MOTOROLA

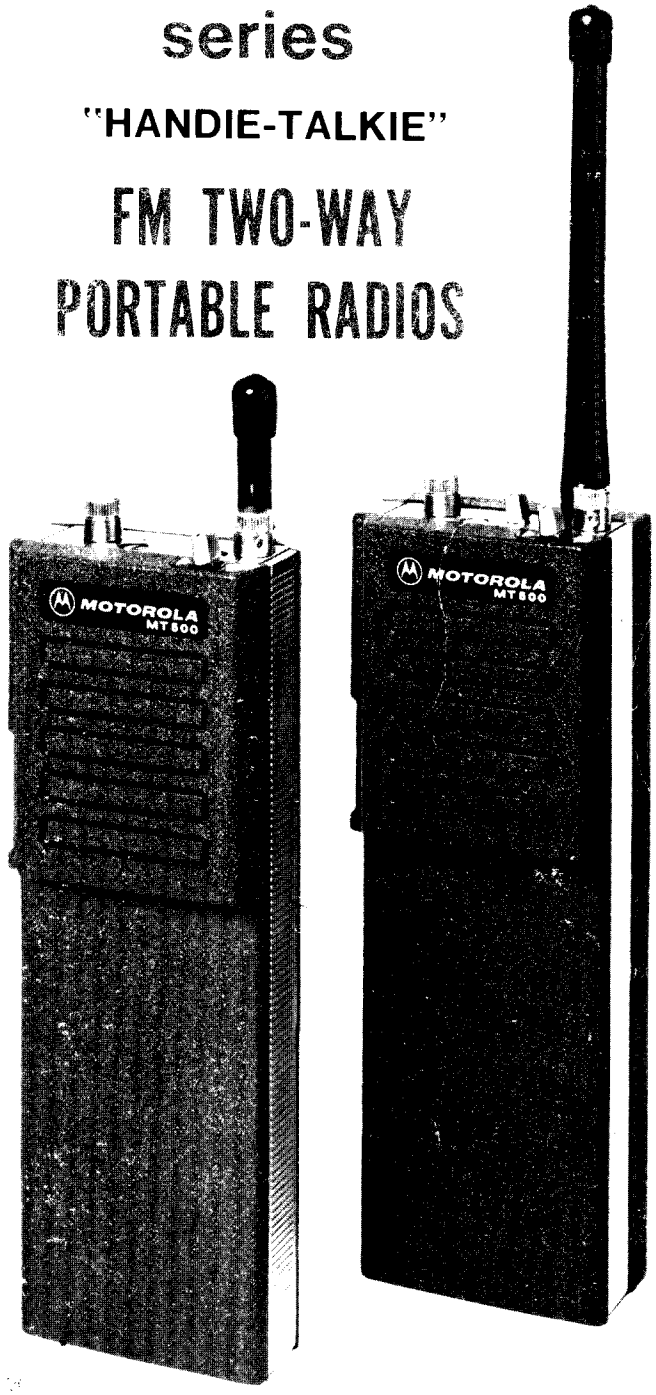
NOTE: This manual covers only VHF and UHF models. Low-band models are included in the later 68P81012C55-B manual, which is available on the RBTIP.

MT500

series

"HANDIE-TALKIE"

FM TWO-WAY PORTABLE RADIOS



68P81012C55-A

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NOTE: Every one of the below-listed publications has been discontinued.

SEPARATE PUBLICATIONS

The following related publications were shipped with the radio. Extra copies can be ordered from your local Parts Depot.

Service Supplements (includes schematic diagrams, parts lists, and other servicing information)	VHF - 68P81012C56 UHF - 68P81012C58
Operator's Booklet	68P81012C50
Time-Out Timer Service Information Sheet	68P81013C45
Transmit-Only Digital PL Service Information Sheet	68P81013C50
Single-Tone Service Information Sheet	68P81013C55
Selective Call —	
(BBB' Series) Service Information Sheet	68P81013C60
(BBU' Series) Service Information Sheet	68P81014C40
Unit ID & Unit ID with Emergency Call Service Information Sheet	68P81013C65

MOTOROLA INC.
ENGINEERING PUBLICATIONS

Communications Products Division
8000 W. SUNRISE BOULEVARD, FT. LAUDERDALE, FLORIDA 33322

68P81012C55
Issue-A

VHF RADIO PERFORMANCE SPECIFICATIONS

General

Model Series:	H23BBB' and H33BBB'				H23BBU' and H33BBU'	
Frequency:	150.8 - 174 MHz				136 - 174 MHz	
Power Supply:	One rechargeable nickel-cadmium battery or one mercury battery					
	"OMNI"				"SLIM-LINE"	
Dimensions: less antenna & knobs (H x W x D in inches):	SHORT		EXTENDED		SHORT	EXTENDED
	6.97 x 2.73 x 1.85 (177 x 69 x 47 mm)		7.62 x 2.73 x 1.85 (193 x 69 x 47 mm)		6.97 x 2.73 x 1.59 (177 x 69 x 40 mm)	7.62 x 2.73 x 1.59 (193 x 69 x 40 mm)
	5W	2W	5W	2W	2W	2W
Weight (ounces) Nickel-Cadmium Battery:	25.3 (717g)	24.9 (706g)	25.9 (734g)	25.5 (723g)	19.9 (564g)	20.4 (578g)
Mercury Battery:	26.8 (760g)	26.4 (748g)	27.4 (777g)	27.0 (766g)	20.9 (593g)	21.4 (607g)
Battery Life (hours)						
Nickel-Cadmium Battery:	8	14 or 9*	8	14 or 9*	8	8
Mercury Battery:	25	30*	25	30*	18	18

*10 - 10 - 80 duty cycle - all others have a 5 - 5 - 90 duty cycle

Transmitter

RF Output Nickel-Cadmium @15.0 V:	5.0 W	2.0 W
Mercury @12.7 V ("omni"):	2.5 W	1.0 W
@ 12.0 V ("slim-line"):		0.8 W
Channel Spacing:	30 kHz (25 kHz international)	
Frequency Separation:	1 MHz full specification to 5.5 MHz with reduced specifications	
Frequency Stability: (-30° to 60° C:	±.0005%	±.0010%.
25° ref)		±.0005%*
Modulation:	16F3	
Spurious & Harmonics:	-50 dB	
FM Noise:	-55 dB	
Audio Response: (from a 6 dB/octave pre-emphasis; 300 to 3000 Hz)	+1, -3 dB	
Audio Distortion: (@1000 Hz, 60% rated max. deviation)	Less than 3%	
FCC Designation:	CC3288 "BBB" CC3289 "BBU"	CC3286 "BBB" CC3287 "BBU"

* Optional

Receiver

	Standard	Protected Receiver Option †
Channel Spacing:	30 kHz (25 kHz international)	
Modulation Acceptance:	+7 kHz	
Frequency Separation:	1 MHz full specification. to 5.5 MHz with reduced specifications	
Sensitivity		
20 dB Quieting:	.35 uV	.50 uV
12 dB SINAD:	.25 uV	.35 uV
Squelch:	.18 uV	.25 uV
Selectivity: (EIA SINAD)	-80 dB**	-85 dB **
Intermodulation:	-70 dB	-80 dB
Frequency Stability: (-30° to +60° C;	±.0010%	
25° C ref)	±.0005%*	
Spurious & Image Rejection:	-75 dB	-80 dB
Audio Output: (@ less than 5% dist.)	500 mW	
FCC Designation:	RC0149	RC0175

* Optional
** For international 25 kHz channel spacing, the selectivity is -75 dB
† "BBU" Model

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

UHF RADIO PERFORMANCE SPECIFICATIONS

General

Model Series:	H24BBU', H24BBB', H34BBU', H34BBB'						
Frequency:	450 - 512 MHz						
Power Supply:	One rechargeable nickel-cadmium battery or one mercury battery						
Dimensions: less antenna & knobs (H x W x D in inches):	"OMNI"				"SLIM-LINE"		
	SHORT		EXTENDED		SHORT	EXTENDED	
	6.97 x 2.73 x 1.85 (177 x 69 x 47 mm)		7.62 x 2.73 x 1.85 (193 x 69 x 47 mm)		6.97 x 2.73 x 1.59 (177 x 69 x 40 mm)	7.62 x 2.73 x 1.59 (193 x 69 x 40 mm)	
Weight (ounces)	4W	1.5W	4W	1.5w	1.5W	1.5W	
Nickel-Cadmium Battery:	25.3 (717g)	24.9 (706g)	25.9 (734g)	25.5 (723g)	19.9 (564g)	20.4 (578g)	
Mercury Battery:	26.8 (760g)	26.4 (748g)	27.4 (777g)	27.0 (766g)	20.9 (593g)	21.4 (607g)	
Battery Life (hours)							
Nickel-Cadmium Battery:	8	14 or 9*	8	14 or 9*	8	8	
Mercury Battery:	25	30*	25	30*	18	18	

*10 - 10 - 80 duty cycle - all others have a 5 - 5 - 90 duty cycle

Transmitter

RF Output		
Nickel-Cadmium @15.0V:	4 W	1.5 W
Mercury @12.7 V (omni):	2 W	1.0 W
@12.0 V (slim-line):		0.7 W
Frequency Separation:	6 MHz full specification. to 8.0 MHz with reduced specifications	
Frequency Stability- (-30° to +60° C: 25° C ref)	+.0005%	
Modulation:	16F3	
Spurious & Harmonics:	-50 dB	
FM Noise:	-55 dB	
Audio Response: (from a 6 dB/octave pre-emphasis: 300 to 3000 Hz)	+1, -3 dB	
Audio Distortion: (@1000 Hz, 60% rated max. deviation)	Less than 3%	
FCC Designation:	CC4254 "BBU" CC4253 "BBB"	CC4252 "BBU" CC4251 "BBB"

Receiver

Channel Spacing:	25 kHz
Modulation Acceptance	+7.5 kHz
Frequency Separation:	1 MHz full specification to 2 MHz with reduced specifications
Sensitivity	
20 dB Quieting:	.50 uV
12 dB SINAD:	.35 uV
Squelch:	.25 uV
Selectivity:	-70 dB
(EIA SINAD)	-75 dB*
Intermodulation:	-70 dB
Frequency Stability: (-30% to +60%C; 25%C ref)	+.0005%
Spurious & Image Rejection:	-70/60 dB
Audio Output: (@less than 5% dist.)	500 mW
FCC Designation:	RC0150

*Optional

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

FOREWORD

SCOPE OF INSTRUCTION MANUAL

This manual offers descriptive data and service information for the equipment listed. Service diagrams, parts lists, and printed circuit board details are also part of this instruction manual.

NOMENCLATURE

Motorola equipment is specifically identified by the model number on the nameplate.

NOTE

Be sure to use the entire model number when making inquiries about your equipment.

Identifiers have been assigned to chassis and kits. Use these identifiers when requesting information or ordering replacements.

PRODUCTION CHANGES

When production and engineering changes are incorporated into the equipment, a revision number is assigned to the chassis or kit affected; -1, -2, -3, etc.

The chassis number complete with revision number, if any, is stamped on the chassis at the time of production. The revision number becomes an integral part of the chassis identifier. Revisions, if any, are listed on the schematic diagram.

INSTRUCTION MANUAL REVISIONS

Changes which occur after an instruction manual is printed are described in the Instruction Manual Revision. These bulletins give the reader complete information on the change including pertinent parts listing data.

NATIONAL SERVICE ORGANIZATION

Motorola provides a nation-wide service organization. Through its maintenance and installation program, Motorola makes available the finest service to those desiring reliable continuous communications on a contract basis.

Motorola's National Service Organization is the largest service organization specializing in mobile communications. It includes over 800 independently owned and operated service stations, strategically located and manned by a force of several thousand FCC licensed personnel.

The area administrative forces, district service managers and district service representatives are in the direct employ of Motorola.

For your contract service requirements, please contact your local Motorola representative or write to:

National Service Manager
Motorola Communications Division
1301 Algonquin Road, Schaumburg, Illinois 60172

CAREFUL USE OF THIS INSTRUCTION MANUAL AND THE MANY SUGGESTIONS CONTAINED IN IT WILL FURTHER INSURE PROPERLY INSTALLED AND MAINTAINED EQUIPMENT. REFER ANY QUESTIONS CONCERNING THIS MANUAL TO THE ENGINEERING PUBLICATIONS DEPARTMENT AT THE ADDRESS SHOWN ON THE TITLE PAGE.

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

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

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
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
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

EPF-8110-A

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

MODEL	RF OUTPUT POWER	TYPE OF SQUELCH	NUMBER OF CHANNELS	* SIZE	DUTY CYCLE
H23BBU1111A	2 W	Carrier	1	SS	5 5 90
H23BBU1112A	2 W	Carrier	1	SE	5 5 90
H23BBU1113A	2 W	Carrier	1	OS	10 10 80
H23BBU1114A	2 W	Carrier	1	OE	10 10 80
H23BBU1121A	2 W	Carrier	2	SS	5 5 90
H23BBU1122A	2 W	Carrier	2	SE	5 5 90
H23BBU1123A	2 W	Carrier	2	OS	10 10 80
H23BBU1124A	2 W	Carrier	2	OE	10 10 80
H23BBU1143A	2 W	Carrier	4	OS	10 10 80
H23BBU1144A	2 W	Carrier	4	OE	10 10 80
H23BBU1164A	2 W	Carrier	6	OE	10 10 80
H23BBU1184A	2 W	Carrier	8	OE	10 10 80
H23BBU3112A	2 W	Tone "PL"	1	SE	5 5 90
H23BBU3113A	2 W	Tone "PL"	1	OS	10 10 80
H23BBU3114A	2 W	Tone "PL"	1	OE	10 10 80
H23BBU3122A	2 W	Tone "PL"	2	SE	5 5 80
H23BBU3123A	2 W	Tone "PL"	2	OS	10 10 80
H23BBU3124A	2 W	Tone "PL"	2	OE	10 10 80
H23BBU3143A	2 W	Tone "PL"	4	OS	10 10 80
H23BBU3144A	2 W	Tone "PL"	4	OE	10 10 80
H23BBU3164A	2 W	Tone "PL"	6	OE	10 10 80
H23BBU3184A	2 W	Tone "PL"	8	OE	10 10 80
H23BBU6112A	2 W	Digital "PL"	1	SE	5 5 90
H23BBU6114A	2 W	Digital "PL"	1	OE	10 10 80
H23BBU6122A	2 W	Digital "PL"	2	SE	5 5 90
H23BBU6124A	2 W	Digital "PL"	2	OE	10 10 80
H23BBU6144A	2 W	Digital "PL"	4	OE	10 10 80
H23BBU6164A	2 W	Digital "PL"	6	OE	10 10 80
H23BBU6184A	2 W	Digital "PL"	8	OE	10 10 80
H33BBU1113A	5 W	Carrier	1	OS	5 5 90
H33BBU1114A	5 W	Carrier	1	OE	5 5 90
H33BBU1123A	5 W	Carrier	2	OS	5 5 90
H33BBU1124A	5 W	Carrier	2	OE	5 5 90
H33BBU1143A	5 W	Carrier	4	OS	5 5 90
H33BBU1144A	5 W	Carrier	4	OE	5 5 90
H33BBU1164A	5 W	Carrier	6	OE	5 5 90
H33BBU1184A	5 W	Carrier	8	OE	5 5 90
H33BBU3113A	5 W	Tone "PL"	1	OS	5 5 90
H33BBU3114A	5 W	Tone "PL"	1	OE	5 5 90
H33BBU3123A	5 W	Tone "PL"	2	OS	5 5 90
H33BBU3124A	5 W	Tone "PL"	2	OE	5 5 90
H33BBU3143A	5 W	Tone "PL"	4	OS	5 5 90
H33BBU3144A	5 W	Tone "PL"	4	OE	5 5 90
H33BBU3164A	5 W	Tone "PL"	6	OE	5 5 90
H33BBU3184A	5 W	Tone "PL"	8	OE	5 5 90
H33BBU6114A	5 W	Digital "PL"	1	OE	5 5 90
H33BBU6124A	5 W	Digital "PL"	2	OE	5 5 90
H33BBU6144A	5 W	Digital "PL"	4	OE	5 5 90
H33BBU6164A	5 W	Digital "PL"	6	OE	5 5 90
H33BBU6184A	5 W	Digital "PL"	8	OE	5 5 90

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), XMT (162-174 MHz)
NUD6292A	TRANSMITTER-RECEIVER BOARD; RCVE (162-174 MHz), XMT (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
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
NLN4191A	ESCUTCHEON; C4R4
NLN4643A	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; C2R2
NLN4573A	CHANNEL ELEMENT DECK, C8R8
NFN6010A	ACTIVE FILTER
NLN4211A	TONE "PL" DECK; EXTENDED FRAME
NLN4645A	TONE "PL" DECK; SHORT FRAME
NLN4212A	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)
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

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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		
H24BBB1111A	1.5 W	Carrier	1	SS	5	5	90
H24BBB1112A	1.5 W	Carrier	1	SE	5	5	90
H24BBB1113A	1.5 W	Carrier	1	OS	10	10	80
H24BBB1114A	1.5 W	Carrier	1	OE	10	10	80
H24BBB1121A	1.5 W	Carrier	2	SS	5	5	90
H24BBB1122A	1.5 W	Carrier	2	SE	5	5	90
H24BBB1123A	1.5 W	Carrier	2	OS	10	10	80
H24BBB1124A	1.5 W	Carrier	2	OE	10	10	80
H24BBB1143A	1.5 W	Carrier	4	OS	10	10	80
H24BBB1144A	1.5 W	Carrier	4	OE	10	10	80
H24BBB1164A	1.5 W	Carrier	6	OE	10	10	80
H24BBB1184A	1.5 W	Carrier	8	OE	10	10	80
H24BBB3112A	1.5 W	Tone "PL"	1	SE	5	5	90
H24BBB3113A	1.5 W	Tone "PL"	1	OS	10	10	80
H24BBB3114A	1.5 W	Tone "PL"	1	OE	10	10	80
H24BBB3122A	1.5 W	Tone "PL"	2	SE	5	5	90
H24BBB3123A	1.5 W	Tone "PL"	2	OS	10	10	80
H24BBB3124A	1.5 W	Tone "PL"	2	OE	10	10	80
H24BBB3143A	1.5 W	Tone "PL"	4	OS	10	10	80
H24BBB3144A	1.5 W	Tone "PL"	4	OE	10	10	80
H24BBB3164A	1.5 W	Tone "PL"	6	OE	10	10	80
H24BBB3184A	1.5 W	Tone "PL"	8	OE	10	10	80
H34BBB1113A	4 W	Carrier	1	OS	5	5	90
H34BBB1114A	4 W	Carrier	1	OE	5	5	90
H34BBB1123A	4 W	Carrier	2	OS	5	5	90
H34BBB1124A	4 W	Carrier	2	OE	5	5	90
H34BBB1143A	4 W	Carrier	4	OS	5	5	90
H34BBB1144A	4 W	Carrier	4	OE	5	5	90
H34BBB1164A	4 W	Carrier	6	OE	5	5	90
H34BBB1184A	4 W	Carrier	8	OE	5	5	90
H34BBB3113A	4 W	Tone "PL"	1	OS	5	5	90
H34BBB3114A	4 W	Tone "PL"	1	OE	5	5	90
H34BBB3123A	4 W	Tone "PL"	2	OS	5	5	90
H34BBB3124A	4 W	Tone "PL"	2	OE	5	5	90
H34BBB3143A	4 W	Tone "PL"	4	OS	5	5	90
H34BBB3144A	4 W	Tone "PL"	4	OE	5	5	90
H34BBB3164A	4 W	Tone "PL"	6	OE	5	5	90
H34BBB3184A	4 W	Tone "PL"	8	OE	5	5	90

KIT NUMBER	DESCRIPTION
NUE6242A	TRANSMITTER-RECEIVER BOARD (450-482 MHz)
NUE6243A	TRANSMITTER-RECEIVER BOARD (482-512 MHz)
NUE6292A	TRANSMITTER-RECEIVER BOARD (450-482 MHz)
NUE6293A	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
NHE6041A	FRAME, C1R1, SHORT
NHE6051A	FRAME, C1R1, EXTENDED
NHE6061A	FRAME, C6R6, EXTENDED
NHE6071A	FRAME, C8R8, EXTENDED
NHE6111A	FRAME, C2R2, SHORT
NHE6121A	FRAME, C2R2, EXTENDED
NHE6131A	FRAME, C4R4, SHORT
NHE6141A	FRAME, C4R4, 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
NLN4191A	ESCUTCHEON; C8R8
NLN4643A	ESCUTCHEON; C4R4
NLE8362A	1.5-WATT POWER AMPLIFIER (450-482 MHz)
NLE8363A	1.5-WATT POWER AMPLIFIER (482-512 MHz)
NLE8372A	4-WATT POWER AMPLIFIER (450-482 MHz)
NLE8373A	4-WATT POWER AMPLIFIER (482-512 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
NLN4644A	TONE "PL" DECK
NLN4646A	TONE "PL" DECK
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)
NLE8521A	INTERCONNECT BD ELECTRICAL HARDWARE (482-512 MHz)
NAE6050A	ANTENNA, FLEX
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

EPF-8111-A

"BBU" 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	KIT NUMBER	DESCRIPTION
H24BBU1111A	1.5 W	Carrier	1	SS	5 5 90	NUE6232A	TRANSMITTER-RECEIVER BOARD (450-482 MHz)
H24BBU1112A	1.5 W	Carrier	1	SE	5 5 90	NUE6233A	TRANSMITTER-RECEIVER BOARD (482-512 MHz)
H24BBU1113A	1.5 W	Carrier	1	OS	10 10 80	NUE6282A	TRANSMITTER-RECEIVER BOARD (450-482 MHz)
H24BBU1114A	1.5 W	Carrier	1	OE	10 10 80	NUE6283A	TRANSMITTER-RECEIVER BOARD (482-512 MHz)
H24BBU1121A	1.5 W	Carrier	2	SS	5 5 90	NUE6312A	TRANSMITTER-RECEIVER BOARD (450-482 MHz)
H24BBU1122A	1.5 W	Carrier	2	SE	5 5 90	NUE6313A	TRANSMITTER-RECEIVER BOARD (482-512 MHz)
H24BBU1123A	1.5 W	Carrier	2	OS	10 10 80	NXN6029A	SECOND OSCILLATOR CRYSTAL (17.865 MHz)
H24BBU1124A	1.5 W	Carrier	2	OE	10 10 80	NXN6030A	SECOND OSCILLATOR CRYSTAL (17.935 MHz)
H24BBU1143A	1.5 W	Carrier	4	OS	10 10 80	KXN1034A	CHANNEL ELEMENT, RECEIVER
H24BBU1144A	1.5 W	Carrier	4	OE	10 10 80	KXN1035A	CHANNEL ELEMENT, TRANSMITTER
H24BBU1164A	1.5 W	Carrier	6	OE	10 10 80	NHE6001A	FRAME: C1R1, SHORT
H24BBU1184A	1.5 W	Carrier	8	OE	10 10 80	NHE6011A	FRAME: C1R1, EXTENDED
H24BBU3112A	1.5 W	Tone "PL"	1	SE	5 5 90	NHE6081A	FRAME: C2R2, SHORT
H24BBU3113A	1.5 W	Tone "PL"	1	OS	10 10 80	NHE6091A	FRAME: C2R2, EXTENDED
H24BBU3114A	1.5 W	Tone "PL"	1	OE	10 10 80	NHE6151A	FRAME: C4R4, SHORT
H24BBU3122A	1.5 W	Tone "PL"	2	SE	5 5 90	NHE6161A	FRAME: C4R4, EXTENDED
H24BBU3123A	1.5 W	Tone "PL"	2	OS	10 10 80	NHE6021A	FRAME: C6R6, EXTENDED
H24BBU3124A	1.5 W	Tone "PL"	2	OE	10 10 80	NHE6031A	FRAME: C8R8, EXTENDED
H24BBU3143A	1.5 W	Tone "PL"	4	OS	10 10 80	NLN4207A	FRONT COVER, CARRIER SQUELCH, SHORT
H24BBU3144A	1.5 W	Tone "PL"	4	OE	10 10 80	NLN4208A	FRONT COVER, CARRIER SQUELCH, EXTENDED
H24BBU3164A	1.5 W	Tone "PL"	6	OE	10 10 80	NLN4184A	FRONT COVER, "PL," EXTENDED
H24BBU3184A	1.5 W	Tone "PL"	8	OE	10 10 80	NLN4183A	FRONT COVER, "PL," SHORT
H24BBU6112A	1.5 W	Digital "PL"	1	SE	5 5 90	NLN4176A	BACK COVER: "SLIM-LINE," SHORT
H24BBU6114A	1.5 W	Digital "PL"	1	OE	10 10 80	NLN4177A	BACK COVER: "SLIM-LINE," EXTENDED
H24BBU6122A	1.5 W	Digital "PL"	2	SE	5 5 90	NLN4178A	BACK COVER: "OMNI," SHORT
H24BBU6124A	1.5 W	Digital "PL"	2	OE	10 10 80	NLN4179A	BACK COVER: "OMNI," EXTENDED
H24BBU6144A	1.5 W	Digital "PL"	4	OE	10 10 80	NLN4180A	BATTERY COVER
H24BBU6164A	1.5 W	Digital "PL"	6	OE	10 10 80	NLN4181A	BATTERY COVER LATCH: "SLIM-LINE"
H24BBU6184A	1.5 W	Digital "PL"	8	OE	10 10 80	NLN4182A	BATTERY COVER LATCH: "OMNI"
						NLN4194A	BATTERY COVER LATCH HARDWARE
						NLN4188A	ESCUTCHEON: C1R1
						NLN4189A	ESCUTCHEON: C2R2
						NLN4643A	ESCUTCHEON: C4R4
						NLN4191A	ESCUTCHEON: C8R8
H34BBU1113A	4 W	Carrier	1	OS	5 5 90	NLE8362A	1.5-WATT POWER AMPLIFIER (450-482 MHz)
H34BBU1114A	4 W	Carrier	1	OE	5 5 90	NLE8363A	1.5-WATT POWER AMPLIFIER (482-512 MHz)
H34BBU1123A	4 W	Carrier	2	OS	5 5 90	NLE8372A	4-WATT POWER AMPLIFIER (450-482 MHz)
H34BBU1124A	4 W	Carrier	2	OE	5 5 90	NLE8373A	4-WATT POWER AMPLIFIER (482-512 MHz)
H34BBU1143A	4 W	Carrier	4	OS	5 5 90	NLN4172A	SLEEVE, "OMNI," SHORT
H34BBU1144A	4 W	Carrier	4	OE	5 5 90	NLN4174A	SLEEVE, "OMNI," EXTENDED
H34BBU1164A	4 W	Carrier	6	OE	5 5 90	NLN4175A	SLEEVE, "OMNI," EXTENDED LESS ANTENNA TUBE
H34BBU1184A	4 W	Carrier	8	OE	5 5 90	NLN4215A	CHANNEL ELEMENT DECK: C7R7
H34BBU3113A	4 W	Tone "PL"	1	OS	5 5 90	NLN4573A	CHANNEL ELEMENT DECK: C8R8
H34BBU3114A	4 W	Tone "PL"	1	OE	5 5 90	NPN6010A	ACTIVE FILTER
H34BBU3123A	4 W	Tone "PL"	2	OS	5 5 90	NLN4211A	TONE "PL" DECK; EXTENDED FRAME
H34BBU3124A	4 W	Tone "PL"	2	OE	5 5 90	NLN4645A	TONE "PL" DECK; SHORT FRAME
H34BBU3143A	4 W	Tone "PL"	4	OS	5 5 90	NLN4212A	DIGITAL "PL" DECK
H34BBU3144A	4 W	Tone "PL"	4	OE	5 5 90	NLN4647A	DIGITAL "PL" RECEIVER BIAS
H34BBU3164A	4 W	Tone "PL"	6	OE	5 5 90	NLN8922A	DIGITAL "PL" CODE PLUG
H34BBU3184A	4 W	Tone "PL"	8	OE	5 5 90	NLE8521A	INTERCONNECT BOARD ELECTRICAL HARDWARE (482-512 MHz)
H34BBU6114A	4 W	Digital "PL"	1	OE	5 5 90	NLN4186A	MOUNTING HARDWARE: "OMNI," EXTENDED
H34BBU6124A	4 W	Digital "PL"	2	OE	5 5 90	NLN4185A	MOUNTING HARDWARE, C7R7 CHANNEL ELEMENT DECK
H34BBU6144A	4 W	Digital "PL"	4	OE	5 5 90	NLN4190A	MOUNTING HARDWARE: "SLIM-LINE," EXTENDED
H34BBU6164A	4 W	Digital "PL"	6	OE	5 5 90	NLN4187A	MOUNTING HARDWARE: "OMNI," SHORT
H34BBU6184A	4 W	Digital "PL"	8	OE	5 5 90	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

EPF-8113-A

DESCRIPTION

1. INTRODUCTION

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

The radios are available in two power ranges, with up to eight channels, and in "BBB" or "BBU" 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 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.

Primary differences in the models involve the number of channels, the type squelch, and the transmitter rf power output. These variations require different transmit power amplifier module complements, and different housing sizes. Radio size is determined by the number of channels, power output, signaling options, and other system related options.

2. STANDARD FEATURES

All VHF and UHF radios in the series have similar appearance and several common features. Each radio has an internal speaker and microphone, an external speaker jack, and an external antenna jack.

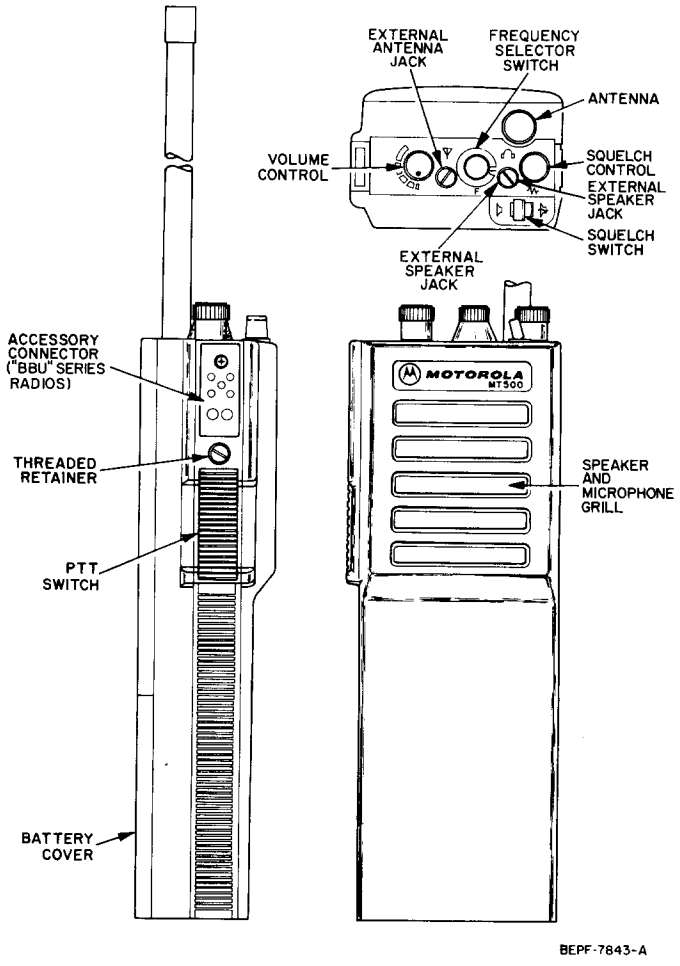


Figure 1. Typical Multiple-Frequency Radio with Squelch Switch

The antenna jack impedance on all MT500 Series radios 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 will 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.

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

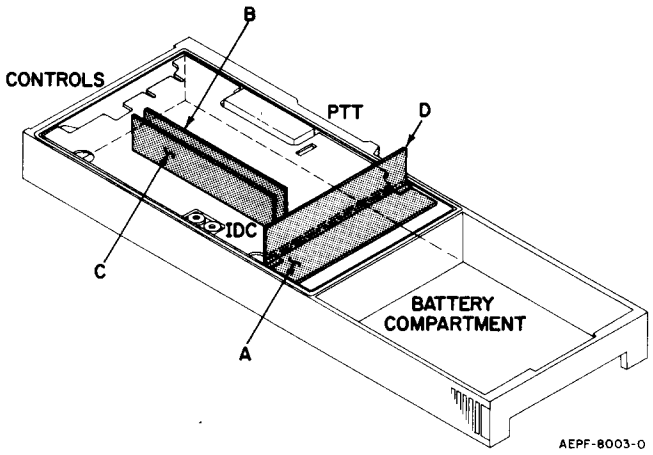


Figure 2. Option Slot Locations

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	B
Transmit-Only Digital PL Deck	B
"PAC•RT" Transmit-Only Tone PL Deck	A

*Includes Two-Tone Selective Call Kit
**Includes Single-tone Kit

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 radios also 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.

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.

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. Protected Receiver

The protected receiver option allows the radio to be operated in areas subject to severe interference. Intermodulation, selectivity, and spurious/image rejection 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 it cannot be recharged.

Both, nickel-cadmium and mercury, batteries are available in two sizes: "slim-line" and "omni." The "omni" battery is large, 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 recommended are as follows: NLN6683 ("slim-line"), NLN6936 ("omni," high power), and NLN6762 ("omni," low power).

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 accessories are collapsible antennas, 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.

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	

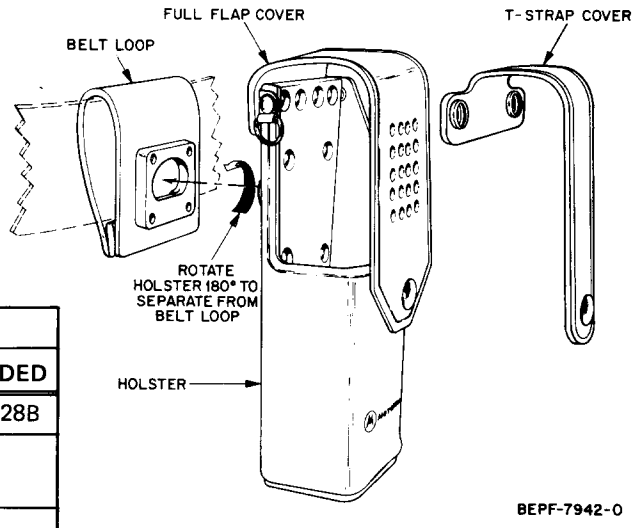


Figure 3. Typical Swivel Case

OPERATION

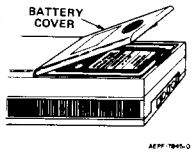
1. INSPECTION

When unpacking, check the contents to be sure that all items ordered have been received.

Inspect the equipment thoroughly as soon after delivery as possible. If any part of the equipment has been damaged in transit, immediately report the extent of damage to the transportation company.

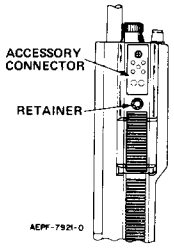
2. BATTERY INSTALLATION

Turn the battery cover screw 1/4-turn counterclockwise to unlock the cover. Remove the cover. Insert a fresh battery with the label facing out and the battery contacts facing down (into the radio). Replace the cover and turn the screw 1/4-turn clockwise.



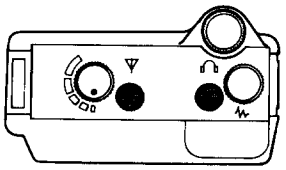
3. EXTERNAL SPEAKER-MICROPHONE INSTALLATION

"BBU" Series radios have an accessory connector on the side. These radios also contain an internal speaker-microphone and will operate without the external speaker-microphone attached. To attach the external speaker-microphone, fit the plug lip into the groove on the top edge of the radio and pivot the plug down against the side of the radio. Secure the plug to the radio by tightening the screw on the plug into the threaded retainer.



4. EXTERNAL ANTENNA AND SPEAKER JACKS

The antenna jack (⍒) is used to attach an external 50-ohm antenna, and also for test purposes. The speaker jack (∩) is used with an optional lapel speaker or earpiece, and also for test purposes. The radio speaker is inoperative when an external speaker is connected to the speaker jack. The two jacks are fitted with threaded protective caps which should be left in place when the jacks are not being used.



5. CONTROL LOCATION AND DESCRIPTION

VOLUME CONTROL - Turns the radio on and off and adjusts the receiver audio volume.

SQUELCH CONTROL - Mutes background noise and reduces unwanted signals.

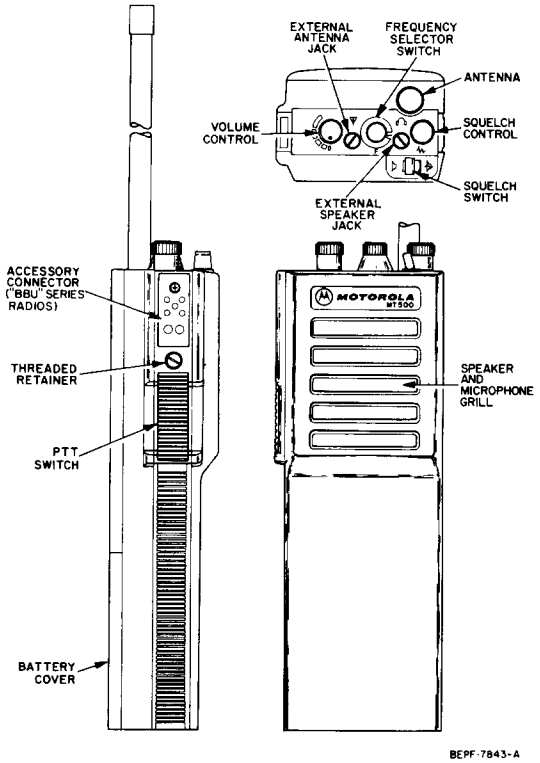
PTT (Push-to-Talk) SWITCH - Press to talk via the transmitter. Receiver operates only when released.

FREQUENCY SELECTOR SWITCH - Selects the operating channel - - toggle switch on two-channel radios, rotary switch on 3- to 8-channel radios.

SQUELCH SWITCH - Primarily used on "Private-Line" models. Receiver operates only with the proper "Private-Line" signal in the " ⊳ " position. Receiver responds to all on-channel signals when in the " ▷ " position.

ACCESSORY CONNECTOR - Normally used to attach an external speaker-microphone. Present only on "BBU" Series radios.

ANTENNA - Fixed antennas normally supplied. Optional collapsible type must be extended before operation.

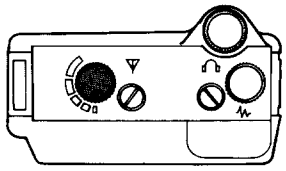


BEPF-7843-A

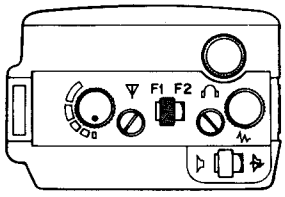
6. BASIC OPERATING PROCEDURE

a. Turn On, Set Volume, and Set Squelch to Receive

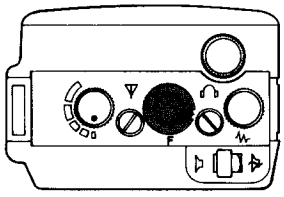
(1) Rotate the volume control one-half turn clockwise to turn on the radio.



(2) If your radio has more than one channel, set the frequency select switch to the desired position (F1, F2, F3, etc.).

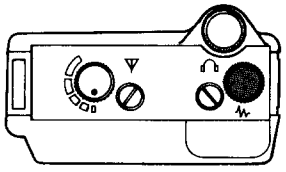


Two-Channel Radio

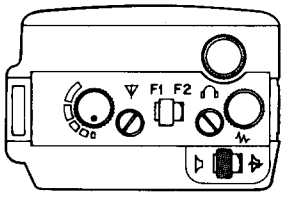


Four-Channel Radio

(3) Rotate the ⁓ (squelch) control to the fully counterclockwise position.



(4) If your radio is a carrier squelch model, proceed to step (5). If your radio is a "Private-Line" model, place the toggle switch in the " ▷ " position.



(5) Listen for a broadcast and set the volume control to a comfortable listening level.

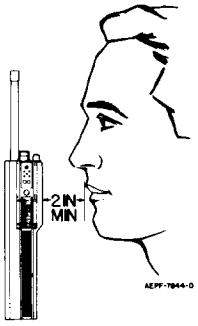
(6) When the channel is clear, slowly rotate the ⁓ (squelch) control clockwise until the noise just stops. This is the threshold setting. DO NOT adjust the control further. Excessive squelch reduces the radio sensitivity.

(7) Your radio is now set to receive calls on your frequency. If your radio is a "Private-Line" model, set the toggle switch to the ▷ position to receive only the calls coded for your radio.

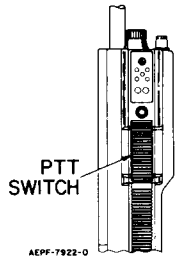
b. Monitor the Channel and Transmit When Channel is Clear

(1) Do not interrupt another user. Listen for broadcasts on your channel. If your radio is a "Private-Line" model, momentarily place the toggle switch in the " ▷ " position to monitor the channel. The channel must be clear before transmitting.

(2) Hold the radio in a vertical position with the speaker-microphone grille two to three inches from your mouth.



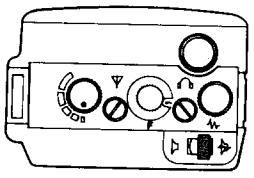
(3) Press the push-to-talk switch on the side of the radio and speak slowly and clearly into the grille area. When finished transmitting, release the push-to-talk switch to receive. Remember, if you transmit while the other party is talking, he will not hear you.



(4) To turn the radio off, rotate the volume control counterclockwise until a click is heard and the mechanical stop is reached.

7. MODEL VARIATIONS AND OPERATION

a. Selective Call Models



Radios equipped with this option have a monitor-reset switch in the location where the "Private-Line" switch is shown.

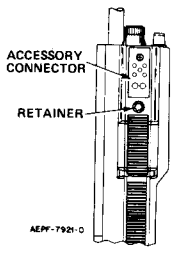
When the radio is turned on, it is in the carrier squelch mode and operates as described in the basic operating procedure.

To operate as a pager, momentarily operate the toggle switch to the " ▷ " position and release it. Your radio now operates as a pager. When you are paged, you will hear a pulsed tone for an individual call or four-tone group call, and a continuous tone for a long-tone B group call. The radio automatically switches to the carrier squelch mode and you will hear the caller's voice. You may now transmit and receive as described in the basic operating procedure.

If you have not been paged, but wish to transmit, first monitor the channel by pressing and holding the monitor-reset switch in the " ▷ " position. When the channel is clear, release the switch and transmit as described in the basic operating procedure.

After receiving a page or after completing a two-way conversation, the radio will remain in the carrier squelch mode. To reset to the pager mode, momentarily operate and release the monitor-reset switch.

b. "BBU" Series Radios



The "BBU" Series radios operate as standard radios with an internal speaker-microphone, or an external speaker-microphone can be attached to the accessory connector. With the external speaker-microphone attached, the push-to-talk button on the external microphone is used instead of the lever on the side of the radio. Operation is as previously described in the basic operating instructions.

c. Time-Out-Timer Option

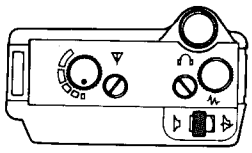
Radios equipped with this option contain a special circuit which turns off the transmitter and emits an alert tone from the speaker after continuously transmitting for a set time interval. When the PTT switch is released, the alert tone is stopped and the receiver operates normally. Another transmission may be initiated immediately after releasing the PTT switch. This option also alerts you if the transmitter is accidentally keyed – preventing channel tie-up.

d. PAC•RT Transmit-Only Tone PL Deck

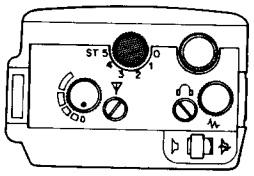
Radios equipped with this option are used within the PAC•RT Portable/Mobile Vehicular Repeater System. With the radio squelch switch in the " ▷ " position, the radio operates in the portable-to-base mode; as a result, all messages from the portable radio are repeated through the PAC•RT Vehicular Repeater to the base station. With the radio squelch switch in the " ▷ " position, the radio operates in the portable-to-portable mode, and the portable radio operator can talk with other portable radio operators in the system without activating any repeaters.

e. Single-Tone Remote Signaling Option

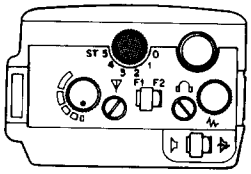
Radios equipped with this option have either a toggle switch ("slim-line" radios) or a rotary switch ("omni" radios) for the single-tone selector switch.



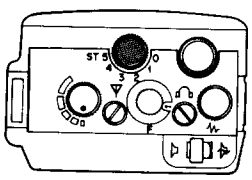
One-Tone Single-Tone Radio



One- to Five-Tone Single-Tone One-Channel Radio



One- to Five-Tone Single-Tone Two-Channel Radio



One- to Five-Tone Single-Tone Multiple-Channel Radio

In the receive mode, the radio operates as described in the "Basic Operating Procedure." If the "omni" radio is equipped with the tone PL option, it operates in the same manner as described in the "Basic Operating Procedure."

With the single-tone selector switch in the "O" position ("omni" radios) or in the " ▷ " position ("slim-line" radios), operation of the radio in the transmit mode is the same as in the standard radio.

Operation of the radio with the single-tone selector switch in the numbered position or in the " ▷ " position is the same as that of a standard radio when it is in the transmitting mode. By pressing the push-to-talk switch, the radio automatically sends out the selected tone after a turn-on delay of 10 ms. The tone duration is fixed at 750 ms.

The microphone is muted before and during the tone transmission. Monitoring of the tones over the radio loudspeaker is provided so that the radio operator will know when the tone has been transmitted and can start his voice message. The transmitted tone is monitored at a low level and is independent of the radio volume control.

f. Unit Identification and Unit Identification with Emergency Call

Radios equipped with unit ID or unit ID with emergency call transmit an identifying code to the base station which tells the operator which radio is "on-the-air."

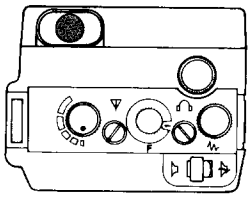
NOTE

You cannot transmit a voice message while the tones are being transmitted.

(1) Radios Equipped for Unit ID Operation

Operate the radio in the normal manner. When the transmitter is turned on by pressing the push-to-talk switch, you will hear the ID tones being transmitted. When the tones end, start your voice message in the normal manner.

(2) Radios Equipped for Unit ID and Emergency Call Operation



To send an emergency call, press the emergency call pushbutton; you will not hear anything, but the ID/emergency message will be repeatedly transmitted until the switch is released. After the switch is released, the radio sends two ID/emergency messages every five seconds for 30 seconds. To stop the sequence early, turn the on/off switch to the off position momentarily and then on again to resume normal operation. Alternatively, the sequence can be stopped by pressing the push-to-talk switch until you hear the ID tones and then release it to resume normal operation.

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 and NLN4463A) can be charged in existing HT220 chargers. However, only 85% of battery capacity is achieved 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		Multiple-Unit Chargers		Vehicular Chargers
		117 V	234 V	117 V	234 V	
"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 UHF	HIGH PWR VHF
Nickel-Cadmium (Rechargeable)								
NLN4462A "Slim-line"	10-10-80	8	---	15.0	1.5	2.0	---	---
NLN4463A "Omni"	10-10-80	9	---	15.0	1.5	2.0	---	---
NLN4463A "Omni"	5-5-90	14	8	15.0	1.5	2.0	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	---	---	2.0	2.5
NLN6683A Low Power "Slim"	5-5-90	18	---	12.0	0.7	0.8	---	---

b. Nickel-Cadmium Batteries (Rechargeable)

Recommended batteries are the "dual charge" NLN4462A ("slim-line") or the "dual charge" NLN4463A ("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 (NLN4463A) 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. Mercury Batteries (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. Other Motorola Batteries

The following older style nickel-cadmium batteries may be used in the MT500 radios but will provide reduced duty cycles: NLN6682, NLN6899, NLN6761, and NLN6900. 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

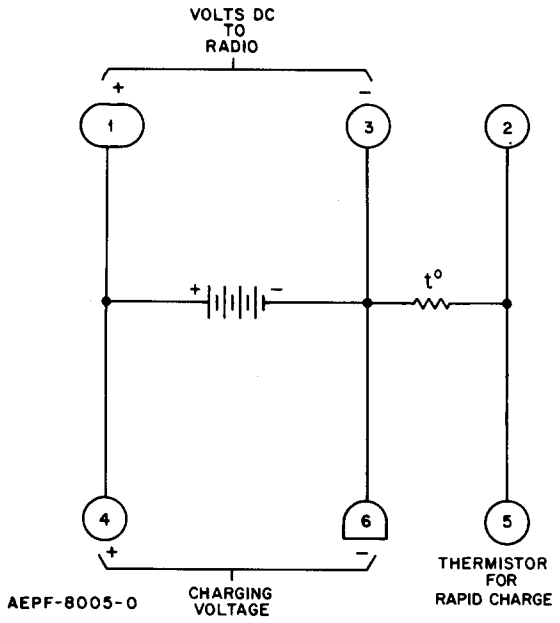


Figure 4. NLN4462A Battery Construction

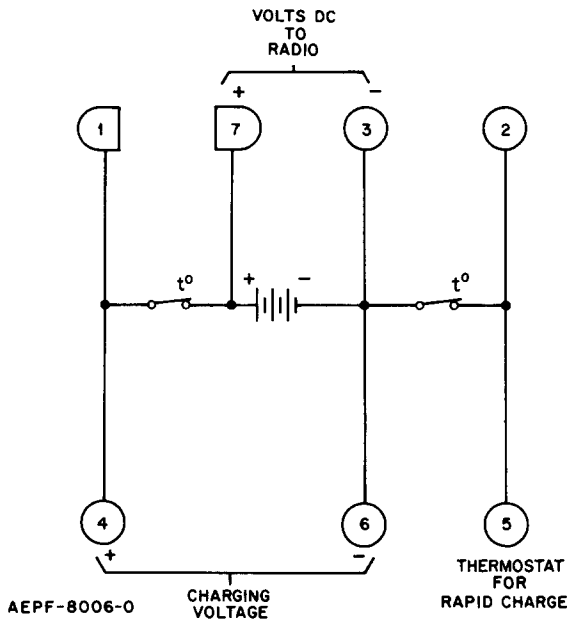


Figure 5. NLN4463A Battery Construction

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 a minimal use of discrete components. Each hybrid module usually performs a complete function, such as an amplifier which has an input and an amplified output. Complete details of each module are presented in the "Hybrid Modules" section.

The receiver is a dual conversion, superheterodyne type (refer to Figures 6 and 7). It consists of an amplifier, two oscillators, two mixers, an injection module, two i-f amplifiers, a 35 kHz i-f detector, and the audio section, which includes a squelch module, an audio preamplifier, an audio power amplifier, and a speaker. The primary difference between VHF and UHF radios involves the preselector in the UHF radio rf circuits.

The transmitter circuits are functionally the same; containing a microphone and an Instantaneous Deviation Control (IDC) module in the audio section (refer to Figures 8 and 9). The rf section contains a channel element, a buffer tripler, a predriver (VHF) or a second tripler (UHF), a driver, and a power amplifier.

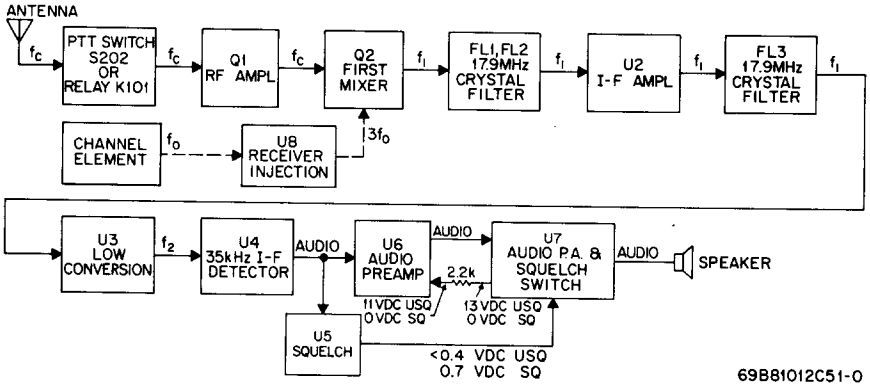


Figure 6. VHF Receiver Block Diagram

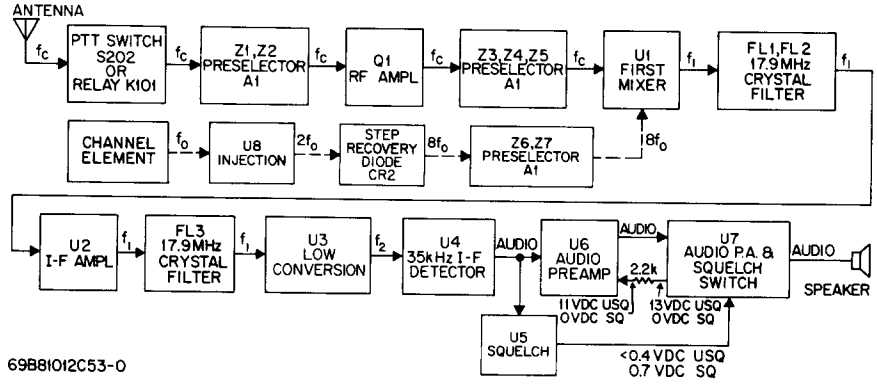


Figure 7. UHF Receiver Block Diagram

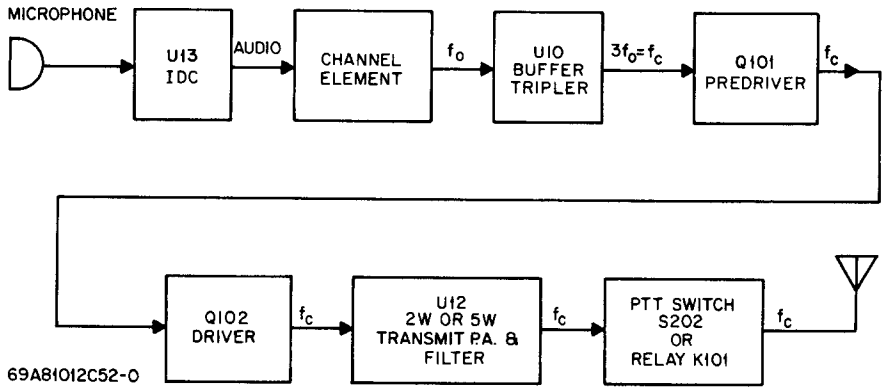


Figure 8. VHF Transmitter Block Diagram

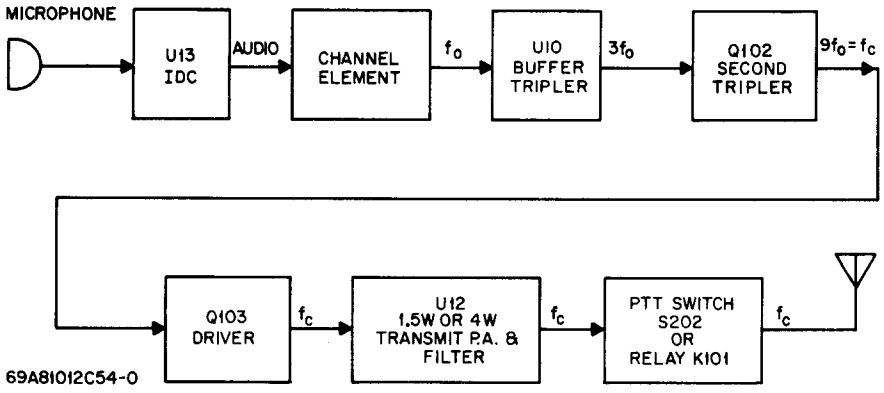


Figure 9. UHF Transmitter Block Diagram

2. OVERALL RECEIVER CIRCUIT

a. RF Circuits, VHF Receivers

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, C13, C14, and L7). The two-pole filter applies the injection signal to first mixer Q2.

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, C16, and the dc ground through L4. Capacitor C18 tunes L5 to 17.9 MHz and along with R14 matches the mixer output to the crystal filter input (FL1).

b. RF Circuits, UHF Receivers

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 helical filters: 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 and produces an output signal ($2f_o$) which is fed through "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.

The received rf signal and the injection signal are mixed in U1, producing the 17.9 MHz i-f signal, which is applied to crystal filter FL1.

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 10.

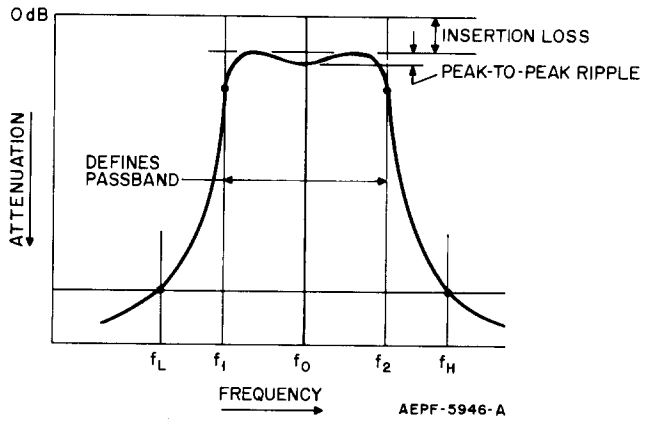


Figure 10. Typical Crystal Filter Response Curve

The filter output is applied to first i-f amplifier U2, where the 17.9 MHz signal is amplified. This amplifier receives B+ only during the receive operating mode. The amplifier provides only gain, since selectivity and unwanted signal injection is provided by the crystal filters.

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 additional i-f bandpass selectivity. This filter output is applied to low conversion module U3 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. The 35 kHz output of the low conversion module is amplified and unwanted amplitude variations (noise) is removed by limiting in the i-f amplifier. The 35 kHz signal from the i-f amplifier is then fed to the FM demodulator of the i-f detector module.

d. Audio Circuits

The 35 kHz 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 and to squelch module U5. The audio preamplifier module contains high-pass and low-pass filters. The high-pass filter attenuates frequencies below 300 Hz, preventing

low frequency "Private-Line" tones from reaching the speaker. The low-pass filter produces the desired audio response characteristic. 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 received audio output is applied to audio power amplifier module U7 which supplies most of the receiver audio amplification to the speaker. Slight audio shaping in this module performs the remaining part of the de-emphasis function.

The squelch switch of audio power amplifier module U7 receives input from squelch module U5 to gate the audio output. When the squelch module output has sufficient current to bring its voltage to 0.7 volt dc, the audio power amplifier and the audio preamplifier modules are turned off (squelched). Less than 0.4 volt dc at the squelch module output biases the audio stages on (unsquelched).

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. Squelch Circuits

A portion of the FM demodulator output (U4) across squelch control R201 is applied to squelch module U5. 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.

When a carrier is received, the detector output consists of audio modulating information (below 4 kHz) and the noise spectrum around 6 kHz 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. OVERALL TRANSMITTER CIRCUIT

a. General

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.

b. Audio Circuits

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 then amplifies, shapes, limits, and filters the audio signal which is then applied to IDC controls R211 through R218 (VHF) or R208 through R213 (UHF). The IDC controls apply a portion of the processed audio to the appropriate channel elements and control the deviation of the transmitter rf signal.

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.

Radios with more than one channel have a frequency selector switch that selects a desired channel element. When the transmitter is "keyed" by the push-to-talk switch, +7.5 volts dc regulated is routed through frequency selector switch S201 to activate the selected channel element. 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

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.

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.

d. RF Circuits, UHF Transmitter

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.

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 C128 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.

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.

4. TONE "PRIVATE-LINE" CIRCUIT

The "Private-Line" (PL) tone circuit consists of two thick-film hybrid modules (U501 and U502). This circuit decodes subaudible PL tones in the receive mode and encodes PL tones in the transmit mode. The operating mode of the PL circuit is determined by dc voltages applied to the PL processor module (U501) from the push-to-talk switch (Basic models), or relay K101 (Universal models).

The receiver remains squelched until it receives a carrier signal which is modulated by a specific low-frequency (subaudible) tone. The PL circuit decodes this tone, if it is the correct tone for the radio, and produces an output that unsquelches the radio. The carrier squelch circuit is still operative in the PL mode and should be set to the threshold position for optimum receiver operation. In the transmit mode, the circuit generates the proper PL tone which continuously modulates the transmitted carrier. The tone PL circuit is described in detail in the "Hybrid Module" section.

5. DIGITAL "PRIVATE-LINE" CIRCUIT

The digital "Private-Line" circuit consists of four hybrid modules (U601, U602, U603, and U604). The circuit function is similar to the tone "Private-Line" previously described, except digital information is used instead of tones to identify a particular radio. This permits more codes than is possible with the low-frequency tones. The digital PL circuit is described in detail in the "Hybrid Module" section.

6. SELECTIVE CALL RADIOS

a. General

The selective call circuit is a decoder which detects and decodes the two-tone sequential paging signal transmitted to the receiver (refer to Figure 11). 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.

When a radio contains this optional circuit, only the receiver circuit is modified. Receiver modules U4, U6, and U7 are involved. The functional block diagram illustrates the electrical interconnections between the selective call circuits and a typical radio receiver.

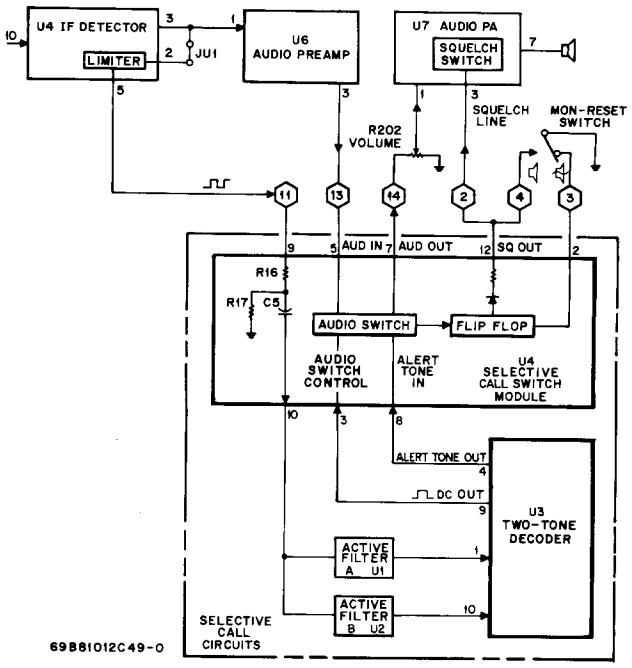


Figure 11. Selective Call Functional Block Diagram

In the paging mode, the flip-flop applies an output to the squelch circuit in the receiver, squelching the audio output. When the proper paging tones are received, the decoder module output operates the audio switch circuit, supplies an alert tone, and sets the flip-flop. The receiver is unsquelched by the flip-flop, and the alert tone is applied to the receiver audio power amplifier by the audio switch. The audio from the detector is inhibited by the audio switch during the alert tone interval to prevent hearing the paging tones. When the alert tone ends, the detector output is applied to the receiver audio amplifiers and normal carrier squelch receiver operation occurs.

Refer to the schematic diagram in the selective call service supplement for a single-code decoder using two active filters (U1 and U2). The tones in each paging code and the corresponding active filters are designated A for the first tone and B for the second tone. Tone A is transmitted for one second followed within 400 milliseconds by tone B, which is transmitted for three seconds. The tones must appear in the proper sequence to produce an alert tone at the speaker.

There are 90 unique frequencies (60 standard and 30 subaudible) from which tones A and B are selected. Each tone is assigned a code number called the "Filter Code." Refer to the coding description appearing later in this manual.

b. Active Tone Filters

The "Permacode" active filter is an extremely narrow band audio amplifier, with the center frequency corresponding to a specific paging tone frequency. The frequency and the code number are stamped on each filter. The specific filters installed in each decoder depend on the system code type and the pager number.

The filter drive output of the i-f detector is a constant 0.40 volt, peak-to-peak, square wave. Refer to U4, the selective call switch logic module. This signal is divided by R16 and R17 and routed to the active filters through C5. If this filter drive signal is at the center frequency of one of the filters, a sine wave output is produced by this filter. The filter output is then applied to the two-tone decoder to start the paging alert process.

c. Decoder Circuit

This module alerts the receiver and controls the audio circuits when the proper sequential tones are received. When tone A is received, the limiter output is routed through the tone A filter to the decoder. The tone A input biases the decoder in preparation for tone B. If the tone B input occurs immediately after the end of tone A, the decoder will trigger. When triggered, the decoder produces an alert tone (Figure 12) and a dc output. The alert tone is a 2 kHz signal, alternately gated on for approximately 180 ms and off for 80 ms.

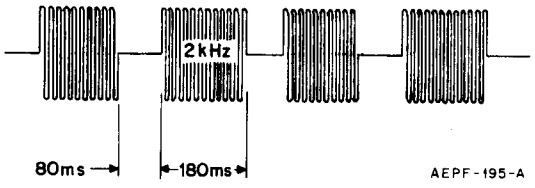


Figure 12. Alert Tone Waveforms

In the quiescent (standby) condition, no output is produced at either of the threshold detectors (pins 12 and 8) and both C1 and C2 are charged to their high-voltage condition. Refer to Figure 13. The normally low output from the 50 ms monostable causes the output of inverter A (pin 11) to be high, which in turn causes the output of inverter B to be low. The "AND" gate D requires a high level at both inputs to produce a high dc output; therefore, since both inputs are low at this time, the output at pin 9 will be low.

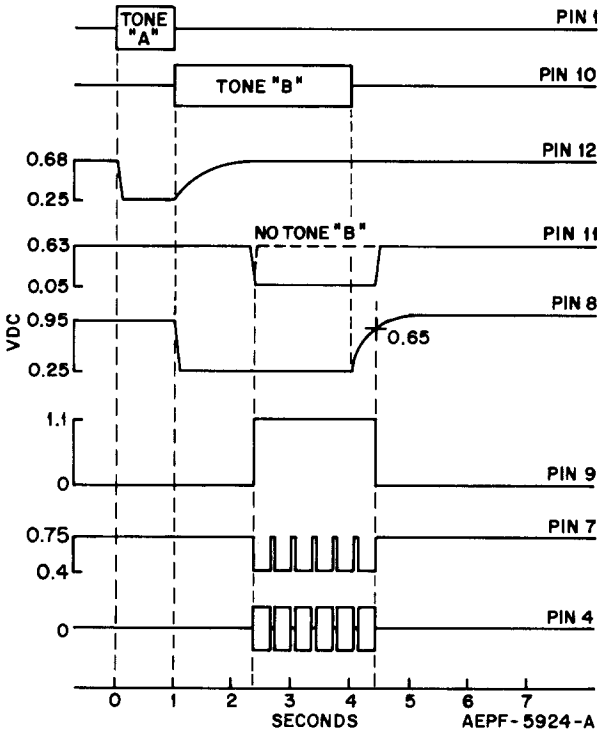


Figure 13. Decoder Module Timing Diagram

When tone A is applied, the tone A threshold detector produces a low output rapidly discharging C2. When tone A is removed, the threshold detector no longer produces a low output and C2 begins recharging through R2. When C2 has charged to 0.65 V dc (about 1.5 sec) the monostable is triggered, producing a short positive pulse. This pulse is transmitted through inverters A and B, resulting in a positive pulse being applied to input 1 of "AND" gate D. If tone B has been received, the tone B threshold detector has a low output, resulting in a high output from inverter E which is routed through gate F to input 2 of gate D. Gate F is an "OR" gate which produces a high output if either input is high. If tone B has been received when the 50 ms monostable triggers, both inputs to D will be high, resulting in a high output at pin 9.

The high dc output (approximately 1.1 V) at pin 9 is applied to inverter C and a ground is produced at pin 11 to maintain a positive level

at input number one (1) of gate D. Gate D will now remain activated for the duration of tone B. The dc output is applied to the astable and tone oscillator circuits in the two-tone decoder module. The astable is activated, and a ground is alternately applied for 180 ms and removed for 80 ms at pin 7. This signal is inverted through inverter G and a recurrent positive pulse is applied at gate H. Gate H produces an output when a positive level is present at both inputs. The output of gate H activates the tone oscillator. Therefore, the tone oscillator is alternately turned on for 180 ms, and off for 80 ms as input number two (2) of gate H shifts in response to the astable output. A pulsating alert tone is proudced. Input number one (1) of gate H remains at a constant level due to the dc output of gate D. When tone B ends, the threshold detector output switches from a ground, and C1 begins charging to the supply level. After about 0.5 sec, this produces a low level at the output of inverter E and a low level at input number two (2) of gate D. Gate D deactivates at this time, and the dc output is removed from pin 9.

d. Selective Call Switch Module

The module contains four sections which connect the two-tone sequential paging circuits to the MT500 audio circuits. These sections are a voltage divider, an audio switch, a squelch flip-flop circuit, and a voltage regulator.

The voltage divider consists of R16, R17, and C5. This circuit couples the 0.4 volt p-p signal from the output of the limiter in the i-f detector module to the active filters of the selective call circuit.

The audio switch provides a means of injecting the alert-tone signal from the two-tone decoder module into the audio circuit of the radio. Refer to the audio switch portion of the selective call switch module, U4, in the selective call service supplement. Normally, audio passes through C1, Q1, and C2, but when an alert tone occurs, a high (approximately 1.1 volts dc) from pin 9 of decoder U3 (DC OUT) is applied to pin 3 of selective call switch module U4 (TWO-TONE SWITCH IN). This high is transmitted through inverters A and B resulting in a high at the base of Q2. Simultaneously, the low output of gate A appears at the base of Q1. Since these are NPN transistors, Q2 turns on while Q1 turns off and the alert tone from pin 4 is routed through C3, Q2, and C2. From C2, AUDIO OUT, the alert tone goes to audio PA U7 and out to the speaker. The alert tone remains on until shortly after tone B ends. With Q1 off, tone B is blocked from entering the audio PA.

To ensure that the alert tone is not blocked during threshold on tight squelch, Q4 applies a ground to the squelch gate which unlocks the squelch. With the squelch unlocked, the audio is enabled and the alert tone can be heard.

The squelch flip-flop provides an output to the receiver squelch circuit. When the squelch output is on (approximately 50 microamps out), the squelch circuit is locked up and will not unsquelch when a carrier is received. If the squelch output is off (no current out), the receiver squelch circuit operates in the normal manner.

When the receiver is first turned on, the flip-flop automatically "sets," turning SQ OUT, U4-12, off. To place the radio in the page mode, the monitor-reset switch is momentarily placed in the reset (▷) position. This resets the flip-flop by removing the ground from U4-2 and unsquelches the receiver by placing a ground on the squelch line.

When an alert tone is detected, the high from gate B "sets" the flip-flop which turns the squelch output off and allows normal carrier squelch operation after the page.

e. Four-tone Selective Call (Group Call)

Refer to the four-tone selective call circuitry in the selective call service supplement. Active filters U1, U2, and decoder module U3 are used to decode a second address which is used as a group call. The circuit for the second address has a slight modification. The dc output, pin 9 of U3, from the second address is tied to the DC OUT, pin 9 of U3, of the first address. This connection allows the alert tone to be taken from pin 4 of the decoder, U3, in the first address because a dc output applied to the astable and tone oscillator circuits in the two-tone decoder produces an alert tone.

f. Long Tone B Selective Call (Group Call)

The group call detector module (U5) is installed when the radio includes this option in the selective call circuit.

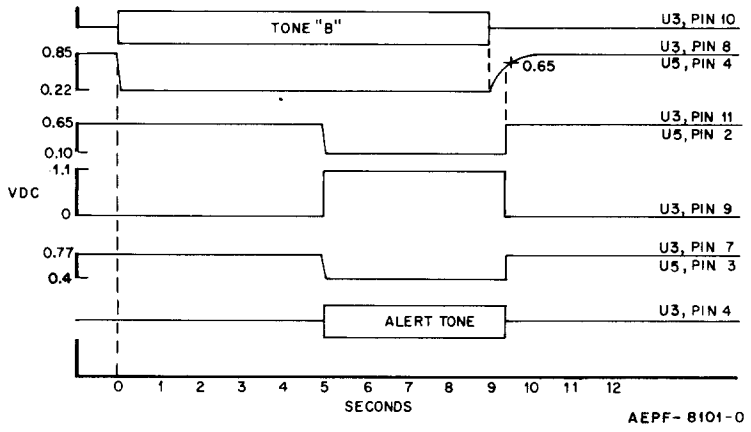


Figure 14. Group Call Signal Timing Diagram

When the optional group call module is used, decoder logic is modified to provide a response in the normal manner or when only tone B is transmitted for eight seconds, refer to Figure 14. Tone B produces a ground at pin 8 and through inverter E; a positive output is produced and routed to gate D, input 2. This positive level has no effect since input 1 of gate D is not positive at this time.

The ground at pin 8 of the two-tone detector module is routed directly to the group call module, U5. If this ground is present more than five seconds, the group call module applies a ground potential to pin 11 of the two-tone detector module. This results in a high output from inverter B to turn on gate D which provides the necessary dc output. At the same time, the group call module applies a ground to pin 7 (astable clamp) and a steady high output is applied to input 2 of gate H. This input, along with the dc output of gate D, turns on gate H, and a steady alert tone is produced by the oscillator. This steady alert tone continues for the duration of tone B (approximately 2.5 seconds). When tone B ends, the low inputs (ground) at pins 7 and 11 are removed, and the decoder turns off.

g. Subaudible

The subaudible module is a low-pass filter and amplifier which attenuates all tones above 300 Hz and amplifies tones below this frequency. This module is installed in place of JU1 near the i-f detector module. This insertion point places the subaudible module between the detector output and the input to the filter drive amplifier. The addition of this module, and the "AZ" type active filters is required for subaudible coding.

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 15. 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.

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.

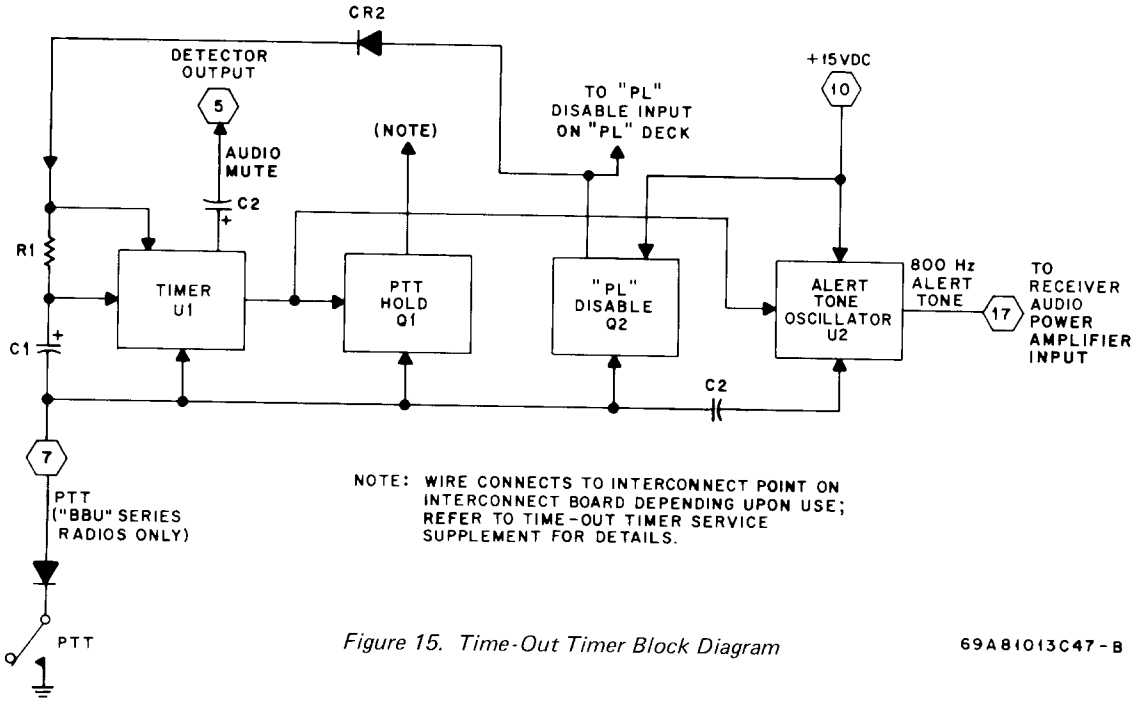


Figure 15. Time-Out Timer Block Diagram 69A81013C47-B

b. Detailed Circuit Description

Refer to the schematic diagram in the "Time-Out Timer Service Supplement." 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 used only the encode mode portion of the tone PL circuit. Refer to the "Hybrid Module" section for a detailed description of the encode mode 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 the "Hybrid Module" section for a detailed description of the encode mode of the tone PL circuit.

10. TRANSMIT-ONLY DIGITAL "PL" DECK

The transmit-only digital PL circuit is identical to the digital PL circuit encode mode. Refer to the "Hybrid Module" section for a detailed description of the encode mode of the digital PL circuit.

11. 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."

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 16.

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.

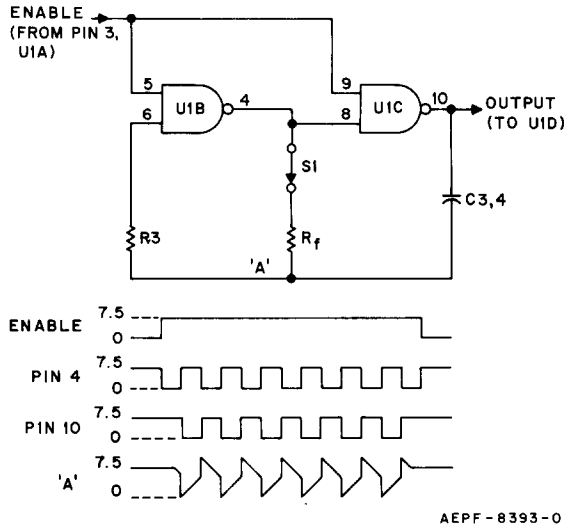


Figure 16. Simplified Oscillator Circuit

12. UNIT IDENTIFICATION RADIOS

a. General

When a radio contains this option, additional circuits are added as shown in functional diagram Figure 17, which also illustrates the electrical interconnections between the Unit Identification (ID) circuits and a typical radio. The interconnection points are identified by a hexagon and a number. This hexagon symbol and number appears on all schematic diagrams and applicable circuit board details.

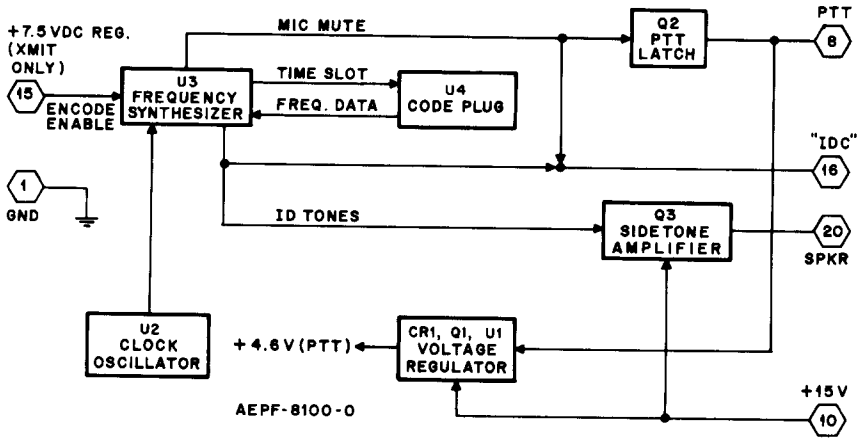


Figure 17. Unit ID Functional Block Diagram

When the radio is turned on, +15 volts dc appears at interconnect point 10. Operation of the unit ID is started when the push-to-talk switch is pressed causing voltage regulator U1 to supply +4.6 volts dc to the unit ID circuitry causing activation of a power-up reset function which energizes the unit ID circuits and push-to-talk relay K101.

K101 turns on +7.5 volts dc (XMIT ONLY) which appears at interconnect point 15 as the encode-enable signal for frequency synthesizer U3. Frequency synthesizer U3 is a CMOS chip that includes control and reset logic circuits, a time-slot generator, and a programmable divider. The encode-enable signal sets a flip-flop which generates a "mic-mute" signal that disables the radio microphone circuit and triggers transmitter PTT latch circuit Q2.

Frequency synthesizer U3 also contains a time-slot generator which produces a series of accurately-timed output pulses ("Modat" type data).

For "Modat" systems, seven 40-millisecond time-slot outputs are generated. The time-slot signals are applied to code plug circuit U4 sequentially to select stored data for each of the tones to be transmitted. Each data location in U4 consists of eight-bit frequency data which represents in binary form the frequency of the audio tones to be transmitted. The eight-bit outputs from U4 are applied in parallel to the programmable divider in U3. This presets the divider network with a specific value so that the clock oscillator frequency can be divided down to the desired tone frequency. The time base for the clocking of the counters in the divider network is crystal controlled oscillator U2 which operates at 246.65 kHz. The resulting output from the synthesizer is a square wave signal for each of the ID tones to be transmitted. These ID tones then appear at interconnect point 16 from where they are connected to the IDC module in the radio. The ID output tones are also fed to side-tone amplifier Q3 to provide monitoring of the ID output via interconnect point 20 to the radio loudspeaker. After the tones are completed, the "mic-mute" signal is reset and the microphone circuit is enabled, or the transmitter is "dekeyed" if the push-to-talk switch has been deactivated during ID transmission.

b. Detailed Circuit Description

Refer to the unit ID schematic diagram in the "Unit ID Service Supplement." When the radio is turned on, +15 volts dc is present at interconnect point 10 which back-biases the collector-base junction of Q3. When the push-to-talk switch in the radio is pressed, Q1 is forward biased through R2 to apply +15 volts dc to regulator U1. The output of U1 is +5 volts dc which is dropped to 4.6 volts dc through CR1 to provide general operating voltage for the circuit. The RC circuit consisting of R4 and C7 provides a delay for the power-up reset function. Pressing the push-to-talk switch also causes relay K101 in the radio to energize applying +7.5 volts dc (XMIT ONLY) to interconnect point 15. This voltage is applied at pin I of U3 to provide the encode-enable signal for the frequency synthesizer chip. The mic-mute flip-flop in U3 is then set to provide a high output (+4.6 volts dc nominal) at pin D of U3 which inhibits the mic input to the IDC circuit in the radio via summing resistor R18 and interconnect point 16. The level at pin D of U3 is also inte-

grated by R5 and C6 to provide the system turn-on delay. The turn-on delay is needed to allow for transmitter, PL, and repeater attack-times before the ID tones are transmitted. After the delay, a high level at pin G of U3 enables the time-slot generator. The high level at pin D of U3 also turns on transistor Q2 to provide a latch for the PTT circuit.

The time-slot generator in U3 generates sequential time-slot output pulses (TS1 through TS7) which are connected to the code plug, pins 12 through 18. The period of these outputs is set by the value of resistor R7 and capacitor C8. Resetting of the time-slot generator is controlled by jumper JU1. For the "Modat" mode, jumper JU1 is in the circuit which applies a ground level at pin BB of U3. This has the effect of resetting the time-slot generator back to TS1 after TS7 has been generated.

As each time-slot output pulse is generated, it is applied to the code plug to select the eight-bit frequency data (D0 through D7) stored at each location. The code plug must be programmed for the proper mode of operation and for the particular three-digit ID code assigned to the unit. The NLN8999A Programmed Code Plug is supplied for "Modat" systems. The NLN4256A Programmable Code Plug is also available for programming in the field using the SP7801681 "Modat" Code Plug Programmer/Reader. Table 7 gives the complete listing of the frequency values and the corresponding eight-bit readout from the code plug for the "Modat" format. The repeat tone (R) is used when two successive code digits are the same; e.g., an ID code of 225 would be encoded 2R5.

The eight-bit frequency data from the code plug (D0 through D7) is read out in parallel and fed to the programmable divider circuit in U3 via pins 2 through 11 on the code plug. The clock oscillator output from U2 is also fed to the programmable divider via choke coil L1 and pin K of U3. The clock frequency of 246.65 kHz is used to drive a programmable divide-by-256 and a divide-by-2 counter that comprise the overall divider. The eight-bit frequency data from the code plug is loaded into the divide-by-256 counter to preset it with a specific count, which is then counted down at the rate determined by the master clock frequency. The result of the counting process is to produce an output square wave whose frequency is equal to the desired tone frequency for each time-slot. This final output frequency, from pin AA of U3, is fed through summing resistor R19 to interconnect point 16. The ID tone output frequency is also connected to the base of emitter follower Q3. From the emitter of Q3, the signal is connected to interconnect point 20 to provide monitoring of the ID tones.

13. UNIT IDENTIFICATION RADIOS WITH EMERGENCY CALL

a. General

When a radio contains this option, additional circuits are added as shown in functional diagram Figure 18, which also illustrates the electrical interconnections between the Unit Identification (ID) circuits and a typical radio. The interconnection points are identified by a hexagon and a number. This hexagon symbol and number appears on all schematic diagrams and applicable circuit board details.

Table 7. Unit ID Frequency Data

TONE CODE NUMBER	TONE FREQUENCY (Hz)			8-BIT FREQUENCY DATA																							
	"MODAT"	ZVEI	CCIR	"MODAT"								ZVEI								CCIR							
				D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
0	637.5	2400	1981	L	L	H	H	H	H	H	L	H	H	L	L	H	H	L	L	H	H	L	L	L	L	L	L
1	787.5	1060	1124	L	H	H	L	L	L	H	L	H	L	L	L	H	L	H	H	H	L	L	H	L	L	L	L
2	937.5	1160	1197	L	H	H	H	H	L	H	H	H	L	L	H	L	H	L	H	H	L	L	H	L	H	H	H
3	1087.5	1270	1275	H	L	L	L	H	H	H	L	H	L	L	H	H	H	H	L	H	L	L	H	H	H	L	H
4	1237.5	1400	1358	H	L	L	H	H	L	H	H	H	L	H	L	L	H	H	H	H	L	H	L	L	L	H	H
5	1387.5	1530	1446	H	L	H	L	L	H	H	L	H	L	H	L	H	H	H	L	H	L	H	L	H	L	L	H
6	1537.5	1670	1540	H	L	H	L	H	H	H	H	H	L	H	H	L	H	L	H	H	L	H	L	H	H	H	L
7	1687.5	1830	1640	H	L	H	H	L	H	H	L	H	L	H	H	H	H	L	L	H	L	H	H	L	L	H	H
8	1837.5	2000	1747	H	L	H	H	H	H	L	L	H	H	L	L	L	L	L	H	H	L	H	H	H	L	L	L
9	1987.5	2200	1860	H	H	L	L	L	L	L	H	H	H	L	L	L	H	H	H	H	L	H	H	H	H	L	L
R	487.5	2600	2110	L	L	L	L	L	L	H	L	H	H	L	H	L	L	L	L	H	H	L	L	L	H	L	L

L = Low logic level (0 V)
H = High logic level (4.6 V)

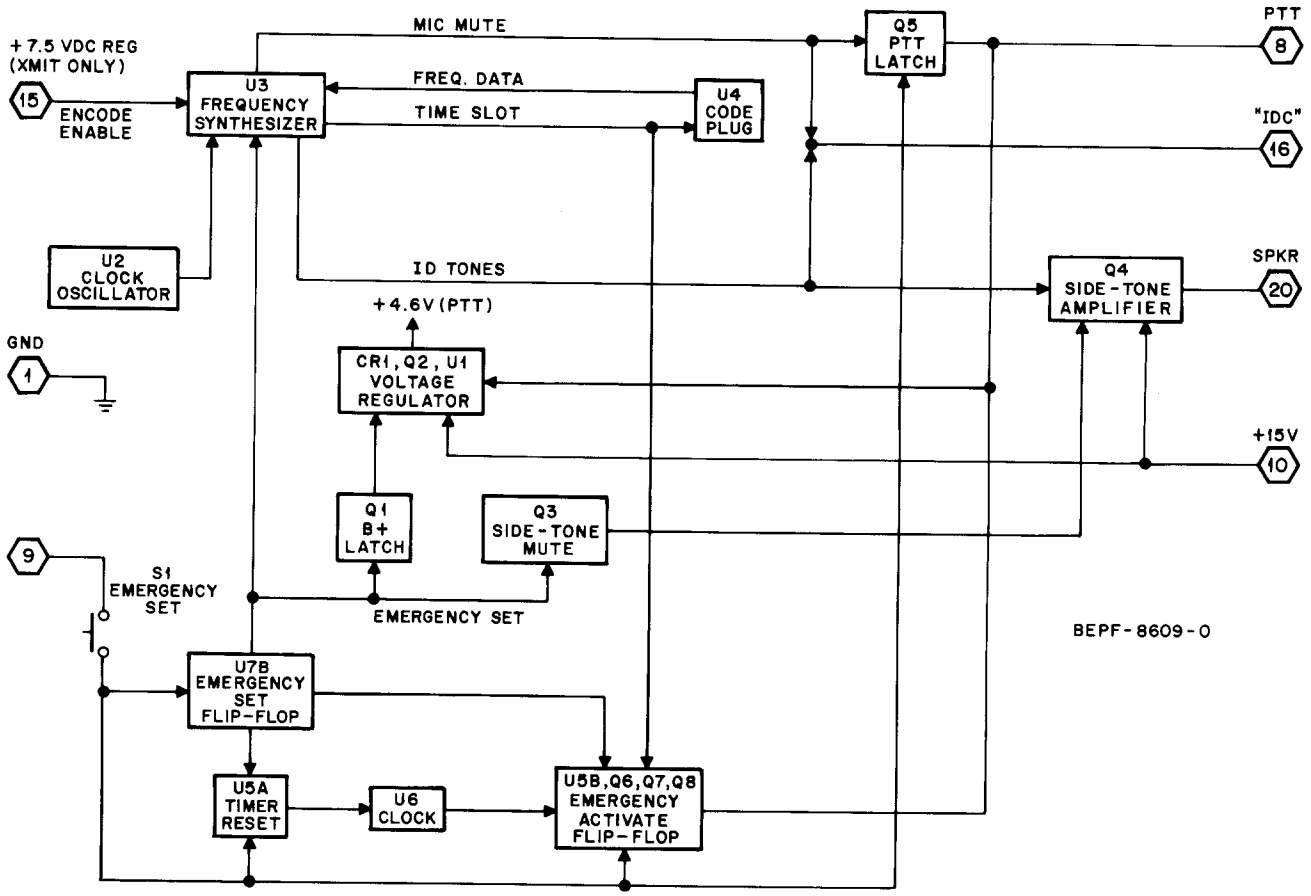


Figure 18. Unit ID and Emergency Call Functional Block Diagram

When the radio is turned on, +15 volts dc appears at interconnect point 10. Operation of the unit ID is started when the push-to-talk switch is pressed causing voltage regulator U1 to supply +4.6 volts dc to the unit ID circuitry causing activation of a power-up reset function which energizes the unit ID circuits and push-to-talk relay K101.

This turns on +7.5 volts dc (XMIT ONLY) which appears at interconnect point 15 as the encode-enable signal for frequency synthesizer U3. Frequency synthesizer U3 is a CMOS chip that includes control and reset logic circuits, a time-slot generator, and a programmable divider. The encode-enable signal sets a flip-flop which generates a "mic-mute" signal that disables the radio microphone circuit and triggers transmitter PTT latch circuit Q5.

Frequency synthesizer U3 also contains a time-slot generator which produces a series of accurately-timed output pulses ("Modat" type data).

For "Modat" systems, seven 40-millisecond time-slot outputs are generated. The time-slot signals are applied to code plug circuit U4 sequentially to select stored data for each of the tones to be transmitted. Each data location in U4 consists of eight-bit frequency data which represents in binary form the frequency of the audio tones to be transmitted. The eight-bit outputs from U4 are applied in parallel to the programmable divider in U3. This presets the divider network with a specific value so that the clock oscillator frequency can be divided down to the desired tone frequency. The time base for the clocking of the counters in the divider network is crystal controlled oscillator U2 which operates at 246.65 kHz. The resulting output from the synthesizer is a square wave signal for each of the ID tones to be transmitted. These ID tones then appear at interconnect point 16 from where they are connected to the IDC module in the radio. The ID output tones are also fed to side-tone amplifier Q4 to provide monitoring of the ID output via interconnect point 20 on the radio loudspeaker. After the tones are completed, the "mic-mute"

signal is reset and the microphone circuit is enabled, or the transmitter is "dekeyed" if the push-to-talk switch has been deactivated during ID transmission.

b. Detailed Circuit Description

(1) Unit ID Function

Refer to the unit ID and emergency call schematic diagram in the "Unit ID Service Supplement." When the radio is turned on, +15 volts dc is present at interconnect point 10. When the push-to-talk switch in the radio is pressed, Q2 is forward biased through R8 to apply +15 volts dc to regulator U1. The output of U1 is +5 volts dc which is dropped to 4.6 volts dc through CR1 to provide general operating voltage for the circuit. The RC circuit consisting of R2 and C1 provides a delay for the power-up reset function. Pressing the push-to-talk switch also causes relay K101 in the radio to energize applying +7.5 volts dc (XMIT ONLY) to interconnect point 15. This voltage is applied at pin I of U3 to provide the encode-enable signal for the frequency synthesizer chip. The mic-mute flip-flop in U3 is then set to provide a high output (+4.6 volts dc nominal) at pin D of U3 which inhibits the mic input to the IDC circuit in the radio via summing resistor R31 and interconnect point 16. The level at pin D of U3 is also integrated by R3 and C6 to provide the system turn-on delay. The turn-on delay is needed to allow for transmitter, PL, and repeater attack-times before the ID tones are transmitted. After the delay, a high level at pin G of U3 enables the time-slot generator. The high level at pin D of U3 also turns on transistor Q5 to provide a latch for the PTT circuit.

The time-slot generator in U3 generates sequential time-slot output pulses (TS1 through TS7) which are connected to the code plug, pins 12 through 18. The period of these outputs is set by the value of resistor R7 and capacitor C9. Resetting of the time-slot generator is controlled by jumper JU1. For the "Modat" mode, jumper JU1 is in the circuit which applies a ground level at pin BB of U3. This has the effect of resetting the time-slot generator back to TS1 after TS7 has been generated.

As each time-slot output pulse is generated, it is applied to the code plug to select the eight-bit frequency data (D0 through D7) stored at each location. The code plug must be programmed for the proper mode of operation and for the particular three-digit ID code assigned to the unit. The NLN8999A Programmed Code Plug is supplied for "Modat" systems. The NLN4256A Programmable Code Plug is also available for programming in the field using the SP7801681 "Modat" Code Plug Programmer/Reader. Table 7 gives the complete listing of the frequency values and the corresponding eight-bit readout from the code plug for the "Modat" format. The repeat tone (R) is used when two successive code digits are the same; e.g., an ID code of 225 would be encoded 2R5.

The eight-bit frequency data from the code plug (D0 through D7) is read out in parallel and fed to the programmable divider circuit in U3 via pins 2 through 11 on the code plug. The clock oscillator output from U2 is also fed to the programmable divider via choke coil L1 and pin K of U3. The clock frequency of 246.65 kHz is used to drive a programmable divide-by-256 and a divide-by-2 counter that comprise the overall divider. The eight-bit frequency data from the code plug is loaded into the divide-by-256 counter to preset it with a specific count, which is then counted down at the rate determined by the master clock frequency. The result of the counting process is to produce an output square wave whose frequency is equal to the desired tone frequency for each time-slot. This final output frequency, from pin AA of U3, is fed through summing resistor R19 to interconnect point 16. The ID tone output frequency is also connected to the base of emitter follower Q4. From the emitter of Q4, the signal is connected to interconnect point 20 to provide monitoring of the ID tones.

(2) Emergency Call Function

When the radio is first turned on, +15 volts dc is present at interconnect point 10 which back biases the collector-base junction of Q4. When the push-to-talk switch in the radio is pressed, Q2 is forward biased through R8 to apply +15 volts dc to regulator U1. The output of U1 is +5 volts dc which is dropped to 4.6 volts dc through CR1 to provide general operating voltage for the unit ID and emergency call circuits and resets the logic circuits for initial activation. When emergency set switch S1 is pressed, +7.5 volts dc from interconnect point 9 is applied to the emergency call logic circuits via R26 setting flip-flops U5A, U5B, and U7A and resetting U7B. With U5B set, its Q output (pin 13) goes high and turns on transistor Q8. The resulting saturation of Q8 grounds interconnection point 8, thereby

simulating the actuation of the PTT switch on the radio; i.e., the +7.5 volts dc (XMIT ONLY) is connected through R25 to provide the encode-enable signal (high logic level) for the frequency synthesizer chip (pin I of U3).

The $\overline{Q}$ output from U7B (flip-flop is in the reset state) turns on transistor Q3 through R9 which holds Q4 off. With Q4 off, the side-tone output at interconnect point 20 is inoperative for the duration of the emergency call operation. The high level from U7B-$\overline{Q}$ is also connected to pin P of frequency synthesizer chip U3 which causes the encoder to transmit in the emergency mode; i.e., the emergency tone (tone 7) is automatically transmitted in time-slot 3 of the unit ID code pattern. For example, if the code plug is programmed for an ID code of 698R123 (where R is the repeat tone and 123 is the actual 3-digit ID code), the synthesizer will automatically change the code to 697R123 to implement the emergency mode transmission. The high present at pin P of the frequency synthesizer accomplisher this by forcing divider input D3 low and D1 high during time-slot 3.

NOTE

For proper operation of the emergency mode, the code plug must be programmed for tone 8 in time-slot 3.

When time-slot 7 of emergency message "A" goes high, this level is fed back to the emergency call circuit via R29 to turn on transistor Q7 and thereby pull the encode-enable input, U3-I, low. When time-slot 7 goes low, Q7 turns off and C2 charges through R25 from IC 15 to start message "B." The integration time for this action is nominally about 60 milliseconds. The negative-going edge of time-slot 7 coincides with the positive-going edge of time-slot 1 which resets U5B via the one-shot circuit consisting of C12 and R27. The discharge time constant of circuit elements R32 and C15 then holds transistor Q8 fully on (saturated), overlapping the maximum time required to initiate message B of the emergency sequence. In this way the sequence is transmitted as a pair of tone bursts every five seconds. If emergency set switch S1 is pressed and held, the sequence is repeated continuously until the switch is released. After release of the switch, two final messages (A and B) are transmitted.

Circuit element U6 is a 24-stage frequency divider that is used as the basic timer for the sequence. The circuit is operated in the RC oscillator mode at a frequency of about 105 kHz. Each flip-flop in the divider chain causes the frequency to be divided by 2 so that the output available at pin 10 of U6 is equivalent to the frequency division of 2^{18}. The divider (counter) advances on a negative-going edge so that when 2^{18} goes low, 2^{19} goes high. The 2^{19} output (pin 11) is connected to the data (D) input, while the 2^{18} output (pin 10) is connected to the clock (C) input of U5B. The Q output of U5B then goes high every five seconds, pulling the collector of transistor Q8 low. This causes the radio to key, applying +7.5 volts dc at interconnect point 15. The clock input of U5A is pulsed each time an emergency sequence is transmitted. On the sixth sequence, the 2^{22} output of U6 (pin 14) is at a logic high level. This causes the Q output of U5A to go high, resetting U6.

If the PTT switch in the radio is pressed and held while the emergency tones are being transmitted, capacitor C21 starts to charge through R24 after the collector of Q8 goes high. When flip-flop U7B is clocked, its Q output goes high while its $\overline{Q}$ output goes low. The Q output provides a pulse to the one-shot circuit. (R39 and C22) at the base of transistor Q6 pulls the encode-enable signal at pin J of U3 on the frequency synthesizer low and then back high allowing the transmission of an ID message with side tones. If the PTT switch is pressed when the radio is in the receive mode, a one-shot circuit consisting of R36 and C18 clocks U7B. The Q output from U7B goes high and resets U6 to disable emergency operation. Pressing the emergency switch at any time restarts the operation.

SELECTIVE CALL TONE CODING

1. INTRODUCTION

The selective call radios require two-tone sequential signaling. Two discrete audio tones are transmitted for a specific period of time.

	TRANSMISSION TIME		INTERPAGE GAP
	TONE A	TONE B	
Tone and Voice Models	1 sec.	3 sec.	1.3 sec.
Subaudible	1 sec.	3 sec.	3 sec.
Long Tone B Group Call Models	0 sec.	8 sec.	

Note: Time between tones cannot exceed 25 milliseconds.

Each radio in the system responds to a unique combination of tones. This combination is determined by the active filters installed in the radio.

There are 90 unique tone frequencies (60 standard and 30 subaudible) from which tones A and B may be selected. Each tone is assigned a code number. This number is usually referred to as the "Filter Code" and is stamped on the body of the active filter. The tone frequency is also stamped on the filter body.

The number that appears on the back of the radio is the paging code number; e.g., SC625 = Two Tone, SC625/476 = Four Tone (Group Call), AZ468 = Subaudible, and SC625/155 = Long Tone B (Group Call). The Tone A and Tone B active filter code and frequency can be determined from this number. Refer to the following tables and paragraphs.

2. GENERAL ENCODING METHOD

Each radio in the system is assigned a three-digit "page code." The relationship between the "page code" and the filter installed in the radio is established by the general encoding method.

The first digit of the three-digit page code determines the tone groups from which Tones A and B are to be selected. The tone groups indicated for each first digit are shown in Table 8. The next two digits of the page code are the specific paging tones for Tones A and B respectively. The paging tone frequencies and their filter code number are shown in Table 9.

Index of Encoding Methods

PAGER CODE TYPE	ENCODING METHOD USED
Three-digit code (625)	General Encoding Method (para. 2)
Three-digit code with a letter prefix (D476)	High Capacity Encoding Method (para. 3)
Three-digit code where the second and third digits are the same (366)	General Alternate Encoding Method (para. 4. b.)
Three-digit code where the second and third digits are the same and includes a letter prefix (B455)	High Capacity Alternate Encoding Method (para. 4. c.)
Three-digit code preceded by AZ (AZ468)	Subaudible Encoding Method (para. 5)
Six-digit code where third, fifth, and sixth digits are same (B465/255)	Long Tone B Group Call Encoding Method (para. 6)

To determine which tone frequencies or filter codes are associated with a given page code, proceed as follows:

a. Locate the first digit of the page code in Table 8, column 1. Note the tone group number for Tones A and B which are indicated in columns 2 and 3 respectively.

b. Refer to the top row of Table 9, and locate the tone group number that was noted for Tone A in Table 8.

c. Refer to the first column of Table 9, and locate the tone number that corresponds to the second digit of the page code.

d. The filter code and tone frequency are found where the tone group column intersects the second digit tone number row.

e. The filter code and tone frequency for the third digit of the page code can be determined by repeating steps 2.b. through 2.d.

EXAMPLE: Page Code 625; According to Table 8, the first digit of this pager (6) indicates that Tone A is selected from tone group 2, and Tone B is selected from tone group 1. The second digit (2) indicates that tone number 2 of group 2 is used for Tone A, and the third digit (5) shows tone number 5 of group 1 is used for Tone B.

Table 8.
General Encoding Plan

FIRST DIGIT OF PAGER CODE	TONE GROUP FROM WHICH TONE A IS SELECTED	TONE GROUP FROM WHICH TONE B IS SELECTED
1	1	1
2	2	2
3	1	2
4	4	4
5	5	5
6	2	1
7	4	5
8	5	4
9	2	4
0	4	2
A	3	3

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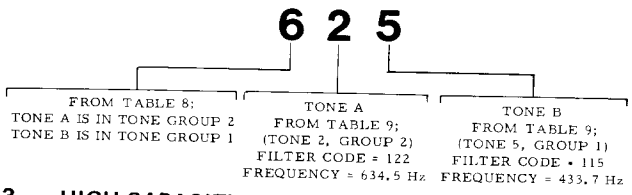

3. HIGH CAPACITY ENCODING METHOD

This encoding method was devised to accommodate the large number of radios used in high capacity paging systems such as the L08 Encoder, the L09 Dial Interconnected Pager Terminal, or the Ultra High Capacity Computer Controlled "Metro-Page" Radio Paging Terminal. Radios encoded by this method are assigned a letter prefix. This prefix is the "Code Type" designation. In the general encoding method, the relationship between the first digit of the page code and the groups selected is arbitrary. In the code assignment method, the selected groups depend on the system code type. Table 10 shows the group selection scheme by code type. In essence, each code type column in this table is used in the same way as Table 8 was used in the general encoding method. In the column for the page code prefix and on the line corresponding to the first digit of the page code, are the groups from which Tones A and B will be selected. Table 9 and the second and third digits of the page code determine the exact filter codes as outlined in paragraph 2.

Table 9.
Tone Groups

TONE NUMBER	TONE GROUP 1		TONE GROUP 2		TONE GROUP 3		TONE GROUP 4		TONE GROUP 5		TONE GROUP 6	
	FILTER CODE	FREQ. (Hz)	FILTER CODE	FREQ. (Hz)	FILTER CODE	FREQ. (Hz)	FILTER CODE	FREQ. (Hz)	FILTER CODE	FREQ. (Hz)	FILTER CODE	FREQ. (Hz)
1	111	349.0	121	600.9	138	288.5	141	339.6	151	584.8	191	1153.4
2	112	368.5	122	634.5	108	296.5	142	358.6	152	617.4	192	1185.2
3	113	389.0	123	669.9	139	304.7	143	378.6	153	651.9	193	1217.8
4	114	410.8	124	707.3	109	313.0	144	399.8	154	688.3	194	1251.4
5	115	433.7	125	746.8	160	953.7	145	422.1	155	726.8	195	1285.8
6	116	457.9	126	788.5	130	979.9	146	445.7	156	767.4	196	1321.2
7	117	483.5	127	832.5	161	1006.9	147	470.5	157	810.2	197	1357.6
8	118	510.5	128	879.0	131	1034.7	148	496.8	158	855.5	198	1395.0
9	119	539.0	129	928.1	162	1063.2	149	524.6	159	903.2	199	1433.4
0	110	330.5	120	569.1	189	1092.4	140	321.7	150	553.9	190	1122.5

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Table 10.
High Capacity Code Type Plan

CODE TYPE	B		C		D		E		F		G		H		J		K		L		M		N		P		Q		R		S		T		U		V		W		Z		AZ	
FIRST DIGIT	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	2	3	2	3	2	4	2	4	2	5	3	4	3	4	3	5	4	6	7	8	17	18
2	2	2	2	2	2	2	2	2	1	3	1	3	1	3	1	4	1	4	1	5	2	2	2	2	2	2	2	2	2	2	2	2	4	3	4	3	5	3	6	4	7	9	17	9
3	3	3	1	2	1	2	1	2	3	3	3	3	3	3	4	1	4	1	5	1	3	3	3	3	3	3	4	2	4	2	5	2	3	3	3	3	3	3	5	6	8	7	18	17
4	1	2	4	4	1	5	2	1	4	4	3	1	3	1	4	4	4	4	1	6	4	4	3	2	3	2	4	4	4	4	2	6	4	4	4	4	3	6	4	4	9	7	9	17
5	1	3	1	4	5	5	1	6	3	1	5	5	1	6	5	5	1	6	5	5	3	2	5	5	2	6	5	5	2	6	5	5	5	5	3	6	5	5	5	5	8	9	18	9
6	2	1	2	1	2	1	6	6	1	4	1	5	6	6	1	5	6	6	6	6	2	4	2	5	6	6	2	5	6	6	6	6	3	5	6	6	6	6	6	6	9	8	9	18
7	3	1	4	1	5	1	6	1	4	1	5	1	6	1	4	5	6	1	6	1	4	2	5	2	6	2	4	5	6	2	6	2	4	5	6	3	6	3	4	5	7	7	17	17
8	2	3	2	4	2	5	2	6	3	4	3	5	3	6	5	4	4	6	5	6	3	4	3	5	3	6	5	4	4	6	5	6	5	4	4	6	5	6	5	4	8	8	18	18
9	3	2	4	2	5	2	6	2	4	3	5	3	6	3	5	1	6	4	6	5	4	3	5	3	6	3	5	2	6	4	6	5	5	3	6	4	6	5	6	5	9	9	9	9

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Table 12.
High Capacity Alternate Page Code Type Plan

CODE TYPE DESIGNATION		B		C		D		E		F		G		H		J		K		L		M		N		P		Q		R		S		T		U		V		W		Y	
SEQUENTIAL TONES FILTER CODE		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
FIRST DIGIT OF PAGER CODE	1	S20	1	S20	1	S20	1	S20	1	S20	1	S20	1	S20	1	S20	1	S20	1	S20	1	S20	3	S20	3	S20	3	S20	4	S20	4	S20	5	S20	4	S20	4	S20	5	S20	6	S20	A
	2	S20	2	S20	2	S20	2	S20	2	S20	3	S20	3	S20	3	S20	4	S20	4	S20	5	S20	2	S20	2	S20	2	S20	2	S20	2	S20	2	S20	3	S20	3	S20	3	S20	4	S20	B
	3	S20	3	CQ	2	CQ	2	CQ	2	CQ	3	CQ	3	CQ	3	CQ	1	CQ	1	CQ	1	CQ	3	CQ	3	CQ	3	CQ	2	CQ	2	CQ	2	CQ	3	CQ	3	CQ	3	CQ	6	S20	Z
	4	CQ	2	S20	4	S20	5	CQ	1	S20	4	CQ	1	CQ	1	CQ	4	CQ	4	S20	6	S20	4	CQ	2	CQ	2	CQ	4	CQ	4	S20	6	CQ	4	CQ	4	S20	6	CQ	4	CQ	B
	5	CQ	3	CQ	4	CQ	5	S20	6	CQ	1	S20	5	S20	6	S20	5	S20	6	CQ	5	CQ	2	S20	5	S20	6	S20	5	S20	6	CQ	5	S20	5	S20	6	CQ	5	S20	5	CQ	Z
	6	CQ	1	CQ	1	CQ	1	CQ	6	CQ	4	CQ	5	CQ	6	CQ	5	CQ	6	CQ	6	CQ	4	CQ	5	CQ	6	CQ	5	CQ	6	CQ	6	CQ	5	CQ	6	CQ	6	S22	6	CQ	A
	7	S22	1	S22	1	S22	1	S22	1	S22	1	S22	1	S22	1	S22	5	S22	1	S22	1	S22	2	S22	2	S22	2	S22	5	S22	2	S22	2	S22	5	S22	3	S22	3	CQ	5	S22	A
	8	S22	3	S22	4	S22	5	S22	6	S22	4	S22	5	S22	6	S22	4	S22	6	S22	6	S22	4	S22	5	S22	6	S22	4	S22	6	S22	6	S22	4	S22	6	S22	6	S22	4	S22	Z
	9	S22	2	S22	2	S22	2	S22	2	S22	3	S22	3	S22	3	S22	1	S22	4	S22	5	S22	3	S22	3	S22	3	S22	2	S22	4	S22	5	S22	3	S22	4	S22	5	S22	5	S22	B

S20 = 1500 HZ (TONE FREQ.) CQ = 1550 HZ (TONE FREQ.) S22 = 1600 HZ (TONE FREQ.)

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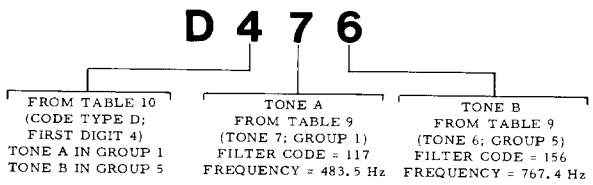
EXAMPLE: Page Code D476 would have the following filters installed

Tone A = Filter Code 117, Frequency 483.5 Hz

Tone B = Filter Code 156, Frequency 767.4 Hz



4. ALTERNATE CODING METHOD

a. Introduction

Dial interconnected paging terminals provide spare radios to substitute for regular radios that are temporarily out of service. Spare radios are encoded with an alternate page code so they will not duplicate codes within the system, yet will easily substitute for system radios. Spare tones used for Tone A are not part of any regular tone groups. Tone B is selected from the regular tone groups. Alternate page codes always have repeating second and third digits. The first digit of alternate pager code determines both the spare tone to be used for Tone A and the regular tone group from which Tone B will be selected. The second or third digit indicates the specific filter to be used for Tone B.

Two alternate encoding methods are used for spare radios; a general encoding method for medium capacity systems, and the high capacity encoding method for high capacity systems. Generally, spare radios will have a three-digit code with no letter prefix. High capacity alternate page codes are prefixed with the system code type letter. To find the filter assignment for a spare radio, with an alternate page code, refer to the following applicable paragraphs.

b. General Alternate Encoding Method

Look up the first digit of the alternate page code in Table 11. On the row corresponding to this digit, the Tone A filter and the group from which Tone B is selected are listed. Then look up the second or third digit of the alternate page code in Table 9. Refer to the group indicated in the previous step for Tone B.

EXAMPLE: Alternate Page Code 366; Refer to Table 11, first digit (3) indicates filter code 130 and frequency 979.9 Hz for Tone A, and Tone B selection is from tone group 2. Refer to Table 9. The second or third digit (6) indicates filter code 126, frequency 788.5 Hz, for Tone B.

Alternate Page Code 366 has the following filters installed:

Tone A = Filter Code 130, Frequency 979.9 Hz

Tone B = Filter Code 126, Frequency 788.5 Hz

Table 11.
Alternate Pager Code Plan

FIRST DIGIT OF ALTERNATE PAGER CODE	TONE A		TONE GROUP FROM WHICH TONE B IS SELECTED
	CODE	FREQ.	
1	160	953.7	1
2	160	953.7	2
3	130	979.9	2
4	160	953.7	4
5	160	953.7	5
6	130	979.9	1
7	130	979.9	5
8	130	979.9	4

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c. High Capacity Alternate Encoding Method

Spare radios in systems using this type of encoding have page codes prefixed with the system code type letter. The Tone A filter and group specified by the first digit of this pager code vary with the code type letter. This is always an S20, CQ, or S22 active filter code. To obtain this information, refer to Table 12. To determine Tone B, proceed as outlined in paragraph 4.b.

EXAMPLE: Alternate Page Code B455; Refer to Table 12 in the code type B column. On row 4, Tone A filter code is CQ, Frequency is 1550 Hz and Tone B selection from tone group 3 is indicated. In Table 2, on row 5, tone group 3 filter code 160 and frequency 953.7 Hz is indicated for Tone B.

SUMMARY: Alternate Page Code B455 requires the following filters. See Table 12.

Tone A = Filter Code CQ, Frequency 1550 Hz

Tone B = Filter Code 160, Frequency 953.7 Hz

5. SUBAUDIBLE CODING METHOD

Subaudible coding differs from the standard in that special low frequency active filters are used. Three subaudible tone groups with a total of 30 tones are available. These are designated groups 17, 18, and 9, and are shown in Table 6. Subaudible pagers are always prefixed with the letter AZ.

Tone groups are selected by the first digit of the page code as in standard coding. Refer to the code type AZ column of the code plan table (Table 3). The specific filters used for Tones A and B are selected from Table 13 in accordance with the second and third digits of the page code.

Table 13. Subaudible Tones

TONE	TONE GROUP 17		TONE GROUP 18		TONE GROUP 9	
	CODE	FREQ. Hz	CODE	FREQ. Hz	CODE	FREQ. Hz
1	101	202.7	4A	141.3	1Z	100.0
2	7A	192.8	4Z	136.5	WB	79.7
3	7Z	186.2	3B	131.8	ZA	94.8
4	WZ	69.3	3A	127.3	ZZ	91.5
5	6A	173.8	3Z	123.0	YB	88.5
6	6Z	167.9	WA	74.4	YA	85.4
7	5B	162.2	2A	114.8	YZ	82.5
8	5A	156.7	2Z	110.9	XB	77.0
9	5Z	151.4	1B	107.2	XA	71.9
0	4B	146.2	1A	103.5	XZ	67.0

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EXAMPLE: To determine the filter assignments for subaudible page code AZ468, proceed as follows: Look up the first digit of the page code (4) in the AZ column of Table 10. Tone groups 9 and 17 are indicated for Tones A and B respectively. With these groups noted, refer to Table 13. In the tone group 9 column, on the line corresponding to the second digit of the page code (6), the Tone A filter (code YA, frequency 85.4 Hz) is shown. In the tone group 17 column of Table 6, on the 8 line, filter code 5A, frequency 156.7 Hz is indicated. This is Tone B filter for this radio.

Summary: Subaudible page code AZ468 will have the following filters installed:

Tone A = Filter Code YA, frequency 85.4 Hz
Tone B = Filter Code 5A, Frequency 156.7 Hz

6. LONG TONE B GROUP CALL CODING METHOD

Radios with the group call option are assigned two code numbers, one for individual call and one for group call. If the individual number is used to call a group radio, it alone will be alerted as is the standard radio. If the group call number is used, all of the other radios in the same group will be alerted along with this radio. The group call radio is assigned filters in the same way as the standard radio. However, only radios with the same Tone B filter are grouped for simultaneous call. Group call codes consist of three digits with repeated second and third digits. The first digit indicates the tone group from which the Tone B filter is selected. The second and third digits show the specific filter selected from that group. A typical group call radio might be coded B465/255. The first number is the individual call code and the next number is the group call code. According to the code assignment table and the filter code table, the following filters are installed in this radio.

Tone A = Filter Code 116, Frequency 457.9 Hz
(Filter 6 of Group 1)

Tone B = Filter Code 125, Frequency 746.8 Hz
(Filter 5 of Group 2)

The group call number of this radio (255) verifies that filter 5 of group 2 is used in the Tone B position. The last digit of the individual call code will always be the same as the second and third digits of the group call number because of the Tone B interrelationship noted above. Also, because of the group requirement for a common Tone B, an additional restriction is applied to individual codes to be grouped. The first digit of the individual number must indicate a Tone B filter selection from the group shown by the first digit of the group call code. For instance, radio (B465/255) cannot be grouped with radio B565 even though the last digits are the same. First digit 5, code type B, indicates a Tone B selection from filter group 3 according to the Code Assignment table. This radio cannot use group call code 255.

Refer to Table 10, the "High Capacity Code Type Plan." Note that for a high capacity system with three tone groups in use, three different first digits will select the same tone group for Tone B. For example, in the code type C column, first digits 1, 6, and 7 all specify tone group 1 for the Tone B selection. Therefore, the following radios in this system will have the same Tone B filter installed and may be grouped for simultaneous call:

C121 through C101 - total 9 radios

C611 through C621 - total 10 radios

C711 through C701 - total 10 radios

Group - total 29 radios

The group call number for all of these radios would be 111. Note that individual page code C111 has been excluded. Since first digit 1 selects the same group for Tones A and B, a pager with this first digit and repeating second and third digits would never be assigned in a system with this code type, because it would have the same Tone A and Tone B filters installed. Page codes C122 through C199 are also excluded for the same reason. For each code type there are three first digits that will specify the same groups for Tones A and B. In code type C these digits are 1, 2, and 4. Therefore, no radios will be assigned in code type C with these first digits and repeating second and third digits.

The maximum number of radios that may be included in a group is equal to the total number of paging tones available in the encoder, minus one. The maximum number of groups in a system is equal to the number of paging tones available.

For example: A 90-call encoder has 10 tones and will accommodate up to 10 groups of 9 radios each. An 870-call encoder has 30 tones and a maximum group call capacity of 30 groups with 29 radios in each group.

Alternate radios may be substituted for group call radios if the alternate unit has the group call option installed and the same group call number assigned. If an alternate radio without the group call option is used in the place of a group call radio, the alternate radio will respond to the individual page code but not to a group call. When several groups are in use, alternate radios with the group call option should not be substituted for radios with different group call numbers, or radios without the group call option. This type of substitution will result in a false alert when the alternate receiver group is paged.

HYBRID MODULES

CAUTION

The hybrid modules in this radio require very specialized equipment for repair. Do not attempt to disassemble.

1. CONSTRUCTION

The following module construction information is presented to help the serviceman better understand the radio.

The hybrid circuit modules used in this radio are sealed complex circuits, consisting of both integrated circuits and discrete components. The resulting module usually performs a complete function in the radio. The modules vary in size, depending on complexity, and have different pin configurations.

Both thick film and thin film technologies are employed in module construction. Both types have an aluminum oxide substrate that forms the base for the circuit. The circuit paths are printed on the substrate with conductive ink in thick film modules and are vacuum deposited with metal in thin film modules.

Chip components are then reflow soldered onto the substrate. Resistors on thin film circuits are chip components, but in thick film modules, most resistors are formed by applying resistive paste between the desired points in the circuit. The paste is usually designed to provide less resistance than desired, and the resistor is trimmed later by removing excess resistive material with a laser or sandblaster until the desired value is obtained.

Thick film capacitors are formed by printing a sandwich composed of two conductive layers separated by an insulating film. Where other capacitor values are required, chip tantalum or ceramic capacitors are attached to the circuit.

Small inductors are produced by screening spiral patterns of conductive material. When large inductors are required, discrete coils or toroids are attached to the circuit.

Active devices (transistors and integrated circuits) are bonded to the thin film substrate in chip form and connected to the circuit with hair-like gold wires. The chips are protected with epoxy.

After the components are soldered in place, most of the modules are coated to keep out moisture. The assembly is then durez coated for protection and the identifying numbers or label is applied.

2. MODULE CIRCUIT DESCRIPTIONS

The following paragraphs describe the more complex module circuits with simplified circuit diagrams where necessary. The descriptions are provided to help understand signal processing in the module, not for module repair purposes.

3. MIXER MODULE, U1

This module is used only in UHF radios and contains a mixer transistor with a tuned output (see Figure 19). 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.

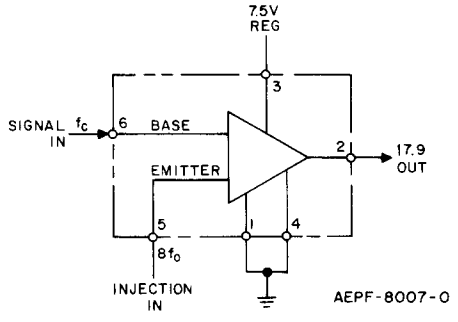


Figure 19. UHF Mixer Module, U1

4. I-F AMPLIFIER MODULE, U2

This module contains an i-f amplifier and a B+ regulator (see Figure 20). The amplifier provides 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.

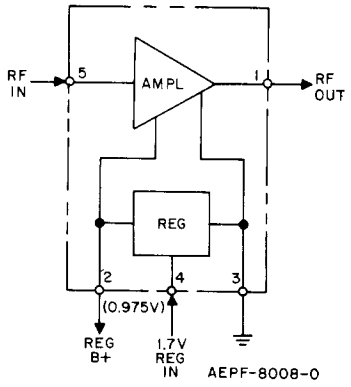


Figure 20. I-F Amplifier Module, U2

5. LOW CONVERSION MODULE, U3

The low conversion module includes an oscillator and a mixer stage (see Figure 21). The first i-f signal (17.9 MHz) is applied to the base of the mixer. Control crystal Y1 determines the frequency of the oscillator. The output of the oscillator is injected into the base of the mixer where it mixes with the i-f signal. The output of the mixer is the second i-f signal at 35 kHz which is capacitively coupled to the i-f detector module.

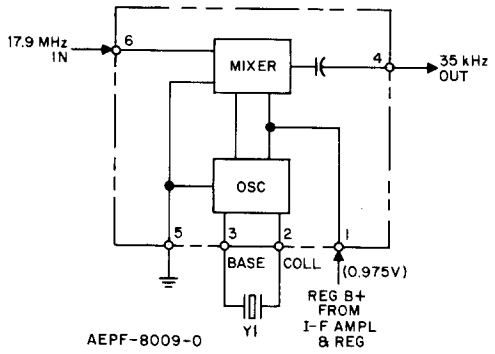


Figure 21. Low Conversion Module, U3

6. I-F DETECTOR, U4

The i-f detector module consists of an i-f amplifier and an audio detector circuit (see Figure 22). 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.

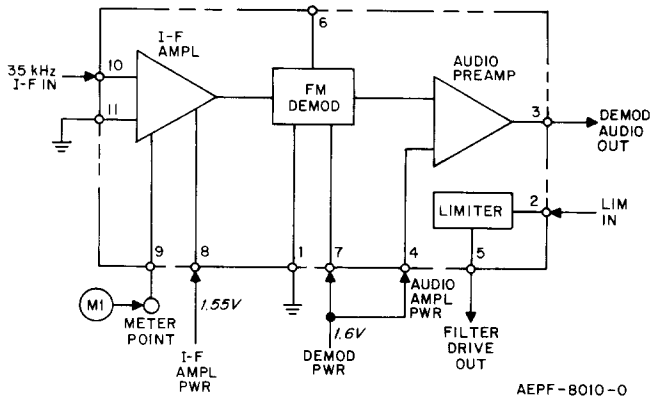


Figure 22. I-F Detector Module, U4

7. SQUELCH MODULE, U5

This module receives noise from the i-f detector module and develops a dc voltage to squelch the receiver (see Figure 23). The noise from the squelch control R201 is applied to pin 5 of the squelch module, which is the input to a high-pass amplifier. The amplifier attenuates frequencies below 4 kHz (including paging and PL tones) and is most sensitive to 6 kHz noise. This noise voltage is limited and detected, producing a dc voltage. This dc output from the detector is applied to a dc amplifier containing an external timing capacitor (C24-VHF or C17-UHF). When the timing capacitor becomes charged (in approximately 100 milliseconds), the amplifier produces a dc output at pin 4. Thus, when a noise input is present, a 0.7 volt dc output appears at pin 4, which squelches the audio power amplifier and audio preamplifier.

When a carrier is received, the detector output consists of audio modulating information (below 4 kHz), and the noise spectrum around 6 kHz is reduced. The dc amplifier output drops to approximately 0.4 volt dc at pin 4 and the receiver is unsquelched.

When the carrier goes off the air, the output at pin 4 increases to about 0.7 volt dc (squelch level) in 100 milliseconds as previously described.

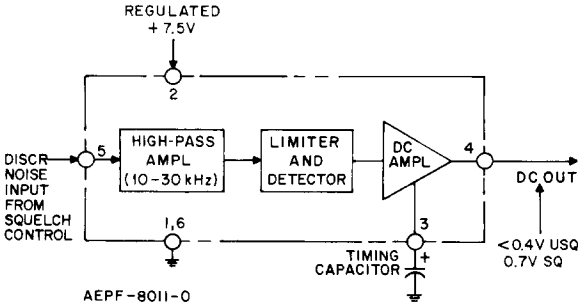


Figure 23. Squelch Module, U5

8. AUDIO PREAMPLIFIER MODULE, U6 AND AUDIO POWER AMPLIFIER, U7

The recovered audio output from i-f detector U4 is amplified and conditioned before being presented to the speaker. The audio preamplifier and audio power amplifier modules perform this conditioning function and are largely responsible for the quality of the received audio signal.

The range of frequencies necessary to reproduce the human voice with good intelligibility is approximately 300 to 3000 Hz. To further increase intelligibility, the signal is emphasized at the rate of 6 dB per octave by the transmitting station. Thus, the recovered audio signal must be de-emphasized by the receiver at the same rate to reproduce the voice accurately. Therefore, the conditioning performed consists of de-emphasizing, amplifying, and shaping audio to desired characteristics.

The audio preamplifier is almost entirely responsible for the audio response of the receiver (see Figure 24). The preamplifier basically attenuates frequencies above and below the audio passband, has a nominal gain of 18 dB at 1000 Hz, and performs part of the de-emphasis function for the receiver. The output of this module is applied to volume control R202. The voltage supply for audio preamplifier module U6 is received from the audio power amplifier squelch switch.

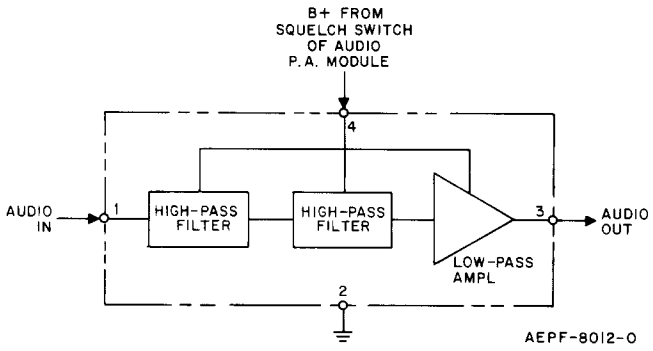


Figure 24. Audio Preamplifier Module, U6

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 25). 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.

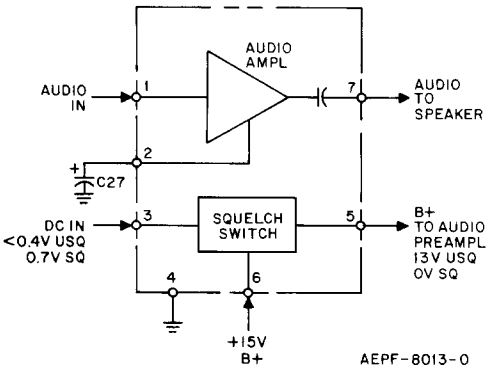


Figure 25. Audio Power Amplifier Module, U7

9. INJECTION MODULE, U8

a. VHF Radios

This is a hybrid module consisting of a common base buffer amplifier followed by a common-emitter tripler stage (see Figure 26). 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.

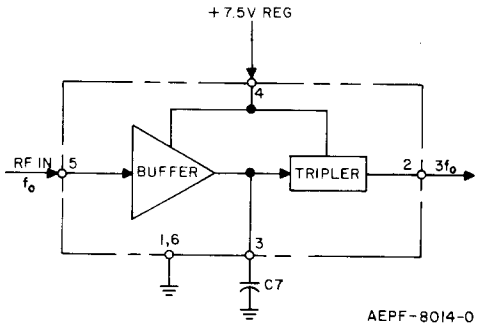


Figure 26. VHF Injection Module, U8

b. UHF Radios

This hybrid module has a common-base buffer transistor circuit with fixed tuning and a frequency doubler common-emitter transistor circuit which, when coupled in L4, has a tunable output (see Figure 27). The channel element output frequency (f_o) is doubled by the injection module doubler.

The injection module output ($2f_o$) is applied to "step recovery" diode CR2 which is used as a "times four" multiplier. The $8f_o$ frequency output of CR2 is then fed into the injection 2-cell helical filter for selectivity.

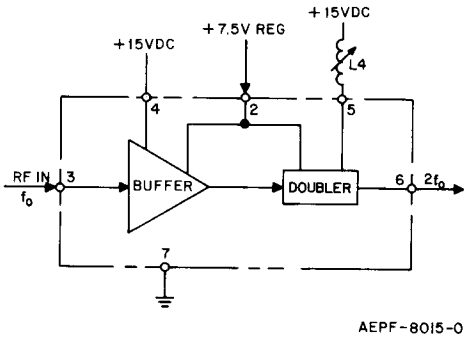


Figure 27. UHF Injection Module, U8

10. REGULATOR MODULE, U9

This module provides the regulated 7.5 volts dc required for use in the transmitter and receiver sections. It consists of a temperature-compensated Zener diode referencing an error amplifier and a series pass transistor with current limiting circuitry (see Figure 28). If the nominal 60 mA current capability of the regulator is exceeded, the output voltage will decrease towards zero volts dc providing short circuit burn-out protection.

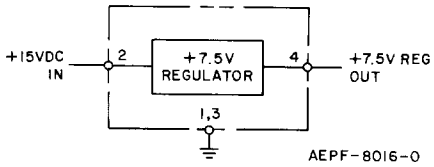


Figure 28. Regulator Module, U9

11. TRIPLER MODULE, U10

Tripler module U10 serves to isolate the channel element from the rest of the transmitter and to triple its input frequency. The module consists of an input low-pass filter followed by a common-base buffer amplifier to present a nominal 50-ohm impedance to the channel element (see Figures 29 and 30). A resonant circuit follows the buffer amplifier, which is tuned by external capacitor C101 (VHF) or C103 (UHF). A common-emitter tripler then follows to multiply the channel element frequency three times.

Capacitor C101 (VHF) or C103 (UHF) is the resonating capacitor for an internal broadband tuned circuit. Proper buffer-tripler module and channel element operation is indicated by the presence of a negative dc voltage on pin 4 of module U10 when measured with a high-impedance dc voltmeter.

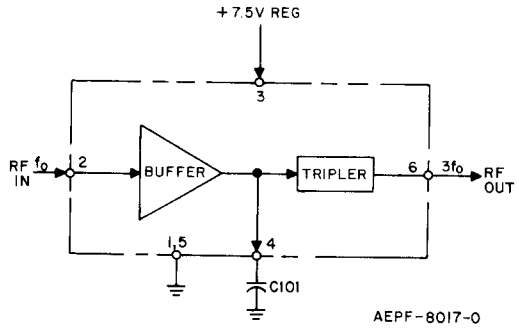


Figure 29. VHF Tripler Module, U10

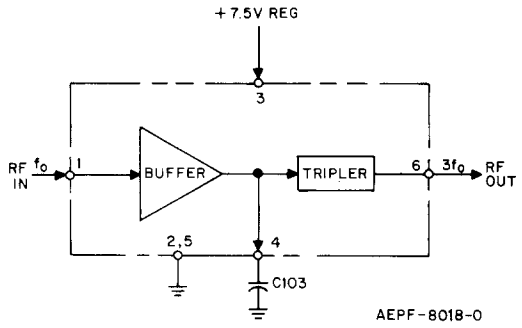


Figure 30. UHF Tripler Module, U10

12. TRANSMIT POWER AMPLIFIER MODULE, U12

a. VHF Radios

The transmit power amplifier module is a single-stage, Class C power amplifier incorporating an integral harmonic filter to attenuate frequencies above the carrier frequency (see Figure 31). It is supplied in four versions differing in frequency coverage and power output. 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. L107 functions as a power adjust coil; JU101 is added to maintain proper adjustment range when a high-power amplifier is used.

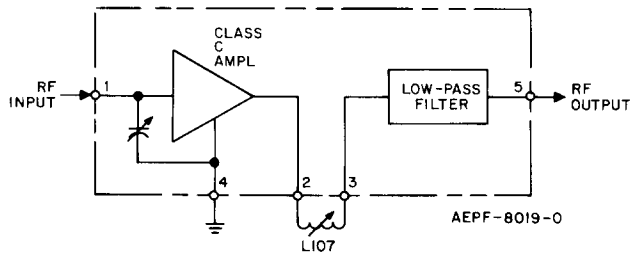


Figure 31.
VHF Transmit Power Amplifier Module, U12

b. UHF Radios

The 1.5-watt power amplifier is a Class C transistor, plug-in module (see Figure 32). Input and output inpedances are 50 ohms. Low-pass, low-Q impedance matching on the input and output provide broadband operation. Transmit B+ is present only when the transmitter is keyed. A five-pole harmonic filter is also included in the module to attenuate frequencies above the carrier frequency.

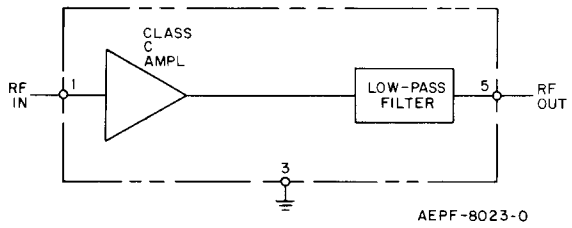


Figure 32.
1.5-Watt Power Amplifier Module, U12

The four-watt power amplifier is a two-transistor, plug-in module (see Figure 33). The first transistor is a Class A stage; the second is a Class C stage. This thin film module also includes a harmonic filter to attenuate frequencies above the carrier frequency.

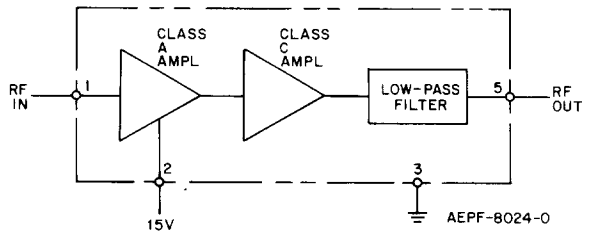


Figure 33.
4-Watt Transmit Power Amplifier Module, U12

13. "INSTANTANEOUS DEVIATION CONTROL" MODULE, U13

The "Instantaneous Deviation Control" (IDC) module located on the interconnect board serves several purposes. The circuit amplifies the low-level signal from the microphone cartridge (see Figure 34). The audio signal is subsequently pre-emphasized, amplified again, and applied to a clipper. As the microphone level is increased from zero volts, 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 voltage level for 5 kHz channel element deviation is adjustable with an external potentiometer.

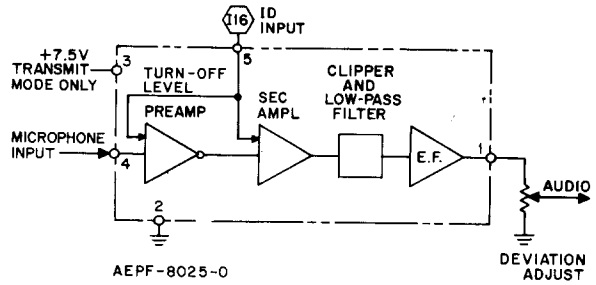


Figure 34.
"Instantaneous Deviation Control" Module, U13

14. CHANNEL ELEMENTS

a. General

The channel elements contain a crystal-controlled, actively compensated oscillator. Transmitter channel elements also contain varactors for modulating the oscillator. Primary differences involve output frequency and the crystal harmonic (overtone) being used.

b. Receiver Channel Elements

Refer to the simplified channel element diagram in Figure 35. The crystal-controlled oscillator employs the third overtone of the crystal and produces an rf output (f_o) at pin 5. In VHF receivers, the rf output is tripled in the injection module, and in UHF receivers the rf output is doubled in the injection module and quadrupled in the "step recovery" diode to produce an $8f_o$ signal.

The channel element receives +7.5 volts dc at pin 4 from a frequency selector switch (multiple frequency models) and enables only the selected channel element. The channel element current drain is approximately 2.5 mA maximum.

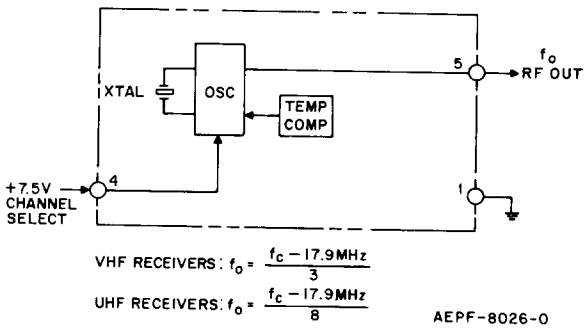


Figure 35.
Receiver Channel Element: CE1, CE2, etc.

c. Transmitter Channel Elements

The transmitter channel element is similar to the receiver channel element, except it has two audio inputs that are applied to varactors in the oscillator (see Figure 36). Also, the third overtone mode of the crystal is employed in the oscillator.

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.

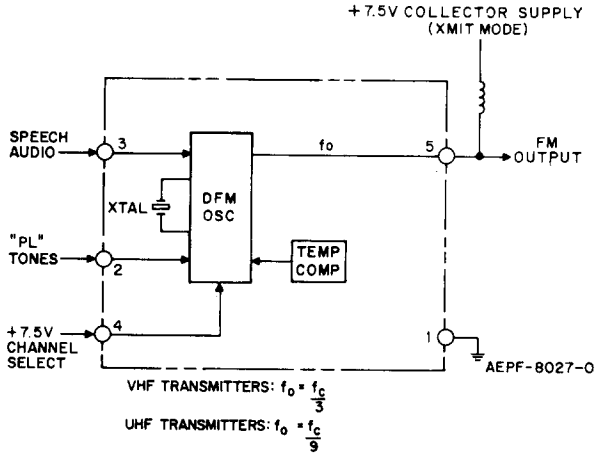


Figure 36.
Transmitter Channel Element: CE101, CE102, etc.

15. 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 37. 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.

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 38. The PL processor functions are altered when the transmitter is keyed.

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

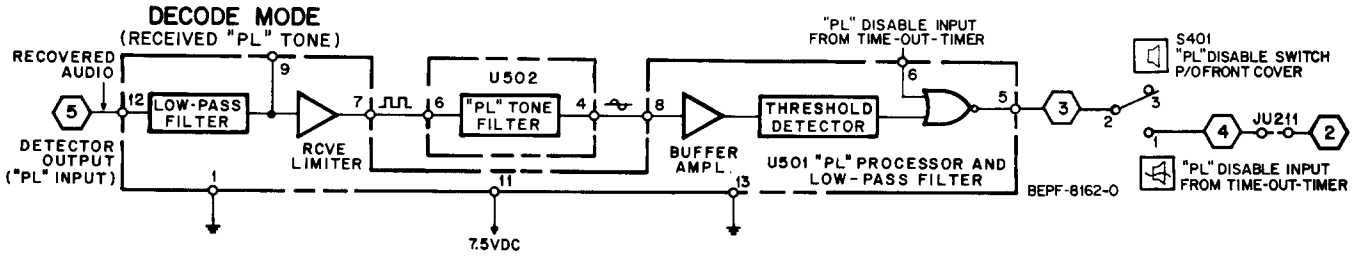


Figure 37. Tone "Private-Line" Circuit, Receive (Decode) Mode

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.

16. DIGITAL "PRIVATE-LINE" MODULES; U601, U602, U603, AND U604

a. General

The digital "Private-Line" circuit is a digital coded squelch system which consists of four thick-film hybrid modules used to encode and decode a 23-bit, binary "Private-Line" communications network. The digital PL deck can be installed in any MT500 "BBU" Series radio.

The digital PL transmitter and receiver are nonsychronous in that data is transmitted continuously with the conventional "sync" or burst signals which identify the beginning or end of a digital series. Each digital code word consists of 23 bits; 12 data bits followed by 11 parity bits. The processor logic acts as a mini-computer; it receiver, stores, and compares recovered code data with that stored in the code plug memory to determine its validity. In the transmit mode, the mini-computer functions as a word generator, producing a 23-bit continuous code. The code sequence is generated by the encoder logic circuits in the processor module, and is determined by the "Permacode" code plug module. The first nine bits are the octal equivalent of the number marked on the code plug, while the next three bits are always the same. The 11 parity bits are constructed by the processor which used a fixed algorithm to operate on the first 12 bits.

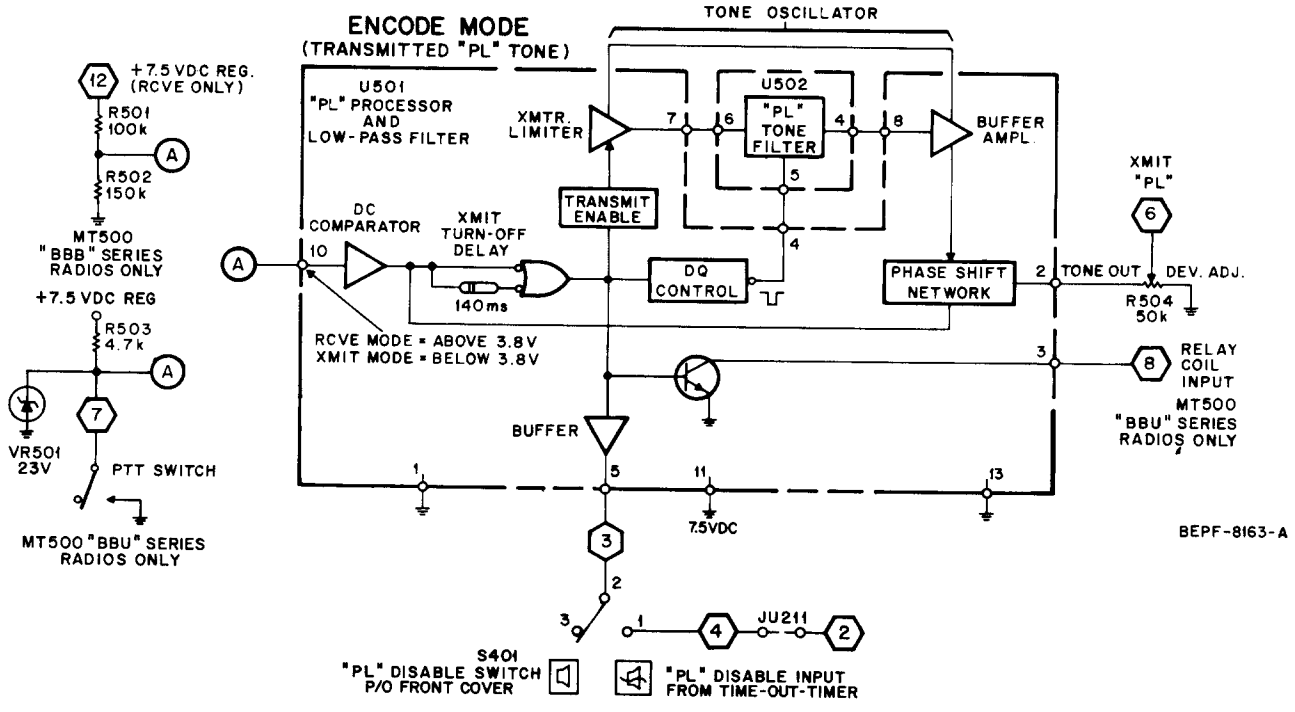


Figure 38. Tone "Private-Line" Circuit, Transmit (Encode) Mode

b. Code Conditioner Module; U601

In the receive mode, recovered audio is applied to pin 1 of the code conditioner module where an active, low-pass filter attenuates signals above 150 Hz; refer to Figure 39. The remaining signal (code) is amplified and applied to an amplitude limiter. The amplitude limited code is available at pin 6. The logic convention for the code word is such that an increase in frequency at the receiver antenna is recognized as a logic one (high) at pin 10 of the code conditioner. A code inverter is provided to accommodate both low and high side receiver mixer injection to maintain the logic convention at pin 10.

The code conditioner module also contains a phase-lock-loop (PLL) circuit, the purpose of which is to sense the incoming frequency and to lock onto the code word. Initially, before a code is detected, the PLL functions in a low sensitivity mode and permits only a percentage of the code word to be presented to the decoder. When a valid code is detected by the decoder, a detect signal appears as a logic high at pin 13 of the code conditioner, and remains high while the correct code is present. Upon detecting the high level, the control circuit will change the PLL to a higher sensitivity mode and permit all of the code to be applied to the decoder. The voltage at pin 12 will then drop low and unsquelch the receiver. The higher sensitivity mode provides additional immunity to audible interference when the detected code is present. Should the receiver momentarily lose data because of flutter, fade, or poor quieting, the switching circuit will hold the PLL in the higher sensitivity mode for approximately 500 miliseconds. With the PL squelch switch in the off position, B+ is applied to pin 14 and causes pin 12 to be low, effectively defeating or overriding the digital PL receive function. The switch does not, however, affect the processor, and the encoder will always produce code in the transmit mode.

c. Digital PL Processor Module; U602

The processor, which employs MOS/LSI logic, contains the necessary encoder and decoder logic as well as a 50 kHz crystal - controlled oscillator to provide timing (clock) pulses which control the logic in both the receive and transmit modes.

In the receive mode, the decoder logic receives and continuously samples data from the PLL output while comparing the incoming data with the preselected code stored in code plug module U604.

In the transmit mode, the push-to-talk pushbutton activates transmit/receive relay K101, and applies ground to pin 15. A 23-bit binary code is produced by the encoder and provided at pin 12. When the push-to-talk pushbutton is released, the current path through the relay coil is maintained through pin 14 of the processor for 120 milliseconds. The length of time is controlled by a timer in the processor. During the 120 milliseconds, the crystal-controlled 135 Hz square wave is gated to pin 12, passed through encode filter module U603, and is transmitted. The receiving radio decoder recognizes the 135 Hz signal as a turn-off code, and the receiver is immediately squelched.

d. Encode Filter Module; U603

The encode filter contains an amplifier, an active low-pass filter, and an inverter which are used only in the transmit mode. The code from pin 12 of the digital PL processor (typically 5 volts peak-to-peak) is coupled through an r-c coupling network to pin 1 of the encode filter. The code is then amplified and filtered to remove higher order audible components. This will cause the corners of the coded output pulses to be slightly rounded. Over all module gain is -10 dB; typical output amplitude is one volt peak-to-peak.

The filtered code at pin 2 is applied to the modulating input to the transmitter channel elements.

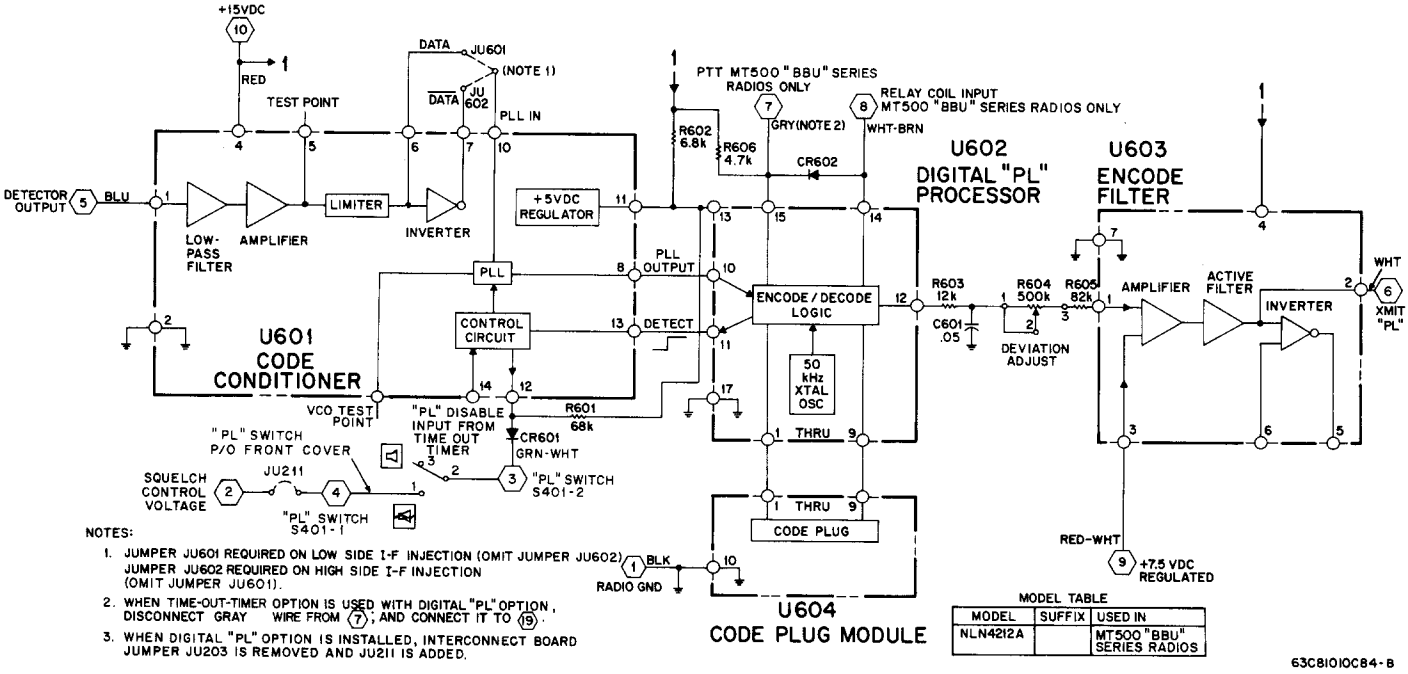


Figure 39. Digital "Private-Line" Circuit

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 40. 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

a. Locate the retaining screw above the push-to-talk switch and remove it (refer to Figure 1).

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.

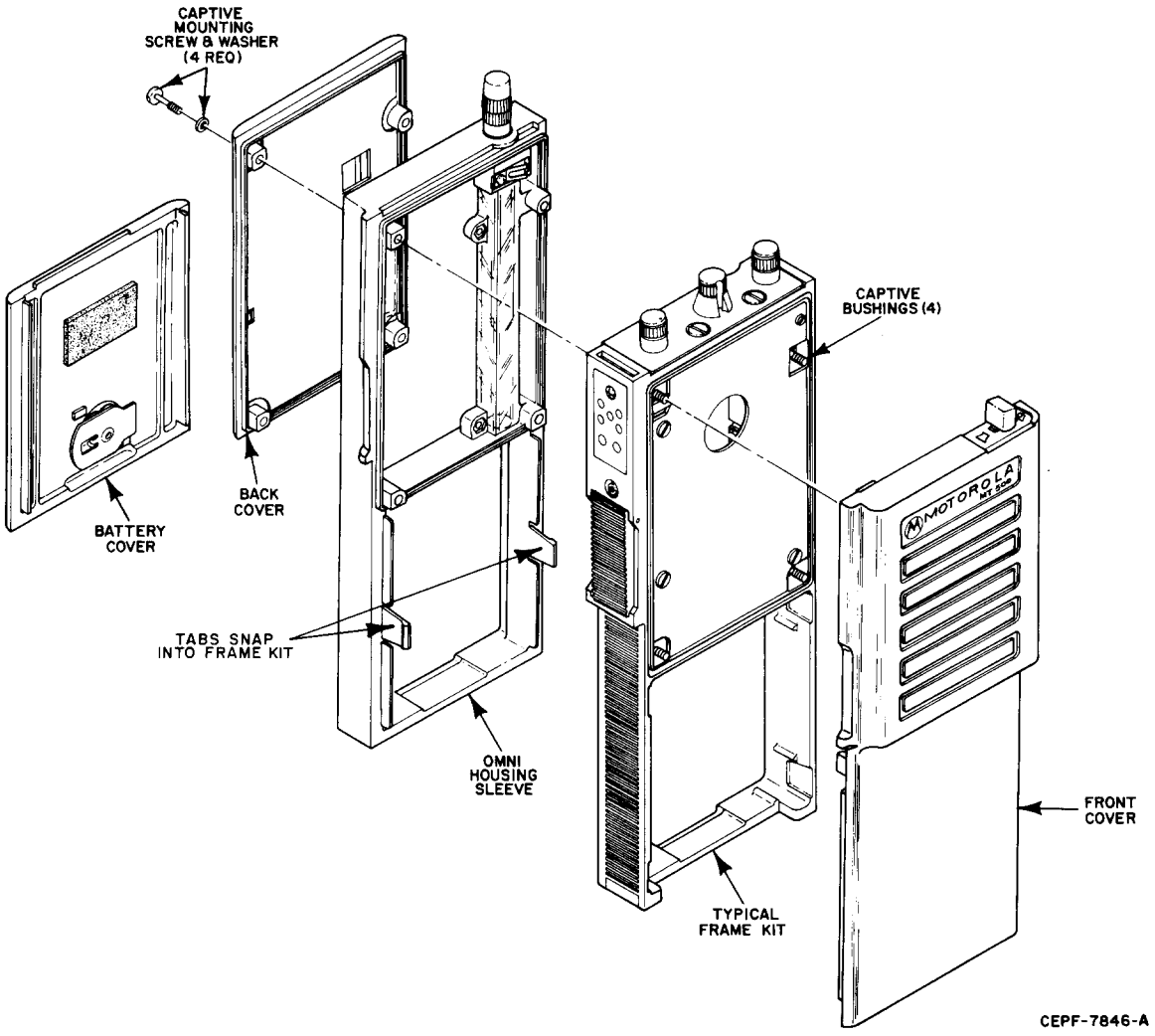
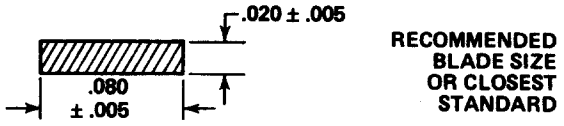


Figure 40. Typical MT500 Radio Disassembly Procedure

4. REMOVING THE TRANSMITTER-RECEIVER CIRCUIT BOARD

CAUTION

When removing or installing the transmitter-receiver circuit board, use a jeweler's screwdriver. The recommended screwdriver blade size is illustrated below. When tightening, use 17- to 22-inch-ounces torque.



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 before 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. ILLUSTRATED PARTS BREAKDOWN

The Illustrated Parts Breakdown (IPB) shows all the mechanical and electrical parts (except circuit boards). The boards shown do not illustrate any particular circuit configuration, and are merely shown for location within the radio. The illustrated parts breakdowns illustrate disassembly of controls, switches, speaker, microphone, etc.

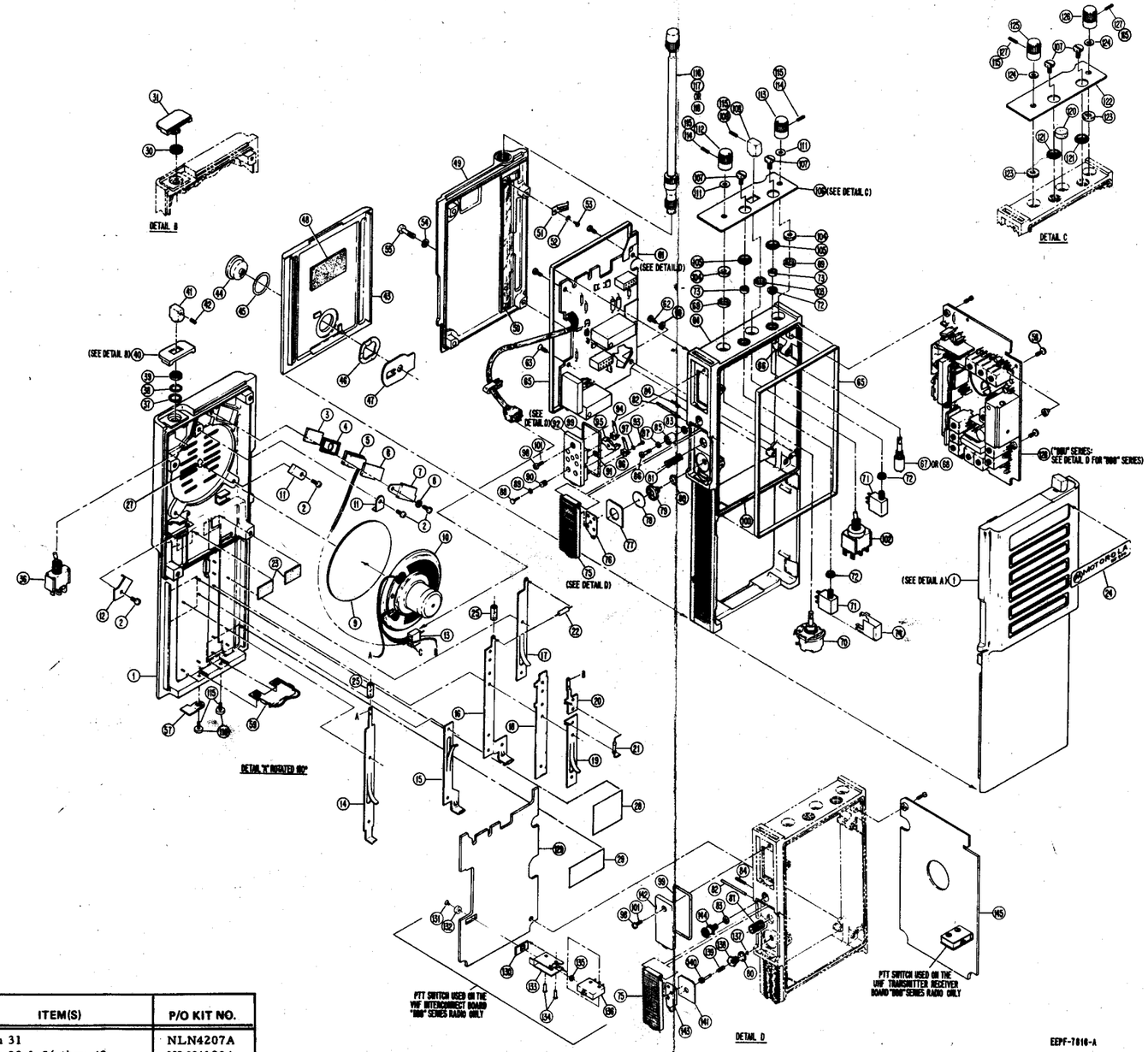
PARTS LIST

Exploded View Parts List — PLF-1303-A

ITEM NO.	NOMENCLATURE	MOTOROLA PART NO.
1	COVER, Front, Extended	15E05633D01
2	SCREW, Mach(2-56x1/8 Phil-Pan)	3S138651
3	CLOTH, Felt, Mic	35C05450B01
4	PAD, Mic	7505577F01
5	CARTRIDGE, Mic	59C82575J02
6	PAD, Clamp	75B82745J01
7	BRACKET, Mic	07C05672D01
8	WASHER, Spring	4B05314E01
9	CLOTH, Felt Grill	35C05370C01
10	SPEAKER	50D05334D01
11	CLAMP, Speaker	42B05670D01
12	CLAMP, Speaker	42B05671D01
13	RECEPT, Conn Assy	01-05956C63
14	STRAP, Contact, Neg	42B05573A01
15	STRAP, Contact, Sen	42B05575A01
16	STRAP, Contact, Charge	42D05283E01
17	STRAP, Contact	42B05576A01
18	INSULATOR, Contact	14D05282E01
19	STRAP, Contact, Pos	42D05280E01
20	STRAP, Contact, Pos	42D05281E01
21	FUSE	65C05214E01
22	RECTIFIER, Silicon	48D82466H13
23	INSULATOR, Paper	1405453F01(VHF) 1405453F02(UHF)
24	NAMEPLATE	33B05537E01
25	TUBING, Teflon (.38)	37S122977
26	Not Used	
27	ADHES. Silicone Rubber	11S10019A88
28	LABEL, Patent	1300868710
29	LABEL, FCC	54A865436
30	GASKET, Plug	32B05315E01
31	PLUG, Cover	38D05115E01
32	Not Used	
33	Not Used	
34	Not Used	
35	Not Used	
36	SWITCH, Toggle, SPDT	40D05061E01
37	GASKET, "O" Ring	32B05082E01
38	WASHER, Special	4B05081E01
39	NUT, Mtg	2B05050E03
40	ESCUTCHEON, Switch	13D05057E01
41	KNOB, Switch	36C05114E01
42	SCREW, Set	3B83174C04
43	COVER, Battery	15E05697D01
44	BUTTON	38D05908D01
45	WASHER, Button	4B05910D01
46	WASHER, Spring	4B05316E01
47	LATCH	55D05907D01
48	PAD	75B05083E01
49	COVER, Rear	15E05698D01
50	SHIELD, Antenna Tube	26C05045E01
51	CLIP, Antenna	42C05860D01
52	WASHER, Spring	4B05314E03
53	SCREW, Antenna Clip	3B05044E01
54	WASHER, Seal	4B84345A06
55	SCREW, Captive	3C05662D01
56	Not Used	
57	INSULATOR, Contact	14C05359E01
58	SCREW, Captive	0305864D01
59	LATCH Assy	NLN4181A
60	WASHER, Insulated	0400474215(UHF)
61	INTERCONNECT Bd. Assy	
62	SCR, Mach(#2-56x3/16 Phl Pan)	3S138661
63	SCR, Mach(#2-56x1/4 Slot Flt Hd)	3S136666
64	FRAME, Short	7E05547D01
65	GASKET, Frame	32C05909D01
66	BUSHING, Cover Mtg	43C05661D01
67	POT, Cermet	18D05055E01
68	POT, Cermet Alternate	18D05333E01
69	NUT, Special	2A82653D03
70	POTENTIOMETER, Control Sw.	18D05370E01
71	JACK, Micro	9D05283B01
72	BUSHING, Shoulder	43B05052E01
73	NUT, Special	2B05050E01
74	SHIELD, Antenna	26D05054E01
75	LEVER	45D05784D01
76	SPRING, Actuator (PTT)	41C05783D03
77	GASKET (PTT)	32C05753E01
78	CONTACT, Disc (PTT)	39C05684E01
79	CONTACT, Feed-Thru (PTT)	39D05681E01
80	SEAL, "O" Ring	32B05082E02
81	SPRING, Compression (PTT)	41B05267E01
82	PIN, Spring	22B05084E01
83	WASHER, Insert	04B05249E01
84	SCREW, Set	03C05246E01
85	INSERT, Threaded	43C05781D01
86	STUD	46C05154E01
87	WASHER, Stud	04B05248E01
88	PIN, Contact	39B05080E01
89	GASKET, "O" Ring	32B05082E03
90	SPRING, Compression	41B05424F01
91	RING, Retaining	42C05463E02
92	RECEPTACLE	09E05677D01
93	SCREW(#0-80x1/8 Fill Hd)	3S139684
94	CONTACT	41C05076E03
95	BLOCK	46C05072E01
96	CONTACT	41C05076E01
97	WASHER	4S134190
98	SCR, Mach(#2-56x1/8 SST)	3S138651
99	SEAL, "O" Ring	32C05075E01
100	ADHESIVE, RTV Silicone Rubber	11S10019A88
101	SEALANT, Compound (PURP)	11S10019A63
102	SWITCH, Toggle	40D05120E01
103	NUT, Special	2A82653D07
104	PAD, Rubber	75A83562H02
105	BUSHING, Insulator	43B05051E01
106	ESCUTCHEON	13D05621D05
107	SCREW, Jack	03B05129E01
108	KNOB, Switch	36C05114E01
109	SCREW, Set	03B83174C04
110	SCREW, Latch	03B05011E01
111	WASHER, Teflon	04B82418B97
112	KNOB, Vol	36C05927D01
113	KNOB, Squelch	36C05927D03
114	S CREW	3B83174C02
115	GLYPTOL	11S00008675
116	ANTENNA, Telescopic(2 Section)	85C05550E01
117	ANTENNA, Telescopic(5 Section)	85D05549E01
118	ANTENNA, Telescopis (6 Section)	85D05509E01
119	SCREW, Jack	3B05129E01
120	PAD, Rubber	75A83562H01
121	BUSHING, Insulating	43B05051E01
122	ESCUTCHEON	13D05621D01
123	PAD, Rubber	75A83562H02
124	WASHER, Teflon	04B82418B97
125	KNOB, Vol	36C05927D01
126	KNOB, Squelch	36C05927D03
127	SCREW, Set	3B83174C02
128	TRANSCEIVER Bd Assy ("BBU" Series)	NUE6232A(UHF) NUE6233A(UHF) NUE6282A(UHF) NUE6283A(UHF) NUE6312A(UHF) NUE6313A(UHF) NUD6241A(VHF) NUD6242A(VHF) NUD6243A(VHF) NUD6282A(VHF) NUD6292A(VHF) NUD6302A(VHF) NUD6303A(VHF) NUD6311A(VHF) NUD6312A(VHF) NUD6313A(VHF)
129	INTERCONNECT Bd Assy	
130	INSULATOR, PTT	1405362E01
131	SCR, Mach (#2-56 x 1/8 Flt Hd)	03S00139675
132	WASHER, Special	04B05361E01
133	BRACKET, Switch	07C05261E01
134	EYELET	05B05095E05
135	NUT, Captive	02B05254E01
136	SWITCH, Micro	40D05265E01
137	RING, Retainer	42B05274E01
138	NUT, PTT	02C05250E01
139	SPRING, PTT	41B05252E01
140	ACTUATOR, PTT	47B05251E01
141	GASKET, Switch	32C05077E01
142	COVER, Receptacle	15E05212E01
143	SPRING, Actuator	41C05783D01
144	STUD, Heat Sink	46C05247E01
145	TRANSCEIVER Bd Assy ("BBB" Series)	NUE6242A(UHF) NUE6243A(UHF) NUE6292A(UHF) NUE6293A(UHF) NUD6282A(VHF) NUD6253A(VHF) NUD6262A(VHF) NUD6272A(VHF)

ITEM(S)	P/O KIT NO.
1 thru 31	NLN4207A
1 thru 30 & 36 thru 42	NLN4183A
43 thru 48	NLN4180A
49 thru 55	NLN4176A
57	NLN4194A
61 thru 101	NHD6081A
61 thru 103	NHD6001A
61 thru 75, 80 thru 84, 98 thru 103, & 130 thru 144	NHD6101A/ NHD6041A
104 thru 115	NLN4189A
116	NAE6271A
117	NAD6324A
118	NAD6322A
119 thru 127	NLN4188A

EPF-8117-O



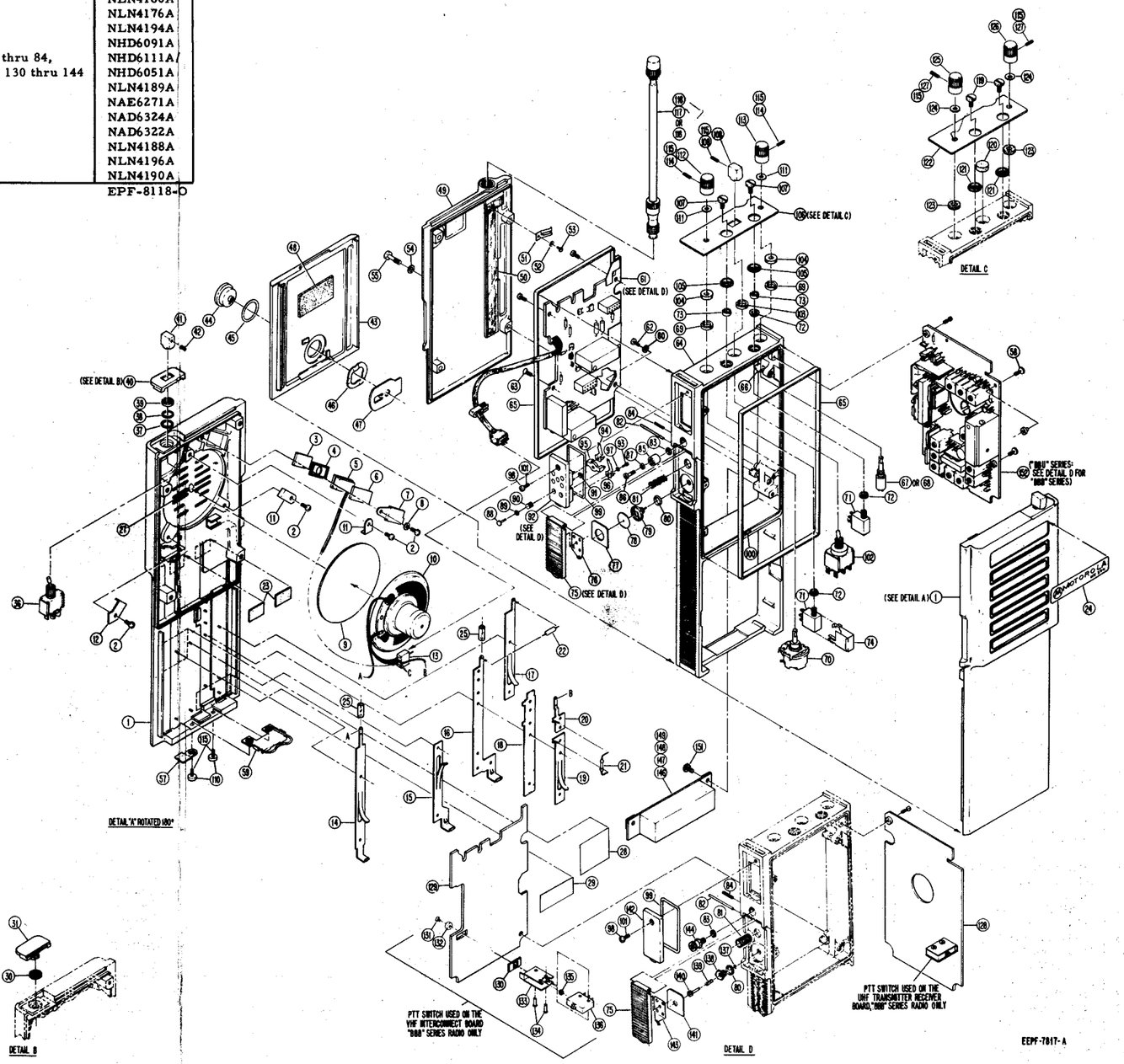
SLIM-LINE, SHORT
C1R1, C2R2

PARTS LIST

Exploded View Parts List PLF-1304-A

ITEM NO.	NOMENCLATURE	MOTOROLA PART NO.
1	COVER, Front, Extended	15E05660D01
2	SCREW,Machine(2-56xl/8PH-Pan)	3S138651
3	CLOTH, Felt Mic	35C05450B01
4	PAD	7505577F01
5	CARTRIDGE, Mic	59C82575J02
6	PAD, Clamp	75B82745J01
7	BRACKET, Mic .	07C05672D01
8	WASHER, Spring	4B05314E01
9	CLOTH, Felt Grill	35C05370C01
10	SPEAKER	50D05334D01
11	CLAMP, Speaker	42B05670D01
12	CLAMP, Speaker	42B05671D01
13	RECEPT, Conn Assy	0105958C86
14	STRAP, Contact, Neg	42B05573A01
15	STRAP, Contact, Sen	42B05575A01
16	STRAP, Contact, Charge	42D05283E01
17	STRAP, Contact	42B05576A01
18	INSULATOR, Contact	14D05282E01
19	STRAP, Contact, Pos	42D05280E01
20	STRAP, Contact, Pos	42D05281E01
21	FUSE	65C05214E01
22	RECTIFIER, Silicon	48D82466H13
23	INSULATOR, Paper	14-82392E05
24	NAMEPLATE	33B05537E01
25	TUBING, Teflon (.38)	37S122977
26	Not Used	
27	ADHES, Silicone Rubber	11S10019A88
28	LABEL, Patent	1305436E01
29	LABEL, FCC	54A865436
30	GASKET, Plug	32B05315E01
31	PLUG, Cover	38D05115E01
32	Not Used	
33	Not Used	
34	Not Used	
35	Not Used	
36	SWITCH, Toggle, SPDT	40D05061E01
37	GASKET, "O" Ring	32B05082E01
38	WASHER, Special	4B05081E01
39	NUT, Mtg	2B05050E03
40	ESCUTCHEON, Switch	13D05057E01
41	KNOB, Switch	36C05114E01
42	SCREW, Set	3B83174C04
43	COVER, Battery	15E05697D01
44	BUTTON	38D05908D01
45	WASHER	4B05910D01
46	WASHER, Spring	4B05316E01
47	LATCH	55D05907D01
48	PAD	75B05083E01
49	COVER, Rear, Extended (SL)	15E05039E01
50	SHIELD, Antenna Tube	26C05045E01
51	CLIP, Antenna	42C05860D01
52	WASHER, Spring	4B05314E03
53	SCREW, Antenna Clip	3B05044E01
54	WASHER, Seal	4B84345A06
55	SCREW, Captive	3C05662D01
56	Not Used	
57	INSULATOR, Contact	14C05359A01
58	SCREW, Captive	0305864D01
59	LATCH Assy	NLN4181A
60	WASHER, Insulated	0400474215
61	INTERCONNECT Bd. Assy.	
62	SCR,Mach(#2-56x3/16 Phl Pan)	3S138661
63	SCR,Mach(#2-56xl/4 Slot Flt Hd)	3S136666
64	FRAME, Extended	7E05640D01
65	GASKET, Frame	32C05909D01
66	BUSHING, Cover Mtg	43C05661D01
67	POT, Cermet	18D05055E01
68	POT, Cermet Alternate	18D05333E01
69	NUT, Special	2A82653D03
70	POTENTIOMETER, Control Sw.	18D05370E01
71	JACK, Micro	9D05283B01
72	BUSHING, Shoulder	43B05052E01
73	NUT, Special	2B05050E01
74	SHIELD, Antenna	26D0505E01
75	LEVER	45D05784D01
76	SPRING, Actuator (PTT)	41C05783D03
77	GASKET (PTT)	32C05753E01
78	CONTACT, Disc (PTT)	39C05684E01
79	CONTACT, Feed-Thru (PTT)	39D05681E01
80	SEAL "O" Ring	32B05082E03
81	SPRING Compression (PTT)	41B05267E01
82	PIN, Spring	22B05084E02
83	WASHER, Insert	04B05249E01
84	SCREW, Set	03C05246E01
85	INSERT, Threaded	43C05781D01
86	STUD	46C05154E01
87	WASHER, Stud	04B05248E01
88	PIN, Contact	39B05080E01
89	GASKET, "O" Ring	32B05082E03
90	SPRING, Compression	41B05424F01
91	RING, Retaining	42C05463E02
92	RECEPTACLE	09E05677D01
93	SCREW(#0-80xl/8 Fill Hd.)	3S139684
94	CONTACT	41C05076E03
95	BLOCK	46C05072E01
96	CONTACT	41C05076E01
97	WASHER	4S134190
98	SCR, Mach(#2-56xl/8 SST)	3S138651
99	SEAL "O" Ring	32C05075E01
100	ADHESIVE, RTV Silicone Rubber	11S10019A63
101	SEALANT, Compound (PURP)	11S10019A63
102	SWITCH, Toggle	40D05120E01
103	NUT, Special	2A82653D07
104	PAD, Rubber	75A83562H02
105	BUSHING, Insulator	43B05051E01
106	ESCUTCHEON	13D05621D05
107	SCREW, Jack	03B05129E01
108	KNOB, Switch	36C05114E01
109	SCREW, Set	03B83174C04
110	SCREW, Latch	03B05011E01
111	WASHER, Teflon	04B82418B97
112	KNOB, Vol	36C05927D01
113	KNOB, Sq.	36C05927D03
114	SCREW, Set	3B83174C02
115	GLYPTOL	11S00008675
116	ANTENNA, Telescopic	85C05550E01
117	ANTENNA, Telescopic(5 section)	85D05549E01
118	ANTENNA, Telescopic(6 section)	85D05509E01
119	SCREW, Jack	3B05129E01
120	PAD, Rubber	75A83562H01
121	BUSHING, Insulating	43B05051E01
122	ESCUTCHEON	13D05621D01
123	PAD, Rubber	75A83562H02
124	WASHER, Teflon	04B82418B97
125	KNOB, Vol	36C05927D01
126	KNOB, Squelch	36C05927D03
127	SCREW, Set	3B83174C02
128	TRANSCEIVER Bd. Assy ("BBB" Series)	NUD6252A(VHF) NUD6253A(VHF) NUD6262A(VHF) NUD6272A(VHF) NUE6242A(UHF) NUE6243A(UHF) NUE6292A(UHF) NUE6293A(UHF)
129	INTERCONNECT Bd. Assy	
130	INSULATOR, PTT	1405362E01
131	SCR, Mach(#2-56 x 1/8 Flt Hd)	03S00139675
132	WASHER, Special	04B05361E01
133	BRACKET, Switch	07C05261E01
134	EYELET	05B05095E05
135	NUT, Captive	02B05254E01
136	SWITCH, Micro	40D05265E01
137	RING, Retainer	42B05274E01
138	NUT, PTT	02C05250E01
139	SPRING, PTT	41B05252E01
140	ACTUATOR, PTT	47B05251E01
141	GASKET, Switch	32C05077E01
142	COVER, Receptacle	15E05212E01
143	SPRING, Actuator	41C05783D01
144	STUD, Heat Sink	46C05247E01
145	PLATE, Information	64C05538E01
146	OPTION Deck (Tone PL)	NLN4211A/ NLN4646A
147	OPTION Deck (Digital PL)	NLN4212A
148	OPTION Deck (Selective Call)	NLN4213A
149	OPTION Deck (Single-Tone)	NLN4723A
150	Not Used	
151	SCREW, Hex(#2-56 x 3/16)	0305493F01
152	TRANSCEIVER Bd. Assy ("BBU" Series)	NUD6241A(VHF) NUD6242A(VHF) NUD6243A(VHF) NUD6282A(VHF) NUD6292A(VHF) NUD6302A(VHF) NUD6303A(VHF) NUD6311A(VHF) NUD6312A(VHF) NUD6313A(VHF) NUE6232A(UHF) NUE6233A(UHF) NUE6282A(UHF) NUE6283A(UHF) NUE6312A(UHF) NUE6313A(UHF)

ITEM(S)	P/O KIT NO.
1 thru 29 & 36 thru 41	NLN4184A
1 thru 31	NLN4208A
43 thru 48	NLN4180A
49 thru 55	NLN4176A
57	NLN4194A
60 thru 101	NHD6091A
60 thru 75, 80 thru 84, 98 thru 103, & 130 thru 144	NHD6111A/ NHD6051A
104 thru 115	NLN4189A
116	NAE6271A
117	NAD6324A
118	NAD6322A
119 thru 127	NLN4188A
145	NLN4196A
151	NLN4190A
	EPF-8118-O



SLIM-LINE, EXTENDED
C1R1, C2R2

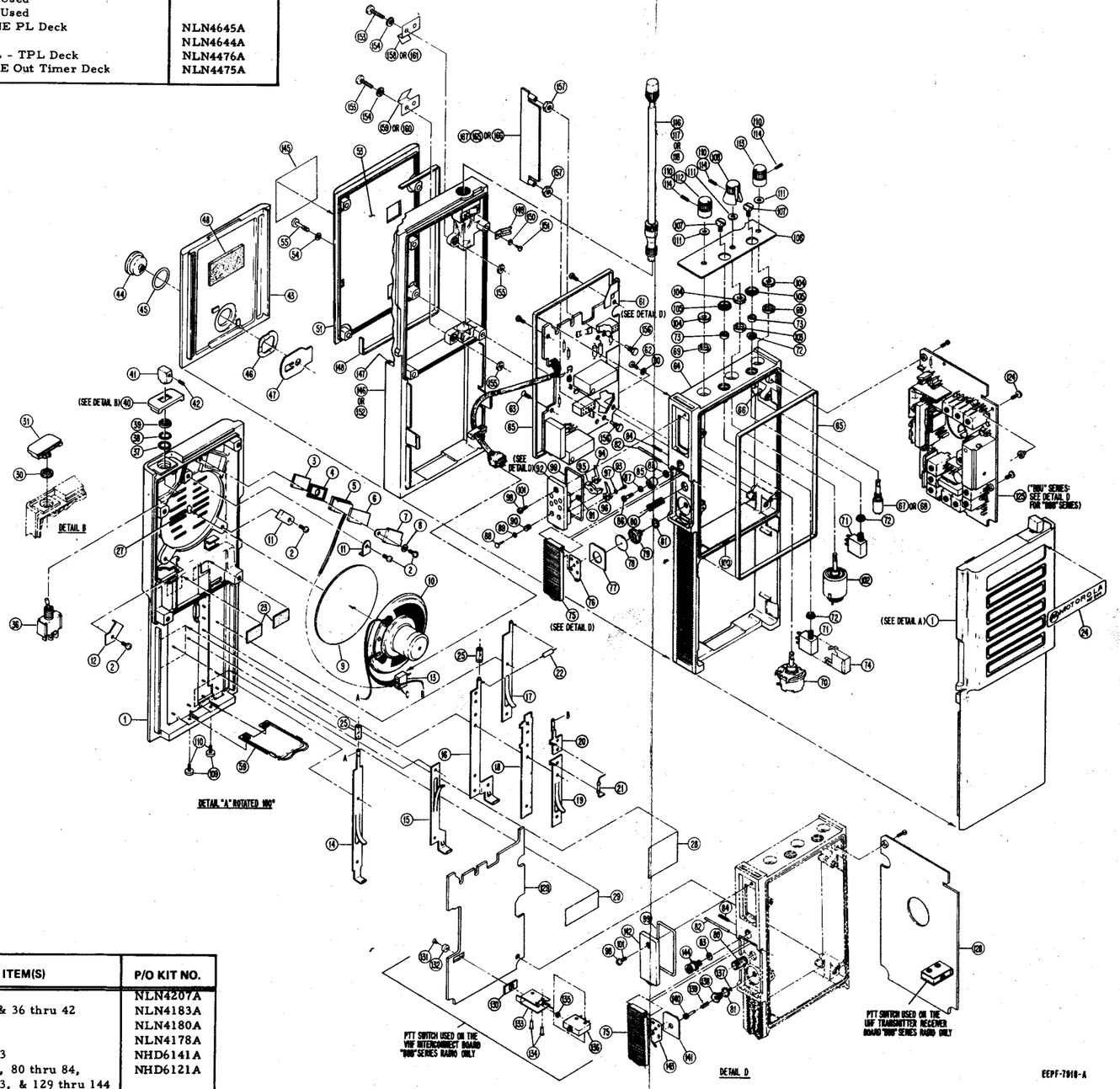
PARTS LIST

Exploded View Parts List PLF-1305-A

ITEM NO.	NOMENCLATURE	MOTOROLA PART NO.
1	COVER, Front, Short	15E05633D01
2	SCREW,Mach(2-56x1/8 Phil Pan)	3S138651
3	CLOTH, Felt, Mic	35C05450B01
4	PAD, Mic	7505577F01
5	CARTRIDGE, Mic	59C82575J02
6	PAD, Clamp	75B82745J01
7	BRACKET, Mic	07C05672D01
8	WASHER, Spring	4B05314E01
9	CLOTH, Felt Grill	35C05370C01
10	SPEAKER	50D05334D01
11	CLAMP, Speaker	42B05670D01
12	CLAMP, Speaker	42B05671D01
13	RECEPT, Conn Assy	01-05956C63
14	STRAP, Contact, Neg	42B05573A01
15	STRAP, Contact, Sen	42B05575A01
16	STRAP, Contact, Charge	42D05283E01
17	STRAP, Contact	42B05576A01
18	INSULATOR, Contact	14D05282E01
19	STRAP, Contact, Pos	42D05280E01
20	STRAP, Contact, Pos	42D05281E01
21	FUSE	65C05214E01
22	RECTIFIER, Silicon	48D82466H13
23	INSULATOR, Paper	1405453F01(VHF) 1405453F02(UHF)
24	NAMEPLATE	33B05537E01
25	TUBING, Teflon (.38LG)	37S122977
26	Not Used	
27	ADHES. Silicone Rubber	11S10019A88
28	LABEL, Patent	1300868710
29	LABEL, FCC	54A865436
30	GASKET, Plug	32B05315E01
31	PLUG, Cover	38D05115E01
32	Not Used	
33	Not Used	
34	Not Used	
35	Not Used	
36	SWITCH, Toggle SPDT	40D05061E01
37	GASKET, "O" Ring	32B05082E01
38	WASHER, Special	4B05081E01
39	NUT, Mtg	2B05050E03
40	ESCUTCHEON, Switch	13D05057E01
41	KNOB, Switch	36C05114E01
42	SCREW, Set	3B83174C04
43	COVER, Battery	15E05697D01
44	BUTTON	38D05908D01
45	WASHER	4B05910D01
46	WASHER, Spring	4B05316E01
47	LATCH	55D05907D01
48	PAD	75B05083E01
49	Not Used	
50	Not Used	
51	COVER, Rear, Short	15E05699D01
52	Not Used	
53	PAD	7505533F02
54	WASHER, Seal	4B84345A06
55	SCREW, Captive	3C05662D03
56	Not Used	
57	Not Used	
58	Not Used	
59	LATCH Assy	NLN4182A
60	WASHER, Insulated	0400474215(UHF)
61	INTERCONNECT Bd Assy	
62	SCR, Mach(#2-56x3/16 Phl Pan)	3S138661
63	SCR, Mach(#2-56xl/4 Slot Flt Hd)	3S136666
64	FRAME, Short	7E05547E01
65	GASKET, Frame	32C05909D01
66	BUSHING, Cover Mtg	43C05661D01
67	POT, Cermet	18D05055E01
68	POT, Cermet Alternate	18D05333E01
69	NUT, Special	2A82653D03
70	POTENTIOMETER, Control Sw.	18D05370E01
71	JACK, Micro	9D05283B01
72	BUSHING, Shoulder	43B05052E01
73	NUT, Special	2B05050E01
74	SHIELD, Antenna	26D05054E01
75	LEVER	45D05784D01
76	SPRING, Actuator (PTT)	41C05783D03
77	GASKET (PTT)	32C05753E01
78	CONTACT, Disc (PTT)	39C05684E01
79	CONTACT, Feed-Thru (PTT)	39D05681E01
80	SPRING, Compression (PTT)	41B05267E01
81	SEAL, "O" Ring	32B05082E02
82	PIN, Spring	22B05084E02
83	WASHER, Insert	04B05249E01
84	SCREW, Set	03C05246E01
85	INSERT, Threaded	43C05781D01
86	STUD	46C05154E01
87	WASHER, Stud	04B05248E01

88	PIN, Contact	39B05080E01
89	GASKET "O" Ring	32B05082E03
90	SPRING, Compression	41B05424F01
91	RING, Retaining	42C05463E02
92	RECEPTACLE	09E05677D01
93	SCREW, (#0-80x1/8 Fill Hd)	3S139684
94	CONTACT	41C05076E03
95	BLOCK	46C05072E01
96	CONTACT	41C05076E01
97	WASHER	4S134190
98	SCR, Mach(#2-56xl/8 SST)	3S138651
99	SEAL "O" Ring	32C05075E01
100	ADHESIVE, RTV Silicone Rubber	11S10019A88
101	SEALANT, Compound	11S10019A63
102	SWITCH, Rotary	40D05119E01
103	NUT, Special	2B82653D05
104	PAD, Rubber	75A83562H02
105	BUSHING, Insulator	43B05051E01
106	ESCUTCHEON	13D05621D05
107	SCREW, Jack	03B05129E01
108	KNOB, Control	36C05926D01
109	SCREW, Latch	3B05011E01
110	GLYPTOL	11S00008675
111	WASHER, Teflon	04B82418B97
112	KNOB, Vol	36C05927D01
113	KNOB, Squelch	36C05927D03
114	SCREW, Set	3B83174C02
115	Not Used	
116	ANTENNA, Telescopic(2 Section)	85C05550E01
117	ANTENNA, Telescopic(5 Section)	85D05549E01
118	ANTENNA, Telescopic(6 Section)	85D05509E01
119	Not Used	
120	Not Used	
121	Not Used	
122	Not Used	
123	Not Used	
124	SCREW, Captive	0305864D01
125	TRANSCEIVER Bd. Assy ("BBU" Series)	NUE6232A(UHF) NUE6233A(UHF) NUE6282A(UHF) NUE6283A(UHF) NUE6312A(UHF) NUE6313A(UHF) NUD6241A(VHF) NUD6242A(VHF) NUD6243A(VHF) NUD6282A(VHF) NUD6292A(VHF) NUD6302A(VHF) NUD6303A(VHF) NUD6311A(VHF) NUD6312A(VHF) NUD6313A(VHF)
126	Not Used	
127	Not Used	
128	TRANSCEIVER Bd. Assy ("BBB" Series)	NUE6242A(UHF) NUE6243A(UHF) NUE6292A(UHF) NUE6293A(UHF) NUD6252A(VHF) NUD6253A(VHF) NUD6262A(VHF) NUD6272A(VHF)
129	INTERCONNECT Bd. Assy	
130	INSULATOR, PTT	1405362E01
131	SCR, Mach(#2-56xl/8 Flt Hd)	03S00139675
132	WASHER, Special	04B05361E01
133	BRACKET, Switch	07C05261E01
134	EYELET	05B05095E05
135	NUT, Captive	02B05254E01
136	SWITCH, Micro	40D05265E01
137	RING, Retainer	42B05274E01
138	NUT, PTT	02C05250E01
139	SPRING, PTT	41B05252E01
140	ACTUATOR, PTT	47B05251E01
141	GASKET, Switch	32C05077E01
142	COVER, Receptacle	15E05212E01
143	SPRING, Actuator	41C05783D01
144	STUD, Heat Sink	46C05247E01
145	PLATE, Information	64C05538E01
146	HOUSING, Sleeve, Short	15E05651D01
147	ADHESIVE, RTV Silicone Rubber	11S10019A76
148	GASKET, Frame	32C05909D01
149	CLIP, Antenna	42C05860D01
150	WASHER, Spring	04B05314E03
151	SCREW, Special	03B05044E01
152	HOUSING, Sleeve	15E05651D02
153	SCREW, Mach(2-56x5/16 Slot Bnd)	3S115356
154	LK Wash (#2 Split)	4S400139
155	NUT (#2 Hex)	2S115676
156	POST, Guide	46C05798E01
157	NUT	02B05797E01

158	CLIP, Option Bd.	42D05445E04
159	CLIP, Option Bd.	42D05445E03
160	CLIP, Option Bd.	42D05445E02
161	CLIP, Option Bd.	42D05445E01
162	Not Used	
163	Not Used	
164	Not Used	
165	TONE PL Deck	NLN4645A NLN4644A
166	DPL - TPL Deck	NLN4476A
167	TIME Out Timer Deck	NLN4475A



ITEM(S)	P/O KIT NO.
1 thru 31	NLN4207A
1 thru 29 & 36 thru 42	NLN4183A
43 thru 48	NLN4180A
51 thru 55	NLN4178A
61 thru 103	NHD6141A
61 thru 75, 80 thru 84, 98 thru 103, & 129 thru 144	NHD6121A
104 thru 114	NLN4643A
116	NAE6271A
117	NAD6324A
118	NAD6322A
145	NLN4196A
146 thru 151	NLN4172A
147 thru 152	NLN4173A
153 thru 157 & 160, 161	NLN4187A
153 thru 159	NLN4195A

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OMNI, SHORT
C4R4, C6R6, C8R8

PARTS LIST

Exploded View Parts List PLF-1306-A

ITEM NO.	NOMENCLATURE	MOTOROLA PART NO.
1	COVER, Front, Extended	15E05660D01
2	SCREW, Machine(2-56x1/8Phl-Pan	3S138651
3	CLOTH, Felt, Mic	35C05450B01
4	PAD, Mic	7505577F01
5	CARTRIDGE, Mic	59C82575J02
6	PAD, Clamp	75B82745J01
7	BRACKET, Mic	07C05672D01
8	WASHER, Spring	4B05314E01
9	CLOTH, Felt Grill	35C05370C01
10	SPEAKER	50D05334D01
11	CLAMP, Speaker	42B05670D01
12	CLAMP, Speaker	42B05671D01
13	RECEPT, Conn Assy	01-05956C63
14	STRAP, Contact, Neg	42B05573A01
15	STRAP, Contact, Sen	42B05575A01
16	STRAP, Contact, Charge	42D05283E01
17	STRAP, Contact	42B05576A01
18	INSULATOR, Contact	14D05282E01
19	STRAP, Contact, Pos	42D05280E01
20	STRAP, Contact, Pos	42D05281E01
21	FUSE	65C05214E01
22	RECTIFIER, Silicon	48D82466H13
23	INSULATOR, Paper	1405453F01(VHF) 1405453F02(UHF)
24	NAMEPLATE	33B05537E01
25	TUBING, Teflon (.38LG)	37S122977
26	Not Used	
27	ADHES, Silicone Rubber	11S10019A88
28	LABEL, Patent	1300868710
29	LABEL, FCC	54A865436
30	GASKET, Plug	32B05315E01
31	PLUG, Cover	38D05115E01
32	Not Used	
33	Not Used	
34	Not Used	
35	Not Used	
36	SWITCH, Toggle, SPDT	40D05061E01
37	GASKET, "O" Ring	32B05082E01
38	WASHER, Special	4B05081E01
39	NUT, Mtg	2B05050E03
40	ESCUTCHEON, Switch	13D05057E01
41	KNOB, Switch	36C05114E01
42	SCREW, Set	3B83174C04
43	COVER, Battery	15E05697D01
44	BUTTON	38D05908D01
45	WASHER	4B05910D01
46	WASHER, Spring	4B05316E01
47	LATCH	55D05907D01
48	PAD	75B05083E01
49	Not Used	
50	Not Used	
51	COVER, Rear	15E05943D01
52	PAD	75B05083E06
53	PAD	7505533F01
54	WASHER, Seal	4B84345A06
55	SCREW, Captive	3C05662D03
56	Not Used	
57	Not Used	
58	Not Used	
59	LATCH Assy	NLN4182A
60	Not Used	
61	INTERCONNECT Bd Assy	
62	SCR, Mach (#2-56x3/16 Phl Pan)	3S138661
63	SCR, Mach(#2-56x1/4Slot FltHd)	3S136666
64	FRAME, Long	7E05640D01
65	GASKET, Frame	32C05909D02
66	BUSHING, Cover Mtg	43C05661D01
67	POT, Cermet	18D05055E01
68	POT, Cermet Alternate	18D05333E01
69	NUT, Special	2A82653D03
70	POTENTIOMETER, Control Sw.	18D05370E01
71	JACK, Micro	9D05283B01
72	BUSHING, Shoulder	43B05052E01
73	NUT, Special	2B05050E01
74	SHIELD, Antenna	26D05054E01
75	LEVER	45D05784D01
76	SPRING, Actuator (PTT)	41C05783D03
77	GASKET (PTT)	32C05753E01
78	CONTACT, Disc (PTT)	39C05684E01
79	CONTACT, Feed-Thru (PTT)	39D05681E01
80	SPRING, Compression(PTT)	41B05267E01
81	SEAL "O" Ring	32B05082E02
82	PIN, Spring	22B05084 E02
83	WASHER, Insert	04B05249E01
84	SCREW, Set	03C05246E01
85	INSERT, Threaded	43C05781D01
86	STUD	46C05154E01
87	WASHER, Stud	04B05248E01
88	PIN, Contact	39B05080E01
89	GASKET, "O"Ring	32B05082E03
90	SPRING, Compression	41B05424F01
91	RING, Retaining	42C05463E02
92	RECEPTACLE	09E05677D01
93	SCR, Mach(#0-80x1/8Fill Hd)	3S139684
94	CONTACT	41C05076E03
95	BLOCK	46C05076E01
96	CONTACT	41C05076E01
97	WASHER	4S134190
98	SCREW, Mach(#2-56x1/8 SST)	3S138651
99	SEAL "O" Ring	32C05075E01
100	ADHESIVE, RTV Silicone Rubber	11S10019A88
101	SEALANT, Compound	11S10019A63
102	SWITCH, Rotary	40D05053E01
103	NUT, Special	2B82653D05
104	PAD, Rubber	75A83562H02
105	BUSHING, Insulator	43B05051E01
106	ESCUTCHEON	13D05621D07
107	SCREW, Jack	03B05129E01
108	KNOB, Control	36C05926D01
109	SCREW, Set	3B05011E01
110	GLYPTOL	11S00008675
111	WASHER, Teflon	04B82418B97
112	KNOB, Vol	36C05927D01
113	KNOB, Squelch	36C05927D03
114	SCREW, Set	3B83174C02
115	Not Used	
116	ANTENNA, Telescopic (2 Section)	85C05550E01
117	ANTENNA, Telescopic (5 Section)	85D05549E01
118	ANTENNA, Telescopic (6 Section)	85D05762A01
119	Not Used	
120	Not Used	
121	Not Used	
122	Not Used	
123	Not Used	
124	SCREW, Captive	0305864D01
125	TRANSCEIVER Bd. Assy ("BBU" Series)	NUE6232A(UHF) NUE6233A(UHF) NUE6282A(UHF) NUE6283A(UHF) NUE6312A(UHF) NUE6313A(UHF) NUD6241A(VHF) NUD6242A(VHF) NUD6243A(VHF) NUD6282A(VHF) NUD6292A(VHF) NUD6302A(VHF) NUD6303A(VHF) NUD6311A(VHF) NUD6312A(VHF) NUD6313A(VHF)
126	Not Used	
127	Not Used	
128	TRANSCEIVER Bd. Assy ("BBB" Series)	NUE6242A(UHF) NUE6243A(UHF) NUE6292A(UHF) NUE6293A(UHF) NUD6253A(VHF) NUD6252A(VHF) NUD6262A(VHF) NUD6272A(VHF)
129	INTERCONNECT Bd. Assy	
130	INSULATOR, PTT	1405362E01
131	SCR, Mach(#2-56x1/8Flt Hd)	03S00139675
132	WASHER, Special	04B05361E01
133	BRACKET, Switch	07C05261E01
134	EYELET	05B05095E05
135	NUT, Captive	02B05254E01
136	SWITCH, Micro	40D05265E01
137	RING, Retainer	42B05274E01
138	NUT, PTT	02C05250E01
139	SPRING, PTT	41B05252E01
140	ACTUATOR, PTT	47B05251E01
141	GASKET, Switch	32C05077E01
142	COVER, Receptacle	15E05212E01
143	SPRING, Actuator	41C05783D01
144	STUD, Heat Sink	46C05247E01
145	PLATE; Information	64C05538E01
146	HOUSING, Sleeve, Extended	15E05858D02
147	ADHESIVE, RTV Silicone Rubber	11S10019A88
148	GASKET, Frame	32C05909D01
149	CLIP, Antenna	42C05860D01
150	WASHER, Spring	04B05314E03
151	SCREW, Special	03B05044E01
152	HOUSING, Sleeve	15E05858D01
153	MACH. Screw(2-56 x 3/8-SlotBind)	0300136745
154	LK Wash(#2 Split)	4S400139
155	NUT (#2 Hex)	2S115676
156	POST, Guide	46C05798E01
157	NUT	02B05791E01
158	CLIP, Option Bd.	42D05445E04
159	CLIP, Option Bd.	42D05445E03
160	CLIP, Option Bd.	42D05445E02
161	CLIP, Option Bd.	42D05445E01
162	SCREW, Guide	46B05800E01
163	CLIP, Option Bd.	4205529F01
164	C7R7 Deck	NLN4215A
165	TONE PL Deck	NLN4645A & NLN4644A
166	DPL & TPL Deck	NLN4478A
167	OPTION Deck (Tone PL)	NLN4211A & NLN4646A
168	OPTION Deck (Digital PL)	NLN4212A
169	OPTION Deck (Selective Call)	NLN4213A
170	OPTION Deck (Single-Tone)	NLN4273A
171	TIME-OUT Timer	NLN4475A
172	SEL Call (4 Tone)	NLN4452A
173	SEL Call (Long Tone)	NLN4727A
174	MULTI Single-Tone	NLN4722A
175	C8R8 Deck	NLN4573A

ITEM(S)	P/O KIT NO.
1 thru 29 & 36 thru 42	NLN4184A
1 thru 31	NLN4208A
43 thru 48	NLN4180A
51 thru 55	NLN4179A
59	NLN4182A
61 thru 103	NHD6031A/21A
61 thru 75, 80 thru 84, 98 thru 103, & 129 thru 144	NHD6071A/61A
104 thru 114	NLN4191A
116	NAE6271A
117	NAD6324A
118	NAD6322A
145	NLN4196A
146 thru 151	NLN4174A
147 thru 152	NLN4175A
153 thru 159 & 160, 161	NLN4187A
153 thru 159	NLN4195A
162	NLN4186A

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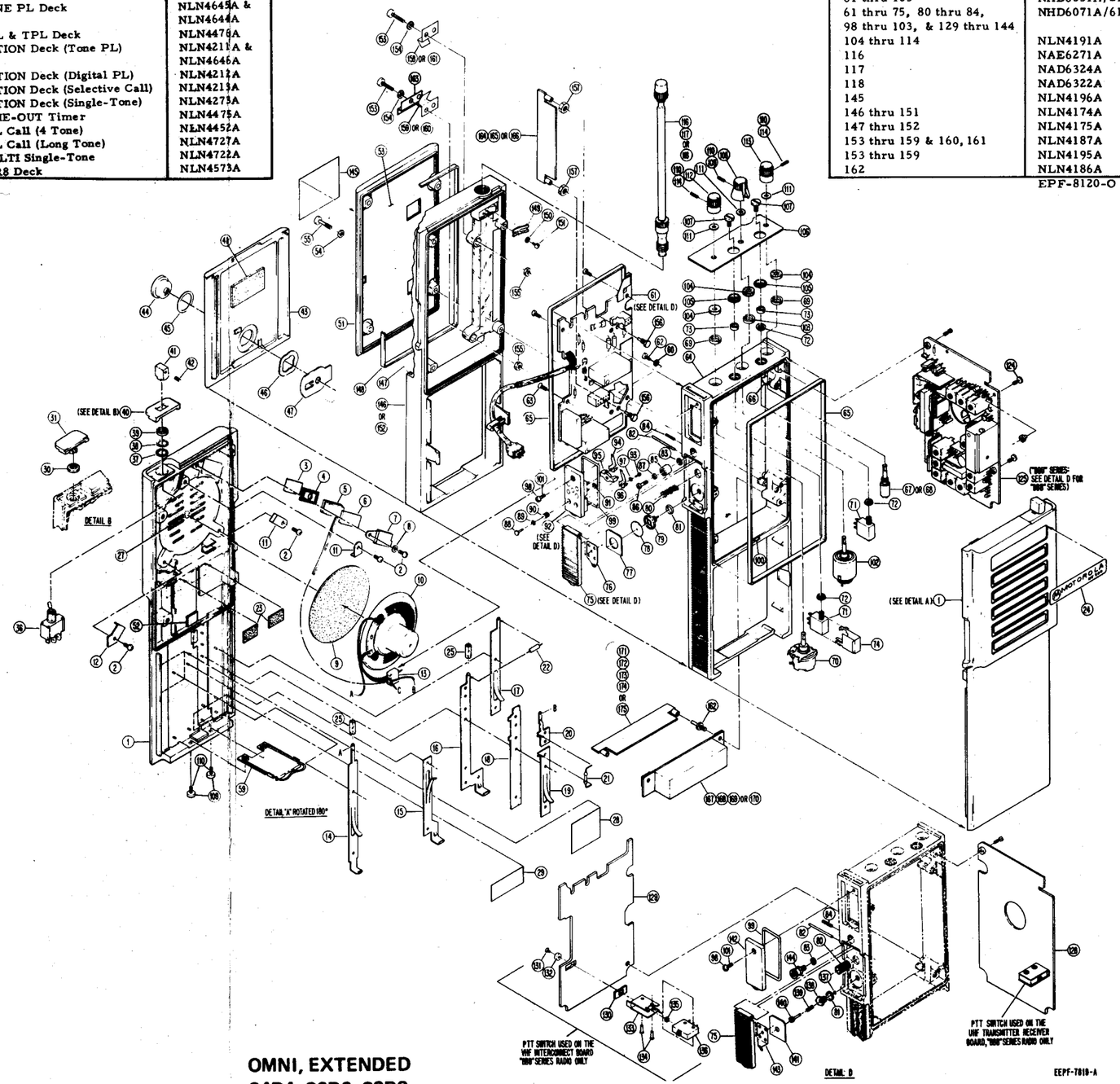

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OMNI, EXTENDED
C4R4, C6R6, C8R8

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.

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 ∩ -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	
D61 Telequipment by Tektronix	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		

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.
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.

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 preceding table.

EQUIPMENT		FUNCTION
MODEL	NAME	
TEK-34A or	Tone Generator	Uses "Vibrasender" reeds to generate paging tones.
S1333A	Audio Synthesizer	Generates all two-tone paging codes automatically.
TEK-61	Active Filter Tester	Permits checking band-pass frequency, insertion loss or gain of active tone filters. (Requires S1333A & ac voltmeter).

4. ADDITIONAL TEST EQUIPMENT FOR RADIOS WITH SELECTIVE CALL

In addition to the test equipment required to service the radio, a tone generator and active filter tester are needed for servicing the selective call circuits.

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 100 k 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 14 for excessive current drain or Table 15 for low current drain.

Table 14. Excessive Current Drain

CHECKING REVEALS	POSSIBLE FAULT
Enough current drain to open power supply	15-volt dc short
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
Current drain of 80 mA to 90 mA; no audio output; 7.5 V line = zero volts	7.5-volt dc line shorted
Current drain of 80 mA to 90 mA; no audio output; 7.5 V line = 5.8 volts	1.7-volt dc line shorted
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 15. Low Current Drain

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	
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

5. MAJOR LOSS OF SENSITIVITY (20 dB QUIETING AND 8 dB RISE)

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.

6. I-F STAGE GAIN MEASUREMENTS

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. If dc voltages on module are okay, reconnect short from pin 3 of U3 to ground and monitor signal level at pin 6 of U3. Remove the short; if the level changes, the mixer in low conversion module U3 is defective, replace U3. If, when the short is removed, the level at pin 6 of U3 does not change, the oscillator of the module is defective. Replace U3.

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.

7. AUDIO STAGE GAIN MEASUREMENTS

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.

8. TAKEOVER MEASUREMENTS

a. General

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 -6 dBm 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.

9. INJECTION RF LEVELS

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.

10. SQUELCH

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.

11. TRANSMITTER HAS NO POWER OUTPUT

a. 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 11.a.(2). If -0.5 volt dc is present, continue with step 11.a.(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.

b. 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 11.b.(2). If 1.5 volts dc to 2.2 volts dc is present, continue with step 11.b.(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 11.b.(3). If the voltage at pin 4 is zero volts dc to -0.5 volt dc, continue with step 11.b.(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.

12. TRANSMITTER HAS LOW POWER OUTPUT

a. 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.

b. 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.

13. TRANSMITTER CURRENT DRAIN

The following tables reflect the nominal current drain for a properly functioning radio. (Tables 16 and 17).

Table 16. 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 17. 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

14. SELECTIVE CALL DECODER CIRCUIT TEST

a. Using the TEK-34A Tone Generator

(1) Insert Motorola "Vibrasender" reeds (with frequencies corresponding to decoder under test) into the Tone 1 and Tone 2 receptacles of the tone generator.

(2) Connect a test cable from the tone generator output to the Ext Mod (external modulation) receptacle of the FM signal generator.

(3) Connect the FM signal generator output to the rf input (antenna jack) of the radio under test using proper tune-up cable.

(4) Adjust FM signal generator to the radio frequency at 3.3 kHz deviation (±750 Hz deviation for subaudible), and rf output level at 0.18 uV (VHF) or 0.25 uV (UHF). Set radio squelch to threshold or "tight" (maximum clockwise rotation of squelch control).

(5) Depress the tone generator TONE 1 pushbutton, hold down for 1 second, then release. Depress tone generator TONE 2 pushbutton, hold down for 3 seconds, then release.

NOTE

There should be no marked time lapse between the release of TONE 1 pushbutton and the depressing of TONE 2 pushbutton; as the TONE 1 button is released, immediately depress TONE 2.

(6) The radio should respond, if not, perform the 20 dB quieting check for the receiver to determine if the trouble is in the decoder or the receiver circuit.

b. Using the S1333A Audio Synthesizer

(1) Set the thumbwheel switches and the adjacent frequency multiplier switches to the desired tone frequencies.

(2) Set the mode switch to CONT A and adjust LEVEL A to the desired output voltage (sufficient to drive the Motorola S1318A Signal Generator at 3.3 kHz deviation).

(3) Set the mode switch to CONT B and adjust LEVEL B to the desired output voltage (same as LEVEL A).

(4) Set mode switch to BURST.

(5) Set cycle switch to A and B.

(6) Set Tone 1 duration to 1 second, set the delay between pulses to 0.1 second. Set Tone 2 to 3.0 seconds.

(7) Connect the test cable from the audio synthesizer output jack to the Ext Mod (external modulation) receptacle of the FM signal generator.

(8) Connect the FM signal generator output to the rf input of the radio under test using proper tune-up cable.

(9) Adjust the FM signal generator to the radio frequency at 3.3 kHz deviation (±750 Hz deviation for subaudible), and rf output level at 0.18 uV (VHF) or 0.25 uV (UHF). Set radio squelch to threshold or "tight."

(10) Press the Cycle Clear pushbutton twice, the first time the button is actuated initiates the cycle, the second time prevents the unit from cycling again.

NOTE

Occasional circuit transients occurring during internal or external switching will turn on two or more of the light emitting diodes. Should this occur, clear the cycle by pressing the Clear/Cycle switch. When all lights are "off," press the Clear/Cycle switch to resume normal operation.

(11) The radio should respond, if not, perform the 20 dB quieting check for the receiver to determine if the trouble is in the decoder or the receiver circuit.

15. SELECTIVE CALL HYBRID MODULE PERFORMANCE CHECKS

a. Active Filter Check, U1 and U2

(1) With no signal applied to the radio, output pin 4 should read less than 2 mV ac (see Table 18).

(2) Apply a signal at the input of the radio modulated at the frequency of the active filter with ±3.3 kHz deviation (±750 Hz deviation for subaudible).

(3) Output pin 4 should read at least 35 mV ac.

(4) Change modulation frequency to the adjacent tone frequency.

(5) Output pin 4 should read less than 5 mV ac.

Table 18. Typical Filter Voltages

PIN NO.	DESCRIPTION	DC VOLTAGE	AC VOLTAGE
1	Input	.60	1 mV
2	B+	1.35	
3	Ground	0	
4	Output	.62	1 mV/ 40 mV*

*With the proper input signal applied.

b. Two-tone Decoder Module Check, U3

(1) Decoder Channel A Check

(a) Apply 100 uV rf signal to radio with "Tone A" modulation at ±3.3 kHz deviation (±750 Hz deviation for subaudible).

(b) Tone A Integrator Timer, pin 12, should drop to 0.25 volts dc or less.

(c) Check Channel "A" sensitivity by reducing the deviation to produce 15 mV at pin 1. Pin 12 must remain below 0.30 volt dc. Reset deviation after completion of this test.

(d) Remove modulation.

(e) Pin 12 should charge back toward 0.67 volt dc (see Table 19). As the voltage at pin 12 approaches 0.67 volt dc a negative going spike should appear at gate timer pin 11.

(2) Decoder Channel B Check

(a) Modulate input signal with "Tone B."

(b) Tone B Integrator Timer, pin 8, should drop to 0.25 volt dc or less.

(c) Check sensitivity of Channel B as in step 3 of Channel A.

(3) Paging Check

(a) Modulate input signal with "Tone A" and "Tone B" in sequence with proper timing; (1 second, 3 seconds).

(b) To page, a negative spike at pin 11 must occur when voltage at pin 8 is low.

(c) Pin 11 should remain at less than 0.1 volt dc at the time of the negative spike when a page occurs.

(d) DC output pin 9 should rise to 1.1 volt dc.

(e) Tone output pin 4 should have a pulsating 2000 Hz ac signal of amplitude 1.1 volt peak-to-peak.

(f) Astable pins 5 and 7 should alternate at a rate of 3 to 5 times a second.

Table 19. Typical Selective Call Decoder Voltages

PIN NO.	DESCRIPTION	DC VOLTAGE	AC VOLTAGE
1	Tone A Input	.62	
2	B+	1.35	
3	Ground	0	
4	Alert Tone Output	1.15	1.0 V* p-p
5	Astable	.77	
6	Timeout	0	
7	Astable	.77	
8	Tone B Integrator	1.0	
9	DC Output	0/1.1*	
10	Tone B Input	.62	
11	Gate Timer	.65	
12	Tone A Integrator	.67	

All measurements taken during standby conditions unless otherwise specified.

*While page is being received.

(g) The Tone Output may be latched on continuously at this time by grounding pin 7.

c. Selective Call Switch Logic Module Checks, U4

(1) Voltage Divider Check

(a) Apply a 100 uV rf signal to the radio with either "Tone A" or "Tone B" modulation at ±3.3 kHz deviation (±750 Hz deviation for subaudible).

(b) Input pin 9 to the divider should be a 0.4 volt peak-to-peak square wave.

(c) Output pin 10 of the divider should be a 2.0 mV peak-to-peak square wave (approx.).

(2) Audio Switch Check

(a) Apply a 1000 uV rf on-carrier signal to the radio with 1000 Hz modulation at ±3.3 kHz deviation.

(b) Pin 7 of U4 should read 0.3 volt rms at 1000 Hz.

(c) Perform a paging check with a 1000 uV rf on-carrier signal, "Tone A" (one second) and "Tone B" (three seconds) modulation at ±3.3 kHz (±750 Hz for subaudible).

(d) During the alert tone, pin 3 should read 1.1 volts dc, and pin 7 should have a 2000 Hz pulsating ac signal at an amplitude of 1 volt peak-to-peak.

(3) Squelch Flip-Flop Check

(a) With no rf signal in and the radio fully unsquelched (fully counterclockwise), turn the radio on; pin 12 should read 0.0 volt dc (flip-flop sets, allowing carrier squelch operation).

(b) Momentarily place the monitor-reset switch to the ▷ position. Release the monitor-reset switch. Pin 12 should read 0.7 volt dc (flip-flop reset); see Table 20.

(c) Perform a paging check with a 1000 uV rf signal, "Tone A" (one second) and "ToneB" (three seconds) modulation at ±3.3 kHz (±750 Hz deviation for subaudible).

(d) At the beginning of the alert tone, pin 12 should read 0.0 volt dc and remain 0.0 volt dc after the alert tone ends (flip-flop set).

d. Long Tone B Group Call Module, U5

(1) Ground input pin 4.

(2) Between 4.5 and 6.5 seconds later, gate timer clamp pin 2 and astable clamp pin 3 should drop to 0.02 volt dc and 0.4 volt dc respectively; see Table 21.

(3) Remove the ground on the input.

(4) Pins 2 and 3 should revert to the standby condition within one second.

Table 20. Typical Selective Call Switch Logic Voltages

PIN NO.	DESCRIPTION	DC VOLTAGE	AC VOLTAGE
1	Rcve +7.5 VDC	7.5	-
2	Reset switch	0	-
3	Audio switch control	0/1.1*	-
4	+7.5 VDC unswitched	7.5	-
5	Audio in	-	0.31 **
6	Auxiliary audio switch control	5	-
7	Audio out	-	0.3 **
8	Alert tone in	1.1	1.1 p-p*
9	Voltage divider in	-	0.4 p-p
10	Voltage divider out	-	2.0 mV p-p
11	Ground	0.0	-
12	Squelch out	0.7	-
13	Regulated B+ out	1.35	-

All measurements taken during standby conditions unless otherwise specified.
*During page.
**1000 uV rf signal modulated with a 1000 Hz tone at ±3.3 kHz deviation.

Table 21. Typical Long Tone B Group Call Voltages

PIN NO.	DESCRIPTION	DC VOLTAGE
1	Ground	0
2	Gate Timer Clamp	.67/.02*
3	Astable Clamp	.77/.4*
4	Input	1.0/.36*
5	B+	1.35

*With Group Call Page

e. Subaudible Module Check, U6

(1) Apply a 100 uV rf signal with 100 Hz modulation to the input of the radio.

(2) Adjust the deviation to produce a 5 mV audio signal at input pin 1.

(3) Output pin 2 should read 32 mV; see Table 22.

(4) Change the modulation frequency to 400 Hz.

(5) Output pin 2 should read less than 2 mV.

Table 22. Typical Subaudible Module Voltages

PIN NO.	DESCRIPTION	DC VOLTAGE	AC VOLTAGE
1	Input	1.2	
2	Output	.55	6X Voltage at Input
3	B+	1.35	
4	Ground	0	

16. TONE "PRIVATE-LINE" SQUELCH CIRCUIT

Refer to the squelch circuit troubleshooting diagram in Figure 41.

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 V 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.

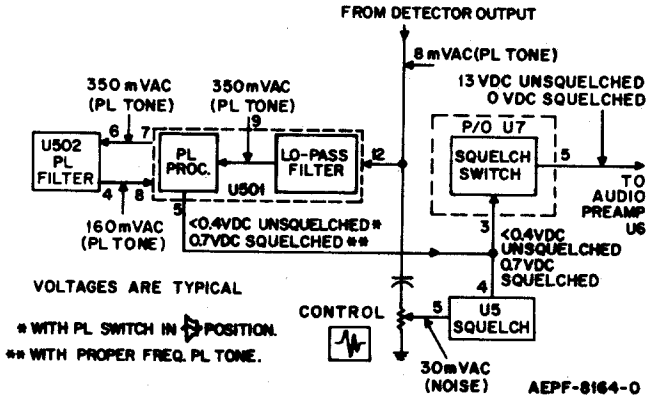


Figure 41. Squelch Circuit Troubleshooting Diagram

17. DIGITAL "PRIVATE-LINE" SQUELCH CIRCUIT

CAUTION

Components on the digital PL circuit board contain CMOS circuitry, making it susceptible to damage by static electricity discharge. For this reason, this board should be handled with extreme care. Refer to handling precautions in next section.

a. General

When a decoding problem is suspected, first turn off the "Private-Line" and check the receiver quieting to be sure the receiver rf circuits are working normally. Inspect the circuit connections and measure the B+ voltage and ground connections to each module.

b. Digital PL Processor Oscillator

The regulated +5 volts dc at pin 11 of U601 provides power to the processor. Measure this voltage before proceeding.

In the receive mode, the output of the processor (U602, pin 12) will always be a symmetrical, 135 ±1 Hz, 5.5 volts peak-to-peak square wave. A distorted or off-frequency signal indicates a defective processor module.

c. Encode Filter

The encode filter module (U603) attenuates the processor output signal. The signal at U603

pin 1 is a 4-volt sawtooth wave coupled from U602 pin 12. The encode filter output (U603 pin 2) is typically 1 ±0.05 volt peak-to-peak. The output waveform may resemble a sawtooth wave.

d. Receiver Squelch

Measure the voltage at pin 12 of U601. Pin 12 will be zero volts dc when either U601 pin 13 is low zero or when the PL switch is in the " ▷ " position, applying 15 volts dc to U601 pin 14.

e. Decode Function Check

Connect the test equipment to the radio as illustrated in the troubleshooting setup diagram (Figure 42). Modulate the carrier with 135 Hz from the digital encoder/decoder and adjust the service monitor for ±1 kHz deviation. Use the service monitor oscilloscope to trace the demodulated signal through the code conditioner (U601) and processor (U602) modules. A symmetrical 135 Hz square wave should be present at U601 pins 6, 7, and 10; and at U602 pin 10. A defective code conditioner module will be evident if the signal at U601 pin 8 drifts in frequency or varies in pulse width, pulse shape, or in amplitude. (The service monitor oscilloscope indication of frequency drift or pulse width variation may be the inability to maintain a stable sync display.)

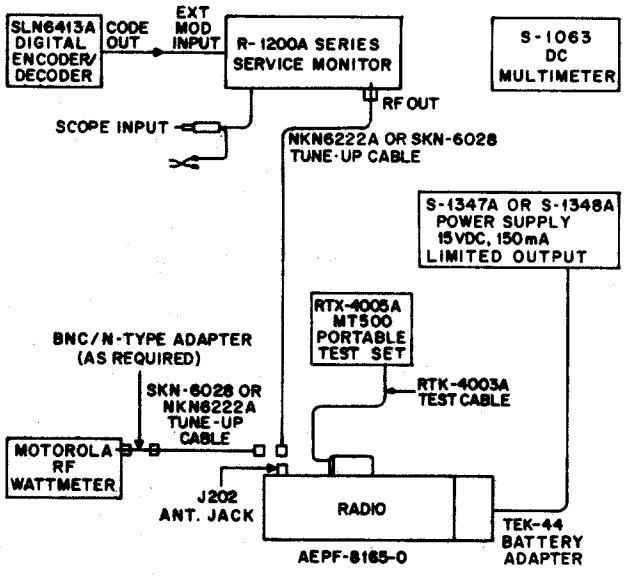


Figure 42.
Digital "Private-Line" Troubleshooting Setup Diagram

Monitor the detect signal at U601, pin 13, while applying a modulated code from the digital encoder/decoder. The detect signal should be zero volts. If the detect signal is high, but the output at U601, pin 12, remains high (squelched) replace the code conditioner module. If a detect signal is not present, use the digital encoder/decoder to check the code plug module as described in the associated equipment manual. Be certain that the "invert" switch on the digital encoder/decoder is in the proper position to maintain compatible logic convention between the radio and the test equipment.

f. Code Plug Module

Remove power from the radio and extract the code plug module. Apply power to the radio and use a Motorola S-1063 DC Multimeter to measure the voltage at the code plug sockets. Pins 1 through 9 should be 5 volts; pin 10 is ground. Replace digital PL processor U601, if the voltage at pins 1 through 9 is significantly less than 5 volts dc.

The pins of the code plug are either a high voltage level (logic 1) or a low voltage level (logic 0), depending upon the code. To determine if the code plug is good, measure the dc voltage with power applied and the plug installed, using a high impedance voltmeter (1 megohm or greater). Refer to the following table (Table 23) for interpreting the pin measurements. The values of the pins having a logic 1 (high) are added to obtain the number for each digit. For example, if the first digit in the code is 5, pin 8 is high (value=4) and pin 6 is high (value=1). When added together (4 + 1), the digit 5 is obtained.

Table 23. Logic Levels at Code Plug Pins

CODE EXAMPLES	1ST DIGIT PINS			2ND DIGIT PINS			3RD DIGIT PINS		
	8	7	6	4	3	5	2	1	9
531	1	0	1	0	1	1	0	0	1
025	0	0	0	0	1	0	1	0	1
226	0	1	0	0	1	0	1	1	0
Value for logic 1 =	4	2	1	4	2	1	4	2	1

NOTE: Logic 0 = Low level voltage
Logic 1 = High level voltage

g. Turn-off Code

Adjust the service monitor to receive and display transmitted code from the radio under test. Press and release the push-to-talk switch several times and observe the code, followed by a 135 Hz burst for 80 to 120 milliseconds after the push-to-talk switch is released. If the burst (turn-off code) is not present, check external diode CR601 and the associated relay circuit. Replace the processor (U602) if the external circuit components are functional.

18. UNIT ID PERFORMANCE TEST

CAUTION

Components on the unit ID board contain CMOS circuitry, making it susceptible to damage by static electricity discharge. For this reason, this board should be handled with extreme care. Refer to handling precautions in next section.

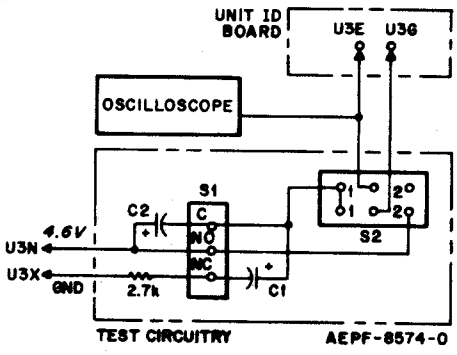
a. Preliminary Setup

(1) Make sure radio is turned off.

(2) Remove the unit ID board from its housing.

(3) Attach the external circuitry (S1, S2, C1, and C2), as shown in Figure 43. (Circuitry shown is in the TEK-83 Unit ID sequencer).

(4) Connect the test equipment as shown in Figure 44.



PARTS LIST

SYMBOL	DESCRIPTION	Motorola Part No.
S1	SPDT, Subminiature, momentary	40-82159D01
S2	DPDT, Switch, toggle	40-05351A01
C1, C2	0.1uF, Capacitor	23-83397D05

Figure 43. Unit ID Test Circuit Diagram

NOTE

To prevent the rf carrier from interfering with the ID circuitry, couple the rf signal from the radio to the service monitor via the 50-ohm jack, 50-ohm cable, and the attenuator. Do not allow the rf carrier to be radiated from the antenna during this test.

b. Procedure

NOTE

The stationary position of switch S1 is normally closed (NC).

(1) Set switch S2 to position 1.

(2) Turn the radio on.

(3) Press the PTT switch.

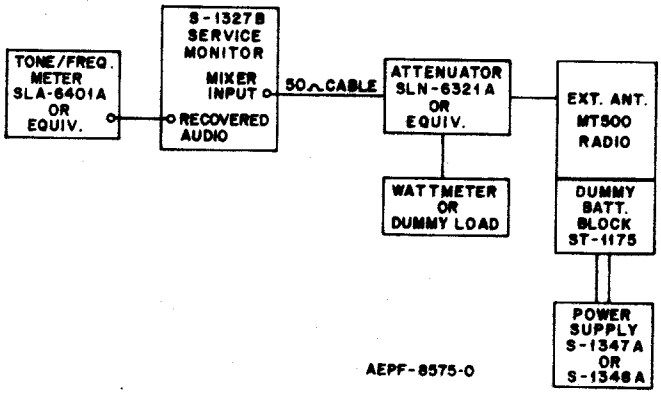


Figure 44. Unit ID Test Equipment Setup Diagram

(4) Press S1 (NC position) once and release. Check the code plug label for proper tones and verify the tone frequency on the frequency meter. The tone frequency should be within ±0.5% of the tone frequencies list in the Unit ID Frequency Data table (Table 7).

(5) The code plug can be checked for accuracy via the bit pattern (D0 through D7) as indicated in the Unit ID Frequency Data table.

(6) Measure the tone deviation. For "MODAT" codes it is nominally ±3 kHz when maximum voice deviation is set at ±5 kHz. Repeat steps 4, 5, and 6 seven times.

(7) Set switch S2 to position 2. Measure the time-slot period. It should be 40 milliseconds ±5 milliseconds for "MODAT."

If the emergency option is used, continue with the following four steps:

(8) Press the emergency switch momentarily and repeat step (4), but tone 7 should be monitored during time-slot 3 instead of tone 8.

(9) Turn off the radio. Remove the external circuitry from the board, reassemble the radio, and turn the radio on.

(10) Press the emergency switch momentarily. Check for the transmission of two emergency messages (with no side tones), followed by four seconds in the receive mode, repeated five times, for a total of 12 emergency messages within 30 seconds.

(11) Press the PTT switch and monitor the side tones over the radio speaker.

19. TROUBLESHOOTING UNIT ID CIRCUIT

Using switches S1 and S2 as required, measure dc levels on the board as outlined in the troubleshooting chart (Table 24). Applicable waveforms are given in the Unit ID Service Supplement. The waveforms assume a "MODAT" code of 698R123. (The actual code label on the code plug would read 6988123.) The timing diagram shown represents typical values for a "MODAT" tone sequence. The voltage levels are representative of "MODAT" codes during manual sequencing or normal operation.

Table 24. Unit ID Troubleshooting Chart

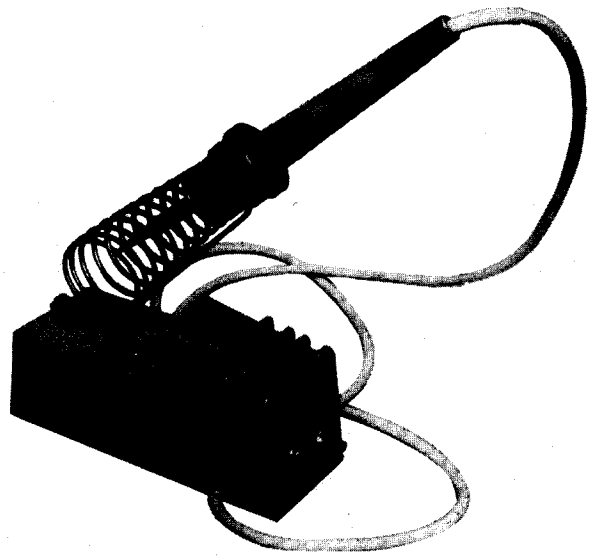
U3 Pin	Description	Transmit Mode	Comment
X, C, M	Ground	0.0 V	
N, J	4.6 V Supply	4.6 V	
P	Emergency	0.0 V	
O-W	8-Bit Frequency Data	T.S. 1-7 Code	See Unit ID Frequency Data table
D	MIC MUTE & PTT Latch	4.6 V during ID transmission	See Waveform
AA	Transmit ID	Tone Sq. Wave	See Waveform
FF, A, DD, GG,B,EE,HH	TS1 to TS6	H/L	See Waveform
I	Encode Enable	> 3.7 V	
AA	ID Tones	4.6 V pp during ID transmission	See Waveform

Note: Voltage level depends on "PL" option. The voltage level during transmit must be lower than the receive mode in all radios.
(H = 4.5 V nominal; L ≤ 1.0 V nominal.)

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

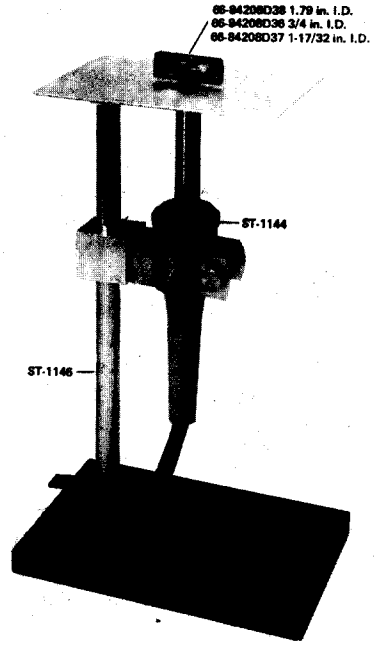
For removal and replacement of components other than hybrid circuits, use a circuit board holder such as the ST-458 Circuit Board Holder or equivalent so both hands can be used. Mount the circuit board in the holder and rotate the board to a convenient position. Gently grasp the component lead with a "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.

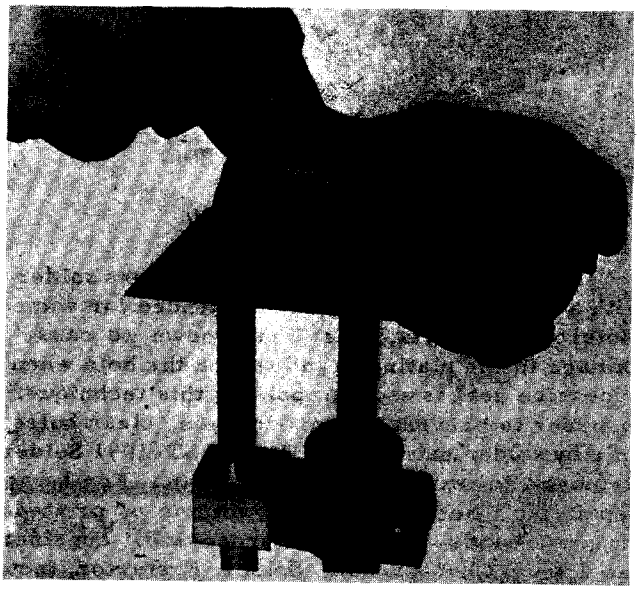


Soldering Iron and Stand For Hybrid Module Removal

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.



Typical Hybrid Module Extraction

END OF DOCUMENT