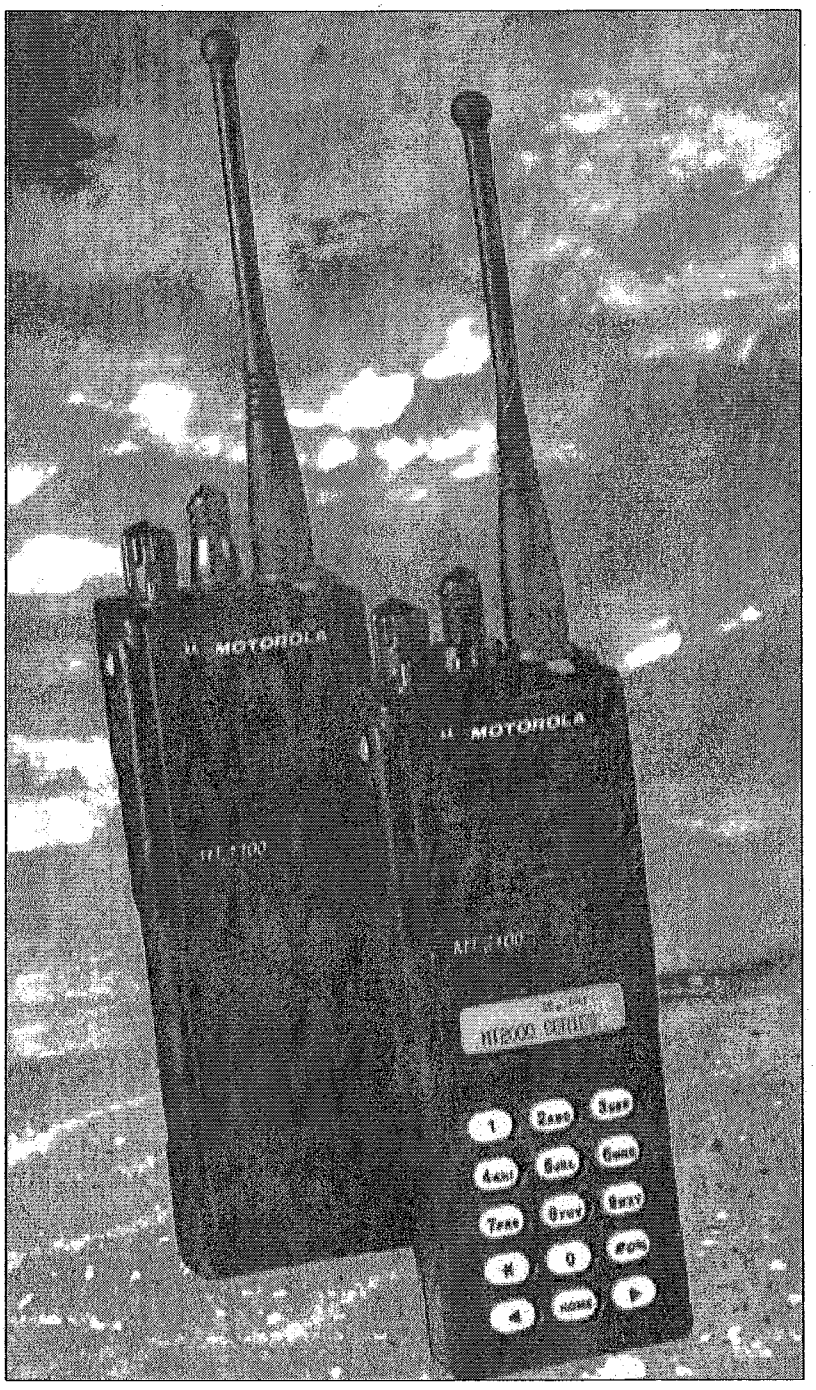
MOTOROLA

Portable Radiotelephones
68 - 88, 136 - 174, 403 - 470 & 450 - 520 MHz
Technical Manual



- GP900
- HT1100
- PTX1200
- GP1200
- MTS2000
- MT2100
- PTX3600
- GP3600

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SAFETY INFORMATION

During normal use, this radio will subject you to radio energy substantially below the level where any kind of harm is reported.

- **DO NOT** however hold the radio with the antenna very close to, or touching exposed parts of the body, especially the face or eyes, while transmitting. The radio will perform best if the microphone is 5 to 10 cm away from the mouth and the radio is vertical.
- **DO NOT** hold the transmit (PTT) key in when not actually desiring to transmit.
- **DO NOT** allow chrildren to play with any radio equipment containing a transmitter.
- **DO NOT** operate the radio near unshielded electrical blasting caps or in an explosive atmosphere.
- **DO NOT** dispose of the battery on a fire as it may explode.

INTRINSICALLY SAFE RADIO INFORMATION

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. Depending on the design of the portable unit, this FM label can be found on the back of the radio housing or the bottom of the radio housing.Their Approval mark is shown below.

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.

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 repairs and 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 Motorola communications equipment certified by Factory Mutual is tested as a system and consists of the FM Approved portable, FM Approved battery, and FM Approved accessories or options, or both. This Approved portable and battery combination must be strictly observed. There must be no substitution of items, even if the substitute has been previously Approved with a different Motorola communications equipment unit. Approved configurations are listed in the FM Approval guide published by FMRC, or in the product FM Supplement. This FM Supplement is shipped with FM Approved radio and battery combination from the manufacturer. The Approval guide, or the Approval standard Class Number 3605 document for repairs and service, can be ordered directly through Factory Mutual Research Corporation located in Norwood, Massachusetts.

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	N = 210 to 260MHz
B = 29.7 to 35.99MHz	P = 336 to 410MHz
C = 36 to 41.99MHz	Q = 403 to 437MHz
D = 42 to 50MHz	R = 438 to 482MHz
E = 367 to 395MHz	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 Display
E = Limited Keypad; No Display
F = Limited Keypad; With Display
G = Full Keypad; No Display
H = Full Keypad; With Display
J = Limited Controls; No Display
K = Limited Controls; Basic Display
L = Limited Controls; Limited Display
M = Rotary Controls; Standard Display
N = Enhanced Controls; Enhanced Display
P = Low Profile; No Display
Q = Low Profile; Basic Display
R = Low Profile; Basic Display, Full Keypad

Position 7 - Channel Spacing

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

Positions 13 - 16

"SP" Model Suffix

Position 12 - Unique Model Variations

C = Cenelec
N = Standard Package

Position 11 - Version

Version Letter (Alpha) - Major Change

Position 10 - Feature Level

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

Position 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 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*

MEPC-95355-C

LIST OF MODELS

CONVENTIONAL SYSTEMS RADIOS GP900 Model Family, Closed Architecture Controller						
Type Designation	Model Number	Frequency Range	Power Level	Physical Package	Ch. Spacing	No. of Freq.
PJ202C	H01FDC9AN1_N	68-88 MHz	1-5 Watts	No keypad	12.5/20/25 kHz	2
PJ202C	H01FDC9AN3_N	68-88 MHz	1-5 Watts	No keypad	12.5/20/25 kHz	16
PJ202J	H01FDG9AN1_N	68-88 MHz	1-5 Watts	3x5 keypad	12.5/20/25 kHz	2
PJ202J	H01FDG9AN3_N	68-88 MHz	1-5 Watts	3x5 keypad	12.5/20/25 kHz	16

INTRINSICALLY SAFE RADIOS GP900 Model Family, Closed Architecture Controller						
Type Designation	Model Number	Frequency Range	Power Level	Physical Package	Ch. Spacing	No. of Freq.
PJ301C	H01KCC9AN3_C	136-174 MHz	0.5-1 Watt	No keypad	12.5/20/25 kHz	16
PJ301J	H01KCG9AN3_C	136-174 MHz	0.5-1 Watt	3x5 keypad	12.5/20/25 kHz	16
PJ501C	H01RCC9AN3_C	403-470 MHz	0.5-1 Watt	No keypad	12.5/20/25 kHz	16
PJ501J	H01RCG9AN3_C	403-470 MHz	0.5-1 Watt	3x5 keypad	12.5/20/25 kHz	16

CONVENTIONAL SYSTEMS RADIOS HT1100 Model Family, Closed Architecture Controller						
Type Designation	Model Number	Frequency Range	Power Level	Physical Package	Ch. Spacing	No. of Freq.
PJ302C	H01KDC9AN1_N	136-174 MHz	1-5 Watts	No keypad	12.5/20/25 kHz	2
PJ302C	H01KDC9AN3_N	136-174 MHz	1-5 Watts	No keypad	12.5/20/25 kHz	16
PJ302J	H01KDG9AN1_N	136-174 MHz	1-5 Watts	3x5 keypad	12.5/20/25 kHz	2
PJ302J	H01KDG9AN3_N	136-174 MHz	1-5 Watts	3x5 keypad	12.5/20/25 kHz	16
PJ502C	H01RDC9AN1_N	403-470 MHz	1-4 Watts	No keypad	12.5/20/25 kHz	2
PJ502C	H01RDC9AN3_N	403-470 MHz	1-4 Watts	No keypad	12.5/20/25 kHz	16
PJ502J	H01RDG9AN1_N	403-470 MHz	1-4 Watts	3x5 keypad	12.5/20/25 kHz	2
PJ502J	H01RDG9AN3_N	403-470 MHz	1-4 Watts	3x5 keypad	12.5/20/25 kHz	16
PJ502D	H01RDD9AN3_N (SP01 MT6000E)	403-470 MHz	1-4 Watts	6 character top display, continuous rotary	12.5/20/25 kHz	99

CONVENTIONAL SYSTEMS RADIOS MT2100 Model Family, Open Architecture Controller						
Type Designation	Model Number	Frequency Range	Power Level	Physical Package	Ch. Spacing	No. of Freq.
PJ202D	H01FDD9AN4_N	68-88 MHz	1-5 Watts	6 character top display	12.5/20/25 kHz	16/32
PJ202D	H01FDD9AN5_N	68-88 MHz	1-5 Watts	6 character top display, continuous rotary	12.5/20/25 kHz	16/250
PJ202H	H01FDH9AN7_N	68-88 MHz	1-5 Watts	14 character front display, 3x5 keypad	12.5/20/25 kHz	250
PJ202H	H01FDH9AN8_N	68-88 MHz	1-5 Watts	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	250
PJ302D	H01KDD9AN4_N	136-174 MHz	1-5 Watts	6 character top display	12.5/20/25 kHz	16/32
PJ302D	H01KDD9AN5_N	136-174 MHz	1-5 Watts	6 character top display, continuous rotary	12.5/20/25 kHz	16/250
PJ302H	H01KDH9AN7_N	136-174 MHz	1-5 Watts	14 character front display, 3x5 keypad	12.5/20/25 kHz	250
PJ302H	H01KDH9AN8_N	136-174 MHz	1-5 Watts	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	250
PJ502D	H01RDD9AN4_N	403-470 MHz	1-4 Watts	6 character top display	12.5/20/25 kHz	16/32
PJ502D	H01RDD9AN5_N	403-470 MHz	1-4 Watts	6 character top display, continuous rotary	12.5/20/25 kHz	16/250
PJ502H	H01RDH9AN7_N	403-470 MHz	1-4 Watts	14 character front display, 3x5 keypad	12.5/20/25 kHz	250
PJ502H	H01RDH9AN8_N	403-470 MHz	1-4 Watts	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	250

LIST OF MODELS (CONTINUED)

INTRINSICALLY SAFE RADIOS MT2100 Model Family, Open Architecture Controller						
Type Designation	Model Number	Frequency Range	Power Level	Physical Package	Ch. Spacing	No. of Freq.
PJ301D	H01KCD9AN4_C	136-174 MHz	0.4-1 Watt	6 character top display	12.5/20/25 kHz	16/32
PJ301D	H01KCD9AN5_C	136-174 MHz	0.4-1 Watt	6 character top display, continuous rotary	12.5/20/25 kHz	16/250
PJ301H	H01KCH9AN7_C	136-174 MHz	0.4-1 Watt	14 character front display, 3x5 keypad	12.5/20/25 kHz	250
PJ301H	H01KCH9AN8_C	136-174 MHz	0.4-1 Watt	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	250
PJ501D	H01RCD9AN4_C	403-470 MHz	0.4-1 Watt	6 character top display	12.5/20/25 kHz	16/32
PJ501D	H01RCD9AN5_C	403-470 MHz	0.4-1 Watt	6 character top display, continuous rotary	12.5/20/25 kHz	16/250
PJ501H	H01RCH9AN7_C	403-470 MHz	0.4-1 Watt	14 character front display, 3x5 keypad	12.5/20/25 kHz	250
PJ501H	H01RCH9AN8_C	403-470 MHz	0.4-1 Watt	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	250

PRIVATE SYSTEMS RADIOS MTS2000 Model Family, Open Architecture Controller						
Type Designation	Model Number	Frequency Range	Power Level	Physical Package	Ch. Spacing	No. of Modes
PJ202H	H01FDH9PW1_N	68-88 MHz	1-5 Watts	14 character front display, 3x5 keypad	12.5/20/25 kHz	106
PJ202H	H01FDH9PW8_N	68-88 MHz	1-5 Watts	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	106
PJ302D	H01KDD9PW1_N	136-174 MHz	1-5 Watts	6 character top display	12.5/20/25 kHz	48
PJ302D	H01KDD9PW5_N	136-174 MHz	1-5 Watts	6 character top display, continuous rotary	12.5/20/25 kHz	48
PJ302F	H01KDF9PW1_N	136-174 MHz	1-5 Watts	14 character front display, 3x2 keypad	12.5/20/25 kHz	160
PJ302H	H01KDH9PW1_N	136-174 MHz	1-5 Watts	14 character front display, 3x5 keypad	12.5/20/25 kHz	106
PJ302H	H01KDH9PW8_N	136-174 MHz	1-5 Watts	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	106
PJ502D	H01RDD9PW1_N	403-470 MHz	1-4 Watts	6 character top display	12.5/20/25 kHz	48
PJ502D	H01RDD9PW5_N	403-470 MHz	1-4 Watts	6 character top display, continuous rotary	12.5/20/25 kHz	48
PJ502F	H01RDF9PW1_N	403-470 MHz	1-4 Watts	14 character front display, 3x2 keypad	12.5/20/25 kHz	160
PJ502H	H01RDH9PW1_N	403-470 MHz	1-4 Watts	14 character front display, 3x5 keypad	12.5/20/25 kHz	106
PJ502H	H01RDH9PW8_N	403-470 MHz	1-4 Watts	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	106

INTRINSICALLY SAFE RADIOS MTS2000 Model Family, Open Architecture Controller						
Type Designation	Model Number	Frequency Range	Power Level	Physical Package	Ch. Spacing	No. of Modes
PJ301D	H01KCD9PW1_C	136-174 MHz	0.4-1 Watt	6 character top display	12.5/20/25 kHz	48
PJ301D	H01KCD9PW5_C	136-174 MHz	0.4-1 Watt	6 character top display, continuous rotary	12.5/20/25 kHz	48
PJ301H	H01KCH9PW1_C	136-174 MHz	0.4-1 Watt	14 character front display, 3x5 keypad	12.5/20/25 kHz	106
PJ301H	H01KCH9PW8_C	136-174 MHz	0.4-1 Watt	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	106
PJ501D	H01RCD9PW1_C	403-470 MHz	0.4-1 Watt	6 character top display	12.5/20/25 kHz	48
PJ501D	H01RCD9PW5_C	403-470 MHz	0.4-1 Watt	6 character top display, continuous rotary	12.5/20/25 kHz	48
PJ501H	H01RCH9PW1_C	403-470 MHz	0.4-1 Watt	14 character front display, 3x5 keypad	12.5/20/25 kHz	106
PJ501H	H01RCH9PW8_C	403-470 MHz	0.4-1 Watt	14 character front display, 3x5 keypad, continuous rotary	12.5/20/25 kHz	106

MPT SHARED SYSTEMS RADIOS PTX1200/GP1200 Model Family, Open Architecture Controller						
Type Designation	**Model Number**	**Frequency Range**	**Power Level**	**Physical Package**	**Ch. Spacing**	**No. of Freq.**
PJ302H	H01KDH9CK7_N	136-174 MHz	1-5 Watts	14 character front display, 3x5 keypad	12.5 kHz	N.A.
PJ302D	H01KDD9CK4_N	136-174 MHz	1-5 Watts	No keypad	12.5 kHz	N.A.
PJ502H	H01RDH9CK7_N	403-470 MHz	1-4 Watts	14 character front display, 3x5 keypad	12.5 kHz	N.A.
PJ502D	H01RDD9CK4_N	403-470 MHz	1-4 Watts	No keypad	12.5 kHz	N.A.
PJ602H	H01SDH9CK7_N	470-520 MHz	1-4 Watts	14 character front display, 3x5 keypad	12.5 kHz	N.A.
PJ602D	H01SDD9CK4_N	470-520 MHz	1-4 Watts	No keypad	12.5 kHz	N.A.

INTRINSICALLY SAFE RADIOS GP1200 Model Family, Open Architecture Controller						
Type Designation	**Model Number**	**Frequency Range**	**Power Level**	**Physical Package**	**Ch. Spacing**	**No. of Freq.**
PJ301D	H01KCD9CK4_C	136-174 MHz	0.5-1 Watt	No keypad	12.5/20/25 kHz	N.A.
PJ301H	H01KCH9CK7_C	136-174 MHz	0.5-1 Watt	14 character front display, 3x5 keypad	12.5/20/25 kHz	N.A.
PJ501D	H01RCD9CK4_C	403-470 MHz	0.5-1 Watt	No keypad	12.5/20/25 kHz	N.A.
PJ501H	H01RCH9CK7_C	403-470 MHz	0.5-1 Watt	14 character front display, 3x5 keypad	12.5/20/25 kHz	N.A.

MEPC-95351-D

INTRODUCTION

SERVICE POLICY

This family of portable radios uses manufacturing technologies that requires a different maintenance and service strategy than used today. The high complexity radio and controller circuitry is built on multi-layer boards with surface mounted components. This manufacturing technology is relatively cheap and gives high quality which drastically will reduce the repair cycle time for customers, and also reduce the spare part inventory which will consist of boards and accessory items only.

The high Mean Time Between Failure (MTBF) means that maintenance and service is based on a "Field Replaceable Unit" (FRU) strategy.

Defective FRUs will be returned to a central repair shop in the factory for evaluation. The defective FRUs will, during the warranty period (one year), be exchanged with factory produced boards at special exchange prices. The advantage is fast feedback of quality problems to the manufacturing plant, maintain a high level of repair quality, and fulfill the customer satisfaction program for quality repairs.

MOTOROLA SERVICE SHOPS/DEALERS AND NATIONAL SERVICE CENTERS

The Motorola Service Shop/Dealer will perform a failure diagnosis of the radio to find the defective board.

and then swap the board while the customer is waiting. The radio software personality will be copied and reprogrammed by means of the RSS. The repair policy is as detailed in the Maintenance and Repair Procedures.

The swap strategy implies that the service shop/dealer will hold a stock of spare boards. Field Replaceable Units which are software programmable, will be preprogrammed with the firmware when shipped from the factory repair shop, leaving only programming of the radio personality to be done by the shop or dealer.

Spare accessories, ordered from Parts, will be held by the shop/dealer in the normal way.

The National Service Centre (NSC) will receive defective boards from local service shops/dealers, attach a tag with the fault description/symptom, and send them to the factory repair shop for exchange.

THE FACTORY REPAIR SHOP

The returned Field Replaceable Units will be replaced by new boards during the warranty period. Defective boards will be investigated by factory quality engineers for evaluation of repair possibilities. Normally, defective boards will be scrapped after technical investigation and registration. The factory will deliver new boards corresponding to received boards to the National Service Centers.

MAINTENANCE AND REPAIR PROCEDURES

THE USER

The user/customer performs normal preventive maintenance as described in the radio user guide. Defective radios are delivered to the dealer or Motorola Service Shop.

MOTOROLA SERVICE SHOP/DEALER SERVICE PROCEDURES

The Motorola Service Shop/Dealer is responsible for warranty repairs, initial trouble-shooting, minor mechanical repairs, board swapping, RSS programming and replacing of defective accessories.

RECOMMENDED AND REQUIRED TEST EQUIPMENT, SERVICE AIDS, AND TOOLS LIST

RECOMMENDED TEST EQUIPMENT

The list of equipment contained in the table below includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specifically for servicing the radio. 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.

MODEL NUMBER	DESCRIPTION	CHARACTERISTICS	APPLICATION
R2000 Series	System Analyzer	This monitor will substitute for items with an asterisk (*)	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1150C	Code Synthesizer		Injection of audio and digital signalling codes
*S1053D *HM-203-7 *SKN6008A *SKN6001A	220 VAC Voltmeter 110 VAC Voltmeter Power Cable for Meter Test Leads for Meter	1 mV to 300 V, 10-Mohm input impedance	Audio voltage measurements
*S1350C *ST1213B (VHF) *ST1223B (UHF)	Watt Meter Plug-in Element RF Dummy Load	50 ohm, ±5% accuracy 10 Watts, maximum 0-1000 MHz, 300 W	Transmitter power output measurements
R1065A	Load Resistor	10-watt Broadband	For use with Wattmeter
S1339A	RF Millivolt Meter	100 µV to 3 V rf 10 kHz to 1.2 GHz	RF level measurements
*R1013A	SINAD Meter		Receiver sensitivity measurements
S1347D or S1348D (programmable)	DC Power Supply	0-20 Vdc, 0-5 Amps current limited	Bench supply for 7.5 Vdc
* Any of the R2000 Series system analysers will substitute for items with an asterisk (*)			

Table 2.1 Recommended Test Equipment

SERVICE AIDS AND RECOMMENDED TOOLS

Refer to the "SERVICE AIDS" and "RECOMMENDED TOOLS LIST" for a listing and description of the service aids and tools designed specifically for servicing the radio, as well as the more common tools required to disassemble and properly maintain the radio.

These kits and/or parts are available from Motorola.

FIELD PROGRAMMING

The radio can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the "Radio Service Software User's Manual" for complete field programming information.

The following table lists service aids recommended for working on the radio. While all of these items are available from Motorola, most are standard shop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Part Number	Description	Application
RKN4035	RIB/Radio/Test Box Cable	Connects radio to RTX4005 test box and RIB.
ELN1505	Battery Eliminator	Used for Cenelec radios. Interconnects radio to power supply.
RLN1014	Battery Eliminator	Interconnects radio to power supply.
RLN4335	Battery Eliminator	With cigarette lighter adapter.
RLN1018	Test Fixture	Provides for test, troubleshooting and programming of the radio when the housing is removed.
RTX4005 or GTF285	Test Box	Enables connection to the universal connector. Allows switching for radio testing.
RLN4008	Radio Interface Box	Enables communications between the radio and the computer's serial communications adapter.
RLN1015	Smart Radio Interface Box	Enchanged version of RLN4008 capable of EPROM programming. Enables communications between the radio and the computer's serial communications adapter.
EPN4040	Power Supply	Used to supply power to the RIB (240 VAC).
EPN4041	Power Supply	Used to supply power to the RIB (220 VAC).
3080369B71	Computer Interface Cable	Connects the computer's asynchronous communications adapter to the RIB.
3080369B72	Computer Interface Cable	Connects the computer's serial communications adapter to the RIB.
3080390B48	Computer Interface Cable	Connects the computer's asynchronous communications adapter to the SRIB.
3080390B49	Computer Interface Cable	Connects the computer's serial communications adapter to the SRIB.
RKN4036	Cloning Cable	Allows a radio to be duplicated from a master radio by transferring programmed data from one radio to another (GP900/HT1100 models only)
GVN6007	MPT1327 1200 Series	Radio Service Software, 3 1/2" floppy disc, English
GVN6008	MPT1327 1200 Series	Radio Service Software, 3 1/2" floppy disc, German
GVN6009	MPT1327 1200 Series	Radio Service Software, 3 1/2" floppy disc, French
GVN6011	MT/MTS Series Select 5	Radio Service Software, 3 1/2" floppy disc, English
GVN6012	MT/MTS Series Select 5	Radio Service Software, 3 1/2" floppy disc, German
GVN6013	MT/MTS Series Select 5	Radio Service Software, 3 1/2" floppy disc, French
GVN6015	MT/MTS Series Select 5	Radio Service Software, 3 1/2" floppy disc, Spanish
EVN4140	900/1100/Visar Series	Radio Service Software, 3 1/2" floppy disc, English
EVN4143	900/1100/Visar Series	Radio Service Software, 3 1/2" floppy disc, German
EVN4144	900/1100/Visar Series	Radio Service Software, 3 1/2" floppy disc, French
EVN4145	900/1100/Visar Series	Radio Service Software, 3 1/2" floppy disc, Spanish
RVN4097	MT/MTS Series	Radio Service Software, 3 1/2" floppy disc, English
SDVN4325	MT/MTS Series Secure Select 5	Radio Service Software, 3 1/2" floppy disc, English
SDVN4319	MT/MTS2010/2013 Series	Radio Service Software, 3 1/2" floppy disc, English/German
5880348B33	SMA to BNC Adaptor	Adapts radio's antenna port to BNC cabling of test equipment to measure RF power. RF power from the side connector is measured with a public speaker/mic accessory.
RLN4201	Battery Tester	Tests battery charge.
RLN4048	Battery Tester Adaptor	Adapts radio batteries to the RLN4201 Battery Tester.
RKN4037	Cable/clip	7.5 V for use with RLN4201 and RLN4048.

Table 2.2 Service Aids

The following table lists the tools recommended for working on the radio; these also are available from Motorola. Note that the R-1070A workstation requires the use of a specific "heat focus head" for each of the components on which this item is used. Each of these heat focus heads must be ordered separately. The individual heat focus heads (and the components on which they are used) are listed at the end of the table.

Part number	Description	Application
6680387A59	Extractor, 2 contact	Removal of discrete surface-mounted devices
6680387A64	Heat controller with safety stand, or	
6680387A65	Safety stand only	
0180382A31	Portable desoldering unit	
6680375A74	0.025 replacement tip, 5/pk	For 0180382A31 portable desoldering unit
0180386A81	Miniature digital readout soldering station (incl. 1/64" micropoint tip)	
0180386A78	Illuminated magnifying glass with lens attachment	
0180386A82	Anti-static grounding kit	Used during all radio assembly and disassembly procedures
6684253C72	Straight probe	
6680384A98	Brush	
1010041A86	Solder (RMA type), 63/37, 0.020" diameter- 1 lb. spool	
1080370B43	RMA liquid flux	
R-1070A	Shields and surface-mounted component - IC removal/rework station (order all heat focus heads separately)	Removal of surface-mounted integrated circuits

Heat Focus Heads	Inside Dimensions of Heads	Used on
6680334B49	0.410" x 0.410"	U601, U702
6680334B50	0.430" x 0.430"	U4, U5, U713
6680334B51	0.492" x 0.492"	U3
6680334B52	0.572" x 0.572"	U701, U705
6680334B53	0.670" x 0.790"	* metal shields B, C, E, and F
6680370B51	0.475" x 0.475"	U204
6680370B54	0.710" x 0.710"	U710
6680370B57	0.245" x 0.245"	U2, U201
6680370B58	0.340" x 0.340"	U101, U102
6680370B66	0.180" x 0.180"	U101, U102
6680371B15	0.460" x 0.560"	* metal shields A, D, G, H, and I
6680371B74	0.470" x 0.570"	U203
* Refer to the SHIELDS LOCATION DETAIL and Shields Parts List in the rear of this manual to match the shield with the proper heat focus head		

Table 2.3 Recommended Test Tools

MAINTENANCE

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

The radios do not require a scheduled preventive maintenance program; however, periodic visual inspection and cleaning is 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, housing assembly, 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 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 Internal Circuit Boards and Components

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

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

Upon completion of the cleaning process, use a soft, absorbent, 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 attributes 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, special precautions must be taken 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.

GENERAL REPAIR PROCEDURES AND TECHNIQUES

Refer to the Disassembly and Reassembly section prior to replacing and substituting parts.

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 compo-

nent from the nearest Motorola Communications Parts office.

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 REPAIR PROCEDURES AND TECHNIQUES

Refer to the Disassembly and Reassembly section prior to replacing and substituting parts.

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.

***N**ote:*
The RF switch spring and the RF switch piston must be ordered separately.

To remove the RF switch:

1. 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 2.1 and use a small heat-focus head to distribute heat over the area occupied by the three solder tabs until the solder softens.
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 step (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 add a small dot of flux to each of the solder pads.

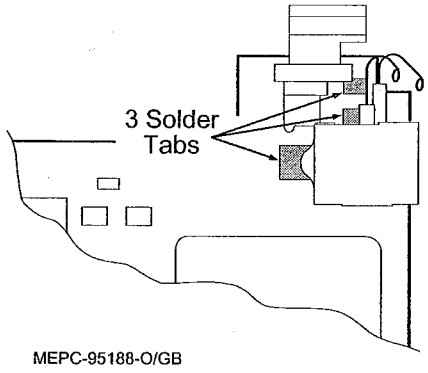


Figure 2.1

To replace the RF switch:

1. Place the RF switch circuit board 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 solder pad geometry between the two circuit boards should provide self alignment. But, a visual inspection should be made to make sure that the notches on the RF switch board do not cover the holes in the main rf board.
2. Place the two plastic alignment pins of the new RF switch assembly into the respective holes on the RF board, making sure to fully bottom the plastic housing on the RF board. Use a soldering iron to solder down the bracket tab, then the two

solder tabs of the plastic switch housing. Take care not to melt the plastic housing. A small amount of force may be applied to the bracket to aid in seating. Be careful in applying force, as excessive force during reflow will cause solder 'squeeze' and, as a result, shorting between adjacent solder pads.

3. While holding the RF switch bracket firmly against the RF board, 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.
4. 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 CARRIERS

Using the appropriate heat-focus heads and settings as specified in Table 2.3, remove and repair all prebumped chip carriers per the procedure outlined in the National Service Technician's Guide to Repairing Leadless Component Assemblies (TT907A). The duration of heating time at the maximum prescribed heat should not exceed sixty seconds.

Caution:
All prebumped carriers removed from a circuit board are not able to be reapplied because of the need for a very controlled amount of solder on each of the pads.

THIN SMALL OUTLINE PACKAGE (TSOP), U714, U715

To remove, apply a small amount of flux to the tops of all the leads. This allows for a smooth pad after part removal. Gently heat both ends of the TSOP using the appropriate heat-focus head until all the leads are lose in the solder; then remove by lifting straight up. Unsoldering and lifting one side at a time could cause a tearing of the solder pads on the opposite side and is therefore not recommended. To apply a new TSOP, reflow and level the solder pads to make them as uniform as possible. Add or remove solder as required. Clean the pads thoroughly, then apply small dots of flux to each of the pads. Use the tackiness of the flux to assist in holding of the part during placement. During heating, the part should self center, but a visual inspection should be done to ensure there are no solder shorts and all the leads are soldered.

SHIELDS

Using the appropriate heat-focus heads and settings as specified in Table 2.3, remove and repair all soldered-down shields per the procedure outlined in the National Service Technician's Guide to Repairing Leadless Component Assemblies (TT907A). It is recommended that the R-1070A Repair Station be used when servicing soldered- down shields. The duration of heating time at the maximum prescribed heat should not exceed sixty seconds.

DISASSEMBLY AND REASSEMBLY

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

- *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.*
- *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.*
- *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.*
- *Do not wear nylon clothing while handling CMOS devices.*
- *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.*
- *When straightening CMOS pins, provide ground straps for apparatus used.*
- *When soldering, use a grounded soldering iron.*
- *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 becomes important for the technician to pay particular attention to the snaps and tabs, and how parts align with each other.

DISASSEMBLY TO BOARD LEVEL

1. Turn off the radio.
2. Remove the battery (See Figure 3.1)
   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 away from the radio.

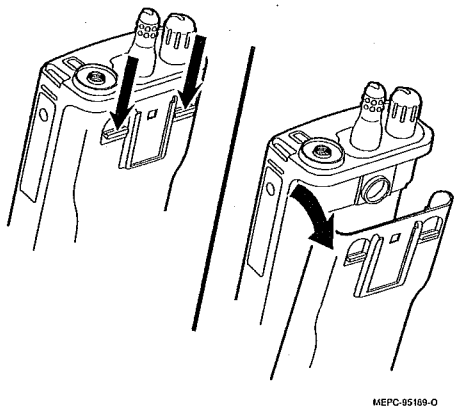


Figure 3.1

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 puling 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 3.2).

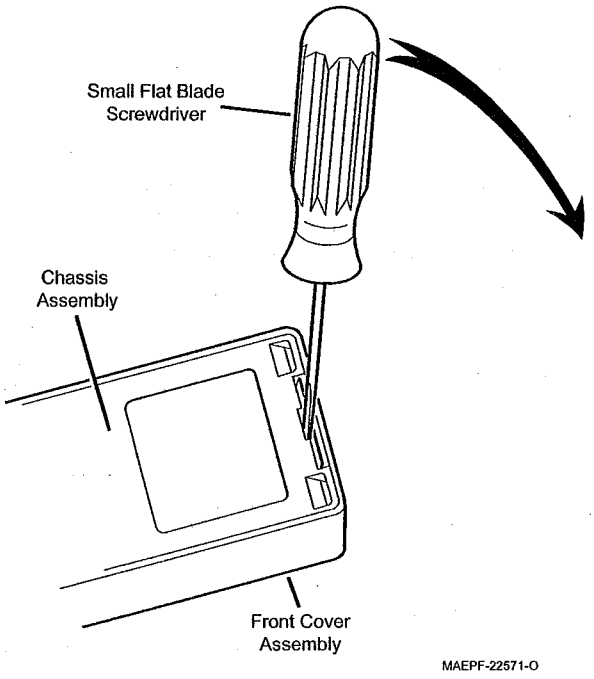


Figure 3.2

a Insert small flat blade screwdriver 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.

b Pry the bottom of the chassis free from the cover by pushing the screwdriver down and rotating the handle of the screwdriver 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 3.3).

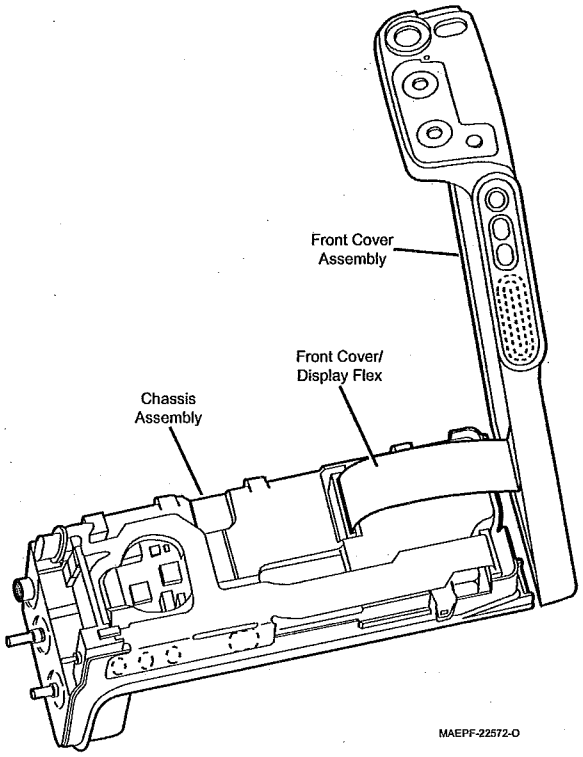


Figure 3.3

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 3.4).

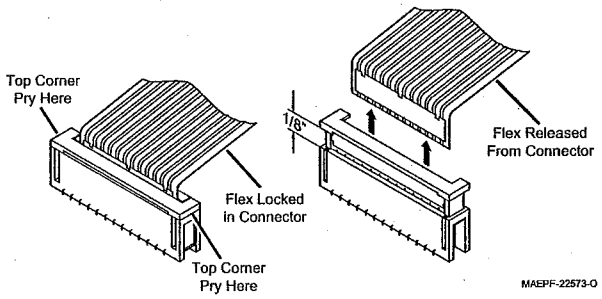


Figure 3.4

a Use a small, thin, flat blade screwdriver (or like instrument) to help raise the sliding portion of the connector approximately 3 mm from its seated position. A slight prying action, alternating back and forth on the top corners of the connector, achieves 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 steps 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 unless it is absolutely necessary.

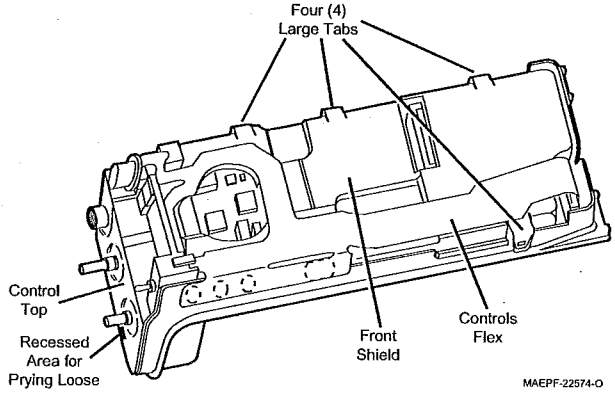


Figure 3.5

9. As a unit, separate the control top, the front shield, and the controls flex from the chassis and circuit boards (See Figure 3.5).

Note:
Four large tabs secure the front shield to the chassis and hold the RF board and the controller board in the chassis.

a Loosen the front shield by prying each of the four tabs away from the chassis. Be careful not to pry the tabs anymore than is necessary to free them from their respective retaining slots. To loosen the shield completely 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 3.6.

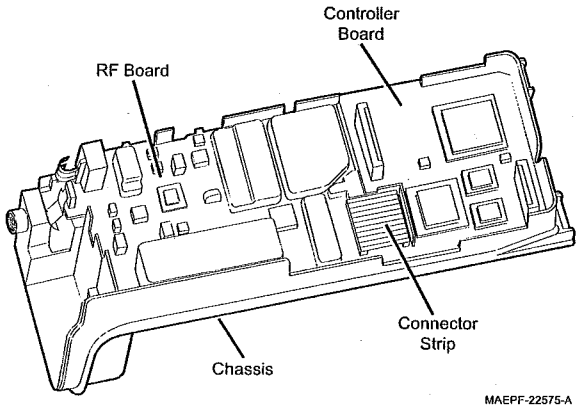


Figure 3.6

DISASSEMBLY OF CONTROL TOP

1. Remove the rubber controls seal from the control top.
2. Turn the control top such that the black 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 3.7).

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.

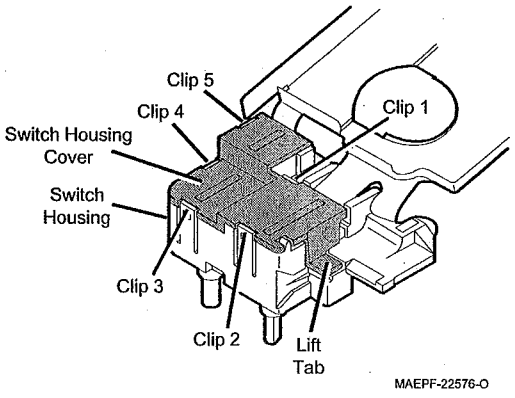


Figure 3.7

   b Using your thumbnail or small flat blade screwdriver, lift the tab that covers the base of the LED approximately 2 mm from its seated position. While applying constant lifting pressure there, (in order) release clips 1, 2, and 3 with the other tool.
   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 edge connector (part of the front cover flex, located behind the universal connector), by sliding 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 3.8).

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.

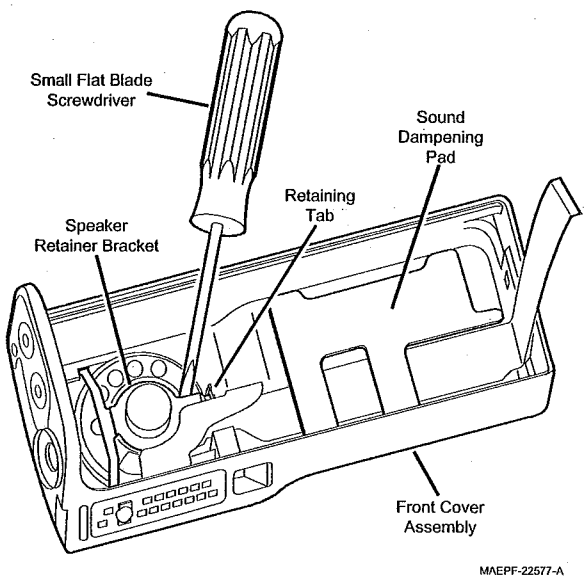


Figure 3.8

   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 the microphone, 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 3.9). 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 so as to compromise the sealing integrity.

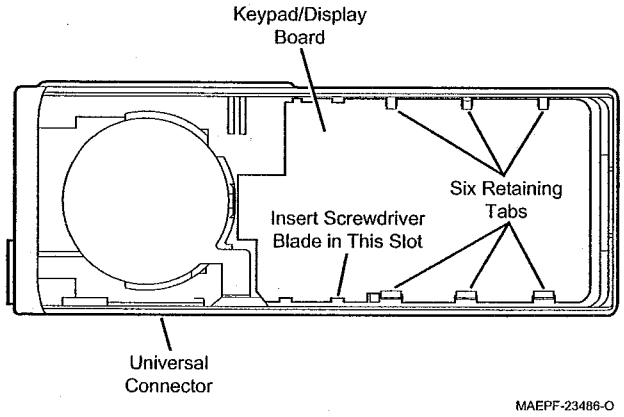


Figure 3.9

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 slid 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 3.10).

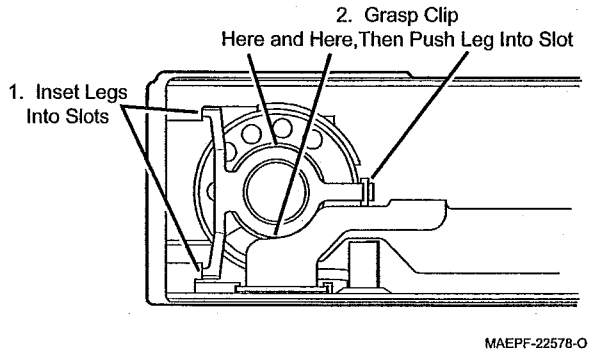


Figure 3.10

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 edge connector so that its gold contacts face the gold contacts of the housing. Align the edge connector with the respective slots in the housing, and slide the connector down into place. Ensure that the edge 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) is coated with a thin film of thermal compound (Motorola part number 1110022A55) or Thermal Pad 7505922Z01 is adhered to the surface.

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 four large tabs 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. 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 3.11). 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.

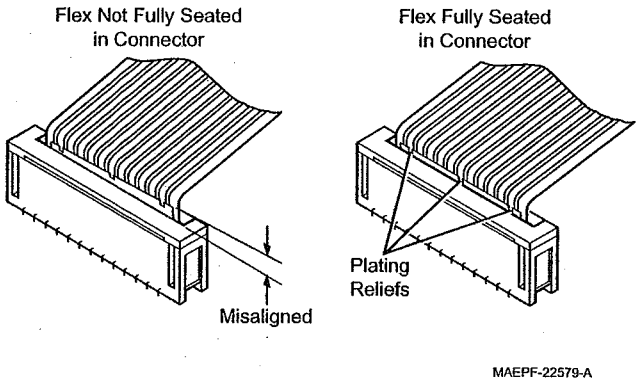


Figure 3.11

4. 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 3.12).

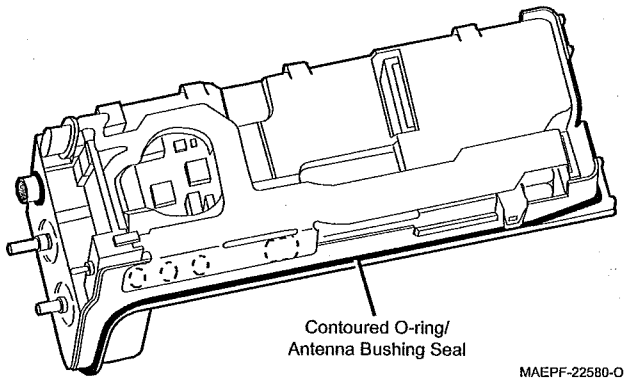


Figure 3.12

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 3.3). 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 described in step 3 of "Control Top/Front Shields..." above.
3. Check to make sure that the O-ring is in place, and slide the chassis (switch end 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 may be necessary.

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

Reinstall the battery.

TRANSCEIVER PERFORMANCE TESTING

CLOSED ARCHITECTURE RADIOS

GENERAL

Performance testing can be carried out using the Test Mode software contained in the radio. This allows the technician to select test frequencies, to configure the radio hardware in a number of predefined ways and monitor a set of radio parameters (Table 4.5 and Table 4.6). The equipment set-up required for performance testing is connected as shown in Chapter 5 - Radio Alignment Procedure.

The test mode or the "Air Test" consists of an RF Test Mode and a CH (Control Head) Test Mode. The RF Test Mode allows performance checking on the transmitter and receiver sections of the radio and the Control Head Test Mode allows the radio controls to be tested.

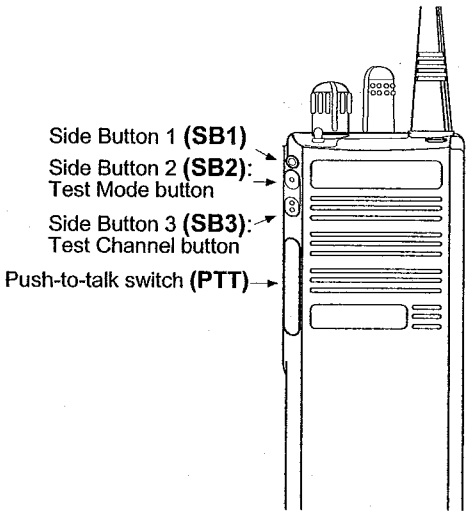
TEST MODE FEATURES

On entering Test Mode, the test mode application will examine the radio model number field of the radio codeplug in order to determine the type of radio and application it is operating within to decide how to support the specific test mode functions for that model.

The radio will be in an idle state, all indicators are extinguished and a keypad acknowledge alert will be sounded.

Keypad alerts will sound as feedback to indicate the channel number/test environment to the user.

Test mode control is provided by the two side buttons, SB2 and SB3.



Test mode button **SB2**, is used to scroll through the test mode environments (Table 4.1). Test channel function button **SB3** is used to enter the RF and CH Test Modes and also to scroll through the list of test channels (Table 4.4).

When the radio is in RF test mode the PTT button is used to key and de-key the transmitter. When the transmitter is keyed the red LED will be illuminated.

RF TEST MODE ENTRY

- Turn the radio on.
- Within ten seconds after the self test is complete, press SB3 five times in succession, ensuring that the first press is within 2 seconds after self test.
- After a keypad acknowledge alert, the radio is on Test Frequency Channel 1, Carrier Squelch Test Environment.
- Each additional press of SB3 will advance to the next test channel (refer to Table 4.4), and a corresponding number of alerts will indicate the channel number.
- Pressing SB2 will scroll through and access test environments as shown in Table 4.1.

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

No. OF BEEPS	ENVIRONMENT	FUNCTION
1	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
3	Tone Private-Line	RX: unsquelch if carrier and tone detected TX: mic audio + tone
7	Dual-Tone Multiple Frequency	RX: not applicable TX: pre-defined DTMF tone pair
13	Select 5	RX: not applicable TX: mic audio + tone

Table 4.1 Test Environments

CONTROL HEAD TEST MODE ENTRY

- Enter the RF Test Mode.
- Press the Test Channel button (SB3) for 4 seconds, when a "beep" is heard.
- The green LED flashes continuously.
- All radio controls (switches, knob and keypad buttons) are tested by operating each one in turn and listening for a corresponding "beep".

To exit either the RF Test Mode or the CH Test Mode, turn the radio off.

OPEN ARCHITECTURE SELECT 5 RADIOS

GENERAL

The test mode allows the technician to monitor a set of radio parameters, to configure the radio hardware in a number of predefined ways, and have access to a number of test procedures.

Two basic areas of functionality are provided by the Test Mode:

- RF test mode - allows the RF functionality of the radio to be tested.
- CU (Control Unit) test mode - allows the radio display, buttons and switches to be tested.

The purpose of the test mode is to test the radio unit and its interfaces, but not to test the various accessories.

Test mode operation is fundamentally the same for radios with 6 character displays and radios with 14 characters displays. The only difference is the manner in which 6 character display radios handle large amounts of information.

> ***Note:***
> *Due to the reduced size of the 6 character display, it is necessary to spread some information over several displays. This information is then presented as a rotating display to the user.*

TEST MODE FEATURES

On entering Test Mode the radio will be in an idle state, all indicators are extinguished and the "RF TST" Mode Select menu message will be displayed.

Test mode control is provided by two Side Buttons and a set of menus (left-hand flushed) which may be scrolled through and selected. The buttons are used to scroll through and select these menus.

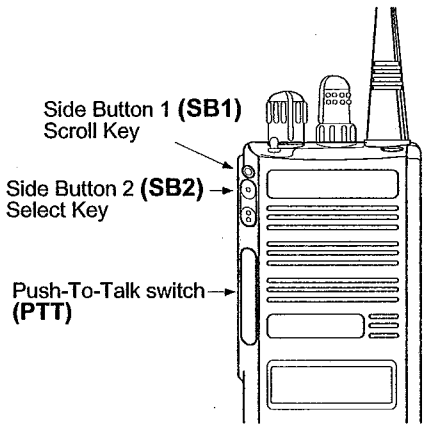
When the radio is in RF test mode the PTT button is used to key and de-key the transmitter. Whenever the transmitter keys up, the test mode application illuminates the red LED and whenever the transmitter keys down the application extinguishes the red LED.

ON ALL MENUS:

- CLEAR will clear the display.
- END will return the radio to the RF TST/CU TST Mode Select level.
- All selections are confirmed by a short "beep".

TEST MODE ENTRY

- Turn the radio on.
- Within ten seconds after power on press the PTT five (5) times, ensuring that the first press is within one second after power on.



- On entry, the "SERVICE" test mode message is displayed for 2 seconds. Following this, each of the following is displayed in sequence:
  - radio software part number
  - radio model number
  - radio serial number

  Each of these "temporary messages" lasts for 2 seconds. After the radio serial number has been displayed for 2 seconds, the display is blanked.
- Pressing SB1 while one of the above "temporary messages" is displayed, cancels the display sequence and directly blanks the radio display.
- Within 6 seconds after the display is blanked the test mode entry password must be entered. The password is as follows:
  - 1 time SB1
  - 2 times SB2
  - 1 time SB1
  - PTT

> ***Note:***
> *In earlier radio software versions no password is required to enter service mode, i. e. after the "temporary messages" the radio enters service mode and the "RF TST" test mode message is displayed.*

The password must be entered correctly the first time, no re-tries are allowed. If an incorrect password is entered, turn off the radio and repeat the power up sequence.

- If the correct password is entered the radio enters test mode and the "RF TST" test mode message is displayed

To exit either the RF Test Mode or the CU Test Mode turn the radio off.

RF/CU TEST MODE SELECT

Pressing the scroll key, **SB1**, alternates between the two Mode Select menus "RF TST" and "CU TST". To select either the RF or CU test menu press **SB2** while the desired menu is being displayed.

RF TEST MODE

On entry into the RF test mode the radio hardware will be configured for the default carrier squelch (CSQ) test mode environment, and the test mode application will examine the following parameters contained in the personality area of the radio codeplug:

- Frequency Range (Midband, VHF or UHF)
- Channel Step Size (5 or 6.25 kHz)
- Tx Channel Number.
- Rx Channel Number.
- Transmit Deviation (0, 2.5, 4 or 5 kHz).
- Channel Bandwidth (12.5, 20 or 25 kHz).
- Transmitter Power Level (1st, 2nd, 3rd or 4th).

TEST MODE ENVIRONMENTS

When the RF menu message **ENVIRO** is displayed, press the select key **SB1** to gain access to the RF test mode environments:

CSQ (Carrier Squelch) . . . (Default)

UNSQ (Unsquelch)

TPL (Tone Private Line)

DTMF (Dual Tone Multi-Frequency)

RC DPL (Radiocom 2000 Digital Public)

RC TR (Radiocom 2000 Trunking)

MPT TR (MPT 1327 Trunking)

SEL 5 (Select 5)

When the appropriate environment is selected the test mode application will configure the radio hardware for this environment.

CHANNEL NUMBERS

From the RF menu select CHAN to gain access to the Channel Number menu messages: 1, 2, ...n and CLEAR (n is the highest channel number specified by theTx/Rx pairs field). The test mode application will examine the number of Tx/Rx pairs field contained in the personality area of the radio codeplug in order to determine how many different channel number menu messages to display. Selecting one of the channel numbers will reconfigure the radio hardware with the specific transmit/receive frequency.

The resulting frequencies will be as follows:

- Transmit frequency: Offset frequency + (Tx channel number #n * Channel step size).
- Receive frequency: Offset frequency + (Rx channel number #n * Channel step size).

The Rx/Tx channel number #n and Channel step size values are extracted from the personality area of the radio codeplug and the offset frequency is derived from the offset frequency calculation performed on entry into RF test mode.

TRANSMIT POWER LEVELS

From the RF menu select **POWER** to gain access to the Transmit power levels: 1st, 2nd...nth (n is the highest power level specified by the highest power level field). The test mode application will examine the highest supported power level field contained in the personality area of the radio codeplug in order to determine how many different power level messages to display. Selecting one of the power levels will re-configure the radio hardware with the specific power level.

CHANNEL BANDWIDTH

From the RF menu select **B/W** to gain access to the Channel Bandwidth menu messages: 12.5, 20, 25 and CLEAR. Selecting any one of the bandwidths will reconfigure the radio hardware with the specific channel bandwidth.

CU TEST MODE

On entry into the Control Unit test mode, all front panel indicators and display segments are displayed for a period of 5 seconds, and then extinguished. When the radio is in Control Unit test mode, all front panel momentary button presses/releases (apart from the dedicated scroll and select keys and the volume control), static switch activations and free revolving rotary activations are monitored. When any one of these is detected a short 'bip' will be heard and the associated button code (in decimal) and state will be displayed on the front panel.

OPEN ARCHITECTURE TRUNKED RADIOS

GENERAL

The 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 4.2

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

Table 4.2 Equipment Initial Control Settings

- When testing TX deviation, where the modulation is greater than 1 kHz, set the Service Monitor low pass filter (LPF) to 15 kHz.
- The Test Set MT/PL switch controls internal/external audio switching.

RF TEST MODE

When the 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 4.4.)
5. Pressing SB2 will scroll through and access test environments as shown in Table 4.3.

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 4.3.

CONTROL HEAD TEST MODE

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.

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 (192.8 Hz) detected TX: mic audio + tone (192.8 Hz)
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 (105.8 Hz) @ correct deviation
6	THS	Trunking	RX: unsquelch if valid outbound signalling word (OSW) detected High Speed TX: 1500 Hz 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: 1500 Hz tone
9	SEC	Secure***	RX: auto-coded clear TX: with key present - encrypted audio with key absent - constant unsquelch

Table 4.3 Test Environments

* radios without display indicate function by emitting a number of beeps
** on 900 MHz radios only
*** on radios equipped with secure option

No. of Beeps	Test Channel	Midband	VHF	UHF 403-470 MHz	UHF 450-520 MHz
1	TX #1	68.175	136.025	403.100	450.025
	RX #1	68.225	136.075	403.150	450.075
2	TX #2	71.450	142.125	424.850	465.225
	RX #2	71.500	142.175	424.900	465.275
3	TX #3	75.525	154.225	438.050	475.225
	RX #3	75.575	154.275	438.100	475.275
4	TX #4	77.600	160.125	444.050	484.975
	RX #4	77.650	160.175	444.100	485.025
5	TX #5	81.800	168.075	456.350	500.275
	RX #5	81.850	168.125	456.400	500.225
6	TX #6	85.100	173.975	463.700	511.975
	RX #6	85.150	173.925	463.750	511.925

Table 4.4 Test Frequencies

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, Test Channel 4 carrier squelch output at antenna	PTT to continuous (during the performance check)	Frequency error to be ±150 Hz
Rated Audio	Mode: GEN Output level: 1.0 mV RF 4th channel test frequency* Mod: 1 kHz tone at 3 kHz deviation (1.5 kHz deviation for 12.5 kHz system) Monitor: DVM: AC Volts	TEST MODE, Test Channel 4 carrier squelch	PTT to OFF (center), meter selector to Audio PA	Set volume control to 3.74 Vrms
Distortion	As above, except to distortion	As above	As above	Distortion <3.0%
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12 dB SINAD	As above	PTT to OFF (center)	RF input to be <0.35 µV
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 3.74 Vrms
	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 <0.25 µV. Preferred SINAD =8-10 dB

Table 4.5 Receiver Performance Checks

* SeeTable 4.4

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, Test Channel 4 carrier squelch	PTT to continuous (during the performance check).	Frequency error to be <150 Hz.
Power RF	As above.	As above	As above.	
Voice Modulation**	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	As above, meter selector to mic.	Deviation: MB, VHF and UHF: ≥3.6 kHz but ≤5.0 kHz.
Voice Modulation (internal)**	Mode: PWR MON 4th channel test frequency* atten to –70, input to RF In/Out.	TEST MODE, Test Channel 4 carrier squelch output at antenna	Remove modulation input.	Press PTT switch on radio. Say "four" loudly into the radio mic. Measure deviation: MB, VHF and UHF: ≥3.8 kHz but ≤5.0 kHz
High-Speed Data Modulation***	As above	TEST MODE, Test Channel 4 THS output at antenna	PTT to continuous (during the performance check).	Deviation: UHF: ≥2.4 kHz but ≤3.6 kHz
DTMF Modulation	As above, 4th channel test frequency*	TEST MODE, Test Channel 4 DTMF output at antenna	As above.	Deviation: MB, VHF and UHF: ≥3.05 kHz but ≤3.45 kHz
PL/PDL 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: MB, VHF and UHF: ≥500 Hz but ≤ 1000 Hz
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: 1 kHz Out level for 25 mVrms at test set.	Conventional talk-around personality (clear mode operation). 1CSQ	As above.	Deviation: UHF: ≥3.8 kHz but ≤ 5.0 kHz
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: 1 kHz Out level for 25 mVrms at test set.	Conventional talk-around personality (secure mode operation), Load key into radio 1 sec.	As above.	Deviation: UHF: ≥3.6 kHz but ≤ 4.4 kHz

Table 4.6 Transmitter Performance Checks

* SeeTable 4.4

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

*** Trunked Only

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

ERROR CODE DISPLAYS TRUNKED RADIOS

Note:
Error codes for other models are listed in Appendix B.

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 4.7 to aid in understanding particular power-up error code displays.

FAILURE DISPLAY		TYPE OF FAILURE	DESCRIPTION	POSSIBLE SOURCE
14-Character Display	6-Character Display			
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
ERROR 01/02	E01/02	NON-FATAL	External EEPROM checksum error	Bad external codeplug data
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
ERROR 01/12	E01/12	NON-FATAL	Internal EEPROM checksum error	Bad internal codeplug data
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

Table 4.7 Power-up Display Codes

Note: Due to the nature of fatal ROM & 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 4.8 to aid in understanding particular operational error code displays.

FAILURE DISPLAY		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

Table 4.8 Operational Display Codes

TRUNKED MPT 1327 DIAGNOSTICS MODE

Note:
Calls which would normally make use of the numeric keypad may not be made whilst in diagnostics mode as the keypad has an alternative use whilst in this mode. Only trunked mode options that do NOT require use of the numeric keypad may be used (i.e. calls to units from the calls in absence list, last number redial calls, dedicated call button calls, emergency calls, and rotary switch calls can all be made), but the display will not provide the usual information associated with these calls when made in trunked mode.

The diagnostics mode allows the technician to monitor system and radio parameters. The diagnostics mode may be entered at any time during the radio's trunked mode operation. The trunked mode will continue to operate, e.g. if the radio was active on a traffic channel then it will be able to transmit and receive as normal.

The diagnostics mode may also be entered when the radio is powered up with no personality programmed. Only a subset of the features will be supported in this case.

Alert tones will continue to be sounded by the radio and the diagnostics display will be briefly overwritten by trunked mode messages.

DIAGNOSTICS MODE FOR 14 CHARACTER DISPLAY MODELS

DIAGNOSTICS MODE ENTRY

The diagnostics mode is entered by entering 120# via the keypad, followed by the required Feature number 0 – 9 (see below). If the radio is not in the idle state when diagnostics mode entry is attempted the keys 120# must be pressed with less that one second between each key press, and the keys pressed will not be shown on the display but the key click will sound as each key is pressed.

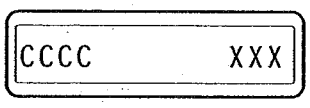
Note:
Not all diagnostic displays can be supported from control and traffic channels. If the information to be displayed is inconsistent with the channel type or hunting state then the fields will be replaced with "".*

When in diagnostics mode, the user may move to another feature by pressing the required feature number 0 – 9. If an attempt is made to enter a mode which is not defined then the error tone will sound and the input will be ignored. No error message will be displayed.

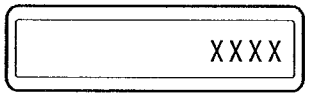
FEATURES

The following features are available in the diagnostics mode by entering the corresponding feature number 0 – 9.

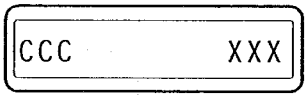
Feature No. 1 displays the current Channel Number (CCCC) and decimal representation of the RSSI level (XXX). Available on traffic and control channels.



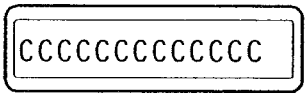
Feature No. 2 displays the last decoded System Identity in hexadecimal. Available on control channels only.



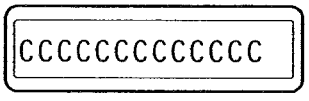
Feature No. 3 displays the number of Correct Codewords received (CCC) and number received with an Error (XXX). Samples for the correct and errored codeword counts will be taken over a 5 second period of time. Available on control channels while not hunting.



Feature No. 4 displays the radio's Software Version number. Available on traffic and control channels and when no personality is programmed.

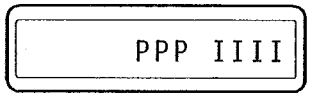


Feature No. 5 display radio's Personality Format number. Available on traffic and control channels and when no personality is programmed.

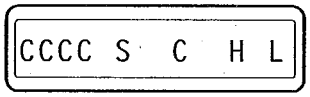


Feature No. 6 displays the radio's own MPT1327 Pre-

fix (PPP) and Identity (IIII) as stored in the radio's current personality. Available on traffic and control channels.



Feature No. 7 displays Channel number (CCCC), Hunting Status (S), Carrier Status (C), Hunt Level (H) and L2 Exceeded (L). Available on control channels only.

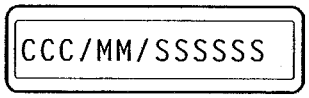


The hunting status will be S when the radio is hunting or "–" when not hunting. The carrier status will be C when carrier is detected by the radio and '-' when no carrier is detected.

Note:
When the radio is hunting the scan rate is slowed down to check one control channel every 2 seconds. This display will be updated every time a channel is selected. When not hunting this display is updated every 5 seconds.

The hunt level will be a number 0, 2 or "–" defining the current level of the channel hunt, i.e. L0, L2 or no hunt currently active. The L2 exceeded flag will be L when L2 is exceeded and "–" otherwise.

Feature No. 8 displays the Electronic Serial Number consisting of Manufacturers Code (CCC), Model Number (MM) and Serial Number (SSSSSS). Available on control and traffic channels and when no personality is programmed.



Feature No. 9 displays the date and time that the internal codeplug was last programmed, last digit of the year (YY), month (MM), day of the month (DD), hour of programming in 24 hour clock format (HH) and minutes of programming time (MM).

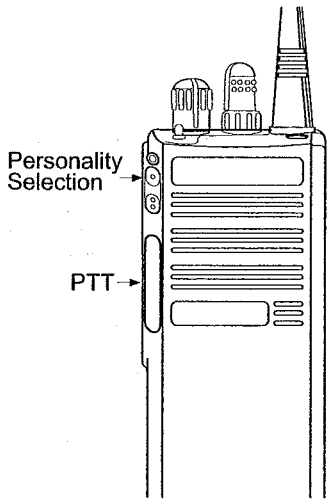
Feature No. 0 return to trunked mode. This display will be overwritten by the next trunked mode display update.

DIAGNOSTICS MODE FOR 6 CHARACTER DISPLAY MODELS

DIAGNOSTICS MODE ENTRY

Diagnostics mode is entered by pressing the **PTT** key whilst holding down the **Personality Selection** key. Diagnostics mode can be selected when the radio is in the idle state and also when the radio does not have a personality. If diagnostics mode is selected when the radio does not have a personality, fewer features are available to the user. The features which are available in diagnostics mode are presented to the user in a predefined sequence. The sequence may be stepped through by pressing the **PTT** key.

Note:
Due to the reduced size of the 6 character display, the information associated with each feature is shown over several displays. This information is then presented as a rotating display to the user.



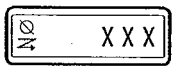
FEATURES

The following features are available in the diagnostics mode sequence:

1 Channel Number and RSSI Level

This is the only display which is available in trunked mode. The other displays can only be seen in diagnostics mode where trunked mode operation is not available.

The current Channel Number (CCCC) and decimal representation of the RSSI level (XXX) are available on traffic and control channels. This is the only display which changes operationally. The displays will be updated when diagnostics information is received. This information is not available when the radio does not have a personality.

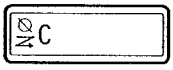


2 Software version number

The radio's software version number is available when the radio does not have a personality.

3 Personality Format Number

The radio's personality format number is available when the radio does not have a personality.



4 Prefix and Identity

The radio's own MPT1327 prefix (PPP) and identity (IIII) as stored in the radios current personality is only available when the radio has a personality.

5 Serial / Manufacturer / Model Numbers

The Electronic Serial Number, manufacturers number (MMM), model number (MM) and the serial number (SSSSSS) is available when the radio does not have a personality.

6 Last programming Time and Date

The date and time that the internal codeplug was last programmed, last digits of the year (YY), month (MM), day of the month (DD), hour of programming in 24 hour clock format (HH) and minutes of programming time (MM). This is available when the radio does not have a personality.

DIAGNOSTICS MODE EXIT

In order to exit from diagnostics mode, the user must press the **personality selection** key twice when the radio is displaying channel information and RSSI level information (feature 1) and once when any of the other features are being displayed.

Upon exiting from diagnostics mode the following display will be seen.

SELECT 5 RADIOS TUNING PROCEDURE

USING DOS BASED RSS

The recommended hardware platform is a 386 or 486 PC (personal computer) with 8 MByte RAM and RSS (Radio Service Software) are required to align the radio. Refer to your RSS Manual for installation and set-up 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 5.1.

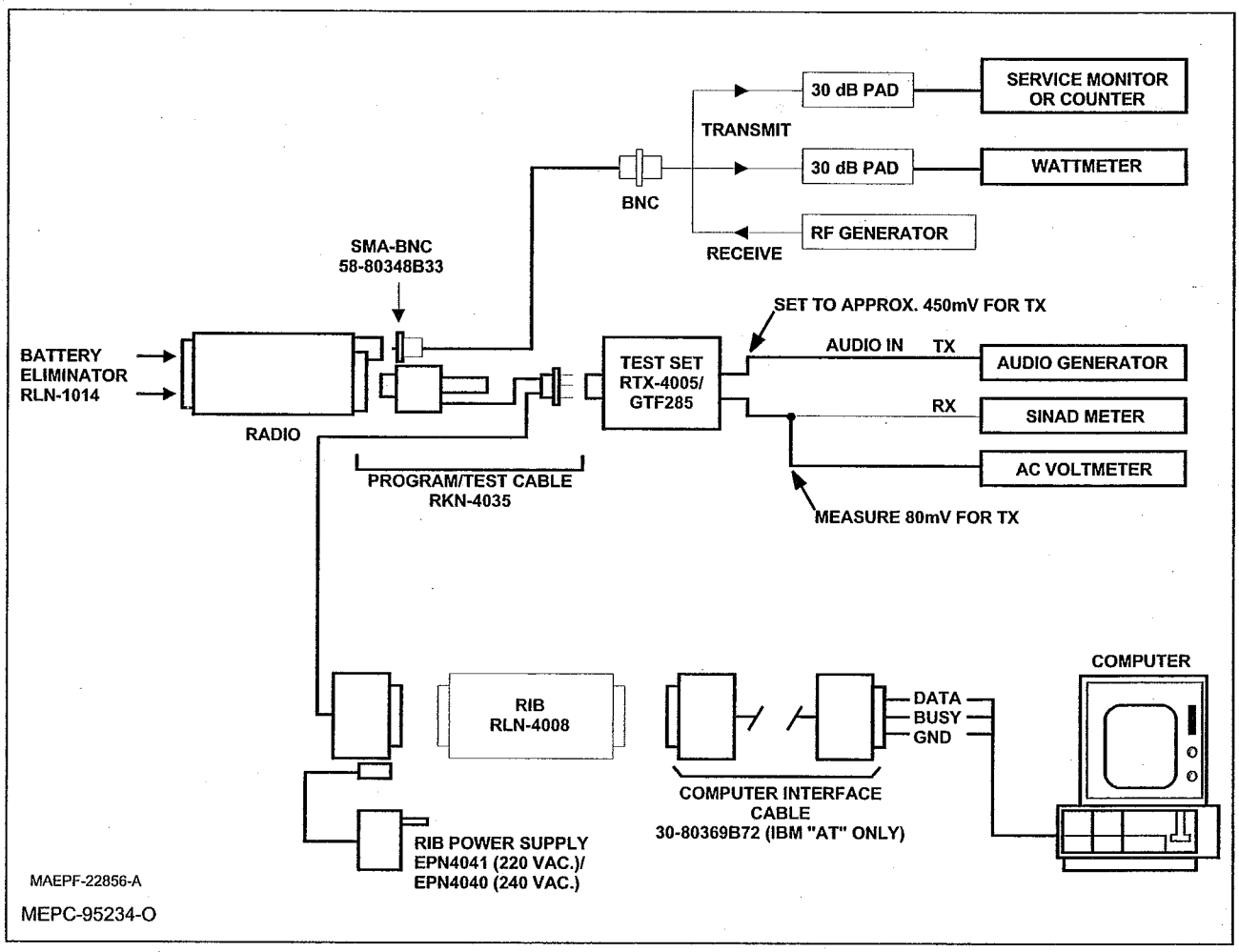


Figure 5.1 Radio Alignment Test Setup

All service and tuning procedures are performed from the SERVICE menu, which is selected by pressing F2 from the MAIN MENU. Figure 5.2 illustrates how the RSS SERVICE screens are organized.

Before going into the Service Aids menu, the radio must first be read using the GET/SAVE/PROGRAM Radio Data menu (if the radio has just been programmed with data loaded from disk or from a newly created codeplug, then it must still be read so that the RSS will have the radio's actual tuning values).

On 1200 Series and 2000/2100 Series Two-way radios, to enter the tuning menu section: from the main menu, press F2 to select SERVICE AIDS. Then press F5 to select Tune Radio.

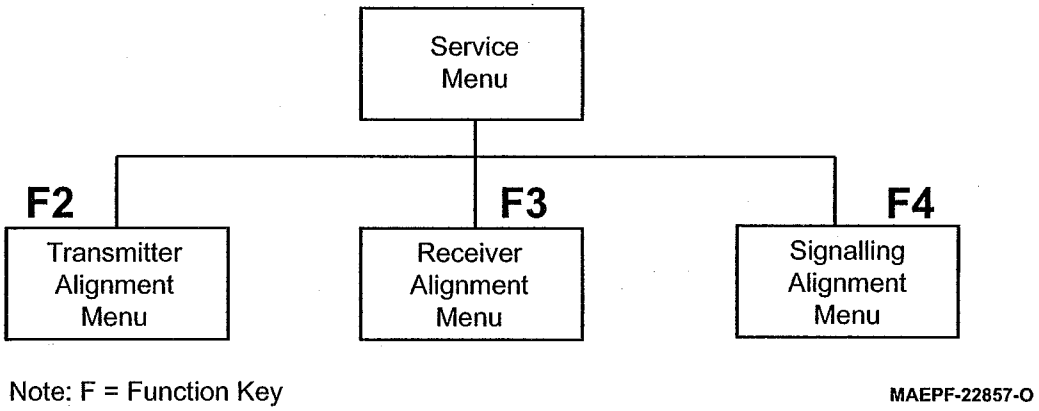


Figure 5.2 RSS Service Menu Layout

All SERVICE screens read and program the radio codeplug directly; you do NOT have to use the RSS GET/SAVE functions to use the SERVICE menus. You will be prompted at each screen to save changed values before exiting the screen.

> ***C**aution:*
> *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 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 of 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 5.3.

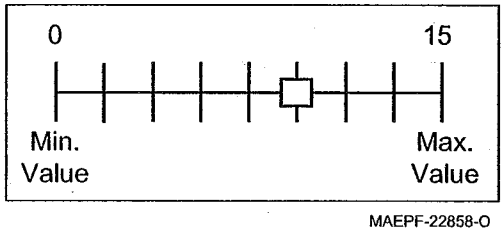


Figure 5.3 Softpot Concept

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. 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. Choose the highest frequency and 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 5.1.

Band	Target
Midband	±150 Hz
VHF	±150 Hz
UHF	±150 Hz

Table 5.1 Reference Oscillator Alignment

6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 - F2 - F10 to return to SERVICE menu.

FRONT-END PRE-SELECTOR (UHF/VHF ONLY)

1. Set the Test Box (RTX4005B) meter selection switch to the "VOL" position, and connect a DC voltmeter capable of 1 mV resolution 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. 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 indicates 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 1mVolt modulated with standard test modulation. (See Table 5.2).
4. Adjust the UP/DOWN arrow keys to obtain rated audio (as close to 3.74 Vrms / 3.38 Vrms Cenelec) into a speaker (28 ohms) or equivalent resistive load.
5. Press F8 to program the softpot value
6. Press F10 to return to the RECEIVER menu.

Channel Spacing	Deviation
25 kHz	3.0 kHz
20 kHz	2.4 kHz
12.5 kHz	1.5 kHz

Table 5.2 Standard Test Modulation (1 kHz Tone)

SQUELCH

1. Press F4 (12.5kHz), F5 (12.5kHz) or F6 (25kHz) to select the SQUELCH softpot. The screen will indicate the receive test frequencies to be used.
2. Select the first test frequency shown, and adjust the UP/DOWN arrow key to the minimum squelch value.
3. Set the RF test generator to the test frequency and modulate the signal generator with standard test modulation. (See Table 5.2). Adjust the generator for a 8-10 dB SINAD level.
4. Adjust the UP/DOWN arrow key until the squelch just closes.
5. Monitor for squelch chatter; if chatter is present, repeat step 4.
6. When no chatter is detected, press F8 to program this value. Press "ENTER" to select next softpot adjustment.
7. Repeat steps 3-6 for all test frequencies shown on the screen.
8. Press F10, F2 then F10 to return to the SERVICE menu.

TRANSMITTER POWER

The radio requires 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 5.3.
5. Press F6 to dekey the radio, and then press F8 to program the value.
6. Repeat steps 4-5 for the remaining test frequencies.
7. Press F10, then F2 to return to the TRANSMIT menu.

Midband	**Power Level**	**Test Frequencies 68 - 88 MHz**
	5 W 1 W	5.2 - 5.4 1.2 - 1.4
VHF	**Power Level**	**Test Frequencies 136 - 174 MHz**
	5 W 1 W	5.2 - 5.4 1.2 - 1.4
UHF	**Power Level**	**Test Frequencies 403-470/450-520 MHz**
	4 W 1 W	4.2 - 4.4 1.2 - 1.4

Table 5.3 Transmit Power Setting

TRANSMIT DEVIATION BALANCE (COMPENSATION)

Compensation alignment balances the modulation sensitivity of the VCO and reference modulation (synthesizer low frequency port) lines. 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: (Secure-Equipped Only)
If a secure module is currently installed in the radio being aligned, refer to "Secure Alignment Procedure" on page 16 , 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 a 80 Hz tone at 100 mVrms into the AC/DC MTR port. Keep the AC voltmeter in parallel to insure the proper input signal level.
4. Press F6 to key the radio, and measure deviation.
5. Press F6 again to dekey the radio, and change the input tone to 3 kHz, 100 mVrms.
6. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the deviation to within ±2% of the value recorded in step 4.
7. Press F6 to dekey the radio, and press F8 to program the softpot value. Press ENTER to move to next softpot value.
8. Repeat steps 3-7 for the remaining test frequencies.
9. Press F10 to return to the TRANSMIT menu.

Note:
The step size change for step 6 is approximately 2.5% softpot value.

TRANSMIT DEVIATION LIMIT 25 KHz

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 1 kHz tone on the AUDIO IN terminal on the test set, 80 mVrms 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 to be within 4.30 - 4.60 kHz.
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 12.5/20 KHz

1. Press F6 to select the TRANSMIT DEVIATION LIMIT 12.5/20 kHz softpot.
2. With the meter selector switch (RTX4005B) set to MIC, inject a 1 kHz tone on the AUDIO IN terminal on the test set, 80 mVrms 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 5.4:

Channel Spacing	Deviation
20 kHz	3.40 - 3.60 kHz
12.5 kHz	2.20 - 2.30 kHz

Table 5.4 Transmit Deviation Limit Reference