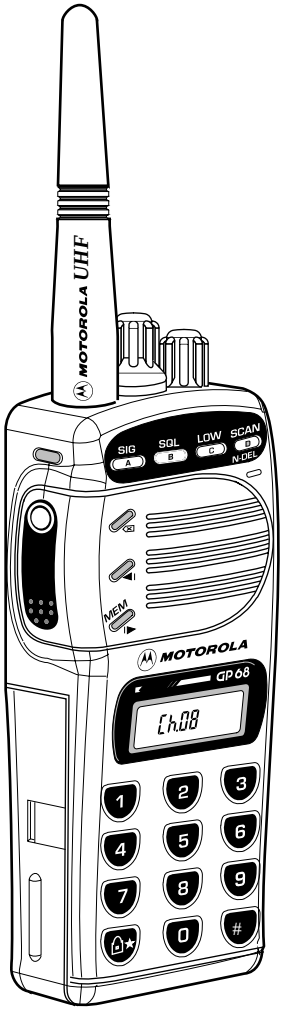
MOTOROLA

GP68 Portable Radios

Service Manual



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Motorola
8000 W. Sunrise Blvd.
Ft. Lauderdale, FL 33322

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Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date are incorporated by instruction manual revision. These revisions are added to the manuals as the engineering changes are incorporated into the equipment.

How to Use This Manual

This manual contains introductory material such as model charts, accessories, and specifications, as well as four sections that deal with specific service aspects of the GP60 Series radios. Refer to the Table of Contents for a general overview of the manual, or to the "Overview" paragraph in each section for a specific overview of the information in that section.

Safety Information

Throughout the text in this publication, you will notice the use of warnings, cautions, and notes. These notations are used to emphasize that safety hazards exist, and care must be taken and observed.

⚠ WARNING

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

⚠ CAUTION

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

NOTE

An operational procedure, practice, or condition, etc., which is essential to emphasize.

Airbag Warning Statement

VEHICLES EQUIPPED WITH AIR BAGS:

⚠ WARNING

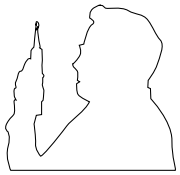
An air bag inflates with great force. **DO NOT** place objects, including communication equipment, in the area over the air bag or in the air bag deployment area. If the communication equipment is improperly installed and the air bag inflates, this could cause serious injury.

• Installation of vehicle communication equipment should be performed by a professional installer/technician qualified in the requirements for such installations. An air bag's size, shape and deployment area can vary by vehicle make, model and front compartment configuration (e.g., bench seat vs. bucket seats).

• Contact the vehicle manufacturer's corporate headquarters, if necessary, for specific air bag information for the vehicle make, model and front compartment configuration involved in your communication equipment installation.

FCC Safety Information

The Federal Communications Commission (FCC), with its action in General Docket 79-144, March 13, 1985, has adopted a safety standard for human exposure to radio frequency (RF) electromagnetic energy emitted by FCC-regulated equipment. Motorola subscribes to the same safety standards for the use of its products. Proper operation of this radio will result in user exposure substantially below the FCC recommended limits.



⚠ WARNING

• *Do not* hold the radio with the antenna very close to, or touching, exposed parts of the body, especially the face, ears, or eyes, while transmitting. Hold the radio in a vertical position with the microphone two to three inches away from the lips.

• *Do not* hold the transmit switch (PTT) on when not actually desiring to transmit.

• *Do not* allow children to play with any radio equipment containing a transmitter.

• *Do not* operate this equipment near electrical blasting caps or in an explosive atmosphere. Under certain conditions, radios can interfere with blasting operations. When you are in the vicinity of construction work, look for, and observe, signs cautioning against radio transmission. If radio transmission is prohibited, you must not transmit until out of the area. Furthermore, you must turn off your radio to prevent any accidental transmission.

• *Do not* replace or charge batteries in a hazardous atmosphere. Contact sparking may occur while installing or removing batteries and cause an explosion.

Turn radio off when removing or installing a battery.

Other Documentation

Table 1 lists other documentation for the GP60 Series Portable Radios.

Table 1. Other Documentation

Information	Location
Basic Use of GP68	GP68 User Manual (6881086C10)
Basic use of Radio Service Software	Radio Service Software Manual (6881086C08)

Technical Support

To obtain technical support, you may call Motorola's Regional Support Centre. When you call, we ask that you have ready the model and serial numbers of the respective radio or its parts.

Ordering Replacement Parts

You can order additional components and some piece parts directly through your Radius price pages. When ordering replacement parts, include the complete identification number for all chassis, kits, and components. If you do not know a part number, include with your order the number of the chassis or kit which contains the part, and a detailed description of the desired component. If a Motorola part number is identified on a parts list, you should be able to order the part through Motorola Parts and Service Division. If only a generic part is listed, the part is not normally available through Motorola. If no parts list is shown, generally, no user serviceable parts are available for the kit.

Latin America Technical Support:

Technical Support
8000 W. Sunrise Blvd.
Ft. Lauderdale, FL. 33322
Tel:1-800-694-2161
954-723-3008 (Spanish)
954-723-3007 (English)

Latin America Warranty Centers:

MOTOROLA DO BRASIL

Rua Bandeira Paulista, 580
Itaim Bibi. 04532-001 Sao Paulo
SAO PAULO, BRAZIL.
TEL: 011-55-11-821-9991

MOTOROLA DE MEXICO, S.A.

Huatabampo #50
Col. Roma
6700 Mexico D.F.
MEXICO D.F., MEXICO
TEL:011-525-564-5479

MOTOROLA DE PUERTO RICO

A Street #21
Maria Julia Industrial Park
PUERTO NUEVO, P. R. 00922
TEL: 1-809-273-2400

Motorola Parts:

Americas Parts Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Model Chart

Description			
	20-channels, 1-5W, 12.5 kHz (keypad)	20-channels, 1-5W, 20/25 kHz (keypad)	**GP68** **VHF** **136 - 174 MHz** X = Indicates one of each required
Model	P93VNB00H2AA	P93VNB20H2AA	

			Item	Description
		X	PMLD4036	GP68 VHF RF Board, 20/25 khz
	X		PMLD4037	GP68 VHF RF Board, 12.5 khz
	X	X	PMLN4059	GP68 Controller Board
	X	X	PMLN4061	GP68 Display Board
	X	X	PMAD4015	VHF 14cm Antenna (155 — 174 MHz)
	X	X	6881086C10	GP68 User Manual
	X	X	PMLN4049	Front Cover (keypad)

Model Chart

Model Chart

Description	20-channels, 1-4W, 12.5 kHz (keypad)	20-channels, 1-4W, 20/25 kHz (keypad)	GP68 UHF 430 - 470 MHz X = Indicates one of each required
Model	P94VNB00H2AA	P94VNB20H2AA	

			Item	Description
		X	PMLE4023	GP68 UHF RF Board, 20/25 khz
	X		PMLE4024	GP68 UHF RF Board, 12.5 khz
	X	X	PMCE4000	GP68 Controller Board
	X	X	PMLN4061	GP68 Display Board
	X	X	NAE6483A	UHF Whip Antenna (430-470 MHz)
	X	X	6881086C10	GP68 User Manual
	X	X	PMLN4049	Front Cover (keypad)

Accessories (Note: Not all accessories are available in all areas.)

Antennas:

PMAD4012	136-155 MHz VHF 9cm Antenna (Red)
PMAD4013	155-174 MHz VHF 9cm Antenna (Black)
PMAD4014	136-155 MHz VHF 14cm Antenna (Red)
PMAD4015	155-174 MHz VHF 14cm Antenna (Black)
PMAE4003	430-470 MHz UHF 9cm Antenna (White)
NAE6483_R	403-520 MHz UHF 17cm Whip Antenna

Carrying Accessories:

HLN8240_R	Replacement 2-1/2” Belt Clip
HLN8255	Spring Action Belt Clip 3”
HLN9985	Waterproof Bag

Battery Chargers:

HTN9013	110V - 3 Hour Desktop Battery Charger
HTN9014	110V - 10 Hour Desktop Battery Charger
HTN8232	110V - 10 Hour Wall Charging Adapter
HTN9015	220V - 3 Hour Desktop Battery Charger with Euro Plug
HTN9016	220V - 10 Hour Desktop Battery Charger with Euro Plug
HTN9002	220V - 10 Hour Wall Charging Adapter with Euro Plug
PMLN4069	Charger Insert

Batteries:

PMNN4000	NiCd Rechargeable High Capacity Battery Pack
PMNN4001	NiCd Rechargeable Medium Capacity Battery Pack

Audio/Signalling Accessories:

HMN9787_R	Light Weight Headset with Swivel Boom Microphone (without VOX)
BDN6647	Medium Weight Headset with Swivel Boom Microphone (without VOX)
BDN6706	Ear Microphone with VOX interface (VOX included)
HMN9725_R	Remote Speaker Microphone
HMN9036	Earbud with Clip Microphone and PTT
HLN9132	Earbud
HLN9133	VOX Adapter Kit

Retrofit Kits:

HLN9087	External Antenna Adapter (BNC Connector)
PMLN4064	DTMF Decode Signalling Retrofit Kit (Pack of ten of PMLN4063)
PMLN4067	SmarTrunk II Retrofit Kit (Pack of ten of PMLN4066)

Manuals/Videos:

6881086C08	GP68 Radio Service Software Manual (English)
6881086C09	GP68 Service Manual (Spanish/Portuguese)
6881086C10	GP68 User Manual (Spanish/Portuguese)
6804370J40	GP68 User Manual (English/Chinese)
6804370J41	GP60 Series Service Manual (English)

Others:

PMLN4068	Radio to Radio Cloning Cable
PMLN4074	Programming Cable
RVN4159	GP68 Radio Service Software

Prices And Availability Subject To Change Without Notice

Performance Specifications for the GP68 Radio

GENERAL

	VHF	UHF
Frequency:	136-174 MHz	430-470 MHz
Channel Capacity:	20 Channels	
Power Supply:	7.5 Volt +/- 20%	
Dimensions with Medium Capacity NiCd Battery: with High Capacity NiCd	130mm x 57mmx29.5mm	
Weight: with Medium Capacity NiCd Battery: with High Capacity NiCd Battery:	404 g 454 g	

Average Battery Life @ (5-5-90 Duty Cycle)	Low Power	High Power	Low Power	High Power
Medium Capacity NiCd Battery:	5 Hrs.	3 Hrs.	5 Hrs	3 Hrs.
High Capacity NiCd Battery:	11 Hrs	7 Hrs	11 Hrs	7 Hrs

Water Seal:	Passes rain testing per IP54
Shock & Vibration:	Impact resistance polycarbonate housing passes TIA RS-603

TRANSMITTER

	VHF		UHF	
RF Output NiCd @ 7.5V:	**Low** 1W	**High** 5W	**Low** 1W	**High** 4W
Frequency:	136-174 MHz		430-470 MHz	
Channel spacing	25 kHz	12.5kHz	25 kHz	12.5kHz
Freq. Stability (-30˚C to +60˚):	.0005%		.0005%	.00025%
Spurs/Harmonics:* Second Harmonic:	-60 dB -50dB		-60 dB -50dB	
Audio Response: (from 6 dB/oct. Pre-Emphasis, 300 to 3000Hz:	+1, -3 dB		+1, -3 dB	
Audio Distortion: @ 1000 Hz, 60% Rated Max. Dev.	<5%		<5%	
Modulation:	16K0F3E	11K0F3E	16K0F3E	11K0F3E
FCC Acceptance:	AZ489FT3786		AZ481FT4811	

*Second Harmonics: VHF: -50dB; UHF: -50dB

RECEIVER

	VHF		UHF	
Channel Spacing	25kHz	12.5kHz	25kHz	12.5kHz
Frequency:	136-174 MHz		430-470 MHz	
Sensitivity 12 dB EIA SINAD**:**	0.25 µV		0.25 µV	
Selectivity EIA:	-65 dB	-60 dB	-60 dB	-55 dB
Intermodulation EIA:	-65 dB	-60 dB	-60 dB	-55 dB
Freq. Stability (-30˚C to +60˚C):	0.0005%		0.0005%	0.00025%
Spur Rejection:	-65 dB		-60 dB	
Second Image Rejection: **	-60 dB		-55 dB	
Audio Output @ <5% Distortion	250 mW into 24Ω			

** f_c ±910kHz: VHF: -60dB; UHF: -55dB

All specifications are subject to change without notice.

Service Aids

The following table lists service aids recommended for working on the GP60 Series Radios.

Motorola Part No.	Description	Application
RTX4005	Portable Test Box	Enables connection to the audio / accessory jack. Allows switching for radio testing.
RKN4034	Test Box cable	Connects radio to Test Box.
RVN4159	Radio Service Software	Software on 3.5” floppy diskette and manual
PMLN4074	Programming Cable	Connects radio to RIB.
PMLN4068	Radio to Radio Cloning Cable	Allows a radio to be duplicated from a master radio by transferring programmed data from the master radio to the other.
RLN4008	Radio Interface Box(RIB)	Enables communications between the radio and the computer’s serial communications adapter.
HSN9412	RIB Power Supply	Used to supply power to the RIB.
HKN9216	Computer Interface Cable	Connects the computer’s serial communications adapter to the RIB.
HLN9390	AT to XT Computer Adapter	Allows HKN9216 to plug into a XT style communications port.
HLN9087	External Antenna Adapter Converts RF port to BNC	Power and sensitivity measurement
01-80304E45	Battery Eliminator	Allows use of Power Supply
81-80377E77	Housing Eliminator	Allows component level analysis

Test Equipment

The following table lists test equipment required to service the GP60 Series Radios and other two-way radios.

Motorola Model No.	Description	Characteristics	Application
R2200, R2400, or R2001 with trunking option	Service Monitor	This monitor will substitute for items with an asterisk *	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1049	Digital Multimeter		Two meters recommended for ac/dc voltage and current measurements
*S1100	Audio Oscillator	67 to 200 Hz tones	Used with service monitor for injection of PL tones
*S1053, *SKN6009, *SKN6001	AC Voltmeter, Power Cable for meter, Test leads for meter	1mV to 300V, 10-Megohm input impedance	Audio voltage measurements
R1053	Dual-trace Oscilloscope	20 MHz bandwidth, 5mV/cm - 20V/cm	Waveform measurements
*S1350, *ST1215 (VHF) *ST1223 (UHF) *T1013	Wattmeter, Plug-in Elements (Vhf & Uhf), RF Dummy Load	50-ohm, $\pm$ 5% accuracy 10 Watts, maximum 0-1000 Mhz, 300W	Transmitter power output measurements
S1339	RF Millivolt Meter	100uV to 3V RF, 10 kHz to 1.2 GHz	RF level measurements
*R1013	SINAD Meter		Receiver sensitivity
S1347 or S1348 (prog)	DC Power Supply	0-20 Vdc, 0-5 Amps	Bench supply for 12.5Vdc

Section 1
Radio Disassembly/Assembly

Overview

This section explains, step by step, how to disassemble and reassemble the GP60 Series portable radio.

Disassemble Radio

Remove Battery

The battery latches are located at the sides of the radio.

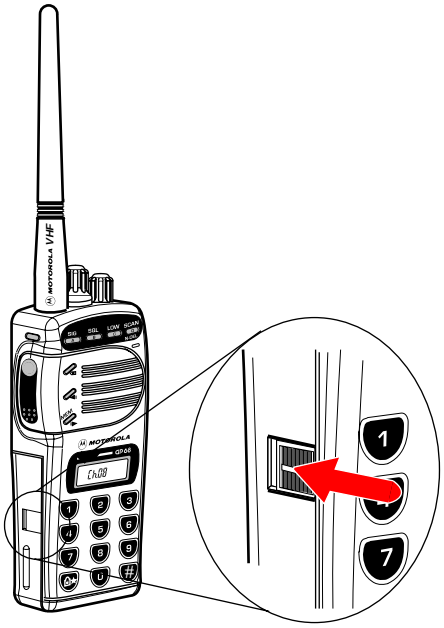


Figure 1-1 Slide Battery Latch

1. Slide latches away from the front panel on both sides of the radio to unlock battery compartment (Figure 1-1).
2. Slide battery cover down and away from radio to remove (Figure 1-2).

Remove Radio's Chassis

1. Remove antenna and both control knobs. The control knobs pull off and the antenna screws off counterclockwise (Figure 1-3).
2. Remove the two screws at the back of the chassis (Figure 1-3).

Figure 1-2 Slide Battery Cover

3. Slide the chassis downwards a little and lift it away from the front housing (Figure 1-3).

NOTE

Please note that the flat ribbon cable still connects the controller board and the RF board. Be careful not to strain this cable while separating the chassis from the front housing.

4. Unlatch the latch lever of the connector on the RF board and disconnect the flat ribbon cable.

Remove RF Board

1. Remove the five screws which hold the RF board to the chassis with a TORX® head screwdriver (Figure 1-4).
2. Gently remove the RF board from the chassis (Figure 1-4).

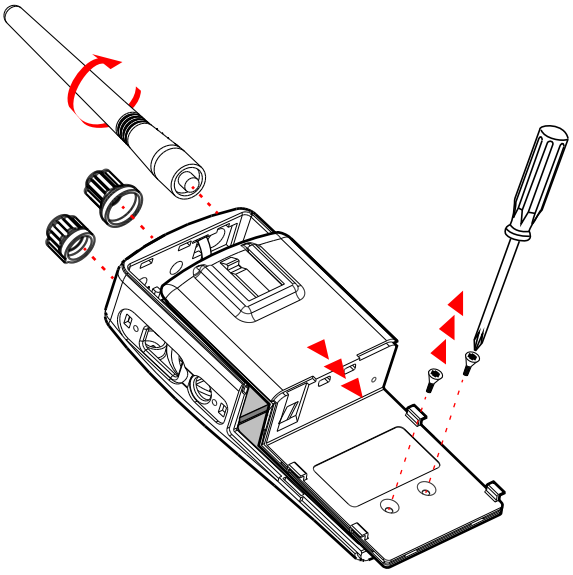


Figure 1-3 Remove Radio Chassis

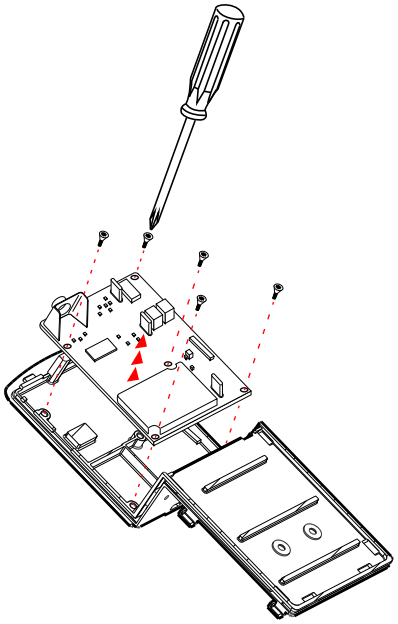


Figure 1-4 Remove RF Board

Remove Controller Board

1. Remove the PTT lever by slipping a small screw driver between it and the Monitor Button and pry it out (Figure 1-5).
2. Remove the two dust covers, that cover the accessories and cloning connectors, at the side of the radio.
3. Unlatch the latch levers on the controller board, and remove the ribbon cable as well as the flex tail from the connectors (Figure 1-6).

Figure 1-5 Removing the PTT lever

4. Use a TORX® head screwdriver to remove the screw (Figure 1-6).
5. Gently lift the bottom of the controller board to disconnect it from the display board (Figure 1-6).
6. Ease the controller board downwards and lift it away from the housing.

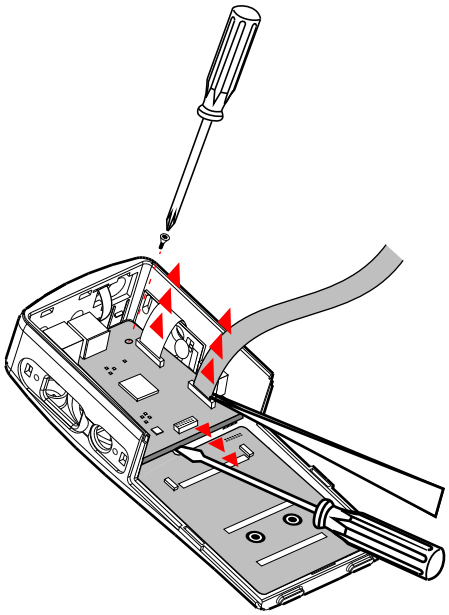


Figure 1-6 Remove Controller Board

Remove Display Board

1. Once the controller board is removed, the whole display board will be visible.
2. Turn the housing so that the front panel buttons faces upwards (Figure 1-7).
3. Gently tap the housing to dislodge the display board (Figure 1-7).

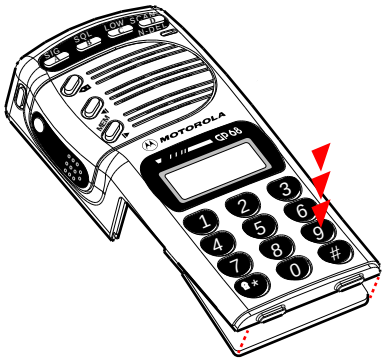


Figure 1-7 Remove Display Board

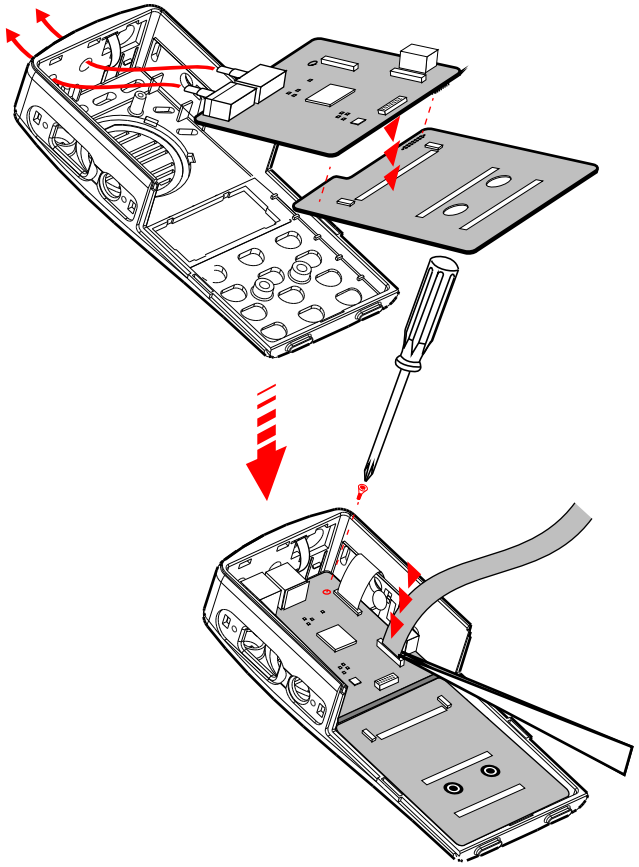


Figure 1-8 Replace Controller Board and Display Board

Reassemble Radio

Replace Controller Board and Display Board

1. Hold the display board in such a manner that the connector is situated at the top right-hand corner (Figure 1-8).
2. Align the connectors of the controller board and the display board and press firmly to connect the two boards (Figure 1-8).
3. Carefully slide the boards into the housing at a 45 degree angle. Care should be taken as the volume and channel shafts are inserted into the openings of control top (Figure 1-8).
4. Fasten the Controller board to the housing with the TORX® head screw (Figure 1-8).
5. Insert the tail from the speaker flex into the connector and lock the latch on the connector (Figure 1-8).
6. Snap on the PTT lever.
7. Replace the dust covers covering the accessories and cloning connectors.

Replace Radio's Chassis

1. Place the RF board on the chassis and tighten the five screws (Figure 1-9).
2. Connect the RF board and the controller board with the flat ribbon cable (Figure 1-9).
3. Place chassis gently into the housing (Figure 1-9).
4. Slide the chassis upwards to properly fit into the housing and press the bottom of the chassis firmly into place (Figure 1-9).

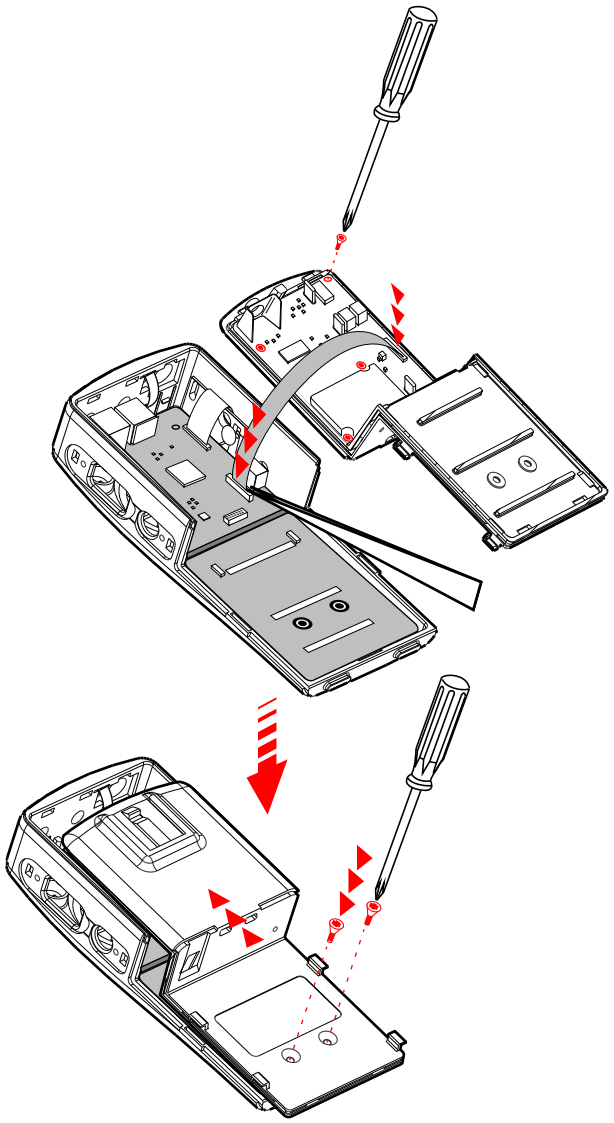


Figure 1-9 Replace Radio's Chassis

NOTE
Be careful to loop the flex ribbon cable properly when assembling the chassis onto the housing.

Replace Battery, Knobs, and Antenna

1. Replace battery pack by sliding the pack in place.
2. Slide battery cover latches towards the front panel to lock.
3. Replace both control knobs and antenna.

Torque Specifications Chart

PART NUMBER	DESCRIPTION	SIZE	TORQUE (IN./LB.)	EXP. VIEW NUMBER*
0304726J01	Screw, Torx T-6	M2 X 0.4 X 5 mm	2.0 (to housing, front) 2.5 (to chassis)	24
0304725J02	Screw, Machine Metric, Flat Head 90 Deg.	M2 X 0.4 X 4 mm	2.5	33
0304726J01	Screw, Self-Tapping	M2 X 0.4 X 4 mm	2.5	34

* Refer to G68 Exploded Mechanical View on page 17 for locations of screws.

Section 2
Theory of Operation

Overview

This section provides a detailed theory of operation for the GP60 Series Radios and its components.

The GP60 Series radio consists three main boards; Controller board, rf board and display board. The controller board is connected to the rf board through a 20 lines flex ribbon cable. The display board is connected to the controller board through a 14 pins board-to-board connector. The top key pads are embedded on a flex that makes connection to the controller via 20 pins connector.

Controller Board

Controller board is the heart of the radio. It contains microcomputer (U401), AFIC (audio processor IC, U451), general 5 volt regulator (U302), 5 volt regulator with reset to power up the microcomputer (U456), Unswitch ram back up 5 volt regulator (U457), audio power amplifier IC (U454), MIC amplifier (U452-1)and rf power control circuitry/APC (U152, U150).

Microcomputer

The GP60 Series VHF and UHF radios use the Motorola 68HC11E20 microcomputer, U401, which utilizes:

- 7.9488 MHz clock rate
- Single chip mode operation
- 16-bit addressing
- Internal watchdog circuitry
- Analog to digital conversion input ports

The microcomputer's operating program is permanently written or "masked" within the microcomputer. Included in U401 is an EEPROM memory which stores channel, signalling, and scan list information.

Microcomputer Power-Up and Reset Routine

On power-up U401's reset line (pin 43) is held low by the AFIC (U451) until the synthesizer (U201, on the rf board) provides a stable 2.1 MHz output. When U451 releases its control, U401's hardware holds the reset line low until it verifies that clock Y401 is operational. When the reset line goes high, U401's hardware delays briefly to allow Y401 to stabilize, then the software begins executing port assignments, RAM checking, and initialization. A fixed delay of 100 mS is added to allow the audio circuitry to settle. Next, an alert beep is generated and the steady state software begins to execute (buttons are read, radio circuits are controlled).

U401's reset line can be controlled directly by the 5 V regulator (U456), the AFIC, and the microcomputer, and indirectly by the synthesizer. U456 drives the reset line low (via pin 3) if it loses regulation. This prevents possible latch-up or overwriting of registers in the microcomputer because the reset line is higher in voltage than pin 55 of U401 (VDD).

U401 can drive the reset line low if it detects a fault condition such as an expired watchdog timer, software stuck in an infinite loop, unplanned hardware inputs, static zaps, etc.

The AFIC and synthesizer can control the reset line during power-up, as outlined above.

Transmit and Receive Audio Circuitry

The GP60 Series Radios receive (Rx) and transmit (Tx) circuits are common to both the VHF and UHF models. Most of the radio processing for Rx and Tx is accomplished in U451, the Audio Filter IC. The Audio Filter IC performs the following functions:

- Tone/Digital PL encoding and decoding
- PL rejection filter (Rx audio)
- Tx pre-emphasis amplifier
- Limiter
- Post-limiter filter
- Tx deviation digital attenuators
- MIC gain attenuator
- Noise squelch digital attenuator
- Microcontroller port expanders (output only)
- 2.5 Vdc reference source

U451 parameters are programmed from U401 microcontroller ROM and EEPROM data via the serial CLOCK and DATA lines. Unless otherwise indicated, all signal levels refer to standard carrier modulation, 1 kHz tone at ±3 kHz deviation.

Tx Audio Path

Internal PTT, MIC Bias Switch and External PTT Sense Circuits

The internal PTT switch (SW402) is connected direct to the input port of the microcomputer (pin 42) to ground. This port is an active low. One of the R415 resistor is used to pull up the line to 5 volt. While PTT (internal) this line will be pulled low. Internal MIC bias is supplied from the +5VTX (switch by microcomputer) through R467 and R468. Internal MIC is connected to the controller board via top keypad flex.

When connecting an external MIC through connector J406, the external PTT sense transistor Q403(pins 2, 3, and 4) switches "ON" when the external PTT switch is closed. Collector voltage Q403-4 is monitored by U401-34. When collector is logic "HI" state, the microcontroller configures the radio for transmit mode. In PTT equipped accessories, the PTT switch is series connected with the external MIC element.

MIC Amplifier

MIC audio from internal MIC MK401 is coupled through C468, J406, and L402 to the MIC amp circuit U452-1. External MIC plug insertion mechanically disconnects the internal MIC. External MIC audio is coupled through L402 to the MIC amp input. Capacitors C458, C460 and C461, and resistors R458, R459 and R460 provide a low audio frequency roll off with a high-pass corner frequency of 1 kHz to improve transmit audio clarity. Crossover gain is 12 dB (at 1 kHz). Reference deviation is obtained with 11.0 mV rms input to the external MIC connector J406.

Tx Audio Mute Gate

Pins 1, 5, and 6 of dual PNP transistor Q403 and resistors R465 and R456 comprise the Tx audio mute gate. Audio Filter IC U451-40, expanded output port, controls PNP transistor Q403 (pins 1, 5, and 6). When U451-40 is logic LO state, a small dc current flows from U452-1-1 MIC amp output into Q403-6 emitter, through Q403, and out of the collector (Q403-1) through R456. A fraction of the emitter current flows out of the base (Q403-5) through R465 to ground (Vss of Audio Filter IC). MIC audio at U452-1-1 passes through the Tx audio mute gate. When U451-40 is logic "HI", Q403-6 is 2.4 Vdc, biasing the device well into cut-off. No current flows through emitter to base/collector, and no MIC audio passes. The mute function is enabled (Q403 pins 1, 5, and 6 is "OFF") when modulating DTMF Signalling.

Pre-emphasis Amp

The Audio Filter IC U451, contains a Tx audio pre-emphasis amp, with external gain setting resistor R451 and C452. Connections are made at each end of resistor R451 to provide interconnection of option board Tx audio through connector J403. Pre-emphasis is 6 dB/octave with a corner frequency of 6600 Hz. Crossover gain is 0 dB at 1 kHz, with passband gain (head-room) of 17.5 dB.

Limiter (Audio Filter IC)

The audio filter IC U451 contains the limiter circuit, which prevents over-deviation of the RF carrier by symmetrically clipping the peaks of the modulating voltage. Audio from the pre-emphasis amplifier circuit is coupled to the limiter. Gain of the limiter stage is adjustable in four 3 dB steps, from -3 dB, 0 dB, +3 dB, and +6 dB. Therefore, Tx audio path gain, or MIC gain, can be adjusted to compensate for different sound environments through the Radio Service Software.

Post-Limiter Filter (Audio Filter IC)

Clipped modulating voltage from the limiter output is coupled to the post-limiter filter. Filtering attenuates the spurious products generated by the limiter. The post-limiter filter is programmable to operate in the following modes:

- EIA mode

PL Encoder

Private Line (CTCSS) is generated by the PL encoder circuit in the Audio Filter IC U451. Tone PL or Digital PL data is user programmable (see user manual) for each mode. On entering transmit mode, TPL or DPL data is programmed to U451 via the serial DATA and CLOCK lines. U401-57 microcontroller output strobes & U451-32 PL CLOCK input at a constant rate during DPL encoding, or at a rate determined by the PL encoder algorithm in the microcontroller for TPL encoding corresponding to tone frequency. The encoded PL is summed with MIC audio at the post-limiter filter input. Digital attenuators are employed to adjust the balance of MIC radio and PL to prevent over deviation of the carrier.

DTMF Encoder

Resistors R423, R424, R425, and R427, and summer U452-2 form the DTMF encoder. Output from U452-2 pin 7 is coupled to U451-13 Audio Filter IC auxiliary Tx modulation input. DTMF encoded signals pass from this input to the post-limiter filter input.

Output from U452-2 pin 7 is also coupled to U451-6 and coupled through Rx audio path to the audio PA for sidetone audio.

Deviation Attenuators (Audio Filter IC)

Carrier deviation is set by programming the digital deviation attenuators of the Audio Filter IC. Deviation data for each mode is entered through the Radio Service Software, and then programmed into U451 from microcontroller U401 on entering transmit mode. U451-19 and U451-20 deviation attenuator outputs are combined through resistors R454, R455 and R457 and dc-coupled to U201-5 (on rf board), the synthesizer modulation input. Capacitor C218 provides a high frequency roll-off corner at 20 kHz to further attenuate spurious signals from U451. The dc voltage at the combined attenuator outputs sets the center frequency for the modulated carrier. Any transient (R x C) voltages in the Tx audio

path must settle within 1 millisecond of PTT activation to prevent center frequency offset.

Rx Audio Path

Audio Processing (Audio Filter IC)

The recovered Rx audio from the rf board (IF detector IC U51) is coupled through to U451-7 and U451-8 on the Audio Filter IC. Rx audio at U451-7 is processed first by the PL rejection filter, which is characterized by a 2-pole, 300 Hz corner frequency high-pass response. Audio de-emphasis is a single pole low pass filter with a corner frequency of 231 Hz. Audio then passes through the digital volume attenuator and buffer amplifier output to U451-23. For standard test modulation, the audio level at U451-7 is 255 mV rms, and output audio level at U451-23 is 765 mV rms with the digital volume attenuator set to minimum attenuation.

PL Decoder

Recovered Rx audio at U451-8, the PL decoder input, first passes through the Tone PL filter, or the Digital PL filter, depending on the PL option selected for the current operating mode. Filtered PL is then coupled to the PL detector circuit, with detected PL output at U451-27 to microcontroller U401-64 where algorithms perform the final PL decoding. Data for the Tone PL frequency or Digital PL code for each mode is programmed through the Radio Service Software.

Rx Audio Mute

The Rx audio mute is controlled by microcontroller U401 via U451-3. The chip disable U454-1 is used to power down audio PA to conserve standby current and mute. When at a logic “0” (0 V to 0.8 V), the U454 is enabled for normal operation. When pin 1 (U454-1) is at a logic “1” (2.0 V to Vcc V), the U481 is disabled (muted).

Audio Power Amplifier

U454 (MC 34119) is a low amplifier capable of low voltage operation (Vcc=2.0 V minimum). The circuit provides a differential output (U454 pins 5 & 8) to the speaker (24 ohms) to maximize the available voltage swing at low voltages. The internal configuration consists of two identical operational amplifiers. Open-loop gain is above or equal to 80 dB (at f<= 100 Hz), and closed-loop gain is about 46 dB set by R485 (feedback resistor) and input impedance (R480, R481, and SW482-2). Variable resistor SW482-2 and R482 provide Rx audio volume adjustment. R482 will set the minimum volume level. The chip disable pin (U454-1) permits powering down the U454 IC for muting purposes and to conserve power.

Noise Squelch Attenuator

The Audio Filter IC U451 contains a 16 step programmable digital squelch attenuator between U451-16 and U451-18. Noise squelch setting is a user programmable option (see user manual), with open squelch at step 0, and tight squelch at step 15.

Option Interface

The option interface provides the ability to interface Motorola designed and third party designed option boards to the radio. The following is a description of the signals available on the option interface.

J403-1

J403 -1 interfaces with pin 42 of U401 and one end of PB401, the PTT switch. This is a wire-or connection with the internal PTT signal. It can either be used as an internal PTT sense or as a PTT input from the option board. This connection is pulled to 5 volts through a 51k ohm resistor. When this connection is shorted to ground the radio microcontroller processes an internal PTT request. This request normally keys the radio unless overridden by other enabled features.

J403-2

J403-2 interfaces with pin 54 of U401. Pin 54 of the microcontroller is bi-directional port D bit 4. In the GP60 Series Radio, this connection option board enables output from the microcontroller. This pin is used to enable option boards or to enable a serial transfer in more complex option boards. When used as a simple option board enable the radio microcontroller sets the output either high or low on power-up to reflect the programmed selection in the radio's wide data. When used in more complex option boards this line enables serial transfers between the radio microcontroller and the option board. Since the serial data out of the microcontroller is used for multiple internal devices, including an option board, this signal indicates when serial data is for option board use and not other electrical subsystems within the radio.

J403-3

Tx Audio input to the radio is available at J403-3 with a sensitivity of 40 mV rms pre-emphasized at a 6dB/octive, and less than 200 ohm output impedance (from the option board). If “flat” audio response is required, the audio output from the option board must be de-emphasized at a -6dB/octive rate, 300 Hz-3 kHz with 0 dB gain at 1 kHz. The low option board output impedance is required to achieve better than 40 dB isolation between main board input (J403-4) and output (J403-3) audio.

J403-4

This is the audio from the internal or external microphone of the radio. J403-4 provides MIC audio output to an option board at a level of 45 mV rms and a 10k ohm input impedance.

J403-5

J403-5 is the logic board ground.

J403-6

J403-6 is interfaced to pin 4 of voltage regulator U456. This is the microprocessors 5 V source from the main board to the option board. Maximum current sourcing is 100 mA. Regulation is ±0.2 Vdc.

J403-7

J403-7 interfaces with pin 52 of U401. Pin 52 of the microcontroller is bi-directional port D bit 3. In the GP60 Series Radio, this connection is for serial data out of the microcontroller. This controls loading of the various electrical subsystems internal to the radio in addition to data required by option boards installed into the radio. For option connector purposes this pin is used to shift multi-byte messages from the radio to an option board. When used for this purpose, pin J403-2 option board enable, is driven low by the radio microcontroller to enable a serial byte transfer to an option board.

J403-8

J403-8 interfaces with pin 51 of U401, the radio microcontroller. Pin 51 of the microcontroller is bi-directional port D bit 2. In the GP60 Series Radio, this is decoder data into the radio. On a DTMF decoder board this would be the serial input for the 4-bits of tone data. On other option boards this input is used as the serial input for a multiple byte message.

J403-9

This option interface pin is connected to the Rx Out signal, pin 23 of the Audio Filter IC, U451 through coupling capacitor C450. In the GP60 Series Radio, this signal de-emphasizes Rx audio and output is always unmuted audio in the radio. This pin may be used as the receive audio to a decoder option board such as DTMF, Two Tone Sequential, or MSK signalling decode. An audio scrambler option board may also use this input for receive audio in. Any option board requiring pre-emphasized audio would have to include the necessary filtering. The level of this de-emphasized audio is 450 mV rms at 15 ohm impedance.

J403-10

This is the Rx audio output of the option board. This connection may be used for option boards that need to enable Rx audio on signaling decodes or to descramble audio as required by the option board descrambling technique. Option board Rx audio input is available at J403-10 with a sensitivity of 100 mV rms at less than 200 ohm output impedance from an option board. R480, a 30k ohm resistor between option board pins J403-9 and J403-10 requires design consideration on the part of any option board using Rx audio output. The Rx audio output level is controlled by the GP60 Series Radio volume control before the audio amp.

J403-11

J403-11 interfaces with pin 53 of U401. Pin 53 of the microcontroller is bi-directional port PD5. In the GP60 Series Radio, this is the CLOCK output from the microcontroller for loading all internal subsystems as well as option boards that require synchronous serial transfers. Option boards requiring a multi-byte transfer may use this output as the CLOCK source for uploading internal option board registers on power-up, channel change, or for reading serial control requests.

J403-12

J403-12 interfaces with pin 63 of U401. Pin 63 of the microcontroller is an input on port A bit 2 of the radio microcontroller. In the GP60 Series Radio, this connection is used for a variety of input signals from an option board. In a simple option board configuration, a falling edge on this pin connection signals that a selective call has been decoded by the option board. For DTMF decoder boards or other simple BCD decoder boards, a falling edge on this pin indicates that a digit decode has been completed and is ready to be shifted into the microcomputer for concatenation and comparison to an ID string. In more complex option boards, a falling edge on this pin indicates that an option board requests a serial transfer on J403-8 and J403-1 or an acknowledgment of data received on J403-7 in a multiple byte transfer.

Adaptive Power Control™ Technology

The GP60 Series Radio power control is specially designed to handle alkaline battery voltage and current characteristics, without compromising output power variation when used with NiCd batteries.

Basically there are three sections of the power control circuitry. Digital to analog converter, voltage to current converter and the cut back circuitry that react on alkaline batteries.

Digital to analog converter consists of shift register U152, R166, R167, R168, R169 and R170. These are the discrete components that make the resistor ladder digital to analog converter. The output of the DAC is in a form of a voltage. Since the power levelling on the rf board requires current as a reference, this voltage has to be converted into current.

Voltage to current converter consists of U150-2, and Q101. This is a standard voltage to current converter.Since the operational amplifier cannot work at zero volt input, reference zero level has been shifted to around 1.5 volt on operational amplifier input by R173 and R174. The DAC voltage also is shifted accordingly by R172. The output of this section will go to the power levelling circuit on the rf board. A delay capacitor is added (C169) to ensure that DAC voltage will appear only after TXB+. A fast discharge transistor (Q404) is needed to ensure that the capacitor is fully discharged before transmitting.

The cut back circuitry (U150-1 circuitry) is used to protect the radio from operating beyond the capability of the supply voltage especially when radio is powered by alkaline batteries. Alkaline batteries have higher internal resistance and

have difficulty to source high current (2.1 ampere at 5 watts operation). If there are forced to do so, the voltage will drop and when the voltage hits 5 volts, the radio will automatically reset by it self. It means the batteries cannot be used at all for transmitting even though there are still a lot of power inside the batteries. With this circuitry, the user will be able to enjoy the radio operation at any battery condition, as long as the batteries are able to source current sufficient to support 100 mW output.

What the circuit does is just protecting the supply voltage from dropping below 5.5 volt by reducing the output power by means of reducing the programmed current to the power levelling circuitry. The circuit is inactive when the voltage is higher than 5.5 volt.

The threshold voltage is tapped from the +5VTX and the supply voltage is sensed on the SWB+. C167 is a compensation capacitor and C165 is a speed up capacitor to ensure that this circuitry can react faster than the power levelling circuitry.

RF Board

RF board consists of synthesizer, VCO, receiver section, five watts power amplifier, harmonic filter with antenna switch and rf power levelling circuitry.

Receiver

The receiver of the GP60 Series UHF and VHF radios consists of 4 major blocks each:

- the front-end module,
- the double balanced mixer,
- the first IF stage (45.1 MHz for VHF and 73.35 MHz for UHF), and
- the back-end IF IC.

The UHF and VHF front-ends consist of three blocks of circuitry each:

- a pre-selector,
- an RF amplifier, and
- a post-selector filter.

All filters are fixed-tuned designs to eliminate the need for factory tuning and to provide wide-band operation.

The VHF design uses both shunt and series coupled topology while the UHF design incorporates only shunt coupled topology. The UHF design is optimal for attenuating undesired signals on its lower side while the VHF design is more heavily attenuated on its upper side. The worst case image frequency for VHF is 90.2 MHz above 136 MHz, while the worst-case of UHF is 146.7MHz below 430MHz.

The UHF pre-selector filter is a 2-pole, 0.1 dB Chebyshev bandpass design implemented in a shunt coupled resonator topology. The 3 dB bandwidth is approximately 45MHz, centered at 450 MHz. The center of the band insertion loss is approximately 1.8 dB. The 2-pole filter is designed to operate with a 50 ohm input termination, while the output termination is the input impedance of the RF amplifier that follows it.

The VHF pre-selector is also a 2-pole, 0.1 dB Chebyshev bandpass design but with shunt series coupled resonator topology. This topology provides fairly symmetrical attenuation around the center frequency of 155 MHz. The 3 dB bandwidth is approximately 60 MHz. Center of band insertion loss is about 1.5 dB. The input is matched to 50 ohms while the output is matched to the proceeding RF amplifier.

The RF amplifier, Q1, is a Motorola MMBR941L NPN device biased in a common emitter configuration. The amp is stabilized by the shunt feedback resistor R1 with a gain of approximately 19 dB at VHF and 16 dB at UHF. The noise figure is about 3.5 dB and 3.0 dB at VHF and UHF, respectively. The VHF amplifier draws 2.5 mA of current while the UHF amplifier draws 3.0 mA of current Both are supplied by the receive 5 Volt supply (indicated as “+5V Rx” on the schematics and block diagrams).

Terminating the RF amp is the post-selector filter. This filter is a 3-pole 0.1 dB Chebyshev design for both bands. The VHF design is series coupled topology while the UHF is shunt coupled. The 3 dB bandwidth is approximately 58 MHz centered at 155 MHz for VHF and 25 MHz centered at 460 MHz for UHF.

The insertion loss of this filter is approximately 2.0 dB for VHF and 2.7 dB for UHF. The filter is designed to be terminated with the amplifier output impedance on one side, and 50 ohm on the other.

The net gain from the receiver front-end is about 14.0 dB (VHF) and 10.8 dB (UHF) in the center of the band. The net center of the band noise figure is approximately (5.5 dB VHF) (5.2 dB UHF). This is sufficient to achieve a typical center of the band sensitivity of 0.25 µV for 12 dBs.

The double balanced mixer is a module. Internal to it is the two baluns and ring diode. The mixer operates with an LO level of about +5 dBm for both VHF and UHF. The mixer conversion loss is approximately 6 dB. The double balanced type mixer provides excellent isolation between any two ports. Since a DBM can operate over a large bandwidth, the same mixer can be used for UHF and VHF radios. The DBM also provides excellent protection against receiver spurs due to non-linearization, such as IM and Half-IF. The purpose of the mixer is to translate the received signal down to the frequency of the first IF, 45.1 MHz for VHF and 73.35 MHz for UHF, where it then enters the IF circuitry.

Intermediate Frequency (IF)

The Intermediate Frequency (IF) section of the portable radio consists of several sections including, the high IF, the

second LO, the second IF, and the IF IC chip. The first LO signal and the RF signal mix to the IF frequency (45.1 MHz for VHF and 73.35 MHz for UHF) which then enters the IF portion of the radio.

The signal first enters the high IF, passes through a crystal filter and is then amplified by the IF amp. The crystal filter provides selectivity, second image protection, and intermodulation protection. The amplifier provides approximately 10 dB of gain at VHF and 18 dB of gain at UHF to the signal. The high IF has an approximate 3 dB bandwidth of 18 kHz.

The filtered and amplified IF signal then mixes with the second local oscillator at 44.645 MHz for VHF and 72.895 MHz for UHF. The second LO uses an amplifier internal to the IF IC, an external crystal and some external chip parts. The oscillator presents an approximate level of -15 dBm to the second IF mixer, internal to the IF IC.

The output of the mixing of the IF signal and the second LO produces a signal at 455 kHz (second IF). This signal is then filtered by external ceramic filters and amplified. It is then passed back to the IF IC, sent to a phase-lock detector, and demodulated. The resulting detected audio output is then sent to the AFIC to recover the audio.

The IF IC also controls the squelch characteristics of the radio. With a few external parts the squelch tail, hysteresis, attack, and delay can be optimized for the radio. The AFIC (on the controller board) allows the radio's squelch opening to be electronically adjusted.

Transmitter

The GP60 Series Radio VHF and UHF transmitters contain five basic circuits:

- a power amplifier,
- an antenna switch,
- a harmonic filter,
- an antenna matching network, and
- a power levelling circuit.

Refer to the block diagram and the schematic for more information.

The PA of both the VHF and UHF transmitters consists of four stages of amplification with the corresponding stages using the same transistors. The first two stages of both PA line-ups utilize the MMBR951L transistor, while the third stage uses a Phillips BLT50 transistor, and the last stage uses the Motorola MRF873 transistor. The VHF PA line-up is capable of supplying 5 watts or more of output power, while the UHF PA line-up is capable of more than 4 watts at the antenna port. The power out of each line-up can be varied by changing the voltage (VCTL) on their second (MMBR951L) stages.

The antenna switch circuit consists of two PIN diodes (CR101 and CR102), a pi network (C145, L115, and part of C140), and a current limiting resistor (R115). The UHF circuit contains one additional capacitor (C149), which is used to tune out CR102's lead inductance. In the transmit mode, TxB+ is applied to the circuit to bias the diodes "on". To enable the Tx signal to go to the antenna rather than the input of the receiver, the shunt diode (CR102) shorts out the receiver port, and the pi network, which operates as a quarter wave transmission line, transforms the low impedance of the shunt diode to a high impedance at the input of the harmonic filter. In the receive mode, the diodes are both off and there exists a low attenuation path between the antenna and receiver ports.

The harmonic filter consists of C141, C142, C169, C165, C166, C168, L112, L113, L114 and part of C140. The design of the harmonic filter for both VHF and UHF is based on a 10-pole, 0.1 dB ripple Chebyshev filter. The antenna output required a 50 ohm termination.

Note that to measure the power out of the transmitter, one must remove the antenna and screw in its place a special BNC adapter, HLN9087A.

Power levelling

The GP60 Series Radios utilize a current comparator automatic level control to control its output power. Incident power (power going out into the antenna) and reflected power (power reflected back into the radio due to antenna mismatch) are detected by two doublers on the 50 db coupler. The detected current is compared with programmed current at the current comparator transistor Q153. The error current then will be amplify by a dc amplifier (Q152, part of U151 and Q155) to generate a control voltage (VCTL). The system will always maintain the detected current to be the same programmed current. The programmed current (supplied by the controller board) is used to set the output power.

C154 on the VCTL and C153 is the compensation capacitors to ensure system stability.

Frequency Generation Circuitry

The frequency generation circuitry is composed of two main IC's, the Fractional-N synthesizer (U201) and the VCO/ Buffer IC (U251). Designed in conjunction to maximize compatibility, the two IC's provide many of the functions which normally would require additional circuitry. The block diagram illustrates the interconnect and support circuitry used in the design. Refer to the schematic for reference designator.

The supply for the synthesizer is from Regulated 5 Volts which also serves the rest of the radio. The synthesizer in turn generates a superfiltered 5 Volts (actually 4.65 Volts) which powers U251.

In addition to the VCO, the synthesizer must interface with the logic and AFIC circuitry. Programming for the synthesizer is accomplished through the data, clock, and chip enable lines (pins 5, 6, and 7) which are driven by the microprocessor, U401. A serial stream of 98 bits is sent whenever the synthesizer is programmed. A 5 Volt dc signal from pin 2 of U201 indicates to the microprocessor that the synthesizer is locked while unlock is indicated by a low voltage on this pin. Transmit modulation from the AFIC is applied to pin 8 of U201. Internally the audio is digitized by the Fractional-N and applied to the loop divider to provide the low-port modulation. The audio is also run through an internal attenuator for modulation balancing purposes before being outputted at pin 28 to the VCO. A 2.1 MHz clock for the AFIC is generated by the Fractional-N and is routed to pin 11 where it is filtered and attenuated from 2.5 Volts to approximately 2 Volts.

Synthesizer

The Fractional-N synthesizer uses a 16.8 MHz crystal (Y201) to provide the reference frequency for the system. The other reference oscillator components external to the IC are C205, C206, R211, R207, and CR203. The loop filter, comprised of R202, R204, R205, C214, C215, and C216, provides the necessary dc steering voltage for the VCO as well as filtering of spurious signals from the phase detector. For achieving fast locking of the synthesizer, an internal adapt charge pump provides higher current capability at pin 31 than when in the normal steady-state mode. Both the normal and adapt charge pumps receive their supply from the voltage multiplier which is made up of C202, C203, C204, C231, CR201, and CR202. By combining two 5 Volt square waves which are 180 out-of-phase along with Regulated 5 Volts, a supply of approximately 12.6 Volts is available at pin 32 for the charge pumps. The current for the normal mode charge pumps is set by R203. The pre-scaler for the loop is internal to U201 with the value determined by the frequency band of operation.

VCO

The VCO (U251) in conjunction with the Fractional-N synthesizer (U201) generates rf in both the receive and the transmit modes of operation. The TRB line (U251 pin 5) determines which oscillator and buffer will be enabled. A sample of the rf signal from the enabled oscillator is routed from U251 pin 23, through a low pass filter, to the pre-scaler input (U201 pin 20). After frequency comparison in the synthesizer, a resultant STEERING LINE VOLTAGE is received at the VCO. This voltage is a DC voltage between 3 and 11 Volts when the PLL is locked on frequency.

In the receive mode, U251 pin 5 is grounded. This activates the receive VCO by enabling the receive oscillator and the receive buffer of U251. On VHF radios, the rf signal at U251 pin 2 is run through a low pass filter. On UHF radios, the rf signal is run through a buffer amplifier before it is passed through the low pass filter. This is to provide additional isolation to the receive VCO from high level received rf signals. The rf signal after the low pass filter is the LO RF INJECTION and it is applied to the first mixer at U41 pin 3.

During the transmit condition, PTT depressed, five volts is applied to U251 pin 5. This activates the transmit VCO by enabling the transmit oscillator and the transmit buffer of U251. The rf signal at U251 pin 4 is run through a low pass filter and an attenuator to give the correct drive level to the input of the PA. This rf signal is the Tx RF INJECTION. Also in transmit mode, the audio signal to be frequency modulated onto the carrier is received by the transmit VCO modulation circuitry at AUDIO IN.

When a high impedance is applied to U251 pin 5, the VCO is operating in BATTERY SAVER mode. In this case, both the receive and transmit oscillators as well as the receive, transmit, and pre-scaler buffer are turned off. In the Fractional-N, the battery saver mode places the A/D and the modulation attenuator in the off state. This mode is used to reduce current drain of the radio.

Display Board

The display driver (U801) is powered up by the +5V line from the controller. Pin 21 and 49 of the U801 should have the voltage of +5V. The clock frequency of the LCD driver is determined by R814, R815, and C801. This frequency is approximately 1.61 kHz.

The +5V line to the U801 also provides bias voltages to pins 23, 24, and 26 of U801 through R811, R812, and R813.

The LEDs are biased, using R802 and R803, through the +5V line. The switch Q801 is controlled by the LCD_BCK_LIGHT_EN line. When this line goes high (i.e. 5V), Q801 is turned on and the LEDs lights up.

The GP60 Series Radio Alignment Procedures

The following procedures are to be done together with the RSS.

RSSI Threshold Adjustment

Tuning Frequency:
Automatic - Frequency displayed on Tuning screen.

- Apply a standard reference level signal of -47 dBm, 1 kHz tone with 3 kHz deviation.
- Adjust the audio output of the radio to rated level (0.25W), i.e. 2.45 V rms.
- Reduce the generator level until 10 dB SINAD is obtained.
- While the radio is in the 10 dB SINAD mode, press the up-arrow key once to program the correct RSSI setting into the radio.

Low Port Modulation

Tuning Frequency:
Automatic - Frequency displayed on Tuning screen.

Deviation Setting:
375 Hz +/- 40 Hz for 12.5 kHz channel spacing,
750 Hz +/- 40 Hz for 20/25/30 kHz channel spacing.

- Set the radio into TX low power mode. The Modulation Analyzer should be set as follows:

FM
PEAK+
15 kHz LP Filter “ON”
All HP Filters “OFF”
De-emphasis “OFF”

- Use the up/down arrow keys to change the low port deviation setting and the F6 key to toggle the PTT.

NOTE
The low port tuning tone is automatically generated internally by the radio. No external modulation injection is required.

VCO Deviation Adjustment

Tuning Frequency:
Automatic - Frequency displayed on Tuning screen.

Deviation Setting:
2.2 kHz +/- 100 Hz for 12.5 kHz channel spacing,
4.6 kHz +/- 200 Hz for 20/25/30 kHz channel spacing.

- Set the radio into TX low power mode.
- Inject a 110 mV rms, 2 kHz audio signal into the external mic using the radio test box.
- The Modulation Analyzer should be set as follows:

FM
PEAK+
15 kHz LP Filter “ON”
All HP Filters “OFF”
De-emphasis “OFF”

- Use the up/down arrow keys to change the deviation setting and the F6 key to toggle the PTT.

Transmitter Power Adjustment

Tuning Frequency:
Automatic - Frequency displayed on Tuning screen.

Power Level:
VHF - 1 W and 5 W,
UHF - 1 W and 4 W.

- For power tuning, it is important to ensure that the DC Voltage **MUST** be maintained under load at 7.5 V +/- 0.1 V (3 A is the current limit).
- Use the up/down keys to change the power setting and the F6 key to toggle the PTT.
- Tune the radio according to the specification above.

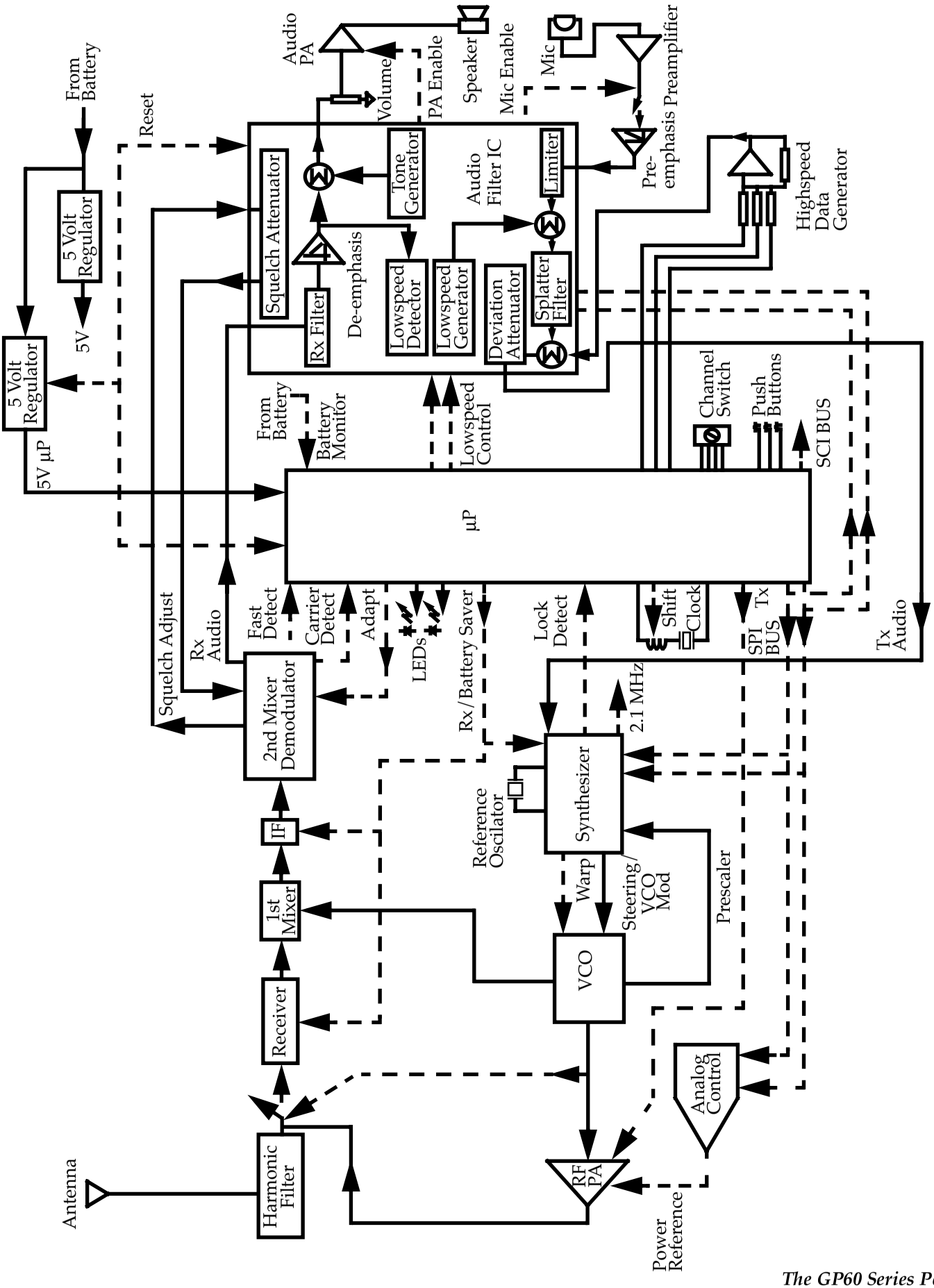
NOTE
To avoid heating the radio too much, do not leave the radio in TX mode continuously and leave a 30 second interval between tuning points.

Reference Oscillator Warp Adjustment

Tuning Frequency:
Automatic - Frequency displayed on Tuning screen.

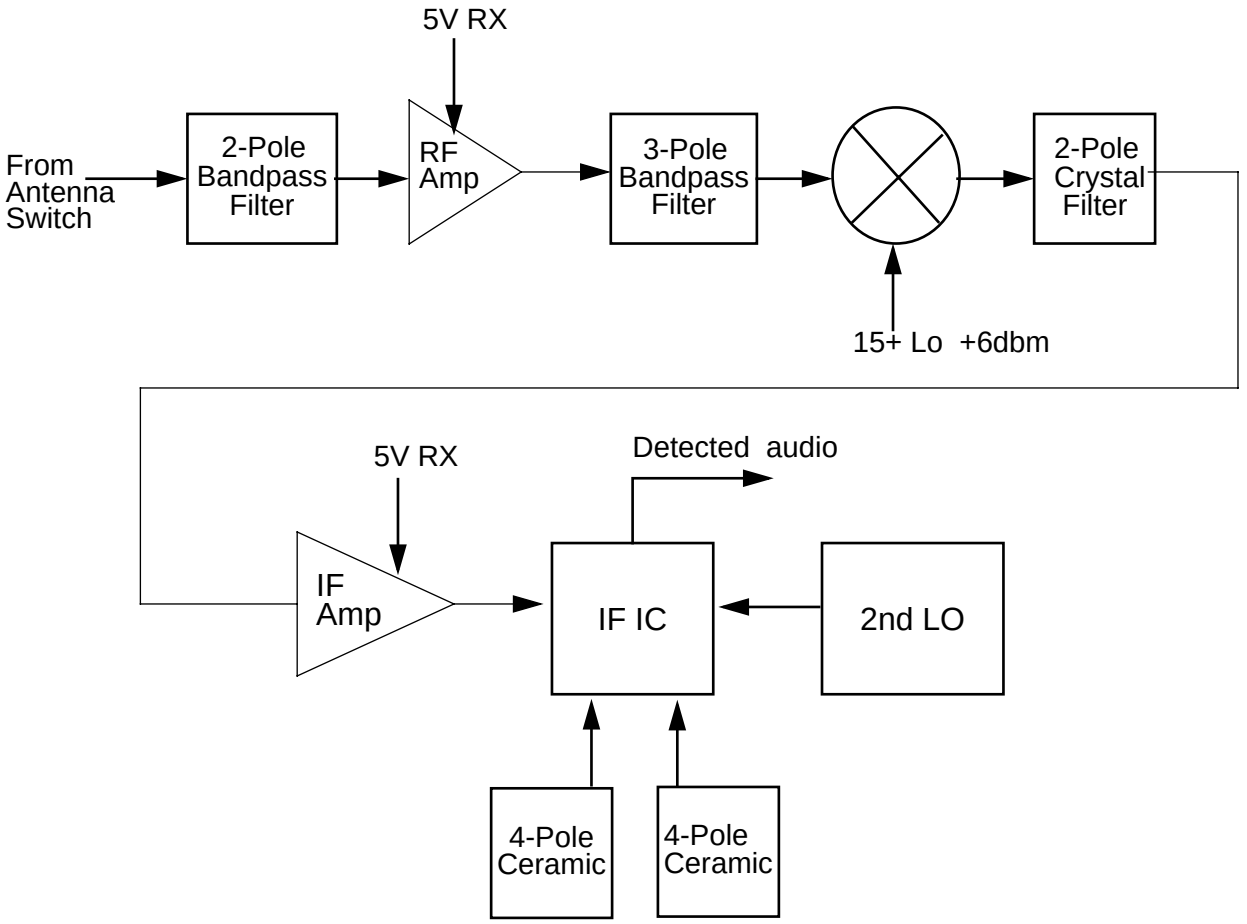
Frequency window:
VHF = +/- 300 Hz,
UHF = +/- 400 Hz.

- Set the radio into TX low power mode.
- Use the up/down arrow keys to change the frequency setting and the F6 key to toggle the PTT.

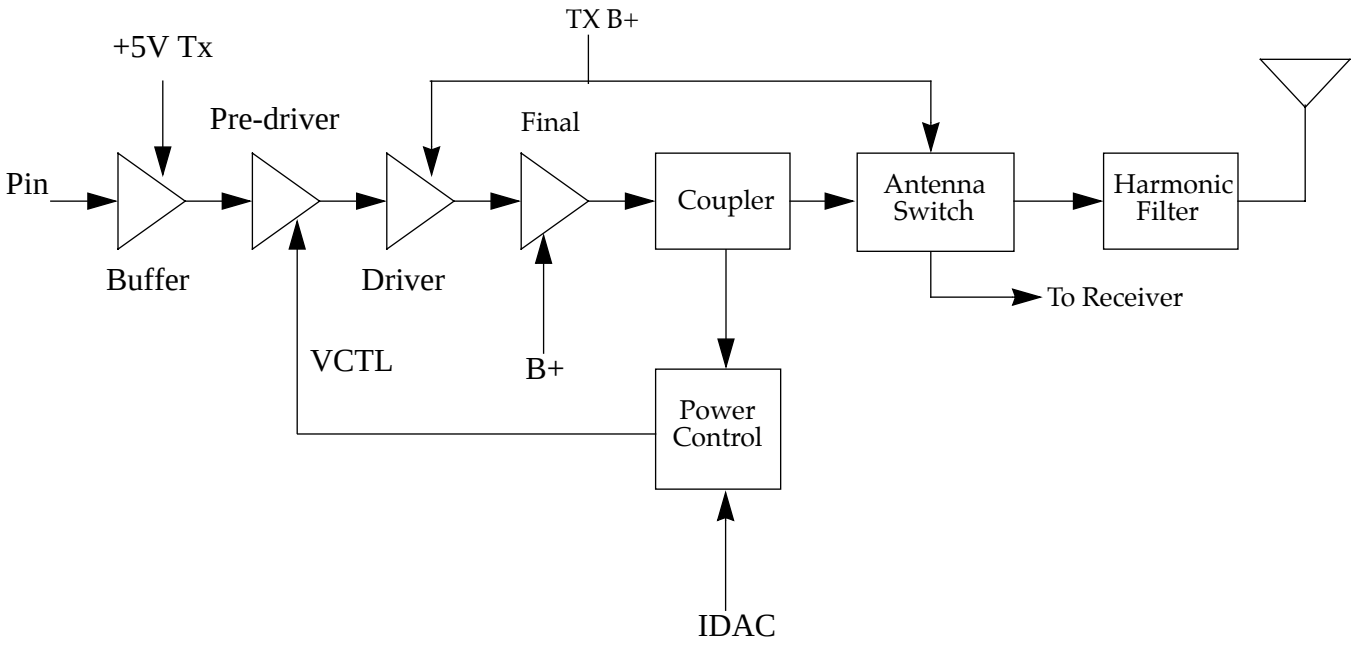


The GP60 Series Portable Radio Functional Block Diagram

RECEIVER BLOCK DIAGRAM

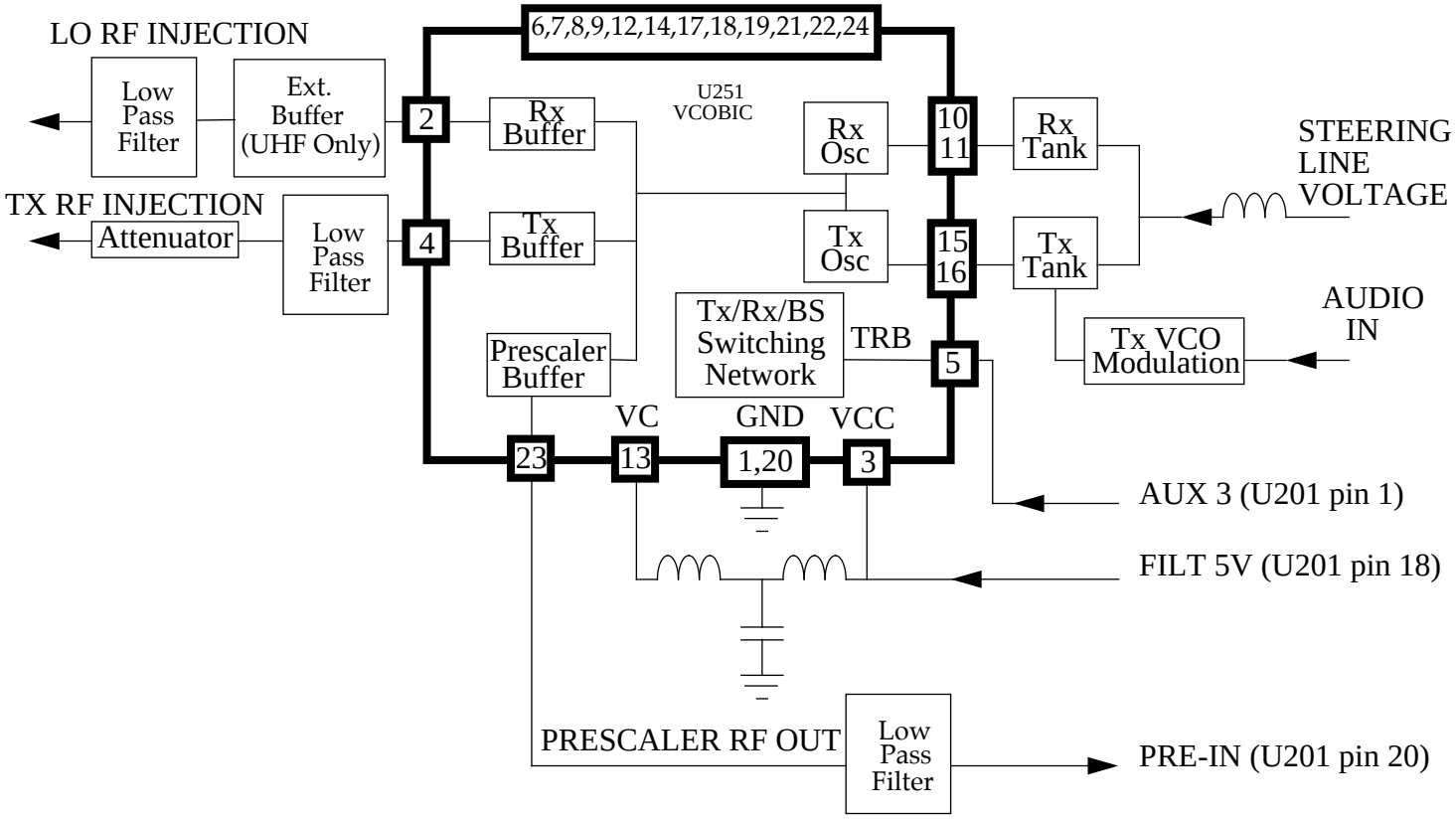


TRANSMITTER BLOCK DIAGRAM

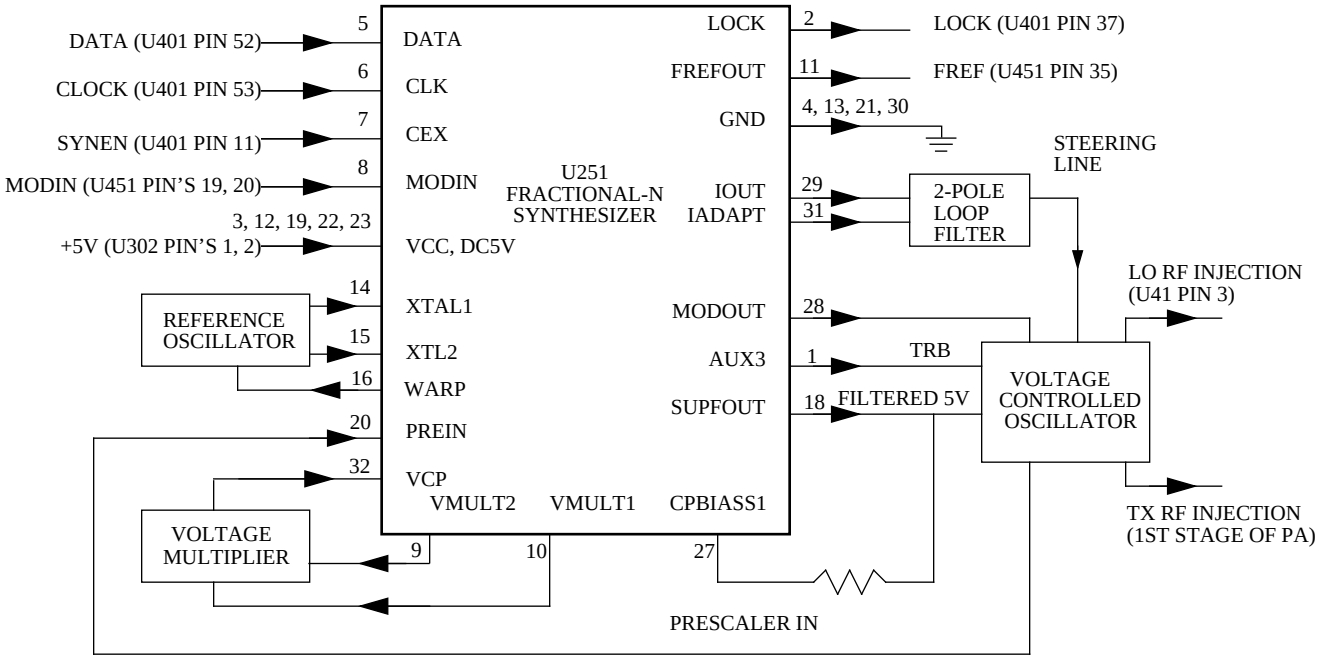


Block Diagram for Receiver and Transmitter

VCO BLOCK DIAGRAM

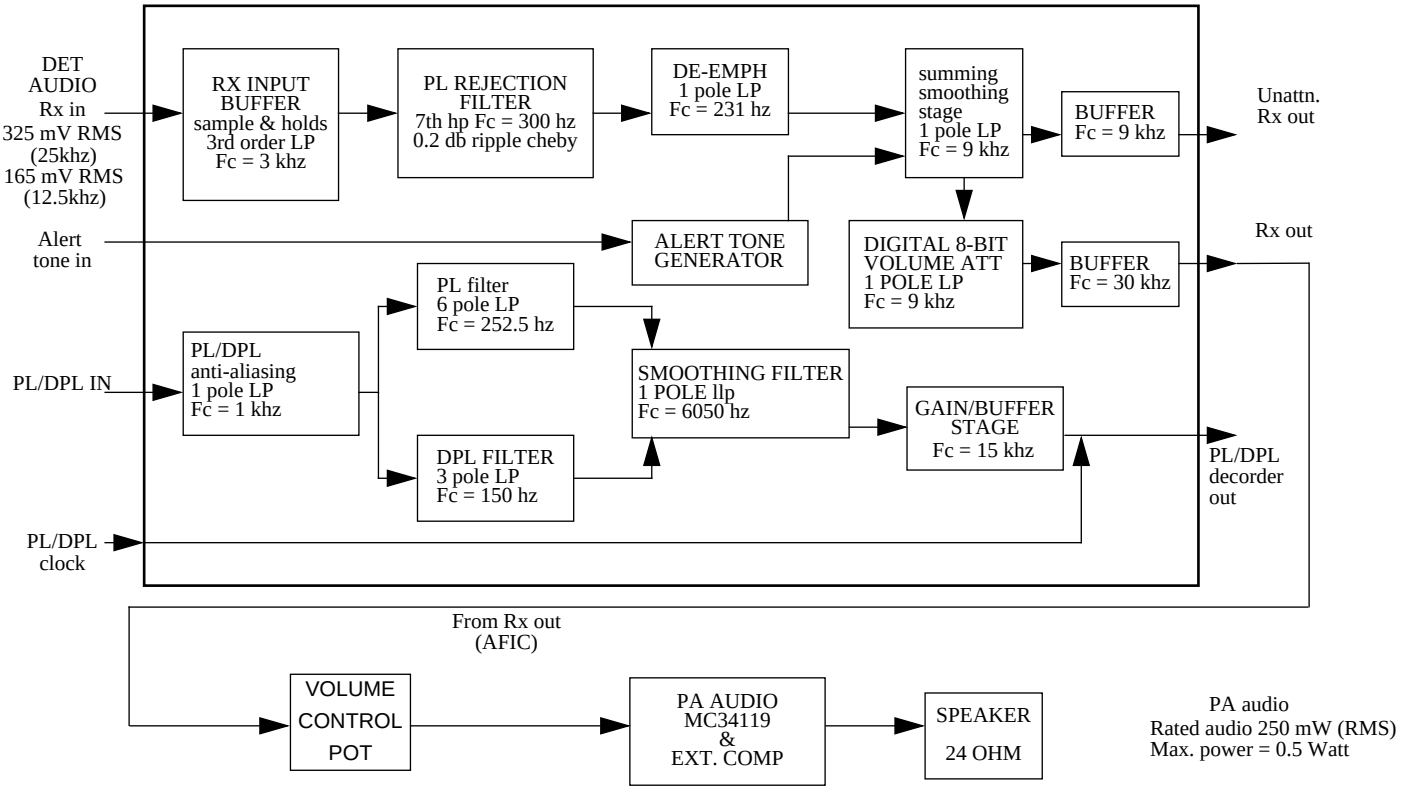


SYNTHESIZER BLOCK DIAGRAM

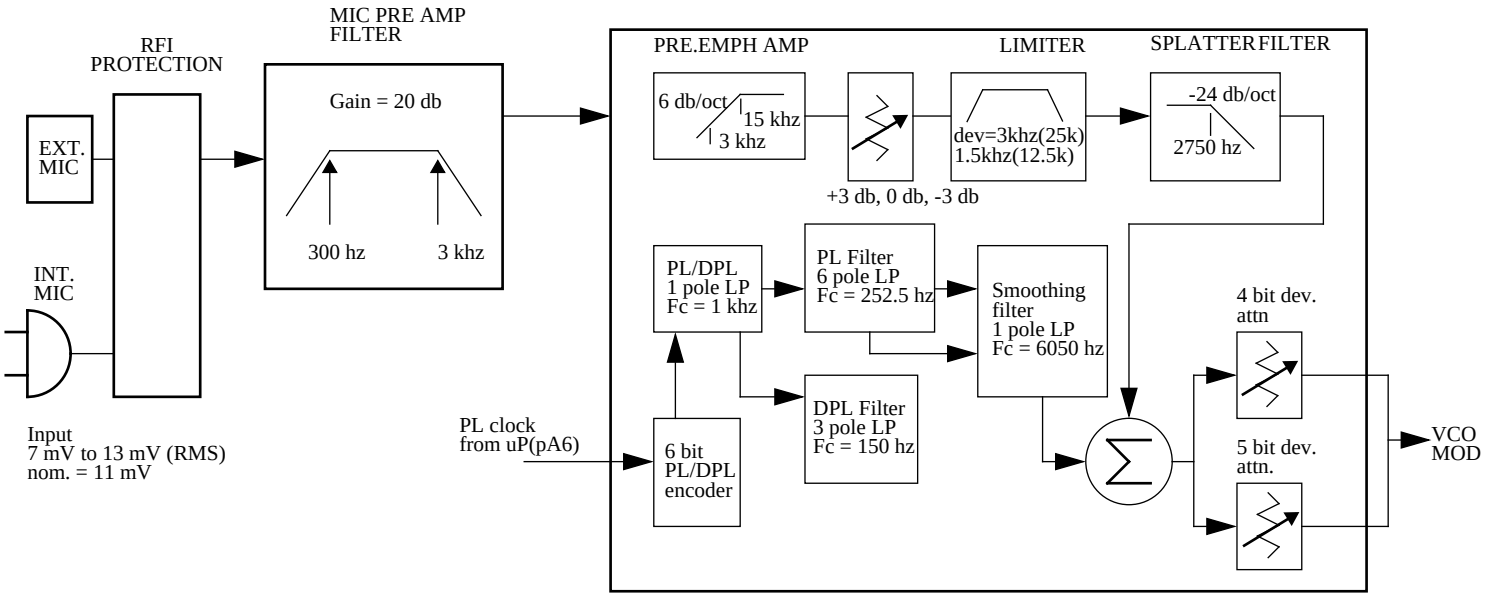


Block Diagram for VCO

RX AUDIO AFIC BLOCK DIAGRAM



TX AUDIO AFIC BLOCK DIAGRAM



Block Diagram for AFIC

Section 3
Accessory

Remote Speaker Microphone

Overview

The remote speaker microphone is an accessory available with the GP68 Series portable radio. This section provides a general description of the remote speaker microphone and describes the operation, handling precautions, and maintenance of this accessory.

Description

The Model HMN9725 Remote Speaker Microphone includes a speaker, a microphone, a push-to-talk (PTT) switch and associated circuitry. A cable, terminated with a special plug, is provided for attaching to the accessory connector on the portable radio.

When the remote speaker microphone is attached to the radio, the speaker in the radio is disabled, and receiver audio is connected to the accessory speaker. Similarly, the accessory microphone is connected to the transmitter, and the accessory PTT switch can now control the PTT function in the radio. The radio microphone and PTT switch are still operational, but you can listen to the radio only through the accessory speaker.

IMPORTANT
Observe safety information in the radio operating instructions.

Operation

1. Attach the microphone's accessory connector to the accessory connector on top of the radio.
2. While listening to the accessory speaker, turn the radio on.
3. Operate radio according to operating instructions supplied with the radio.

NOTE
The microphone will perform best if it is worn as shown in Figure 3-1.

Handling Precautions

To avoid damage to circuits, observe the following handling, shipping, and servicing precautions.

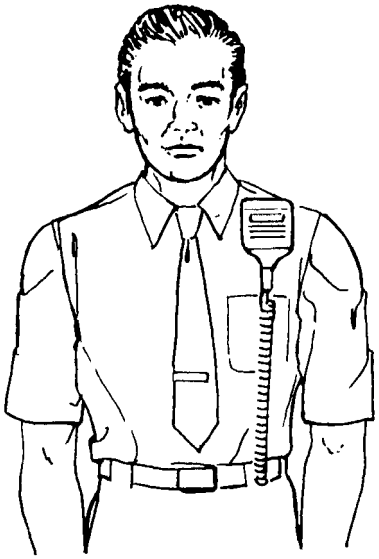


Figure 3-1. Ideal Microphone Position

- Prior to and while servicing a remote speaker microphone, particularly after moving within the service area, momentarily place both hands on a bare metal, earth-grounded surface. This will discharge any static charge which may have accumulated on the person doing the service.
- Whenever possible, avoid touching any electrically conductive part of the unit with your hands.

NOTE
Wearing a conductive wrist strap (Motorola No. RSX-4015A) will minimize static buildup during servicing.

WARNING
While wearing a conductive wrist strap, be careful near high voltage sources. The good ground provided by the wrist strap will also increase the danger of lethal shock from accidentally touching high voltage sources.

- When servicing a unit, avoid carpeted areas, dry environments, and certain types of clothing (silk, nylon, etc.) because they contribute to static buildup.

- All electrically powered test equipment should be grounded. Apply the ground lead from the test equipment to the unit before connecting the test probe. Similarly, disconnect the test probe prior to removing the ground lead.

- If the microphone cartridge is removed from the unit, place it on a conductive surface, such as a sheet of aluminium foil which is connected to ground through 100k ohms of resistance.

WARNING
If the aluminium foil is connected directly to ground, be cautious of possible electrical shock from contacting the foil at the same time as other electrical circuits.

- When soldering, be sure the soldering iron is grounded.

- Prior to replacing circuit components or touching the microphone cartridge, be sure to discharge any static buildup. Since voltage differences can exist across the human body, it is recommended that only one hand be used if it is necessary to touch the microphone cartridge and associated wiring.

- Replacement microphone cartridges should be kept in conductive packaging until they are placed in unit.

Maintenance

Refer to the schematic diagram (shown in Figure 3-2), the exploded view (shown in Figure 3-3), and the parts lists. Every part in the microphone is identified and illustrated for assistance in removal and replacement. If necessary, the external surfaces of the remote speaker microphone may be cleaned with a 0.5% solution of mild dishwashing detergent in water (one teaspoon of detergent in a gallon of water).

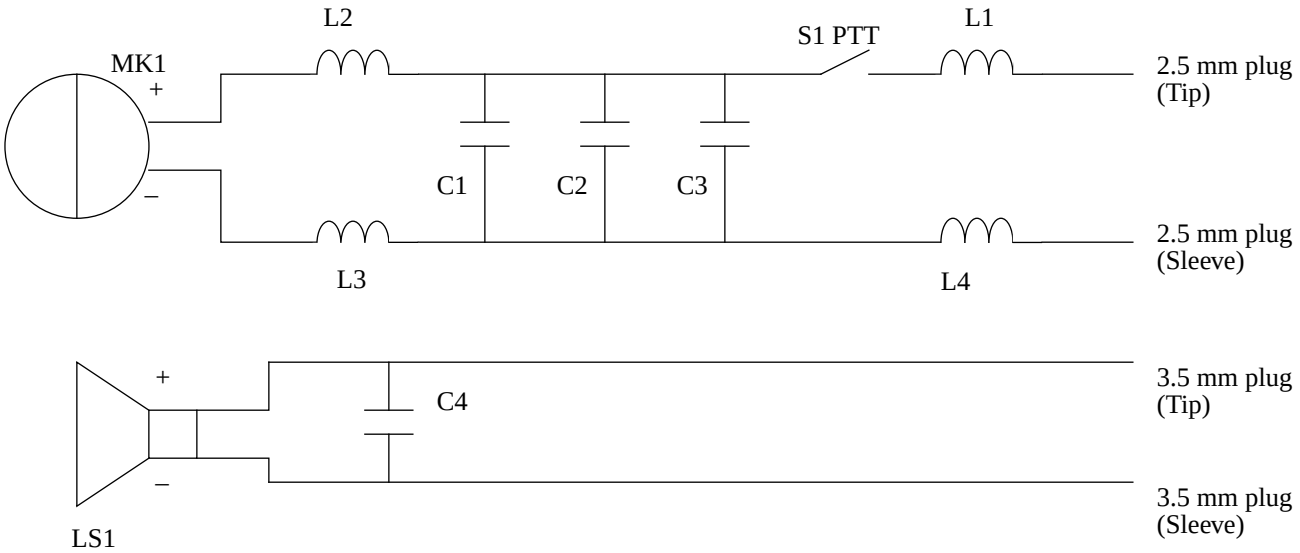


Figure 3-2. Schematic Diagram

Parts List

HMN9725 Remote Speaker Microphone PL-931024-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	0105953N42	Front Housing, items 1 thru 5
2	3305259Q01	Nameplate, Motorola
3	4505182Q01	Lever, PTT
4	3505152J01	Grille, cloth
5	1105461R01	Adhesive
6	0180703Y70	Coil cord & connector
7	0180703Y67	PCB: Includes electrical parts
8	3905834K06	Switch: dome, PTT (S1)
9	3205231Q01	Seal, dome
10	1405219Q01	Boot, microphone
11	0180703Y69	Microphone assembly
12	5005910P05	Speaker (LS1)
13	7505283Q02	Pad, speaker
14	3205690R01	Gasket
15	6405689R01	Plate, housing mounting
16	0300139982	Screw, Phillips; 2-56 x 5/32"
17	1505172Q01	Housing, back
18	0484345A06	Washer, 3 used
19	0305137Q02	Screw, Phillips, 3 used
20	0105959N54	Belt clip assembly
21	0300139982	Screw, Phillips, 4 used

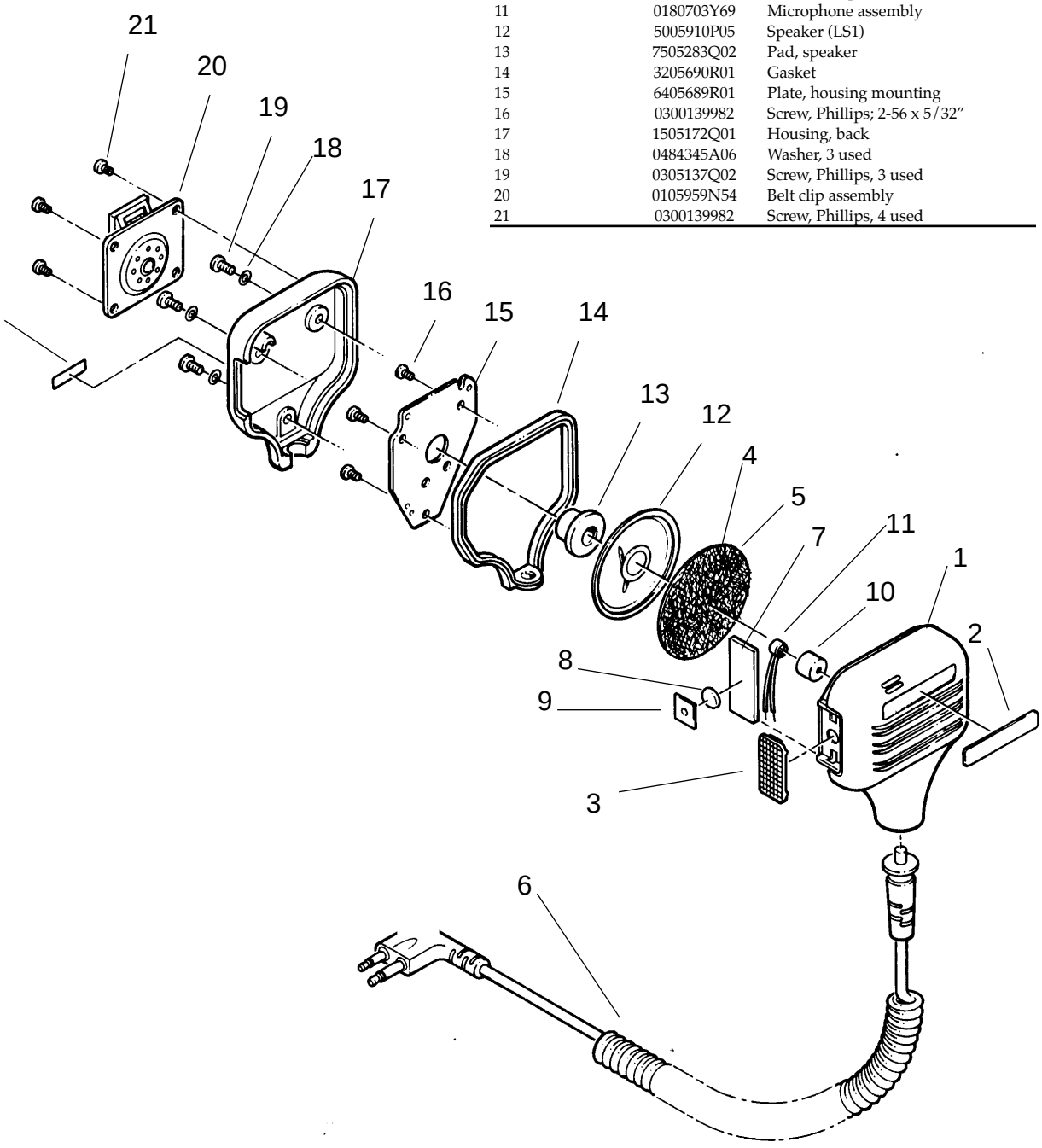


Figure 3-3. Exploded View

GP68 Option Board
(Only applicable for GP68 Radios)

Installation

Please refer to Figure 3-4.

1. Dismantle the radio by first removing the chassis from the front housing. See drawing above. (Refer to Section 1 - Radio Disassembly / Assembly for instructions on dismantling the radio).

NOTE
When separating the chassis from the front housing, be careful not to overstress the interconnect flex connecting the RF Board to the Controller Board.

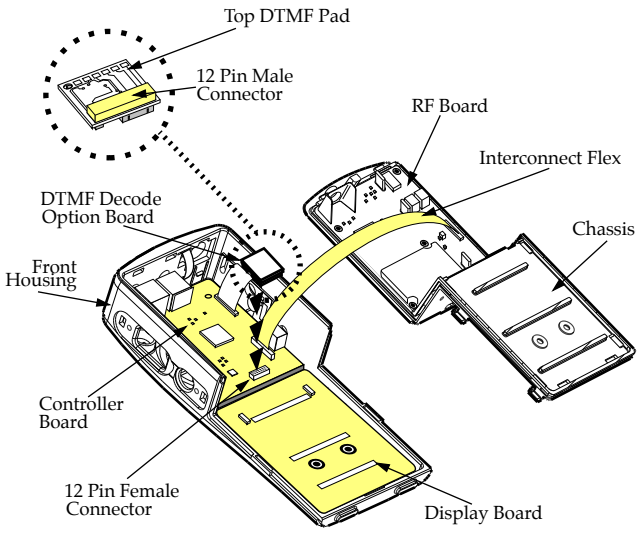


Figure 3-4. Exploded View of the Radio with DTMF Option Board

2. Remove the protective liner from the double-faced adhesive located on the foam pad (on the same side of the logic board as the 12-pin male connector). Orient the Option Board so that the 12-pin male connector is at the lower edge and facing downwards. See Figure 3-4.

3. Attach the Option Board to the Controller Board by inserting the 12-pin male connector into the 12-pin female connector on the Controller Board. Push until it is securely in place.

4. Re-assemble the radio.

Option Board Enable Procedure

The programming options are Selcal, Decode and Serial. To enable one of these options, turn the radio off, press and hold the key, and turn the radio on. The DTMF and SmarTrunk II™ options screen will appear on the display. The default is ´**OPt.OFF**´. Press the and MEM keys to show the options, **SEL.CAL, dECOdE,** and **SEriAL**. Select the ´**dECOdE**´ option for the DTMF option board.

If you are installing the SmarTrunk II™ option board, select ´**SEriAL**´. When the correct option is selected, turn the radio off to save it to memory.

DTMF Decode Option
Kit numbers: PMLN 4063 — Decode Board
PMLN 4064 — Decode Board (10-pack)

Overview

The DTMF Decode Option Board is an accessory available with the GP68 portable radio. This board requires the radio to be disassembled before it can be installed. Please follow the instructions below carefully.

Description

The Motorola DTMF Decode Option Board is designed for compatible Motorola Radios. Check with the latest price pages or your nearest Authorized Dealer to confirm compatibility. The connection is made to the option interface on the Controller Board. When your radio is equipped with this DTMF Decode Option Board, your radio will be able to decode DTMF Selective Call signals.

Theory Of Operation

A DTMF tone pair will be sent to Ain(U701-8), then DV(U701-14) will signal a detection by going high after a valid tone pair is sensed and decoded at the output pins D1(U701-2), D2(U701-1), D4(U701-16) and D8(U701-15). The DV will remain high until a loss of the current DTMF signal occurs. The transition of this DV signal (from high to low) will be used to acknowledge the micro-P at the main board. When DV is high, the shift register will latch the decoded tone from the DTMF decoder (U701) through parallel ports. The shift register then arranges the 4-bit decoded signal from DTMF decoder (U701) and places into serial form, where D8 is the most significant bit, followed by D4, D2, D1 and finally four more high bits.

H H H H D1 D2 D4 D8
LSB MSB

The microcontroller of the main board senses a transition of DV(U701-14) from high to low. The microcontroller will then send a serial clock to the 8 bit static shift register clock (U702-10) and retrieve the signal from Q8(U702-3).

Packing List

DTMF Decode Option Board

DTMF Decode Signalling Retrofit Kit Instruction (English)

Programming DTMF Codes

Dealer Programming

You may now program the DTMF Decode codes into the radio. Enter the Special Programming Mode by pressing the MEM key, then turn the radio on. Each code entered may be up to 8 digits, using any of the numeric keys and the #, SIG A, SQL B, LOW C, or SCAN D keys. Rotate the selector switch until Acn Id appears on the display. Press the MEM button and enter the acknowledgment code. Press the Yellow **Light/Enter** button to store the code.

Rotate the selector switch clockwise and ´**INd ID**´ will appear on the screen. Press the MEM key and enter the **Individual ID** code. Press the Yellow **Light/Enter** button to store the code.

Rotate the selector knob clockwise and ´**GrP. ID**´ will appear on the display. Press the MEM key and enter the **Group ID** code. Press the Yellow **Light/Enter** button to store the code. Rotate the selector switch clockwise and ´**ALL. ID**´ will appear on the display. Press the MEM button and enter the **ALL ID** code. Press the Yellow **Light/Enter** button to store the code. Turn the radio off.

This completes the programming of the DTMF decode option board.

SmarTrunk II™ Operation

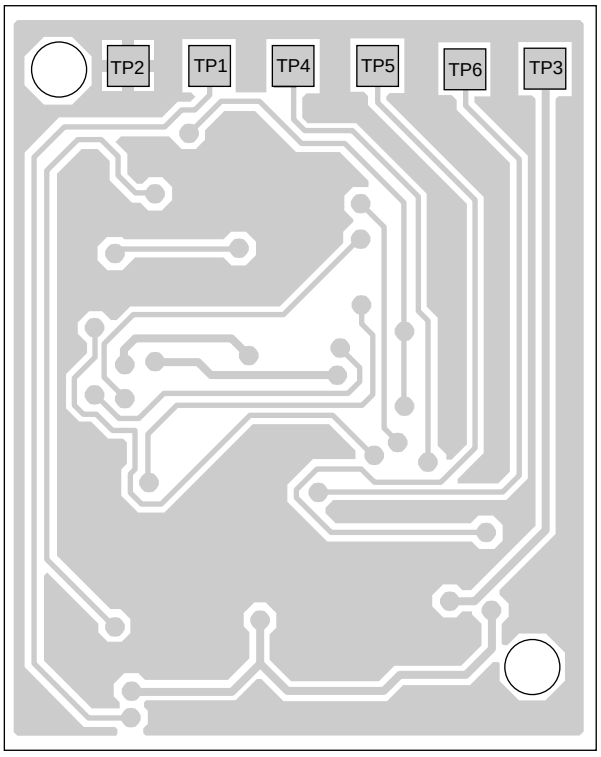
For programming and operating instructions, please refer to the *SmarTrunk II™ Logic Board Installation and Operation Manual* (Motorola manual number 68P04370J43).

SmarTrunk II™ Option Board

Kit number:PMLN 4066; PMLN 4067, 10-pack (Manual included)

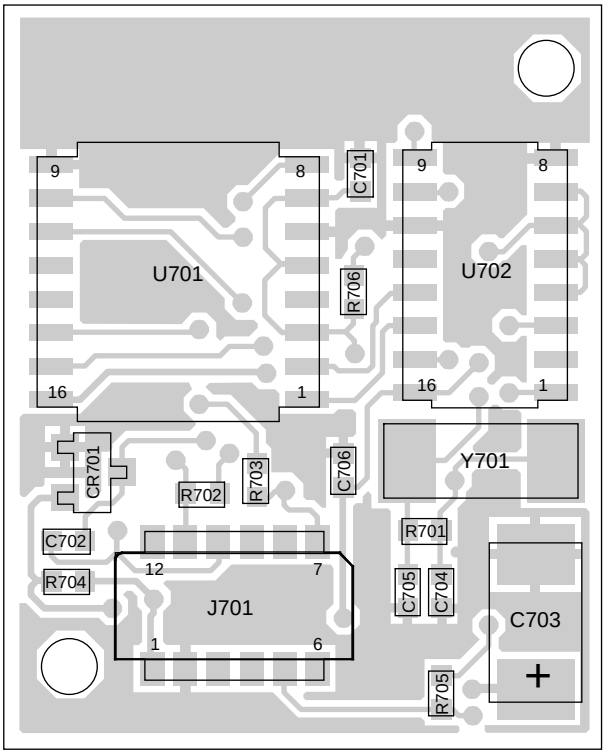
DTMF Decoder Option Board (PMLN4063)

VIEWED FROM SIDE 1



MAEPF-25974-O

VIEWED FROM SIDE 2

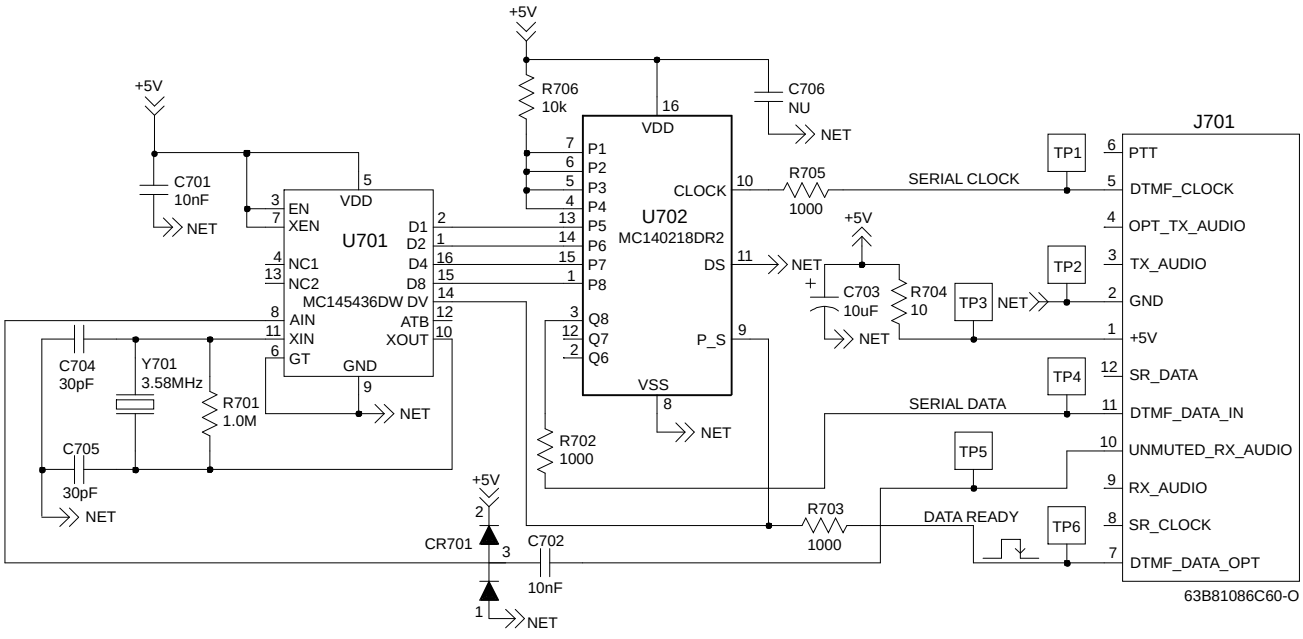


MAEPF-25975-O

Circuit Board Details
for DTMF Decoder Option Board (PMLN4063)

Parts List
PMLN4063A, DTMF Decode Signalling Retrofit Kit

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, Fixed : +-5%; 50V unless stated
C701, C702	2113741F49	10nF
C703	2311049J26	10uF, 16V
C704, C705	2113740F38	30pF
C706	---------	Not Placed
		DIODE :
CR701	4813833C07	Diode
		CONNECTOR :
J701	2804652J01	12 Pin Connector
		RESISTOR, Fixed : ohm +-5%; .0625W unless stated
R701	0662057B22	1.0M
R702, R703	0662057A49	1000
R704	0662057A01	10
R705	0662057A49	1000
R706	0662057A73	10K
		MODULE :
U701	5180914W01	DTMF Decode
U702	5113806A09	Shift Register
		CRYSTAL :
Y701	4880915W01	Oscillator, 3.58MHz
		PCB :
	8404750J01	DTMF Board



Schematic Diagram/Parts List for DTMF Decoder Option Board (PMLN4063)

Section 4
Radio Programming Information

Overview of the Programming Process

NOTE
This section assumes that you have read the GP68 User Manual, and have understood the basic operation of this radio.

To prepare properly programmed radios for your customers, you should

1. set your radio (Dealer's radio) into Dealer Programming Mode,
2. program your radio with all the necessary parameters, as required by your customers, and then
3. clone these parameters over to all your customers' radios (the User's radios)

Setting the Radio to Dealer Programming Mode

To set the Dealer's radio to Dealer Programming Mode, remove jumper R417 (Figure 4-1). With this programming function enabled, the dealer can

- program all the required channel parameters, such as which channels should be on the scan list, and the received and transmit frequencies for a particular channel.
- clone the programmed settings over to a User's radio.

NOTE
If the battery power is low, the radio, the radio would display LOBAT, to indicate that the battery needs to be recharged or replaced.

IMPORTANT
If the Dealer's radio is to be given to the customer, remember to replace R417 with a 51K resistor to disable the programming function.

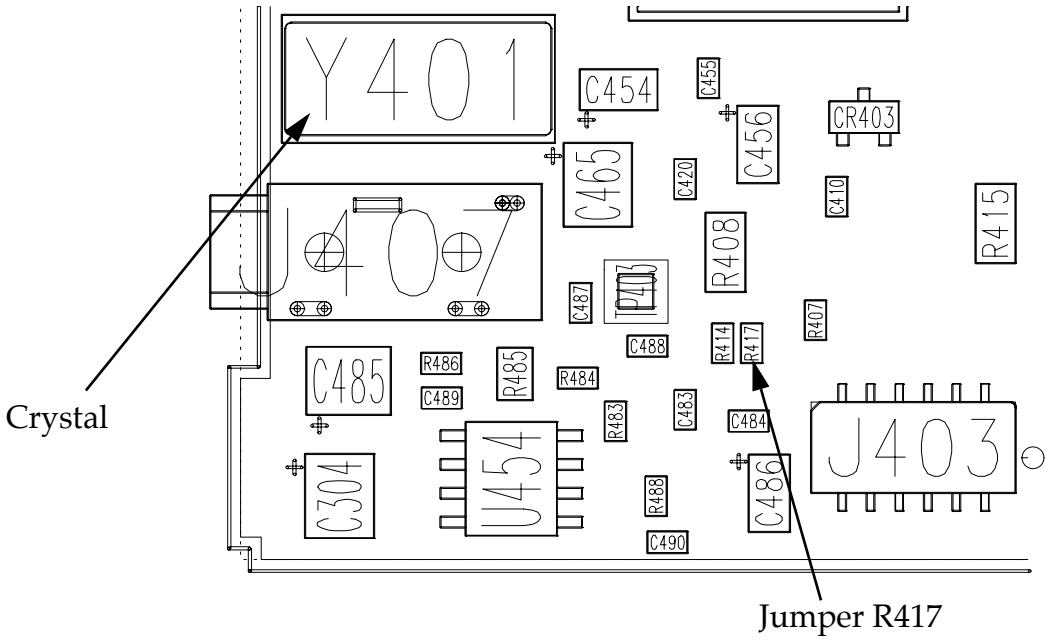


Figure 4-1 Location of the Jumper R417 on the GP68 Radio.

Cloning Radio Parameters to User Radios

Cloning duplicates the contents of Radio 1 (master radio) into Radio 2 (slave radio). Tuning and alignment information are not affected by cloning.

Parameters which are cloned

When a Dealer Configuration GP60 Series radio is used as the master, the following parameters are cloned:

- Channel Settings: Rx and Tx frequencies, Offsets, Receive and Transmit PL/DPL Codes, Default Squelch Mode.
- Active User Parameters: High/Low Power Setting, Squelch Level, Current Channel Selection.
- SPM Parameters: All User Modifiable parameters.

Additionally, when cloning the GP68 radios, the following parameters are also cloned:

- Active User Parameters: PTT ID Transmit Enable/ Disable
- Phone Memories.
- SPM Parameters: User Modifiable parameters like including Phone Access/De-access Codes, as well as all dealer configured DTMF IDs (PTT, Individual, Ack, Group, and All IDs).
- Option Board Setting configured through the Option Board Setup Mode.

Option Board Setup Mode

The Option Board Setting should be set to **OPTION OFF** (´**OPt.OFF**´) in the Dealer's radio while programming channels to avoid any interaction with pre-installed option boards. However, since the Signalling Squelch Mode can only be accessed if the option board setting is not **OPTION OFF** (not ´**OPt.OFF**´), it is recommended that any option board be installed in the Dealer's radio only after all the user configuration is completed.

1 Turn the radio on while holding down , and keep holding until the radio sounds a ringing Option Board Setup Mode start-up tone (takes about 3 seconds).

NOTE
At power-up, all display segments light for about 2 seconds, followed by a brief display of the software version which is installed in your radio.

2 If the battery voltage level is low, the display indicates rPLbAt, the ´**BATT**´ indicator flashes and the radio sounds a *low battery alert* tone. You must turn off the radio and replace, or recharge, the batteries.

3 If the batteries are above the threshold level, the radio enters the Option Board Setup Mode and the LCD displays the current option board setting (**OPt.OFF, SEL.CAL, dECOdE, SEriAL**). You can select among the four options by using and MEM to scroll through the options.

4 See Section 3 of this manual for more details.

Parameters which are not cloned

- All hardware tuning and alignment parameters
- Unit Serial Number

NOTE
When cloning the GP68 Keypad Model, the Full Serial Option Board Configuration Data (if any, which are stored in Signalling System One or in Full Serial Option Board) is not cloned.

NOTE
Cloning will take approximately **3-5** seconds. If any of the radios is turned off while cloning, the other radio will display an error after 3 seconds (refer to Table 4-1, **Cloning Error Messages,** on page 4-3 for explanation of error messages).

To Clone a Radio

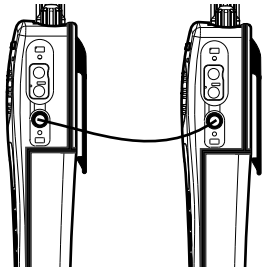


Figure 4-2 Cloning a Radio.

1 Connect both radios with the cloning cable through the SCI ports.

2 Turn on the slave radio.

3 Turn on the master radio while pressing SIG A.

4 The master radio will display the following message (Figure 4-3) if cloning can proceed, otherwise an error message will be shown (refer to Table 4-1, **Cloning Error Messages,** on page 4-3).

Figure 4-3 .

5 The slave radio displays the following message (Figure 4-4) while it is being programmed.

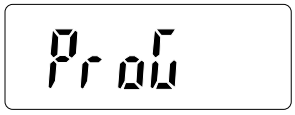


Figure 4-4 .

NOTE

If battery level is low, the slave radio will display rPLbAt, and you will need to replace or recharge the battery before repeating the procedure.

6 When cloning is completed, both radios will reset automatically.

7 Disconnect radios from the cloning cable. They are now ready for operation.

Error Conditions

An error may occur when cloning a radio. When this happens, an error message is displayed. Table 4-1 lists the causes and the possible solutions for each error message.

Table 4-1Cloning Error Messages

Error Message	Problem	Solution
Err.01	Incompatible software options error.	Cloning from the master radio to the slave radio cannot be performed.
Err.02	Timeout error a. The cloning cable connection is not properly connected or slave radio is not turned on. b. Communication between the two radios is disrupted during the cloning process.	a. Check the cloning cable connection and also verify that the slave radio is turned on. b. Check the cloning connection and all other connections.
Err.03	Master radio checksum error	Although the master radio may still function, it should be serviced by a dealer.
Err.04	No Programmed Channels Error	a. If this occurs on the slave radio, repeat cloning procedure. If it persist, the radio must be serviced by a dealer. b. If this occurs on the master radio, the radio must be serviced by a dealer.

Programming the GP68 Radio

Operator Controls and Indicators

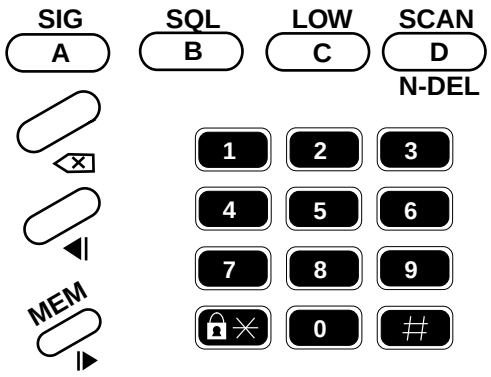


Figure 4-5 Keypad Buttons used for programming the GP68 Radios.

When programming is enabled, certain buttons have additional functions:

- SQL B - Used to program the squelch level (quick press) or PL/DPL code (long press). During DTMF dialing, or editing of phone number and IDs, this key specifies DTMF digit '**B**'.
- LOW C -Toggles between High and Low transmit power levels (quick press); also used to program the frequency step size (long press). During DTMF dialing, or editing of phone number and IDs, this key specifies DTMF digit '**C**'.
- - Toggles between Megahertz(MHz) Mode (Frequency display) and Channel Mode (Channel display). When editing phone numbers and IDs, this key acts as a backspace (rubout) key.
- - Selects the TX (repeater) offset frequency type. When editing phone numbers and IDs, this key scrolls the display to the left.

Programming the Radio Parameters

All programming functions are performed while the radio is in the Megahertz (MHz) Mode (Frequency Display). If the radio is in Channel Mode (Channel Display), momentarily press to enter the MHz mode.

To Program a Channel

There are twenty memory channels available. Each memory channel consists of a receive/transmit frequency pair, the type of TX offset, the offset frequency, the Receive PL/DPL Code, the Transmit PL/DPL Code, and the default Squelch Mode Setting (CSQ, CTCSS and Signalling Squelch).

1 If required, momentarily press to enter the MHz mode.

2 Select the desired frequency, type of TX offset and offset frequency (see page 4-5 onwards).

3 Press and hold the **Enter Button** for 3 seconds.

The LCD displays the following to prompt you to select the channel number (Figure 4-6).

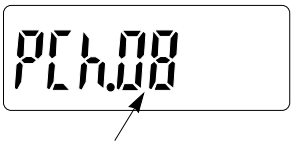


Figure 4-6 .

The channel number flashes if it is unprogrammed, but lights continuously if it is programmed.

4 Use the **Channel Selector Knob** to select the desired channel number.

5 Momentarily press the **Enter Button** again to program the selected memory channel.

The radio remains in **MHz** mode after successful programming of the channel.

WARNING

If the selected memory channel was already programmed (channel number lit continuously), the new frequency information overwrites the previous information in memory.

To Verify a Programmed Channel

All the data for a programmed channel (receive and transmit frequencies, TX offset type, offset frequency, receive and transmit PL/DPL codes, and default Squelch Mode Setting) can be copied over into the MHz mode for verification.

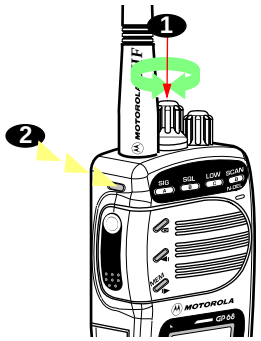


Figure 4-7 Verifying a Programmed Channel.

1 If required, momentarily press to enter the Memory mode.

2 Rotate the **Channel Selector Knob** to the desired memory channel number.

3 Press and hold the **Enter Button** for 3 seconds.

*A valid **keypress** tone sounds when the memory channel data has been successfully copied over to the MHz mode.*

To Enable or Disable PTT ID Transmission

The radio transmits a programmable DTMF identification code (unit ID), indicating which portable is in operation. The PTT ID can be edited using the S**pecial Programming Mode** (see page 4-10).

During a conversation, the code is normally sent only on the initial PTT press (unless PTT ID has been disabled). The '**TX**' indicator lights for the duration of the PTT ID. If there is no PTT or receive activity for 7 seconds, or if you change the frequency or channel (or scan resumes), the PTT ID is once again transmitted on the next PTT press.

NOTE

PTT ID can be enabled/disabled by pressing and holding (#). Upon pressing the button you will hear a beep; hold the button down until you hear a second beep, indicating that the PTT ID status has been changed, then release the button. When PTT ID is *disabled*, the "dot" indicator flashes on the display.

To Change the Default Squelch Modes

Carrier squelch (CSQ), Tone Private-Line (PL) and Digital Private-Line (DPL) operations are configurable on a per channel basis. If an option board is installed, Signalling squelch (SelCall) operation will also be configurable on a per channel basis. If the Squelch Mode is set in Megahertz mode, then it will become the channel's default squelch mode when the information is programmed into a channel.

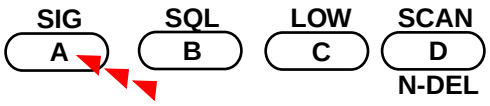


Figure 4-8 Changing the Default Squelch Modes.

To change squelch modes temporarily for a channel:

1 Momentarily press SIG (A) to change between CSQ, Coded (PL/DPL) and Signalling squelch modes.

IMPORTANT

Squelch modes reset to the previous programmed values when the channel is changed. Squelch mode changes in MHz mode are permanent.

When '**CTCSS**' is off, the radio operates in CSQ mode. In this mode, you will hear all conversations on the selected receive channel.

When '**CTCSS**' is on continuously, the radio operates in Coded (PL/DPL) squelch mode. In this mode, you will hear only those conversations on the selected receive channel which have the same PL/DPL code as your radio.

Figure 4-9 LCD Display for Changing Default Squelch Modes.

When '**CTCSS**' is flashing (which requires that an option board is selected first via the Option Board Setup Mode), the radio operates in Signalling squelch mode, and unmutes only after a valid Voice Selective Call (SelCall) has been decoded. The radio automatically enters CSQ mode for a period of time. If there is no receive activity, the radio resumes Signalling squelch mode and the LCD reverts to the appropriate receive mode display.

When transmitting in Signalling squelch mode, PL/DPL is transmitted if the Transmit PL/DPL code is non-zero (unless the Transmit PL/DPL is programmed for '**000**'). After PTT is released, the radio automatically enters CSQ mode for a period of time. If there is no receive activity, the radio resumes Signalling Squelch mode. No visual indication is given.

Refer to **Receiving a Voice Selective Call** in the **User's Manual** for more information on this squelch mode.

NOTE

A radio equipped with a Voice SelCall option operating in the PL/DPL mode unmutes for the correct PL/DPL code, or if a SelCall is decoded.

To Select the Frequency Step Size

The frequency step size determines the incremental steps that the receiver will take when you rotate the **Channel Selector Knob**, or when the radio is scanning the frequency band.

The available frequency step sizes are 5, 10, 12.5, 15, 20, and 25 KHz.

1 Press and hold LOW (C) until the display indicates the current frequency step size (takes about 3 seconds). For example, the following display (Figure 4-10) represents a frequency step size of 12.5 KHz.

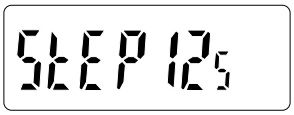


Figure 4-10 .

2 Rotate the **Channel Selector Knob** to scroll through the available frequency steps until the desired frequency step size is displayed.

*When the frequency step size passes the upper or lower limit, the radio loops to the opposite limit and sounds a **wrap-around** tone.*

3 Momentarily press the **Enter Button** to enter the displayed frequency step size and return to normal operation (the radio automatically does this after 5 seconds of inactivity).

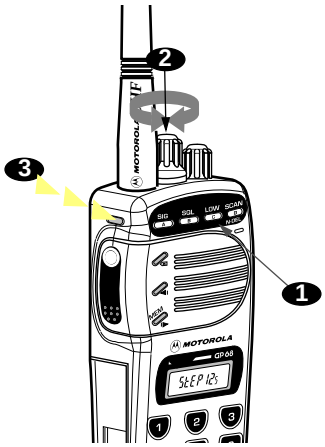


Figure 4-11 Selecting the Frequency Step Size.

WARNING

The user-defined TX frequency may be changed automatically without indication depending on the change in the frequency step size selected. To reset your user-defined TX frequency, see **To Select the TX Offset** on page 4-7.

To Select a Receive Frequency

There are several ways to select a receive frequency:

- by entering the frequency directly via the numeric keypad,
- by using the **Channel Selector Knob**/keypad combination.

Using the Keypad only

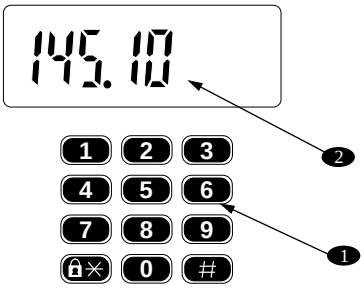


Figure 4-12 Using the Keypad to Select a Receive Frequency.

1 Enter the desired frequency directly using the number buttons on the keypad.

2 The LCD is updated after each keypress.

NOTE

You have approximately 5 seconds between each number entry; otherwise, the radio reverts back to the previously selected frequency.

*With each number entry, a **valid keypress** tone sounds. When 6 digits are displayed, the receiver is set to the entered frequency.*

NOTE

If an invalid number is pressed, the valid number nearest the invalid keypress is entered such that the selected frequency will not be outside the allowed frequency band. Valid frequencies entered via the keypad are dependent on the frequency step size previously selected. The LCD only displays valid numbers.

Using the Channel Selector Knob and Keypad Together

1 Enter the first few digits of the desired frequency directly using the number buttons on the keypad. The LCD is updated after each keypress.

2 Press the **Enter Button** to commit the partially-entered frequency. Un-entered digits are coerced to the nearest valid frequency.

3 Rotate the **Channel Selector Knob** clockwise to increase, or counter-clockwise to decrease, the frequency (starting at the next available frequency) until the desired frequency is displayed. The frequency increments, or decrements, according to the selected frequency step size.

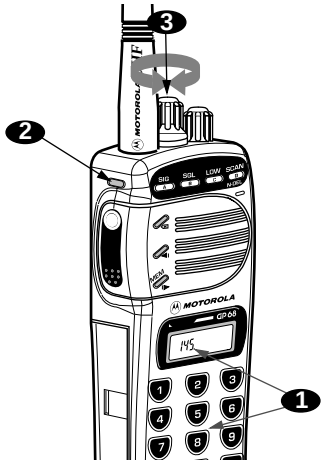


Figure 4-13 Using the Channel Selector Knob and Keypad to Select a Receive Frequency.

When the frequency selection passes the upper or lower limit, the radio loops to the opposite limit and sounds a ***wrap-around*** *tone.*

To Select the TX Offset

For the GP68, the transmit frequency can be the same as the receive frequency (no offset), it can have a standard positive or negative offset, or it can be a user-defined TX frequency.

NOTE
The Tx Offsets are only visible on the Dealer Programmable GP68. The offsets are not shown on the User GP68.

1 Momentarily press ◀ to toggle between no offset, standard positive or negative offset, or user-defined TX frequency. The offset mode is set according to the table shown (Table 4-2).

Table 4-2 TX Offset Modes.

Indicator(s)	Offset Mode
None	No offset (simplex)
+	Standard Positive Offset
-	Standard Negative Offset
+ -	User-defined TX Frequency

The indicator(s) light according to which corresponding mode is currently selected, and the LCD displays the TX frequency whenever the radio is keyed (for example, see Figure 4-14).

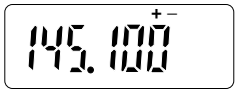


Figure 4-14 .

To Program a User-Defined TX Frequency

1 Press and hold ◀ until the "+ –" indicators begin to flash (takes about 3 seconds). The LCD will display the current user-defined TX frequency.

2 You can now enter the desired TX frequency either directly via the numeric keypad or by rotating the **Channel Selector Knob** and scrolling through the available frequencies (according to the selected frequency step size).

3A If using the keypad to enter a user-defined TX frequency, either completely key in the desired frequency or, to fill in trailing zeros, press the **Enter Button**. Once the frequency is fully entered, press the **Enter Button** again to exit the user-defined entry mode and commit the selected TX frequency.

NOTE
The radio automatically exits the user-defined entry mode after 5 seconds of inactivity and commits the selected TX frequency ONLY if you have completely keyed in the desired frequency (a partially-entered frequency is NOT stored by the radio).

3B If using the **Channel Selector Knob** to enter a user-defined TX frequency, press the **Enter Button** to commit the selected TX frequency and return to normal operating mode (the radio automatically does this after 3 seconds of inactivity).

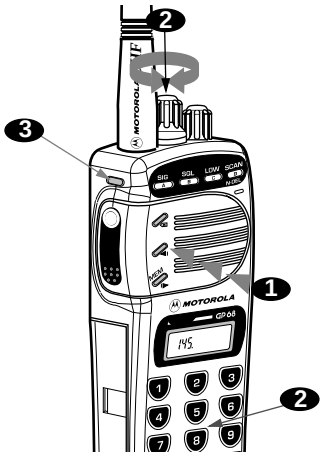


Figure 4-15 Programming a User-Defined TX Frequency.

NOTE
When receiving in MHz mode, the radio displays the selected RX frequency; when transmitting, the radio displays the selected TX frequency.

To Select the Receive PL/DPL Code

There are 126 different Receive PL/DPL codes available, numbered from 001 to 126 (see Table 4-3, **Receive and Transmit PL/DPL Codes,** on page 4-9). Receive PL/DPL code '**000**' represents Carrier squelch.

1 From the frequency mode, press and hold SQL (B) until the LCD displays '**rPL.**" followed by the active Receive PL code number (takes about 3 seconds). In the following example (Figure 4-16), the Receive PL/DPL code is 014.

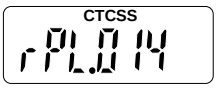


Figure 4-16 .

2 Rotate the **Channel Selector Knob** clockwise to increase, or counter-clockwise to decrease, the active Receive PL/DPL code.

NOTE
If you reach the upper or lower limit of the PL/DPL codes, the displayed code wraps around to the opposite limit and starts to increment or decrement from that point.

3 Press the **Light/Enter Button** for three seconds, then release. Press the **Light/Enter Button** again until "**Pch**" with the channel number is displayed.

The new Receive PL/DPL code is adopted.

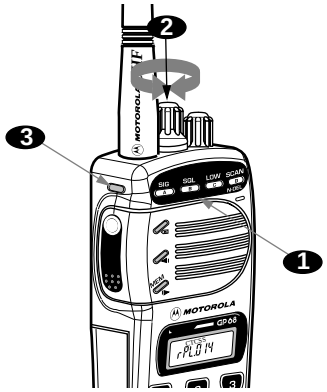


Figure 4-17 Selecting the Receive PL/DPL Code.

To Select the Transmit PL/DPL Code

There are 126 different Transmit PL/DPL codes available, numbered from 001 to 126 (see **Receive and Transmit PL/DPL Codes** on page 4-9). Transmit PL/DPL code '**000**' represents Carrier squelch.

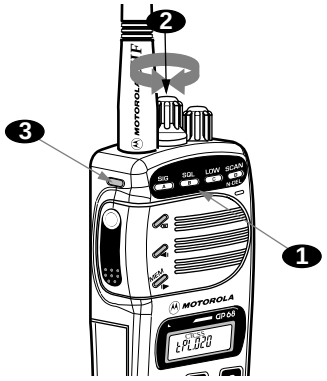


Figure 4-18 Selecting the Transmit PL/DPL Code.

1 From the frequency mode, press and hold SQL (B) until the LCD displays '**rPL.**" followed by the active Receive PL code number (takes about 3 seconds). Press SQL (B) momentarily to toggle the display to '**tPL.**" followed by the active Transmit PL code number. You can toggle between editing of the Receive and Transmit PL/DPL by pressing SQL (B) momentarily. In the following example (Figure 4-19), the Transmit PL/DPL code is 020.

2 Rotate the **Channel Selector Knob** clockwise to increase, or counter-clockwise to decrease, the active Transmit PL/DPL code.

Figure 4-19 .

NOTE
If you reach the upper or lower limit of the PL/DPL codes, the displayed code wraps around to the opposite limit and starts to increment or decrement from that point.

3 Press the **Light/Enter Button** for three seconds, then release. Press the **Light/Enter Button** again until "**Pch**" with the channel number is displayed.

The new Transmit PL/DPL code is adopted.

NOTE
If the Receive PL/DPL code is programmed for '**000**', then the Receive PL/DPL (Coded squelch) mode cannot be selected. To select the Receive PL/DPLmode, the Receive code must be changed to other than zero (see **To Select the Receive PL/DPL Code** on page 4-7 and **Receive and Transmit PL/DPL Codes** on page 4-9). For Transmit, PL/DPL codes are transmitted if the selected Transmit PL/DPL Code is non-zero.

Receive and Transmit PL/DPL Code Tables

When selecting a Receive or Transmit PL/DPL code, Table 4-3, **Receive and Transmit PL/DPL Codes,** on page 4-9, gives the PL frequencies, equivalent PL codes (if applicable) and DPL codes corresponding to the display **rPL.XXX** or **tPL.XXX** where **XXX** is in the range 001 to 126. **rPL.000** and **tPL.000** represents Carrier squelch (CSQ) for Receive and Transmit respectively.

Table 4-3 Receive and Transmit PL/DPL Codes

rPL.XXX tPL.XXX	PL FREQ (Hz)	EQUIV. PL CODE	rPL.XXX tPL.XXX	PL FREQ (Hz)	EQUIV. PL CODE
000	CSQ	-	022	136.5	4Z
001	67.0	XZ	023	141.3	4A
002	69.3	WZ	024	146.2	4B
003	71.9	XA	025	151.4	5Z
004	74.4	WA	026	156.7	5A
005	77.0	XB	027	162.2	5B
006	79.7	WB	028	167.9	6Z
007	82.5	YZ	029	173.8	6A
008	85.4	YA	030	179.9	6B
009	88.5	YB	031	186.2	7Z
010	91.5	ZZ	032	192.8	7A
011	94.8	ZA	033	203.5	M1
012	97.4	ZB	034	206.5	8Z
013	100.0	1Z	035	210.7	M2
014	103.5	1A	036	218.1	M3
015	107.2	1B	037	225.7	M4
016	110.9	2Z	038	229.1	9Z
017	114.8	2A	039	233.6	M5
018	118.8	2B	040	241.8	M6
019	123.0	3Z	041	250.3	M7
020	127.3	3A	042	254.1	OZ
021	131.8	3B			

rPL.XXX tPL.XXX	EQUIV. DPL CODE	rPL.XXX tPL.XXX	EQUIV. DPL CODE	rPL.XXX tPL.XXX	EQUIV. DPL CODE	rPL.XXX tPL.XXX	EQUIV. DPL CODE
043	23	065	152	087	343	109	606
044	25	066	155	088	346	110	612
045	26	067	156	089	351	111	624
046	31	068	162	090	364	112	627
047	32	069	165	091	365	113	631
048	43	070	172	092	371	114	632
049	47	071	174	093	411	115	645
050	51	072	205	094	412	116	654
051	54	073	223	095	413	117	662
052	65	074	226	096	423	118	664
053	71	075	243	097	431	119	703
054	72	076	244	098	432	120	712
055	73	077	245	099	445	121	723
056	74	078	251	100	464	122	731
057	114	079	261	101	465	123	732
058	115	080	263	102	466	124	734
059	116	081	265	103	503	125	743
060	125	082	271	104	506	126	754
061	131	083	306	105	516		
062	132	084	311	106	532		
063	134	085	315	107	546		
064	143	086	331	108	565		

Programming and Option Boards

NOTE
It is not necessary for a Dealer's radio to have an option board installed in order to perform the programming.

If no Option Boards were Installed in the Dealer's Radio

- Select the appropriate option board setting via the Option Board Setup Mode.
- Perform all necessary channel programming functions, including default radio settings, channel settings, and phone numbers.
- Perform any programming of DTMF Selective Call IDs (if necessary), and configure SPM defaults.
- Clone the programmed settings over to the user radios.

If an Option Board is Installed in the Dealer's Radio

NOTE
In this procedure, you would not be able to select Signalling Squelch Mode as a channel default. However, if you do need to do so, remove the Option Board and follow the steps outlined in **If no Option Boards were Installed in the Dealer's Radio**.

Special Programming Modes						
Display Shows:	**Description:**	**USER**	**DEALER**	**SEL CAL**	**DECODE**	**SERIAL**
ScnLSt	Edit Channel Scan List	X	X	X	X	X
ErASCHn	Erase Single Channel		X	X	X	X
PhnAcc	Edit Phone Access Code	X	X	X	X	X
PhnDEA	Edit Phone De-access Code	X	X	X	X	X
tot.xxx†	Edit Time Out Timer	X	X	X	X	X
PTt.Id	Edit PTT ID		X	X	X	X
Acn.Id	Edit Acknowledgment ID				X	
Ind.Id	Edit Individual Call ID				X	
GrP.Id	Edit Group Call ID				X	
ALL.Id	Edit All Call ID				X	
Sc-On/Sc-OFF	Set SelCall Tone Status			X	X	X
St-On/St-OFF	Set Sidetone Status	X	X	X	X	X
AL-OFF/AL-Pot	Set Alert Tone Volume	X	X	X	X	X
bS-OFF/bS-Nor/bS-Enh	Set Battery Saver Status	X	X	X	X	X
bt-NiC/bt-ALn	Set Battery Type	X	X	X	X	X
Ac-Aut/Ac-SPt/Ac-HSt	Set Accessory Option	X	X	X	X	X

Figure 4-20 Special Programming Modes

NOTE
You can use the procedure for **If no Option Boards were Installed in the Dealer's Radio** if the option board does not have any interaction with the programming procedure.

- Disable any installed option boards via the Option Board Setup Mode by selecting **'OPt.OFF'**.
- Perform all necessary programming functions, including default radio settings, channel settings, and phone numbers.
- Select the appropriate option board setting for the User's radio via the Option Board Setup Mode.
- Perform any programming of DTMF Selective Call IDs (if necessary), and configure SPM defaults.
- Clone the programmed settings over to the user radios.

Special Programming Mode (SPM)

See Figure 4-20.

NOTE
In addition to the parameters accessible by the user, the Dealer's Radio allows you to access additional parameters of the radio. These are: Erase Single Channel, Edit PTT ID, *Edit Acknowledgment ID, *Edit Individual Call ID, *Edit Group Call ID, and *Edit All Call ID. (* Only if DTMF Option Board is selected in Option Board Setup Mode). The Special Programming mode also provides a Factory Reset feature which allows you to return certain user-modifiable parameters in the radio to the factory-default values (IDs and access/de-access codes are unaffected by this programming feature).

Edit the Channel Scan List

1 Rotate the **Channel Selector Knob** to select the ScnLSt menu item.

2 Use ◀ or MEM ▶ to scroll through the channels (01 to 20).

*A **invalid keypress** tone sounds when you have reached the upper or lower limit of the channel scan list.*

A flashing channel number indicates that the channel is *excluded* from the scan list. A channel number that lights continuously indicates the channel is *included* in the scan list. For example, a display showing SCh.18 with flashing digits indicates that channel 18 is *excluded* from the scan list.

3 Press the **Enter Button** to toggle the state of a channel in the scan list from included to excluded, or from excluded to included.

*A **valid keypress** tone sounds when the new setting is stored.*

4 To exit the scan list edit mode, select another menu item by turning the **Channel Selector Knob**.

NOTE
In a Full Serial Option Board Configured Radio, the Channel Scan List can be configured to exclude Full Serial Channels from the Scan List so that conventional channel scan can function correctly.

Erase a Single Channel from Memory

1 Rotate the **Channel Selector Knob** to select the ErASCh menu item.

2 Use the ◀ or the MEM ▶ to scroll through the channels (01 to 20).

A flashing channel number indicates that the particular channel is unprogrammed (erased). For example, a display showing ECh.10 with flashing digits indicates that channel 10 is *erased.*

3 To erase a programmed channel (non-flashing channel numbers), press the **Enter Button**.

*A **valid keypress** tone sounds when the channel has been successfully erased.*

NOTE
Pressing the **Enter Button** for an unprogrammed channel (flashing channel numbers) results in an *invalid keypress* tone, and the keypress is ignored.

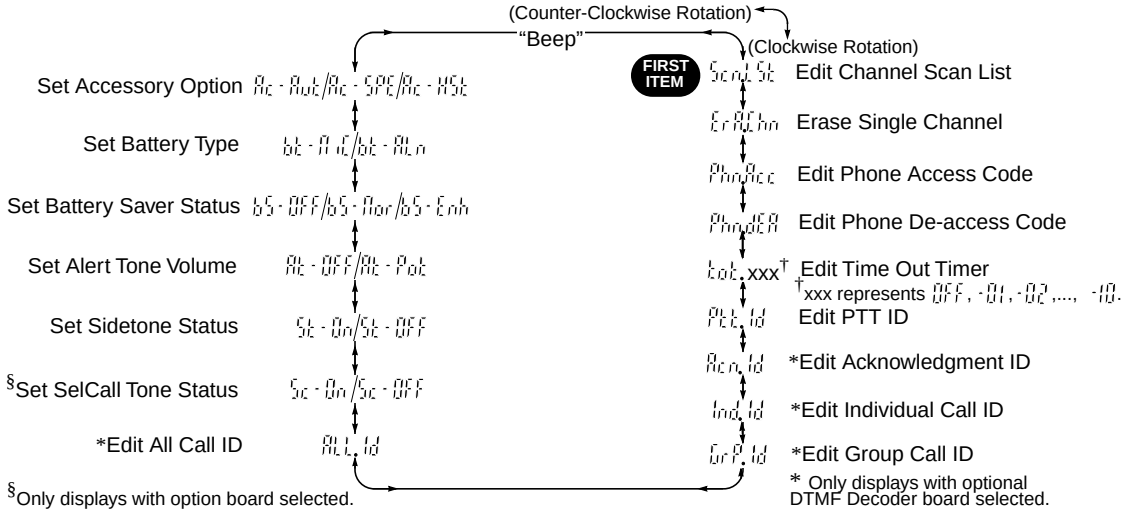


Figure 4-21 Special Programming Mode Options.

4 To exit this edit mode, select another menu item by turning the **Channel Selector Knob**.

Edit Time Out Timer

This menu item allows you to select the Time Out Timer length.

1 Rotate the **Channel Selector Knob** to select the '**Edit Time Out Timer**' menu item. The menu will display the current setting: tot.xxx , where xxx represents one of OFF, -01, -02,..., -10. The default display of tot.-01 shows the time out timer setting of one minute.

2 Use the ◀ or the MEM ▶ to change the current status.

3 Select another menu item by turning the **Channel Selector Knob** to commit this new setting.

Edit PTT ID

1 Rotate the **Channel Selector Knob** to select the PtT.Id menu item.

2 Press any key (except the **Enter Button**) to enter the PTT ID edit mode. The LCD displays the currently programmed PTT ID. For an ID which exceeds the length of the 6-digit display, the rightmost digit flashes to indicate more digits exist on the right.

You can now change or enter numbers as required, up to a maximum of 8, using any of the numeric keys, as well as the *, **#**, **A**, **B**, **C**, and **D** keys. The flashing cursor indicates the position of the next digit to be entered. You can also enter a

pause between the digits of the ID by first pressing ⊡✳, immediately followed by #. However, any pauses entered at the *end* of the ID are not stored.

*Two medium-pitched "beeps" sound when a pause is successfully entered, and the display changes from '**A**' to '**–**' to visually represent the pause*

3 Use ◀ or MEM ▶ to scroll through the existing ID's digits. To change the PTT ID, use ⌫ to erase the unwanted digits, and then enter the new digits. The display shows the new digits as they are being entered. When the flashing cursor is under a digit, the maximum number has been entered.

*If you attempt to add more than 8 digits, an **invalid keypress** tone sounds and the keypress is ignored.*

4a Press the **Enter Button** to store the new PTT ID and return to the SPM browse menu.

*A **valid keypress** tone sounds when the ID has been successfully stored.*

4b To abort the data entry, select another menu item by turning the **Channel Selector Knob**, or wait until the edit mode times-out (after 5 seconds of inactivity).

Edit Selective Call IDs

NOTE
To support Selective Call o operation, the Option Board Setting must be set to **'dECOdE'** for Simple Decoder in order to access the ID parameters.

1 Rotate the **Channel Selector Knob** to select the appropriate menu item (Acn.Id = Acknowledgment ID, Ind.Id = Individual Call ID, Grp.Id = Group Call ID and ALL.Id = All Call ID).

2 Press any key (except the **Enter Button**) to enter the appropriate edit mode. The **LCD Screen** displays the currently programmed ID number. For an ID which exceeds the length of the 6-digit display, the rightmost digit flashes to indicate more digits exist on the right.

You can now enter or change digits as required, up to a maximum of 8, using any of the numeric keys, as well as the ∗, #, **A**, **B**, **C**, and **D** keys. The flashing cursor indicates the position of the next digit to be entered.

NOTE
Pause digits *cannot* be entered with Selective Call ID numbers. Therefore, a '*****' must not be immediately followed by a '**#**', but they are valid in combination with all other digits.

3 Use ◀ or MEM ▶ to scroll through the existing ID's digits. To change the selected ID, use ⌫ to erase the unwanted digits, and then enter the new digits. The display shows the new digits as they are being entered. When the flashing cursor is under a digit, the maximum number of digits has been entered.

*If you attempt to add more than 8 digits, an **invalid keypress** tone sounds and the keypress is ignored.*

4a Press the **Enter Button** to store the ID number and return to the SPM browse menu.

*A **valid keypress** tone sounds when the ID has been successfully stored.*

4b To abort the data entry, select another menu item by turning the **Channel Selector Knob**, or wait until the edit mode times-out (after 5 seconds of inactivity).

Factory Reset Feature

This feature is intended to allow you to erase certain programmable parameters and restore the radio to the factory default settings. The radio, upon reset, clears all memory channels stored in the non-volatile memory area, clears all phone number storage locations, and restores the default settings to the different user-modifiable parameters (coded squelch type, squelch level, channel-step size, etc.).

NOTE
The Factory Reset feature does not clear the IDs or access/de-access codes, nor does it change the Option Board Setup setting.

1 With the radio in Special Programming Mode, press and hold the **PTT Button**.

2 While holding PTT**,** press **1**, **3**, **5**, **7**, **9** in sequence.

As the sequence is entered, the **LCD Screen** (which is initially cleared) displays an'**o**' for each digit entered.

*Any incorrect digit entered results in an **invalid keypress** tone, the **LCD Screen** is cleared again and you must reenter the sequence, starting with the first digit.*

Once the sequence has been entered successfully, the **LCD Screen** displays the prompt ErASE?, indicating that the reset procedure is ready to be activated.

3 Press the **Enter Button** to confirm the reset process. Pressing any other key or releasing the **PTT Button** cancels the process and returns the radio to the SPM Browse menu.

The display blanks when the reset is in progress.

*When the process is successfully completed, the **LCD Screen** displays -donE- and a ringing reset tone sequence sounds.*

Section 5
Troubleshooting

Overview

This section contains five troubleshooting tables for the following components:

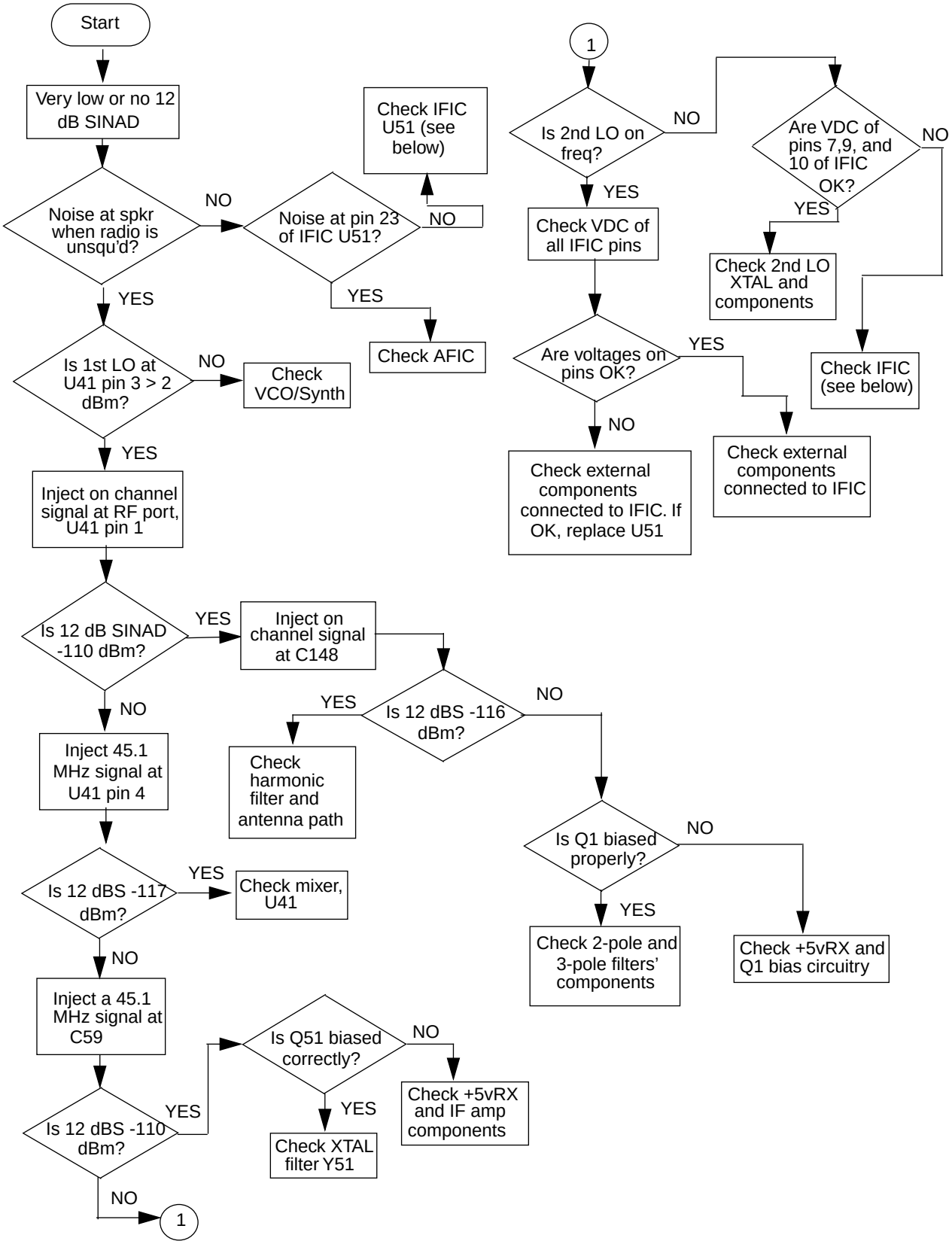
- Receiver
- Transmitter
- Synthesizer
- Microprocessor
- Voltage Controlled Oscillator (VCO)
- LCD

Troubleshooting Charts

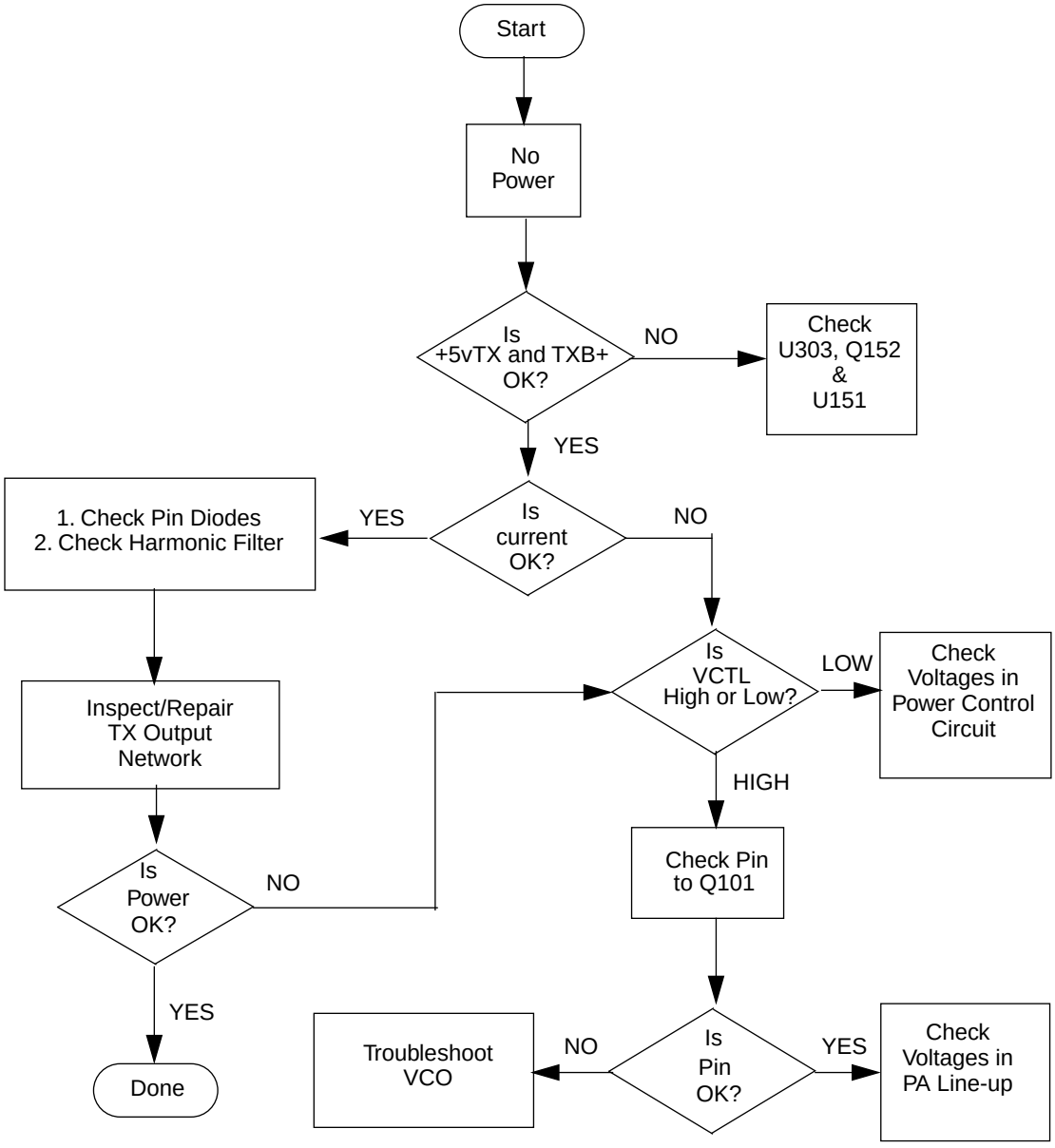
Refer to following pages.

Troubleshooting and Repair Comments

While troubleshooting, if you determine that the reference oscillator crystal (Y201) is defective, the entire Radio Frequency (RF) board must be replaced. When the new Radio Frequency board is installed, the eight-digit oscillator temperature compensation code, supplied with the new RF board, must be programmed into the radio controller. See the Radio Service Software (RSS) manual, number 6881086C08 (in English), section 5.3.3. Simply enter the eight-digit code in to the box on the RSS Reference Oscillator data program using the F8 key on your computer. Keep the new oscillator compensation code in your records.



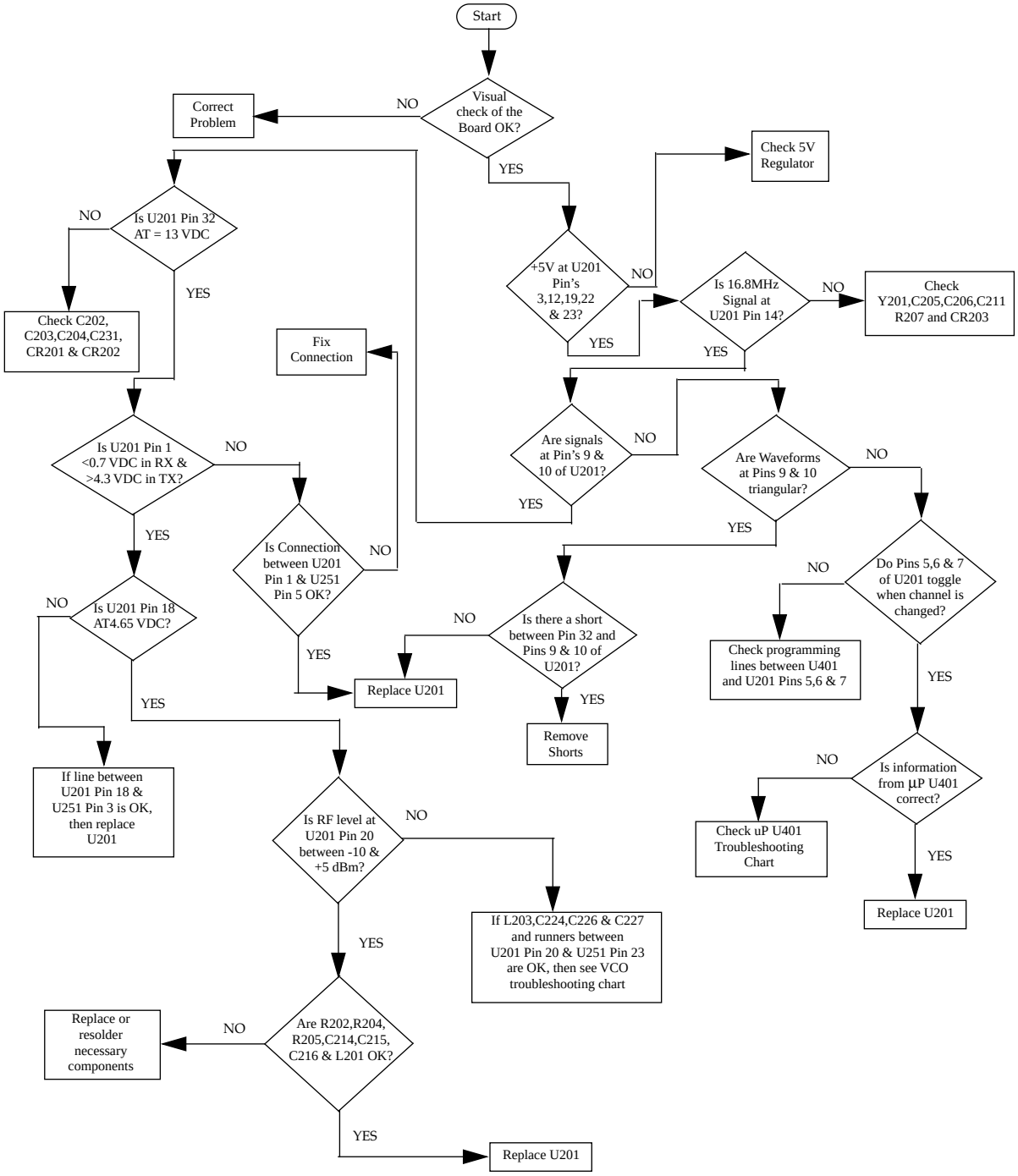
Troubleshooting Flow Chart for Receiver



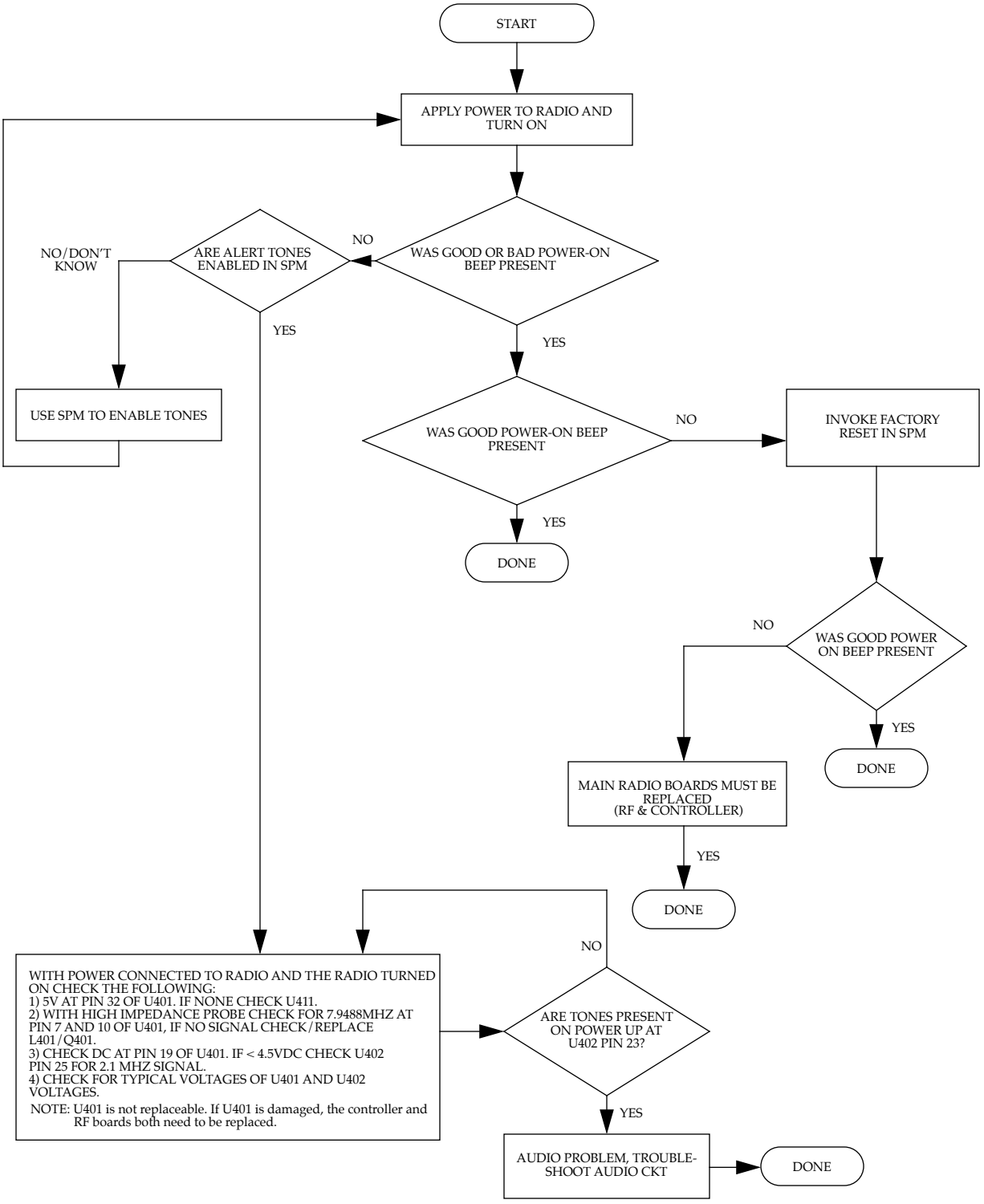
NOTE

When using the (81-80377E77) housing eliminator for Level III analysis, the power level needs to be set at "minimum" on the power level setting to avoid any damage to the radio. This can be performed by either the STS (RVN-4159A) transmit power tuning field, or by the low power setting on the radio keypad. The transmitter alignment procedures cannot be performed with the housing eliminator.

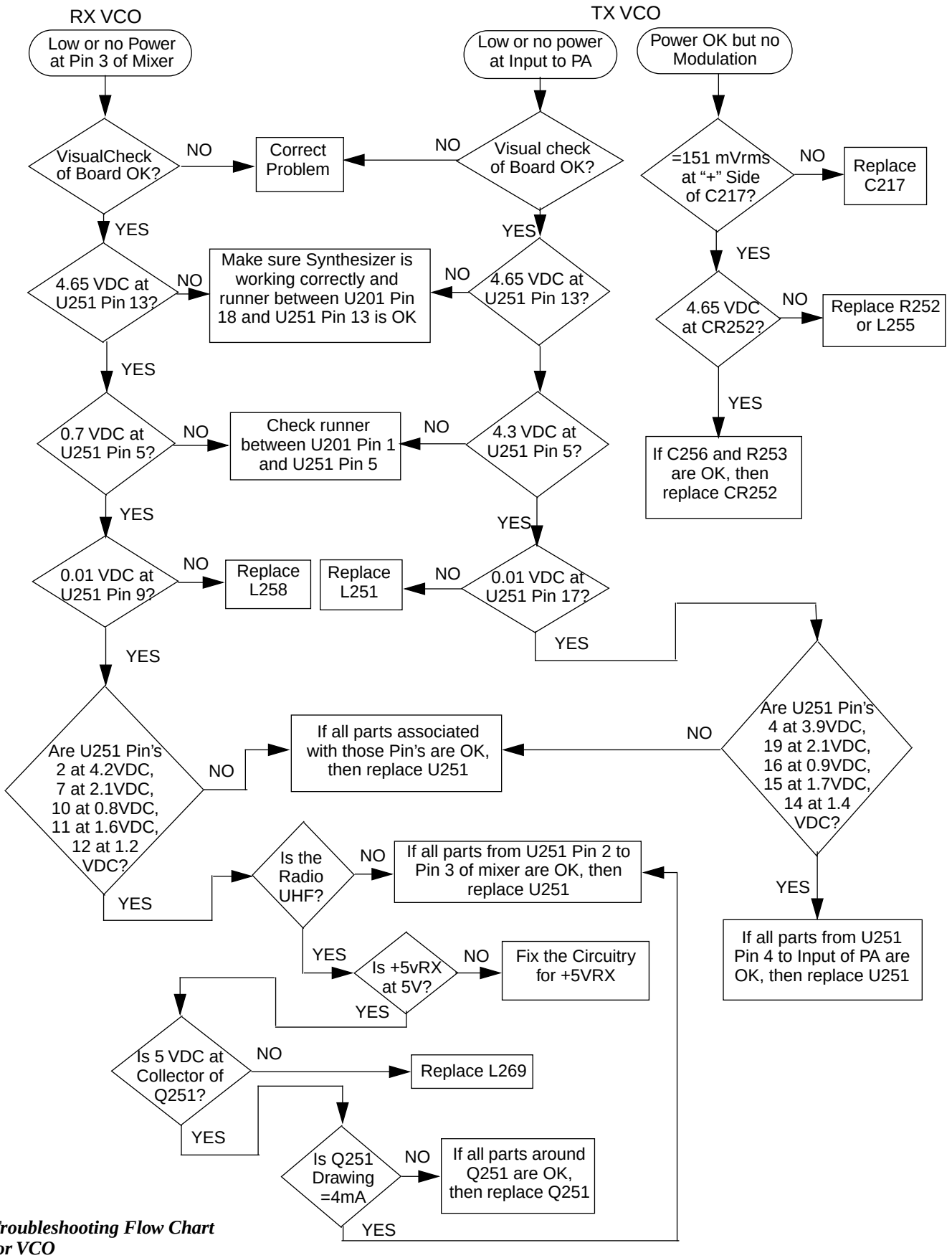
Troubleshooting Flow Chart for Transmitter



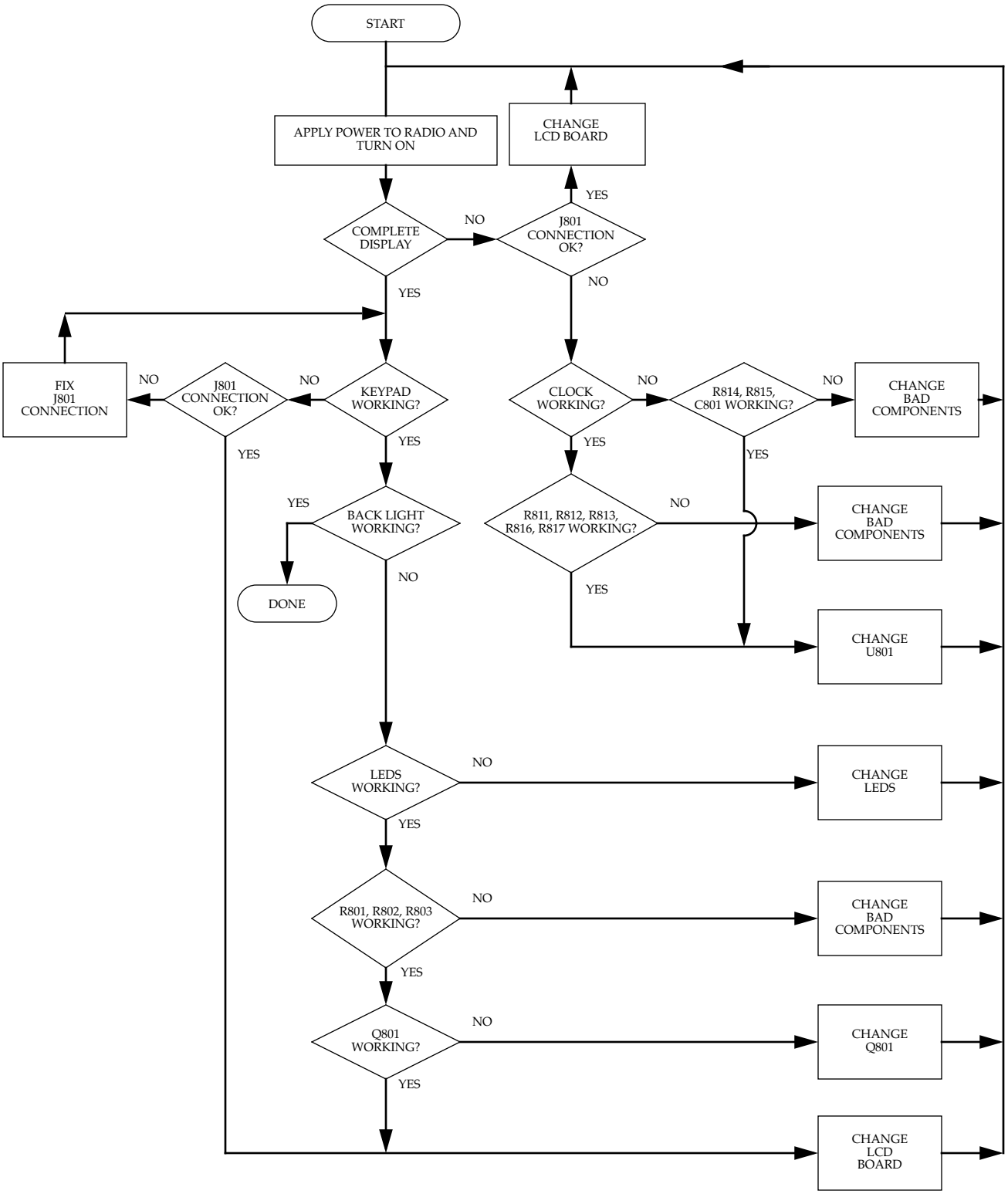
Troubleshooting Flow Chart for Synthesizer



Troubleshooting Flow Chart for Microcontroller



Troubleshooting Flow Chart for VCO



Troubleshooting Flow Chart for Display Board