) / 1.06"(27.03mm)
With Ultra-Slim Battery:
H = 5.57" (141.5mm)
W1 = 2.37" (60.1mm) / 2.35" (59.8mm)
D2 = 1.47"(37.4mm) / 1.72"(43.6mm)
With Slim Battery:
H = 5.57" (141.5 mm)
W1 = 2.37" (60.1 mm) / 2.35" (59.8 mm)
D2 = 1.47"(37.4mm) / 1.72"(43.6mm)
With High Cap Battery:
H = 5.57" (141.5mm)
W1 = 2.37" (60.1mm) / 2.35" (59.8mm)
D2 = 1.69"(42.9mm) / 1.93"(48.9mm)

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

Weight: (w/o Antenna):
Less Battery: 6.84 oz (260g)
With Li-Ion Standard: 14.47 oz (410g)
With Li-Ion High Cap: 14.81 oz (420g)

FCC ID:
AZ489FT3830

RECEIVER

Frequency Range: 136–174 MHz

Bandwidth: 38 MHz

Analog Sensitivity (typical)
(12 dB SINAD): 0.200 µV

Digital Sensitivity (typical)
(1% BER): 0.285 µV
(5% BER): 0.18 µV

Intermodulation (typical): -79 dB

Selectivity (typical):
(25 kHz Channel): -79 dB
(12.5 kHz Channel): -70 dB

Spurious Rejection (typical): -78 dB

Frequency Stability
(-30+60°C; 25°C reference): ±0.0001%

Rated Audio:
External Speaker: 500 mW

FM Hum and Noise (typical):
25 kHz -54 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 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 3000 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): 1670 mA
Receive Current Drain (Rated Audio): 319 mA
Standby Current Drain: 138 mA

Recommended Battery:
- **Li-Ion (Ultra Slim):** NNTN8305_
- *or* **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 = 5.57" (141.5mm)
  W1 = 2.37" (60.1mm) / 2.35" (59.8mm)
  D2 = 1.07"(27.03mm) / 1.06"(27.03mm)
- **With Ultra-Slim Battery:**
  H = 5.57" (141.5mm)
  W1 = 2.37" (60.1mm) / 2.35" (59.8mm)
  D2 = 1.47"(37.4mm) / 1.72"(43.6mm)
- **With Slim Battery:**
  H = 5.57" (141.5 mm)
  W1 = 2.37" (60.1 mm) / 2.35" (59.8mm)
  D2 = 1.47"(37.4mm) / 1.72"(43.6mm)
- **With High Cap Battery:**
  H = 5.57" (141.5mm)
  W1 = 2.37" (60.1mm) / 2.35" (59.8mm)
  D2 = 1.69"(42.9mm) / 1.93"(48.9mm)

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

Weight: (w/o Antenna):
- **Less Battery:** 6.84 oz (260g)
- **With Li-Ion Standard:** 14.47 oz (410g)
- **With Li-Ion High Cap:** 14.81 oz (420g)

FCC ID:
AZ489FT5860

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:
- **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:** 764–775; 793–805 MHz
- **800 MHz:** 806–824; 851–869 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 -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, 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 UHF1 (380–470 MHz), UHF2 (450–520 MHz), VHF (136–174 MHz) and 764–870 MHz frequency bands, a general description of ASTRO APX 3000 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 indicates a potentially hazardous situation which, if not avoided, might result in equipment damage.

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

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

1.3 Radio Description

The ASTRO APX 3000 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.

Table 1-1. ASTRO APX 3000 Basic Features

Feature	APX 3000
Channel Capability	512
FLASHport Memory	64MB

1.4 FLASHport®

The ASTRO APX 3000 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 3000 radio's reference oscillator every time the radio is taken apart, or once per year, whichever comes first. (See Reference Oscillator Alignment). 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.

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.

- The APX 3000 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 3000 radio is designed to be submerged to a maximum depth of 1 meter, with a maximum submersion time of 30 minutes. 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.

Chapter 3 Basic Theory of Operation

This chapter discusses the basic operational theory of the ASTRO APX 3000 radio, which is a wideband, synthesized radio available in the UHF1 (380–470 MHz), UHF2 (450–520 MHz), VHF (136–174 MHz) and 764–870 MHz frequency bands. All ASTRO APX3000 radios are capable of both analog operation (12.5 kHz or 25 kHz bandwidths), ASTRO mode (digital) operation (12.5 kHz only) and X2-TDMA mode (12.5 kHz only).

3.1 Major Assemblies

The ASTRO APX 3000 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 micro controller 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.
- **Control Top** – Contains an ON/OFF switch and one programmable button.
- **Side Control** – Contains 2 programmable buttons and 2 arrow buttons.
- **Back Kit**– Contains one TX/RX LED that is solid amber upon receiving and red upon PTT. The bottom LED represents the Bluetooth LED that will emit Blue color LED at certain flashing rates for different Bluetooth events.

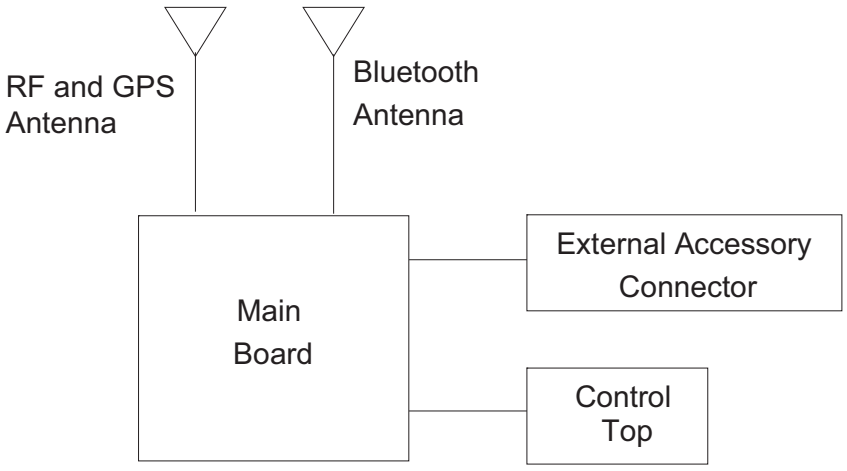


Figure 3-1. APX 3000 Overall Block Diagram

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 3-4 and Figure 3-5.

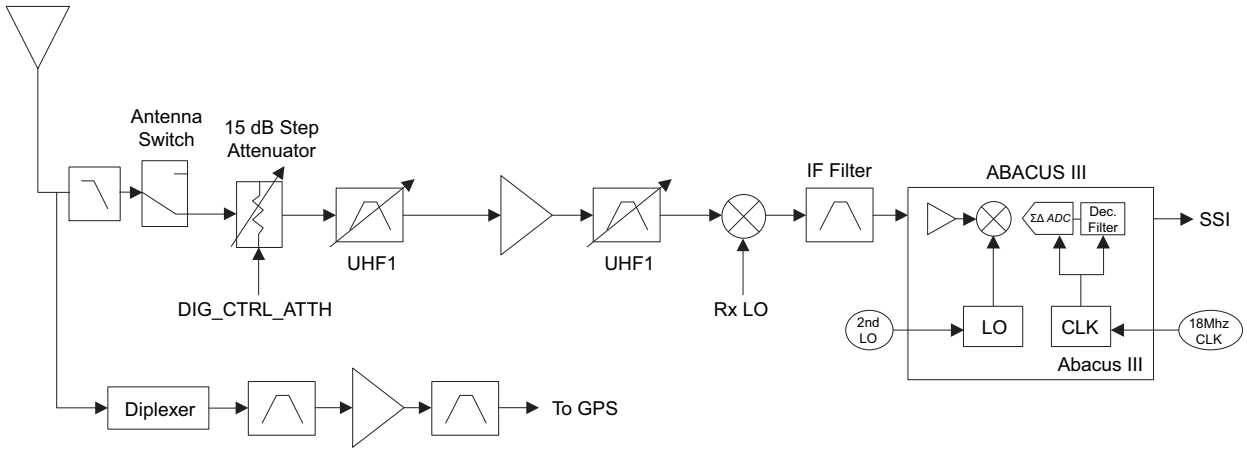


Figure 3-2. Receiver Block Diagram (UHF1)

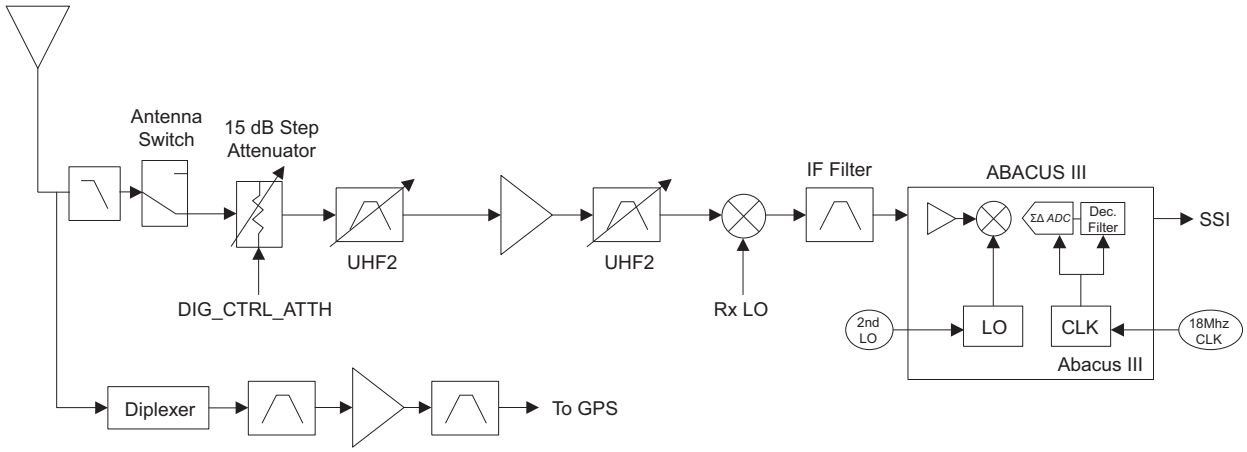


Figure 3-3. Receiver Block Diagram (UHF2)

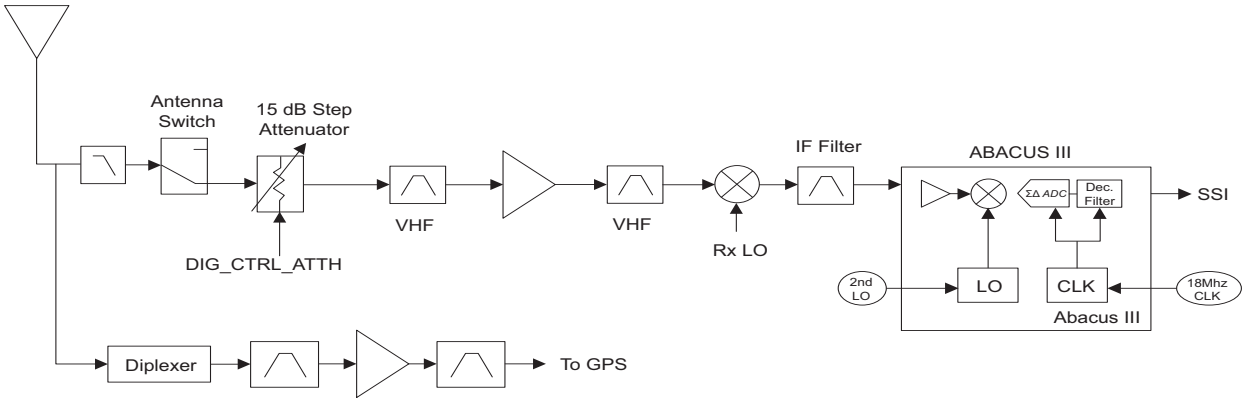


Figure 3-4. Receiver Block Diagram (VHF)

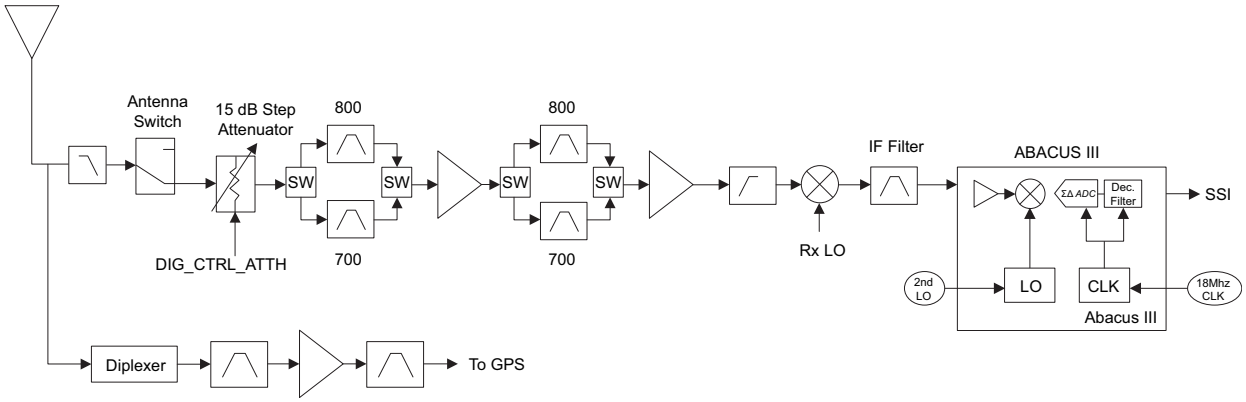


Figure 3-5. Receiver Block Diagram (700/800 MHz)

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.

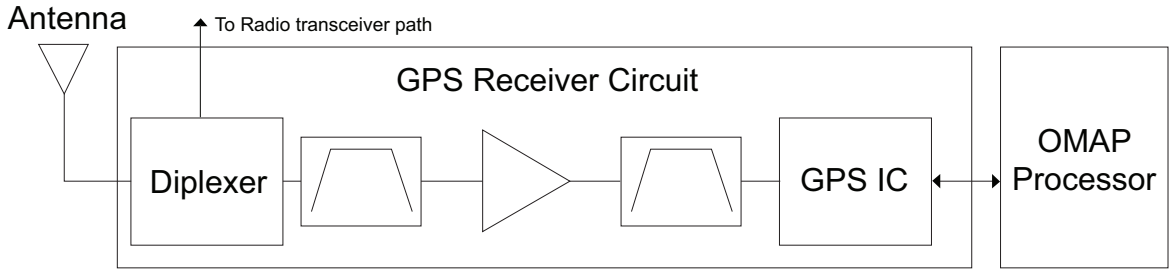


Figure 3-6. GPS Diagram

3.2.1.2 UHF1 Front-End

From the 15 dB Step Attenuator, a UHF1 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 UHF2 Front-End

From the 15 dB Step Attenuator, a 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 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 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).

3.2.1.5 700/800 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).

3.2.1.6 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 and Figure 3-9) via the SSI interface. The Trident IC processes the SSI data for application to the voltage controlled oscillator as a modulation signal.

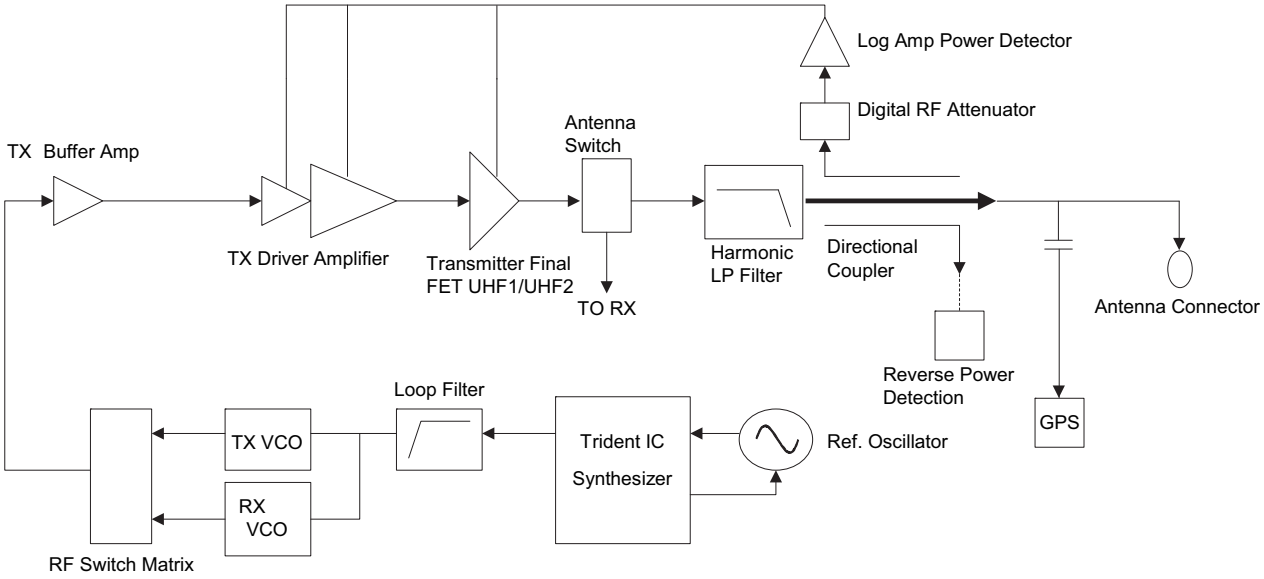


Figure 3-7. Transmitter (UHF1/UHF2) Block Diagram

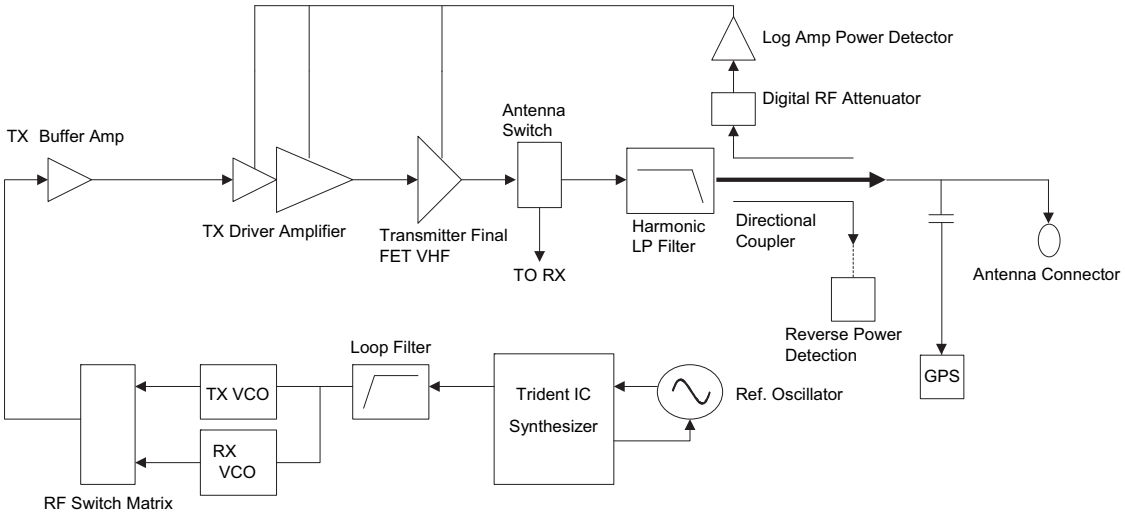


Figure 3-8. Transmitter (VHF) Block Diagram

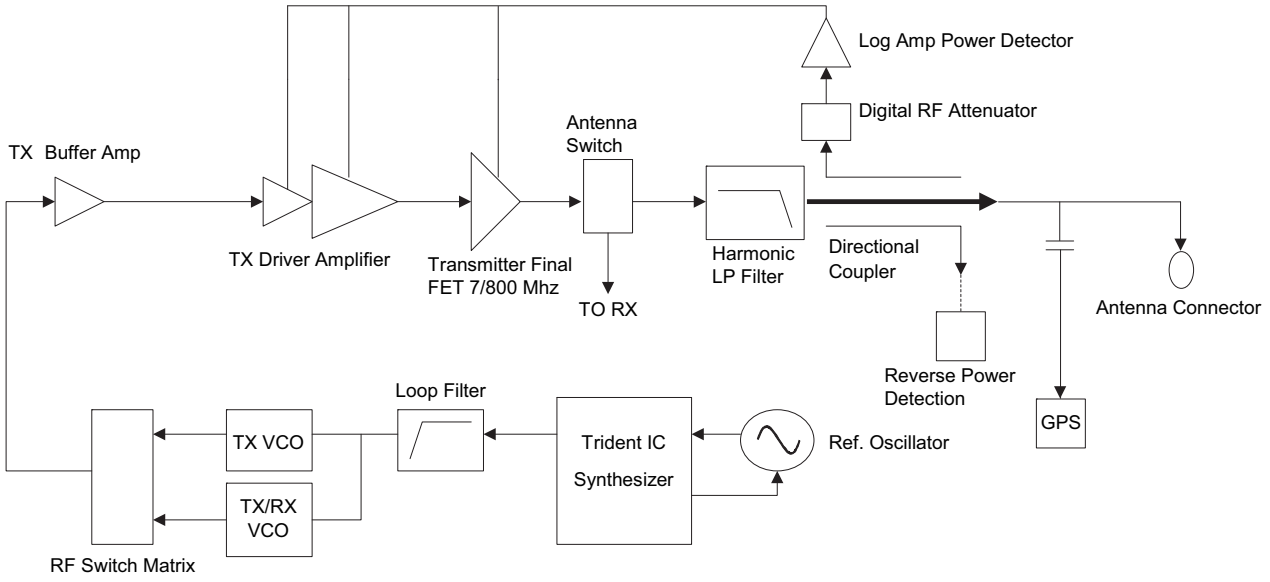


Figure 3-9. Transmitter (700/800 MHz) Block Diagram

3.2.2.1 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.

3.2.2.2 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.

3.2.2.3 700/800 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 3-10.) comprises of five functional sections within the main board. 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 external audio section has a CODEC and 1W audio PA (MAKO) to support accessories. The User Interface section provides communication and control to a side connector interface conforming to GCAI (Global Communications Accessory Interface) specifications. The GPS and Bluetooth section comprises of a Global Positioning Satellite(GPS), Bluetooth combo chipset, an AVR Bluetooth controller IC, SDRAM, LF wakeup IC, Accelerometer IC and MACE IC on the main board for secure communication control.

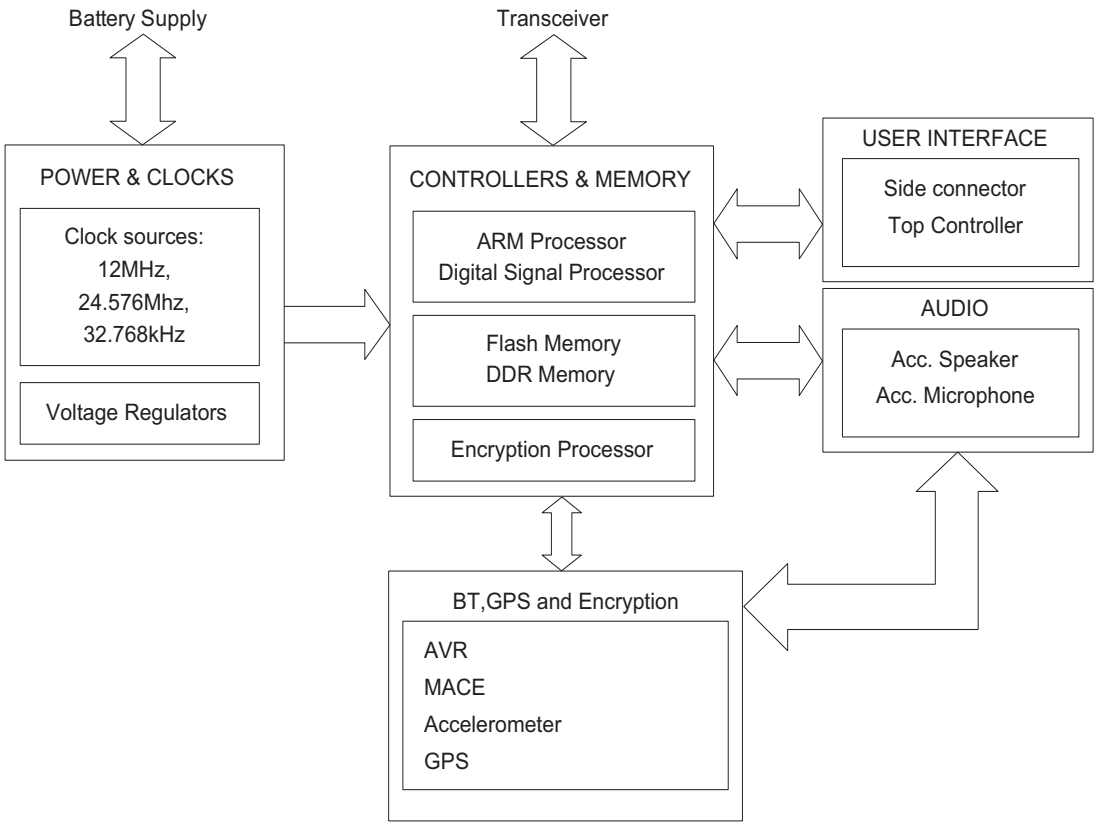


Figure 3-10. Controller Block Diagram

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 power supply 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 only supports microphone and speaker connection for external accessories. 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. The external speaker path uses the CODEC for volume control and to convert the audio signal from digital to analog. The external microphone uses the CODEC's ADC to deliver digital audio samples to the DSP controller.

The user interface block consists of a Bluetooth LED, top controls, side control 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 flexes 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 3-11). 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.

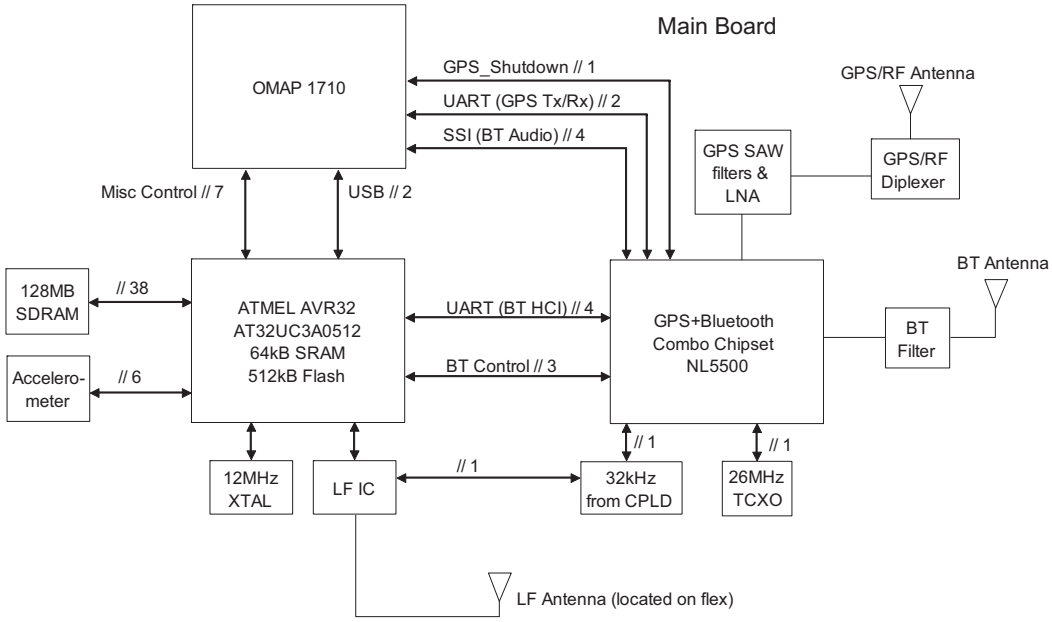


Figure 3-11. GPS/Bluetooth/Accelerometer Block Diagram

3.4.1 Radio with Mace

In addition to the Mace features, the Main 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 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. 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 main 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 3000 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 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
PMLN6208_	Chassis Opener	Used to disassemble chassis from housing.
66012031001	Battery Adapter	Used in place of battery to connect radio to an external power supply.
66012075001	Vacuum Test Fixture	Used to connect the vacuum/pressure hose to the radio.
NLN9839_	Vacuum Pump Kit	Vacuum pump with gauge and vacuum hose. Requires Vacuum Test Fixture (66012075001).
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.
PMKN4012_	Programming Cable	Used to program the radio through Customer Programming Software and Tuner Software.
PMKN4013_	Programming/Service Cable	Used to program and service the radio through Customer Programming Software and Tuner Software.
RLN4460_	Portable Test Set	Used for radio performance checks. Connects to radio's universal connector and allows remote switching and signal injection/outputs for test equipment measurements.
66012036001	APX3000 Covert Board Debugging Fixture	To be assembled with Flex, Debug (0104055J17), flex, Extended Main (0104052J79), Assy, Flex, NFC (0104052J74), front housing kit (0104052J79), and FSTN Display with Bezel (72012008001).

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 3000 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.

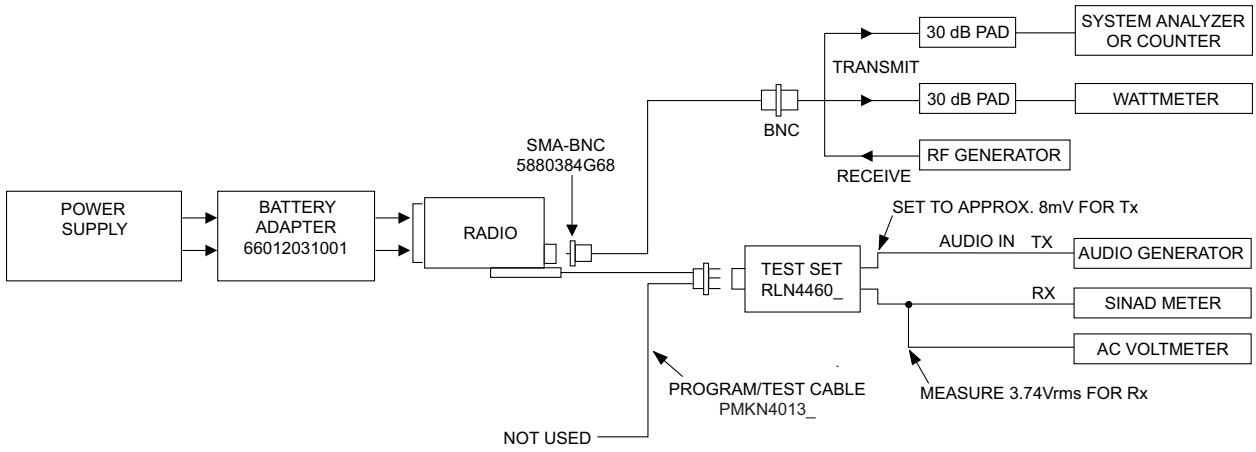


Figure 5-1. Performance Checks Test Setup

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 (DRSM or debugging fixture required).

NOTE: The radio needs to be attach to a Display RSM to enable the display capability.

5.2.1 Access the Test Mode

To enter the display radio test mode:

1. Turn the radio on.
2. Within 10 seconds, press **Middle Button** 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

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

Name of Display	Description	Appears
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

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.

NOTE: Press the **Top Side Button** to advance the test environments from "**RF TEST**", "**CH TEST**", "**CID TEST**" then press the **Top 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 test mode. The test mode menu "**CH TEST**" is displayed, indicating that you have selected the Control Top test mode. Go to Section CH Test Mode.

     NOTE: Each press of the **Top Side Button** scrolls through "**RF TEST**", "**CH TEST**" and "**CID TEST**".

   - Press the **Top 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 RF Test Mode.

     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 3000 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)

Test Channel	UHF1		UHF2		VHF		700–800 MHz	
	RX	TX	RX	TX	RX	TX	RX	TX
F1	380.075	380.025	450.075	450.025	136.075	136.025	764.0625	764.0125
F2	390.075	390.025	460.075	460.025	142.075	142.125	769.0625	769.0125
F3	400.075	400.025	471.075	471.025	154.275	154.225	775.9375	775.9875
F4	411.075	411.025	484.925	484.975	160.175	160.125	851.0625	794.0125
F5	424.975	424.925	485.075	485.025	168.125	168.075	860.0625	809.0125
F6	435.075	435.025	495.075	495.025	173.925	173.975	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 CH Test Mode

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

To perform the buttons and switches checks:

1. Press the **Top Side Button** until CH TEST appears. Then press **Top Button.**
2. Release the **Top Button**; "148/0" appears, which indicates that the **Top Button** is in the open position.
3. Press the **Top Button** again; "148/1" appears, which indicates that the **Top Button** is in the closed position.
4. Press the **Top Side Button**; "96/1" appears; release, "96/0" appears.
5. Press **Side Middle Button**; "97/1" appears; release, "97/0" appears.

6. Press **Up Arrow Button**; "99/1" appears; release, "99/0" appears.
7. Press the **Down Arrow Button**; "100/1" appears; release, "100/0" 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)	**UHF1:** ±2 ppm **UHF2:** ±2 ppm **VHF:** ±1 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.

*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 3000

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).	**UHF1:** ±2 ppm **UHF2:** ±2 ppm **VHF:** ±2 ppm (272–348 Hz) **700-800 MHz:** ±1.5ppm (1146–1305 Hz)
RF Power	As above	As above	As above	**UHF1**: 1–5 Watt **UHF2**: 1–5 Watt **VHF**: 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
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 3000

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).	**UHF1**: 1–5 Watt **UHF2**: 1–5 Watt **VHF**: 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.*

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.

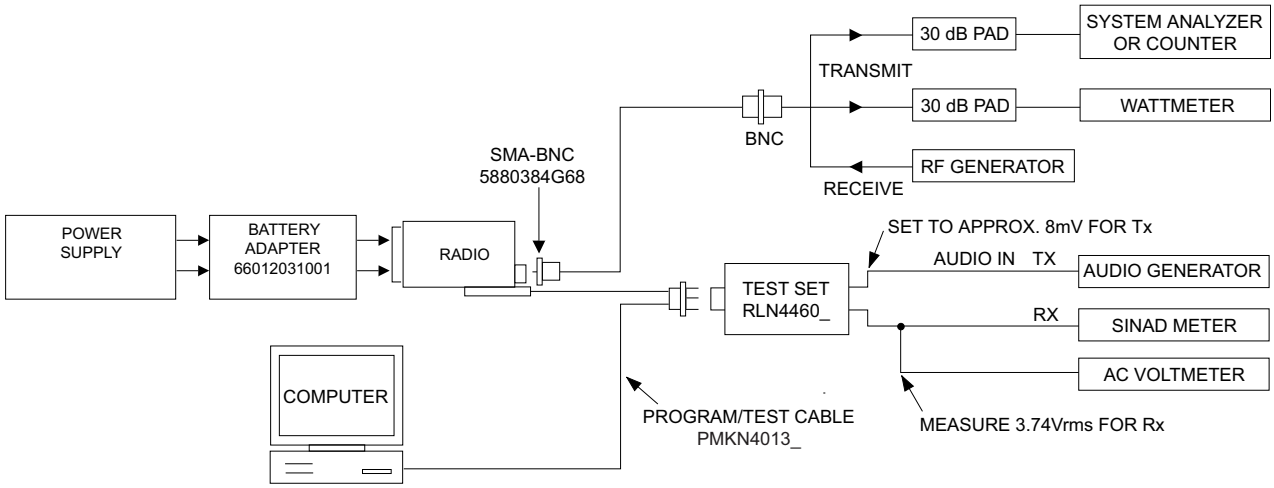


Figure 6-1. Radio Alignment Test Setup

> **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.

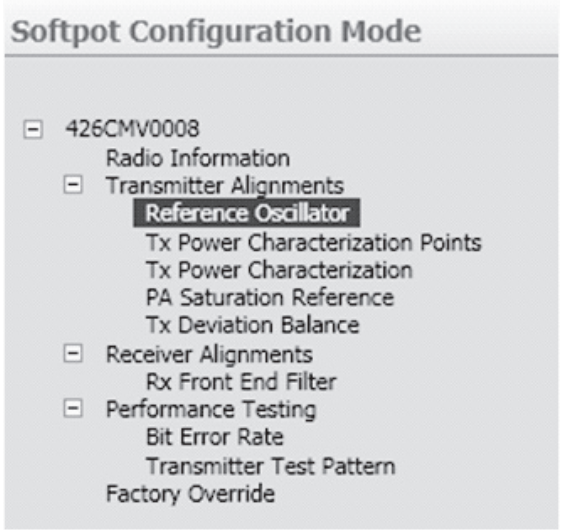


Figure 6-2. Tuner Software Main Menu

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.

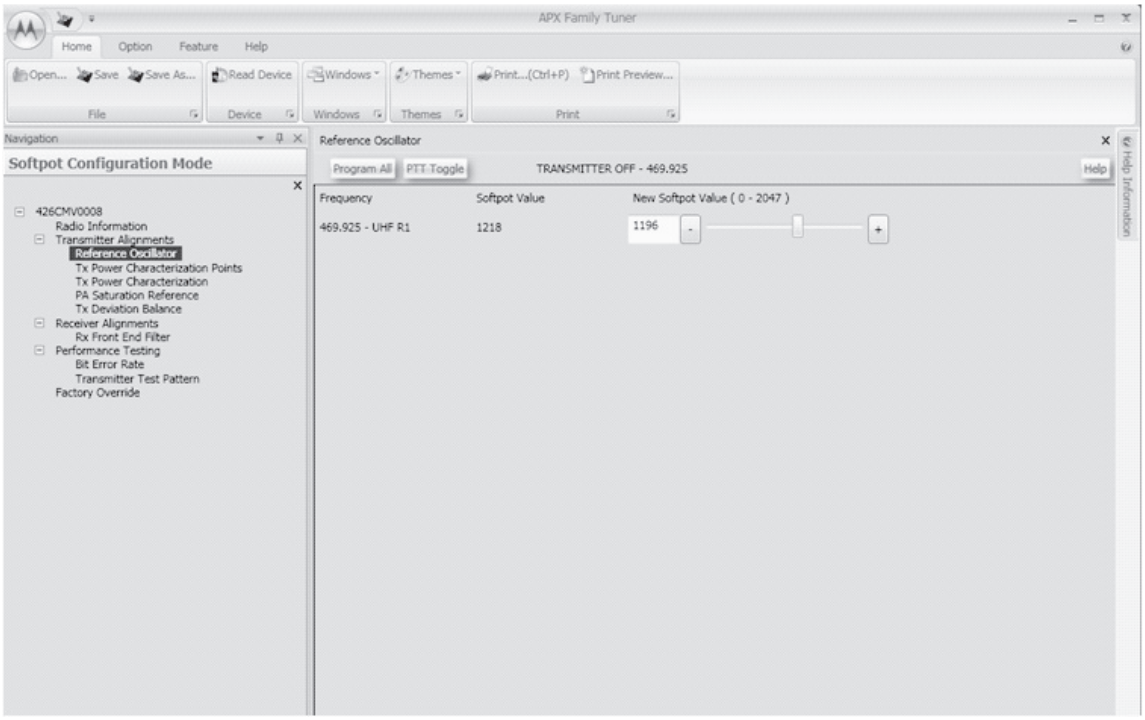


Figure 6-3. Typical Softpot Screen

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.

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.

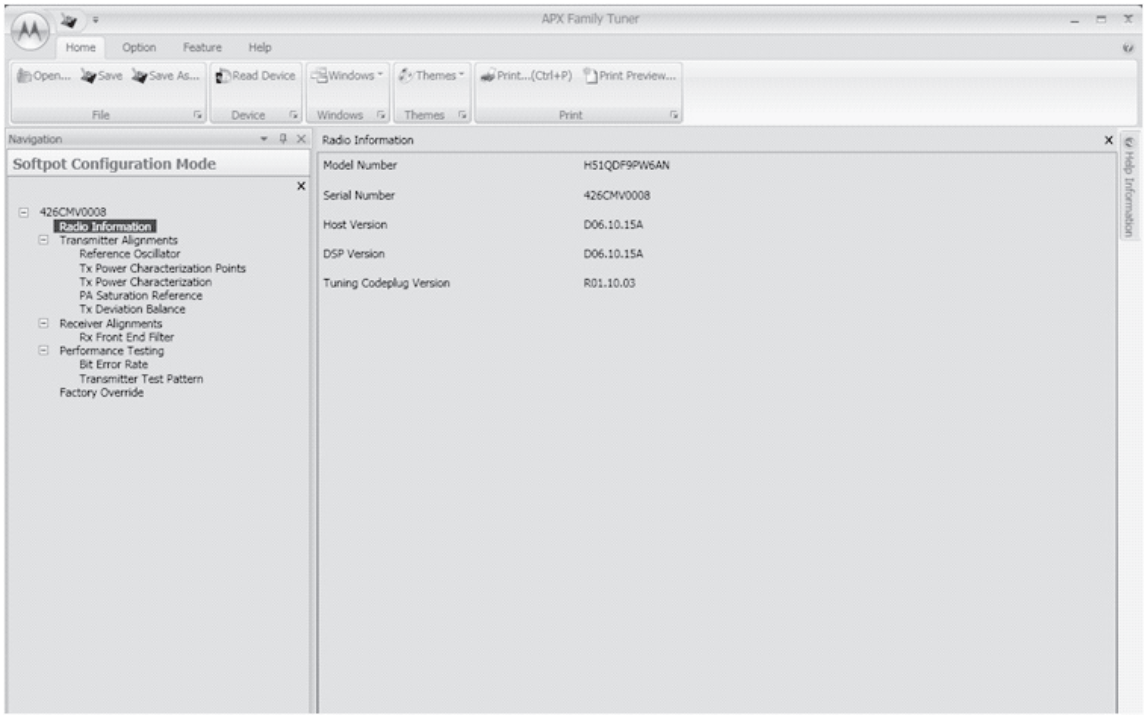


Figure 6-4. Radio Information Screen

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.

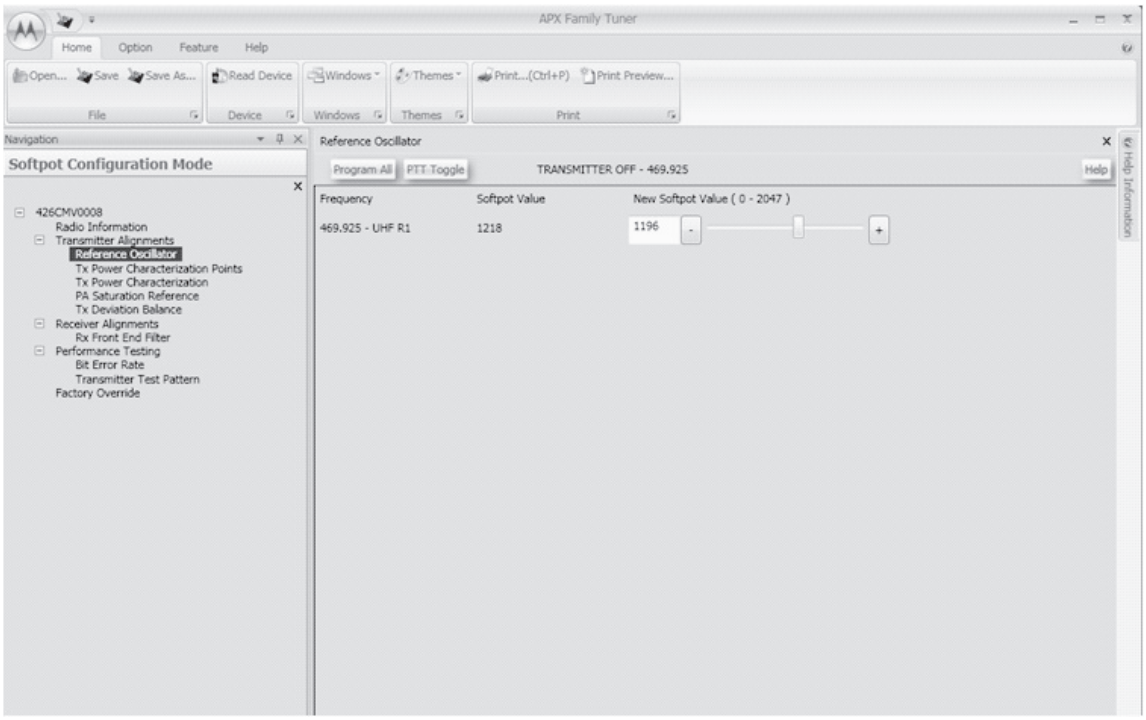


Figure 6-5. Reference Oscillator Alignment Screen (UHF1)

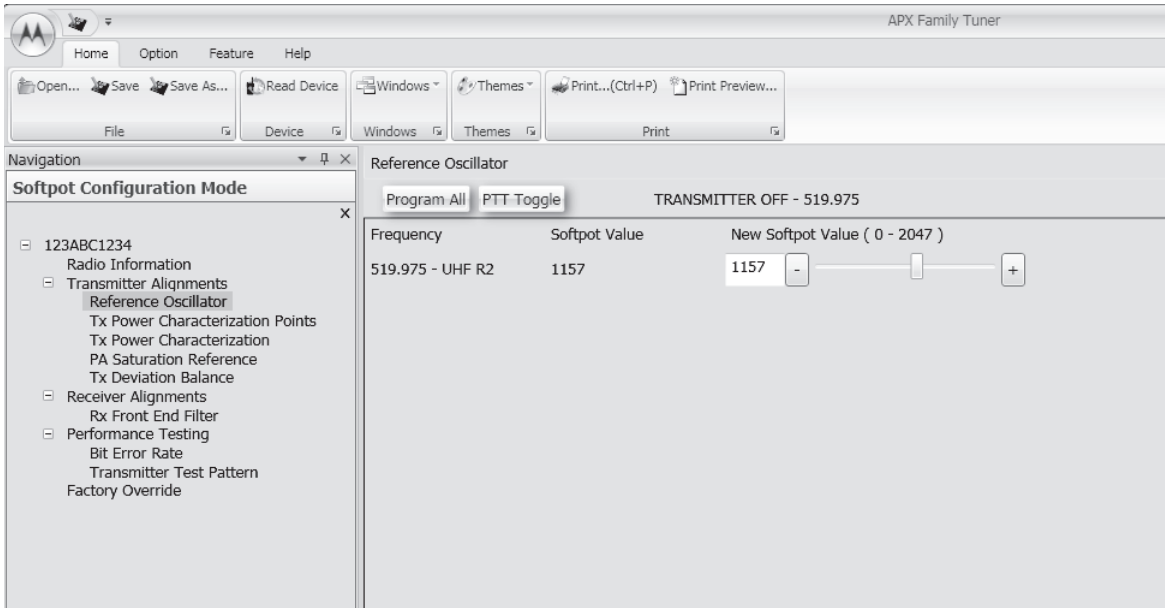


Figure 6-6. Reference Oscillator Alignment Screen (UHF2)

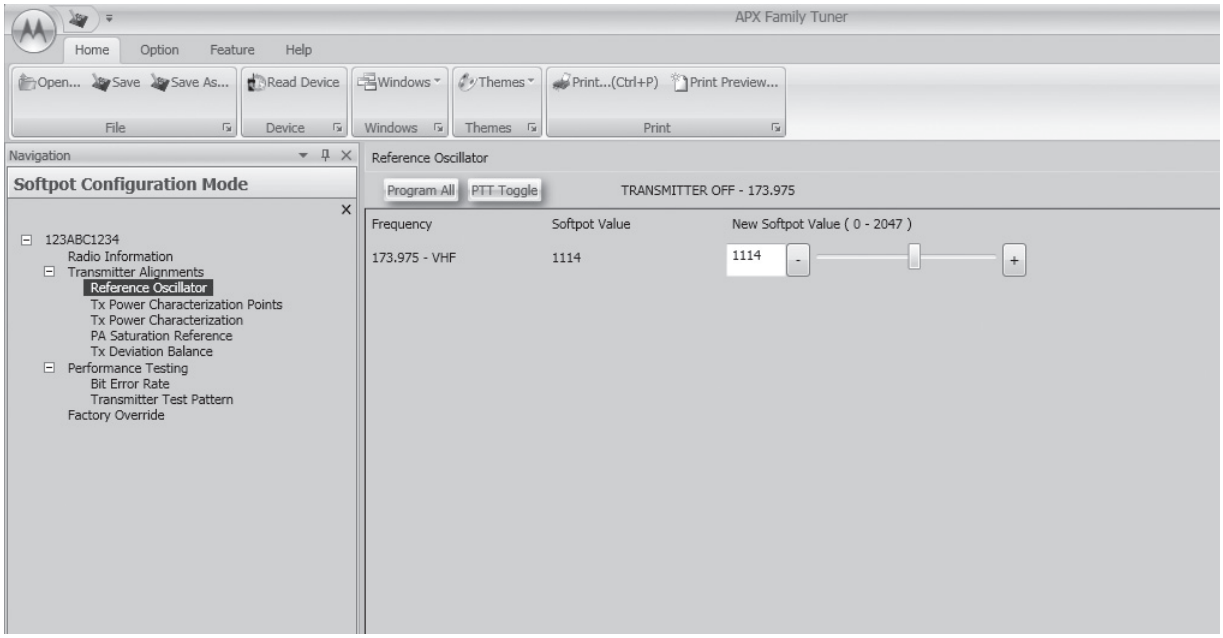


Figure 6-7. Reference Oscillator Alignment Screen (VHF)

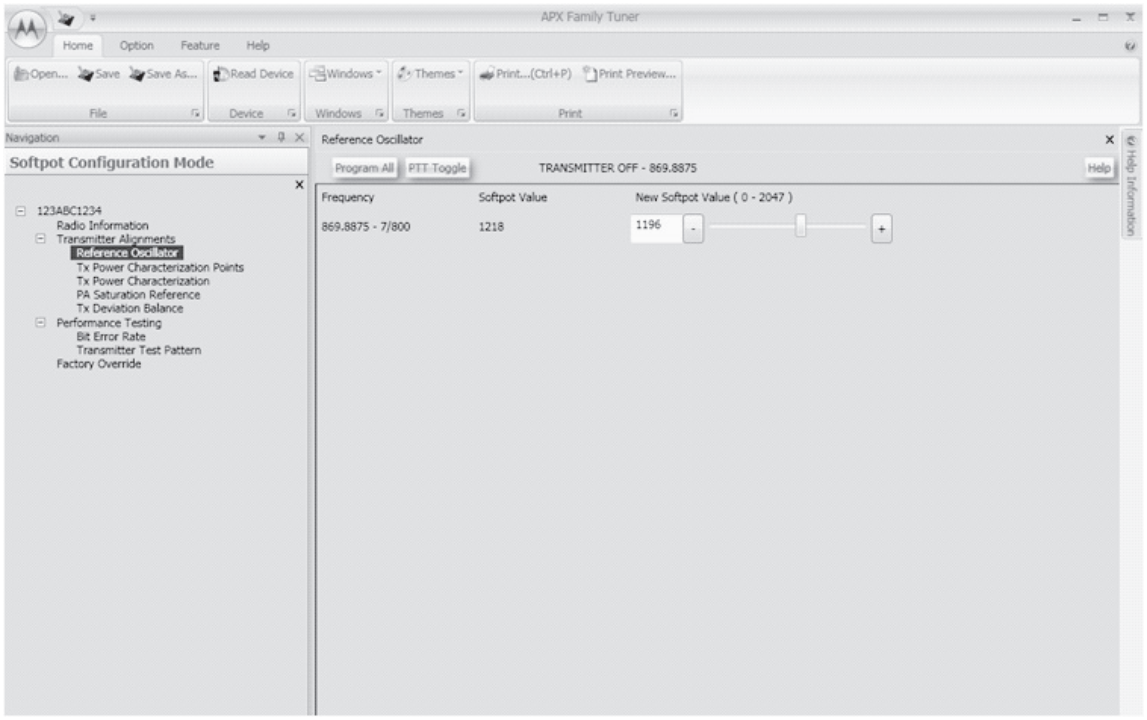


Figure 6-8. Reference Oscillator Alignment Screen (700/800 MHz)

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

   UHF1

   - Set the base frequency to 469.925 MHz

   UHF2

   - Set the base frequency to 519.975 MHz

   VHF

   - Set the base frequency to 173.975 MHz

   700/800 MHz

   - 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
UHF1	±50 Hz
UHF2	±50 Hz
VHF	±50 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.

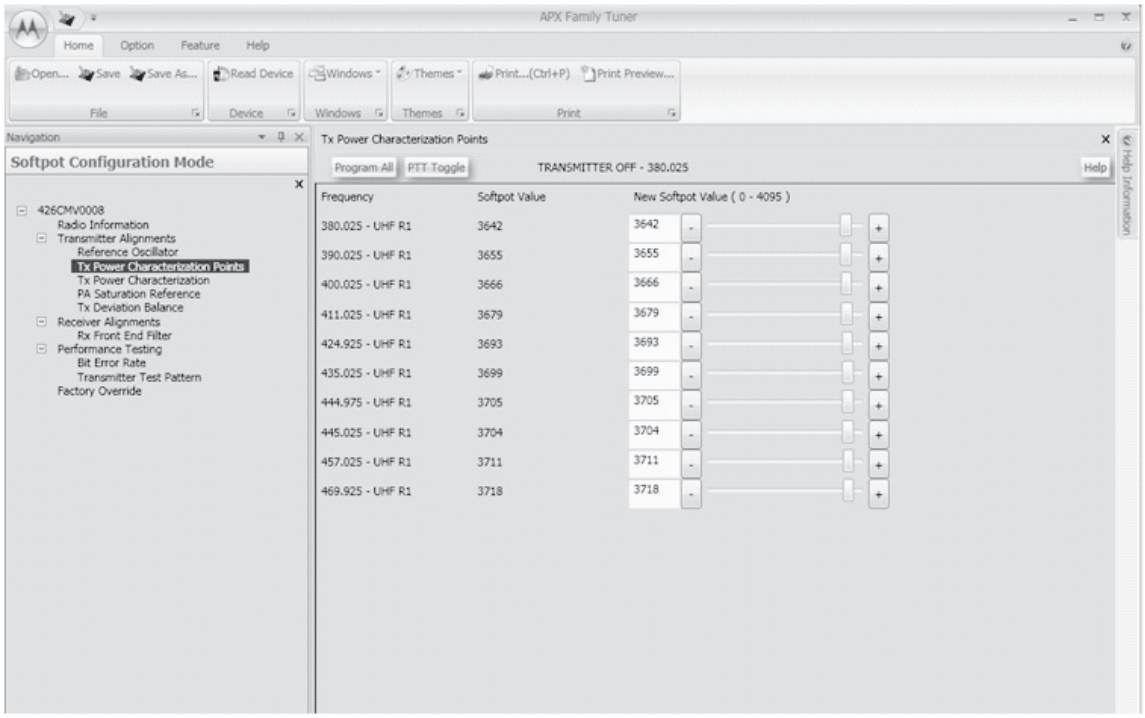


Figure 6-9. Transmit Power Characterization Points Alignment Screen (UHF1)

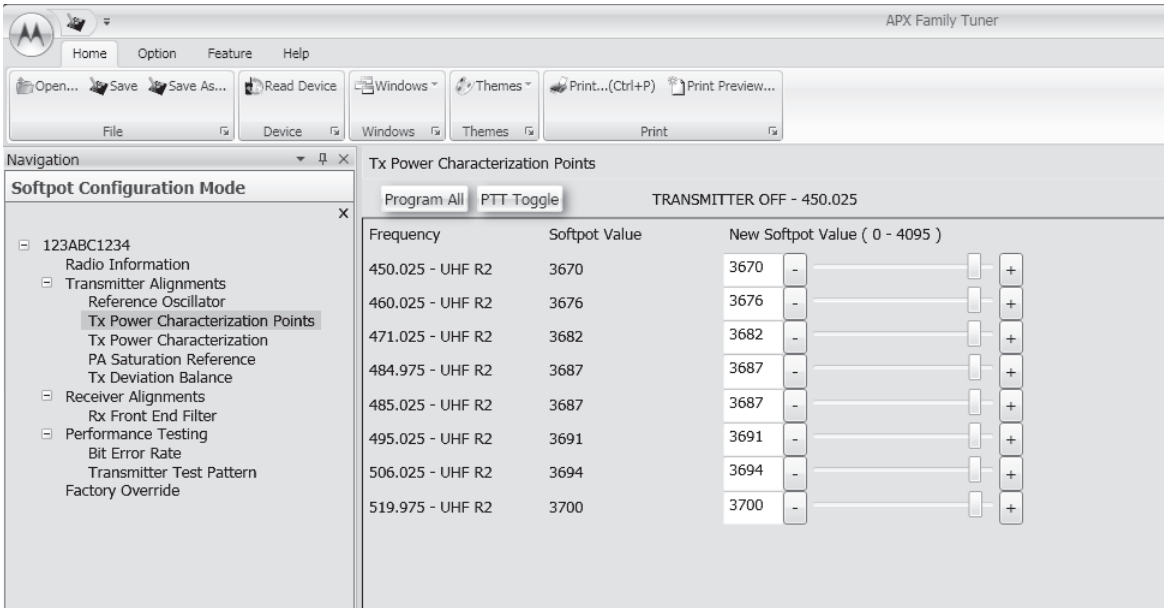


Figure 6-10. Transmit Power Characterization Points Alignment Screen (UHF2)

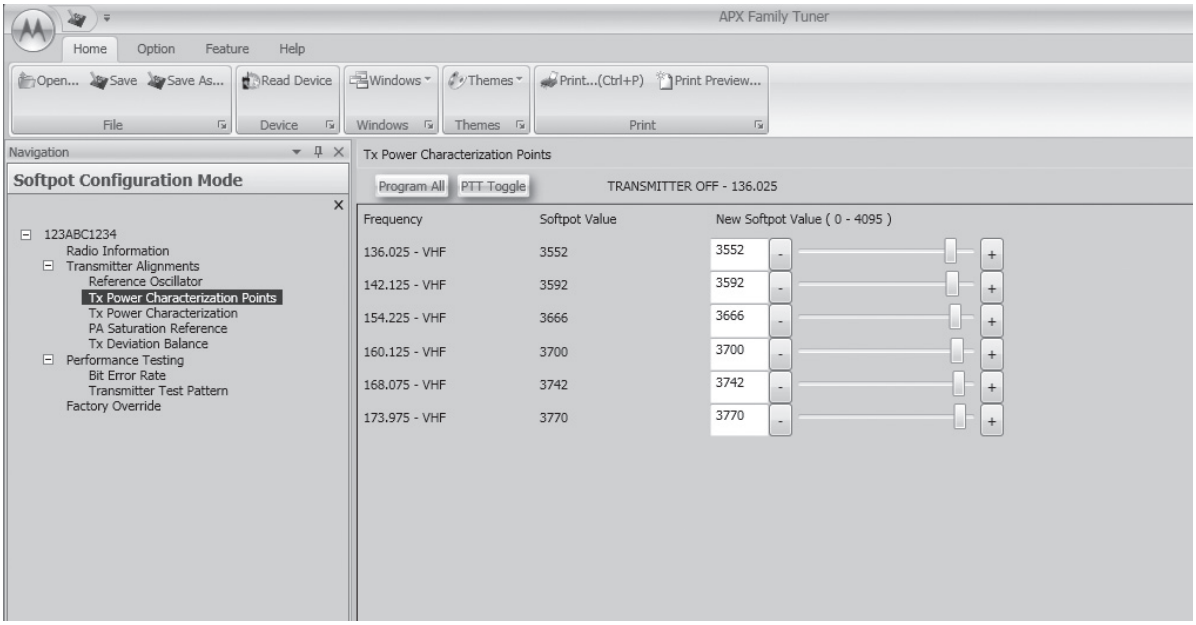


Figure 6-11. Transmit Power Characterization Points Alignment Screen (VHF)

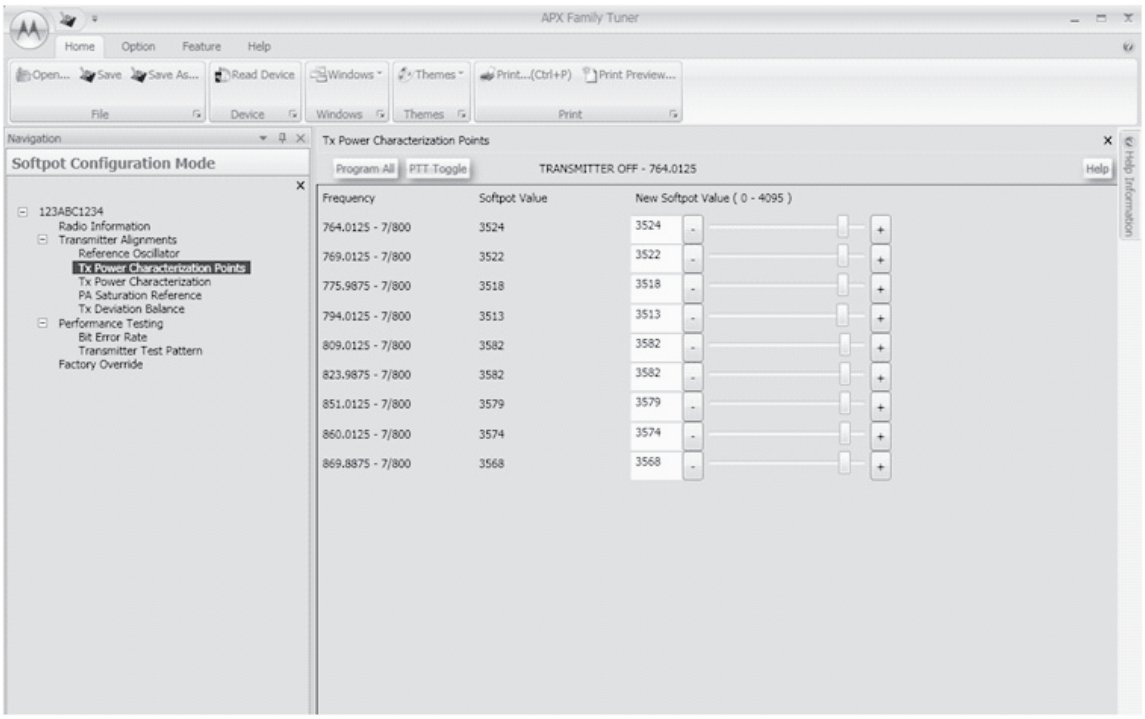


Figure 6-12. Transmit Power Characterization Points Alignment Screen (700/800MHz)

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.

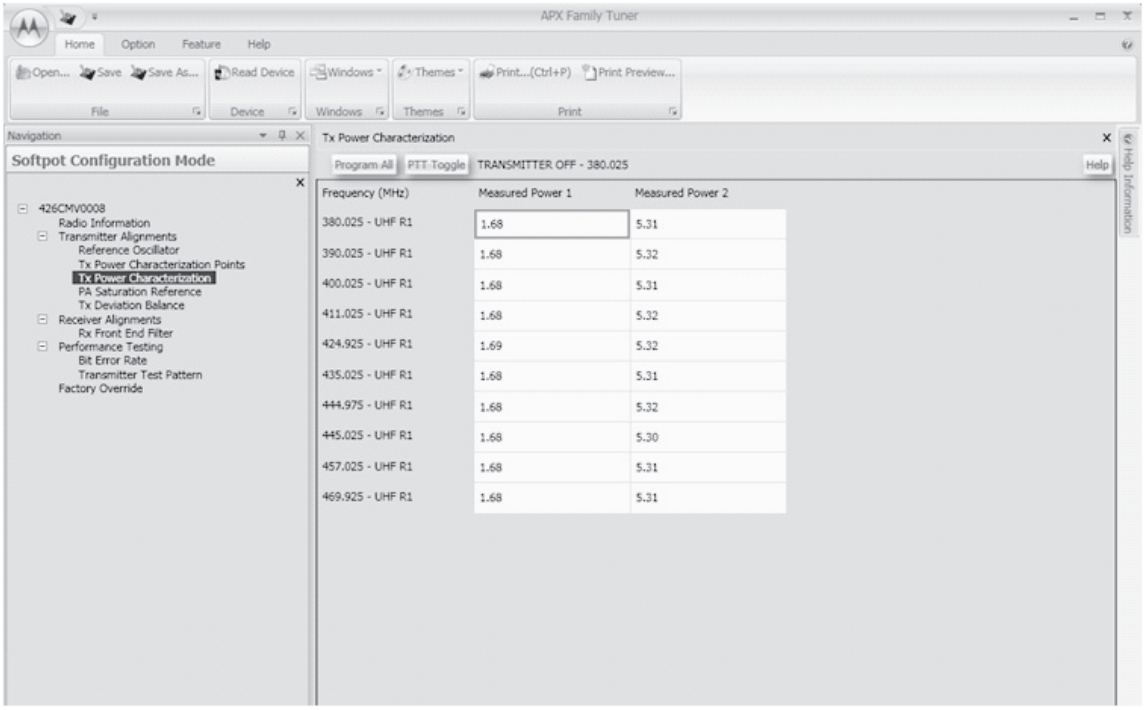


Figure 6-13. Transmit Power Characterization Alignment Screen (UHF1)

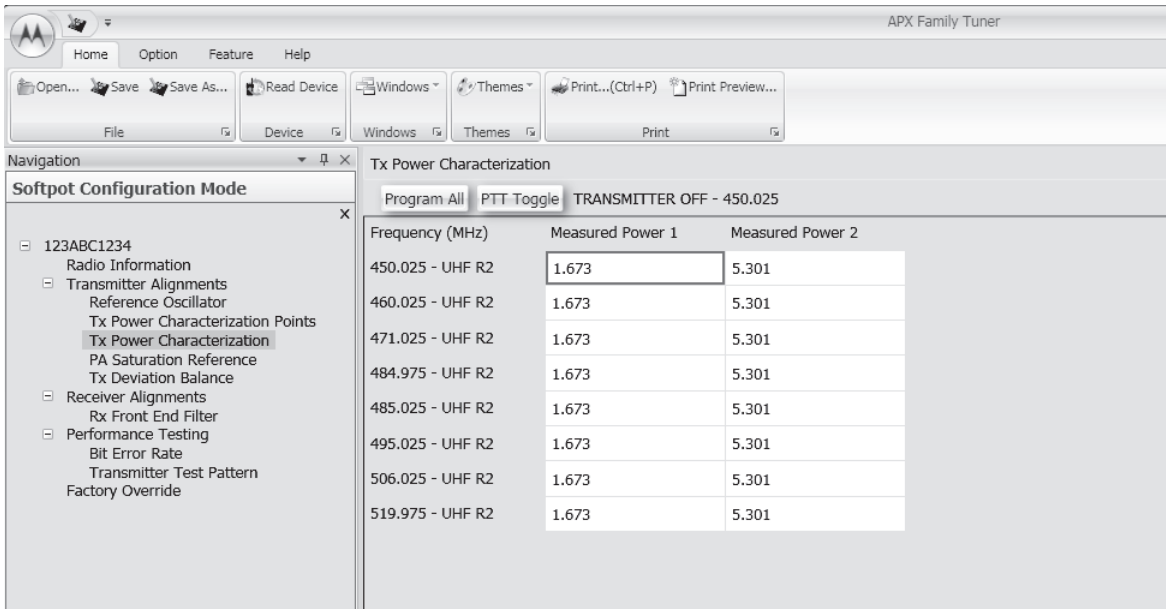


Figure 6-14. Transmit Power Characterization Alignment Screen (UHF2)

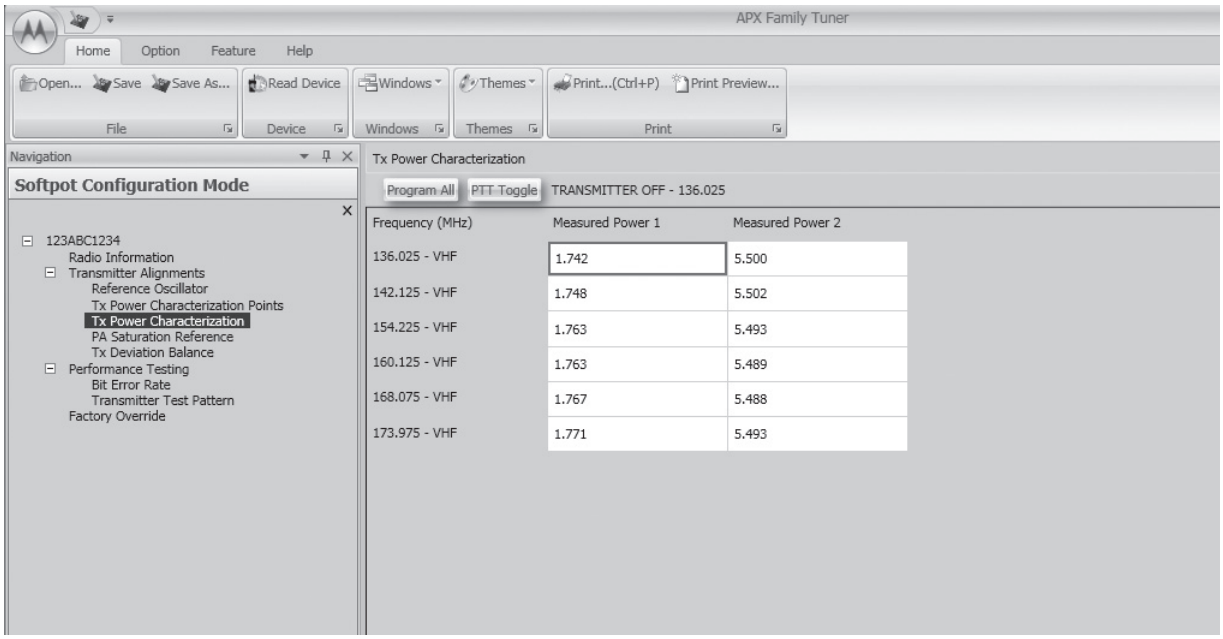


Figure 6-15. Transmit Power Characterization Alignment Screen (VHF)

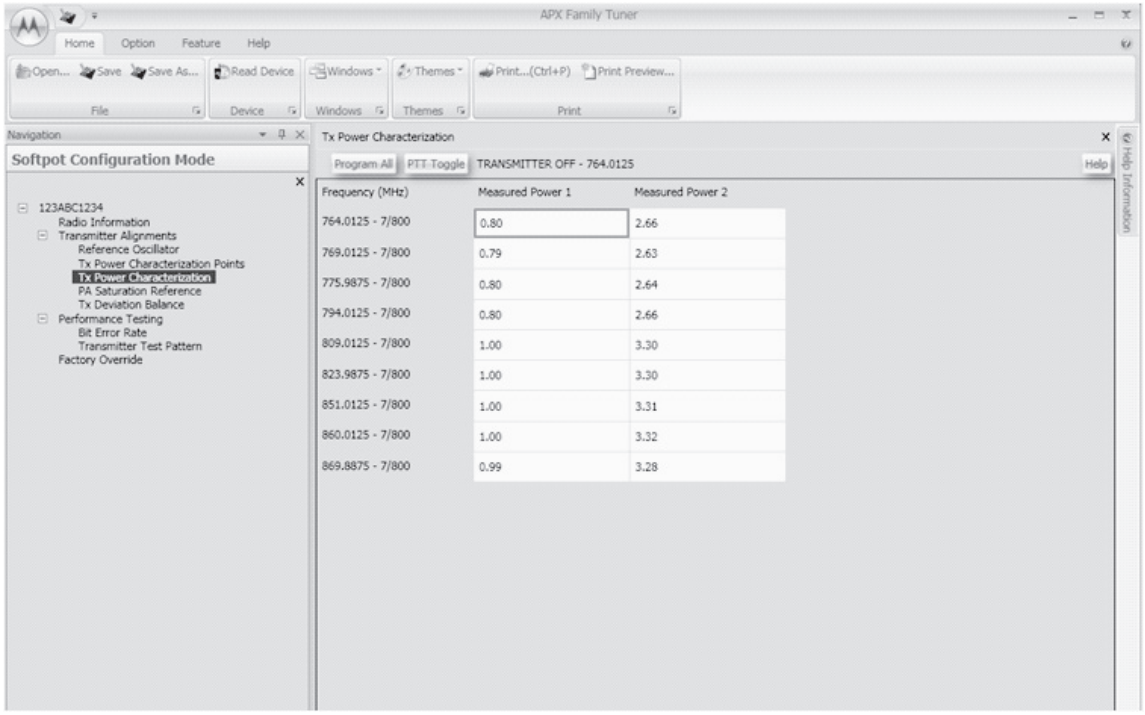


Figure 6-16. Transmit Power Characterization Alignment Screen (700/800 MHz)

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.

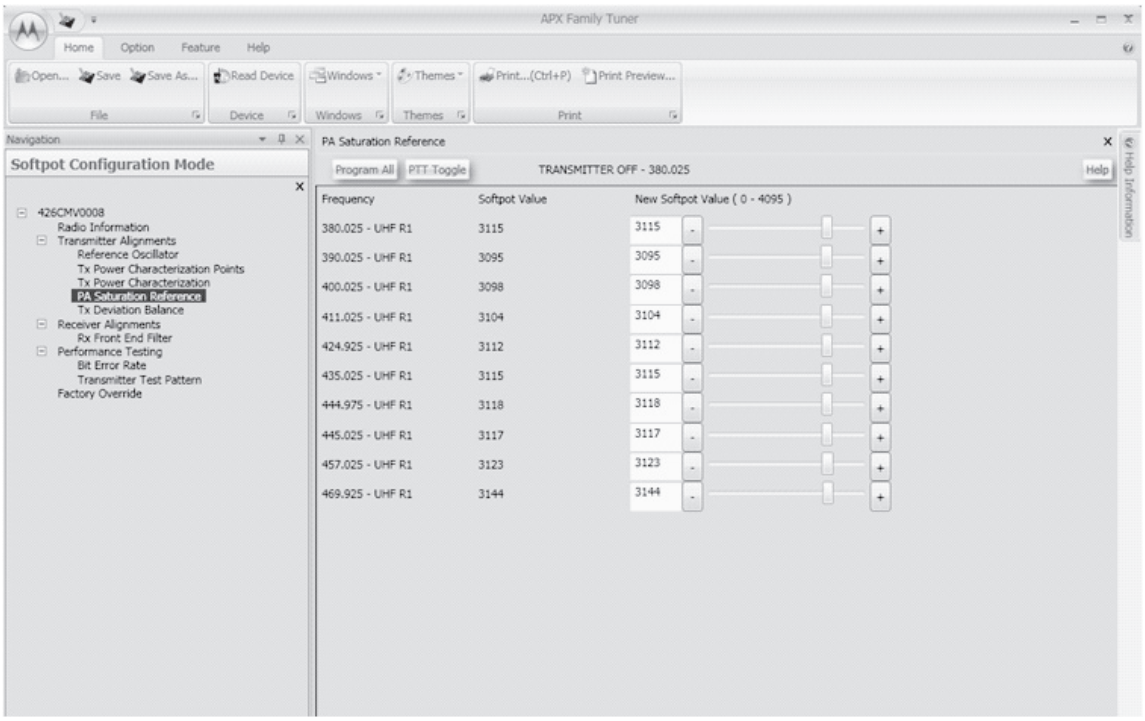


Figure 6-17. PA Saturation Referencing Alignment Screen (UHF1)

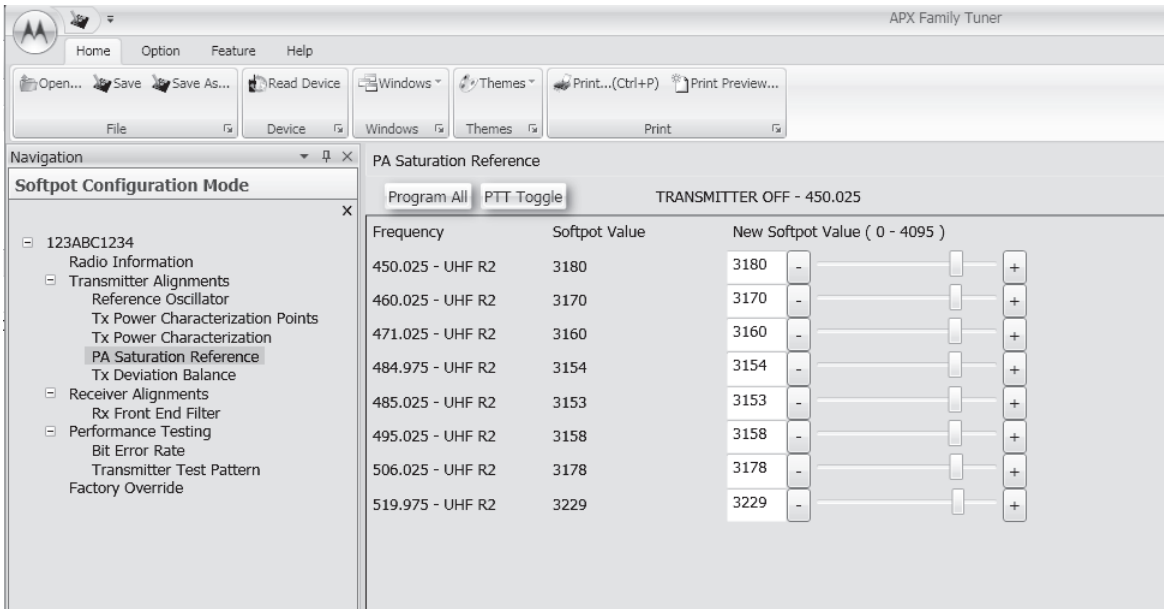


Figure 6-18. PA Saturation Referencing Alignment Screen (UHF2)

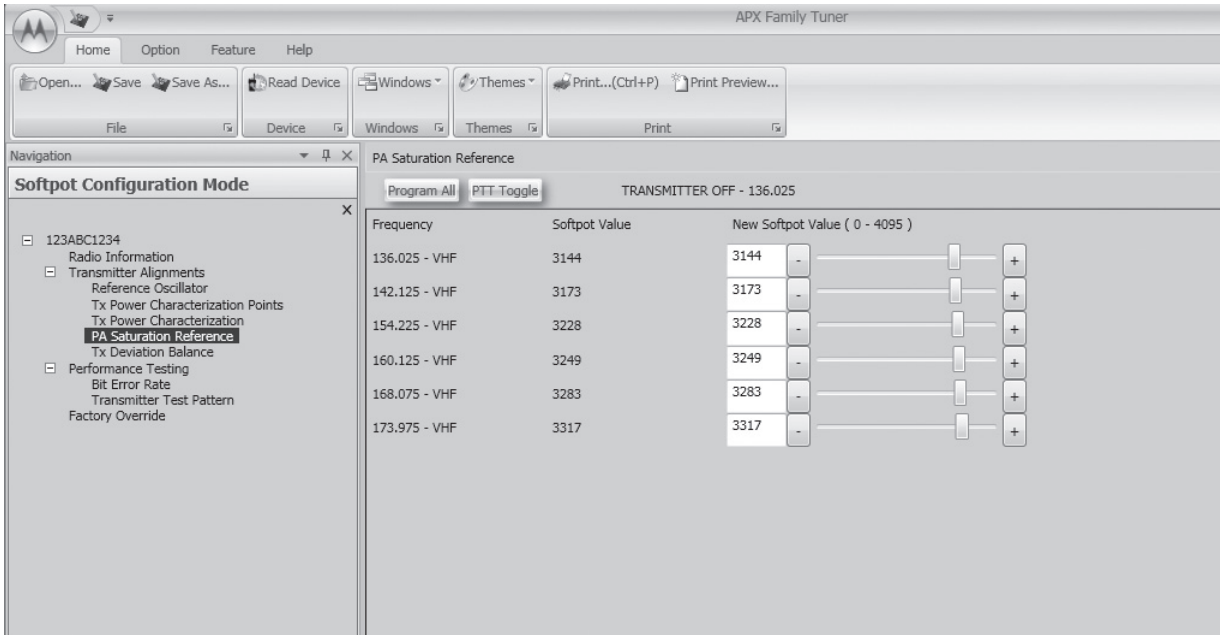


Figure 6-19. PA Saturation Referencing Alignment Screen (VHF)

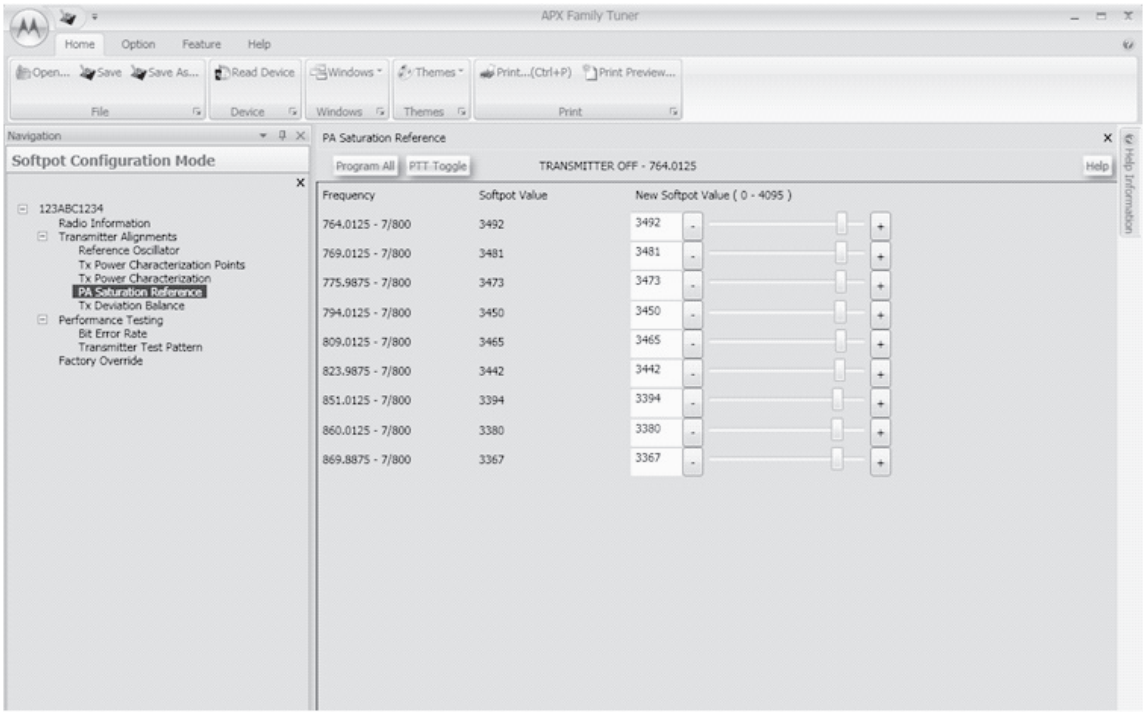


Figure 6-20. PA Saturation Referencing Alignment Screen (700/800 MHz)

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.

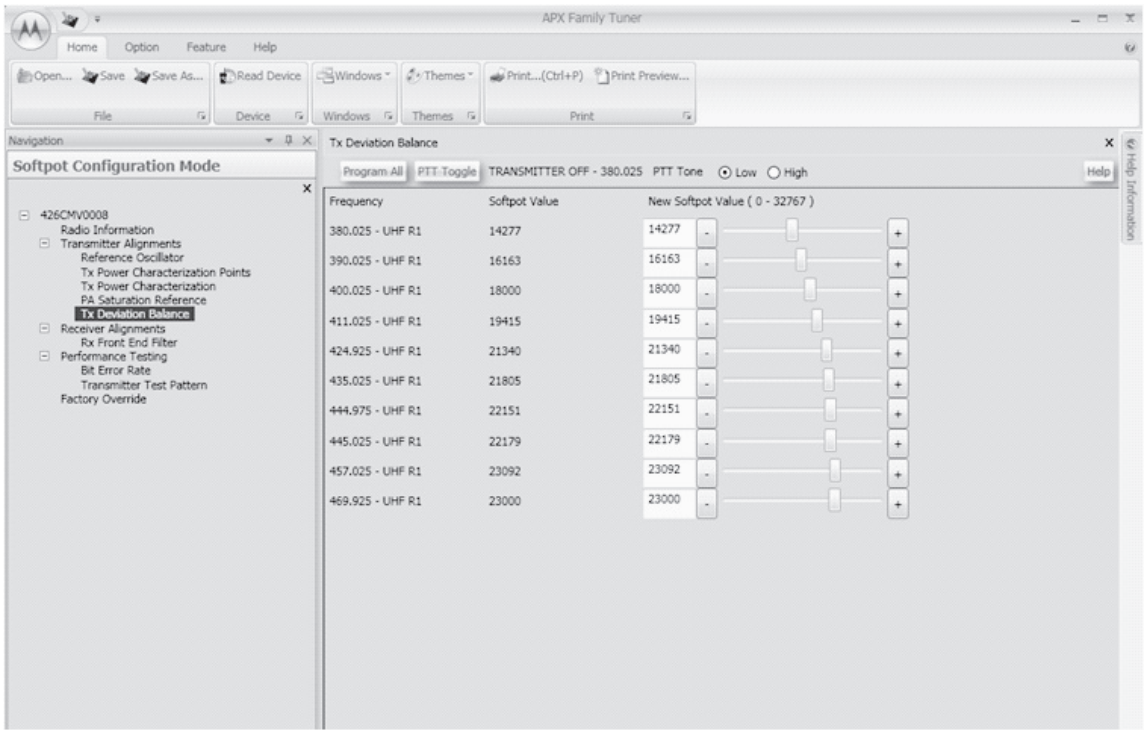


Figure 6-21. Transmit Deviation Balance Alignment Screen (UHF1)

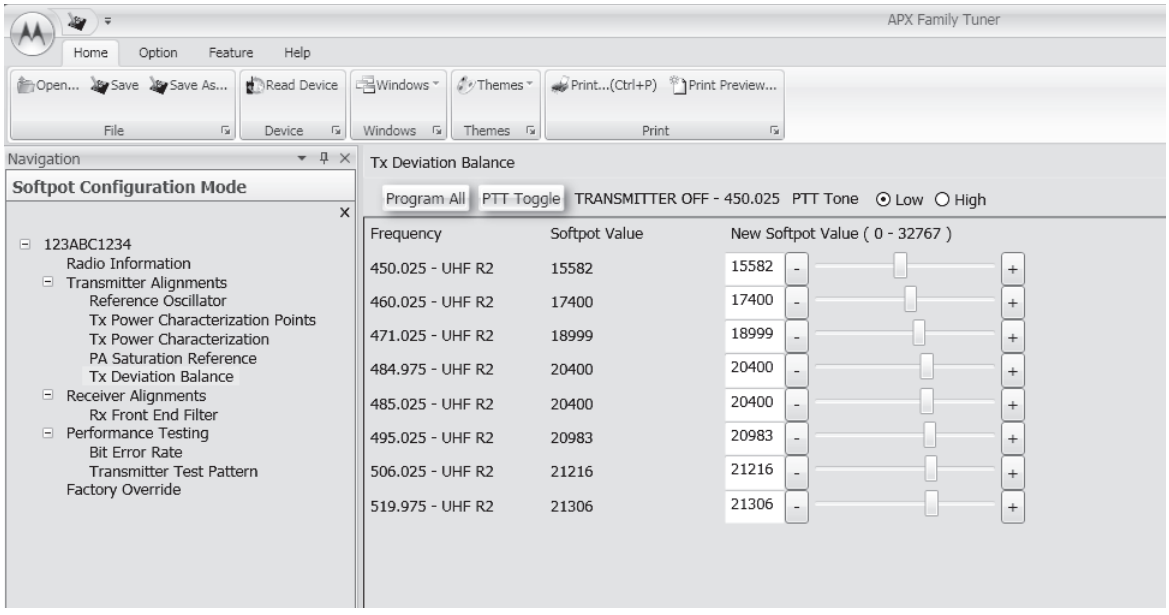


Figure 6-22. Transmit Deviation Balance Alignment Screen (UHF2)

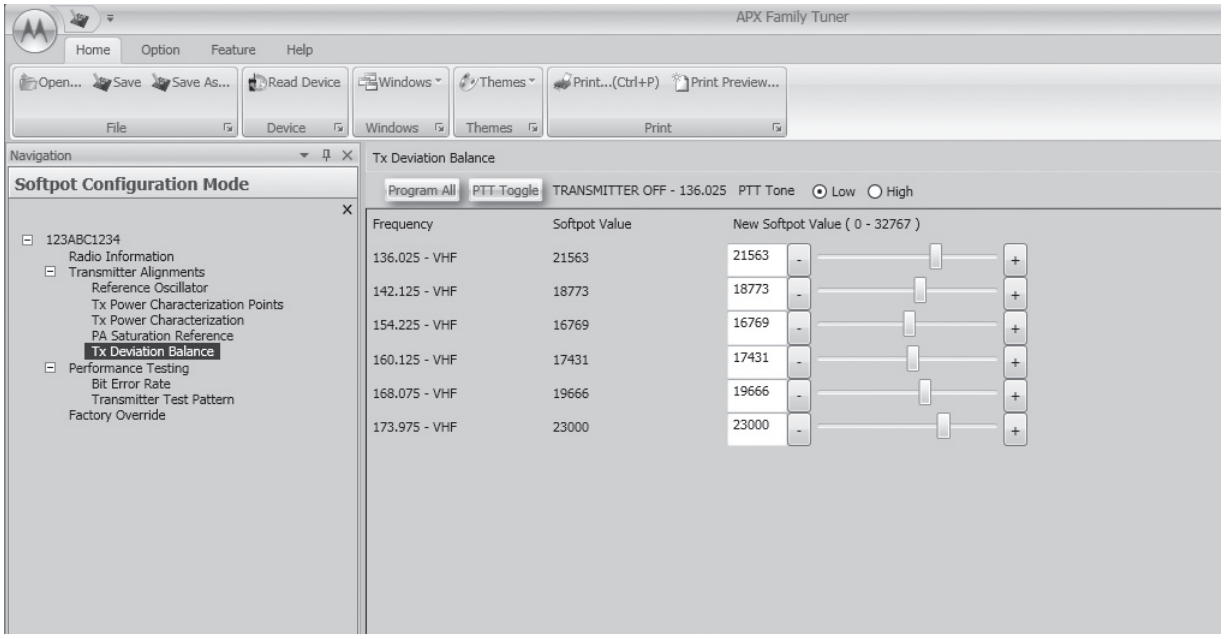


Figure 6-23. Transmit Deviation Balance Alignment Screen (VHF)

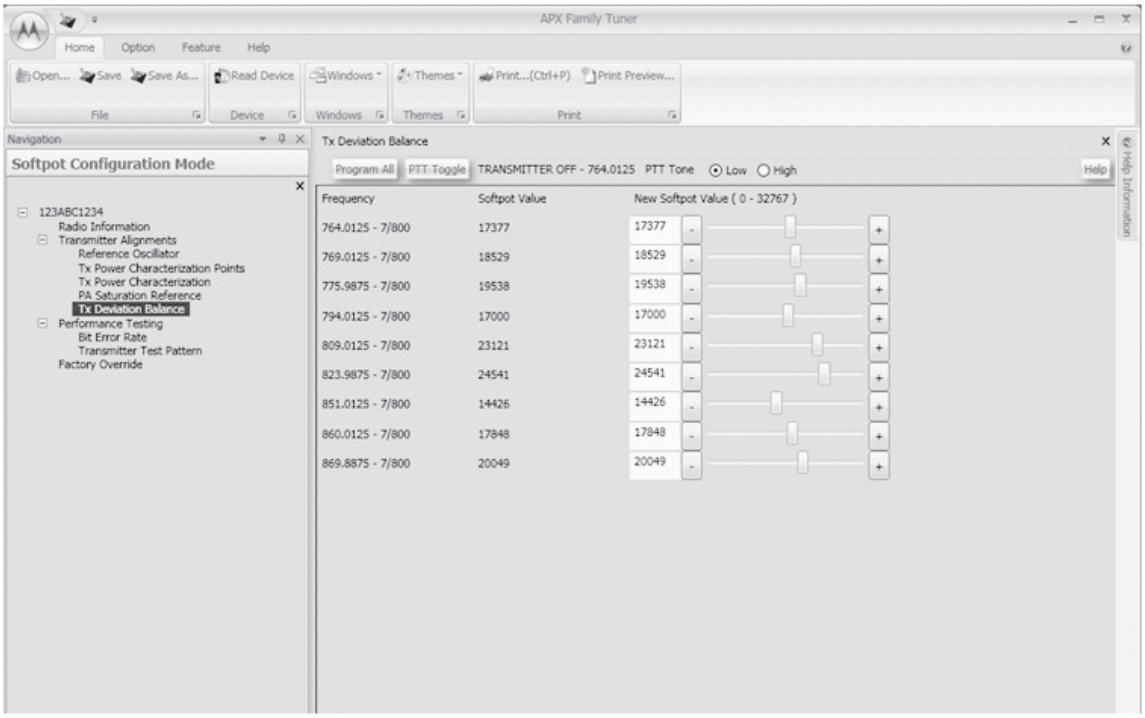


Figure 6-24. Transmit Deviation Balance Alignment Screen (700/800 MHz)

6.6 Front End Filter Alignment Notes

> 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 (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.
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 to 4 for all frequencies.
6. Left-click the **Program All** button on the screen to save the tuned values in the radio.

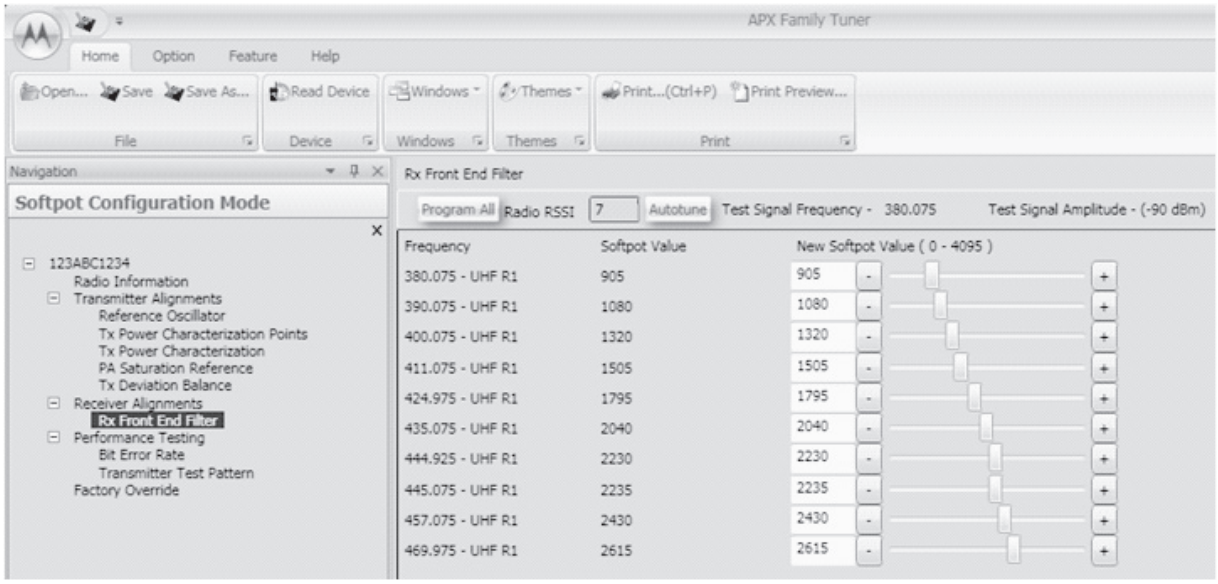


Figure 6-25. Front End Filter Alignment Screen (UHF1)

6.6.2 Procedure for UHF 2 (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 6-26.

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 to 4 for all frequencies.

Left-click the **Program All** button on the screen to save the tuned values in the radio.

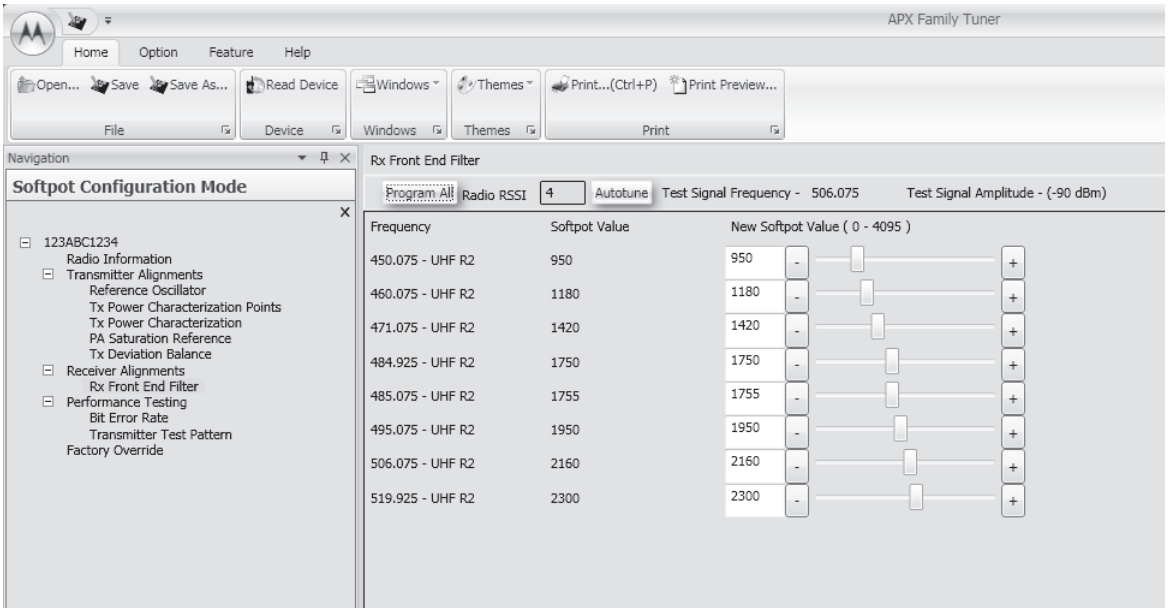


Figure 6-26. Front End Filter Alignment Screen (UHF2)

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 3000 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.

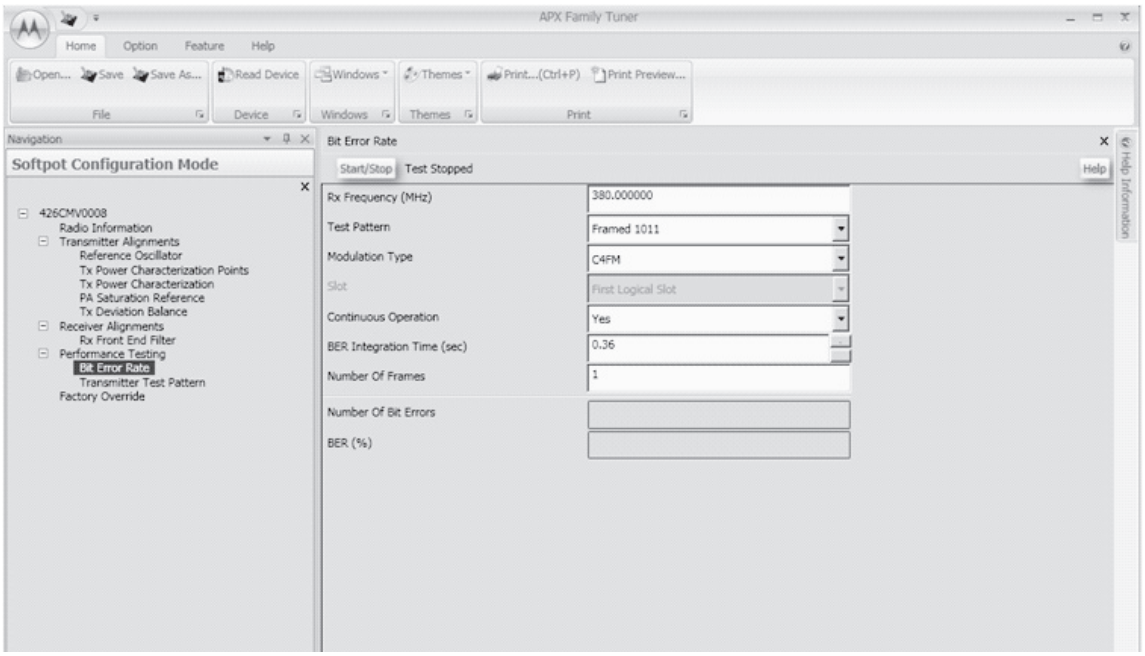


Figure 6-27. Bit Error Rate Screen (UHF1)

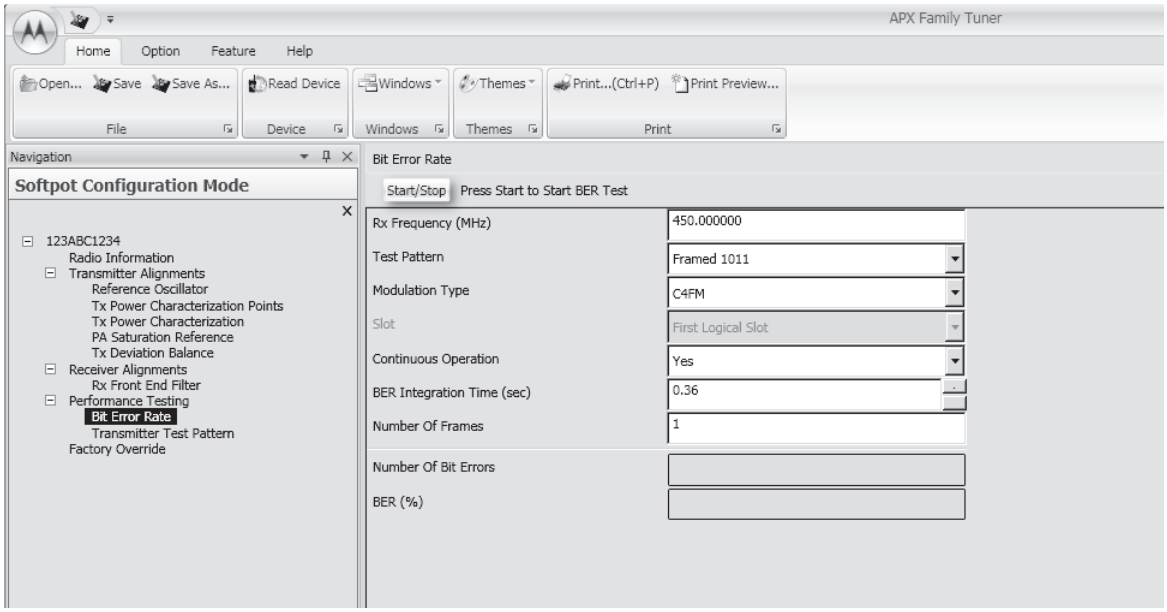


Figure 6-28. Bit Error Rate Screen (UHF2)

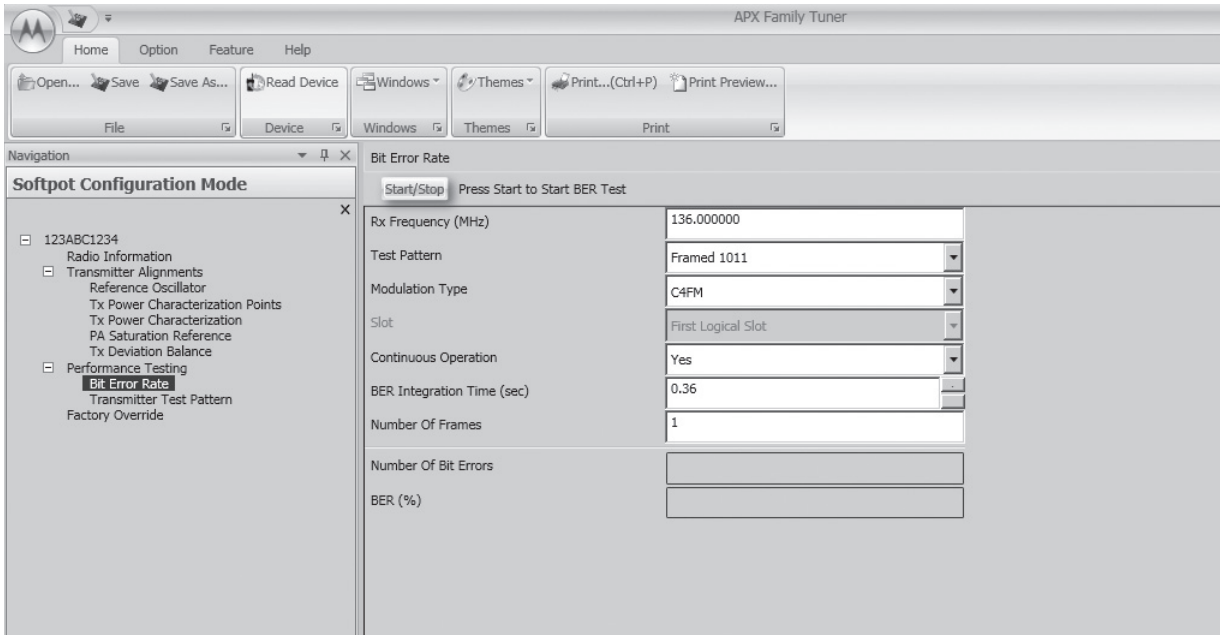


Figure 6-29. Bit Error Rate Screen (VHF)

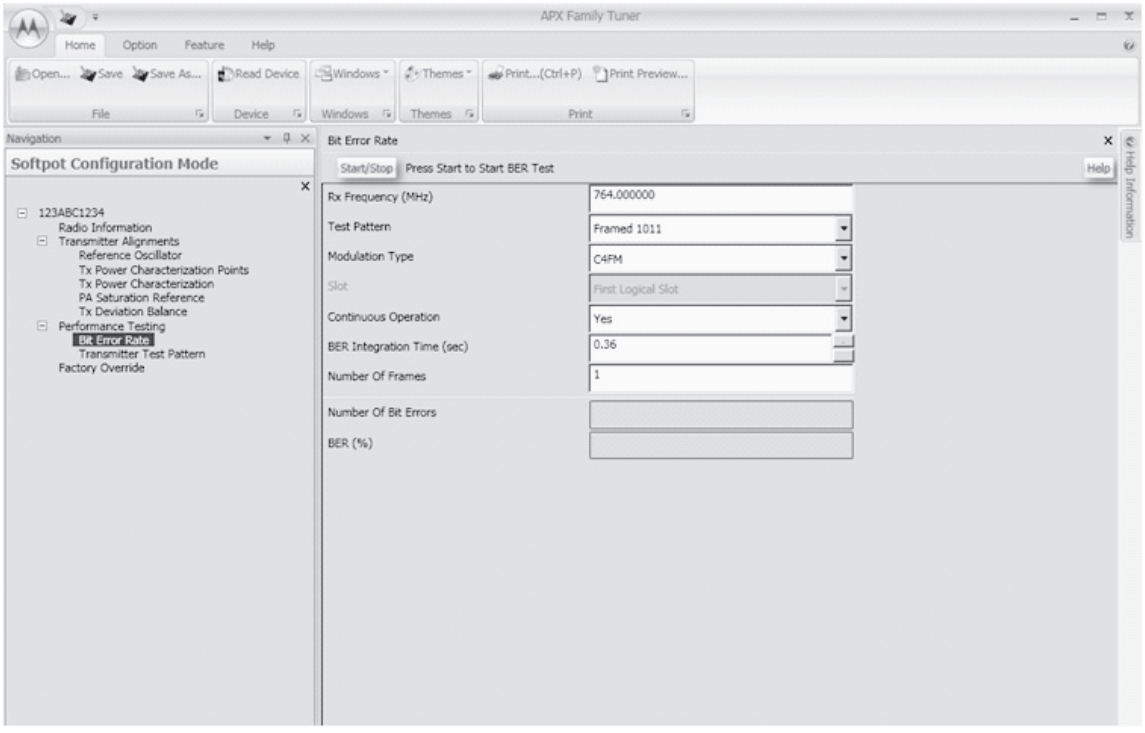


Figure 6-30. Bit Error Rate Screen (700/800 MHz)

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.

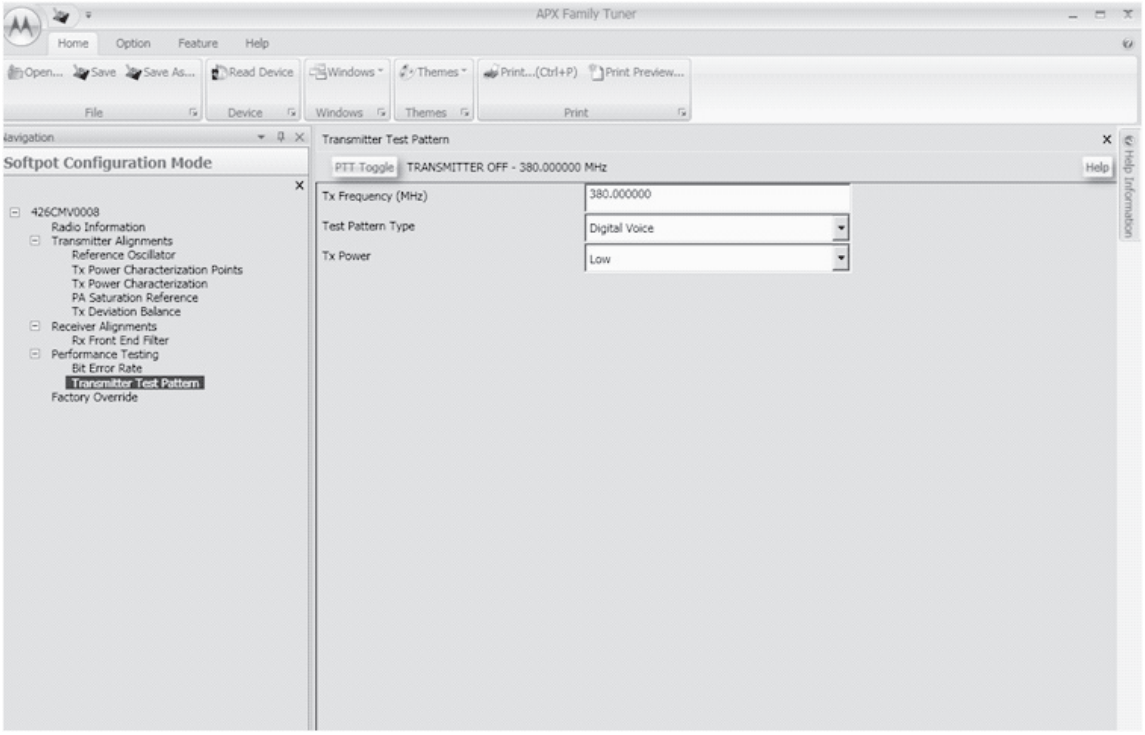


Figure 6-31. Transmitter Test Pattern Screen (UHF1)

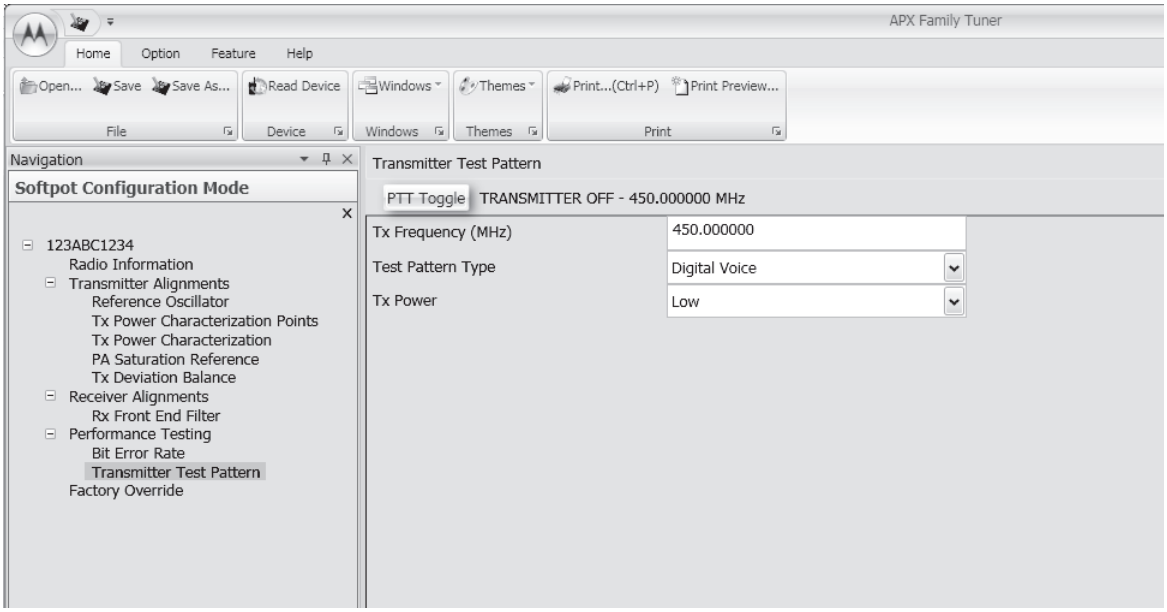


Figure 6-32. Transmitter Test Pattern Screen (UHF2)

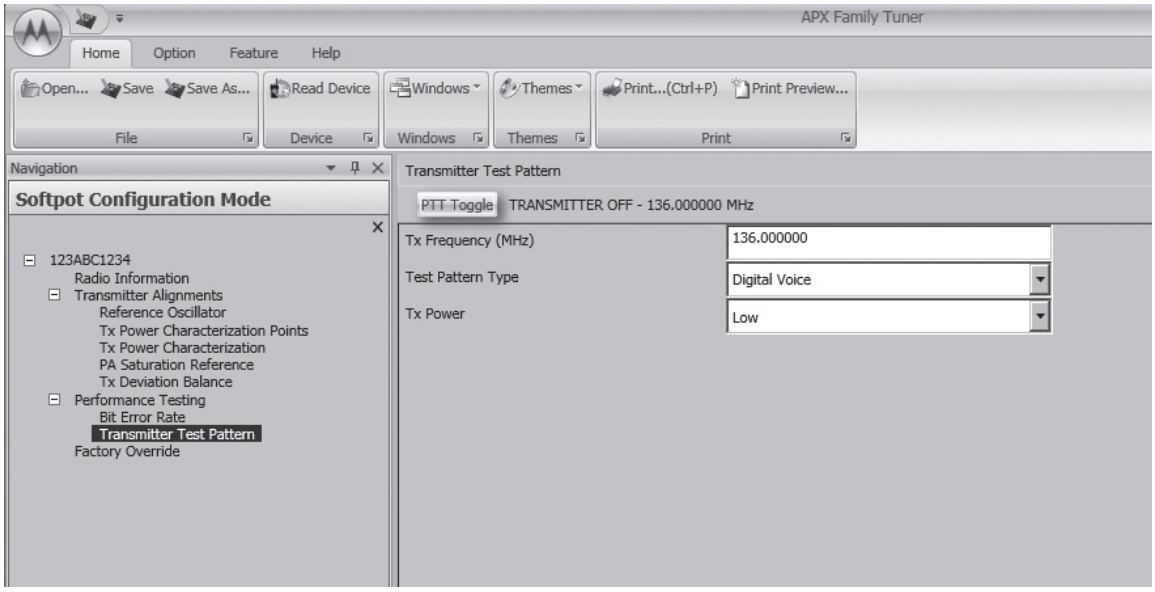


Figure 6-33. Transmitter Test Pattern Screen (VHF)

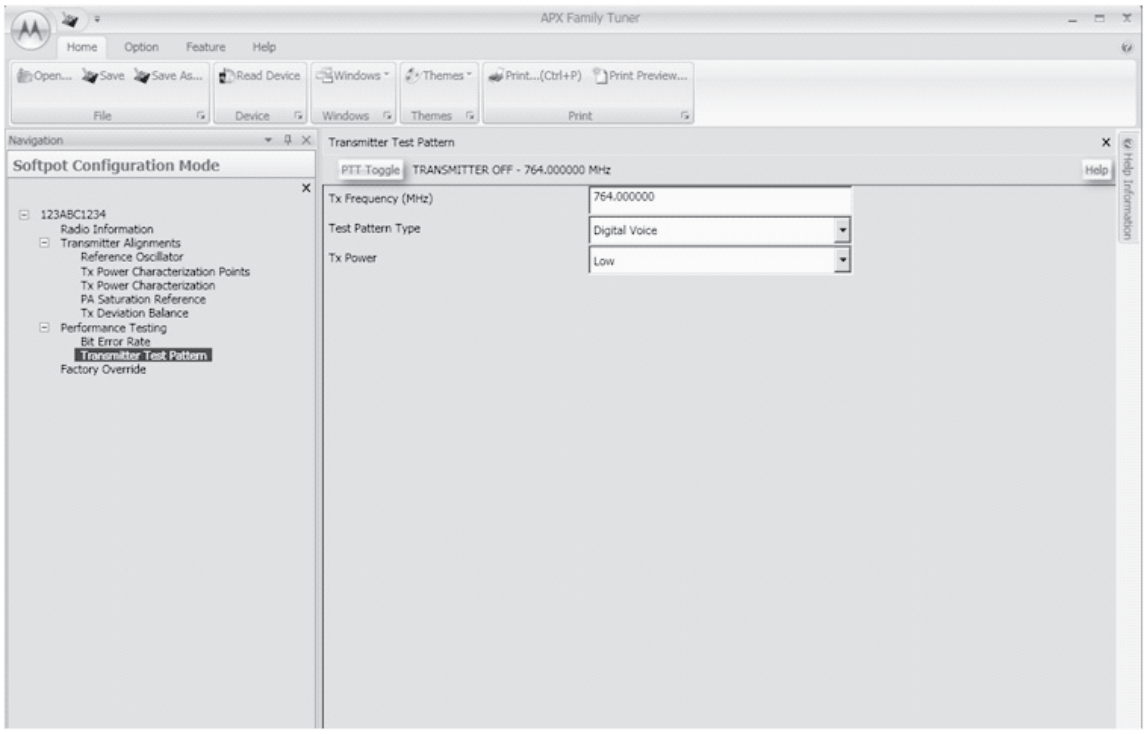


Figure 6-34. Transmitter Test Pattern Screen (700/800 MHz)

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
- 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.
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 3000 are identified by the following kit numbers:

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

Kit Number	Description
NNTN8421_	APX3000 ADP KIT (UHF1)
NNTN8422_	APX3000 ADP/DES/DES-XL/DES-OFB KIT (UHF1)
NNTN8424_	APX3000 ADP/AES KIT (UHF1)
NNTN8423_	APX3000 ADP/DVP-XL KIT (UHF1)
NNTN8439_	APX3000 ADP/DVP-XL/AES KIT (UHF1)
NNTN8440_	APX3000 ADP/DVP-XL/DES/DES-XL/DES-OFB KIT (UHF1)
NNTN8441_	APX3000 ADP/AES /DES/DES-XL/DES-OFB KIT (UHF1)
NNTN8415_	APX3000 ADP KIT (700/800 MHz)
NNTN8416_	APX3000 ADP/DES/DES-XL/DES-OFB KIT (700/800 MHz)
NNTN8417_	APX3000 ADP/DVP-XL KIT (700/800 MHz)

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

Kit Number	Description
NNTN8418_	APX3000 ADP/AES KIT (700/800 MHz)
NNTN8436_	APX3000 ADP/DVP-XL/AES KIT (700/800 MHz)
NNTN8437_	APX3000 ADP/DVP-XL/DES/DES-XL/DES-OFB KIT (700/800 MHz)
NNTN8438_	APX3000 ADP/AES /DES/DES-XL/DES-OFB (700/800 MHz)
NNTN8451_	APX3000 ADP KIT (UHF2)
NNTN8446_	APX3000 ADP/DES/DES-XL/DES-OFB KIT (UHF2)
NNTN8452_	APX3000 ADP/DVP-XL KIT (UHF2)
NNTN8445_	APX3000 ADP/AES KIT (UHF2)
NNTN8453_	APX3000 ADP/DVP-XL/AES KIT (UHF2)
NNTN8454_	APX3000 ADP/DVP-XL/DES/DES-XL/DES-OFB KIT (UHF2)
NNTN8455_	APX3000 ADP/AES /DES/DES-XL/DES-OFB (UHF2)
NNTN8443_	APX3000 ADP KIT (VHF)
NNTN8444_	APX3000 ADP/DES/DES-XL/DES-OFB KIT (VHF)
NNTN8447_	APX3000 ADP/DVP-XL KIT (VHF)
NNTN8448_	APX3000 ADP/AES KIT (VHF)
NNTN8456_	APX3000 ADP/DVP-XL/AES KIT (VHF)
NNTN8449_	APX3000 ADP/DVP-XL/DES/DES-XL/DES-OFB KIT (VHF)
NNTN8450_	APX3000 ADP/AES/DES/DES-XL/DES-OFB (VHF)

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. 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.

7.3 Select an Encryption Key

Encryption key is strapped to personality/channel programmable via CPS.

7.4 Erase an Encryption Key

APX 3000 only supports this feature for erasing an encryption key.

7.4.1 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.

When all the encryption keys have been erased, the display shows “ALL KEYS ERASED”. (On DRSM or debugging fixture.)

Notes

Chapter 8 Disassembly/Reassembly Procedures

This chapter provides detailed procedures for disassembling/reassembling and ensuring submergibility of the APX 3000 radios. When performing these procedures, refer to 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 3000 radio's standard accessories.

8.1 APX 3000 Exploded View (Main Subassemblies)

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

This section contains the APX 3000 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.

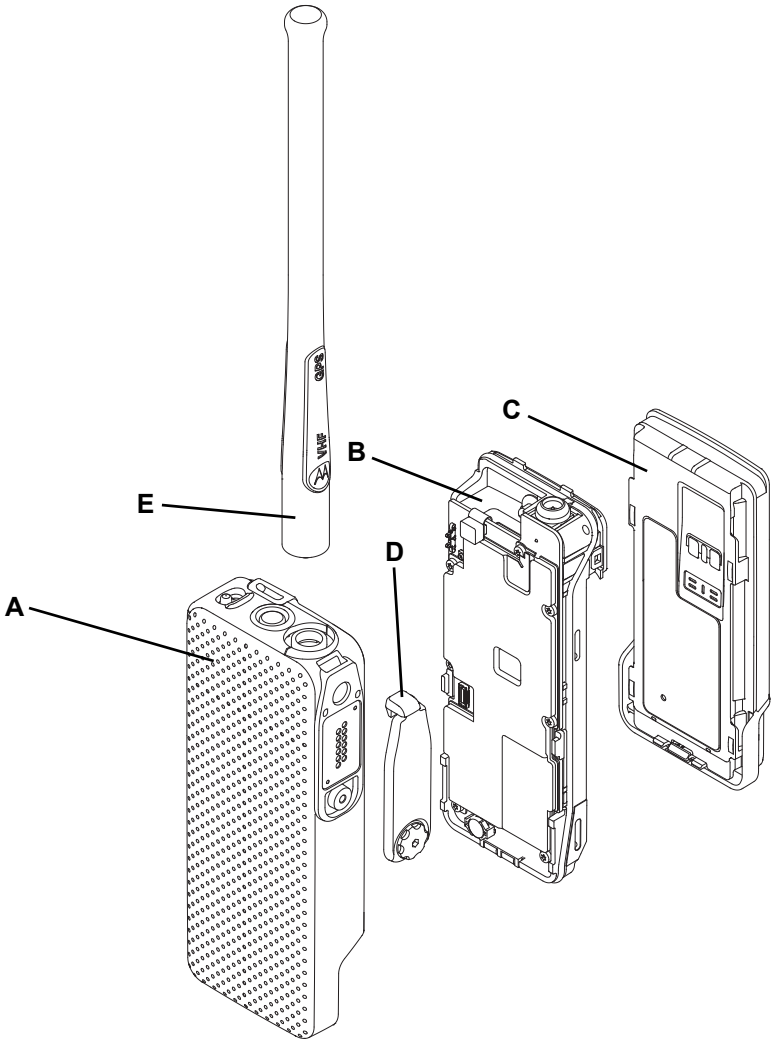


Figure 8-1. APX 3000 Partial Exploded View

Table 8-1. APX 3000 Partial Exploded View Parts List

Item Letter	Description	Exploded View and Parts List
A	Front Kit Assembly	Refer to Figure 10-1.
B	Back Kit Assembly	Refer to Figure 10-2.
C	Battery Assembly	Refer to Figure 10-2.
D	Accessory-Connector Cover Assembly	Refer to Figure 10-1.
E	Antenna Assembly	Refer to 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	PMLN6208_	Horizon Land	–	To remove chassis from housing.
Bit, Torx T6	–	–	–	For 2nd Shield & Main PCB & Shroud.
Black Stick	–	Hexacon Electric Co.	MA-800G	For removing the shroud from chassis.
Driver, Torque	–	–	–	–
Allen wrench	–	–	–	To loosen accessory-connector cover thumb screw (if thumb screw is too tight).
Anti-static ground kit	0180386A82	–	–	To place radio and components during disassembly and reassembly.
Vacuum Pump kit	NLN9839_	Motorola	–	For vacuum test. Requires 66012075001 Vacuum Test Fixture.
Vacuum Test Fixture	66012075001	Brusia	BE-MO-121242	To connect the vacuum/pressure hose of the Vacuum Pump Kit 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	Screw, 2nd Shield & Main PCB & Shroud.	3.0

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 switching the On/Off switch.
- Remove the Accessory-Connector cover (5†), the antenna, the battery, the Bottom Label (46†††) and any other accessory connected to the radio.

8.4.1 Remove Accessory-Connector Cover (5†)

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.

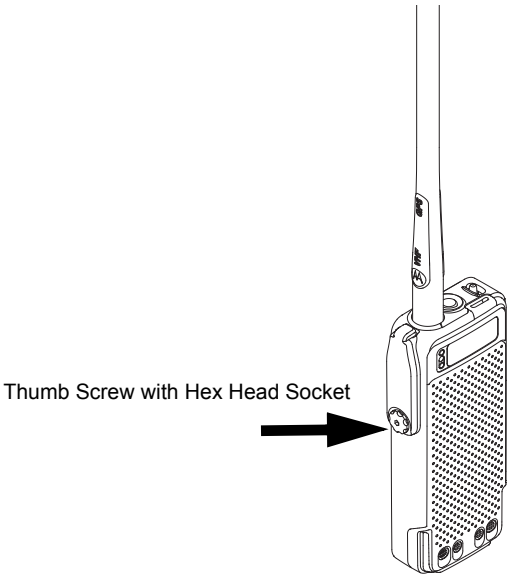


Figure 8-2. Removing the Thumb Screw

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.

8.4.2 Remove Antenna

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

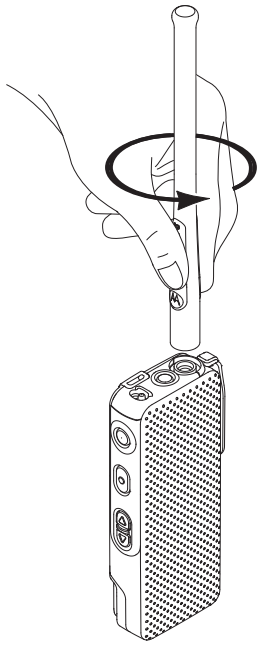


Figure 8-3. Removing the Antenna

8.4.3 Remove Battery (40†††*)

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 3000 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.

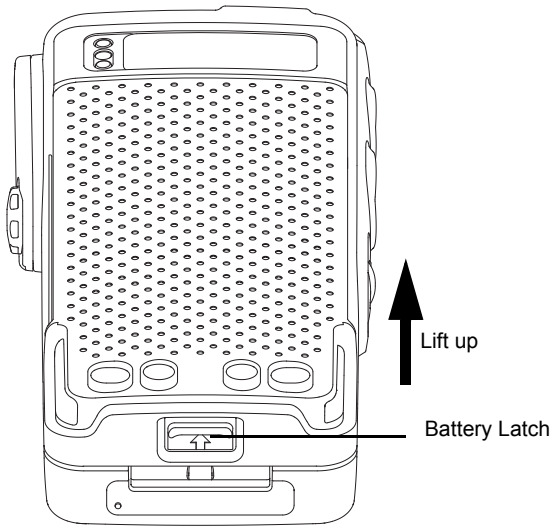


Figure 8-4. Lifting up the latch

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

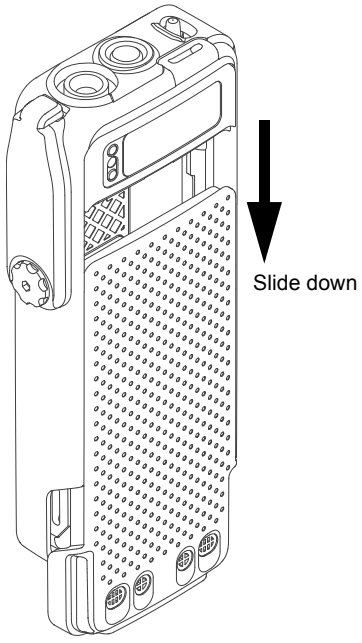


Figure 8-5. Removing the Battery

8.4.4 Removal of the Back Kit Assembly (B)

This section contains instructions for disassembling the radio.

8.4.4.1 Removal of the Chassis (33†††)

1. With the Battery removed, disengage the Chassis (33†††) using the Chassis Opener as shown in Figure 8-6.

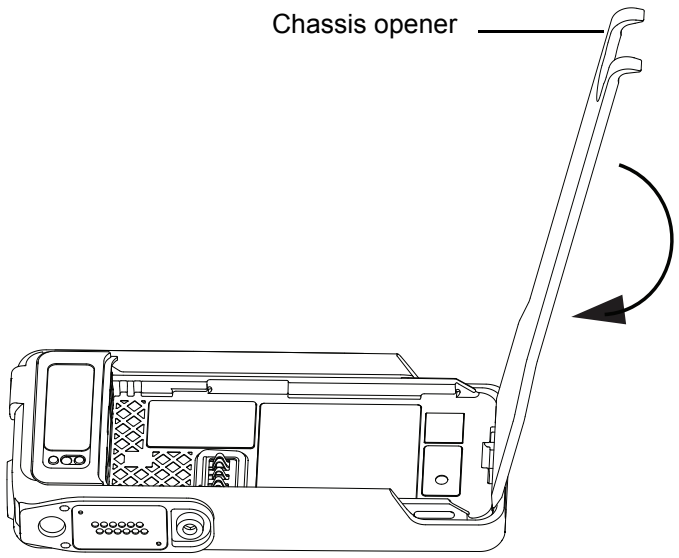


Figure 8-6. Disengage the Chassis

NOTE: The Seal, Vacuum Port (45†††*) and the Label Gore Port (43†††) must be removed each time the Chassis is removed (for leak test).

2. After the Chassis (33†††) is disengaged, remove the connector at the bottom of the back kit and lay both sub-assemblies on the anti-static mat (part of anti-static ground kit) as shown in Figure 8-7.

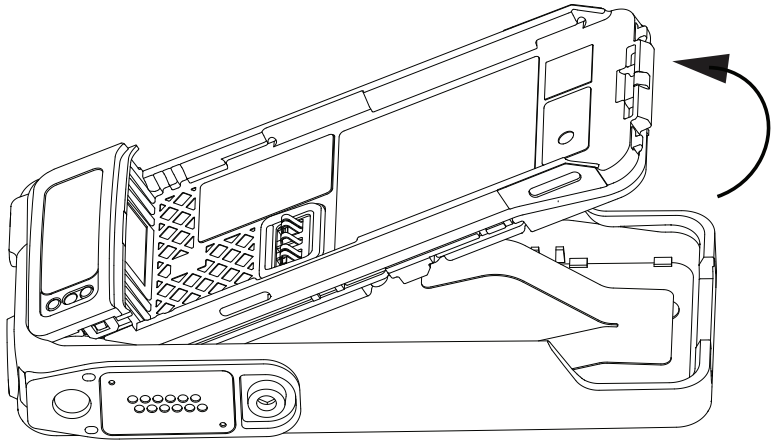


Figure 8-7. Remove the Chassis Assembly

8.4.4.2 Removal of the Secondary Shield Assembly (26†††*)

1. Remove the chassis screws (26†††*) as shown in Figure 8-8.

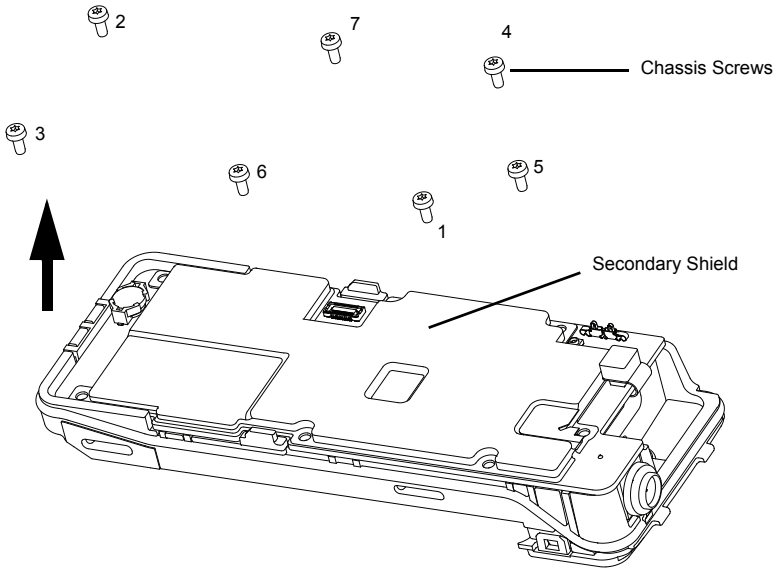


Figure 8-8. Remove the chassis screws

2. With the chassis screws removed, lift the Secondary Shield Assembly (26†††*) out from the Chassis (33†††) as shown in Figure 8-9.

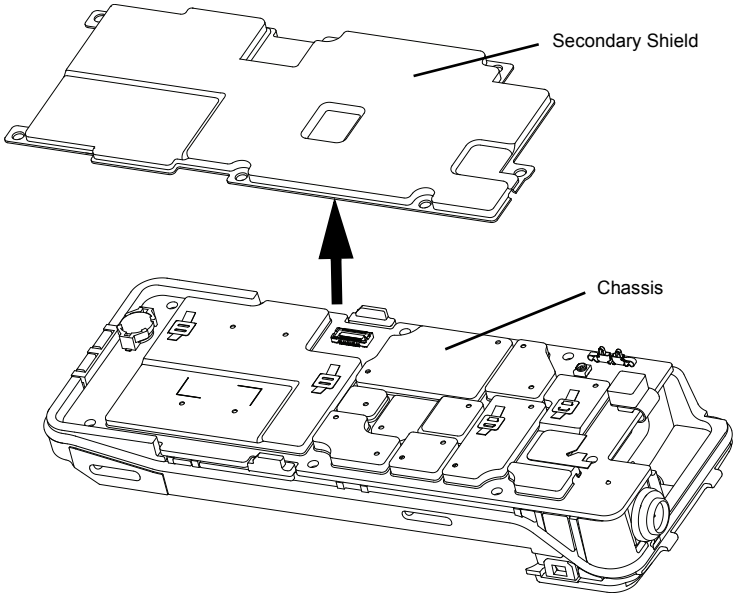


Figure 8-9. Remove the Secondary Shield Assembly

8.4.4.3 Removal of the Main Board(29††)

1. Remove the Main O-Ring (28†††*) and NFC Flex connector at the antenna holder as shown in Figure 8-10.

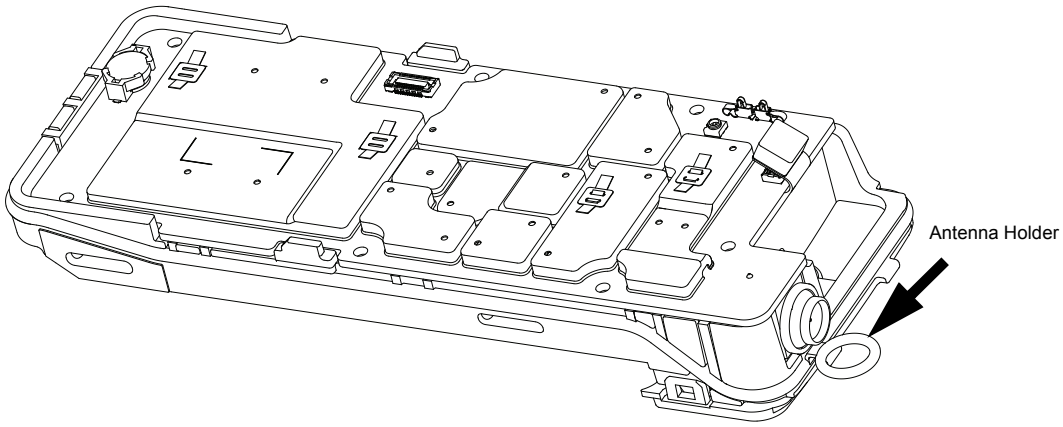


Figure 8-10. Remove the Main O-Ring at the antenna holder

2. Lift up the Main Board (29††) from the Chassis as shown in Figure 8-11.

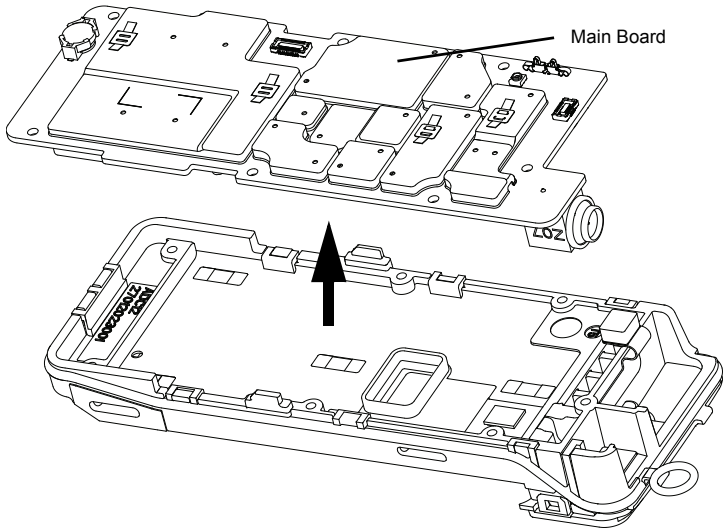


Figure 8-11. Lift up the Main Board from the Chassis

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 (31†††*) whenever the Main Board is removed.

8.4.4.4 Removal of Battery Seal (40†††*)

1. Remove the battery seal at battery contact (40†††*) as shown in Figure 8-12.

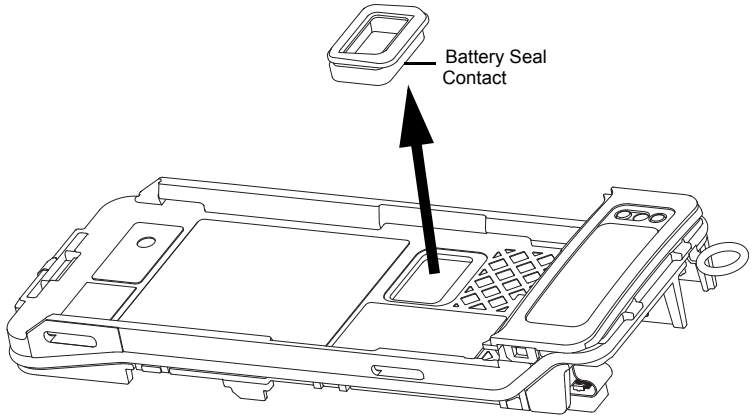


Figure 8-12. Remove Battery Seal

8.5 Serviceable Components of the Main Sub-Assemblies

8.5.1 Servicing Main Board Assembly

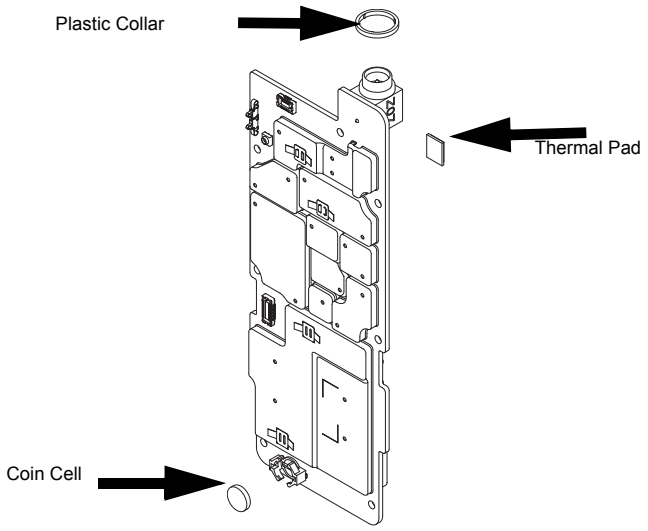


Figure 8-13. Serviceable Components – Main Board Assembly

8.5.1.1 Servicing Coin Cell:

1. Complete steps from Section 8.4.4.1. through Section 8.4.4.3.
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 8.4.4.1. through Section 8.4.4.3.
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

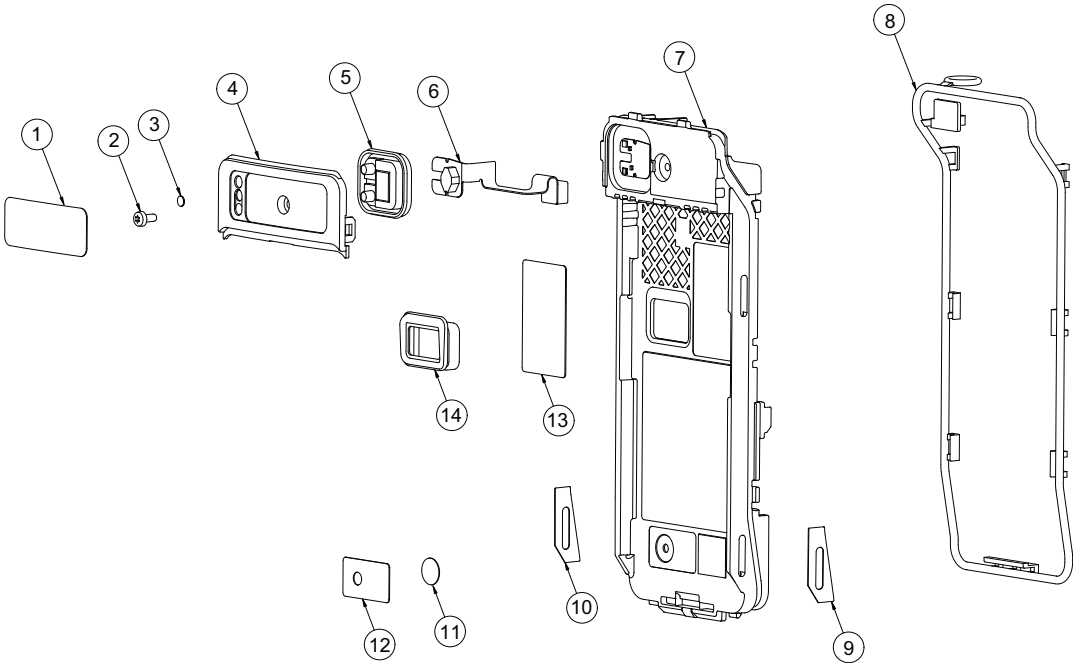


Figure 8-14. Serviceable Components – Chassis Assembly

NOTE: When servicing NFC Assy Flex, assemble the NFC Assy Flex first before assembling back the poron.

Table 8-4. Serviceable Components

Item No.	Description
1	Label Shroud
2	Screw, Shroud
3	Bluetooth Pairing Indication Label
4	Shroud
5	Lightpipe, LEDs
6	Assy, Flex, NFC
7	Chassis
8	Main Seal
9	Label, Chassis Left
10	Label, Chassis Right
11	Seal, Vacuum Port
12	Label, Gore Port
13	Label, FM Approved Logo (Bottom) Label, Bottom Blank
14	Battery Seal Contact

8.5.2.1 Servicing Label Gore Port:

1. Complete steps from 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 of its backer and place in the respective location.
6. Apply slight pressure to set the adhesive.

Label Gore Port should always be replaced when back kit assembly is removed.

8.5.2.2 Servicing Seal, Vacuum Port:

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.

Seal, Vacuum Port should always be replaced when back kit assembly is removed.

8.5.2.3 Servicing Battery Contact Seal:

1. Complete steps from Section 8.4.4.1. through Section 8.4.4.3.
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 8.4.4.1. through Section 8.4.4.3.
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 Shroud Label, NFC flex and Lightpipe:

1. Complete steps from Section 8.4.
2. Remove the Shroud Label with the aid of a Black Stick.
3. Remove the Chassis Screw at the center of shroud.
4. Remove the Shroud with the aid of Black Stick.
5. Remove the Lightpipe from the Chassis.
6. Replace the new Lightpipe into the Chassis. Ensure that the seal is set properly and not stretched.
7. Replace the new Shroud and torque the Chassis Screw with 3.0 in-lbf with a Torx IP6 Bit.
8. Peel the new Shroud Label of its backer and place it in the original location.
9. Apply slight pressure to set the adhesive.

8.5.3 Servicing Main Housing (A)

1. Remove top control Bracket and Rotary Switch spring (which is attached to the top control bracket) at the same time.
2. Remove top control Assy Flex.

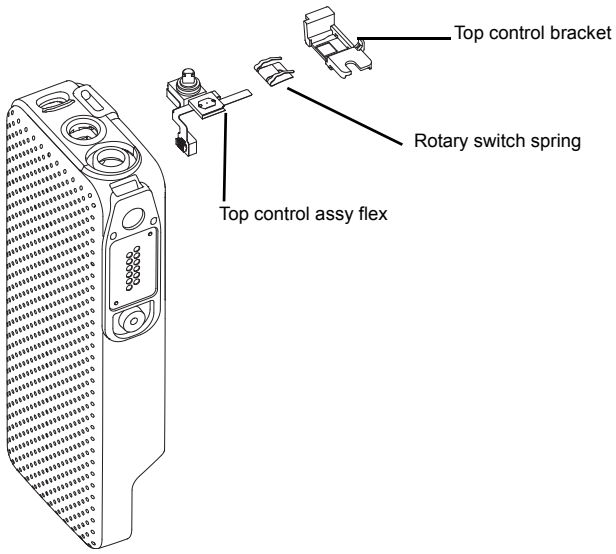


Figure 8-15. Serviceable Components – Main Housing

NOTE:

Top Control Bracket Removal

1. By using one finger, turn the bracket 45ºC upwards until the bracket is in vertical position.
2. Lift the bracket carefully from its placing.

Top Control Assy Flex Removal

1. Carefully remove the board to board connector.
2. Remove the flex connector.
3. Remove the Top Control Assy flex from the front housing.

8.6 Radio Reassembly

This section contains instructions for reassembling the radio.

8.6.1 Reassemble the Battery Seal(40†††*)

1. Assemble the battery seal (40†††*) as shown in Figure 8-16.

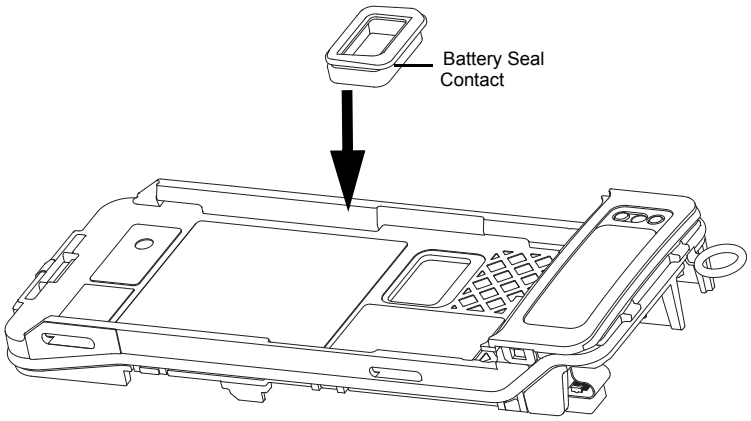


Figure 8-16. Assemble the Battery Seal

2. With the Main Board (29††) seated in the Chassis (33†††), gently assemble the Main O-Ring (28†††*) and the connector to the Antenna Holder as shown in Figure 8-17.

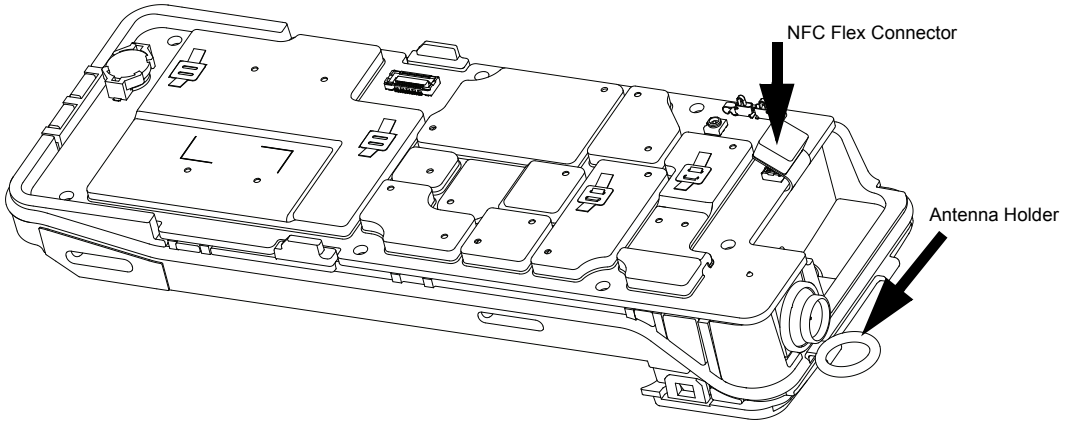


Figure 8-17. Assemble the Main O-Ring at Antenna Holder

8.6.2 Reassemble the Main Board (29††)

1. Place the Main Board into the Chassis (33+++) as shown in Figure 8-18.

.

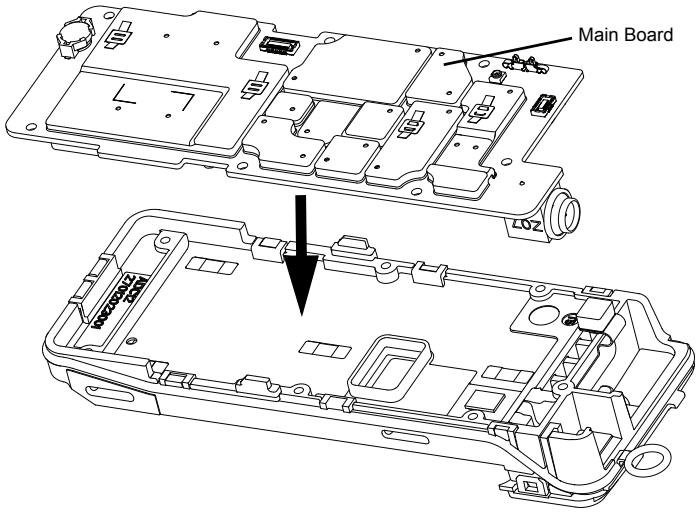


Figure 8-18. Assemble the RF Board

NOTE: Ensure that the Battery Contact Seal (40†††*) does not pinch and the tabs of the Main O-Ring are held in place when assembling the Main Board into the Chassis.

8.6.3 Reassemble the Secondary Shield Assembly (26†††*)

1. With Main Board (29††) assembled, place the Secondary Shield Assembly (26†††*) onto the Main Board as shown in Figure 8-19.

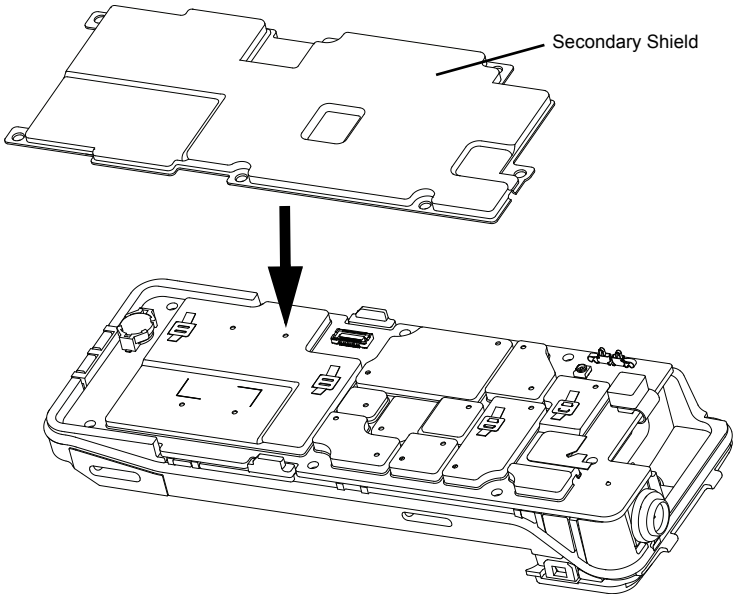


Figure 8-19. Assemble the Secondary Shield Assembly

2. Torque all seven Chassis Screws (25†††) with a Torx IP6 Bit and a Torque Driver to 3.0 in-lbf in the sequence as shown in Figure 8-20.

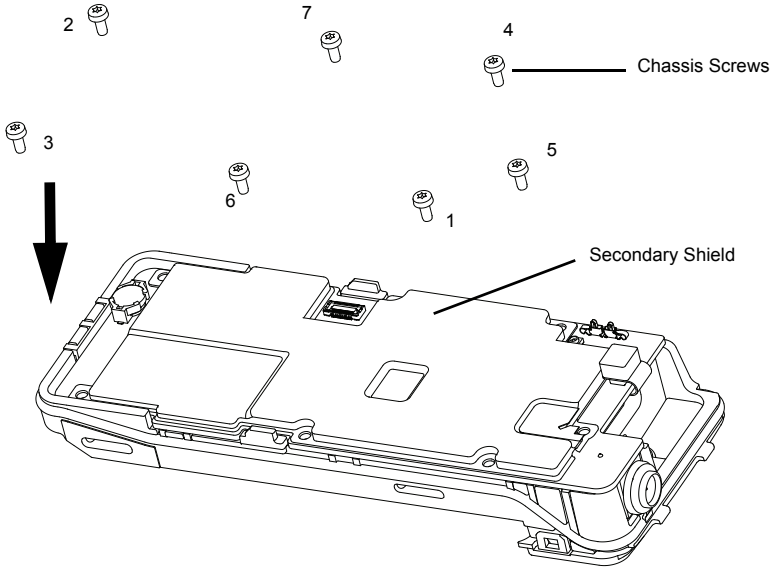


Figure 8-20. Torque in the Chassis Screws.

8.6.4 Reassemble the Main Subassemblies (A and B)

1. Complete the steps in Section 8.6.2. through Section 8.6.3.
2. Connect the connector on main flex to main board. Slide the Chassis assembly into the Front Housing as shown in Figure 8-21.

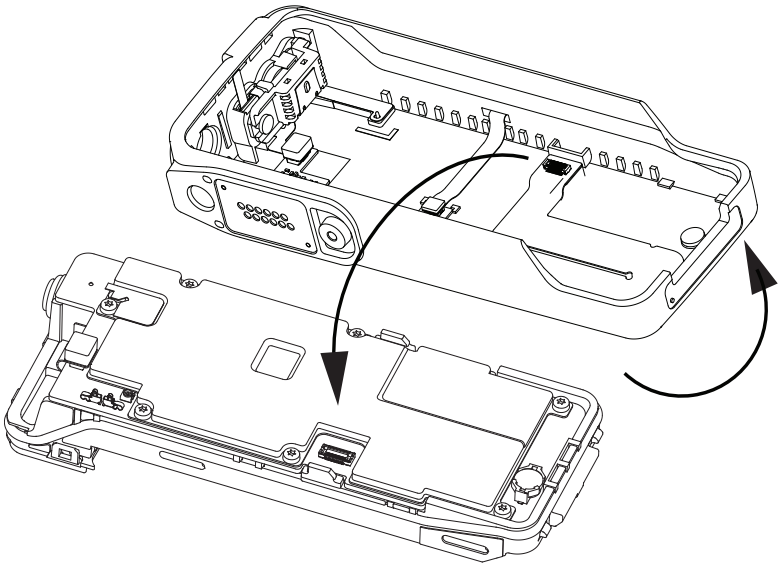


Figure 8-21. Slide chassis assembly into Front Housing

NOTE: Main Flex needs to be seated properly before assembly.

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 8-22.

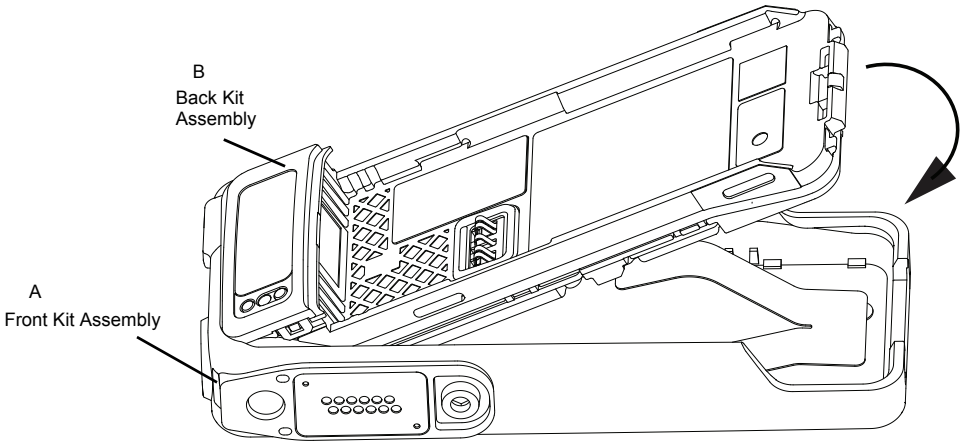


Figure 8-22. Assemble Back Kit and Front Kit together

8.6.5 Reassemble the Accessory-Connector Cover

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.

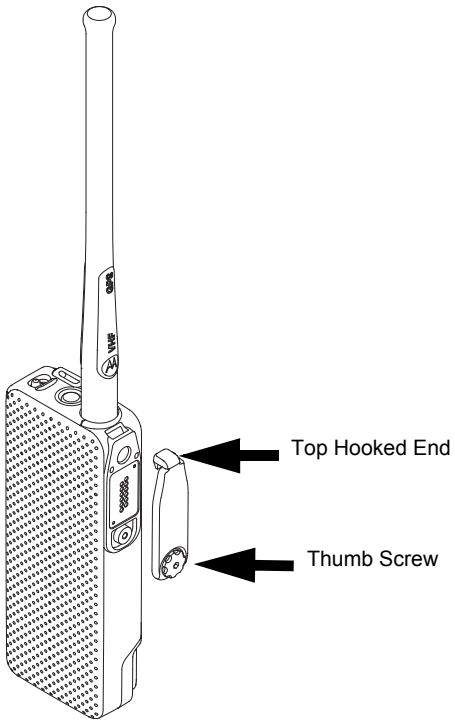


Figure 8-23. Engaging Hook and Seating Cover

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.

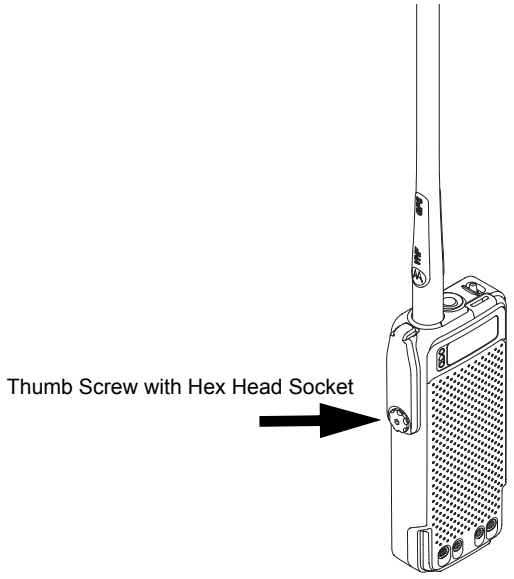


Figure 8-24. Securing the Cover

8.6.6 Reassemble the Antenna

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

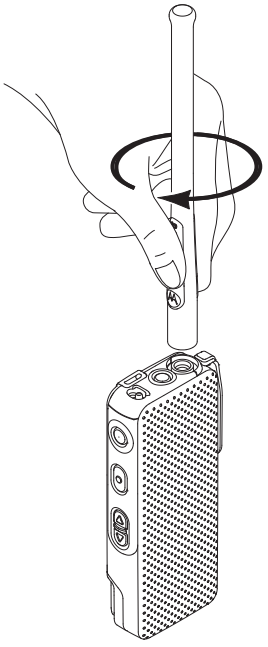


Figure 8-25. Attaching the Antenna

8.6.7 Reassemble the Seal, Vacuum Port (45†††*), Label Gore Port (43†††) and Bottom Label (45†††)

1. Adhere and gently press the Seal, Vacuum Port (43†††) on the chassis' recess as shown in Figure 8-26.

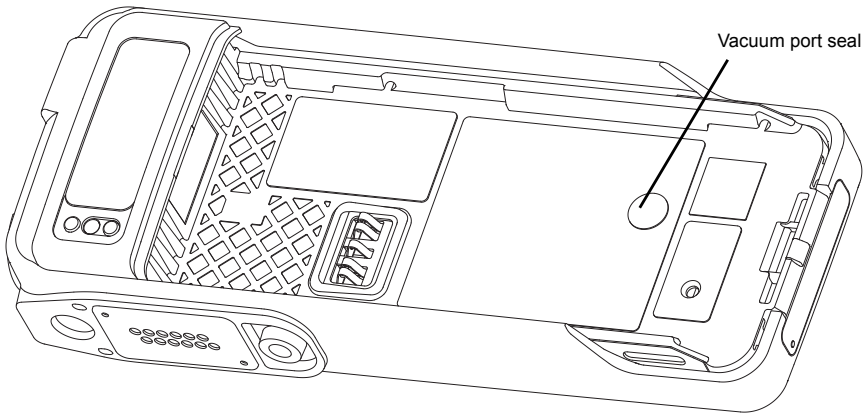


Figure 8-26. Assemble the Seal, Vacuum Port

2. With the Seal, Vacuum Port assembled, adhere the Label Gore Port (43†††) on the chassis' recess as shown in Figure 8-27.

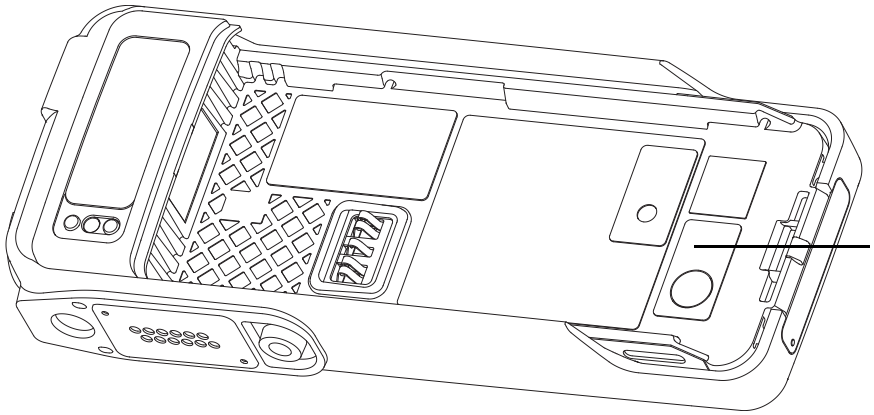


Figure 8-27. Assemble the Label Gore Port

3. Adhere the Bottom Label (46†††) on the recess at the bottom of the Front Housing as shown in Figure 8-28.

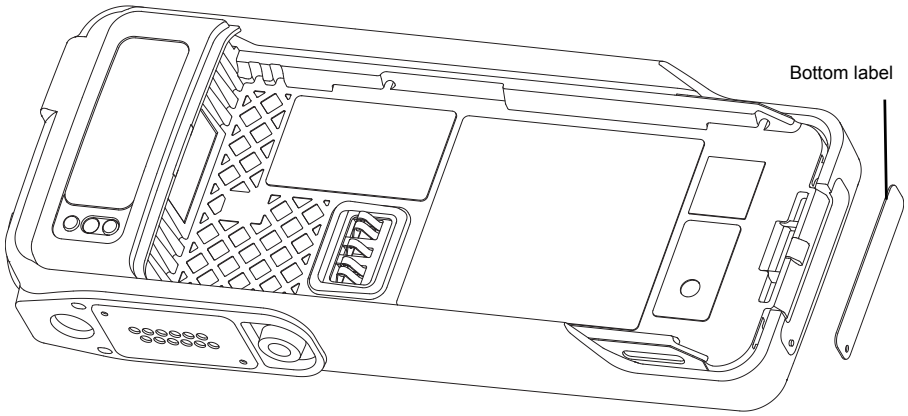


Figure 8-28. Assemble the Bottom Label

8.6.8 Reassemble the Battery

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 8-29.

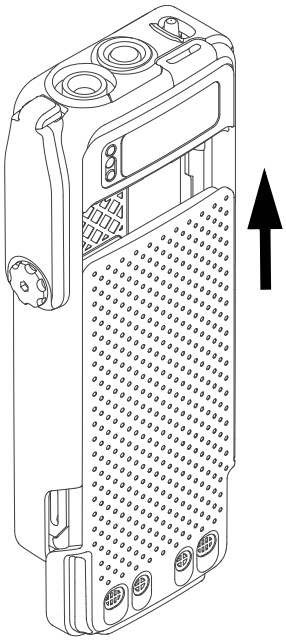


Figure 8-29. Attaching Battery – Slide into Position

8.7 Ensuring Radio Submergibility

This section discusses radio submergibility concerns, tests, and disassembly and reassembly of ASTRO APX 3000 radios.

8.7.1 Standards

ASTRO APX 3000 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 3000 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.

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 Specialized Test Equipment

This section summarizes the specialized test equipment necessary for testing the integrity of ASTRO APX 3000 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.

8.7.3.1 Vacuum Pump Kit NLN9839_

The Vacuum Pump Kit includes a Vacuum Pump with gauge and a Vacuum Hose. The Vacuum Test Fixture (P/N 66012075001) which connects the vacuum pump to the radio, must be ordered separately.

8.7.4 Disassembly

Disassemble the radio according to Section 8.4.

8.7.5 Reassembly

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

To reassemble the radio:

1. Inspect the Main O-Ring on the Chassis (33†††) for any damage or foreign material.
2. Inspect the Battery Contact Seal (40†††*) on the Main Board Assembly (29††)for any damage.
3. Inspect the mating seal surfaces on the Chassis (33†††) 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.

8.7.6 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 Seal, Vacuum Port (45†††*) and Label Gore Port (43†††) that cover the Vacuum port.

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

8.7.6.1 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 (66012075001)
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.

8.7.6.2 Test Procedure

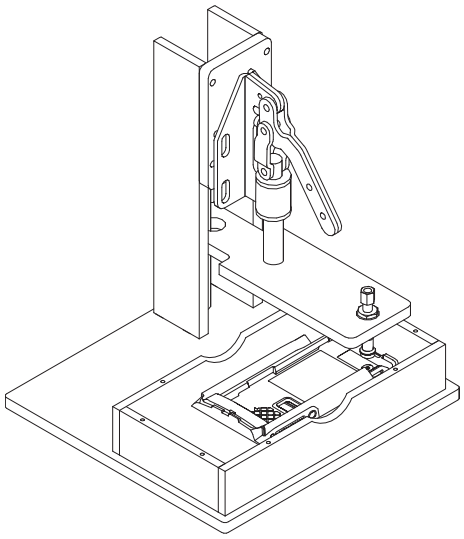


Figure 8-30. Attaching Vacuum Test Fixture

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 0.2 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.
   - If the needle falls more than 0.2 inHg, the radio fails the vacuum test and the radio might leak if submerged. Additional troubleshooting of the radio is required.

8.7.7 Immersibility Test

Immersibility 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. Immersibility 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.

NOTE: 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 Exploded Views and Parts Lists.

To conduct the immersibility test:

1. Observe if 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. Cover the ventilation hole with a brand new Seal, Vacuum Port and label gore port.
4. Attach a long string to the radio and submerge the radio into a water-filled container with the depth of 1m.
5. Watch for any continuous series of bubbles. A steady stream of bubbles indicates a sign of leakage.

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.

6. 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
7. 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.

To avoid equipment damage, keep the area inside the Battery contact pocket is dry before assembling battery.

8. See Troubleshooting Leak Areas.

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.

NOTE: 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 (43), 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 Chassis

- If leak occurs through the Main O-Ring (28†††*), it will need to be replaced.
- If leak occurs elsewhere on the Chassis (33†††), it will need to be replaced.

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 circuit board replacement.

Component-level service information can be found in the “ASTRO APX 3000 Portable Radios Detailed Service Manual,” Motorola publication number 68012007045.

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
02/88	DSP RAM Fatal Error – **Note:** Not a checksum failure	Turn the radio off, then on

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

Error Code	Description	Corrective Action
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
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	1. Dead Battery	Replace with charged battery
	2. Blown Fuse	Send radio to depot
	3. On/Off Switch	
	4. Regulators	
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

Table 9-3. Receiver Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements at Room Temperature)
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	Reallign if necessary
	2. Accessories	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 External 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 3000 digital portable radios. The following table lists the exploded views for the radio in different configurations:

Table 10-1. APX 3000 Exploded Views and Controller Kit

10.1 APX 3000 Front Kit Exploded View

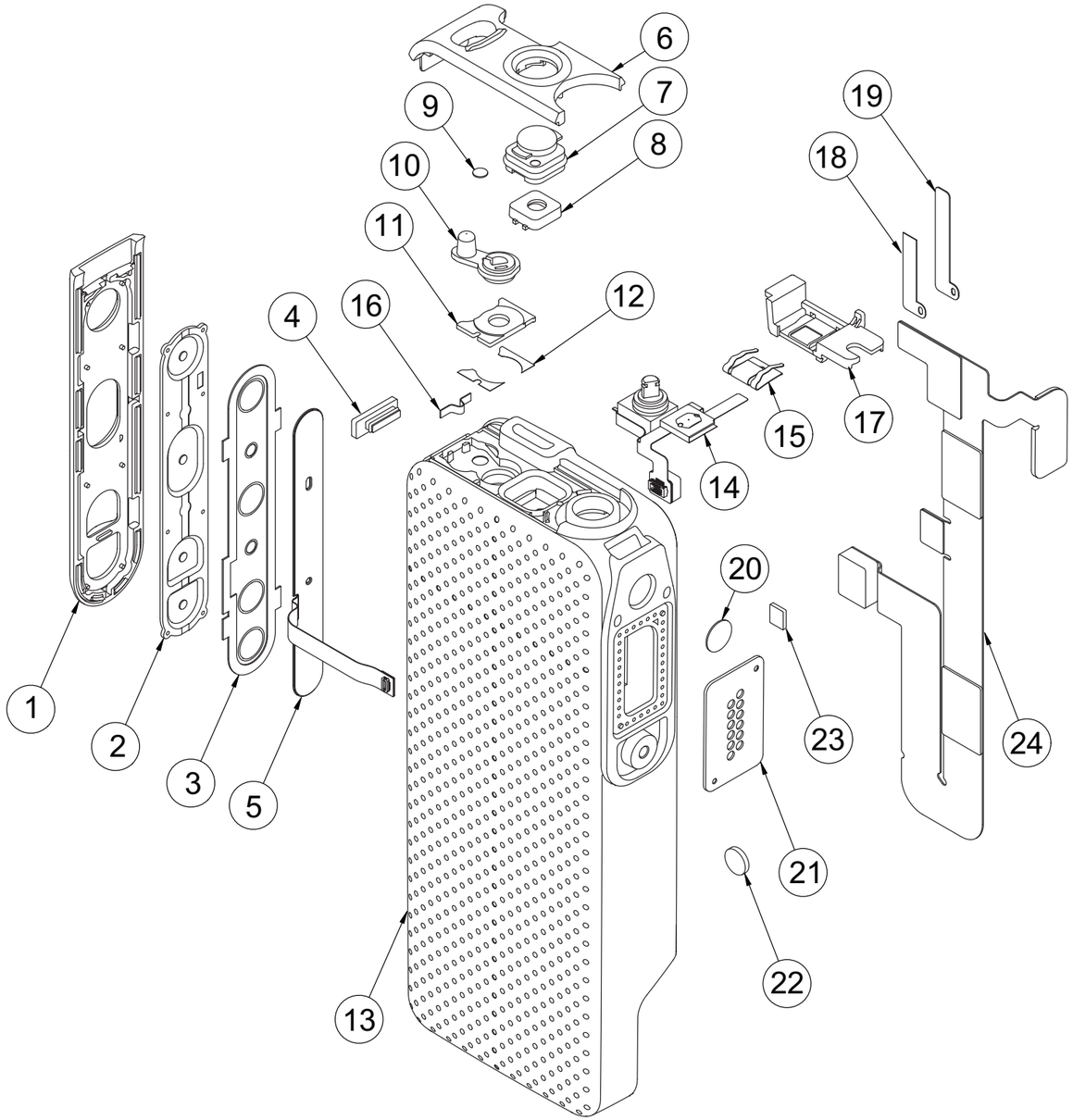


Figure 10-1. APX 3000 Front Kit Exploded View

10.2 APX 3000 Front Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
1†	**13012038001**	Bezel. Side
2†	**75012180001**	Side Control, Silicon
3†	**11012095001**	Mylar, PEN/PET, Adhesive, Seal
4†	**38012038001**	Seal, Side Cap
5†	**1014052J58**	Assy, Flex, Side Control
6†	**13012039001**	Bezel, Top Ctrl
7†	**38012037001**	Assy, Emergency Button
8†	**32012209001**	Gasket, Emergency
9†	**54012295001**	Label, Green Dot
10†	**42012081001**	Retainer, Power ON/OFF
11†	**11012104001**	Adhesive, Retainer, Power ON/OFF
12†	**5501207001**	Lever, Power ON/OFF
13†	**15012208001**	Housing Assy, Front
14†††	**0104052J59**	Assy, Flex, Top Control
15†††	**41012013001**	Spring, Switch, Rotary
16†	**41012014001**	Spring, Switch, Rotary, Torque
17†††	**07012048001**	Bracket, Top Control
18†	**11012108001**	Adhesive, Bluetooth Antenna
19†	**39012077001**	Metal Element, Bluetooth Antenna
20†	**54012294001**	Label, Front-HSG
21†	**33012027001**	Escutcheon, GCAI
22†	**75012118001**	Pad, Poron, Coin-cell
23†	**75012183001**	Pad, Poron, BTB, 10pin, Plug, Side
24†	**0104052J75**	Assy, Flex, Main

NOTE:

†. Items cannot be ordered individually.

††. RF Board Kit for different bandsplit.

†††. Items can be ordered individually but they are included in the assembly front kit (0104052J79).

10.3 APX 3000 Back Kit Exploded View

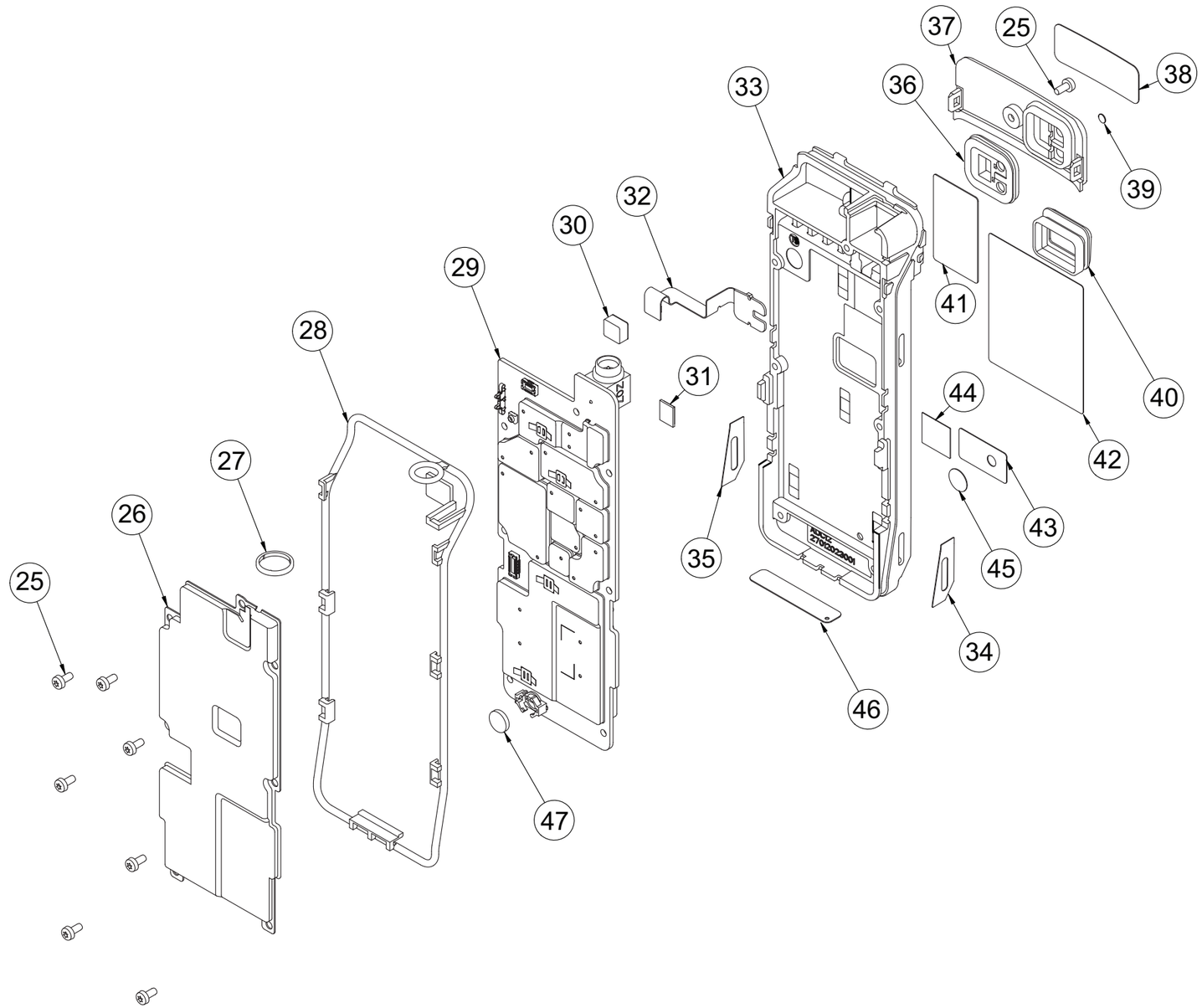


Figure 10-2. APX 3000 Back Kit Exploded View

10.4 APX 3000 Back Kit Exploded View Parts List

Item No.	Motorola Part Number	Description
25†††*	**0386104Z04**	Screw, Chassis
26†††*	**26012242001**	Shield, Secondary
27†††*	**43012045001**	Collar, Plastic
28†††*	**32012212001**	Main, Seal
29††	**MLF4094AZ** **MLE4858AZ** **MLE4912** **MLD4565**	RF Board Kit, 700/800 MHz RF Board Kit, UHF1 RF Board Kit, UHF2 RF Board Kit, VHF
30†††	**75012184001**	Pad, Poron, BTB, 12pin, Plug, NFC
31†††*	**75012182001**	Pad, Thermal & Conductive
32†††	**0104052J74**	Assy, Flex, NFC
33†††	**27012023001**	Chassis
34†††	**54012285001**	Label, Chassis Left
35†††	**54012285002**	Label, Chassis Right
36†††	**61012070001**	Lightpipe, LEDs
37†††	**15012209001**	Shroud
38†††	**54012276001**	Label, Shroud
39†††	**54012253001**	Bluetooth Pairing Indication Label
40†††*	**32012150001**	Seal, Battery Contact
41†††	**54012279001**	Label, FM**
42†	**54012242001**	Label, FCC
43†††	**54012298001**	Label, Gore Port
44†	**33012034001**	Label, ITID
45†††*	**3286058L01**	Seal, Vacuum Port
46†††	**54012283001** **54012283002**	Label, Bottom Blank Label, FM Approved Logo (Bottom)**
47†††*	**6071520M01**	Batt Coin 3V Li Rechargeable

NOTE:

†. Items cannot be ordered individually.

††. RF Board Kit for different bandsplit.

†††. Items can be ordered individually but they are included in the chassis back kit.

†††* Items are not in chassis back kit, but can be ordered individually.

**Items orderable for depot and FM qualified customers/dealers only.

Notes

Appendix A Accessories

Motorola provides the following approved optional accessories to improve the productivity of the APX 3000 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 Replacement Parts Ordering

B.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.

B.2 Transceiver Board Ordering Information

When ordering a replacement Transceiver Board, refer to the applicable Model Chart in the front of this manual. Read the Transceiver Board note, and include the proper information with your order.

B.3 Motorola Online

Motorola Online users can access our online catalog at

http://www.motorolasolutions.com

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://www.motorolasolutions.com

B.4 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.

B.5 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)

B.6 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)

B.7 Parts Identification

Radio Products and Solutions Organization*
(United States and Canada)
1-800-422-4210

B.8 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).

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.*
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.
PC Board	Printed Circuit Board. Also referred to as a PCB.

Term	Definition
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 (Conversation) 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.
real-time clock	A module that keeps track of elapsed time even when a computer is turned off.

Term	Definition
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.

Notes

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