

ASTRO® Digital Spectra®
and Digital Spectra Plus
UHF
VHF
800 MHz
Mobile Radios

Basic Service Manual





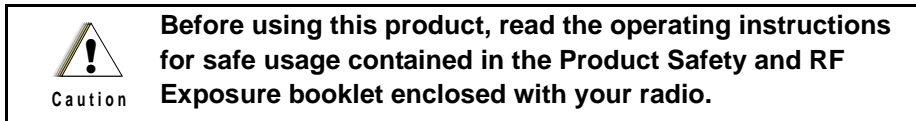
**ASTRO[®] Digital Spectra[®]
and Digital Spectra Plus[®]
VHF/UHF/800 MHz Digital Mobile Radios
Basic Service Manual**

Foreword

This manual covers all models of the ASTRO® Digital Spectra® and ASTRO Digital Spectra Plus mobile radios (models W3, W4, W5, W7, and W9), unless otherwise specified. It includes all the information necessary to maintain peak product performance and maximum working time, using levels 1 and 2 maintenance procedures. This level of service goes down to the board replacement level and is typical of some local service centers, self-maintained customers, and distributors.

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

Product Safety and RF Exposure Compliance



ATTENTION!

This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements. Before using this product, read the RF energy awareness information and operating instructions in the Product Safety and RF Exposure booklet enclosed with your radio (Motorola Publication part number 6881095C99) to ensure compliance with RF energy exposure limits.

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

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. To obtain FMRs, contact the Customer Care and Services Division (refer to "Appendix A Replacement Parts Ordering").

Computer Software Copyrights

The Motorola products described in this manual may include copyrighted Motorola computer programs stored in semiconductor memories or other media. Laws in the United States and other countries preserve for Motorola certain exclusive rights for copyrighted computer programs, including, but not limited to, the exclusive right to copy or reproduce in any form the copyrighted computer program. Accordingly, any copyrighted Motorola computer programs contained in the Motorola products described in this manual may not be copied, reproduced, modified, reverse-engineered, or distributed in any manner without the express written permission of Motorola. Furthermore, the purchase of Motorola products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Motorola, except for the normal non-exclusive license to use that arises by operation of law in the sale of a product.

Document Copyrights

No duplication or distribution of this document or any portion thereof shall take place without the express written permission of Motorola. No part of this manual may be reproduced, distributed, or transmitted in any form or by any means, electronic or mechanical, for any purpose without the express written permission of Motorola.

Disclaimer

The information in this document is carefully examined, and is believed to be entirely reliable. However, no responsibility is assumed for inaccuracies. Furthermore, Motorola reserves the right to make changes to any products herein to improve readability, function, or design. Motorola does not assume any liability arising out of the applications or use of any product or circuit described herein; nor does it cover any license under its patent rights nor the rights of others.

Trademarks

MOTOROLA, the Stylized M logo, FLASHport, and ASTRO are registered in the US Patent & Trademark Office. All other product or service names are the property of their respective owners.

Table of Contents

Foreword ii

- Product Safety and RF Exposure Compliance ii
- Manual Revisions ii
- Computer Software Copyrights ii
- Document Copyrights ii
- Disclaimer ii
- Trademarks ii

Commercial Warranty xii

- Limited Warranty xii
 - MOTOROLA COMMUNICATION PRODUCTS 1-xii
 - I. What This Warranty Covers And For How Long xii
 - II. General Provisions xii
 - III. State Law Rights xiii
 - IV. How To Get Warranty Service xiii
 - V. What This Warranty Does Not Cover xiii
 - VI. Patent And Software Provisions xiv
 - VII. Governing Law xiv

Model Numbering, Charts, and Specifications xv

- Mobile Radio Model Numbering Scheme xv
- ASTRO Digital Spectra Motorcycle 15 Watt (Ranges 1 and 2) Model Chart xvi
- ASTRO Digital Spectra Motorcycle 15 Watt (Ranges 3 and 3.5) Model Chart xvii
- ASTRO Digital Spectra VHF 10–25 Watt Model Chart xviii
- ASTRO Digital Spectra VHF 25–50 and 50–110 Watt Model Chart xix
- ASTRO Digital Spectra VHF 10–25 and 50–110 Watt Model Chart (cont.) xx
- ASTRO Digital Spectra UHF 10–25 Watt Model Chart xxii
- ASTRO Digital Spectra UHF 20–40 Watt Model Chart xxiii
- ASTRO Digital Spectra UHF 20–40 Watt Model Chart (cont.) xxiii
- ASTRO Digital Spectra UHF 50–110 Watt Model Chart xxiv
- ASTRO Digital Spectra UHF 50–110 Watt Model Chart (cont.) xxv
- ASTRO Digital Spectra 800 MHz Model Chart xxvi
- ASTRO Digital Spectra Plus VHF 25–50 and 50–110 Watt Model Chart xxvii
- ASTRO Digital Spectra Plus VHF 25–50 and 50–110 Watt Model Chart (cont.) xxviii
- ASTRO Digital Spectra Plus UHF 20–40 Watt Model Chart xxix
- ASTRO Digital Spectra Plus UHF 20–40 Watt Model Chart (cont.) xxx
- ASTRO Digital Spectra Plus UHF 50–110 Watt Model Chart xxxi
- ASTRO Digital Spectra Plus UHF 50–110 Watt Model Chart (cont.) xxxii
- ASTRO Digital Spectra Plus 800 MHz Model Chart xxxiii
- ASTRO Digital Spectra Plus 800 MHz Model Chart (cont.) xxxiv
- VHF Radio Specifications xxxv
- UHF Radio Specifications xxxvi
- 800 MHz Radio Specifications xxxvii

Chapter 1	Introduction	1-1
1.1	Notations Used in This Manual	1-1
1.2	Radio Descriptions.....	1-1
1.2.1	FLASHport®.....	1-2
1.3	Control Head Descriptions.....	1-2
1.3.1	General	1-2
1.3.1.1	Model W3 Control Head.....	1-3
1.3.1.2	Model W3 Controls	1-3
1.3.1.3	Models W4, W5, W7, and W9 Controls Head.....	1-4
1.3.1.4	Models W4, W5, W7, and W9 Controls	1-5
Chapter 2	Basic Maintenance.....	2-1
2.1	Introduction	2-1
2.2	Preventive Maintenance	2-1
2.2.1	Reference Oscillator	2-1
2.2.2	Inspection.....	2-1
2.2.3	Cleaning.....	2-1
2.2.4	Cleaning External Plastic Surfaces.....	2-2
2.2.5	Cleaning Internal Circuit Boards and Components.....	2-2
2.3	Handling Precautions.....	2-2
Chapter 3	Basic Theory of Operation	3-1
3.1	Introduction	3-1
3.2	General Overview	3-1
3.3	Analog Mode of Operation.....	3-2
3.3.1	Receive Operation	3-2
3.3.2	Transmit Operation	3-2
3.4	ASTRO Mode of Operation.....	3-2
3.5	Control Head Assembly	3-2
3.5.1	Display (W4, W5, and W7 Models).....	3-2
3.5.2	Display (W9 Model).....	3-3
3.5.3	Vacuum Fluorescent (VF) Display Driver.....	3-3
3.5.4	Vacuum Fluorescent (VF) Voltage Source (W9 Model).....	3-3
3.5.5	Controls and Indicators	3-3
3.5.6	Status LEDs	3-3
3.5.7	Backlight LEDs.....	3-3
3.5.8	Vehicle Interface Port (VIP)	3-4
3.5.8.1	Remote-Mount	3-4
3.5.8.2	Dash-Mount	3-4
3.5.9	Power Supplies	3-4
3.5.10	Ignition Sense Circuits	3-4
3.6	Power Amplifier.....	3-4
3.6.1	Gain Stages	3-4
3.6.2	Power Control	3-5
3.6.3	Circuit Protection.....	3-5
3.6.4	DC Interconnect.....	3-5
3.7	Front-End Receiver Assembly	3-5
3.8	Radio Frequency (RF) Board.....	3-5
3.9	Voltage-Controlled Oscillator (VCO).....	3-6

3.9.1	VHF Radios	3-6
3.9.2	UHF and 800 MHz Radios	3-6
3.10	Command Board.....	3-6
3.11	VOCON (Vocoder/Controller) Board.....	3-7
3.11.1	ASTRO Digital Spectra	3-7
3.11.2	ASTRO Digital Spectra Plus	3-7

Chapter 4 Test Equipment, Service Aids, and Tools..... 4-1

4.1	Recommended Test Equipment	4-1
4.2	Service Aids and Recommended Tools.....	4-2
4.3	Field Programming Equipment	4-5
4.3.1	ASTRO Digital Spectra	4-5
4.3.1.1	ASTRO Digital Spectra W3 Smart RIB Issue	4-6
4.3.1.2	ASTRO Digital Spectra Remote W3 Y Cable	4-6
4.3.2	ASTRO Digital Spectra Plus	4-7
4.3.2.1	ASTRO Digital Spectra Plus Model W3.....	4-7

Chapter 5 Performance Checks 5-1

5.1	Introduction	5-1
5.2	Test Setup	5-1
5.2.1	ASTRO Digital Spectra	5-1
5.2.2	ASTRO Digital Spectra Plus	5-2
5.3	Test Mode.....	5-2
5.3.1	Entering Test Mode	5-2
5.3.2	RF Test Mode	5-3
5.3.3	Control Head Test Mode.....	5-5
5.4	Receiver Performance Checks	5-6
5.5	Transmitter Performance Checks	5-7

Chapter 6 Radio Alignment Procedure..... 6-1

6.1	Introduction	6-1
6.2	RSS	6-1
6.2.1	ASTRO Digital Spectra	6-1
6.2.2	Softpot	6-2
6.2.3	Reference Oscillator Alignment	6-3
6.2.4	Transmit Power Alignment.....	6-4
6.2.5	Transmit Current Limit Alignment	6-6
6.2.6	Transmit Deviation Balance (Compensation) Alignment	6-7
6.2.7	Transmit Deviation Limit Alignment	6-8
6.2.8	Bit Error Rate (BER) Performance Check	6-10
6.3	ASTRO Digital Spectra and Digital Spectra Plus Tuner Software	6-10
6.3.1	Radio Information	6-14
6.3.2	Reference Oscillator Alignment	6-14
6.3.3	Transmit Power Alignment.....	6-16
6.3.4	Transmit Current Limit Alignment	6-18
6.3.5	Transmit Deviation Balance (Compensation) Alignment	6-18
6.3.6	Transmit Deviation Limit Alignment	6-20
6.3.7	Bit Error Rate (BER) Test	6-22

6.3.8	Transmitter Test Pattern	6-23
-------	--------------------------------	------

Chapter 7 Encryption 7-1

7.1	Universal Crypto Module Kits.....	7-1
7.1.1	ASTRO Digital Spectra	7-1
7.1.2	ASTRO Digital Spectra Plus	7-1
7.1.3	Secure Dispatch Operation.....	7-1
7.1.4	Secure Emergency Operation.....	7-2
7.2	Load an Encryption Key.....	7-2
7.2.1	Model W3.....	7-2
7.2.2	Models W4, W5, W7, and W9.....	7-3
7.3	Erase a Key	7-3
7.3.1	Model W3.....	7-3
7.3.2	Models W4, W5, W7, and W9.....	7-4
7.4	Erase a Single Key (Model W3).....	7-5
7.5	Erase All Keys.....	7-5
7.5.1	Model W3.....	7-5
7.5.2	Models W4, W5, W7, and W9.....	7-6
7.6	Over-the-Air Rekeying	7-6
7.6.1	ASTRO Digital Spectra Model W3.....	7-7
7.6.2	ASTRO Digital Spectra Models W4, W5, W7, and W9	7-9
7.7	Advanced Secure Operation.....	7-10
7.7.1	Multikey Operation	7-10

Chapter 8 Disassembly/Reassembly Procedures 8-1

8.1	Introduction	8-1
8.2	Replacement Procedures	8-1
8.2.1	Required Tools and Supplies.....	8-2
8.2.2	Control Head Boards	8-2
8.2.2.1	Model W3.....	8-2
8.2.2.2	Models W4, W5, and W7	8-3
8.2.2.3	Model W9.....	8-4
8.2.3	Remote Back Housing Interface Board.....	8-5
8.2.3.1	Models W4, W5, and W7	8-5
8.2.4	Remote Interconnect Board.....	8-6
8.2.4.1	Low-/Mid-Power Radios.....	8-6
8.2.4.2	High-Power Radios	8-6
8.2.5	Power Amplifier Board	8-7
8.2.5.1	Low-/Mid-Power Radios.....	8-7
8.2.5.2	High-Power Radios	8-7
8.2.5.3	800 MHz Radios	8-8
8.2.5.3.1	Back-End Removal	8-8
8.2.5.3.2	PC Board Removal	8-8
8.2.5.3.3	PC Board Installation	8-9
8.2.5.3.4	Back-End Installation	8-10
8.2.6	VOCON (Vocoder/Controller) Board.....	8-11
8.2.7	Command Board.....	8-11
8.2.7.1	Low-/Mid-Power Radios.....	8-11
8.2.7.2	High-Power Radios	8-12
8.2.8	Receiver Front-End Board	8-13

8.2.8.1	Low-/Mid-Power Radio	8-13
8.2.8.2	High-Power Radio.....	8-13
8.2.9	VCO Board	8-14
8.2.9.1	Low-/Mid-Power Radio	8-14
8.2.9.2	High-Power Radio.....	8-15
8.2.10	RF Board	8-15
8.2.10.1	Low-/Mid-Power Radio	8-15
8.2.10.2	High-Power Radio.....	8-16
8.3	Final Reassembly	8-16
8.3.1	Power Amplifiers.....	8-16
8.3.2	Command Board.....	8-17
8.3.3	Dash Control Head Board.....	8-17
8.3.4	Model W3 Hand-Held Control Head	8-17
8.4	Fastener Torque Chart	8-18

Chapter 9 Basic Troubleshooting 9-1

9.1	Introduction	9-1
9.2	Replacement Board Procedures.....	9-1
9.3	Power-Up Error Codes	9-1
9.3.1	ASTRO Digital Spectra	9-2
9.3.2	ASTRO Digital Spectra Plus	9-3
9.4	Operational Error Codes.....	9-4
9.4.1	ASTRO Digital Spectra	9-4
9.4.2	ASTRO Digital Spectra Plus	9-5
9.5	Transmitter Troubleshooting.....	9-5
9.6	Receiver Troubleshooting.....	9-9
9.7	Synthesizer Troubleshooting	9-12

Chapter 10 Functional Block Diagrams and Connectors 10-1

10.1	Digital Spectra Functional Block Diagram (Models W3, W4, W5, W7, and W9)	10-2
10.2	Digital Spectra Plus Functional Block Diagram (Models W3, W4, W5, W7, and W9)	10-3
10.3	Radio Connectors	10-4
10.4	Radio Connector Locations	10-5
10.5	Radio Connector Locations (cont.)	10-5
10.6	Extender Cable (P501)	10-6
10.7	Control Head Cabling Diagram.....	10-6

Chapter 11 Exploded Views and Parts Lists 11-1

11.1	Model W3 Hand-Held Control Head Exploded View	11-2
11.2	Model W4 Rotary Control Head Exploded View	11-3
11.3	Models W5 and W7 Pushbutton Control Head Exploded View	11-4
11.4	Model W9 Pushbutton Control Head Exploded View	11-5
11.5	Low-Power (15W) Radio Exploded View	11-6
11.6	Mid-Power (20-40/25-50/35W) Radio Exploded View	11-7
11.7	High-Power (50-110W) Radio Exploded View	11-8
11.8	Motorcycle Interconnect Board and Assembly	11-9
11.9	Low- and Mid-Power Interconnect Board and Assembly.....	11-9
11.10	Small Pushbutton Parts	11-10

11.11 Large Pushbutton Parts 11-10

Appendix A Replacement Parts Ordering.....A-1

A.1 Basic Ordering InformationA-1
A.2 Transceiver Board and VOCON Board Ordering Information.....A-1
A.3 Motorola Online.....A-1
A.4 Mail OrdersA-1
A.5 Telephone OrdersA-2
A.6 Fax OrdersA-2
A.7 Parts IdentificationA-2
A.8 Product Customer Service.....A-2

Glossary..... Glossary-1

Index..... Index-i

List of Figures

Figure 1-1. Typical W3 Hand-Held Control Head	1-3
Figure 1-2. Typical W4 Rotary Control Head.....	1-4
Figure 1-3. Typical W5 Pushbutton Control Head	1-4
Figure 1-4. Typical W7 Pushbutton Control Head	1-4
Figure 1-5. Typical W9 Pushbutton Control Head	1-5
Figure 5-1. ASTRO Digital Spectra Performance Checks Test Setup.....	5-1
Figure 5-2. ASTRO Digital Spectra Plus Performance Checks Test Setup.....	5-2
Figure 5-3. Rotary Control Head Key-Closure Displays (W4)	5-5
Figure 5-4. Pushbutton Control Head Key-Closure Displays (W5 and W7)	5-6
Figure 5-5. Pushbutton Control Head Key-Closure Displays (W9)	5-6
Figure 6-1. ASTRO Digital Spectra Radio Alignment Test Setup	6-1
Figure 6-2. RSS Service Menu Layout.....	6-2
Figure 6-3. Softpot Concept	6-2
Figure 6-4. Reference Oscillator Alignment Screen	6-4
Figure 6-5. Transmit Power Alignment Screen	6-5
Figure 6-6. Transmit Current Limit Alignment Screen	6-6
Figure 6-7. Transmit Deviation Balance (Compensation) Alignment Screen	6-8
Figure 6-8. Transmit Deviation Limit Alignment Screen	6-9
Figure 6-9. ASTRO Digital Spectra Plus Radio Alignment Test Setup	6-11
Figure 6-10. Tuner Menu Layout.....	6-12
Figure 6-11. Typical Softpot Adjustment Screen	6-13
Figure 6-12. Radio Information Screen	6-14
Figure 6-13. Reference Oscillator Alignment Screen	6-15
Figure 6-14. Typical Transmit Power Alignment Screen	6-16
Figure 6-15. Transmit Current Limit Alignment Screen	6-18
Figure 6-16. Transmit Deviation Balance (Compensation) Alignment Screen	6-20
Figure 6-17. Transmit Deviation Limit Alignment Screen	6-21
Figure 6-18. Bit Error Rate Test Screen	6-23
Figure 6-19. Transmitter Test Pattern Screen	6-23
Figure 8-1. Model W4 Rotary Control Head Assembly Screw and Snap Sequence.....	8-3
Figure 8-2. Models W5 and W7 Pushbutton Control Head Assembly Screw Sequence	8-3
Figure 8-3. PA Board Screw Fastening Sequence (800 MHz 15-Watt PA)	8-9
Figure 8-4. PA Board Screw Fastening Sequence (800 MHz 20- and 35-Watt PA).....	8-10
Figure 8-5. Installing the Final Device.....	8-10
Figure 10-1. Digital Spectra Models W3, W4, W5, W7, and W9 Functional Block Diagram	10-2
Figure 10-2. Digital Spectra Plus Models W3, W4, W5, W7, and W9 Functional Block Diagram	10-3
Figure 10-3. J0103 Remote-Mount Control Head Connector.....	10-4
Figure 10-4. J5 Control Cable for Remote-Mount Control Head.....	10-4
Figure 10-5. J6 Radio Operations Connector.....	10-4
Figure 10-6. J2 Rear Accessory Connector	10-4
Figure 10-7. P104 Microphone Jack	10-4
Figure 10-8. Dash-Mount Radio Connector Locations	10-5
Figure 10-9. Remote-Mount Radio Connector Locations.....	10-5
Figure 10-10. Command Board Connector Locations.....	10-5
Figure 10-11. VOCON Board Connector Locations	10-5
Figure 10-12. P501 Extender Cable.....	10-6
Figure 10-13. Control Head Cabling Diagram	10-6
Figure 11-1. Model W3 Hand-Held Control Head Exploded View.....	11-2
Figure 11-2. Model W4 Rotary Control Head Exploded View	11-3
Figure 11-3. Models W5 and W7 Pushbutton Control Head Exploded View	11-4

Figure 11-4. Model W9 Pushbutton Control Head Exploded View	11-5
Figure 11-5. Low-Power (15W) Radio Exploded View	11-6
Figure 11-6. Mid-Power (20-40/25-50/35W) Radio Exploded View.....	11-7
Figure 11-7. High-Power (50-110W) Radio Exploded View	11-8
Figure 11-8. Motorcycle Interconnect Board and Assembly (HLN6365) Exploded View	11-9
Figure 11-9. Low- and Mid-Power Interconnect Board and Assembly (HLN6344) Exploded View.....	11-9

List of Tables

Table 1-1.	ASTRO Digital Spectra/Spectra Plus Basic Features	1-2
Table 4-1.	Recommended Motorola Test Equipment.....	4-1
Table 4-2.	Wattmeter Plug-In Elements	4-2
Table 4-3.	Recommended Non-Motorola Test Equipment.....	4-2
Table 4-4.	Common Service Aids for Board-Level Troubleshooting	4-3
Table 4-5.	Service Aids for ASTRO Digital Spectra Board-Level Troubleshooting	4-4
Table 4-6.	Service Aids for ASTRO Digital Spectra Plus Board-Level Troubleshooting	4-5
Table 4-7.	Recommended Tools for Board-Level Troubleshooting.....	4-5
Table 4-8.	ASTRO Digital Spectra Field Programming Items	4-6
Table 4-9.	ASTRO Digital Spectra Plus Field Programming Items	4-7
Table 5-1.	Test-Mode Displays	5-2
Table 5-2.	Test Frequencies	5-4
Table 5-3.	Signaling Types	5-5
Table 5-4.	Receiver Performance Checks	5-6
Table 5-5.	Transmitter Performance Checks	5-7
Table 6-1.	Reference Oscillator Alignment	6-4
Table 6-2.	Transmit Power Settings.....	6-5
Table 6-3.	Reference Oscillator Alignment	6-16
Table 6-4.	Transmit Power Settings.....	6-17
Table 7-1.	ASTRO Digital Spectra UCM Listing.....	7-1
Table 7-2.	ASTRO Digital Spectra Plus UCM Listing.....	7-1
Table 8-1.	Required Alignments After Board Replacement	8-1
Table 8-2.	Required Tools and Supplies	8-2
Table 8-3.	Fastener Torque Chart.....	8-18
Table 9-1.	ASTRO Digital Spectra Power-Up Error Codes	9-2
Table 9-2.	ASTRO Digital Spectra Plus Power-Up Error Codes	9-3
Table 9-3.	ASTRO Digital Spectra Operational Error Codes	9-4
Table 9-4.	ASTRO Digital Spectra Plus Operational Error Codes	9-5
Table 9-5.	Transmitter Troubleshooting Chart	9-5
Table 9-6.	Receiver Troubleshooting Chart	9-9
Table 9-7.	Synthesizer Troubleshooting Chart.....	9-12
Table 11-1.	Model W3 Hand-Held Control Head Exploded View Parts List.....	11-2
Table 11-2.	Model W4 Rotary Control Head Parts List.....	11-3
Table 11-3.	Models W5 and W7 Pushbutton Control Head Parts List	11-4
Table 11-4.	Model W9 Pushbutton Control Head Parts List	11-5
Table 11-5.	Low-Power (15W) Radio Parts List.....	11-6
Table 11-6.	Mid-Power (20-40/25-50/35W) Radio Parts List	11-7
Table 11-7.	High-Power (50-110W) Radio Parts List	11-8
Table 11-8.	Motorcycle Interconnect Board and Assembly (HLN6365) Parts List.....	11-9
Table 11-9.	Low- and Mid-Power Interconnect Board and Assembly (HLN6344) Parts List	11-9
Table 11-10.	Small Pushbutton Parts List.....	11-10
Table 11-11.	Large Pushbutton Parts List.....	11-10

Related Publications

ASTRO Digital Spectra and Digital Spectra Plus Model W3 User's Guide	6881090C61
ASTRO Digital Spectra and Digital Spectra Plus Models W4, W5, W7, and W9 User's Guide ..	6881090C62
ASTRO Digital Spectra Hand-Held Control Head User's Guide (Model W3).....	6881073C25
ASTRO Digital Spectra (Model W4, W5, W7, and W9) User's Guide.....	6881074C80
ASTRO Digital Spectra and Digital Spectra Plus Mobile Radios Detailed Service Manual	6881076C25
ASTRO Digital Spectra Mobile Radios Dual Control Head Radio System Service Manual.....	6881091C78
ASTRO Spectra and Digital Spectra FM Two-Way Mobile Radios Installation Manual	6881070C85
ASTRO Spectra Motorcycle Radios Supplemental Installation Manual.....	6880103W01
CPS Programming Installation Guide	6881095C44
KVL 3000 User's Manual	6881131E16
Spectra VHF VCO Section Detailed Service Manual Supplement.....	6881074C48
Spectra High-Power Power Amplifier Detailed Service Manual Supplement.....	6881077C25
Spectra Systems 9000 Control Unit Detailed Service Manual Supplement.....	6881077C30
Spectra A5 and A7 Control Head Instruction Manual	6881109C33
Spectra A4 Control Head Instruction Manual	6881109C34

Commercial Warranty

Limited Warranty

MOTOROLA COMMUNICATION PRODUCTS

I. What This Warranty Covers And For How Long

MOTOROLA 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 Digital Spectra and Digital Spectra Plus 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.

III. State Law Rights

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:
 - any of the seals on the battery enclosure or cells are broken or show evidence of tampering.
 - 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.
- H. Freight costs to the repair depot.
- I. A Product which, due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA's published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.
- J. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.
- K. Normal and customary wear and tear.

VI. Patent And Software Provisions

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
- C. should the Product or parts become, or in MOTOROLA's opinion be likely to become, the subject of a claim of infringement of a United States patent, that such purchaser will permit MOTOROLA, at its option and expense, either to procure for such purchaser the right to continue using the Product or parts or to replace or modify the same so that it becomes non-infringing or to grant such purchaser a credit for the Product or parts as depreciated and accept its return. The depreciation will be an equal amount per year over the lifetime of the Product or parts as established by MOTOROLA.

MOTOROLA will have no liability with respect to any claim of patent infringement which is based upon the combination of the Product or parts furnished hereunder with software, apparatus or devices not furnished by MOTOROLA, nor will MOTOROLA have any liability for the use of ancillary equipment or software not furnished by MOTOROLA which is attached to or used in connection with the Product. The foregoing states the entire liability of MOTOROLA with respect to infringement of patents by the Product or any parts thereof.

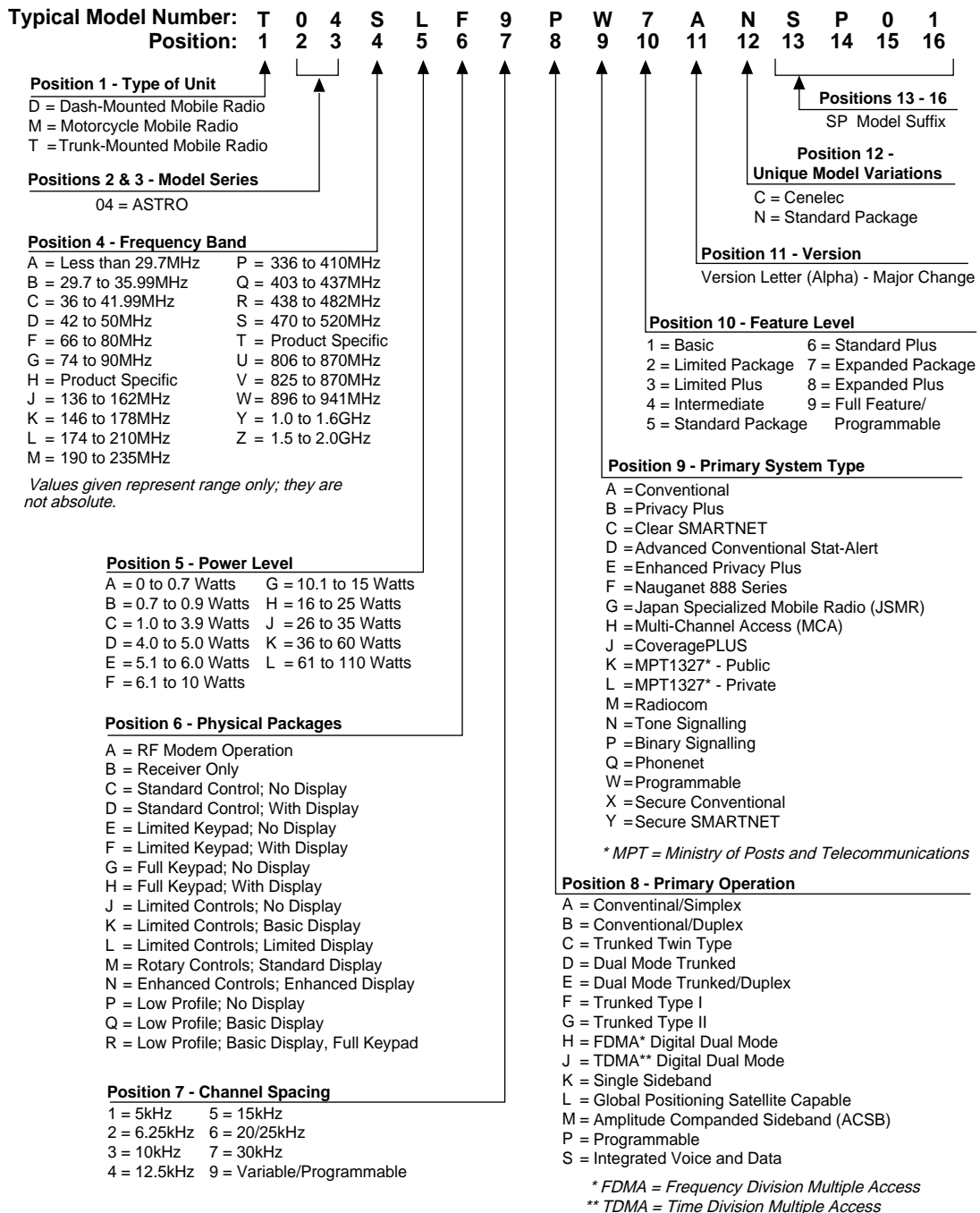
Laws in the United States and other countries preserve for MOTOROLA certain exclusive rights for copyrighted MOTOROLA software such as the exclusive rights to reproduce in copies and distribute copies of such Motorola software. MOTOROLA software may be used in only the Product in which the software was originally embodied and such software in such Product may not be replaced, copied, distributed, modified in any way, or used to produce any derivative thereof. No other use including, without limitation, alteration, modification, reproduction, distribution, or reverse engineering of such MOTOROLA software or exercise of rights in such MOTOROLA software is permitted. No license is granted by implication, estoppel or otherwise under MOTOROLA patent rights or copyrights.

VII. Governing Law

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

Model Numbering, Charts, and Specifications

Mobile Radio Model Numbering Scheme



MAEPF-27247-0

ASTRO Digital Spectra Motorcycle 15 Watt (Ranges 1 and 2) Model Chart

Model Number										Description		
M04JGF9PW4AN											Model W4 (136-162 MHz), Range 1, 15 Watt, 128 Channels	
M04JGF9PW5AN											Model W5 (136-162 MHz), Range 1, 15 Watt, 128 Channels	
M04JGH9PW7AN											Model W7 (136-162 MHz), Range 1, 15 Watt, 128 Channels	
M04KGF9PW4AN											Model W4 (146-174 MHz), Range 2, 15 Watt, 128 Channels	
M04KGF9PW5AN											Model W5 (146-174 MHz), Range 2, 15 Watt, 128 Channels	
M04KGF9PW7AN											Model W7 (146-174 MHz), Range 2, 15 Watt, 128 Channels	
M04RGF9PW4AN											Model W4 (438-470 MHz), Range 2, 15 Watt, 128 Channels	
M04RGF9PW5AN											Model W5 (438-470 MHz), Range 2, 15 Watt, 128 Channels	
M04RGF9PW7AN											Model W7 (438-470 MHz), Range 2, 15 Watt, 128 Channels	
M04UGF9PW4AN											Model W4 (800 MHz), 15 Watt, 128 Channels	
M04UGF9PW5AN											Model W5 (800 MHz), 15 Watt, 128 Channels	
M04UGF9PW7AN											Model W7 (800 MHz), 15 Watt, 128 Channels	
										Item No.	Description	
X	X	X									HLD6066_	VHF Power Amplifier Board, 25-Watt
X	X	X	X	X	X	X	X	X	X	X	HKN6062_	Cable, Control Head to Radio
X	X	X									HLD4342_	VHF VCO Carrier
			X	X	X						HLD4343_	VHF VCO Carrier, CEPT
			X	X	X						HLD6032_	VHF Power Amplifier Board, Range 2, 25-Watt
X	X	X									HLD6061_	VHF VCO, Range 1, 136-162 MHz
			X	X	X						HLD6062_	VHF VCO Board, Range 2, 146-174 MHz
						X	X	X			HLE6046_	UHF VCO Carrier, Range 2
						X	X	X			HLE6062_	UHF RF Power Amplifier Board, Range 2, 25-Watt
						X	X	X			HLE6102_	UHF VCO Board, Range 2
								X	X	X	HLF6078_	800 MHz RF Power Amplifier Board, 15-Watt
								X	X	X	HLF6079_	800 MHz VCO Board
								X	X	X	HLF6080_	800 MHz VCO Carrier Board
X	X	X	X	X	X	X	X	X	X	X	HLN1368_	White Motorcycle Enclosure and Hardware
X	X	X	X	X	X	X	X	X	X	X	HLN6127_*	Low-Power Dash Hardware
X	X	X	X	X	X		X	X		X	HLN6193_	MPL Button Kit
X	X	X	X	X	X	X	X	X	X	X	HLN6342_*	Motorcycle Hardware
X	X	X	X	X	X	X	X	X	X	X	HLN6365_	Interface Board Kit
X	X	X	X	X	X	X	X	X	X	X	HLN6418_*	Transceiver Hardware
	X	X		X			X			X	HLN6444_*	W5 Motorcycle Control Head Hardware
				X			X			X	HLN6445_*	W7 Motorcycle Control Head Hardware
		X								X	HLN6454_	Motorcycle Control Head Board Kit
X	X	X	X	X	X	X	X	X	X	X	HLN6458_	Vocoder Controller
X			X								HLN6459_	Interface Board
		X				X				X	HLN6523_*	W7 Button Kit
	X			X						X	HLN6548_*	W5 Button Kit
					X			X			HLN6549_*	W4 Button Kit
X	X	X	X	X	X	X	X	X	X	X	HLN6562_	Motorcycle Command Board Kit
	X	X		X	X	X	X	X	X	X	HLN6563_	Motorcycle Control Head
X			X			X			X		HLN6571_	Spare Button Kit
X	X	X	X	X	X	X	X	X	X	X	HMN1079_	Weatherproof Microphone
X	X	X									HRD6001_	VHF Receiver Board, Range 1, Standard
			X	X	X						HRD6002_	VHF Receiver Board, Range 2, Standard
						X	X	X			HRE6002_	UHF Receiver Board, Range 2, Standard
								X	X	X	HRF6004_	800 MHz FX Front-End
			X	X	X						HRN4009_	VHF RF Board
						X	X	X			HRN4010_	UHF RF Board
X	X	X									HRN6014_	VHF RF Board, ASTRO
								X	X	X	HRN6019_	800 MHz RF Board, ASTRO
X	X	X	X	X	X	X	X	X	X	X	HSN6003_	Weatherproof Speaker
X			X			X		X			PMLN4019_	W4 Motorcycle Control Head
							X				RAE4024_	UHF Antenna, Quarterwave
							X	X	X		RAF4011_	800 MHz Antenna, 3 dB Gain

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Motorcycle 15 Watt (Ranges 3 and 3.5) Model Chart

Model Number					Description
M04RGF9PW4ANSP02					Model W4 (450-482 MHz), Range 3, 15 Watt, 128 Channels
M04RGF9PW5ANSP02					Model W5 (450-482 MHz), Range 3, 15 Watt, 128 Channels
M04RGF9PW4ANSP01					Model W4 (453-488 MHz), Range 3.5, 15 Watt, 128 Channels
M04RGF9PW5ANSP01					Model W5 (453-488 MHz), Range 3.5, 15 Watt, 128 Channels
M04RGH9PW7ANSP01					Model W7 (453-488 MHz), Range 3.5, 15 Watt, 128 Channels
Item No.					Description
X	X	X	X	X	HKN6062_ Cable, Control Head to Radio
X	X				HLE6000_ UHF VCO Carrier, Range 3
		X	X	X	HLE6000_SP01 UHF VCO Carrier, Range 3.5
X	X				HLE6043_ UHF RF Power Amplifier Board, Range 3, 40-Watt
		X	X	X	HLE6043_SP01 UHF RF Power Amplifier Board, Range 3.5, 40-Watt
X	X				HLE6103_ UHF VCO Hybrid, Range 3
		X	X	X	HLE6103_SP01 UHF VCO Hybrid, Range 3.5
X	X	X	X	X	HLN1368_ White Motorcycle Enclosure and Hardware
X	X	X	X	X	HLN6127_* Low-Power Dash Hardware
	X		X	X	HLN6193_ MPL Button Kit
X	X	X	X	X	HLN6342_* Motorcycle Hardware
X	X	X	X	X	HLN6365_ Interface Board Kit
X	X	X	X	X	HLN6418_* Transceiver Hardware
	X		X		HLN6444_* W5 Motorcycle Control Head Hardware
				X	HLN6445_* W7 Motorcycle Control Head Hardware
X	X	X	X	X	HLN6458_ Vocoder Controller
				X	HLN6523_* W7 Button Kit
	X		X		HLN6548_* W5 Button Kit
X		X			HLN6549_* W4 Button Kit
X	X	X	X	X	HLN6562_ Motorcycle Command Board Kit
	X		X	X	HLN6563_ Motorcycle Control Head
X	X	X	X	X	HLN6571_ Spare Button Kit
X	X	X	X	X	HMN1079_ Weatherproof Microphone
X	X				HRE6003_ UHF Receiver Board, Range 3, Standard
		X	X	X	HRE6003_SP01 UHF Receiver Board, Range 3.5, Standard
X	X	X	X	X	HRN6020_ UHF RF Board, ASTRO
X	X	X	X	X	HSN6003_ Weatherproof Speaker
X		X			PMLN4019_ W4 Motorcycle Control Head
X	X	X	X	X	RAE4024_ UHF Antenna, Quarterwave

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra VHF 10–25 Watt Model Chart

Model Number										Description			
D04JHH9PW3AN										Model W3 (136-145.9 MHz), 10-25 Watt, 255 Channels			
D04JHF9PW4AN										Model W4 (136-162 MHz), 10-25 Watt, 128 Channels			
D04JHF9PW5AN										Model W5 (136-162 MHz); 10-25 Watt, 128 Channels			
D04JHH9PW7AN										Model W7 (136-162 MHz), 10-25 Watt, 255 Channels			
T04JHH9PW9AN										Model W9 (136-162 MHz), 10-25 Watt, 255 Channels			
D04KHH9PW3AN										Model W3 (146-145.9 MHz), 10-25 Watt, 255 Channels			
D04KHF9PW4AN										Model W4 (146-174 MHz), 10-25 Watt, 128 Channels			
D04KHF9PW5AN										Model W5 (146-174 MHz), 10-25 Watt, 128 Channels			
D04KHH9PW7AN										Model W7 (146-174 MHz), 10-25 Watt, 255 Channels			
T04KHH9PW9AN										Model W9 (146-174 MHz), 10-25 Watt, 255 Channels			
										Item No.		Description	
X	X	X	X	X						HRD6001_	Front-End Receiver Board Kit (Range 1, 136-162 MHz)		
					X	X	X	X		HRD6002_	Front-End Receiver Board Kit (Range 2, 146-174 MHz)		
X	X	X	X	X		X	X	X		HRN6014_	RF Board Kit		
X	X	X	X	X		X	X	X	X	HLD4342_	VCO Board Kit		
X	X	X	X	X						HLD6061_	VCO Hybrid Kit (Range 1, 136-162 MHz)		
					X	X	X	X	X	HLD6062_	VCO Hybrid Kit (Range 2, 146-174 MHz)		
X	X	X	X	X	X	X	X	X	X	HLN5558_	Command Board Kit		
X	X	X	X	X	X	X	X	X	X	HLN6458_	VOCON Board Kit		
X	X	X	X	X		X	X	X	X	HLD6066_	Power Amplifier Board		
				X					X	HLN6344_	Interface Board		
	X	X	X			X	X	X		HLN6401_	Control Head Interconnect Board		
	X					X				AAHN4045_	W4 Control Head		
		X	X				X	X		HLN6396_	W5,W7 Control Head Board		
			X						X	HCN1078_	W9 Control Head		
	X	X	X			X	X	X		HMN1080_	Microphone		
			X						X	HMN1061_	Microphone		
X	X	X	X	X	X	X	X	X	X	HSN4018_	Speaker		
			X						X	HLN4921_	Control Head (W9) Trunnion		
			X						X	HLN5488_	Radio Microphone Installation Hardware (W9 Trunnion)		
X	X	X	X		X	X	X	X		HLN6015_	Trunnion/Hardware (Dash Mount)		
	X	X	X			X	X	X		HLN6060_	Dash-Mount Hardware		
X				X	X				X	HLN6185_*	Remote-Mount, SECURENET Control-Head Hardware		
X	X	X	X	X	X	X	X	X	X	HLN6418_*	Transceiver Hardware		
		X					X			HLN6440_*	Control Head without Keypad Hardware		
			X					X		HLN6441_*	Control Head with Keypad Hardware		
						X				HLN6493_*	Plug Kit		
			X						X	HLN4952_	Fuse Kit		
			X						X	HKN4356_	Radio Cable (Length -17 Feet)		
X	X	X	X		X	X	X	X		HKN4191_	Power Cable (Length - 20 Feet)		
			X						X	HKN4192_	Power Cable (Length - 20 Feet)		
			X						X	HLN6481_*	Systems 9000 E9 Clear Button Kit		
	X					X				HLN6549_*	C4 Button Kit		
	X					X				HLN6105_	Emergency/Secure/MPL Button Kit		
		X	X				X	X		HLN6193_	Emergency/MPL Field Option Button Kit		
		X					X			HLN6548_*	SMARTNET Button Kit		
			X					X		HLN6523_*	SMARTNET Button Kit		
				X					X	HLN6167_	Option Button Kit		
				X						HLD4343_	VCO Board Kit; VHF CEPT		
				X						HLD6032_	Power Amplifier Board Kit		
X				X						HLN6127_	Hardware, Radio Dash Low-Power		
X				X						HLN6459_	W3 Interface Board		
X				X						HMN4044_	ASTRO Handheld Control Head (W3)		
				X						HRN4009_	RF Board Kit		

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = Kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra VHF 25–50 and 50–110 Watt Model Chart

Model Number													Description	
D04JKH9PW3AN													Model W3 (136-145.9 MHz), 25-50 Watt, 128 Channels	
D04JKF9PW4AN													Model W4 (136-162 MHz), 25-50 Watt, 128 Channels	
D04JKF9PW5AN													Model W5 (136-162 MHz); 25-50 Watt, 128 Channels	
D04JKH9PW7AN													Model W7 (136-162 MHz), 25-50 Watt, 255 Channels	
T04JKH9PW9AN													Model W9 (136-162 MHz), 25-50 Watt, 255 Channels	
D04KKF9PW3AN													Model W3 (146-174 MHz), 25-50 Watt, 128 Channels	
D04KKF9PW4AN													Model W4 (146-174 MHz), 25-50 Watt, 128 Channels	
D04KKF9PW5AN													Model W5 (146-174 MHz), 25-50 Watt, 128 Channels	
D04KKH9PW7AN													Model W7 (146-174 MHz), 25-50 Watt, 255 Channels	
T04KKH9PW9AN													Model W9 (146-174 MHz), 25-50 Watt, 255 Channels	
T04JLH9PW3AN													Model W3 (136-145.9 MHz), 50-110 Watt, 128 Channels	
T04JLF9PW4AN													Model W4 (136-162 MHz), 50-110 Watt, 128 Channels	
T04JLF9PW5AN													Model W5 (136-162 MHz), 50-110 Watt, 128 Channels	
T04JLH9PW7AN													Model W7 (136-162 MHz), 50-110 Watt, 255 Channels	
T04JLH9PW9AN													Model W9 (136-162 MHz), 50-110 Watt, 255 Channels	
T04KLH9PW3AN													Model W3 (146-174 MHz), 50-110 Watt, 255 Channels	
T04KLF9PW4AN													Model W4 (146-174 MHz), 50-110 Watt, 128 Channels	
T04KLF9PW5AN													Model W5 (146-174 MHz), 50-110 Watt, 128 Channels	
T04KLH9PW7AN													Model W7 (146-174 MHz), 50-110 Watt, 255 Channels	
T04KLH9PW9AN													Model W9 (146-174 MHz), 50-110 Watt, 255 Channels	
Item No.													Description	
X	X	X	X	X					X	X	X	X	HRD6001_	Front-End Rcvr Board Kit (Range 1, 136-162 MHz)
				X	X	X	X	X	X	X	X	X	HRD6002_	Front-End Rcvr Board Kit (Range 2, 146-174 MHz)
X	X	X	X	X	X	X	X	X	X	X	X	X	HRN6014_	RF Board Kit
X	X	X	X	X					X	X	X	X	HLD4342_	VCO Board Kit
X	X	X	X	X					X	X	X	X	HLD6061_	VCO Hybrid Kit (Range 1, 136-162 MHz)
				X	X	X	X	X	X	X	X	X	HLD6062_	VCO Hybrid Kit (Range 2, 146-174 MHz)
X	X	X	X	X	X	X	X	X	X	X	X	X	HLN5558_	Command Board Kit
X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6458_	VOCON Board Kit
								X	X	X	X		HLD6064_	Power Amplifier Board (50-110W, Range 1, 136-162 MHz)
X	X	X	X	X	X	X	X	X					HLD6022_	Power Amplifier Board (25-50W, Range 1, 136-174 MHz)
									X	X	X	X	HLD6063_	Power Amplifier Board (50-110W, Range 2, 146-174 MHz)
			X										HLN6344_	Interface Board
X	X	X	X	X	X	X							HLN6401_	Control Head Interconnect Board
X			X						X				AAHN4045_	W4 Control Head
							X	X	X	X	X	X	HLN6486_	High-Power Interconnect Board
							X	X	X				HLN6432_	Control Head Back Housing
	X	X			X	X			X	X			HLN6396_	W5,W7 Control Head Board
			X						X			X	HCN1078_	W9 Control Head
X	X	X	X	X	X	X	X	X	X	X	X	X	HMN1080_	Microphone
				X					X			X	HMN1061_	Microphone
X	X	X	X	X	X	X	X	X					HSN4018_	Speaker
						X	X	X	X	X	X	X	HSN6001_	Speaker
			X						X			X	HLN4921_	Control Head (W9) Trunnion
			X										HLN5488_	Radio Microphone Installation Hardware (W9 Trunnion)
X			X	X									HLN6185_*	Remote-Mount, SECURENET Control-Head Hardware
						X	X	X	X	X	X	X	HLN6231_	Remote W4, W5, W7 Control-Head Trunnion
						X	X	X	X	X	X	X	HLN6233_*	Option Connector Hardware

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra VHF 10–25 and 50–110 Watt Model Chart (cont.)

Model Number														Description		
D04JKH9PW3AN														Model W3 (136-145.9 MHz), 25-50 Watt, 128 Channels		
D04JKF9PW4AN														Model W4 (136-162 MHz), 25-50 Watt, 128 Channels		
D04JKF9PW5AN														Model W5 (136-162 MHz); 25-50 Watt, 128 Channels		
D04JKH9PW7AN														Model W7 (136-162 MHz), 25-50 Watt, 255 Channels		
T04JKH9PW9AN														Model W9 (136-162 MHz), 25-50 Watt, 255 Channels		
D04KKF9PW3AN														Model W3 (146-174 MHz), 25-50 Watt, 128 Channels		
D04KKF9PW4AN														Model W4 (146-174 MHz), 25-50 Watt, 128 Channels		
D04KKF9PW5AN														Model W5 (146-174 MHz), 25-50 Watt, 128 Channels		
D04KKH9PW7AN														Model W7 (146-174 MHz), 25-50 Watt, 255 Channels		
T04KKH9PW9AN														Model W9 (146-174 MHz), 25-50 Watt, 255 Channels		
T04JLH9PW3AN														Model W3 (136-145.9 MHz), 50-110 Watt, 128 Channels		
T04JLF9PW4AN														Model W4 (136-162 MHz), 50-110 Watt, 128 Channels		
T04JLF9PW5AN														Model W5 (136-162 MHz), 50-110 Watt, 128 Channels		
T04JLH9PW7AN														Model W7 (136-162 MHz), 50-110 Watt, 255 Channels		
T04JLH9PW9AN														Model W9 (136-162 MHz), 50-110 Watt, 255 Channels		
T04KLH9PW3AN														Model W3 (146-174 MHz), 50-110 Watt, 255 Channels		
T04KLF9PW4AN														Model W4 (146-174 MHz), 50-110 Watt, 128 Channels		
T04KLF9PW5AN														Model W5 (146-174 MHz), 50-110 Watt, 128 Channels		
T04KLH9PW7AN														Model W7 (146-174 MHz), 50-110 Watt, 255 Channels		
T04KLH9PW9AN														Model W9 (146-174 MHz), 50-110 Watt, 255 Channels		
														Item No.	Description	
														X	HLN6132_*	High-Power Installation Hardware
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6015_	Trunion/Hardware (Dash Mount)
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6060_	Dash-Mount Hardware
														X	HLN6121_*	High-Power Radio Hardware
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6418_*	Transceiver Hardware
														X	HLN6440_*	Control Head without Keypad Hardware
														X	HLN6441_*	Control Head with Keypad Hardware
														X	HLN6525_*	High-Power Transceiver Hardware
														X	HLN6493_*	Plug Kit
														X	HLN4952_	Fuse Kit
														X	HKN4356_	Radio Cable (Length -17 Feet)
														X	HKN6039_	Cable (Length - 17 Feet)
														X	HKN4051_	Cable and Fuse
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	HKN4191_	Power Cable (Length - 20 Feet)
														X	HKN4192_	Power Cable (Length - 20 Feet)
														X	HLN6481_*	Systems 9000 E9 Clear Button Kit
														X	HLN6549_*	C4 Button Kit
														X	HLN6105_	Emergency/Secure/MPL Button Kit
														X	HLN6193_	Emergency/MPL Field Option Button Kit
														X	HLN6548_*	SMARTNET Button Kit
														X	HLN6523_*	SMARTNET Button Kit
														X	HLN6167_	Option Button Kit
X														X	HLN6459_	W3 Interface Board Kit
X														X	HMN4044_	ASTRO Handheld Control Head (W3)
X														X	TLN5277_	Filter Kit
														X	HKN6096_	Handheld Control Head "Y" Cable Kit
														X	HLN6291_	Installation Hardware Kit
														X	HLN6574_	W3 Interconnect Board Kit

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra UHF 10–25 Watt Model Chart

Model Number					Description	
D04RHH9PW3AN					Model W3 (438-470 MHz), 10-25 Watt, 255 Channels	
D04RHF9PW4AN					Model W4 (438-470 MHz), 10-25 Watt, 128 Channels	
D04RHF9PW5AN					Model W5 (438-470 MHz), 10-25 Watt, 128 Channels	
D04RHH9PW7AN					Model W7 (438-470 MHz), 10-25 Watt, 255 Channels	
T04RHH9PW9AN					Model W9 (438-470 MHz), 10-25 Watt, 255 Channels	
Item No.					Description	
	X				AAHN4045_	Front Housing
X	X	X	X	X	HAE4003_	Antenna
X	X	X	X		HKN4191_	Power Cable (Length-20 Feet)
X	X	X	X	X	HLE6046_	VCO Carrier, Range 2
X	X	X	X	X	HLE6062_	Power Amplifier, 25W, Range 2
X	X	X	X	X	HLE6102_	VCO Hybrid Kit, Range 2
X	X	X	X	X	HLN5558_	Command Board Kit
X	X	X	X		HLN6015_	Trunnion
	X	X	X		HLN6073_	Dash-Mount Hardware
	X				HLN6105_	Emergency/Secure/MPL Button Kit
	X				HLN6549_*	C4 Button Kit
	X	X	X		HLN6401_	Control Head Interconnect Board
X	X	X	X	X	HLN6418_*	Transceiver Hardware
X	X	X	X	X	HLN6458_	VOCODER Controller
	X	X	X		HMN1080_	Microphone
X	X	X	X	X	HRE6002_	Receiver, Range 2
	X	X	X	X	HRN6020_	RF Board Kit
X	X	X	X	X	HSN4018_	Speaker
		X			HLN6548_*	SMARTNET Button Kit
		X	X		HLN6193_	Emergency/MPL Field Option Button Kit
		X	X		HLN6396_	DEK Compatible Control Head
		X			HLN6440_*	Control Head without Keypad Hardware
			X		HLN6441_*	Control Head with Keypad Hardware
			X		HLN6523_*	SMARTNET Button Kit
				X	HCN1078_	W9 Control Head
				X	HKN4192_	Power Cable (Length-20 Feet)
				X	HKN4356_	Radio Cable
				X	HLN4921_	Trunnion
				X	HLN4952_	Fuse Kit
				X	HLN5488_	Installation Hardware
				X	HLN6162_*	Remote Hardware
				X	HLN6167_	Option Button Kit
X				X	HSN6185_	Remote-Mount, SECURENET Control-Head Hardware
				X	HLN6344_	Interface Board
				X	HLN6481_*	Systems 9000 E9 Clear Button Kit
				X	HLN6493_*	Plug Kit
				X	HMN1061_	Microphone
X					HLN6127_	Dash Hardware, Low-Power Kit
X					HLN6459_	W3 Interface Board Kit
X					HMN4044_	ASTRO Handheld Control Head (W3)
X					HRN4010_	Low-Power RF Board Kit
X					TLN5277_	Filter Kit

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra UHF 20–40 Watt Model Chart

Model Number														Description			
D04QKH9PW3AN														Model W3 (403-433 MHz), 20-40 Watt, 128 Channels			
D04QKF9PW4AN														Model W4 (403-433 MHz), 20-40 Watt, 128 Channels			
D04QKF9PW5AN														Model W5 (403-433 MHz), 20-40 Watt, 128 Channels			
D04QKH9PW7AN														Model W7 (403-433 MHz), 20-40 Watt, 255 Channels			
T04QKH9PW9AN														Model W9 (403-433 MHz), 20-40 Watt, 255 Channels			
D04RKH9PW3ANSP01														Model W3 (450-482 MHz), 20-40 Watt, 128 Channels			
D04RKF9PW4AN														Model W4 (450-482 MHz), 20-40 Watt, 128 Channels			
D04RKF9PW5AN														Model W5 (450-482 MHz), 20-40 Watt, 128 Channels			
D04RKH9PW7AN														Model W7 (450-482 MHz), 20-40 Watt, 255 Channels			
T04RKH9PW9AN														Model W9 (450-482 MHz), 20-40 Watt, 255 Channels			
D04SKH9PW3AN														Model W3 (482-512 MHz), 20-40 Watt, 128 Channels			
D04SKF9PW4AN														Model W4 (482-512 MHz), 20-40 Watt, 128 Channels			
D04SKF9PW5AN														Model W5 (482-512 MHz), 20-40 Watt, 128 Channels			
D04SKH9PW7AN														Model W7 (482-512 MHz), 20-40 Watt, 255 Channels			
T04SKH9PW9AN														Model W9 (482-512 MHz), 20-40 Watt, 255 Channels			
														Item No.	Description		
	X														AAHN4045_	Front Housing	
X	X	X	X	X											HAE4002_	Antenna, Roof Top	
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	HKN4191_	Power Cable (Length-20 Feet)	
				X											X	HKN4192_	Power Cable (Length-20 Feet)
				X											X	HKN4356_	Radio Cable (Length-17 Feet)
X	X	X	X	X												HLE6045_	VCO Carrier, Range 1
X	X	X	X	X												HLE6049_	Power Amplifier, 40W, Range 1
X	X	X	X	X												HLE6101_	VCO Hybrid Kit, Range 1
				X											X	HLN4921_	Trunnion
				X											X	HLN4952_	Fuse Kit
				X											X	HLN5488_	Installation Hardware
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		HLN5558_	Command Board Kit
X	X	X	X		X	X	X	X		X	X	X	X			HLN6015_	Trunnion/Hardware (Dash Mount)
X	X	X	X		X	X	X	X		X	X	X	X			HLN6073_	Dash-Mount Hardware
		X				X									X	HLN6548_*	SMARTNET Button Kit
				X												HLN6162_*	Remote-Mount Hardware
				X											X	HLN6167_	Option Button Kit
X				X					X	X					X	HLN6185_*	Remote-Mount, SECURENET Control-Head Hardware
		X	X			X	X						X	X		HLN6193_	Emergency/MPL Field Option Button Kit
		X	X			X	X						X	X		HLN6396_	Control Head Deck Compatible
	X					X							X			HLN6105_	Emergency/Secure/MPL Button Kit
	X					X							X			HLN6549_*	C4 Button Kit
				X											X	HLN6344_	Interface Board
	X	X	X			X	X	X			X	X	X			HLN6401_	Control Head Interconnect Board
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		HLN6418_*	Transceiver Hardware
		X				X								X		HLN6440_*	Control Head without Keypad Hardware
			X				X							X		HLN6441_*	Control Head with Keypad Hardware
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		HLN6458_	VOCODER Controller
				X										X		HLN6481_*	Systems 9000 E9 Clear Button Kit
				X										X		HLN6493_*	Plug Kit
			X				X							X		HLN6523_*	SMARTNET Button Kit
	X	X	X			X	X	X				X	X	X		HMN1080_	Microphone
X	X	X	X	X												HRE6001_	Receiver F/E, Range 1
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		HRN6020_	RF Board
			X											X		HMN1061_	Microphone

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra UHF 20–40 Watt Model Chart (cont.)

Model Number													Description						
D04QKH9PW3AN													Model W3 (403-433 MHz), 20-40 Watt, 128 Channels						
D04QKF9PW4AN													Model W4 (403-433 MHz), 20-40 Watt, 128 Channels						
D04QKF9PW5AN													Model W5 (403-433 MHz), 20-40 Watt, 128 Channels						
D04QKH9PW7AN													Model W7 (403-433 MHz), 20-40 Watt, 255 Channels						
T04QKH9PW9AN													Model W9 (403-433 MHz), 20-40 Watt, 255 Channels						
D04RKH9PW3ANSP01													Model W3 (450-482 MHz), 20-40 Watt, 128 Channels						
D04RKF9PW4AN													Model W4 (450-482 MHz), 20-40 Watt, 128 Channels						
D04RKF9PW5AN													Model W5 (450-482 MHz), 20-40 Watt, 128 Channels						
D04RKH9PW7AN													Model W7 (450-482 MHz), 20-40 Watt, 255 Channels						
T04RKH9PW9AN													Model W9 (450-482 MHz), 20-40 Watt, 255 Channels						
D04SKH9PW3AN													Model W3 (482-512 MHz), 20-40 Watt, 128 Channels						
D04SKF9PW4AN													Model W4 (482-512 MHz), 20-40 Watt, 128 Channels						
D04SKF9PW5AN													Model W5 (482-512 MHz), 20-40 Watt, 128 Channels						
D04SKH9PW7AN													Model W7 (482-512 MHz), 20-40 Watt, 255 Channels						
T04SKH9PW9AN													Model W9 (482-512 MHz), 20-40 Watt, 255 Channels						
													Item No.	Description					
				X	X	X	X	X										HAE4003_	Antenna, Quarterwave
					X	X	X	X										HLE6000_	VCO Carrier, Range 3
					X	X	X	X										HLE6043_	Power Amplifier, 40W, Range 3
					X	X	X	X										HLE6103_	VCO Hybrid Kit, Range 3
					X	X	X	X										HRE6003_	Receiver F/E, Range 3
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	HSN4018_	Speaker
				X					X									HCN1078_	W9 Control Head
										X	X	X	X	X				HAE4004_	Antenna, Roof Top
										X	X	X	X	X				HLE6041_	VCO Carrier, Range 4
										X	X	X	X	X				HLE6044_	Power Amplifier, 40W, Range 4
										X	X	X	X	X				HLE6104_	VCO Hybrid Kit, Range 4
										X	X	X	X	X				HRE6004_	Receiver F/E, Range 4
X					X				X									HLN6459_	W3 Interface Board
X					X				X									HMN4044_	ASTRO Handheld Control Head (W3)

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra UHF 50–110 Watt Model Chart

Model Number										Description			
T04QLF9PW4AN										Model W4 (403-433 MHz), 50-110 Watt, 128 Channels			
T04QLF9PW5AN										Model W5 (403-433 MHz), 50-110 Watt, 255 Channels			
T04QLH9PW7AN										Model W7 (403-433 MHz), 50-110 Watt, 255 Channels			
T04QLH9PW9AN										Model W9 (403-433 MHz), 50-110 Watt, 255 Channels			
T04RLF9PW4AN										Model W4 (450-482 MHz), 50-110 Watt, 128 Channels			
T04RLF9PW5AN										Model W5 (450-482 MHz), 50-110 Watt, 128 Channels			
T04RLH9PW7AN										Model W7 (450-482 MHz), 50-110 Watt, 255 Channels			
T04RLH9PW9AN										Model W9 (450-482 MHz), 50-110 Watt, 255 Channels			
T04SLF9PW4AN										Model W4 (482-512 MHz), 50-110 Watt, 128 Channels			
T04SLF9PW5AN										Model W5 (482-512 MHz), 50-110 Watt, 128 Channels			
T04SLHPW7AN										Model W7 (482-512 MHz), 50-110 Watt, 128 Channels			
T04SLHPW9AN										Model W9 (482-512 MHz), 50-110 Watt, 128 Channels			
Item No.										Description			
X				X						AAHN4045_	Front Housing		
X	X	X	X							HAE4002_	Antenna, Roof Top		
				X	X	X	X			HAE4003_	Antenna, Quarterwave		
								X	X	X	X	HAE4004_ Antenna, Roof Top	
X	X	X	X	X	X	X	X	X	X	X	X	HKN4051_ Cable and Fuse	
X	X	X	X	X	X	X	X	X	X	X	X	HKN4356_ Radio Cable (Length-17 Feet)	
X	X	X	X	X	X	X	X	X	X	X	X	HKN6039_ Cable (Length-17 Feet)	
				X	X	X	X					HLE6039_ VCO Carrier, Range 3	
								X	X	X	X	HLE6040_ Power Amplifier Board, Range 4	
								X	X	X	X	HLE6041_ VCO Carrier, Range 4	
X	X	X	X									HLE6045_ VCO Carrier, Range 1	
X	X	X	X									HLE6051_ Power Amplifier Board, 100W, Range 1	
X	X	X	X									HLE6101_ VCO Hybrid Kit, Range 1	
				X	X	X	X					HLE6103_ VCO Hybrid Kit, Range 3	
								X	X	X	X	HLE6104_ VCO Hybrid Kit, Range 4	
X	X	X	X	X	X	X	X	X	X	X	X	HLN4952_ Fuse Kit	
X	X	X	X	X	X	X	X	X	X	X	X	HLN5558_ Command Board Kit	
X				X				X				HLN6105_ Emergency/Secure/MPL Button Kit	
X	X	X	X	X	X	X	X	X	X	X	X	HLN6121_* High-Power Radio Hardware	
X	X	X	X	X	X	X	X	X	X	X	X	HLN6132_* Installation Hardware, High-Power	
X	X	X		X	X	X		X	X	X		HLN6231_ Remote W4, W5, W7 Control-Head Trunion	
X	X	X	X	X	X	X	X	X	X	X	X	HLN6233_* Option Connector Hardware	
X				X				X				HLN6549_* C4 Button Kit	
X	X	X		X	X	X		X	X	X		HLN6432_ Back Housing, Control Head	
X	X	X	X	X	X	X	X	X	X	X	X	HLN6458_ VOCON Board Kit	
X	X	X	X	X	X	X	X	X	X	X	X	HLN6486_ Interconnect Board	
				X	X			X	X	X		HLN6493_* Plug Kit	
X	X	X	X	X	X	X	X	X	X	X	X	HLN6525_* High-Power Transceiver Hardware	
X	X	X	X	X	X	X		X	X	X		HMN1080_ Microphone	
X	X	X	X					X			X	HMN1061_ Microphone	
				X								HRE6001_ Receiver Board Kit, Range 1	
				X	X	X	X					HRE6003_ Receiver Board Kit, Range 3	
								X	X	X	X	HRE6004_ Receiver Board Kit, Range 4	
X	X	X	X	X	X	X	X	X	X	X	X	HRN6020_ RF Board	
X	X	X	X	X	X	X	X		X	X		HSN6001_ Speaker	
	X			X				X				HLN6548_* SMARTNET Button Kit	
	X	X		X	X			X	X			HLN6193_ Emergency/MPL Field Option Button Kit	
	X	X		X	X			X	X			HLN6396_ W5, W7 Control Head Board	

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra UHF 50–110 Watt Model Chart (cont.)

Model Number										Description			
T04QLF9PW4AN										Model W4 (403-433 MHz), 50-110 Watt, 128 Channels			
T04QLF9PW5AN										Model W5 (403-433 MHz), 50-110 Watt, 255 Channels			
T04QLH9PW7AN										Model W7 (403-433 MHz), 50-110 Watt, 255 Channels			
T04QLH9PW9AN										Model W9 (403-433 MHz), 50-110 Watt, 255 Channels			
T04RLF9PW4AN										Model W4 (450-482 MHz), 50-110 Watt, 128 Channels			
T04RLF9PW5AN										Model W5 (450-482 MHz), 50-110 Watt, 128 Channels			
T04RLH9PW7AN										Model W7 (450-482 MHz), 50-110 Watt, 255 Channels			
T04RLH9PW9AN										Model W9 (450-482 MHz), 50-110 Watt, 255 Channels			
T04SLF9PW4AN										Model W4 (482-512 MHz), 50-110 Watt, 128 Channels			
T04SLF9PW5AN										Model W5 (482-512 MHz), 50-110 Watt, 128 Channels			
T04SLHPW7AN										Model W7 (482-512 MHz), 50-110 Watt, 128 Channels			
T04SLHPW9AN										Model W9 (482-512 MHz), 50-110 Watt, 128 Channels			
										Item No.		Description	
	X				X			X			HLN6440_*	Control Head without Keypad Hardware	
		X			X			X			HLN6441_*	Control Head with Keypad Hardware	
		X			X			X			HLN6523_*	SMARTNET Button Kit	
			X			X			X		HCN1078_	W9 Control Head	
			X			X			X		HLN4921_	Trunnion	
			X			X			X		HLN6167_	Option Button Kit	
			X			X			X		HLN6481_*	Systems 9000 E9 Clear Button Kit	

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra 800 MHz Model Chart

Model Number					Description	
D04UJF9PW3AN					Model W3 (800 MHz), 35 Watt, 128 Channels	
D04UJF9PW4AN					Model W4 (800 MHz), 35 Watt, 128 Channels	
D04UJF9PW5AN					Model W5 (800 MHz), 35 Watt, 128 Channels	
D04UJF9PW7AN					Model W7 (800 MHz), 35 Watt, 255 Channels	
T04UJF9PW9AN					Model W9 (800 MHz), 35 Watt, 255 Channels	
Item No.					Description	
	X				AAHN4045_	Front Housing
X	X	X	X		HKN4191_	Power Cable (Length-20 Feet)
X	X	X	X	X	HLF6077_	Power Amplifier
X	X	X	X	X	HLF6079_	VCO Hybrid
X	X	X	X	X	HLF6080_	VCO Carrier
X	X	X	X		HLN6015_	Trunnion/Hardware
	X				HLN6040_	Phon/Page/Emer/MPL Button
X	X	X	X	X	HLN6126_*	Mid-Power Dash Mount Radio Hardware
		X	X		HLN6193_	Emergency/MPL Field Option Button Kit
	X				HLN6549_*	C4 Button Kit
	X	X	X		HLN6401_	Control Head Interconnect Board
	X	X	X	X	HLN6418_*	Transceiver Hardware
	X	X	X		HMN1080_	Microphone
X	X	X	X	X	HRF6004_	Front-End Receiver Kit
X	X	X	X	X	HRN6019_	RF Board Kit
X	X	X	X	X	HSN4018_	Speaker
X	X	X	X	X	RRA4914_	Antenna
X	X	X	X	X	HLN5558_	Command Board Kit
		X			HLN6548_*	SMARTNET Button Kit
		X	X		HLN6396_	Control Head Deck Compatible
		X			HLN6440_*	Control Head without Keypad Hardware
X	X	X	X	X	HLN6458_	VOCODER Controller
			X		HLN6441_*	Control Head with Keypad Hardware
			X		HLN6523_*	SMARTNET Button Kit
				X	HCN1078_	W9 Control Head
				X	HKN4192_	Power Cable (Length-20 Feet)
				X	HKN4356_	Radio Cable (Length-17 Feet)
				X	HLN4921_	Trunnion, Control Head w9
				X	HLN4952_	Fuse Kit
				X	HLN5488_	Installation Hardware (W9 Trunnion) Radio Microphone
				X	HLN6167_	Option Button Kit
X				X	HLN6185_*	Remote-Mount, SECURENET Control Head Hardware
				X	HLN6344_	Interface Board
				X	HLN6481_*	Systems 9000 E9 Clear Button Kit
				X	HLN6493_*	Plug Kit
				X	HMN1061_	Microphone

X = Item Included

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Plus VHF 25–50 and 50–110 Watt Model Chart

Model Number										Description	
D04JKH9SW7AN										Model W7 (136-162 MHz), 25-50 Watt, 512 Channels	
D04KKH9SW3AN										Model W3 (146-174 MHz), 25-50 Watt, 512 Channels	
D04KKF9SW4AN										Model W4 (146-174 MHz), 25-50 Watt, 512 Channels	
D04KKF9SW5AN										Model W5 (146-174 MHz); 25-50 Watt, 512 Channels	
D04KKH9SW7AN										Model W7 (146-174 MHz), 25-50 Watt, 512 Channels	
T04KKH9SW9AN										Model W9 (146-174 MHz), 25-50 Watt, 512 Channels	
T04KLH9SW3AN										Model W3 (146-174 MHz), 50-110 Watt, 512 Channels	
T04KLF9SW4AN										Model W4 (146-174 MHz), 50-110 Watt, 512 Channels	
T04KLF9SW5AN										Model W5 (146-174 MHz), 50-110 Watt, 512 Channels	
T04KLH9SW7AN										Model W7 (146-174 MHz), 50-110 Watt, 512 Channels	
T04KLH9SW9AN										Model W9 (146-174 MHz), 50-110 Watt, 512 Channels	
Item No.										Description	
X										HRD6001_	Front-End Rcvr Board Kit (Range 1, 136-162 MHz)
	X	X	X	X	X	X	X	X	X	HRD6002_	Front-End Rcvr Board Kit (Range 2, 146-174 MHz)
X	X	X	X	X	X	X	X	X	X	HRN6014_	RF Board Kit
X	X	X	X	X	X	X	X	X	X	HLD4342_	VCO Board Kit
X										HLD6061_	VCO Hybrid Kit (Range 1, 136-162 MHz)
	X	X	X	X	X	X	X	X	X	HLD6062_	VCO Hybrid Kit (Range 2, 146-174 MHz)
X	X	X	X	X	X	X	X	X	X	HLN5558_	Command Board Kit
X	X	X	X	X	X	X	X	X	X	HLN6837_	VOCON Board Kit
X	X	X	X	X	X					HLD6022_	Power Amplifier Board (25-50W, Range 2, 146-174 MHz)
					X	X	X	X	X	HLD6063_	Power Amplifier Board (50-110W, Range 2, 146-174 MHz)
					X					HLN6344_	Interface Board
X		X	X	X						HLN6401_	Control Head Interconnect Board
		X				X				AAHN4045_	W4 Control Head
						X	X	X	X	HLN6486_	High-Power Interconnect Board
						X	X	X		HLN6432_	Control Head Back Housing
X			X	X			X	X		HLN6396_	W5,W7 Control Head Board
					X				X	HCN1078_	W9 Control Head
O	O	O	O	O	O	O	O	O	O	NTN9801_	ASTRO Spectra Plus UCM
		X	X	X			X	X	X	HMN1080_	Microphone
					X				X	HMN1061_	Microphone
X	X	X	X	X	X					HSN4018_	Speaker
						X	X	X	X	HSN6001_	Speaker
					X				X	HLN4921_	Control Head (W9) Trunnion
					X				X	HLN5488_	Radio Microphone Installation Hardware (W9 Trunnion)
	X				X					HLN6185_*	Remote-Mount, SECURENET Control-Head Hardware
						X	X	X		HLN6231_	Remote W4, W5, W7 Control-Head Trunnion
						X	X	X	X	HLN6233_*	Option Connector Hardware
						X	X	X	X	HLN6132_*	High-Power Installation Hardware
X	X	X	X	X						HLN6015_	Trunnion/Hardware (Dash Mount)
X	X	X	X	X						HLN6060_	Dash-Mount Hardware
						X	X	X	X	HLN6121_*	High-Power Radio Hardware
X	X	X	X	X	X					HLN6866_*	Transceiver Hardware
			X				X			HLN6440_*	Control Head without Keypad Hardware
X				X				X		HLN6441_*	Control Head with Keypad Hardware
					X	X	X	X	X	HLN6525_*	High-Power Transceiver Hardware
					X				X	HLN6493_*	Plug Kit
					X	X	X	X	X	HLN4952_	Fuse Kit
					X	X	X	X	X	HKN4356_	Radio Cable (Length -17 Feet)

X = Item Included

O = Optional item

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Plus VHF 25–50 and 50–110 Watt Model Chart (cont.)

Model Number										Description		
D04JKH9SW7AN										Model W7 (136-162 MHz), 25-50 Watt, 512 Channels		
D04KKH9SW3AN										Model W3 (146-174 MHz), 25-50 Watt, 512 Channels		
D04KKF9SW4AN										Model W4 (146-174 MHz), 25-50 Watt, 128 Channels		
D04KKF9SW5AN										Model W5 (146-174 MHz); 25-50 Watt, 128 Channels		
D04KKH9SW7AN										Model W7 (146-174 MHz), 25-50 Watt, 512 Channels		
T04KKH9SW9AN										Model W9 (146-174 MHz), 25-50 Watt, 512 Channels		
T04KLH9SW3AN										Model W3 (146-174 MHz), 50-110 Watt, 512 Channels		
T04KLF9SW4AN										Model W4 (146-174 MHz), 50-110 Watt, 128 Channels		
T04KLF9SW5AN										Model W5 (146-174 MHz), 50-110 Watt, 128 Channels		
T04KLH9SW7AN										Model W7 (146-174 MHz), 50-110 Watt, 512 Channels		
T04KLH9SW9AN										Model W9 (146-174 MHz), 50-110 Watt, 512 Channels		
										Item No.	Description	
						X	X	X	X	X	HKN4051_	Cable and Fuse
X	X	X	X	X							HKN4191_	Power Cable (Length - 20 Feet)
					X						HKN4192_	Power Cable (Length - 20 Feet)
						X	X	X	X	X	HKN6039_	Cable (Length - 17 Feet)
					X					X	HLN6481_*	Systems 9000 E9 Clear Button Kit
		X					X				HLN6549_*	C4 Button Kit
X		X	X	X	X		X	X	X	X	HLN6105_	Emergency/Secure/MPL Button Kit
			X					X			HLN6548_*	SMARTNET Button Kit
X				X					X		HLN6523_*	SMARTNET Button Kit
					X					X	HLN6167_	Option Button Kit
	X										HLN6459_	W3 Interface Board Kit
	X					X					HMN4044_	ASTRO Handheld Control Head (W3)
	X					X					TLN5277_	Filter Kit
						X					HKN6096_	Handheld Control Head "Y" Cable Kit
						X					HLN6291_	Installation Hardware Kit
						X					HLN6574_	W3 Interconnect Board Kit

X = Item Included

O = Optional item

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Plus UHF 20–40 Watt Model Chart

Model Number										Description	
D04QKH9SW3AN										Model W3 (403-433 MHz), 20-40 Watt, 512 Channels	
D04QKF9SW4AN										Model W4 (403-433 MHz), 20-40 Watt, 128 Channels	
D04QKF9SW5AN										Model W5 (403-433 MHz), 20-40 Watt, 128 Channels	
D04QKH9SW7AN										Model W7 (403-433 MHz), 20-40 Watt, 512 Channels	
T04QKH9SW9AN										Model W9 (403-433 MHz), 20-40 Watt, 512 Channels	
D04RKH9SW3AN										Model W3 (450-482 MHz), 20-40 Watt, 512 Channels	
D04RKF9SW4AN										Model W4 (450-482 MHz), 20-40 Watt, 128 Channels	
D04RKF9SW5AN										Model W5 (450-482 MHz), 20-40 Watt, 128 Channels	
D04RKH9SW7AN										Model W7 (450-482 MHz), 20-40 Watt, 512 Channels	
T04RKH9SW9AN										Model W9 (450-482 MHz), 20-40 Watt, 512 Channels	
Item No.										Description	
	X					X				AAHN4045_	Control Head Assembly (W4)
X	X	X	X	X						HAE4002_	Antenna, Roof Top
					X	X	X	X	X	HAE4003_	Antenna, Quarterwave
				X					X	HCN1078_	W9 Control Head
X	X	X	X		X	X	X	X		HKN4191_	Power Cable (Length-20 Feet)
				X					X	HKN4192_	Power Cable (Length-20 Feet)
				X					X	HKN4356_	Radio Cable (Length-17 Feet)
					X	X	X	X	X	HLE6000_	VCO Carrier, Range 3
					X	X	X	X	X	HLE6043_	Power Amplifier, 40W, Range 3
X	X	X	X	X						HLE6045_	VCO Carrier, Range 1
X	X	X	X	X						HLE6049_	Power Amplifier, 40W, Range 1
X	X	X	X	X						HLE6101_	VCO Hybrid Kit, Range 1
					X	X	X	X	X	HLE6103_	VCO Hybrid Kit, Range 3
				X					X	HLN4921_	Trunnion
				X					X	HLN4952_	Fuse Kit
				X					X	HLN5488_	Installation Hardware
X	X	X	X	X	X	X	X	X	X	HLN5558_	Command Board Kit
X	X	X	X		X	X	X	X		HLN6015_	Trunnion/Hardware (Dash Mount)
X	X	X	X		X	X	X	X		HLN6073_	Dash-Mount Hardware
	X	X	X	X		X	X	X	X	HLN6105_	Emergency/Secure/MPL Button Kit
				X					X	HLN6167_	Option Button Kit
				X					X	HLN6185_*	Remote-Mount, SECURENET Control-Head Hardware
				X					X	HLN6344_	Interface Board
		X	X				X	X		HLN6396_	Control Head Deck Compatible
	X	X	X			X	X	X		HLN6401_	Control Head Interconnect Board
X	X	X	X	X	X	X	X	X	X	HLN6418_*	Transceiver Hardware
		X						X		HLN6440_*	Control Head without Keypad Hardware
			X						X	HLN6441_*	Control Head with Keypad Hardware
X					X					HLN6459_	W3 Interface Board
				X					X	HLN6481_*	Systems 9000 E9 Clear Button Kit
				X					X	HLN6493_*	Plug Kit
			X					X		HLN6523_*	SMARTNET Button Kit
								X		HLN6548_*	SMARTNET Button Kit
	X					X				HLN6549_*	C4 Button Kit
X	X	X	X	X	X	X	X	X	X	HLN6837_	VOCODER Controller
				X					X	HMN1061_	Microphone
	X	X	X			X	X	X		HMN1080_	Microphone
X					X					HMN4044_	ASTRO Handheld Control Head (W3)

X = Item Included

O = Optional

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Plus UHF 20–40 Watt Model Chart (cont.)

Model Number										Description	
D04QKH9SW3AN										Model W3 (403-433 MHz), 20-40 Watt, 512 Channels	
D04QKF9SW4AN										Model W4 (403-433 MHz), 20-40 Watt, 128 Channels	
D04QKF9SW5AN										Model W5 (403-433 MHz), 20-40 Watt, 128 Channels	
D04QKH9SW7AN										Model W7 (403-433 MHz), 20-40 Watt, 512 Channels	
T04QKH9SW9AN										Model W9 (403-433 MHz), 20-40 Watt, 512 Channels	
D04RKH9SW3AN										Model W3 (450-482 MHz), 20-40 Watt, 512 Channels	
D04RKF9SW4AN										Model W4 (450-482 MHz), 20-40 Watt, 128 Channels	
D04RKF9SW5AN										Model W5 (450-482 MHz), 20-40 Watt, 128 Channels	
D04RKH9SW7AN										Model W7 (450-482 MHz), 20-40 Watt, 512 Channels	
T04RKH9SW9AN										Model W9 (450-482 MHz), 20-40 Watt, 512 Channels	
Item No.										Description	
X	X	X	X	X						HRE6001_	Receiver F/E, Range 1
						X	X	X	X	HRE6003_	Receiver F/E, Range 3
X	X	X	X	X	X	X	X	X	X	HRN6020_	RF Board
X	X	X	X	X	X	X	X	X	X	HSN4018_	Speaker
O	O	O	O	O	O	O	O	O	O	NTN9801_	UCM, ASTRO Spectra Plus

X = Item Included

O = Optional

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Plus UHF 50–110 Watt Model Chart

Model Number													Description		
T04QLH9SW3AN													Model W3 (403-433 MHz), 50-110 Watt, 512 Channels		
T04QLF9SW4AN													Model W4 (403-433 MHz), 50-110 Watt, 128 Channels		
T04QLF9SW5AN													Model W5 (403-433 MHz), 50-110 Watt, 128 Channels		
T04QLH9SW7AN													Model W7 (403-433 MHz), 50-110 Watt, 512 Channels		
T04QLH9SW9AN													Model W9 (403-433 MHz), 50-110 Watt, 512 Channels		
T04RLH9SW3AN													Model W3 (450-482 MHz), 50-110 Watt, 512 Channels		
T04RLF9SW4AN													Model W4 (450-482 MHz), 50-110 Watt, 128 Channels		
T04RLF9SW5AN													Model W5 (450-482 MHz), 50-110 Watt, 128 Channels		
T04RLH9SW7AN													Model W7 (450-482 MHz), 50-110 Watt, 512 Channels		
T04RLH9SW9AN													Model W9 (450-482 MHz), 50-110 Watt, 512 Channels		
T04SLH9SW3AN													Model W3 (482-512 MHz), 50-110 Watt, 512 Channels		
T04SLF9SW4AN													Model W4 (482-512 MHz), 50-110 Watt, 128 Channels		
T04SLF9SW5AN													Model W5 (482-512 MHz), 50-110 Watt, 128 Channels		
T04SLH9SW7AN													Model W7 (482-512 MHz), 50-110 Watt, 512 Channels		
T04SLH9SW9AN													Model W9 (482-512 MHz), 50-110 Watt, 512 Channels		
													Item No.	Description	
X	X												X	AAHN4045_	Control Head Assembly (W4)
X	X	X	X	X										HAE4002_	Antenna, Roof Top
					X	X	X	X	X					HAE4003_	Antenna, Quarterwave
									X	X	X	X	X	HAE4004_	Antenna, Roof Top
				X									X	HCN1078_	W9 Control Head
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HKN4051_	Cable and Fuse
	X	X	X	X		X	X	X	X		X	X	X	HKN4356_	Radio Cable (Length-17 Feet)
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HKN6039_	Power Cable (Length-17 Feet)
X					X				X					HKN6096_	Handheld Control Head "Y" Cable Kit
					X	X	X	X	X					HLE6039_	VCO Carrier, Range 3
									X	X	X	X	X	HLE6040_	Power Amplifier Board, Range 4
									X	X	X	X	X	HLE6041_	VCO Carrier, Range 4
X	X	X	X	X										HLE6045_	VCO Carrier, Range 1
X	X	X	X	X										HLE6051_	Power Amplifier Board, 100W, Range 1
X	X	X	X	X										HLE6101_	VCO Hybrid Kit, Range 1
					X	X	X	X	X					HLE6103_	VCO Hybrid Kit, Range 3
									X	X	X	X	X	HLE6104_	VCO Hybrid Kit, Range 4
				X					X				X	HLN4921_	Trunnion
	X	X	X	X		X	X	X	X	X	X	X	X	HLN4952_	Fuse Kit
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN5558_	Command Board Kit
	X					X				X				HLN6105_	Emergency/Secure/MPL Button Kit
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6121_*	High-Power Radio Hardware
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6132_*	Installation Hardware, High-Power
				X					X				X	HLN6167_	Option Button Kit
	X	X	X			X	X	X		X	X	X		HLN6231_	Remote W4, W5, W7 Control-Head Trunnion
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6233_*	Option Connector Hardware
X					X				X					HLN6291_	Installation Hardware Kit
		X	X			X	X			X	X			HLN6396_	W5, W7 Control Head Board
	X	X	X			X	X	X		X	X	X		HLN6432_	Back Housing, Control Head
		X				X				X				HLN6440_*	Control Head without Keypad Hardware
		X				X				X				HLN6441_*	Control Head with Keypad Hardware

X = Item Included

O = Optional

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Plus UHF 50–110 Watt Model Chart (cont.)

Model Number														Description	
T04QLH9SW3AN														Model W3 (403-433 MHz), 50-110 Watt, 512 Channels	
T04QLF9SW4AN														Model W4 (403-433 MHz), 50-110 Watt, 128 Channels	
T04QLF9SW5AN														Model W5 (403-433 MHz), 50-110 Watt, 128 Channels	
T04QLH9SW7AN														Model W7 (403-433 MHz), 50-110 Watt, 512 Channels	
T04QLH9SW9AN														Model W9 (403-433 MHz), 50-110 Watt, 512 Channels	
T04RLH9SW3AN														Model W3 (450-482 MHz), 50-110 Watt, 512 Channels	
T04RLF9SW4AN														Model W4 (450-482 MHz), 50-110 Watt, 128 Channels	
T04RLF9SW5AN														Model W5 (450-482 MHz), 50-110 Watt, 128 Channels	
T04RLH9SW7AN														Model W7 (450-482 MHz), 50-110 Watt, 512 Channels	
T04RLH9SW9AN														Model W9 (450-482 MHz), 50-110 Watt, 512 Channels	
T04SLH9SW3AN														Model W3 (482-512 MHz), 50-110 Watt, 512 Channels	
T04SLF9SW4AN														Model W4 (482-512 MHz), 50-110 Watt, 128 Channels	
T04SLF9SW5AN														Model W5 (482-512 MHz), 50-110 Watt, 128 Channels	
T04SLHSW7AN														Model W7 (482-512 MHz), 50-110 Watt, 512 Channels	
T04SLHSW9AN														Model W9 (482-512 MHz), 50-110 Watt, 512 Channels	
														Item No.	Description
				X									X	HLN6481_*	Systems 9000 E9 Clear Button Kit
	X	X	X	X		X	X	X	X		X	X	X	HLN6486_	Interconnect Board
				X					X					HLN6493_*	Plug Kit
			X					X					X	HLN6523_*	SMARTNET Button Kit
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6525_*	High-Power Transceiver Hardware
		X					X						X	HLN6548_*	SMARTNET Button Kit
	X					X					X			HLN6549_*	C4 Button Kit
X					X					X				HLN6574_	W3 Interface Board
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HLN6837_	VOCON Board Kit
	X	X	X			X	X	X			X	X	X	HMN1080_	Microphone
				X					X				X	HMN1061_	Microphone
														HMN4044_	Handheld Control Head
X	X	X	X	X										HRE6001_	Receiver Board Kit, Range 1
					X	X	X	X	X					HRE6003_	Receiver Board Kit, Range 3
										X	X	X	X	HRE6004_	Receiver Board Kit, Range 4
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HRN6020_	RF Board
X	X	X	X	X	X	X	X	X	X	X	X	X	X	HSN6001_	Speaker
O	O	O	O	O	O	O	O	O	O	O	O	O	O	NTN9801_	UCM, ASTRO Spectra Plus

X = Item Included

O = Optional

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Plus 800 MHz Model Chart

Model Number								Description	
M04UGF9SW4AN								Model W4 (800 MHz), 15 Watt, 128 Channels	
M04UGF9SW5AN								Model W5 (800 MHz), 15 Watt, 128 Channels	
M04UGH9SW7AN								Model W7 (800 MHz), 15 Watt, 512 Channels	
D04UJH9SW3AN								Model W3 (800 MHz), 35 Watt, 512 Channels	
D04UJF9SW4AN								Model W4 (800 MHz), 35 Watt, 128 Channels	
D04UJF9SW5AN								Model W5 (800 MHz), 35 Watt, 128 Channels	
D04UJH9SW7AN								Model W7 (800 MHz), 35 Watt, 512 Channels	
T04UJH9SW9AN								Model W9 (800 MHz), 35 Watt, 512 Channels	
								Item No.	Description
				X				AAHN4045_	Front Housing, W4 Control Head
			X	X	X	X		HKN4191_	Power Cable (Length-20 Feet)
			X	X	X	X	X	HLF6077_	Power Amplifier
X	X	X						HLF6078_	15W. 800 MHz Power Amplifier
X	X	X	X	X	X	X	X	HLF6079_	VCO Hybrid
X	X	X	X	X	X	X	X	HLF6080_	VCO Carrier
			X	X	X	X		HLN6015_	Trunnion/Hardware
X	X	X		X	X	X	X	HLN6688A_	Phon/Page/Emer/MPL Button
			X	X	X	X	X	HLN6126_	Mid-Power Dash Mount Radio Hardware
X	X	X		X	X	X	X	HLN6645A_	Emergency/MPL Field Option Button Kit
				X				HLN6549_*	W4 Button Kit
				X	X	X		HLN6401_	Control Head Interconnect Board
X	X	X						HLN6365_	Interface Board, Motorcycle
X	X	X	X	X	X	X	X	HLN6418_*	Transceiver Hardware
				X	X	X		HMN1080_	Microphone, Modified Standard
X	X	X	X	X	X	X	X	HRF6004_	Front-End Receiver Kit
X	X	X	X	X	X	X	X	HRN6019_	RF Board Kit
			X	X	X	X	X	HSN4018_	Speaker
			X	X	X	X	X	RRA4914_	Antenna
			X	X	X	X	X	HLN5558_	Command Board Kit
X	X	X						HLN6562_	Command Board, Motorcycle
	X					X		HLN6548_*	SMARTNET Button Kit
					X	X		HLN6396_	Control Head Deck Compatible
					X			HLN6440_*	W5 Control Head without Keypad Hardware
X								PMLN4019_	W4 ASTRO Motorcycle Control Head
	X	X						HLN6563_	Motorcycle Control Head
		X						HLN6445_*	Hardware, Control Head, Motorcycle
					X			HLN6208_	Button, Spectra SECURENET
						X		HLN6441_*	W7 Control Head with Keypad Hardware
		X				X		HLN6523_*	SMARTNET Button Kit
							X	HCN1078_	W9 Control Head
			O	O	O	O	X	HKN4192_	Power Cable (Length-20 Feet)
				O	O	O	X	HKN4356_	Remote Mount Radio Cable (Length-17 Feet)
							X	HLN4921_	Trunnion, Control Head W9
							X	HLN4952_	Fuse Kit
							X	HLN5488_	Installation Hardware (W9 Trunnion)
							X	HLN6167_	Option Button Kit
			X	O	O	O	X	HLN6185_*	Remote-Mount, SECURENET Control Head Hardware
				O	O	O	X	HLN6344_	Interface Board, Remote Mount
							X	HLN6481_*	Systems 9000 E9 Clear Button Kit
							X	HMN1061_	Microphone

X = Item Included

O = Optional

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

ASTRO Digital Spectra Plus 800 MHz Model Chart (cont.)

Model Number								Description	
M04UGF9SW4AN								Model W4 (800 MHz), 15 Watt, 128 Channels	
M04UGF9SW5AN								Model W5 (800 MHz), 15 Watt, 128 Channels	
M04UGH9SW7AN								Model W7 (800 MHz), 15 Watt, 512 Channels	
D04UJH9SW3AN								Model W3 (800 MHz), 35 Watt, 512 Channels	
D04UJF9SW4AN								Model W4 (800 MHz), 35 Watt, 128 Channels	
D04UJF9SW5AN								Model W5 (800 MHz), 35 Watt, 128 Channels	
D04UJH9SW7AN								Model W7 (800 MHz), 35 Watt, 512 Channels	
T04UJH9SW9AN								Model W9 (800 MHz), 35 Watt, 512 Channels	
								Item No.	Description
			X					HLN6638_	Radio Hardware
X	X	X	X	X	X	X	X	HLN6837_	Vocoder/Controller
			X	X	X	X		HLN6073_	Radio Hardware
			X					HLN6459_	Interface Board
			X					HMN4044_	Handheld Control Head
			X					HLN6613_	Transceiver Hardware
				X			X	HLN6493_*	Large Black Plug Kit
X	X	X		X	X	X	X	HLN6105_	Spare Button Kit
							X	HLN6675_*	System 9000 Button Kit Secure
X	X	X						HLN6639_*	Radio Hardware
X	X	X						HKN6062_	Cable, Control Head to Radio
X	X	X						HLN6179_	Motorcycle Adapter Control Head Speaker
X	X	X						HKN6032_	Motorcycle Power Cable
X	X	X						HLN6180_	Motorcycle Mounting Hardware
X	X	X						HLN6342_*	Motorcycle Hardware Secure
				X				HLN6249_*	Button, Secure
X	X	X						RAF4011_	800 MHz Antenna, 3 dB Gain
X	X	X						HSN6003_	Motorcycle Waterproof Speaker
X	X	X						HMN1079_	Modified Motorcycle Waterproof Microphone
		X					X	HLN6524_	Button, Conventional
				O	O	O		HKN6432_	Back Housing Kit
				O	O	O		HLN6231_	Hardware, Remote-Mount Dash
	X							HLN6444_*	Hardware, Control Head, Motorcycle

X = Item Included

O = Optional

_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

* = kit not available. Order piece parts from the Customer Care and Services Division.

VHF Radio Specifications

GENERAL		RECEIVER		TRANSMITTER	
FCC Designations:	AZ492FT3772 AZ492FT3773	Frequency Range:	Range 1: 136–162 MHz Range 2: 146–174 MHz	Frequency Range:	Range 1: 136–162 MHz Range 2: 146–174 MHz
Temperature Range:	Operating: –30°C to +60°C Storage: –40°C to +85°C	Channel Spacing:	12.5 kHz, 25 kHz	Rated Output Power:	Low-Power Radio: 10–25 Watt Variable Mid-Power Radio: 25–50 Watt Variable High-Power Radio: 50–110 Watt Variable
Power Supply:	12 Vdc Negative Ground Only	Input Impedance:	50 Ohm	Channel Spacing:	12.5 kHz, 25 kHz
Battery Drain: (Maximum)		Frequency Separation:	Range 1: 26 MHz Range 2: 28 MHz	Channel Increment Step:	2.5 kHz
10–25 Watt Variable:		Sensitivity: (per EIA spec. RS204C)		Output Impedance:	50 Ohm
Standby @ 13.8 V:	0.8 A	20 dB Quieting: (25/30 kHz Channel Spacing)		Frequency Separation:	
Receive at Rated Audio @ 13.8 V:	3.0 A	With Optional Preamp:	0.30 µV	Range 1:	26 MHz
Transmit @ Rated Power:	7.0 A	Without Optional Preamp:	0.50 µV	Range 2:	28 MHz
25–50 Watt Variable:		12 dB SINAD (25/30 kHz Channel Spacing)		Frequency Stability:	
Standby @ 13.8 V:	0.8 A	With Optional Preamp:	0.20 µV	(–30 to +60°C; 25°C Ref.):	±0.00025%
Receive at Rated Audio @ 13.8 V:	3.0 A	Without Optional Preamp:	0.35 µV	Modulation Limiting:	
Transmit @ Rated Power:	13.5 A	Selectivity: (per EIA Specifications)		25 kHz/30 kHz Channel Spacing:	±5.0 kHz
50–110 Watt Variable:		(Measured in the Analog Mode)		12.5 kHz Channel Spacing:	±2.5 kHz
Standby @ 13.8 V:	0.9 A	25/30 kHz Channel Spacing:	–80 dB	FM Hum and Noise:	
Receive at Rated Audio @ 13.8 V:	4.0 A	12.5 kHz Channel Spacing:	–70 dB	(Measured in the Analog Mode):	–45 dB
Transmit @ Rated Power:	27.5 A	Intermodulation: (per EIA Specifications)		Emission (Conducted and Radiated):	–75 dB
		(Measured in the Analog Mode)		Audio Sensitivity:	
Dimensions (H x W x D)		With Optional Preamp:	–70 dB	(For 60% Max. Deviation at 1 kHz):	0.08V ±3 dB
W4, W5, and W7 Models:		Without Optional Preamp:	–80 dB	Audio Response:	
Remote-Mount Control Head:	2.0" x 7.1" x 2.2" (50.8 mm x 180.3 mm x 55.9 mm)	Spurious Rejection:		(Measured in the Analog Mode)	
Dash-Mount Radio:	2.0" x 7.1" x 8.6" (50.8 mm x 180.3 mm x 218.4 mm)	With Optional Preamp:	–80 dB	(6 dB/Octave Pre-Emphasis 300 to 3000 Hz):	+1, –3 dB
W9 Model:		Without Optional Preamp:	–83 dB	Emissions Designators:	
Remote-Mount Control Head:	3.4" x 6.5" x 1.7" (86.4 mm x 165.1 mm x 43.2 mm)	Frequency Stability:		8K10F1E, 11K0F3E, 15K0F2D, 16K0F3E, 20K0F1E, and 15K0F1D	
Speaker: (excluding mounting bracket)	5.5" x 5.5" x 2.5" (139.7 mm x 139.7 mm x 63.5 mm)	(–30° to +60°C; 25°C Reference):	±0.00025%	AZ492FT3771: 11K0F1D, 11K0F2D AZ492FT3772: 10K0F1D, 10K0F2D AZ492FT3773: 11K0F1D, 11K0F2D	
Weight:		Audio Output: (per EIA Specifications)			
Mid-Power Radio:	6.1 lbs (2.8 kg)	(Measured in the Analog Mode):			
High-Power Radio:	11.2 lbs (5.1 kg)	5 Watts at Less Than 3% Distortion			
Speaker:	1.5 lbs (0.7 kg)	10 Watts Optional with Reduced Duty Cycle			
		12 Watts for High-Power Radios			

Specifications subject to change without notice.

All measurements are taken in the test mode at 25 kHz channel spacing except where indicated.

UHF Radio Specifications

GENERAL		RECEIVER	TRANSMITTER
FCC Designations:	AZ492FT4786 AZ492FT4787	Frequency Range:	Frequency Range:
Temperature Range:		Range 1: 403–433 MHz	Range 1: 403–433 MHz
Operating:	–30°C to +60°C	Range 2: 438–470 MHz	Range 2: 438–470 MHz
Storage:	–40°C to +85°C	Range 3: 450–482 MHz	Range 3: 450–482 MHz
Power Supply:	12 Vdc Negative Ground Only	Range 4: 482–512 MHz	Range 4: 482–512 MHz
Battery Drain: (Maximum)		Channel Spacing:	Rated Output Power:
1–6 Watt Variable:		12.5 kHz or 25 kHz	Low-Power Radio: 1–6 Watt Variable
Standby @ 13.8 V:	0.7 A	Input Impedance:	Mid-Power Radio: 10–25 Watt Variable
Receive at Rated Audio @ 13.8 V:	3.0 A	50 Ohm	20–40 Watt Variable
Transmit @ Rated Power:	4.0 A	Frequency Separation:	High-Power Radio: 50–110* Watt Variable
10–25 Watt Variable:		Range 1 and 4: 30 MHz	Channel Spacing:
Standby @ 13.8 V:	0.7 A	Range 2 and 3: 32 MHz	12.5 kHz or 25 kHz
Receive at Rated Audio @ 13.8 V:	3.0 A	Sensitivity: (per EIA spec. RS204C)	Output Impedance:
Transmit @ Rated Power:	4.0 A	20 dB Quieting: (25 kHz Channel Spacing)	50 Ohm
20–40 Watt Variable:		With Optional Preamp: 0.30 µV	Frequency Separation:
(30 W Max. in Talkaround Mode)		Without Optional Preamp: 0.50 µV	Range 1 and 4: 30 MHz
Standby @ 13.8 V:	0.7 A	12 dB SINAD (25 kHz Channel Spacing)	Range 2 and 3: 32 MHz
Receive at Rated Audio @ 13.8 V:	3.0 A	With Optional Preamp: 0.20 µV	Frequency Stability:
Transmit @ Rated Power:	13.0 A	Without Optional Preamp: 0.35 µV	(–30° to +60°C; 25°C Ref.): ±0.00025%
78 Watt (Range 3 & 4)/110 W (Range 1 & 3):		Selectivity: (per EIA Specifications)	Modulation Limiting:
Standby @ 13.8 V:	0.8 A	(Measured in the Analog Mode)	25 kHz Channel Spacing: ±5.0 kHz
Receive at Rated Audio @ 13.8 V:	4.0 A	25 kHz Channel Spacing: –75 dB	12.5 kHz Channel Spacing: ±2.5 kHz
Transmit @ Rated Power:	31.5 A	12.5 kHz Channel Spacing: –70 dB	FM Hum and Noise:
Dimensions (H x W x D)		Intermodulation: (per EIA Specifications)	(Measured in the Analog Mode): –45 dB
W4, W5, and W7 Models:		(Measured in the Analog Mode)	Emission (Conducted and Radiated): –70 dB
Remote-Mount Control Head: 2.0" x 7.1"x 2.2"		With Optional Preamp: –70 dB	Audio Sensitivity:
(50.8 mm x 180.3 mm x 55.9 mm)		Without Optional Preamp: –75 dB	(For 60% Max. Deviation at 1 kHz): 0.08V ±3 dB
Dash-Mount Radio: 2.0" x 7.1"x 8.6"		Spurious Rejection:	Audio Response:
(50.8 mm x 180.3 mm x 218.4 mm)		With Optional Preamp: –80 dB	(Measured in the Analog Mode)
W9 Model:		Without Optional Preamp: –83 dB	(6 dB/Octave Pre-Emphasis 300 to 3000Hz):
Remote-Mount Control Head: 3.4" x 6.5"x 1.7"		Frequency Stability:	+1, –3 dB
(86.4 mm x 165.1 mm x 43.2 mm)		(–30° to +60°C; 25°C Reference): ±0.00025%	Emissions Designators:
Speaker: (excluding mounting bracket)		Audio Output: (per EIA Specifications)	8K10F1E, 11K0F3E, 15K0F2D, 16K0F3E,
5.5" x 5.5"x 2.5"		(Measured in the Analog Mode):	20K0F1E, 15K0F1D, 11K0F1D, and 11K0F2D
(139.7 mm x 139.7 mm x 63.5 mm)		5 Watts at Less Than 3% Distortion	
Weight:		10 Watts Optional with Reduced Duty Cycle	
Mid-Power Radio: 6.1 lbs (2.8 kg)		12 Watts for High-Power Radios	
High-Power Radio: 11.2 lbs (5.1 kg)			
Speaker: 1.5 lbs (0.7 kg)			

Specifications subject to change without notice.
 All measurements are taken in the test mode at 25 kHz channel spacing except where indicated.
 * Maximum power 78 Watts above 470 MHz.

800 MHz Radio Specifications

GENERAL		RECEIVER	TRANSMITTER
FCC Designations:	AZ492FT5759 AZ492FT5751	Frequency Range: 851–869 MHz	Frequency Range: Repeater Mode: 806–824 MHz Talkaround Mode: 851–869 MHz
Temperature Range:		Channel Spacing: 12.5 kHz/20 kHz/25 kHz	
Operating:	–30°C to +60°C	Input Impedance: 50 Ohm	Rated Output Power:
Storage:	–40°C to +85°C	Frequency Separation: 18 MHz	Mid-Power Radio: 15 Watt High-Power Radio: 35 Watt
Power Supply:	12 Vdc Negative Ground Only	Sensitivity: (per EIA spec. RS204C) 20 dB Quieting: (25 kHz Channel Spacing): 0.50µV	Channel Spacing: 12.5 kHz/20 kHz/25 kHz
Battery Drain: (Maximum)		12 dB SINAD: (25 kHz Channel Spacing): 0.35µV	Output Impedance: 50 Ohm
15 Watt:		Digital Sensitivity:	Frequency Separation: 18 MHz
Standby @ 13.8 V:	0.7 A	1% BER (12.5 kHz channel): 0.30µV	Frequency Stability: (–30° to +60°C; 25°C Ref.): ±0.00015%
Receive at Rated Audio @ 13.8 V:	3.0 A	5% BER (12.5 kHz channel): 0.25µV	Modulation Limiting: 25 kHz Channel Spacing: ±5.0 kHz
Transmit @ Rated Power:	6.5 A	Selectivity: (per EIA Specifications) (Measured in the Analog Mode) 25 kHz Channel Spacing: –75 dB	Modulation Fidelity (C4FM): 12.5 kHz Digital Channel: ±2.8 kHz
35 Watt: (30 W max. in Talkaround mode)		Intermodulation: (per EIA Specifications) (Measured in the Analog Mode): –75 dB	FM Hum and Noise: (Measured in the Analog Mode): –40 dB
Standby @ 13.8 V:	0.7 A	Spurious Rejection: –90 dB	Emission (Conducted and Radiated): –60 dBc
Receive at Rated Audio @ 13.8 V:	3.0 A	Frequency Stability: (–30° to +60°C; 25°C Reference): ±0.00015%	Audio Sensitivity: (For 60% Max. Deviation at 1 kHz): 0.08V ±3 dB
Transmit @ Rated Power:	14.0 A	Audio Output: (per EIA Specifications) (Measured in the Analog Mode): 5 Watts at Less Than 3% Distortion 10 Watts Optional with Reduced Duty Cycle 12 Watts for High-Power Radios	Audio Response: (Measured in the Analog Mode) (6 dB/Octave Pre-Emphasis 300 to 3000Hz): +1, –3 dB
Dimensions (H x W x D)			Emissions Designators: 8K10F1E, 15K0F1D, 10K0F2D, 11K0F3E, 15K0F2D, 10K0F1D, 16K0F3E, and 20K0F1E
W4, W5, and W7 Models:			
Remote-Mount Control Head:	2.0" x 7.1" x 2.2" (50.8 mm x 180.3 mm x 55.9 mm)		
Dash-Mount Radio:	2.0" x 7.1" x 8.6" (50.8 mm x 180.3 mm x 218.4 mm)		
W9 Model:			
Remote-Mount Control Head:	3.4" x 6.5" x 1.7" (86.4 mm x 165.1 mm x 43.2 mm)		
Speaker: (excluding mounting bracket)	5.5" x 5.5" x 2.5" (139.7 mm x 139.7 mm x 63.5 mm)		
Weight:			
Mid-Power Radio:	6.1 lbs (2.8 kg)		
High-Power Radio:	11.2 lbs (5.1 kg)		
Speaker:	1.5 lbs (0.7 kg)		

Specifications subject to change without notice.
All measurements are taken in the test mode at 25 kHz channel spacing except where indicated.

Chapter 1 Introduction

1.1 Notations Used in This Manual

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

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



Caution

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



WARNING

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



DANGER

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

1.2 Radio Descriptions

The ASTRO Digital Spectra and Digital Spectra Plus radios are among the most sophisticated two-way radios available. The ASTRO Digital Spectra is available with VHF, UHF, and 800 MHz bands, and the Digital Spectra Plus is available with VHF and 800 MHz bands only.

The ASTRO Digital Spectra and Digital Spectra Plus radios provide 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. Such features add up to better, more cost-effective two-way radio communications.

ASTRO Digital Spectra and Digital Spectra Plus radios are available in five models. Table 1-1 provides a description of basic features for the five models covered in this manual.

Table 1-1. ASTRO Digital Spectra/Spectra Plus Basic Features

Feature	W3	W4	W5	W7	W9
Display	2 line/14 characters Liquid-Crystal Display (LCD) with 8 Status Annunciators	1 line/8 characters Vacuum Fluorescent Display	1 line/8 characters Vacuum Fluorescent Display	1 line/8 characters Vacuum Fluorescent Display	1 line/11 characters Vacuum Fluorescent Display
Mode & Volume Controls	Rocker Switches	Rotary Mode & Volume Controls	Rocker Switch Mode & Volume Controls	Rocker Switch Mode & Volume Controls	Rocker Switch Mode & Volume Controls
Numeric Keypad	Yes	No	No	Yes	Yes
Channel Capability (Digital Spectra)	255	128	128	255	255
Channel Capability (Digital Spectra Plus)	512	128	128	512	512
Remote Mount	Available	Available	Available	Available	Available
Dash Mount	Available	Available	Available	Available	Not Available

1.2.1 FLASHport®

The ASTRO Digital Spectra and Digital Spectra Plus radios utilize Motorola's revolutionary 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, the radio's features and capabilities can be upgraded with FLASHport software, similar to the way a computer can be loaded with different software.

1.3 Control Head Descriptions

1.3.1 General

The control heads used with ASTRO Digital Spectra and Digital Spectra Plus radios have microprocessor circuitry that operates the standard and optional features built into the system. The control head design allows installation in even the smallest of vehicles. Systems that have many options require more control head buttons, not larger control heads.

The control heads may be field-programmed to add options or alter the information stored in certain areas of its electronic memory.

The following illustrations show some typical ASTRO Digital Spectra and Digital Spectra Plus control heads.

1.3.1.1 Model W3 Control Head

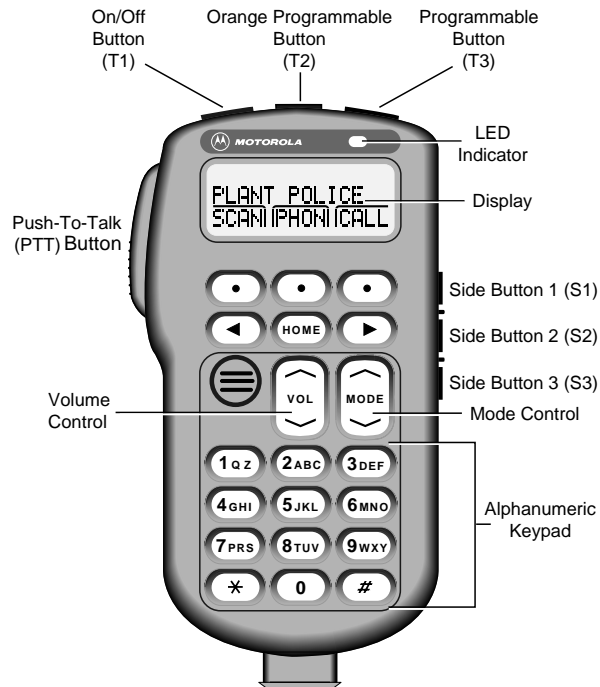


Figure 1-1. Typical W3 Hand-Held Control Head

1.3.1.2 Model W3 Controls

- On/Off Button (T1) — Turns the radio on and off.
- Orange Programmable Button (T2) — Programmed at the factory for emergency. Field-programmable by a qualified radio technician.
- Programmable Button (T3) — Field-programmable by a qualified radio technician.
- LED Indicator — Green/red light-emitting diode indicates operating status.
- Display — Two-line x 14-character display provides visual information about many radio features.
- Keypad — Provides control of, and data interface with, many features.
- Programmable Side Button 1 (S1) — Field-programmable by a qualified radio technician.
- Programmable Side Button 2 (S2) — Field-programmable by a qualified radio technician.
- Programmable Side Button 3 (S3) — Field-programmable by a qualified radio technician.
- Mode Control — Is used for selecting modes and programming menus.
- Volume Control — Is used for selecting the volume level, editing names, and making certain radio adjustments.
- Push-To-Talk (PTT) Button — Engages the transmitter.

1.3.1.3 Models W4, W5, W7, and W9 Controls Head

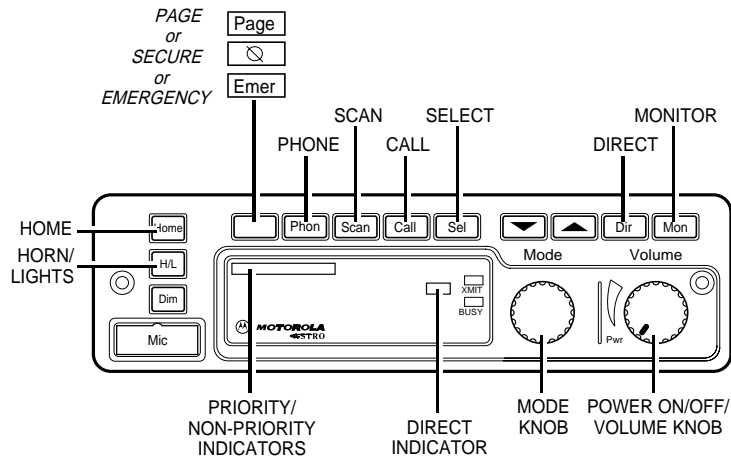


Figure 1-2. Typical W4 Rotary Control Head

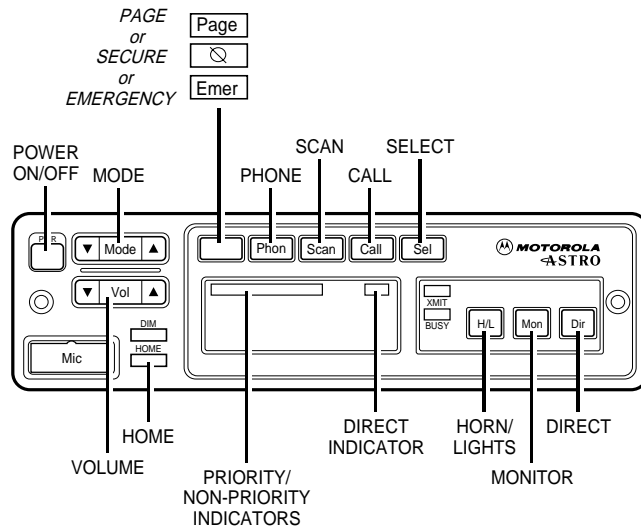


Figure 1-3. Typical W5 Pushbutton Control Head

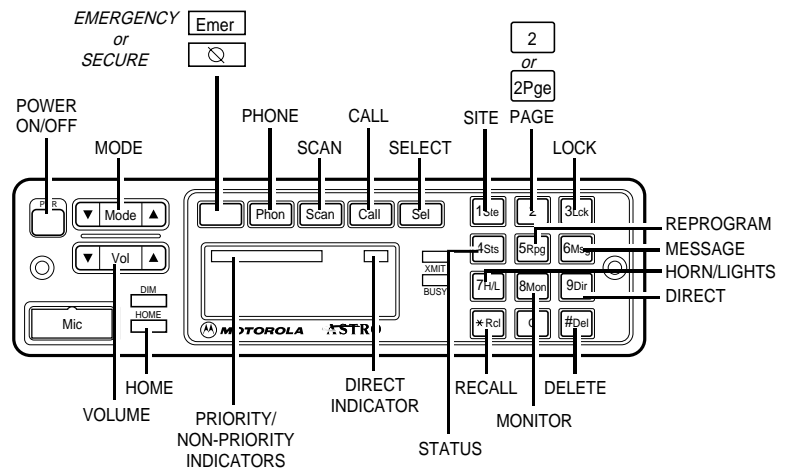
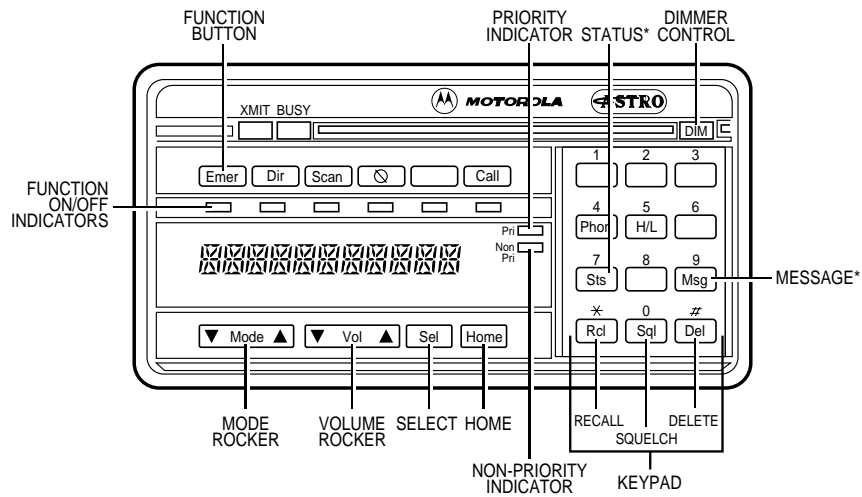


Figure 1-4. Typical W7 Pushbutton Control Head



* Optional buttons (included but not installed or programmed)

Figure 1-5. Typical W9 Pushbutton Control Head

1.3.1.4 Models W4, W5, W7, and W9 Controls

- **Power Switch** — The power (PWR) switch turns the radio and its accessories on or off. The power switch is part of the rotary volume knob on the W4 model, a push-type switch on the W5 and W7 models, and a slide switch on the right-hand bottom surface of the W9 model.
- **Mode Switch** — The Mode switch is used for selecting modes and programming menus. The Mode switch is a rotary switch on the W4 model and a rocker switch on the W5, W7, and W9 models. Pressing the right side of this rocker switch increases the mode number. Pressing the left side decreases the mode number. If you press and hold the switch, it scrolls the mode number up or down. The mode names appear in the display window.
- **Volume Switch** — The Volume switch is used for selecting the volume level, editing names, and making certain radio adjustments. The Volume switch is a rotary switch on the W4 model and a rocker switch on the W5, W7, and W9 models. On the pushbutton models, pressing and releasing the volume switch checks the volume setting. Your display will show "VOLUME __" and a number value (0-15). Press and hold the left side to decrease the volume. The number value scrolls up or down to your desired level. The Volume rocker switch also controls the volume level of the public address (PA) and external radio speaker (Ex Rd) options when they are enabled. The display window shows "PA VOL __" when public address is on and the Volume rocker switch is pressed.
- **Dim Button** — The DIM button is used to control the brightness of the display and button backlighting. When you turn on the system, the display comes on at the brightness level it was on before the system was last turned off. Press the DIM button once to reduce the brightness of the display to medium level and twice for low brightness level. Press the DIM button a third time to turn the display and button backlighting off. This is called the "surveillance" mode.
- **Home Button** — The Home button is used for restoring preprogrammed mode, establishing programmed mode, selecting programming entries, etc. Press the Home button to go to the radio's preprogrammed "home" mode. On the W7 models, you may use the Home button instead of Mode switch to change modes. Hold the Home button until a beep sounds to enter the configuration state. The display shows an entry prompt. Use the keypad to enter your new mode choice and press the Home button again. Your mode is now changed without scrolling.
- **Select Button** — The Sel button is used to configure radio options.

- Option Buttons — The option buttons are used for turning options on and off, such as Phone, Scan, Emergency Call, and Secure.
- Display — The vacuum fluorescent (VF) display's primary function is to display mode numbers, mode names, volume level, and the status of options. It also functions as an on-off indicator for the entire system and plays an integral role in the operator's reconfiguration of options. The display is 8 characters on W4, W5, and W7 models; 11 characters on the W9 model.
- XMIT and BUSY Indicators — The XMIT indicator lights when the radio is transmitting. The BUSY indicator lights when the selected channel is busy.
- Scan Indicators — When scan operation detects activity on a non-priority (NON-PRI) channel, the NON-PRI indicator light comes on. Activity on a second priority channel causes the priority (PRI) indicator to light. First priority channel activity causes PRI to flash.
- 12-Button Keypad (W7 and W9) — The keypad is used to change the status of options and for entering numbers. Several keys serve multiple functions. See the ASTRO Digital Spectra or Digital Spectra Plus User's Guide for a complete description of keypad operation.
 - Site (**Ste** - #1 key) — Forces the radio to scan for a new site when the automatic multiple-site select (AMSS) feature for wide-area coverage is in use.
 - Page (**2** or **2Pge** - #2 Key) — Initiates a Call Alert page/enters Call ID list programming.
 - Lock (**Lck** - #3 key) — Locks the radio onto the current site when the AMSS feature is in use.
 - Status (**Sts** - #4 key) — Used alone or in conjunction with other keypad buttons and the **Sel** button to send a status transmission, indicating a predetermined condition change.
 - Regroup (**Rpg** - #5 key) — Requests a change in the radio's talkgroup assignment when the dynamic regrouping feature is used.
 - Message (**Msg** - #6 key) — Used alone or in conjunction with other keypad buttons and the **Sel** button to transmit a message, indicating a response or temporary condition.
 - Horn/Lights (**H/L** - #7 key) — Selects/enables radio external alarms.
 - Monitor (**Mon** - #8 key) — Monitors the radio for channel traffic.
 - Direct/Simplex (**Dir** - #9 key) — Used for talkaround (mobile-to-mobile) conversations.
 - Recall (**Rcl** - * key) — Reviews modes in scan and phone lists.
 - Delete (**Del** - # key) — Used when editing stored lists.

Chapter 2 Basic Maintenance

2.1 Introduction

This section of the manual describes preventive maintenance, handling precautions, and some basic repair procedures and techniques. Each of these topics provides information vital to the successful operation and maintenance of your radio.

2.2 Preventive Maintenance

Radios are shipped from the factory with a worst-case frequency error of ± 200 Hz for VHF, ± 300 Hz for UHF, and ± 500 Hz for 800 MHz. These specifications are tighter than the most stringent FCC-required specifications of 2 ppm (parts per million) for both VHF and UHF, and 1.5 ppm for 800 kHz, within which the radio will operate to specification.

2.2.1 Reference Oscillator

For radios that have been in storage for over six months from the factory ship date, the reference oscillator should be checked when the radio is initially deployed to the field. It is strongly recommended that the reference oscillator be checked every time the radio is serviced or at least once a year, whichever comes first.

The crystal contained in the reference oscillator naturally drifts over time due to its aging characteristic. Periodic (annual) adjustment of the reference oscillator is important for proper radio operation.

Improper adjustment can result in both poor performance and interference with other users operating on adjacent channels.

A recommended test setup and tuning procedure is detailed in *Chapter 6. Radio Alignment Procedure*. The frequency counter used for this procedure must have a stability of 0.1 ppm or better.

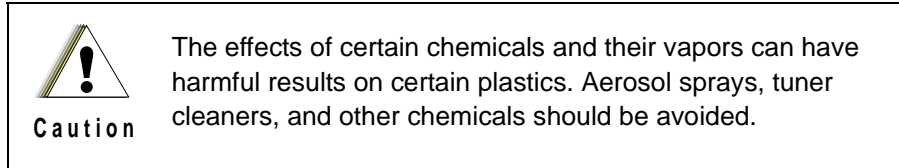
2.2.2 Inspection

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.

2.2.3 Cleaning

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the radio. External surfaces include the control head and radio chassis. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime. Internal surfaces should be cleaned only when the radio is disassembled for servicing or repair.

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water. The only factory recommended liquid for cleaning the printed circuit boards and their components is isopropyl alcohol (70% by volume).



2.2.4 Cleaning External Plastic Surfaces

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, lint-free 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.

2.2.5 Cleaning Internal Circuit Boards and Components

Isopropyl alcohol may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the radio.

Alcohol is a high-wetting liquid and can carry contamination into unwanted places if an excessive quantity is used. Make sure that controls or tunable components are not soaked with the liquid. Do not use high-pressure air to hasten the drying process, since this could cause the liquid to puddle and collect in unwanted places.

Upon completion of the cleaning process, use a soft, absorbent, lint-free cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, front cover, or back cover.

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

2.3 Handling Precautions

Complementary metal-oxide semiconductor (CMOS) 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. DO NOT attempt to disassemble the radio without observing the following handling precautions:

- Eliminate static generators (plastics, Styrofoam, etc.) in the work area.
- Remove nylon or double-knit polyester jackets, roll up long sleeves, and remove or tie back loose-hanging neckties.
- Store and transport all static-sensitive devices in ESD-protective containers.
- Disconnect all power from the unit before ESD-sensitive components are removed or inserted unless otherwise noted.
- Use a static-safeguarded workstation, through the use of an anti-static kit (Motorola part number 01-80386A82). This kit includes a wrist strap, two ground cords, a static-control table mat and a static-control floor mat.

NOTE: Be sure that the table and floor mats are properly grounded.

When these items are not readily available, observing the following techniques will minimize the chance of damage:

-
- If a static-sensitive device is to be temporarily set down, use a conductive surface for placement of the device.
 - Make skin contact with a conductive work surface first and maintain this contact when the device is set down or picked up.
 - Always wear a conductive wrist strap when servicing this equipment. The Motorola part number for a replacement wrist strap that connects to the table mat is 42-80385A59.
 - For additional information, refer to *Service and Repair Note SRN-F1052, Static Control Equipment for Servicing ESD Sensitive Products*, available from the Literature Distribution Center.

Motorola
Literature Distribution Center
2200 Galvin Drive, Suite 2218
Elgin, IL 60123
(847) 783-2522
(847) 783-2523/2524 (Fax)

Notes

Chapter 3 Basic Theory of Operation

3.1 Introduction

The following theory will help isolate the problem to a particular board. Using circuit board replacement as the basic service approach maximizes the working time of the radio.

3.2 General Overview

The ASTRO Digital Spectra and Digital Spectra Plus radios are wideband, synthesized, fixed-tuned radios. The ASTRO Digital Spectra is available with VHF, UHF, and 800 MHz bands. The ASTRO Digital Spectra Plus is available with VHF and 800 MHz bands only. All ASTRO Digital Spectra radios are capable of both analog operation and ASTRO mode (digital) in 12.5 kHz, 20 kHz, 25 kHz, or 30 kHz bandwidths.

The ASTRO Digital Spectra and Digital Spectra Plus radios consist of seven major assemblies, six of which are in the main radio chassis. They are:

- Control Head Assembly (Dash- or Remote-Mount) — is connected, directly or remotely, to the front of the transceiver by the interconnect board or remote interconnect board and control cable. This assembly contains a vacuum fluorescent (VF) display, VF driver, microprocessor and serial bus interface.
- Power Amplifier (PA) — contains antenna switch, directional coupler/detector, and amplifier(s).
- Front-End Receiver Assembly — contains pre-amplifier, preselector, mixer, and injection filter.
- Radio-Frequency (RF) Board — contains receiver IF amplifier, demodulator, synthesizer logic and filtering circuitry, and digital receiver back-end integrated circuit (IC).
- VCO/Buffer/Divider Board — contains voltage-controlled oscillator (VCO), divider, receive and transmit buffers.
- Command Board — contains power control/regulator, digital-to-analog (D/A) IC, serial bus interface, and audio power amplifier (PA).
- VOCON (Vocoder/Controller) Board (Digital Spectra radio) — contains the microcomputer unit (MCU), its associated memory and memory management integrated circuit, and the digital-signal processor (DSP) and its associated memories and support IC.

For the ASTRO Digital Spectra Plus radio, the VOCON board architecture is based on a Dual-Core processor, which contains a DSP Core, an MCODE 210 Microcontroller Core, and custom peripherals. The board also contains memory ICs and DSP-support ICs.

3.3 Analog Mode of Operation

3.3.1 Receive Operation

When the radio is receiving, the signal comes from the antenna/antenna-switch on the power amplifier board to the front-end receiver assembly. The signal is then filtered, amplified, and mixed with the first local-oscillator signal generated by the voltage-controlled oscillator (VCO). The resulting intermediate frequency (IF) signal is fed to the IF circuitry on the RF board, where it is again filtered and amplified. This amplified signal is passed to the digital back-end IC, where it is mixed with the second local oscillator to create the second IF at 450 kHz. The analog IF is processed by an analog-to-digital (A/D) converter, where it is converted to a digital bit stream and divided down to a baseband signal, producing digital samples. These samples are converted to current signals and sent to the digital-signal processor (DSP)-support IC. The DSP-support IC digitally filters and discriminates the signal, and passes it to the DSP. The DSP decodes the information in the signal and identifies the appropriate destination for it. For a voice signal, the DSP routes the digital voice data to the DSP-support IC for conversion to an analog signal. The DSP-support IC then presents the signal to the audio power amplifier on the command board, which drives the speaker. For signaling information, the DSP decodes the message and passes it to the microcomputer.

3.3.2 Transmit Operation

When the radio is transmitting, microphone audio is passed to the command board limiter, then to the DSP-support IC where the signal is digitized. The DSP-support IC passes digital data to the DSP where pre-emphasis and low-pass (splatter) filtering are done. The DSP returns this signal to the DSP-support IC where it is reconverted into an analog signal and scaled for application to the voltage-controlled oscillator as a modulation signal. Transmitted signaling information is accepted by the DSP from the microcomputer, coded appropriately, and passed to the DSP-support IC, which handles it the same as a voice signal. Modulation information is passed to the synthesizer along the modulation line. A modulated carrier is provided to the power amplifier (PA) board, which transmits the signal under dynamic power control.

3.4 ASTRO Mode of Operation

In the ASTRO mode (digital mode) of operation, the transmitted or received signal is limited to a discrete set of deviation levels, instead of continuously varying. 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 specifically defined algorithm to recover information.

In the ASTRO transmit mode, microphone audio is processed the same as an analog mode with the exception of the algorithm the DSP uses to encode the information. This algorithm will result in deviation levels that are limited to discrete levels.

3.5 Control Head Assembly

3.5.1 Display (W4, W5, and W7 Models)

The control head assembly for W4, W5, and W7 models has an 8-character, alphanumeric, vacuum fluorescent display. The anodes and the grids operate at approximately 34 Vdc when on and 0 Vdc when off. The filament operates at approximately 24 Vrms. The voltage for the display is generated by a fixed-frequency, variable duty-cycle controlled "flyback" voltage converter. The switching frequency is approximately 210 kHz. The internal microprocessor controls the voltage converter, which provides approximately 3.7 Vdc to the vacuum fluorescent (VF) driver and approximately 2.4 Vrms to the VF display.

3.5.2 Display (W9 Model)

The control head assembly for a W9 model has an 11-character, alphanumeric, vacuum fluorescent display. It needs three separate voltages to operate: the cathode needs 35V to accelerate electrons to the anode; the grid needs 40V to totally shut off current flow; the filament needs 3.8 Vrms at 80 mA. These voltages are obtained from the transformer on the display controller board.

3.5.3 Vacuum Fluorescent (VF) Display Driver

This VF display driver receives ASCII data from the VOCON board, decodes it into display data, and then scans the display with the data. Once properly loaded into the display, data is refreshed without any further processor action. The display driver is periodically reset by the actions of transistors that watch the clock line from the microprocessor to the display driver. When the clock line is held low for more than 600 milliseconds, the display driver resets and new display data follows.

3.5.4 Vacuum Fluorescent (VF) Voltage Source (W9 Model)

Voltage for the VF display is generated by a fixed frequency, variable-duty cycle driven, flyback voltage converter. An emitter-coupled astable multivibrator runs at approximately 150 kHz. The square wave output from this circuit is integrated to form a triangle that is applied to the non-inverting input of half an integrated circuit (IC).

During start up, the inverting input is biased at 3.7V. A transistor is on while the non-inverting input voltage is below 3.7V. This allows current to flow in a transformer, building a magnetic field. When the triangle wave exceeds 3.7V, the transistor turns off and the magnetic field collapses, inducing negative current in the transformer.

This current flow charges two capacitors. As the voltage on one of the capacitors increases beyond 35V, a diode begins to conduct, pulling the integrated circuit's inverting input below 3.7V. This decreases the cycle time to produce the 35V. The 41V supply is not regulated, but it tracks the 35V supply.

Similarly, the ac supply for VF filament is not regulated, but is controlled to within one volt by an inductor on the display board.

3.5.5 Controls and Indicators

The control head assembly processes all the keypad (button) inputs and visual indicators through the microprocessor. Some of the buttons double as function keys for radio options. All buttons are backlit to allow operation in low light. Refer to *Chapter 1. Introduction* (page 1-3 and page 1-5) for a functional description of each control switch, button, or indicator.

3.5.6 Status LEDs

These LEDs are driven by the display driver as though they were decimal points on the VF display. Level shifting transistors are required for this since the display driver uses 39 Vdc for control signals.

3.5.7 Backlight LEDs

The microprocessor operates the backlight LEDs. A transistor supplies base current to the individual LED driver transistors. The driver transistors act as constant current sources to the LEDs. Some backlight LEDs are connected to a thermistor. This circuit allows more current to flow through these LEDs at room temperature and reduces current as the temperature rises.

3.5.8 Vehicle Interface Port (VIP)

3.5.8.1 Remote-Mount

The VIPs allow the control head to operate outside circuits and to receive inputs from outside the control head. There are three VIP outputs that are used for relay control. There are also three VIP inputs that accept inputs from switches. See the cable kit section for typical connections of VIP input switches and VIP output relays.

The VIP output pins are located on the back of the control head below the area labeled "VIP." These connections are used to control relays. One end of the relay should be connected to switched B+, while the other side is connected to a software-controlled on/off switch inside the control head. The relay can be normally on or normally off depending on how the VIP outputs are configured. The function of these VIP outputs can be defined by field programming the radio. Typical applications for VIP outputs are external horn/lights alarm and horn ring transfer relay control.

3.5.8.2 Dash-Mount

The VIP outputs are driven by a serial-to-parallel shift register. The output transistors are capable of sourcing 300mA current. Primarily, these transistors control external relays. The relay is connected between the collector and switched B+.

Each VIP input transistor is connected to a dedicated input port through transistors used for input protection. These VIP inputs are connected to ground with either normally open or normally closed switches.

3.5.9 Power Supplies

The +5V supply is a three-terminal regulator IC to regulate the 12V SWB+ down for the digital logic hardware.

3.5.10 Ignition Sense Circuits

A transistor senses the vehicle ignition's state, disabling the radio when the ignition is off. For negative-ground systems, the orange lead is typically connected to the fuse box (+12V).

3.6 Power Amplifier

The power amplifier (PA) is a multi-stage, discrete-transistor RF amplifier consisting of the following:

- Low-level power controlling stage
- Drivers
- Final amplifier
- Directional coupler
- Antenna switch
- Harmonic filter

3.6.1 Gain Stages

The first stage buffers the RF signal, filters harmonics, and acts as a variable amplifier. All of the amplifying stages are matched using transmission lines, capacitors, and inductors and are supplied with dc from either A+, keyed 9.4V, or 9.6V sources. Following the last gain stage, PIN diodes switch the signal flow either from the antenna to the receiver, or from the last gain stage to the antenna.

3.6.2 Power Control

A directional coupler and detector network controls power. It senses the forward power from the last gain stage and feeds the detected voltage back to the command board control circuitry, where it is compared to a reference voltage set during power-set procedures. The dc feed voltage is corrected and supplied to the “controlled” stage of the power amplifier. Circuitry on the power amplifier board controls the gain of the first stage and is proportional to the dc control voltage.

3.6.3 Circuit Protection

Current and temperature sensing circuitry on the power amplifier board feed sensed voltages to the command board for comparison. If the command board suspects a fault condition, it overrides the power control function and cuts the power back to a level that is safe for the conditions.

3.6.4 DC Interconnect

The ribbon cable connector carries sensed voltages for power and protection to the command board. It also carries A+ feed to the command board for distribution throughout the internal transceiver chassis and carries control voltage from the command board to the power amplifier board.

The rear battery connector carries A+ from the battery to the power amplifier board. The red lead goes directly to the A+ terminal on the PA board. The black lead from the battery connector ties to the chassis, and connection to the power amplifier board is made through the board mounting screws.

A+ ground connection for the internal transceiver chassis is through the RF coax ground connectors and through the mechanical connection of the power amplifier heatsink to the rest of the radio. During test conditions in which the power amplifier assembly (board and heatsink) is physically disconnected from the rest of the radio, it is acceptable to rely on the coax cable connections to carry ground to the internal chassis.

3.7 Front-End Receiver Assembly

The receiver front-end consists of a preselector, a mixer circuit, and an injection filter. The receiver injection (1st local oscillator) comes from the VCO assembly through a coax cable. The injection filter is either fixed-tuned or tuned at the factory depending upon the bandsplit. The output of the filter is connected to the mixer.

The preselector is a fixed-tuned filter. The receiver signal is fed to the preselector from the antenna switch in the PA for the 800 MHz radios, or the preamp output for VHF and UHF. The signal is then sent to the mixer integrated circuit where it is connected to the mixer transistor. The receiver injection is also fed to this point. The mixer output is at the 1st IF center frequency of 109.65MHz. This signal is sent to the 1st IF on the RF board through a coaxial cable.

3.8 Radio Frequency (RF) Board

The RF board contains the common synthesizer circuits and dual IF receiver and demodulation circuits. A 4-pole crystal filter at 109.65MHz provides first IF selectivity. For HRN6014D, HRN6020C, HRN6019C, HRN4009D, HRN4010C, and later RF board kits, two 2-pole crystal filters provide first IF selectivity at 109.65MHz. The output of the filter circuit is fed directly to the custom digital backend circuit module. An amplifier (at 109.65MHz), the second mixer, the second IF amplifiers (at 450 kHz), the IF digital-to-analog converter, and the baseband down-converter are part of the digital backend circuit module. The digital backend circuit module also converts a 2.1MHz reference to a 2.4MHz clock for the DSP support circuit module.

Synthesizing for the first and second VCO is performed by the prescaler and synthesizer ICs. These ICs are programmed through a serial data bus from signals generated on the VOCON board. A dc voltage, generated on the command board, sets the synthesizer's reference oscillator frequency of 16.8MHz. This voltage is controlled by the digital-to-analog converter (D/A), and is the only element of the RF board requiring alignment.

The second local oscillator runs at 109.2MHz (low-side injection), and consists of a VCO that is frequency-locked to the reference oscillator. Part of the local oscillator's circuitry is in the prescaler IC.

A clamp and rectifier circuit on the RF board generates a negative dc voltage of 4 volts (nominal) for increasing the total voltage available to the first VCO and second local oscillator's VCO. The circuit receives a 300 kHz square wave output from the prescaler IC, then clamps, rectifies, and filters the signal for use as the negative steering line for the two VCOs.

3.9 Voltage-Controlled Oscillator (VCO)

3.9.1 VHF Radios

The voltage-controlled oscillator (VCO) assembly utilizes a common-gate FET in a Colpitts configuration as the gain device. The LC tank circuit's capacitive portion consists of a varactor bank and a laser-trimmed stub capacitor. The inductive portion consists of microstrip transmission line resonators. The stub capacitor serves to tune out build variations. Tuning is performed at the factory and is not field adjustable. The varactor network changes the oscillator frequency when the dc voltage of the steering line changes. The microstrip transmission lines are shifted in and out of the tank by PIN diodes for coarse frequency jumps. A third varactor is used in a modulation circuit to modulate the oscillator during transmit.

The VCO output is coupled to a transistor for amplification and for impedance buffering. The output of this stage passes through a low-pass filter where the signal is split into three paths. One path feeds back to the synthesizer prescaler; the other two provide injection for the RX and TX amplification strings. The receive injection signal is further amplified and passed to the RX front-end injection filter. The transmit signal goes to an ECL divider, which divides the signal by two. The signal is amplified and buffered and then injected into the transmitter's low-level amplifier.

A 5V regulator provides power to the divider. All transmit circuitry operates from keyed 9.4 volts to conserve current drain while the radio is receiving. A transistor/resistor network drives the PIN diodes in the VCO tank. These driver networks provide forward bias current to turn diodes on and reverse the bias voltage to turn the diodes off. AUX 1 AND AUX 2 lines control the PIN diode driver networks.

3.9.2 UHF and 800 MHz Radios

The VCO assembly generates variable frequency output signals controlled by the two steering lines. The negative steering line increases the tuning range of the VCO, while the positive steering line affects the synthesizer control loop to incrementally change the frequency.

The VCO generates a signal in the required frequency range. For UHF and 800 MHz radios, this signal is fed to the doubler/buffer circuit which, in turn, doubles the VCO output frequency and amplifies it to the power level required by the TX buffer and RX mixer. A PIN diode switch routes the signal to the TX port when the keyed 9.4V is high. Otherwise, the signal is routed to the RX port. The VCO assembly's synthesizer feedback output is the same as the doubler output frequency.

3.10 Command Board

The serial input/output IC provides command board functions including buffers for PTT, channel active, squelch mute, busy, and data transmission, and logic functions for switched B+, emergency, reset, and power control.

The regulator and power control circuits include an unswitched +5V discrete circuit and the regulator/power control IC, which produces both switched +5V and 9.6V. The unswitched +5V source is used as a reference for its switched +5V source. Filtered unswitched +5V is used for the microcontrol circuits. Switched +5V and 9.6V are controlled by a digital transistor from the serial input/output IC. The power control circuitry receives power set and limit inputs from the digital-to-analog IC, and feedback from the RF power amplifier. Based on those inputs, the power control circuitry produces a control voltage to maintain a constant RF power level to the antenna.

The reset circuits consist of the power-on reset, high/low battery voltage reset, and the external bus system reset. The reset circuits allow the microcomputer to recover from an unstable situation; for example, no battery on the radio, battery voltage too high or too low, and remote devices on the external bus not communicating. Communication in RS-232 protocol is provided by an IC which interfaces to the rear accessory connector (J2).

3.11 VOCON (Vocoder/Controller) Board

The VOCON board, located on the top side of the radio chassis, contains a microcontrol unit (MCU) with its flash memory, DSP, and DSP-support ICs. The VOCON board controls receive/transmit frequencies, the display, and various radio functions, using either direct logic control or serial communication to external devices. The connector J801 provides interface between the encryption module and the VOCON board for encrypting voice messages.

3.11.1 ASTRO Digital Spectra

The VOCON board executes a stored program located in the FLASH ROM. Data is transferred to and from memory by the microcontrol unit data bus. The memory location from which data is read, or to which data is written, is selected by the address lines.

The support-logic IC acts as an extension of the microcontrol unit by providing logic functions such as lower address latch, reset, memory address decoding, and additional control lines for the radio. The VOCON board controls a crystal-pull circuit to adjust the crystal oscillator frequency on the microcontrol unit, so that the E-clock harmonics do not cause interference with the receive channel.

The vocoder circuitry on the VOCON board is powered by a switched +5 volt regulator located on the command board. This voltage is removed from the board when the radio is turned off by the control head switch.

The DSP IC performs signaling, voice encoding/decoding, audio filtering, and volume control functions. This IC performs Private-Line/Digital Private-Line (PL/DPL) encode and alert-tone generation. The DSP IC transmits pre-emphasize analog signals and applies a low-pass (splatter) filter to all transmitted signals. It requires a 33MHz crystal to function. An 8 kHz interrupt signal generated by the DSP-support IC is also required for functionality. This device is programmed using parallel programming from the microcontrol unit and the DSP-support IC.

The DSP-support IC performs analog-to-digital and digital-to-analog conversions on audio signals. It contains attenuators for volume, squelch, deviation, and compensation, and it executes receiver filtering and discrimination. The IC requires a 2.4MHz clock to function (generated by the digital back-end IC) and is programmed by the microcontrol unit's SPI bus.

3.11.2 ASTRO Digital Spectra Plus

The VOCON board, located on the top-side of the chassis, contains a Dual-Core processor, which, in turn, contains a DSP Core, an MCore Microcontroller Core, and custom peripherals. The board also contains memory ICs and DSP support ICs.

The VOCON board controls receive/transmit frequencies, the display, and various radio functions, using either direct logic control or serial communication to external devices. The connector J801 provides an interface between the encryption module and the VOCON board for encrypting voice messages.

The VOCON board executes a stored program located in the FLASH ROM. Data is transferred to and from memory by the microcontroller unit data bus. The memory location from which data is read, or to which data is written, is selected by the address lines.

The vocoder circuitry on the VOCON board is powered by two regulated voltage supplies: 3.0 Vdc and 1.8 Vdc. These regulated supplies are powered by a switched 5 Vdc regulator located on the command board. This 5 Vdc supply also powers some vocoder circuitry. This voltage is removed from the board when the radio is turned off by the control head switch.

The DSP Core inside the Dual-Core processor performs signaling, voice encoding/decoding, audio filtering, and volume control functions. This core performs Private-Line/Digital Private-Line (PL/DPL) encode and alert-tone generation. The DSP Core transmits pre-emphasized analog signals and applies a low-pass (splatter) filter to all transmitted signals. The Dual-Core processor requires a 16.8MHz and a 32 kHz clock to function.

The DSP-support ICs perform analog-to-digital and digital-to-analog conversions on audio signals. They contain attenuators for volume, squelch, deviation, and compensation. The receiver interface IC requires a 2.4MHz clock to function (generated by the digital back-end IC) and is programmed by the microcontroller unit's SPI bus.

Chapter 4 Test Equipment, Service Aids, and Tools

4.1 Recommended Test Equipment

The list of equipment contained in Table 4-1 includes most of the standard test equipment required for servicing Motorola mobile radios, as well as several unique items designed specifically for servicing this family of radios. The *Characteristics* column is included so that equivalent equipment can 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 Motorola Test Equipment

Motorola Model Number	Description	Characteristics	Application
R-1013_* or R-1370_*	SINAD Meter SINAD Meter with RMS Voltmeter	w/o RMS audio voltmeter w/RMS audio voltmeter	Receiver sensitivity measurements
R-1074_*	Fluke 87 Digital Multimeter	True RMS metering, 200kHz frequency counter, 32-segment bar graph with backlit display	Recommended for ac/dc voltage and current measurements
R-1151_*	Code Synthesizer 2, Expanded		Injection of audio and digital signaling codes
R-1377_*	AC Voltmeter	1mV to 300V, 10-Megohm input impedance	Audio voltage measurements
R-1439_ or R-1440_ (See Table 4-2 for plug-in elements)	BIRD Wattmeter BIRD Wattmeter	Power range: 100 mW to 100W, 2MHz to 1GHz, UHF-F connector Power range: 100 mW to 100W, 2MHz to 1GHz, N-female connector	Transmitter power measurements
R-1611_	Dual-Channel 100Mhz Oscilloscope (Agilent)	Two-channel, 100MHz bandwidth, 200 M sample rate/ sec., 2MB memory/channel	Waveform measurements
R-2600 Series	System Analyzer	This item will substitute for items with an asterisk (*).	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
S-1339_	RF Millivolt Meter	100 μ V to 3V RF 10 kHz to 1GHz	RF-level measurements
S-1348_	DC Power Supply, Programmable	0-20 Vdc, 0-5 Amps current limited	Bench supply for 7.5 Vdc
SLN-6435	Audio Isolation Transformer		Audio measurements (audio PA must NOT be grounded)

Table 4-2 contains a listing of the plug-in elements that are available for the BIRD wattmeters listed in the Table 4-1.

Table 4-2. *Wattmeter Plug-In Elements*

Power	25-60MHz	50-125MHz	100-250MHz	200-500MHz	400-1000MHz
5W	---	01-80305F21	01-80305F29	01-80305F38	01-80305F46
10W	---	01-80305F22	01-80305F30	01-80305F39	01-80305F47
25W	01-80305F15	01-80305F23	01-80305F31	01-80305F40	01-80305F48
50W	01-80305F16	01-80305F24	01-80305F32	01-80305F41	01-80305F49
100W	01-80305F17	01-80305F25	01-80305F33	01-80305F42	01-80305F50
250W	01-80305F18	01-80305F26	01-80305F34	01-80305F43	01-80305F51
500W	01-80305F19	01-80305F27	01-80305F35	01-80305F44	01-80305F52
1000W	01-80305F20	01-80305F28	01-80305F36	01-80305F45	01-80305F53

Table 4-3 contains a listing of non-Motorola test equipment recommended for servicing mobile radios.

Table 4-3. *Recommended Non-Motorola Test Equipment*

Model Number	Description	Application
Agilent 8901_	Modulation Analyzer	Reference oscillator deviation and compensation measurements
Weinschel 49 30 43	30 dB RF Attenuator	For tests that require a modulation analyzer or wattmeter

4.2 Service Aids and Recommended Tools

Refer to the tables in this section for a listing and description of the service aids and tools designed specifically for servicing this family of radios, as well as the more common tools required to disassemble and properly maintain the radio. These kits and/or parts are available from the Motorola Parts Division offices listed in the *Replacement Parts Ordering* section located on page A-1 of this manual.

Table 4-4 lists recommended service aids common to both ASTRO Digital Spectra and ASTRO Digital Spectra Plus radios. While all of these items are available from Motorola, most are standard shop equipment items, and any equivalent item capable of the same performance can be substituted for the item listed.

Table 4-4. Common Service Aids for Board-Level Troubleshooting

Motorola Part Number	Description	Application
30-80370E06	Extender Cable	Provides extension cable for VOCON Board (connectors P501/J501)
RPX-4725A (includes 30-80370E05 Extender Cable)	Command and Control Service Cable Kit	Provides extension cables for servicing digital and analog circuits
RPX-4724A (includes:	RF Service Cable Kit	Provides interface cables needed to service the RF boards
28-84606M01	Crimp-On Mini UHF Male Connector	Adapts any coax of appropriate size (RPG58 or equivalent) for mating to antenna connector
30-80373B25	RX Injection Board	Connects to the RX injection output of the VCO assembly for testing RX injection level
30-80373B26*	Output Cable BNC Male to SMB Male Cable	Mates to printed-circuit board mounted SMB female connectors
30-80373B41*	BNC Female to Taiko-Denki Male Cable	Mates to printed-circuit board mounted Taiko-Denki female connectors
30-80373B27**	BNC Male to SMB Female Cable	Mates to cable-mounted SMB male connectors
01-80355A28**)	BNC Female to Taiko-Denki Female Adapter	Mates to cable-mounted Taiko-Denki male connectors
TKN-8531	Key-Variable Loader Cable	Used to load encryption keys into the radio (see also 58-80219R01 below)
58-80219R01	Adapter Cable	Must be ordered and used with TKN-8531
58-80367B21	Mini UHF Male to 'N' Female Adapter	
58-80367B22	Mini UHF Male to UHF Female Adapter	

* These cables allow connection to:

- VCO injection output to power amplifier for testing TX injection level
- Receiver front-end/mixer output for testing the proper mixer conversion gain
- Synthesizer feedback input for testing feedback buffer and prescaler operation
- RF board IF input for testing receiver back-end sensitivity
- RX injection output of the VCO assembly

**These cables allow connection to:

- Power amplifier test input
- Receiver input cable for testing RX loss through harmonic filter and antenna switch
- VCO synthesizer feedback level
- Receiver front-end/mixer output for testing the proper mixer conversion gain

Table 4-5 lists additional service aids that can be used in troubleshooting ASTRO Digital Spectra radios.

Table 4-5. Service Aids for ASTRO Digital Spectra Board-Level Troubleshooting

Motorola Part Number	Description	Application
RLN-4008_	Radio Interface Box (RIB)	Enables communications between the radio and the RSS
RLN-1015_	Smart RIB (SRIB)	Enables communications between the radio and the RSS. Required to FLASH the radio
RLN-4488_	Battery Pack	Used to supply backup power to SRIB
01-80357A57	Wall-Mounted Power Supply	Used to supply power to the RIB (120 Vac)
01-80358A56	Wall-Mounted Power Supply	Used to supply power to the RIB (220 Vac)
01-80302E27	Adapter	Used to supply power to the SRIB (120 Vac)
25-80373E86	Adapter	Used to supply power to the SRIB (220 Vac)
30-80369B71 (25-pin to 15-pin) or 30-80369B72 (9-pin to 15-pin)	Computer Interface Cable	Connects the computer's serial communications adaptor to the RIB
30-80390B48 (9-pin to 9-pin) or 30-80390B49 (25-pin to 9-pin)	Computer Interface Cable	Connects the computer's serial communications adaptor to the SRIB
30-80369B73 or 01-80300B10	Radio Interface Cable	Connects low-power and mid-power radios to the RIB
	Radio Interface Cable	Connects high-power radios to the RIB
RVN-4184	Radio Service Software (DOS Version)	Replaces RVN-4124. Software on 3-1/2 in. and 5-1/4 in. floppy disks
RVN-4183	Customer Programming Software (Windows Version)	Programming software; available only on CD.

Table 4-6 lists additional service aids that can be used in troubleshooting ASTRO Digital Spectra Plus radios.

Table 4-6. Service Aids for ASTRO Digital Spectra Plus Board-Level Troubleshooting

Motorola Part Number	Description	Application
30-85001D01	Programming Flash Cable	Used with Tuner Software, CPS, and FLASHport
RVN-4185	Customer Programming Software and Tuner Software	Programming and radio alignment software on CD

Table 4-7. Recommended Tools for Board-Level Troubleshooting

Motorola Part Number	Description	Application
01-80386A82	Anti-Static Grounding Kit	Used during radio assembly and disassembly procedures
RSX-4043_	Roto-Torq Adjustable Torque Screwdriver	Used during radio assembly and disassembly procedures
66-80163F01	Insertion and Extraction Tool	Provides assistance in installation and/or removal of wires from VIP and accessory connectors
01-80370B87	L-Shaped Hex Key Set	Used during radio assembly and disassembly procedures
01-80320B16	Magnetic Screwdriver Set with Bits	Used during radio assembly and disassembly procedures

4.3 Field Programming Equipment

The ASTRO family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. For ASTRO Digital Spectra radios, refer to the applicable *Radio Service Software User's Guide* for complete field programming information. For ASTRO Digital Spectra Plus radios, refer to the online help in the Customer Programming Software.

4.3.1 ASTRO Digital Spectra

The ASTRO Digital Spectra radios use an electrically erasable, programmable read-only memory (EEPROM) device to store information on frequencies, squelch codes, signaling codes, time-out timer durations, and other parameters.

The ASTRO Digital Spectra radios can be programmed in the field any number of times without removing the EEPROM from the radio. To program, an IBM® or IBM PC-compatible computer is connected to the radio through the rear accessory connector. Once the computer is connected to the radio, the prompts provided by the software can be followed.

The following items, available through the Customer Care and Services Division (except the computer), are required when programming ASTRO Digital Spectra Model radios.

Table 4-8. ASTRO Digital Spectra Field Programming Items

Type or Part Number	Description
01-80300B10 Programming Cable	Used to connect high-power radios (50W-110W) directly to the RIB or SRIB.
30-80369B71 Computer Interface Cable	RLN-4008 RIB-to-computer cable. For computers with a 25-pin serial (COM) port.
30-80369B72 Computer Interface Cable	RLN-4008 RIB-to-computer cable. For computers with a 9-pin serial (COM) port.
30-80369B73 Programming Cable	RIB-to-radio programming cable for low- and mid-power radios.
30-80390B48 Computer Interface Cable	RLN-1015 SRIB-to-computer cable. For computers with a 9-pin serial (COM) port.
30-80390B49 Computer Interface Cable	RLN-1015 SRIB-to-computer cable. For computers with a 25-pin serial (COM) port.
Computer, IBM or IBM PC-compatible	
CVN-6085 Radio Service Software (3-1/2" disks)	Software that provides the capability of changing the radio frequencies, squelch codes, and other radio parameters. Replaces RVN-4100.
RLN-1015A Smart Radio Interface Box (SRIB)	A voltage-level shifter to enable communications between the radio and the computer's RS-232 port. Allows use of FLASHport technology.
RLN-4008B Radio Interface Box (RIB)	A voltage-level shifter to enable communications between the radio and the computer's RS-232 port.
RPX-4719 Radio Service Software Package	Kit containing software licensing agreement, software order forms, and a list of available software. Must be ordered prior to ordering any software.
RKN-4047A EEPROM Flash Program Interface Cable	Used to load the radio with new features using FLASHport technology. Requires RLN-1015 SRIB.

4.3.1.1 ASTRO Digital Spectra W3 Smart RIB Issue

When flashing a Model W3 mobile radio, the smart RIB box tends to reset if the correct power-up sequence is not observed. To avoid this problem, you must power up the radio before you use the smart RIB box. You might damage the control head or the RIB box if you use a modified RIB box to flash Model W3 radios.

4.3.1.2 ASTRO Digital Spectra Remote W3 Y Cable

The remote Y cable required for high-power Model W3 radios cannot be used for programming. The accessory connector in this cable does not have the BUS+, BUS-, and BUSY lines.

In mid-power radios, when this cable is used, programming must be done through the rear accessory connector.

4.3.2 ASTRO Digital Spectra Plus

The ASTRO Digital Spectra Plus radios use a flash memory device to store information on frequencies, squelch codes, signaling codes, time-out timer durations, and other parameters.

The ASTRO Digital Spectra Plus radios can be programmed in the field any number of times without removing the flash memory from the radio. To program, an IBM or IBM PC-compatible computer is connected to the radio through the front connector using the programming cable. Once the computer is connected to the radio, the prompts provided by the user-friendly software can be followed.

The following items, available through the Customer Care and Services Division (except the computer), are required when programming ASTRO Digital Spectra Plus radios.

Table 4-9. ASTRO Digital Spectra Plus Field Programming Items

Type or Part Number	Description
30-85001D01 Programming Cable	Used to connect radio directly to the computer.
Computer, IBM or IBM PC-compatible	
RVN-4185 Customer Programming Software and Tuner Software	This software enables you to program the radio's features and align its parameters.

4.3.2.1 ASTRO Digital Spectra Plus Model W3

For the ASTRO Digital Spectra Plus radio with a W3 control head, it is possible for the message FL01/90 to display while using the HKN6155 programming cable for tuner, CPS, or flash programming. Upon completion of the operation, a reset will clear the message. Powering on the radio before attaching the programming cable will decrease the occurrence of the FL01/90 message.

Notes

Chapter 5 Performance Checks

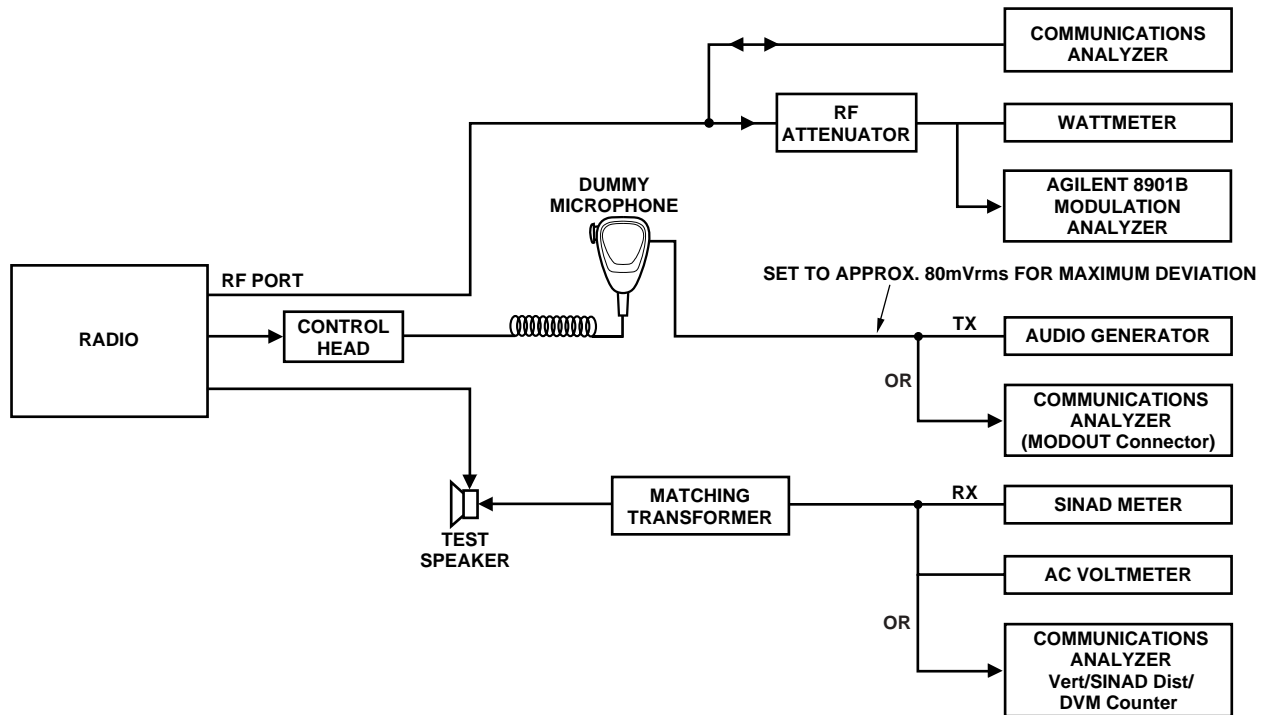
5.1 Introduction

This section covers performance checks used to verify that the 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 equipment must be maintained in compliance with the manufacturer's recommended calibration schedule.

5.2 Test Setup

The equipment required for performance checks is connected as shown in the following diagrams.

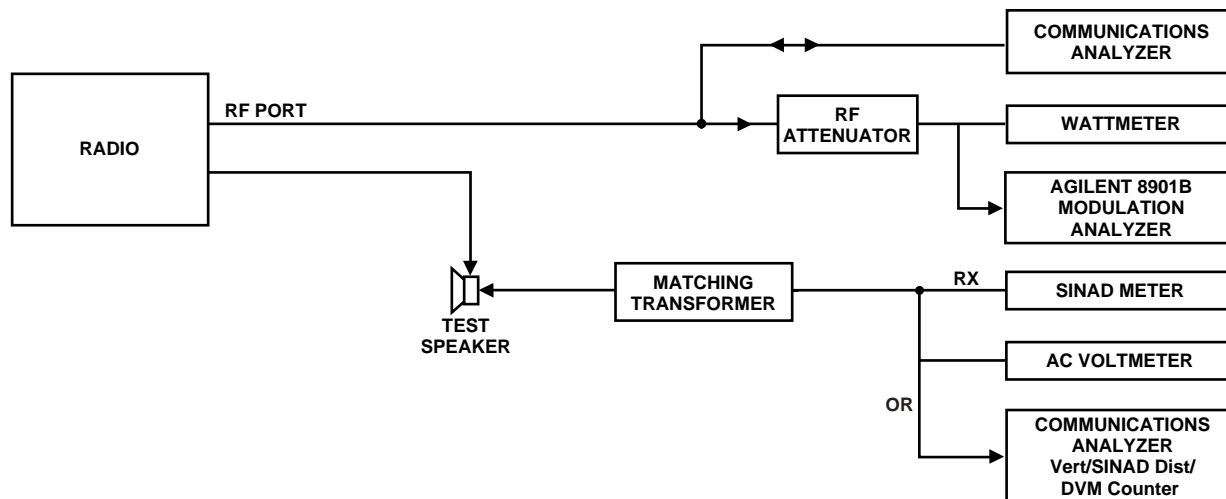
5.2.1 ASTRO Digital Spectra



MAEPF-27500-0

Figure 5-1. ASTRO Digital Spectra Performance Checks Test Setup

5.2.2 ASTRO Digital Spectra Plus



MAEPF-27501-O

Figure 5-2. ASTRO Digital Spectra Plus Performance Checks Test Setup

5.3 Test Mode

NOTE: The test mode for the ASTRO Spectra radio is different from the standard Spectra radio, but is similar to the ASTRO portable test mode.

Be sure to transmit into a load when keying a radio under test.

5.3.1 Entering Test Mode

1. To enter test mode, turn the radio on.
2. Within 10 seconds after Self Test is complete, press the **Home** button five times in succession. The Self Test for the ASTRO Digital Spectra Plus radio is displayed as SPECTRA+.
3. The radio will show a series of displays that will give information regarding various version numbers and subscriber-specific information. The displays are described in Table 5-1.

Table 5-1. Test-Mode Displays

Display Name	Description	Appears
SERVICE	Indicates the radio has entered test mode	Always
Radio Host Software Version	The version of radio firmware	Always
DSP Software Version	The version of firmware being used by the DSP	Always
EMC Secure Version	Version of the encryption hardware	When the radio is secure equipped

Table 5-1. Test-Mode Displays (Continued)

Display Name	Description	Appears
Encryption Firmware	Firmware version for encryption	When the radio is secure equipped
Encryption Type 1	Type of encryption being used	When the radio is secure equipped
Encryption Type 2	Type of encryption being used	When the radio is secure equipped
Control Head Version	Control head firmware version number	Always
Auxiliary Control Head	Firmware version for the auxiliary control head	When an auxiliary control head is present
Siren Version	Firmware version for the siren	When a siren is present
VRS Version Number	Firmware version for the VRS	When VRS is present
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
ROM Size	Memory capacity of the flash port	Always
FLASHcode	The FLASHcodes, as programmed as a part of the radio's codeplug	Always

Note: All displays are temporary and will expire without any user intervention. If the information is longer than the physical length of the control head display, it will wrap around to the next display. After the last display, RF TEST will be displayed.

4. Pressing the **Mode** rocker will cause the displays to stop. The test mode menu, CH TEST, will be displayed.
5. Pressing the **Home** button will cause the displays to stop. The RF test mode will be entered. The display will show 1 CSQ, indicating test frequency 1, Carrier Squelch mode.
6. Go to the **RF Test Mode** section.

5.3.2 RF Test Mode

A special routine, called **RF TEST MODE** or *air test*, has been incorporated in the radio.

1. **Enter the RF test mode by pressing the Home button when the test mode menu RF TEST is displayed. Use the Mode rocker to cause the radio to display the test mode menu, RF TEST, if the display reads CH TEST.**

2. In RF test mode, press the **Volume** rocker to adjust the volume. The volume display for the ASTRO Digital Spectra will be in 256 increments, not the usual 16, while in the test mode. This allows for precise setting of rated audio, etc.
For the ASTRO Digital Spectra Plus, the volume is still displayed as a value between 0 to 15.
3. Press the **Home** button to move the cursor back and forth between the frequency and signaling type (See Table 5-2 on this page and Table 5-3 on page 5-5). The first digit will flash to indicate which type is currently selected. Press the **Mode** button to scroll through the available selections.

Table 5-2. Test Frequencies

Test Channel	VHF	UHF	800 MHz
Range 1 - TX #1	136.050	403.050	806.050
Range 1 - RX #1	136.025	403.025	851.025
Range 1 - TX #2	149.050	418.050	823.950
Range 1 - RX #2	149.025	418.525	860.025
Range 1 - TX #3	161.950	432.950	868.950
Range 1 - RX #3	161.975	432.975	868.975
Range 2 - TX #1	146.050	438.050	None
Range 2 - RX #1	146.025	438.025	None
Range 2 - TX #2	160.050	454.050	None
Range 2 - RX #2	160.025	454.025	None
Range 2 - TX #3	173.950	469.950	None
Range 2 - RX #3	173.975	469.975	None
Range 3 - TX #1	None	450.050	None
Range 3 - RX #1	None	450.025	None
Range 3 - TX #2	None	466.050	None
Range 3 - RX #2	None	466.025	None
Range 3 - TX #3	None	481.950	None
Range 3 - RX #3	None	481.975	None
Range 4 - TX #1	None	482.050	None
Range 4 - RX #1	None	482.025	None
Range 4 - TX #2	None	497.050	None
Range 4 - RX #2	None	497.025	None
Range 4 - TX #3	None	511.950	None
Range 4 - RX #3	None	511.975	None

Table 5-3. Signaling Types

Display	Modulation	Demodulation	Type
CSQ	None	None	Carrier Squelch
TPL	192Hz	192Hz	Private-Line
AST	1200Hz	N/A	ASTRO (digital)
USQ	None	None	Open Squelch

When in the transmit test mode, DTMF modulation produces a sidetone in the speaker. All signaling types will continually modulate the transmitted signal for detection/measurement by external instruments.

5.3.3 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio and is entered through the front panel programming sequence. This test mode allows you to perform button and display tests to verify proper operation.

1. Enter the control head test mode by pressing the Home button when the test mode menu, CH TEST, is displayed. Use the Mode rocker to cause the radio to display the test mode menu, CH TEST, if the display reads RF TEST.
2. Press the Mode switch to change the test mode from the RF test mode to the control head test mode (CH TEST).

NOTE: Once the CH Test has been selected by pressing Home, pressing the Mode switch will not change the control head test mode back to the RF test mode. You must turn the radio off and reenter the RF test mode as described earlier.

3. When the control head test mode is selected (CH TEST), press the Home button. The display will show the interpreted key number. Status of the key press is indicated to the right of the key number.

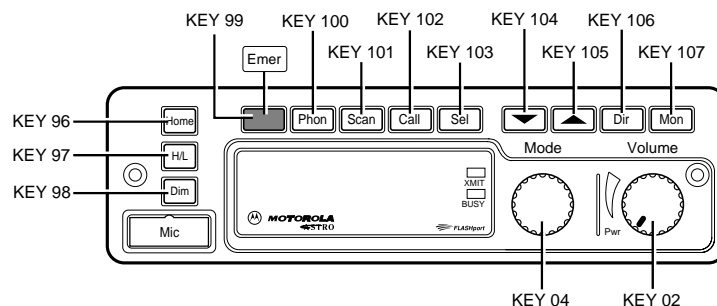


Figure 5-3. Rotary Control Head Key-Closure Displays (W4)

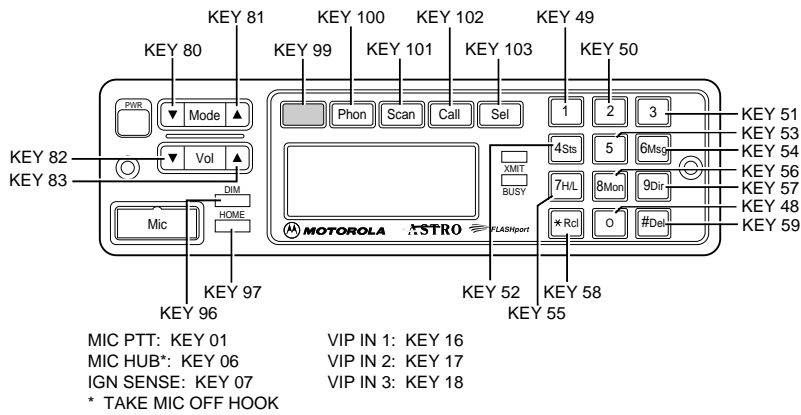


Figure 5-4. Pushbutton Control Head Key-Closure Displays (W5 and W7)

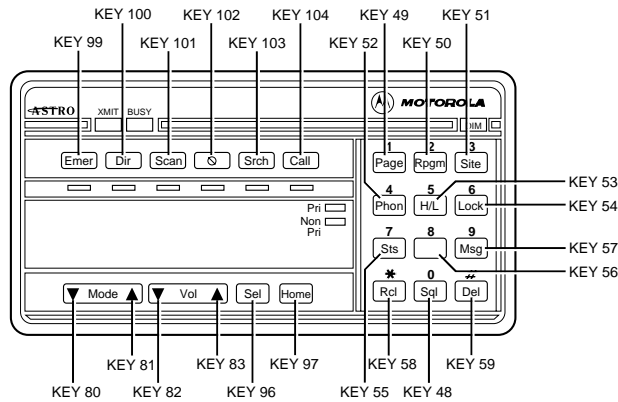


Figure 5-5. Pushbutton Control Head Key-Closure Displays (W9)

4. Switch the radio power off temporarily to exit the test mode and return to normal radio operation.

5.4 Receiver Performance Checks

Table 5-4. Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Condition	Comments
Reference Frequency	Mode: PWR MON 1st channel test frequency* Monitor: Frequency error Input at RF In/Out	TEST MODE, 1 CSQ output at antenna	Press and hold PTT switch.	Frequency error to be ± 70 Hz (VHF) ± 150 Hz (UHF) ± 150 Hz (800 MHz)
Rated Audio	Mode: GEN Output level: 1.0mV RF 1st channel test frequency* Mod: 1 kHz tone at 3 kHz deviation Monitor: DVM: ac Volts	TEST MODE, 1 CSQ	Release PTT switch.	Set volume control to 6.3 Vrms across the speaker
Distortion	As above, except to distortion	TEST MODE, 1 CSQ	Release PTT switch.	Distortion < 3.0%

Table 5-4. Receiver Performance Checks (Continued)

Test Name	System Analyzer	Radio	Test Condition	Comments
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12 dB SINAD	TEST MODE, 1 CSQ	Release PTT switch.	RF input to be < 0.35 μ V
Noise Squelch Threshold (only radios with conventional system need to be tested)	RF level set to 1 mV RF	TEST MODE, 1 CSQ	Release PTT switch.	Set volume control to 3.16 Vrms across the speaker
	As above, except change frequency to a conventional system. Raise RF level from zero until radio unsquelches.	Out of TEST MODE; select a conventional system	Release PTT switch.	Unsquelch to occur at < 0.25 μ V

* Test frequencies are listed in Table 5-2.

5.5 Transmitter Performance Checks

Table 5-5. Transmitter Performance Checks

Test Name	System Analyzer	Radio	Test Condition	Comments
Reference Frequency	Mode: PWR MON 1st channel test frequency** Monitor: Frequency error Input at RF In/Out	TEST MODE, 1 CSQ	Press and hold PTT switch.	Frequency error to be \pm 70 Hz (VHF) \pm 150 Hz (UHF) \pm 150 Hz (800 MHz)
Power RF	As above	TEST MODE, 1 CSQ	Press and hold PTT switch.	Refer to the Radio Specifications in the front of the manual.
Voice Modulation	Mode: PWR MON 1st channel test frequency** atten to -70, input to RF In/Out, Monitor: DVM, ac Volts Set 1 kHz Mod Out level for 0.025 Vrms at test set, 80 mVrms at dummy microphone input	TEST MODE, 1 CSQ	Press and hold PTT switch.	Deviation: VHF, UHF, and 800 MHz: \geq 3.6 kHz but \leq 5.0 kHz
Voice Modulation (internal)	Mode: PWR MON 1st channel test frequency** atten to -70, input to RF In/Out	TEST MODE, 1 CSQ, output at antenna	Remove modulation input from dummy microphone. Press and hold PTT switch.	Press PTT switch on microphone and say "four" loudly into the radio mic. Measure deviation: VHF, UHF, and 800 MHz: \geq 3.8 kHz but \leq 5.0 kHz

Table 5-5. Transmitter Performance Checks (Continued)

Test Name	System Analyzer	Radio	Test Condition	Comments
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to 1st channel test frequency**; B/W to narrow	TEST MODE, 1 TPL	Remove modulation input from dummy microphone. Press and hold PTT switch.	Deviation: VHF, UHF, and 800 MHz: >= 500 Hz but <= 1000 Hz
Talkaround Modulation (radios with conventional, clear mode, talkaround operation only)	Change frequency to conventional talkaround frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, ac volts Set 1 kHz Mod Out level for 80 mVrms at dummy microphone.	Conventional talkaround personality (clear mode operation) 1 CSQ	Press and hold PTT switch.	Deviation: UHF and 800 MHz: >= 3.8 kHz but <= 5.0 kHz
Talkaround Modulation (radios with conventional, secure mode, talkaround operation only) *	Change frequency to conventional talkaround frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, ac volts Mod: 1 kHz out level for 80 mVrms at dummy microphone.	Conventional talkaround personality (secure mode operation). Load key into radio 1 sec.	Press and hold PTT switch.	Deviation: UHF and 800 MHz: >= 3.6 kHz but <= 4.4 kHz

* The secure mode, talkaround modulation test is only required for radios that do not have clear mode talkaround capability.

** Test frequencies are listed in Table 5-2.

Chapter 6 Radio Alignment Procedure

6.1 Introduction

This section describes both receiver and transmitter radio alignment procedures using either of the following radio alignment software:

- ASTRO Digital Spectra Radio Service Software (DOS-based)
- ASTRO Digital Spectra and Digital Spectra Plus Tuner software (Windows-based)

6.2 RSS

6.2.1 ASTRO Digital Spectra

An IBM or IBM PC-compatible computer and radio service software (RSS) are required to align the ASTRO Digital Spectra radio. Refer to the applicable RSS manual for installation and setup procedures for the software.

To perform the alignment procedures, the radio must be connected to the computer, radio interface box (RIB), and a universal test set as shown in Figure 6-1.

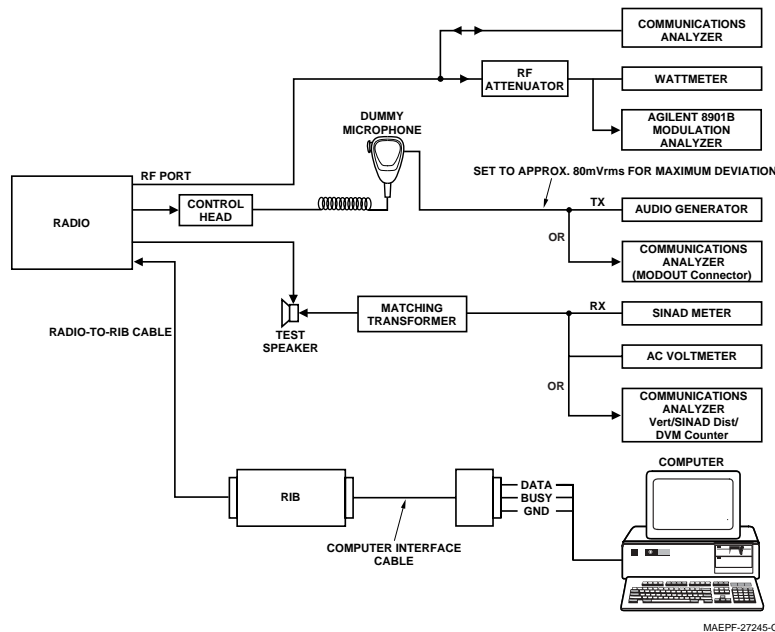


Figure 6-1. ASTRO Digital Spectra Radio Alignment Test Setup

All service and tuning procedures are performed from the SERVICE menu, which is selected by pressing F2 from the MAIN MENU. Figure 6-2 illustrates how the RSS alignment SERVICE screens are organized.

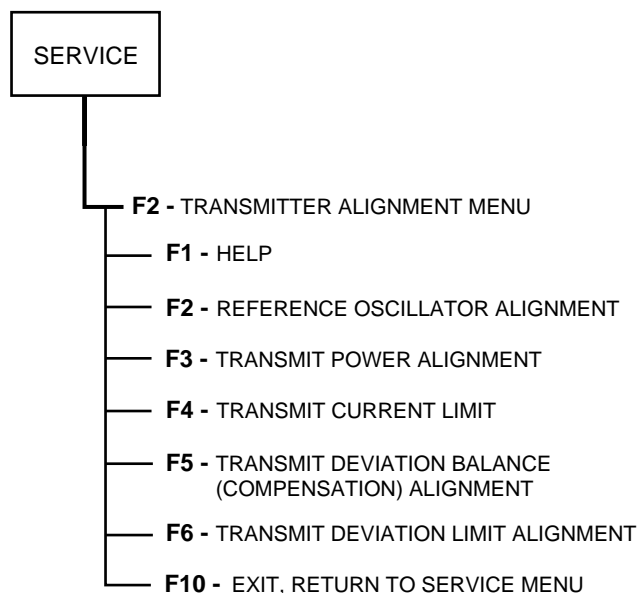


Figure 6-2. RSS Service Menu Layout

All SERVICE screens read and program the radio codeplug directly; you do NOT have to use the RSS GET/SAVE functions to use the SERVICE menus.

6.2.2 Softpot

The SERVICE screens introduce the concept of the *softpot*, an analog SOFTWARE-controlled POTentiometer used for adjusting all transceiver alignment controls.

Each SERVICE screen provides the capability to increase or decrease the softpot value with the keyboard UP/DOWN arrow keys respectively. A graphical scale is displayed indicating the minimum, maximum, and proposed value of the softpot, as shown in Figure 6-3.

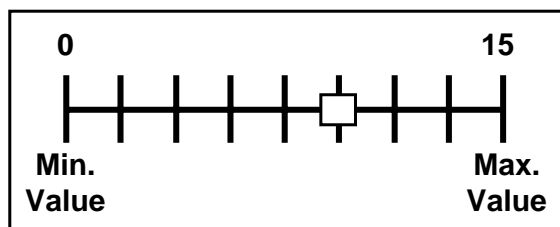


Figure 6-3. Softpot Concept

Adjusting the softpot value sends information to the radio to increase (or decrease) dc voltage in the corresponding circuit. For example, pressing the UP arrow key at 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 alignment procedures in the sequence indicated.

NOTE: Some of the following screens may vary depending upon the radio under test and the version of radio service software you are using. Refer to your radio service software user's guide.

6.2.3 Reference Oscillator Alignment

Radios are shipped from the factory with a worst-case frequency error of ± 200 Hz for VHF, ± 300 Hz for UHF, and ± 500 Hz for 800 MHz. These specifications are tighter than the more stringent FCC requirement of 1.5 ppm for all bands.

For radios that have been in storage for over six months from the factory ship date, the reference oscillator should be checked when the radio is initially deployed to the field. It is strongly recommended that the reference oscillator be checked every time the radio is serviced or at least once a year, whichever comes first.

The crystal contained in the reference oscillator naturally drifts over time due to its aging characteristic. Periodic (annual) adjustment of the reference oscillator is important for proper radio operation.

Improper adjustment can result in both poor performance and interference with other users operating on adjacent channels.

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

1. Initial set up using the R-2670 Communication Analyzer:
 - RF Control: MONITOR
 - B/W: WB
 - Freq: RSS 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
2. Initial set up using the 8901_ Series Modulation Analyzer:
 - Press the green Automatic Operation button on the analyzer.
 - Press the **FREQ** key.
 - Type 7.1 followed by the **SPCL** button to set the 8901_ modulation analyzer for maximum accuracy.
3. Read the radio using the RSS.
4. From the SERVICE MENU, press **F2** to select the TRANSMITTER ALIGNMENT MENU.
5. Press **F2** again to select the REFERENCE OSCILLATOR alignment screen (Figure 6-4).

MOTOROLA Radio Service Software ASTRO Model: T04SLF9PW7AN		Use UP/DOWN Arrows To Adjust Softpot.	
MAIN:SERVICE:TX ALIGN:REF OSC			
REFERENCE OSCILLATOR -----			
Frequency	Current Value		
-----	-----		
869.9875	72	New Softpot Value.....72	
Transmitter..On			
0	-----X-----		255
MIN			MAX
F1 HELP	F2	F3	F4
	F5	F6 TOGGLE PTT	F7
		F8 PROGRAM VALUE	F9
			F10 EXIT

Figure 6-4. Reference Oscillator Alignment Screen

6. If you are using the R-2670 Communication Analyzer, enter the frequency displayed on the RSS screen in the “RF control” section of the R-2670. Under the “Meter” section of the display, choose RF DISPLAY.
7. Press **F6** to key the radio. The screen will indicate that the radio is transmitting.
8. Wait 5 seconds until the analyzer reading settles. Record the transmitter frequency (or note the frequency error reading on the screen).
9. Use the Up and Down arrow keys on your computer keyboard to adjust the reference oscillator softpot value. Allow approximately five seconds for the analyzer frequency reading to stabilize after each change.
10. Adjust the frequency error, as indicated in Table 6-1.

Table 6-1. Reference Oscillator Alignment

Band	Target
VHF	±70Hz
UHF	±150Hz
800 MHz	±150Hz

11. Press **F6** again to dekey the radio.
12. Press **F8** to program the new softpot value.
13. Press **F10** once to return to the TRANSMITTER ALIGNMENT MENU, or press **F10** twice to return to the SERVICE MENU.

6.2.4 Transmit Power Alignment

NOTE: All power measurements are to be made at the antenna port.

NOTE: The transmitter power setting keeps the radiated power at or below the level specified in the exclusionary clause for low power devices of IEEE Standard C95.1-1991.

NOTE: The power amplifier must be firmly mounted to the transceiver for accurate power adjustment.

1. From the SERVICE MENU, press **F2** to select the TRANSMITTER ALIGNMENT MENU.
2. Press **F3** to select the TRANSMIT POWER alignment screen. The screen will indicate the transmit frequencies to be used (Figure 6-5).

MOTOROLA Radio Service Software ASTRO Model: T04SLF9PW7AN MAIN:SERVICE:TX ALIGN:TX POWER	Use UP/DOWN Arrows To Adjust Softpot.																																																	
TRANSMIT POWER ----- <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Frequency</th> <th colspan="3" style="text-align: center;">Current Value</th> <th colspan="3" style="text-align: center;">New Softpot Value</th> </tr> <tr> <th></th> <th style="text-align: center;">High Pwr</th> <th style="text-align: center;">Mid Pwr</th> <th style="text-align: center;">Low Pwr</th> <th style="text-align: center;">High Pwr</th> <th style="text-align: center;">Mid Pwr</th> <th style="text-align: center;">Low Pwr</th> </tr> </thead> <tbody> <tr> <td>806.0125</td> <td style="text-align: center;">35</td> <td style="text-align: center;">35</td> <td style="text-align: center;">35</td> <td style="text-align: center;">10</td> <td style="text-align: center;">23</td> <td style="text-align: center;">23</td> </tr> <tr> <td>821.0125</td> <td style="text-align: center;">42</td> <td style="text-align: center;">42</td> <td style="text-align: center;">42</td> <td style="text-align: center;">11</td> <td style="text-align: center;">28</td> <td style="text-align: center;">28</td> </tr> <tr> <td>851.0125</td> <td style="text-align: center;">50</td> <td style="text-align: center;">50</td> <td style="text-align: center;">50</td> <td style="text-align: center;">20</td> <td style="text-align: center;">33</td> <td style="text-align: center;">33</td> </tr> <tr> <td>866.0125</td> <td style="text-align: center;">60</td> <td style="text-align: center;">60</td> <td style="text-align: center;">66</td> <td style="text-align: center;">33</td> <td style="text-align: center;">40</td> <td style="text-align: center;">40</td> </tr> <tr> <td>869.9875</td> <td style="text-align: center;">70</td> <td style="text-align: center;">70</td> <td style="text-align: center;">70</td> <td style="text-align: center;">43</td> <td style="text-align: center;">45</td> <td style="text-align: center;">45</td> </tr> </tbody> </table> <p style="text-align: center;">Transmitter..On</p> <p style="text-align: center;">0 -----X----- 127</p> <p style="text-align: center;">MIN -----+-----+-----+-----+-----+-----+-----+-----+-----+----- MAX</p>		Frequency	Current Value			New Softpot Value				High Pwr	Mid Pwr	Low Pwr	High Pwr	Mid Pwr	Low Pwr	806.0125	35	35	35	10	23	23	821.0125	42	42	42	11	28	28	851.0125	50	50	50	20	33	33	866.0125	60	60	66	33	40	40	869.9875	70	70	70	43	45	45
Frequency	Current Value			New Softpot Value																																														
	High Pwr	Mid Pwr	Low Pwr	High Pwr	Mid Pwr	Low Pwr																																												
806.0125	35	35	35	10	23	23																																												
821.0125	42	42	42	11	28	28																																												
851.0125	50	50	50	20	33	33																																												
866.0125	60	60	66	33	40	40																																												
869.9875	70	70	70	43	45	45																																												
F1 HELP	F2	F3	F4	F5	F6 TOGGLE PTT	F7	F8 PROGRAM VALUE	F9	F10 EXIT																																									

Figure 6-5. Transmit Power Alignment Screen

3. Press **Tab** (or **Enter** or **Return**) to select a frequency field (starting with the highest frequency shown).
4. Press **F6** to key the radio. The screen will indicate that the radio is transmitting.
5. Use the **UP/DOWN** arrow keys to adjust the transmit power per the values shown in Table 6-2.

Table 6-2. Transmit Power Settings

VHF Rated Output Power	Min. Level	Max. Level
10-25W	10.5W	28W
25-50W	26.5W	56W
50-110W	54W	113W
UHF Rated Output Power	Min. Level	Max. Level
6W	6W	7W
10-25W	10.5W	28W
20-40W	20.5W	45W
78W	76W	80W
15W	16W	19W
50-110W	54W	110W

Table 6-2. Transmit Power Settings (Continued)

800 MHz Rated Output Power	Min. Level	Max. Level
15W	15W	20W
35W (Repeater Mode)	37W	42W
30W (Talkaround Mode)	32W	42W

6. Press **F6** to dekey the radio.
7. Press **F8** to program the value.
8. Repeat steps 3-7 for the remaining frequencies.
9. Press **F10** once to return to the TRANSMITTER ALIGNMENT MENU, or press **F10** twice to return to the SERVICE MENU.

6.2.5 Transmit Current Limit Alignment

1. From the SERVICE MENU, press **F2** to select the TRANSMITTER ALIGNMENT MENU.
2. Press **F4** to select the TRANSMIT CURRENT LIMIT alignment screen. The screen will indicate the transmit frequencies to be used (Figure 6-6).

NOTE: The current limit before alignment should be set to 15 (for no limiting).

MOTOROLA Radio Service Software ASTRO Model: T04SLF9PW7AN					Use UP/DOWN Arrows To Adjust Softpot.					
MAIN:SERVICE:TX ALIGN:CURRENT LIMIT										
CURRENT LIMIT -----										
Frequency		Current Value			New Softpot Value					
-----		-----			-----					
806.0125		11			11					
821.0125		11			11					
851.0125		11			11					
866.0125		11			11					
869.9875		11			11					
Transmitter..On										
0									15	
MIN		-----+	-----+	-----+	X	-----+	-----+	-----+	-----+	MAX
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	
HELP					TOGGLE PTT		PROGRAM VALUE		EXIT	

Figure 6-6. Transmit Current Limit Alignment Screen

3. Press **Tab** (or **Enter** or **Return**) to select a frequency field (starting with the test frequency with the highest current drain).
4. Press **F6** to key the radio. The screen will indicate that the radio is transmitting.
5. Use the **DOWN** arrow key to decrease the current limit relative value until the transmit power output begins to drop.
6. Then, increase the current limit value by one increment.
7. Press **F8** to program the new softpot value.

8. Press **F10** once to return to the TRANSMITTER ALIGNMENT MENU, or press **F10** twice to return to the SERVICE MENU.

6.2.6 Transmit Deviation Balance (Compensation) Alignment

NOTE: Compensation alignment is only required after replacing (or servicing) the command board, VOCON (vocoder/controller) board, RF board, or the VCO board.

Compensation alignment balances the modulation sensitivity of the VCO and reference modulation (synthesizer low-frequency port) lines. The compensation algorithm is critical to the operation of signaling schemes that have very-low-frequency components (for example, DPL) and could result in distorted waveforms if improperly adjusted.

Compensation values are adjusted at the different test frequencies to achieve a flat VCO modulation sensitivity with respect to the RF frequency and with respect to the low frequency response of the synthesizer.

This test can be done with either the R-2670 Communication Analyzer or the 8901_ Series Modulation Analyzer. The R-2670 analyzer is recommended.

1. Initial set up 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 via the soft key menu. Select 20 kHz for the "Low Pass" setting.
 - In the "RF Control" section of the R-2670, enter the frequency displayed on the RSS screen (choose a test frequency from the list of frequencies displayed under Transmit Deviation Balance [Compensation] in RSS). Move the cursor to the "B/W" setting and select "WIDE +/- 100 kHz" via 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 set up using the 8901_ Series Modulation Analyzer:
 - Press the **FM MEASUREMENT** button. (The "Error 03-input 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 button.
3. From the SERVICE MENU, press **F2** to select the TRANSMITTER ALIGNMENT MENU.
4. Press **F5** to select the TRANSMIT DEVIATION BALANCE (COMPENSATION) alignment screen (Figure 6-7).

MOTOROLA Radio Service Software ASTRO Model: T04SLF9PW7AN		Use UP/DOWN Arrows To Adjust Softpot.
MAIN:SERVICE:TX ALIGN:BAL ATTN		
TRANSMIT DEVIATION BALANCE (COMPENSATION)		

Frequency	Current Value	New Softpot Value

806.0125	30	30
821.0125	30	30
851.0125	30	30
866.0125	45	45
869.9875	45	45
Transmitter..Off		
0	-----X-----	63
MIN		MAX
F1 HELP	F2 TOGGLE LOW TONE PTT	F3 TOGGLE HIGH TONE PTT
F4	F5	F6 PROGRAM VALUE
F7	F8	F9 EXIT
F10		

Figure 6-7. Transmit Deviation Balance (Compensation) Alignment Screen

5. Press **Tab** to select and start the alignment at the *lowest* frequency listed.
6. Press **F3** (TOGGLE LOW TONE PTT) to key the radio. Wait approximately five seconds until the frequency displayed on the analyzer stabilizes.
7. Measure and record the deviation value from the 8901_ analyzer or the ac voltage value from the R-2670 analyzer.
8. Press **F3** to dekey the radio.
9. Press **F6** (TOGGLE HIGH TONE PTT) to key the radio. Wait approximately 5 seconds until the voltage shown on R-2670 analyzer, or the deviation shown on the 8901_ analyzer, stabilizes.
10. Use the Up and Down arrow keys on the computer keyboard to adjust the deviation to within $\pm 1.5\%$ of the value recorded in step 6.
11. Press **F6** to dekey the radio, and then press **F6** again to verify the deviation setting.
12. Press **F8** to program the new softpot value.
13. Repeat steps 4 through 10 to ensure the correct deviation balance value has been saved.
14. Repeat steps 4 through 11 for each of the remaining frequencies.
15. Press **F10** once to return to the TRANSMITTER ALIGNMENT MENU, or press **F10** twice to return to the SERVICE MENU.

6.2.7 Transmit Deviation Limit Alignment

This test can be done with either the R-2670 communication analyzer or the 8901_ Series Modulation Analyzer. The R-2670 is recommended.

1. Initial set up using the R-2670 Communication Analyzer:
 - Connect a BNC cable between the "DEMODO OUT" port and the "VERT/SINAD DIST/DMM COUNTER IN" port of 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 via the soft key menu. Select 20 kHz for the "Low Pass" setting.

- In the "RF Control" section of the R-2670, enter the frequency displayed on the RSS screen (choose a test frequency from the list of frequencies displayed under TRANSMIT DEVIATION LIMIT screen in RSS). Move the cursor to the "B/W" setting and select "WIDE +/- 100 kHz" via the soft key menu.
 - Place the R-2670 cursor in the "Display" zone. Move the cursor to the "Meter" setting and select "AC VOLTS" via the soft key menu. Move the cursor to the "Range" setting and select "AUTO."
2. Initial set up using the 8901_ Series Modulation Analyzer:
 - Press the **FM MEASUREMENT** button. (The "Error 03-input 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 button.
 3. From the SERVICE MENU, press **F2** to select the TRANSMITTER ALIGNMENT MENU.
 4. Press **F6** to select the TRANSMIT DEVIATION LIMIT alignment screen (Figure 6-8).

MOTOROLA Radio Service Software ASTRO Mobile Model: T04SLF9PW7AN		Use UP/DOWN Arrows To Adjust Softpot.	
MAIN:SERVICE:TX ALIGN:DEVIATION			
TRANSMIT DEVIATION LIMIT -----			
Frequency	Current Value	New Softpot Value	
813.4750	11750	11750	
822.4750	11750	11750	
858.4750	11800	11800	
867.9750	11800	11800	
Transmitter..Off			
0			32767
MIN	-----+-----+-----+-----X-----+-----+-----+-----+-----+-----		MAX
F1 HELP	F2	F3	F4
	F5	F6 TOGGLE PTT	F7
		F8 PROGRAM VALUE	F9
			F10 EXIT

Figure 6-8. Transmit Deviation Limit Alignment Screen

5. Press **Tab** to select and start the alignment at the *lowest frequency* listed.
6. Press **F6** and observe the measurement.
7. Wait approximately 5 seconds until the voltage shown on the R-2670 analyzer, or the deviation shown on the 8901_ analyzer, stabilizes.
8. Adjust the deviation limit to within 0.158 to 0.163 Vac on the R-2670 analyzer, or 2.785 to 2.885 kHz on the 8901_ analyzer. The optimum setting is 0.160 Vac (2.83 kHz).
9. Press **F6** again to dekey the radio.
10. Press **F8** to program the new softpot value.
11. Repeat steps 4 through 7 to ensure the correct deviation limit is saved.
12. Repeat steps 3 through 7 for each of the remaining frequencies.
13. If the transmit limit adjustment required was excessive, repeat or recheck the transmit deviation balance (compensation) procedure on page 6-7.
14. Press **F10** once to return to the TRANSMITTER ALIGNMENT MENU, or press **F10** twice to return to the SERVICE MENU.

6.2.8 Bit Error Rate (BER) Performance Check

This check tests the Bit Error Rate (BER) of the radio's receiver at a desired frequency.

Required equipment and software: R-2670 system analyzer, with P25 option; IBM PC-compatible computer, RSS

In Generate mode, the R-2670 system analyzer modulates the RF carrier with a 1011Hz tone test pattern to test the Unit Under Test (UUT) receiver. The test pattern received by the UUT is compared in the UUT with a stored version of the test pattern to compute a BER.

1. Connect the RF Input port of the UUT to the RF IN/OUT port of the analyzer.
2. Set up the R-2670 as follows:
 - Place the cursor in the RF Zone, and configure the analyzer as follows:
RF control: Generate
Preset: B/W: NB
Freq: Desired test frequency; for example, 851.0625MHz
Output Level: -50.0 dBm
Gen RF Out: RF I/O
 - Place the cursor on the Mode field in the Display Zone.
 - Select PROJECT 25 STD.
 - Set the METER field to RF DISPLAY.
 - Place the cursor on the CODE field in the Audio Zone.
 - Select the 1011 Hz PAT softkey.
This generates a 1011Hz tone test pattern. If this pattern is received correctly by the UUT, the measured BER should be zero.
 - Set the deviation in the Audio Zone as PROJ25Dev: 2.83 kHz ~.
3. Using the RSS, configure the UUT as follows:
 - In the RSS Main Menu, press **F2** to select SERVICE: Alignment.
 - Press **F5** to select Performance Testing.
 - Press **F2** to select Bit Error Rate.
 - Enter the desired test frequency in the Rx Frequency (MHz) field; for example, 851.0625MHz.
 - Set the Modulation Type to 12.5 kHz/C4FM.
 - Set the BER Integration Time (sec) to not less than 7.200.
 - Press **F6** (Start/Stop) to begin the test.
4. Monitor the radio's received BER (%) results on the computer.
5. Reduce the analyzer output level to achieve a standard Bit Error Rate of 5%. The analyzer RF output level should be within the SINAD specification of the UUT.

6.3 ASTRO Digital Spectra and Digital Spectra Plus Tuner Software

A personal computer (PC) and Tuner Software are required to align the radio. Please refer to the *CPS Programming Installation Guide* (Motorola part number 6881095C44) for installation and setup procedures for the software. To perform the alignment procedures, the radio must be connected to the computer and to a universal test set, as shown in the following figure.

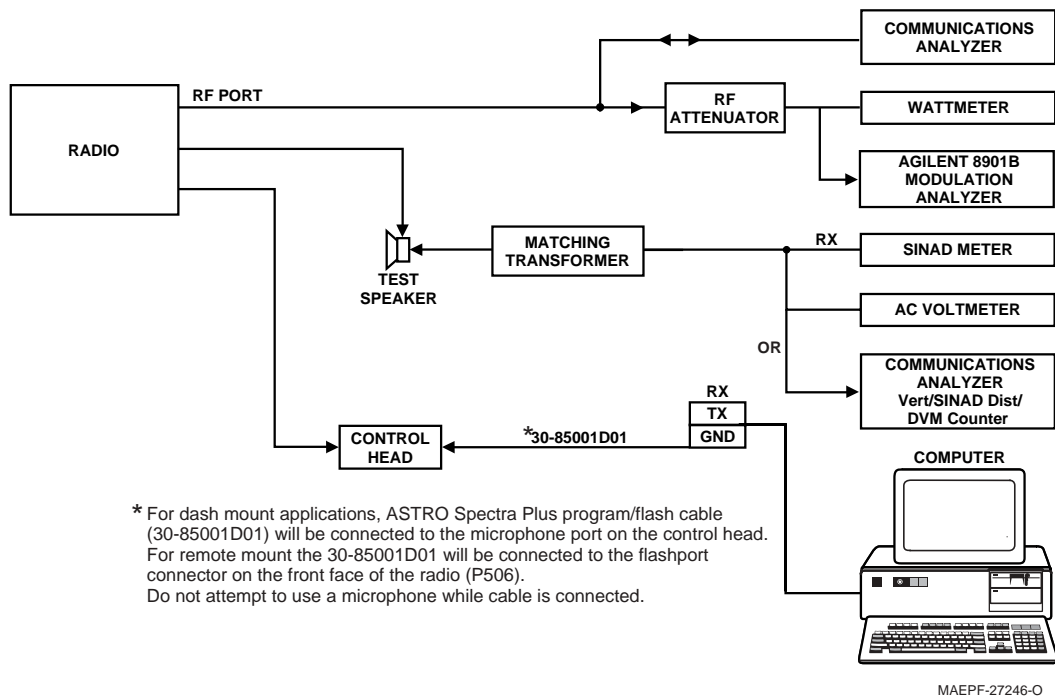



Figure 6-9. ASTRO Digital Spectra Plus Radio Alignment Test Setup



Caution

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

Select **Tuner** from the **START** menu. To read the radio, use the **File** → **Read Device** menu or click on . Figure 6-10 illustrates how the alignment screens are organized. To access a screen, double-click on the desired screen name in the **Tuner** menu.

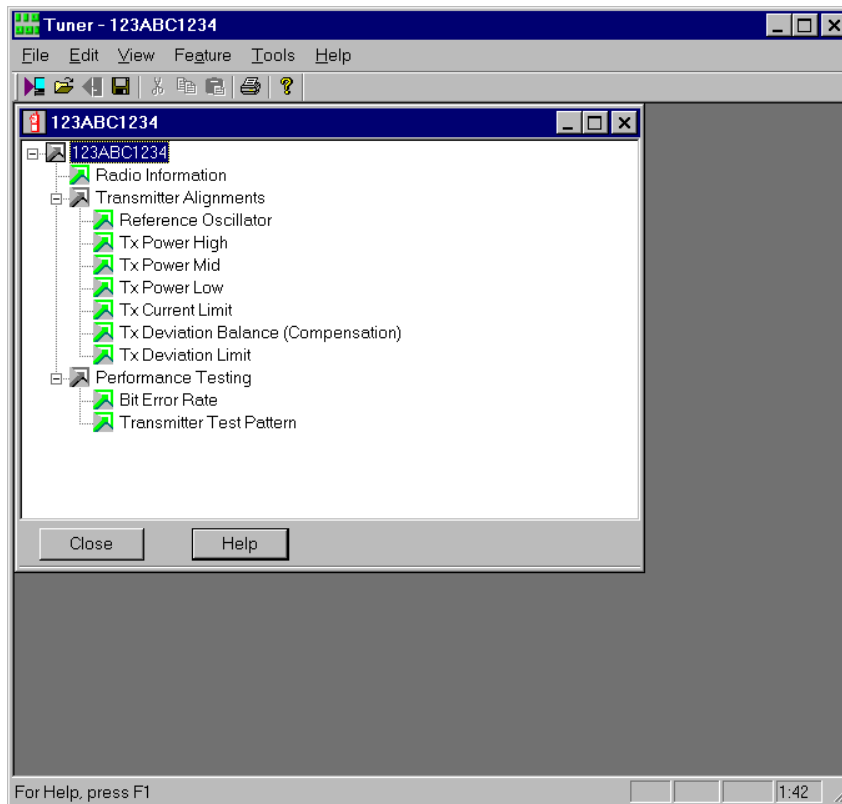


Figure 6-10. Tuner Menu Layout

The alignment screens introduce the concept of the “softpot,” an analog **SOFTWARE**-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 may 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 the **slider** or the screen’s **spin buttons** (▲ and ▼), or by entering the new value from the keyboard. A graphical scale on the display indicates the minimum, maximum, and proposed value of the softpot; see Figure 6-11.

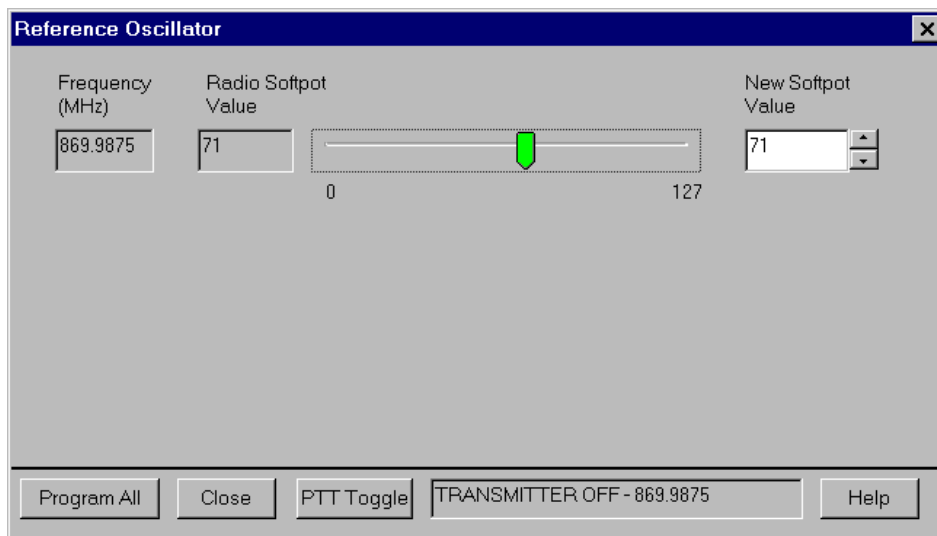


Figure 6-11. Typical Softpot Adjustment Screen

Adjusting the softpot value sends information to the radio to increase (or decrease) a voltage in the corresponding circuit. For example, left-clicking the **UP spin button (▲)** 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.

Digital Spectra only: Each Digital Spectra tuning screen contains a **Program** button. Pressing the **Program** button sets only the softpot value associated with the currently selected frequency, so it is necessary to press the **Program** button after tuning each softpot at each and every frequency.

Digital Spectra Plus only: Each Digital Spectra tuning screen contains a **Program All** button. Pressing the **Program All** button sets all softpot values shown on the screen at the same time, which makes it possible to first adjust all the softpot values and then press the **Program All** button to set the values before leaving a screen. Pressing the **Program All** button more than once has no adverse effect on the new values.

Perform the following procedures in the sequence indicated.

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

6.3.1 Radio Information

Figure 6-12 shows a typical Radio Information screen. All of the data appearing here is informational and cannot be changed..

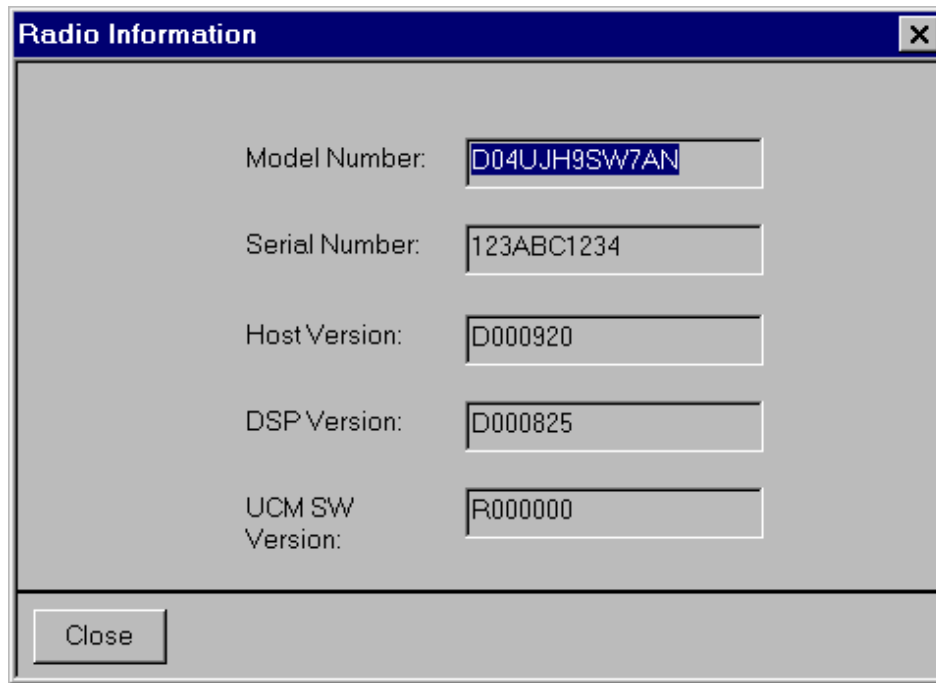


Figure 6-12. Radio Information Screen

6.3.2 Reference Oscillator Alignment

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

Radios are shipped from the factory with a worst-case frequency error of ± 200 Hz for VHF, ± 300 Hz for UHF, and ± 500 Hz for 800 MHz. These specifications are tighter than the more stringent FCC requirements of 1.5 ppm for all bands.

For radios that have been in storage for over six months from the factory ship date, the reference oscillator should be checked when the radio is initially deployed to the field. It is strongly recommended that the reference oscillator be checked every time the radio is serviced or at least once a year, whichever comes first.

The crystal contained in the reference oscillator naturally drifts over time due to its aging characteristic. Periodic (annual) adjustment of the reference oscillator is important for proper radio operation.

Improper adjustment can result in both poor performance and interference with other users operating on adjacent channels.

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

- Initial set up using the R-2670 Communication Analyzer:
 - RF Control: MONITOR
 - B/W: WB
 - Freq: RSS 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 set up 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 8901_ modulation analyzer for maximum accuracy.
1. Select the **Reference Oscillator** alignment screen. See Figure 6-13.

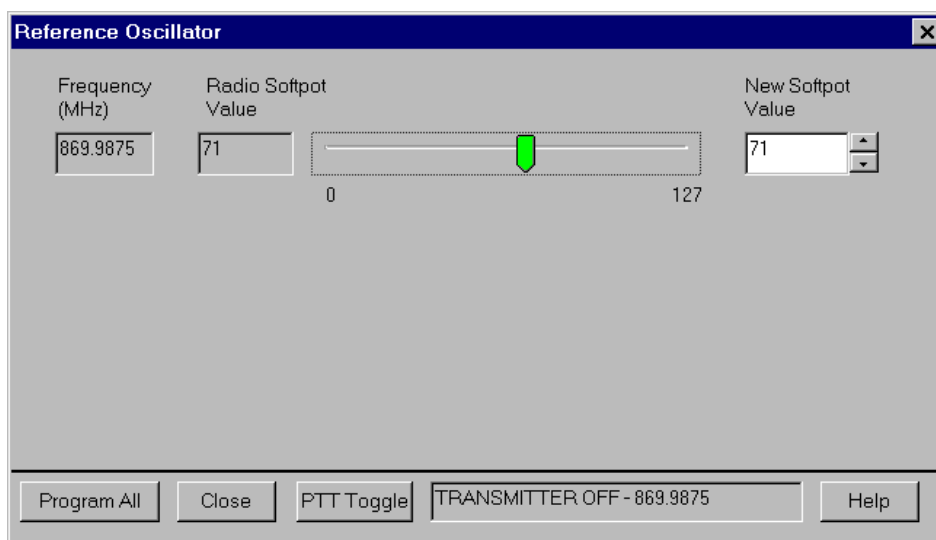


Figure 6-13. Reference Oscillator Alignment Screen

2. If you are using the R-2670 analyzer, enter the frequency displayed on the RSS screen in the "RF control" section of the R-2670. Under the "Meter" section of the display, choose RF DISPLAY.
3. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
4. Wait five seconds until the analyzer reading stabilizes, and then record the transmitter frequency.
5. Adjust the reference oscillator's softpot value until the measured value is as close as possible to the frequency shown on the screen. Allow approximately five seconds for the analyzer frequency reading to stabilize after each change. See Table 6-1 on page 6-4 and Table 6-3 on page 6-16.

Table 6-3. Reference Oscillator Alignment

Band	Target
800 MHz	±100 Hz

6. Left-click the **Program** (Digital Spectra) or **Program All** (Digital Spectra Plus) button on the screen to dekey the radio and save the tuned values.
7. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

6.3.3 Transmit Power Alignment

Transmit Power alignment is required after replacing (or servicing) the transceiver board.

This alignment procedure adjusts the transmit power of the radio and must be performed for two different power levels, at multiple frequencies for each power level, 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.

Notes

- The same softpot attenuation value will result in DIFFERENT radio output power levels at different frequencies.
 - All power measurements are to be made at the antenna port.
1. Select the **TX Power (High, Mid, or Low)** alignment screen. The screen will indicate the transmit frequencies to be used. See Figure 6-14.

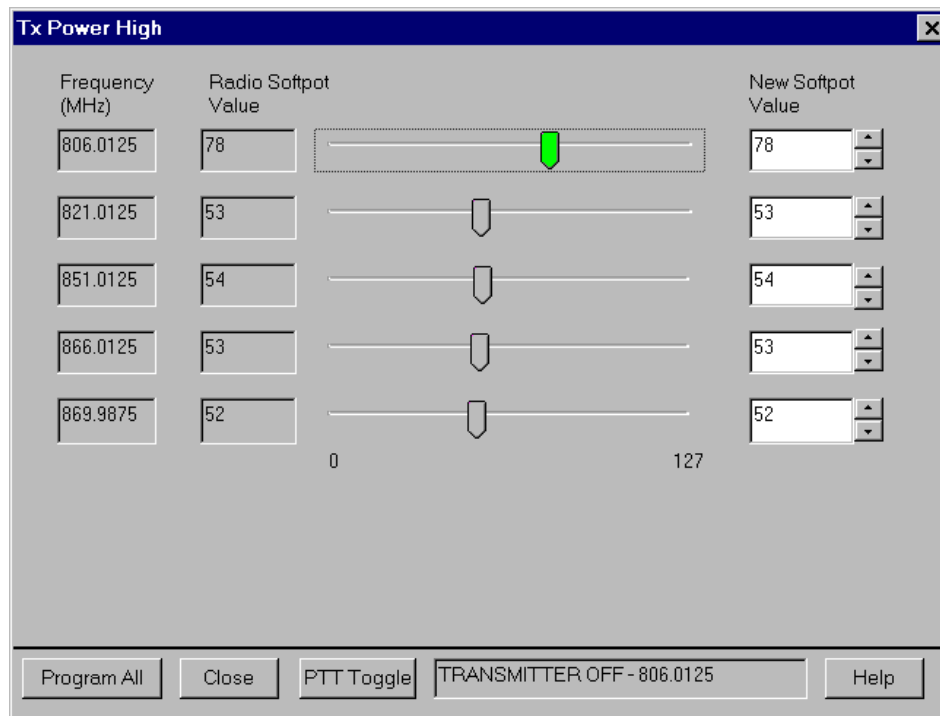


Figure 6-14. Typical Transmit Power Alignment Screen

2. Left-click the desired frequency field (starting with the highest frequency shown).
3. Left-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. Adjust the softpot value until the required power, as shown in Table 6-4, is indicated on the service monitor.

Table 6-4. Transmit Power Settings

VHF Rated Output Power**	Min. Level	Max. Level
10-25W	10.5W	28W
25-50W	26.5W	56W
50-110W	54W	113W
UHF Rated Output Power*	Min. Level	Max. Level
6W	6W	7W
10-25W	10.5W	28W
20-40W	20.5W	45W
78W	76W	80W
15W	16W	19W
50-110W	54W	110W
800 MHz Rated Output Power**	Min. Level	Max. Level
15W	15W	20W
35W (Repeater Mode)	37W	42W
30W (Talkaround Mode)	32W	42W

*These transmit power settings are used for Digital Spectra radios only.

**These transmit power settings are used for both Digital Spectra and Digital Spectra Plus radios.

6. Repeat the above process for all frequencies and all power levels.
7. Left-click the **Program** (Digital Spectra) or **Program All** (Digital Spectra Plus) button on the screen to dekey the radio and save the tuned values.

Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

6.3.4 Transmit Current Limit Alignment

This procedure is required for mobile radios only. Transmit Current Limit adjustment is required after replacing (or servicing) the RF Board.

This alignment procedure limits the transmitter current drain of the radio.

1. Click on the **PTT Toggle** button to make the radio transmit.
2. While transmitting, measure the current drain at each of the test frequencies.
3. Re-select the frequency which had the highest current reading (This only needs to be done on a single frequency since all other frequencies will be adjusted automatically).
4. Adjust the softpot value by manipulating the slider bar, incrementing the New Softpot Value spin box, or directly entering the desired value into the New Softpot Value spin box. Using a service monitor to measure transmit power, decrease the softpot value from its maximum until the measured transmit power begins to drop.
5. Increase the softpot value by one unit.
6. Press the **Program** (Digital Spectra) or **Program All** (Digital Spectra Plus) button to save the tuned value in the radio.

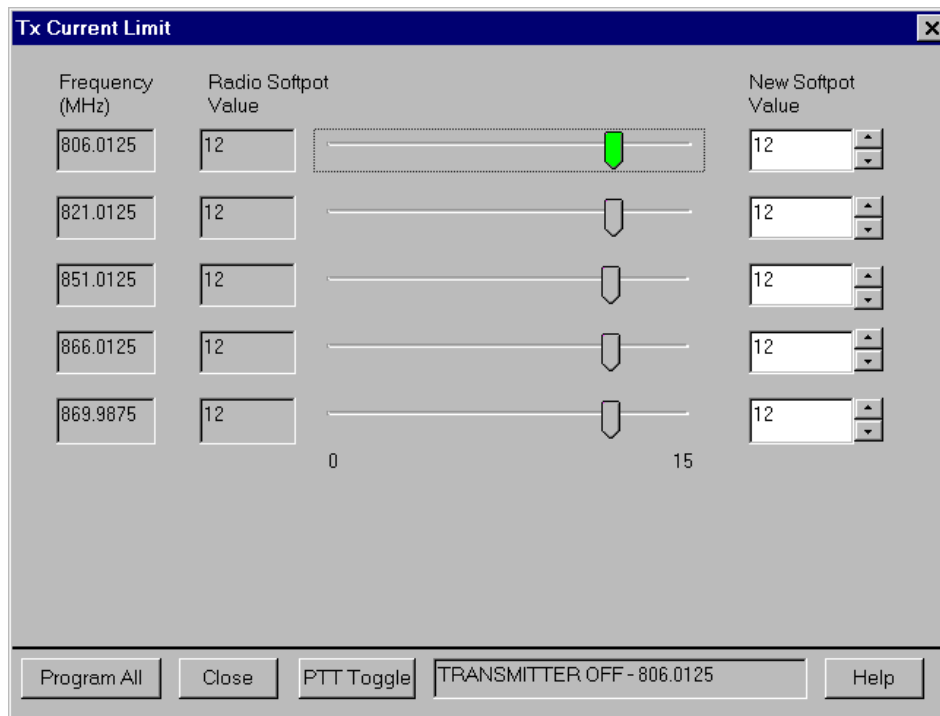


Figure 6-15. Transmit Current Limit Alignment Screen

6.3.5 Transmit Deviation Balance (Compensation) Alignment

This alignment is required after replacing (or servicing) the VOCON board or the transceiver board.

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 signaling 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.

Proper alignment requires a modulation analyzer or meter with a frequency response to less than 10Hz 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 test 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 set up 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, enter the frequency displayed on the RSS screen. 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 set up using the 8901_ Series Modulation Analyzer:
 - Press the **FM MEASUREMENT** button. (The “*Error 03-input 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 will indicate the transmit frequencies to be used. See Figure 6-16.
4. Left-click the desired frequency field (starting with the highest frequency shown).
5. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.

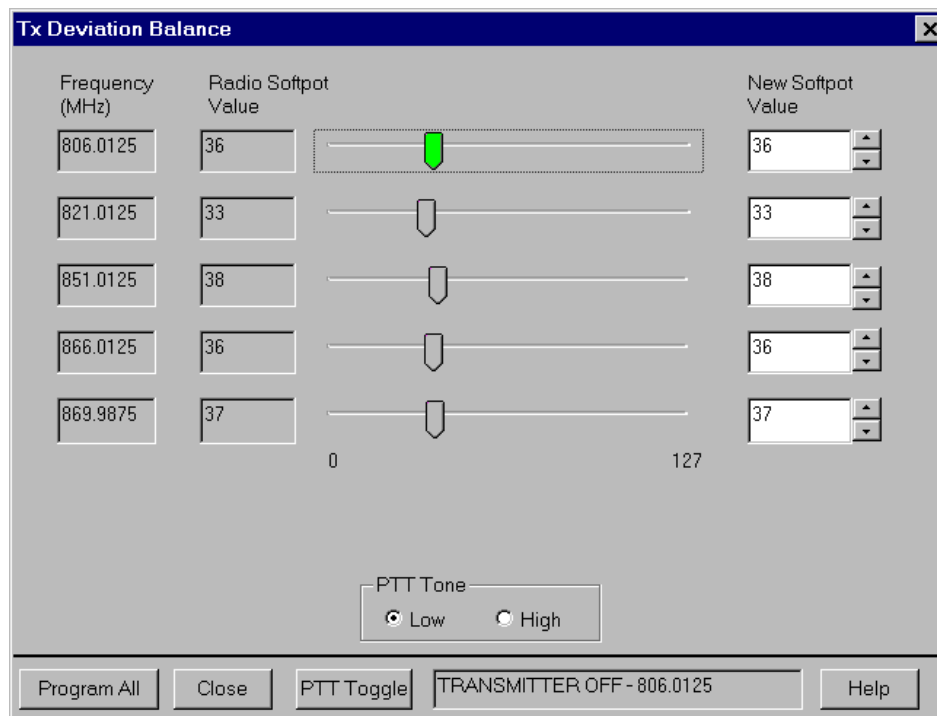


Figure 6-16. Transmit Deviation Balance (Compensation) Alignment Screen

6. Left-click the **PTT Tone: Low** button.
7. Left-click the **PTT Toggle** button on the screen to enable transmission. The screen indicates whether the radio is transmitting. Wait approximately 5 seconds until the voltage shown on R-2670, or the deviation shown on the 8901_ analyzer, stabilizes.
8. Measure and record the ac voltage value from the R-2670 analyzer or the deviation value from the 8901_ series analyzer.
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. Repeat the above process for all frequencies.
12. Left-click the **Program** (Digital Spectra) or **Program All** (Digital Spectra Plus) button on the screen to dekey the radio and save the tuned values.
13. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

6.3.6 Transmit Deviation Limit Alignment

This alignment is required after replacing (or servicing) the VOCON board or the transceiver board.

This alignment procedure limits the modulation of a baseband signal. It is used for primary modulation limiting.

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.

This test 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 set up 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, enter the frequency displayed on the RSS screen. 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 set up using the 8901_ Series Modulation Analyzer:
 - Press the **FM MEASUREMENT** button. (The “Error 03-input 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 Limit** alignment screen. The screen will indicate the transmit frequencies to be used. See Figure 6-17.

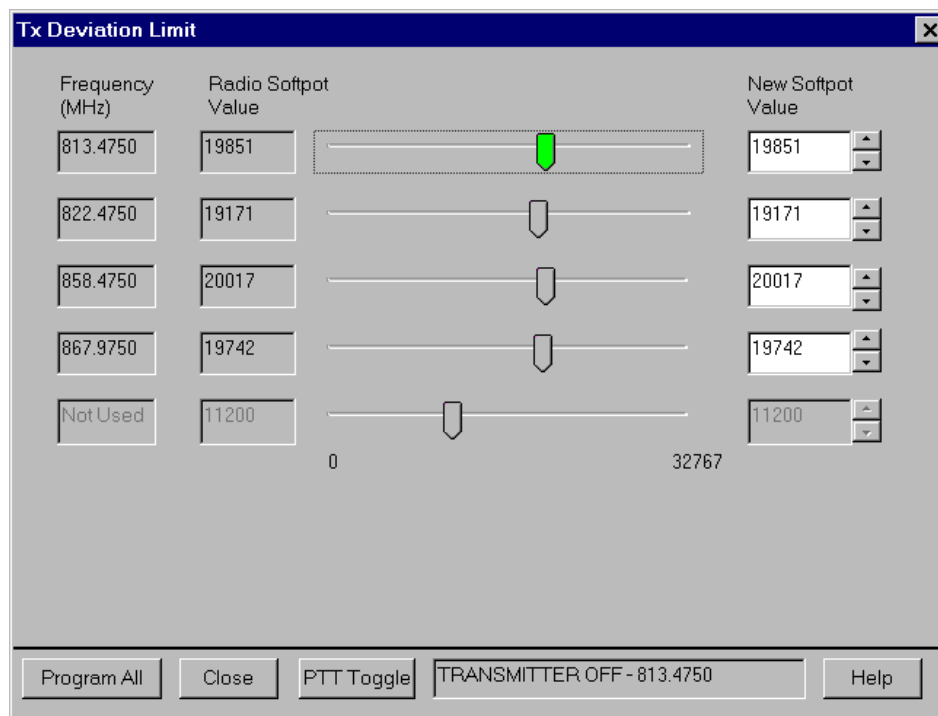


Figure 6-17. Transmit Deviation Limit Alignment Screen

4. Left-click the desired frequency field (starting with the highest frequency shown).

5. Left-click the **PTT Toggle** button on the screen to make the radio transmit. Wait approximately 5 seconds until the deviation/voltage displayed on the analyzer stabilizes. The screen indicates whether the radio is transmitting.
6. Adjust the deviation limit to within 0.158 to 0.163 Vac on the R-2670 (2.785 to 2.885 kHz). The optimum setting is 0.160 Vac (2.83 kHz).
7. Repeat the above process for all frequencies.
8. Left-click the **Program** (Digital Spectra) or **Program All** (Digital Spectra Plus) button on the screen to dekey the radio and save the tuned values.
9. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

6.3.7 Bit Error Rate (BER) Test

This screen is used to test the Bit Error Rate (BER) of the radio's receiver at a desired frequency and contains the following fields:

- Rx Frequency:

This field selects the Receive Frequency directly in MHz.
- Test Pattern:

This field selects the Digital test pattern — TIA. Choices are: Standard Tone Test Pattern (framed 1011) and Standard Interface Test Pattern (CCITT V.52).
- 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 to make the BER test repeat 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.

NOTE: When Continuous Operation = Yes, all fields will be grayed out while test is in progress. They will be enabled when the test is complete, or if 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.
- 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 that 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.
- Integration Time:

This field represents the amount of time over which the Bit Error Rate is to be calculated. The range is from 0.360 to 91.8 seconds in increments of 0.360 seconds.

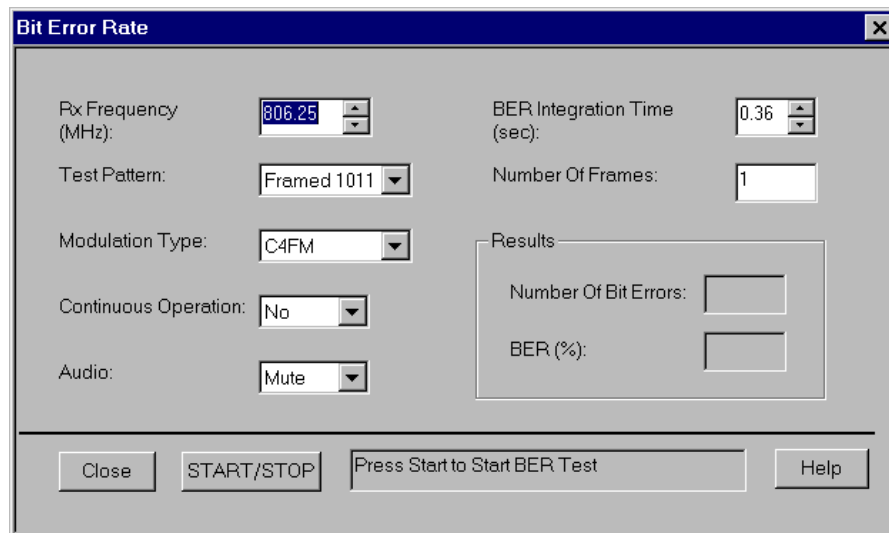


Figure 6-18. Bit Error Rate Test Screen

6.3.8 Transmitter Test Pattern

This screen is used to transmit specific test patterns at a desired frequency so that the user can perform tests on the radio's transmitter and 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.

- Test Pattern Type:

This field represents the type of test pattern which will be transmitted by the radio when the PTT TOGGLE button is pressed.

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

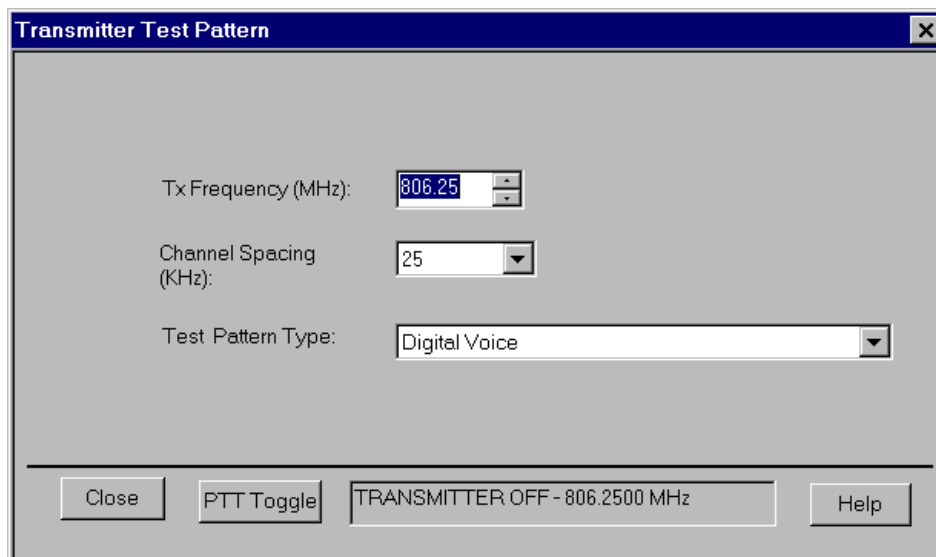


Figure 6-19. Transmitter Test Pattern Screen

Notes

Chapter 7 Encryption

7.1 Universal Crypto Module Kits

This information applies to both conventional and trunked systems.

The following tables contain the Universal Crypto Module (UCM) kits for the ASTRO Digital Spectra and Digital Spectra Plus radios.

7.1.1 ASTRO Digital Spectra

Table 7-1. ASTRO Digital Spectra UCM Listing

Kit Number	Description
HLN1441	DES, DES-XL, DES-OFB ENCRYPTION KIT - UCM
NTN1147	DVP-XL ENCRYPTION KIT - UCM
NTN1158	DVI-XL ENCRYPTION KIT - UCM
NTN1369	DES-XL / DVP-XL ENCRYPTION KIT - UCM
NTN1565	DES-OFB / DVP-XL ENCRYPTION KIT - UCM

7.1.2 ASTRO Digital Spectra Plus

Table 7-2. ASTRO Digital Spectra Plus UCM Listing

Kit Number	Description
NNTN4024A	DES, DES-XL, DES-OFB ENCRYPTION KIT - UCM
NNTN4025A	DVI-XL ENCRYPTION KIT - UCM
NNTN4026A	DVP-XL ENCRYPTION KIT - UCM
NNTN4027A	DES, DES-XL, DES-OFB WITH DVP-XL ENCRYPTION KIT - UCM
NNTN4204A	AES WITH DES ENCRYPTION KIT - UCM
NNTN4205A	AES WITH DES, DES-XL, DES-OFB ENCRYPTION KIT - UCM

7.1.3 Secure Dispatch Operation

On personalities or talkgroups that are programmed to be secure-selectable, press and release the *Secure* button to toggle between secure and clear.

- The secure status annunciator lit solid (**ON**) indicates that the transmitted signal is encrypted when the **PTT** button is pressed.
-

- The secure status annunciator not lit (**OFF**) indicates that the transmitted signal is non-encrypted.

Whether the current personality is strapped for secure or clear, the secure status annunciator correctly displays the transmit operation as being either secure (encrypted) or clear (non-encrypted).

NOTE: You cannot change from secure to clear while the **PTT** button is pressed. The radio will generate an illegal tone and the transmission will be terminated.

Secure-equipped radios automatically determine whether a secure or clear voice message is being received. This allows you to receive either type of message without having to reset the programmable secure button.

7.1.4 Secure Emergency Operation

Clear or secure emergency-call operation is determined by the programming of the selected mode (or talkgroup) or the default emergency mode, if set up. Otherwise, transmit operation is controlled by the setting of the secure, programmable button. You will not be able to change from secure to clear, or from clear to secure, operation during an emergency call.

7.2 Load an Encryption Key

7.2.1 Model W3

To load an encryption key into a Model W3 radio:

1. Ensure that an encryption module is installed in the radio.
2. Load an encryption key into the radio's memory from a key-variable loader (KVL) using the correct loader for the radio's encryption type.

To load the key, attach the keyloader cable to the front of the radio. (Refer to the KVL instruction manual for loading.)

3. **KEYLOADING** is displayed on your radio while the key transfer is in progress.



For single-key radios, a short tone sounds when a key is successfully loaded.

For multikey radios, an alternating tone sounds for a few seconds after keys are successfully loaded.


NOTE: An invalid encryption key aborts a secure transmission. **KEYFAIL** is displayed and a keyfail tone (consecutive medium-pitched beeps) sounds until you release the **PTT** button.

4. If a mode is not programmed for either secure or clear-only operation, use the secure programmable button to select secure or clear transmission.

NOTE: You cannot change from secure to clear, or from clear to secure, while pressing the **PTT** button.

7.2.2 Models W4, W5, W7, and W9

To load an encryption key into a Model W4, W5, W7, or W9 radio:

1. Turn on the radio and set the volume level.
The position of the  button is not important.
2. Connect the cable from the key-variable loader (KVL) to the microphone connector on the radio.
3. Load an encryption key into the radio's memory from a KVL using the correct loader for the radio's encryption type.

Refer to your KVL user's manual for more information on keyloading.

7.3 Erase a Key

This feature allows you to select any one, or all, of the encryption keys to erase.

7.3.1 Model W3

1. Press  to scroll to ERAS.





2. Press the  button below ERAS.



The last selected and stored key is displayed.

3. Do one of the following:

NOTE: ERASED alternates with the key name if you go to a key that has been erased.

Press  to scroll forward in the list; press  to scroll backward.

OR

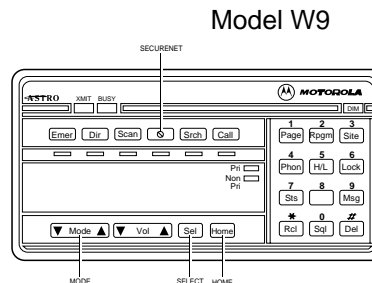
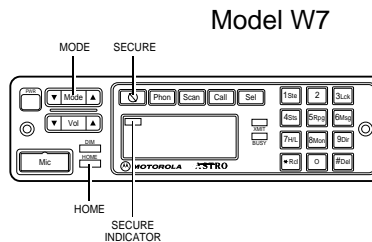
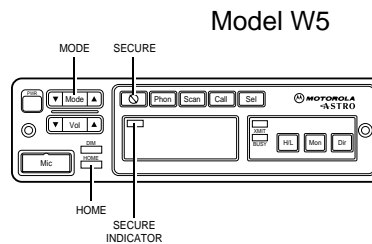
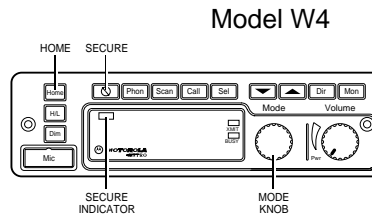
With Direct Entry, press the numeric keys to jump to the desired encryption key.

4. Go to Section 7.4: "Erase a Single Key (Model W3)" on page 7-5.

7.3.2 Models W4, W5, W7, and W9

The *Select Key to Erase* feature allows you to manually select any one, or all, of the encryption keys to erase.

1. To enter the Advanced Secure menu, press and hold the **Q** button until a tone sounds.



2. Turn the **Mode** knob (W4) or press the **Mode** rocker switch (W5, W7, W9) to scroll to the ERASE KEY option.
3. Press the **Set** button to enter the Key Erase menu.

The display changes to show the last key that was selected and stored after the Key Erase menu was entered.


4. Turn the **Mode** knob (W4) or press the **Mode** rocker switch (W5, W7, W9) to scroll to the desired key.
5. To delete the selected key, press the **Set** Button.

The radio deletes the key, and the display alternates between the key name and ERASED.

NOTE: When you scroll to an erased key, the display alternates between the key name and ERASED.

7.4 Erase a Single Key (Model W3)

To erase a single key:

1. Press the  button below **SNGL** to request erasure of the selected key.



ERASE SNGL KEY, YES and NO are displayed.




2. Press the button below **YES**.

The internal selected key is set to zero.

ERASED is alternately displayed with the key name confirming the erasure.




3. To exit the menu without erasing a key, press the  button below **ABRT**, or the **PTT** button, or the mode button, or **HOME**.

The home mode is displayed.

7.5 Erase All Keys

7.5.1 Model W3

To erase all keys at the same time:

1. Press the  button below **ALL** to request erasure of all keys.



ERASE ALL KEYS, YES and NO are displayed.



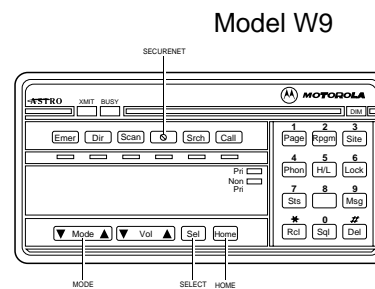
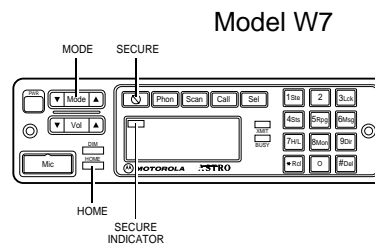
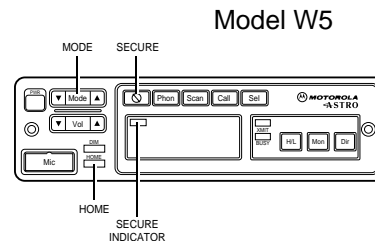
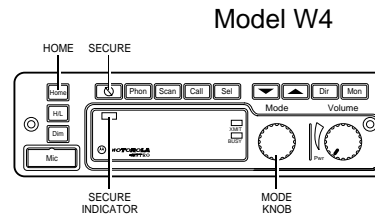
2. Press the button below **YES**. All keys are erased.

ERASED is alternately displayed with the key name confirming the erasure.



7.5.2 Models W4, W5, W7, and W9

1. To enter the Advanced Secure menu, press and hold the **Q** button until a tone sounds.



2. Turn the **Mode** knob (W4) or press the **Mode** rocker switch (W5, W7, W9) to scroll to the **ALL** option.
3. Press the **Set** button to erase all the keys in the radio.

The display shows **PLS WAIT** (W4, W5, W7) or **PLEASE WAIT** (W9) for two seconds, followed by **ERASED** being shown for about two seconds, then the display reverts back to **ALL**.

4. To abort from the key-erase menu, press the **HOME** button or the **PTT** button.

Pressing the **PTT** button causes the radio to transmit.


7.6 Over-the-Air Rekeying

The over-the-air rekeying (OTAR) feature allows the dispatcher to reprogram the encryption keys in the radio remotely.

7.6.1 ASTRO Digital Spectra Model W3

1. Press  until REKY appears.



2. Press  below REKY.

REQUEST REKY is displayed.




3. Press the **PTT** button to send the rekey request.

PLEASE WAIT is displayed.

4. One of the following occurs:



The radio sounds five tones when the dispatcher has received the request.

NOTE: Any subsequent pressing of the **PTT** button will exit the feature and allow you to transmit in the normal manner. Pressing  or the emergency button also exits the feature.

If the display momentarily shows REKEY FAIL and a bad-key tone sounds, the rekey operation failed because the radio does not contain the Unique Shadow Key (USK).



You have to load the USK into the radio using the KVL before the radio can be reprogrammed over the air.

NOTE: If you exit at this point, but stay on the current channel in the dispatch mode, the radio momentarily shows REKEYED or DENIED and sounds a tone indicating the status of the rekey request.

If the display shows **NO ACK** and a bad-key tone sounds, then the dispatcher has not acknowledged your request after the radio has tried five times to send it.



The radio then returns to the display message in step 2, allowing you to retry the request.


If the request is accepted and the radio is successfully rekeyed, the display momentarily shows **REKEYED**.

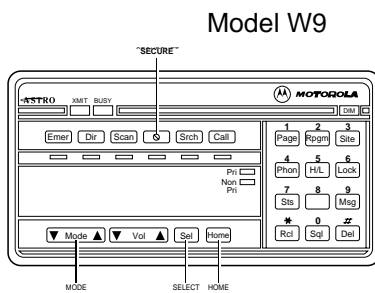
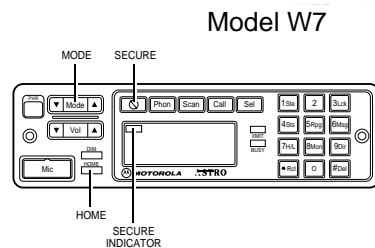
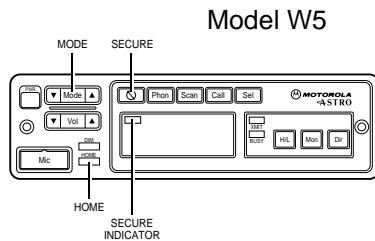
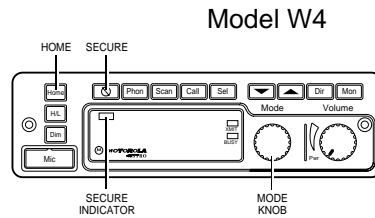


If the display momentarily shows **DENIED** and a bad-key tone sounds, the request has been denied by the dispatcher, and the radio returns to the home display.



7.6.2 ASTRO Digital Spectra Models W4, W5, W7, and W9

1. To enter the Advanced Secure menu, press and hold the  button until a tone sounds.



2. Do one of the following;

Model W4: Using the **Mode** knob, scroll to the REKY option.

OR

Models W5, W7, or W9: Using the **Mode** rocker switch, scroll to the REKY REQ option.

3. To enter the rekey request menu, press and release the **SEL** button.
4. To initiate a rekey request, press and release either the **Sel** button or the **PTT** button.

The radio displays PLS WAIT (W4, W5, W7) or PLEASE WAIT (W9).

5. One of the following occurs:
 - If the radio receives an acknowledgment from the dispatcher, five tones sound.
 - If the radio does not receive an acknowledgment from the dispatcher, the display shows `NO ACK`.
 - After the radio is rekeyed, it displays `REKEYED` and returns to dispatch mode.
 - If the dispatcher does not allow it to be rekeyed, the radio displays `DENIED` and returns to dispatch mode after three seconds.
6. Press `(HOME)` to exit and return to normal operation.

7.7 Advanced Secure Operation

NOTE: The Advanced Secure feature is available only on radios that have been equipped by the factory to support it. The radio must also be equipped with an encryption module.

Advanced Secure incorporates the Multikey feature and a dual-encryption feature into the existing secure system. Multikey allows a radio to be equipped with multiple encryption keys. A default key is included and is associated with the current mode. The keys are strapped to a given mode or are operator-selectable and can be indexed into groups of keys (for example, 16 keys can be indexed into two groups of eight keys). The keys are loaded using a manual keyloader.

In addition, your radio can support up to eight different encryption algorithms simultaneously.

7.7.1 Multikey Operation


The multikey feature can be used in both conventional and trunked applications.

- **Conventional Multikey** - The encryption keys can be selectively strapped, one per each channel, by a qualified radio technician. In addition, you can have operator-selectable keys, operator-selectable indices, and operator-selectable key erasure. Encryption keys are loaded into the radio through a KVL.
- **Trunked Multikey** - If you use your radio for both conventional and trunked applications, the encryption keys have to be strapped for trunking on a per talkgroup, or announcement group, basis. In addition, a different encryption key can be strapped to other features such as private call, dynamic regrouping, failsoft, interconnect, system wide, or emergency talkgroup.

Chapter 8 Disassembly/Reassembly Procedures

8.1 Introduction

This section details the procedures necessary to remove and replace the printed circuit boards in the ASTRO Digital Spectra and Digital Spectra Plus radios. After troubleshooting and determining which board needs to be replaced, disconnect the test equipment, the antenna cable, and unhook the dc power.

 WARNING	Disconnect all dc power to the radio before removing any boards from the radio. Failure to remove power can result in unit damage caused by transients or accidental shorts, as well as a shock hazard.
---	--

Locate the exploded view drawing of the radio in *Chapter 11: Exploded Views and Parts Lists*. Keep it handy for reference when disassembling and reassembling the radio.

When installing a new circuit board, all mounting screws should be *started* before any are torqued. This helps assure proper board alignment with the chassis.

After installing a new board, refer to Table 8-1 and perform the alignment procedures indicated for the replaced board.

Table 8-1. Required Alignments After Board Replacement

Board Replaced	Alignment Required				
	Reference Oscillator	Transmit Deviation Balance (compensation)	Transmit Deviation Limit	Transmit Power	Transmit Current Limit
Command Board	X				
VCO (Voltage Controlled Oscillator)		X	X		
RF (Radio Frequency) Board	X	X	X		
PA (Power Amplifier) Board				X	X
VOCON Board	X	X	X	X	X

8.2 Replacement Procedures

NOTE: After performing alignment procedures, always exit the SERVICE menu entirely (to the MAIN MENU) to save all changes properly. Failure to do so can result in a alignment (or other) failure.

8.2.1 Required Tools and Supplies

Table 8-2. Required Tools and Supplies

Tools and Supplies
Small, flat-blade screwdriver
2.5 mm hex-key driver
Torx® T8, T10, and T15 drivers
3.0 mm Allen wrench
Thermal compound (Motorola part number 11-83166A01, or equivalent)
Electromagnetic Interference (EMI) metallic shielding tape (Motorola part number 11-85984D01, or equivalent)

8.2.2 Control Head Boards

8.2.2.1 Model W3

NOTE: Numbers shown in brackets in the following procedure refer to item numbers in Figure 11.1: “Model W3 Hand-Held Control Head Exploded View,” on page 11-2, and in Table 11.1, “Model W3 Hand-Held Control Head Exploded View,” on page 11-2.

1. Remove the strain-relief boot (part of cable assembly [15]) from the housing assembly [7] by applying downward pressure on the boot and pulling it away from the control head until they are completely separated.
2. Carefully remove the rubber seal (part of cable assembly [15]) from the housing assembly [7] opening.

NOTE: Take care to avoid damaging this seal.

3. Using a small screwdriver, remove the seal support wedge [14] from the control head.
4. Using a small screwdriver to depress the telco lever, remove the telco connector (part of cable assembly [15]) from the control head, and pull the cable assembly away from the housing (like a telephone jack).
5. Remove the rear cover assembly [2] from the control head.
6. Locate the recesses in the lower portion of the housing on both sides of the rear cover's snap features and, prying the snaps until the two parts separate, remove the rear cover from the unit.
7. Remove the two snap retainers [4] from between the circuit board [5] and the housing assembly [7].
8. Disconnect the microphone assembly [8] connector from the circuit board [5].
9. Carefully remove the microphone cable assembly from the keypad [6].
10. Carefully pry the housing's snap features from the circuit board [5].

NOTE: Be careful to avoid damaging circuit board components.

There are seven snaps locking the circuit board to the housing. As the snap features are deflected, push the circuit board upward, using the keypad, to release the circuit board from the snap features.

11. Remove the circuit board assembly from the housing.
12. Remove the keypad [6] from the housing assembly [7].

8.2.2.2 Models W4, W5, and W7

NOTE: For the following procedure, refer to *Chapter 11: Exploded Views and Parts Lists*, beginning on page 11-3, for the exploded view and associated parts list applicable to the model being disassembled.

1. Unplug the microphone.
2. Remove the two front panel screws using a 2.5mm hex-key driver.
3. Disconnect the control cable on remote models.
4. Grasp the front panel firmly, and carefully unplug the control head assembly from the radio or remote control head back housing.
5. Lay the control head face down on a clean, flat surface, being careful not to scratch or mar the display.
6. Using a Torx T10 driver, remove the control head screws:
 - Model W4: four screws [callouts 5-8], as shown in Figure 8-1.

The Model W4 has, in addition to the screws, four snap features [callouts 1-4], which are shown in Figure 8-1.

- Model W5 and Model W7: seven screws, as shown in Figure 8-2.

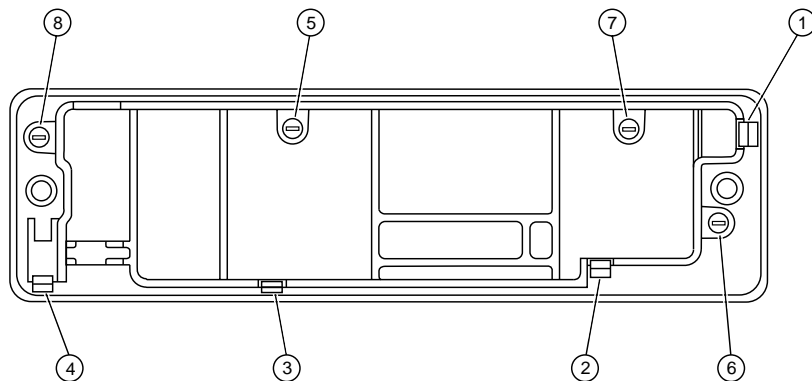


Figure 8-1. Model W4 Rotary Control Head Assembly Screw and Snap Sequence

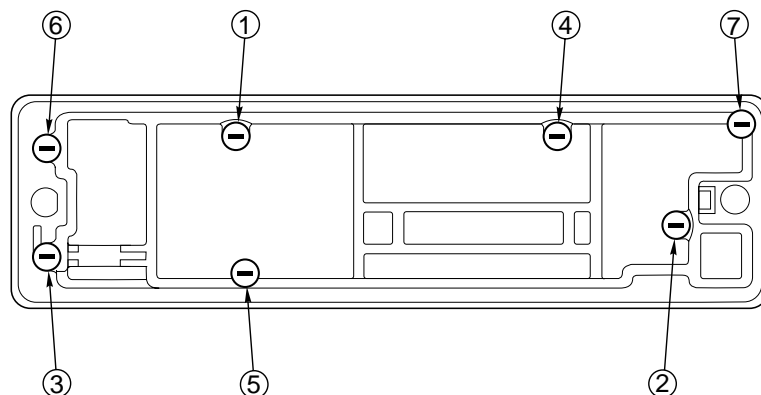


Figure 8-2. Models W5 and W7 Pushbutton Control Head Assembly Screw Sequence

7. Carefully separate the printed circuit board, internal spacer, and elastomer keypad assembly from the front panel.

On rotary control head models, care must be taken not to damage the flex circuit when separating the printed circuit board from the front housing. Do not disturb the buttons in the front panel.

On rotary control head models, the flex circuit must also be unplugged.

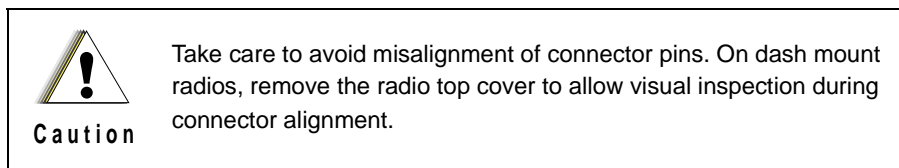
8. On rotary control head models, desolder the XMIT and BUSY LED before removing the elastomer keypad.
9. Remove the elastomer keypad from the printed circuit board.

NOTE: Before you unsnap the PC board, notice that the board slips under a hook on the right and snaps on the left. This will facilitate assembly.

10. Remove the PC board from the internal spacer. The PC board snaps into and out of the spacer.
11. To reassemble, snap the PC board into the internal spacer. Before you press the elastomer keypad into the board, make sure that the conductive pads in the board and the elastomer keypad are clean and free of any foreign material.
12. On rotary control head models, solder the XMIT and Busy LEDs onto the PC board.

NOTE: On rotary control head models, the flex circuit must be connected to the PC board prior to attaching the PC board to the spacer.

13. Install the PC board internal spacer and elastomer keypad assembly into the front panel. Replace the screws and torque them to 6-8 in.-lbs.



14. For dash-mounted radios, plug the interconnect board into the radio, then plug in the control head assembly and fasten it with the two front panel screws (torqued to 4-6 in.-lbs).

OR

For remote-mount control heads, replace the front panel into the remote control head back housing, make sure the gasket is in place, then torque the screws to 4-6 in.-lbs. Replace any plugs and cables on the rear of the control head.

8.2.2.3 Model W9

NOTE: Before disassembling the W9 control head, note the location of the labeled bottom.

NOTE: Refer to Figure 11-4: "Model W9 Pushbutton Control Head Exploded View," on page 11-5 and Table 11-4, "Model W9 Pushbutton Control Head Parts List," on page 11-5 for the callout numbers in this section.

1. Using a Torx T15 driver, remove the two 30mm machine screws [29] from the back housing [31] of the control head.
2. Fold the front housing [41] over so that the front housing is face down and the back housing is on your working surface with the flex cable [18] attached.

- Using a Torx T10 driver, remove the five 8mm tapping screws [17] from the Display Board Kit [37], the two 10mm captive screws [12] with the leaf assembly spring [11], and the two 16mm tapping screws [38] from the control PC board.
- Remove the Command Board Kit [36] from the back housing and the Display Board Kit [37] from the front housing.
- Remove the elastomer keypad [7], ON/OFF switch gasket [34], the "D" Connector Gasket [33], the solder side shield [16], and the component side shield [19] from the PC boards.

NOTE: Be careful to not bend the tabs on the shields when removing them and align them carefully when replacing the shields. When working with chips and SOT (small outline transistor) parts, use extreme caution when heating. Never reuse a chip or SOT part; always replace with the correct Motorola part.

- Install the new PC board with the elastomer keypad, the ON/OFF switch gasket, the "D" Connector Gasket, the "D" Connector O-ring, the solder-side shield, and the component-side shield in the appropriate locations.
- Reassemble the Command Board Kit [36] into the back housing [31], making sure that the power switch is in the proper location and replace the two tapping screws [38], torquing them to 6-8 in.-lbs.
- Reassemble the Display Board Kit [37] into the front housing [41], making sure that the elastomer keypad [7] is in the proper location.
- Replace the captive screws [12] and the leaf assembly spring [11] in the front housing, and torque them to 6-8 in.-lbs.

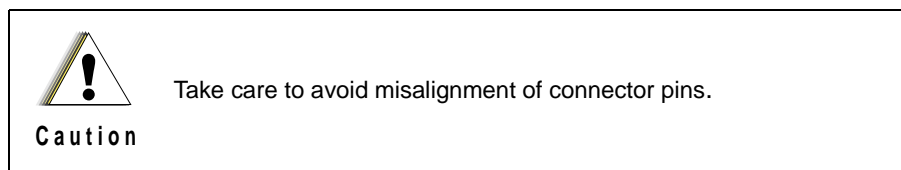
NOTE: Before assembling the leaf assembly spring, check that the insulator [10] on the board is present. Ensure that the leaf assembly spring and captive screws are aligned properly to prevent stripping the front housing screw bosses.

- Close the assembly by replacing the front housing [41] and the two screws in the back housing [31]. Torque the screws to 6-8 in.-lbs.

8.2.3 Remote Back Housing Interface Board

8.2.3.1 Models W4, W5, and W7

- Unplug the microphone.
- Disconnect the control cable from the control head on remote models.
- Remove the two front panel screws using a 2.5mm hex-key driver.
- Grasp the front panel firmly, and carefully unplug the control head assembly from the radio or remote control head back housing.
- Remove the two remote back housing interface attachment screws.
- Remove the remote control head interface board from the remote control head back housing.
- Attach the new interface PC board to the back housing with two screws torqued to 6-8 in.-lbs.

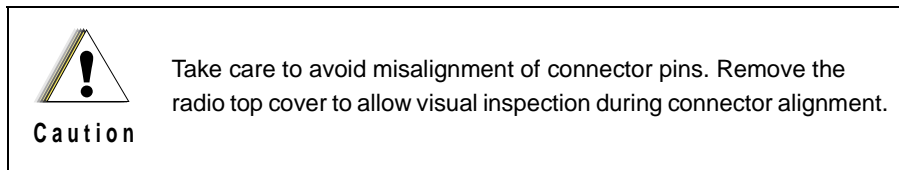


- Reassemble the back housing to the front housing with two screws torqued to 4-6 in.-lbs.

8.2.4 Remote Interconnect Board

8.2.4.1 Low-/Mid-Power Radios

1. Remove the two front panel screws using a 2.5mm hex key driver.
2. Grasp the front panel firmly, and carefully unplug it from the radio.
3. Remove the three screws that hold the remote interconnect board to the front panel using a Torx T10 driver.
4. Install the new remote interconnect board onto the front panel, and replace the screws. Torque the screws to 6-8 in.-lbs.



5. Reassemble the front panel into the radio and replace the screws.
6. Torque the screws to 4-6 in.-lbs.

8.2.4.2 High-Power Radios

1. Use a Torx T15 driver to remove the two screws in the radio top cover. Remove the radio top cover.
2. Remove the ribbon cable [38-conductor] from between the command board and the interconnect board by first disconnecting the cable at the command board side and then at the interconnect board.
3. Disengage the retaining wire on the back of the interconnect board at the chassis side.
4. Use the radio key to unlatch the radio handle and use a Torx T15 driver to remove the two interconnect board screws that are inside the handle.
5. Turn the radio upside down and use a Torx T15 driver to remove the four bottom-cover screws. Remove the bottom cover.
6. Remove the RF board shield and unplug the coaxial cable that comes up from the other side of the radio. Move the end of the coaxial cable out from behind the interconnect board.
7. Pull the retaining wire up into position so that the interconnect board can be slid back away from the front of the radio, and then up and out from the radio chassis.
8. Remove the rubber gasket from the front of the interconnect board by pulling it up and over the D-connectors.
9. Gently pry each of the arms on the interconnect board spacer so that the snap feature on the arms can be slid past the interconnect board.
10. Place the interconnect board spacer onto the new interconnect board, by making sure that each arm is aligned in the proper slot and snaps securely into place.
11. Replace the rubber gasket, retaining wire, coaxial cable, bottom cover (torque four screws to 6-8 in.-lbs), and interconnect board screws (torque two screws to 10-12 in.-lbs).
12. Turn the radio top side up and re-insert the ribbon cable [38-conductor] by first connecting the command board side, and then the interconnect board side. This cable is connected to two 38-pin connectors. The cable is keyed so that the cable fits only in the correct position.

13. Fold the ribbon cable down flat. Replace the top cover and torque the two screws to 6-8 in.-lbs. These screws are self-tapping and caution should be used so that the screws enter the previously cut threads.

8.2.5 Power Amplifier Board

8.2.5.1 Low-/Mid-Power Radios

1. Use a Torx T15 driver to remove the four screws from the PA cover, and then remove the cover and the PA shield.
2. Use a metric 3.0mm Allen wrench to remove the two Allen-head screws from the heatsink.
3. Carefully separate the PA assembly from the transceiver chassis.
NOTE: Before disconnecting, note which RF cable goes to the VCO (TX injection) and which goes to the RX front end. This will facilitate assembly.
4. Disconnect the large ribbon-cable connector from the command board, the small connector from the PA board, and two RF cables from their respective boards in the transceiver chassis.
5. Install the feed-through plat and grounding clip, making sure the RF cable is installed into the clip.
6. Install the receiver cable clip, making sure the cable is routed under the clip, and then fold the cables.
7. Connect the large ribbon-cable connector to the command board connector.
8. Connect the small connector to the PA.
9. Connect the RF cables to their respective boards in the transceiver chassis.
10. Be careful not to pinch the RF or ribbon cables, and position the PA assembly on the chassis.
11. Install the two Allen-head screws through the heatsink. Before tightening the mounting screws, check that the command board connector and RF connectors are in place. Torque the mounting screws to 14 in.-lbs.
12. Press the PA compartment shield and install the PA cover. Torque the screws to 10-12 in.-lbs.
13. Perform the radio alignment procedures and performance check procedures recommended in Table 8-1 on page 8-1.

8.2.5.2 High-Power Radios

1. Use a Torx T15 driver to remove the top cover by removing the two screws.
2. Disconnect the 12-conductor ribbon cable from the bottom of the power amplifier board.
3. Disconnect the red (A+) power cable from the bottom of the PA board.
4. Turn the radio upside down. Use a Torx T15 driver to remove the four bottom-cover screws. Remove the bottom cover.
5. Remove the PA shield.
6. Remove the harmonic filter cover.
7. Desolder the mini UHF cable connector from the PA board and the coax clip.
8. Disconnect the two coaxial cables from the board-mounted receptacles and the coax clip, noting where each cable goes for reassembly.
9. Use a Torx T15 driver to remove the two screws that anchor the PA board to the chassis.
10. Use a Torx T8 driver to remove the nine screws that anchor the components to the chassis.
11. Remove the PA board by carefully lifting the board out of the chassis while guiding it past the coaxial cables.

NOTE: Before disconnecting, note which RF cable goes to the VCO (TX injection) and which goes to the RX front end. This will facilitate assembly.

12. Apply a thin white coat of thermal compound (for example, Motorola part no. 11-83166A01) in the power transistor mounting locations of the chassis where the thermal compound was removed.
13. Locate the new PA board into the chassis cavity by feeding the short coaxial cable through the hole in the board and starting all the screws. After the ten PA screws are started, torque them to 8-10 in.-lbs.
14. Install the new strip outline emitters onto the new PA board by replacing the eight screws, and torque to 6-8 in.-lbs.
15. Solder the collector leads to the board.
16. Plug the coaxial cables into the mating receptacles on the board.
17. Solder the braided coaxial cable to the power amplifier board at the tip and at the braid.
18. Snap the harmonic-filter shield into place, and replace the power-amplifier shield over the power amplifier cavity. Make sure that the PA cover is firmly seated into the chassis cavity.
19. Replace the bottom cover, and torque the four bottom-cover screws to 6-8 in.-lbs.
20. Turn the radio top side up, and reconnect the 12-conductor ribbon cable to the bottom of the PA board.
21. Reconnect the red (A+) power lead to the bottom of the PA board.
22. Replace the radio top cover and torque the two screws to 6-8 in.-lbs.

8.2.5.3 800 MHz Radios

8.2.5.3.1 Back-End Removal

1. 20- and 35-watt radios only: Use a Torx T15 driver to remove four screws from the PA cover, and then remove the cover and lift the PA shield and the harmonic filter shield cover.
2. Use a metric 3.0-mm Allen wrench to remove the two Allen-head screws from the heatsink.
3. Carefully separate the PA assembly from the chassis.

NOTE: Before disconnecting, note which RF cable goes to the VCO and which goes to the RX front-end. This will facilitate assembly.

4. Disconnect the large ribbon cable connector from the command board, the small connectors from the PA board, and the two RF cables from their respective boards in the chassis.

8.2.5.3.2 PC Board Removal

NOTE: Before unfolding the RF cables, note how each is routed. This will facilitate assembly.

1. 15-watt radios: Insert a small, flat-blade screwdriver into the clip slot to deflect the snap holding one side of the clip to the shield and remove the two plastic clips that hold the RF cables to the shield. Unfold the RF cables and remove the PA compartment shield.

20- and 35-watt radios: Use a Torx T15 driver to remove two screws, and pull feed-through plate from the side of the PA assembly. Remove RF cable clip. Unfold the RF cables and push them through the slots in the PA compartment.

2. Unsolder the three leads for pass device Q9500.
3. Use a Torx T8 driver to remove two screws from the power shield.
4. 35-watt radios only: Remove two screws from the final device.
5. Disconnect the red power lead.

6. Use a Torx T15 driver to remove the larger screws. (Five screws are used on 15-watt, six on the 20- and 35-watt.)
7. Carefully lift the PC board from the heatsink.

NOTE: Before unsoldering the RF cables, note which cable is attached to each connector on the board. This will facilitate assembly since the cables differ in length.

8. Unsolder the antenna coax cable attached to the bottom of the board.
9. Unsolder and remove the power module shield.
10. Unsolder the RF cables from the board.

8.2.5.3.3 PC Board Installation

1. Solder the RF cables to the board connectors.
2. Clean any old thermal compound from the mounting surfaces of the power transistor, power module, and (on 20- and 35-watt models) the final device.

If the power transistor insulator was not disturbed, it is not necessary to clean beneath it.

3. Apply a new, uniform coat of thermal compound (e.g., Motorola part no. 11-83166A01), which is thick enough to fill all small air voids, to the mounting surfaces.

NOTE: Do not use a thick coating of compound and do not allow any small bits of dirt or debris to get in the compound; such would degrade the thermal efficiency of the heatsink.

4. Solder the three leads of the Q9500 pass device.
5. Install the PC board, and then attach and tighten the screws (torque 8-10 in.-lbs.) in the sequence shown in Figure 8-3.

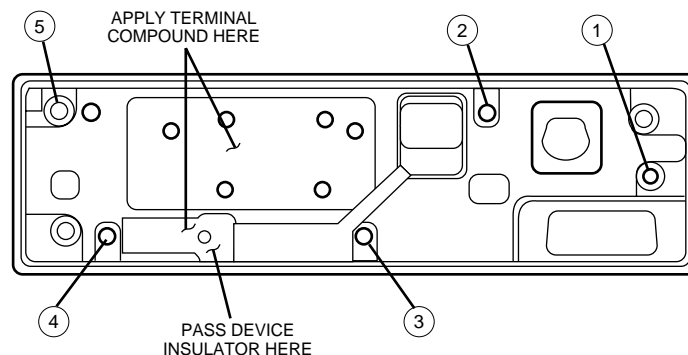


Figure 8-3. PA Board Screw Fastening Sequence (800 MHz 15-Watt PA)

6. 20- and 35-watt radios only: Install the final device with two screws (torque 8-10 in.-lbs.). The properly oriented final device is shown in Figure 8-4.

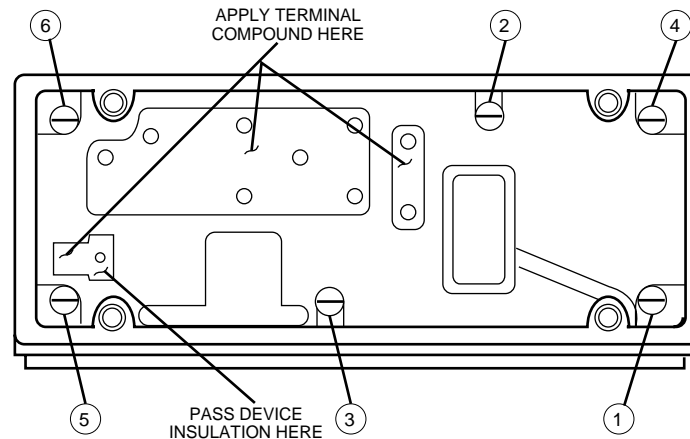


Figure 8-4. PA Board Screw Fastening Sequence (800 MHz 20- and 35-Watt PA)

7. Place the power module shield over the power module.
8. Install the power module and shield with two compression washers and screws (torque 6-8 in.-lbs.).
9. 20- and 35-watt radios only (Figure 8-5): Solder the final device leads and five caps. Caps must be soldered flat to the board, and each cap surrounding the final device must be soldered as close to the device as possible.

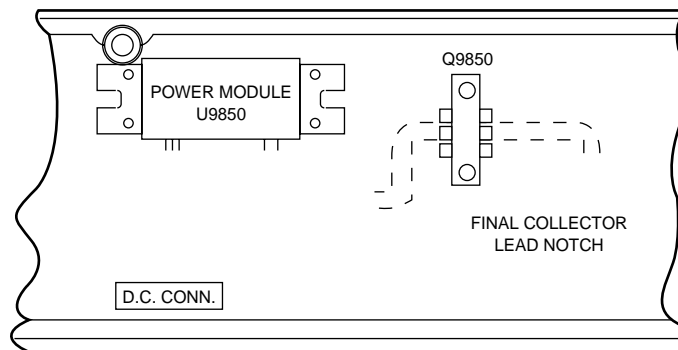


Figure 8-5. Installing the Final Device

10. Solder the power module leads, module shield, and transistor leads.
11. Install the red power lead.

8.2.5.3.4 Back-End Installation

1. 15-watt radios: Carefully position the RF cables through the slots in the PA shield and install the shield. Fold the RF cables under metal clips and install the two plastic clips.

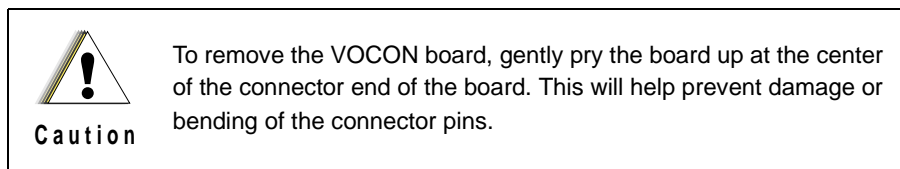
20- and 35-watt radios: Push the RF cables through the slots in the PA compartment. Install the feed-through plate making sure the RF cable is routed under the plate. Install RF cable clip making sure the cable is routed under clip; fold the cables.
2. Connect the large ribbon cable connector to the command board connector.
3. Connect the small connector to the PA.
4. Connect the RF cables to their respective boards in the chassis.
5. Be careful not to pinch the RF or ribbon cables, and position the PA assembly on the chassis.
6. Install the two Allen-head screws through the heatsink. Before tightening the mounting screws, check that the command board connector and RF connectors are in place.

7. Tighten the mounting screws (torque 8-10 in.-lbs.).
8. 20- and 35-watt radios only: Press the PA compartment shield, and install the PA cover.

8.2.6 VOCON (Vocoder/Controller) Board

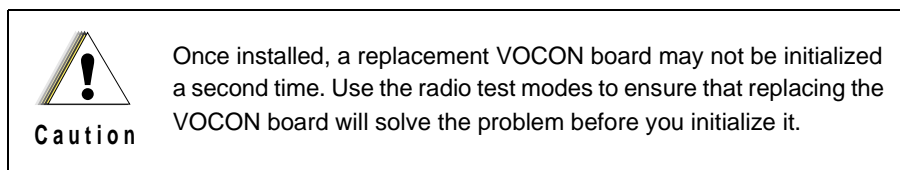
NOTE: If you want to keep the information currently stored in the radio code plug, save its contents with the appropriate application software before you remove the original VOCON board. Refer to the Radio Service Software (RSS) user's manual, or the Customer Programming Software online help.

1. Use a Torx T15 driver to remove the top cover by removing the four screws.
2. Remove the VOCON board shield.



3. Remove the board from the command board after reading the NOTES and CAUTIONS in this section.
4. Place the new board into the radio by aligning the pins and pressing the board firmly into place, and then replace the board shield.
5. Replace the radio top cover, and use four new screws (torque to 10-12 in.-lbs.) to secure the top cover. Ensure the screws are aligned with the holes.

NOTE: Replacement VOCON boards are preprogrammed to enable the radio to function only at test mode level. To restore the radio to complete operation, you must program the VOCON board via the radio service software or the Customer Programming Software.



6. Program the VOCON board as indicated in Table 8-1 on page 8-1. Programming procedures are found in *Chapter 6: Radio Alignment Procedure* of this manual.

8.2.7 Command Board

8.2.7.1 Low-/Mid-Power Radios

1. Remove the radio top cover.
2. Remove the PA assembly.
3. Remove the VOCON board according to previous instructions. See CAUTION notes in VOCON board replacement section.
4. Disconnect the PA connector and the control head connector.
5. Remove the heatsink clip from the power transistor on the command board.
6. Use a Torx T15 driver to remove six mounting screws.

7. Carefully lift the command board from the housing, making sure that the floating header is with the RF board.
8. To reassemble the command board, apply a thin coat of thermal compound (for example, Motorola part no. 11-83166A01) to the audio amplifier mounting surface.

NOTE: *Do not* use a thick coating of compound as it could degrade the thermal efficiency of the heatsink.

Prior to installing the command board, make sure the male-to-male command board header is fully seated in the RF board.
9. Install the new command board, and clip the power devices to the chassis, being sure that the insulator is in place behind the devices.
10. Install new mounting screws (torque 8-10 in.-lbs.), starting with the screw holding down the audio amplifier. Ensure the screws are aligned with the holes.
11. Connect the VOCON board and option board.
12. Install the VOCON board shield.
13. Reconnect the two connectors.
14. Install the PA assembly, control head, and radio covers.

8.2.7.2 High-Power Radios

1. Use a Torx T15 driver to remove the two screws. Remove the top cover.
2. Disconnect and remove the 12-conductor ribbon cable from the command board and the PA board.
3. Disconnect the 38-conductor ribbon cable from the command board.
4. Remove the heatsink clip from the three transistors in the corner of the board.
5. Remove the VOCON board shield.
6. Remove the VOCON board from the command board after reading the NOTES and CAUTIONS in the VOCON board section.
7. Use a Torx T15 driver to remove the six screws retaining the command board.
8. Gently work the command board out of the chassis cavity and then remove the foam piece from the crystal near the PA ribbon connector.
9. To reassemble the command board, apply a thin coat of thermal compound (for example, Motorola Part No. 11-83166A01) to the audio amplifier mounting surface.

NOTE: Do not use a thick coating of compound as it could degrade the thermal efficiency of the heatsink. Prior to installing the command board, make sure the male-to-male command board header is fully seated in the RF board.
10. Install the new command board into the chassis cavity.
11. Replace the foam piece.
12. Using six new screws, start all the screws, and then torque them to 8-10 in.-lbs. Ensure the screws are aligned with the holes.
13. Replace the heatsink.
14. Connect the 12-conductor ribbon cable from the command board to the PA board.
15. Connect the 38-conductor ribbon cable to the command board.
16. Reassemble the VOCON board.

17. Replace the section VOCON board shield and the top cover, and then torque the screws to 6-8 in.-lbs.

8.2.8 Receiver Front-End Board

8.2.8.1 Low-/Mid-Power Radio

1. Remove the radio top cover.
2. Remove the two mounting screws and unplug the control head.
3. Remove the EMI metallic shielding tape (Motorola Part No.11-85984D01). Be careful to prevent any tape particles from falling inside the chassis.
4. Disconnect the coaxial cable that passes through the front of the chassis from the RF board.
5. Remove the PA assembly.
6. Disconnect the coaxial cable that passes through the rear of the chassis to the receiver front end.
7. Remove the four screws and front-end cover, and carefully lift the receiver front-end board from the chassis.

NOTE: Be careful to insert the Rx injection coaxial cable straight into the receptacle on the VCO board, and be sure it is fully inserted. Be careful not to bend the tip of the coaxial cable, which provides the contact for the connection.

8. Install the new assembly, being careful not to damage the RF connection that passes through the chassis to the VCO.
9. Reconnect both coaxial cables.
10. Clean the chassis surface with isopropyl alcohol, and place a new piece of EMI metallic shielding tape (Motorola Part No. 11-85984D01) over the coaxial cable passing through the front of the chassis.

NOTE: The EMI metallic shielding tape must cover the hole in the receiver front-end board. This same piece of tape must also cover at least half of the coaxial cable.

11. Install the front end cover and four mounting screws.
12. Install the PA assembly, control head, and radio cover.

NOTE: No alignment is necessary.

8.2.8.2 High-Power Radio

1. Turn the radio top side down and use a Torx T15 driver to remove the four bottom-cover screws.
2. Remove the bottom cover.
3. Remove the power amplifier and RF board shields.
4. Disconnect the RX coaxial cable that comes through the power amplifier board.
5. Disconnect the coaxial cable from the RF board.
6. Feed both cables back to the top side of the radio.
7. Using a Torx T15 driver, remove the two top cover screws, and then remove the radio top cover.
8. Using a Torx T15 driver remove the four screws to the receiver front-end shield, and then remove the shield.

- Carefully remove the front-end receiver board from the radio chassis cavity and disconnect the coaxial cable beneath it.

NOTE: Be careful to insert the Rx injection coaxial cable straight into the receptacle on the VCO board, and be sure it is fully inserted.

Also, be careful to not bend the tip of the coaxial cable, which provides the contact for the connection. Make sure all connections are tight, and that all shields are pressed firmly into their proper cavities.

- Install the new front-end receiver board into the radio chassis cavity.
- Reconnect the coaxial cable beneath the front-end board.
- Feed the coaxial cables through the chassis into the opposite side.
- Using four new screws and a Torx T15 driver, install the receiver front-end shield, and then torque the screws to 8-10 in.-lbs. Ensure the screws are aligned with the holes.
- Replace the radio top cover, and torque the two top-cover screws to 6-8 in.-lbs.
- Turn the radio topside down and reconnect the coaxial cable into the power amplifier board and RF board receptacles.
- Replace the power amplifier shield, RF board shield, and bottom cover.
- Torque the four bottom-cover screws to 6-8 in.-lbs.

NOTE: No alignment is necessary.

8.2.9 VCO Board

8.2.9.1 Low-/Mid-Power Radio

- Remove the radio bottom cover.
- Remove the PA assembly and disconnect the TX injection coax that passes through the chassis to the VCO board.
- Remove the RF board cover.
- Remove the six mounting screws and the cover.
- Carefully lift the board far enough to expose the Rx injection coaxial cable underneath, which runs from a receptacle on the VCO through a hole in the chassis to the receiver front end assembly.
- Unplug the coaxial cable from the receptacle on the VCO board, and then lift straight up on the VCO board to remove it from the chassis.
- To install the new board, plug in the Rx injection coaxial cable (from the receiver front end) into the receptacle near the outer edge of the board.
- Align the opposite edge connector with the RF board connector and snap it into place.

NOTE: Be sure the board and gasket are straight and that the board does not bind as the screws are tightened, pulling the board down to the cavity ledge. Tighten the screws evenly to avoid warping the board. It is very important to use proper screw torque to ensure proper operation in vibration environments. Use only new screws.

- Connect the PA board's RF cable to the VCO board connector (through the chassis).
- Using six new mounting screws, install the VCO cover, and then torque the screws to 8-10 in.-lbs. Ensure the screws are aligned with the holes.
- Install the PA assembly and the radio cover.

8.2.9.2 High-Power Radio

1. Turn the radio topside down and remove the four bottom-cover screws, and remove the bottom cover.
2. Remove the power amplifier and RF board shields.
3. Remove the six VCO board shield screws and remove the VCO board shield.
4. Gently pry up on the VCO board, where it extends over the RF board, until the VCO board is disconnected from the RF board.
5. Disconnect the two coaxial cables that plug into the VCO board and remove the board.
6. Remove the metal VCO gasket from around the VCO board.
7. Place the VCO metal gasket around the new VCO board.

NOTE: Be sure the board and gasket are straight and that the board does not bind as the screws are tightened, pulling the board down to the cavity ledge. Tighten the screws evenly to avoid warping the board. It is very important to use proper screw torque to ensure proper operation in vibration environments. Use only new screws.

8. Reconnect both of the coaxial cables to the VCO board.
9. Place the board into the chassis cavity by aligning the pins on the VCO board with the mating part on the RF board, and pressing the board firmly into place.
10. Replace the VCO board shield using six new mounting screws, and then torque the screws to 8-10 in.-lbs.
11. Install the power amplifier and RF board shields.
12. Replace the bottom cover, and torque the four bottom-cover screws to 6-8 in.-lbs.

8.2.10 RF Board

8.2.10.1 Low-/Mid-Power Radio

1. See the previous paragraph and remove the VCO board.
2. Remove the control head.
3. Disconnect the RF cable that passes through the chassis to the RF board.
4. Remove the six mounting screws, and then remove the RF board.
5. Install the new RF board, and connect the RF cable through the front of the chassis to the RF board.
6. Install six new mounting screws in the RF board, but wait to tighten them until after you install the VCO board. Ensure the screws are aligned with the holes.

NOTE: Make sure the male-to-male command board header is fully seated in the command board before installing the RF board.

7. Install the VCO board.
8. Tighten the new RF and VCO board mounting screws (torque to 8-10 in.-lbs.). Ensure the screws are aligned with the holes.

NOTE: It is very important to use proper screw torque on both boards to ensure proper operation in vibration environments.

9. Install the control head and radio covers.

8.2.10.2 High-Power Radio

1. Turn the radio topside down, remove the four bottom-cover screws, and then remove the bottom cover.
2. Remove the six VCO board shield screws.
3. Remove the VCO board and the RF board shields from the radio chassis.
4. Gently pry up on the VCO board, where it extends over the RF board, until the VCO board is disconnected from the RF board.
5. Remove the six RF board screws, and then move the VCO board out of the way.

NOTE: The coaxial cables that go to the VCO board do not need to be disconnected in order to move the VCO board out of the way. Make sure the male-to-male command board header is fully seated in the command board before installing the RF board.
6. Gently pry the RF board up away from the chassis cavity to disconnect the RF board from the command board on the other side of the chassis.
7. Plug the 24-pin connector from between the RF board and the command board into the new RF board.
8. Carefully place the new RF board into the chassis cavity.
9. Connect the RF board to the command board with the 24-pin connector.
10. Install the VCO board into place, making sure that the VCO board is properly connected to the RF board.
11. Install six new mounting screws in the RF board, and then torque them to 8-10 in.-lbs. Ensure the screws are aligned with the holes.
12. Replace the VCO board shield.
13. Install six new mounting screws in the VCO board, and then torque them to 8-10 in.-lbs. Ensure the screws are aligned with the holes.
14. Replace the bottom cover, and torque the four bottom-cover screws to 6-8 in.-lbs.

8.3 Final Reassembly

8.3.1 Power Amplifiers

1. Apply a thin coat of thermal compound (for example, Motorola Part No. 11-83166A01) to the pre-driver, driver and final device heatsink mounting surfaces.

NOTE: Do not use a thick coating of compound as it could degrade the thermal efficiency of the heatsink.



Caution

Do not bend or twist the PA board. Such stress may crack the surface mount components and hybrid circuit.

2. Tighten mounting screws on the pre-driver, driver, and final device before you attempt to transmit. This will insure proper thermal conduction.
3. Tighten the antenna connector nut (refer to Table 8-3: "Fastener Torque Chart" on page 8-18 for torque value) to ensure the connector is well grounded.

8.3.2 Command Board

NOTE: This assumes the PA is attached, the control head is detached, and the control head interconnect board is disconnected.

1. Before reassembly, apply a thin coat of thermal compound (for example, Motorola Part No. 11-83166A01) to the bottom of the audio PA.
2. Insert the command board into the PA accessory connector (J503) before inserting it into the RF board connector (P500). It might be necessary to angle the command board towards the PA.
3. Ensure the accurate placement of the insulator between Q500, Q502, and Q521 and the chassis wall. Be careful, when placing the command board, not to fold or damage the insulator.
4. Start all six of the mounting screws before tightening and then tighten them evenly to ensure you do not warp the board.
5. Reconnect the control head interconnect board to command board.
6. Plug and secure the control head with two screws.
7. Reconnect the VOCON board and option board (if any) prior to installing covers.

8.3.3 Dash Control Head Board

When reassembling the control head, make sure the microphone pins are properly inserted through the elastomeric keypad. Also make sure the elastomeric keypad inserts are secured to the PC board.

8.3.4 Model W3 Hand-Held Control Head

NOTE: Numbers shown in parentheses in the following procedure refer to item numbers in Table 11.1, "Model W3 Hand-Held Control Head Exploded View," on page 11-2.

1. To reassemble the housing assembly [7]:
 - A. Insert the transmit indicator [11] into the housing. Ensure that the top surface of the lightpipe is below the label recess of the housing.
 - B. Attach the nameplate label [13] to the front of the housing. Ensure that the label is securely attached.
 - C. Install the PTT actuator [9] into the housing. Ensure that its lip is seated in the groove in the housing.
 - D. Install the PTT lever [10] and the PTT boot [12] into the housing. Ensure that the lever is seated in its nest and the boot is located properly in the recesses in the housing.
 - E. Install the keypad [6] into the housing. Ensure that all of the keys are located in the correct openings in the housing.
2. Install the microphone assembly [8] into the keypad. Ensure that the front surface of the cartridge is located up against the keypad membrane.

NOTE: The membrane is the rain seal and is very sensitive to puncture by sharp objects.

3. Connect the microphone cable connector to the mating location on the circuit board [5].
4. Install the circuit board [5] into the housing assembly [7] as follows:
 - A. Hold the housing assembly so that its key openings face downward and its top faces away from you.

- B. Pivot the circuit board's display down under the retention features in the housing and rotate the board downward, ensuring that the board is positioned between the snap features. Ensure that the microphone assembly's [8] wire passes through the opening in the circuit board.
- C. Press downward firmly on the board until the seven snap features lock the board into place.
5. Install the two snap retainers [4] between the circuit board and the side wall of the housing assembly [7], one on each side.
 6. Install the main seal [3] onto the rear cover assembly [2], placing the seal under the retainer features around the perimeter of the cover.
 7. Install the rear cover assembly [2] onto the housing assembly [7]. Starting at the top of the cover, pivot the cover toward the housing and squeeze the two halves together until the snap features at the lower end of the rear cover engage the housing's features and snap closed.
 8. Insert the cable assembly's [15] telco connector into the opening in the bottom of the housing, ensuring that it correctly is oriented.
 9. Press the telco connector in place until it snaps in (like a phone plug).
 10. Place the seal support wedge [14] into the housing's opening, orientating it so that its long portion is under the telco connector lever, and then push until it is properly seated.
 11. Push the rubber seal (part of the cable assembly [15]) into the housing's opening and ensure that it is properly seated.
- NOTE:** This seal must be inserted completely into the housing to ensure the rain seal.
12. Push the strain relief boot (part of the cable assembly [15]) into the housing, and ensure that it is properly seated.
 13. Insert the kit label [1] into the recess on the rear cover, ensuring that it is securely attached.

8.4 Fastener Torque Chart

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

Table 8-3. Fastener Torque Chart

Part Number	Description	Repair Torque (in.-lbs.)	Where Used
N/A	Hex nut, 7/16	6-8	Mini-UHF antenna connector
03-10907A97	Screw, M3.5X30	10-12	Interconnect board (high-power)
03-10911A11	Screw, machine M3X8	6-8	PA boards device attachment
03-10943A10	Screw, machine M3X6	8-10	TO-39 heatsink (PA, Q3804) (very low-, low-, and mid-power)

Table 8-3. Fastener Torque Chart (Continued)

Part Number	Description	Repair Torque (in.-lbs.)	Where Used
03-10943J15	Screw, tapping M3.5X8	8-10	Controller board attachment (except for control head and remote dash board)
03-10943R55	Screw, tapping M3X8	6-8	Pivot pin (high-power)
03-10945A11	Screw, plastite M3X16	6-8	Control head and remote dash board attachment
03-10945A14	Screw, plastite M3X8	6-8	Remote control cable cover
03-1098A33	Screw, machine	6-8	Back housing W9 control head
03-12016A27	Screw, tapping, M3.5X22	8-10	All PC board attachment (except for control head, controller board, and remote dash board)
03-80041S01	Screw, captive	6-8	Control head leaf spring
03-80043L01	Screw, tapping M3X10	6-8	External power connector accessory clip
03-80043L01	Screw, M3.0X10	6-8	Lock housing (high-power)
03-80077M01	Screw, hex M3X18	4-6	Control heat mounting
			Remote front housing mounting
03-80077M04	Screw, hex M3X22	6-8	Remote cable mounting
03-80077M06	Screw, hex M4X16	10-12	Mid-power heatsink mounting
03-80102P01	Screw, tapping M3.5X10	6-8	Mid-power PA cover, top and bottom radio covers (high-, mid-, and low-power)
03-80114M02	Screw, machine M5X10	10-12	Radio mounting (very low-, low-, and mid-power)
03-84244C06	Wing screw M5X10	10-12	Radio mounting

Notes

Chapter 9 Basic Troubleshooting

9.1 Introduction

This section of the manual contains troubleshooting charts, error codes, a functional block diagram, interconnect diagrams, and flexible circuit information. This section can help you isolate a problem to the board level. Board-level troubleshooting does not attempt to isolate problems to the component level. Component-level service information can be found in the *ASTRO Digital Spectra and Digital Spectra Plus Mobile Radios Detailed Service Manual*. (Refer to the “Related Publications” section of this manual on page xii for the specific manual number.)

NOTE: To access the various connector pins, use the housing eliminator/test fixture along with the diagrams found in this section of the manual. (Refer to the section, “Service Aids and Recommended Tools,” on page 4-2 for the appropriate Motorola service aids and tools parts numbers.)

9.2 Replacement Board Procedures

Once a problem has been isolated to a specific board, use one of the following recommended repair procedures:

- Install a good board from your inventory into the radio.
- Order a replacement board from Customer Care and Services Division at 1-800-422-4210.
- Troubleshoot the defective board using the *ASTRO Digital Spectra and Digital Spectra Plus Mobile Radios Detailed Service Manual*. (Refer to the “Related Publications” section of this manual on page xii for the specific manual number.)

9.3 Power-Up Error Codes

When the radio is turned on (power-up), the radio performs cursory 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. 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 inhibit user operation; non-fatal errors do not. Use the following tables to aid in understanding particular power-up error code displays.

9.3.1 ASTRO Digital Spectra

Table 9-1. ASTRO Digital Spectra Power-Up Error Codes

Error Code	Description	Corrective Action
01/02	External EEPROM checksum non-fatal error	Reprogram the codeplug.
01/81	ROM checksum failure	Reprogram the FLASH memory.
01/82	External EEPROM checksum failure	Reprogram the codeplug.
01/84	EEPROM is blank	Program the EEPROM.
01/88	RAM failure - Note: not a checksum failure	Turn the radio off, then on.
01/90	General hardware failure	Turn the radio off, then on.
01/92	Internal EEPROM checksum failure	Reprogram the codeplug.
02/10	DSP support IC checksum non-fatal error	Turn the radio off, then on.
02/81	DSP ROM checksum failure	Reprogram the FLASH memory.
02/82	DSP RAM 1 failure	Replace the VOCON board.
02/84	DSP RAM 2 failure	Replace the VOCON board.
02/88	DSP RAM failure - Note: not a checksum failure	Turn the radio off, then on.
02/90	General DSP hardware failure (DSP startup message not received correctly)	Turn the radio off, then on.
02/A0	ADSIC checksum failure	Replace the VOCON board.
05/10	Control head not communicating with radio	Turn the radio off, then on.
05/81	Control head ROM checksum failure	Replace the control head.
08/10	Siren/PA not communicating with radio	Turn the radio off, then on.
09/10	Secure option not communicating with radio	Turn the radio off, then on.

9.3.2 ASTRO Digital Spectra Plus

Table 9-2. ASTRO Digital Spectra Plus Power-Up Error Codes

Error Code	Description	Error Type	Corrective Action
ERROR 01/02	FLASH ROM Codeplug Checksum	NON-FATAL	Reprogram the codeplug.
ERROR 01/12	Security Partition Checksum	NON-FATAL	Reprogram the security partition.
ERROR 01/22	Tuning Codeplug Checksum	NON-FATAL	Reprogram the tuning partition.
FAIL 01/81	FLASH ROM Checksum	FATAL	Reprogram the radio firmware.
FAIL 01/82	FLASH ROM Codeplug Checksum	FATAL	Reprogram the codeplug.
FAIL 01/88	External RAM Fail	FATAL	Turn the radio off, then on.
FAIL 01/90	General Hardware	FATAL	Turn the radio off, then on.
FAIL 01/92	Security Partition Checksum	FATAL	Reprogram the security partition.
FAIL 01/93	Flashport AUTHENT CODE Failure	FATAL	Replace the VOCON board.
FAIL 01/98	Internal RAM Fail	FATAL	Replace the VOCON board.
FAIL 01/A2	Tuning Codeplug Checksum	FATAL	Reprogram the tuning partition.
FAIL 02/81	DSP ROM Checksum	FATAL	Reprogram the DSP firmware.
FAIL 02/88	DSP RAM Fatal Error	FATAL	Turn the radio off, then on.
FAIL 02/90	General DSP Hardware Failure	FATAL	Turn the radio off, then on.
ERROR 05/10	Control Head Hardware Error	NON-FATAL	Turn the radio off, then on.
FAIL 05/81	Control Head ROM Checksum Error	FATAL	Replace the control head.
ERROR 06/10	Aux Control Head Hardware Error	NON-FATAL	Turn the radio off, then on.
FAIL 06/81	Aux Control Head ROM Checksum Error	FATAL	Replace the aux. control head.
ERROR 08/10	Siren Hardware Error	NON-FATAL	Turn the radio off, then on.

Table 9-2. ASTRO Digital Spectra Plus Power-Up Error Codes (Continued)

Error Code	Description	Error Type	Corrective Action
FAIL 08/81	Siren ROM Checksum Error	FATAL	Replace the siren.
ERROR 09/10	Secure Hardware Error	NON-FATAL	Replace the secure module.
FAIL 09/90	Secure Hardware Fatal Error	FATAL	Replace the secure module.
ERROR 12/10	VRS Hardware Error	NON-FATAL	Turn the radio off, then on.
FAIL 12/81	VRS ROM Checksum Error	FATAL	Replace the VRS.
ERROR 1C/10	TRC Hardware Error	NON-FATAL	Turn the radio off, then on.
FAIL 1C/81	TRC ROM Checksum Error	FATAL	Replace the TRC.

9.4 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 the following tables to aid in understanding particular operational error codes.

9.4.1 ASTRO Digital Spectra

Table 9-3. ASTRO Digital Spectra Operational Error Codes

Error Code	Description	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	1. Reprogram codeplug 2. Replace RF board.
FAIL 002	Selected Mode/Zone Codeplug Checksum Error	Reprogram codeplug.

9.4.2 ASTRO Digital Spectra Plus

Table 9-4. ASTRO Digital Spectra Plus Operational Error Codes

Error Code	Description	Error Type	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	NON-FATAL	1. Reprogram codeplug 2. Replace RF board.
FAIL 002	Personality checksum or system block error	NON-FATAL	Reprogram codeplug.

9.5 Transmitter Troubleshooting

The following table can help you troubleshoot problems that might occur in the transmitter section of your radio.

Table 9-5. Transmitter Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)	
No RF Power Output	TX Power Level Programming	Check TX power level programming (from the appropriate radio programming software).	
	No Keyed 9.4 Vdc from Command Board	Check for keyed 9.4 Vdc on J500 pin 15 with transmitter keyed. If none, replace the command board.	
	No Injection to Power Amplifier		1. Check the lock line (J500 pin 14). If not less than 2 Vdc, go to the Synthesizer Troubleshooting Chart on page 9-12.
			2. Measure injection, which should be > +18 dBm. If low, replace the VCO board.
	Power Amplifier	Measure PA control voltage (P503 pin 2). If >6 Vdc, replace the PA board.	
Power Control Circuit	If PA control voltage above was <6 Volts, replace the command board.		

Table 9-5. Transmitter Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No Modulation	VCO Board	1. All modulation testing should be done with the radio keyed and 1Vrms on the microphone high line of the microphone.
		2. Is radio properly tuned? (See <i>Chapter 6. Radio Alignment Procedure.</i>)
		3. Is there > 400 mVrms at J500 pin 11? If so, replace the VCO board.
	Command Board	If there is > 400 mVrms (ac coupled) at P501 pin 49 and not at J500 pin 11, replace the command board.
	VOCON Board	If there is >200 mVrms modulation at J501 pin 39 and no modulation at J501 pin 49, replace the VOCON board.
Distorted Modulation	Bandwidth	Is the correct bandwidth selected (use the appropriate radio programming software)? Is radio properly tuned? (See <i>Chapter 6: Radio Alignment Procedure.</i>)
	Compensation Not Set/ Working (DPL Distorted)	Check compensation setting. If compensation won't adjust, go to <i>Can't Set Compensation</i> below.
	VOCON Board	With 80 mVrms on the mic high line, is the signal on pin 49 of P501 distorted (ac coupled)? If so, replace the VOCON board.
	Command Board	With 80 mVrms on the mic high line, is the output of the command board VCO Mod (pin 11 of J500) distorted? If so, replace the command board.
	VCO Board	Replace VCO board.

Table 9-5. Transmitter Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Bad Microphone Sensitivity	Check Deviation and Compensation	Retune, if necessary.
	Microphone	Speak loudly into the microphone while monitoring the microphone line (pin 6 of P502). If it is not >80 mVrms, then replace the microphone.
	Command Board	With 80 mVrms on the mic high line, check pin 39 of P501. If not >100 mVrms (ac coupled), replace the command board.
	VOCON Board	With 80 mVrms on the mic high line, check pin 49 of P501. If not >100 mVrms (ac coupled), replace the VOCON board.
	Command Board	With 80 mVrms on the mic high line, monitor the VCO mod line (pin 11 on J500). Voltage should be >200 mVrms. If not, replace the command board.
	VCO Board	If correct voltage was found on pin 11 of J500, replace the VCO board.
No/Low signaling (PL, DPL, Trunking, MDC)	Check Programming	Reprogram codeplug.

Table 9-5. Transmitter Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Can't Set Compensation	VOCON Board	Vary deviation and compensation controls from maximum to minimum. With the low frequency source active (using the appropriate radio programming software—see <i>Chapter 6: Radio Alignment Procedure</i>) voltage or pin 48 of P501 should vary from <100 mVrms to >3 mVrms. With the high frequency source active, voltage on pin 49 of P501 (ac coupled) should vary from <100 mVrms to >3 mVrms.
	Command Board	1. All modulation testing should be done with the radio keyed and 1 Vrms on the mic high line of the microphone. Check that normal voice deviation is OK. Otherwise, go to <i>No Modulation</i> or <i>Bad Microphone Sensitivity</i> .
		2. Set deviation and compensation controls to maximum. Voltage on pin 17 of J500 should be > 3 V p-p. Voltage @ pin 11 of J500 should be >3 V p-p. If not, replace the command board.
RF Board	If maximum deviation can be set to > 5.0 kHz, but compensation cannot be set, then replace the RF board. Otherwise, replace the VCO board.	

NOTE: The P501 pins can be probed on the extender cable (see the P501 Extender Cable diagram on page 10-6).

9.6 Receiver Troubleshooting

The following table can help you troubleshoot problems that might occur in the receiver section of your radio.

Table 9-6. Receiver Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Radio Dead, Display Does Not Light Up	Blown Fuse	Check fuse in red lead of power cable (or green lead if used.)
	On/Off Switch (Control Head)	Check for SWB+ at pin 31 of J502 on the command board. If not there, check for SWB+ at pin 21 of P502 on the control head.
	Regulators (Command Board)	Check for 9.6 Vdc on pin 10 of J500 and +5V on pin 1 of J500. If not there, check for A+ at pin 30 of 502. If OK, then replace the command board.
	ASTRO Spectra Plus VOCON Board	Check U410 pin 1 for 1.8 Vdc. Check U411 pin 1 for 3.0 Vdc. Check TP401 for 16.8 MHz. If any of these is missing, replace the VOCON board.
Radio Dead, Display Lights Up	Audio PA Circuit	Check continuity of F500 on command board. If open, check for speaker leads shorted to ground, replace. F500 is located just above U450.
	Synthesizer (RF Board)	Check the synthesizer A Clock line (pin 19 of J500). If >3V, then go to the Synthesizer Troubleshooting Chart on page 9-12. If <3V, check P501 pin 8. If <3V there, replace control head; otherwise, replace the command board.
	RF Board	Check pin 7 of P501 for 2.4 MHz. If <3V, replace the RF board.
	Regulators (Command Board)	1. Check for 9.6 Vdc on pin 10 of J500 and +5 Vdc on pin 1 of J500. If not there, then check for A+ at pin 30 of P502 and SWB+ at pin 31 of J502. If OK, replace the command board. 2. Check pin 38 of P501 for A+. If not there, replace the command board. Check pins 33, 34, 37 of P501 for 5 Vdc. If not there, replace the command board.

Table 9-6. Receiver Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No Receiver Audio or Receive Does Not Unsilence	Audio PA Circuit	1. Check codeplug to ensure correct frequency and signaling (PL, DPL) is enabled (use the appropriate radio programming software). 2. Check continuity of F500 on command board. If open, check for speaker leads shorted to ground. Replace, if necessary.
	Regulators (Command Board)	Check for 9.6 Vdc on pin 10 of J500 and +5V on pin 1 of J500. If not there, then check for A+ at pin 30 of P502 and SWB+ at pin 31 of P502. If OK, replace the command board.
	RF Board	Replace RF board.
	VOCON Board	Replace VOCON board.
Audio Distorted or Not Loud Enough	Codeplug	Is the codeplug properly configured including bandwidth and signaling?
	VOCON Board	Is there >100 mVrms audio on pin 40 of P501? If not, replace VOCON board.
	Synthesizer Not On Frequency/Working	Check synthesizer frequency across pins 14 and 16 of P503. If off by more than 250Hz, then go to the Synthesizer Troubleshooting Chart on page 9-12.
	Command Board	Replace command board.

Table 9-6. Receiver Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
RF Sensitivity Poor	Synthesizer Not On Frequency/Working	Check local oscillator frequency. If off by more than 250 Hz, then go to the Synthesizer Troubleshooting Chart (page 9-12).
	Antenna Switch (Amplifier Board)	Check insertion loss from antenna connector to Rx front end coax from the PA. If loss is less than 1.8 dB, then the problem is in the transceiver housing.
	Receiver Front-End Assembly or VCO Board	1. Measure the gain of the front end assembly by injecting a signal at the desired receive frequency and measuring the output level at 109.65 MHz. Net conversion gain should be >8 dB.
		2. If conversion gain is <8 dB, then check the dc supply voltage fed into the front end on the center conductor of the output coax to the RF board. If it is less than 9.4 Vdc, check the RF board.
RF Board	3. Check the injection level from the VCO board. If it is less than +2 dBm, then replace the VCO board. If injection is OK, then replace the receiver front-end assembly.	
	RF Board	Using a TEK-10 probe, check the sensitivity into the RF board @ 109.65 MHz. If sensitivity is worse than -118.5 dBm for 12 dB SINAD, replace the RF board.
Radio Will Not Squelch	Codeplug	Check the offending channel for spurious activity by monitoring with a known-good radio or service monitor. If possible, remove the offending source (computer, etc.). If not, increase the squelch level using the appropriate radio programming software.
Radio Will Not Turn Off	On/Off Switch (Control Head)	Check for SWB+ pin 31 P502 on the command board. If SWB+ is not there, check for SWB+ at pin 21 of P502 on the command board. Replace the control head.
	Command Board	Does SWB+ on pin 31 of P502 switch on and off as the control head switch is operated? If so, replace the command board.
Excessive Noise in Fading Conditions	Check Programming for Correct Bandwidth	Reprogram codeplug with correct bandwidth.

NOTE: The P501 pins can be probed on the extender cable (see the P501 Extender Cable diagram on page 10-6).

9.7 Synthesizer Troubleshooting

The following table can help you troubleshoot problems that might occur in the synthesizer section of your radio.

Table 9-7. Synthesizer Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Does Not Lock on Any Channel	VCO	With radio in receive mode, measure pin 1 of J601 using a high impedance probe. Measured level should be -5 dBm \pm 6 dB, and the frequency should be 370 to 380MHz. If not, replace the VCO board.
	Reference Oscillator/RF Board	Is there >1.5 Vp-p of 2.1 MHz on pin 21 of J500? If not, replace the RF board.
	VOCON Board	Do both the chip select lines (pins 16 & 20 of J500) go low during mode changes? Is there data on the clock & data lines going into the RF board (pins 18 & 19 of J500)? If not, replace the VOCON board.
Does Not Lock on Some Channels	Programming	Check the mode programming information to ensure that the correct frequency programming information has been entered.
	VCO	With the radio in receive mode; unplug the loop feedback coax from the VCO board to the RF board. Measured level should be -5 dBm \pm 5 dB, and the frequency should be 370 to 380 MHz. If not, replace the VCO board.
	RF Board	Replace the RF board.
Does Not Lock in Tx (or Talkaround)	RF Board	Check the Aux bit states (pin 9 & 11 J601). When changing from receive to transmit to talkaround, pin 9 and 11 of J601 should alternate between a high voltage (>8V) and a low voltage (<1V). If either pin does not alternate between these voltages, replace the RF board.
	VCO	Replace the VCO board.

Table 9-7. Synthesizer Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Synthesizer Malfunctioning	Synthesizer Not Locked	Check the synthesizer lock line (pin 14 of J500). If > 1 V, then the synthesizer is not locked. Go to <i>Does Not Lock on Some Channels</i> above.
	Reference Oscillator Not On Frequency/ Working	1. Check the reference oscillator frequency. It should be 16.8 MHz \pm 4 Hz. THIS MUST BE MEASURED @ 25° C (77° F) TO BE ACCURATE.
		2. Retune the reference oscillator if frequency is incorrect.
	VOCON Board	If the reference oscillator will not tune on frequency, is reference control voltage (pin 2 of J500) tuning 1.5 to 3.0 volts, and is the 5 volt supply 5 V \pm .2 V? If not, replace the VOCON board.
	Programming (EEPROM)	Check mode programming information to ensure that the correct frequency programming information has been entered.
	RF Board	Replace the RF board.

Notes

Chapter 10 Functional Block Diagrams and Connectors

This chapter contains the ASTRO Digital Spectra and Digital Spectra Plus functional block diagrams and connector locations.

10.1 Digital Spectra Functional Block Diagram (Models W3, W4, W5, W7, and W9)

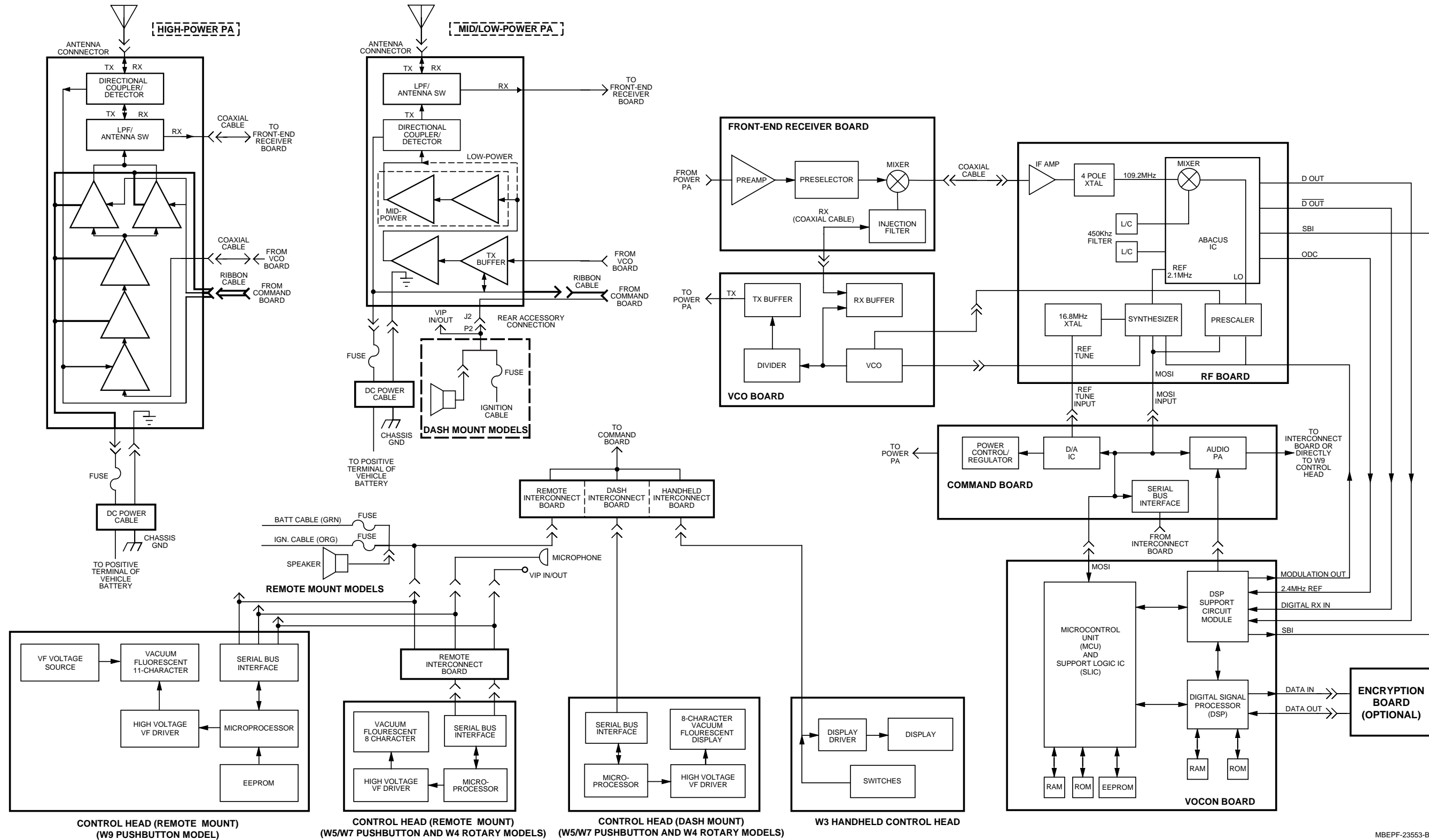


Figure 10-1. Digital Spectra Models W3, W4, W5, W7, and W9 Functional Block Diagram

MBEPF-23553-B

10.2 Digital Spectra Plus Functional Block Diagram (Models W3, W4, W5, W7, and W9)

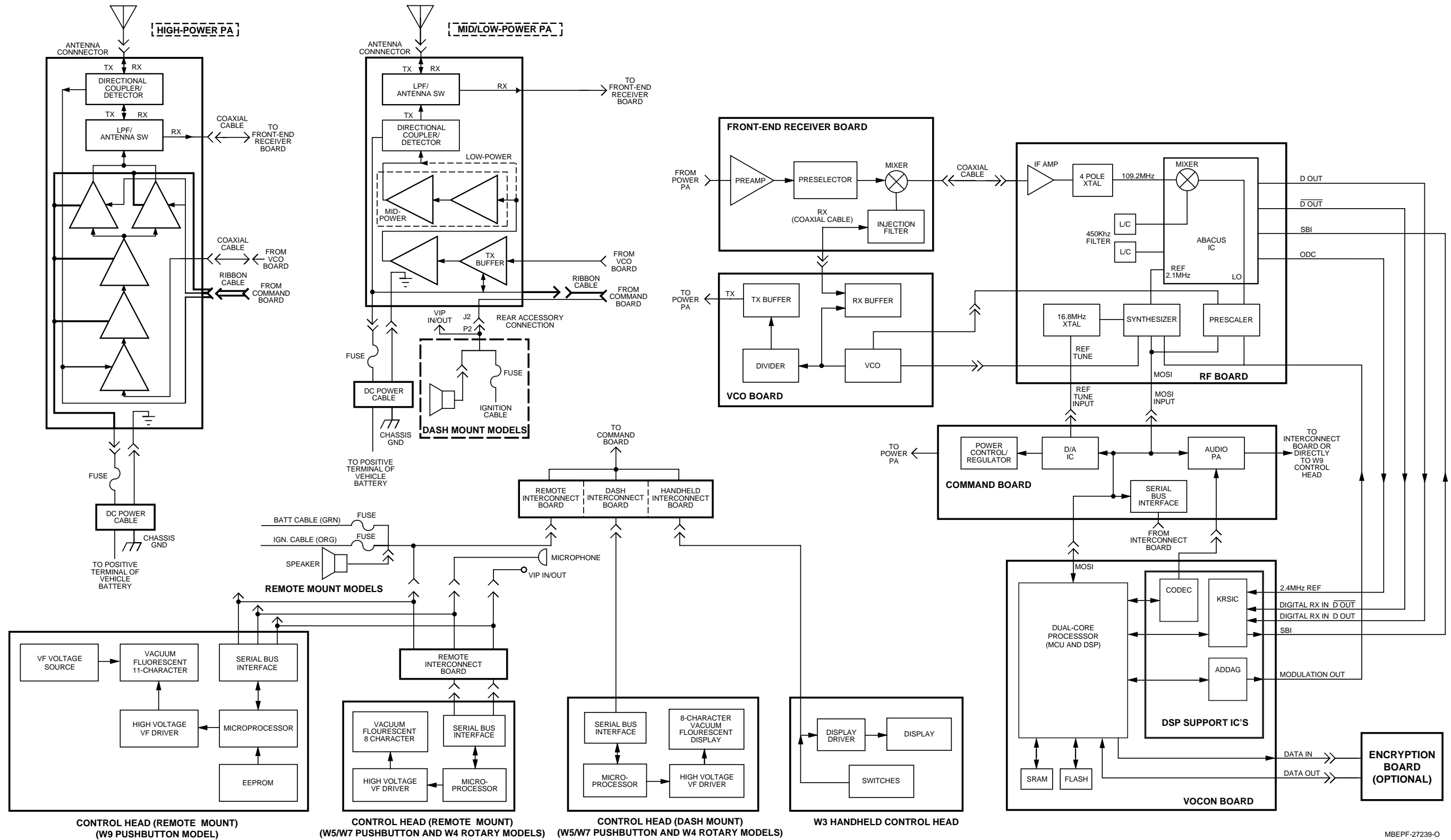


Figure 10-2. Digital Spectra Plus Models W3, W4, W5, W7, and W9 Functional Block Diagram

MBEPF-27239-O

10.3 Radio Connectors

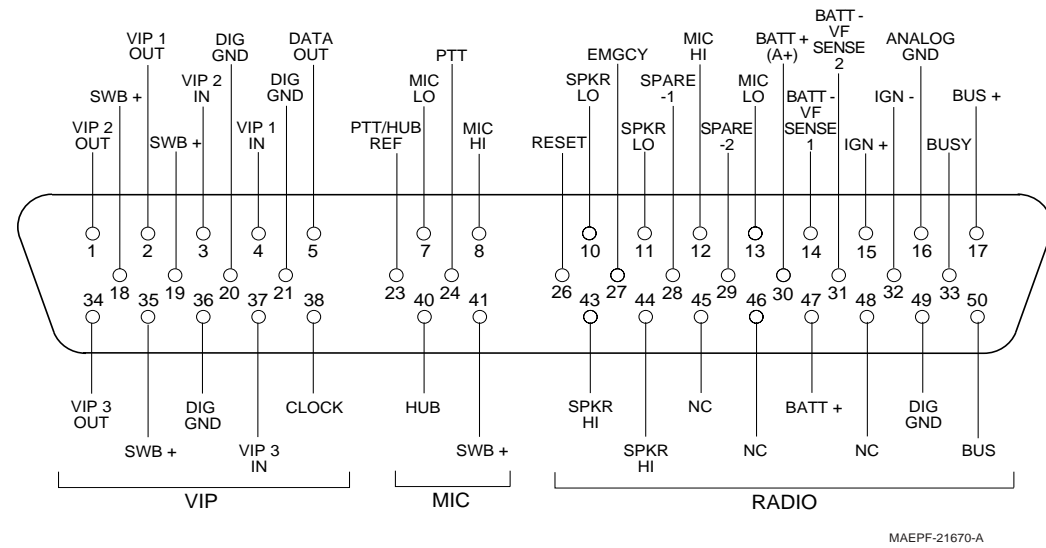


Figure 10-3. J0103 Remote-Mount Control Head Connector

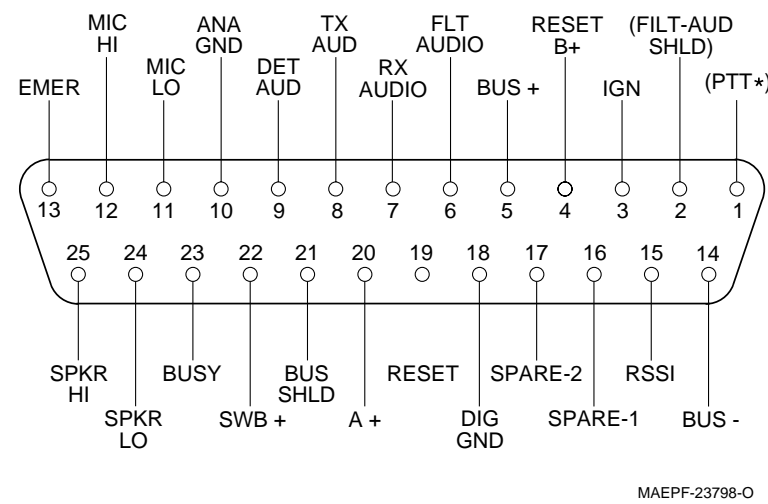


Figure 10-4. J5 Control Cable for Remote-Mount Control Head

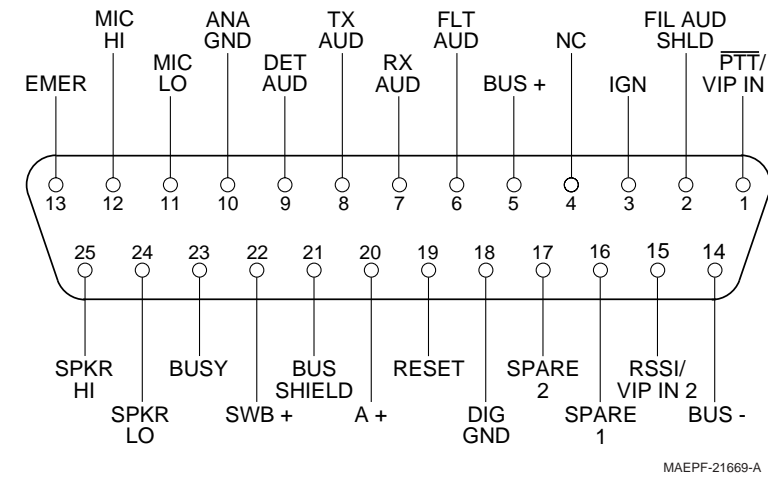
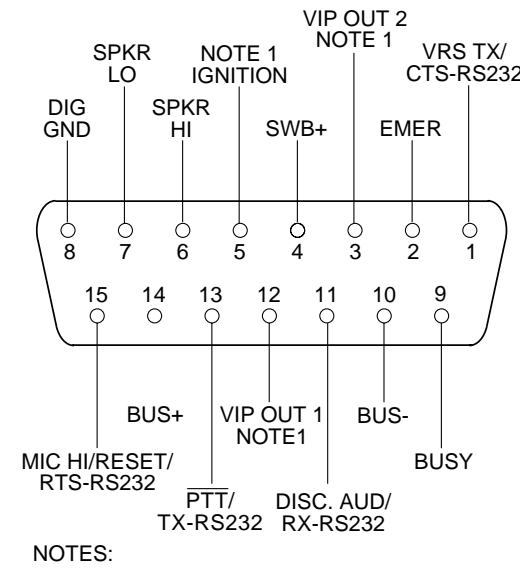
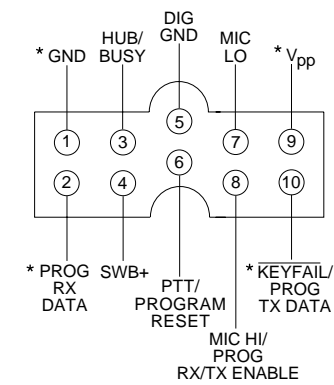


Figure 10-5. J6 Radio Operations Connector



NOTES:
 1. FUNCTIONAL ONLY IN DASH-MOUNT CONFIGURATION. N.C. IN REMOTE-MOUNT CONFIGURATION.

Figure 10-6. J2 Rear Accessory Connector



* PINS 1, 2, 9, AND 10 ARE NO CONNECTIONS (NC) ON P104 OF A REMOTE-MOUNT CONTROL HEAD. DETAIL SHOWN FROM CONTROL HEAD FRONT VIEW (MALE PIN VIEW)

Figure 10-7. P104 Microphone Jack

10.4 Radio Connector Locations

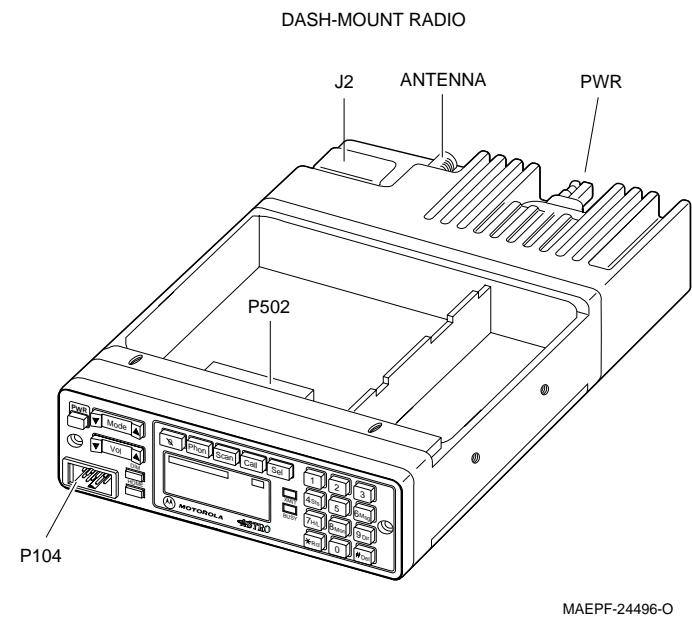


Figure 10-8. Dash-Mount Radio Connector Locations

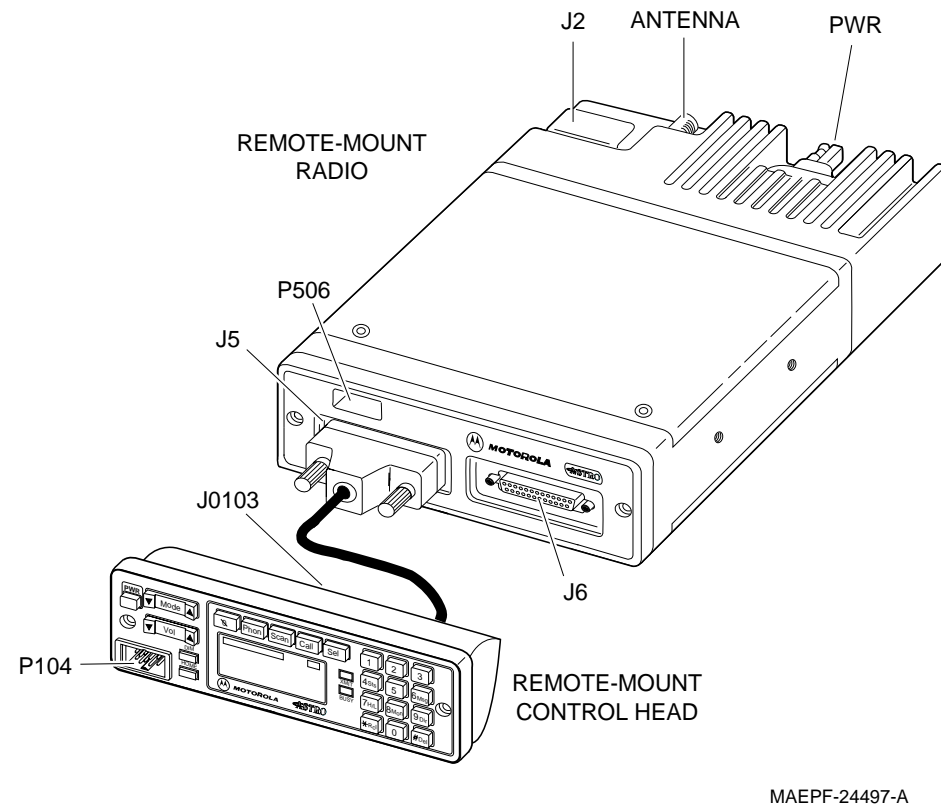


Figure 10-9. Remote-Mount Radio Connector Locations

10.5 Radio Connector Locations (cont.)

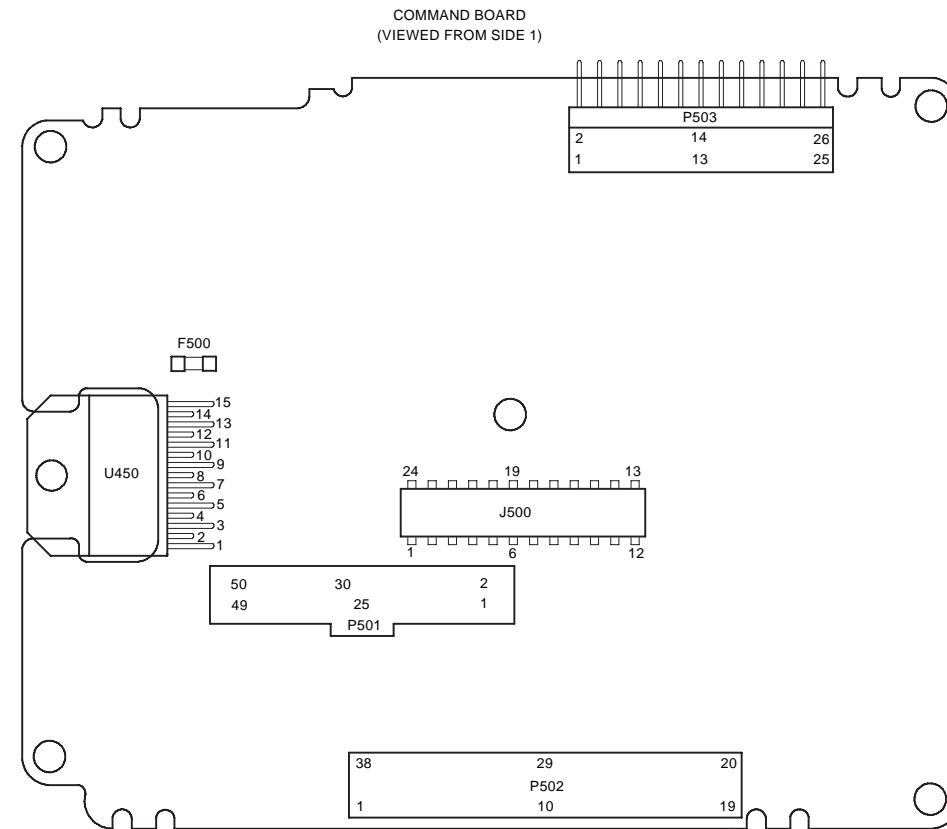


Figure 10-10. Command Board Connector Locations

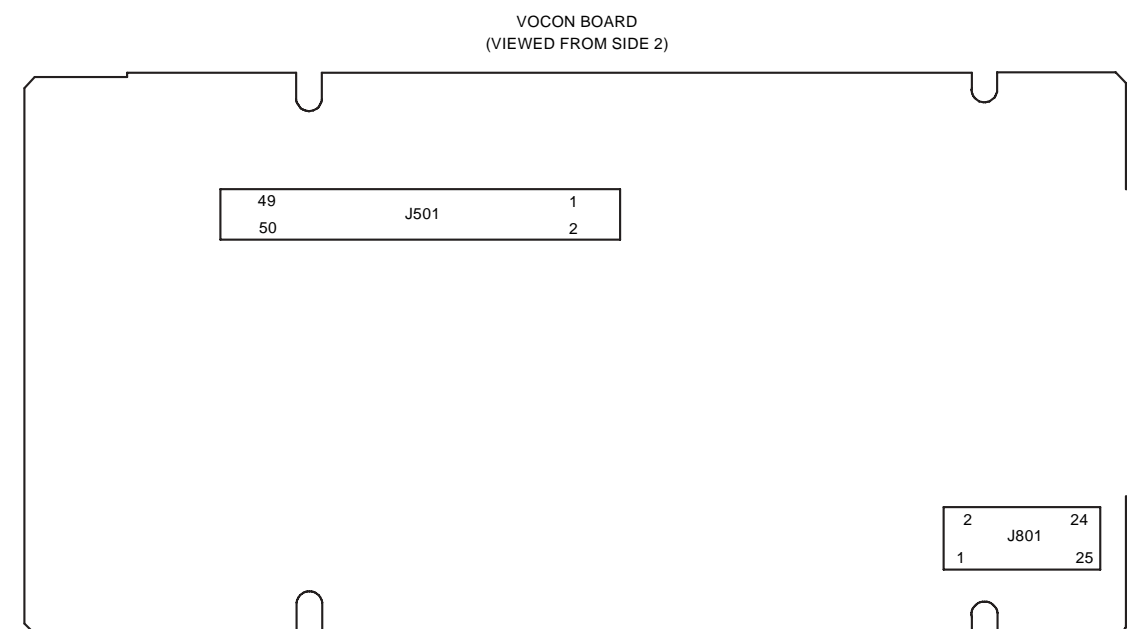


Figure 10-11. VOCON Board Connector Locations

10.6 Extender Cable (P501)

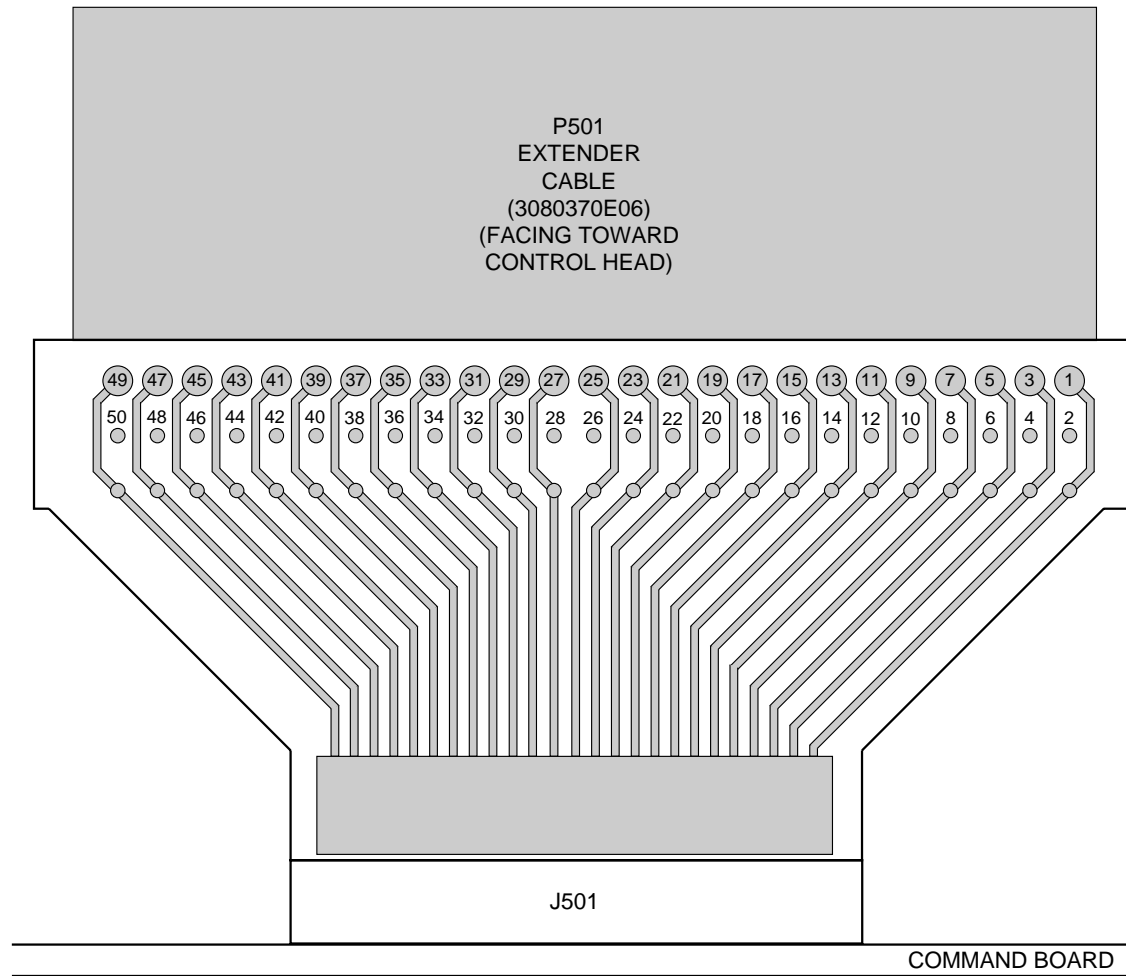


Figure 10-12. P501 Extender Cable

10.7 Control Head Cabling Diagram

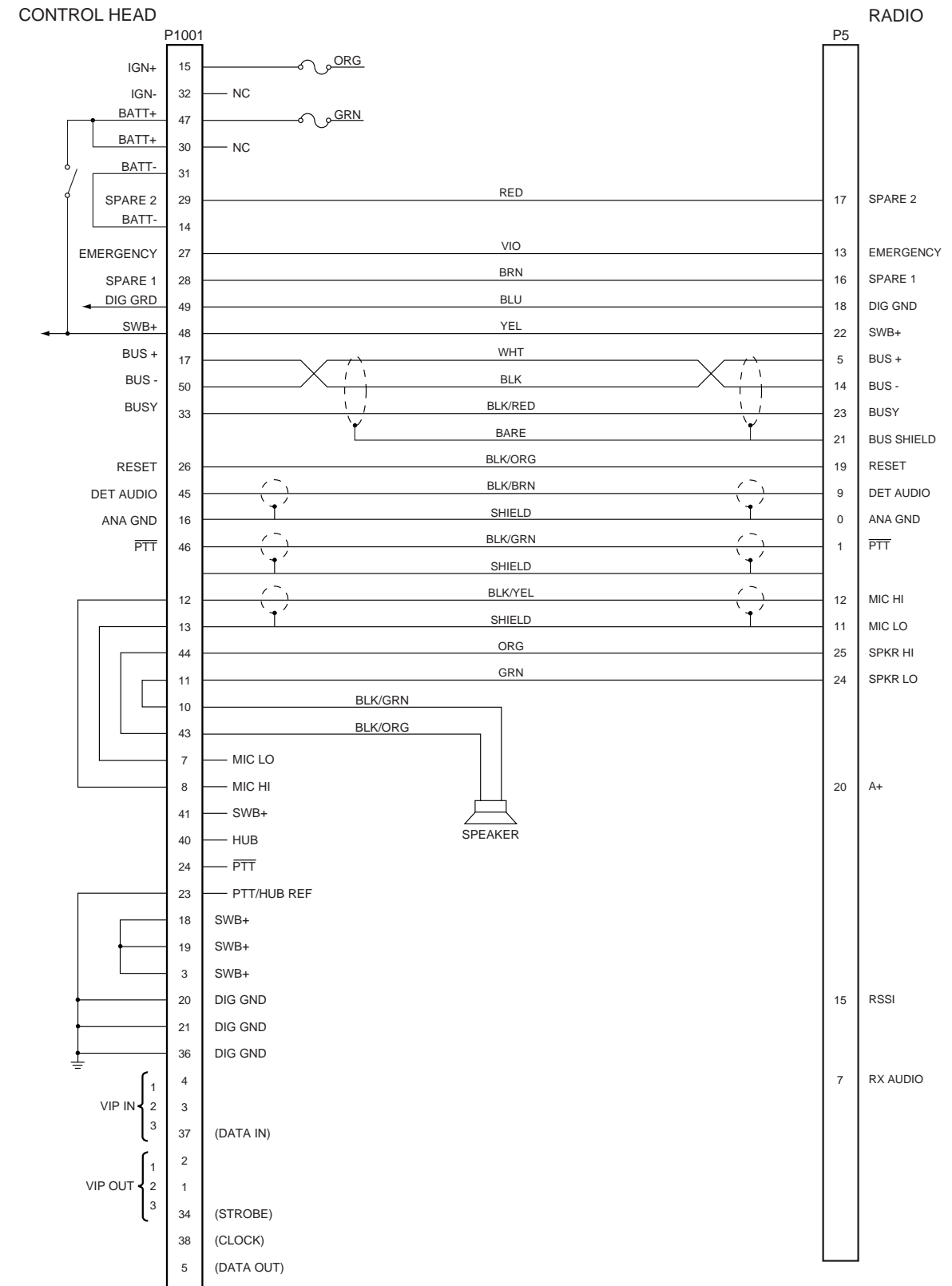


Figure 10-13. Control Head Cabling Diagram

Chapter 11 Exploded Views and Parts Lists

This chapter contains the exploded views and associated parts lists for each of the ASTRO Digital Spectra and Digital Spectra Plus control heads. Tables containing pushbutton parts lists are also included.

11.1 Model W3 Hand-Held Control Head Exploded View

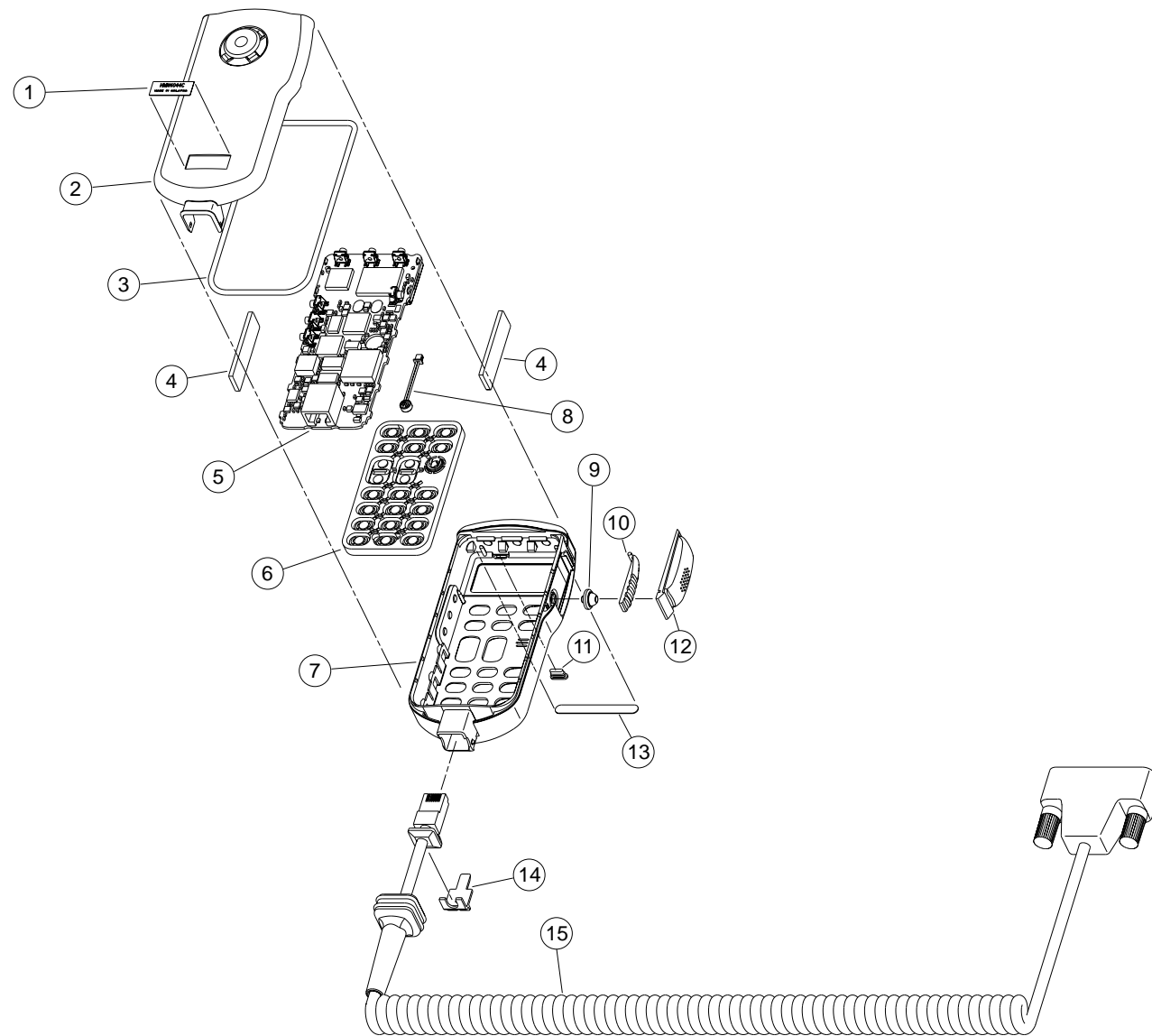


Figure 11-1. Model W3 Hand-Held Control Head Exploded View

Table 11-1. Model W3 Hand-Held Control Head Exploded View Parts List

Item No.	Motorola Part No.	Description
1	Not available	LABEL
2	0105955T26	ASSEMBLY, Rear Cover
3	3205082E93	SEAL, Main
4	4205343Y01	RETAINER, Snap (Qty 2)
5	0102707D81	BOARD, SB9600 Circuit
6	7505832X01	KEYPAD (Part of Item 7)
7	0102707D86	ASSEMBLY, Housing (Includes Items 6 and 9 thru 13)
8	0102708D08	ASSEMBLY, Microphone
9	7505618V02	ACTUATOR, PTT (Part of Item 7)
10	4505850X01	LEVER, PTT (Part of Item 7)
11	3205839X01	INDICATOR, Transmit (Part of Item 7)
12	3805835X01	BOOT, PTT (Part of Item 7)
13	3305409X17	LABEL (Part of Item 7)
14	3205274V01	WEDGE, Seal Support
15	HKN6095_	ASSEMBLY, Cable

Note: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.
Universal Crypto Module (UCM) part numbers and descriptions are listed in the Encryption chapter of this manual.

11.2 Model W4 Rotary Control Head Exploded View

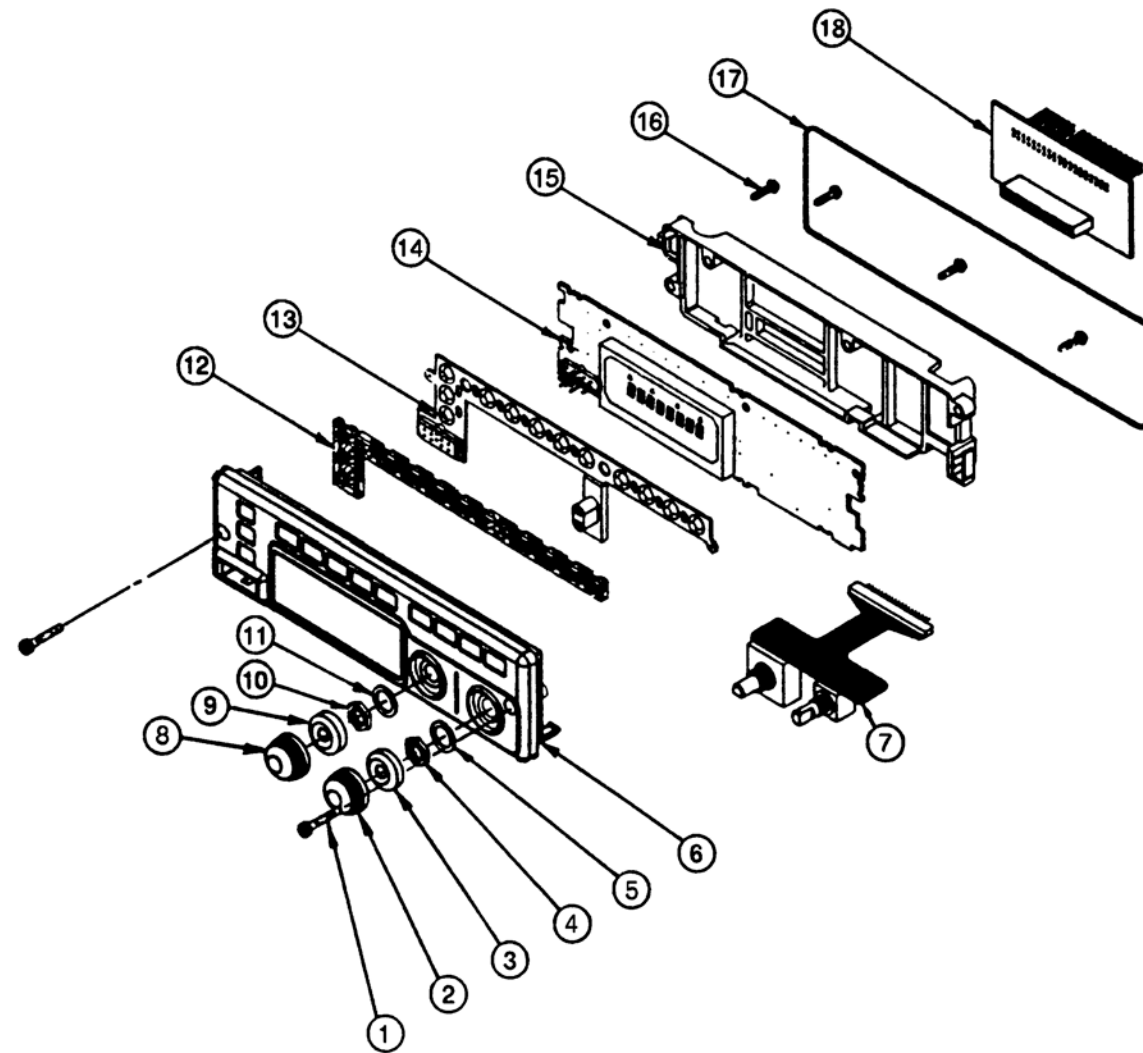


Figure 11-2. Model W4 Rotary Control Head Exploded View

Table 11-2. Model W4 Rotary Control Head Parts List

Item No.	Motorola Part No.	Description
1	0380077M01	SCREW, Control Head Mounting (Qty 2)
2	3602113Z05	KNOB, Volume Control
3	3205805V01	GASKET, W4 Shaft (Qty 2)
4	0284218M01	NUT, Volume Switch
5	0484219M01	LOCKWASHER, Volume Switch
6	1502117Z07 or 1502117Z08	HOUSING, Front Cover (Mobile) HOUSING, Front Cover (Motorcycle)
7	0102709J83	ASSEMBLY, Volume and Rotary Switch
8	3602113Z03	KNOB, Mode Control
9	3205805V01	GASKET, W4 Shaft (Qty 2)
10	0284218M02	NUT, Mode Switch
11	0484219M02	LOCKWASHER, Mode Switch
12	6105129X01	LIGHTPIPE
13	7505128X01	KEYPAD
14	AAHN4045_ or PMLN4019_	ASSEMBLY, Circuit Board (Mobile) ASSEMBLY, Circuit Board (Motorcycle)
15	4302112Z02	SPACER, Internal
16	0310945A14	SCREW, Machine (Qty 4)
17	3280289L02	GASKET, Housing
18	HLN6401_	ASSEMBLY, Circuit Board Interconnect

Notes: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.
 The HKN4356_ Radio Cable is used to remote mount the W4 Control Head.
 Universal Crypto Module (UCM) part numbers and descriptions are listed in the Encryption chapter of this manual.

11.3 Models W5 and W7 Pushbutton Control Head Exploded View

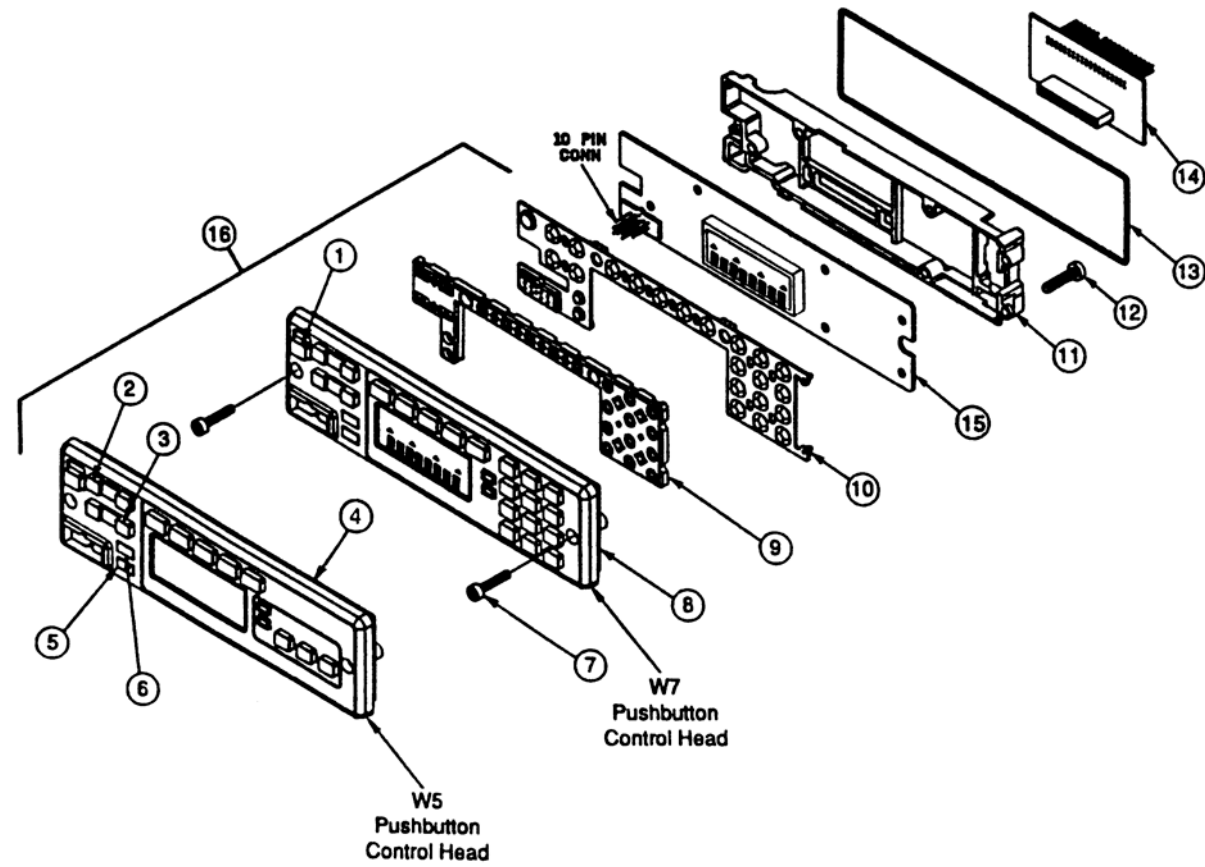


Figure 11-3. Models W5 and W7 Pushbutton Control Head Exploded View

Table 11-3. Models W5 and W7 Pushbutton Control Head Parts List

Item No.	Motorola Part No.	Description
1	3880227M04	SWITCH, On/Off Cap
2	3880009P01	SWITCH, Mode Rocker
3	3880009P02	SWITCH, Volume Rocker
4	1580020S17 or 1580020S19	HOUSING, W5 Front Cover (Mobile) HOUSING, W5 Front Cover (Motorcycle)
5	3880092J05	PUSHBUTTON, HOME
6	3880092J05	PUSHBUTTON, DIM
7	0380077M01	SCREW, (Qty 2)
8	1580020S16 or 1580020S18	HOUSING, W7 Front Cover (Mobile) HOUSING, W7 Front Cover (Motorcycle)
9	6180017S01	LIGHTPIPE
10	7580012S03	KEYPAD
11	4380019S02	SPACER, Internal Frame
12	0310945A14	SCREW, Tapping (Qty 7)
13	3280289L02	GASKET, Housing
14	HLN6401_	BOARD, Interconnect
15	HLN6396_ or HLN6563_	BOARD, Control Head (Mobile) BOARD, Control Head (Motorcycle)
16	0180049S09 or 0180049S11 or 0180049S08 or 0180049S10	ASSEMBLY, W5 Front Cover (Mobile) ASSEMBLY, W5 Front Cover (Motorcycle) ASSEMBLY, W7 Front Cover (Mobile) ASSEMBLY, W7 Front Cover (Motorcycle) Item 16 includes items 1, 2, 3, 4 or 8, 5, 6, 9, and 10

Notes: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.
 The HKN4356_ Radio Cable is used to remote mount the W5 and W7 Control Head.
 Universal Crypto Module (UCM) part numbers and descriptions are listed in the Encryption chapter of this manual.

11.4 Model W9 Pushbutton Control Head Exploded View

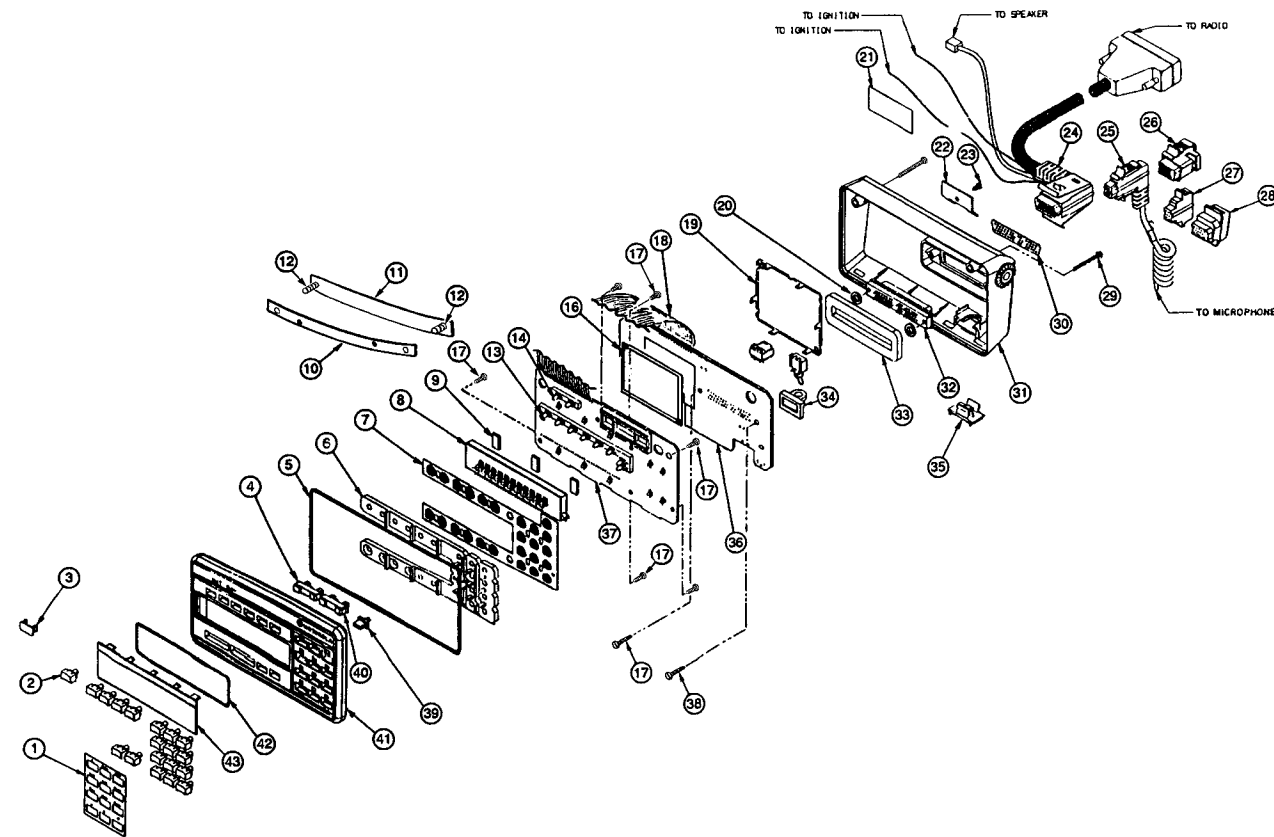


Figure 11-4. Model W9 Pushbutton Control Head Exploded View

Table 11-4. Model W9 Pushbutton Control Head Parts List

Item No.	Motorola Part No.	Description
1	1380087J01	ESCUTCHEON
2	HLN5083_	BUTTON, Emergency
	HLN5091_	BUTTON, Dir
	HLN5066_	BUTTON, Scan
	HLN5256_	BUTTON, Srch
	HLN5074_	BUTTON, Call
	HLN5268_	BUTTON, Page
	HLN5259_	BUTTON, RPGM
	HLN5258_	BUTTON, Site
	HLN5090_	BUTTON, PHON
	HLN5072_	BUTTON, H/L
	HLN5257_	BUTTON, Lock
	HLN5076_	BUTTON, RCL
	HLN5085_	BUTTON, SQL
	HLN5078_	BUTTON, Del
	HLN5087_	BUTTON, Home
	HLN5079_	BUTTON, Sel
	HLN5095_	BUTTON, Blank
3	3880253K01	PLUG
4	3880195P03	SWITCH, Mode Rocker

Table 11-4. Model W9 Pushbutton Control Head Parts List (Continued)

Item No.	Motorola Part No.	Description
5	3205145X01	GASKET, Internal Frame
6	6105126X01	LIGHTPIPE, Keypad
7	7505127X01	KEYPAD
8	7280242J01	DISPLAY, VF
9	7580094M05	PAD, Shock (Qty 3)
10	1405410X01	INSULATOR
11	4180042S01	SPRING, Leaf Assy
12	0380041S01	SCREW, Captive (Qty 4)
13	6180026R02	SPACER, LED (8-Position)
14	6180027R02	SPACER, LED (2-Position)
16	2680190P02	SHIELD, Solder Side (Includes two 1480269K01 insulators)
17	0310945A11	SCREW, Tapping (Qty 5)
18	3080034K01	CABLE, Flex
19	2680190P02	SHIELD, Component Side
20	3205082E90	O-RING "D" Connector (Qty 2)
21	3380178M01	NAMEPLATE
22	0784323C01	BRACKET, Strain Relief
23	0310908A18	SCREW, Machine
24	HKN4356_	CABLE, Radio
25	HMN1050_ or HMN1080_ or HMN1061_	KIT, Microphone
26	1580221J01	HOUSING, VIP Connector (Optional)
27	7502118Z01	COVER, Rubber Dust (MIC)
28	7502118Z02	COVER, Rubber Dust (VIP)
29	0310908A33	SCREW, Machine (Qty 2)
30	3205198X01	GASKET, Face
31	1505199X01	HOUSING, Back
32	2805778W01	CONNECTOR, Mini "D" 50 Contact
33	3205143X01	GASKET, "D" Connector
34	3205143X01	GASKET, On/Off Switch
35	3880128J01	KEY, On/Off
36	HCN4046_	BOARD KIT, Command (includes Display Board)
37	HCN4046_	BOARD KIT, Display (includes Command Board)
38	0310945A14	SCREW, Tapping (Qty 2)
39	3880092J05	KEY, Blank
40	3880195P02	SWITCH, Volume Rocker
41	1505125X09	HOUSING, Front
42	3205144X01	GASKET, Lens
43	6105146X01	LENS, VF Display

Note: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.
Universal Crypto Module (UCM) part numbers and descriptions are listed in the Encryption chapter of this manual.

11.5 Low-Power (15W) Radio Exploded View

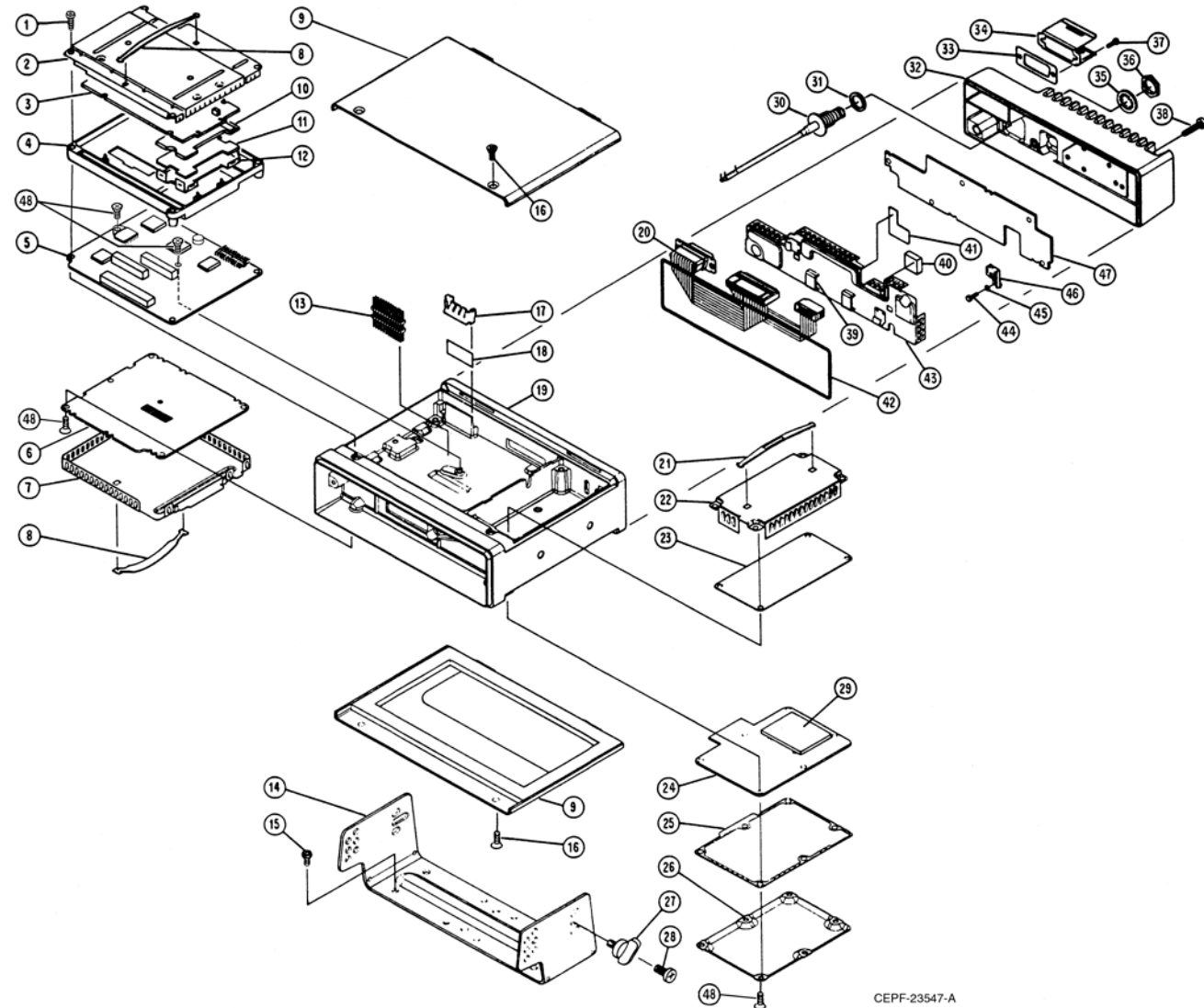


Figure 11-5. Low-Power (15W) Radio Exploded View

Table 11-5. Low-Power (15W) Radio Parts List

Item No.	Motorola Part No.	Description
1	0312016A27	SCREW, Tapping 3.5 x 0.6 x 22 (Board Mounting)
2	2605704V02	SHIELD, Top
3	HLN6458_	KIT, Controller Board
4	2705703V02	CASTING, Controller
5	HLN5558_	KIT, Command Board
6	HRN6019_	KIT, RF Board (800 MHz)
7	1580099L01	SHIELD, RF Board
8	5584300B01	HANDLE (Qty 2)
9	1580264N04	COVER (Includes gasket)
10	2605131X01	SHIELD, Encryption Board (Optional)
11	-----	BOARD, Encryption (Optional)

Table 11-5. Low-Power (15W) Radio Parts List (Continued)

Item No.	Motorola Part No.	Description
12	4205566W01	CLIP, Encryption Board (Optional)
13	2880260M03	HEADER, Floating
14	0780086N01	TRUNNION, Mounting
15	0312002B14	SCREW, Self-Drilling 10-16 x 10 (Qty 4)
16	0380102P01	SCREW, Tapping 3.5 x 0.6 x 10 (Qty 8)
17	4280007M02	CLIP, Regulator
18	1480001M03	INSULATOR, Regulator
19	2780082N01	CHASSIS, Consolidated
20	3080239N02	CABLE, PA Ribbon
21	5584300B01	HANDLE (Qty 2)
22	1580098L01	COVER, Front-End Receiver
23	HRF6004_	KIT, Front-End Receiver Board (800 MHz)
24	HLF6080_	KIT, VCO Board (800 MHz)
25	3280247N01	GASKET, VCO
26	1580097L01	COVER, VCO Board
27	0384244C06	SCREW, Wing 5 x 0.8 x 10 (Qty 4)
28	0380114M02	SCREW, Machine 5 x 0.8 x 10 (Qty 8)
29	HLF6079_	KIT, VCO Hybrid Board (800 MHz)
	1580223N02	COVER, VCO Hybrid (not included in item 29)
30	3080261M05	CABLE, Mini (includes items 35 and 36)
31	3280089M02	GASKET, Antenna
32	2680009M02	HEATSINK
33	3080261M05	GASKET, Accessory Connector
34	4280016M03	CLIP, Accessory Connector
35	0400132718	LOCKWASHER, Internal Tooth
36	0280142M01	NUT, Hex, 7/16"
37	0380043L01	SCREW, Metric 3.0 x 10 (Qty 4)
38	0380077M03	SCREW, Hex Socket (Qty 2)
39	4280265M02	CLIP, PA Coax (Qty 2)
40	4380104N01	SPACER, PA Shield
41	1480143M01	INSULATOR, Shield
42	3280053P01	GASKET, Heatsink
43	2680011M01	SHIELD, PA Board
44	0310911A11	SCREW, Machine 3.5 x 0.5 x 8
45	0480217E01	WASHER, Compression
46	2680187N02	HEATSINK
47	HLF6078_	KIT, Low-Power PA Board (15W; 800 MHz)
48	0310943J15	SCREW, Tapping 3.5 x 0.6 x 8
NON-REFERENCED ITEMS		
	3080091M01	CABLE, Speaker
	7505295B01	PAD, Crystal
	7580094M05	PAD, VF Display Shock (Qty 3)

Note: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.

11.6 Mid-Power (20-40/25-50/35W) Radio Exploded View

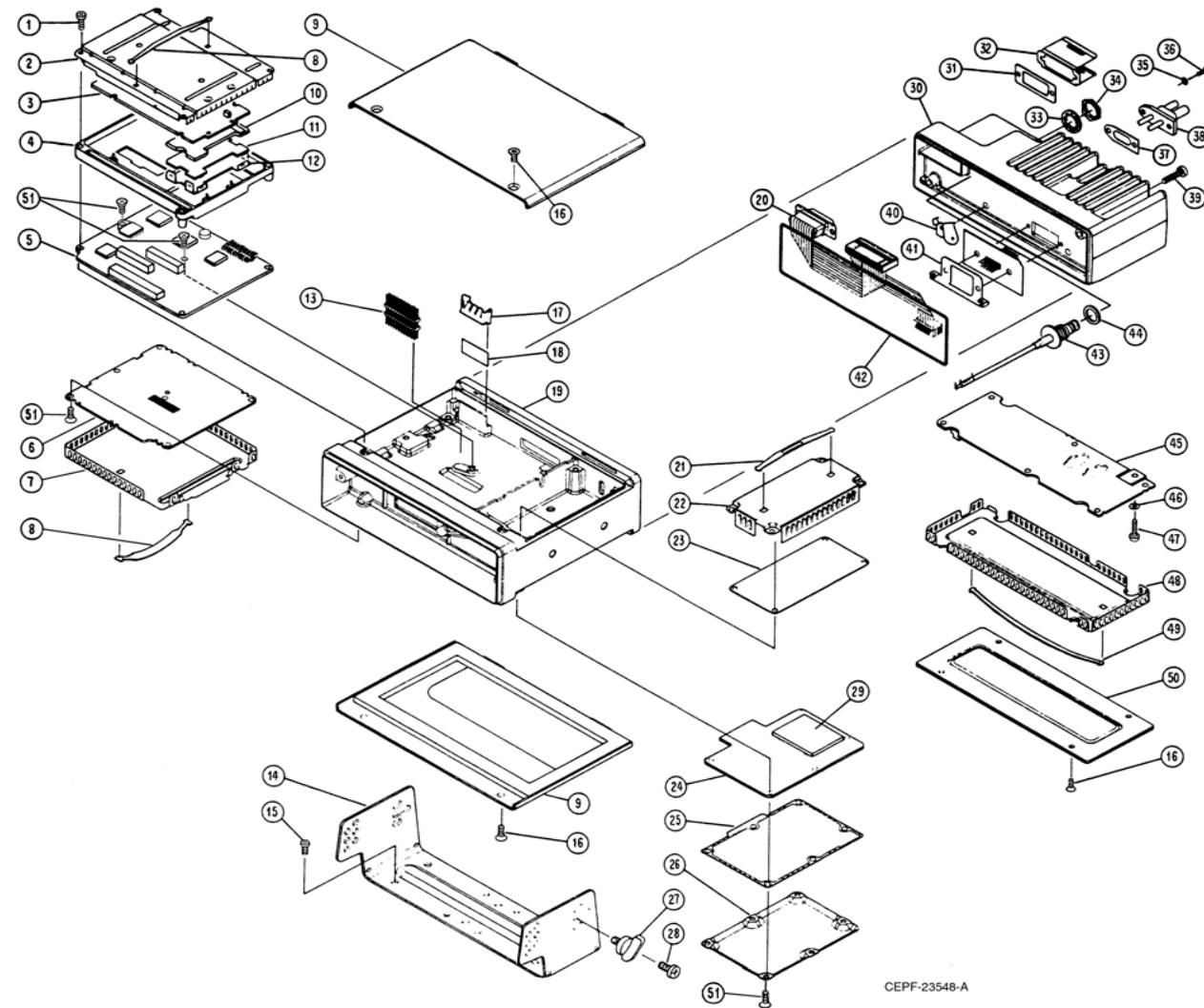


Figure 11-6. Mid-Power (20-40/25-50/35W) Radio Exploded View

Table 11-6. Mid-Power (20-40/25-50/35W) Radio Parts List

Item No.	Motorola Part No.	Description
1	0312016A27	SCREW, Tapping 3.5 x 0.6 x 22 (Board Mounting)
2	2605704V02	SHIELD, Top
3	HLN6458_	BOARD KIT, Controller
4	2705703V02	CASTING, Controller
5	HLN5558_	Kit, Command Board
6	HRN6014_ or HRN6020_ or HRN6019_	KIT, RF Board (VHF) KIT, RF Board (UHF) KIT, RF Board (800 MHz)
7	1580099L01	SHIELD, RF Board
8	5584300B01	HANDLE (Qty 2)
9	1580264N04	COVER (Includes gasket)
10	2605131X01	SHIELD, Encryption Board (Optional)
11	-----	BOARD, Encryption (Optional)
12	4205566W01	CLIP, Encryption Board (Optional)
13	2880260M01	HEADER, Floating
14	0780086N01	TRUNNION, Mounting
15	0312002B14	SCREW, Self-Drilling 10-16 x 10 (Qty 4)
16	0380102P01	SCREW, Tapping 3.5 x 0.6 x 10 (Qty 8)
17	4280007M01	CLIP, Regulator
18	1480001M01	INSULATOR, Regulator
19	2780082N01	CHASSIS, Consolidated
20	3080239N02	CABLE, PA Ribbon
21	5584300B01	HANDLE (Qty 2)
22	1580098L01	COVER, Front-End Receiver
23	HRD6001_ or HRD6002_ or HRE6001_ or HRE6002_ or HRE6003_ or HRE6004_ or HRF6004_	KIT, Front-End Receiver Board (VHF Range 1, 136-162MHz) KIT, Front-End Receiver Board (VHF Range 2, 146-174MHz) KIT, Front-End Receiver Board (UHF Range 1, 403-433MHz) KIT, Front-End Receiver Board (UHF Range 2, 438-470MHz) KIT, Front-End Receiver Board (UHF Range 3, 450-482MHz) KIT, Front-End Receiver Board (UHF Range 4, 482-512MHz) KIT, Front-End Receiver Board (800 MHz)
24	HLD6000_ or HLE6046_ or HLF6080_	KIT, VCO Board (VHF) KIT, VCO Board (UHF) KIT, VCO Board (800 MHz)
25	3280247N01	GASKET, VCO
26	1580097L01	COVER, VCO Board
27	0384244C06	SCREW, Wing 5 x 0.8 x 10 (Qty 4)
28	0380114M02	SCREW, Machine 5 x 0.8 x 10 (Qty 8)

Table 11-6. Mid-Power (20-40/25-50/35W) Radio Parts List

Item No.	Motorola Part No.	Description
29	HLD6061_ or HLD6062_ or HLE6101_ or HLE6102_ or HLE6103_ or HLE6104_ or HLF6079_	KIT, VCO Hybrid Board (VHF Range 1, 136-162MHz) KIT, VCO Hybrid Board (VHF Range 2, 146-174MHz) KIT, VCO Hybrid Board (UHF Range 1, 403-433MHz) KIT, VCO Hybrid Board (UHF Range 2, 438-470MHz) KIT, VCO Hybrid Board (UHF Range 3, 450-482MHz) KIT, VCO Hybrid Board (UHF Range 4, 482-512MHz) Kit, VCO Hybrid Board (800 MHz)
	1580223N02	COVER, VCO Hybrid (not included in item 29)
30	2680010M02	HEATSINK, Mid-Power Amplifier (PA)
31	3280088M01	GASKET, Accessory Connector
32	4280016M03	CLIP, Accessory Connector
33	0400132718	LOCKWASHER, Internal Tooth
34	0280142M01	NUT, Hex, 7/16"
35	0400131974	WASHER, Flat
36	0380043L01	SCREW, Metric 3.0 x 10 (Qty. 4)
37	3280015M01	GASKET, Power Connector
38	0980272N02	CONNECTOR, Power
39	0380077M06	SCREW, Hex Socket (Qty 2)
40	4280264M02	CLIP, PA Coax
41	4280192N01	CLIP, Coax
42	3280053P01	GASKET, Heatsink
43	3080261M04	CABLE, Mini (includes items 33 and 34)
44	3280089M02	GASKET, Antenna
45	HLD6066_ or HLD6032_ or HLD6022_ or HLE6049_ or HLE6062_ or HLE6043_ or HLE6044_ or HLF6077_	KIT, Mid-Power PA Board (25-50W; VHF Range 1 136-162MHz) KIT, Mid-Power PA Board (25-50W; VHF Range 2, 146-174MHz) KIT, Mid-Power PA Board (25-50W; VHF Range 2, 146-174MHz) KIT, Mid-Power PA Board (20-40W; UHF Range 1, 403-433MHz) KIT, Mid-Power PA Board (20-40W; UHF Range 1, 403-433MHz) KIT, Mid-Power PA Board (20-40W; UHF Range 3, 450-482MHz) KIT, Mid-Power PA Board (20-40W; UHF Range 4, 482-512MHz) KIT, Mid-Power PA Board (35W; 800 MHz)
46	0480217E01	WASHER, Compression
47	0310911A11	SCREW, Machine 3.5 x 0.5 x 8
48	2680186M01	SHIELD, PA
49	5584300B04	HANDLE
50	1580048N01	Cover, PA Mid-Power
51	0310943J15	SCREW, Tapping 3.5 x 0.6 x 8
NON-REFERENCED ITEMS		
	3080091M01	CABLE, Speaker
	7505295B01	PAD, Crystal
	7580094M05	Pad, VF Display Shock (Qty 3)

Note: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.

11.7 High-Power (50-110W) Radio Exploded View

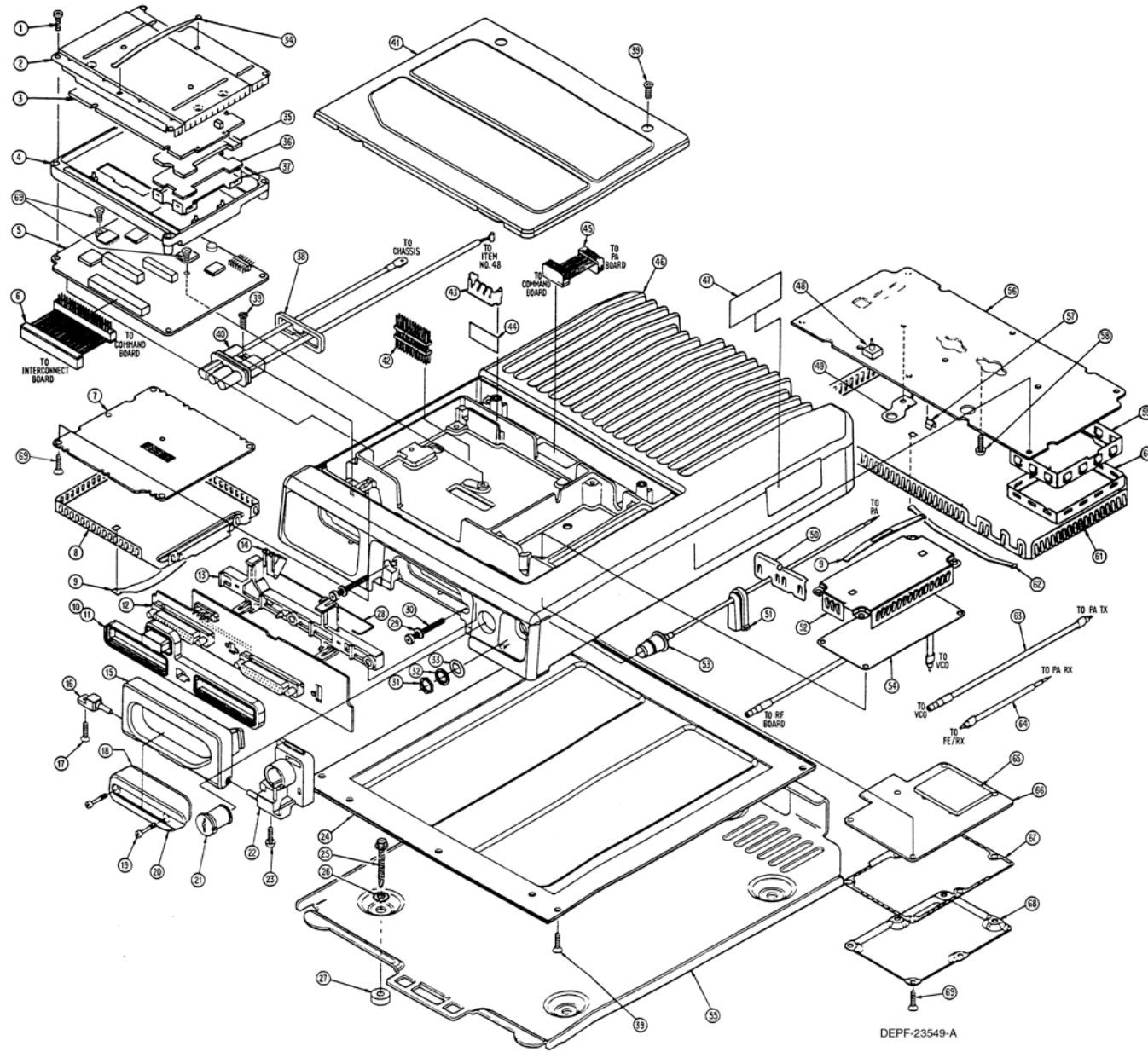


Figure 11-7. High-Power (50-110W) Radio Exploded View

Table 11-7. High-Power (50-110W) Radio Parts List

Item No.	Motorola Part No.	Description
1	0312016A27	SCREW, Tapping 3.5 x 0.6 x 22 (Board Mounting)
2	2605704V02	SHIELD, Top
3	HLN6458_	KIT, Controller Board
4	2705703V02	CASTING, Controller
5	HLN5558_	KIT, Command Board
6	3080211R01	CABLE, Command Bd to Interconnect Bd Ribbon

Table 11-7. High-Power (50-110W) Radio Parts List

Item No.	Motorola Part No.	Description
7	HRN6014_ or HRN6020_ or HRN6019_	KIT, RF Board (VHF) KIT, RF Board (UHF) KIT, RF Board (800 MHz)
8	1580099L01	SHIELD, RF Board
9	5584300B01	HANDLE (Qty 2)
10	3280206R01	GASKET, Connector
11	3280206R02	GASKET, SecureNet Connector
12	HLN5558_	KIT, Interconnect Board
13	4380110R01	SPACER, Interconnect Board
14	4280232R01	CLIP, Interconnect Board
15	5580102R01	HANDLE
16	4780176P01	PIN, Pivot
17	0310943R55	SCREW, Tapping
18	3280118R01	COVER Gasket
19	0380214R01	SCREW, Captive
20	3880122R01	CONNECTOR
21	5580370A01	LOCK
22	1580218R01	HOUSING, Lock (Non-replacable item)
23	0380043L01	SCREW, Tapping (Non-replacable item)
24	1580216R01	COVER, Bottom
25	0312002A28	SCREW, Self-Drilling
26	0400007688	LOCKWASHER
27	4382292M01	BUSHING, Spacer
28	4280210R01	RETAINER, Wire
29	0405171J03	WASHER, Fiber
30	0310908A97	SCREW, Machine
31	0280242M01	NUT, Hex; 7/16"
32	0400132718	LOCKWASHER, Internal-Tooth 7/16"
33	0480285R01	WASHER, Special
34	5584300B01	HANDLE
35	2605131X01	SHIELD, Encryption Board (Optional)
36	-----	BOARD, Encryption (Optional)
37	4205566W01	CLIP, Encryption Board (Optional)
38	3205457V01	GASKET, Power Connector
39	0380102P01	SCREW, Tapping
40	3080114R02	CONNECTOR, Power
41	1580217R01	COVER, Top
42	2880260M03	HEADER, Floating
43	4280007M02	CLIP, Regulator
44	1480001M01	INSULATOR, Regulator
45	3080212R01	CABLE, Command Bd to PA Bd Ribbon
46	2780133P02	CHASSIS
47	3380080E01	NAMEPLATE, FCC
48	0780255R01	BRACKET, Feed-Through
49	2680201R01	HEATSINK Diode-Bracket
50	4280261R01	CLIP, Coaxial Antenna
51	3280120R01	GASKET, Mini-Internal Connector
52	1580098L01	SHIELD, Front-End Receiver
53	3080261M03	CABLE, Mini

Table 11-7. High-Power (50-110W) Radio Parts List

Item No.	Motorola Part No.	Description
54	HRD6001_ or HRD6002_ or HRE6001_ or HRE6002_ or HRE6003_ or HRE6004_ or HRF6004_	KIT, Front-End Receiver Board (VHF Range 1, 136-162MHz) KIT, Front-End Receiver Board (VHF Range 2, 146-174MHz) KIT, Front-End Receiver Board (UHF Range 1, 403-433MHz) KIT, Front-End Receiver Board (UHF Range 2, 438-470MHz) KIT, Front-End Receiver Board (UHF Range 3, 450-482MHz) KIT, Front-End Receiver Board (UHF Range 4, 482-512MHz) KIT, Front-End Receiver Board (800 MHz)
55	1580132P01	TRAY, Mounting
56	HLD6064_ or HLD6063_ or HLE6051_ or HLE6039_ or HLE6040_	KIT, High-Power PA Board (50-110W; VHF Range 1, 136-162MHz) KIT, High-Power PA Board (50-110W; VHF Range 2, 146-174MHz) KIT, High-Power PA Board (50-110W; UHF Range 1, 403-433MHz) KIT, High-Power PA Board (50-110W; UHF Range 3, 450-482MHz) KIT, High-Power PA Board (50-110W; UHF Range 4, 482-512MHz)
57	4280202R01	CLIP, Coaxial
58	0310911A11	SCREW, Machine
59	2680139P01	SHIELD, Harmonic Filter
60	1580208R01	COVER, Harmonic Shield
61	2680138P02	SHIELD, Power Amplifier (PA)
62	5584300B04	HANDLE, PA Shield
63	3080152M15	CABLE, Coaxial Transmitter
64	3080037R12	CABLE, Coaxial Receiver
65	HLD6061_ or HLD6062_ or HLE6101_ or HLE6102_ or HLE6103_ or HLE6104_ or HLF6079_ or 1580223N02	KIT, VCO Hybrid Board (VHF Range 1, 136-162MHz) KIT, VCO Hybrid Board (VHF Range 2, 146-174MHz) KIT, VCO Hybrid Board (UHF Range 1, 403-433MHz) KIT, VCO Hybrid Board (UHF Range 2, 438-470MHz) KIT, VCO Hybrid Board (UHF Range 3, 450-482MHz) KIT, VCO Hybrid Board (UHF Range 4, 482-512MHz) KIT, VCO Hybrid Board (800 MHz) COVER, VCO Hybrid (not included in item 29)
66	HLD6000_ or HLE6046_ or HLF6080_	Kit, VCO Board (VHF) Kit, VCO Board (UHF) Kit, VCO Board (800 MHz)
67	3280247N01	GASKET, VCO
68	1580097L01	COVER, VCO Board
69	0310943J15	SCREW, Tapping 3.5 x 0.6 x 8
NON-REFERENCED ITEMS		
	3080091M01	CABLE, Speaker
	7505295B01	PAD, Crystal
	7580094M05	PAD, VF Display Shock (Qty 3)

Note: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.

11.8 Motorcycle Interconnect Board and Assembly

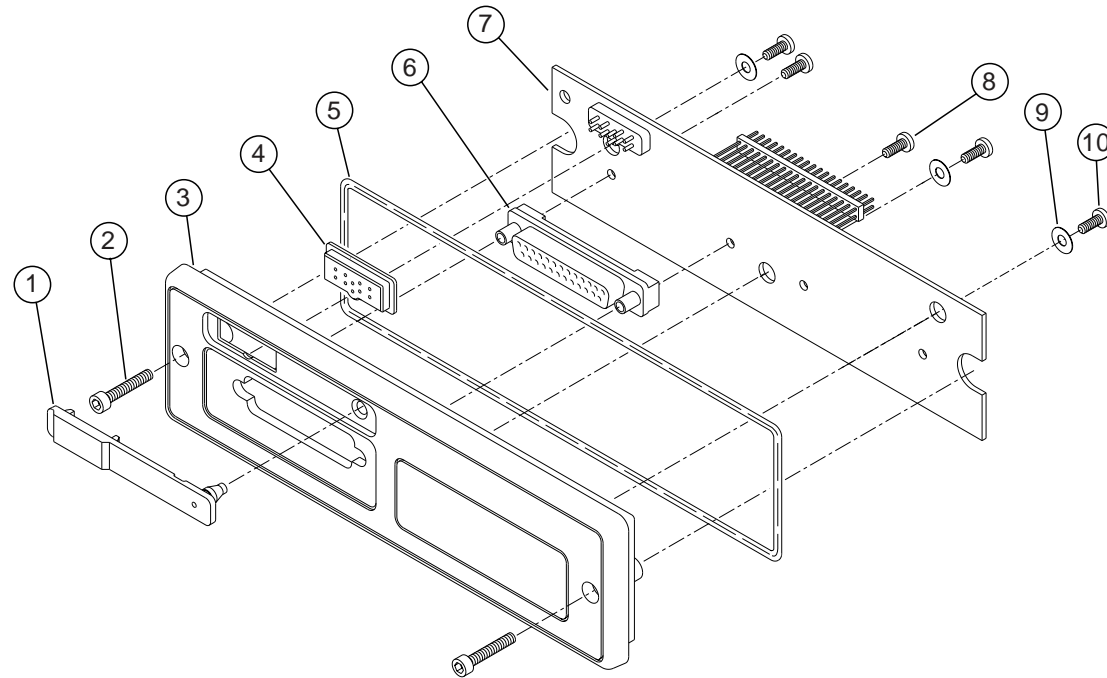


Figure 11-8. Motorcycle Interconnect Board and Assembly (HLN6365) Exploded View

Table 11-8. Motorcycle Interconnect Board and Assembly (HLN6365) Parts List

Item No.	Motorola Part No.	Description
1	3880064P01	CAP, DVP Connector
2	0380077M01	SCREW, Front Mount
3	1580062P07	HOUSING, Remote Front
4	3280063P01	GASKET, DVP Connector
5	3280289L02	GASKET, O-Ring
6	0980159P01	CONNECTOR, D-Sub
7	HLNxxxx_	BOARD, Interconnect (See dealer for applicable kit number.)
8	300139581	SCREW, Mach 4-40X5/16 P
9	400131974	WASHER, Flt.130.312
10	0310945A11	SCREW, Tapping P3.12X1.27X8

Note: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.

11.9 Low- and Mid-Power Interconnect Board and Assembly

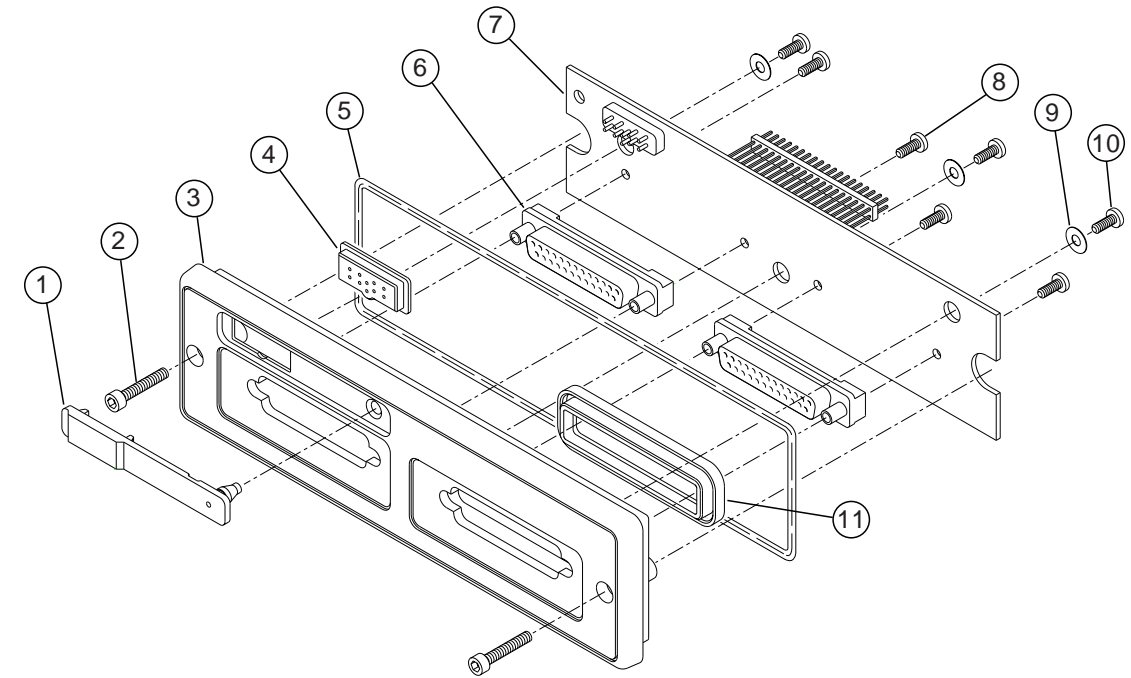


Figure 11-9. Low- and Mid-Power Interconnect Board and Assembly (HLN6344) Exploded View

Table 11-9. Low- and Mid-Power Interconnect Board and Assembly (HLN6344) Parts List

Item No.	Motorola Part No.	Description
1	3880064P01	CAP, DVP Connector
2	0380077M01	SCREW, Front Mount
3	1580062P06	HOUSING, Remote Front
4	3280063P01	GASKET, DVP Connector
5	3280289L02	GASKET, O-Ring
6	0980159P01	CONNECTOR, D-Sub
7	HLNxxxx_	BOARD, Interconnect (See dealer for applicable kit number.)
8	300139581	SCREW, Mach 4-40X5/16 P
9	400131974	WASHER, Flt.130.312
10	0310945A11	SCREW, Tapping P3.12X1.27X8
11	3280025R01	GASKET, Remote
Not shown	1580005G01*	COVER, Dust

Note: _ = The latest version kit. When ordering, refer to your specific kit for this suffix letter.

* = Used when the option cable is not used or when the radio is stowed.

11.10 Small Pushbutton Parts

Table 11-10. Small Pushbutton Parts List

Part Number	Graphic Legend	Part Number	Graphic Legend
3805671X02	1	3805671X21	9wxy
3805671X03	2	3805671X22	* Rcl
3805671X04	3	3805671X23	#Del
3805671X05	4	3805671X24	1Ste
3805671X06	5	3805671X25	2Pge
3805671X07	6	3805671X26	3Lck
3805671X08	7	3805671X27	4Sts
3805671X09	8	3805671X28	5Rpg
3805671X10	9	3805671X29	6Msg
3805671X11	0	3805671X30	7H/L
3805671X12	*	3805671X31	8Mon
3805671X13	#	3805671X32	9Dir
3805671X14	2abc	3805671X33	Mon
3805671X15	3def	3805671X34	H/L
3805671X16	4ghi	3805671X35	DIR
3805671X17	5jkl	3805671X36	Urg
3805671X18	6mno	3805671X37	RTT
3805671X19	7prs	3805671X38	Home
3805671X20	8tuv	3805671X39	Dim

11.11 Large Pushbutton Parts

Table 11-11. Large Pushbutton Parts List

Part Number	Graphic Legend	Part Number	Graphic Legend
3805672X01	--	3805672X10	H/L
3805672X02	MPL	3805672X11	Sts
3805672X03	Scan	3805672X12	Call
3805672X04	DVP	3805672X13	Msg
3805672X05	PA	3805672X14	Rcl
3805672X06	Sirn	3805672X15	Mode
3805672X07	Wail	3805672X16	ExRd
3805672X08	Hi/Lo	3805672X17	Del
3805672X09	Man	3805672X18	Sel
3805672X19	Mon	3805672X52	Emer
3805672X20	DTMF	3805672X53	Stdy
3805672X21	Yelp	3805672X54	ECC
3805672X22	MVS	3805672X55	Rptr
3805672X23	Play	3805672X56	State
3805672X24	Rply	3805672X57	Reg
3805672X25	Rcrd	3805672X58	AirHn
3805672X26	Emer	3805672X59	TB Scn
3805672X27	Ext	3805672X60	SCC
3805672X28	F/R	3805672X61	Srch
3805672X29	Alt	3805672X62	Lock
3805672X30	Tel	3805672X63	Page
3805672X31	Sql	3805672X64	Rear
3805672X32	DES	3805672X65	Xfer
3805672X33	Txt	3805672X66	ST
3805672X34	Indv	3805672X67	VHF
3805672X35	Pvt	3805672X68	UHF
3805672X36	Site	3805672X69	Aux
3805672X37	AA	3805672X70	QC II
3805672X38	Sub	3805672X71	Mute
3805672X39	Home	3805672X72	Pri

Table 11-11. Large Pushbutton Parts List (Continued)

Part Number	Graphic Legend	Part Number	Graphic Legend
3805672X40	Menu	3805672X73	Blu
3805672X41	Rpgm	3805672X74	Div
3805672X42	Step	3805672X75	RTT
3805672X43		3805672X76	Send
3805672X44	Phon	3805672X77	Front
3805672X45	Dir	3805672X78	Bid
3805672X46	Text	3805672X79	ZONE
3805672X47	Rvw	3805672X80	TRBL
3805672X48	Sec	3805672X81	OVHD
3805672X49	Ø	3805672X82	UNGD
3805672X50	L/S	3805672X83	RSSI
3805672X51	S/S	3805672X84	VRS
3805672X85	A/B	3805669X12	ETrp
3805672X86	Chan	3805669X13	LvTe
3805672X87	PRTT	3805669X14	ArTe
3805672X88	RtRn	3805669X15	LvGg
3805672X89	Emp#	3805669X16	ArGg
3805672X90	Pass	3805669X17	P/in
3805672X91	Cir	3805669X18	P/out
3805672X92	URG	3805669X19	Serv
3805672X93	A	3805669X20	O/S
3805672X94	B	3805669X21	Rev
3805672X95	C	3805669X22	Stby
3805672X96	D	3805669X23	Sts 1
3805672X97	E	3805669X24	Sts 2
3805672X98	F	3805669X25	Sts 3
3805672X99	G	3805669X26	Sts 4
3805669X01	K	3805669X27	Sts 5
3805669X02	L	3805669X28	Sts 6
3805669X03	T/Z	3805669X29	Sts 7
3805669X04	30	3805669X30	Sts 8

Table 11-11. Large Pushbutton Parts List (Continued)

Part Number	Graphic Legend	Part Number	Graphic Legend
3805669X05	Entr	3805669X31	Drvr
3805669X06	M/WT	3805669X32	Bdg#
3805669X07	MAck	3805669X33	LnBl
3805669X08	Time	3805669X34	RtBl
3805669X09	SRun	3805669X35	LnRn
3805669X10	ERun	3805669X36	s
3805669X11	STrp	3805669X37	t

Appendix A Replacement Parts Ordering

A.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.

Crystal orders should specify the crystal type number, crystal and carrier frequency, and the model number in which the part is used.

A.2 Transceiver Board and VOCON Board Ordering Information

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

A.3 Motorola Online

Motorola Online users can access our online catalog at

<https://www.motorola.com/businessonline>

To register for online access, please call 800-814-0601 (for U.S. and Canada Service Centers only).

A.4 Mail Orders

Send written orders to the following addresses:

**Replacement Parts/
Test Equipment/Manuals/
Crystal Service Items:**

Motorola Inc.
Customer Care and Services
Division*
Attention: Order Processing
1307 E. Algonquin Road
Schaumburg, IL 60196
U.S.A.

Federal Government Orders:

Motorola Inc.
U.S. Federal Government
Markets Division
Attention: Order Processing
7230 Parkway Drive
Landover, MD 21076
U.S.A.

International Orders:

Motorola Inc.
Customer Care and Services
Division*
Attention: Order Processing
1307 E. Algonquin Road
Schaumburg, IL 60196
U.S.A.

A.5 Telephone Orders

Customer Care and Services Division*
(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 (International Orders)

U.S. Federal Government Markets Division (USFGMD)
1-800-826-1913 Federal Government Parts - Credit Cards Only
8:30 AM to 5:00 PM (Eastern Standard Time)

A.6 Fax Orders

Customer Care and Services Division*
(United States and Canada)
1-800-622-6210
847-576-3023 (International)

USFGMD
(Federal Government Orders)
1-800-526-8641 (For Parts and Equipment Purchase Orders)

A.7 Parts Identification

Customer Care and Services Division*
(United States and Canada)
1-800-422-4210, menu 3

A.8 Product Customer Service

Customer Response Center
(Non-technical Issues)
1-800-247-2346
FAX:1-800-247-2347

*The Customer Care and Services Division (CCSD) was formerly known as 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	<i>See analog-to-digital conversion.</i>
Abacus IC	A custom integrated circuit providing a digital receiver intermediate frequency (IF) backend.
ADC	<i>See analog-to-digital converter.</i>
ADDAG	<i>See Analog-to-Digital, Digital-to-Analog and Glue.</i>
ALC	<i>See automatic level control.</i>
analog	Refers to a continuously variable signal or a circuit or device designed to handle such signals. <i>See also digital.</i>
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. <i>See also D/A.</i>
analog-to-digital converter	A device that converts analog signals into digital data. <i>See also DAC.</i>
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.
band	Frequencies allowed for a specific purpose.
BBP	<i>See baseband interface port.</i>
baseband interface port	Synchronous serial interface to the transceiver board used to transfer transmit and receive audio data.
BGA	<i>See ball grid array.</i>
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.
CODEC	<i>See coder/decoder.</i>
coder/decoder	A device that encodes or decodes a signal.

Term	Definition
CPS	<i>See Customer Programming Software.</i>
Customer Programming Software	Software with a graphical user interface containing the feature set of an ASTRO radio. <i>See also RSS.</i>
D/A	<i>See digital-to-analog conversion.</i>
DAC	<i>See digital-to-analog converter.</i>
default	A pre-defined set of parameters.
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. <i>See also analog.</i>
digital-to-analog conversion	Conversion of a digital signal to a voltage that is proportional to the input value. <i>See also A/D.</i>
digital-to-analog converter	A device that converts digital data into analog signals. <i>See also ADC.</i>
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.
DPL	<i>See Digital Private-Line. See also PL.</i>
DSP	<i>See digital signal processor.</i>
DSP code	<i>See digital signal processor code.</i>
DTMF	<i>See dual tone multi-frequency.</i>
dual tone multi-frequency	The system used by touch-tone telephones. DTMF assigns a specific frequency, or tone, to each key so that it can easily be identified by a microprocessor.
EEPOT	Electrically Programmable Digital Potentiometer.
EEPROM	<i>See Electrically Erasable Programmable Read-Only Memory.</i>

Term	Definition
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.
FCC	Federal Communications Commission.
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	<i>See frequency generation unit.</i>
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	<i>See Florida Manual Revision.</i>
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	<i>See General-Purpose Input/Output.</i>
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	<i>See integrated circuit.</i>
IF	Intermediate Frequency.
IMBE	A sub-band, voice-encoding algorithm used in ASTRO digital voice.

Term	Definition
inbound signaling word	Data transmitted on the control channel from a subscriber unit to the central control unit.
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	<i>See inbound signaling word.</i>
key-variable loader	A device used to load encryption keys into a radio.
kHz	<i>See kilohertz.</i>
kilohertz	One thousand cycles per second. Used especially as a radio-frequency unit.
KVL	<i>See key-variable loader.</i>
LCD	<i>See liquid-crystal display.</i>
LED	<i>See LED.</i>
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	<i>See low-speed handshake.</i>
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	<i>See microcontroller unit.</i>
MDC	Motorola Digital Communications.
MDI	MCU/DSP Interface internal to the Patriot IC.
MHz	<i>See Megahertz.</i>
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	<i>See Master In Slave Out.</i>

Term	Definition
MOSI	<i>See Master Out Slave In.</i>
multiplexer	An electronic device that combines several signals for transmission on some shared medium (e.g., a telephone wire).
MUX	<i>See multiplexer.</i>
NiCd	Nickel-cadmium.
NiMH	Nickel-metal-hydride.
OMPAC	<i>See over-molded pad-array carrier.</i>
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	<i>See outbound signaling word.</i>
OTAR	<i>See over-the-air rekeying.</i>
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.
paging	One-way communication that alerts the receiver to retrieve a message.
Patriot IC	A dual-core processor that contains an MCU and a DSP in one IC package.
PC Board	Printed Circuit Board. Also referred to as a PCB.
phase-locked loop	A circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.
PL	<i>See private-line tone squelch.</i>
PLL	<i>See phase-locked loop.</i>
private-line tone squelch	A continuous sub-audible tone that is transmitted along with the carrier. <i>See also DPL.</i>
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	<i>See Programmable Read-Only Memory.</i>

Term	Definition
PTT	<i>See Push-to-Talk.</i>
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. <i>See also CPS.</i>
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	<i>See random access memory.</i>
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.
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	<i>See radio frequency.</i>
RF PA	<i>See radio frequency power amplifier.</i>
RIB	<i>See Radio Interface Box.</i>
ROM	<i>See read-only memory.</i>

Term	Definition
RPCIC	Regulator/power control IC.
RPT/TA	<i>See repeater/talkaround.</i>
RSS	<i>See Radio Service Software.</i>
RTC	<i>See real-time clock.</i>
RX	Receive.
RX DATA	Recovered digital data line.
SAP	<i>See Serial Audio CODEC Port.</i>
SCI IN	Serial Communications Interface Input line.
Serial Audio CODEC Port	SSI to and from the GCAP II IC CODEC used to transfer transmit and receive audio data.
Serial Communication Interface Input Line	A full-duplex (receiver/transmitter) asynchronous serial interface.
SCI IN	<i>See Serial Communication Interface Input Line.</i>
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	<i>See software potentiometer.</i>
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	<i>See Serial Peripheral Interface.</i>
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	<i>See static RAM.</i>
SRIB	Smart Radio Interface Box. <i>See RIB.</i>
SSI	<i>See Synchronous Serial Interface.</i>

Term	Definition
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.
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 (<i>See ISW and OSW</i>).
system select	The act of selecting the desired operating system with the system-select switch (also, the name given to this switch).
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.
TOT	<i>See time-out timer.</i>
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.
TSOP	<i>See thin small-outline package.</i>
TX	Transmit.
UART	<i>See also Universal Asynchronous Receiver Transmitter.</i>
UHF	Ultra-High Frequency.
Universal Asynchronous Receiver Transmitter	A microchip with programming that controls a computer's interface to its attached serial devices.
Universal Serial Bus	An external bus standard that supports data transfer rates of 12 Mbps.
USB	<i>See Universal Serial Bus.</i>
VCO	<i>See voltage-controlled oscillator.</i>
vector sum excited linear predictive coding	A voice-encoding technique used in ASTRO digital voice.
VHF	Very-High Frequency.
VIP	Vehicle Interface Port.
VOCON	<i>See vocoder/controller.</i>

Term	Definition
vocoder	An electronic device for synthesizing speech by implementing a compression algorithm particular to voice. <i>See also voice encoder.</i>
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. <i>See also vocoder.</i>
voltage-controlled oscillator	An oscillator in which the frequency of oscillation can be varied by changing a control voltage.

Notes

Index

Numerics

800 MHz radio specifications xxxviii

A

advanced secure operation7-10
alignment procedures
 RSS
 BER (bit error rate) performance check6-10
 introduction6-1
 reference oscillator6-3
 transmit current limit6-6
 transmit deviation balance6-7
 transmit deviation limit6-8
 transmit power6-4
 tuner
 BER (bit error rate) test6-22
 introduction6-10
 reference oscillator6-14
 transmit current limit6-18
 transmit deviation balance (compensation)6-18
 transmit deviation limit6-20
 transmit power6-16
 transmitter test pattern6-23
analog mode of operation3-2
annunciator, secure status7-1
ASTRO mode of operation3-2

B

backlight LEDs, control head3-3
BER (bit error rate)
 performance check (RSS)6-10
 test (tuner)6-22
 test screen (tuner)6-23
board theory of operation3-7

C

cable, P501 extender10-6
cabling, control head10-6
codes
 operational error9-4
 power-up error9-1
command board
 reassembly8-17
 replacement8-11
 theory of operation3-6
connector locations10-5
control head
 backlight LEDs3-3
 board replacement8-2
 cabling10-6
 controls1-5

controls and indicators3-3
descriptions1-2
ignition sense circuits3-4
power supplies3-4
status LEDs3-3
theory of operation3-2
controls, control head1-5, 3-3
copyrights
 computer softwareii
 documentii

D

dash control-head board reassembly8-17
dash-mount vehicle interface port3-4
descriptions
 control heads1-2
 radio1-1
disassembly/reassembly, introduction8-1
displays, front-panel access test-mode5-2

E

encryption
 advanced secure operation7-10
 conventional multikey7-10
 erasing
 a single key7-5
 all keys7-5
 keys7-3
 key loading7-2
 multikey operation7-10
 over-the-air rekeying7-6
 secure status annunciator7-1
 trunked multikey7-10
erasing
 all encryption keys7-5
 encryption keys7-3
 single encryption key7-5
exploded view
 high-power (50-110W)11-8
 low- and mid-power interconnect board11-9
 low-power (15W)11-6
 mid-power (20-40/25-50/35W)11-7
 Model W311-2
 Model W411-3
 Model W511-4
 Model W711-4
 Model W911-5
 motorcycle interconnect board11-9
extender cable, P50110-6

F

fastener torque values8-18
features
 radio1-2
field programming
 ASTRO Digital Spectra4-5

ASTRO Digital Spectra Plus	4-7
equipment	4-5
FLASHport technology	1-2
frequencies, test	5-4
front-end receiver theory of operation	3-5
front-panel access test-mode displays	5-2

H

handling precautions	2-2
----------------------------	-----

I

ignition sense circuits, control head	3-4
indicators, control head	3-3
interconnect board replacement	8-6

K

key, erasing encryption	7-3
key-variable loader (KVL)	7-2

L

limitations, remote W3 Y cable	4-6
loading encryption keys	7-2

M

maintenance	
cleaning	2-1
inspection	2-1
preventive	2-1
reference oscillator	2-1
manual	
notations	1-1
revisions	ii
mode	
analog operation	3-2
ASTRO operation	3-2
control-head test	5-5
performance checks test	5-2
RF test	5-3
model chart	
800MHz	
Spectra	xxvii
Spectra Plus	xxxiv
motorcycle 15 Watt (ranges 1 and 2)	xvii
motorcycle 15 Watt (ranges 3 and 3.5)	xviii
UHF 10-25 Watt	xxii
UHF 20-40 Watt	xxiii, xxx
UHF 50-110 Watt	xxv, xxxii
VHF 10-25 Watt	xix, xxviii, xxix
VHF 10-25/50-110 Watt	xx
model numbering scheme	xvi
multikey operation	
conventional	7-10
introduction	7-10
trunked	7-10

N

notations	
manual	1-1
warning, caution, and danger	1-1

O

operation	
advanced secure	7-10
analog mode	3-2
ASTRO mode	3-2
command board theory	3-6
control head	3-2
conventional multikey	7-10
front-end receiver assembly theory	3-5
multikey	7-10
power supply theory	3-4
RF board theory	3-5, 3-7
trunked multikey	7-10
VOCON board theory	3-7
voltage-controlled oscillator theory	3-6
operational error codes	9-4
ordering replacement parts	A-1
over-the-air rekeying	7-6
overview, basic theory	3-1

P

parts list	
high-power (50-110W)	11-8
large pushbuttons	11-10
low- and mid-power interconnect board	11-9
low-power (15W)	11-6
mid-power (20-40/25-50/35W)	11-7
Model W3	11-2
Model W4	11-3
Model W5	11-4
Model W7	11-4
Model W9	11-5
motorcycle interconnect board	11-9
small pushbuttons	11-10
parts, ordering replacement	A-1
performance checks	
overview	5-1
receiver	5-6
signaling types	5-5
test	
frequencies	5-4
mode	5-2
setup	5-1
transmitter	5-7
power amplifier	
board replacement	8-7, 8-14
reassembly	8-16
theory of operation	3-4
power supplies, control head	3-4
power-up error codes	9-1
preventive maintenance, periodic	2-1
product safety information	ii
programming equipment, field	4-5
pushbuttons	
large	11-10

- small 11-10
- R**
- radio
- descriptions 1-1
 - features 1-2
 - information screen 6-14
 - upgrading with FLASHport 1-2
- reassembly
- command board 8-17
 - dash control-head board 8-17
 - power amplifier 8-16
 - W3 hand-held control head 8-17
- receiver
- front-end board replacement 8-13
 - performance checks 5-6
 - troubleshooting 9-9
- reference oscillator
- alignment
 - RSS 6-3
 - tuner 6-14 - alignment screen
 - RSS 6-4
 - tuner 6-15
- remote control-head board replacement 8-5
- remote W3 Y cable limitations 4-6
- remote-mount vehicle interface port 3-4
- replacement parts, ordering A-1
- replacing
- command board 8-11
 - control-head boards 8-2
 - interconnect board 8-6
 - power amplifier board 8-7
 - receiver front-end board 8-13
 - remote control-head board 8-5
 - RF board 8-15
 - VCO board 8-14
 - VOCON board 8-11
- RF board
- replacement 8-15
 - theory of operation 3-5
- RF exposure compliance information ii
- RF test mode 5-3
- RIB power-up recommendations 4-6
- RSS
- alignment
 - reference oscillator 6-3
 - transmit current limit 6-6
 - transmit deviation balance (compensation) 6-7
 - transmit deviation limit 6-8
 - transmit power 6-4 - bit error rate (BER) performance check 6-10
 - radio alignment introduction 6-1
 - screen
 - reference oscillator alignment 6-4
 - transmit current limit alignment 6-6
 - transmit deviation balance (compensation) alignment 6-8
 - transmit deviation limit alignment 6-9
 - transmit power alignment 6-5 - service menu layout 6-2
- S**
- screen
- RSS
 - reference oscillator alignment 6-4
 - service menu 6-2
 - transmit current limit alignment 6-6
 - transmit deviation balance (compensation) alignment 6-8
 - transmit deviation limit alignment 6-9
 - transmit power alignment 6-5 - tuner
 - bit error rate (BER) test 6-23
 - menu 6-12
 - radio information 6-14
 - reference oscillator alignment 6-15
 - transmit current limit alignment 6-18
 - transmit deviation balance (compensation) alignment 6-20
 - transmit deviation limit alignment 6-21
 - transmit power alignment 6-16
 - transmitter test pattern 6-23
 - typical softpot adjustment 6-13
- secure operation, key-variable loader 7-2
- secure status annunciator 7-1
- service aids, recommended 4-2
- service menu layout, RSS 6-2
- signaling types 5-5
- smart RIB power-up considerations 4-6
- softpot
- adjustment screen (tuner) 6-13
 - use 6-2
 - values 6-2
- specifications
- 800 MHz xxxviii
 - UHF xxxvii
 - VHF xxxvi
- status LEDs, control head 3-3
- synthesizer troubleshooting 9-12
- T**
- test
- equipment, recommended 4-1
 - frequencies 5-4
 - setup, performance checks 5-1
- test mode
- control-head 5-5
 - displays 5-2
 - performance checks 5-2
 - RF 5-3
- theory of operation
- command board 3-6
 - control head 3-2
 - front-end receiver assembly 3-5
 - overview 3-1
 - power amplifier 3-4
 - RF board 3-5
 - VOCON board 3-7
 - voltage-controlled oscillator 3-6
- tools, recommended 4-2
- torque values, fastener 8-18
- trademark information ii
- transmit

current limit alignment		U	
RSS	6-6	UHF specifications	xxxvii
tuner	6-18		
current limit alignment screen		V	
RSS	6-6	VCO	
tuner	6-18	board replacement	8-14
deviation balance (compensation) alignment		theory of operation	3-6
RSS	6-7	vehicle interface port	
tuner	6-18	dash-mount	3-4
deviation balance (compensation) alignment screen		remote-mount	3-4
RSS	6-8	VHF specifications	xxxvi
tuner	6-20	view, exploded	
deviation limit alignment		high-power (50-110W)	11-8
RSS	6-8	low- and mid-power interconnect board	11-9
tuner	6-20	low-power (15W)	11-6
deviation limit alignment screen		mid-power (20-40/25-50/35W)	11-7
RSS	6-9	Model W3	11-2
tuner	6-21	Model W4	11-3
power alignment		Model W5	11-4
RSS	6-4	Model W7	11-4
screen (RSS)	6-5	Model W9	11-5
screen (tuner)	6-16	motorcycle interconnect board	11-9
tuner	6-16	VOCON board	
power settings		replacement	8-11
RSS	6-5	theory of operation	3-7
tuner	6-17		
transmitter		W	
performance checks	5-7	W3 hand-held control head reassembly	8-17
test pattern		warning, caution, and danger notations	1-1
description	6-23		
screen	6-23		
troubleshooting	9-5		
troubleshooting			
introduction	9-1		
operational error codes	9-4		
power-up error codes	9-1		
receiver	9-9		
replacing boards	9-1		
synthesizer	9-12		
transmitter	9-5		
trunked multikey operation	7-10		
tuner			
alignment			
reference oscillator	6-14		
transmit current limit	6-18		
transmit deviation balance (compensation)	6-18		
transmit deviation limit	6-20		
transmit power	6-16		
transmitter test pattern	6-23		
bit error rate (BER) test	6-22		
menu screen	6-12		
radio alignment introduction	6-10		
screen			
bit error rate (BER) test	6-23		
menu	6-12		
radio information	6-14		
reference oscillator alignment	6-15		
transmit current limit alignment	6-18		
transmit deviation balance (compensation)			
alignment	6-20		
transmit deviation limit alignment	6-21		
transmit power alignment	6-16		
transmitter test pattern	6-23		
typical softpot adjustment	6-13		
types of signaling	5-5		



Motorola, Inc.
8000 West Sunrise Boulevard
Ft. Lauderdale, FL 33322

MOTOROLA, the Stylized M Logo, ASTRO, and Spectra are registered in the U.S. Patent and Trademark Office. All other product or service names are the property of their respective owners.
© Motorola, Inc. 2002, 2003.
All rights reserved. Printed in U.S.A.



6881076C20-E