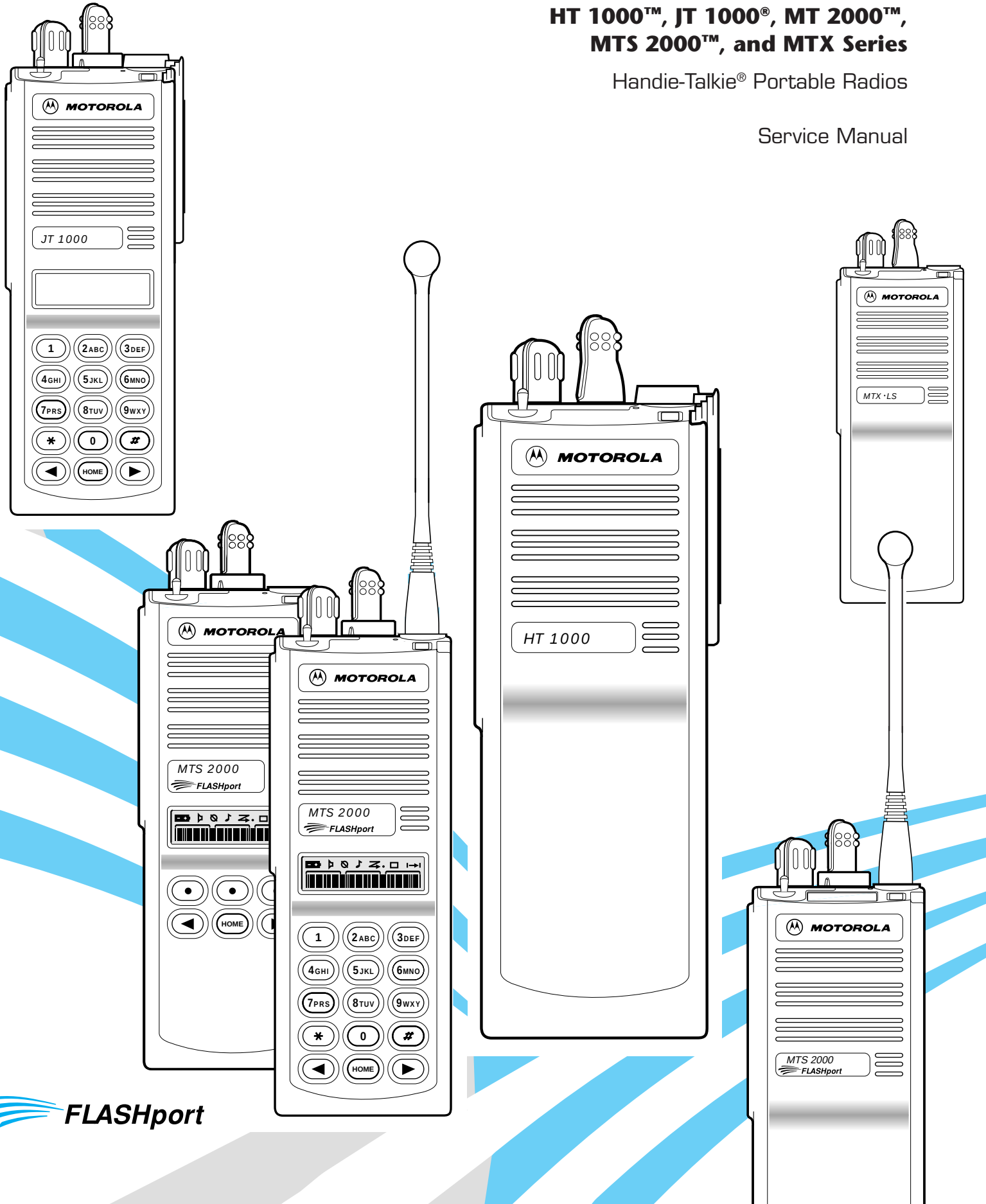
MOTOROLA

HT 1000™, JT 1000®, MT 2000™, MTS 2000™, and MTX Series

Handie-Talkie® Portable Radios

Service Manual



FLASHport

Foreword

General

The information contained in this manual relates to all HT1000, JT 1000, MT 2000, MTS 2000, and MTX Series Portable Radios, unless otherwise specified. This manual provides sufficient information to enable service shop personnel to troubleshoot and repair HT1000, JT 1000, MT 2000, MTS 2000, and MTX Series Portable Radios to the component level.

Safety Information

Before operating your radio, please read the "Safety Information" section in the front of this manual.

Manual Revisions

Changes which occur after this manual is printed are described in "FMRs." These FMRs provide complete replacement pages for all added, changed, and deleted items, including pertinent parts list data, schematics, and component layout diagrams.

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HT 1000™, JT 1000®, MT 2000™, MTS 2000™, and MTX Series Handie-Talkie® Portable Radios

Service Manual

Commercial, Government and Industrial Solutions Sector
8000 W. Sunrise Boulevard
Fort Lauderdale, Florida 33322

68P81200C75-A

Safety and General Information

IMPORTANT INFORMATION ON SAFE AND EFFICIENT OPERATION

READ THIS INFORMATION BEFORE USING YOUR RADIO

Radio Frequency (RF) Operational Characteristics

To transmit (talk) you must push the Push-To-Talk button; to receive (listen) you must release the Push-To-Talk button. When the radio is transmitting, it generates radio frequency (RF) energy; when it is receiving, or when it is off, it does not generate RF energy.

Radio Operation and EME Exposure

Your Motorola radio is designed to comply with the following national and international standards and guidelines regarding exposure of human beings to radio frequency electromagnetic energy (EME):

- United States Federal Communications Commission, Code of Federal Regulations; 47 CFR part 2 sub-part J
- American National Standards Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999 Edition
- National Council on Radiation Protection and Measurements (NCRP) of the United States, Report 86, 1986
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6. Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz, 1999
- Australian Communications Authority Radiocommunications (Electromagnetic Radiation - Human Exposure) Standard 1999 (applicable to wireless phones only)

Two-way Radio Operation

When using your radio, **hold the radio in a vertical position with the microphone one to two inches (2.5 to 5 centimeters) away from the lips.**

Body-worn Operation

To maintain compliance with FCC RF exposure guidelines, if you wear a radio on your body when transmitting, always place the radio in **a Motorola approved clip, holder, holster, case, or body harness for this product**. Use of non-Motorola-approved accessories may exceed FCC RF exposure guidelines. **If you do not use a Motorola approved body-worn accessory and are not using the radio in the intended use positions along side of the head in the phone mode or in front of the face in the**

two-way radio mode, then ensure the antenna and radio is kept the following minimum distances from the body when transmitting:

- Phone or Two-way radio mode: one inch (2.5 centimeters)
- Data operation using any data feature with or without an accessory cable: one inch (2.5 centimeters)

Antenna Care

Use only the supplied or an approved replacement antenna. Unauthorized antennas, modifications, or attachments could damage the radio and may violate FCC regulations.

DO NOT hold the antenna when the radio is "IN USE". Holding the antenna affects call quality and may cause the radio to operate at a higher power level than needed.

Approved Accessories

For a list of approved Motorola accessories, look in the appendix or accessory section of your radio's User Guide.

Electromagnetic Interference/ Compatibility

NOTE: Nearly every electronic device is susceptible to electromagnetic interference (EMI) if inadequately shielded, designed or otherwise configured for electromagnetic compatibility.

Facilities

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

Aircraft

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

Medical Devices

- **Pacemakers**

  The Health Industry Manufacturers Association recommends that a minimum separation of 6 inches (15 centimeters) be maintained between a handheld wireless radio and a pacemaker.These recommendations are consistent with those of the U.S. Food and Drug Administration.

  Persons with pacemakers should:

  - ALWAYS keep the radio more than 6 inches (15 centimeters) from their pacemaker when the radio is turned ON.
  - not carry the radio in the breast pocket.
  - use the ear opposite the pacemaker to minimize the potential for interference.
  - turn the radio OFF immediately if you have any reason to suspect that interference is taking place.

- **Hearing Aids**

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

- **Other Medical Devices**

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

Safety And General

Use While Driving

Check the laws and regulations on the use of radios in the area where you drive, always obey them.

When using your radio while driving, please:

- Give full attention to driving and to the road.
- Use hands-free operation, if available.
- Pull off the road and park before making or answering a call if driving conditions so require.

WARNING

Operational Warnings

For Vehicles With An Air Bag

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

Potentially Explosive Atmospheres

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

NOTE: The areas with potentially explosive atmospheres referred to above include fueling areas such as below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles, such as grain, dust or metal powders, and any other area where you would normally be advised to turn off your vehicle engine. Areas with potentially explosive atmospheres are often but not always posted.

Blasting Caps And Areas

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

Operational Cautions

Caution

Antennas

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

Batteries

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

Important Safety Information: Intrinsically Safe Radios

FMRC Approved Equipment

Anyone intending to use a radio in a location where hazardous concentrations of flammable material exist (hazardous atmosphere) is advised to become familiar with the subject of intrinsic safety and with the National Electric Code NFPA 70 (National Fire Protection Association) Article 500 (hazardous [classified] locations).

An Approval Guide, issued by Factory Mutual Research Corporation (FMRC), lists manufacturers and the products approved by FMRC for use in such locations. FMRC has also issued a voluntary approval standard for repair service (“Class Number 3605").

FMRC Approval labels are attached to the radio to identify the unit as being FM Approved for specified hazardous atmospheres. This label specifies the hazardous Class/Division/Group along with the part number of the battery that must be used. Their Approval mark is shown below.

FM

APPROVED

WARNING

Do not operate radio communications equipment in a hazardous atmosphere unless it is a type especially qualified (e.g. FMRC Approved) for such use. An explosion or fire may result.
Do not operate the FMRC Approved Product in a hazardous atmosphere if it has been physically damaged (e.g. cracked housing). An explosion or fire may result.
Do not replace or charge batteries in a hazardous atmosphere. Contact sparking may occur while installing or removing batteries and cause an explosion or fire.

WARNING

Do not replace or change accessories in a hazardous atmosphere. Contact sparking may occur while installing or removing accessories and cause an explosion or fire.
Do not operate the FMRC Approved Product unit in a hazardous location with the accessory contacts exposed. Keep the connector cover in place when accessories are not used.
Turn radio off before removing or installing a battery or accessory.
Do not disassemble the FMRC Approved Product unit in any way that exposes the internal electrical circuits of the unit.

Radios must ship from the Motorola manufacturing facility with the hazardous atmosphere capability and FM Approval labeling. Radios will not be “upgraded” to this capability and labeled in the field.

A modification changes the unit's hardware from its original design configuration. Modifications can only be done by the original product manufacturer at one of its FMRC audited manufacturing facilities.

WARNING

Failure to use an FMRC Approved Product unit with an FMRC Approved battery or FMRC Approved accessories specifically approved for that product may result in the dangerously unsafe condition of an unapproved radio combination being used in a hazardous location.
Unauthorized or incorrect modification of an FMRC Approved Product unit will negate the Approval rating of the product.

Repair of FMRC Approved Products

REPAIRS FOR MOTOROLA FMRC APPROVED PRODUCTS ARE THE RESPONSIBILITY OF THE USER.

You should not repair or relabel any Motorola manufactured communication equipment bearing the FMRC Approval label (“FMRC Approved Product”) unless you are familiar with the current FMRC Approval Standard for repair service (“Class Number 3605").

You may want to consider using a repair facility that operates under 3605 repair service approval.

WARNING

Incorrect repair or relabeling of any FMRC Approved Product unit could adversely affect the Approval rating of the unit.
Use of a radio that is not intrinsically safe in a hazardous atmosphere could result in serious injury or death.

FMRC's Approval Standard Class Number 3605 is subject to change at any time without notice to you, so you may want to obtain a current copy of 3605 from FMRC. Per the December, 1994 publication of 3605, some key definitions and service requirements are as follows:

Repair

A repair constitutes something done internally to the unit that would bring it back to its original condition Approved by FMRC. A repair should be done in an FMRC Approved facility.

Items not considered as repairs are those in which an action is performed on a unit which does not require the outer casing of the unit to be opened in a manner which exposes the internal electrical circuits of the unit. You do not have to be an FMRC Approved Repair Facility to perform these actions.

Relabeling

The repair facility shall have a method by which the replacement of FMRC Approval labels are controlled to ensure that any relabeling is limited to units that were originally shipped from the Manufacturer with an FM Approval label in place. FMRC Approval labels shall not be stocked by the repair facility. An FMRC Approval label shall be ordered from the original manufacturer as needed to repair a specific unit. Replacement labels may be obtained and applied by the repair facility providing satisfactory evidence that the unit being relabeled was originally an FMRC Approved unit. Verification may include, but is not limited to: a unit with a damaged Approval label, a unit with a defective housing displaying an Approval label, or a customer invoice indicating the serial number of the unit and purchase of an FMRC Approved model.

Do Not Substitute Options or Accessories

The communications equipment package that Motorola submits to FMRC for testing and approval is tested as a system that consists of the communications unit itself and the battery, antenna and other options or accessories that make up the rest of the package to be approved. This approved package must be strictly observed and there must be no substitution of items, even if the substitute you wanted to consider appears as an approved accessory elsewhere in the Guide for some other communications equipment unit. Approved configurations are listed by FMRC Approved Product in the annual Approval Guide published by FMRC. That guide, and the Approval Standard Class Number 3605 document, can be ordered from the following address.

Training Resource Center, Publications-Order Processing Dept.
Factory Mutual Engineering and Research
1151 Boston-Providence Turnpike
PO Box 9102
Norwood, MA, 02062
telephone (617) 762-4300

Notes

List of Effective Pages

HT 1000™, JT 1000®, MT 2000™, MTS 2000™, and MTX Series Handie-Talkie® Portable Radios

Service Manual

Motorola Publication Number 68P81200C75-A

Issue Dates of Original and Revised (FMR) Pages are:

Original: March, 2001

The Number of pages in this publication is 161 consisting of the following:

Page Number	Issue or FMR No.	Issue or FMR Date
Front Cover	A	3/01
Inside Front Cover (Foreword)	A	3/01
Title	A	3/01
Safety 0 thru Safety 6	A	3/01
A and B (blank)	A	3/01
i thru xvi	A	3/01
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Appendix A 1 thru 10	A	3/01
Appendix B 1 thru 18	A	3/01
Inside Back Cover (blank)	A	3/01
Back Cover	A	3/01

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Related Publications Available Separately

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Service Manual (early version radios; first issue- 4/93) 68P81200C25
Service Manual (later version radios; first issue- 7/94) 68P81200C40
Service Manual (this publication; present version radios; first issue- 3/98) 68P81200C75
includes:
- all servicing information
- assembly / disassembly
- maintenance

Theory Manual 68P81200C15
includes:
- theory of operation
- troubleshooting information and troubleshooting charts

Operating Instructions
- HT 1000 A Model Portable Radios 68P81071C70
- HT 1000 B Model and later Portable Radios 68P81079C50
- JT 1000 Portable Radios 68P81078C45
- JT 1000 Portable Radios Front Panel Programming Instructions 68P81081C30
- MT 2000 Portable Radios 68P81076C65
- MTS 2000 I Portable Radios 68P81072C15
- MTS 2000 II and III Portable Radios 68P81072C45
- MTX Series Model B3 Privacy Plus Portable Radios 68P81072C10
- MTX Series Model B4 Privacy Plus Portable Radios 68P81073C60
- MTX Series Model B5 and B7 Privacy Plus Portable Radios 68P81072C40
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Mobile Vehicular Adapter (MTVA) Operating Instructions. 68P81075C85
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Option•Mate, HT 1000 Analog Voice Security; Installation/
Programming/Troubleshooting Manual 68P81084C35
Option•Mate, HT 1000 Analog Voice Security Operating Instructions 68P81084C36
Option•Mate, HT 1000 Analog Voice Security Service Help Card 68P81084C37

Refer to Chapter 10 for ordering information.

Model Numbering System

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

Position 1 - Type of Unit

H = Hand-Held Portable

Positions 2 & 3 - Model Series

Position 4 - Frequency Band

A = Less than 29.7MHz	P = 336 to 410MHz
B = 29.7 to 35.99MHz	Q = 403 to 437MHz
C = 36 to 41.99MHz	R = 438 to 482MHz
D = 42 to 50MHz	S = 470 to 520MHz
F = 66 to 80MHz	T = Product Specific
G = 74 to 90MHz	U = 806 to 870MHz
H = Product Specific	V = 825 to 870MHz
J = 136 to 162MHz	W = 896 to 941MHz
K = 146 to 178MHz	Y = 1.0 to 1.6GHz
L = 174 to 210MHz	Z = 1.5 to 2.0GHz
M = 190 to 235MHz	

Values given represent range only; they are not absolute.

Position 5 - Power Level

A = 0 to 0.7 Watts
B = 0.7 to 0.9 Watts
C = 1.0 to 3.9 Watts
D = 4.0 to 5.0 Watts
E = 5.1 to 6.0 Watts
F = 6.1 to 10 Watts

Position 6 - Physical Packages

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

Position 7 - Channel Spacing

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

Position 8 - Primary Operation

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

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

Position 9 - Primary System Type

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

** MPT = Ministry of Posts and Telecommunications*

Position 10 - Feature Level

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

Position 11 - Version

Version Letter (Alpha) - Major Change

Position 12 - Unique Model Variations

C = Cenelec
N = Standard Package

Positions 13 - 16

"SP" Model Suffix

Model Charts Model Programming, Flashing, and Cloning

Model Charts General Description

Four model charts cover the three families of radios discussed in this publication:

- Conventional Systems Radios, HT 1000
- Conventional Systems Radios, JT 1000 and MT 2000
- Private Systems Radios
- Shared Systems Radios

Each model chart lists the model number and its description, and the three main radio components: the transceiver board, the controller board, and the front cover. A single model may be built using alternate controller boards and alternate transceiver boards. The model charts will list all alternate controllers and all alternate transceivers for any one particular model. Other model components are referenced in electrical parts lists and exploded view parts lists located toward the rear of the manual.

To determine which controller and transceiver is in a radio, that radio must be opened and physically examined. Identification kit number labels are attached to the controller board and to the transceiver board.

Programming, Flashing, and Cloning

All HT 1000, JT 1000, MT 2000, MTS 2000, and MTX Series Radios covered in this manual are clonable. The JT 1000 Model Radios are also front-panel programmable, and the MTS 2000 Series Radios are "flashable." The following cloning information applies only to HT 1000 Model Radios.

HT 1000 Model Radios:

- VHF DN models **cannot** be cloned to AN, BN, or CN models.
- Any DN model can be cloned from like CN or DN models.
- Prior to cloning any AN or BN model into a like CN or DN model, a code plug fix must be performed on the AN or BN model. Failure to do so could seriously degrade the scan and battery-saver capabilities of the CN or DN model radio. For code plug-fix information, order Service Repair Notice, SRN-1218.
  Note: Cloning any AN model into a like CN or DN model will remove the TEST MODE capability.

MODEL CHART
Conventional Systems Radios
(HT 1000 Models)

MODEL NUMBER	DESCRIPTION
H01KDC9AA1DN	VHF, 2F, 5- to 1-Watt
H01KDC9AA3DN	VHF, 16F, 5- to 1-Watt
H01RDC9AA1DN	UHF B1, 2F, 4- to 1-Watt
H01RDC9AA3DN	UHF B1, 16F, 4- to 1-Watt
H01SDC9AA1DN	UHF B2, 2F, 4- to 1-Watt
H01SDC9AA3DN	UHF B2, 16F, 4- to 1-Watt
H01UCC6AA3DN	800MHz, 16F, 3-Watt

								ITEM NO.	DESCRIPTION
A								NUD7085E / NUD7085F / NUD7091A / NUD7091B / NUD7095B	Transceiver Board
	A							NUD7070E / NUD7070F / NUD7092A / NUD7092B NUD7095B	Transceiver Board
		A						NUE7240D / NUE7240E / NUE7265A / NUE7265B NUE7272B	Transceiver Board
			A					NUE7231C / NUE7231D / NUE7266A / NUE7266B NUE7272B	Transceiver Board
				A				NUE7241D / NUE7241E / NUE7267A / NUE7267B NUE7273B	Transceiver Board
					A			NUE7232C / NUE7232D / NUE7268A / NUE7268B NUE7273B	Transceiver Board
						A		NUF6394B / NUF6497A / NUF6497B / NUF6500D	Transceiver Board
B	B							NCN6129C / NCN6129D / NCN6129E / NCN6129F / NCN6129G /NCN6138A / NCN6138B / NCN6140A / NCN6140B	Controller Board *
		B	B	B	B			NCN6129C / NCN6141A / NCN6141B / NCN6141C	Controller Board *
						B		NCN6129C / NCN6145A / NCN6145B / NCN6145C	Controller Board *
B	B	B	B	B	B	B		NCN6140C	Controller Board *
X	X	X	X	X	X	X		NTN7151B / NTN7151C	Front Cover
X		X		X				NTN7156A / NTN7156B	Front Cover

Note: This model chart lists the model numbers and their respective major components of all conventional systems radios covered in this publication.

A = Alternate transceiver board supplied, see “Model Charts General Description” (this section).

B = Alternate controller board supplied, see “Model Charts General Description” (this section).

X = One item is supplied per radio.

* = The radio model number is required when placing an order for the controller board. The model number can be found on the FCC Label on the back of the radio. Refer to Replacement Parts Ordering, Section 10 of this manual for instructions on how to place an order.

MODEL CHART
Conventional Systems Radios
(JT 1000 and MT 2000 Models)

MODEL NUMBER	DESCRIPTION
H01KDH9PA3AN	JT 1000, VHF, 16CH, Front Display
H01RDH9PA3AN	JT 1000, UHF B1, 16CH, Front Display
H01SDH9PA3AN	JT 1000, UHF B2, 16CH, Front Display
H01KDD9AA4AN	MT 2000, VHF, 16F, 5- to 1-Watt, Top Display
H01KDH9AA7AN	MT 2000, VHF, 16CH, 5- to 1-Watt, Front Display
H01RDD9AA4AN	MT 2000, UHF B1, 16F, 4- to 1-Watt, Top Display
H01RDH9AA7AN	MT 2000, UHF B1, 16CH, 4- to 1-Watt, Front Display
H01SDD9AA4AN	MT 2000, UHF B2, 16F, 4- to 1-Watt, Top Display
H01SDH9AA7AN	MT 2000, UHF B2, 16CH, 4- to 1-Watt, Front Display
H01UCD6AA4AN	MT 2000, 800MHz, 16F, 4- to 1-Watt, Top Display
H01UCH6AA7AN	MT 2000, 800MHz, 16CH, 4- to 1-Watt, Front Display

												ITEM NO.	DESCRIPTION
A			A	A								NUD7070E / NUD7070F / NUD7095A / NUD7095B / NUD7092B	Transceiver Board
	A				A	A						NUE7231C / NUE7231D / NUE7272A / NUE7272B / NUE7272C / NUE7272D	Transceiver Board
		A					A	A				NUE7232C / NUE7232D / NUE7273A / NUE7273B / NUE7273C	Transceiver Board
									A	A		NUF6394B / NUF6498A / NUF6498B / NUF6498C / NUF6500A / NUF6500B / NUF6500C / NUF6500D	Transceiver Board
B	B	B										NTN7089C / NTN7089D / NCN6146A	Controller Board *
			B	B	B	B	B	B	B	B		NTN7091D / NTN7091E / NCN6147A / NCN6147B	Controller Board *
			X		X		X		X			NTN7152A / NTN7152B	Front Cover
X	X	X		X		X		X		X		NTN7154A / NTN7154B	Front Cover

Note: This model chart lists the model numbers and their respective major components of all conventional systems radios covered in this publication.

A = Alternate transceiver board supplied, see “Model Charts General Description” (this section).

B = Alternate controller board supplied, see “Model Charts General Description” (this section).

X = One item is supplied per radio.

* = The radio model number is required when placing an order for the controller board. The model number can be found on the FCC Label on the back of the radio. Refer to Replacement Parts Ordering, Section 10 of this manual for instructions on how to place an order.

MODEL CHART
Private Systems Radios
(MTS 2000 Models)

MODEL NUMBER	DESCRIPTION
H01KDD9PW1BN	VHF, 16-Mode, Top Display, 5- to 1-Watt
H01KDF9PW1BN	VHF, 160-Mode, Front Display, Limited Keypad, 5- to 1-Watt
H01KDH9PW1BN	VHF, 160-Mode, Front Display, Full Keypad, 5- to 1-Watt
H01RDD9PW1BN	UHF B1, 16-Mode, Top Display, 4- to 1-Watt
H01RDF9PW1BN	UHF B1, 160-Mode, Front Display, Limited Keypad, 4- to 1-Watt
H01RDH9PW1BN	UHF B1, 160-Mode, Front Display, Full Keypad, 4- to 1-Watt
H01SDD9PW1BN	UHF B2, 16-Mode, Top Display, 4- to 1-Watt
H01SDF9PW1BN	UHF B2, 160-Mode, Front Display, Limited Keypad, 4- to 1-Watt
H01SDH9PW1BN	UHF B2, 160-Mode, Front Display, Full Keypad, 4- to 1-Watt
H01UCD6PW1BN	800MHz, 16-Mode, Top Display, 3-Watt
H01UCF6PW1BN	800MHz, 160-Mode, Front Display, Limited Keypad, 3-Watt
H01UCH6PW1BN	800MHz, 160-Mode, Front Display, Full Keypad, 3-Watt
H01WCD4PW1CN	900MHz, 16-Mode, Top Display, 2.4W (Typ), 2.9W (Max)
H01WCF4PW1CN	900MHz, 160-Mode, Front Display, Limited Keypad
H01WCH4PW1CN	900MHz, 160-Mode, Front Display, Full Keypad

															ITEM NO.	DESCRIPTION
A	A	A													NUD7070E / NUD7070F / NUD7095A / NUD7095B / NUD7092B	Transceiver Board
			A	A	A										NUE7231C / NUE7272A / NUE7272B / NUE7272C / NUE7272D	Transceiver Board
						A	A	A							NUE7232C / NUE7273A / NUE7273B / NUE7273C	Transceiver Board
									A	A	A				NUF6410B / NUF6500A / NUF6500B / NUF6500C / NUF6500D / NUF6533A	Transceiver Board
												A	A	A	NUF6395C / NUF6499A / NUF6499B / NUF6499C / NUF6499D	Transceiver Board
B	B	B	B	B	B	B	B	B	B	B	B				NTN7620E / NCN6150A / NCN6150B / NCN6176A	Controller Board *
												B	B	B	NCN6106C / NCN6153A / NCN6153B	Controller Board *
X			X			X			X			X			NTN7152A / NTN7152B	Front Cover
	X			X			X			X			X		NTN7153A / NTN7153B	Front Cover
		X			X			X			X			X	NTN7154A / NTN7154B	Front Cover

Note: This model chart lists the model numbers and their respective major components of all private systems radios covered in this publication.

A = Alternate transceiver board supplied, see “Model Charts General Description” (this section).

B = Alternate controller board supplied, see “Model Charts General Description” (this section).

X = One item is supplied per radio.

* = The radio model number and flash code are required when placing an order for the controller board. The model number can be found on the FCC Label on the back of the radio. The Flashcode can be obtained several ways:

- Check the FCC Label on the back of the radio.
- Hook the radio (or sister radio) up to the Smart RIB.
- Contact Product Services at 800-424-7674, and have the radio option information available.

Refer to Replacement Parts Ordering, Section 10 of this manual for instructions on how to place an order.

MODEL CHART
Shared Systems Radios
(MTX 838, MTX 8000, MTX•LS, and MTX 9000 Models)

MODEL NUMBER	DESCRIPTION
	MTX 838
H01KDC9DB3AN	VHF, 16-Mode, 5- to 1-Watt
H01KDD9DB4AN	VHF, 99-Mode, Top Display, 5- to 1-Watt
H01KDF9DB5AN	VHF, 160-Mode, Front Display, Limited Keypad, 5- to 1-Watt
H01KDH9DB7AN	VHF, 160-Mode, Front Display, Full Keypad, 5- to 1-Watt
H01RDC9DB3AN	UHF B1, 16-Mode, 4- to 1-Watt
H01RDD9DB4AN	UHF B1, 99-Mode, Top Display, 4- to 1-Watt
H01RDF9DB5AN	UHF B1, 160-Mode, Front Display, Limited Keypad, 4- to 1-Watt
H01RDH9DB7AN	UHF B1, 160-Mode, Front Display, Full Keypad, 4- to 1-Watt
H01SDC9DB3AN	UHF B2, 16-Mode, 4- to 1-Watt
H01SDD9DB4AN	UHF B2, 99-Mode, Top Display, 4- to 1-Watt
H01SDH9DB7AN	UHF B2, 160-Mode, Front Display, Full Keypad, 4- to 1-Watt
H01UCC6DF3AN	800MHz, 16-Mode, Type II
	MTX 8000
H01UCC6DB3AN	800MHz, 16-Mode, Type I
H01UCF6DB5AN	800MHz, 160-Mode, Front Display, Limited Keypad, 3-Watt
H01UCH6DB7AN	800MHz, 160-Mode, Front Display, Full Keypad, 3-Watt
	MTX•LS
H01UCC6DU3AN	800MHz, 16F
	MTX 9000
H01WCC4DB3AN	900MHz, 16-Mode, 2.4W (Typ), 2.9W (Max)
H01WCF4DB5AN	900MHz, 160-Mode, Front Display, Limited Keypad
H01WCH4DB7AN	900MHz, 160-Mode, Front Display, Full Keypad

ITEM NO.	DESCRIPTION
NUD7085E / NUD7085F / NUD7096A / NUD7096B / NUD7095A / NUD7095B	Transceiver Board
NUE7240D / NUE7240E / NUE7274A / NUE7274B / NUE7272A / NUE7272B	Transceiver Board
NUE7241C / NUE7241D / NUE7241E / NUE7275A / NUE7275B	Transceiver Board
NUF6423B / NUF6501A / NUF6501B / NUF6501C	Transceiver Board
NUF6424B / NUF6502A / NUF6502B / NUF6502C	Transceiver Board
NUF6460A / NUF6460B	Uniboard *
NTN7512D / NTN7512E / NCN6147A / NCN6147B	Controller Board *
NTN7513D / NTN7513E / NCN6153A / NCN6153B	Controller Board *
NTN7857D / NTN7857E / NCN6147A / NCN6147B	Controller Board *
NTN7858D / NTN7858E / NCN6153A / NCN6153B	Controller Board *
NTN7151B / NTN7151C	Front Cover
NTN7152A / NTN7152B	Front Cover
NTN7153A / NTN7153B	Front Cover
NTN7154A / NTN7154B	Front Cover

Note: This model chart lists the model numbers and their respective major components of all shared systems radios covered in this publication.

A = Alternate transceiver board supplied, see "Model Charts General Description" (this section).

B = Alternate controller board supplied, see "Model Charts General Description" (this section).

X = One item is supplied per radio.

* = The radio model number is required when placing an order for the uniboard. The model number can be found on the FCC Label on the back of the radio. Refer to Replacement Parts Ordering, Section 10 of this manual for instructions on how to place an order.

List of Antennas

ANTENNA KIT NOS.	DESCRIPTION
NAD6566*	Helical (136 - 151MHz)
NAD6567*	Helical (151 - 162MHz)
NAD6568*	Helical (162 - 174MHz)
NAD6563*	Helical Wideband (136 - 174MHz)
NAE6546*	Helical (403 - 435MHz)
NAE6547*	Helical (435 - 470MHz)
NAE6548*	Helical (470 - 512MHz)
NAE6549*	Whip (403 - 512MHz)
NAF5037*	Whip (800MHz)
NAF5038*	Whip (900MHz)
NAF5039*	Dipole (800MHz)
NAF5040*	Dipole (900MHz)
NAF5042*	Quarter Wave, Stubby (800MHz, 900MHz)

List of Batteries

BATTERY KIT NOS.	DESCRIPTION
NTN7143	High-Capacity Nickel-Cadmium (groups A, B, C, D)
NTN7144	Ultra-High-Capacity Nickel-Cadmium (groups A, B, C, D)
NTN7146*	High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups D, F, G)
NTN7147*	Ultra-High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups D, F, G)
NTN7341*	Ultra-High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups C, D, E, F, G)
NTN7372*	High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups C, D, E, F, G)

WARNING

Substitution of components may impair the intrinsic safety of the radio.

* These accessories are approved as being intrinsically safe by Factory Mutual Research Corporation (FMRC). Refer to the radio label for intrinsic safety ratings and required batteries. Only the accessories and antennas noted (by *) may be used on approved radios.

Maintenance Specifications for VHF Radios

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT3768	**Frequency Range:**	*136–178MHz	**RF Power:**	
Power Supply:	Nickel-Cadmium Battery	**Bandwidth:**	42MHz	**136-174MHz**	1-5 Watts
Battery Voltage:		**Quieting Sensitivity (20dBQ):**	0.5µV Max.	**174-178MHz**	1-4 Watts
Nominal:	7.5 Volts	**Usable Sensitivity**		**Frequency Range:**	*136–178MHz
Range:	6 to 9 Volts	**(12dB SINAD):**	0.35µV Max.	**Freq. Stability**	
Battery Drain, Typical:		**Intermodulation:**	–70dB	**–30 to +60°C; 25°C ref.:**	± .0005%(30kHz syst)
Standby:	56mA	**Selectivity**		**:**	± .0003%(12.5kHz syst)
Receive:	180mA	**(30kHz Adjacent Channel):**	–70dB	**Emission (Conducted and Radiated):**	–66dBw
Transmit:	2100mA	**(12.5kHz Adjacent Channel):**	–70dB	**FM Hum and Noise**	
Temperature Range:		**Spurious Rejection:**	–70dB	**(Companion Receiver):**	–45dB Typical
Operating:	–30°C to +60°C	**Freq. Stability**		**Distortion:**	3% Typical
Storage:	–40°C to +85°C	**(–30 to +60°C; 25°C reference):**	± 0.0005%	**Modulation Limiting:**	±5kHz (30kHz syst)
Duty Cycle (5-5-90):	1 Watt/5 Watts	**Rated Audio:**	500mW	**:**	± 2.5kHz(12.5kHz syst)
High Cap. Battery:	11.2 Hrs./8 Hrs.	**Distortion (At Rated Audio):**	3% Typical	**Recommended Battery:**	
Ultra-High Cap. Battery:	12.9 Hrs./9 Hrs.	**Channel Spacing:**	30kHz	**High Capacity:**	NTN7143
Dimensions (H x W x D)			12.5kHz	**Ultra–High Capacity:**	NTN7144
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra–High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

* Frequencies in the 174-178MHz range are not permitted in the USA.

Maintenance Specifications for UHF Radios

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC	AZ489FT4781 (403-470MHz)	**Frequency Range:**	403-470MHz	**RF Power:**	
Designation:	AZ489FT4780 (450-520MHz)		*450-520MHz	**403-470MHz**	1-4 Watts
Power Supply:	Nickel-Cadmium Battery	**Bandwidth:**	70MHz	**450-512MHz**	1-4 Watts
Battery Voltage:		**Quieting Sensitivity (20dBQ):**	0.5µV Max.	**512-520MHz**	1-3 Watts
Nominal:	7.5 Volts	**Usable Sensitivity**		**Frequency Range:**	403-470MHz
Range:	6 to 9 Volts	**(12dB SINAD):**	0.35µV Max.		*450-520MHz
Battery Drain, Typical:		**Intermodulation:**	–70dB	**Freq. Stability**	
Standby:	60mA	**Selectivity**		**(–30 to +60°C; 25°C ref.):**	± .0005%(25kHz syst)
Receive:	180mA	**(25kHz Adjacent Channel):**	–70dB	**:**	± .0003%(12.5kHz syst)
Transmit:	1800mA	**(12.5kHz Adjacent Channel):**	–60dB	**Emission (Conducted and Radiated):**	–66dBw
Temperature Range:		**Spurious Rejection:**		**FM Hum and Noise**	
Operating:	–30°C to +60°C	**450-512MHz**	–70dB	**(Companion Receiver):**	–45dB Typical
Storage:	–40°C to +85°C	**512-520MHz**	–65dB	**Hear Clear:**	–48dB Typical
Duty Cycle (5-5-90):	1 Watt/4 Watts	**Freq. Stability**		**Distortion:**	3% Typical
High Cap. Battery:	11 Hrs./8.4 Hrs.	**(–30 to +60°C; 25°C reference):**	± 0.0005%	**Modulation Limiting:**	±5kHz (25kHz syst)
Ultra-High Cap. Battery:	12.7 Hrs./9.7 Hrs.	**Rated Audio:**	500mW	**:**	±2.5kHz (12.5kHz syst)
Dimensions (H x W x D)		**Distortion (At Rated Audio):**	3% Typical	**Recommended Battery:**	
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)	**Channel Spacing:**	25kHz	**High Capacity:**	NTN7143
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)		12.5kHz	**Ultra–High Capacity:**	NTN7144
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra–High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

* Frequencies in the 512-520MHz range are not permitted in the USA.

Maintenance Specifications for 800MHz Radios

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT5747	**Frequency Range:**	851–870MHz	**RF Power:**	3 Watts
Power Supply:	Nickel-Cadmium Battery	**Bandwidth:**	19MHz	**Frequency Range:**	806–824MHz 851–869MHz
Battery Voltage:		**Quieting Sensitivity (20dBQ):**	0.5µV Max.	**Freq. Stability**	
Nominal:	7.5 Volts	**Usable Sensitivity**		**(–30 to +60°C; 25°C ref.):**	± .00025%
Range:	6 to 9 Volts	**(12dB SINAD):**	0.35µV Max.	**(821-824MHz Capable):**	± .00015%
Battery Drain, Typical:		**Intermodulation:**	–70dB	**Emission (Conducted and Radiated):**	–46dBw
Standby:	65mA	**Selectivity**		**FM Hum and Noise**	
Receive:	190mA	**(25kHz Adjacent Channel):**	–70dB	**(Companion Receiver):**	–40dB Typical
Transmit:	1900mA	**Spurious Rejection:**	–70dB	**Distortion:**	3% Typical
Temperature Range:		**Freq. Stability**		**Modulation Limiting:**	±5kHz
Operating:	–30°C to +60°C	**(–30+60°C; 25°C reference):**	± .00025%	**(821-824MHz):**	±4kHz
Storage:	–40°C to +85°C	**(821-824MHz Capable):**	±.00015%	**Recommended Battery:**	
Duty Cycle (5-5-90):		**Rated Audio:**	500mW	**High Capacity:**	NTN7143
High Cap. Battery:	8 Hours	**Distortion (At Rated Audio):**	3% Typical	**Ultra–High Capacity:**	NTN7144
Ultra-High Cap. Battery:	9 Hours	**Channel Spacing:**	25kHz		
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra–High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

Maintenance Specifications for 900MHz Radios

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT5748	**Frequency Range:**	935–941MHz	**RF Power:**	2.4 Watts (Typ.) 2.9 Watts (Max.)
Power Supply:	Nickel-Cadmium Battery	**Bandwidth:**	6MHz	**Frequency Range:**	896–902MHz 935–941MHz
Battery Voltage:		**Quieting Sensitivity (20dBQ):**	0.5µV Max.	**Freq. Stability**	
Nominal:	7.5 Volts	**Usable Sensitivity**		**(–30 to +60°C; 25°C ref.):**	± .00015%
Range:	6 to 9 Volts	**(12dB SINAD):**	0.35µV Max.	**Emission (Conducted and Radiated):**	–46dBw
Battery Drain, Typical:		**Intermodulation:**	–60dB	**FM Hum and Noise**	
Standby:	65mA	**Selectivity**		**(Companion Receiver /**	
Receive:	185mA	**(12.5kHz Adjacent Channel):**	–60dB	**HEAR CLEAR):**	–45dB Typical
Transmit:	1910mA	**Spurious Rejection:**	–60dB	**Distortion:**	3% Typical
Temperature Range:		**Freq. Stability**		**Modulation Limiting:**	±2.5kHz
Operating:	–30°C to +60°C	**(–30+60°C; 25°C reference):**	± .00015%	**Recommended Battery:**	
Storage:	–40°C to +85°C	**Rated Audio:**	500mW	**High Capacity:**	NTN7143
Duty Cycle (5-5-90):		**Distortion (At Rated Audio):**	3% Typical	**Ultra–High Capacity:**	NTN7144
High Cap. Battery:	8 Hours	**Channel Spacing:**	12.5kHz		
Ultra-High Cap. Battery:	9 Hours				
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra–High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

Glossary

A/D	Analog to Digital converter; converts an instantaneous dc voltage level to a corresponding digital value.
ALC	Automatic Level Control; a circuit in the transmit RF path that controls RF power amplifier output, provides leveling over frequency and voltage, and protects against high VSWR.
CMOS	Complementary metal-oxide semiconductor.
Channel	Defines conventional transmit and receive frequencies and muting conditions.
Closed Architecture	A controller configuration that utilizes a microcontroller with no external memory (non-FLASHport operation).
CBI	(Customer Board Initialization) When the controller board is received, it will need a serial from the defect unit. The serial is manually entered via the RSS prior to proceeding any further with the replacement process.
D/A	Digital to Analog converter; converts a digital value to a corresponding dc voltage value.
DTMF	Dual Tone Multi-Frequency.
DPL	Digital Private-Line™.
Firmware	Software or a software/hardware combination of computer programs and data, with a fixed logic configuration stored in a read-only memory; information can not be altered or reprogrammed.
FGU	Frequency Generation Unit.
Flashcode	A Motorola term (model option definition code) that determines what FLASHport options are in a radio.
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.
IC	Integrated Circuit.
ISW	Inbound Signalling Word; data transmitted on the control channel from the subscriber unit to the central controller.
LTR	Logic Trunked Radio; a registered trademark of E.F. Johnson Company.
MCU	MicroControl Unit.
MDC	Motorola Digital Code.
OMPAC	Over-Molded Pad-Array Carrier; a Motorola custom IC package, distinguished by the presence of solder balls on the bottom pads.
Open Architecture	A controller configuration that utilizes a microprocessor with extended ROM, RAM, and EEPROM, (FLASHport capable).
OSW	Outbound Signalling Word; data transmitted on the control channel from the central controller to the subscriber unit.
PC Board	Printed Circuit board.
PL	Private-Line® tone squelch; a continuous sub-audible tone that is transmitted along with the carrier.

PLL	Phase-Locked Loop; a circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.
PTT	Push-To-Talk; the switch located on the left side of the radio which, when pressed, causes the radio to transmit.
Registers	Short-term data-storage circuits within the microcontrol unit or programmable logic IC.
RESET	Reset line; an input to the microcontroller that restarts execution.
RF PA	Radio Frequency Power Amplifier.
RSS	Radio Service Software.
RSSI	Received signal strength indicator; a dc voltage proportional to the received rf signal strength.
RX DATA	Recovered digital data line.
SLIC	Support-Logic IC; a custom gate array used to provide I/O and memory expansion for the microcontroller.
SmartRib	Use in conjunction with the RSS to read the Flashcode and Model Number, and to flash upgrade radios.
Softpot	Software potentiometer; a computer-adjustable electronic attenuator.
Software	Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system.
Squelch	Muting of audio circuits when received signal levels fall below a pre-determined value.
SRAM	Static-RAM chip used for volatile, program/data memory.
Standby Mode	An operating mode whereby the radio is muted but still continues to monitor data.
TOT	Time-Out Timer; a timer that limits the length of a transmission.
TPL	Tone Private-Line; Continuous Tone Coded Squelch System (CTCSS), industry standard.
TSOP	Thin Small-Outline Package.
µC	Microcontrol unit (see MCU).
VCO	Voltage-Controlled Oscillator; an oscillator whereby the frequency of oscillation can be varied by changing a control voltage.
VSWR	Voltage Standing Wave Ratio.

Introduction

1

This manual includes safety information, model charts, specifications, fundamental disassembly/reassembly procedures; schematic diagrams, printed circuit board details, flex circuit diagrams, and several parts lists to completely cover the HT 1000, JT 1000, MT 2000, MTS 2000, and MTX series radios. Hereafter, the text will refer collectively to these radios as "this family of radios." For maintenance/troubleshooting, theory, accessories, and operation of the radio, refer to the applicable manuals available separately. To help you with your selection, a list is provided in this manual, titled "Related Publications Available Separately."

Special notices are incorporated into the text, alerting you to safety hazards and suggesting procedures. These notices are divided and labeled according to the information they contain so that you can become immediately aware of the type of information being presented. The three classifications are: WARNINGS, CAUTIONS, and NOTES.

WARNING

This is an operational procedure, practice, or condition, etc., which may result in injury or death if not carefully observed.

Caution

This is an operational procedure, practice, or condition, etc., which may result in damage to the equipment if not carefully observed.

NOTE: This is an operational procedure, practice, or condition, etc., which is essential to emphasize.

Notes

Test Equipment, Service Aids, and Tools

2

Recommended Test Equipment

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

Table 1 Recommended Test Equipment

MOTOROLA MODEL NUMBER	DESCRIPTION	CHARACTERISTICS	APPLICATION
R2600 Series R2670 (for trunking)	System Analyzer	This monitor will substitute for items with an asterisk (*)	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1097A	Digital Multimeter	4,000 counts True RMS Metering 0.3% basic accuracy	Digital voltmeter recommended for ac/dc voltage and current measurements
*R1150E	Code Synthesizer		Injection of audio and digital signalling codes
*R1527A	Portable Test Receiver	Counter; CTCSS, DCS, and DTMF decoder	Portable Radio Monitor
R1368A	Dual-Trace Oscilloscope	20MHz bandwidth (some system analyzers, R2000 series, are 15MHz bandwidth) 5mV to 5V/division	Waveform measurements
*S1350C *ST1213B (VHF) *ST1223B (UHF)	Watt Meter Plug-in Element RF Dummy Load	50-ohm, ±5% accuracy 10 Watts, maximum 0-1000MHz, 300W	Transmitter power output measurements
R1065	Load Resistor	10-watt Broadband	For use with Wattmeter
S1339A	RF Millivolt Meter	100µV to 3V rf 10kHz to 1.2GHz	RF level measurements
*R1013B or *R1370A	SINAD Meter SINAD Meter V/RMS	RMS Audio Voltmeter	Receiver sensitivity measurements
S1347D or S1348D (programmable)	DC Power Supply	0-20Vdc, 0-5 Amps current limited	Bench supply for 7.5Vdc

Service Aids and Recommended Tools

Refer to the “Service Aids” in Table 2 and “Recommended Service Tools” list in Table 3 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 United States and Canada Aftermarket Product Division listed in the “Replacement Parts Ordering” section at the back of this manual.

Field Programming

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the applicable “Radio Service Software User's Manual” for complete field programming information.

The following table lists service aids recommended for working on this family of radios. These items are available from Aftermarket Products Division (APD).

Table 2 Service Aids

MOTOROLA PART NO.	DESCRIPTION	APPLICATION
Servicers Video Tape	Video Tape	Includes Radio Introduction.
RKN-4035D	RIB/Radio/test set cable	Connects radio to RTX-4005B Test Box and RIB.
RLN-1014A	Battery Eliminator	Interconnects radio to power supply.
RLN-1018A	Test Fixture	Provides for troubleshooting of the radio when the housing is removed.
RTX-4005B or both RTX-4005A / RPX-4665A	Portable Test Set Field Modification Kit	Allows switching for radio testing.
RLN-4460A	Portable/Mobile Test Set	Provides more convenient testing of mobiles and portables.
RLN-4008B	Radio Interface Box (RIB)	Enables communications between the radio and the computer's serial communications adapter.
RLN-1015C 0180302E27 3080390B48	Smart RIB Power Supply Computer Interface Cable	Used to read Flashcode. Used to supply power to the Smart RIB. Connects computer serial adapter to Smart RIB.
0180357A57 0180358A56	Wall-mounted Power Supply Wall-mounted Power Supply	Used to supply power to the RIB (120 VAC). Used to supply power to the RIB (220 VAC).
3080369B71 3080369B72	Computer Interface Cable	Use B72 for the IBM PC AT (7-pin). All other IBM models use B71.Connects the computer's serial communications adapter to the RIB (25-pin).
RKN-4036D	Cloning Cable	Allows a radio to be duplicated from a master radio by transferring programmed data from one radio to another (HT 1000/MT 2000 Models Only).
RVN-4097L	Radio Service Software	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
RVN-4098G	Radio Service Software (HT/JT 1000/VISAR Models Only)	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
RVN-4138B	Radio Service Software MTX•LS Model	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
5880348B33	SMA to BNC Adaptor	Adapts radio's antenna port to BNC cabling of test equipment.
RLN-4201B	Battery Tester	Tests battery charge.
RLN-4048A	Battery Tester Adapter	Adapts HT 1000, JT 1000, MT 2000, MTS 2000, and MTX Series radio batteries to the RLN-4201 Battery Tester.
RTL-4208A	RF Probe	50-ohm, high-frequency probe.
RT-5144/48/0 RT-5144/48/2	Test Probe (black) Test Probe (red)	Needle-fine test probes for high-density circuitry.

Service Tools

The following table lists the tools recommended for working on this family of radios; these tools are also available from Motorola. The R-1319A solder/desolder workstation requires the use of some reflow nozzles which are included with the workstation

Table 3 Recommended Service Tools

MOTOROLA PART NO.	DESCRIPTION	APPLICATION
R1319A	Chip Master Surface Mount Device (SMD) Rework Station	Temperature-controlled, self-contained soldering/ desoldering repair station for installation and removal of surface-mounted devices. Removes RF PA's.
0180356B79	Solder/Desolder Station	For soldering and desoldering thru-hole components.
0180372E51	Illuminated Magnifying System	
0180386A82	Anti-static Grounding Kit	Used during all radio assembly and disassembly procedures.
6680384A98	Brush	
1010041A86	Solder (RMA type), 63/37, 0.020" diameter, 1 lb. spool	
0180303E45	SMD Tool Kit	Kit includes chemicals and hand tools required to do many SMD rework procedures.
6680334E07	Chassis/Front Cover Separation Tool	Used to pry the chassis away from the front cover during disassembly.
6680334E08	Flex Connector Opening Tool	Used to raise the sliding portion of the flex connectors.

Transceiver Performance Testing

3

General

The HT 1000, JT 1000, MT 2000, MTS 2000, and MTX series radios have been prepared to meet published specifications through their manufacturing process, with the use of laboratory-quality test equipment of highest accuracy. The recommended field service equipment 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.

Setup

Supply voltage can be connected from the battery eliminator. The equipment required for alignment procedures is connected as shown in the Radio Alignment Test Setup diagram.

Initial equipment control settings should be as indicated in the following table, and should hold for all alignment procedures except as noted in Table 4.

Table 4 Equipment Initial Control Settings

SERVICE MONITOR	TEST SET	POWER SUPPLY
Monitor Mode: Pwr Mon RF Attn: –70 AM, CW, FM: FM O'scope Source: Mod O'scope Horiz: 10mSec/Div O'scope Vert: 2.5kHz/Div O'scope Trig: Auto Monitor Image: Hi Monitor BW: Nar Monitor Squelch: mid CW Monitor Vol: 1/4 CW	Spkr set: A Spkr/load: Speaker PTT: OFF (center)	Voltage: 7.5Vdc DC on/standby: Standby Volt Range: 10 Current: 2.5

* When testing TX deviation, where the modulation is greater than 1kHz, set the Service Monitor low pass filter (LPF) to 15kHz.

** The Test Set MT/PL switch controls internal/external audio switching.

Test Mode

RF Test Mode, HT 1000/JT 1000 Radios

NOTE: This note applies to software version R02.09 and earlier. If the radio is placed in TEST MODE

with Option•Mate interface plug enabled through the HT 1000 RSS, TX and RX audio will be muted. Do not test Analog Voice Security (AVS) installed radios in the TEST MODE.

When the HT 1000/JT 1000 radio is operating in its normal environment, the radio's microcontroller controls the RF channel selection, transmitter key-up, and receiver muting. However, when the unit is on the bench for testing, alignment, or repair, it is removed from its normal environment. It cannot receive commands from its system and, therefore, the internal microcontroller will not key the transmitter nor unmute the receiver. This prevents the use of normal tune-up procedures. To solve this problem a special routine, called TEST MODE or “air test,” has been incorporated in the radio.

To enter test mode:

1. Turn the radio on.
2. Within ten seconds after the self test is complete, press the monitor button (side button 3, SB3) five times in succession. After the fifth press:
   a. (HT 1000 radios), a tone is emitted to indicate that the rf test mode has been entered.
   b. (JT 1000 radios), the display will show the firmware version of the microprocessor for two seconds, emit a tone, then display TEST MODE).
3. Each additional press of SB3 will advance to the next test channel. (refer to Table 6), and a corresponding set of tones will indicate the channel.
4. Pressing SB2 will scroll through and access test environments as shown in Table 5.

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

To exit test mode, turn the radio off then back on.

Table 5 Test Environments, HT 1000/JT 1000 Radios

NO. OF BEEPS	DESCRIPTION	FUNCTION
1	Carrier Squelch	RX: if carrier detected TX: mic audio
3	Tone Private-Line	RX: unsquelch if carrier and tone (192.8Hz) detected TX: mic audio + tone (192.8Hz)
4	Digital Private-Line	RX: unsquelch if carrier and digital code (131) detected TX: mic audio + digital code (131) detected

Table 6 Test Frequencies, HT 1000 / JT 1000

NO. OF BEEPS	TEST CHANNEL	VHF	UHF BAND 1	UHF BAND 2	800
1	TX #1	136.025	403.100	450.025	806.0125
	RX #1	136.075	403.150	450.075	851.0625
2	TX #2	142.125	424.850	465.225	815.0125
	RX #2	142.175	424.900	465.275	860.0625
3	TX #3	154.225	438.050	475.225	824.9875
	RX #3	154.275	438.100	475.275	869.9375
4	TX #4	160.125	444.050	484.975	851.0125
	RX #4	160.175	444.100	485.025	851.0625
5	TX #5	168.075	456.350	500.275	860.0125
	RX #5	168.125	456.400	500.325	860.0625
6	TX #6	173.975	463.700	511.975	869.9875
	RX #6	173.925	463.650	511.925	869.9375

Control Head Test Mode, HT 1000/JT 1000 Radios

To check the buttons and the switches, perform the following tests:

1. Turn radio on.
2. After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds. After the fifth press, a tone is emitted to indicate that the RF test mode has been entered.
3. Exit the RF test mode and enter the control head test mode by pressing and holding SB3 for more than three seconds. Upon entering the control head test mode, a tone is emitted and the green LED begins flashing. The green LED continues to flash until the control head test mode is exited.

   NOTE: Return to the RF test mode by pressing and holding SB3 for more than three seconds. Then re-enter the control head test mode by pressing and holding SB3 for more than three seconds.

4. Test each switch (toggle, rotary, or button-actuated) by changing the position of the switch. A tone is emitted to indicate a “good test” each time a switch position is changed.

   NOTE: Pressing and releasing a button-actuated switch are both considered switch-position changes.

   NOTE: No tone when a switch position is changed indicates a test failure. Test the on/off volume potentiometer/switch by rotating the potentiometer clockwise and counter

clockwise. The loudness of tone beeps will increase and decrease accordingly.

NOTE: During test mode, the volume level is not regulated to the same limits as during normal radio operation.

To exit test mode, turn the radio off then back on.

RF Test Mode, MT 2000, MTS 2000, and MTX Series Radios

When the MT 2000, MTS 2000, or MTX series radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting. However, when the unit is on the bench for testing, alignment, or repair, it is removed from its normal environment. It cannot receive commands from its system and, therefore, the internal microcomputer will not key the transmitter nor unmute the receiver. This prevents the use of normal tune-up procedures. To solve this problem a special routine, called TEST MODE or "air test," has been incorporated in the radio.

To enter test mode:

1. Turn the radio on.
2. After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds.
3. After "RF TEST" appears (on 14-character displays) or "RF TST" appears (on 6-character displays), press the orange button on top of the radio once. "1 CSQ" appears, indicating: test frequency 1, carrier squelch mode.
4. Each additional press of SB3 will advance to the next test channel. (Refer to Table 8.)
5. Pressing SB2 will scroll through and access test environments as shown in Table 7.

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

   NOTE: Radios without display indicate test-environment function by emitting a corresponding number of beeps. See Table 7.

Control Head Test Mode, MT 2000, MTS 2000, and MTX Series Radios

To check the display, the buttons, and the switches, perform the following tests:

1. Turn radio on.
2. After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds.
3. After "RF TEST" appears on the display, press side button 1 (SB1), "CH TEST" (14-character radio) or "CH TST" (6-character radio) appears on the display.
4. Next, press and hold the orange button on top of the radio; all segments on the display will light, and the LED on the control top will illuminate a yellowish color.

5. Release the orange button; ”3/0” appears, which indicates that switch 3 is in the open condition.
6. Press the orange button again; “3/1” appears, which indicates that switch 3 is in the closed condition.
7. Rotate the mode selector knob; ”4/0” thru ”4/15” appears, which indicates that knob 4 is in mode position 1 thru 15.
8. Rotate the concentric switch; ”65/0” and “65/1” appears.
9. Rotate the volume control; “2/0” thru “2/255” appears.
10. Press SB1, view “96/1”; release, view “96/0”
11. Press SB2, view “97/1”; release, view “97/0”
12. Press SB3, view “98/1”; release, view “98/0”
13. Press PTT, view “1/1”; release, view “1/0”
14. Toggle Switch in ‘A’ position “64/0”, ‘B’ position “64/1”, ‘C’ position “64/2”
15. Keypad:

- Press 0, view “48/1”; release, view “48/0”
- Press 1, view “49/1”; release, view “49/0”
- Press 2, view “50/1”; release, view “50/0”
- Press 3, view “51/1”; release, view “51/0”
- Press 4, view “52/1”; release, view “52/0”
- Press 5, view “53/1”; release, view “53/0”
- Press 6, view “54/1”; release, view “54/0”
- Press 7, view “55/1”; release, view “55/0”
- Press 8, view “56/1”; release, view “56/0”
- Press 9, view “57/1”; release, view “57/0”
- Press *, view “58/1”; release, view “58/0”
- Press #, view “59/1”; release, view “59/0”
- Press <, view “128/1”; release, view “128/0”
- Press HOME, view “129/1”; release, view “129/0”
- Press >, view “130/1”; release, view “130/0”

To exit test mode, turn the radio off then back on.

Table 7 Test Environments, MT 2000, MTS 2000, and MTX Series Radios

NO. OF BEEPS	DISPLAY	DESCRIPTION	FUNCTION
1*	CSQ	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
2	HC	Hear Clear**	RX: unsquelch if carrier detected TX: compressed mic audio
3	TPL	Tone Private-Line	RX: unsquelch if carrier and tone (192.8Hz) detected TX: mic audio + tone (192.8Hz)
4	DPL	Digital Private-Line	RX: unsquelch if carrier and digital code (131) detected TX: mic audio + digital code (131) detected
5	TLS	Trunking Low Speed	RX: unsquelch if carrier detected TX: mic audio + connect tone (105.8Hz) @ correct deviation
6	THS	Trunking	RX: unsquelch if valid outbound signalling word (OSW) detected High Speed TX: 1500Hz tone
7	DTM multiple freq.	dual-tone	RX: unsquelch if carrier detected TX: selected DTMF tone pair
8	M12	MDC1200	RX: unsquelch if carrier detected without DOS (1800Hz); squelch if carrier detected with DOS (1800Hz) TX: 1500Hz tone
9	SEC	Secure***	RX: auto-coded clear TX: with key present - encrypted audio with key absent - constant unsquelch

* radios without display indicate function by emitting a number of beeps
** on 900 MHz radios only
*** on radios equipped with secure option
**** not available on all radios

Table 8 Test Frequencies, MT 2000, MTS 2000, and MTX Series Radios

TEST CHANNEL	VHF	UHF BAND 1	UHF BAND 2	800	900	R-BAND
TX #1	136.025	403.100	450.025	806.0125	896.0125	885.0125
RX #1	136.075	403.150	450.075	851.0625	935.0625	830.0125
TX #2	142.125	424.850	465.225	815.0125	899.0125	885.0125
RX #2	142.175	424.900	465.275	860.0625	938.0625	859.9875
TX #3	154.225	438.050	475.225	824.9875	901.9875	885.0125
RX #3	154.275	438.100	475.275	869.9375	940.9375	859.9875
TX #4	160.125	444.050	484.975	851.0125	935.0125	895.0125
RX #4	160.175	444.100	485.025	851.0625	935.0625	859.9875
TX #5	168.075	456.350	500.275	860.0125	938.0125	905.0125
RX #5	168.125	456.400	500.225	860.0625	938.0625	859.9875
TX #6	173.975	463.700	511.975	869.9875	940.9875	914.9875
RX #6	173.925	463.750	511.925	869.9375	940.9375	859.9875

Table 9 Receiver Performance Checks

TEST NAME	COMMUNICATIONS ANALYZER	RADIO	TEST SET	COMMENTS
Reference Frequency	Mode: PWR MON 4th channel test frequency◊ Monitor: Frequency error Input at RF In/Out	TEST MODE, 4 CSQ output at antenna	PTT to continuous during the performance check)	Frequency error to be ±150Hz
Rated Audio	Mode: GEN Output level: 1.0mV RF 4th channel test frequency◊ Mod: 1kHz tone at 3kHz deviation (1.5kHz deviation for 12.5kHz system) Monitor: DVM: AC Volts	TEST MODE, 4 CSQ	PTT to OFF (center), meter selector to Audio PA	Set volume control to 3.74Vrms
Distortion	As above, except to distortion	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12dB SINAD.	As above	PTT to OFF (center)	RF input to be < 0.35µV
Noise Squelch Threshold (only radios with conventional system need to be tested)	RF level set to 1mV RF	As above	PTT to OFF (center), meter selection to Audio PA, spkr/load to speaker	Set volume control to 3.74Vrms
	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	As above	Unsquelch to occur at < 0.25µV. Preferred SINAD= 8-10dB

◊ See Table 6 or Table 8 as applicable.

Table 10 Transmitter Performance Checks

TEST NAME	COMMUNICATIONS ANALYZER	RADIO	TEST SET	COMMENTS
Reference Frequency	Mode: PWR MON 4th channel test frequency◊ Monitor: Frequency error Input at rf In/Out.	TEST MODE, 4 CSQ	PTT to continuous (during the performance check).	Frequency error to be < 150Hz.
Power RF	As above.	As above, 4 CSQ	As above.	Refer to Maintenance Specifica tions page in front of manual.
Voice Modulation Δ	Mode: PWR MON 4th channel test frequency◊ atten to –70, input to RF In/Out, Monitor: DVM, AC Volts Set 1kHz Mod Out level for 0.025Vrms at test set, 80mVrms at AC/DC test set jack	As above, 4 CSQ	As above, mete selector to mic.	Deviation: VHF, UHF, and 800MHz: ≥ 3.6kHz but ≤ 5.0kHz.
Low-Speed Data Modulation 800/900 UHF	As above.	TEST MODE 4TLS output at antenna	PTT to continuous (during the performance check).	Deviation: UHF, 800MHz: ≥ 500Hz but ≤ 1000Hz.
Voice Modulation (internal) Δ	Mode: PWR MON 4th channel test frequency◊ atten to –70, input to RF In/Out.	TEST MODE, 4 CSQ, output at antenna.	Remove modulation input.	Press PTT switch on radio. Say “four” loudly into the radio mic. Measure deviation: VHF, UHF, and 800MHz: ≥ 3.8kHz but ≤ 5.0kHz. 900MHz: ≤ 2.5kHz.
High-Speed Data Modulation***	As above.	TEST MODE, 4 THS, output at antenna.	PTT to continuous (during the performance check).	Deviation: UHF and 800MHz: ≥ 2.4kHz but ≤ 3.6kHz. 900MHz: ≥ 1.52kHz but ≤ 1.95kHz.
DTMF Modulation	As above, 4th channel test frequency◊	TEST MODE, 4 DTMF, output at antenna.	As above.	Deviation: VHF, UHF, and 800MHz: ≥ 3.05kHz but ≤ 3.45kHz. 900MHz: ≥ 1.5kHz but ≤ 1.9kHz.
PL/DPL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to a conventional transmit frequency, BW to narrow.	Conventional coded squelch personality (clear mode operation). 4 TPL 4 DPL	As above.	Deviation: VHF, UHF, and 800MHz: ≥ 500Hz but ≤ 1000Hz. 900MHz: ≥ 250Hz but ≤ 500Hz.
Talk-around Modulation (radios with conventional, clear mode, talk-around operation only	Change frequency to conventional talk-around frequency. Mode: PWR MON deviation, attenuation to –70, input to RF In/Out Monitor: DVM, AC volts Mod: 1kHz Out level for 25mVrms at test set.	Conventional talk-around personality (clear mode operation). 1 CSQ	As above.	Deviation: UHF and 800MHz: ≥ 3.8kHz but ≤ 5.0kHz. 900MHz: ≥ 1.95kHz but ≤ 2.45kHz.
Talk-around Modulation (radios with conventional, secure mode, talk-around operation only (**)	Change frequency to conventional talk-around frequency. Mode: PWR MON deviation, attenuation to –70, input to RF In/Out Monitor: DVM, AC volts Mod: 1kHz Out level for 25mVrms at test set.	Conventional talk-around personality (secure mode operation). Load key into radio 1 Sec.	As above.	Deviation: UHF and 800MHz: ≥ 3.6kHz but ≤ 4.4kHz.

* 800 MHz radios only

** The secure mode, talk-around modulation test is only required for trac mode radios which do not have clearmode talk-around capability.

*** Trunked Only

Δ When testing voice modulation in the continuous mode, AGC must be disabled.

◊ See Table 6 or Table 8 as applicable.

Error-Code Displays

4

Power-up Display Codes

At 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 display. The presence of an error code should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors will inhibit user operation, while non-fatal errors will not. Use Table 11 to aid in understanding particular power-up error code displays.

Table 11 Power-up Display Codes

FAILURE DISPLAY		TYPE OF FAILURE	DESCRIPTION	POSSIBLE SOURCE
14-Character Display	6-Character Display			
ERROR 01/02	E01/02	NON-FATAL	External EEPROM checksum error	Bad external codeplug data
ERROR 01/12	E01/12	NON-FATAL	Internal EEPROM checksum error	Bad internal codeplug data
ERROR 09/10	E09/10	*NOTE:* Refer to the Secure Module Appendix “ERROR 09/10” section at the rear of this manual for more information.		
FAIL 01/81	F01/81	FATAL	External ROM/Flash checksum error	Bad ROM data, Defective ROM
FAIL 01/82	F01/82	FATAL	External EEPROM checksum error	Bad external codeplug data, Defective external EEPROM
FAIL 01/84	F01/84	FATAL	External EEPROM checksum blank	Unprogrammed external codeplug data
FAIL 01/88	F01/88	FATAL	External RAM error	Defective RAM
FAIL 01/90	F01/90	FATAL	Hardware failure	Defective IC
FAIL 01/92	F01/92	FATAL	Internal EEPROM checksum error	Bad internal codeplug data, Defective microcontroller
FAIL 01/93	F01/93	FATAL	Flashport security error	Improper RSS
FAIL 01/94	F01/94	FATAL	Internal EEPROM checksum blank	Unprogrammed internal codeplug data
FAIL 01/98	F01/98	FATAL	Internal RAM error	Defective microcontroller

NOTE: Due to the nature of fatal ROM and RAM errors, it may not be possible to present an error code on the display. In these cases the radio will attempt to display the appropriate error code, generate an illegal mode tone for one second and then reset its microcontroller.

Operational Display Codes

During operation, the radio performs dynamic tests to determine if it is working properly. Problems detected during these tests are presented as error codes on the radio display. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 12 to aid in understanding particular operational error code displays.

Table 12 Operational Display Codes

FAILURE CODE		DESCRIPTION	POSSIBLE SOURCE
14-Character Display	**6-Character Display**		
FAIL 001	F001	Synthesizer out of lock	Bad frequency data in codeplug; defective synthesizer
FAIL 002	F002	Selected Mode (Zone/Channel) codeplug checksum error	Bad codeplug data
FAIL 100	F100	Incompatible trunking software and hardware	Trunking hardware decoder disabled in codeplug; old SLIC IC version
FAIL 101	F101	Incompatible MDC1200 software and hardware	MDC 1200 hardware decoder disabled in codeplug; old SLIC IC version

Radio Alignment Procedure

5

General

An IBM PC (personal computer) and Radio Service Software (RSS) are required to align the 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 PC, RIB (radio interface box), and Universal Test Set as shown in Figure 1.

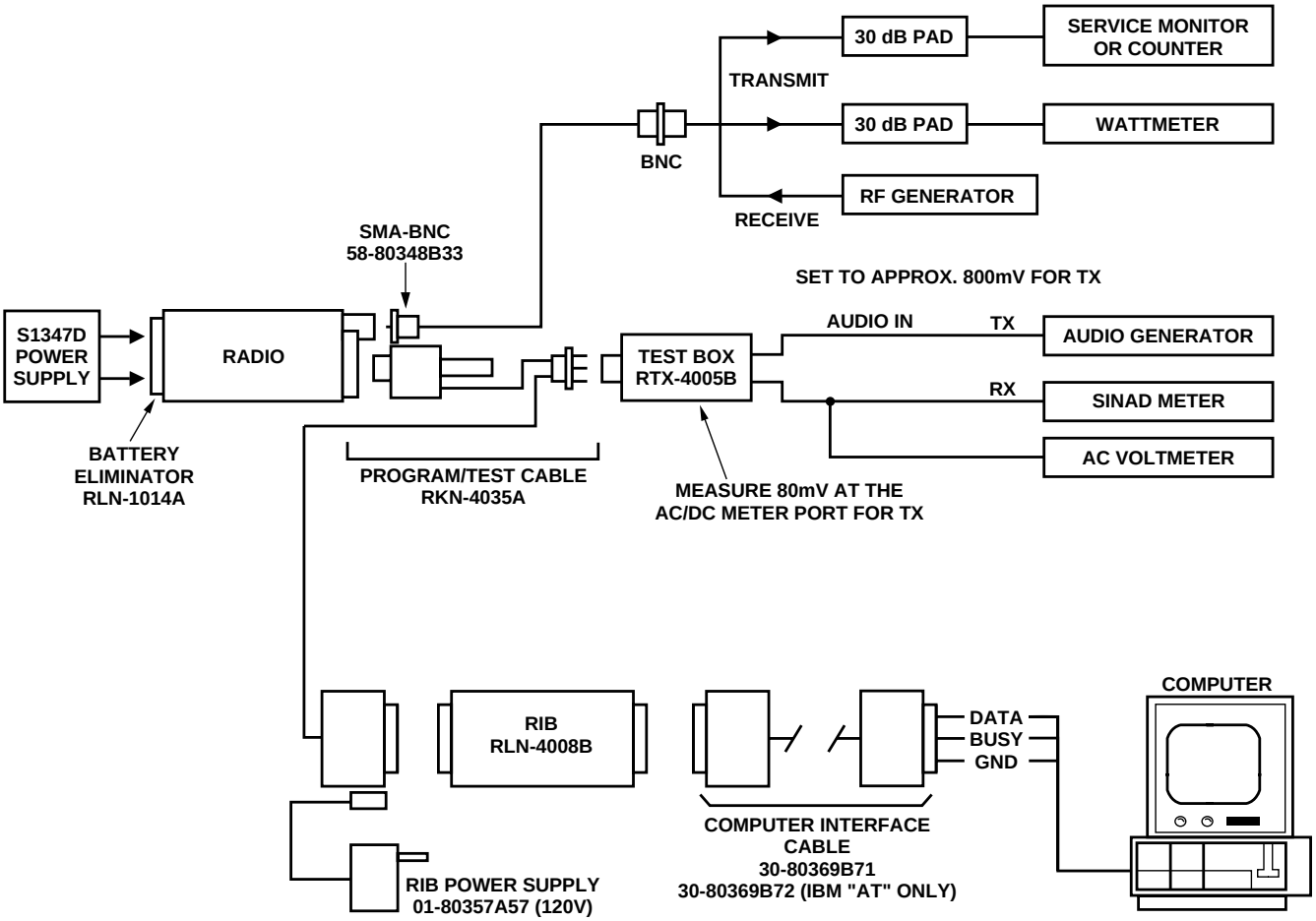


Figure 1 Radio Alignment Test Setup

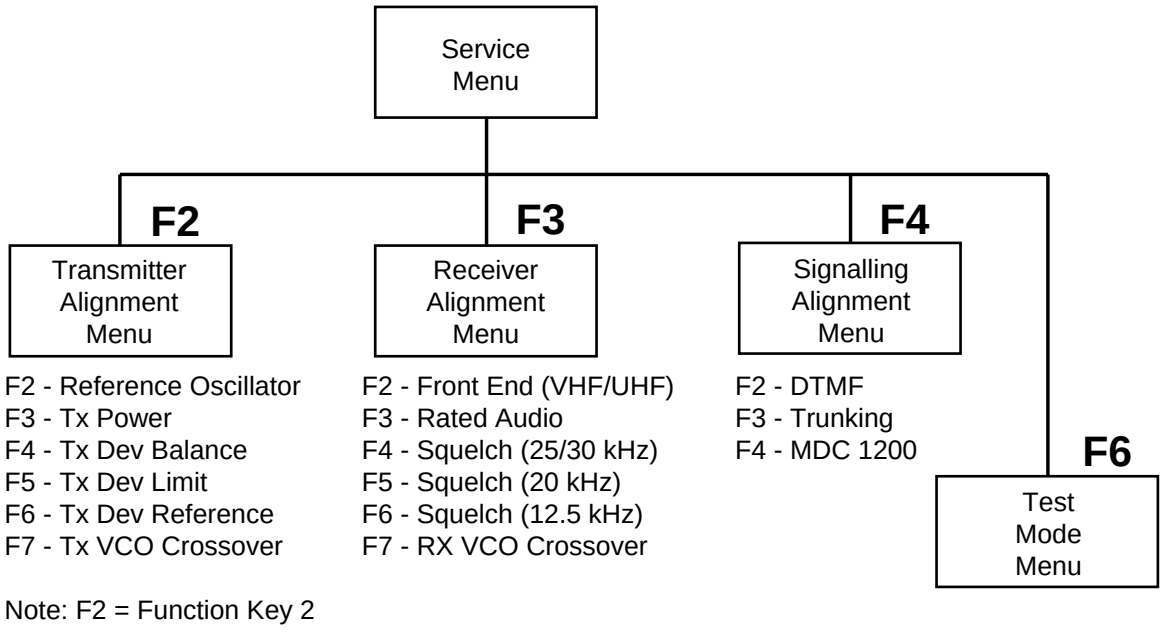


Figure 2 RSS Service Menu Layout

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

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. You will be prompted at each screen to save changed values before exiting the screen. RSS references in this manual are to HT 1000 / JT 1000 RSS. Some slight differences may be noted it you are using the MTS/MTX RSS.

Caution

Do NOT switch radios in the middle of any SERVICE procedure. Always use the EXIT key to return to the MAIN menu screen before disconnecting the radio. Improper exits from the SERVICE screens may leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

The radio contains internal test modes that can be accessed from the RSS. The test modes permit the service technician to easily select various frequency, modulation, and transmit power combinations to verify proper operation of the radio. The test modes can be used to check both transmit and receive operation. From the Service Menu press F6 to navigate to the TEST MODE screen.

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 3.

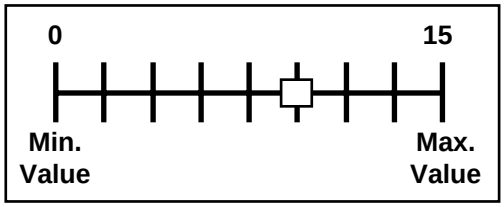


Figure 3 Softpot Concept

Adjusting the softpot value sends information to the radio to increase (or decrease) a DC voltage in the corresponding circuit. For example, pressing the UP arrow key at the Reference Oscillator screen instructs the radio microprocessor to increases the voltage across a varactor in the reference oscillator to increase the frequency.

In ALL cases, the softpot value is just a relative number corresponding to a D/A (Digital-to-Analog) generated voltage in the radio. All standard measurement procedures and test equipment are similar to previous radios.

Perform the following procedures in the sequence indicated.

Reference Oscillator Alignment

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

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F2 again to select the REFERENCE OSCILLATOR softpot.
3. Press F6 to key the radio. The screen will indicate that the radio is transmitting.
4. Measure the transmit frequency on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the reference oscillator per the targets shown in Table 13.

Table 13 Reference Oscillator Alignment

BAND	TARGET
VHF	0 to 300 Hz
UHF	0 to 300 Hz
800/900 MHz	0 to 300 Hz

Front-End Pre-Selector (VHF/UHF only)

NOTE: This procedure is only required for tuning the front-end filter varactors in the VHF and UHF models. The 800 and 900 MHz models utilize a stripline pre-selector.

1. Set the Test Box (RTX4005B) meter selection switch to the "VOL" position, and connect a dc voltmeter capable of 1mV resolution on a 2V scale to the Test Box AC/DC meter port to monitor the Received Signal Strength Indicator (RSSI).
2. From the SERVICE menu, press F3 to select RECEIVER alignment.
3. Press F2 to select the FRONT END FILTER softpot. The screen will indicate the receive frequencies at which the filter is to be tuned.
4. Set the RF test generator to the first receive frequency +150 Hz. Set the RF level at the radio standard antenna port to 4.0 µVolts with no modulation.
5. Adjust the UP/DOWN arrow keys to obtain a peak voltage on the dc voltmeter.
6. Press F8 to program the softpot value.
7. Repeat steps 4-6 for the remaining test frequencies.
8. Press F10 and F2 to return to the RECEIVER menu.

Rated Audio

1. Set test box (RTX-4005B) meter selection switch to the "AUDIO PA" position and connect an ac voltmeter to the test box ac/dc meter port.
2. Press F3 to select the RATED AUDIO softpot. The screen will indicate the receive test frequency to be used.
3. Set the RF test generator to the receive test frequency, and set the RF level at the radio standard antenna port to 1 mV modulated with standard test modulation (see Table 14).

Table 14 Standard Test Modulation (1 kHz Tone)

Band	Deviation
VHF/UHF/800 MHz	3.0 kHz
900 MHz	1.5 kHz

4. Adjust the UP/DOWN arrow keys to obtain rated audio (as close as possible to 3.74 Vrms) into a speaker (28 ohms) or equivalent resistive load.
5. Press F8 to program the softpot value.
6. For HearClear-equipped radios, go to step 7; otherwise press F10 to return to the RECEIVER menu.
7. Now set the RF test generator to the receive test frequency, and set the RF level at the radio standard antenna port to 1 mV modulated with a 1kHz tone, 1.2kHz deviation.

8. Select the Hear Clear RATED AUDIO softpot, and adjust the UP/DOWN arrow keys to obtain rated audio (3.74 Vrms) into a speaker (28 ohms) or equivalent resistive load.
9. Press F8 to program the softpot value.
10. Press F10 to return to the RECEIVER menu.

Squelch

NOTE: Verify that audio output is set to rated audio (3.74 Vrms)

1. Select the 25kHZ squelch tuning menu. (note: 25 kHZ must be tuned before tuning either 12.5kHZ or 20kHZ squelch).
2. With no signal applied, decrease the softpot value until squelch opens. Set the RF test generator to the frequency plus the following offset; (VHF: +200HZ), (UHF: +200HZ), (800MHZ: +500HZ). Adjust the generator for 8 to 10 dB Sinad.
3. Increase the softpot until the squelch closes.
4. Monitor for squelch chatter. If chatter is present, increase the softpot until no chatter is detected. Press F8 to program the softpot value. Press ENTER to select the next softpot adjustment.
5. Repeat step 2 through 4 for all test frequencies shown on the screen.
6. If you are using 25kHZ channel spacing, skip to step 8. Otherwise, go into the 12.5kHZ or 20kHZ squelch tuning menus.
7. Repeat steps 2 through 5.
8. Press F10, then F10 again to return to the service menu.

Transmitter Power

VHF and UHF radios require two power-level adjustments, a high-power or rated-power adjustment, and a low-power adjustment. The low power adjustment is required since the radio may be used in a reduced power mode, or with a vehicular adapter.

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

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F3 to select the TRANSMIT POWER softpot. The screen will indicate the transmit test frequencies to be used.
3. Begin with the highest test frequency shown.
4. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the transmit power per the value shown in Table 15.
5. Press F6 to dekey the radio, and then press F8 to program the value.
6. Repeat steps 4 and 5 for the remaining test frequencies.
7. Press F10, then F2 to return to the TRANSMIT menu.

Table 15 Transmit Power Setting

VHF			**UHF**		
Power Level	Test Frequencies		Power Level	Test Frequencies	
	136 - 174MHz	177.975MHz		450 - 512MHz	512 - 520MHz
5 W	5.2 - 5.4	4.2 - 4.4	**4 W**	4.2 - 4.4	3.2 - 3.4
1 W	1.2 - 1.4	1.2 - 1.4	**1 W**	1.2 - 1.4	1.2 - 1.4
800 MHz			**900 MHz**		
Power Level	All Test Frequencies		Power Level	All Test Frequencies	
3 W	3.2 - 3.4		**2.4 W (Typ.)** **2.9 W (Max.)**	2.4 - 2.6	

Transmit Deviation Balance (Compensation)

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 signalling schemes that have very low frequency components (e.g. DPL) and could result in distorted waveforms if improperly adjusted.

NOTE: Disable all audio band filters on the service monitor.

NOTE: (Secure-Equipped Radios Only)
If a secure module is currently installed in the radio being aligned, refer to the appendix at the rear of this manual. Read section III, “Secure Alignment Procedure”, before performing the transmit deviation balance (compensation) procedure.

1. Press F4 to select the TRANSMIT DEVIATION BALANCE softpot. The screen will indicate the transmit test frequencies to be used.
2. Begin with the lowest test frequency shown on the screen.
3. Set the Test Box (RTX4005B) meter selector switch to the “MX DISC” position, and inject an 80Hz tone at 100mVrms into the AC/DC MTR port. Keep the ac voltmeter in parallel to ensure the proper input signal level.
4. Press F6 to key the radio, and measure deviation. Record this measurement.
5. Change the input tone to 3 kHz, 100mVrms and use the UP/DOWN arrow keys to adjust the deviation to within ±2% of the value recorded in step 4.
6. Change the input tone back to 80 Hz and measure the deviation.
7. Repeat steps 5 and 6 until the 3kHz tone deviation is within ±2% of the 80Hz tone deviation.
8. Press F6 to dekey the radio, and press F8 to program the softpot value. Press ENTER to move to next softpot value.

9. Repeat steps 3 through 8 for the remaining test frequencies.
10. Press F10 to return to the TRANSMIT menu.

NOTE: The step size change for step 5 is approximately 2.5% per softpot value. This adjustment should only be made to the 3kHz deviation. Do not adjust the 80Hz deviation.

Transmit Deviation Limit

1. Press F5 to select the TRANSMIT DEVIATION LIMIT softpot. The screen will indicate the transmit test frequencies to be used.
2. Begin with the lowest test frequency shown on the screen.
3. With the meter selector switch (RTX4005B) set to MIC, inject a 1kHz tone on the AUDIO IN terminal on the test set, 80mVrms as measured on the AC/DC MTR port.
4. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the deviation per the values shown in Table 16.

Table 16 Transmit Deviation Limit

BAND	Deviation (KHz)
VHF/UHF/800 MHz	4.30 - 4.60
900 MHz	2.20 - 2.30

5. Press F6 to dekey the radio, and press F8 to program the softpot value. Press ENTER to move to the next softpot value.
6. Repeat steps 3-5 for the remaining frequencies shown on the screen.
7. Press F10 to return to the TRANSMIT menu.

Transmit Deviation Limit Reference

NOTE: This procedure is required for VHF, UHF, and 800 MHz models with 20kHz channel spacing and VHF and UHF models with 12.5kHz channel spacing. This procedure is not required for 900MHz models.

1. Press F6 to select the TRANSMIT DEVIATION LIMIT REFERENCE softpot.
2. With the meter selector switch (RTX4005B) set to MIC, inject a 1kHz tone on the AUDIO IN terminal on the test set, 80mVrms as measured on the AC/DC MTR port.
3. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the deviation per Table 17.

Table 17 Transmit Deviation Limit Reference

Channel Spacing	Deviation (kHz)
20 KHz	3.40 - 3.60
12.5 KHz	2.20 - 2.30

4. Press F6 to dekey the radio, and press F8 to program the softpot value.
5. Press F10 to return to the TRANSMIT menu.

VCO Crossover Frequency

NOTE: This procedure is only required after the field repair of a VHF or UHF VCO.

In order for a phase-locked-loop to tune very wide bandwidths, both negative and positive control voltages (Vcntl) are required. This procedure sets the crossover frequency at which the negative Vcntl (or –Vee) switches from zero to negative.

Transceiver Board Identification

VHF Radios

VHF transceiver board NUD7070 and NUD7085 (“C” and later) kits include new VCO varactors, and are factory aligned with a new transmit VCO crossover frequency of 164.850MHz.

Since the transmit crossover frequency has changed, whenever transmit VCO crossover alignment (an RSS function) is performed, circuit board identification will be important. The “C” kits can be identified by the circuit board number 5511Y02 or 5511Y32 visible on side 2 of the board, located along the circuit board edge just next to crystal filter FL1. All future VHF transceiver boards will be in the “5511Y” series.

Anytime a controller board or transceiver board is replaced in a radio, it will be necessary to perform the RSS transmit VCO crossover alignment, and check the transmit VCO crossover frequency. The RSS screen for this alignment will show a “current value” box with a frequency already assigned, placed inside the box. When performing transmit VCO crossover alignment, first check the transceiver circuit board number. In a VHF radio:

- If the board number is any “5511Y” series number, other than 5511Y01 or 5511Y31, the transmit VCO crossover frequency in the “current value” box should be 164.850MHz. If it is not, change it to 164.850MHz.
- If the board number is 5511Y01, 5511Y31 or any other number not in the 5511Y series, the transmit VCO crossover frequency in the “current value” box should be 161.50500MHz. If it is not, change it to 161.50500MHz.

VCO varactors (CR201, 202, and 203) in “C” and later kits are not interchangeable with VCO varactors in earlier kits; Motorola parts and part numbers are different. When replacing a VCO varactor, Identify the transceiver board and order replacement parts from the applicable parts list.

UHF, 403-470MHz Radios

UHF transceiver board (403 - 470MHz band split) NUE7231 and NUE7240 (“C” and later) kits include new VCO varactors, and are factory aligned with a new transmit VCO crossover frequency of 449.500MHz.

Since the transmit crossover frequency has changed, whenever transmit VCO crossover alignment (an RSS function) is performed, UHF band split and circuit board identification will be important.

- UHF band split can positively be determined by checking the markings on the power amplifier shield. If the power amplifier shield marking is 25U04 or 85Y10, then the transceiver is a 403 - 470MHz band split. If the power amplifier shield marking is 25U05 or 85Y11, then the transceiver is a 450 - 520MHz band split.
- The “C” kits can be identified by the circuit board number 4221J07 or 4221J37 visible on side 2 of the board, located along the circuit board edge just next to crystal filter FL1. All future UHF transceiver boards will be in the “4221J” series.

Anytime a controller board or transceiver board is replaced in a radio, it will be necessary to perform the RSS transmit VCO crossover alignment, and check the transmit VCO crossover frequency. The RSS screen for this alignment will show a “current value” box [ ] with a frequency already assigned, placed inside the box. When performing transmit VCO crossover alignment, determine the UHF transceiver band split, and then check the transceiver circuit board number. In a UHF radio (403 - 470MHz range):

- If the board number is any “4221J” series number, other than 4221J01 thru 4221J06 or 4221J36, the transmit VCO crossover frequency in the “current value” box should be 449.500MHz. If it is not, change it to 449.500MHz.
- If the board number is 4221J01 thru 4221J06, 4221J36, or any other number not in the 4221J series, the transmit VCO crossover frequency in the “current value” box should be 438.025MHz. If it is not, change it to 438.025MHz.

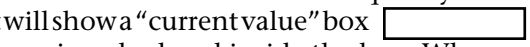
VCO varactors (CR201, 203, 207, 208, and 209) in “C” and later kits are not interchangeable with VCO varactors in earlier kits; Motorola parts and part numbers are different. When replacing a VCO varactor, identify the UHF transceiver band split and the transceiver circuit board number, and then order replacement parts from the applicable parts list.

UHF, 450-520MHz Radios

UHF transceiver board (450 - 520MHz band split) NUE7232 and NUE7241 (“C” and later) kits include new VCO varactors, and are factory aligned with a new transmit VCO crossover frequency of 495.375MHz.

Since the transmit crossover frequency has changed, whenever transmit VCO crossover alignment (an RSS function) is performed, UHF band split and circuit board identification will be important.

- UHF band split can positively be determined by the markings on the power amplifier shield. If the power amplifier shield marking is 25U04 or 85Y10, then the transceiver is a 403 - 470MHz band split. If the power amplifier shield marking is 25U05 or 85Y11, then the transceiver is a 450 - 520MHz band split.
- The "C" kits can be identified by the circuit board number 4221J07 or 4221J37 visible on side 2 of the board, located along the circuit board edge just next to crystal filter FL1. All future UHF transceiver boards will be in the "4221J" series.

Anytime a controller board or transceiver board is replaced in a radio, it will be necessary to perform the RSS transmit VCO crossover alignment, and check the transmit VCO crossover frequency. The RSS screen for this alignment will show a "current value" box  with a frequency already assigned, placed inside the box. When performing transmit VCO crossover alignment, determine the UHF transceiver band split, and then check the transceiver circuit board number. In a UHF radio (450 - 520MHz range):

- If the board number is any "4221J" series number, other than 4221J01 thru 4221J06 or 4221J36, the transmit VCO crossover frequency in the "current value" box should be 495.375MHz. If it is not, change it to 495.375MHz.
- If the board number is 5521Y03, the transmit VCO crossover frequency in the "current value" box should be 486.025MHz. If it is not, change it to 486.025MHz.

VCO varactors (CR201, 203, 207, 208, and 209) in "C" and later kits are not interchangeable with VCO varactors in earlier kits; Motorola parts and part numbers are different. When replacing a VCO varactor, identify the UHF transceiver band split and the transceiver circuit board number, and then order replacement parts from the applicable parts list.

TX VCO Crossover Procedure

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F7 to select the TRANSMIT VCO CROSSOVER softpot. The screen will indicate the transmit test frequency to be used.
3. Connect a dc voltmeter capable of 1mV resolution to test point 5 (TP5), which is accessible through a hole in the bottom side VCO circuitry shield.
4. Beginning with the default softpot frequency of line 2, press F6 to key the transmitter, and adjust the UP/DOWN arrow keys until the voltage reading at TP5 is 3.0 ±0.1 volts. The frequency will increment in steps of 50kHz.
5. Press F6 again to dekey the transmitter, and press F8 to program the softpot value.
6. Press F10 twice to return to the SERVICE menu.

RX VCO Crossover Procedure

1. From the SERVICE menu, press F3 to select RECEIVER alignment.
2. Press F5 to select the RECEIVE VCO CROSSOVER softpot. The screen will indicate the receive test frequency to be used.
3. Connect a dc voltmeter capable of 1mVolt resolution to test point 5 (TP5), which is accessible through a hole in the bottom side VCO circuitry shield.
4. Beginning with the default softpot frequency of line 2, adjust the UP/DOWN arrow keys until the voltage reading at TP5 is 3.0 ±0.1volts.
5. Press F8 to program the softpot value.
6. Press F10 twice to return to the SERVICE menu.

Signalling Deviation

Transmit deviation balance compensation and transmit deviation limit adjustments should be completed before signalling deviation is adjusted.

DTMF Tuning

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F2 to select the DTMF softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the DTMF deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the DTMF deviation per Table 18.
6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 to return to the SIGNALLING menu.

High Speed Signalling

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F3 to select the TRUNKING HIGH SPEED softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the TRUNKING HIGH SPEED deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the TRUNKING HIGH SPEED deviation per Table 18.

Table 18 Signalling Deviation

Channel Spacing (kHz)	DTMF	High Speed	MDC	Single Tone
25 / 30	3.05-3.45	2.5-3.5	3.40-3.75	3.0-4.0
20 (VHF/UHF)	2.44-2.76	2.0-2.8	2.6-3.0	2.4-3.2
20 (821-824, 866-869)	2.44-2.76	2.0-2.8	2.6-3.0	2.4-3.2
12.5	1.55-1.85	1.40-1.75	1.640-1.875	1.5-2.0

6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 to return to the SIGNALLING menu.

MDC 1200

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F4 to select the MDC softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the MDC deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the MDC deviation per Table 18.
6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 twice to return to the SERVICE menu.

Alignment Procedure Conclusion

The radio alignment procedure is now complete; the radio may be disconnected and returned to service.

Disassembly and Reassembly

6

Caution

THIS RADIO CONTAINS STATIC-SENSITIVE DEVICES. DO NOT OPEN THE RADIO UNLESS PROPERLY GROUNDED. TAKE THE FOLLOWING PRECAUTIONS WHEN WORKING ON THIS UNIT.

1. Store and transport all complementary metal-oxide semiconductor (CMOS) devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS devices into conventional plastic “snow” trays used for storage and transportation of other semiconductor devices.
2. Ground the working surface of the service bench to protect the CMOS device. We recommend using the Motorola Static Protection Assembly (part number 0180386A82), which includes a wrist strap, two ground cords, a table mat, and a floor mat.
3. Wear a conductive wrist strap in series with a 100k resistor to ground. Replacement wrist straps that connect to the bench top covering are Motorola part number RSX-4015.
4. Do not wear nylon clothing while handling CMOS devices.
5. Neither insert nor remove CMOS devices with power applied. Check all power supplies that are to be used for testing CMOS devices to be certain that there are no voltage transients present.
6. When straightening CMOS pins, provide ground straps for apparatus used.
7. When soldering, use a grounded soldering iron.
8. If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

General

Since this product disassembles and reassembles without the use of any screws, it is important for the technician to pay particular attention to the snaps and tabs, and how parts align with each other.

NOTE: In the disassembly/reassembly procedure, the numbers in parentheses refer to call-out numbers in the referenced figures.

Disassembly to Board Level

1. Turn off the radio.
2. Remove the battery (see Figure 4).
   a. Hold the radio such that the battery is tilted down.
   b. Press down on the two battery-release levers.
   c. With the release levers pulled down, the top of the battery will fall away from the radio.
   d. Remove the battery completely from the radio.

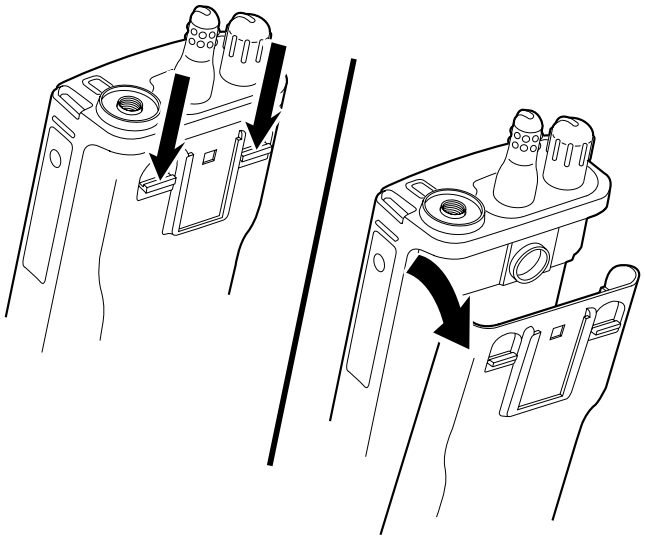


Figure 4 Removing the Battery

3. Loosen the antenna by turning it in a counterclockwise direction, and remove it from the radio.
4. Remove the volume on/off knob and the channel selector switch knob by pulling them off their respective switch shafts.

   NOTE: Both knobs slide on and off but fit very snug on their respective switch shafts. A small flat blade screwdriver may be necessary to help pry the knobs loose. Take care not to mar the surrounding radio surface.

5. Separate the front cover assembly from the internal electronics (chassis) (see Figure 5).
   a. Insert the chassis/front cover separation tool (Motorola part no. 6680334E07) or like instrument in the slotted area at the bottom center of the radio. Take care not to mar the O-ring sealing area on the housing.

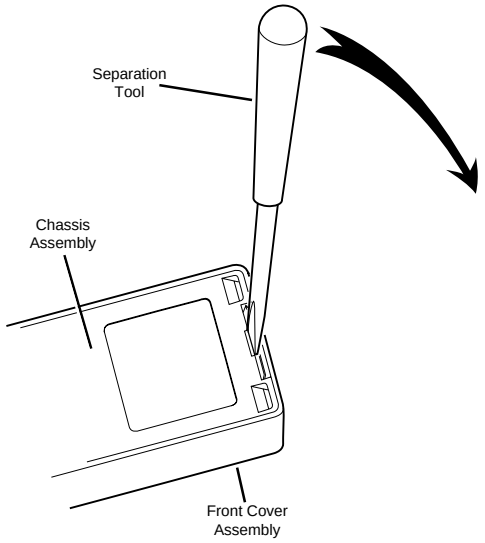


Figure 5 Separating the Cover From the Chassis

b. Pry the bottom of the chassis free from the cover by pushing the separation tool down and rotating the handle of the separation tool over and behind the base of the radio. This prying action forces the thin inner plastic wall toward the base of the radio, which releases the two chassis base tabs.

NOTE: A flexible ribbon cable (front cover/display flex), which connects to the front cover assembly and the chassis, keeps you from completely separating the two units.

c. Lay the chassis down, and rotate the front cover back and partially away from the chassis (see Figure 6).

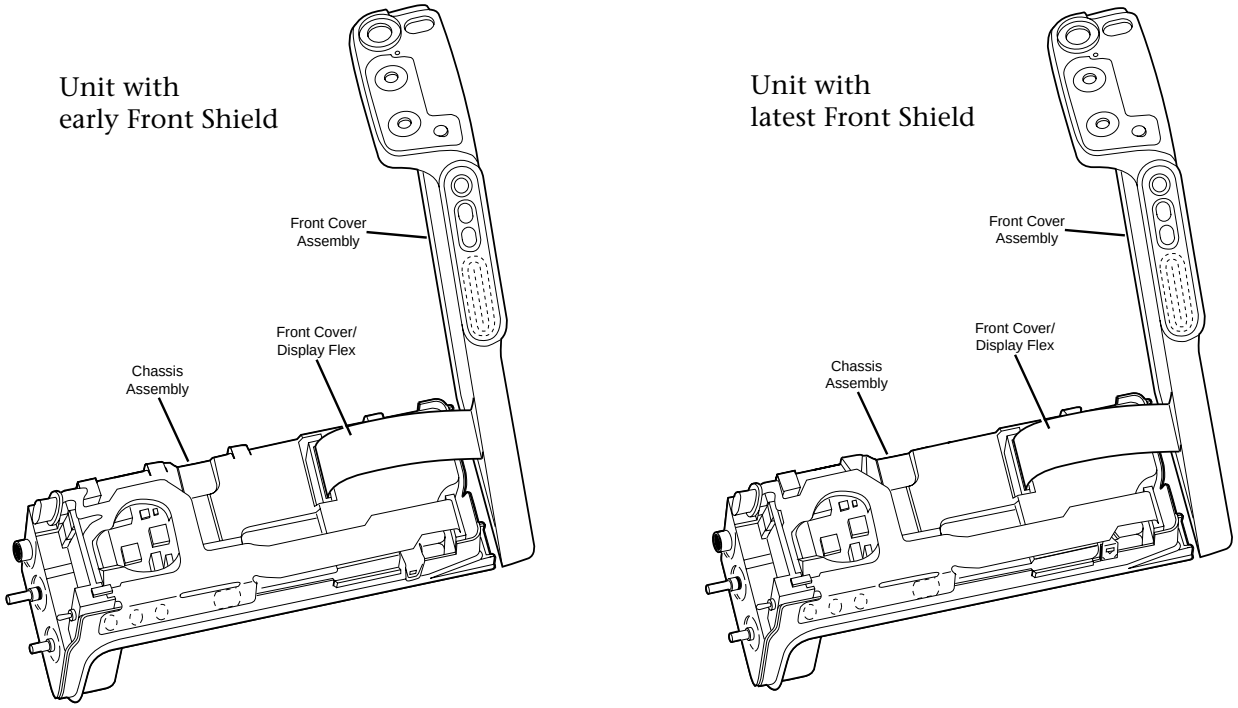


Figure 6 Rotating the Front Cover

6. Disconnect the front cover display flex from the connector on the chassis.

   NOTE: A special locking connector secures the flex to the chassis (see Figure 7).

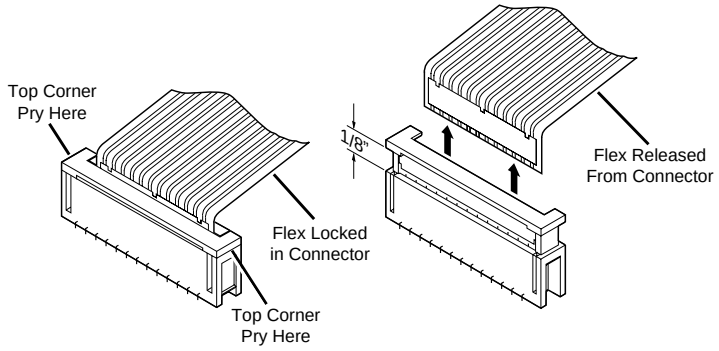


Figure 7 Disconnecting the Flex

   a. Use the flex connector opening tool, large curved end (Motorola part no. 6680334E08), or like instrument to help raise the sliding portion of the connector approximately 1/8 of an inch from its seated position. A slight prying action will achieve the best results for unlocking the connector.

   b. Remove the flex from the chassis connector.

7. Remove the contoured O-ring/antenna bushing seal from the chassis.

8. Disconnect the controls flex from the connector on the controller board by following the procedure in step 6a and 6b.

   NOTE: A large portion of the controls flex is attached to the large metal shield (front shield) with adhesive. Do not remove the controls flex from the front shield.

9. As a unit, separate the control top, the front shield, and the controls flex from the chassis and circuit boards (see Figure 8).

   NOTE: Three locking clips (four tabs on early front shield) secure the front shield to the chassis and hold the RF board and the controller board in the chassis.

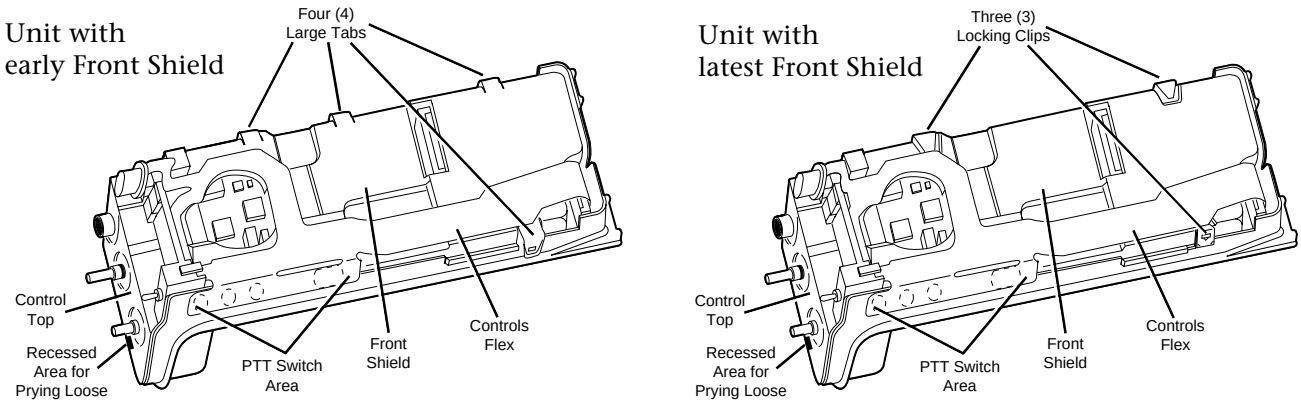


Figure 8 Separating Control Top From the Chassis

a. Loosen the front shield by prying each of the three clips (four tabs on early front shield) away from the chassis. Be careful not to pry the clips/tabs any more than is necessary to free them from their respective retaining slots. To completely loosen the shield from the chassis, a slight lifting and clockwise twisting action may be required.

b. Insert a small, flat-blade screwdriver in the recessed area of the control top and pry the control top slightly away from the chassis.

c. Completely remove the control top/front shield/controls flex unit from the chassis.

10. Carefully remove the RF board and the controller board from the chassis.

NOTE: The RF board and the controller board are connected together with a stiff connector strip (P301/P704. See Figure 9.

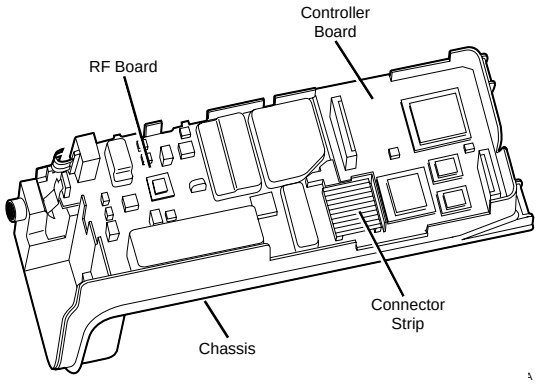


Figure 9 Removing the RF and Controller Boards

Disassembly of Control Top

1. Remove the rubber controls seal from the control top.
2. Turn the control top such that the grey switch housing cover is facing up.

a. Five retaining clips hold the switch housing cover to the switch housing. Clips 1, 2, and 3 are important during disassembly (see Figure 10).

NOTE: To perform step 2b, two tools will be required; your thumbnail or small, flat-blade screwdriver, and a pen, pencil, or another small, flat-blade screwdriver.

b. Using your thumbnail or small, flat-blade screwdriver, lift the tab that covers the base of the LED approximately 1/16 of an inch from its seated position. While applying constant lifting pressure there, (in order) release clips 1, 2, and 3 with the other tool.

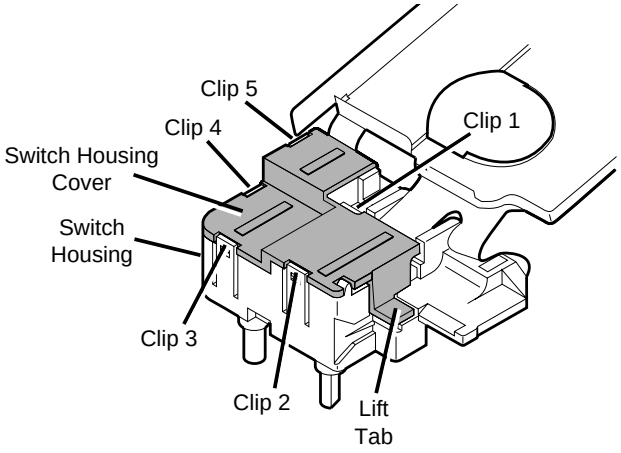


Figure 10 Switch Housing Retaining Clips

c. The cover will pop loose from the switch housing.

3. Push the three switches and the LED out of the switch housing.
4. The remainder of the controls flex is attached to the switch housing with adhesive. Do not remove the flex from the switch housing unless it is absolutely necessary.

Disassembly of Front Cover Assembly

1. On top display model radios only, release the display board by using a "press and pull" action on the top two corners of the display board. Press down on the two top corners of the display board and pull the top of the board away from the two corner retaining tabs. The display board will free itself from the retaining tabs and two retaining slots in the front cover housing.
2. Remove the wedge connector (part of the front cover flex, located behind the universal connector), by sliding it out of the plastic rails that hold it in place. A slight prying action, alternating back and forth on the bottom corners of the connector, achieves the best results. Be careful not to damage the spring contacts on the wedge.
3. Remove the speaker retainer bracket, speaker, microphone, and front cover flex from the front cover housing (see Figure 11).

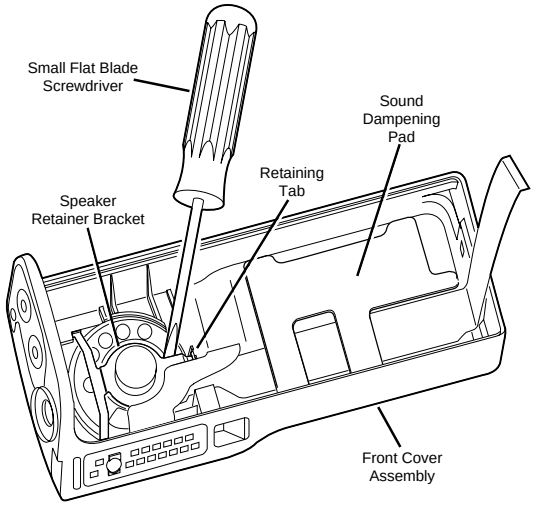


Figure 11 Removing the Speaker and Flex From the Front Cover

NOTE: The speaker and front cover flex are held in position with a three-leg retainer bracket. The legs of the bracket are secured by slots in the front cover. When removing the retainer bracket, use caution not to damage the speaker.

a. Disengage the retainer bracket leg that points toward the bottom of the front cover from its retaining tab.

   (1) Insert a small, flat-blade screwdriver under the base of the bracket leg near the ring.

   (2) Lift the bracket leg until it pops loose from under its retaining tab.

b. Lift the freed leg of the retainer bracket and use it to pull the remaining two legs of the bracket out and away from their respective slots in the front cover housing.

c. Pull the rubber microphone boot, containing themicrophone, from its seated position. Unless you are replacing the microphone, leave the microphone in the boot.

4. Remove, if necessary, and replace the sound dampening pad.

5. As necessary, replace the speaker and/or microphone while out of the front cover housing.

   NOTE: If the microphone is replaced, ensure that the microphone is reinstalled back into the rubber boot with the microphone port facing the round hole at the bottom of the boot.

6. On front display model radios only, notice that the keypad/display board is secured to the front cover housing using six tabs, three small tabs on one side and three larger tabs on the universal connector side. Remove the keypad/display board by inserting a small flat-blade screwdriver in the circuit board slot provided (slot nearest the top retaining tab on the universal connector side of the radio, see Figure 12). A slight prying action will release the keypad/display board. If applicable, remove the rubber keypad.

   NOTE: Be careful not to mar the front cover housing O-ring sealing area. Doing so will compromise the sealing integrity of the radio.

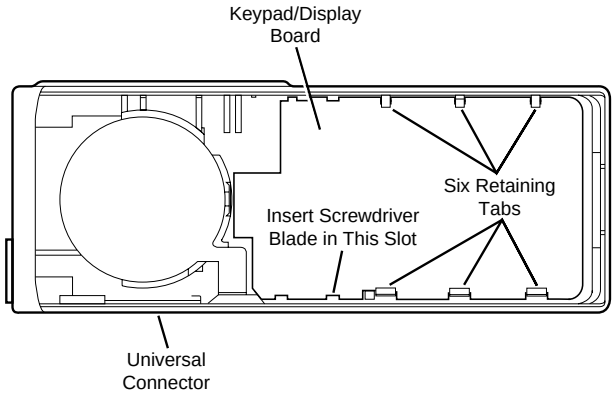


Figure 12 Removing the Keypad/Display Board

Reassembly

Reassembly is the reverse of disassembly. Some suggestions and illustrations are provided to help you more easily reassemble the radio.

Keypad/Display Board (front display model radios only)

1. If applicable, replace the rubber keypad.
2. Place the keypad/display board into the front cover housing at an angle such that the three small slots on the edge of the board slide under the three mating retaining tabs. Ensure that the board slides under the tabs.
3. Near the three larger slots on the other side of the board, use finger pressure to push and press that side of the board down until it snaps into place under the three large retaining tabs.

Front Cover Assembly

1. Place the speaker and microphone into their respective positions in the front cover. Make sure that the speaker is seated properly in the recessed area provided.
2. Press the rubber microphone boot into its respective recessed area in the front cover housing. The little rubber flap in the back of the rubber boot should fold up to cover the microphone insertion opening.
3. Reinstall the speaker retainer bracket (see Figure 13).

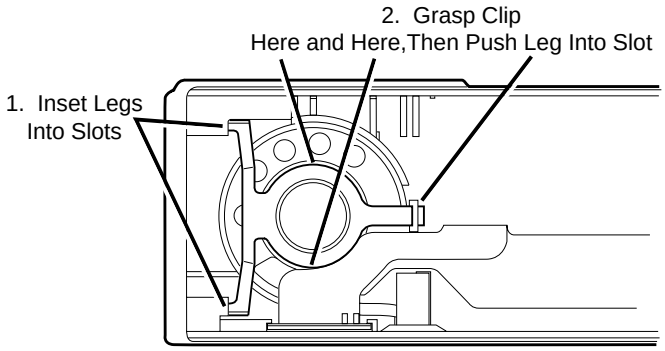


Figure 13 Reinstalling the Speaker Retainer Bracket

   a. Position the spring bracket over the speaker, and toward the top of the front cover housing; insert the appropriate two legs of the bracket into their respective slots.
   b. Grasp the center portion of the spring bracket (ring area) with thumb and forefinger.
   c. While holding the ring area of the spring bracket at approximately the same height as the speaker's base, push the remaining leg down and into its respective slot.
4. Orient the wedge connector so that its gold contacts face the gold contacts of the housing. Align the wedge connector with the respective slots in the housing, and slide the connector down into place. Ensure that the wedge connector is fully seated into position.

5. On top display model radios only, seat the display board by inserting the two display board tabs into their mating slots in the front cover housing. Push the top of the display board toward the top of the radio until the front cover housing retaining tabs engage the display board and secure it into position.

Chassis

Inside of the chassis where the RF board fits is a protruding block that functions as the PA heatsink. To help provide maximum heat transfer, ensure that the PA heatsink block (top surface) includes a thermal pad (Motorola part number 7505922Z01) adhered to it.

Place the RF board and controller board into the chassis. Ensure that the plastic cover that more rigidly holds the two boards together is snapped into place.

Control Top

1. Reinstall the switches and LED into the switch housing.
2. Reinstall the switch housing cover onto the switch housing by sliding tabs 4 and 5 of the cover into their respective clips on the housing. Then press down on the cover to engage tabs 1, 2, and 3.

Control Top/ Front Shield/ Controls Flex as a Unit to Chassis

1. Slide the control top into the appropriate position in the chassis, and place the front shield into position over the chassis and circuit boards.
2. Check to see that the three clip recesses (four large tabs on early front shield) of the front shield are aligned with the respective slots on the sides of the chassis, then snap the front shield in place. Ensure that the shield is fully seated, especially in the PTT switch area.
3. **a. Units using early front shield with tabs (no separate clips), skip step three (3); proceed to step four (4).**
   b. Units using latest front shield with separate clips – Insert clip 1 (Motorola part number 4285350C01) onto front shield by orienting clip stamped “1” with front shield recess stamped “1”. Insert the narrow hook end of the clip into the slot of the front shield. While keeping the clip hook in to the front shield slot, press the bent portion of the clip toward the front shield until it snaps into place. The two remaining clips (Motorola part number 4285350C02) are stamped “2”. Insert these clips into the recessed areas on the front shield stamped “2”, and snap them into place as was done with clip stamped “1”.
4. Slide the connector end of the controls flex into the special locking connector mounted on the control board. Ensure that the flex is fully seated into the board connector and secure the connection.

   NOTE: View the flex connection at a slight angle from the bottom of the radio (see Figure 14). If the flex is fully seated, the orange circuit plating will be parallel with the connector top surface and three reliefs in the plating will make the flex plating appear to be separated. If the orange plating of the flex is not parallel with the connector's top surface, or the three reliefs

are raised enough to see plating under them, then the flex is not fully seated.

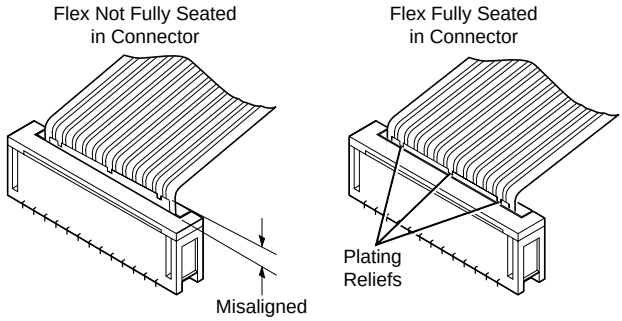


Figure 14 Seating the Flex

5. Reinstall the rubber controls top seal on the control top.

   NOTE: Two tabs are provided in the emergency button area to help hold the seal in place.

Front Cover Assembly to Chassis

1. Install the contoured O-ring/antenna bushing seal around the antenna and in the groove provided (see Figure 15).

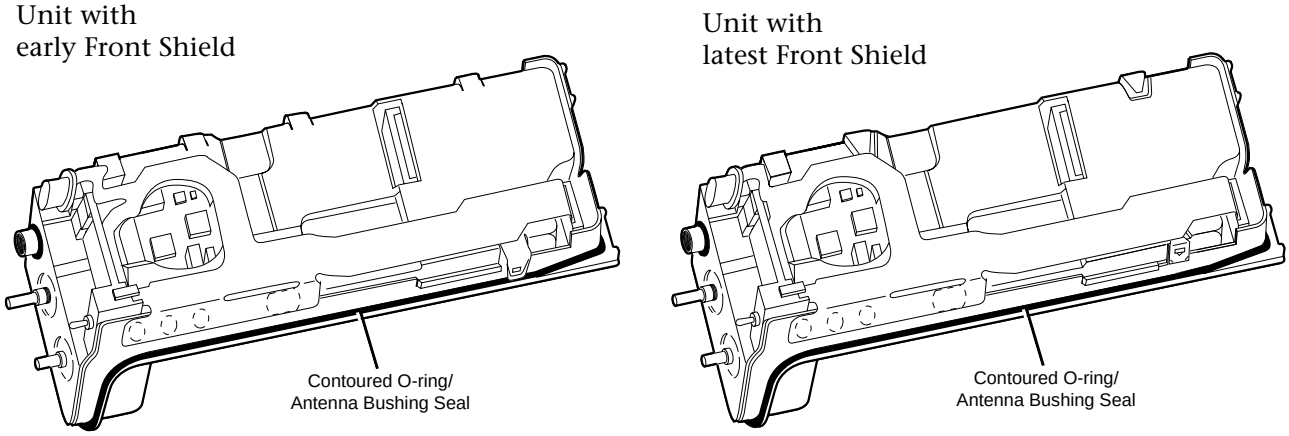


Figure 15 Installing the O-Ring/Antenna Bushing Seal

2. Orient the front cover assembly with the chassis, and insert the front cover/display flex connector into the locking connector of the controller board (refer back to Figure 6). Secure the connection. View the flex connection at a slight angle from the top of the radio and ensure that the flex connector is fully seated into the locking connector as illustrated in Figure 7.
3. Check to make sure that the O-ring is in place, and slide the chassis (control top first) into the front cover assembly. Check to ensure that the orange emergency button seal slides into position freely.

   NOTE: When performing the next part of this step, pay particular attention to the O-ring near the bottom of the radio to ensure that it does not raise up and get pinched between the front

cover clip and the chassis.With the top of the chassis fully seated, lower the bottom of the chassis and press it into the front cover assembly until it snaps into place.

4. Check the emergency button again. If it is cocked to one side, repositioning it will be necessary.

Knobs, Antenna, and Battery

1. Reinstall the switch knobs and antenna; the shorter knob with the volume on/off switch, the taller knob with the channel selector switch.
2. Reinstall the battery.

Notes

Maintenance

7

Introduction

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

Preventive Maintenance

In order to avoid operating outside the limits set by the FCC, it is recommended that the reference oscillator of the HT 1000, JT 1000, MT 2000, MTS 2000, and MTX radio be aligned every time the radio is disassembled, or once a year, whichever comes first. Periodic visual inspection and cleaning are also recommended.

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 or desired.

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 front cover, chassis (rear cover), and battery case. 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, such as JOY®, in water. The only factory recommended liquid for cleaning the printed circuit boards and their components is isopropyl alcohol (70% by volume).

Caution

The effects of certain chemicals and their vapors can have harmful results on certain plastics. Aerosol sprays, tuner cleaners, and other chemicals should be avoided.

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, lintless cloth or tissue should be used to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

Cleaning 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, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, front cover, or back cover.

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

Safe Handling of CMOS Devices

Complementary metal-oxide semiconductor (CMOS) devices are used in this family of radios. While the benefits of CMOS are many, their characteristics make them susceptible to damage by electrostatic or high voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, you must take special precautions to prevent device damage during disassembly, troubleshooting, and repair. Handling precautions are mandatory for CMOS circuits, and are especially important in low humidity conditions. DO NOT attempt to disassemble the radio without first referring to the CMOS CAUTION paragraph in the Disassembly and Reassembly section of the manual.

Repair Procedures and Techniques

Refer to the Disassembly and Reassembly section of the manual for pertinent information prior to replacing and substituting parts.

General

Parts Replacement and Substitution

Special care should be taken to be as certain as possible that a suspected component is actually the one at fault. This special care will eliminate unnecessary unsoldering and removal of parts, which could damage or weaken other components or the printed circuit board itself.

When damaged parts are replaced, identical parts should be used. If the identical replacement component is not locally available, check the parts list for the proper Motorola part number and order the component from the nearest Motorola Communications Parts office listed in the “Replacement Parts Ordering” section of this manual.

Rigid Circuit Boards

This family of radios uses bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The printed-through holes may interconnect multiple layers of the printed circuit. Therefore, care should be exercised to avoid pulling the plated circuit out of the hole.

When soldering near the module socket pins, use care to avoid accidentally getting solder in the socket. Also, be careful not to form solder bridges between the module socket pins. Closely examine your

work for shorts due to solder bridges. When removing modules with metal enclosures, be sure to desolder the enclosure ground tabs as well as the module pins.

Flexible Circuits

The flexible circuits are made from a different material than the rigid boards, and different techniques must be used when soldering. Excessive prolonged heat on the flexible circuit can damage the material. Avoid excessive heat and excessive bending. For parts replacement, use the ST-1087 Temperature-Controlled Solder Station with a 600 or 700 degree tip, and use small diameter solder such as ST-633. The smaller size solder will melt faster and require less heat being applied to the circuit.

To replace a component on a flexible circuit, grasp the edge of the flexible circuit with seizers (hemostats) near the part to be removed, and pull gently. Apply the tip of the soldering iron to the component connections while pulling with the seizers. Do not attempt to puddle out components. Prolonged application of heat may damage the flexible circuit.

Specific

During all repair procedures, heating neighboring components can be minimized by:

- using upper heat only.
- using the correct size heat-focus head, approximately the same size as the carrier being replaced.
- keeping the heat focus head approximately 1/8” above the printed circuit board when removing or replacing the device.

Caution

If neighboring PBGA components are heated above 365 degrees F. (185 degrees C.), they will suffer die-bond delamination and possible “popcorn” failure.

Strip Connector (P301/P704)

On the latest version HT 1000, JT 1000, MT 2000, MTS 2000, and MTX series radios, a strip connector, two female connectors and a strain relief electrically connect the RF board with the controller board. On earlier versions of these radios, the RF board and controller board were connected using a jumper flex that soldered directly to the circuit board solder pads.

An interconnect kit, REX4350A, is available to retrofit earlier version jumper-flex radios with the later version strip connector parts. The REX4350A kit includes the following items:

- CONNECTOR, Female (J301) 0905461X01
- CONNECTOR, Female (J704) 0905461X01
- CONNECTOR, Male (P301/P704) 0905461X01
- STRAIN RELIEF 4205507X01
- INSTRUCTIONS 6880309F14

Jumper Flex (on radios shipped prior to 7/94)

Jumper flexes are not available. They are replaced with connectors as described in paragraph "a" of this section. If the jumper flex needs to be replaced, order Interconnect Kit REX4350A. The retrofit kit includes all of the parts required and detailed instructions on the removal of the old jumper flex, and the installation of the new connector arrangement.

RF Switch (S101):

Refer to the applicable exploded view and to your radio's RF board (antenna contact area) to locate the RF switch components.

NOTE: The RF switch spring and the RF switch piston must be ordered separately.

To Remove the RF Switch:

1. On VHF and UHF radios, unsolder the two tabs of the RF switch bracket that secure the RF switch to the RF board. On 800MHz and 900MHz radios, use a #2 slotted screwdriver to straighten the two tabs of the RF switch bracket that wrap around the RF board. Use your forefinger to hold the RF switch bracket to the RF board while straightening the tabs to avoid lifting the solder tabs on the opposite end of the RF switch bracket.
2. Refer to Figure 16 and use a small heat-focus head to distribute heat over the area occupied by the three solder tabs until the solder softens.

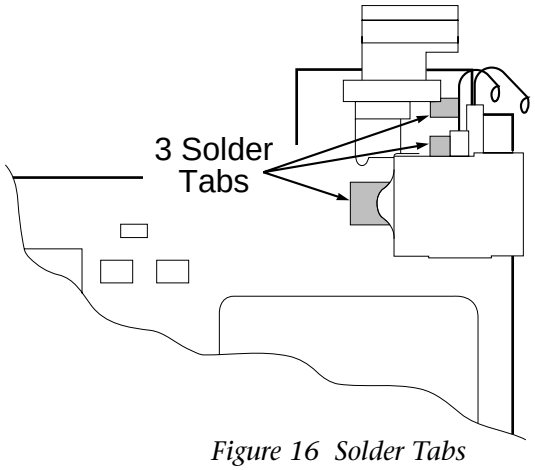


Figure 16 Solder Tabs

3. Carefully lift the RF switch assembly away from the rf board. Notice that the RF switch circuit board remains attached (soldered) to the RF board.
4. Using the same heat-focus head as in steps (2) and (3), unsolder the RF switch circuit board, and remove it from the RF board using forceps.
5. In the RF switch circuit board area, reflow all the solder pad areas on the main RF board such that similarly shaped pads have uniform solder heights. Add or remove solder as required. Clean the RF board thoroughly. Then swab on a minimum amount of flux to each of the solder pads.

To Replace the RF Switch:

1. Place the RF switch assembly on the RF main board and gently heat. Visually inspect to make sure no flux migrated onto the gold plated areas of the RF switch board. The guide pins should provide self alignment between the two circuit boards. Visually inspect the

plastic switch housing to ensure that it has not warped due to overheating.

2. While holding the RF switch bracket firmly against the RF board:

- VHF and UHF radios - solder the two leads of the housing to the solder pads on the RF board.
- 800MHZ and 900MHz radios - bend the two tabs around the side of the RF board as close to the board edge as possible to hold the bracket down tightly.

3. Insert the new RF switch spring and RF switch piston into the RF switch assembly. The contacts of the piston should be facing the gold-plated pads of the RF switch board. Once the spring and piston are inserted into the RF switch, they will be retained by the switch.

Chip Components

Use either the RLN-4062 Hot-Air Repair Station or the Motorola 0180381B45 Repair Station for chip component replacement. When using the 0180381B45 Repair Station, select the TJ-65 mini-thermojet hand piece. On either unit, adjust the temperature control to 700 degrees F. (370 degrees C), and adjust the airflow to a minimum setting. Airflow can vary due to component density.

1. To remove a chip component, select a hot- air hand piece and position the nozzle of the hand piece approximately 1/8" (0.3cm) above the component to be removed. Begin applying the hot air. Once the solder reflows, remove the component using a pair of tweezers. Using solder wick and a soldering iron or a power desoldering station, remove the excess solder from the pads.
2. To replace a chip component using a soldering iron, select the appropriate micro-tipped soldering iron and apply fresh solder to one of the solder pads. Using a pair of tweezers, position the new chip component in place while heating the fresh solder. Once solder wicks onto the new component, remove the heat from the solder. Heat the remaining pad with the soldering iron and apply solder until it wicks to the component. If necessary, touch up the first side. All solder joints should be smooth and shiny.
3. To replace a chip component using hot air, select the hot-air hand piece and reflow the solder on the solder pads to smooth it. Apply a drop of solder paste flux to each pad. Using a pair of tweezers, position the new component in place. Position the hot-air hand piece approximately 1/8" (0.3cm) above the component and begin applying heat. Once the solder wicks to the component, remove the heat and inspect the repair. All joints should be smooth and shiny.

Plastic-Ball Grid-Array (PBGA), Over-Molded Pad-Array Carrier (OMPAC), and Glob Top Components

The term Plastic-Ball Grid-Array (PBGA) will be used to describe most of this products type of modules. PBGA modules may be the construction of an Over-Molded Pad-Array Carrier (OMPAC) component or "Glob Top" component. A U204 synthesizer component in one radio may be an OMPAC and the same U204 synthesizer in another radio may be a Glob Top. The two components look a little different, but are electrically the same and are interchangeable.

Caution

If neighboring PBGA components are heated above 365 degrees F. (185 degrees C.), they will suffer die-bond delamination and possible “popcorn” failure. To prevent this delamination problem, circuit boards to be repaired must be baked in an oven for eight hours at 260 degrees F. (125 degrees C.) prior to solder repairs.

Caution

All pad-array carriers in these radios, except for the IF IC (U3), are PBGA components. Prior to use, all PBGA components must be kept in the sealed bag (with moisture-indicator card) as supplied by the Motorola Parts Department. Once the sealed bag is opened and/or the PBGA component subjected to ambient humidity (for an unknown amount of time or for more than 96 hours) then that PBGA component must be baked in an oven for at least eight hours at 260 degrees F. (125 degrees C.)

During all repair procedures, heating neighboring components can be minimized by:

- using upper heat only.
- using the correct size heat-focus head, approximately the same size as the carrier being replaced.
- keeping the heat focus head approximately 1/8”-1/4” (0.3cm-0.6cm) above the printed circuit board when removing or replacing the device.

To Remove a PBGA Component, select the R-1319 Rework Station and the appropriate heat- focus head (approximately the same size as the PBGA. Attach the heat-focus head to the chimney heater. Adjust the temperature control to approximately 415 degrees F (215 degrees C); 445 degrees F (230 degrees C) maximum. Apply the solder paste flux around the edge of the PBGA. Place the circuit board in the circuit board holder, and position the PBGA component under the heat-focus head. Lower the vacuum tip and attach it to the PBGA component by turning on the vacuum pump. Lower the heat-focus head until it is approximately 1/8”-1/4” (0.3cm-0.6cm) above the carrier. Turn on the heater and wait until the PBGA component lifts off the circuit board. Once the part is off, grab it with a pair of tweezers and turn off the vacuum pump. Remove the circuit board from the R-1319’s circuit board holder.

Caution

The application of heat to the PBGA device, beginning at ambient air temperature and ending with the PBGA component lifting from the circuit board, should take longer than 60 seconds. If the PBGA component lifts from the circuit board earlier than 60 seconds:

- check the temperature control setting on the rework station, and if OK
- lift the heat-focus head an additional 1/8" from nominal setting, and
- check the circuit board plating for possible damage.

To Replace an PBGA component,

the solder pads on the board must first be cleaned of all solder to ensure alignment of the new chip carrier. Prepare the site by using solder wick and a soldering iron to remove all solder from the solder pads on the circuit board. If a power desoldering tool is available, it can be used instead of the solder wick. Clean the solder pads with alcohol and a small brush. Dry and inspect. Ensure that all solder is removed.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux in the trench of the flux block and spread it using a one-inch putty knife. Flux the PBGA component by placing it in the trench of the flux block. Once the flux is applied, place the PBGA component on the circuit board, making certain that it is oriented correctly on the board. Position the heat-focus head over the PBGA component and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) over the carrier. Using the same heat setting used to remove the PBGA component, turn on the heater and wait for the carrier to reflow (heating and reflow should take longer than 60 seconds).Watch the PBGA component reflow and note that when a proper reflow has taken place, the PBGA component will drop (usually one side, then the other). The end result is that both sides have reflowed, and the PBGA component is sitting parallel to the circuit board.

Once the carrier reflows, raise the heat-focus head and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

Thin Small Outline Package (TSOP) Components

Removing and Replacing a TSOP Component:

will be done with the R-1319, using the same procedure used to remove and replace an PBGA component.

Place the circuit board in the circuit board holder. Select the proper heat focus head and attach it to the heater chimney. Position the TSOP component under the heat-focus head. Lower the vacuum tip and attach it to the component by turning on the vacuum pump. Lower the focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm)

above the component. Turn on the heater and wait until the TSOP lifts off the circuit board.

Once the part is off, turn off the heat, grab the part with a pair of tweezers, and turn off the vacuum pump. Prepare the circuit board for the new component by applying solder paste flux to the solder pads. Position the circuit board under the heat-focus head, lower the head to approximately 1/8"-1/4" (0.3cm-0.6cm) above the board, and turn on the heat. When the solder left behind on the pads reflows, turn off the heat and raise the heat-focus head. Remove the circuit board from the holder and inspect the pads to ensure that the solder has flattened out and that there are no solder shorts. Clean the area with alcohol and a small brush.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux to the solder pads and place the new component on the circuit board. Position the heat-focus head over the component and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) above the carrier. Turn on the heater and wait for the component to reflow.

Once the component reflows, raise the heat-focus head and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

Shields

Removing and Replacing the Shields:

will be done with the R-1319, using the same procedure used to remove and replace TSOP and PBGA components.

Place the circuit board in the circuit board holder. Select the proper heat focus head and attach it to the heater chimney. Add solder paste flux around the base of the shield. Position the shield under the heat-focus head. Lower the vacuum tip and attach it to the shield by turning on the vacuum pump. Lower the focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the shield. Turn on the heater and wait until the shield lifts off the circuit board. Once the shield is off, turn off the heat, grab the part with a pair of tweezers, and turn off the vacuum pump. Remove the circuit board from the circuit board holder.

To replace the shield, add solder to the shield if necessary, using a micro-tipped soldering iron. Next, rub the soldering iron tip along the edge of the shield to smooth out any excess solder. Use solder wick and a soldering iron to remove excess solder from the solder pads on the circuit board. Place the circuit board back in the circuit board holder. Place the shield on the circuit board using a pair of tweezers. Position the heat-focus head over the shield and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) above the shield. Turn on the heater and wait for the solder to reflow.

Once complete, turn off the heat, raise the heat-focus head, and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

RF PA (U105)

The procedure for removing and replacing the RF PA is very similar to the procedure for removing and replacing an PBGA or a TSOP

component. But because the device is large, extra heating time is required to flow the pads. And as a result, neighboring components (especially those on the opposite side of the circuit board) will heat, reflow, and may inadvertently move. Be careful when performing the following procedure.

Refer to Figure 17 for RF PA nomenclature.

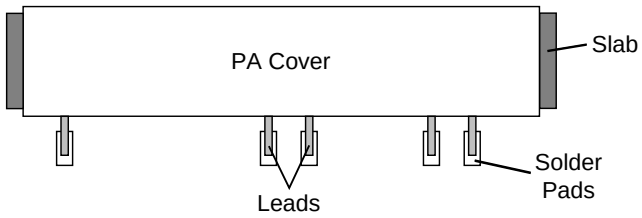


Figure 17 RF PA Nomenclature

To Remove the RF PA,

add flux to the leads of the device, and use a soldering iron and pair of tweezers to heat and lift each lead free and clear of its respective solder pad on the circuit board. Use the R-1319 Rework Station and the heat-focus head designed especially for removal of the RF PA. Attach the heat-focus head to the chimney heater. Adjust the temperature control to approximately 415 degrees F (215 degrees C) 445 degrees F (230 degrees C) maximum. Apply solder paste to the exposed solder pads under the PA. Place the circuit board in the circuit board holder, and position the RF PA under the heat-focus head. Lower the heat-focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the PA cover. Turn on the heater and begin the reflow cycle. Heating time should not be less than two minutes.

Once the part has reflowed, before trying to remove the PA, carefully lower the circuit board holder as follows:

- Loosen the thumbscrew on the shaft of the circuit board holder,
- push the spring-loaded holder down and away from the heat-focus head, and
- retighten the thumbscrew with the holder in the bottomed position.

Grab the PA with a large pair of tweezers and remove it from the circuit board. Let the circuit board cool for approximately two minutes. Then remove the circuit board from the circuit board holder.

To Replace the RF PA;

if necessary, add solder to the PA ground plane on the printed circuit board. Then clean each PA lead solder pad on the circuit board to ensure alignment of the new RF PA. Prepare the sight by using solder wick and a soldering iron to remove all solder from the solder pads. Clean the solder pads with alcohol and a small brush. Dry and inspect. Ensure that all solder is removed.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux to the ground plane and to the leads' solder pads. Once the flux is applied, place the new RF PA on

the circuit board, making certain that the PA heatsink sits flush on the board. Position the heat-focus head over the RF PA and lower it to approximately 1/8″-1/4″ (0.3cm-0.6cm)) above the PA cover. Turn on the heater and begin the reflow cycle. Heating time should not be less than two minutes.

Once the RF PA reflows, raise the heat-focus head and wait approximately two minute for the part to cool. Remove the circuit board and inspect the solder joint between the slab and the ground plane. No cleaning should be necessary. Use the soldering iron and add solder to each of the RF PA leads and associated pads. Inspect the lead/pad bond for opens and solder shorts.

Exploded Views

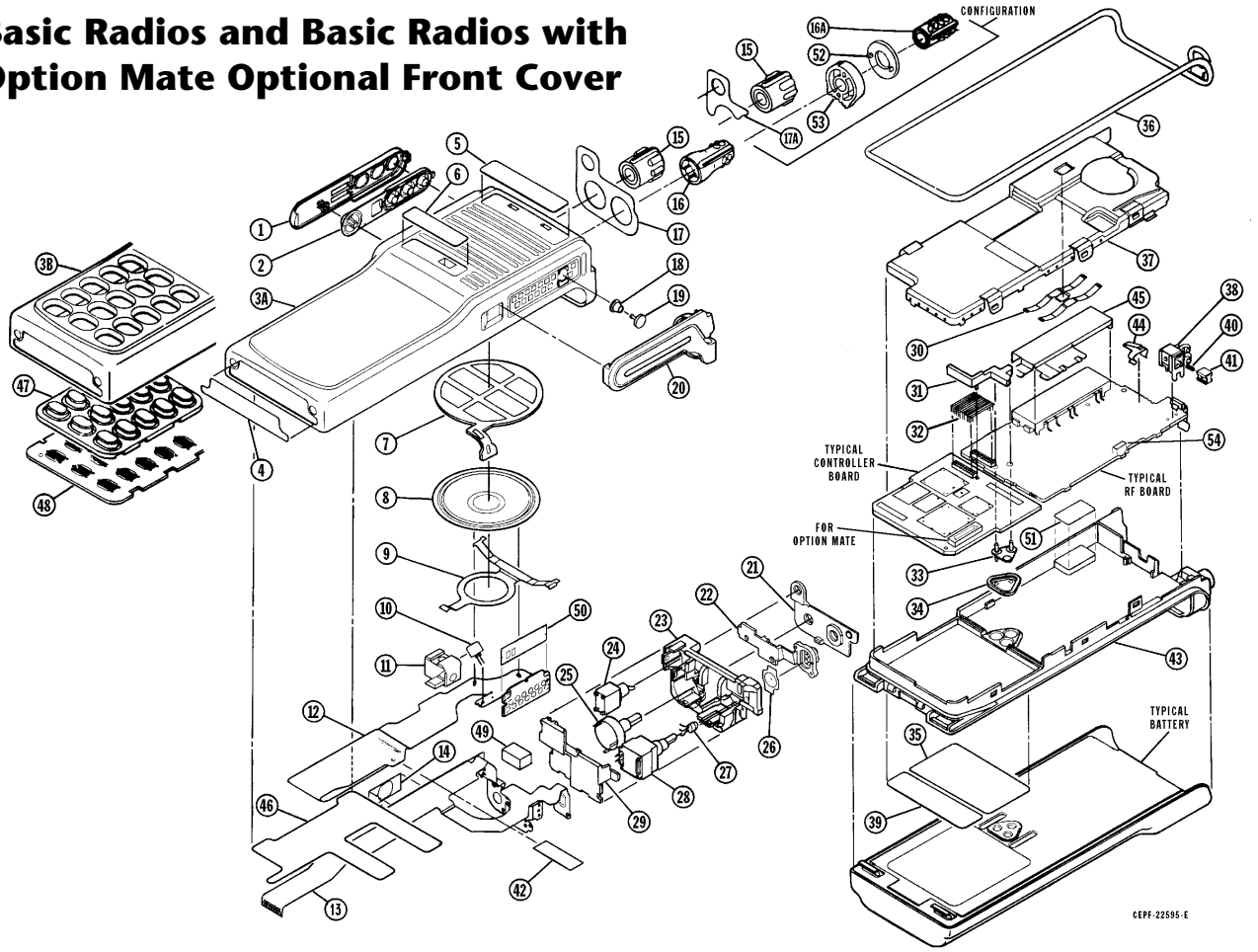
8

There are several models in this family of radios: HT 1000, JT 1000, MT 2000, MTS 2000, and MTX Series radios.The exploded view diagrams in this section illustrate this family of radios by capturing them into one of four categories:

- basic radios
- top-display radios
- keypad radios
- uni-board radios

Determine which category describes your unit, and use the appropriate exploded view to help identify components with description and Motorola part number.

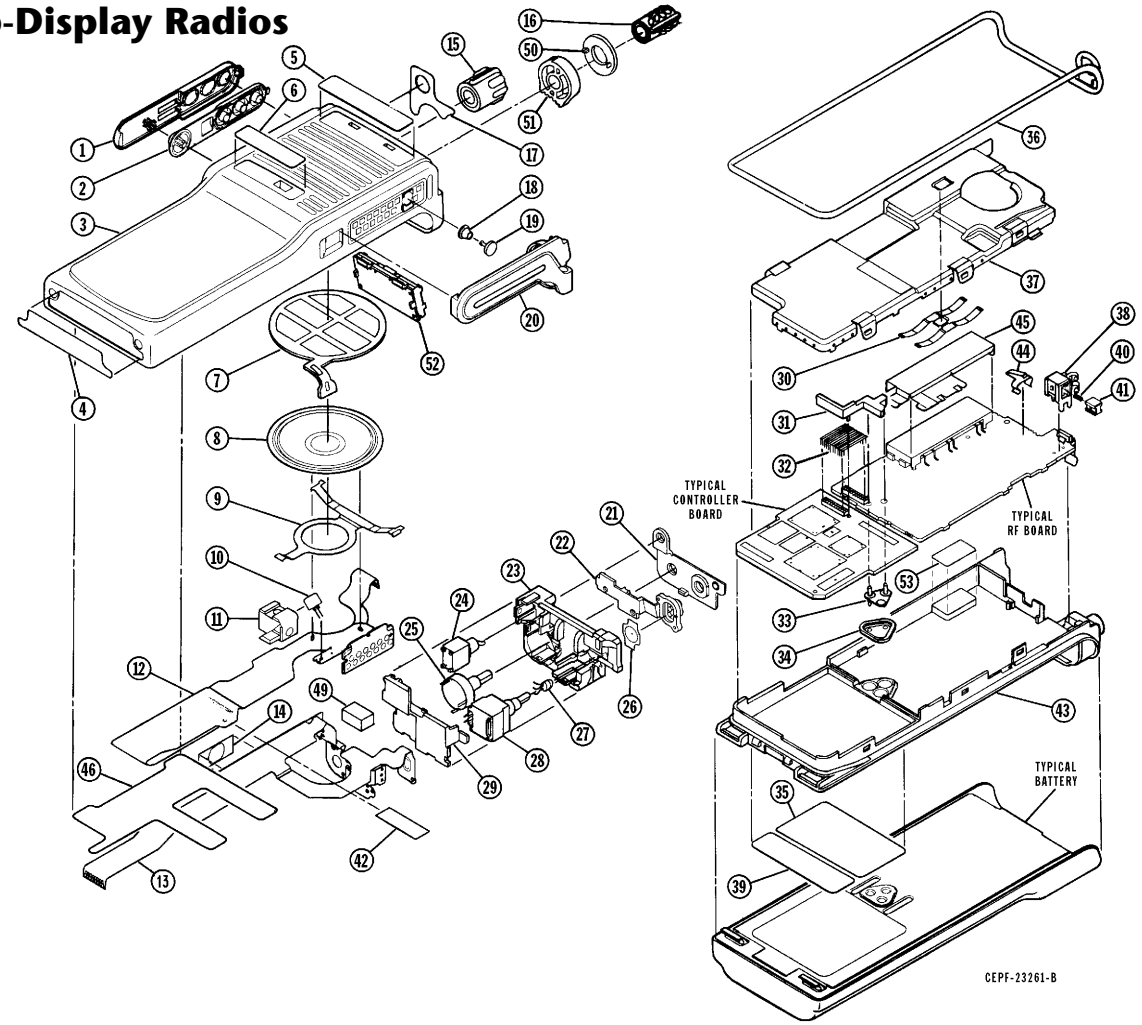
Basic Radios and Basic Radios with Option Mate Optional Front Cover



ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3A	1505627V05	COVER, Front
	or 1505627V03	COVER, Front; Option•Mate
3B	1505637V06	COVER, Front; DTMF
	or 1505637V07	COVER, Front; DTMF Option•Mate
4	- - - - - - - - - -	LABEL, Agency Approval; not field replaceable
5	3305183R55	LABEL, Motorola
6	3305183R56	LABEL, HT1000
7	3505535X02	FELT, Speaker
8	See Note 1	SPEAKER (LS401)
9	0705470V01	BRACKET, Speaker Retainer
10	See Note 1	MICROPHONE (MK401)
11	1405330W01	BOOT, Microphone
12	8405310W04	FLEX, Front Cover/Display
13	8405333W03	FLEX, Controls
14	3905517V01	POPPLE, PTT (p/o S406)
15	3605253V01	KNOB, On/Off/Volume
16	3605254V02	KNOB, Frequency; 2-Freq. Radios
	or 3605254V01	KNOB, Frequency; 16-Frequency Radios
16A	3605636V01	KNOB, Frequency; Option•Mate
17	1305872U02	ESCUTCHEON, Control Top; 2-Freq. Radios
	or 1305872U01	ESCUTCHEON, Control Top; 16-Freq. Radios
17A	1305698V01	ESCUTCHEON, Control Top; Option•Mate
18	3205160W01	SEAL, Actuator; for S101
19	2205159W01	PIN, Actuator; for S101
20	3205514W01	SEAL, Accessory Connector
21	3205177Z01	SEAL, Control Top
22	3205178Z01	SEAL, Emergency Button
23	2705877U01	HOUSING, Switch
24	See Note 1	SWITCH, Toggle (S402)
25	See Note 1	POTENTIOMETER/SWITCH, On/Off/Volume Control (R401/S403)
26	3905329W01	POPPLE, Emergency Button
27	See Note 1	LED (CR400A/CR400B)
28	See Note 1	SWITCH, Frequency (S401)
29	1505632V01	COVER, Switch Housing
30	- - - - - - - - - -	SPRING, PA; not field replaceable, order front shield (item 37)
31	4205507X01	STRAIN RELIEF
32	See Note 1	CONNECTOR, Strip (P301/P704)
33	See Note 2	PLUG, Connector (P404)
34	3205820V02	SEAL, Connector Plug
35	- - - - - - - - - -	LABEL, Rear; Information; not field replaceable
36	3205176Z01	O-RING, Contoured/SEAL, Antenna
37	2605891U03	SHIELD, Front (earlier radios)
	or 2685351C01	SHIELD, Front (latest radios; requires CLIPs, Locking: 4285351C01 [Numbered 1, 1 req'd] and 4285351C02 [Numbered 2, 2 req'd])
38	See Note 1	SWITCH, RF (S101)
39	- - - - - - - - - -	LABEL, Barcode; not field replaceable
40	4105266V01	SPRING, RF Switch
41	4405524V01	PISTON, RF Switch
42	1405307X01	INSULATOR
43	1505892U06	CHASSIS (Rear Cover)
44	3905838V01	CONTACT, Antenna Shield Ground (800MHz and 900MHz radios only)
45	2605898U01	SHIELD, PA (800MHz and 900MHz radios (only)
46	7505334W01	PAD, Sound Dampening
47	7505437W01	KEYPAD, DTMF
48	5102463J08	CIRCUIT BOARD, DTMF
49	7505393N33	PAD, Shock
50	3205827V01	WEDGE, Universal
51	7505922Z01	PAD, Thermal
52	1305633V01	RING, Concentric; Escutcheon
53	3605635V01	Knob, Concentric Ring
54	1405307X07	TAPE, Insulator (trim to size, 0.3" x 0.2")

Notes: 1. Refer to electrical parts list (miscellaneous)
2. Refer to electrical parts list (transceiver board)

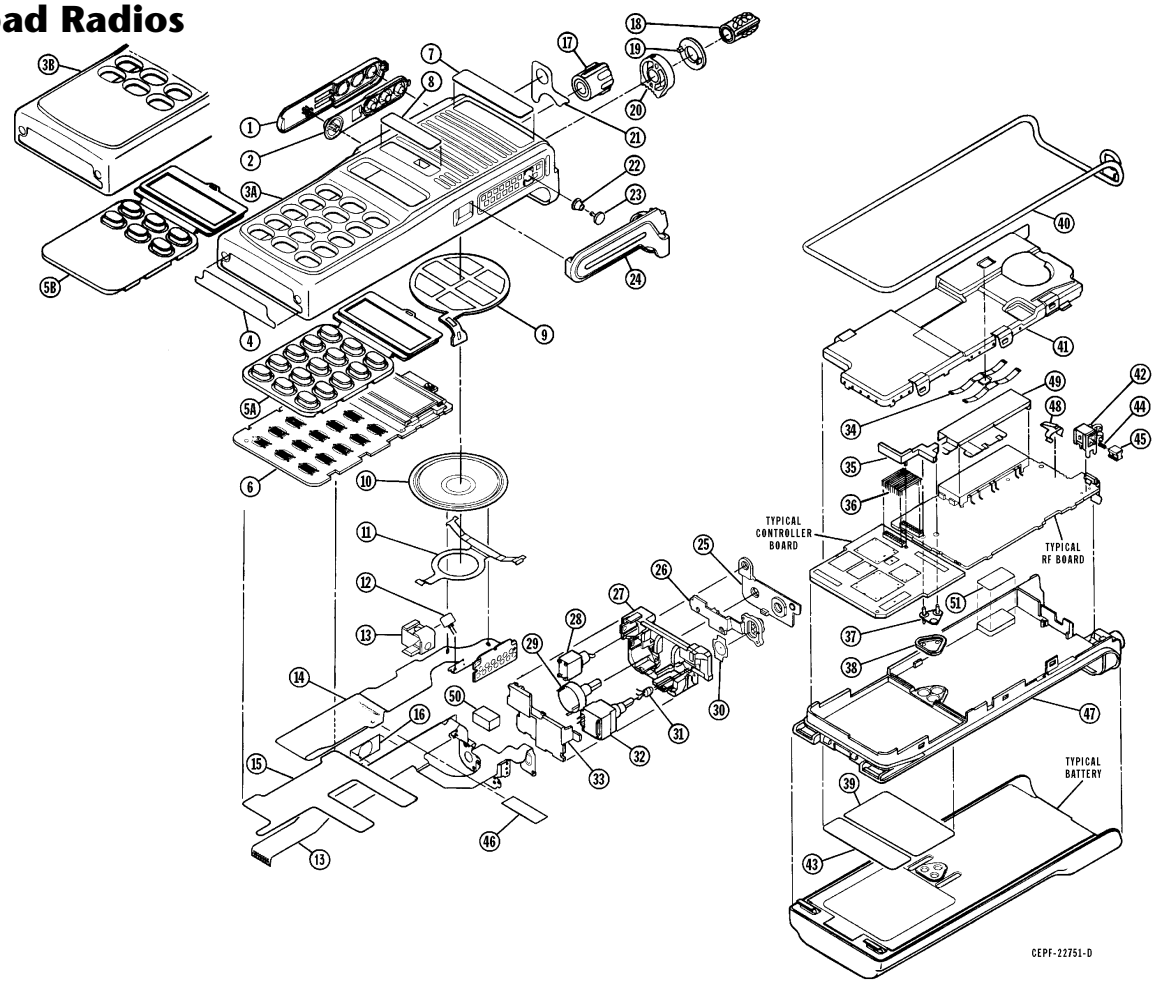
Top-Display Radios



ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3	1505627V04	COVER, Front
4	- - - - - - - - -	LABEL, Agency Approval; not field replaceable
5	3305183R55	LABEL, Motorola
6	3305183R70 or 3305183R71 or 3305183R94	LABEL, MT 2000 LABEL, MTS 2000 LABEL, MTX
7	3505535X02	FELT, Speaker
8	See Note 1	SPEAKER (LS401)
9	0705470V01	BRACKET, Speaker Retainer
10	See Note 1	MICROPHONE (MK401)
11	1405330W02	BOOT, Microphone
12	8405641V02	FLEX, Front Cover/Display
13	8405333W03	FLEX, Controls
14	3905517V01	POPPLE, PTT (p/o S406)
15	3605253V01	KNOB, On/Off/Volume
16	3605636V01	KNOB, Frequency
17	1305698V01	ESCUTCHEON, Control Top
18	3205160W01	SEAL, Actuator; for S101
19	2205159W01	PIN, Actuator; for S101
20	3205514W01	SEAL, Accessory Connector
21	3205177Z01	SEAL, Control Top
22	3205178Z01	SEAL, Emergency Button
23	2705877U01	HOUSING, Switch
24	See Note 1	SWITCH, Toggle (S402)
25	See Note 1	POTENTIOMETER/SWITCH, On/Off/Volume Control (R401/S403)
26	3905329W01	POPPLE, Emergency Button
27	See Note 1	LED (CR400A/CR400B)
28	See Note 1	SWITCH, Frequency (S401)
29	1505632V01	COVER, Switch Housing
30	- - - - - - - - -	SPRING, PA; not field replaceable, order front shield (item 37)
31	4205507X01	STRAIN RELIEF
32	See Note 1	CONNECTOR, Strip (P301/P704)
33	See Note 2	PLUG, Connector (P404)
34	3205820V02	SEAL, Connector Plug
35	- - - - - - - - -	LABEL, Rear; Information; not field replaceable
36	3205176Z01	O-RING, Contoured/SEAL, Antenna
37	2605891U03 or 2685351C01	SHIELD, Front (earlier radios) SHIELD, Front (latest radios; requires CLIPs, Locking: 4285351C01 [Numbered 1, 1 req'd] and 4285351C02 [Numbered 2, 2 req'd])
38	See Note 1	SWITCH, RF (S101)
39	- - - - - - - - -	LABEL, Barcode; not field replaceable
40	4105266V01	SPRING, RF Switch; part of item 39
41	4405524V01	PISTON, RF Switch; part of item 39
42	1405307X01	INSULATOR
43	1505892U06	CHASSIS (Rear Cover)
44	3905838V01	CONTACT, Antenna Shield Ground (800MHz and 900MHz radios only)
45	2605898U01	SHIELD, PA (800MHz and 900MHz radios only)
46	7505334W01	PAD, Sound Dampening
47	Not Used	
48	Not Used	
49	7505393N33	PAD, Shock
50	1305633V01	RING. Concentric; Escutcheon
51	3605635V01	KNOB, Concentric Ring
52	5105238U82	LCD, Top Display
53	7505922Z01	PAD, Thermal

Notes: 1. Refer to electrical parts list (miscellaneous)
2. Refer to electrical parts list (transceiver board)

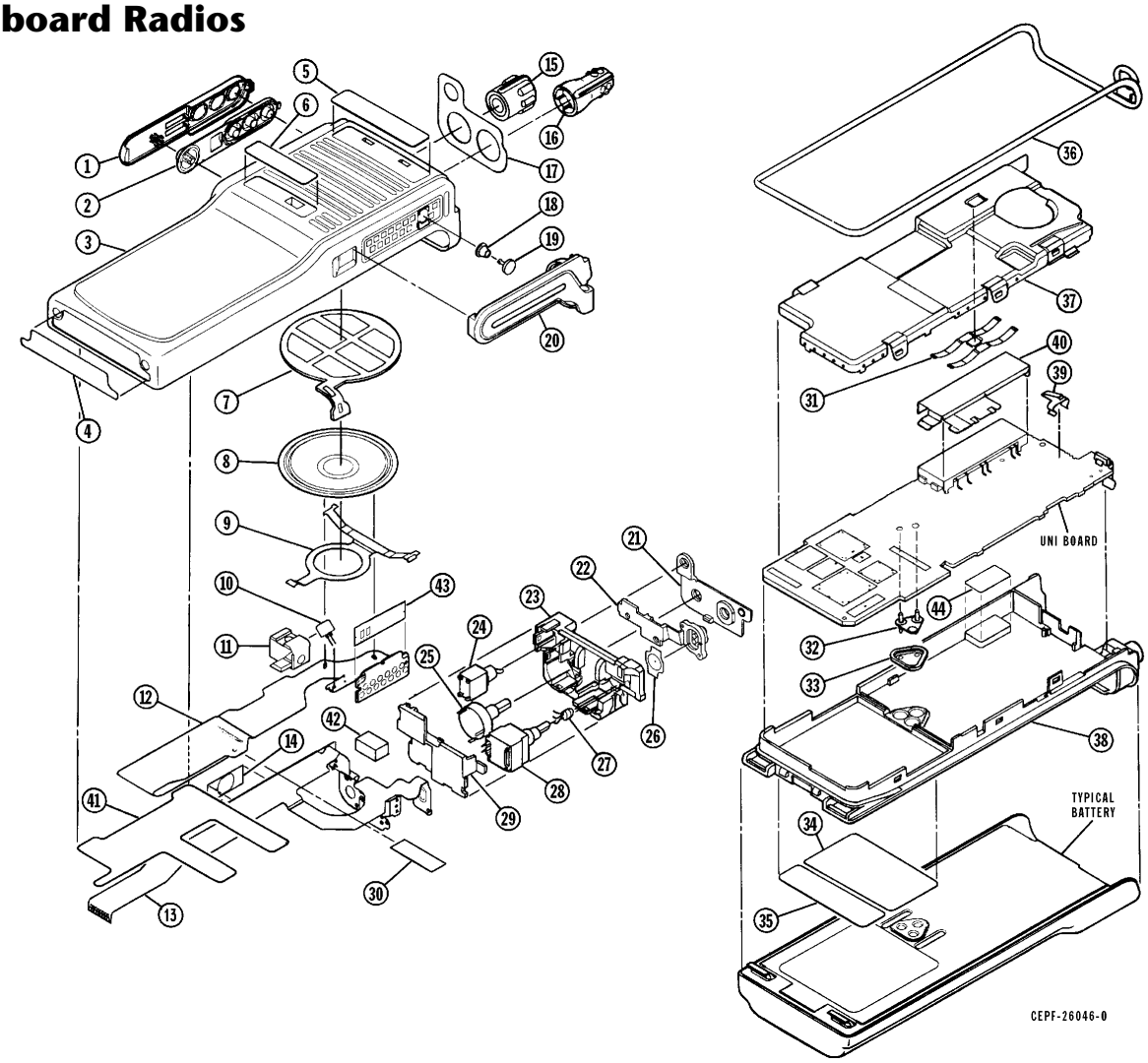
Keypad Radios



ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3A	1505637V04	COVER, Front; Full Keypad
3B	1505637V05	COVER, Front; Limited Keypad
4	- - - - - - - - -	LABEL, Agency Approval; not field replaceable
5A	7505870U01	KEYPAD, 15-key
5B	7505870U02	KEYPAD, 6-key
6	5105238U83	MODULE, Display
7	3305183R55	LABEL, Motorola
8	3305183R70	LABEL, MT2000
	or 3305183R71	LABEL, MTS2000
	or 3305183R94	LABEL, MTX
	or 3305409X06	LABEL, JT 1000
9	3505535X02	FELT, Speaker
10	See Note 1	SPEAKER (LS401)
11	0705470V01	BRACKET, Speaker Retainer
12	See Note 1	MICROPHONE (MK401)
13	1405330W02	BOOT, Microphone
14	8405310W04	FLEX, Front Cover/Display
15	8405333W03	FLEX, Controls
16	3905517V01	POPPLE, PTT (p/o S406)
17	3605253V01	KNOB, On/Off/Volume
18	3605636V01	KNOB, Frequency
19	1305633V01	RING, Concentric; Escutcheon
20	3605635V01	KNOB, Concentric Ring
21	1305698V01	ESCUTCHEON, Control Top
22	3205160W01	SEAL, Actuator; for S101
23	2205159W01	PIN, Actuator; for S101
24	3205514W01	SEAL, Accessory Connector
25	3205177Z01	SEAL, Control Top
26	3205178Z01	SEAL, Emergency Button
27	2705877U01	HOUSING, Switch
28	See Note 1	SWITCH, Toggle (S402)
29	See Note 1	POTENTIOMETER/SWITCH, On/Off/ Volume Control (R401/S403)
30	3905329W01	POPPLE, Emergency Button
31	See Note 1	LED (CR400A/CR400B)
32	See Note 1	SWITCH, Frequency (S401)
33	1505632V01	COVER, Switch Housing
34	- - - - - - - - -	SPRING, PA; not field replaceable, order front shield (item 41)
35	4205507X01	STRAIN RELIEF
36	See Note 1	CONNECTOR, Strip (P301/P704)
37	See Note 2	PLUG, Connector (P404)
38	3205820V02	SEAL, Connector Plug
39	- - - - - - - - -	LABEL, Rear; Information; not field replaceable
40	3205176Z01	O-RING, Contoured/SEAL, Antenna
41	2605891U03	SHIELD, Front (earlier radios)
	or 2685351C01	SHIELD, Front (latest radios; requires CLIPs, Locking: 4285351C01 [Numbered 1, 1 req'd] and 4285351C02 [Numbered 2, 2 req'd])
42	See Note 1	SWITCH, RF (S101)
43	- - - - - - - - -	LABEL, Barcode; not field replaceable
44	4105266V01	SPRING, RF Switch
45	4405524V01	PISTON, RF Switch
46	1405307X01	INSULATOR
47	1505892U06	CHASSIS (Rear Cover)
48	3905838V01	CONTACT, Antenna Shield Ground (800MHz and 900MHz radios only)
49	2605898U01	SHIELD, PA (800MHz and 900MHz radios only)
50	7505393N33	PAD, Shock
51	7505922Z01	PAD, Thermal

Notes: 1. Refer to electrical parts list (miscellaneous)
2. Refer to electrical parts list (transceiver board)

Uni-board Radios



ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3	1505627V05	COVER, Front
4	- - - - - - - - - -	LABEL, Agency Approval; not field replaceable
5	3305183R55	LABEL, Motorola
6	3305252X18	LABEL, MTX•LS
7	3505535X02	FELT, Speaker
8	See Note 1	SPEAKER (LS401)
9	0705470V01	BRACKET, Speaker Retainer
10	See Note 1	MICROPHONE (MK401)
11	1405330W01	BOOT, Microphone
12	8405310W04	FLEX, Front Cover/Display
13	8405333W03	FLEX, Controls
14	3905517V01	POPPLE, PTT (p/o S406)
15	3605253V01	KNOB, On/Off/Volume
16	3605254V01	KNOB, Frequency; 16-Frequency
17	1305872U01	ESCUTCHEON, Control Top; 16-Freq.
18	3205160W01	SEAL, Actuator; for S101
19	2205159W01	PIN, Actuator; for S101
20	3205514W01	SEAL, Accessory Connector
21	3205177Z01	SEAL, Control Top
22	3205178Z01	SEAL, Emergency Button
23	2705877U01	HOUSING, Switch
24	See Note 1	SWITCH, Toggle (S402)
25	See Note 1	POTENTIOMETER/SWITCH, On/Off/ Volume Control (R401/S403)
26	3905329W01	POPPLE, Emergency Button
27	See Note 1	LED (CR400A/CR400B)
28	See Note 1	SWITCH, Frequency (S401)
29	1505632V01	COVER, Switch Housing
30	1405307X01	INSULATOR
31	- - - - - - - - - -	SPRING, PA; not field replaceable, order front shield (item 37)
32	See Note 2	PLUG, Connector (P404)
33	3205820V02	SEAL, Connector Plug
34	- - - - - - - - - -	LABEL, Rear; Information; not field replaceable
35	- - - - - - - - - -	LABEL, Barcode; not field replaceable
36	3205176Z01	O-RING, Contoured/SEAL, Antenna
37	2605891U03 or 2685351C01	SHIELD, Front (earlier radios) SHIELD, Front (latest radios; requires CLIPs, Locking: 4285351C01 [Numbered 1, 1 req'd] and 4285351C02 [Numbered 2, 2 req'd])
38	1505892U06	CHASSIS (Rear Cover)
39	3905838V01	CONTACT, Antenna Shield Ground
40	2605898U01	SHIELD, PA
41	7505334W01	PAD, Sound Dampening
42	7505393N33	PAD, Shock
43	3205827V01	WEDGE, Universal
44	7505922Z01	PAD, Thermal

Notes: 1. Refer to electrical parts list (miscellaneous)
2. Refer to electrical parts list (transceiver board)

Notes

Component Location Diagrams, Parts Lists,and Schematic Diagrams

9

Introduction

General

Except for the MTX•LS model, transceiver components and controller components reside on separate circuit boards. Refer to the model charts located in the front of this manual (prior to Section 1) to determine the controller board and transceiver board unique to your model radio. Then locate the appropriate transceiver board and controller board component location diagram, schematic diagram, and parts list located in this section of the manual.

NOTE: Transceiver components and controller components in the MTX•LS model radio are all part of a single circuit board (uni-board).

Component location diagrams of the controls flex, two front cover/ display flexes, and the strip connector are also located in this section. A miscellaneous parts list accompanies the flex circuits.

Almost all circuit boards in this family of radios are either six or eight layers. Layer 1 is the outer most layer viewed from side 1, and layer 6 or 8 (as applicable) is the outer most layer viewed from sine 2. A typical 8-layer circuit board detail, viewing copper steps in proper layer sequence, is illustrated in Figure 18.

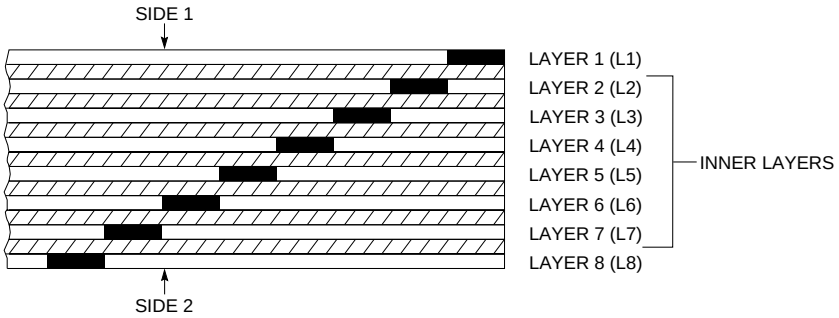


Figure 18. Circuit Board Layers

Transceiver

Frequently, transceivers that use a common transceiver board will be combined into one component location diagram, one schematic diagram, and one parts list. The differences between transceivers will be noted throughout the applicable parts list.

Controller

Frequently, controllers that use a common controller board will be combined into one component location diagram, one schematic diagram, and one parts list. The differences between controllers will be noted throughout the applicable parts list.

Schematic and Circuit Board Notes

Most all of the schematic diagrams in this manual include specific notes. Typically the notes are colored red to make them stand-out from the overall schematic. The following two notes are general and apply to all schematic and circuit board applications.

1. Unless otherwise stated, resistor values are in ohms (k = 1000), capacitor values are in picofarads (pF) or microfarads (µF), and inductor values are in microhenrys (µH) or nanohenrys (nH).
2. DC voltages are measured from point indicated to chassis ground using a high impedance (10 megohm) Motorola DC voltmeter or equivalent. Transmitter measurements should be made with a 1.2uF choke in series with the voltage probe to prevent circuit loading.

Reference Designator Assignment

Reference designators are assigned in the following manner:

- Units Series = Receiver
- 100 SERIES = Transmitter
- 200 SERIES = Frequency Generation
- 300 SERIES = Miscellaneous
- 400 SERIES = Housing/Escutcheon
- 500 SERIES = Display
- 600 SERIES = Hear Clear Option
- 700 SERIES = Controller

Interconnect Tie Point Legend

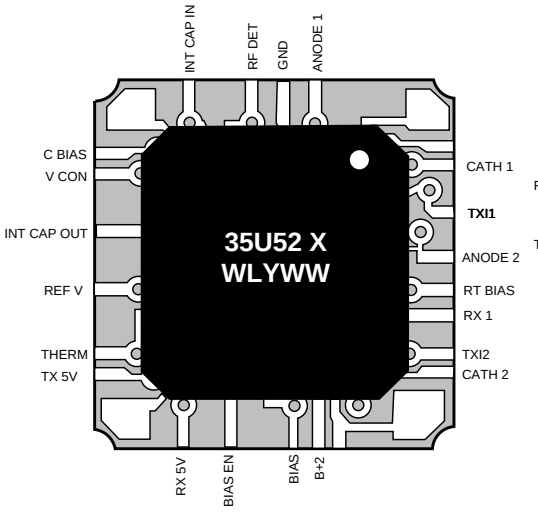
5V REG	=	Regulated Five Volts
B+	=	Battery Voltage (7.5V)
R5	=	Receiver Five Volts
T5	=	Transmitter Five Volts
CLK	=	Clock
D	=	Data
DAC	=	Digital To Analog Converter
DAC RST	=	DAC Reset
LCK	=	Lock
NC	=	No Connection
SYN	=	Synthesizer
VR	=	Voltage Regulator

Integrated Circuit Details with Pin-Out Names

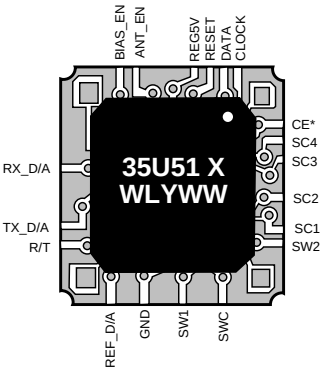
Because of today's technology, integrated circuits and special modules are able to perform a vast amount of functions in a single component. The components are getting smaller and the number of IO pins is getting greater, to the point that there is not enough room to put enough IC information on the schematics and circuit boards. To help troubleshoot and signal trace this family of radios, several of the IC's are detailed with pin-out names and illustrated on the next few pages.

Remember that PBGA components in a radio can be a combination of OMPAC and/or Glob Top. Although the illustrations on the next few pages reflect OMPAC devices, like GlobTop components are electrically the same.

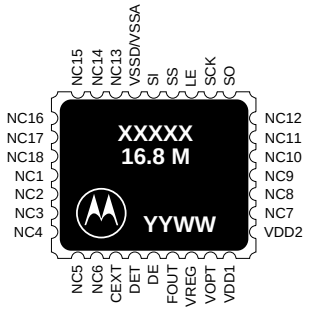
U101, ALC



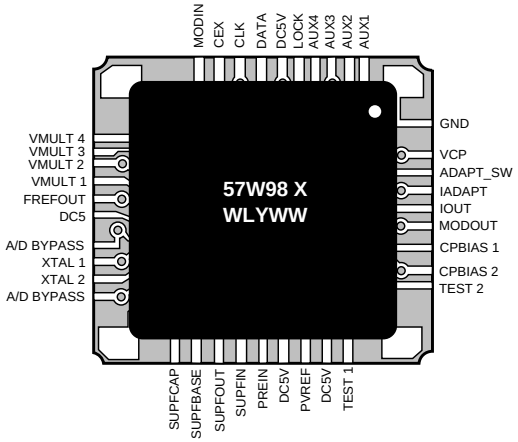
U102, D/A



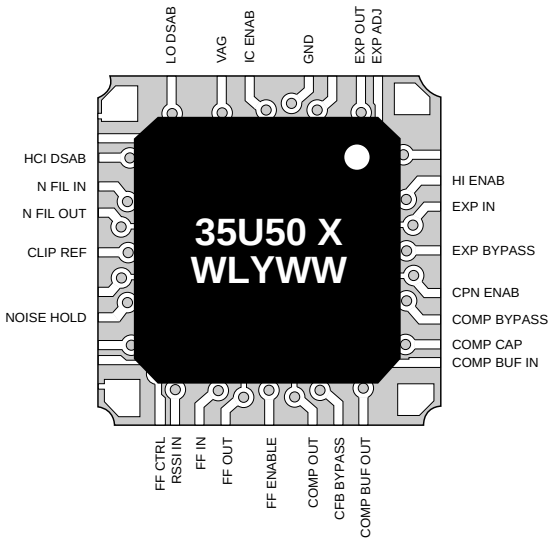
U203, REF. OSC.



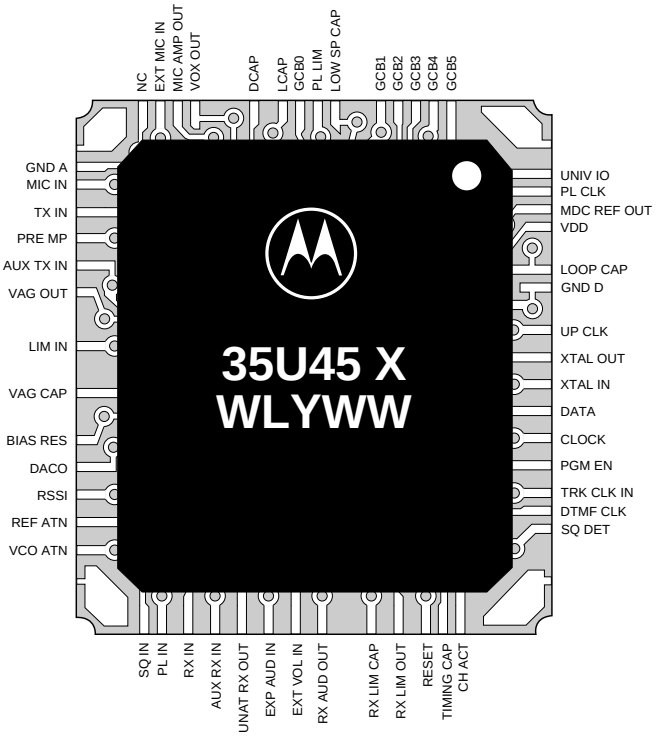
U204, SYNTHESIZER



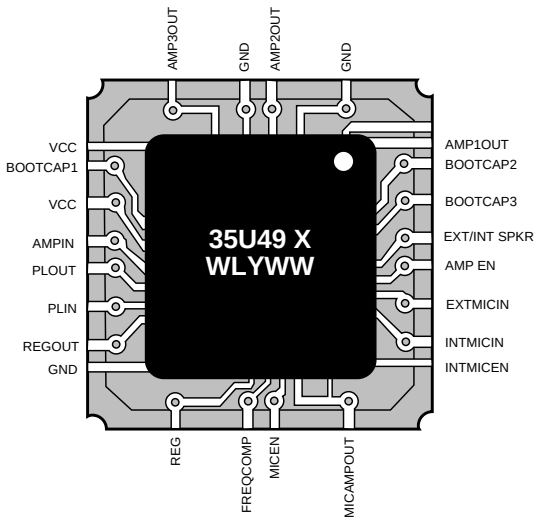
U601, HEAR CLEAR



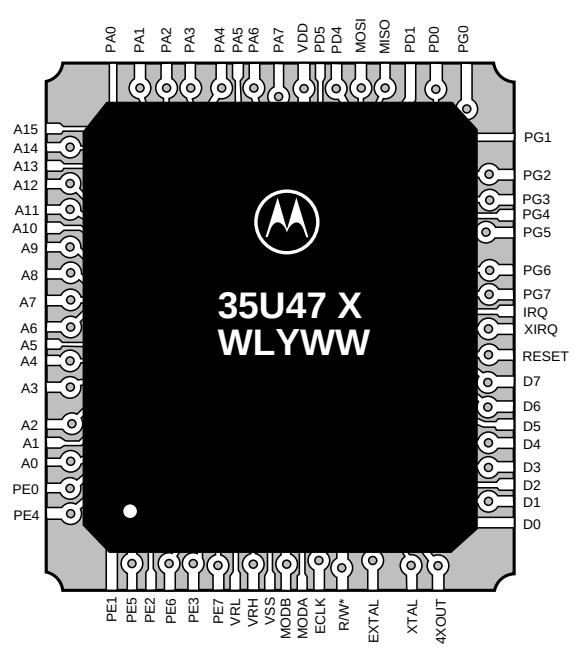
U701, ASFIC



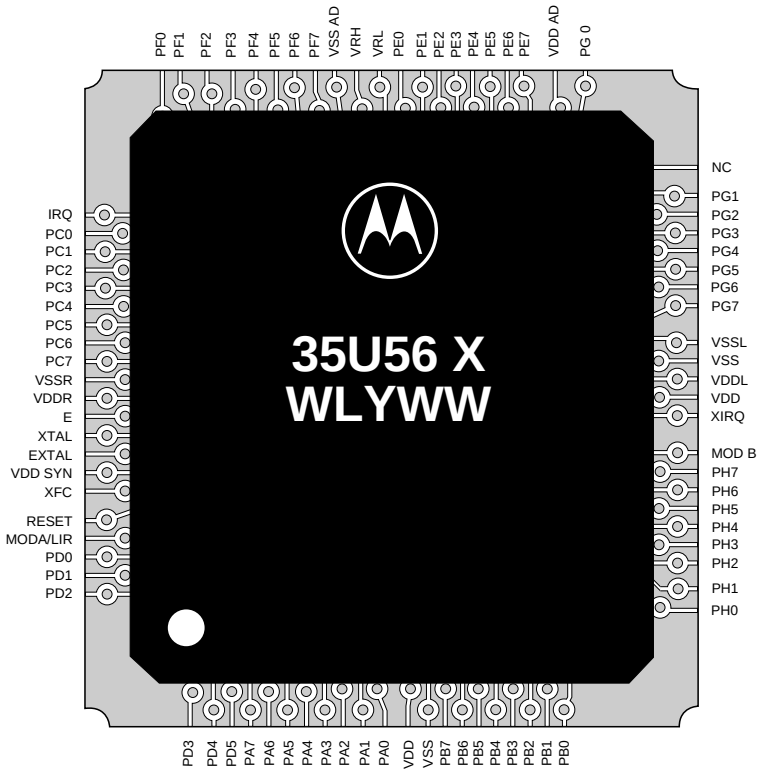
U702, AUDIO PA, Open Controller
U706, AUDIO PA, Closed Controller



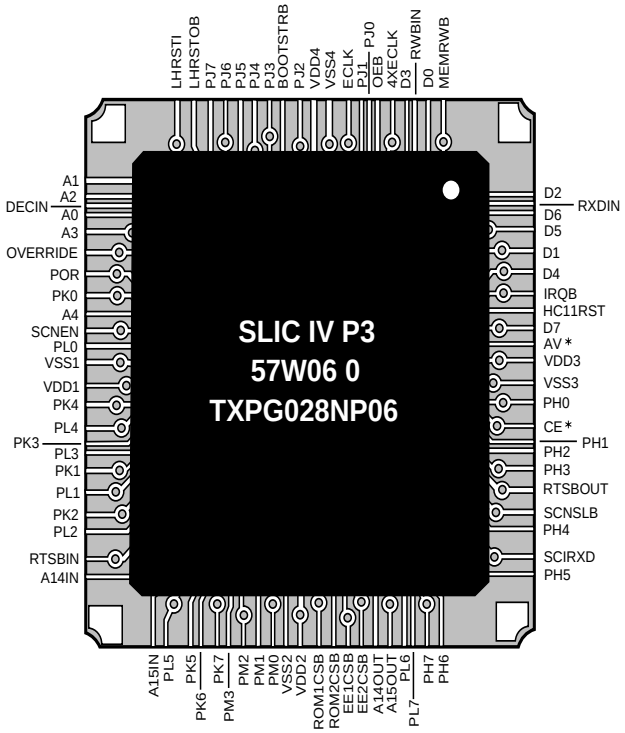
U705, MICROCOMPUTER
Open Controller



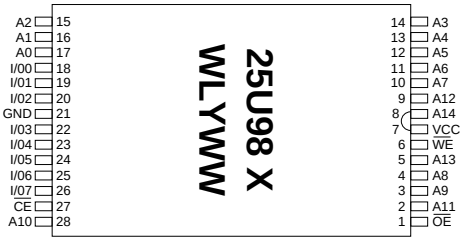
U705, MICROCOMPUTER
Closed Controller



U710, SLIC IV
Open Controller

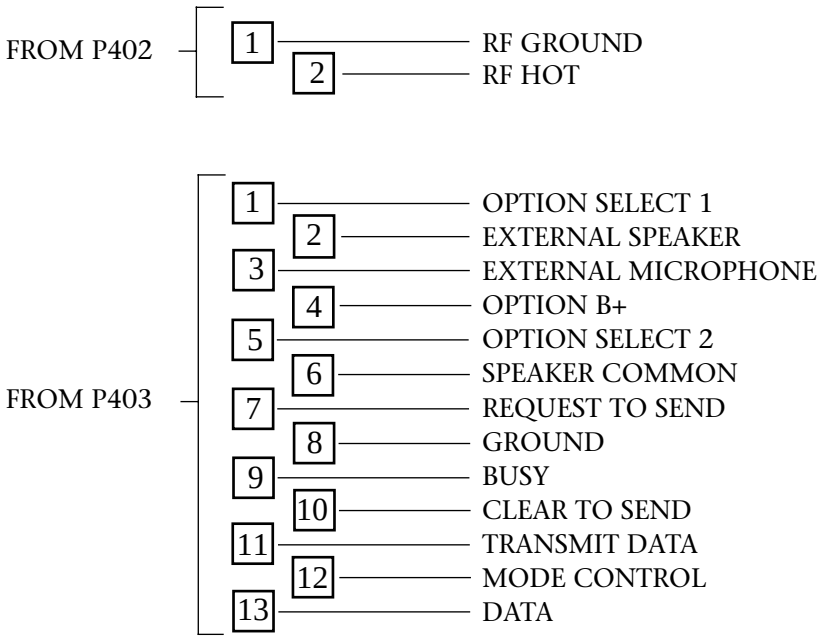


U713, EEPROM



U714, SCRAM

Universal Connector Pin Numbers and Signal Assignments



Universal Connector Option Select (OPT SEL) Definition

MODE #	MODE	OPT SEL 1	OPT SEL 2	COMMENT
00	External PTT	0	0	
01	External Audio	0	1	External Speaker
10	Mandown	1	0	
11	Normal Operation	1	1	
A	MTVA			Fixed Audio Output Level
B	“SMART” SB9600 Accessory			Identifies SB9600 Accessory
C	External RF Modem/FAX			Enables AUX TX and Discriminator Audio Output

Notes