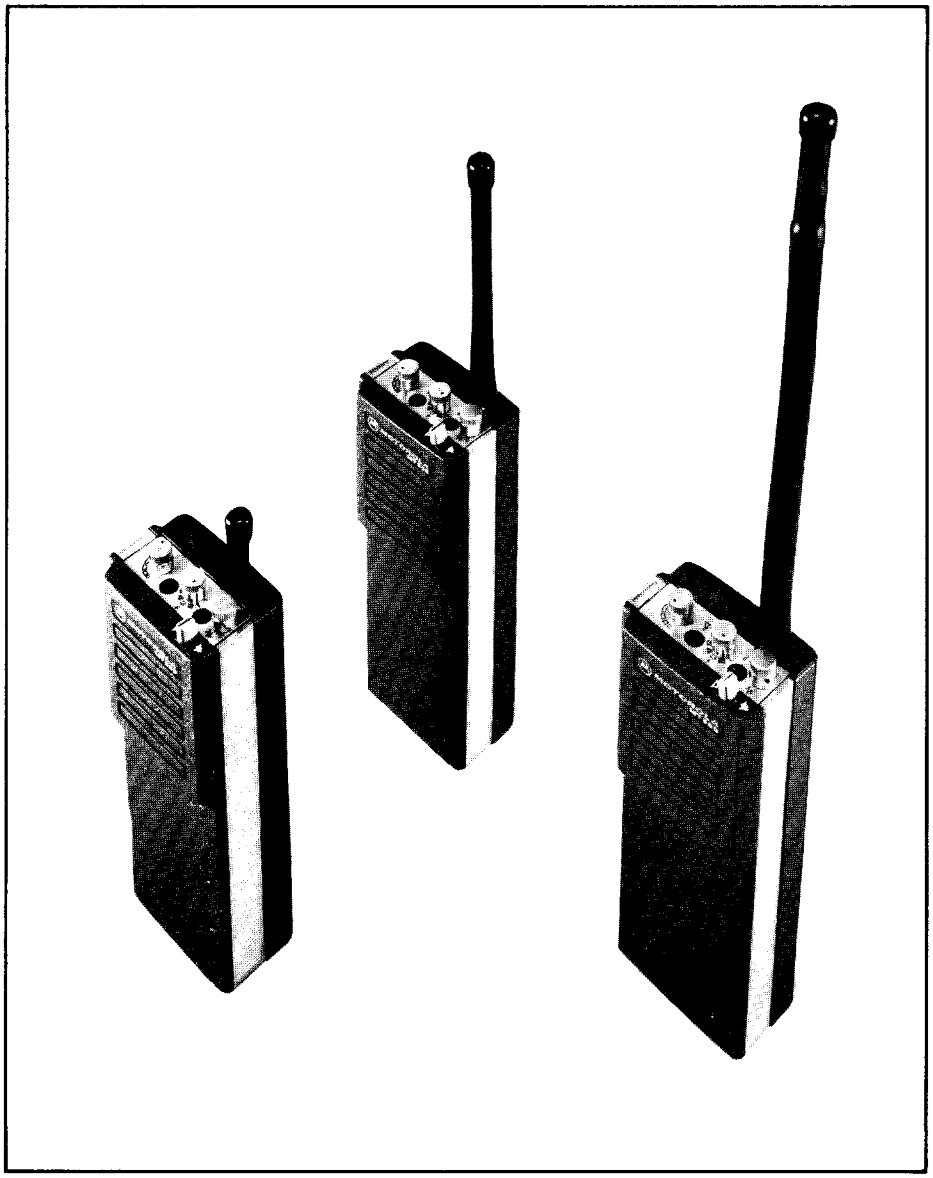
MOTOROLA

MT500 SERIES

"Handie-Talkie"

FM Two-Way Portable Radios

NOTE: THIS MANUAL APPLIES TO LOW-BAND, VHF, AND UHF MODELS



THIS MANUAL HAS BEEN
DISCONTINUED

Theory/Maintenance Manual

68P81012C55-B

MOTOROLA

INSTRUCTION MANUAL REVISION
for
Manual No. 68P81012C55-B
MT500 SERIES
"Handie-Talkie" Radios

FMR-897
Issue-2

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to supplement your manual. Installation of these changes in earlier equipment is not necessary except as recommended in Motorola Service and Repair Notes (SRN's).

REVISION DETAILS

No.	Change Affects	Item Number	Suffix
1	General Information	---	---
2	General Information	---	---

CHANGES

No.	
1	New "Digital Private-Line" (DPL) "C" Models replace the corresponding UHF and VHF "B" Models. The model complement is exactly the same, except that the NLN5874C DPL Deck replaces the NLN5874A Deck.

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MOTOROLA

MT500 SERIES
"Handie-Talkie"
FM Two-Way Portable Radios

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NOTE: Every one of the below-listed manuals is discontinued.

RELATED PUBLICATIONS AVAILABLE SEPARATELY

(Includes schematic diagrams, circuit board component layout diagrams, parts lists, and alignment procedures)

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Low Band Service Manual	68P81017C55
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Selective Call Options	68P81013C60
Single-Tone Option	68P81013C55
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Multiple-Unit Rapid Battery Chargers	68P81003C06
Multiple-Unit Rapid Battery Chargers	68P81102C57

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68P81012C55-B

"BBB" AND "BBU" SERIES
LOW-BAND MODEL CHART

CODE:

- [A] = ALTERNATE ITEM
- [N] = PACKAGE ITEM
- [X] = ONE ITEM
- [2] = NUMBER OF ITEMS
- [H] = OPTIONAL ITEM

MODEL	NUMBER OF CHANNELS	TYPE OF SQUELCH	RECEIVE CRYSTAL (10 PPM) KXN6193A	TRANSMIT CRYSTAL KXN6194A	RECEIVE CRYSTAL (5 PPM) KXN6197A	ANTENNA (30-35 MHz) NAB6001A	ANTENNA (35-40 MHz) NAB6002A	ANTENNA (40-45 MHz) NAB6003A	BASIC FRAME 1 FREQ. (30-36 MHz) NHB6021A	BASE FRAME 1 FREQ. (36-42 MHz) NHB6022A	BASIC FRAME 1 FREQ. (42-50 MHz) NHB6023A	UNIV FRAME 1 FREQ. (30-36 MHz) NHB6031A	UNIV FRAME 1 FREQ. (36-42 MHz) NHB6032A	UNIV FRAME 1 FREQ. (42-50 MHz) NHB6033A	BASIC FRAME 2 FREQ. (30-36 MHz) NHB6061A	BASIC FRAME 2 FREQ. (36-42 MHz) NHB6062A	BASIC FRAME 2 FREQ. (42-50 MHz) NHB6063A	UNIV FRAME 2 FREQ. (30-36 MHz) NHB6071A	UNIV FRAME 2 FREQ. (36-42 MHz) NHB6072A	UNIV FRAME 2 FREQ. (42-50 MHz) NHB6073A	BASIC FRAME 6 FREQ. (30-36 MHz) NHB6081A	BASIC FRAME 6 FREQ. (36-42 MHz) NHB6082A	BASIC FRAME 6 FREQ. (42-50 MHz) NHB6083A	UNIV FRAME 6 FREQ. (30-36 MHz) NHB6091A	UNIV FRAME 6 FREQ. (36-42 MHz) NHB6092A	UNIV FRAME 6 FREQ. (42-50 MHz) NHB6093A	BASIC FRAME 4 FREQ. (30-36 MHz) NHB6101A	BASIC FRAME 4 FREQ. (36-42 MHz) NHB6102A	BASIC FRAME 4 FREQ. (42-50 MHz) NHB6103A	UNIV FRAME 4 FREQ. (30-36 MHz) NHB6111A	UNIV FRAME 4 FREQ. (36-42 MHz) NHB6112A	UNIV FRAME 4 FREQ. (42-50 MHz) NHB6113A
H31BBB1114A	1	CS	X	X	H	N	N	N	A	A	A																					
H31BBB1124A	2	CS	2	2	H	N	N	N							A	A	A															
H31BBB1144A	4	CS	4	4	H	N	N	N																			A	A	A			
H31BBB1164A	6	CS	6	6	H	N	N	N													A	A	A									
H31BBB3114A	1	PL	X	X	H	N	N	N	A	A	A																					
H31BBB3124A	2	PL	2	2	H	N	N	N							A	A	A															
H31BBB3144A	4	PL	4	4	H	N	N	N																			A	A	A			
H31BBB3164A	6	PL	6	6	H	N	N	N													A	A	A									
H31BBU1114A	1	CS	X	X	H	N	N	N				A	A	A																		
H31BBU1124A	2	CS	2	2	H	N	N	N										A	A	A												
H31BBU1144A	4	CS	4	4	H	N	N	N																						A	A	A
H31BBU1164A	6	CS	6	6	H	N	N	N																A	A	A						
H31BBU3114A	1	PL	X	X	H	N	N	N				A	A	A																		
H31BBU3124A	2	PL	2	2	H	N	N	N										A	A	A												
H31BBU3144A	4	PL	4	4	H	N	N	N																						A	A	A
H31BBU3164A	6	PL	6	6	H	N	N	N																A	A	A						
H31BBU6114A	1	DPL	X	X	H	N	N	N				A	A	A																		
H31BBU6124A	2	DPL	2	2	H	N	N	N										A	A	A												
H31BBU6144A	4	DPL	4	4	H	N	N	N																						A	A	A
H31BBU6164A	6	DPL	6	6	H	N	N	N																A	A	A						

MODEL	HARDWARE KIT (SLIM-LINE EXTENDED) NLN4186A	BATTERY COVER NLN4180A	ESCUTCHEON (1 FREQ.) NLN4188A	ESCUTCHEON (2 FREQ.) NLN4189A	LABEL NLN4196A	BATTERY ("OMNI" MODELS) NLN4463A	TUNING TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS) NLN4605A	SERVICE TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS) NLN4606A	TWO-TONE SELECTIVE CALL NLN5485A	FRONT COVER NLN5486A	TONE "PL" DECK - BASIC NLN5487A	DIGITAL "PL" DECK NLN5488A	FRONT COVER - SELECTIVE CALL DECK NLN5489A	FRONT COVER - "PL" NLN5490A	ESCUTCHEON (4 F & 6 F) NLN5510A	BACK COVER ("OMNI" EXTENDED) NLN4179A	TONE "PL" DECK - UNIV NLN5696A	FOUR-TONE SELECTIVE CALL DECK NLN5697A	SELECTIVE CALL DECK (LONG TONE B) NLN5698A	FREQUENCY SWITCH - 4 F & 6 F NLN5712A	CARRY CASE & T STRAP NLN6846A	TRANSCEIVER BOARD (30-36 MHz) NUB6081A	TRANSCEIVER BOARD (36-42 MHz) NUB6082A	TRANSCEIVER BOARD (42-50 MHz) NUB6083A	ANTENNA (45-50 MHz) NAB6004A	PACKING NBN6044A	ACTIVE FILTER NFN6010A	LATCH NLN4182A	HARDWARE ("SLIM-LINE" OPTION) NLN4190A	CODE PLUG NLN5762A
H31BBB1114A		X	X		X	N	X	X	H	X			H			X		H	H		N	A	A	A	N	N		X		
H31BBB1124A		X		X	X	N	X	X	H	X			H			X		H	H		N	A	A	A	N	N		X		
H31BBB1144A		X			X	N	X	X	H	X			H		X	X		H	H	X	N	A	A	A	N	N		X		
H31BBB1164A		X			X	N	X	X	H	X			H		X	X		H	H	X	N	A	A	A	N	N		X		
H31BBB3114A	X	X	X		X	N	X	X			X			X		X					N	A	A	A	N	N	X	X	X	
H31BBB3124A	X	X		X	X	N	X	X			X			X		X					N	A	A	A	N	N	X	X	X	
H31BBB3144A	X	X			X	N	X	X			X			X	X	X				X	N	A	A	A	N	N	X	X	X	
H31BBB3164A	X	X			X	N	X	X			X			X	X	X				X	N	A	A	A	N	N	X	X	X	
H31BBU1114A		X	X		X	N	X	X	H	X			H			X		H	H		N	A	A	A	N	N		X		
H31BBU1124A		X		X	X	N	X	X	H	X			H			X		H	H		N	A	A	A	N	N		X		
H31BBU1144A		X			X	N	X	X	H	X			H		X	X		H	H	X	N	A	A	A	N	N		X		
H31BBU1164A		X			X	N	X	X	H	X			H		X	X		H	H	X	N	A	A	A	N	N		X		
H31BBU3114A	X	X	X		X	N	X	X						X		X	H				N	A	A	A	N	N	X	X	X	
H31BBU3124A	X	X		X	X	N	X	X						X		X	H				N	A	A	A	N	N	X	X	X	
H31BBU3144A	X	X			X	N	X	X						X	X	X	H			X	N	A	A	A	N	N	X	X	X	
H31BBU3164A	X	X			X	N	X	X						X	X	X	H			X	N	A	A	A	N	N	X	X	X	
H31BBU6114A	X	X	X		X	N	X	X				X		X		X					N	A	A	A	N	N		X	X	X
H31BBU6124A	X	X		X	X	N	X	X				X		X		X					N	A	A	A	N	N		X	X	X
H31BBU6144A	X	X			X	N	X	X				X		X	X	X				X	N	A	A	A	N	N		X	X	X
H31BBU6164A	X	X			X	N	X	X				X		X	X	X				X	N	A	A	A	N	N		X	X	X

EPF-9525-O

"BBB" SERIES VHF MODEL CHART

CODE:

- [X] = ONE ITEM SUPPLIED.
- [2] = NUMBER OF ITEMS SUPPLIED AS INDICATED.
- [A] = ALTERNATE ITEM SUPPLIED, CHOICE DEPENDS ON CARRIER FREQUENCY.
- [N] = ITEMS SUPPLIED IN "PACKAGE" MODELS. SEE YOUR MOTOROLA SALES REPRESENTATIVE FOR FURTHER DETAILS.

*SS = "SLIM-LINE" (SHORT)
SL = "SLIM-LINE" (EXTENDED)
OS = "OMNI" (SHORT)
OE = "OMNI" (EXTENDED)

KIT NUMBER	DESCRIPTION
NUD6252A	TRANSMITTER-RECEIVER BOARD 150.8-162 MHz
NUD6253A	TRANSMITTER-RECEIVER BOARD 162-174 MHz
NUD6262A	TRANSMITTER-RECEIVER BOARD; RCVE (150.8-162 MHz); XMIT (162-174 MHz)
NUD6272A	TRANSMITTER-RECEIVER BOARD; RCVE (162-174 MHz); XMIT (150.8-162 MHz)
NXN6029A	SECOND OSCILLATOR CRYSTAL (17.865 MHz)
NXN6030A	SECOND OSCILLATOR CRYSTAL (17.935 MHz)
KXN1075A	CHANNEL ELEMENT, RECEIVER
KXN1083A	CHANNEL ELEMENT, TRANSMITTER; 10 PPM
KXN1042A	CHANNEL ELEMENT, TRANSMITTER; 5 PPM
NHD6101A	FRAME; C1R1, SHORT
NHD6111A	FRAME; C1R1, EXTENDED
NHD6041A	FRAME; C2R2, SHORT
NHD6051A	FRAME; C2R2, EXTENDED
NHD6121A	FRAME; C4R4, SHORT
NHD6131A	FRAME; C4R4, EXTENDED
NHD6161A	FRAME; C5R5, EXTENDED
NHD6061A	FRAME; C6R6, EXTENDED
NHD6071A	FRAME; C8R8, EXTENDED
NLN4207A	FRONT COVER; CARRIER SQUELCH, SHORT
NLN4208A	FRONT COVER; CARRIER SQUELCH, EXTENDED
NLN4184A	FRONT COVER; "PL" SQUELCH, EXTENDED
NLN4183A	FRONT COVER; "PL" SQUELCH, SHORT
NLN4176A	BACK COVER; "SLIM-LINE," SHORT
NLN4177A	BACK COVER; "SLIM-LINE," EXTENDED
NLN4178A	BACK COVER; "OMNI," SHORT
NLN4179A	BACK COVER; "OMNI," EXTENDED
NLN4180A	BATTERY COVER
NLN4181A	BATTERY COVER LATCH; "SLIM-LINE"
NLN4182A	BATTERY COVER LATCH; "OMNI"
NLN4194A	BATTERY COVER LATCH HARDWARE
NLN4188A	ESCUTCHEON; C1R1
NLN4189A	ESCUTCHEON; C2R2
NLN4643A	ESCUTCHEON; C4R4
NLN5157A	ESCUTCHEON; C5R5
NLN4191A	ESCUTCHEON; C8R8
NLD6942A	2-WATT POWER AMPLIFIER 150.8-162 MHz
NLD6943A	2-WATT POWER AMPLIFIER 162-174 MHz
NLD6952A	5-WATT POWER AMPLIFIER 150.8-162 MHz
NLD6953A	5-WATT POWER AMPLIFIER 162-174 MHz
NLN4172A	SLEEVE; "OMNI", SHORT
NLN4174A	SLEEVE; "OMNI," EXTENDED
NLN4175A	SLEEVE; "OMNI," EXTENDED LESS ANTENNA TUBE
NLN4215A	CHANNEL ELEMENT DECK; C7R7
NLN4573A	CHANNEL ELEMENT DECK; C8R8
NFN6010A	ACTIVE FILTER
NLN4646A	TONE "PL" DECK; EXTENDED FRAME
NLN4644A	TONE "PL" DECK; SHORT FRAME
NLN4195A	MOUNTING HARDWARE; C7R7 CHANNEL ELEMENT DECK
NLN4190A	MOUNTING HARDWARE; "SLIM-LINE," EXTENDED
NLN4186A	MOUNTING HARDWARE; "OMNI," EXTENDED
NLN4187A	MOUNTING HARDWARE; "OMNI," SHORT
NLN4196A	LABEL
NLN4605A	TUNING TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS)
NLN4606A	SERVICE TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS)
NAD6219A	ANTENNA, HELICAL 150.8-162 MHz
NAD6220A	ANTENNA, HELICAL 162-174 MHz
NLN4462A	BATTERY, NICKEL-CADMIUM; "SLIM-LINE"
NLN4463A	BATTERY, NICKEL-CADMIUM; "OMNI"
NLN6803B	CARRYING CASE AND "T" STRAP; "SLIM-LINE," SHORT
NLN6844B	CARRYING CASE AND "T" STRAP; "SLIM-LINE," EXTENDED
NLN6845B	CARRYING CASE AND "T" STRAP; "OMNI," SHORT
NLN6846B	CARRYING CASE AND "T" STRAP; "OMNI," EXTENDED

MODEL	RF OUTPUT POWER	TYPE OF SQUELCH	NUMBER OF CHANNELS	* SIZE	DUTY CYCLE		
H23BBB1111A	2 W	Carrier	1	SS	5	5	90
H23BBB1112A	2 W	Carrier	1	SE	5	5	90
H23BBB1113A	2 W	Carrier	1	OS	10	10	80
H23BBB1114A	2 W	Carrier	1	OE	10	10	80
H23BBB1121A	2 W	Carrier	2	SS	5	5	90
H23BBB1122A	2 W	Carrier	2	SE	5	5	90
H23BBB1123A	2 W	Carrier	2	OS	10	10	80
H23BBB1124A	2 W	Carrier	2	OE	10	10	80
H23BBB1143A	2 W	Carrier	4	OS	10	10	80
H23BBB1144A	2 W	Carrier	4	OE	10	10	80
H23BBB1164A	2 W	Carrier	6	OE	10	10	80
H23BBB1184A	2 W	Carrier	8	OE	10	10	80
H23BBB3112A	2 W	Tone "PL"	1	SE	5	5	90
H23BBB3113A	2 W	Tone "PL"	1	OS	10	10	80
H23BBB3114A	2 W	Tone "PL"	1	OE	10	10	80
H23BBB3122A	2 W	Tone "PL"	2	SE	5	5	90
H23BBB3123A	2 W	Tone "PL"	2	OS	10	10	80
H23BBB3124A	2 W	Tone "PL"	2	OE	10	10	80
H23BBB3143A	2 W	Tone "PL"	4	OS	10	10	80
H23BBB3144A	2 W	Tone "PL"	4	OE	10	10	80
H23BBB3154A	2 W	Tone "PL"	5	OE	10	10	80
H23BBB3164A	2 W	Tone "PL"	6	OE	10	10	80
H23BBB3184A	2 W	Tone "PL"	8	OE	10	10	80
H33BBB1113A	5 W	Carrier	1	OS	5	5	90
H33BBB1114A	5 W	Carrier	1	OE	5	5	90
H33BBB1123A	5 W	Carrier	2	OS	5	5	90
H33BBB1124A	5 W	Carrier	2	OE	5	5	90
H33BBB1143A	5 W	Carrier	4	OS	5	5	90
H33BBB1144A	5 W	Carrier	4	OE	5	5	90
H33BBB1164A	5 W	Carrier	6	OE	5	5	90
H33BBB1184A	5 W	Carrier	8	OE	5	5	90
H33BBB3113A	5 W	Tone "PL"	1	OS	5	5	90
H33BBB3114A	5 W	Tone "PL"	1	OE	5	5	90
H33BBB3123A	5 W	Tone "PL"	2	OS	5	5	90
H33BBB3124A	5 W	Tone "PL"	2	OE	5	5	90
H33BBB3143A	5 W	Tone "PL"	4	OS	5	5	90
H33BBB3144A	5 W	Tone "PL"	4	OE	5	5	90
H33BBB3154A	5 W	Tone "PL"	5	OE	5	5	90
H33BBB3164A	5 W	Tone "PL"	6	OE	5	5	90
H33BBB3184A	5 W	Tone "PL"	8	OE	5	5	90

MODEL	NUD6252A	NUD6253A	NUD6262A	NUD6272A	NXN6029A	NXN6030A	KXN1075A	KXN1083A	KXN1042A	NHD6101A	NHD6111A	NHD6041A	NHD6051A	NHD6121A	NHD6131A	NHD6161A	NHD6061A	NHD6071A	NLN4207A	NLN4208A	NLN4184A	NLN4183A	NLN4176A	NLN4177A	NLN4178A	NLN4179A	NLN4180A	NLN4181A	NLN4182A	NLN4194A	NLN4188A
H23BBB1111A	A	A	A	A	A	A	X	X		X									X				X				X	X		X	X
H23BBB1112A	A	A	A	A	A	A	X	X			X									X				X			X	X		X	X
H23BBB1113A	A	A	A	A	A	A	X	X		X									X						X		X		X		X
H23BBB1114A	A	A	A	A	A	A	X	X			X									X						X	X		X		X
H23BBB1121A	A	A	A	A	A	A	2	2				X							X				X				X	X		X	
H23BBB1122A	A	A	A	A	A	A	2	2					X							X				X			X	X		X	
H23BBB1123A	A	A	A	A	A	A	2	2				X							X						X		X		X		
H23BBB1124A	A	A	A	A	A	A	2	2					X							X						X	X		X		
H23BBB1143A	A	A	A	A	A	A	4	4						X					X						X		X		X		
H23BBB1144A	A	A	A	A	A	A	4	4							X					X						X	X		X		
H23BBB1164A	A	A	A	A	A	A	6	6									X			X						X	X		X		
H23BBB1184A	A	A	A	A	A	A	8	8										X		X						X	X		X		
H23BBB3112A	A	A	A	A	A	A	X	X			X										X			X			X	X		X	X
H23BBB3113A	A	A	A	A	A	A	X	X		X												X			X		X		X		X
H23BBB3114A	A	A	A	A	A	A	X	X			X										X					X	X		X		X
H23BBB3122A	A	A	A	A	A	A	2	2					X								X			X			X	X		X	
H23BBB3123A	A	A	A	A	A	A	2	2				X										X			X		X		X		
H23BBB3124A	A	A	A	A	A	A	2	2					X								X					X	X		X		
H23BBB3143A	A	A	A	A	A	A	4	4						X								X			X		X		X		
H23BBB3144A	A	A	A	A	A	A	4	4							X						X					X	X		X		
H23BBB3154A	A	A	A	A	A	A	5	5								X					X					X	X		X		
H23BBB3164A	A	A	A	A	A	A	6	6									X				X					X	X		X		
H23BBB3184A	A	A	A	A	A	A	8	8										X			X					X	X		X		
H33BBB1113A	A	A	A	A	A	A	X		X	X									X						X		X		X		X
H33BBB1114A	A	A	A	A	A	A	X		X		X									X						X	X		X		X
H33BBB1123A	A	A	A	A	A	A	2		2			X							X						X		X		X		
H33BBB1124A	A	A	A	A	A	A	2		2				X							X						X	X		X		
H33BBB1143A	A	A	A	A	A	A	4		4					X					X						X		X		X		
H33BBB1144A	A	A	A	A	A	A	4		4						X					X						X	X		X		
H33BBB1164A	A	A	A	A	A	A	6		6								X			X						X	X		X		
H33BBB1184A	A	A	A	A	A	A	8		8									X		X						X	X		X		
H33BBB3113A	A	A	A	A	A	A	X		X	X												X			X		X		X		X
H33BBB3114A	A	A	A	A	A	A	X		X		X										X					X	X		X		X
H33BBB3123A	A	A	A	A	A	A	2		2			X										X			X		X		X		
H33BBB3124A	A	A	A	A	A	A	2		2				X								X					X	X		X		
H33BBB3143A	A	A	A	A	A	A	4		4					X								X			X		X		X		
H33BBB3144A	A	A	A	A	A	A	4		4						X						X					X	X		X		
H33BBB3154A	A	A	A	A	A	A	5		5							X					X					X	X		X		
H33BBB3164A	A	A	A	A	A	A	6		6								X				X					X	X		X		
H33BBB3184A	A	A	A	A	A	A	8		8									X			X					X	X		X		

MODEL	NLN4189A	NLN4643A	NLN5157A	NLN4191A	NLD6942A	NLD6943A	NLD6952A	NLD6953A	NLN4172A	NLN4174A	NLN4175A	NLN4215A	NLN4573A	NFN6010A	NLN4646A	NLN4644A	NLN4195A	NLN4190A	NLN4186A	NLN4187A	NLN4196A	NLN4605A	NLN4606A	NAD6219A	NAD6220A	NLN4462A	NLN4463A	NLN6803B	NLN6844B	NLN6845B	NLN6846B
H23BBB1111A					A	A															X	X	X	N	N	N		N			
H23BBB1112A					A	A															X	X	X	N	N	N			N		
H23BBB1113A					A	A			X												X	X	X	N	N		N			N	
H23BBB1114A					A	A				X											X	X	X	N	N		N				N
H23BBB1121A	X				A	A															X	X	X	N	N	N		N			
H23BBB1122A	X				A	A															X	X	X	N	N	N			N		
H23BBB1123A	X				A	A			X												X	X	X	N	N		N			N	
H23BBB1124A	X				A	A				X											X	X	X	N	N		N				N
H23BBB1143A		X			A	A			X												X	X	X	N	N		N			N	
H23BBB1144A		X			A	A				X											X	X	X	N	N		N				N
H23BBB1164A				X	A	A				X											X	X	X	N	N		N				N
H23BBB1184A				X	A	A					X	X	X				X		X		X	X	X	N	N		N				N
H23BBB3112A					A	A								X	X			X			X	X	X	N	N	N			N		
H23BBB3113A					A	A			X					X		X				X	X	X	X	N	N		N			N	
H23BBB3114A					A	A				X				X	X				X		X	X	X	N	N		N				N
H23BBB3122A	X				A	A								X	X			X			X	X	X	N	N	N			N		
H23BBB3123A	X				A	A			X					X		X				X	X	X	X	N	N		N			N	
H23BBB3124A	X				A	A				X				X	X				X		X	X	X	N	N		N				N
H23BBB3143A		X			A	A			X					X		X				X	X	X	X	N	N		N			N	
H23BBB3144A		X			A	A				X				X	X				X		X	X	X	N	N		N				N
H23BBB3154A			X		A	A				X				X	X						X	X	X	N	N		N				N
H23BBB3164A				X	A	A				X				X	X				X		X	X	X	N	N		N				N
H23BBB3184A				X	A	A					X	X	X	X	X		X		X		X	X	X	N	N		N				N
H33BBB1113A							A	A	X												X	X	X	N	N		N			N	
H33BBB1114A							A	A		X											X	X	X	N	N		N				N
H33BBB1123A	X						A	A	X												X	X	X	N	N		N			N	
H33BBB1124A	X						A	A		X											X	X	X	N	N		N				N
H33BBB1143A		X					A	A	X												X	X	X	N	N		N			N	
H33BBB1144A		X					A	A		X											X	X	X	N	N		N				N
H33BBB1164A				X			A	A		X											X	X	X	N	N		N				N
H33BBB1184A				X			A	A			X	X	X				X		X		X	X	X	N	N		N				N
H33BBB3113A							A	A	X					X		X				X	X	X	X	N	N		N			N	
H33BBB3114A							A	A		X				X	X				X		X	X	X	N	N		N				N
H33BBB3123A	X						A	A	X					X		X				X	X	X	X	N	N		N			N	
H33BBB3124A	X						A	A		X				X	X				X		X	X	X	N	N		N				N
H33BBB3143A		X					A	A	X					X		X				X	X	X	X	N	N		N			N	
H33BBB3144A		X					A	A		X				X	X				X		X	X	X	N	N		N				N
H33BBB3154A			X				A	A		X				X	X						X	X	X	N	N		N				N
H33BBB3164A				X			A	A		X				X	X				X		X	X	X	N	N		N				N
H33BBB3184A				X			A	A			X	X	X	X	X		X		X		X	X	X	N	N		N				N

"BBU" SERIES VHF MODEL CHART

CODE:

- [X] = ONE ITEM SUPPLIED.
- [Z] = NUMBER OF ITEMS SUPPLIED AS INDICATED.
- [A] = ALTERNATE ITEM SUPPLIED, CHOICE DEPENDS ON CARRIER FREQUENCY.
- [N] = ITEMS SUPPLIED IN "PACKAGE" MODELS. SEE YOUR MOTOROLA SALES REPRESENTATIVE FOR FURTHER DETAILS.

* SS	=	"SLIM-LINE" (SHORT)
SE	=	"SLIM-LINE" (EXTENDED)
OS	=	"OMNI" (SHORT)
OE	=	"OMNI" (EXTENDED)

KIT NUMBER	DESCRIPTION
NUD6241A	TRANSMITTER-RECEIVER BOARD (136-150.8 MHz)
NUD6242A	TRANSMITTER-RECEIVER BOARD (150.8-162 MHz)
NUD6243A	TRANSMITTER-RECEIVER BOARD (162-174 MHz)
NUD6282A	TRANSMITTER-RECEIVER BOARD; RCVE (150.8-174 MHz), XMIT (162-174 MHz)
NUD6292A	TRANSMITTER-RECEIVER BOARD; RCVE (162-174 MHz), XMIT (150.8-162 MHz)
NUD6302A	TRANSMITTER-RECEIVER BOARD; (150.8-162 MHz)
NUD6303A	TRANSMITTER-RECEIVER BOARD; (162-174 MHz)
NUD6311A	TRANSMITTER-RECEIVER BOARD; (136-150.8 MHz)
NUD6312A	TRANSMITTER-RECEIVER BOARD; (150.8-162 MHz)
NUD6313A	TRANSMITTER-RECEIVER BOARD; (162-174 MHz)
NXN6029A	SECOND OSCILLATOR CRYSTAL (17.865 MHz)
NXN6030A	SECOND OSCILLATOR CRYSTAL (17.935 MHz)
KXN1075A	CHANNEL ELEMENT, RECEIVER
KXN1083A	CHANNEL ELEMENT, TRANSMITTER, 10 PPM
KXN1042A	CHANNEL ELEMENT, TRANSMITTER, 5 PPM
NHD6001A	FRAME; C2R2, SHORT
NHD6011A	FRAME; C2R2, EXTENDED
NHD6021A	FRAME; C6R6, EXTENDED
NHD6031A	FRAME; C8R8, EXTENDED
NHD6081A	FRAME; C1R1, SHORT
NHD6091A	FRAME; C1R1, EXTENDED
NHD6141A	FRAME; C4R4, SHORT
NHD6151A	FRAME; C4R4, EXTENDED
NHD6171A	FRAME; C5R5, EXTENDED
NLN4183A	FRONT COVER; "PL," SHORT
NLN4184A	FRONT COVER; "PL," EXTENDED
NLN4207A	FRONT COVER; CARRIER SQUELCH, SHORT
NLN4208A	FRONT COVER; CARRIER SQUELCH, EXTENDED
NLN4176A	BACK COVER; "SLIM-LINE," SHORT
NLN4177A	BACK COVER; "SLIM-LINE," EXTENDED
NLN4178A	BACK COVER; "OMNI," SHORT
NLN4179A	BACK COVER; "OMNI," EXTENDED
NLN4180A	BATTERY COVER
NLN4181A	BATTERY COVER LATCH, "SLIM-LINE"
NLN4182A	BATTERY COVER LATCH, "OMNI"
NLN4194A	BATTERY COVER LATCH HARDWARE
NLN4188A	ESCUTCHEON; C1R1
NLN4189A	ESCUTCHEON; C2R2
NLN4643A	ESCUTCHEON; C4R4
NLN5157A	ESCUTCHEON; C5R5
NLN4191A	ESCUTCHEON; C8R8
NLD6941A	2-WATT POWER AMPLIFIER (136-150.8 MHz)
NLD6942A	2-WATT POWER AMPLIFIER (150.8-162 MHz)
NLD6943A	2-WATT POWER AMPLIFIER (162-174 MHz)
NLD6951A	5-WATT POWER AMPLIFIER (136-150.8 MHz)
NLD6952A	5-WATT POWER AMPLIFIER (150.8-162 MHz)
NLD6953A	5-WATT POWER AMPLIFIER (162-174 MHz)
NLN4172A	SLEEVE; "OMNI," SHORT
NLN4174A	SLEEVE; "OMNI," EXTENDED
NLN4175A	SLEEVE; "OMNI," EXTENDED LESS ANTENNA TUBE
NLN4215A	CHANNEL ELEMENT DECK, C7R7
NLN4573A	CHANNEL ELEMENT DECK, C8R8
NFN6010A	ACTIVE FILTER
NLN4211A	TONE "PL" DECK; EXTENDED FRAME
NLN4645A	TONE "PL" DECK; SHORT FRAME
NLN5874A	DIGITAL "PL" DECK
NLN4647A	DIGITAL "PL" RECEIVER BIAS
NLN8922A	DIGITAL "PL" CODE PLUG
NLN4186A	MOUNTING HARDWARE; "OMNI," EXTENDED
NLN4187A	MOUNTING HARDWARE; "OMNI," SHORT
NLN4190A	MOUNTING HARDWARE; "SLIM-LINE," EXTENDED
NLN4195A	MOUNTING HARDWARE; C7R7 CHANNEL ELEMENT DECK
NLN4196A	LABEL
NLN4605A	TUNING TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS)
NLN4606A	SERVICE TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS)
NAD6221A	ANTENNA, HELICAL (136-142 MHz)
NAD6222A	ANTENNA, HELICAL (142-150.8 MHz)
NAD6219A	ANTENNA, HELICAL (150.8-162 MHz)
NAD6220A	ANTENNA, HELICAL((162-174 MHz)
NLN4462A	BATTERY, NICKEL-CADMIUM; "SLIM-LINE"
NLN4463A	BATTERY, NICKEL-CADMIUM; "OMNI"
NLN6803B	CARRYING CASE AND "T" STRAP; "SLIM-LINE," SHORT
NLN6844B	CARRYING CASE AND "T" STRAP; "SLIM-LINE," EXTENDED
NLN6845B	CARRYING CASE AND "T" STRAP; "OMNI," SHORT
NLN6846B	CARRYING CASE AND "T" STRAP; "OMNI," EXTENDED

MODEL	RF OUTPUT POWER	TYPE OF SQUELCH	NUMBER OF CHANNELS	* SIZE	DUTY CYCLE	NUD6241A	NUD6242A	NUD6243A	NUD6282A	NUD6292A	NUD6302A	NUD6303A	NUD6311A	NUD6312A	NUD6313A	NXN6029A	NXN6030A	KXN1075A	KXN1083A	KXN1042A	NHD6001A	NHD6011A	NHD6021A	NHD6031A	NHD6081A	NHD6091A	NHD6141A	NHD6151A	NHD6171A	NLN4183A	NLN4184A	NLN4207A	NLN4208A	NLN4176A	NLN4177A	NLN4178A	NLN4179A
H23BBU1111A	2 W	Carrier	1	SS	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	X	X						X							X		X			
H23BBU1112A	2 W	Carrier	1	SE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	X	X							X							X		X		
H23BBU1113A	2 W	Carrier	1	OS	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	X	X						X							X				X	
H23BBU1114A	2 W	Carrier	1	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	X	X							X							X				X
H23BBU1121A	2 W	Carrier	2	SS	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2	2		X											X		X			
H23BBU1122A	2 W	Carrier	2	SE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2	2			X											X		X		
H23BBU1123A	2 W	Carrier	2	OS	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	2	2		X											X				X	
H23BBU1124A	2 W	Carrier	2	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	2	2			X											X				X
H23BBU1143A	2 W	Carrier	4	OS	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	4	4								X					X				X	
H23BBU1144A	2 W	Carrier	4	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	4	4									X					X				X
H23BBU1164A	2 W	Carrier	6	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	6	6				X										X				X
H23BBU1184A	2 W	Carrier	8	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	8	8					X									X				X
H23BBU3112A	2 W	Tone "PL"	1	SE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	X	X							X					X				X		
H23BBU3113A	2 W	Tone "PL"	1	OS	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	X	X						X					X						X	
H23BBU3114A	2 W	Tone "PL"	1	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	X	X							X					X						X
H23BBU3122A	2 W	Tone "PL"	2	SE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2	2			X									X				X		
H23BBU3123A	2 W	Tone "PL"	2	OS	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	2	2		X									X						X	
H23BBU3124A	2 W	Tone "PL"	2	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	2	2			X									X						X
H23BBU3143A	2 W	Tone "PL"	4	OS	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	4	4								X			X						X	
H23BBU3144A	2 W	Tone "PL"	4	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	4	4									X			X						X
H23BBU3154A	2 W	Tone "PL"	5	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	5	5										X		X						X
H23BBU3164A	2 W	Tone "PL"	6	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	6	6				X								X						X
H23BBU3184A	2 W	Tone "PL"	8	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	8	8					X							X						X
H23BBU6112B	2 W	Digital "PL"	1	SE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	1	1							X					X				X		
H23BBU6114B	2 W	Digital "PL"	1	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	1	1							X					X						X
H23BBU6122B	2 W	Digital "PL"	2	SE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2	2			X									X				X		
H23BBU6124B	2 W	Digital "PL"	2	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	2	2			X									X						X
H23BBU6144B	2 W	Digital "PL"	4	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	4	4									X			X						X
H23BBU6164B	2 W	Digital "PL"	6	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	6	6				X								X						X
H23BBU6184B	2 W	Digital "PL"	8	OE	10 10 80	A	A	A	A	A	A	A	A	A	A	A	A	8	8					X							X						X
H33BBU1113A	5 W	Carrier	1	OS	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	X		X					X							X				X	
H33BBU1114A	5 W	Carrier	1	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	X		X						X							X				X
H33BBU1123A	5 W	Carrier	2	OS	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2		2	X											X				X	
H33BBU1124A	5 W	Carrier	2	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2		2		X											X				X
H33BBU1143A	5 W	Carrier	4	OS	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	4		4							X					X				X	
H33BBU1144A	5 W	Carrier	4	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	4		4								X					X				X
H33BBU1164A	5 W	Carrier	6	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	6		6			X										X				X
H33BBU1184A	5 W	Carrier	8	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	8		8				X									X				X
H33BBU3113A	5 W	Tone "PL"	1	OS	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	X		X					X					X						X	
H33BBU3114A	5 W	Tone "PL"	1	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	X		X						X					X						X
H33BBU3123A	5 W	Tone "PL"	2	OS	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2		2	X									X						X	
H33BBU3124A	5 W	Tone "PL"	2	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2		2		X									X						X
H33BBU3143A	5 W	Tone "PL"	4	OS	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	4		4							X			X						X	
H33BBU3144A	5 W	Tone "PL"	4	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	4		4								X			X						X
H33BBU3154A	5 W	Tone "PL"	5	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	5		5									X		X						X
H33BBU3164A	5 W	Tone "PL"	6	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	6		6			X								X						X
H33BBU3184A	5 W	Tone "PL"	8	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	8		8				X							X						X
H33BBU6114B	5 W	Digital "PL"	1	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	X		X						X					X						X
H33BBU6124B	5 W	Digital "PL"	2	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	2		2		X									X						X
H33BBU6144B	5 W	Digital "PL"	4	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	4		4								X			X						X
H33BBU6164B	5 W	Digital "PL"	6	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	6		6			X								X						X
H33BBU6184B	5 W	Digital "PL"	8	OE	5 5 90	A	A	A	A	A	A	A	A	A	A	A	A	8		8				X							X						X

MODEL	NLN4180A	NLN4181A	NLN4182A	NLN4194A	NLN4188A	NLN4189A	NLN4643A	NLN5157A	NLN4191A	NLD6941A	NLD6942A	NLD6943A	NLD6951A	NLD6952A	NLD6953A	NLN4172A	NLN4174A	NLN4175A	NLN4215A	NLN4573A	NFN6010A	NLN4211A	NLN4645A	NLN5874A	NLN4647A	NLN8922A	NLN4186A	NLN4187A	NLN4190A	NLN4195A	NLN4196A	NLN4605A	NLN4606A	NAD6221A	NAD6222A	NAD6219A	NAD6220A	NLN4462A	NLN4463A	NLN6803B	NLN6844B	NLN6845B	NLN6846B
H23BBU1111A	X	X		X	X					A	A	A																			X	X	X	N	N	N	N	N		N			
H23BBU1112A	X	X		X	X					A	A	A																			X	X	X	N	N	N	N		N		N		
H23BBU1113A	X		X		X					A	A	A				X															X	X	X	N	N	N	N		N			N	
H23BBU1114A	X		X		X					A	A	A					X														X	X	X	N	N	N	N		N				N
H23BBU1121A	X	X		X		X				A	A	A																			X	X	X	N	N	N	N	N		N			
H23BBU1122A	X	X		X		X				A	A	A																			X	X	X	N	N	N	N	N			N		
H23BBU1123A	X		X			X				A	A	A				X															X	X	X	N	N	N	N		N			N	
H23BBU1124A	X		X			X				A	A	A					X														X	X	X	N	N	N	N		N				N
H23BBU1143A	X		X				X			A	A	A				X															X	X	X	N	N	N	N		N			N	
H23BBU1144A	X		X				X			A	A	A					X														X	X	X	N	N	N	N		N				N
H23BBU1164A	X		X						X	A	A	A					X														X	X	X	N	N	N	N		N				N
H23BBU1184A	X		X						X	A	A	A						X	X	X							X			X	X	X	X	N	N	N	N		N				N
H23BBU3112A	X	X		X	X					A	A	A									X	X							X		X	X	X	N	N	N	N	N			N		
H23BBU3113A	X		X		X					A	A	A				X					X		X					X			X	X	X	N	N	N	N		N			N	
H23BBU3114A	X		X		X					A	A	A					X				X	X					X				X	X	X	N	N	N	N		N				N
H23BBU3122A	X	X		X		X				A	A	A									X	X							X		X	X	X	N	N	N	N	N			N		
H23BBU3123A	X		X			X				A	A	A				X					X		X					X			X	X	X	N	N	N	N		N			N	
H23BBU3124A	X		X			X				A	A	A					X				X	X					X				X	X	X	N	N	N	N		N				N
H23BBU3143A	X		X				X			A	A	A				X					X		X					X			X	X	X	N	N	N	N		N			N	
H23BBU3144A	X		X				X			A	A	A					X				X	X					X				X	X	X	N	N	N	N		N				N
H23BBU3154A	X		X					X		A	A	A					X				X	X									X	X	X	N	N	N	N		N				N
H23BBU3164A	X		X						X	A	A	A					X				X	X					X				X	X	X	N	N	N	N		N				N
H23BBU3184A	X		X						X	A	A	A						X	X	X	X	X					X			X	X	X	X	N	N	N	N		N				N
H23BBU6112B	X	X		X	X					A	A	A												X	X	X			X		X	X	X	N	N	N	N	N			N		
H23BBU6114B	X		X		X					A	A	A					X							X	X	X	X				X	X	X	N	N	N	N		N				N
H23BBU6122B	X	X		X		X				A	A	A												X	X	X			X		X	X	X	N	N	N	N	N			N		
H23BBU6124B	X		X			X				A	A	A					X							X	X	X	X				X	X	X	N	N	N	N		N				N
H23BBU6144B	X		X				X			A	A	A					X							X	X	X	X				X	X	X	N	N	N	N		N				N
H23BBU6164B	X		X						X	A	A	A					X							X	X	X	X				X	X	X	N	N	N	N		N				N
H23BBU6184B	X		X						X	A	A	A						X	X	X				X	X	X	X			X	X	X	X	N	N	N	N		N				N
H33BBU1113A	X		X		X								A	A	A	X															X	X	X	N	N	N	N		N			N	
H33BBU1114A	X		X		X								A	A	A		X														X	X	X	N	N	N	N		N				N
H33BBU1123A	X		X			X							A	A	A	X															X	X	X	N	N	N	N		N			N	
H33BBU1124A	X		X			X							A	A	A		X														X	X	X	N	N	N	N		N				N
H33BBU1143A	X		X				X						A	A	A	X															X	X	X	N	N	N	N		N			N	
H33BBU1144A	X		X				X						A	A	A		X														X	X	X	N	N	N	N		N				N
H33BBU1164A	X		X						X				A	A	A		X														X	X	X	N	N	N	N		N				N
H33BBU1184A	X		X						X				A	A	A			X	X	X							X			X	X	X	X	N	N	N	N		N				N
H33BBU3113A	X		X		X								A	A	A	X					X		X					X			X	X	X	N	N	N	N		N			N	
H33BBU3114A	X		X		X								A	A	A		X				X	X					X				X	X	X	N	N	N	N		N				N
H33BBU3123A	X		X			X							A	A	A	X					X		X					X			X	X	X	N	N	N	N		N			N	
H33BBU3124A	X		X			X							A	A	A		X				X	X					X				X	X	X	N	N	N	N		N				N
H33BBU3143A	X		X				X						A	A	A	X					X		X					X			X	X	X	N	N	N	N		N			N	
H33BBU3144A	X		X				X						A	A	A		X				X	X					X				X	X	X	N	N	N	N		N				N
H33BBU3154A	X		X					X					A	A	A		X				X	X									X	X	X	N	N	N	N		N				N
H33BBU3164A	X		X						X				A	A	A		X				X	X					X				X	X	X	N	N	N	N		N				N
H33BBU3184A	X		X						X				A	A	A			X	X	X	X	X					X			X	X	X	X	N	N	N	N		N				N
H33BBU6114B	X		X		X								A	A	A		X							X	X	X	X				X	X	X	N	N	N	N		N				N
H33BBU6124B	X		X			X							A	A	A		X							X	X	X	X				X	X	X	N	N	N	N		N				N
H33BBU6144B	X		X				X						A	A	A		X							X	X	X	X				X	X	X	N	N	N	N		N				N
H33BBU6164B	X		X						X				A	A	A		X							X	X	X	X				X	X	X	N	N	N	N		N				N
H33BBU6184B	X		X						X				A	A	A			X	X	X				X	X	X	X			X	X	X	X	N	N	N	N		N				N

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"BBB" SERIES UHF MODEL CHART

CODE:

- [X] = ONE ITEM SUPPLIED
- [2] = NUMBER OF ITEMS SUPPLIED AS INDICATED.
- [A] = ALTERNATE ITEM SUPPLIED, CHOICE DEPENDS ON CARRIER FREQUENCY.
- [N] = ITEMS SUPPLIED IN "PACKAGE" MODELS. SEE YOUR MOTOROLA SALES REPRESENTATIVE FOR FURTHER DETAILS.

- * SS = "SLIM-LINE" (SHORT
- SE = "SLIM-LINE" (EXTENDED)
- OS = "OMNI" (SHORT)
- OE = "OMNI" (EXTENDED)

MODEL	RF OUTPUT POWER	TYPE OF SQUELCH	NUMBER OF CHANNELS	* SIZE	DUTY CYCLE			TRANSMITTER-RECEIVER BOARD (450-482 MHz) NUE6242A	TRANSMITTER-RECEIVER BOARD (482-512 MHz) NUE6243A	TRANSMITTER-RECEIVER BOARD (450-482 MHz) NUE6292A	TRANSMITTER-RECEIVER BOARD (482-512 MHz) NUE6293A	SECOND OSCILLATOR CRYSTAL (17.865 MHz) NXN6029A	SECOND OSCILLATOR CRYSTAL (17.935 MHz) NXN6030A	CHANNEL ELEMENT, RECEIVER KXN1034A	CHANNEL ELEMENT, TRANSMITTER KXN1035A	FRAME: C1R1, SHORT NHE6041A	FRAME: C1R1, EXTENDED NHE6051A	FRAME: C2R2, SHORT NHE6111A	FRAME: C2R2, EXTENDED NHE6121A	FRAME: C4R4, SHORT NHE6131A	FRAME: C4R4, EXTENDED NHE6141A	FRAME: C5R5, EXTENDED NHE6291A	FRAME: C6R6, EXTENDED NHE6061A	FRAME: C8R8, EXTENDED NHE6071A	FRONT COVER: "PL," SHORT NLN4183A	FRONT COVER: "PL," EXTENDED NLN4184A	FRONT COVER: CARRIER SQUELCH, SHORT NLN4207A	FRONT COVER: CARRIER SQUELCH, EXTENDED NLN4208A	BACK COVER: "SLIM-LINE", SHORT NLN4176A	BACK COVER: "SLIM-LINE," EXTENDED NLN4177A	BACK COVER: "OMNI," SHORT NLN4178A	BACK COVER: "OMNI," EXTENDED NLN4179A	BATTERY COVER NLN4180A	BATTERY COVER LATCH: "SLIM-LINE" NLN4181A	BATTERY COVER LATCH: "OMNI" NLN4182A	BATTERY COVER LATCH HARDWARE NLN4194A	ESCUTCHEON: C1R1 NLN4188A
H24BBB1111A	1.5 W	Carrier	1	SS	5	5	90	A	A	A	A	X	A	X	X	X											X		X				X	X		X	X
H24BBB1112A	1.5 W	Carrier	1	SE	5	5	90	A	A	A	A	X	A	X	X		X											X		X			X	X		X	X
H24BBB1113A	1.5 W	Carrier	1	OS	10	10	80	A	A	A	A	X	A	X	X	X											X				X		X		X		X
H24BBB1114A	1.5 W	Carrier	1	OE	10	10	80	A	A	A	A	X	A	X	X		X											X				X	X		X		X
H24BBB1121A	1.5 W	Carrier	2	SS	5	5	90	A	A	A	A	X	A	2	2			X									X		X				X	X		X	
H24BBB1122A	1.5 W	Carrier	2	SE	5	5	90	A	A	A	A	X	A	2	2				X									X		X			X	X		X	
H24BBB1123A	1.5 W	Carrier	2	OS	10	10	80	A	A	A	A	X	A	2	2			X									X				X		X		X		
H24BBB1124A	1.5 W	Carrier	2	OE	10	10	80	A	A	A	A	X	A	2	2				X									X				X	X		X		
H24BBB1143A	1.5 W	Carrier	4	OS	10	10	80	A	A	A	A	X	A	4	4					X							X				X		X		X		
H24BBB1144A	1.5 W	Carrier	4	OE	10	10	80	A	A	A	A	X	A	4	4						X							X				X	X		X		
H24BBB1164A	1.5 W	Carrier	6	OE	10	10	80	A	A	A	A	X	A	6	6								X					X				X	X		X		
H24BBB1184A	1.5 W	Carrier	8	OE	10	10	80	A	A	A	A	X	A	8	8									X				X				X	X		X		
H24BBB3112A	1.5 W	Tone "PL"	1	SE	5	5	90	A	A	A	A	X	A	X	X		X									X				X			X	X		X	X
H24BBB3113A	1.5 W	Tone "PL"	1	OS	10	10	80	A	A	A	A	X	A	X	X	X									X						X		X		X		X
H24BBB3114A	1.5 W	Tone "PL"	1	OE	10	10	80	A	A	A	A	X	A	X	X		X									X						X	X			X	X
H24BBB3122A	1.5 W	Tone "PL"	2	SE	5	5	90	A	A	A	A	X	A	2	2				X							X				X			X	X		X	
H24BBB3123A	1.5 W	Tone "PL"	2	OS	10	10	80	A	A	A	A	X	A	2	2			X							X						X		X		X		
H24BBB3124A	1.5 W	Tone "PL"	2	OE	10	10	80	A	A	A	A	X	A	2	2				X							X						X	X		X		
H24BBB3143A	1.5 W	Tone "PL"	4	OS	10	10	80	A	A	A	A	X	A	4	4					X					X						X		X		X		
H24BBB3144A	1.5 W	Tone "PL"	4	OE	10	10	80	A	A	A	A	X	A	4	4						X					X						X	X		X		
H24BBB3154A	1.5 W	Tone "PL"	5	OE	10	10	80	A	A	A	A	X	A	5	5							X				X						X	X		X		
H24BBB3164A	1.5 W	Tone "PL"	6	OE	10	10	80	A	A	A	A	X	A	6	6								X			X						X	X		X		
H24BBB3184A	1.5 W	Tone "PL"	8	OE	10	10	80	A	A	A	A	X	A	8	8									X		X						X	X		X		
H34BBB1113A	4 W	Carrier	1	OS	5	5	90	A	A	A	A	X	A	X	X	X											X				X		X		X		X
H34BBB1114A	4 W	Carrier	1	OE	5	5	90	A	A	A	A	X	A	X	X		X											X				X	X		X		X
H34BBB1123A	4 W	Carrier	2	OS	5	5	90	A	A	A	A	X	A	2	2			X									X				X		X		X		
H34BBB1124A	4 W	Carrier	2	OE	5	5	90	A	A	A	A	X	A	2	2				X									X				X	X		X		
H34BBB1143A	4 W	Carrier	4	OS	5	5	90	A	A	A	A	X	A	4	4					X							X				X		X		X		
H34BBB1144A	4 W	Carrier	4	OE	5	5	90	A	A	A	A	X	A	4	4						X							X				X	X		X		
H34BBB1164A	4 W	Carrier	6	OE	5	5	90	A	A	A	A	X	A	6	6								X					X				X	X		X		
H34BBB1184A	4 W	Carrier	8	OE	5	5	90	A	A	A	A	X	A	8	8									X				X				X	X		X		
H34BBB3113A	4 W	Tone "PL"	1	OS	5	5	90	A	A	A	A	X	A	X	X	X									X						X		X		X		X
H34BBB3114A	4 W	Tone "PL"	1	OE	5	5	90	A	A	A	A	X	A	X	X		X									X						X	X		X		X
H34BBB3123A	4 W	Tone "PL"	2	OS	5	5	90	A	A	A	A	X	A	2	2			X							X						X		X		X		
H34BBB3124A	4 W	Tone "PL"	2	OE	5	5	90	A	A	A	A	X	A	2	2				X							X						X	X		X		
H34BBB3143A	4 W	Tone "PL"	4	OS	5	5	90	A	A	A	A	X	A	4	4					X					X						X		X		X		
H34BBB3144A	4 W	Tone "PL"	4	OE	5	5	90	A	A	A	A	X	A	4	4						X					X						X	X		X		
H34BBB3154A	4 W	Tone "PL"	5	OE	5	5	90	A	A	A	A	X	A	5	5							X				X						X	X		X		
H34BBB3164A	4 W	Tone "PL"	6	OE	5	5	90	A	A	A	A	X	A	6	6								X			X						X	X		X		
H34BBB3184A	4 W	Tone "PL"	8	OE	5	5	90	A	A	A	A	X	A	8	8									X		X						X	X		X		

MODEL	ESCUTCHEON: C2R2 NLN4189A	ESCUTCHEON: C4R4 NLN4643A	ESCUTCHEON: C5R5 NLN5157A	ESCUTCHEON: C8R8 NLN4191A	1.5-WATT POWER AMPLIFIER (450-482 MHz) NLE8362A	1.5-WATT POWER AMPLIFIER (482-512 MHz) NLE8363A	4-WATT POWER AMPLIFIER (450-482 MHz) NLE8372A	4-WATT POWER AMPLIFIER (482-512 MHz) NLE8373A	SLEEVE: "OMNI," SHORT NLN4172A	SLEEVE: "OMNI," EXTENDED NLN4174A	SLEEVE: "OMNI," EXTENDED LESS ANTENNA TUBE NLN4175A	CHANNEL DECK, C7R7 NLN4215A	CHANNEL ELEMENT DECK, C8R8 NLN4573A	ACTIVE FILTER NFN6010A	TONE "PL" DECK NLN4644A	TONE "PL" DECK NLN4646A	MOUNTING HARDWARE: "OMNI," EXTENDED NLN4186A	MOUNTING HARDWARE: "OMNI," SHORT NLN4187A	MOUNTING HARDWARE: "SLIM-LINE," EXTENDED NLN4190A	MOUNTING HARDWARE: C7R7 CHANNEL ELEMENT DECK NLN4195A	LABEL NLN4196A	TUNING TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS) NLN4605A	SERVICE TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS) NLN4606A	INTERCONNECT BD ELECTRICAL HARDWARE (482-512 MHz) NLE8521A	ANTENNA, FLEX NAE6050A	BATTERY, NICKEL-CADMIUM: "SLIM-LINE" NLN4462A	BATTERY, NICKEL-CADMIUM: "OMNI" NLN4463A	CARRYING CASE AND "T" STRAP, "SLIM-LINE," SHORT NLN6803B	CARRYING CASE AND "T" STRAP, "SLIM-LINE," EXTENDED NLN6844B	CARRYING CASE AND "T" STRAP, "OMNI," SHORT NLN6845B	CARRYING CASE AND "T" STRAP, "OMNI," EXTENDED NLN6846B
H24BBB1111A					A	A															X	X	X	X	N	N		N			
H24BBB1112A					A	A															X	X	X	X	N	N			N		
H24BBB1113A					A	A			X												X	X	X	X	N		N			N	
H24BBB1114A					A	A				X											X	X	X	X	N		N				N
H24BBB1121A	X				A	A															X	X	X	X	N	N		N			
H24BBB1122A	X				A	A															X	X	X	X	N	N			N		
H24BBB1123A	X				A	A			X												X	X	X	X	N		N			N	
H24BBB1124A	X				A	A				X											X	X	X	X	N		N				N
H24BBB1143A		X			A	A			X												X	X	X	X	N		N			N	
H24BBB1144A		X			A	A				X											X	X	X	X	N		N				N
H24BBB1164A				X	A	A				X											X	X	X	X	N		N				N
H24BBB1184A				X	A	A					X	X	X				X			X	X	X	X	X	N		N				N
H24BBB3112A					A	A								X		X	X		X		X	X	X	X	N	N			N		
H24BBB3113A					A	A			X					X	X			X			X	X	X	X	N		N			N	
H24BBB3114A					A	A				X				X		X	X				X	X	X	X	N		N				N
H24BBB3122A	X				A	A								X		X			X		X	X	X	X	N	N			N		
H24BBB3123A	X				A	A			X					X	X			X			X	X	X	X	N		N			N	
H24BBB3124A	X				A	A				X				X		X	X				X	X	X	X	N		N				N
H24BBB3143A		X			A	A			X					X	X			X			X	X	X	X	N		N			N	
H24BBB3144A		X			A	A				X				X		X	X				X	X	X	X	N		N				N
H24BBB3154A			X		A	A				X				X		X	X				X	X	X	X	N		N				N
H24BBB3164A				X	A	A				X				X		X	X				X	X	X	X	N		N				N
H24BBB3184A				X	A	A					X	X	X	X		X	X			X	X	X	X	X	N		N				N
H34BBB1113A							A	A	X												X	X	X	X			N			N	
H34BBB1114A							A	A		X											X	X	X	X			N				N
H34BBB1123A	X						A	A	X												X	X	X	X			N			N	
H34BBB1124A	X						A	A		X											X	X	X	X			N				N
H34BBB1143A		X					A	A	X												X	X	X	X			N			N	
H34BBB1144A		X					A	A		X											X	X	X	X			N				N
H34BBB1164A				X			A	A		X											X	X	X	X			N				N
H34BBB1184A				X			A	A			X	X	X				X			X	X	X	X	X			N				N
H34BBB3113A							A	A	X					X	X			X			X	X	X	X			N			N	
H34BBB3114A							A	A		X				X		X	X				X	X	X	X			N				N
H34BBB3123A	X						A	A	X					X	X			X			X	X	X	X			N			N	
H34BBB3124A	X						A	A		X				X		X	X				X	X	X	X			N				N
H34BBB3143A		X					A	A	X					X	X			X			X	X	X	X			N			N	
H34BBB3144A		X					A	A		X				X		X	X				X	X	X	X			N				N
H34BBB3154A			X				A	A		X				X		X	X				X	X	X	X			N				N
H34BBB3164A				X			A	A		X				X		X	X				X	X	X	X			N				N
H34BBB3184A				X			A	A			X	X	X	X		X	X			X	X	X	X	X			N				N

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"BBU" SERIES UHF MODEL CHART

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*SS = "SLIM-LINE" (SHORT)
SE = "SLIM-LINE" (EXTENDED)
OS = "OMNI" (SHORT)
OE = "OMNI" (EXTENDED)

MODEL	RF OUTPUT POWER	TYPE OF SQUELCH	NUMBER OF CHANNELS	* SIZE	DUTY CYCLE
H24BBU1111A	1.5 W	Carrier	1	SS	5 5 90
H24BBU1112A	1.5 W	Carrier	1	SE	5 5 90
H24BBU1113A	1.5 W	Carrier	1	OS	10 10 80
H24BBU1114A	1.5 W	Carrier	1	OE	10 10 80
H24BBU1121A	1.5 W	Carrier	2	SS	5 5 90
H24BBU1122A	1.5 W	Carrier	2	SE	5 5 90
H24BBU1123A	1.5 W	Carrier	2	OS	10 10 80
H24BBU1124A	1.5 W	Carrier	2	OE	10 10 80
H24BBU1143A	1.5 W	Carrier	4	OS	10 10 80
H24BBU1144A	1.5 W	Carrier	4	OE	10 10 80
H24BBU1164A	1.5 W	Carrier	6	OE	10 10 80
H24BBU1184A	1.5 W	Carrier	8	OE	10 10 80
H24BBU3112A	1.5 W	Tone "PL"	1	SE	5 5 90
H24BBU3113A	1.5 W	Tone "PL"	1	OS	10 10 80
H24BBU3114A	1.5 W	Tone "PL"	1	OE	10 10 80
H24BBU3122A	1.5 W	Tone "PL"	2	SE	5 5 90
H24BBU3123A	1.5 W	Tone "PL"	2	OS	10 10 80
H24BBU3124A	1.5 W	Tone "PL"	2	OE	10 10 80
H24BBU3143A	1.5 W	Tone "PL"	4	OS	10 10 80
H24BBU3144A	1.5 W	Tone "PL"	4	OE	10 10 80
H24BBU3154A	1.5 W	Tone "PL"	5	OE	10 10 80
H24BBU3164A	1.5 W	Tone "PL"	6	OE	10 10 80
H24BBU3184A	1.5 W	Tone "PL"	8	OE	10 10 80
H24BBU6112B	1.5 W	Digital "PL"	1	SE	5 5 90
H24BBU6114B	1.5 W	Digital "PL"	1	OE	10 10 80
H24BBU6122B	1.5 W	Digital "PL"	2	SE	5 5 90
H24BBU6124B	1.5 W	Digital "PL"	2	OE	10 10 80
H24BBU6144B	1.5 W	Digital "PL"	4	OE	10 10 80
H24BBU6164B	1.5 W	Digital "PL"	6	OE	10 10 80
H24BBU6184B	1.5 W	Digital "PL"	8	OE	10 10 80
H34BBU1113A	4 W	Carrier	1	OS	5 5 90
H34BBU1114A	4 W	Carrier	1	OE	5 5 90
H34BBU1123A	4 W	Carrier	2	OS	5 5 90
H34BBU1124A	4 W	Carrier	2	OE	5 5 90
H34BBU1143A	4 W	Carrier	4	OS	5 5 90
H34BBU1144A	4 W	Carrier	4	OE	5 5 90
H34BBU1164A	4 W	Carrier	6	OE	5 5 90
H34BBU1184A	4 W	Carrier	8	OE	5 5 90
H34BBU3113A	4 W	Tone "PL"	1	OS	5 5 90
H34BBU3114A	4 W	Tone "PL"	1	OE	5 5 90
H34BBU3123A	4 W	Tone "PL"	2	OS	5 5 90
H34BBU3124A	4 W	Tone "PL"	2	OE	5 5 90
H34BBU3143A	4 W	Tone "PL"	4	OS	5 5 90
H34BBU3144A	4 W	Tone "PL"	4	OE	5 5 90
H34BBU3154A	4 W	Tone "PL"	5	OE	5 5 90
H34BBU3164A	4 W	Tone "PL"	6	OE	5 5 90
H34BBU3184A	4 W	Tone "PL"	8	OE	5 5 90
H34BBU6114B	4 W	Digital "PL"	1	OE	5 5 90
H34BBU6124B	4 W	Digital "PL"	2	OE	5 5 90
H34BBU6144B	4 W	Digital "PL"	4	OE	5 5 90
H34BBU6164B	4 W	Digital "PL"	6	OE	5 5 90
H34BBU6184B	4 W	Digital "PL"	8	OE	5 5 90

MODEL	NUE6231A TRANSMITTER-RECEIVER BOARD (403-430 MHz)	NUE6232A TRANSMITTER-RECEIVER BOARD (450-482 MHz)	NUE6233A TRANSMITTER-RECEIVER BOARD (482-512 MHz)	NUE6272A TRANSMITTER-RECEIVER BOARD (440-470 MHz)	NUE6281A TRANSMITTER-RECEIVER BOARD (403-430 MHz)	NUE6282A TRANSMITTER-RECEIVER BOARD (450-482 MHz)	NUE6283A TRANSMITTER-RECEIVER BOARD (482-512 MHz)	NUE6302A TRANSMITTER-RECEIVER BOARD RCVE (440-470 MHz) XMIT (403-430 MHz)	NUE6312A TRANSMITTER-RECEIVER BOARD (450-482 MHz)	NUE6313A TRANSMITTER-RECEIVER BOARD (482-512 MHz)	NXN6029A SECOND OSCILLATOR CRYSTAL (17.865 MHz)	NXN6030A SECOND OSCILLATOR CRYSTAL (17.935 MHz)	KXN1034A CHANNEL ELEMENT, RECEIVER	KXN1035A CHANNEL ELEMENT, TRANSMITTER	NHE6001A FRAME; C1R1, SHORT (450-512 MHz)	NHE6211A FRAME; C1R1, SHORT (403-430 MHz)	NHE6011A FRAME; C1R1, EXTENDED (450-512 MHz)	NHE6221A FRAME; C1R1, EXTENDED (403-430 MHz)	NHE6081A FRAME; C2R2, SHORT (450-512 MHz)	NHE6231A FRAME; C2R2, SHORT (403-430 MHz)	NHE6091A FRAME; C2R2, EXTENDED (450-512 MHz)	NHE6241A FRAME; C2R2, EXTENDED (403-430 MHz)	NHE6151A FRAME; C4R4, SHORT (450-512 MHz)	NHE6251A FRAME; C4R4, SHORT (403-430 MHz)	NHE6161A FRAME; C4R4, EXTENDED (450-512 MHz)	NHE6261A FRAME; C4R4, EXTENDED (403-430 MHz)	NHE6201A FRAME; C5R5, EXTENDED (440-512 MHz)	NHE6291A FRAME; C5R5, EXTENDED (403-430 MHz)	NHE6021A FRAME; C6R6, EXTENDED (450-512 MHz)	NHE6271A FRAME; C6R6, EXTENDED (403-430 MHz)	NHE6031A FRAME; C8R8, EXTENDED (450-512 MHz)	NHE6281A FRAME; C8R8, EXTENDED (403-430 MHz)
H24BBU1111A	A	A	A	A	A	A	A	A	A	A	A	A	X	X	A	A																
H24BBU1112A	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H24BBU1113A	A	A	A	A	A	A	A	A	A	A	A	A	X	X	A	A																
H24BBU1114A	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H24BBU1121A	A	A	A	A	A	A	A	A	A	A	A	A	2	2					A	A												
H24BBU1122A	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H24BBU1123A	A	A	A	A	A	A	A	A	A	A	A	A	2	2					A	A												
H24BBU1124A	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H24BBU1143A	A	A	A	A	A	A	A	A	A	A	A	A	4	4									A	A								
H24BBU1144A	A	A	A	A	A	A	A	A	A	A	A	A	4	4											A	A						
H24BBU1164A	A	A	A	A	A	A	A	A	A	A	A	A	6	6															A	A		
H24BBU1184A	A	A	A	A	A	A	A	A	A	A	A	A	8	8																	A	A
H24BBU3112A	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H24BBU3113A	A	A	A	A	A	A	A	A	A	A	A	A	X	X	A	A																
H24BBU3114A	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H24BBU3122A	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H24BBU3123A	A	A	A	A	A	A	A	A	A	A	A	A	2	2					A	A												
H24BBU3124A	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H24BBU3143A	A	A	A	A	A	A	A	A	A	A	A	A	4	4									A	A								
H24BBU3144A	A	A	A	A	A	A	A	A	A	A	A	A	4	4											A	A						
H24BBU3154A	A	A	A	A	A	A	A	A	A	A	A	A	5	5													A	A				
H24BBU3164A	A	A	A	A	A	A	A	A	A	A	A	A	6	6															A	A		
H24BBU3184A	A	A	A	A	A	A	A	A	A	A	A	A	8	8																	A	A
H24BBU6112B	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H24BBU6114B	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H24BBU6122B	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H24BBU6124B	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H24BBU6144B	A	A	A	A	A	A	A	A	A	A	A	A	4	4											A	A						
H24BBU6164B	A	A	A	A	A	A	A	A	A	A	A	A	6	6															A	A		
H24BBU6184B	A	A	A	A	A	A	A	A	A	A	A	A	8	8																	A	A
H34BBU1113A	A	A	A	A	A	A	A	A	A	A	A	A	X	X	A	A																
H34BBU1114A	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H34BBU1123A	A	A	A	A	A	A	A	A	A	A	A	A	2	2					A	A												
H34BBU1124A	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H34BBU1143A	A	A	A	A	A	A	A	A	A	A	A	A	4	4									A	A								
H34BBU1144A	A	A	A	A	A	A	A	A	A	A	A	A	4	4											A	A						
H34BBU1164A	A	A	A	A	A	A	A	A	A	A	A	A	6	6															A	A		
H34BBU1184A	A	A	A	A	A	A	A	A	A	A	A	A	8	8																	A	A
H34BBU3113A	A	A	A	A	A	A	A	A	A	A	A	A	X	X	A	A																
H34BBU3114A	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H34BBU3123A	A	A	A	A	A	A	A	A	A	A	A	A	2	2					A	A												
H34BBU3124A	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H34BBU3143A	A	A	A	A	A	A	A	A	A	A	A	A	4	4									A	A								
H34BBU3144A	A	A	A	A	A	A	A	A	A	A	A	A	4	4											A	A						
H34BBU3154A	A	A	A	A	A	A	A	A	A	A	A	A	5	5													A	A				
H34BBU3164A	A	A	A	A	A	A	A	A	A	A	A	A	6	6															A	A		
H34BBU3184A	A	A	A	A	A	A	A	A	A	A	A	A	8	8																	A	A
H34BBU6114B	A	A	A	A	A	A	A	A	A	A	A	A	X	X			A	A														
H34BBU6124B	A	A	A	A	A	A	A	A	A	A	A	A	2	2							A	A										
H34BBU6144B	A	A	A	A	A	A	A	A	A	A	A	A	4	4											A	A						
H34BBU6164B	A	A	A	A	A	A	A	A	A	A	A	A	6	6															A	A		
H34BBU6184B	A	A	A	A	A	A	A	A	A	A	A	A	8	8																	A	A

MODEL	NLN4207A FRONT COVER; CARRIER SQUELCH, SHORT	NLN4208A FRONT COVER; CARRIER SQUELCH, EXTENDED	NLN4184A FRONT COVER; "PL," EXTENDED	NLN4183A FRONT COVER; "PL," SHORT	NLN4176A BACK COVER; "SLIM-LINE," SHORT	NLN4177A BACK COVER; "SLIM-LINE," EXTENDED	NLN4178A BACK COVER; "OMNI," SHORT	NLN4179A BACK COVER; "OMNI," EXTENDED	NLN4180A BATTERY COVER	NLN4181A BATTERY COVER LATCH; "SLIM-LINE"	NLN4182A BATTERY COVER LATCH; "OMNI"	NLN4194A BATTERY COVER LATCH HARDWARE	NLN4188A ESCUTCHEON; C1R1	NLN4189A ESCUTCHEON; C2R2	NLN4643A ESCUTCHEON; C4R4	NLN5157A ESCUTCHEON; C5R5	NLN5191A ESCUTCHEON; C8R8	NLE8361A 1.5-WATT POWER AMPLIFIER (403-420 MHz)	NLE8362A 1.5-WATT POWER AMPLIFIER (450-482 MHz)	NLE8363A 1.5-WATT POWER AMPLIFIER (482-512 MHz)	NLE8730A POWER AMPLIFIER HARDWARE KIT (403-430 MHz)	NLE8731A POWER AMPLIFIER HARDWARE KIT (440-482 MHz)	NLE8732A POWER AMPLIFIER HARDWARE KIT (482-512 MHz)	NLE8371A 4-WATT POWER AMPLIFIER (403-430 MHz)	NLE8372A 4-WATT POWER AMPLIFIER (450-482 MHz)	NLE8373A 4-WATT POWER AMPLIFIER (482-512 MHz)
H24BBU1111A	X				X				X	X		X	X					A	A	A	A	A	A			
H24BBU1112A		X				X			X	X		X	X					A	A	A	A	A	A			
H24BBU1113A	X						X		X		X		X					A	A	A	A	A	A			
H24BBU1114A		X						X	X		X		X					A	A	A	A	A	A			
H24BBU1121A	X				X				X	X		X		X				A	A	A	A	A	A			
H24BBU1122A		X				X			X	X		X		X				A	A	A	A	A	A			
H24BBU1123A	X						X		X		X			X				A	A	A	A	A	A			
H24BBU1124A		X						X	X		X			X				A	A	A	A	A	A			
H24BBU1143A	X						X		X		X				X			A	A	A	A	A	A			
H24BBU1144A		X						X	X		X				X			A	A	A	A	A	A			
H24BBU1164A		X						X	X		X						X	A	A	A	A	A	A			
H24BBU1184A		X						X	X		X						X	A	A	A	A	A	A			
H24BBU3112A			X			X			X	X		X	X					A	A	A	A	A	A			
H24BBU3113A				X			X		X		X		X					A	A	A	A	A	A			
H24BBU3114A			X					X	X		X		X					A	A	A	A	A	A			
H24BBU3122A			X			X			X	X		X		X				A	A	A	A	A	A			
H24BBU3123A				X			X		X		X			X				A	A	A	A	A	A			
H24BBU3124A			X					X	X		X			X				A	A	A	A	A	A			
H24BBU3143A				X			X		X		X				X			A	A	A	A	A	A			
H24BBU3144A			X					X	X		X				X			A	A	A	A	A	A			
H24BBU3154A			X					X	X		X					X		A	A	A	A	A	A			
H24BBU3164A			X					X	X		X						X	A	A	A	A	A	A			
H24BBU3184A			X					X	X		X						X	A	A	A	A	A	A			
H24BBU6112B			X			X			X	X		X	X					A	A	A	A	A	A			
H24BBU6114B			X					X	X		X		X					A	A	A	A	A	A			
H24BBU6122B			X			X			X	X		X		X				A	A	A	A	A	A			
H24BBU6124B			X					X	X		X			X				A	A	A	A	A	A			
H24BBU6144B			X					X	X		X				X			A	A	A	A	A	A			
H24BBU6164B			X					X	X		X						X	A	A	A	A	A	A			
H24BBU6184B			X					X	X		X						X	A	A	A	A	A	A			
H34BBU1113A	X						X		X		X		X											A	A	A
H34BBU1114A		X						X	X		X		X											A	A	A
H34BBU1123A	X						X		X		X			X										A	A	A
H34BBU1124A		X						X	X		X			X										A	A	A
H34BBU1143A	X						X		X		X				X									A	A	A
H34BBU1144A		X						X	X		X				X									A	A	A
H34BBU1164A		X						X	X		X						X							A	A	A
H34BBU1184A		X						X	X		X						X							A	A	A
H34BBU3113A				X			X		X		X		X											A	A	A
H34BBU3114A			X					X	X		X		X											A	A	A
H34BBU3123A				X			X		X		X			X										A	A	A
H34BBU3124A			X					X	X		X			X										A	A	A
H34BBU3143A				X			X		X		X				X									A	A	A
H34BBU3144A			X					X	X		X				X									A	A	A
H34BBU3154A			X					X	X		X					X								A	A	A
H34BBU3164A			X					X	X		X						X							A	A	A
H34BBU3184A			X					X	X		X						X							A	A	A
H34BBU6114B			X					X	X		X		X											A	A	A
H34BBU6124B			X					X	X		X			X										A	A	A
H34BBU6144B			X					X	X		X				X									A	A	A
H34BBU6164B			X					X	X		X						X							A	A	A
H34BBU6184B			X					X	X		X						X							A	A	A

MODEL	NLN4172A SLEEVE; "OMNI," SHORT	NLN4174A SLEEVE; "OMNI," EXTENDED	NLN4175A SLEEVE; "OMNI," EXTENDED LESS ANTENNA TUBE	NLN4215A CHANNEL ELEMENT DECK; C7R7	NLN4573A CHANNEL ELEMENT DECK; C8R8	NFN6010A ACTIVE FILTER	NLN4211A TONE "PL" DECK; EXTENDED FRAME	NLN4645A TONE "PL" DECK; SHORT FRAME	NLN5874A DIGITAL "PL" DECK	NLN4647A DIGITAL "PL" RECEIVER BIAS	NLN8922A DIGITAL "PL" CODE PLUG	NLE8521A INTERCONNECT BD ELECTRICAL HARDWARE (482-512 MHz)	NLN4186A MOUNTING HARDWARE; "OMNI," EXTENDED	NLN4195A MOUNTING HARDWARE; C7R7 CHANNEL ELEMENT DECK	NLN4190A MOUNTING HARDWARE; "SLIM-LINE," EXTENDED	NLN4187A MOUNTING HARDWARE; "OMNI," SHORT	NLN4196A LABEL	NLN4605A TUNING TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS)	NLN4606A SERVICE TOOL (ONE SUPPLIED PER 20 OR LESS RADIOS)	NAE6050B ANTENNA, FLEX	NLN4462A NICKEL-CADMIUM BATTERY; "SLIM-LINE"	NLN4463A NICKEL-CADMIUM BATTERY; "OMNI"	NLN6803B CARRYING CASE AND "T" STRAP; "SLIM-LINE," SHORT	NLN6844B CARRYING CASE AND "T" STRAP; "SLIM-LINE," EXTENDED	NLN6845B CARRYING CASE AND "T" STRAP; "OMNI," SHORT	NLN6846B CARRYING CASE AND "T" STRAP; "OMNI," EXTENDED
H24BBU1111A												X					X	X	X	N	N		N			
H24BBU1112A												X					X	X	X	N	N			N		
H24BBU1113A	X											X					X	X	X	N		N			N	
H24BBU1114A		X										X					X	X	X	N		N				N
H24BBU1121A												X					X	X	X	N	N		N			
H24BBU1122A												X					X	X	X	N	N			N		
H24BBU1123A	X											X					X	X	X	N		N			N	
H24BBU1124A		X										X					X	X	X	N		N				N
H24BBU1143A	X											X					X	X	X	N		N			N	
H24BBU1144A		X										X					X	X	X	N		N				N
H24BBU1164A		X										X					X	X	X	N		N				N
H24BBU1184A			X	X	X							X	X	X			X	X	X	N		N				N
H24BBU3112A						X	X					X			X		X	X	X	N	N			N		
H24BBU3113A	X					X		X				X				X	X	X	X	N		N			N	
H24BBU3114A		X				X	X					X	X				X	X	X	N		N				N
H24BBU3122A						X	X					X			X		X	X	X	N	N			N		
H24BBU3123A	X					X		X				X				X	X	X	X	N		N			N	
H24BBU3124A		X				X	X					X	X				X	X	X	N		N				N
H24BBU3143A	X					X		X				X				X	X	X	X	N		N			N	
H24BBU3144A		X				X	X					X	X				X	X	X	N		N				N
H24BBU3154A		X				X	X					X	X				X	X	X	N		N				N
H24BBU3164A		X				X	X					X	X				X	X	X	N		N				N
H24BBU3184A			X	X	X	X	X					X	X	X			X	X	X	N		N				N
H24BBU6112B									X	X	X	X			X		X	X	X	N	N			N		
H24BBU6114B		X							X	X	X	X	X				X	X	X	N		N				N
H24BBU6122B									X	X	X	X			X		X	X	X	N	N			N		
H24BBU6124B		X							X	X	X	X	X				X	X	X	N		N				N
H24BBU6144B		X							X	X	X	X	X				X	X	X	N		N				N
H24BBU6164B		X							X	X	X	X	X				X	X	X	N		N				N
H24BBU6184B			X	X	X				X	X	X	X	X	X			X	X	X	N		N				N
H34BBU1113A	X											X					X	X	X	N		N			N	
H34BBU1114A		X										X					X	X	X	N		N				N
H34BBU1123A	X											X					X	X	X	N		N			N	
H34BBU1124A		X										X					X	X	X	N		N				N
H34BBU1143A	X											X					X	X	X	N		N			N	
H34BBU1144A		X										X					X	X	X	N		N				N
H34BBU1164A		X										X					X	X	X	N		N				N
H34BBU1184A			X	X	X							X	X	X			X	X	X	N		N				N
H34BBU3113A	X					X		X				X				X	X	X	X	N		N			N	
H34BBU3114A		X				X	X					X	X				X	X	X	N		N				N
H34BBU3123A	X					X		X				X				X	X	X	X	N		N			N	
H34BBU3124A		X				X	X					X	X				X	X	X	N		N				N
H34BBU3143A	X					X		X				X				X	X	X	X	N		N			N	
H34BBU3144A		X				X	X					X	X				X	X	X	N		N				N
H34BBU3154A		X				X	X					X	X				X	X	X	N		N				N
H34BBU3164A		X				X	X					X	X				X	X	X	N		N				N
H34BBU3184A			X	X	X	X	X					X	X	X			X	X	X	N		N				N
H34BBU6114B		X							X	X	X	X	X				X	X	X	N		N				N
H34BBU6124B		X							X	X	X	X	X				X	X	X	N		N				N
H34BBU6144B		X							X	X	X	X	X				X	X	X	N		N				N
H34BBU6164B		X							X	X	X	X	X				X	X	X	N		N				N
H34BBU6184B			X	X	X				X	X	X	X	X	X			X	X	X	N		N				N

EPF-8113-B

DESCRIPTION

1. INTRODUCTION

The MT500 Series "Handie-Talkie" radios described in this manual were designed for normal everyday rough handling. In addition, the radios are weather-sealed against dust, moisture and splashing water.

The radios are available as either "BBB" (basic) or "BBU" (universal) models. The "BBB" models are for hand-held only operation. The "BBU" models offer an integral side (accessory) connector to permit interchangeable use of an external speaker-microphone, automatic connection and operation with a "Converta-Com" console, and basic hand-held operation.

Extensive use is made of integrated circuits and both thick and thin film hybrid modules. Use of advanced microelectronic technology provides a radio design featuring higher performance, increased capabilities, and small, rugged packaging.

All operating controls, except the push-to-talk switch, are conveniently located on top of the radio (see Figure 1).

The VHF and UHF radios are available in four different sizes: "slim-line" short, "slim-line" extended, "omni"-short, and "omni"-extended. As additional channels or functions are added to the radio, increasingly larger housings are used until the "omni"-extended version is reached. Low band radios are available in the "omni"-extended housing.

Primary differences in the models involve the frequency of operation, the number of channels, the type squelch, and the transmitter rf output. Radio size in VHF and UHF models is determined by the number of channels, power output, signaling options, and other system-related options.

2. STANDARD FEATURES

All MT500 radios have similar appearance and several common features. Each radio has an external speaker jack, and an external antenna jack.

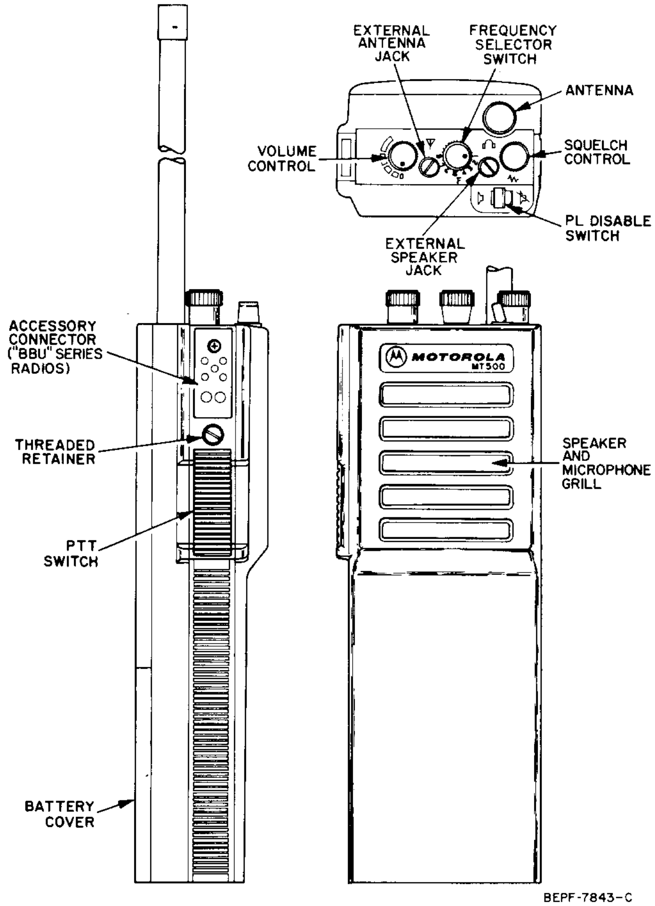


Figure 1.
Typical Multiple-Frequency Radio with Squelch Switch

The antenna jack impedance is 50 ohms. This permits attaching 50-ohm cables and test equipment to the antenna jack without impedance matching adapters.

The radio is powered by a nickel-cadmium or mercury battery. The standard "dual charge" nickel-cadmium battery has been designed for interchangeable use in both 16-hour slow-charge and 1-hour rapid-charge battery chargers. The "dual charge" battery can be charged either in or outside of the radio and is compatible with all HT220 radios. A dc input fuse is located in the battery compartment for easy access.

"BBU" Series radios are capable of operating with an external speaker-microphone attached to the radio by a connector and cord. This allows two-way communication while the radio is carried at the side of the user. The housing of the external speaker-microphone is equipped with a clip on the back cover which allows the user to attach it to a coat or shirt pocket, or lapel. This allows the user to listen to incoming messages and talk into the external speaker-microphone without removing the radio from the belt or vehicular charger. The internal speaker in the radio is disconnected when the external speaker-micropnone is used. The external speaker-microphone is equipped with a push-to-talk switch that actuates only the external microphone.

"BBU" Series radios are also capable of operating in the "Converta-Com" console. Automatic connection is made to the mobile antenna, microphone, and charging circuitry when the radio is inserted into the console.

3. MODEL VARIATIONS AND OPTIONS

a. General

Many options are available for the radio; including selective call (tone paging), special "Private-Line" circuits, time-out timer, single-tone, battery options, and size options.

When the radio is ordered, option codes are used to specify the option in the radio. The option code consists of the letter H followed by three digits. The first digit defines the general category and the other two numbers describe the specific option in the category. The general categories are listed in Table 1.

When some options or circuit functions are added to the radio, an additional printed circuit board is required. This additional circuit board is wired to the interconnect circuit board in one of four option slots (see Figure 2). Options mounted into any combination of option slots may either increase the length of the radio or the thickness, or both. An extended housing is required for a circuit board mounted in option slot A. An "omni" short housing is required for circuit boards mounted in option slots B or C. An "omni" extended housing is required for circuit boards mounted in option slots A, B, C, and D. Table 2 lists the options and their mounting position. In some cases options can be mounted in either of two option slots. On low band radios, only option slots A and D are available.

Table 1. Option Codes

CODE DIGIT	CATEGORY
H1	Antennas
H2	Batteries
H3	Cases and Clips
H4	Housings
H5	Channel Elements
H6	International
H7	Signaling Options
H8	Tone PL and Digital PL Squelch Options
H9	Other Internal Options

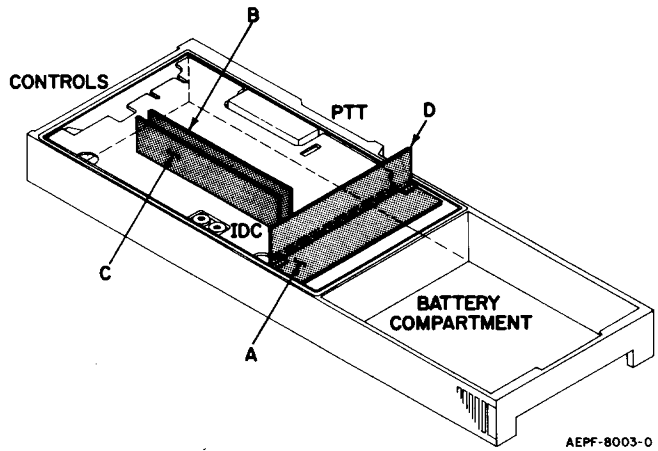


Figure 2. Option Slot Locations

Table 2. Typical Option Slot Requirements

OPTION	OPTION SLOT MOUNTED IN
Tone PL Deck	A or B
Digital PL Deck	A
Selective Call	
Two-Tone	A
Four-Tone *	D
Long-Tone B *	D
Subaudible * #	D
Single-tone	A
Multiple Single-tone **	D
C7R7 Deck #	C
C8R8 Deck #	D
Time-Out Timer	C or D
Transmit-Only Tone PL Deck	A or B
Transmit-Only Digital PL Deck	A or B
"PAC•RT" Transmit-Only Tone PL Deck #	A

* Includes Two-Tone Selective Call Kit (A)
** Includes Single-Tone Kit
# Used on VHF and UHF Radios Only

b. "Private-Line" Decks

Coded squelch (tone or digital) reduces annoying co-channel message reception. The radio only responds to those calls that have the proper individual PL code. When a message is finished, the receiver is muted until another radio in the system originates a message with the proper PL code.

c. Selective Call Options

The selective call option for the MT500 Series "Handie-Talkie" radios provides a two-tone paging circuit in the radio. The selective call circuitry is primarily a decoder which detects and decodes the two-tone sequential paging signal transmitted to the receiver. The decoded signal controls the squelch circuit in the receiver, permitting the alert tone and voice message to appear at the speaker only when the proper code is received.

The selective call option may be installed in VHF or UHF radios containing transmit-only tone PL or transmit-only digital PL options.

Two types of group call are offered: four-tone selective call (dual address), and long-tone B selective call. The four-tone selective call is basically two single-address circuits with the second address used for group call. The long-tone B selective call is implemented by adding a group call module to the two-tone selective call circuit.

d. Single-tone Remote Signaling

This tone emitting option enables a radio operator to activate relays on other devices from a remote location or allows the transmission of a tone signal, which could have a predetermined meaning, to the monitoring station. The standard option allows up to five selectable tones plus an "off" position. This option cannot be used with Unit ID options.

e. Time-Out Timer

The time-out timer shuts off the radio transmitter if transmission time exceeds a set time duration. This prevents inadvertent and prolonged transmitter "keying" which ties up a repeater or a channel. The transmitter is automatically reverted to standby and an audible alert tone is emitted to signal this condition to the operator. Once the channel is clear, the operator can initiate another transmission.

f. PAC•RT Transmit-Only Tone PL Deck

Radios equipped with this option are used for PAC•RT vehicular repeater system access. Transmit-only tone PL is available during both receive and transmit modes; as a result, this minimizes system-access time. During "talk around," the PL disable switch removes the transmitted PL tones from the carrier when in the " ♮ " position. PAC•RT operation is compatible with VHF and UHF radios only.

g. Transmit-Only Tone PL Deck

The transmit-only tone PL deck provides a coded tone which continuously modulates the transmitted carrier, while the push-to-talk switch is pressed.

h. Transmit-Only Digital PL Deck

The transmit-only digital PL deck provides a coded tone which continuously modulates the transmitted carrier, while the push-to-talk switch is pressed.

i. VHF Protected Receiver

The protected receiver option allows the radio to be operated in areas subject to severe interference. Intermodulation and selectivity have been increased to provide better protection from interference, but receiver sensitivity has been reduced. The protected receiver option is intended for use in major urban areas where communications are directed to a base station or repeater rather than portable-to-portable communications.

j. UHF High Selectivity (-75 dB) Circuitry

The high selectivity option allows the radio to operate in areas subject to severe interference. Selectivity has been increased to -75 dB (EIA SINAD) to provide better protection from interference. The high selectivity option is intended for use in major urban areas where adjacent rf traffic is extremely dense.

k. Unit Identification and Unit Identification with Emergency Call

MT500 Series unit identification (ID) option is compatible with the Motorola digital "Modat" system. This option provides automatic unit identification or automatic unit identification and secondary emergency status indication at the control dispatch point. A dispatcher equipped with a "Modat" decoder is automatically provided with a visual readout for positive identification of the specific radio that is transmitting a signal. The emergency status is activated when the operator presses a special pushbutton on the radio. This emergency status is then indicated at the dispatch point by both an audible tone and a visual readout. Unit ID minimizes air time required for normal communications.

4. BATTERIES

The MT500 Series radio is supplied with a rechargeable nickel-cadmium battery ("package" models). The radio will operate from a mercury battery at a longer battery life than the nickel-cadmium battery, but the mercury battery cannot be recharged.

Both, nickel-cadmium and mercury, batteries are available in two sizes: "slim-line" and "omni." The "omni" battery is for the larger housing, and provides an extended duty cycle when used in low power radios. The "slim-line" battery cannot be replaced by an "omni" battery due to a difference in size.

The recommended rechargeable nickel-cadmium batteries are the NLN4462 ("slim-line") or the NLN4463 ("omni"). The following older style of nickel-cadmium batteries may be used in the MT500 radios but will provide reduced duty cycles: NLN6682 ("slim-line"), NLN6899 ("slim-line"), NLN6761 ("omni"), NLN6900 ("omni"), and NLN8232 ("omni"). All of these nickel-cadmium batteries may be recharged in the MT500 battery chargers.

The nonrechargeable mercury batteries reccommended are as follows: NLN6683 ("slim-line"), NLN6936 ("omni," high power), and NLN6762 ("omni," low power).

Table 3. Detachable Swivel Case Components

ITEM	"SLIM-LINE"		"OMNI"	
	SHORT	EXTENDED	SHORT	EXTENDED
Holster	NLN4525B	NLN4526B	NLN4527B	NLN4528B
Belt Loop, 2.5 in. or Belt Loop, 3.0 in.	NLN4529 NLN4530		NLN4529 NLN4530	
T-Strap or Full Flap	NLN4532 NLN4531		NLN4532 NLN4531	
Nylon Cord Strap Omni Back Swivel	NLN5476 --------		NLN5476 NLN5546	

5. CARRYING ACCESSORIES

The MT500 Series radio is supplied with a holster (carrying case) with a snap-on belt loop and a "T" strap cover ("package" models). Holsters with a detachable swivel belt loop are available, and also, a full flap cover is available. Refer to Table 3 and Figure 3 for the available swivel case components.

The radio back cover can be replaced with an optional belt-clip back cover for direct attachment of the radio to the belt.

6. OTHER ACCESSORIES

Motorola offers many other accessories to increase your communications efficiency. Some of the more popular accessoreis are collapsible antennas (for VHF and UHF radios), nickel-cadmium battery chargers, audio accessories, surveillance accessories, and "Converta-Com" accessories (Universal radios only). Consult your Motorola sales representative for a complete list of available equipment.

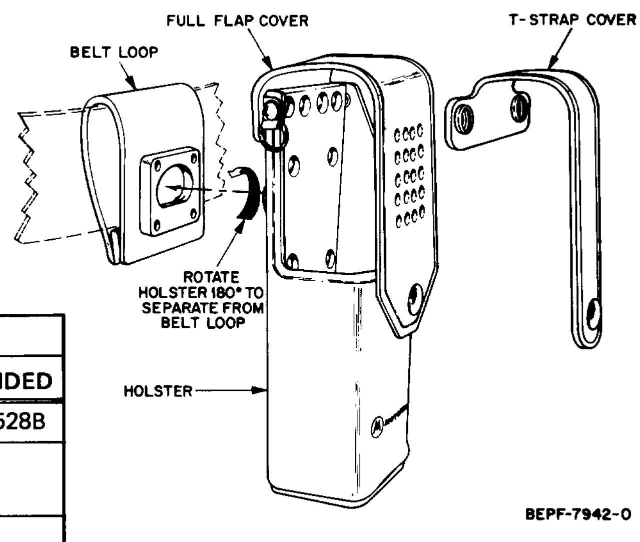


Figure 3. Typical Swivel Case

BATTERY CHARGING

1. CHARGERS AVAILABLE

a. General

Available nickel-cadmium battery chargers include single-unit models, multiple-unit models, and vehicular models (refer to Table 4).

Single-unit chargers are available for either the "slim-line" or "omni" model radios and for the "slim-line" or "omni," "dual charge" MT500 batteries. All of the chargers will charge a battery while in or out of the radio. There are chargers available that operate from 117 volts ac and others that operate from 234 volts ac. The radio receiver may be operated while in the battery charger.

The rapid-charge battery chargers will recharge a "dual charge" MT500 nickel-cadmium battery fully in one hour. A slow-charge battery charger will charge a "dual charge" MT500 nickel-cadmium battery in approximately 16 hours.

Multiple-unit battery chargers are available for either the "slim-line" or "omni" model radios and for the "slim-line" or "omni," "dual charge" MT500 batteries. These chargers will charge 12 batteries while in or out of the radio. There are multiple-unit chargers available that operate from 117 volts ac and others that operate from 234 volts ac. The characteristics of these chargers are the same as previously described for the single-unit chargers.

Vehicular chargers are available for the "dual charge" batteries, either "slim-line" or "omni" models. These chargers mount in a vehicle and hold a single radio. The radio may be operated while the battery is being charged. The chargers are available for 6- or 12-volt systems (order with the appropriate charger cable and antenna cable).

b. Use of Other Motorola Battery Chargers

The "dual charge" MT500 batteries (NLN4462A, NLN4463A, and NLN4463B) can be charged in existing HT220 chargers. The NLN4463B battery will achieve 100% of battery capacity after 16 hours of charging. The NLN4462A and NLN4463A batteries will only achieve 85% of battery capacity after 16 hours of charging. Additional charging of the battery will not increase the battery capacity.

NOTE

Charge batteries only when ambient temperature is between +5°C and +40°C (+40°F and +104°F).

2. BATTERIES AVAILABLE

a. General

The MT500 "dual charge" nickel-cadmium battery can be used as a rapid-charge battery (one-hour recharge cycle when used with Motorola rapid charger) or as a slow-charge battery (16-hour recharge cycle when used with Motorola slow charger). Different sizes provide various duty cycles and operating times depending upon the radio power and operating conditions (refer to Table 5).

Table 4. Available Chargers

Housing Type	Charge Rate	Single-Unit Chargers 117 V	Single-Unit Chargers 234 V	Multiple-Unit Chargers 117 V	Multiple-Unit Chargers 234 V	Vehicular Chargers
"Slim-line"	Slow	NLN4557 NLN6684B	NLN4559 NLN6993B	NLN4558	NLN4559	NLN6691
	Rapid	NLN4565	NLN4567	NLN4566	NLN4568	
"Omni"	Slow	NLN4561 NLN6804B	NLN4563 NLN6997B	NLN4562	NLN4564	NLN6892
	Rapid	NLN4569	NLN4571	NLN4570	NLN4572	

6000 series models are stellar blue color, others are shadow bronze color.

Table 5. Battery Characteristics

BATTERY MODEL	DUTY CYCLE	BATTERY LIFE (HOURS)		RATED BATTERY VOLTAGE	RATED POWER OUTPUT (WATTS)				
		LOW PWR., VHF, UHF, CS, "PL," "BBB," "BBU," "DPL"	HIGH PWR, VHF, UHF, CS, "PL," "BBB," "BBU," "DPL"		LOW PWR UHF	LOW PWR VHF	HIGH PWR LOW BAND	HIGH PWR UHF	HIGH PWR VHF
Nickel-Cadmium (Rechargeable)									
NLN4462A "Slim line"	5-5-90	8	---	15.0	1.5	2.0	---	---	---
NLN4463 "Omni"	10-10-80	9	---	15.0	1.5	2.0	---	---	---
NLN4463 "Omni"	5-5-90	14	8	15.0	1.5	2.0	6.0	4.0	5.0
Mercury (Not Rechargeable)									
NLN6762A Low Power "Omni"	10-10-80	30	---	12.7	1.0	1.0	---	---	---
NLN6936A High Power "Omni"	10-10-80	30	---	12.7	1.0	1.0	---	---	---
NLN6936A High Power "Omni"	5-5-90	---	25	12.7	---	---	3.0	2.0	2.5
NLN6683A Low Power "Slim"	5-5-90	18	---	12.0	0.7	0.8	---	---	---

b. <u>Nickel-Cadmium Batteries</u> (Rechargeable)

Recommended batteries are the "dual charge" NLN4462A ("slim-line") or the "dual charge" NLN4463 ("omni") (see Figures 4 & 5). Charging voltage is applied to these batteries through three contacts in the bottom of the battery. Two of the contacts receive charging voltage, and the third contact connects an internal thermistor (NLN4462A) or thermostat (NLN4463) to the charger. The thermistor or thermostat senses battery temperature and automatically controls the charger output to permit maximum charger output without overheating the battery.

c. <u>Mercury Batteries</u> (Not Rechargeable)

Mercury batteries will provide longer life than nickel-cadmium batteries, but cannot be recharged. They are available in either "slim-line" or "omni" sizes: NLN6683A ("slim-line"), NLN6936A ("omni," high power), and NLN6762A ("omni," low power).

d. <u>Other Motorola Batteries</u>

The following older style nickel-cadmium batteries may be used in the MT500 radios but will provide reduced duty cycles: NLN6682 ("slim-line"), NLN6899 ("slim-line"), NLN6761 ("omni"), and NLN6900 ("omni"). These batteries may also be recharged in the MT500 chargers. Refer to Table 6 for charging times of different charger-battery configurations.

3. CHARACTERISTICS

The nickel-cadmium battery consists of 12 cells connected in series to provide a nominal 15-volt dc output.

The voltage of a nickel-cadmium battery remains approximately constant under load until the battery approaches the discharged condition. At this time, a marked decrease in the voltage occurs and the discharged condition (1.0 V per cell) is reached abruptly. Metering to determine

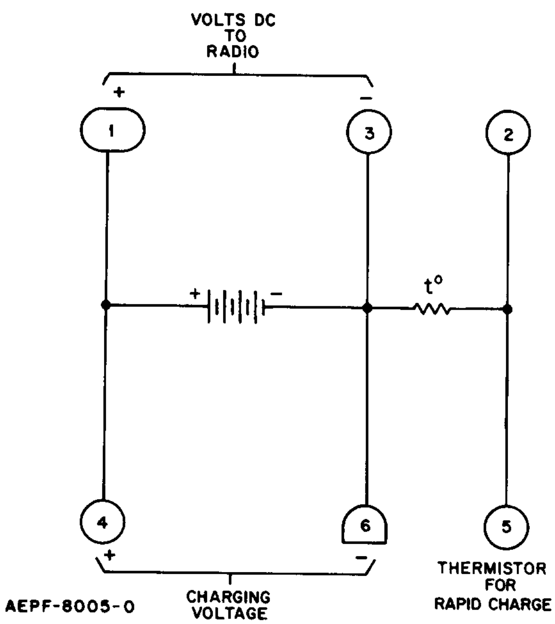


Figure 4. NLN4462A Battery Construction

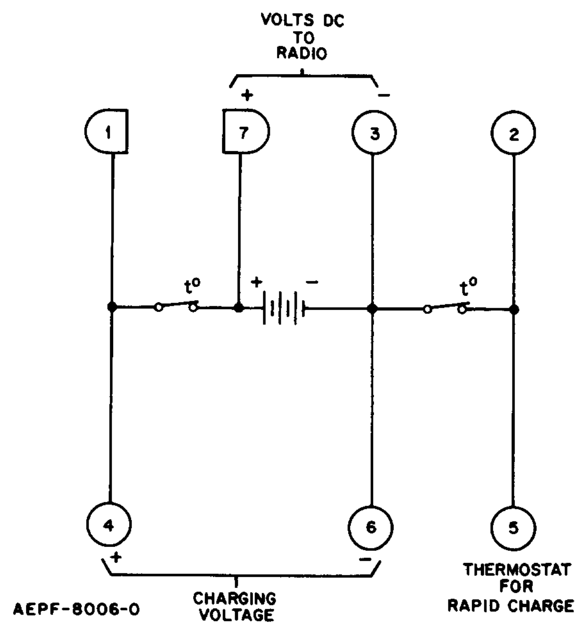


Figure 5. NLN4463 Battery Construction

the state of charge in this type of battery is difficult and is not normally performed. A general characteristic of all rechargeable batteries in storage is self discharge. If the battery is used after unknown periods of storage, it is recommended that it be charged at the full charging rate using an approved battery charger (refer to Table 6).

4. MAINTENANCE

The only maintenance required is recharging the battery and keeping the contacts clean. Use only a Motorola approved charger. The use of other chargers, unless approved, will void the battery guarantee and may result in permanent damage to the battery. Follow the charging instructions which accompany each charger.

5. STORAGE

The battery may be stored at room temperature in any state of charge without damage. As previously stated, however, the battery is subject to self discharge and should be recharged after extended storage.

Table 6. Charging Times for Charger-Battery Combinations

BATTERY MODEL	SINGLE-UNIT BATTERY CHARGER				MULTIPLE–UNIT BATTERY CHARGER				VEHICULAR BATTERY CHARGER
	SLOW CHARGE		RAPID CHARGE		SLOW CHARGE		RAPID CHARGE		
	NLN4557 NLN4559 NLN6684B NLN6993B	NLN4561 NLN4563 NLN6804B NLN6997B	NLN4565 NLN4567	NLN4569 NLN4571	NLN4558 NLN4560	NLN4562 NLN4564	NLN4566 NLN4568	NLN4570 NLN4572	NLN6691 NLN6692
NLN4462	16		1		16		1		16*
NLN4463		16		1		16		1	16*
NLN6682	16		1		16		1		16
NLN6761		16		1		16		1	16
NLN6899	16		1		16		1		16
NLN6900		16		1		16		1	16

6000 series models are stellar-blue color, others are shadow-bronze color.

* Will obtain only 85% of rated capacity

THEORY OF OPERATION

1. GENERAL

The MT500 Series FM radios consist of hybrid modules and discrete components. Each hybrid module usually performs a complete function, such as an amplifier which has an input and an amplified output.

The receivers are dual-conversion, superheterodynes (refer to Figures 6, 7, and 19). Both VHF and UHF receivers consist of an rf amplifier, two oscillators, two mixers, an injection module, two 35 kHz i-f amplifiers, an i-f detector, and an audio section. The audio section includes a squelch module, an audio preamplifier, an audio power amplifier, and a speaker. The primary difference between VHF and UHF radios is the preselector in the UHF radio. The low band radio has little in common with VHF and UHF radios, except for the audio power amplifier section. The front end of the low band radio consists of an rf amplifier, a first injection oscillator, a first mixer, and an 8.4 MHz i-f amplifier. The second injection oscillator, second mixer, 455 kHz i-f amplifier, demodulator, and squelch circuit are all contained in integrated circuit U1.

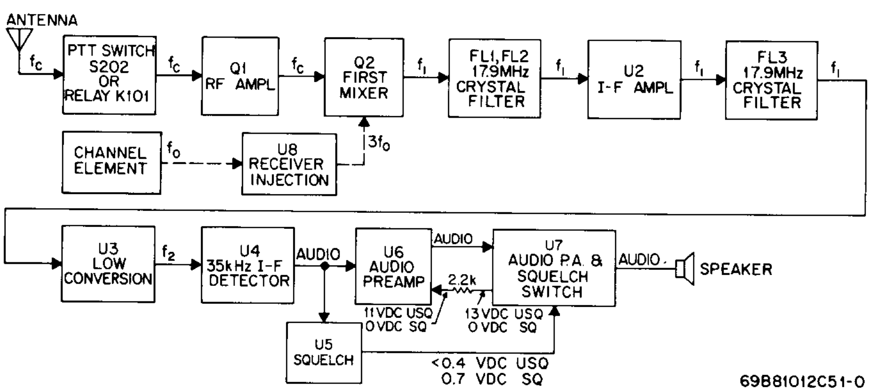


Figure 6. VHF Receiver Block Diagram

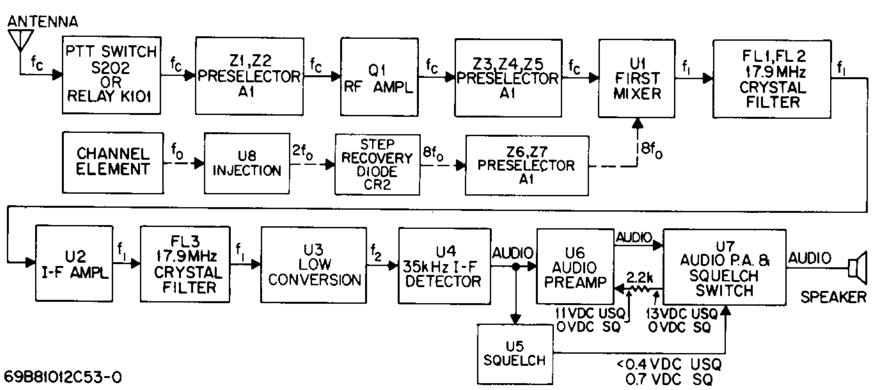


Figure 7. UHF Receiver Block Diagram

The transmitter circuits are functionally the same, containing a microphone and an Instantaneous Deviation Control (IDC) module in the audio section (refer to Figures 23, 24, and 32). The VHF and UHF transmitters contain a channel element, a buffer tripler, a predriver (VHF) or a second tripler (UHF), a driver, and a power amplifier. The low band rf transmitter consists of an oscillator, a multiplier ($2f_o$, 30-36 MHz; $3f_o$, 36-50 MHz), a predriver, a driver, and a power amplifier.

2. VHF AND UHF RECEIVER CIRCUITS

a. RF Circuits, VHF Receivers (Refer to Figure 6 and the schematic diagram in Service Manual 68P81012C56)

The received signal at the antenna is coupled through the accessory connector ("BBU" Series radios) and through external antenna jack J202 to push-to-talk switch S202 ("BBB" Series radios) or pin 3 of relay K101 ("BBU" Series radios). In the receive mode, the rf signal is fed through contact 2 of the push-to-talk switch ("BBB" Series radios) or pin 1 of relay K101 ("BBU" Series radios) to the two-pole filter (L1, C1, C2, and L2). Input coil L1 is tapped to match the 50-ohm antenna to the filter impedance. Capacitors C3 and C4 form a capacitive network to match the rf amplifier base impedance to the filters. The rf amplifier is a discrete bipolar device. Resistors R5, R3, and R1 are used to dc bias the rf amplifier. Resistor R2 and capacitor C5 form a feedback network used to stabilize the rf amplifier. Diode CR1 is an rf overload protection diode to prevent large dc spikes (static disharge) from burning out the rf amplifier. The capacitive network, consisting of C6 and C8, matches the rf amplifier collector impedance to the second two-pole filter (L3, C9, C10, and L4). This filter output is applied to first mixer Q2 where it is mixed with the injection signal from receiver injection module U8. The injection module receives an input signal (f_o) from the channel element and produces an output signal ($3f_o$) which is filtered by a two-pole filter (L6, C11, C14, and L7). The two-pole filter applies the injection signal to first mixer Q2.

First oscillator injection from the receiver channel element is enabled only when 7.5 volts dc is applied to pin 4. The crystal-controlled oscillator employs the third overtone of the crystal and produces an output (f_o) at pin 5. Refer to the simplified channel element diagram (Figure 8). This output is tripled by the injection module (U8). U8 consists of a common base buffer amplifier followed by a common-emitter tripler stage (see Figure 9). Between the buffer and tripler stages is an inductor tuned externally for each band split by a fixed capacitor (C7).

The injection frequency is passed by the filter consisting of L6, L7, and associated capacitors and applied to the first mixer.

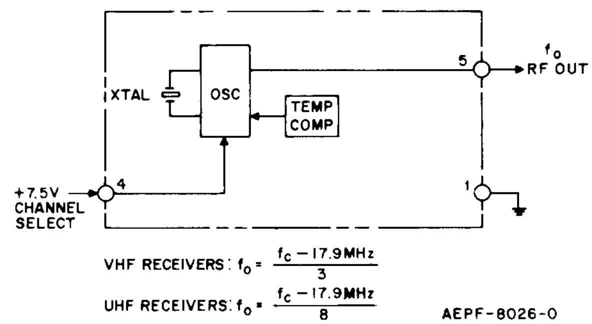


Figure 8.
Receiver Channel Element: CE1, CE2, etc.

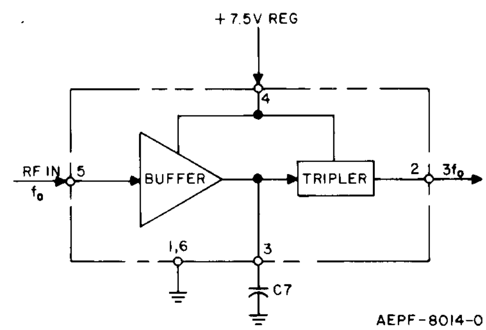


Figure 9. VHF Injection Module, U8

Field-effect transistor Q2 is used as the first mixer stage. The incoming rf signal is supplied to the gate through the preceding filter stage. Injection power is applied to the source and the output is taken off the drain by L5. Biasing is accomplished through R6, and the dc ground is provided through L4. Capacitor C18 tunes L5 to 17.9 MHz and along with R14, matches the mixer output to the crystal filter input (FL1). Further discussion is continued in paragraph c, "I-F Circuits."

b. RF Circuits, UHF Receivers (Refer to Figure 7 and the schematic diagram in Service Manual 68P81012C58)

The received signal at the antenna is coupled through the accessory connector ("BBU" Series radios only) and through external antenna jack J202 to push-to-talk switch S202 ("BBB" Series radios) or pin 7 of relay K101 ("BBU" Series radios). In the receive mode, the rf signal is fed through contact 2 of the push-to-talk switch ("BBB" Series radios) or pin 5 of relay K101 ("BBU" Series radios) to a two-pole helical filter in the preselector.

The preselector consists of seven low-loss, highly selective, helical resonant cavities, which are divided into three sections: The RF-Amp 2-cell (Z1, Z2), the mixer 3-cell (Z3, Z4, Z5), and the injection frequency 2-cell (Z6, Z7). Capacitive coupling is used to couple the signal through the resonant cavity apertures. The preselector has a flat nose bandwidth and a steep skirt response to provide rapid attenuation of signals outside the accepted bandwidth. Filter cells Z1, Z2, Z3, Z4 and Z5 are tuned to the carrier frequency ($8f_o$ + i-f) for minimum insertion loss, and filter cells Z6 and Z7 are tuned to the injection frequency ($8f_o$) for minimum insertion loss. Components L1 and C2 provide an impedance match between the 50-ohm output of the helical filter and the base of rf amplifier Q1. The filter output is amplified by Q1. Components L3 and C6 match the rf amplifier output to the 50-ohm three-pole helical filter. Coil L2 is an rf choke on the 7.5-volt dc line and CR1 provides protection for the rf amplifier from extremely large signals (static discharges). Resistor R2 and capacitor C3 form a feedback network to stabilize the rf amplifier. The amplified rf signal then passes through a three-pole helical filter which provides additional selectivity. The filter output is applied to mixer U1, where it is mixed with the injection signal from receiver injection module U8.

The injection module receives an input signal (f_o) from the channel element (see Figure 8). The channel element output is buffered by a common-base transistor with fixed tuning (see Figure 10). A common-emitter transistor then doubles the frequency (tuned through L4) and its output is coupled to "step-recovery" diode CR2. The "step-recovery" diode is used as a "times four" multiplier. The output signal ($8f_o$) of the "step-recovery" diode is then fed into the injection two-pole helical filter for additional selectivity. The filtered output is then applied to the mixer.

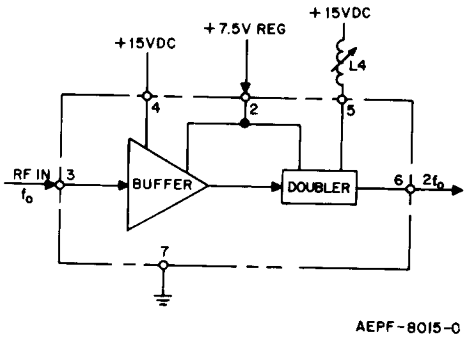


Figure 10. UHF Injection Module, U8

The received rf signal and the injection signal are mixed in U1 (see Figure 11). The mixer module provides about 5 dB of conversion gain. The carrier frequency ($8f_o$ + 17.9 MHz) is mixed with the injection frequency ($8f_o$) resulting in an amplified 17.9 MHz output. The amplified 17.9 MHz output is routed to the crystal filter via the tuned (fixed) output circuit of the module. The mixer is located in the preselector housing for better spray protection from undesired signals.

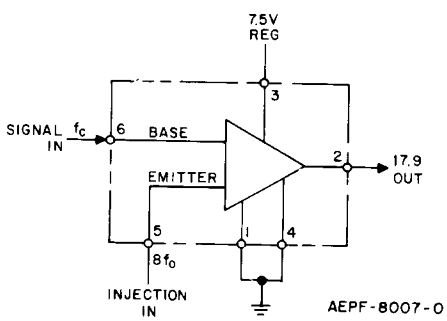


Figure 11. UHF Mixer Module, U1

c. I-F Circuits

The i-f circuits are functionally identical in both VHF and UHF receivers; however, decoupling circuits external to the modules vary slightly.

The received signal from the mixer passes through crystal filters FL1 and FL2 which form a four-pole bandpass filter centered at 17.9 MHz. The overall bandwidth of the filter is approximately 12 kHz and the maximum insertion loss is about 3 dB. A typical response curve is shown in Figure 12.

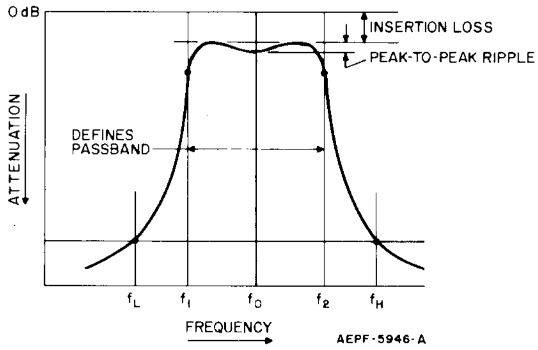


Figure 12.
Typical Crystal Filter Response Curve

The filter output is applied to first i-f amplifier U2. The i-f amplifier and a B+ regulator module (see Figure 13) provide approximately 23 dB of gain for the 17.9 MHz i-f signal. The voltage regulator supplies 0.97 volt dc to the i-f amplifier and low conversion module U3. This regulated voltage maintains the gain of these stages at a constant level, preventing variation that might occur due to changes in battery voltage.

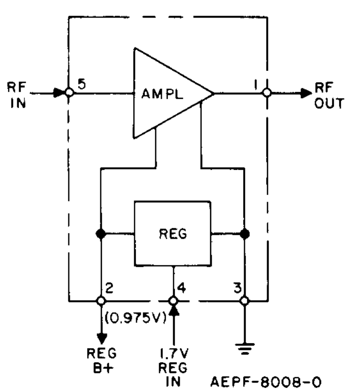


Figure 13. I-F Amplifier Module, U2

The output of i-f amplifier U2 is applied to 17.9 MHz crystal filter FL3, which operates the same as FL1 and FL2, providing addition i-f bandpass selectivity. This filter output is applied to low conversion module U3 (see Figure 14), where it is mixed with the output from the oscillator which is contained within the low conversion module. This oscillator is controlled by external oscillator crystal Y1. The 35 kHz low conversion product is routed to the i-f amplifier of module U4 (see Figure 15). In U4 the 35 kHz output of the low conversion module is amplified and unwanted amplitude variation (noise) is removed by limiting in the i-f amplifier. An i-f test point (M1) for troubleshooting or alignment is provided at pin 9 of the i-f detector module. The audio detector circuit extracts the FM audio modulation from the second i-f signal and produces an audio output (voice message) at pin 3 of the i-f detector module, which is applied to audio preamplifier module U6 and to squelch module U5. In a radio with the selective call option, a second audio output at pin 5 of the i-f detector module is a filter drive output which is a square wave at the coding tone frequencies.

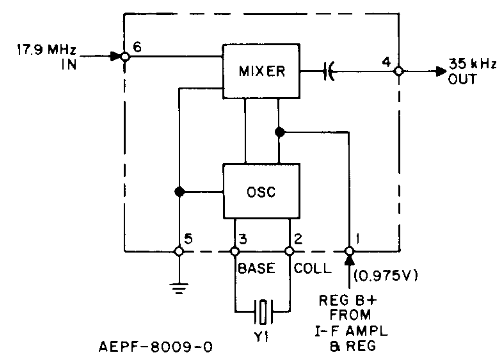


Figure 14. Low Conversion Module, U3

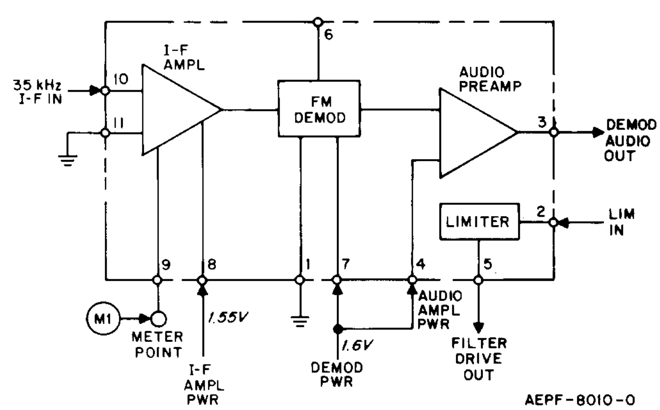


Figure 15. I-F Detector Module, U4

d. <u>Audio Circuits</u>

The 35kHz output of the second i-f amplifier is applied to the FM demodulator to extract the FM audio modulation from the second i-f signal and produce an audio output (voice message). The recovered audio output is applied to audio preamplifier module U6 (see Figure 16), and to squelch module U5. The audio preamplifier module contains two high-pass filters and one low-pass filter. The high-pass filters attenuate frequencies below 300 Hz, preventing low frequency "Private-Line" tones from reaching the speaker. The low-pass filter provides the necessary de-emphasis at 6 dB per octave. The overall response of the preamplifier attenuates frequencies above and below the audio passband, and has a nominal gain of 18 dB at 1 kHz.

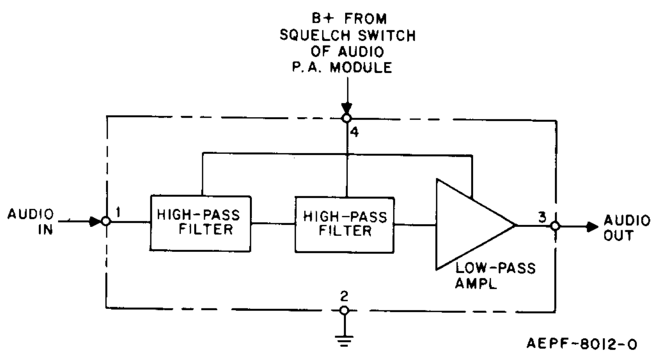


Figure 16. Audio Preamplifier Module, U6

The audio output is applied across volume control R202 and small series resistor R203. The volume control forms a voltage divider and applies a portion of the audio signal to audio power amplifier module U7. The small series resistor connected to the volume control provides some audio signal to U7 with the volume control at the minimum position. This avoids missing messages, since a small audio output is heard when a signal is received and the control is in the minimum volume position.

The audio power amplifier supplies most of the receiver audio amplification by delivering 37 dB of gain at 1000 Hz to the 39-ohm speaker (see Figure 17). The slight audio shaping in this module also performs the remaining part of the de-emphasis function. Another major function of the audio power amplifier module is squelch gating. The dc output of the squelch module into the squelch switch of the audio power amplifier module gates the audio output. When the squelch switch input (pin 3) has sufficient current to bring its voltage to 0.7 volt dc, the audio power amplifier and audio preamplifier modules are turned off (squelched). A voltage of 0.4 volt dc or less on pin 3 biases the audio stages on.

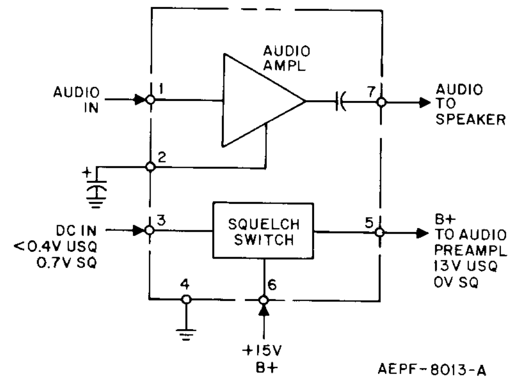


Figure 17. Audio Power Amplifier Module, U7

The audio signal is applied to the speaker in the front cover via external speaker jack J201 and accessory connector J203 ("BBU" Series radios) to speaker LS401. Accessory connector contacts J203-4 and J203-4' act as a normally closed switch within the connector. The switch is opened when a mating connector is attached to J203. This disables the internal speaker when accessories, such as an external speaker-microphone, are attached to the radio.

e. <u>Squelch Circuits</u>

A portion of the FM demodulator output (U4) across squelch control R201 is applied to squelch module U5 (see Figure 18). The signal is applied to a high-pass amplifier which attenuates frequencies below 4 kHz and is most sensitive to 6 kHz noise. This noise voltage is limited and then applied to a noise detector which converts the noise to a dc voltage. This dc voltage from the detector is applied to a dc amplifier containing external timing capacitor C24 (VHF) or C17 (UHF). When the capacitor becomes charged, the dc amplifier produces a dc output. Thus, when a noise input is present, 0.7 volt dc output occurs at the squelch output to turn off (squelch) the audio preamplifier and the audio power amplifier modules.

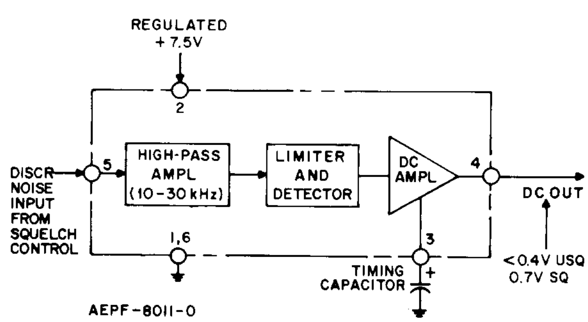


Figure 18. Squelch Module, U5

When a carrier is received, the detector output consists of audio modulating information (below 4kHz) and the noise spectrum around 6kHz is reduced. The dc amplifier output is now about zero volts dc and the radio is turned on (unsquelched).

When the carrier goes off the air, the output of the squelch module increases to about 0.7 volt dc (squelched) as previously described.

3. LOW BAND RECEIVER CIRCUITS

a. RF Circuits (Refer to Figure 19 and the schematic diagram in Service Manual 68P81017C55)

The received signal at the antenna is coupled through accessory connector J203 ("BBU" Series radios), or through external antenna jack J202 to push-to-talk switch S202 ("BBB" Series radios), or pin 3 of relay K201 ("BBU" Series radios). In the receive mode, the rf signal is fed through contact pin 2 of PTT switch S201 ("BBB" Series radios), or contact pin 1 of relay K201 ("BBU" Series radios) to the two-pole selectivity filter consisting of L1, L2, C1, C2, C3, C4, and C5.

Input coil L1 is capacitively tapped to match the 50-ohm antenna to the filter impedance. Capacitors C4 and C5 form a capacitive network to match the rf amplifier input impedance to the filter. The rf amplifier is a discrete bi-polar device. Resistors R1, R2, and R4 provide dc bias for the rf amplifier. Diode CR1 prevents static discharge from damaging the rf amplifier.

The capacitive network, consisting of C7 and C8, matches the rf amplifier collector impedance to the second two-pole filter (L3, L4, C7, C8, C9, and C10). This filter network output is applied to first mixer Q2, where it is mixed with the injection signal from the first receiver oscillator. The crystal-controlled oscillator, consisting of the cascode configuration of Q3 and Q4, employs the third overtone of the crystal to produce an output, f_{o1}. The injection signal is applied to a harmonic filter (T1 and C45), where it is inductively coupled to the source of the first mixer. A selector switch enables only the desired crystal network.

Field-effect transistor Q2 is used as the first mixer stage. The incoming rf signal, f_c, is applied to the gate through the preceding filter stage. Injection power, f_{o1}, is applied to the source and the output is taken from the drain by L5. Biasing is accomplished through L4, L5, and R24. The capacitive network, consisting of C11 and C12, tunes L5 to 8.4 MHz and matches the mixer output to crystal filter input FL1.

b. I-F Circuits

The received signal from the mixer passes through crystal filter FL1, which forms a two-pole bandpass filter centered at 8.4MHz. The overall bandwidth of the filter is approximately 12kHz, and the maximum insertion loss is 2 dB. A typical response curve is shown in Figure 12.

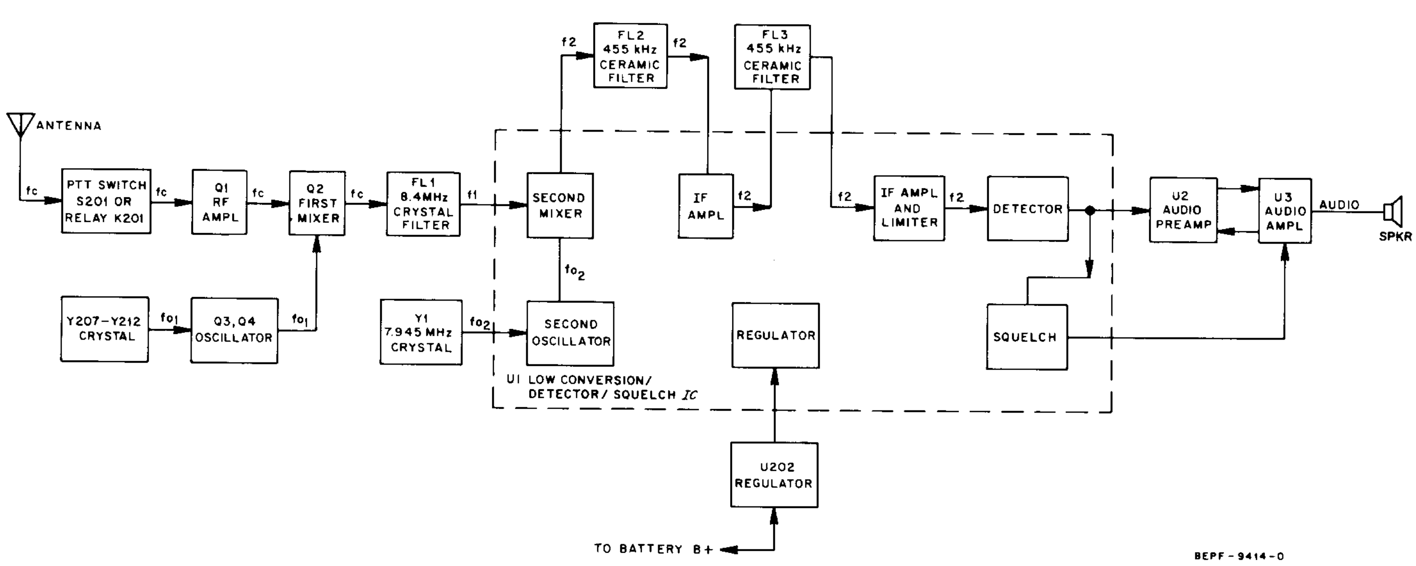


Figure 19. Low Band Receiver Block Diagram

The filter output is matched to the second mixer input of low conversion/detector/squelch integrated circuit U1 by L9, C15, and C16 (see Figure 20). This integrated circuit receives dc voltage only in the receive operating mode and provides regulated 4.6 Vdc and 2.7 Vdc internal to the integrated circuit. The regulator has short circuit protection circuitry. The first i-f signal is mixed with a 7.945 MHz injection signal, f_{o2}, from the second oscillator, producing a 455 kHz second i-f signal, f_2. Crystal Y1 controls the second oscillator frequency. This second i-f signal passes through ceramic filters FL2 and FL3 to the last i-f gain/limiter stage. Ceramic filters provide the majority of the receiver selectivity, having respective bandwidths of 15 kHz and 20 kHz. The second i-f signal is then demodulated by a quadrature detector and amplified by an audio gain stage to pin 5.

c. Audio Circuits

The received audio output is applied to audio preamplifier module U2 (see Figure 21). The audio preamplifier module contains high-pass and low-pass filters. The high-pass filters attenuate frequencies below 300 Hz, thus preventing low frequency "Private-Line" tones from reaching the speaker. The low-pass filters produce the desired 6 dB-per-octave de-emphasis characteristic. The audio output is applied across volume control potentiometer R257 and series resistor R256. The volume control forms a voltage divider and applies a portion of the audio signal to audio power amplifier module U3. The small series resistor connected to the volume control provides a portion of the audio signal to U3, with the volume control at the minimum position. This avoids missing messages, since a small audio output is heard when the control is in the minimum volume position. The audio power amplifier provides the remaining amplification (see Figure 22).

The audio signal is applied to speaker LS401, located behind the front cover housing, via external speaker jack J201 and accessory connector J203 ("BBU" Series radios). Accessory contacts J203 and J204 act as a normally-closed switch within the connector. The switch is opened when a mating connector is attached to J203. This disables the internal speaker when accessories such as the external speaker-microphone are attached to the radio.

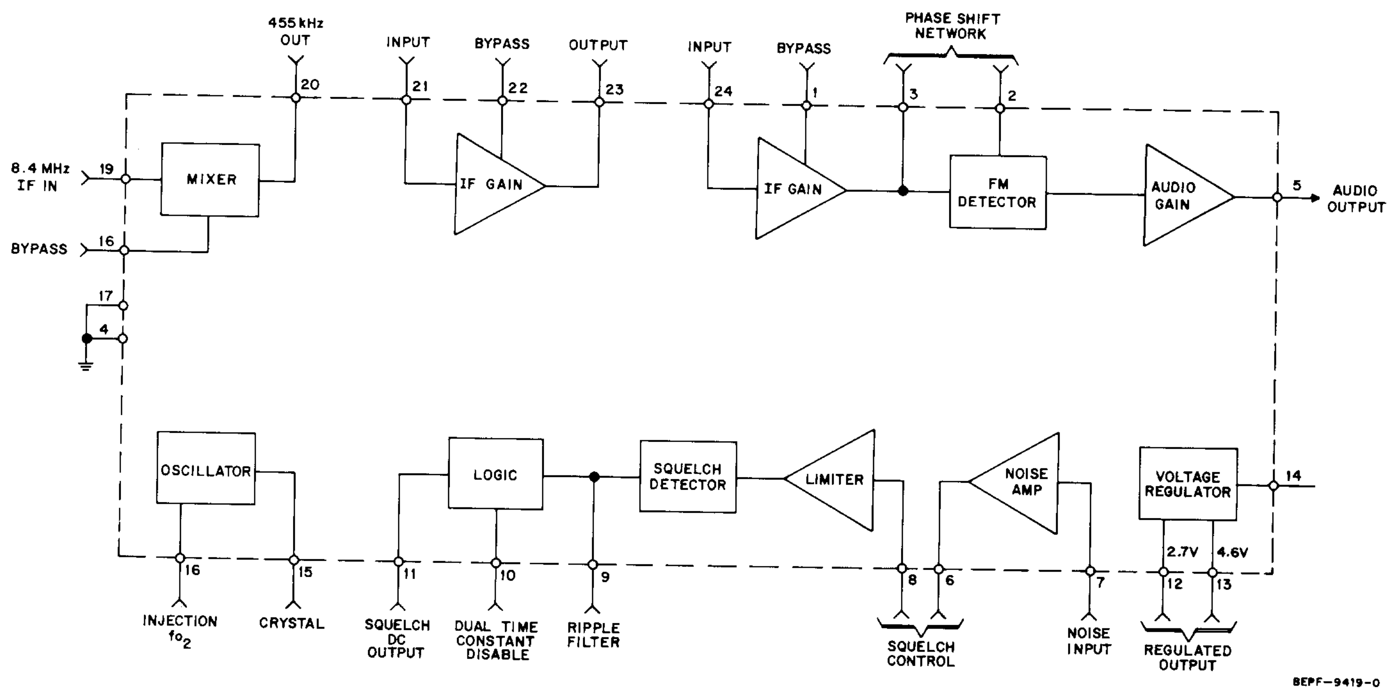


Figure 20. Low Conversion/Detector/Squelch Circuit, U1

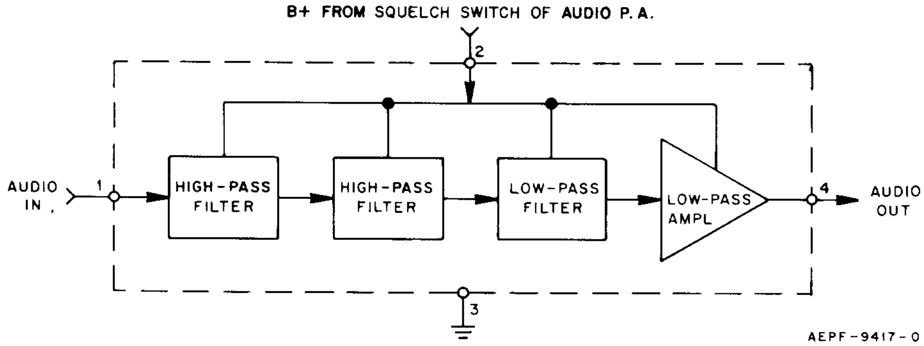


Figure 21. Audio Preamplifier Module, U2

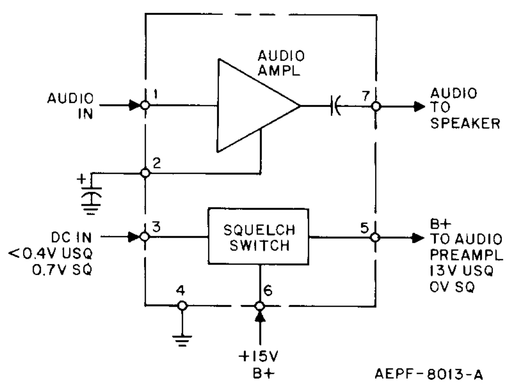


Figure 22.
Audio Power Amplifier Module, U3

d. Squelch Circuits

The discriminator noise output is first applied to an amplifier and then to a pre-emphasis network, which attenuates frequencies below 300 Hz (providing uniform response for frequencies between 300 Hz and 2 kHz), and passes frequencies above 2 kHz. This noise voltage is then amplified and limited before being applied to the squelch detector, which converts the noise to a dc voltage. This dc voltage controls logic circuits which charge and discharge timing capacitor C47 with two separate charging rates, depending upon the received carrier strength. The charging rate is slow under weak received signal conditions, and fast under strong received signal conditions. The slow charge rate prevents squelch chatter while holding the audio stages "on" during marginal received strength. The fast charge rate turns the audio stages off immediately after the carrier goes off the air to eliminate annoying squelch tail noise burst. Removing capacitor C23 from pin 10 will permit conventional single time-constant operation. Q5 driver transistor buffers the logic level from U1 to U3 audio power amplifier to gate the audio output. When the squelch output has sufficient current to bring the voltage to 0.7 volt dc, the audio power amplifier and the audio preamplifier are turned off (squelched). Less than 0.4 volt dc at the squelch output causes the audio stages to turn on (unsquelch).

4. VHF AND UHF TRANSMITTER CIRCUITS

a. General (Refer to Figures 23 and 24)

When push-to-talk switch S202 of a "BBB" Series radio is pressed, B+ is applied to the transmitter circuits through the push-to-talk switch. For "BBU" Series radios, when internal push-to-talk switch S202 or external speaker-microphone push-to-talk switch S1 is pressed, ground is applied to relay coil K101. This energizes the relay to switch the input voltages (battery B+ and +7.5 volts dc regulated) and the antenna circuit from the receiver to the transmitter.

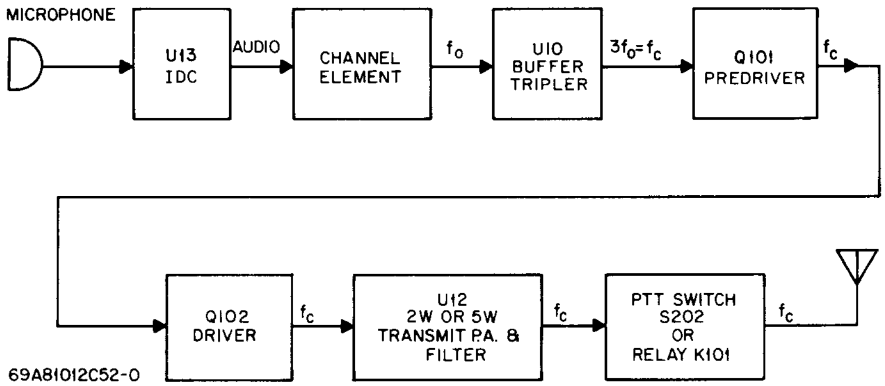


Figure 23. VHF Transmitter Block Diagram

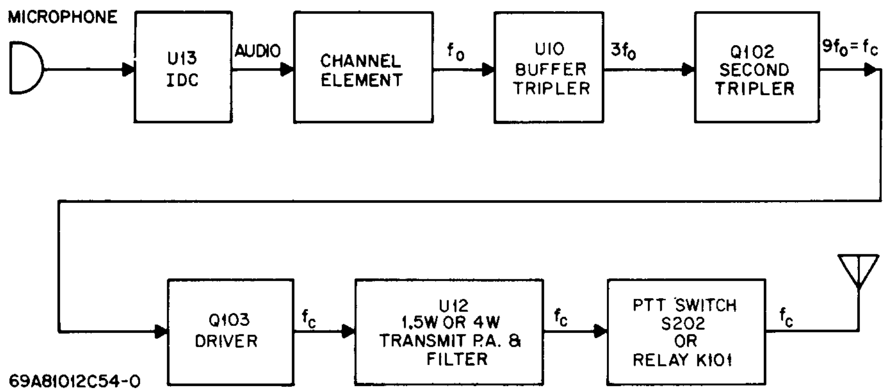


Figure 24. UHF Transmitter Block Diagram

b. Audio Circuits [Refer to the schematic diagram in Service Manuals 68P81012C56 (VHF) and 68P81012C58 (UHF)]

With the push-to-talk switch pressed, low-level audio from the microphone is routed directly to "Instantaneous Deviation Control" (IDC) module U13 in "BBB" Series radios. In the "BBU" Series radios, R207 and R208 (VHF) or R216 and R217 (UHF) keep diodes CR201 and CR202 back biased. When either internal push-to-talk switch S202 or external speaker-microphone push-to-talk switch S1 is pressed, a ground return is provided for the appropriate microphone, and CR201 or CR202 becomes forward biased energizing relay K101. The low-level microphone audio then couples to the IDC module through C209 or C208. Diode CR204 (not used in "BBB" Series VHF radio) at the input of the IDC module protects it from transient peak voltages. The IDC module located on the interconnect board serves several purposes. The circuit amplifies the low-level signal from the microphone cartridge (see Figure 25). The audio signal is subsequently pre-emphasized, amplified again, and applied to a clipper. As the microphone level is increased from zero volt, the clipper will initially have no effect, but at a prescribed point will limit the amplitude (which limits maximum transmitter deviation), resulting in a square-wave output. The clipper is followed by a filter which attenuates frequencies above 3 kHz. Harmonic energy which could interfere with adjacent channels is eliminated. The output is then applied to IDC controls R211 through R218 (VHF) or R208 through R213 (UHF). The IDC potentiometers apply a portion of the processed audio to the appropriate channel elements and control the deviation of the transmitter rf signal.

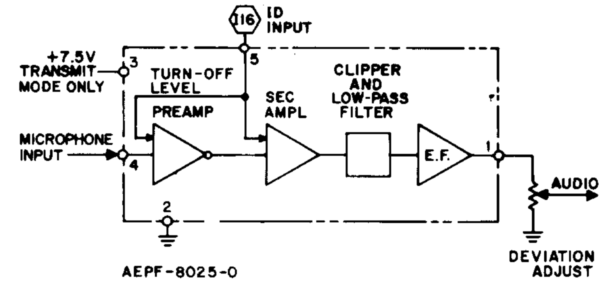


Figure 25.
"Instantaneous Deviation Control" Module, U13

Generation and modulation of the rf signal occurs in the transmit channel element. Each transmit channel element contains a crystal-controlled oscillator, a direct FM modulator, and temperature compensation circuitry (see Figure 26).

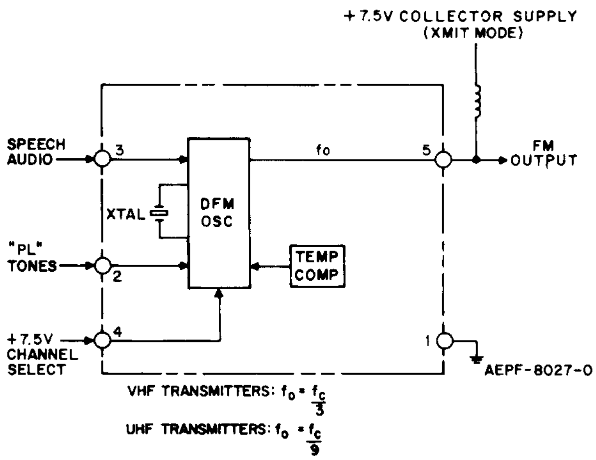


Figure 26.
Transmitter Channel Element: CE101, CE102, etc.

Speech audio from the IDC circuit is applied to the module at pin 3. In "Private-Line" models, tones or digital information is applied at pin 2. Both of these inputs frequency modulate the oscillator resulting in an FM output.

Radios with more than one channel have a frequency selector switch that selects the desired channel element. The switch allows +7.5 volts dc to be applied to pin 4 to enable only the selected channel element when the push-to-talk switch is pressed. When the push-to-talk switch is pressed, (transmit mode), +7.5 volts dc is applied to pin 5 which is also the rf output. The dc voltage at pin 5 supplies collector voltage to the stages in all transmitter channel elements, but only the selected one (+7.5 volts dc at pin 4) will operate.

The rf output at pin 5 is frequency modulated and is one-third of the VHF transmitter carrier frequency or one-ninth of the UHF transmitter carrier frequency. The maximum battery current drain for the channel element is approximately 10.5 mA.

The modulated audio signal and oscillator signal is directly coupled from the channel element to tripler module U10 of the rf circuits.

c. RF Circuits, VHF Transmitter (Refer to the schematic diagram in Service Manual 68P81012C56)

The rf output signal from the selected channel element is received by tripler module U10. The buffer amplifier of the tripler module serves to isolate the channel element from the rest of the transmitter. The buffer amplifier also drives the first tripler which multiplies the channel element frequency three times. A resonant circuit follows the buffer amplifier. A common-emitter, first tripler follows, which is tuned by the external combination of L101 and C103. Components C104 and L101 serve as a trap for twice the channel element frequency. Choke L102 applies dc voltage to the tripler module.

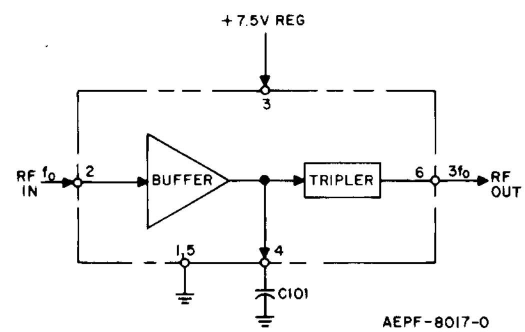


Figure 27. VHF Tripler Module, U10

Components L103, C106, and C107 form a tuned circuit and input match for predriver Q101. R101 and R102 provide a slight amount of dc bias for reliable operation over temperature extremes, while L104 provides output tuning and applies dc voltage to the collector of Q101. R103 ensures that the predriver remains in saturation and delivers a constant power output to driver Q102. Components C109 and C110 provide input matching and L105 provides a dc return for the base of driver Q102. Battery B+ is fed to the driver via choke L106, and partial output matching to transmit power amplifier module U12 is provided by C111.

Transmit power amplifier module U12 is a single-stage, Class C power amplifier incorporating a low-pass filter. The adjustable trimmer, located on the top of the module, is used to correctly match the output of driver transistor Q102 to the power amplifier module input. Transmit B+ is supplied from choke L108 and bead E101. L107 functions as a power adjust coil; jumper JU101 is added to maintain proper adjustment range when a high-power amplifier is used. The low-pass filter attenuates frequencies above the carrier frequency.

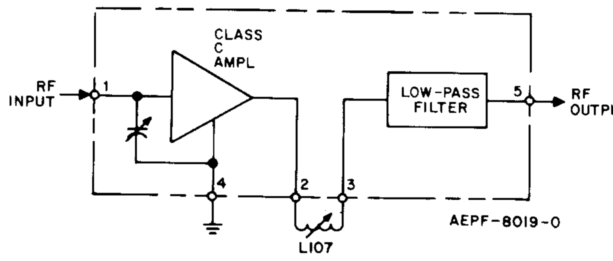


Figure 28. VHF Transmit Power Amplifier Module, U12

d. RF Circuits, UHF Transmitter (Refer to the schematic diagram in Service Manual 68P81012C58)

The rf output signal from the channel element selected by the frequency selector switch is received by the buffer amplifier of tripler module U10. The buffer amplifier serves to isolate the channel element from the rest of the transmitter. The buffer amplifier also drives the first tripler which multiplies the channel element frequency three times. A parallel resonant circuit follows the buffer amplifier which has the center frequency controlled by external capacitor C103; furthermore, a negative-going voltage on pin 4 of U10 implies that the module is receiving power from the channel element. A common-emitter tripler then follows, which is tuned by the external combination of L102 and C104. The rf output of tripler U10 is applied to discrete external selectivity filters. Components C107 and L102 serve as a 100-MHz trap for twice the channel element frequency. Components L103 and C109 form a 50-MHz trap for the tripler module output. Capacitive-tap transformer C110 and C111 presents an output impedance of 50 ohms to allow a 50-ohm wattmeter to be directly attached to C110 and C111 after L104 is removed. The capacitive-tap transformer also provides input matching to second tripler Q102.

The inductive coupling coil, L104, couples the tripler U10 output signal ($3f_o$) to the input circuit of second tripler Q102.

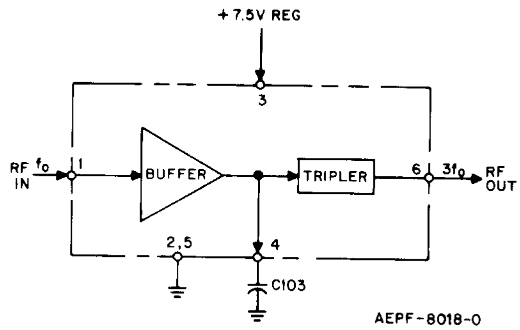


Figure 29. UHF Tripler Module, U10

Components L105 and C112 form a parallel resonant input circuit for second tripler Q102. Second tripler Q102 amplifies and triples the output signal received from tripler U10. The collector circuitry of Q102 consists of two traps and a circuit matching network. The collector of Q102 receives dc voltage through choke L106. L109 and C116 form a 150-MHz trap and L110 and C119 form a 300-MHz trap for the rf output signal ($9f_o$) of Q102. Capacitors C120 and C121 form a capacitive-tap transformer to match the driver Q103 base circuit impedance. The emitter of Q102 is used as a metering point for the current flow through this Class C stage.

The rf output signal is applied to the base of driver Q103 through low-pass and matching filter L115 and C130. Driver Q103 amplifies the rf signal power to a level sufficient to operate all power modules. Components L116, R107, and beads E107 and E109 provide a dc return for the base of driver Q103. Battery B+ is fed to the driver via L117 and E105. Partial output matching to transmit power amplifier module U12 is provided by C134. Components L118, C135, C132, R108, L119, E106, and C136 provide a matching network and a spurious attenuation network between driver Q103 and transmit power amplifier module U12. Trimmer capacitor C132 provides an adjustment point for detuning the power output applied to transmit power amplifier module U12.

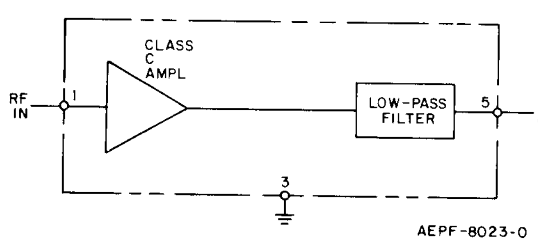


Figure 30.
1.5-Watt Power Amplifier Module, U12

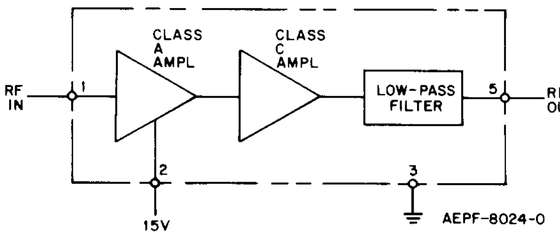


Figure 31.
4-Watt Transmit Power Amplifier Module, U12

Low-power amplifier module U12 is a single-stage, Class C amplifier incorporating a low-pass filter. High-power amplifier module U12 is a two-stage, Class A and Class C amplifier incorporating a low-pass filter. Both the low-power amplifier module and the high-power amplifier module amplify the rf signal and then apply it to the low-pass filter which attenuates frequencies above the carrier frequency. Battery B+ is supplied to pin 2 of the transmit power amplifier module.

5. LOW BAND TRANSMITTER CIRCUITS

(Refer to Figure 32 and the schematic diagram in Service Manual 68P81017C55)

a. Audio Circuits

In "BBB" Series radios, audio from the microphone is routed directly to "Instantaneous Deviation Control" (IDC) module U201. In "BBU" Series radios, R251 and R252 keep diodes CR207 and CR209 reverse-biased. When either internal push-to-talk (PTT) switch S202 or external speaker-microphone PTT switch Sl is pressed, a ground return is provided for the appropriate microphone and CR207 or CR208 becomes forward-biased, energizing relay K201. The microphone audio couples to the IDC module through C231 or C222. Diode VR201 ("BBU" only) at the input to the IDC module protects it from static discharge.

The IDC module amplifies, shapes, limits, and filters the microphone audio, which is then applied (through C202) to IDC controls R201 through R206. The IDC control applies a portion of the processed audio to the appropriate oscillator varactor diode (CR201 through CR206) to control the deviation of the transmitter rf signal.

b. RF Circuits

Generation and modulation of the rf signal occurs in the transmitter oscillator. The oscillator consists of transistor Q101 and associated parts (which are common to all channels) and crystals Y201 through Y206 and associated parts (which are selected by frequency-selector switch S201 in multi-frequency radios only).

The parts associated with oscillator transistor Q101 are as follows. Components R101, R102, and CR101 provide a temperature-compensated base bias. Components R103 and RT101 form a temperature-compensated collector load. Emitter-resistor R105, and capacitors C101 and C102, form part of the oscillator resonant circuit. The crystal operates at a frequency slightly above its fundamental series resonance, and appears as an inductive reactance in the circuit.

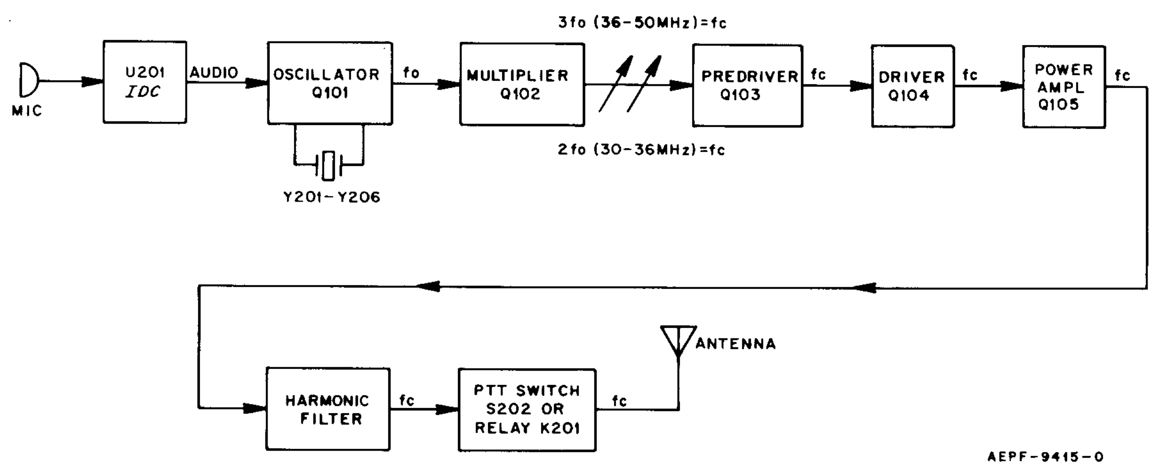


Figure 32. Low Band Transmitter Block Diagram

Varactor diodes CR201 through VR206 are biased at approximately 4 Vdc by R225, R226, and diodes CR218 and CR219 (CR220 in 3- to 6-frequency radios). At this bias, the diode appears as a 56 pF capacitor in parallel with warp coils L201 through L206. When the oscillator is warped on frequency, the parallel combination of the varactor diode and warp coil (in parallel with C101, C102, and series inductors L207 through L212) combine to yield a 32 pF load to the crystal.

Audio from the IDC control is applied to the varactor via resistors R207 through R212. This causes the diode capacitance to change in proportion to the instantaneous audio voltage, which causes a corresponding change in the oscillator frequency.

Low frequency PL tones are applied to the oscillator varactor at tie point ⟨6⟩. There is only a single adjustment for PL deviation, located on the PL circuit board.

The oscillator output appearing at the collector of Q101 is coupled to Q102 via C103, with Q102 operating as a multiplier. Its collector load is a two-pole Butterworth filter (L102, L103, C105, C106, C107, C108, C109) which is tuned to a harmonic of the oscillator. For the low-frequency split (30-36 MHz) the second harmonic is selected. For mid- and high-frequency splits (36-50 MHz), the third harmonic is selected. R106 and L101 provide a high impedance dc path. The filter attenuates the oscillator fundamental frequency, as well as all harmonics other than the one desired.

The filtered output of Q102 is applied to the base of the pre-driver stage (Q103), which operates as a buffer amplifier. The function of the buffer amplifier is to provide sufficient input level for proper driver operation. Components R107 and R108 provide base bias for the stage, while R109 is used for emitter bias. The output of Q103 is coupled to driver Q104 through interstage matching transformer T101. The driver is a class C stage which amplifies the pre-driver output signal to a level sufficient to ensure saturation of rf power amplifier (PA) stage Q105. Battery B+ is fed to the driver through choke L104 and resistor R112. Capacitors C117, C118, C127, and tunable inductor L105 match the output of the driver to the input of class C power amplifier Q105.

Components L106 and R115 feed B+ to the collector of Q105, while R113 provides base bias. A feedback network, composed of R114, L110, and C119, is used for stabilization of the amplifier stage. Components L107, C120, and L108 provide a tunable collector load to the stage. The PA output is then coupled to the low-pass filter, which consists of L220, L221, C226, C227, C228, C229, and C230. These elements comprise two M-derived filter sections which attenuate frequencies above the carrier frequency.

In "BBB" models, the transmitted rf is coupled through PTT switch S202 (pin 1) to pin 3. Capacitor C224 passes rf to antenna matching network L222 and C241. In "BBU" models, the rf is coupled through K201 (pin 8) to pin 3. Capacitor C224 couples rf through antenna jack J202 and the side connector jack (J203) to the antenna matching network (L222 and C241).

6. TONE "PRIVATE-LINE" MODULES; U501 AND U502

a. General

The tone PL option consists of two hybrid modules mounted on a circuit board. One module is the tone PL processor which is soldered into the circuit board, and the other is the tone filter which determines the PL operating frequency and is a plug-in module.

The tone PL processor module performs two functions: (1) the generation of the proper transmit PL tone and the associated "reverse burst" phase shift which acts as a turn-off code when the push-to-talk switch is released; and (2) decoding of a selected PL tone which consequently unsquelches the receiver. To assist in the decoding function the tone PL processor module incorporates an internal low-pass filter to eliminate undesirable frequencies.

b. Receiver Decoding Operation

Refer to the receive (decode) mode diagram, Figure 33. The low-pass filter (U501) is an active filter-amplifier which provides about 32 dB gain at frequencies below 250 Hz, and provides over 20 dB attenuation at frequencies above 350 Hz. Recovered audio from the discriminator is applied to input pin 12 of the low pass filter, but due to the filter characteristics, only the low frequency PL tones are amplified. Amplified PL tones at the filter output (pin 9) are applied to the PL processor module where they are again amplified and amplitude-limited by the receive-limiter circuit.

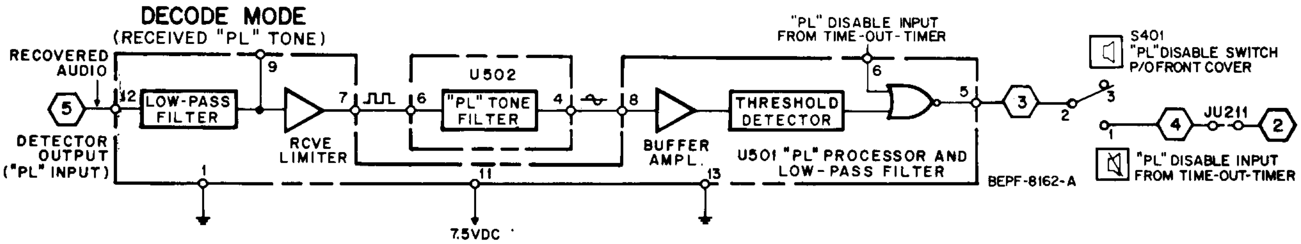


Figure 33. Tone "Private-Line" Circuit, Receive (Decode) Mode

The limited subaudible tones (pin 7 of U501) are applied to the input (pin 6) of PL tone filter U502, which will pass only one selected subaudible PL tone at almost unity gain (-1 dB). Attenuation of all other tones is greater than 20 dB. If the carrier is being modulated with the correct tone, an output (160 mV) appears at the tone filter output (pin 4 of U502). The tone is then amplified through the buffer amplifier and sensed at the threshold detector in U501. A logic high condition is applied to the input of the audio switch gate, which results in a low voltage level (below 0.6 volt) at pin 5 of U501. This low voltage condition unsquelches the receiver.

If the PL squelch switch is in the " ▷ " position, the tone decoder circuit is bypassed and the receiver operates as a carrier squelched radio without PL.

The logic in squelch module U5 is such that "Private-Line" sensitivity is controlled by carrier squelch sensitivity. Therefore, for best PL sensitivity, the squelch control on the radio must be set to threshold sensitivity or to the fully unsquelched position.

c. Transmitter Encoder Operation

Refer to the transmit (encode) mode diagram, Figure 34. The PL processor functions are altered when the transmitter is keyed.

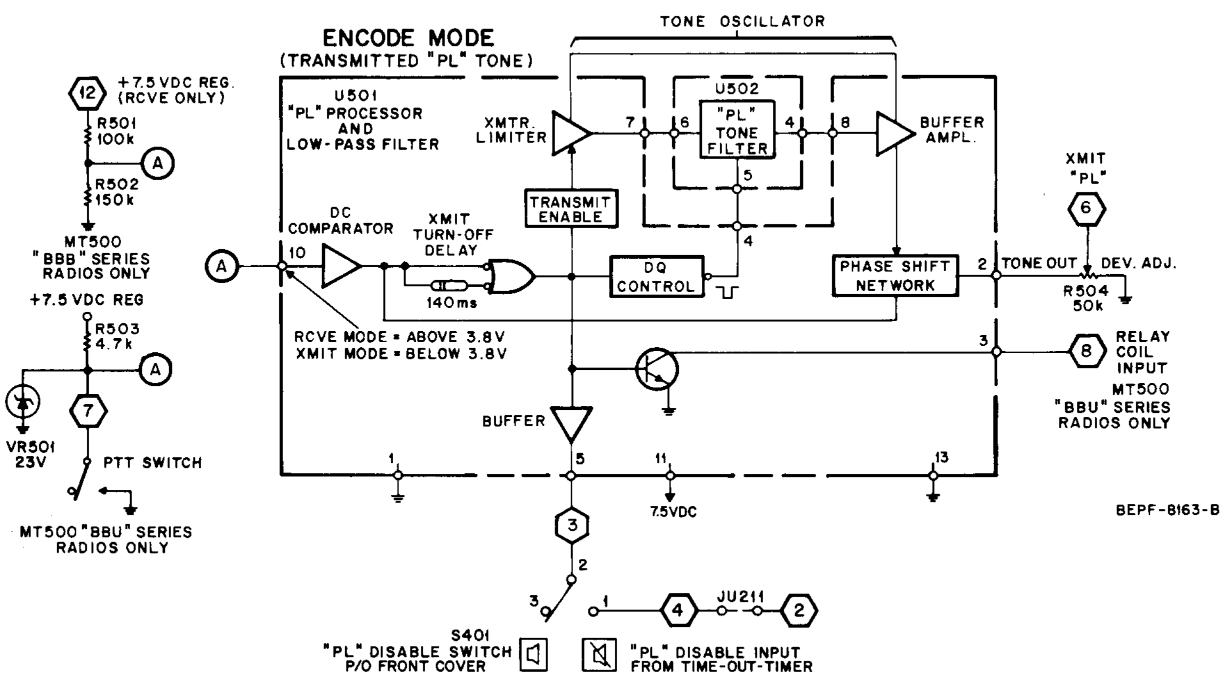


Figure 34. Tone "Private-Line" Circuit, Transmit (Encode) Mode

The dc comparator controls the state of the PL processor. The processor is in the transmit mode when the voltage on the comparator input (pin 10) is less than 3.8 volts dc. When the push-to-talk switch is pressed, the voltage on pin 10 of the PL processor (U501) goes low. This produces an output from the "xmit turn-off delay" circuit which (1) enables the tone oscillator circuit, (2) saturates a transistor that provides a ground at pin 3 of U501, (3) squelches the receiver during transmit, and (4) turns on the DQ control circuit.

The ground at pin 3 energizes relay K101, which switches the radio to the transmit mode.

The tone oscillator operates continuously while the transmitter is "keyed" and is not affected by the PL switch. The oscillator is formed by the transmit-limiter in U501, the PL tone filter, U502, and the buffer amplifier in U501. The tone filter is the frequency determining device in the oscillator. It is a high Q, narrow bandpass filter that passes its center frequency and blocks all other frequencies. Positive feedback is employed to sustain oscillation and to keep the oscillation and to keep the oscillator out of limiting, producing a sinusoidal output at pin 2 of U501 while the transmitter is keyed.

The DQ control circuit produces a negative-going 20 ms pulse at pin 4 of U501 when the push-to-talk pushbutton is pressed, and a negative-going 20 ms pulse 140 msec after the push-to-talk pushbutton is released. The pulse acts upon the PL tone filter to lower the Q of the circuit. This results in faster oscillator start-up initially and produces a rapid decay at the end of a transmission.

When the push-to-talk pushbutton is released, the phase shift network produces a signal that is 240 degrees out-of-phase with the original tone. This reverse burst continues for 140 ms. During this time, relay K101 remains energized until the "xmit turn-off delay" releases the transmitter. Thus, the transmitter is on for 140 ms following the release of the push-to-talk switch. This eliminates the "squelch tail" noise burst in the listening receivers.

7. TIME-OUT TIMER CIRCUIT

a. General

The time-out timer circuit consists of two integrated circuit timers (U1 and U2), two switching transistors (Q1 and Q2), an rc timing network (R1 and C1), and other discrete components. Refer to Figure 35. Timer U1 controls the time allowed to transmit a message, after which the radio reverts to its receive mode, and simultaneously turns on alert tone oscillator U2 to generate and emit an alert tone from the speaker. The alert tone is heard as long as the push-to-talk switch is pressed. When the push-to-talk switch is released, the alert tone ceases and the time-out timer circuit reverts to its standby mode.

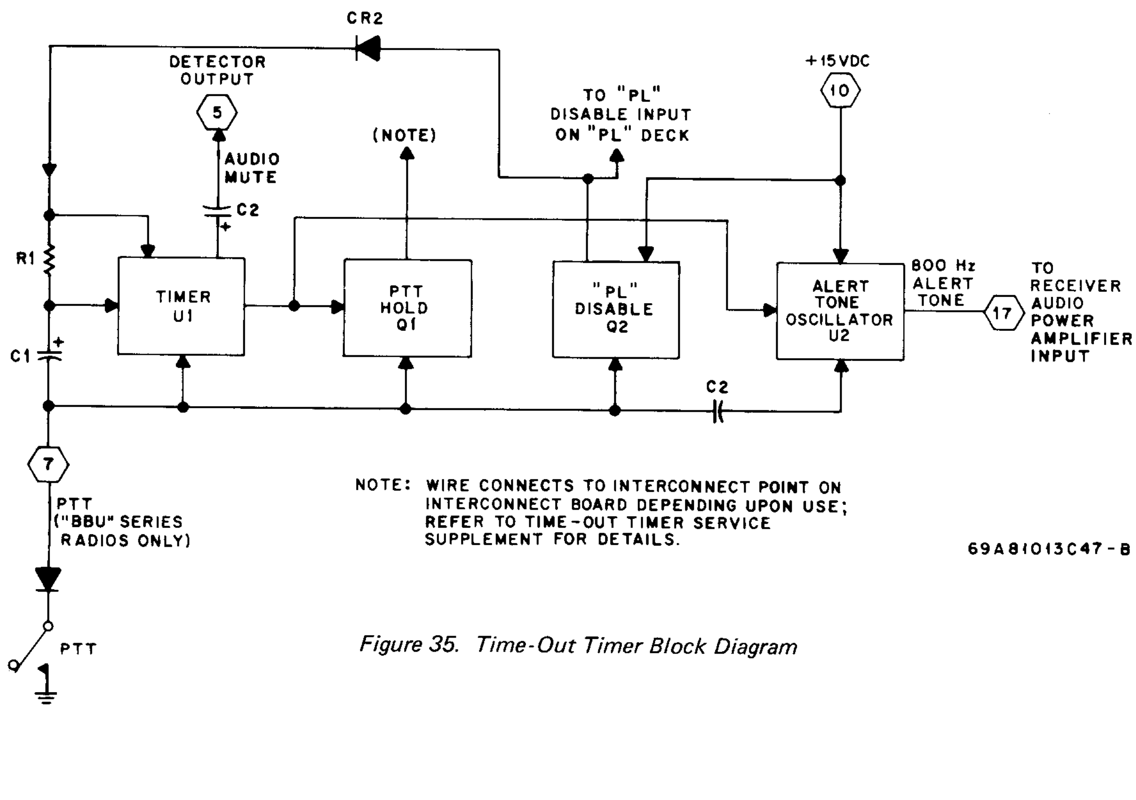


Figure 35. Time-Out Timer Block Diagram

Switching transistor Q1 (push-to-talk hold) "keys" the radio when the push-to-talk switch is pressed and "dekeys" the radio when 60-second timer U1 resets, shutting off Q1.

If the radio is equipped with a PL deck, switching transistor Q2 (PL disable) controls the PL deck output by providing 15 volts dc to the PL deck "PL Disable Input" during transmit and time-out modes.

b. Detailed Circuit Description

Refer to the schematic diagram in the "Time-Out Timer Service Supplement" (68P81013C45). When the push-to-talk switch is pressed, the circuit path from 15 volts dc through voltage divider R6 and R5 to ground biases Q2 into conduction to provide 15 volts dc at the collector of Q2. This 15-volt dc potential is fed to the PL disable input of the PL circuit (if used), and through CR2 to timer U1. With the push-to-talk switch pressed, pin 1 of U1 goes low, causing timer U1 to set. Pin 3 of U1 goes high, turning on transistor Q1 to "key" the radio and capacitor C1 starts charging through resistor R1. When the voltage across capacitor C1 reaches two-thirds of the voltage from Q2, timer U1 resets, bringing pin 3 of U1 low to turn off transistor Q1 and "dekey" the radio which returns to a normal receive mode.

The low level at pin 3 of U1 causes pin 1 of U2 to also go low, enabling alert tone oscillator U2 to generate an alert tone which is coupled through CR1 to audio power amplifier U7.

Pin 7 of U1 also goes low to ac ground the detector output in the radio through capacitor C2 which shunts noise and received audio, causing the squelch module to turn on the audio power amplifier and amplify the alert tone.

When the push-to-talk switch is released, Q2 is turned off to allow normal PL operation and to remove the 15 volts dc from U1. Timer U1 and alert tone oscillator U2 are turned off and capacitor C1 discharges. Pin 7 of U1 becomes an open collector, ungrounding the detector output to allow normal audio and squelch operation. Diode CR1 becomes back-biased allowing normal audio operation. In the receive mode, since the push-to-talk line is high, the time-out-timer has no appreciable current drain.

8. "PAC•RT" TRANSMIT-ONLY TONE "PL" DECK

The PAC•RT transmit-only tone PL circuit is very similar to the tone PL circuit. The difference is that the PAC•RT transmit-only PL circuit uses only the encode mode portion of the tone PL circuit.

9. TRANSMIT-ONLY TONE "PL" DECK

The transmit-only tone PL circuit is identical to the tone PL circuit encode mode. Refer to paragraph 6.c. for a detailed description of the encode mode of the tone PL circuit.

10. SINGLE-TONE REMOTE SIGNALING

a. General

The single-tone remote signaling circuit consists of one CMOS integrated circuit, a transistor, and supplemental passive circuitry which generates a switched selectable tone in the audio range for 750 ms duration. The circuitry also provides for sidetone monitoring of the transmitted tones and a microphone muting function.

The circuitry is divided into three significant stages: timer, oscillator, and audio buffer-sidetone amplifier. Refer to the schematic diagram in the "Single-Tone Service Supplement" (68P81013C55).

b. Detailed Circuit Description

The timer (U1A) controls the duration of the transmitted tone. When the push-to-talk switch is pressed, the +7.5 VDC (XMIT ONLY) line goes high. Pins 1 and 2 of U1A and pin 5 of U1B remain low due to the uncharged capacitors C1 and C2. As a result, pin 3 of U1A and pin 4 of U1B are high (+7.5 VDC). C1 begins to charge through R1 from the +7.5 VDC line and C2 begins to charge through R2 and CR3 from the high potential on pin 3 of U1A. This high from pin 3 of U1A is also routed through R6 to the interconnect point 16 (IDC INPUT) of the interconnect board, causing the radio IDC module U13 to inhibit any signal coming from the radio microphone. Pin 4 of U1B is routed to the tone selector switch S1 wiper.

If the tone selector switch is in the off position, the momentary high from pin 4 of U1B is routed through CR2 to pins 1 and 2 of U1A rapidly charging C1, which causes pin 3 of U1A to go low, inhibiting the oscillator and unmuting the radio microphone.

If the tone selector switch is in any other position but OFF, C1 continues to charge through R1 while the tone oscillator runs. When the voltage at pins 1 and 2 of U1A reaches threshold (about 3.75 volts) after approximately 750 ms, pin 3 of U1A goes low, inhibiting the oscillator and unmuting the radio microphone.

The tone oscillator consists of gates U1B, U1C and the feedback network of C3 and C4, R3, and frequency select resistors R8 through R17. Refer to the simplified oscillator circuit diagram in Figure 36.

When the enable line from pin 3 of U1A goes high, the capacitor consisting of C3 and C4 charges and discharges through the resistor network R_f (selected by S1). The voltage at point A is returned to the input (pin 6 of U1B) through isolation resistor R3. When the enable line goes low, the oscillator stops with the output remaining high, as shown on the accompanying timing diagram.

Gate U1D serves as an audio buffer to isolate the oscillator from the speaker and IDC module. R7 provides the proper audio level into the IDC input while R4 drives amplifier Q1 to provide side-tone monitoring. R5 adjusts the volume level to the speaker.

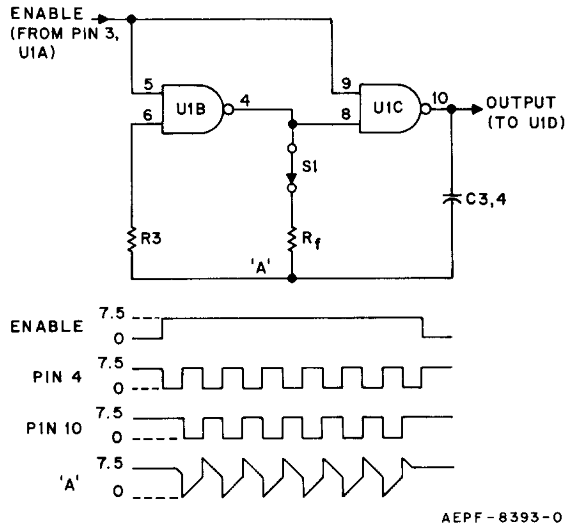


Figure 36. Simplified Oscillator Circuit

DISASSEMBLY

1. GENERAL

For most servicing, remove the battery cover, back cover, and front cover. If the radio uses the "omni" housing, it must be unsnapped from the radio frame. This provides access to the transmitter-receiver circuit board and to the interconnect circuit board. Turn the radio off before disassembly and before reassembly.

2. PROCEDURE

a. Refer to Figure 37). Turn the slotted screw head on the battery cover one-quarter turn counterclockwise and remove the battery cover.

b. Remove the battery.

c. Loosen the four captive screws holding the back cover and remove the back cover.

d. Remove the snap-on sleeve (omni housing only).

e. Loosen the four captive bushings holding the frame kit to the front cover.

f. Separate the front cover from the frame kit.

g. The wires connecting the front cover to the frame kit can be unplugged if desired.

3. REMOVING THE TRANSMIT POWER AMPLIFIER MODULE (VHF and UHF Models)

a. Locate the retaining screw above the push-to-talk switch and remove it (refer to Figure 37).

b. From the interconnect board side of the frame kit, grasp the transmit power amplifier module and unplug it from the transmitter-receiver circuit board.

c. Reverse the disassembly procedure to install the transmit power amplifier module.

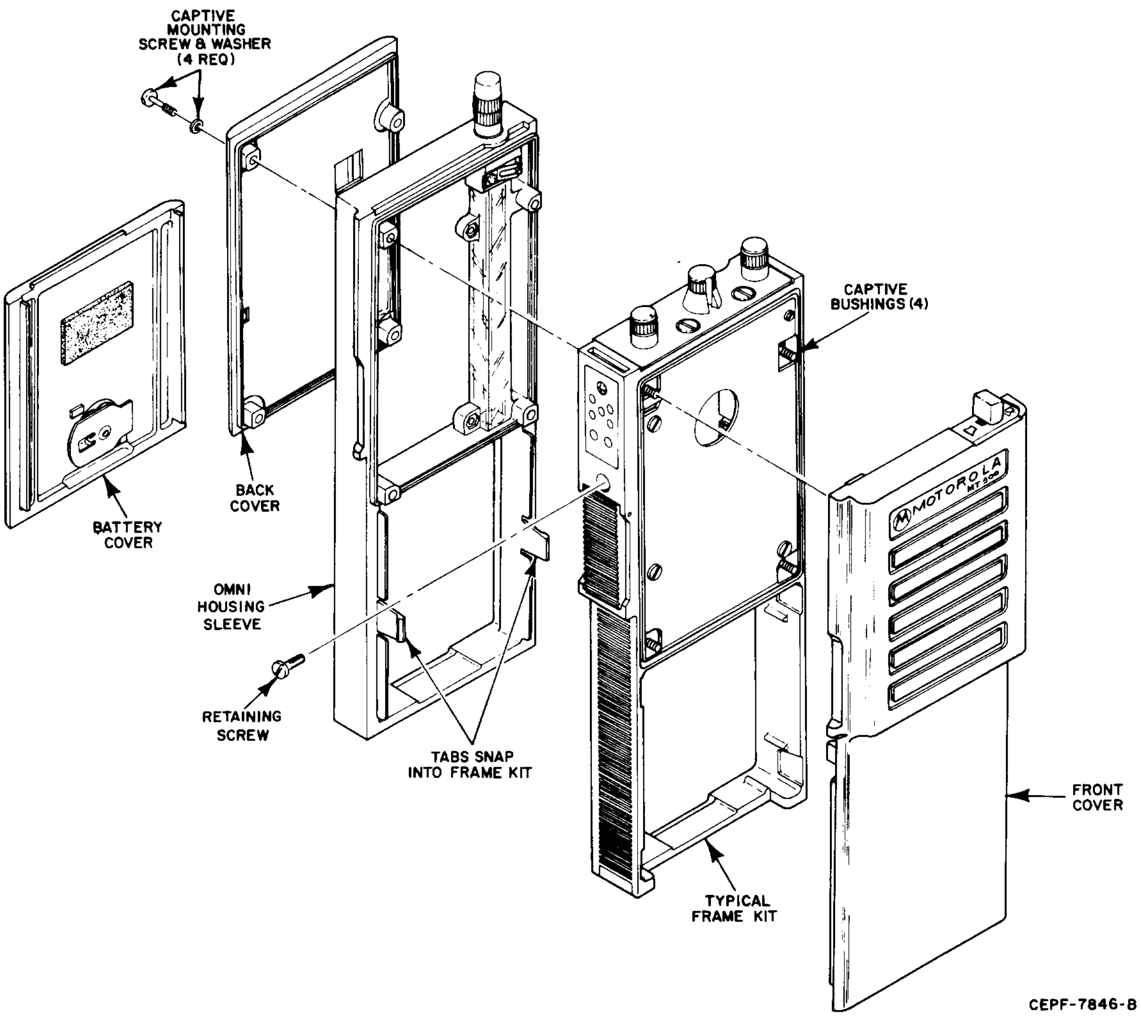


Figure 37. Typical MT500 Radio Disassembly Procedure

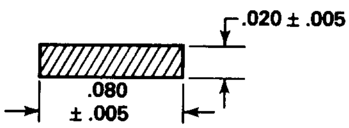
4. REMOVING THE TRANSMITTER-RECEIVER CIRCUIT BOARD

CAUTION

On low band units, attempting to remove the transceiver board without first removing the screw holding the heat sink to the frame could extensively damage the transceiver board.

CAUTION

When removing or installing the transmitter-receiver circuit board, use a jeweler's screwdriver. The recommended screwdriver blade size is illustrated below.



RECOMMENDED BLADE SIZE OR CLOSEST STANDARD

a. Remove the four screws securing the transmitter-receiver circuit board to the frame kit.

b. With a tuning wand or similar non-metallic tool, carefully pry up the corners of the circuit board until it can be grasped firmly.

c. Carefully pull the circuit board out.

d. Reverse the disassembly procedure to install the transmitter-receiver circuit board. Be careful to properly align the connectors of both circuit boards so they will neither bind nor become damaged when they are reassembled.

5. REMOVING THE MIXER MODULE, UHF RADIOS

The mixer module in the UHF radio is located in the preselector housing.

a. From the component side of the transmitter-receiver circuit board, remove the mixer cover on top of the preselector housing by removing two screws.

b. Before removing the mixer module, notice that the component side of the module is facing the circuit board speaker hole. ALL replacements must be repositioned in this same manner.

c. Two wires enter the mixer chamber from the side of the preselector cells and are soldered to the mixer module lugs; unsolder these wires from the mixer module.

d. Refer to the circuit board details for the location of the four leads securing the mixer module to the circuit board.

NOTE

Mixer leads will unsolder easier with the preselector screw nearest the mixer leads removed temporarily.

e. Gently grasp the mixer module with a "seizer" (Motorola ST-207 or 6683117C01).

f. Unsolder the four leads of the mixer module using a soldering iron and solder extractor and the technique described in the "Repair" section.

g. Remove the mixer module from the preselector housing.

h. Reverse the disassembly procedure to install the mixer module. Be careful to properly position the mixer module in the same manner as the one just removed. If improperly installed, sensitivity will be greatly reduced.

6. REMOVING THE PRESELECTOR, UHF RADIOS

a. Remove the mixer module (paragraph 5 of this section).

b. With the mixer module removed, remove the two screws that hold the preselector in position. The preselector screws are located on the solder side of the circuit board.

c. Refer to the circuit board details for the location of the four leads that are to be unsoldered. One is located next to cavity Z7; three are located in "bulges" of the preselector housing, one next to cavity Z1, one next to cavity Z2, and one next to cavity Z3.

d. Unsolder the four leads of the preselector using a soldering iron and a solder extractor.

e. Remove the preselector housing and its gasket. If the gasket is not damaged and is free of solder, it can be reused.

NOTE

The preselector housing must be seated firmly against the circuit board.

f. Reassembly is almost the reverse of disassembly, except for one step. Use the preselector housing screws (2) to secure the preselector and its gasket to the circuit board <u>before</u> soldering the four preselector leads.

g. Continue to reassemble the preselector and mixer module in the reverse of the disassembly procedure.

7. DISCRETE COMPONENT AND HYBRID MODULE REPLACEMENT

Refer to the "Repair" section of this manual.

8. U1 I-F/SQUELCH/AUDIO INTEGRATED CIRCUIT REMOVAL (Low Band Radios)

This IC has been 100% tested and the troubleshooting procedure for the receiver is designed so that problem areas can be rapidly isolated. Replacement of the IC should be performed only when all other possibilities are exhausted. Removal of U1 is a difficult operation and can be performed only a limited number of times before the transceiver board becomes unusable.

TEST EQUIPMENT AND SERVICE AIDS

1. GENERAL

This section describes all the test equipment and service aids required for maintaining the MT500 Series "Handie-Talkie" portable radios. See your Motorola sales representative for aid in ordering test equipment. He will analyze your requirements and help you select the latest available equipment to suit your individual needs. He can also advise you of new test equipment and service aids that become available after the printing of this manual.

2. TEST EQUIPMENT

Refer to the list of test equipment. Battery operated test equipment is recommended when available. The listed items or equivalents may be used.

3. SPECIAL SERVICE AIDS

Several service aids have been designed especially for servicing the MT500 Series radios. These aids are available from the Motorola Communications Division Parts Department. Refer to the table on the following page.

Test Equipment Table

MODEL NO.	NAME	CHARACTERISTICS	APPLICATION
R-1200A series	Service Monitor	--	Signal generator and frequency/ deviation meter for wide-range troubleshooting and alignment
S-1347A or S-1348A	DC Power Supply	0-20 Vdc, 0-5 Amps, Current limited.	Bench supply for 15 volts dc.
HP400FL	AC Voltmeter	Measures to -90 dBm	Audio voltage measurements and Takeover measurements
S-1063B	Solid-State DC Multimeter	100 mV min. full scale, 1 uA-300 mA, 11 megohms input resistance, 0.2 Ω -50 megohm resistance.	DC voltage and resistance measurements.
SLN-6055A with SLN-6083A termination.	RF Probe	0.3 to 10 volts full scale, 10 MHz to 400 MHz	Plugs into S1063 DC Multimeter for making rf measurements.
or S1339A	RF Millivoltmeter	100 uV to 3 V rf 10 kHz to 1.2 GHz	
R-1004A	Dual-Trace Oscilloscope	10 MHz bandwith, 10 mV/cm	Waveform measurements
S-1350A	Wattmeter	2.5 and 10 watt ranges, terminating type.	Transmitter power output measurement.
S-1067B	Audio Oscillator	--	Audio circuit testing
SLN-6413	Digital Encoder/ Decoder	--	For servicing digital "Private-Line" circuit
S-1333B	Tone Generator	10 to 9999 Hz tones	For servicing audio circuit and tone "Private-Line"-circuit.
or SLN-6381A	Audio Frequency Synthesizer		
R1013A	SINAD Meter	--	Receiver Alignment
HP331A	Distortion Analyzer	--	Distortion and AC Voltage Measurements

MODEL NUMBER	DESCRIPTION
NKN-6248A	Tune-Up Cable - provides for connection of the radio's rf (antenna jack) and audio jack to test equipment.
NKN-6247A	RF Adapter Cable - 12-inch coaxial cable (with BNC connector on one end, a miniature phone plug on other end) allows connection of the radio rf output to test equipment or mobile antenna.
TEK-44	Battery Block - allows an external power source to be used while servicing. Also provides convenient test jacks for input voltage and current measurements.
RTX-4005A	Test Set - provides capability for testing many transmitter and receiver functions. Transmitter modulation and keying can be simulated and receiver troubleshooting points can be tested without opening the radio ("BBU" Series). With the radio front cover removed, all MT500 models are allowed the same convenience. Test set used in conjunction with any of the following test cables.
RTK-4000A	Test Cable - allows MT500 "BBU" Series radios to be tested with covers in place, when used with RTX-4005A Test Set.
RTK-4001A	Test Cable - allows all MT500 models ("BBB" or "BBU" Series) to be tested without covers in place, when used with RTX-4005A Test Set.
RTK-4003A	Test Cable - 6-inch coaxial cable (with BNC connector on one end, radio side connector interface on other end) allows rf measurements of the MT500 "BBU" Series radio to be made from the radio side connector. Test Set is not required for this measurement.
RTK-4008A	Test Cable - allows VHF transceiver boards to be powered up while separated from interconnect board.
RTK-4009A	Test Cable - allows UHF transceiver boards to be powered up while separated from interconnect board.
RSX-4030A	Torque Screwdriver - used to apply proper torque to the PA heat sink and transceiver board hold-down screws.
RSX-4031A	Re-Striking Tool - designed to replace the "bow" and spring tension in MT500 channel element pins that have been lost due to multiple insertion. This insures that proper connection is made with the radio circuit board.
ST-1087	Weller Soldering Station - grounded soldering iron allows convenient removal of soldered-in MOS devices.
ST-1144 / ST-1146	Module Desoldering Iron - allows convenient removal of soldered-in modules without damaging module or printed wiring board. (Order tips separately).
NLN-4605A	Tuning Tool Kit - consists of one 6605607E01 Tuning Tool for channel elements and tunable coils; and one 6605599E01 Tuning Tool for preselector tuning and other servicing needs.
NLN-4606A	Service Tool Kit - Consists of one 5505717E01 Service Tool for removal of all spanner type nuts, including the collapsible antenna.
For added convenience, the following tools are suggested, but not necessary aids for the MT500 radios.	
ST-1182	Wrench - removes speaker jacks and battery latch. (Xcelite TW32) NOTE: Service Tool 5505717E01 also accomplishes these items.
ST-635	Wrench - removes volume, squelch, frequency select switch, PL switch and "BBU" Series push-to-talk feedthrough assembly. (Xcelite TW140) NOTE: Service Tool 5505717E01 also accomplishes these items.
ST-1183	Screw Wrench - used on volume, squelch, frequency select switch, PL switch, and power amplifier mounting nuts. (Bristol DS 060) NOTE: Tuning Tool 6605599E01 also accomplishes these items.
RSX-4011A	Screw Wrench - used for preselector tuning and power amplifier mounting set screw. (Bristol DS 048) NOTE: Tuning Tool 6605599E01 also accomplishes these items.

TROUBLESHOOTING

1. INTRODUCTION

Servicing of the MT500 Series radio requires the localizing of the malfunctioning circuit before the defective component can be isolated and replaced. Since localizing and isolating a defective component constitutes the most time-consuming part of troubleshooting, a thorough understanding of the circuits involved will aid the technician in performing efficient servicing. The technician must know how one function affects another; he must be familiar with the overall operation of the radio and the procedures necessary to place it back in operation in the shortest possible time.

The radio functional block diagram, schematic diagram, and troubleshooting table provides valuable information for troubleshooting purposes. The functional diagram provides signal flow information in a simplified format while the schematic diagram provides the detailed circuitry and the biasing voltages required for isolating malfunctioning components. The troubleshooting table further isolates malfunctioning components. Generally, it may be assumed that if the radio is totally inoperative, the power input (battery) is completely discharged. However, if the radio operates in the transmit mode but not in the receive mode (or vice versa), it may be assumed that the battery is serviceable and that one or more functional circuits are defective or marginal. By using the diagrams, troubleshooting tables, and deductive processes, the suspected circuit may be readily found.

2. MOS HANDLING PRECAUTIONS

MOS (Metal Oxide Semiconductor) devices are used in the digital "PL," unit ID, and single-tone circuitry. While the attributes of MOS type devices are many, their characteristics make them susceptible to damage by electrostatic or high voltage charges. Therefore, when the service technician encounters MOS circuits, special precautions to prevent device damage must be taken during repair procedures outlined in the following sections. The following handling precautions are recommended for MOS circuits and are especially true in dry-humidity conditions.

a. Store and transport all MOS devices in conductive material so that all exposed leads are shorted together. Do not insert MOS devices into conventional plastic "snow" or plastic trays of the type used for storage and transportation of other semiconductor devices.

b. Ground the working surface of the service bench to protect the MOS device.

c. Wear a conductive wrist strap in series with a 100k resistor to ground (Motorola part number ST-1191).

d. Do not wear nylon clothing while handling MOS devices.

e. Neither insert nor remove MOS devices with power applied. Check all power supplies to be used for testing MOS devices and be certain there are no voltage transients present.

f. When straightening MOS leads, provide ground straps for apparatus used.

g. When soldering, use a grounded soldering iron.

h. If at all possible, handle all MOS devices by the packages 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.

3. POWER CHECK

a. To check the battery voltage, remove the battery from the radio.

b. Use a dc multimeter to check the battery voltage. If the nickel-cadmium battery voltage is 12 volts dc or lower, recharge or replace it with a fresh or fully charged battery. If the mercury battery voltage is 10 volts dc or lower, replace it with a fresh battery.

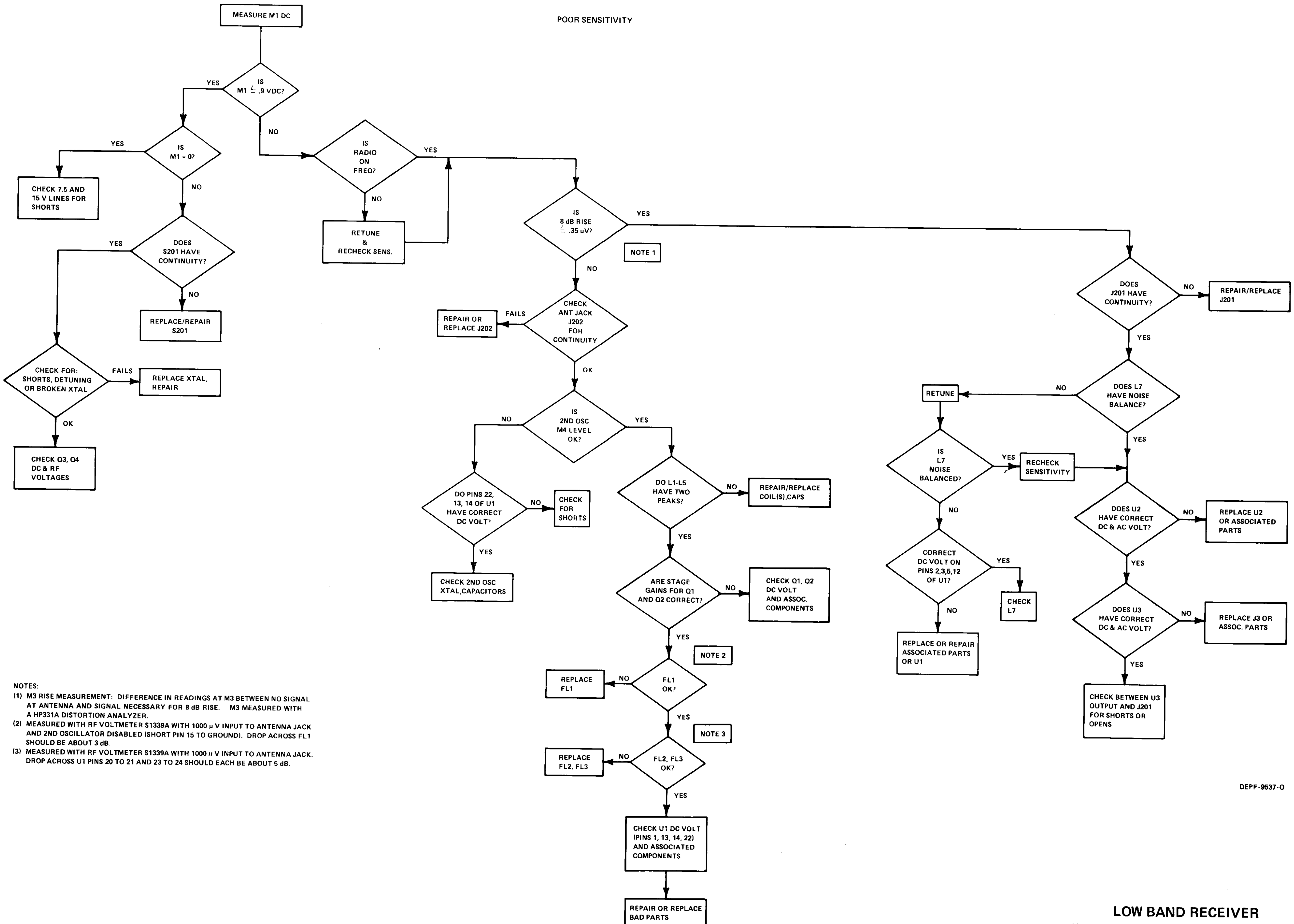
4. EXCESSIVE CURRENT DRAIN

a. Disassemble the radio to the frame and front cover.

b. Use the dummy battery block and dc power supply to power the radio. Set the power supply for 15 volts dc output and a current limit of 150 mA.

c. Connect an ac voltmeter to the speaker jack of the radio using the proper adapter cable (see "Service Aids" table) to monitor audio output.

d. Turn the radio on and check for one or more of the conditions noted in Table 7 for excessive current drain or Tables 8 and 9 for low current drain.



NOTES:

(1) M3 RISE MEASUREMENT: DIFFERENCE IN READINGS AT M3 BETWEEN NO SIGNAL AT ANTENNA AND SIGNAL NECESSARY FOR 8 dB RISE. M3 MEASURED WITH A HP331A DISTORTION ANALYZER.

(2) MEASURED WITH RF VOLTMETER S1339A WITH 1000 μV INPUT TO ANTENNA JACK AND 2ND OSCILLATOR DISABLED (SHORT PIN 15 TO GROUND). DROP ACROSS FL1 SHOULD BE ABOUT 3 dB.

(3) MEASURED WITH RF VOLTMETER S1339A WITH 1000 μV INPUT TO ANTENNA JACK. DROP ACROSS U1 PINS 20 TO 21 AND 23 TO 24 SHOULD EACH BE ABOUT 5 dB.

LOW BAND RECEIVER TROUBLESHOOTING CHART

Table 7. Excessive Current Drain

CHECKING REVEALS	POSSIBLE FAULT
Enough current drain to open power supply	15-volt dc short (VHF and UHF)
Current drain of 90 mA to 120 mA with audio output; R7 (UHF) is hot	Injection voltage, 7.5 V (VHF) or 15 V (UHF), shorted Channel element pin 5 shorted (VHF and UHF)
Current drain of 80 mA to 90 mA; no audio output; 7.5 V line = zero volts	7.5-volt dc line shorted (VHF and UHF)
Current drain of 80 mA to 90 mA; no audio output; 7.5 V line = 5.8 volts	1.7-volt dc line shorted (VHF and UHF)
Current drain of 130 mA; noise but no audio	7.5-volt or 4.6-volt line shorted (Low Band)
Current drain of 25 mA to 180 mA; no audio output; current varies with volume control; audio module is hot	Audio output is shorted
Speaker makes noise but no audio indicated on ac voltmeter connected to speaker jack	Speaker jack not isolated from frame
No noise from speaker, but audio indicated on ac voltmeter connected to speaker jack	Short after speaker jack
No audio on speaker or ac voltmeter connected to speaker jack	Short before speaker jack

Table 8. Low Current Drain (VHF and UHF)

CHECKING REVEALS	POSSIBLE FAULT
Current drain is less than 25 mA for all volume control settings; dc voltage on pin 3 of U7 is greater than 0.6 volt	Receiver is squelched
Voltage at junction of R12, CR2, and C29 is greater than 1 volt	+7.5 volts dc regulated (transmit only) line
Voltage at junction of R12, CR2, and C29 is less than 1 volt	Squelch circuit
Current drain is less than 25 mA for all volume control settings; dc voltage on pin 3 of U7 is less than 0.3 volt	Major loss of sensitivity Audio stage gain measurements

Table 9. Low Current Drain (Low Band)

CHECKING REVEALS	POSSIBLE FAULT
Current drain is less than 25 mA for all volume control settings	2.7-volt dc line (pin 12 U1) or pin 2 shorted
No change in current when squelched (no squelch)	Squelch potentiometer shorted to ground
Current reads 10 mA for all volume settings	Squelch circuit
Current drain is less than 25 mA for all volume control settings	Check 15-volt line for short
No control at low volume settings	R257 and/or C218

5. LOW BAND RECEIVER TROUBLESHOOTING PROCEDURE

a. Disassemble the radio to the frame and front cover.

b. Set the power supply for 15 volts dc output and a current limit output of 150 mA.

c. Major Area Isolation - Refer to the trouble-shooting chart on the previous page.

6. MAJOR LOSS OF SENSITIVITY - 20 dB QUIETING AND 8 dB RISE (VHF and UHF Models)

a. Disassemble the radio to the frame and front cover.

b. Use the dummy battery block and dc power supply to power the radio. Set the power supply for 15 volts dc output and a current limit output of 150 mA.

c. Connect an rf generator to the external antenna jack; rf output level set to minimum.

d. Connect an ac voltmeter to metering point M1 (i-f detector U4, pin 9) and another ac voltmeter to the external speaker jack.

e. While increasing the rf signal output level to 0.35 uV (VHF) or 0.5 uV (UHF), monitor the rise in ac level at M1 and the quieting at the external speaker jack. If the rise at M1 is 8 dB or greater and the quieting is less than 20 dB, refer to the "Audio Stage Gain Measurements" procedure in this section, or if the rise at M1 is less than 8 dB and the quieting is less than 20 dB, continue with step f.

f. VHF — Check the change in dc level at test point M2 with and without the first oscillator disabled. The dc level should be 0.3 volt dc higher with the first oscillator enabled. If less than 0.3 volt dc, refer to the "Injection RF Levels" in this section.

UHF — With an rf millivoltmeter and a high impedance probe, measure the rf level at the input of preselector cell Z7. If less than -6 dBm, refer to the "Injection RF Levels" in this section. Typical level at this point is -2 dBm.

g. Check the rf level at module U3, pin 2 with an rf millivoltmeter and a high impedance probe. If the level is less than -4 dBm, replace crystal Y1; if it is still low, replace module U3. Typical level is 200 mV (-1 dBm).

h. Set the frequency selector switch to an unused position or remove the channel element corresponding to the frequency selector switch setting (CE1/F1, CE2/F2, etc.).

i. On VHF radios, inject 17.9 MHz from the rf generator to the junction of C17 and C18 (VHF), or on UHF radios, inject 17.9 MHz from the rf generator through a 30 pF capacitor to mixer U1, pin 2. While increasing the 17.9 MHz rf generator output level to 5 uV (VHF) or 2 uV (UHF), monitor the rise in ac level at M1 and the quieting at the external speaker jack. If the rise at M1 is greater than 8 dB and quieting is greater than 20 dB, then perform the "Front-End Takeover Measurements" in this section. Or if the rise at M1 is greater than 8 dB but quieting is less than 20 dB, then first perform the "Front-End Takeover Measurements" and then the "Audio Stage Gain Measurements" in this section. Or if the rise at M1 is less than 8 dB and quieting is less than 20 dB, perform the "I-F Stage Gain Measurements."

j. Use an rf millivoltmeter with a high impedance probe and monitor the junction of C17 and C18 (VHF) or mixer U1, pin 2 (UHF). Increase the 17.9 MHz rf generator output level until the rf millivoltmeter indicates -30 dBm.

k. Use the rf millivoltmeter and check the rf level at i-f amplifier U2, pin 5. The level should not be less than -33 dBm (3 dB loss for 17.9 MHz filter). If less than -33 dBm, check C19 (VHF) or C11 (UHF). Change FL1, FL2, and FL3.

NOTE

Crystal filters FL1, FL2, and FL3 are a matched set; therefore, if one is defective, all three crystals must be replaced.

7. I-F STAGE GAIN MEASUREMENTS (VHF and UHF Models)

NOTE

When using an rf millivoltmeter for rf level checks, ALWAYS use it with a high impedance probe.

a. Disassemble the radio to the frame and front cover.

b. Use the dummy battery block and dc power supply to power the radio. Set the power supply for 15 volts dc output and a current limit output of 150 mA.

c. Connect a rf generator to the external antenna jack; rf output level is set to minimum.

d. Adjust the 17.9 MHz rf generator to provide -33 dBm at i-f amplifier U2, pin 5. Use an rf millivoltmeter and check the rf level at i-f amplifier U2, pin 1; it must be greater than -13 dBm (20 dB gain for the module). If not, check the dc voltages on U2, and replace it if defective.

e. Disable the second oscillator in low conversion module U3 by shorting pin 3 to ground.

f. Adjust the rf generator to provide -17 dBm at i-f amplifier U2, pin 1. Use an rf millivoltmeter and check the rf level at low conversion module U3, pin 6; it must be greater than -19 dBm (2 dB loss for 17.9 MHz filter). If not, change filters FL1, FL2, and FL3.

NOTE

Crystal filters FL1, FL2, and FL3 are a matched set; therefore, if one is defective, all three crystals must be replaced.

g. With the second oscillator of low conversion module U3 still disabled, adjust the rf generator until the rf millivoltmeter indicates -19 dBm at pin 6 of U3.

h. Remove the short from pin 3 of U3. Use an ac voltmeter to measure the ac level at i-f detector U4, pin 10; this ac level (35 kHz) must be greater than -19 dB. If not, check the dc voltages on module U3, and replace it if defective.

i. Adjust the rf generator until an ac voltmeter indicates -50 dBm for i-f detector module U4, pin 10.

j. With an ac voltmeter, measure the signal level at M1; it must be greater than -35 dBm (15 dB gain for the module). If not, check the dc voltages on U4, and replace it if defective.

8. AUDIO STAGE GAIN MEASUREMENTS (VHF and UHF Models)

These measurements are to be made only if 8 dB rise sensitivity into the external antenna jack is less than 0.35 uV (VHF) or 0.5 uV (UHF). All measurements are to be made with an ac voltmeter (HP400FL with its 100 kHz filter removed) under the following conditions: 1000 uV at the carrier frequency fed into the external antenna jack, 1 kHz tone, and 3 kHz deviation.

a. Check the audio level at pin 3 of U4. It must be at least -30 dBm. If not, check the dc voltages on U4, and replace it if defective. Check the resistance from the top of squelch control R201 to ground (approximately 25 k).

b. Use the ac voltmeter to compare the signal levels at audio preamplifier U6, pins 1 and 3. Audio preamplifier U6, pin 3 must be at least 15 dB greater than the level at pin 1. If not, check the dc voltages on U6, and replace it if defective.

c. Volume control R202 controls the signal level at audio power amplifier U7, pin 1. Set the volume control to its maximum clockwise position and measure the signal level input to pin 1 of audio power amplifier U7. The level at U7, pin 1 should be the same as the level at pin 3 of audio preamplifier U6. If less, check C205, C204, and the dc resistance from the top of the volume control to the wiper arm (less than 25 ohms).

d. Set the volume control to its maximum counterclockwise position without turning off the radio and measure the signal level input to pin 1 of audio power amplifier U7. The level at U7, pin 1 should be at least 25 dB below the level at pin 3 of U6. If not, measure the dc resistance from the top of the volume control to the bottom of the volume control (approximately 25 k), the resistance from the bottom of the volume control to ground (56 ohms), and the resistance from the wiper arm to the bottom of the volume control (25 ohms). Replace the volume control if defective.

e. Monitor audio power amplifier U7, pin 1 with an ac voltmeter and adjust volume control R202 until -40 dBm is indicated on the ac voltmeter. Check the level at pin 7 of U7; it must be greater than -5 dBm (35 dB gain for the module). If not, check the dc voltages on U7; check the dc resistance from pin 7 of U7 to ground (39 ohms). Replace U7 if defective.

f. Adjust volume control R202 fully clockwise (maximum audio output). Check the level at pin 7 of U7; it must be greater than +15 dB (4.4 volts rms). If not, check the dc voltages on U7; check the dc resistance from pin 7 of U7 to ground (39 ohms). Replace U7 if defective.

9. TAKEOVER MEASUREMENTS (VHF and UHF Models)

a. <u>General</u>

The takeover measurements are a simple procedure for analyzing the rf portion of the receiver. The procedure measures the amount of noise present at i-f detector test point M1. In any receiver, a small amount of noise is present at the input. This noise is amplified and applied to the following stage, where it is further amplified and passed on. The contribution of each stage to the total noise produced in the receiver is an indication of the gain of that stage. The takeover procedure consists of measuring the noise level at M1, and then noting the drop in noises as selected stages are turned off. This drop in noise is related to the gain of the stage which has been turned off. The only equipment required for the takeover procedure is a sensitive, high impedance ac voltmeter (HP400FL), a lead, and a 0.01 uF capacitor for shorting stage inputs.

NOTE

Incorrect takeover readings at the front end of the receiver can be caused by a defective component in one of the following stages.

b. Front End Takeover Measurements, VHF Radios

(1) Inject 10 mV at the carrier frequency into the external antenna jack.

(2) Use an rf millivoltmeter with a high impedance probe grounded on the frame nearest the rf amplifier. Trace the signal path from external antenna jack J202 through C212, through PTT switch S202 ("BBB") or relay K101 ("BBU") and through C30. The level at the coaxial cable should be -25 dBm ±5 dBm. The other levels traced should be ±3 dBm from this level. The output of the rf amplifier (after C9) can be measured with a gain of approximately 5 to 10 dB.

(3) The following front end takeovers are taken with no rf signal applied; therefore disconnect the signal generator from the external antenna jack. Connect an ac voltmeter to test point M1.

(4) Monitor the total front end takeover noise level while connecting a 0.01 uF capacitor between the drain of Q2 and ground. If zero, check the dc voltages on Q2. Check for correct voltage at M2 (+0.8 volt dc); if incorrect, replace Q2.

(5) Remove the 0.01 uF capacitor connected between Q2 drain and ground.

(6) Monitor the rf amplifier takeover noise level with a 0.01 uF capacitor from the collector of Q1 to ground. If greater than 10 dB, check for possible rf amplifier regeneration and check rf amplifier dc voltages. If rf amplifier takeover is zero, check the rf amplifier dc voltages. If incorrect, replace Q1.

c. Front End Takeover Measurements, UHF Radios

(1) Inject 10 mV at the carrier frequency into the external antenna jack.

(2) Use an rf millivoltmeter with a high impedance probe grounded on the frame nearest the rf amplifier. Trace the signal path from external antenna jack J202 through C26, through PTT switch S202 ("BBB") or relay K101 ("BBU") and through C27. The level at the coaxial cable should be -25 dBm ±5 dBm. The other levels traced should be ±3 dBm from this level. Check the output of preselector filter Z1 and Z2, insertion loss should be approximately 3 dB through the filter. Only a gross (>10 dB) loss in signal can be determined by this method. The output of the rf amplifier (after C5) can be measured with a gain of approximately 5 to 10 dB.

(3) The following front end takeover measurements are taken with no rf signal applied; therefore disconnect the signal generator from the external antenna jack. Connect an ac voltmeter to test point M1.

(4) Monitor the total front end takeover noise level while connecting a 0.01 uF capacitor between pin 2 of U1 and ground. Record this indication for reference. If zero, check the dc voltages on U1 and replace if defective. Typical takeover is 12 dB.

(5) Remove the 0.01 uF capacitor connected between pin 2 of U1 and ground.

(6) Monitor the rf amplifier takeover noise level while connecting a short across L2 to bring the collector of Q1 to ac ground. Typical takeover is 3 dB. If the noise takeover level is greater than 10 dB, check for possible rf amplifier regeneration and check rf amplifier dc voltages. Check C1, C3, and R2 to ensure they are not cracked or broken. Replace Q1 if defective. If the rf amplifier takeover noise level is zero, check rf amplifier Q1 dc voltages. If incorrect, check for damaged parts in rf amplifier circuit. If all parts are okay, change Q1. If dc voltages are correct, check C4 and C5 to ensure they are not cracked or broken. If everything checked is okay, continue to the next step.

(7) Disable injection signal by removing the channel element corresponding to the frequency selector switch setting (CE1/F1, CE2/F2, etc.), or disable injection signal by connecting a 0.01 uF capacitor from pin 6 of injection module U8 to

ground. With the ac voltmeter still connected to meter point M1, monitor the total front end takeover noise level while connecting a 0.01 uF capacitor between pin 2 of U1 and ground. If total front end takeover is equal to that which was recorded in step (4) go to step (8). If total front end takeover is less than was recorded in step (4), solder a piece of coaxial cable to the input of preselector cell Z3. Attach the other end of the coaxial cable to an rf generator, and check sensitivity by increasing the rf signal output level. Monitor the rise in the ac level at M1. If 8 dB rise is less than 1.5 uV, then the problem is in the rf amplifier. If 8 dB rise is greater than 1.5 uV, then check for a "cold" solder joint on mixer module U1, pin 6 (inside preselector housing, top of module - refer to "Disassembly" section to gain access to mixer module U1). Check mixer module U1 dc voltage levels. The tap of preselector cell Z3 and Z5 must be a dc short; if not, change the preselector. If there is a dc short between Z3 and Z5, remove capacitor C5 and increase the rf generator output level to 10 mV. Measure the noise level using an rf voltmeter with a high impedance probe at mixer module U1, pin 6 (three-cell preselector filter Z3, Z4, and Z5 should be retuned for maximum level at pin 6 of U1). The difference between the input of Z3 and the level at pin 6 of U1 should be less than 6 dB (6 dB loss). If greater than 6 dB, unsolder the tap from pin 6 of U1 and remeasure the level at the tap of preselector cell Z5. If still greater than 6 dB (6 dB loss), remove both mixer module U1 and the preselector and replace the preselector (preselector is bad, mixer module U1 is good). If less than 6 dB (6 dB loss) change mixer module U1.

(8) If the front end takeover measurement in step (7) is the same as in step (4), enable the injection signal by either replacing the channel element removed in step (7) or disconnecting the 0.01 uF capacitor from pin 6 of injection module U8 to ground. Check the rf level at the junction of R6 and Z7 with an rf voltmeter and a high impedance probe. If the level is less than -6 dBm, check "Injection RF Levels" in this section. If the level is -6dBm or greater, check for a "cold" solder joint on pin 5 of mixer module U1 (inside preselector housing, top of module — refer to "Disassembly" section to gain access to mixer module U1).

(9) The taps of Z7 and Z6 must be dc shorts; if not, the preselector is bad.

(10) Disable the injection signal by removing the channel element corresponding to the frequency selector switch setting (CE1/F1, CE2/F2, etc.), or disable the injection signal by connecting a 0.01 uF capacitor from pin 6 of injection module U8 to ground. Connect a coaxial cable to the junction of R6 and Z7 and the other end to an rf generator. Set the rf generator output level to 10 mV. The frequency of the signal must set to $8f_o$ (17.9 MHz lower than the carrier frequency). Check the level at pin 5 of the mixer module U1 with an rf voltmeter and a high impedance probe (two-cell preselector filter Z7 and Z6 should be retuned for maximum level at pin 5 of U1). The difference between the junction of R6 and Z7 should be less than 8 dB (8 dB loss). If greater than 8 dB, unsolder the cell Z6 tap from pin 5 of U1 and remeasure the level at the tap of preselector cell Z6. If the loss is still greater than 8 dB, remove both mixer module U1 and the preselector and replace the preselector (preselector is bad, mixer module U1 is good). If less than 8 dB (8 dB loss) change mixer module U1.

(11) Remove all ac shorts and coaxial cables used in making measurements.

10. INJECTION RF LEVELS (VHF and UHF Models)

All measurements are to be made with an rf voltmeter and a high impedance probe (Motorola S-1339 or S-1340).

a. VHF Radios

(1) Check the dc voltage at M2 (approximately +0.8 volt dc). If not correct, examine circuitry for shorts or opens. Replace Q2.

(2) Check channel element frequency.

(3) Check the output of the channel element (pin 5). If it is less than -10 dB, check the channel element dc voltages. Change the channel element if defective.

(4) Check the dc voltage at pin 5 of the channel element with a channel element known to be good (approximately 5.5 volts dc). If not correct, check the circuitry. Replace U8 if defective.

(5) Check the output of injection module U8 (pin 5). If it is less than 0 dBm, check U8 voltages. Check L6, L7, and associated parts. Replace U8 if it is defective.

b. UHF Radios

(1) Check the channel element frequency.

(2) Check the output of the channel element (pin 5). If less than -10 dBm, check the dc voltages on the channel element. Change the channel element if defective.

(3) Check the input to injection module U8, pin 3. If it is less than -10 dBm, check continuity of pin 7 of J2/P2.

(4) Check the doubler coil input to injection module U8, pin 5. If it is less than +6 dBm, check L4 and C7. Injection module U8 should be Motorola part number 5105177D16 for 450 MHz to 482 MHz and part number 5105177D36 for 482 MHz to 512 MHz. Change U8 if the wrong one is in place or it is defective.

(5) Check the output of injection module U8, pin 6. If it is less than +5 dBm, check the tuning of L4.

(6) Check the times-four multiplier (CR2 step-recovery diode output at the junction of CR2 and R6. If it is less than 0 dBm, check CR2 and R6.

(7) Check the input to preselector cell Z7. If it is less than -6 dBm, check R6.

11. SQUELCH (VHF and UHF Models)

a. Squelch Will Not Open

(1) Check squelch module U5, pin 5. There should be no dc voltage; if a dc voltage is present, check C203. If no ac voltage is present, check i-f detector module U4, pin 3; if still no ac voltage is measured, check the sensitivity of i-f detector module U4 (refer to paragraph 6.h.). Check C203 and R201.

(2) The ac voltage to squelch module U5, pin 5, should vary with rotation of squelch control R201. If it does not, check the dc resistance of the control.

b. Radio Will Not Squelch

The ac voltage to squelch module U5, pin 5, should vary with rotation of squelch control R201. If it does not, check the dc resistance of the control. The dc voltage at pin 3 of squelch module U5 should change one volt with rotation of the squelch control. If it does not, replace C24 (VHF) or C17 (UHF). Check the polarity of CR2 (VHF) or CR3 (UHF). If it still does not change one volt, replace squelch module U5.

c. Radio "Pops"

Check C25 in audio output circuit.

d. Chatter in Radio

Check R12 and C29 (VHF) or R11 and C19 (UHF).

e. Audio Changes Tone When Squelch Control Is Rotated

Squelch control is wired wrong.

12. TRANSMITTER HAS NO POWER OUTPUT

a. Low Band Radios

(1) Check the dc voltage at TP101 (-0.5 volt dc). If there is no dc voltage at TP101, continue with step 12.a.(2). If at least -0.4 volt dc is present, continue with step 12.a.(7).

(2) Check the collector of Q101 for an rf output. If the output is present, proceed to step 12.a.(4).

(3) If Q101 has no output, check the dc voltages at the device (refer to the schematic diagram in the service manual for typical dc readings). Check the varactor cathode for 3.9 volts dc. Check for continuity between the varactor and the crystal (Y201). Also test for continuity between the base of Q101 and crystal Y201.

(4) Check the emitter of Q102 and the collector of Q103 for rf voltage outputs. If the output is present, proceed to step 12.a.(6).

(5) If Q102 or Q103 have no output, check the dc voltages at the devices. Check the rf input to the base. Also check the associated parts for damage. If the preceding tests yield negative results, replace the device.

(6) Check the resistance to ground at TP101. Test the secondary of T101 for continuity. If this test indicates continuity, replace Q104.

(7) Check the supply current. The reading should indicate greater than 190 mA. If the current is satisfactory, proceed to step 12.a.(9).

(8) If the current from the supply is approximately 100 mA, check rf choke L104. If the current is 60 mA, replace Q104.

(9) Check the base of Q105 for an rf voltage input. If no rf voltage is present, check for damaged parts between Q105 base to Q104 collector. Also check for opens or shorts.

(10) Check the collector of Q105 for an rf voltage output. If there is no rf output, check the dc voltage on the collector. If 15 volts dc is present, replace Q105.

(11) If rf voltage is present at the collector of Q105 but not at the antenna jack, follow the signal path with an rf diode probe. If rf voltage is low, inspect the area for shorts or opens. Check the coaxial cable for shorts or opens. Also check the antenna jack for an open circuit.

b. VHF Radios

(1) Check dc voltage at metering point M101 (-0.5 volt dc). If there is no dc voltage at M101, continue with step 12.b.(2). If -0.5 volt dc is present, continue with step 12.b.(7).

(2) Check pin 4 of buffer-tripler U10. The voltage should read -0.7 volt dc if the oscillator and buffer-tripler are functioning properly (amount of negative voltage present is dependent on amount of oscillator drive; meter will read +0.7 volt dc if no drive is present).

(3) If no drive is present, check the oscillator for an rf output (+6 dBm rf, typical value when measured with rf voltmeter). Check the buffer-tripler (U10) dc voltages.

(4) If the voltage is negative at pin 4 of U10, check for transmit 12.3 volts dc on the collector of Q101, and check for 7.5 volts dc on pins 2 and 6 of buffer-tripler U10 and channel element pins 4 and 5. Also check pin 2 of the channel element for zero volts (a dc voltage on the varactor could cause the oscillator not to oscillate).

(5) Check the parts between buffer-tripler U10, pin 6, and the base of Q101 (an rf diode probe may be useful in detecting signal loss due to shorts or open circuits.

(6) Check the Q101 junction resistances. To check the base-emitter junction, use the X10 scale.

(7) If the voltage at meter point M101 is -0.5 volt dc, remove transmit PA U12 and tune the L104 coil for peak current. If everything is working properly up to pin 1 of transmit PA module U12, the radio will draw between 120 mA and 150 mA.

(8) Check transmit PA U12 input, pin 1, for rf voltage (≈ 16 volts rf). If no rf voltage is present, check dc voltages of driver Q102 collector (15 volts dc) and base (zero volts dc).

(9) Check for wrong parts, damaged parts, and shorts or opens between the Q101 collector and the Q102 base. Follow the signal path with an rf diode probe.

(10) If rf voltage is present at the transmit PA U12 input, check for rf voltage at the transmit PA output, pin 5 (≈ 10 volts rf). If no rf voltage is present at the transmit PA output, check the voltages on pins 1, 2, 3, and 5. If dc voltages are correct, tune the trimmer capacitor. If the current does not change, replace the transmit PA module with another transmit PA module that is known to be good.

(11) If rf voltage is present at the transmit PA output, pin 5, but not at the antenna jack, check coaxial cable shorts and opens. Also, check C212 for proper value and damage, and check the antenna jack for continuity.

NOTE

Radio does not draw same current on antenna as into 50-ohm load at antenna jack.

(12) If rf voltage is present at the antenna jack but not at the antenna, check the rf voltage at the accessory connector of the "BBU" Series radio and check for continuity through the connector.

c. UHF Radios

(1) Check the dc voltages at metering point M101. The voltage should read approximately 1.7 volts dc if the oscillator, buffer-tripler, and second tripler transistor are functioning properly. The amount of voltage at M101 is dependent on the amount of drive at the base of Q102. If the dc voltage at M101 is less than 1.5 volts dc, continue with step 12.c.(2). If 1.5 volts dc to 2.2 volts dc is present, continue with step 12.c.(8).

(2) Check pin 4 of buffer-tripler U10. The voltage should read approximately -0.5 volt dc if the oscillator, buffer, and the first tripler transistor are functioning properly. The amount of negative voltage present is dependent on the amount of oscillator drive; the meter will read +0.7 volt dc if no drive is present. If the voltage at pin 4 is zero volts dc to +0.7 volt dc, continue with step 12.c.(3). If the voltage at pin 4 is zero volts dc to -0.5 volt dc, continue with step 12.c.(5).

(3) Check the oscillator for rf output (700 mV rf is a typical value measured with a Motorola Model S1339 RF Millivoltmeter). If less than 500 mV rf is measured, check the dc voltage of the oscillator. If the dc voltages are correct, substitute another known good oscillator.

(4) If the rf output voltage of the oscillator is correct, check the dc voltages of buffer-tripler U10. Also check C103 for correct value.

(5) If the voltage is negative at pin 4 of U10, check for 15 volts dc on the collector of Q102.

(6) Check Q102 junction resistances. To check the base-emitter junction, use the x1 scale on the meter or remove L105.

(7) Check parts between buffer-tripler U10, pin 6, and the base of Q102, and also check R104 and C115 (an rf diode probe may be useful in detecting signal loss caused by shorts or open circuits).

(8) If the voltage at metering point M101 is between 1.5 and 2.2 volts dc, remove transmit PA module U12 and tune second tripler coils L109 and L110 for peak current. If everything is working properly up to pin 1 of transmit PA module U12, the radio will draw approximately 110 mA for "BBB" Series radios and approximately 120 mA for "BBU" Series radios.

(9) Check the transmit PA U12 input, pin 1, for rf voltage (approximately 3 volts rf). This measurement should be made with the PA removed, using an rf millivoltmeter (Motorola Model S1339A) and a 50-ohm adapter connected through a coaxial cable to the power amplifier input. Tune C132 for maximum rf voltage. If less than 3 volts rf is present, continue with step 11.b.(10). If rf voltage is correct, continue with step 11.b.(13).

(10) Check the dc voltages at the collector (15 volts dc) and the base (zero volts dc) of driver Q103.

(11) Check Q103 junction resistances. To check the base-emitter junction, use the x1 scale or remove L116.

(12) Check for wrong parts, damaged parts, and shorts or opens between the collector of Q102 and the PA input pin 1. Follow the signal path with an rf diode probe for "go, no-go" type measurements.

(13) If 3 volts rf is present at the transmit PA U12 input, check for rf voltage at the transmit PA output, pin 5. If no rf voltage is present at the transmit PA module output, check the dc voltages on pins 1, 2, and 5 (pin 4 not used). If the dc voltages are correct, replace the transmit PA module with another transmit PA module that is known to be good.

(14) If rf voltage is present at the transmit PA output, pin 5, but not at the antenna jack, check the coaxial cable for shorts and opens. Check C26 for the proper value or damage. Check the antenna jack for continuity.

(15) If rf voltage is present at the antenna jack, but not at the antenna, check the rf voltage at the accessory connector of the "BBU" Series radio and check continuity through the connector. Check antenna matching parts L203, C217, and C218 for proper value, shorts, damage, etc.

13. TRANSMITTER HAS LOW POWER OUTPUT

a. Low Band Radios

(1) Tune the radio for maximum power output. Check metering point TP101 for -0.5 volt dc Low voltage indicates insufficient rf drive from the transmitter front end.

(2) If the voltage at TP101 is -0.5 volt dc or greater, check the rf readings on Q104 and Q105. If the readings are low, check the immediate area for damaged capacitors or defective rf bypass chokes. Inspect the low-pass filter located on the interconnect board for damaged parts. Also check the coaxial cable between C224 and the antenna jack. These parts are critical to maintain a good standing-wave-ratio between the transmitter and the antenna jack.

b. VHF Radios

(1) Check if meter point M101 is low (less than -0.5 volt dc). Low voltage means low drive from the transmitter front end.

(2) Replace transmit PA U12 with another that is known to be good. Check transmit PA U12 input, pin 1, for rf voltage (approximately 5 volts rf). This measurement should be made with the PA removed, using an rf millivoltmeter (Motorola Model S1339A) and a 50-ohm adapter connected through a coaxial cable and in-series 100 pF capacitor to the power amplifier input pin. If the rf drive is about 5 volts and a known-good transmit PA still has a low power output, look for wrong parts, damaged parts, and bad coaxial cable between the transmit PA module and the

antenna jack. These parts are critical to maintain a good standing-wave-ratio between the transmit PA and the antenna jack.

c. UHF Radios

(1) Check if meter point M101 is low (less than 1.5 volts dc). Low voltage means low drive from the transmitter front end.

(2) Replace transmit PA U12 with another that is known to be good. Check transmit PA U12 input, pin 1, for rf voltage (approximately 3 volts rf). This measurement should be made with the PA module removed, using an rf millivoltmeter (Motorola Model S1339A) and a 50-ohm adapter connected through a coaxial cable to the power amplifier input. Tune C132 for maximum rf voltage. If the rf drive at pin 1 of the PA is approximately 3 volts rf and the known-good transmit PA module still has low power output, look for wrong parts, damaged parts, or a bad coaxial cable between the transmit PA module and the antenna jack. These parts are critical to maintain a good standing-wave-ratio between the transmit PA and the antenna jack.

14. TRANSMITTER CURRENT DRAIN

The following tables reflect the nominal current drain for a properly functioning radio. (Tables 10, 11, and 12).

Table 10. Nominal Current Drains for Low Band Radios

STAGE	NOMINAL DRAIN	NOTES
Relay	22 mA	"BBU" Series radio only
Regulator	1.5 mA	Internal standby drain
Regulator	60 mA	With output shorted to ground
IDC	8 mA	
Oscillator	8 mA	
Tripler	14 mA	With proper RF drive
Predriver	24 mA	With proper RF drive
Driver	130 mA	With proper RF drive
6 W PA	660 mA	With proper RF drive

Table 11. Nominal Current Drains for VHF Radios

STAGE	NOMINAL DRAIN	NOTES
Relay	22 mA	"BBU" Series radio only
Regulator	1.5 mA	Internal standby drain
Regulator	60 mA	With output shorted to ground
IDC	8 mA	
Channel Element	10 mA	
Buffer-Tripler	20 mA	
Predriver	9.3 mA	
Driver	100 mA	
2.0 W PA	250 uA	Idle current with no RF drive
2.0 W PA	250 mA	With proper RF drive
5 W PA	250 uA	Idle current with no RF drive
5 W PA	800 mA	With proper RF drive

Table 12. Nominal Current Drains for UHF Radios

STAGE	NOMINAL DRAIN	NOTES
Relay	22 mA	"BBU" Series radio only
Regulator	1.5 mA	Internal standby drain
Regulator	60 mA	With output shorted to ground
IDC	8 mA	
Channel Element	10 mA	
Buffer-Tripler	18 mA	
2nd Tripler	20 mA	
Driver	45 mA	
1.5 W PA	5 mA	Idle current with no RF drive
1.5 W PA	310 mA	With proper RF drive
4 W PA	120 mA	Idle current with no RF drive
4 W PA	850 mA	With proper RF drive

15. TONE "PRIVATE-LINE" SQUELCH CIRCUIT

Refer to the squelch circuit troubleshooting diagram (Figure 38).

NOTE

"Private-Line" voltages referenced are minimum values.

Approximately 35 mV of noise is required at pin 5 of U5, the squelch module, for squelch action. With the proper input at pin 5 of U5, the output at pin 4 should be 0.7 volt dc, turning off the audio stages. The dc voltage reading at pin 4 of U5 should also change from 0.4 volt dc to 0.7 volt dc as the squelch control is rotated clockwise.

For tone "Private-Line" circuit troubleshooting, refer to the diagram for minimum tone levels. The dc voltage output at pin 5 of U501, the PL processor module, controls audio turn-off in the same manner as the noise squelch circuit. The dc voltage reading at pin 5 of U501 will also change from 0.6 volt dc to 4 volts dc as the PL is switched on. All PL tone level measurements are taken with the receiver fully quieted.

Due to module design, the dc output of U501 is 2 volts dc and the dc output of U5 is 0.7 volt dc. Because either one of these outputs can control the squelch switch circuit, a dc voltage reading at pin 3 of U7, the first audio module, will be either 4 volts dc or 0.7 volt dc when the radio is squelched.

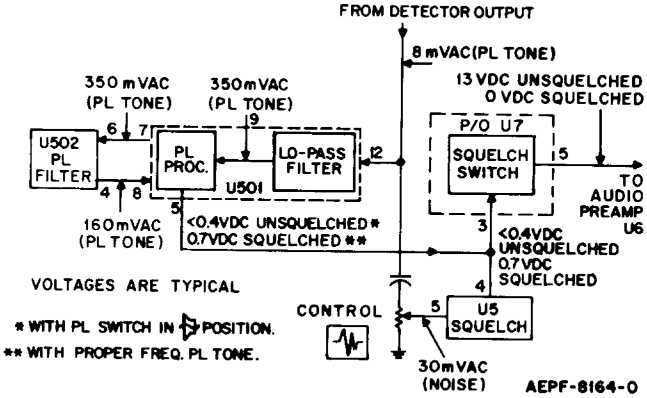
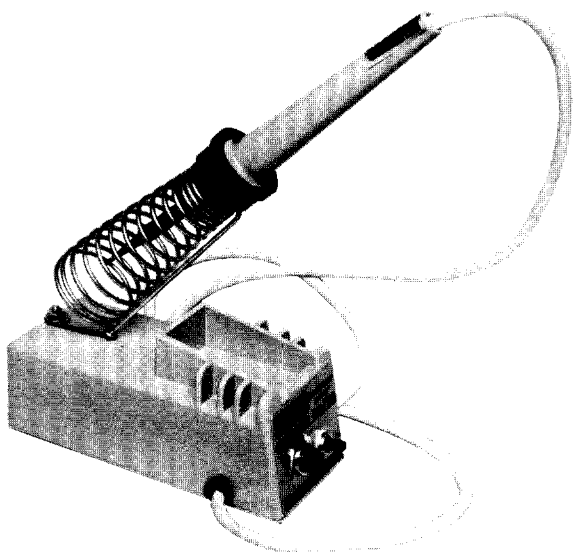


Figure 38. Squelch Circuit Troubleshooting Diagram

REPAIR

1. INTRODUCTION

Early printed circuit board repair techniques stressed the use of low wattage soldering tools to prevent board damage when components were removed. Experience has shown that the low wattage iron may actually cause printed circuit damage. A considerable amount of time is usually required to heat a connection to the melting point with a low wattage iron. During this time, heat is conducted away from the connection along the printed wiring. This conducted heat may separate the printed wiring from the board or damage nearby solder connections. The ST-1087 Soldering Station, with an 800-degree tip, is an excellent choice for printed circuit work. This iron has a temperature-controlled tip to prevent excessive heating and increase tip life.



Soldering Station (ST-1087)

Clearing circuit board holes of excess solder with a pick, as formerly recommended for some Motorola products, has been shown to cause damage to the plating in and around the hole when excessive zeal is used in applying this technique. In order to prevent this occurrence, clear holes only by solder extraction. Use the ST-1091 Solder Remover to extract molten solder. For large repair facilities, in which a volume of printed circuit boards are to be processed, consider the Pace SX300 Vacuum Solder Extractor (not available from Motorola, Inc.).

The hybrid circuit modules in this radio may be damaged by either excessive heat or lead stress. Do not remove hybrid circuits indiscriminately; carefully eliminate all other failure possibilities before removing a module. A special soldering tip for removing hybrid circuit modules is available. A clamp or stand is also available to hold the iron in the vertical position for module removal.

2. PARTS AND SUBSTITUTION

When damaged parts must be replaced, identical parts should be used. If the identical replacement component is not locally available, check the parts list of the respective printed circuit board for the proper Motorola part number and order the components from the nearest Motorola Replacement Parts Depot as listed in the "Replacement Parts Ordering" section of this instruction manual. If for any reason substitutions must be made immediately, it is recommended that the substitutions be replaced as soon as the proper replacement part is available. The substituted part must have identical electrical properties and must be of equal or higher voltage and current ratings.

3. DISCRETE COMPONENT REPLACEMENT

For removal and replacement of components other than hybrid circuits, use a circuit board holder such as the ST-458 Circuit Board Holder or equivalent so both hands can be used. Mount the circuit board in the holder and rotate the board to a convenient position. Gently grasp the component lead with a "seizer" (Motorola ST-207) or needle-nose pliers. Heat the solder connection until molten, and remove the lead from the board. Do not apply the soldering iron any longer than necessary to free the lead. After the component has been removed, prepare the board for the new component by extracting all solder from the mounting holes.

Use resin solvent and a small brush to clean this portion of the printed circuit after the excess solder has been removed. Use the leads of the defective component as a model to form the leads of the replacement. Remove insulators and spacers on the defective component and install these on the new component. Insert the new component with a slight bend on the leads at the board to prevent movement while soldering. Heat the lead and the printed circuit at the connection pad with a clean, hot, well-tinned iron. Apply solder in moderation. Use only enough to fill the hole, coat the pad, and provide a slight fillet around the component lead. Immediately remove the solder and iron when this has been accomplished. Allow time for solidification before proceeding. Do not disturb the component while the connection is cooling. After the solder has solidified, clip the lead as close to the board as possible. Clean away residue with resin solvent and a small brush. The finished connection should have a bright, mirror-like, appearance.

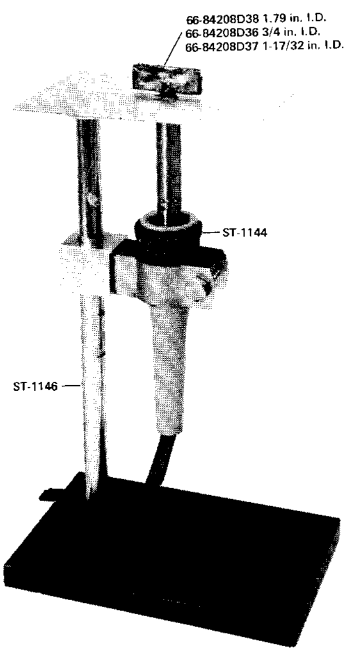
4. HYBRID MODULE REPLACEMENT

To replace hybrid circuit modules, attach the appropriate hybrid circuit tip to the soldering iron and mount the iron in the vertical position with the tip up as shown in the following figure. Apply power, and when the iron is hot enough to melt solder, feed solder into the tip. The tip is full when the molten solder forms a slightly round surface in the reservoir. Allow approximately 2 minutes for temperature stabilization before proceeding. Remove flux that may be floating on the solder by passing a pencil lightly across the surface of the solder.

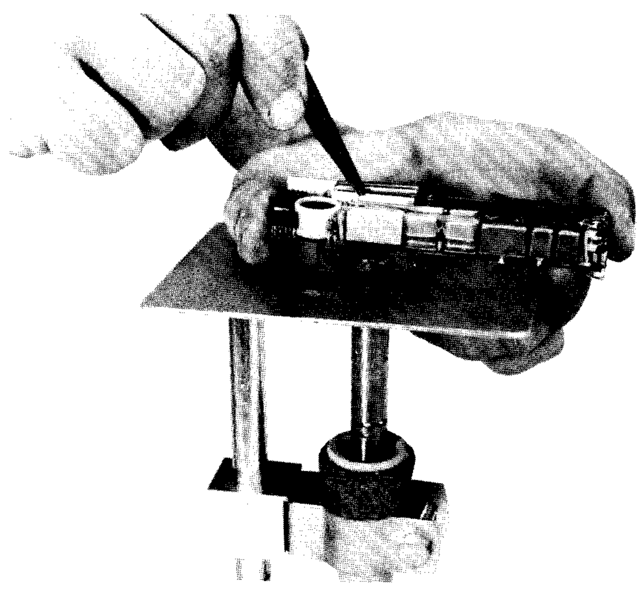
CAUTION

Check the underside of the board to be sure that all module leads are straight before attempting extraction. If any of the leads are bent, straighten these before proceeding with the removal procedure.

Position the board above the iron, as shown in the figure so that the tip indexes all of the printed circuit connections for the module to be removed. Place the board on the tip, allow time for the solder to melt (approximately 2 seconds) and gently "wiggle" the module from side to side. When the module "wiggles" freely, lift it straight out of the board and immediately remove the board from the soldering iron. Do not use excessive force to remove a module; if the unit cannot be lifted easily, some of the connections are probably not free. Check to make sure that all of the module connections are in contact with the molten solder in the tip of the iron when the board is placed on the tip. When the module has been removed, prepare the board as outlined in preceding paragraph. Use special care to ensure that excess solder is extracted from all of the mounting holes. This will help assure trouble-free insertion of the new module. Carefully insert the new module. When the module is fully inserted and evenly seated on the board, solder each lead.



Soldering Iron and Stand For Hybrid Module Removal



Typical Hybrid Module Extraction

END OF DOCUMENT