MOTOROLA

GTX
LTR® / Privacy Plus®
900 MHz
Mobile Radio
Service Manual

6880906Z19-O

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MOTOROLA

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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 service manual revisions. 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 GTX Mobile Radio. 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.

Technical Support

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

Service Policy

If malfunctions occur within 30 days that cannot be resolved over the phone with Product Services, a defective major component should be returned. You must obtain authorization from Radius Product Services before returning the component.

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. 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.

Radius 30-Day Warranty
Technical Support
Radius Product Services
8000 W. Sunrise Blvd.
Plantation, FL 33322

Motorola Radio Support Center
Attention: Warranty Return
3761 South Central Avenue
Rockford, IL 61102 USA
1-800-227-6772 (U.S. & Canada)

Radius Major Component Repair
Motorola Radio Support Center
3760 South Central Avenue
Rockford, IL 61102 USA

Motorola Parts
Worldwide System and
Aftermarket Products Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Worldwide System and
Aftermarket Products Division
Attention: International Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Customer Service
1-800-422-4210
1-847-538-8198 (FAX)

Parts Identification
1-847-538-0021
1-847-538-8194 (FAX)

Model Chart

Model	Freq..	Description
M11WGD4CB1_N	8	GTX Privacy Plus, 900 MHz, 12.5 kHz, 12 W
M11WGD4CU1_N	8	GTX LTR, 900 MHz, 12.5 kHz, 12 W

GTX
LTR / Privacy Plus
Mobile Radio
900 MHz
12 Watts RF Power

Item	Description
HLN9634_	Hardware Kit
HLF9009_	Main Board, Privacy Plus, 12.5 kHz, 12 W
HLF90010_	Main Board, LTR, 12.5 kHz, 12 W
FLN8744_	Control Head Board

			Item	Description				
	X		HUF3029_	Radio, Privacy Plus, 12.5 kHz, 12 W		X		
		X	HUF3031_	Radio, LTR, 12.5 kHz, 12 W			X	
	X		HUF3030_	Unified Chassis, Privacy Plus, 12.5 kHz, 12 W		X		
		X	HUF3032_	Unified Chassis, LTR, 12.5 kHz, 12 W			X	
	X	X	HCN3018_	Control Head				X
	X	X	HMN3413_	Compact Microphone				
	X	X	GLN7317_	Trunnion				
	X	X	GKN6270_	Power Cable				
	X	X	6880907Z66	Installation Manual				
	X	X	6880907Z20	GTX LTR User's Guide (English/French)				
	X	X	6880907Z19	GTX Privacy Plus User's Guide (English/French)				

GTX
LTR / Privacy Plus
Mobile Radio
900 MHz
30 Watts RF Power

Model			Description	Freq.	Description
	M11WRD4CB1_N		GTX Privacy Plus, 900 MHz, 12.5 kHz, 30 W	8	
		M11WRD4CU1_N	GTX LTR, 900 MHz, 12.5 kHz, 30 W	8	

Item	Description	Item	Hardware Kit	Main Board, Privacy Plus, 12.5 kHz, 30 W	Main Board, LTR, 12.5 kHz, 30 W	Control Head Board
		HLN9634_				
		HLF9003_				
		HLF9004_				
		FLN8744_				

			Item	Description				
	X		HUF3007_	Radio, Privacy Plus, 12.5 kHz, 30 W		X		
		X	HUF3011_	Radio, LTR, 12.5 kHz, 30 W			X	
	X		HUF3009_	Unified Chassis, Privacy Plus, 12.5 kHz, 30 W		X		
		X	HUF3013_	Unified Chassis, LTR, 12.5 kHz, 30 W			X	
	X	X	FCN3018	Control Head				X
	X	X	HMN3413_	Compact Microphone				
	X	X	HLN9640_	Trunnion				
	X	X	HKN4191_	Power Cable				
	X	X	6880907Z66	Installation Manual				
	X	X	6880907Z20	GTX LTR User's Guide (English/French)				
	X	X	6880907Z19	GTX Privacy Plus User's Guide (English/French)				

Accessories

Audio

HMN3413	Compact Microphone
HMN1035_R	Heavy Duty Palm Microphone
HMN3013	DTMF Non-Backlit Microphone with Hang-Up Clip
AAREX4617	Handset with Hang-up Clip
HLN9073	Hang-up Clip

Speaker

FSN5510	7.5 W External Speaker

Installation

HLN9640	Trunnion Kit; 30 W
GLN7317	Trunnion Kit; 12 W

Cables

HKN4191	Power Cable; 30 W
GKN7270	Power Cable; 12 W
GKN6271	Ignition Sense Cable
GKN6272	External Alarm Relay and Cable

Antennas

RRA4935	900 MHz, 3 dB Gain w / 14 ft. Cable

Control Station

RLN4834	Control Station Package; 30 W
HLN3067	Control Station Package; 12 W
GLN7318	Base Station Tray
HPN4001	Power Supply and Cable (greater than 25 W)
HPN4002	Power Supply and Cable (less than or equal to 25 W)
HKN9088	Mobile Mini-U Antenna Adapter
HMN3000	Desk Micophone

Manuals/Kits

6880907Z20	GTX LTR User's Guide (English / French)
6880907Z19	GTX Privacy Plus User's Guide (English / French)
6880907Z66	Installation Manual
RVN4150	GTX Radio Service Software Kit

Maintenance Specifications

GENERAL

Frequency:	900 MHz	
Model Number:	M11WRD4CB1_N, M11WRD4CU1_N	M11WGD4CB1_N, M11WGD4CU1_N
RF Output:	30 W	12 W
RF Output (Talkaround):	20 W	10 W
FCC Description:	ABZ99FT3004	AZ492FT5782
Dimensions (H x W x L):	1.73” x 6.61” x 8.62” (44mm x 168mm x 219mm)	1.73” x 6.61” x 6.67”” (44mm x 168mm x 169mm)
Weight:	4.30 lb (1.95 kg)	2.67 lb (1.21 kg)
Frequency Range *: Transmit Talkaround Receive	896 – 941 MHz 896 – 902 MHz 935 – 941 MHz 935 – 941 MHz	
Channel Spacing:	12.5 kHz	
Channel Capacity:	10 Trunked Modes / 10 Conventional Channels	
Group Capacity:	8 Trunked Talkgroups	
Frequency Stability:	1.5 ppm	
Input Voltage:	13.6 V dc	13.8 V dc
Temperature Range: Operating Storage	 -30 to +60°C -40 to +85°C	
Tx Current:	12.0A (30 W)	6.0A (12 W)

* 821 - 825 MHz & 866 - 870 MHz is available outside of the U.S.

TRANSMITTER

Power Output:	30 W (896 – 902 MHz) 20 W (935 – 941 MHz)	12 W (896 – 902 MHz) 10 W (835 – 941 MHz)
Channel Spacing:	12.5 kHz	
Maximum Frequency Separation:	6 MHz	
Modulation Limiting:	2.5 kHz	
FM Hum & Noise:	-35 dB	
Conducted / Radiated Emission:	-13 dBm	
Audio Response (300-3000 Hz):	+1 to -3 dB	
Audio Distortion:	Less than 5%	

RECEIVER

Channel Spacing:	12.5 kHz
Sensitivity (12dB SINAD):	0.35 µV
Intermodulation:	-65 dB
Adjacent Channel Selectivity:	-65 dB
Spurious Rejection:	-65 dB
Audio Output Power:	4W (internal speaker) 7.5W (external speaker)
Audio Distortion @ Rated Audio:	5%
Current Drain: OFF Standby Rated	 30 mA 450 mA 1.5A (4W internal speaker) 1.7A (7.5W external speaker)
Conducted Spurious Emission:	Per FCC part 90

MIL STANDARDS- THE GTX MOBILE RADIO IS DESIGNED TO MEET OR EXCEED MOST REQUIREMENTS FOR MIL STD 810 C, D, AND E

Applicable MIL-STD:	810C		810D		810E	
	Methods	**Procedures**	**Methods**	**Procedures**	**Methods**	**Procedures**
Low Pressure	500.1	1	500.2	1	500.3	1
High Temperature	501.1	1,2	501.2	1,2	501.3	1,2
Low Temperature	502.1	1	502.2	1,2	502.3	1,2
Temperature Shock	503.1	1	503.2	1	503.3	1
Rain	506.1	2	506.2	2	506.3	2
Humidity	507.1	2	507.2	2	507.3	2
Salt Fog	509.1	1	509.2	1	509.3	1
Dust	510.1	1	510.2	1	510.3	1
Vibration	514.2	8,10	514.3	1	514.4	1
Shock	516.2	1,3,5	516.3	1,5	516.4	1,5
Crash Safety Shock					516.4	5
Packaged Vibration					514.4	

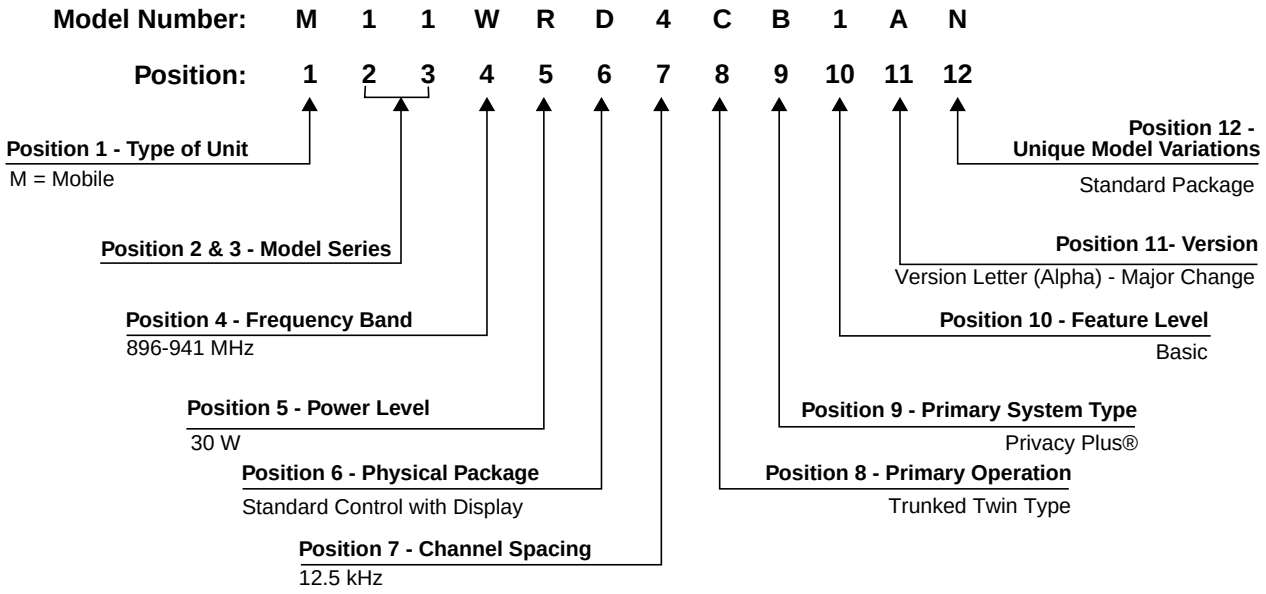
All specifications subject to change without notice.

Radio Model Numbering System

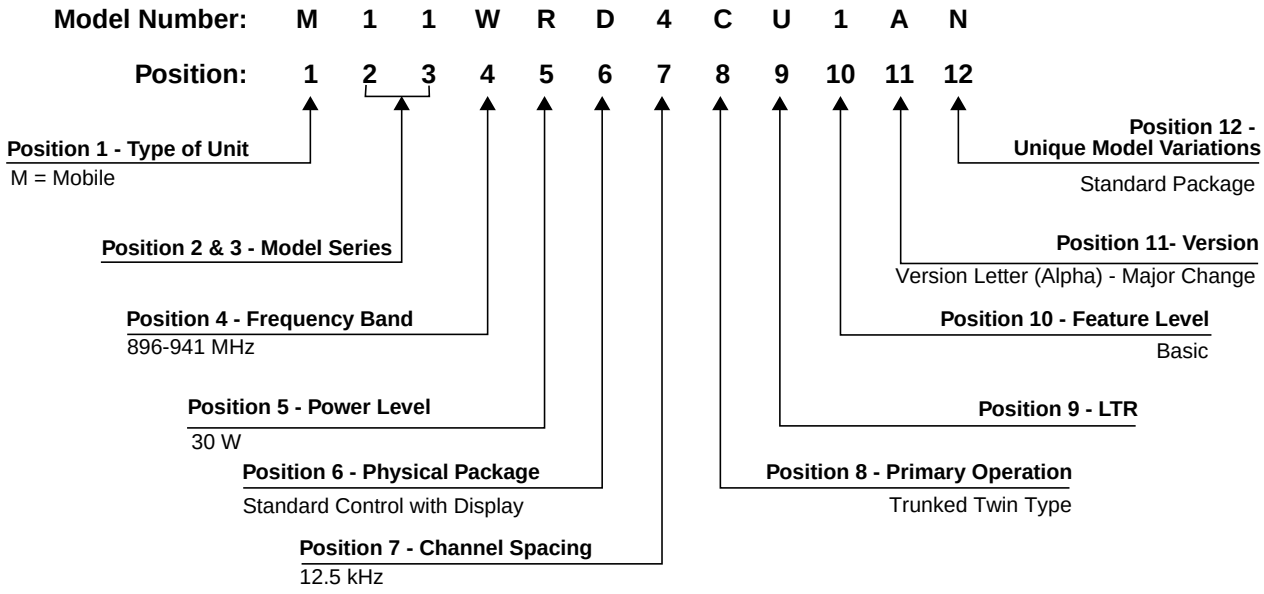
The model number, serial number, and Motorola FCC designation number are all on a label attached to the back of your radio.

All GTX LTR and Privacy Plus radio models are synthesized, 8 trunked mode, 10-conventional channel units that come standard with Tone Private-Line (TPL) / Digital Private-Line (DPL) coded squelch or carrier squelch, which may be enabled / disabled on a per channel basis. Programming changes can be made by your local dealer.

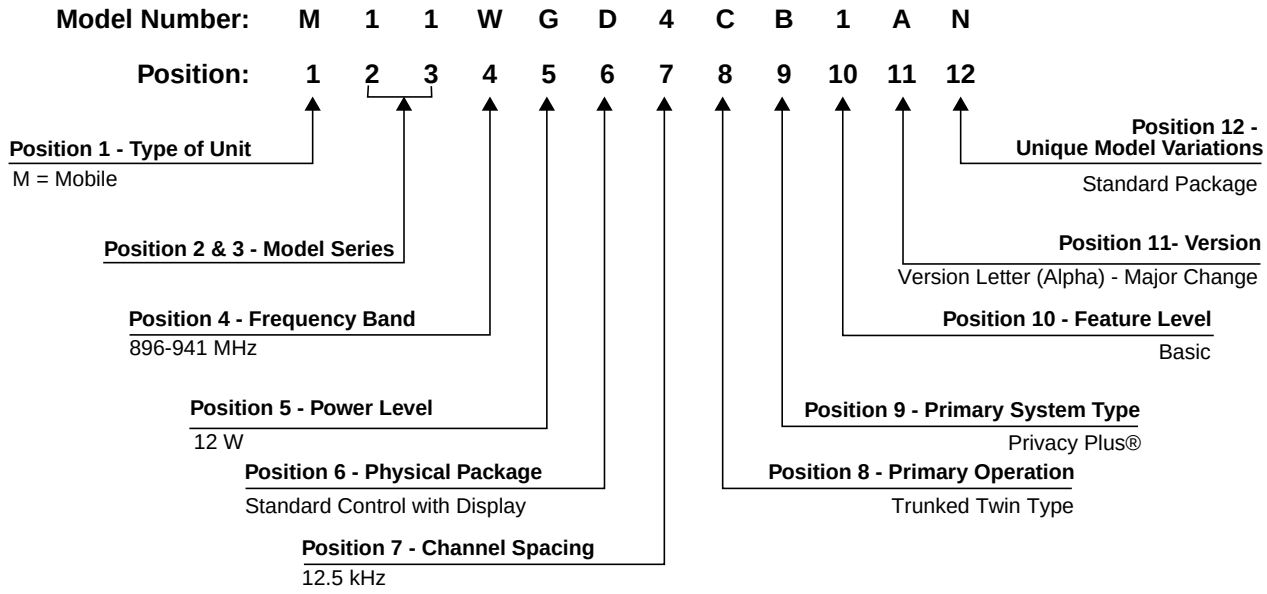
GTX Privacy Plus



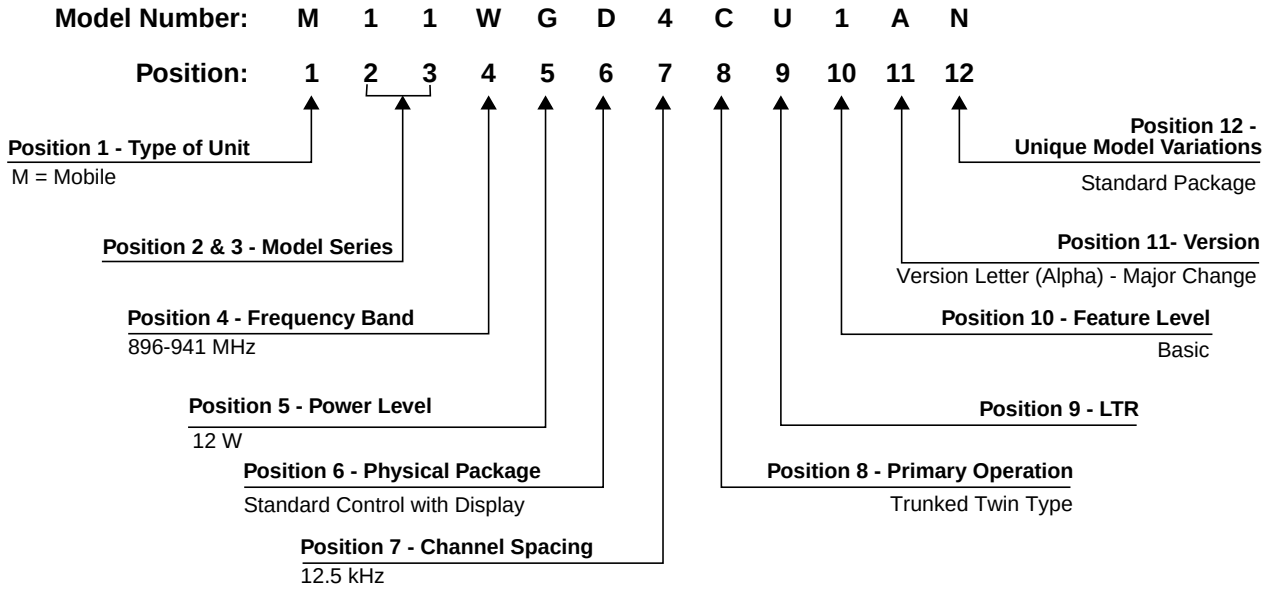
GTX LTR



GTX Privacy Plus



GTX LTR



Section 1
Introduction

Notational Conventions

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

WARNING

Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

Caution

CAUTION

Indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury. CAUTION may also be used to alert against unsafe practices and property-damage-only accident hazards.

Note

NOTE

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

Scope of this Manual

This manual includes model/kit information, specifications, disassembly/reassembly procedures, maintenance, alignment, troubleshooting, and all theory, schematic diagrams, printed circuit board details and parts lists for all parts in the equipment described.

CAUTION

This manual is intended for use by experienced technicians who are familiar with similar types of equipment.

Safety information

Every radio, when transmitting, radiates energy into the atmosphere which may, under certain conditions, causes the generation of a spark.

All users of vehicles fitted with radios should be aware of the following warnings:

WARNING

- Do not operate the radio near flammable liquids or in the vicinity of explosive devices.
- During normal use, the radio will subject you to radio energy substantially below the level where any kind of harm is reported.

To ensure personal safety, please observe the following simple rules:

WARNING

- Do not transmit when the antenna is very close to, or touching, exposed parts of the body, especially the face and eyes.
- Do not hold the transmit (PTT) key in when not desiring to transmit.
- Check the laws and regulations on the use of two-way mobile radios in the areas where you drive. Always obey them. Also, when using your radio while driving, please:

  give full attention to driving,

  use hands-free operation, if available, and

  pull off the road and park before making or answering a call if driving conditions so require.

Air Bag Warning

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 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.

LP Gas Warning

WARNING

It is mandatory that radios installed in vehicles fueled by liquefied petroleum gas conform to the National Fire Protection Association standard NFPA 58, which applies to vehicles with a liquid propane (LP) gas container in the trunk or other sealed off space within the interior of the vehicle. The NFPA 58 requires the following:

- Any space containing radio equipment shall be isolated by a seal from the space in which the LP gas container and its fittings are located.
- Removable (outside) filling connections shall be used.
- The container space shall be vented to the outside.

Section 2
Basic Maintenance

Introduction

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

Preventive Maintenance

The radios do not require a scheduled preventive maintenance program; however, periodic visual inspection and cleaning is recommended.

Inspection

Check that the external surfaces of the radios are clean, and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed or desired.

Cleaning

CAUTION

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

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the radio. External surfaces include the front cover, housing and assembly. These surfaces should be cleaned whenever a visual inspection reveals the presence of smudges, grease, and/or grime. Internal surfaces should be cleaned only when the radio is disassembled for servicing or repair.

The only recommended agent for cleaning the external radio surfaces is a 0.5%solution of mild dishwashing detergent in water. the only factory recommended liquid for cleaning the printed circuits boards and their components is isopropyl alcohol (70% by volume).

Plastic Surfaces

The detergent solution should be applied sparingly with a stiff non-metallic, short-bristled brush to work all loose dirt away from the radio. A soft, absorbent, lint-free cloth or tissue should be used to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

Circuit Boards and Components

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

CAUTION

Alcohol is a high-wetting liquid and can carry contamination into unwanted places if an excessive quantity is used.

Make sure that controls or tunable components are not soaked with the liquid. Do not use high-pressure air to hasten the drying process. This could cause the liquid to puddle and collect in unwanted places. Upon completion of the cleaning process, use a soft, absorbent, lint-free cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, front cover, or back cover.

NOTE

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

Safe Handling of CMOS Devices

Complementary metal-oxide semiconductor (CMOS) devices are used in this family of radios. While the attributes of CMOS are many, their characteristics make them susceptible to damage by electrostatic or high voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, special precautions must be taken to prevent device damage during disassembly, troubleshooting, and repair. Handling precautions are mandatory for CMOS circuits and are especially important in low humidity conditions.

CAUTION

Do not attempt to disassemble the radio without observing the following handling precautions.

Precautions

1. Eliminate static generators (plastics, stryofoam, etc. in the work area.

2. Remove nylon or double-knit polyester jackets, roll up long sleeves, and remove or tie back loose hanging neckties.

3. Store and transport all static-sensitive devices in ESD-protective containers.

4. If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same dame as touching the leads.

5. Disconnect all power from the unit before ESD-sensitive components are removed or inserted unless otherwise noted.

6. Use a static safeguarded workstation, which can be accomplished through the use of an anti-static kit (Motorola part number 0180386A82). This kit includes a writ strap, two ground cords, a static-control table mat and a static-control floor mat. For additional information, refer to Service and Repair Note SRN F1052, “Static Control Equipment for Servicing ESD Sensitive Products”, available form Motorola Literature Distribution 2290 Hammond Drive Schaumburg, IL 60173 (847) 576-2826.

   When these items are not readily available, observing the following techniques will minimize chance of damage.

- If a static-sensitive device is to be temporarily set down, use a conductive surface for placement of the device.

- Make skin contact with a conductive work surface first and maintain this contact when the device is set down or picked up.

7. Always wear a conductive strip when servicing this equipment. the Motorola part number for a replacement wrist strap that connects to the table mat is 42-80385A59.

8. When straightening CMOS pins, provide ground straps for apparatus used.

9. When soldering, use a grounded soldering iron.

Repair Procedures and Techniques

The radio support center is at the following addresses:

Motorola Radio Support Center
3651 South Central Avenue
Rockford, Ill, 61102
Telephone: (800) 227-6772
(815) 847-1400

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

Parts Replacement

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

When damaged parts are replaced, identical parts should be used. If the identical replacement component is not locally available, check the parts list for the proper Motorola part number and order the component from the nearest Motorola Communications Parts office.

Rigid Circuit Boards

This family of radios uses bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The printed-through holes may interconnect multiple layers of the printed circuit.

CAUTION
Therefore, care should be exercised to avoid pulling the plated circuit out of the hole.

When soldering near the 16 or 18-pin connector, use care to avoid accidentally getting solder in the connector.

CAUTION
Be careful not to form solder bridges between the connector pins. Closely examine your work for shorts due to solder bridges.

Chip Components

Use either the RLN4062 Hot-Air Repair Station or the Motorola 0180381B45 Repair Station for chip component replacement. When using the 0180381B45 Repair Station, select the TJ-65 mini-thermojet hand piece. On either unit, adjust the temperature control to 700˚ F

(370˚ C), and adjust the airflow to a minimum setting. Airflow can vary due to component density.

Chip Component Removal

To remove a chip component, select a hot-air hand piece and position the nozzle of the hand piece approximately 1/8" above the component to be removed. Begin applying the hot air. Once the solder reflows, remove the component using a pair of tweezers. Using solder wick and a soldering iron or a power desoldering station, remove the excess solder from the pads.

Chip Component Replacement

To replace a chip component using a soldering iron, select the appropriate micro-tipped soldering iron and apply fresh solder to one of the solder pads. Using a pair of tweezers, position the new chip component in place while heating the fresh solder. Once solder wicks onto the new component, remove the heat from the solder. Heat the remaining pad with the soldering iron and apply solder until it wicks to the component. If necessary, touch up the first side. All solder joints should be smooth and shiny.

To replace a chip component using hot air, select the hot-air hand piece and reflow the solder on the solder pads to smooth it. Apply a drop of solder paste flux to each pad. Using a pair of tweezers, position the new component in place. Position the hot- air hand piece approximately 1/8" above the component and begin applying heat. Once the solder wicks to the component, remove the heat and inspect the repair. All joints should be smooth and shiny.

Over-Molded Pad-Array Carrier (OMPAC)

ASFIC U0201 is an OMPAC. It must be kept in a sealed bag with dessicant in the bag (in a "dry box" as supplied by the Motorola Parts Department prior to use. If the OMPAC is ambient for an unknown amount of time or for more than 96 hours, then it must be baked for at least eight hours at 260˚ F (185˚ C).

If neighboring OMPAC components are heated above 365˚ F (185˚ C), they will suffer die-bond delamination and possible "popcorn" failure.

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

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

OMPAC Removal

To remove the OMPAC, select the R-1319A Air-Flow Station and the appropriate heat- focus head (approximately the same size as the OMPAC. Attach the heat-focus head to the chimney heater. Adjust the temperature control to approximately 415˚ F (215˚ C) 445˚ F (230˚ C) maximum. Adjust the airflow slightly above the minimum setting. Apply the solder paste flux around the edge of the OMPAC. Place the circuit board in the R-1070A's circuit board holder, and position the OMPAC under the heat-focus head. Lower the vacuum tip and attach it to the OMPAC by turning on the vacuum pump. Lower the heat-focus head until it is approximately 1/8" (0.3cm) above the carrier. Turn on the heater and wait until the OMPAC lifts off the circuit board. Once the part is off, grab it with a pair of tweezers and turn off the vacuum pump. Remove the circuit board from the R-1070A's circuit board holder.

OMPAC Replacement

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

Once the preparation is complete, place the circuit board back in the R-1070A's circuit board holder. Add solder paste flux in the trench of the flux block and spread it using a one-inch putty knife. Flux the OMPAC by placing it in the trench of the flux block. Once the flux is applied, place the OMPAC on the circuit board, making certain that it is oriented correctly on the board. Position the heat-focus head over the OMPAC and lower it to approximately 1/8" (0.3cm) over the carrier. Using the same heat and airflow setting used to remove the OMPAC, turn on the heater and wait for the carrier to reflow (heating and reflow should take longer than 60 seconds).

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

Shields

Removing and replacing the shields will be done with the R-1070A, using the same heat and airflow profile used to remove and replace OMPAC components.

Shield Removal

Place the circuit board in the R-1070A's holder. Select the proper heat focus head and attach it to the heater

chimney. Add solder paste flux around the base of the shield. Position the shield under the heat-focus head. Lower the vacuum tip and attach it to the shield by turning on the vacuum pump. Lower the focus head until it is approximately 1/8”(0.3cm) above the shield. Turn on the heater and wait until the shield lifts off the circuit board. Once the shield is off, turn off the heat, grab the part with a pair of tweezers, and turn off the vacuum pump. Remove the circuit board from the R-1070A's circuit board holder.

Shield Replacement

To replace the shield, add solder to the shield if necessary, using a micro-tipped soldering iron. Next, rub the soldering iron tip along the edge of the shield to smooth out any excess solder. Use solder wick and a soldering iron to remove excess solder from the solder pads on the circuit board. Place the circuit board back in the R-1070A's circuit board holder. Place the shield on the circuit board using a pair of tweezers. Position the heat-focus head over the shield and lower it to approximately 1/8” above the shield. Turn on the heater and wait for the solder to reflow.

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

Replacement of Transistor Q6505

This section provides a replacement procedure for Q6505, the RF power output transistor in the 30-Watt power amplifier.

To replace Q6505, proceed as follows:

Before proceeding, ensure that the following tools and materials are on hand:

- Alcohol (isopropyl).
- High temperature solder, SN96AG04 composition. Motorola Part No. 1180433L04.
- Hot air gun (600 degrees maximum temperature).
- Low lint wipers.
- Soldering station including a soldering iron with chisel-style tip which is approximately 1/8-inch in size.
- Solder flux.
- Solder wick.
- Stiff brush, natural bristles approximately 1-cm high and 1-cm wide.
- Thermal compound, Motorola Part No. 1180382B13.
- Transistor assembley tool 0293.

1. Remove main board from radio chassis following procedure provided in Section 6 of this service manual, Motorola Publication 6880906Z19.
2. After main board is removed from radio chassis, clean off thermal paste from all surfaces that have thermal paste on them using low lint wipers.

Removing Faulty Transistor

1. Before removing faulty transistor, observe carefully how flange capacitors C6567 and C6568 are mounted. This will help you later in mounting new capacitors.
2. Set hot air gun for medium temperature and low air speed. This will ensure that other components in vicinity of Q6505 will not get dislodged and moved accidently.
3. Train hot air gun on flanges of transistor. After a few moments, the solder holding flanges will reflow enabling transistor and flange capacitors C6567 and C6568 to be lifted off main board together.

Preparing Main Board for New Transistor

1. Using solder wick, isopropyl alcohol, and stiff bristle brush, remove excess solder and clean pads on main board where transistor was soldered.
2. Place main board, with its heavy side up, on transistor assembly tool. Heavy side is side with PA module and antenna connector. Make certain that all guide pins on transistor assembly tool are engaged into their corresponding holes in main board.
3. Identify the six pads on main board corresponding to the six flanges on transistor. The four corner pads are ground; the middle pad towards antenna connector is the transistor collector; and the opposite middle pad is the transistor emitter.

NOTE

In next step, be certain to tin transistor pads and fill via holes with high temperature solder, composition SN96PB04.

4. Using solder iron, carefully tin each of the six pads so that they are covered with a thin coat of solder and all via holes are filled.

Positioning New Transistor

1. Place a small spot of flux on each of the six main-board pads to which the flanges of transistor are to be soldered.

2. Insert the narrow-diameter side of a spacer, Motorola Part Number 4380545K01, into each of the two transistor mounting holes in main board.

3. Ensure that new transistor is correct replacement type by verifying that M25C20 is printed on transistor face.

NOTE
Collector flange of transistor is the one with its corner cut off.

4. Position new transistor onto transceiver board with collector flange oriented towards antenna connector. Ensure that transistor is sitting snug on main board with all six flanges flat on their corresponding main-board pads.

5. Lower arm of Distaco clamp on transistor assembly tool. Then lock clamp with its lever to clamp transistor in place on main board.

Soldering Transistor

1. Place a small spot of flux on each of the six transistor flanges.

2. 2. Solder each transistor flange to transceiver board as follows:

2A. Set soldering iron temperature to approximately 400 degrees Centigrade.

2B. Melt a small mound of solder onto flat face of soldering iron.

CAUTION
In next step, to avoid damage to transistor and capacitors, ensure that each soldering operation takes no more than three to four seconds to accomplish.

3. Press face of soldering iron firmly to flange for no more than three to four seconds.

4. Inspect transistor flange carefully to ensure it is soldered securely, and that it is not shorted to any of the other flanges or to the transistor heat sink.

Installing Flange Capacitors C6567 and C6568.

NOTE
Capacitors C6567 and C6568 get mounted flat on transistor collector and ground flanges with non-solderable edge flush against transistor body. Each capacitor is attached by soldering its outside solderable edge to one of the transistor ground flanges and its inside solderable edge to transistor collector flange. There must be a gap of approximately 2 millimeters between the two capacitors (i.e., room to insert a chisel style solder iron tip) to ensure that good solder joints can be made between capacitor leads and collector flange of transistor.

1. Ensure that both capacitors C6567 and C6568 are correct replacement type by verifying that Motorola Part Number is 2113742B23, value is 12pF, and marking is Cl.

CAUTION
In next two steps, to avoid damage to transistor and capacitors, ensure that soldering operations take no more than three to four seconds to accomplish.

2. Solder outside solderable edge of each capacitor to one transistor ground flange, being certain that each capacitor is flat on transistor flange with non-solderable edge flush against transistor body.

3. Place a small drop of flux on transistor collector flange between capacitors. Place chisel style solder iron tip between capacitors and onto collector flange of transistor. Feed in some high temperature solder (SN96PB04) so that inside solderable edges of both capacitors are soldered securely to collector flange of transistor.

4. Examine soldered capacitors. Ensure that they are reasonably flush against transistor body and are not shorting transistor collector flange to transistor heat sink.

5. Examine surrounding components to ensure that none of them have been damaged or displaced.

Reassembly of Radio

1. Examine face of transistor heat sink. Ensure that it is free from burrs and flux, which could prevent a good thermal contact to radio chassis.

2. Spread thermal compound on heat sink of the following components:

- Transistor Q6505
- PAmoduleU6501
- Audio PA module U401
- +9.3V voltage regulator U601

3. Install transceiver board into radio chassis following procedure provided in Section 6 of this service manual, Motorola Publication 6880906Z19.

Section 3
Test Equipment, Service Aids, and Tools

Test Equipment

The list in Table 3-1 includes all standard test equipment required for servicing two-way mobile radios. Battery-operated test equipment is recommended when available. The “Characteristics” column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola model listed is either a unique item or no substitution is recommended.

Table 3-1. Recommended Test Equipment

Model No.	Description	Characteristics	Application
R2000 Series with trunking option	Communications System Analyzer		Frequency / deviation meter and signal generator for wide-range troubleshooting and alignment
R1053	Dual Trace Oscilloscope	200 MHz bandwidth,	For waveform measurements
FLUKE 8012	Digital Multimeter		AC / DC voltage and current meter
T1013A	Load resistor	0-1000MHz, 300 W	For use with wattmeter
S1339A	RF Millivolt Meter 10 kHz to 1.2 GHz	100 V to 3V rf	RF level measurements
R1011B	DC Power Supply	0-40Vdc, 30 Amps	Bench supply for 13.8Vdc current limited

Field Programming

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

Table 3-2. Service Aids

Part No.	Description	Application
RLN4008B	Radio Interface Box	Enables communications between the radio and the computer's serial communications adapter.
EPN4040A	Power Supply	Used to supply power to the RIB (240 VAC).
0180358A56	Power Supply	Used to supply power to the RIB (220 VAC).
0180357A57	110V AC-to-DC Adapter	Used to supply power to the RIB (110 VAC).
3080070N01	Combined Interface Cable	Connects radio to RLN4008B RIB.
GKN6270A	DC Power Cable for radio	Interconnects radio to power supply.
HKN4191B	35 W Power Cable for radio	Interconnects radio to power supply.
3080369B72	Computer Interface Cable	Connects the computer's serial communications adapter (9 pin) to the RIB.
3080369B71	Computer Interface Cable	Connects the computer's serial communications adapter (25 pin) to the RIB.
RLN4438A	Adapter	25 pin (F) to 9 pin (M) adapter, for use with 3080369B72 for AT applications.
RVN4150B	Radio Service Software (RSS)	For GTX radio programming.
68P02948C70	GTX (RSS) Radio Service Software Manual	Provides detailed instruction on RSS used in GTX radios.
RLN4460A	Test Fixture	For radio testing
3008566C12	Test Cable	For connecting between the radio and RLN4460A.

Service Tools

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

Table 3-3. Service Tools

Part No.	Description	Application
0180381B45 110 VAC or 0180300E06 220 VAC	MBT250 Surface-mount / through-hole repair station	Temperature-controlled, self-contained soldering / desoldering repair station for installation and removal of surface-mounted devices.
8180369E97	Flux holder / applicator	Allows for the proper amount of flux to be applied to pad grid arrays for repair.
1105139W02	30cc plastic syringe and flux paste	For use with flux holder / applicator 8180369E97.
0180386A81	Miniature digital readout soldering station (includes 1 / 64” micropoint tip)	
0180386A78	Illuminated magnifying glass with lens attachment	
0180386A82	Anti-static grounding kit	Used during all radio assembly and disassembly procedures
6684253C72	Straight prober	
6680384A98	Brush	
1010041A86	Solder (RMA type), 63 / 37, 0.020” diameter, 1 lb. spool	
R-1070A (superseded by R1319A)	Shields and surface-mounted component - IC removal / rework station	Removal of surface-mounted integrated circuits
R1319A 6680332E82 6680332E83 6680332E84 6680333E28	Surface-Mounted Device Rework Station R1319A Reflow Nozzle R1319A Reflow Nozzle R1319A Reflow Nozzle R1319A Reflow Nozzle	Removal of surface-mounted integrated circuits For IC removal (approximate size 0.8 in. x 0.8 in.) For IC removal (approximate size 0.6 in. x 0.6 in.) For IC removal (approximate size 0.5 in. x 0.5 in.) For removal of RF PA
0293	Transmitter Assembly Tool	Replacement for transisator Q6505

Section 4
Test Mode, Error Codes and Performance Tests

Front Panel Test Mode

The functions of the radio controls for the Front Panel Test Mode are as follows:

Test Mode/Entry

Test Mode allows radio checks to be performed in the field. To provide a level of protection to the Test Mode entry, proceed according to the following sequence:

1. Place radio in TRUNKING operation mode and wait for 6 seconds. (See Quick Start card for instructions on how to enter that mode.)
2. Turn radio off.
3. Verify that RIB is off.
4. Turn radio power supply (13.6 V DC) on .
5. Turn radio on.

The radio enters Test Mode operation:

- Speaker unmutes.
- One beep is heard to indicate operation on the first test frequency (default).
- Display shows "4 1" .

  CHANNEL

  MODE (4 IS INITIAL MODE)

Test Mode/Channel Selection

Use the PTT switch for channel selection. A short press and de-press on the PTT switch (button-like push) will advance the radio to the next channel (cyclical) . Seven channels are available during test mode, as shown in Table 4-1.

Test Mode/Tx Modulation

Use PTT switch for modulation type selection. A continuous press will advance the radio to the next modulation test (cyclic scroll) and perform Tx test until PTT is released. The modulation selection is described in Table 4-2.

Table 4-1. Test Mode/Channel Selection

Channel Number	Rx Frequency	Tx Frequency	Display
1	935.0125 MHz	896.0125 MHz	“M 1” (2)
2	941.9875 MHz	901.9875 MHz	“M 2” (2)
3	938.5125 MHz	899.5125 MHz	“M 3” (2)
4	CC1 (1)	CC1-45 MHz	“M 4” (2)
5	CC2 (1)	CC2-45 MHz	“M 5” (2)
6	CC3 (1)	CC3-45 MHz	“M 6” (2)
7	CC4 (1)	CC4-45 MHz	“M 7” (2)

1. CC1-CC4 are control channels programmed in association with the selected trunking system.
2. M stands for modulation type (0-3). See Table 4-2.

Table 4-2. Test Mode/Tx Modulation

Modulation Type	Internal Speaker Audio Signaling	Internal Microphone Status	Display
CSQ	None	On	“0 C” (1)
Low Speed	Busy Channel	On	“1 C” (1)
High Speed	Call Back	Off	“2 C” (1)
DTMF “#”	DTMF “#”	Off	“3 C” (1)

1. C stands for the selected channel (1-7). See Table 4-1.

Fail Mode

The radio will enter Fail Mode upon detecting one of the following errors:

- Application startup self check error
- Codeplug information check error

There are two categories of errors: critical and non-critical. Critical errors will stop radio normal operation. Refer to Table 4-3.

Exiting Test Mode

To exit Test Mode, proceed as follows:

- Turn radio off.
- Turn RIB on.

Table 4-3. Fail Mode

Error number	Failure Description	Display	Critical	Tone Sound
1	Internal RAM	F 01	Yes	Illegal tone
2	External RAM	F 02	Yes	Illegal tone
5	OTP checksum	F 05	Yes	Illegal tone
6	Codeplug checksum	E 06	Yes	Illegal tone
7 (1)	Codeplug personality	E 06	No	Illegal Tone (when selected personality has checksum error)
8	Codeplug tuning error	E 06	Yes	Ilegal tone

1. For error no. 7, personality (system) change is allowed although the illegal tone is heard. For error no. 8 the temporary illegal tone is heard. (See the Quick Start card for instructions on how to change personality.) To exit fail mode, power radio off.

   Non-critical errors will be temporarily indicated as described in Table 4-2.

Table 4-4. Transmitter Performance Checks

Test Name	Communication Analyzer	Radio	Test Set	Comments
Reference Frequency	Mode: PWR MON 2nd channel test frequency Monitor. Frequency error input at RF In / Out	TEST MODE, Display: 2 0	PTT to continuous (during the performance check)	Frequency error to be < 700 Hz
Power RF	Same as Above	TEST MODE, Display: 2 0	Same as Above	Refer to Maintenance Specification page x
Voice Modulation	Mode: PWR MON 4th channel test frequency atten to -70, input to rf In / Out Monitor: DVM, AC Volts Set 1kHz mod Out level for 0.025Vrms at test set, 80mVrms at AC / DC test set jack.	TEST MODE, Display: 2 0	Same as Above, meter selector to mic	Deviation: 800 MHz: 3.6 kHz but 5.0 kHz *900 MHz:* 2.5 kH
Low-Speed Data Modulation 800 / 900	Same as Above	TEST MODE, Display: 2 1	PTT to continuous (during the performance check)	Deviation: 800 MHz: 800 Hz but 1200 Hz *900 MHz:* 350 Hz 650 Hz

Table 4-4. Transmitter Performance Checks (Cont'd.)

Test Name	Communication Analyzer	Radio	Test Set	Comments
Voice Modulation (Internal)	Mode: PWR MON 2nd channel test frequency atten to -70, input to RF In / Out	TEST MODE, Display: 2 0	Remove modulation input	Press PTT switch on radio. Say “four” loudly into the radio mic. Measure deviation: 800 MHz: 3.8 kHz but 5.0 kHz 900 MHz: 2.5 kHz
High-Speed Data Modulation	Same as Above	TEST MODE, Display: 2 2	PTT to continuous (during the performance check)	Deviation: 800 MHz: 2.3 kHz but 3.8 kHz 900 MHz : 1.2 kHz but 2 kHz
DTMF Modulation (# SIGN)	Same as Above 2nd channel test frequency	TEST MODE, Display: 2 3 output at antenna	Same as Above	Deviation: 800 MHz: 2.8 kHz but 3.8 kHz 900 MHz : 1.4 kHz but 1.9 kHz
PL / DPL Modulation (radios with conventional coded squelch operation only)	Change frequency to a conventional transmit frequency, BW to narrow	Conventional coded squelch personality	Same as Above	Deviation: 800 MHz: 500 Hz but 1000 Hz 900 MHz: 250 Hz but 500 Hz
Talk-around Modulation (radios with conventional talk-around operation only)	Change frequency to conventional talk-around frequency. Mode:PWR MON deviation, attenuation to -70, input to RF In / Out Monitor: DVM, AC volts Set 1kHz Mod Out level for 25mVrms at test set.	Conventional talk-around personality	Same as Above	Deviation: 800 MHz: 3.8 kHz but 5.0 kHz 900 MHz : 1.9 kHz but 2.45 kHz

Table 4-5. Receiver Performance Checks

Test Name	Communication Analyzer	Radio	Test Set	Comments
Rated Audio	Mode: GEN Output level: 1.0mV RF 1st Channel test frequency Mod: 1 kHz tone at 3 kHz deviation Monitor: DVM: AC Volts	TEST MODE, Channel 0 Modulation Type 1	PTT to OFF (center), meter to Audio PA	Set volume control to 3.74 Vrms
Distortion	Same as above, except for distortion	Same as Above	Same as Above	Distortion <5.0%
Sensitivity (SINAD)	Same as above, except SINAD, lower the rf level for 12 dB SINAD	Same as Above	PTT to OFF (center)	RF input to be <0.35 V

Table 4-5. Receiver Performance Checks (Cont'd.)

Test Name	Communication Analyzer	Radio	Test Set	Comments
Noise Squelch Threshold (only radios with conventional system need to be tested	RF level set to 1mV RF	Same as Above	PTT to OFF (center), meter selection to Audio PA, spkr/load to speaker	Set volume control to 3.74 Vrms
	As above, except change frequency to a conventional system. Raise RF level from Zero until radio unsquelches.	out of TEST MODE, select a conventional system	Same as Above	Unsquelch to occur at <0.3 V Preferred SINAD=<12 dB

Section 5
Disassembly & Reassembly For 12 W Models

Introduction

This chapter explains, step by step, how to disassemble and assemble the radio, to board level.

Disassemble the Radio

Remove the Control Head

1. Turn the radio upside down.
2. Insert a small flat blade screw driver, or similar, in the recess between the control head and the chassis. Refer to Figure 5-1.
3. Press until the side of the control head releases.
4. Pull the control head away from the radio.
5. Remove the speaker pad and flat cable from the connector on the radio side. Refer to Figure 5-2 and Figure 5-6.

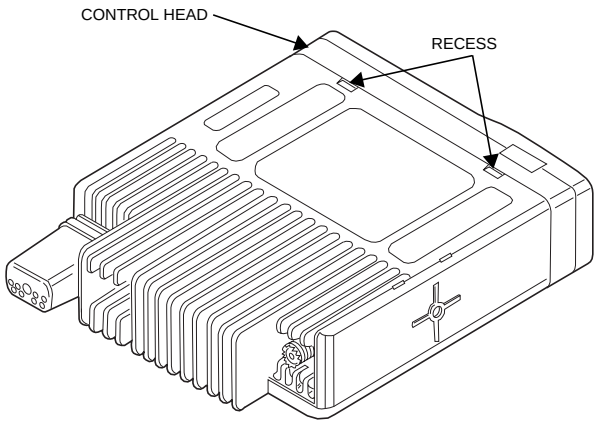


Figure 5-1. Control Head Removal

Remove the Top Cover

1. Turn the radio upside down.
2. Insert a small flat bladed screw driver in the side recesses between the cover and the chassis.
3. Tilt the cover until the side snaps off the latch.
4. Repeat the operation on the opposite side of the radio.

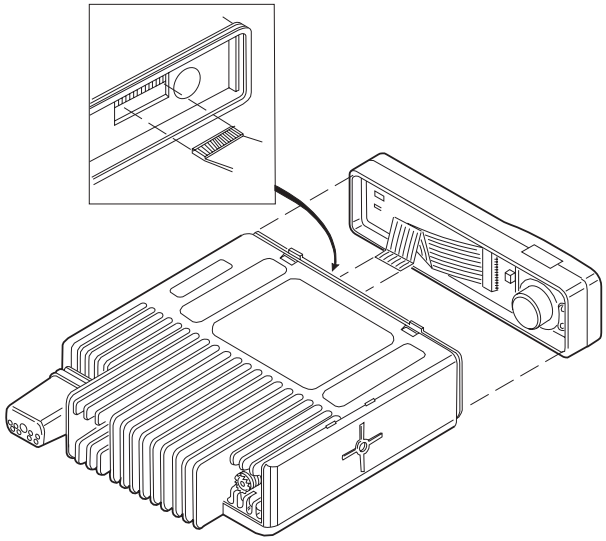


Figure 5-2. Flat Cable Removal

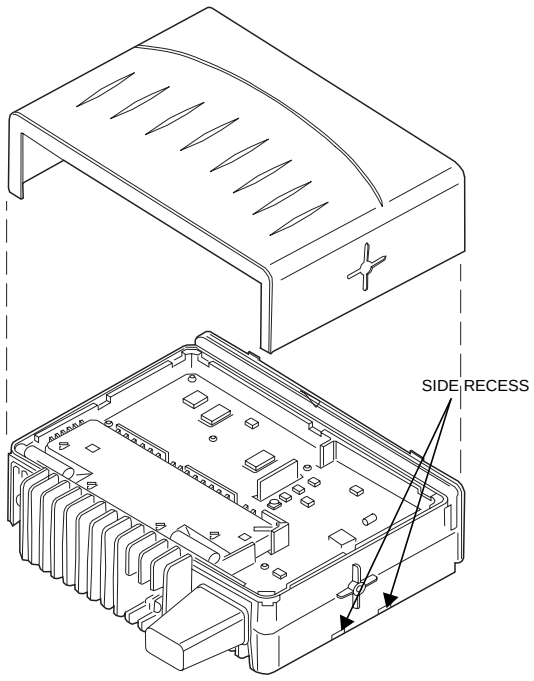


Figure 5-3. Top Cover Removal

5. Turn the radio right side up.
6. Lift the top cover over the chassis.

Remove the Main Board

1. Remove the 3 screws of the PA shield using a T8 TORX driver. Remove the PA shield by gently prying up each corner of the shield.
2. Remove the power and antenna connector retaining clips by inserting a small flat blade screw driver between the clip and the top of the chassis wall and gently prying the clip upwards.
3. Pull out the accessory clamp and connector gasket.
4. Pull out the accessory kit.
5. Remove the 8 screws securing the main board to the chassis.
6. Carefully remove the main board by rotating it out of the chassis.
7. Slowly lift the board on the front edge, the side with the connector that mates with the control head, and pull gently toward the front of the radio.

CAUTION

The thermal grease can act as an adhesive and cause the leads of the heat dissipating devices to be over stressed if the board is lifted too quickly.

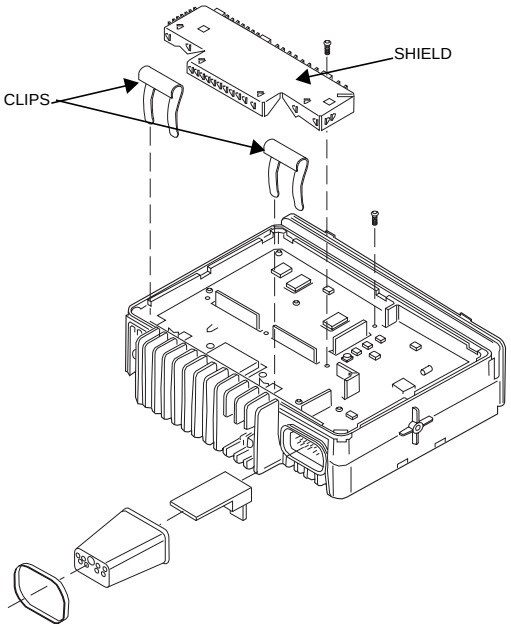


Figure 5-4. Main Board Removal

Disassemble the Control Head

1. To pull out the circuit board from the control head housing, insert a small bladed screw driver in the side groove near the four protruding tabs. Remove the board from the control head housing.
2. Disconnect the speaker from the board by removing it from the socket.
3. Remove the keypad from the control head housing by lifting it up from the board. Care should be taken not to touch or get other contaminates on the conductive pads on the under side of the keypad or conductive contacts on the printed circuit board.
4. Take the LCD frame out of the control head.

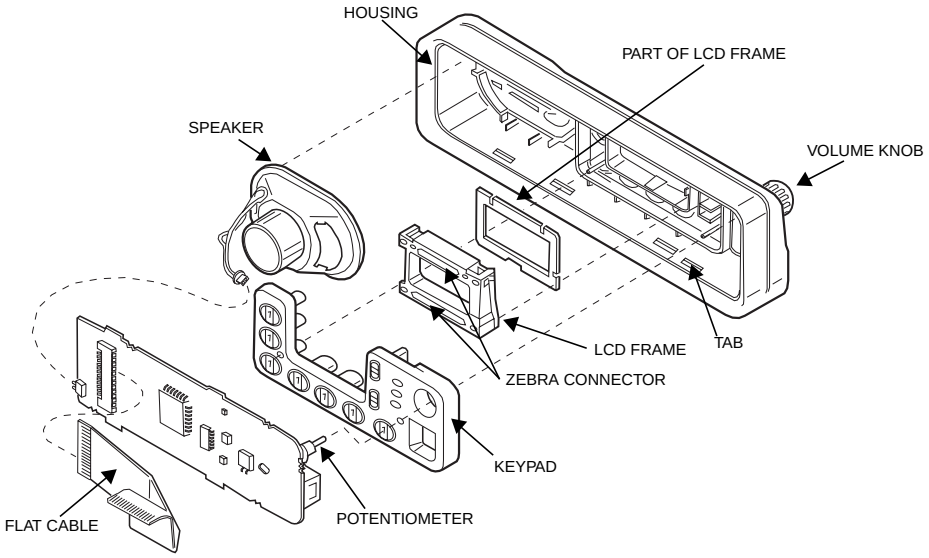


Figure 5-5. Control Head Removal

Assemble the Radio

Assemble the Control Head

1. Insert the LCD frame with LCD and Zebra connectors into its place.
2. Place the keypad onto the board assembly, making sure the keypad is flush with the board.
3. Rotate the potentiometer counterclockwise. Rotate the volume knob counterclockwise. This will allow you to insert the potentiometer smoothly into its place in the volume knob.
4. Make sure the speaker including the gasket is well positioned into the pocket of the housing..
5. Connect the speaker to the circuit board.
6. During the installation of the circuit board, ensure the four protruding tabs snap into the recesses.

Replace the Main Board

1. Inspect and if necessary, reapply thermal grease to the heatsinking pads in the chassis.
2. Rotate the main board into the chassis and ensure that the board is flush to the chassis.
3. Install the 8 screws with 0.4 -07 NM (4-6 in lbs) of torque using a T8 TORX driver.
4. Before installing the connector retaining clips, ensure that the board is sitting flush on the chassis mounting surface.
5. Install the PA shield and secure it with 3 screws.

Replace the Top Cover and Control Head

1. Position the top cover over the chassis and replace. Ensure that the chassis crosses snap into the cover's openings.
2. Connect the flat cable to the connector on the radio.
3. Assemble the speaker pad by sliding the slit of the pad over the flat cable. Refer to Figure 5-6.
4. Push the speaker pad onto the chassis.
5. Press the control head onto the chassis until the protruding taps on the chassis snap into the recesses inside the housing.

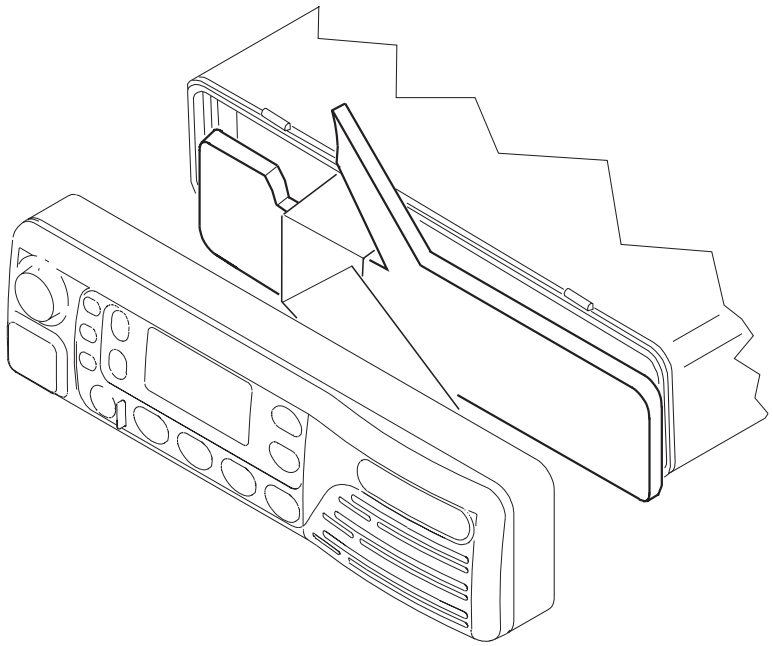


Figure 5-6.

Section 6
Disassembly & Reassembly For 30 W Models

Introduction

This chapter explains, step by step, how to disassemble and assemble the radio, to board level.

Disassemble the Radio

Remove the Control Head

1. Turn the radio upside down.
2. Insert a small flat blade screw driver, or similar, in the recess between the control head and the chassis. Refer to Figure 6-1.
3. Press until the side of the control head releases.
4. Pull the control head away from the radio.
5. Remove the speaker pad and flat cable from the connector on the radio side. Refer to Figure 6-2 and Figure 6-7.

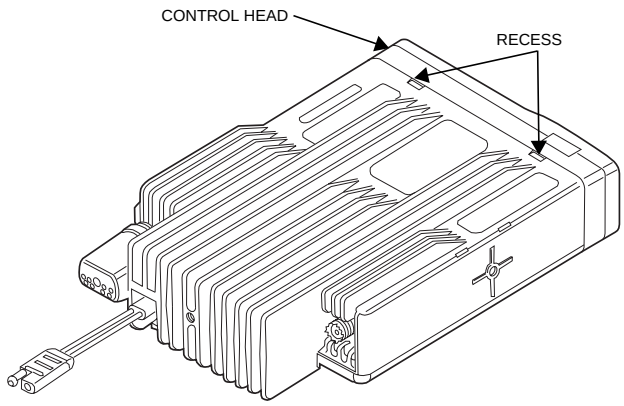


Figure 6-1. Control Head Removal

Remove the Top Cover

1. Turn the radio upside down.
2. Insert a small flat bladed screw driver in the side recesses between the cover and the chassis.
3. Tilt the cover until the side snaps off the latch.
4. Repeat the operation on the opposite side of the radio.

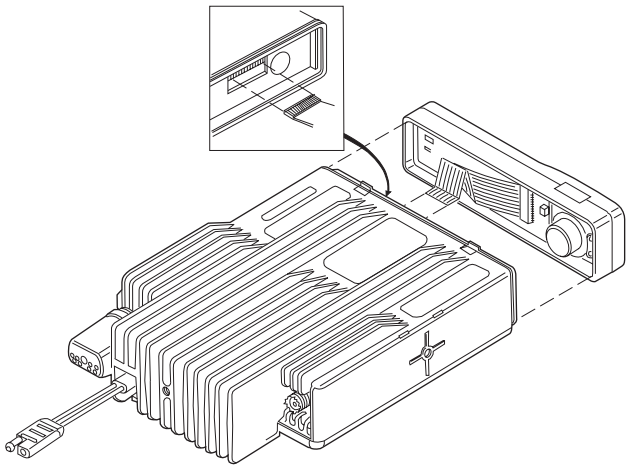


Figure 6-2. Flat Cable Removal

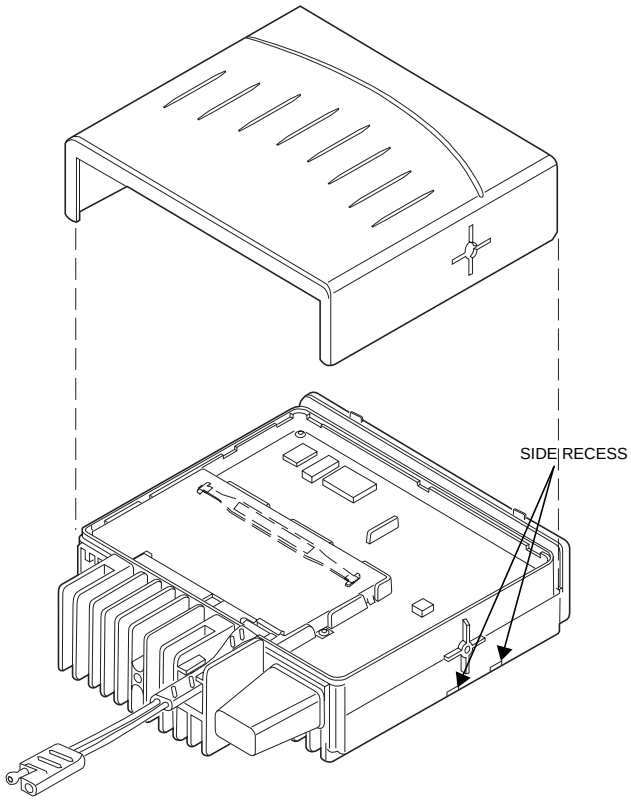


Figure 6-3. Top Cover Removal

5. Turn the radio right side up.
6. Lift the top cover over the chassis.

Remove the Main Board

1. Remove the 4 screws of the PA shield using a T8 TORX driver.

CAUTION
The PA shield has sharp edges. Handle with care when removing and replacing.

2. Remove the PA shield as follows:

2A. Hold the shield handle with your index and middle fingers while pressing your thumb downward on the shield. Keep all fingers curled upward as shown in Figure 6-4.

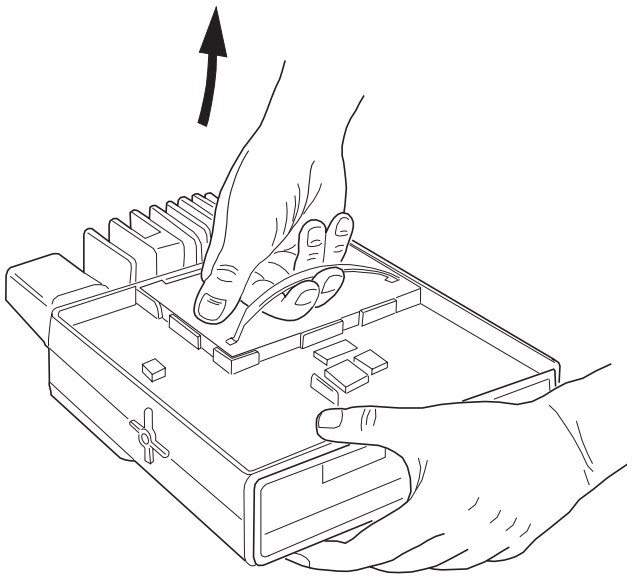


Figure 6-4. Shield Removal

2B. Keeping the other hand away from the PA shield, place your thumb on top of the front of the radio while placing your fingers underneath the chassis. Refer to Figure 6-4. Make sure this hand is away from the PA shield.

2C. Holding the chassis firmly, remove the PA shield by pulling upward on the handle.

3. Remove the antenna connector retaining clip by inserting a small flat bladed screw driver between the clip and the top of the chassis wall and gently prying the clip upwards.

4. Pull out the accessory clamp and connector gasket.

5. Pull out the accessory kit.

6. Twist the sleeve of the power cable 90 degrees and lift up and out from the chassis.

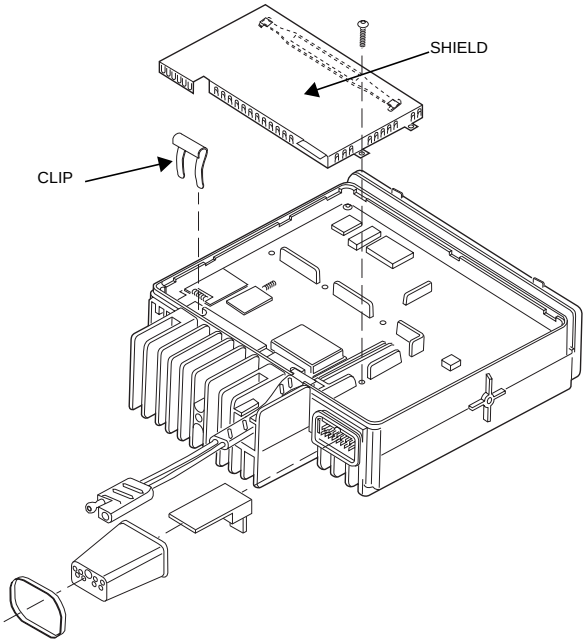


Figure 6-5. Main Board Removal

7. Remove the 14 screws securing the main board to the chassis.

8. Carefully remove the main board by rotating it out of the chassis.

9. Slowly lift the board on the front edge, the side with the connector that mates with the control head, and pull gently toward the front of the radio.

CAUTION
The thermal grease can act as an adhesive and cause the leads of the heat dissipating devices to be over stressed if the board is lifted too quickly.

Disassemble the Control Head

1. To pull out the circuit board from the control head housing, by inserting a small bladed screw driver in the side groove near the four protruding tabs. Remove the board from the control head housing.

2. Disconnect the speaker from the board by removing it from the socket.

3. Remove the keypad from the control head housing by lifting it up from the board. Care should be taken not to touch or get other contaminates on the conductive pads on the under side of the keypad or conductive contacts on the printed circuit board.

4. Take the LCD frame out of the control head.

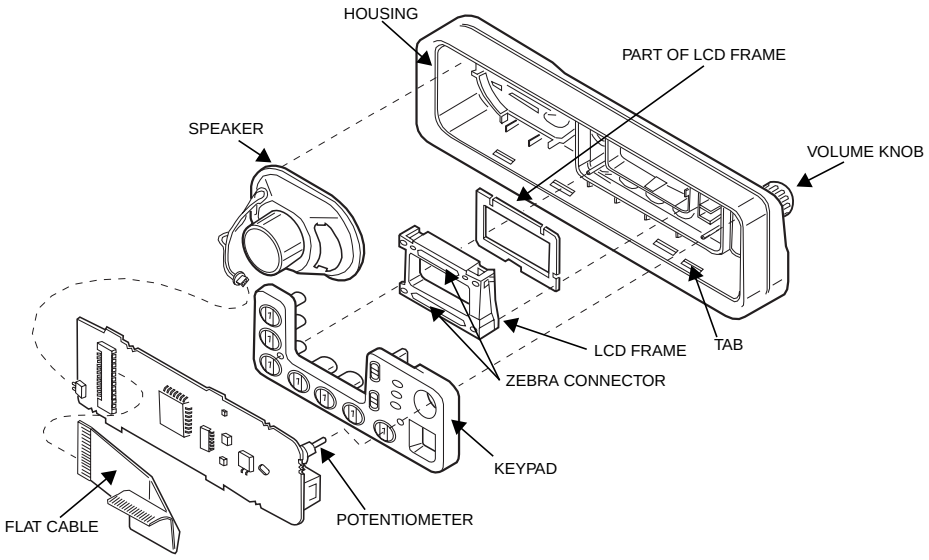


Figure 6-6. Control Head Removal

Assemble the Radio

Assemble the Control Head

1. Insert the LCD frame with LCD and Zebra connectors into its place.
2. Place the keypad onto the board assembly, making sure the keypad is flush with the board.
3. Rotate the potentiometer counterclockwise. Rotate the volume knob counterclockwise. This will allow you to insert the potentiometer smoothly into its place in the volume knob.
4. Make sure the speaker is well positioned into the pocket of the housing.
5. Connect the speaker to the circuit board.
6. During the installation of the circuit board, ensure the four protruding tabs snap into the recesses.

Replace the Main Board

1. Inspect and if necessary, reapply thermal grease to the heatsinking pads in the chassis.
2. Rotate the main board into the chassis and ensure that the board is flush to the chassis.
3. Install the 14 screws with 0.4 -07 NM (4-6 in lbs) of torque using a T8 TORX driver.
4. Before installing the connector retaining clip and power cable, ensure that the board is sitting flush on the chassis mounting surface.
5. Install the PA shield and secure it with the 4 screws.

Replace the Top Cover and Control Head

1. Position the top cover over the chassis and replace. Ensure that the chassis crosses snap into the cover's openings.
2. Connect the flat cable to the connector on the radio.
3. Assemble the speaker pad by sliding the slit of the pad over the flat cable. Refer to Figure 6-7.
4. Push the speaker pad onto the chassis.
5. Press the control head onto the chassis until the protruding taps on the chassis snap into the recesses inside the housing.

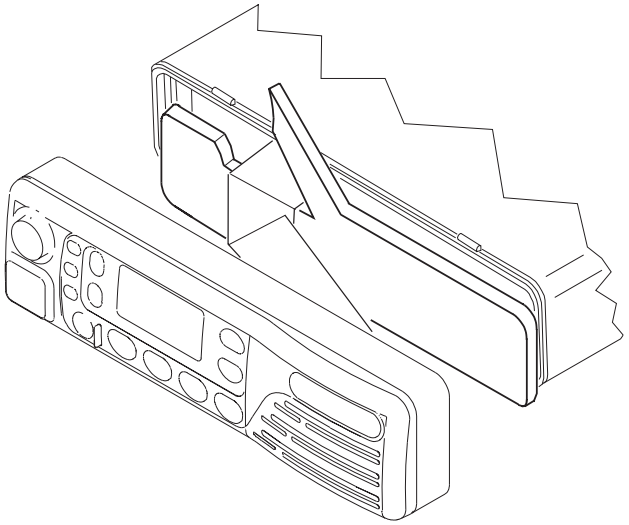


Figure 6-7.

Section 7
Radio Tuning Procedure

Radio Tuning Procedure

General

An IBM PC (personal computer) and RSS (Radio Service Software) are required to align the radio. Refer to the applicable RSS Manual for installation and setup procedures for the software.

To perform the alignment procedures, the radio must be connected to the PC, RIB (Radio Interface Box), and Test Set as shown in Figure 7-1.

Service Menu

Figure 7-2 illustrates the Main Service Menu structure. All SERVICE screens read and program the radio codeplug directly; you do NOT have to use the RSS GET/SAVE functions to program new tuning values.

CAUTION

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

The SERVICE screens use the concept of the "Softpot", an analog SOFTware controlled POTentiometer used for adjusting all transceiver alignment controls.

Each SERVICE screen provides the capability to increase or decrease the 'softpot' value with the keyboard UP/DOWN arrow keys respectively. A graphical scale is displayed indicating the minimum, maximum, and proposed value of the softpot, as shown in Figure 7-3.

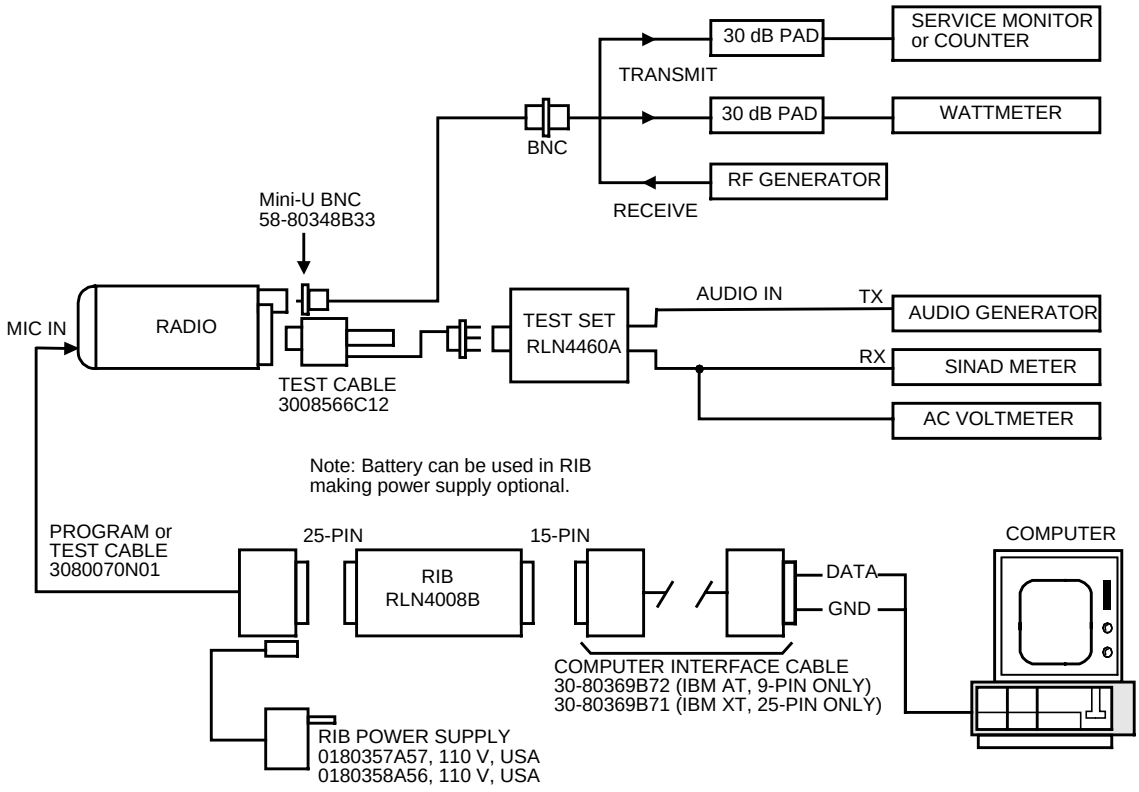


Figure 7-1. Radio Alignment Test Setup

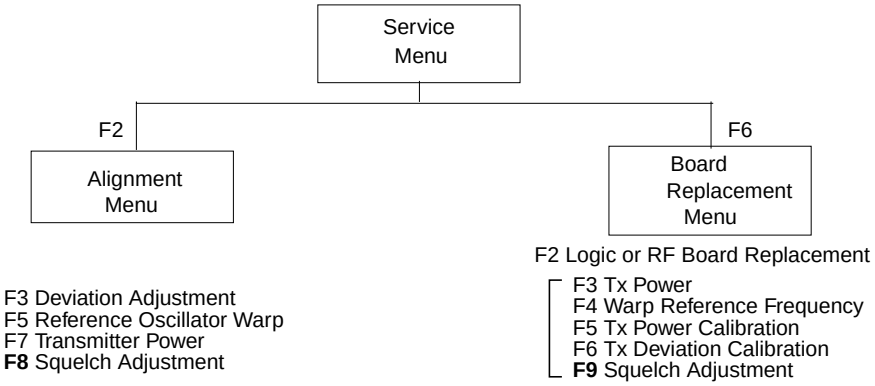


Figure 7-2. Service Menu Structure

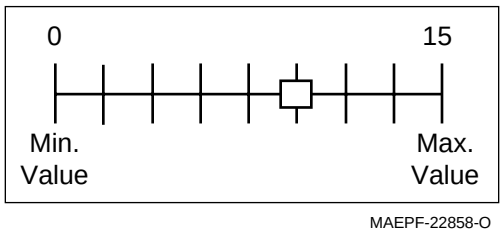


Figure 7-3. Softpot Concept

Tuning Procedure

Starting the Tuning Procedure

1. From the SERVICE menu, press F6 to select BOARD REPLACEMENT.
2. Press **F2** for LOGIC OR RF BOARD replacement.

NOTE
Perform the following procedures in the sequence indicated.

Alignment Default Data

1. Press **F2** to select ALIGNMENT DEFAULT DATA.
2. Press **F8** for PROGRAM VALUE.

Tx Power

1. Press **F3** to select Tx POWER.
2. Press **F6** to key the radio. The screen will indicate that the radio is transmitting.
3. Adjust the transmit power value with the UP/DOWN arrow keys.
4. Press **F6** again to dekey the radio, and then press **F8** to program the softpot value.

Reference Oscillator Alignment

NOTE
The frequency of the transmitter must be checked on installation and at least annually.

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

1. Press **F4** to select the REFERENCE OSCILLATOR softpot.
2. Press **F6** to key the radio. The screen will indicate that the radio is transmitting.
3. Measure the transmit frequency that appears on the screen of your frequency counter.
4. Use the UP/DOWN arrow keys to adjust the reference oscillator.
5. Press **F6** again to dekey the radio and then press **F8** to program the softpot value.

Transmitter Power

NOTE
During Tx POWER tuning, measure and note the DC transmit current (I_{Tx}) for each channel in the high power band.

1. Press **F5** to select the Tx POWER calibration softpot. The screen will indicate the transmit test frequencies to be used.
2. Press **F6** to key the radio.
3. Use the UP/DOWN arrow keys to adjust the transmit power value.
4. Press **Enter** to select next softpot frequency.
5. Repeat steps 3 and 4 for the remaining test frequencies.
6. Press **F6** to dekey the radio.
7. Press **F8** to program the value.

Transmit Current Limit

NOTE
Larger Softpot values yields increased CUTBACK resulting in LOWER POWER.

1. After Tx POWER tuning the TRANSMIT CURRENT LIMIT screen will appear. Select the frequency with the highest DC transmit current (I_{Tx}) measured during the Tx POWER tuning procuedure.
2. Press **F6** to key the radio.
3. Use the UP/DOWN arrow keys to adjust the DC transmit current value per Table 7-1.

Table 7-1. Transmit Current Limit Tune Windows

Model	Min	Max
900_12W	4.60 A	5.10 A
900_30W	I_{Tx} + 0.4 A	I_{Tx} + 1.0 A

4. Press **F6** to dekey the radio.
5. Press **F8** to program the value.

Transmit Deviation Balance (Compensation) & Deviation Limit

Compensation alignment balances the modulation sensitivity of the VCO and reference modulation (synthesizer low frequency port) lines. Compensation algorithm is critical to the operation of signaling schemes that have very low frequency components (e.g. DPL) and could result in distorted waveforms if improperly adjusted.

1. Press **F6** to select TX DEVIATION CALIBRATION. The screen will indicate the transmit test frequencies to be used.
2. Begin with the lowest test frequency shown on the screen.
3. Press **F6** to key the radio. Record this measurement.
4. Press **F4** to select 2.5 kHz.
5. Use the UP/DOWN arrow keys to adjust the deviation to within 0.5 dB of the value recorded in step 3.
6. Press **Enter** to move to next softpot value.
7. Repeat steps 5 and 6 for the remaining frequencies.
8. Press **F8** to program the softpot value.

Transmit Deviation Limit

The transmit deviation limit softpot sets the maximum deviation of the carrier. Tuning is performed for 12.5 kHz channel spacing.

1. Begin with the lowest test frequency shown on the screen.
2. Press **F6** to key the radio.
3. With Test Box 4460A: inject a 1 kHz tone, 2000 mVrms.
4. Use the UP/DOWN arrow keys to adjust the deviation to between 2.2 kHz and 2.4kHz.
5. Press **Enter** to move to the next softpot value.
6. Repeat steps 4 and 5 for the remaining frequencies shown on the screen.
7. Press **F6** to dekey the radio.
8. Press **F8** to program the softpot value.

Squelch

The squelch softpots set the signal to noise ratio at which the squelch opens.

1. Press **F9** to select SQUELCH Adjustment.
2. Adjust the UP/DOWN arrow key to the minimum squelch value.
3. Apply a standard RF input level of -47 dBm to the radio on the test frequency.

4. Adjust the radio's volume control to obtain rated audio power at the external speaker of the accessory connector.

5. Reduce the RF input level until 10 dB SINAD is measured.

6. Adjust the UP/DOWN arrow key until the squelch just closes. Monitor for squelch chatter and adjust UP as required.

7. When no chatter is detected press F8 to program.

Ending the Tuning Procedure

1. Press **F2** to continue.

2. Press **F10**, **F10** to return to the Service menu

Section 8
Theory of Operation

Introduction

This section provides theory of operation information for the radio. It starts with a block diagram level functional description of the entire radio. This is followed by a detailed functional description for each of the four major functions that make up the radio.

Overview

The main radio is a single board design, consisting of the transmitter, receiver, and controller circuits.

The control head is mounted directly on the front of the radio. The control head contains a speaker, LED indicators, a microphone connector and buttons which provide the user with interface control over the various features of the radio and a display.

In addition to the power cable and antenna cable, an accessory cable can be attached to a connector on the rear of the radio. The accessory cable provides the necessary connections for items such as external speaker, foot operated PTT, ignition sensing, public address, remote desk set and data modem.

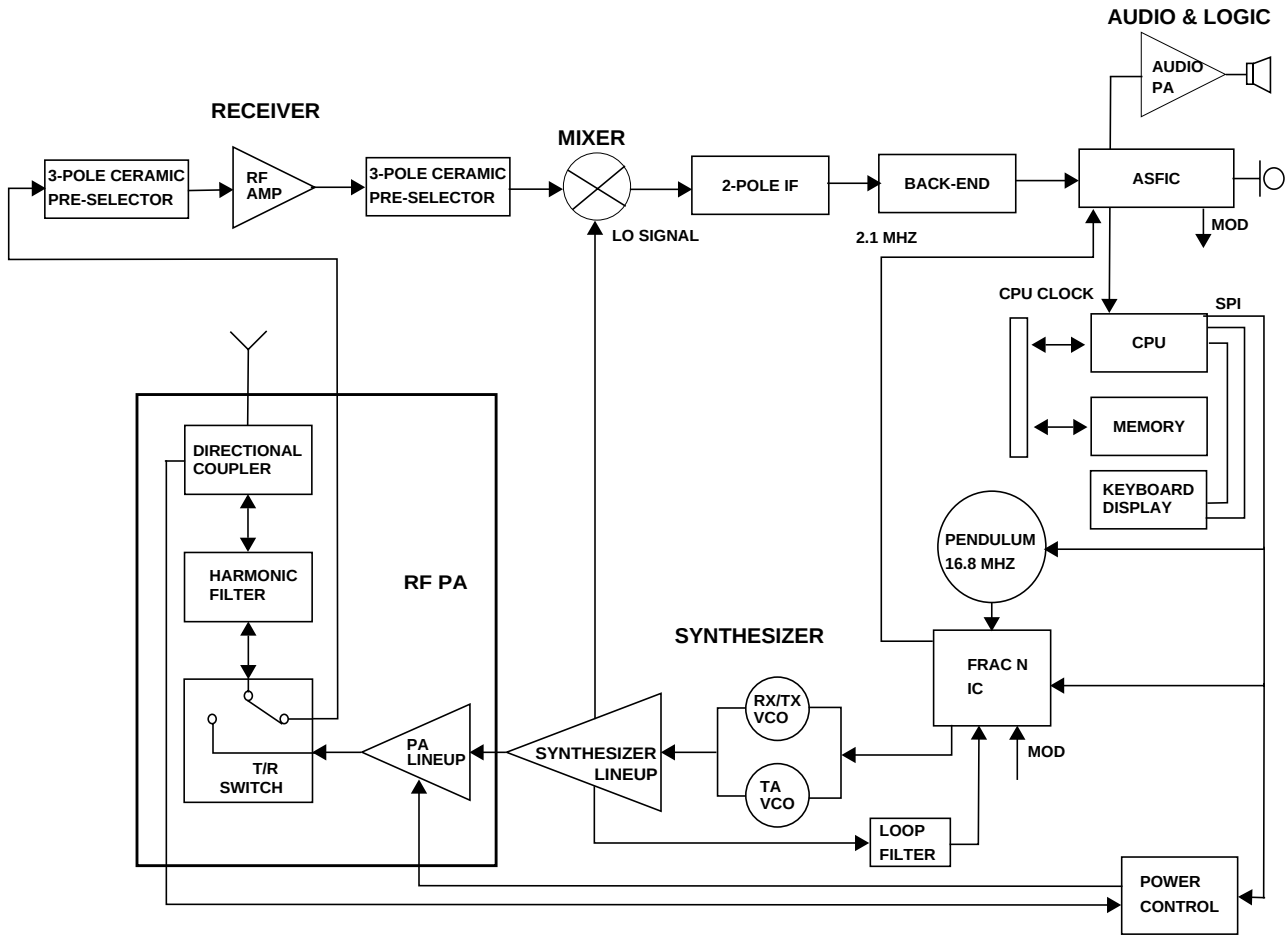


Figure 8-1. 900-MHz Radio Functional Block Diagram

Receiver Detailed Functional Description

The receiver is composed of four sections: receiver front end, receiver IF, receiver back end and the Audio Signal Filter IC (ASFIC) that is part of the controller section.

The RF signal from the antenna switch in the PA section enters the first bandpass filter (FL5203). The first bandpass filter has three poles, a 938-MHz center frequency, a 6-MHz wide passband and a 35-dB rejection for image frequencies (857 to 863MHz).

After the first bandpass filter, the signal passes to a pair of hot-carrier limiting diodes (D5303) placed in front of RF preamplifier Q5301. The hot-carrier diodes limit strong signals to prevent them from overdriving the RF preamplifier and damaging it.

The RX front end is a Low Noise Amplifier (LNA) that consists of Q5301. Its main purpuse is to set the noise figure of the receiver. The front end amplifier as well as the IF amplifiers are shut off during transmit by K9.1 line via switch Q5230, to provide isolation in talk-around mode.

After the LNA, the signal enters a second bandpass filter (FL5204), which is identical to FL5203. The bandpass filters are fixed tuned from 935 to 941 MHz.

After the second bandpass filter, mixer U5211 down-converts the signal to the IF frequency.

The mixer is a passive double-balance mixer that gets a local oscillator signal in the range of 895.9 to 901.9 MHz from the synthesizer and works on 4-dBm power. The IF frequency is 45.1 MHz. A diplexer matches the mixer IF port to 50 Ohm out of the IF frequency band. The diplexer consists of R5401, C5404, L5402.

The IF signal is fed to first crystal filter Y5201 through matching network L5401, C5200.

Crystal filter Y5201 has two poles. The crystal filter is followed by matching elements, that match the filter output impedance to the input impedance of IF amplifier Q5201.

Following the IF amplifier is a matching network that matches the IF amplifier output impedance to the input impedance of a second 45.1-MHz crystal filter (Y5202). The second crystal filter is followed by matching elements that match the output of the second crystal filter to the input of the receiver back end circuits. After the matching circuit, the signal passes a pair of hot-carrier limiting diodes (D5201) placed in front of the back end circuit.

The receiver back end consists of BBR IC (U5201) that contains the following functions:

- Preamplifier & mixer to convert the signal to a second IF frequency of 455 kHz.
- Second LO circuit
- Second IF amplifiers
- FM Demodulator
- Audio amplifier

In addition to BBR IC, the back end contains the following components:

- Second LO resonator for 44.645 MHz (Y5211)
- Crystal filters for 455 kHz (FL5201, FL5202)
- Demodulator filter (C5224)

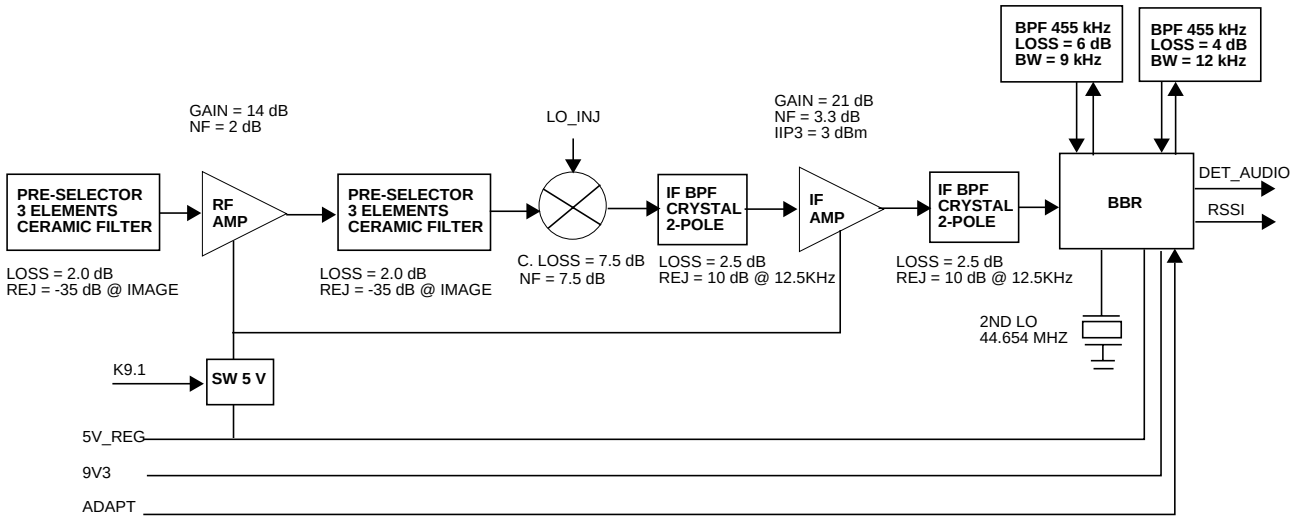


Figure 8-2. Receiver Functional Block Diagram

The IF signal routed to BBR IC is amplified, converted to 455 kHz, filtered, limited and demodulated.

Demodulated audio comes out of BBR IC at U5201-28 and is fed to the ASFIC, which is part of the radio controller section.

In addition to the audio output signal, the receiver section provides an RSSI (Receiver Signal Strength Indicator) at U5201-11. The RSSI signal is fed to the ASFIC and accessory connector.

ADAPT signal into U5201-22 controls the BBR IC. The normally low (0 VDC) ADAPT signal is high (5 VDC) during change of radio channels, transition from transmit to receive or at turn-on. The ADAPT signal is used to control precharge of capacitor C5231 at DEMOD_OUT. This is done in order to eliminate the transient during frequency change or when the radio goes from transmit to receive mode.

Transmitter Detailed Functional Description

12 Watt PA

The 12-W PA is a three-stage radio frequency (RF) power amplifier used to amplify the output from the TX injection lineup to the radio transmit level. It consists of driver stage Q6501 followed by a two-stage power module U6501.

The two stages of the power module operate from the A+ supply voltage. The module is switched on/off by the K9.1 line through switch U6502 (which connects the A+ line to pin 2 of U6501 when transmit is enabled). The RF drive, which is routed into transistor Q6501, is controlled from Q6506 via the PA control line. The rising control voltage on the PA control line causes a rising collector voltage on Q6501. This causes more power out of the stage. Conversely, a decreasing control line voltage decreases the power delivered into the next stage. By controlling the drive power to U6501 and the following stages in the power amplifier lineup, ALC loop is able to regulate the output power of the transmitter.

The antenna switch is switched synchronously with the keyed 9.1 voltage. In the transmit mode, this 9.1 voltage is high—turning on diodes CR6502, CR6503 and CR6504. When CR6502 is turned on, it forms a low impedance to the RF transmit path and allows the signal to pass through. Diodes CR6503 and CR6504 short the ends of quarter wavelength lines to ground, presenting a high impedance towards the receiver. In this way no power is delivered into the receiver, the transmit path remains undisturbed, and the receiver is protected during transmission.

In the receive mode, all these diodes are off. The off capacitance of CR6502 is tuned by L6508 to form a high impedance looking into the transmitter. Therefore, energy coming in the receive mode is channeled to the RX port.

Harmonics of the transmitter are attenuated by the harmonic filter. The harmonic filter is formed by inductors L6513 and L6518 as well as capacitors C6540-C6542, C6551-C6553. This network forms a low-pass filter to attenuate harmonic energy of the transmitter to specifications level.

A forward-power detector follows the harmonic filter. This forward-power detector is a microstrip printed circuit, which couples a small amount of the forward energy and to diode CR6506 where it is rectified. This rectified signal (VFORWARD) forms the forward voltage which the power control circuit holds constant. Holding this voltage constant (which is proportional to the RF rectified energy appearing across the diode) ensures the forward-power out of the radio is held to a constant value.

Thermistor R6519 senses temperature in the area of the power module. This signal is fed back into the power control circuit to protect the power amplifier against over-temperature conditions.

Resistor R6520, in series with the A+ line supply, feeds voltage to the power module. The voltage across R6520 is monitored and the difference voltage is channeled to the power control circuit. The power control circuit monitors the voltage drop across the resistor which is determined by the magnitude of the drain current in U6501. It uses this as a limiting mechanism whereby the power control circuit limits the magnitude of current that can be drawn by U6501. This protects the device from over dissipation.

Bias voltage reverse polarity protection for the transmitter is provided by diode CR6508. Under reverse polarity conditions to the radio, this diode conducts and protects the radio from damage. This diode also provides transient over-voltage protection by breaking down when the supply voltage to the radio exceeds 24 V.

30 Watt PA

The 30-Watt PA is a four stage radio frequency (RF) power amplifier used to amplify the output from the TX injection lineup to the radio transmit level. It consists of driver stage Q6501, two-stage power module U6501 and RF final device transistor Q6505.

Q6505 and U6501 operate from the A+ supply voltage. U6501 is switched on/off by the K9.1 line through switch U6502 (which connects the A+ line to pin 2 of U6501 when transmit is enabled). The RF drive, which is routed into transistor Q6501, is controlled from Q6506 via the PA control line. The rising control voltage on the PA control line causes a rising collector voltage on Q6501. This causes more power out of the stage. Conversely, a decreasing control line voltage decreases the

power delivered into the next stage. By controlling the drive power to U6501 and the following stages in the power amplifier lineup, ALC loop is able to regulate the output power of the transmitter.

The antenna switch is switched synchronously with the keyed 9.1 voltage. In the transmit mode, this 9.1 voltage is high—turning on diodes CR6502, CR6503 and CR1. When CR6502 is turned on, it forms a low impedance to the RF transmit path and allows the signal to pass to the antenna via harmonic filter hybrid H6502. Diode CR1 in H6502 forms a low impedance that is transformed up to an open circuit through a quarter wavelength transmission line. This prevents transmitter power from being delivered into the receiver. Diode CR6503 is also turned on in transmit mode further isolating the receiver from transmitter energy. The transmitter power from the antenna switch passes to the antenna via harmonic filter hybrid module H6502. H6502 incorporates a low pass filter, which attenuates harmonic energy out of the transmitter to specifications level.

In receive mode, diodes CR6502, CR6403 and CR1 are all off. The off capacitance of CR6502 is tuned by L6512 to form a high impedance network looking into the transmitter. Therefore, received signal energy from the antenna is channeled to the input of the receiver with minimal loss maximizing sensitivity.

A forward power detector utilizing a directional coupler is included in the harmonic filter hybrid. This forward-power detector is a microstrip printed circuit, which couples a small amount of the forward energy to diode CR2 where it is rectified. This rectified signal (VFORWARD) forms the forward voltage which the power control circuit holds constant. Holding this voltage constant (which is proportional to the RF rectified energy appearing across the diode) ensures the forward-power out of the radio is held to a constant value.

Thermistor R6519 senses temperature in a location near Q6505. This signal is fed back into the power control circuit to protect Q6505 against over-temperature conditions.

Resistor R6520, in series with the A+ line supply, feeds voltage to Q6505. The voltage across R6520 is monitored and the difference voltage is channeled to the power control circuit. The power control circuit monitors the voltage drop across the resistor, which is determined by the magnitude of the collector current in Q6505. It uses this as a limiting mechanism whereby the power control circuit limits the magnitude of current that can be drawn by Q6505. This protects the device from over dissipation.

Bias voltage reverse polarity protection for the transmitter is provided by diode CR6508. Under reverse polarity conditions to the radio, this diode conducts and protects the radio from damage. This diode also provides transient over-voltage protection by breaking down when the supply voltage to the radio exceeds 24 VDC.

Power Control Circuitry

The power control circuitry consists of three mechanisms:

Power Set

The control loop compares the power output level to the pre-set value. The VFORWARD voltage from the forward power detector is amplified by U701 pins 5 -7, and compared to D / A U702-2 & 4. Should a difference be detected, an error current is generated in the loop integrator U702-8 & 9, until equilibrium is obtained. The use of 2 D / A outputs for power set enables fine tuning where pin 2 is coarse tune through resistor R703 and pin 4 is fine tune through resistor R706.

Current Limit

Current to the power module U6501 (or RF final device Q6505) is monitored using R6520 and compared to a pre-set limit D / A U702-11 and U701-(1-3). When the limit is exceeded, an error current is generated through diode CR721 to the loop integrator, which lessens the PA_CNTRL line and reduces the power amplifier output.

Thermal Protection

When the power module U6501 (or RF final device Q6505) overheats, the resistance of thermistor R6519 drops. Because of the voltage divider formed by R721, R725, and R6519, this resistance drop is sensed and amplified through U701-(12-14). This causes a current error through diode CR721 to flow into the loop integrator and reduce transmitted output power.

When controller U101-45, detects a voltage proportional to 85 degrees Centigrade through R726-727 it reduces transmit power by 50 percent during subsequent Tx key-ups.

Synthesizer Detailed Functional Description

The complete synthesizer subsystem consists of reference oscillator U5700, Fractional-N Synthesizer IC U5702, two on-board voltage controlled oscillators, buffer stage U5701, and two discrete buffer amplifiers Q5707, and Q5705.

Reference oscillator U5700 contains a temperature compensated crystal which operates at a frequency of 16.8 MHz. The output of the oscillator U5700-10 is applied to U5702-14 via R5715 and C5733.

There are two varactor tuned VCOs. The oscillator frequency is controlled by the voltage applied via L5701 and L5702. This control voltage ranges from 2.5 to 10.5 VDC. A lower control voltage produces a lower fre-

quency and a higher control voltage produces a higher frequency respectively.

The RX/TX VCO (896 - 902MHz band) provides the first LO injection frequency which is 39 MHz below the RX carrier frequency and TX injection for conventional mode. The RX/TX VCO is selected by pulling U5702-1 low.

The Talk-Around (TA) VCO (935 - 941MHz band) provides the transmit frequency in TA mode. The TA VCO is selected by pulling U5702-1 high.

The buffer stage U5701 and feedback amplifier Q5703 provide the necessary gain and isolation for the synthesizer loop.

Fractional-N Synthesizer IC U5702 consists of:

- Prescaler,
- Programmable loop divider,
- Control divider logic,
- Phase detector,
- Charge pump,
- A/D Converter for low frequency digital modulation,
- Balance attenuator to balance the high and low frequency analog modulation,
- 13-V positive voltage multiplier,
- Serial interface for control,
- Super filter for the regulated 9.3 V DC

C5712 is the super filter capacitor. The output voltage of the super filter U5702-18, drops from 9.3 VDC to about 8.5 VDC. This filtered 8.5 VDC supplies voltage for the VCOs, the VCO switching units U5704 & U5705, feedback amplifier Q5703, and synthesizer charge pump resistor network R5707- R5709.

The synthesizer supply voltage is provided by the 5 VDC regulator U5703. The 2.1 MHz reference signal at U5702-11 is generated by dividing down the signal of reference oscillator U5700 after it is applied to U5702-14.

In order to generate a high voltage that supplies the charge pump output stage at VCP (U5702-32), 13 V DC is generated at pin 3 of CR5700 by the positive voltage multiplier circuitry. This voltage multiplier is a diode capacitor network driven by two 1.05 MHz, 180-degree out-of-phase signals from U5702-9 &10.

The serial interface (SPI_DATA) is connected to the microprocessor via the data line (U5702-5), clock line (U5702-6), and chip enable line (U5702-5). Proper enabling of these lines allows the microprocessor to program the synthesizer.

The output of the VCO is fed to the buffer input port of U5701-1. The output of the buffer U5701-5 is applied to the input of the feedback amplifier Q5703 through an attenuator network consisting of R5735, R5733 and R5732. To close the synthesizer loop, the output of Q5703 is connected to PREIN (U5702-20) of the synthesizer. The buffer output U5701-5 also provides the signal for receiver LO injection and transmit injection line-up. The charge pump current is present at U5702-31.

The loop filter (which consists of R5716, R5717, R5734, C5750, C5744, C5745, C5736, C5746, C5747, C5794, C5795, C5796, C5797, C5798, C5799) will then transform this current into a voltage that will, in turn, be applied to Vcontrol of the VCOs and steer the output frequency.

In order to modulate the PLL a two-point modulation method is utilized. The audio signal is applied to both the A/D converter (low frequency path) as well as the balance attenuator (high frequency path) via U5702-8.

The A/D converter will convert the low-frequency, analog modulating signal into a digital code that will in turn be applied to the loop divider. This will cause the carrier to deviate. The balance attenuator is used to adjust the VCO deviation sensitivity to high frequency modulating signals. The output of the balance attenuator is present at the MODOUT port U5702-28.

The transmit injection line-up consists of two amplifier stages, Q5707 & Q5705, used to provide a constant output to drive the RF transmitter and provide isolation. The Q5705 stage is actively biased through Q5701, and Q5707 has passive biasing. The TX injection line-up is on only during the transmit mode (K 9.1V line is at 9.1 V).

The first VCO is used for receive LO_INJ and TX_INJ in the conventional 896-902 MHz transmit band. The second VCO is used for TX_ INJ in the talk-around 935-941 MHz transmit band.

The VCOs get their control voltage through L5701 and L5702. Q5704 and Q5706 are the oscillation transistors. C5793, C5792 and C5785, C5784 are the oscillator feedback capacitors. U5706 and U5707 are micro strip resonators. CR5701 and CR5702 are the varactors. C5790 and C5782 determine the VCO KV. C5703 and C5704 determine the VCO operation frequency. C5791 and C5783 are the coupling capacitors between the tank and the oscillation transistor.

The two VCOs are coupled to buffer amplifier Q5702 through C5789 and C5786. The buffer amplifier output signal is fed to U5701-pin 1 through C5770 & R5736.

Controller Detailed Functional Description

General

The radio controller consists of four main subsections:

- Digital Control
- Audio Processing
- Power Control
- Voltage Regulation

The digital section consists of a microprocessor, memory ICs, glue logic circuitry, signal MUX ICs, On / Off circuit, and general purpose Input / Output circuitry.

The controller is based on the Motorola 68HC11K1 microprocessor-U101, 8-Kbyte SRAM-U103, 32 Kbyte-Flash memory-U102, and 8 Kbyte EEPROM -U104.

NOTE

From this point on, the 68HC11K1 microprocessor will be referred to as K1µP or µP.
References to a Control Head will be to type P+ (Display radio).

Voltage Regulators

Voltage regulation for the controller is provided by 3 separate devices: +5 VDC U631, +9.3 VDC U601, and UNSW 5V (R621 and VR621). An additional regulator is located in the RF section.

5 VDC regulation for the digital circuitry is provided by U631. Input and output capacitors C631, C632 and C633-635 are used to reduce high-frequency noise and provide additional charge during short battery transients. This regulator provides a reset output U631-5 that drops to 0 VDC when the regulator output goes out of regulation. This is used to reset the controller in order to prevent improper operation. Diode D631 prevents discharge of C632 by negative spikes on the 9.3 voltage.

Regulator U601 is used to generate the 9.3 VDC required by some audio circuits, the RF circuitry and power control circuitry. Input and output capacitors C601-603 and C604-605 are used to reduce high-frequency noise. R602-603 set the regulator output voltage. If the voltage at U601-1 is greater than 1.3 VDC the regulator output decreases and if the voltage is less than 1.3 VDC, the regulator output increases. This regulator output is electronically disabled by a 0 VDC signal on U601-2. Q601 and associated circuitry R601, R604-605 disable the regulator when the radio is turned off.

UNSW_+5V_CL is only used by a few circuits, which draw low current and require 5 VDC while the radio is off.

UNSW_+5V_CL is used to save the internal U103 RAM data. C622 allows the battery voltage to be disconnected for a couple of minutes without losing RAM parameters. Diode D621 prevents radio circuitry from discharging this capacitor.

The SW_+B voltage is monitored by the µP through voltage divider R641-642. Diode VR641 limits the divided voltage to 5.1 VDC in order to protect the µP.

Diode CR6508 located in the PA section acts as protection against transients and reverse polarity of the supply voltage.

Electronic On/Off

The radio has circuitry which allows radio software and / or external triggers to turn the radio on or off without direct user action. This allows, for example, automatic turn-on when ignition is sensed and off when ignition is off.

Q611 is used to provide SW_B+ to the various radio circuits. Q611 acts as an electronic on / off switch controlled by Q612 (the switch is on while Q612 is on). When the radio is turned on, the voltage at the base of Q612 is high (about 0.6 V). Q612 switches on (saturation) and pulls down the voltage at Q611-base. This turns on Q611 and supplies SW_B+ to the radio. The on resistance of Q611 is very low (less than 1 OHM), so the voltage level at SWB+ is essentially the same as A+.

The electronic on / off circuitry can be enabled by the microprocessor (through ASFIC, B+ _CONTROL), the mechanical On / Off button on the control head (ON_OFF_CONTROL), or the ignition sense circuitry (IGNITION_CONTROL). If one of the three paths causes a low at the collector of Q612, the electronic ON process is engaged.

Mechanical On/Off

This refers to the typical on / off button which is located on the control head and turns the radio on and off. While the on / off button is turned on, line ON_OFF_CONTROL goes high during the short pulse generated by the ON_OFF “one-shot” circuitry in the control head. This switches the radio on. The microprocessor is alerted through line ANALOG_ 3 which is pulled to low by Q925 (in Control Head Model P+) while the on / off button is turned on. If the software detects a low state, it asserts B+_CONTROL via ASFIC-GCB2, which keeps Q612 and Q611 on, and in turn the radio is switched on.

When the on / off button is turned off, the software detects the line ANALOG_3 changing to low and switches the radio off by setting B+_CONTROL to low.

Ignition

Ignition sense is used to prevent the radio from draining the vehicle's battery while the engine is not running.

When the IGNITION input goes above 1.3VDC, Q450, Q612 and Q611 turn on, supplying SW_B+ to the radio and enabling U601 and U631 to supply the regulated voltage (+5 VDC and 9.3 VDC) to all the circuitry. The µP starts to run the software, reads the line IGNITION_SENSE, determines from the level that the IGNITION input is active and sets the B+_CONTROL (via the ASFIC-GCB2) to high and latches SW_B+ on.

When the IGNITION line drops below 1.3 VDC, Q450 switches off and R441 pulls line IGNITION_SENSE high. The software is alerted by line IGNITION_SENSE to switch off the radio by setting B+ CONTROL line to low. Whenever the IGNITION line goes above 1.3 VDC, the above process will be repeated—depending if the radio was previously on or off**.**

The ignition sense capability can be disabled by turning switch S401-2 & 4 on. This supplies FLT_A+ via R452 to the ignition sense pin continuously. The radio is shipped with ignition sense disabled.

Hook

The HOOK line is used to inform the µP when the Microphone´s hang-up switch is engaged. Depending on the radio's programing , the µP turns the audio PA on or off. The signal is routed from J101-3 and J400-14 through transistor Q101 to the K1µP U101-23. The voltage range of HOOK in normal operating mode is 0-5 VDC.

Microprocessor Clock Synthesizer

The clock source for the controller's microprocessor system is generated by the ASFIC (U201). Upon power-up the synthesizer (U5701) generates a 2.1 MHz waveform that is routed from the RF section (via C202) to the ASFIC (on U201 XTAL_IN). For the main board controller, the ASFIC uses 2.1 MHz as a reference input clock signal for its internal synthesizer. The ASFIC, in addition to audio circuitry, has a programmable synthesizer which can generate a synthesized signal ranging from 1200 Hz to 32.769 MHz with steps of 1200 Hz.

While the radio is turned on, the ASFIC generates a default 3.6864 MHz CMOS square wave µP CLK (on U201-UPCLK) which is routed to the µP (U101-EXTAL). After the µP starts operation, it reprograms the ASFIC synthesizer clock to a higher µP CLK frequency (usually 7.3728 or 14.7456 MHz) and continues operation.

The ASFIC synthesizer clock is controlled by the software, and may slightly be changed while harmonics of this clock source interfere with the specific radio receive frequency.

The ASFIC synthesizer loop components (C228, C229 and R222) set the switching time and jitter of the clock output. If the synthesizer cannot generate the required clock frequency it will switch back to its default 3.6864 MHz frequency.

Serial Peripheral Interface (SPI)

The µP communicates with the other programmable ICs through its SPI port. This port consists of SPI TRANSMIT DATA U101-1, SPI RECEIVE DATA U101-80, SPI CLK U101-2 and chip select lines going to the various programmable ICs. This BUS is a synchronous bus (the timing clock signal CLK is sent with SPI TRANSMIT DATA or SPI RECEIVE DATA).

In the controller section, there are three ICs on the SPI BUS: ASFIC (U201-E3), EEPROM (U104-1) and D/A (U731-6). In the RF sections, there are 2 ICs on the SPI BUS: Pendulum (Reference Oscillator U5702-24) and Synthesizer (U5701-7). The SPI TRANSMIT DATA and CLK lines going to the RF section are filtered with L131 and L132 to minimize noise. The chip select lines for the ICs are decoded by the address decoder U105.

The SPI BUS is also used for the control head. U106 buffers the SPI TRANSMIT DATA and CLK lines to the control head. U106 serves also to switch off the CLK signal for the LCD display while it is not selected via LCD_CE signal.

When the µP needs to program any of these ICs, it drops down the chip select line of the specific IC to a logic 0 and then sends the proper data and clock signals. The data sent to the various ICs are different. For example the ASFIC receives 21 bytes (168 bits) while the DAC needs 3 bytes (24 bits). After the data has been sent the chip select line is returned to a logic 1.

SBEP Serial Interface

The SBEP serial interface line allows the radio to communicate with the Radio Service Software (RSS). This interface connects to the Microphone connector (J902) via Control Head connector (J101) and comprises BUS+ (J101-15). The line is bi-directional, meaning that either the radio or the DPS can drive the line.

The connection from the Control Head is made through the BUS+ line, via L421 (SCI_RSS line) and diode CR151 to the U101-78-RxD and U101-79-TxD ports.

Microprocessor (Open Controller)

For this radio, the K1µP is configured to operate in the expanded or bootstrap modes. In expanded mode the K1µP uses external memory ICs, whereas in bootstrap mode it uses only its internal memory. In normal radio

operation, the K1µP is operating in the expanded mode.

In the radio expanded mode, the K1µP (U101) has access to three external memory ICs: U102 (Flash memory), U103 (SRAM), U104 (EEPROM). Also, within the K1µP there are 768 bytes of internal RAM and 640 bytes of internal EEPROM, as well as glue logic circuitry to select external memory ICs.

The external EEPROM (U104) as well as the K1µP's own internal EEPROM contain the radio information which is customer specific, referred to as the codeplug. This information consists of items such as: 1) frequency operating band, 2) channel frequencies, and 3) general tuning information. General tuning information and other more frequently accessed items are stored in the internal EEPROM (within the 68HC11K1), while the remaining data is stored in the external EEPROM. (See the particular IC subsection for more details.)

The external SRAM (U103) as well as the K1µP's own internal RAM are used for temporary calculations required by the software during normal radio operation. All of the data stored in both of these locations is lost when the radio is powered off. (See the particular IC subsection for more details.)

The Flash memory contains the actual Radio Operating Software. This software is common to all radios for the same model type. For example, Privacy Plus models have a different version of software in Flash memory than an LTR model. (See the particular IC subsection for more details.)

The K1µP has an address bus of 16 address lines (A0-A15), a data bus of 8 data lines (D0-D7). and three control lines; CSPROG (U101-29) to select U102-30 (OTP memory), CSGP2 (U101-28) to select U103-20 (SRAM) and PG7_R_W for read and write. All other chips (ASFIC / PENDULLUM / DAC / FRACN / LCD / LED / EEPROM) are selected by 3 lines of the K1µP using chip select decoder U105. When the K1µP is functioning normally, the address and data lines should be within CMOS logic levels.

The low-order address lines (A0-A7) and the data lines (D0-D7) should change.

On the K1µP the lines XIRQ (U101-30), MODA LIR (U101-77), MODB VSTPY (U101-76) and RESET (U101-75) should be logic high during all normal K1µP operation. Whenever a data or an address line becomes unloaded or shorted to an adjacent line, a common symptom is that short negative pulses occur on the RESET line, with a period of 20 msec. When two lines are short-circuited, mid logic level (around 2.5 V) may be observed, while these lines are opposite driven by two different ICs.

The MODA LIR (U101-77) and MODB VSTPY (U101-76) inputs to the K1µP must be at a logic 1 level for proper operation. After the K1µP starts execution, it will periodically pulse these lines to determine the desired operating mode. While the Central Processing Unit (CPU) is running a new instruction, MODA LIR (as an open-drain CMOS output) drops low.

However, since it is an open-drain output, the signal waveform rise has an exponential shape, like an RC circuit.

The µP has eight analog-to-digital converter ports (A / D): PE0 to PE7. These lines may measure voltage levels in the range of 0 to 5 VDC and convert that level to a number ranging from 0 to 255 which can be read by the software to take appropriate action.

For example, U101-46 is the battery voltage detect line. R641 and R642 form a resistor divider on SW_B+. With 47.5K and 16.2 K and a voltage range of 11 V to 17 V, the A / D port would see 2.74 V to 4.24 V which would then be converted to a digital value in the range of 140 to 217 respectively.

U101-51 is the high reference voltage for the A / D ports on the K1µP. Resistor R106 and capacitor C106 filter the +5 VDC reference. If this voltage is lower than +5 VDC the A / D readings will be incorrect. Likewise U101-50 is the low reference for the A / D ports. This line is normally tied to ground. If this line is not connected to ground, the A / D readings will be incorrect.

Capacitors C104, C105 serve to filter out any AC noise which may ride on +5VDC at U101.

One-Time Programmable (Flash) Memory

The 32-KByte Flash memory (U102) contains the radio's operating software. This memory is read-only. The memory access signals (EN_CE, EN_OE and EN_WE) are generated by the µP.

Capacitor C131 serves to filter out any AC noise which may ride on +5V at U101, and C132 filters out any AC noise on Vpp.

Electrically Erasable Programmable Memory (EEPROM)

EEPROM (U104) contains the radio's operating parameters such as operating frequency and signalling features, commonly known as the codeplug. It is also used to store radio operating state parameters such as current mode and volume. U104 is a 8 Kbyte device. This memory can be written to in excess of 100,000 times and will retain the data when power is removed from the radio. The memory access signals (SI, SO and SCK) are generated by the K1µP and chip select (CS_) is generated by address decoder U105.

Additional EEPROM is contained in the K1µP (U101). This EEPROM is used to store radio tuning and alignment data. Like the external EEPROM this memory can

be programmed multiple times and will retain the data when power is removed from the radio.

NOTE
The external EEPROM plus the 640 bytes of internal EEPROM in the 68HC11K1 comprise the complete codeplug.

Static Random Access Memory (SRAM)

The SRAM (U103) contains temporary radio calculations or parameters that can change very frequently, and which are generated and stored by the software during its normal operation. The information is lost when the radio is turned off. The device allows an unlimited number of write cycles. SRAM accesses are indicated by the EN_CS signal U103-20 (which comes from U101-28) going low. U103 is commonly referred to as the external RAM as opposed to the internal RAM which is the 768 bytes of RAM which is part of the 68HC11K1. Both RAM spaces serve the purpose. However, the internal RAM is used for the calculated values which are accessed most often. Capacitor C133 serves to filter out any AC noise which may ride on +5VDC at U103.

Control Head

Control Head is available for user interface. The Control Head contains the internal speaker, the microphone connector, several buttons to operate the radio and several indicator LEDs to inform the user about the radio status. Additionally Control Head uses a 3 digit LCD (Liquid Crystal Display) for the channel number.

When turned on, the On/Off switch turns the voltage regulators on by pulling ON_OFF_CONTROL to high and connects the base of Q925(P), Q825(K) to FLT_A+. This transistor pulls the line ANALOG_3 to low to inform the µP that the On/Off button is pressed. If the radio is switched off, the µP will switch it on and vice versa. All other buttons work the same way. If a button is pressed, it will connect one of the 3 lines ANALOG_1,2,3 to a resistive voltage divider connected to +5VDC. The voltages of the lines are A/D converted inside the µP and specify the pressed button.

All the back light and indicator LEDs are driven by current sources and controlled by the µP via SERIAL PERIPHERAL INTERFACE (SPI) interface. The LED status is stored in shift register U941(P). Line LED CE enables the serial write process via Q941(P), while line LED CLCK BUF shifts the data of line SPI DATA BUF into the shift register.

In addition Control Head contains the LCD H931, the display driver U932 and a transistor Q953 to switch the display driver on and off. Q953 is controlled by the µP via shift register U941, The display data of line SPI DATA BUF is shifted into the display driver by clock signal LCD CLCK BUF.

Controller Audio & Signaling Circuits

General

Audio Signalling Filter IC (ASFIC)

The ASFIC (U201) used in the controller has four functions;

- RX/TX audio shaping, i.e. filtering, amplification, attenuation
- RX/TX signalling, PL/DPL/HST/LST
- Squelch detection
- Microprocessor clock signal generation (see Microprocessor Clock Synthesizer Description Block).

The ASFIC is programmable through the SPI BUS (U201-E3/F1/F2), normally receiving 21 bytes. This programming sets up various paths within the ASFIC to route audio and/or signalling signals through the appropriate filtering, gain and attenuator blocks. The ASFIC also has 6 General Control Bits GCB0-5 which are CMOS level outputs. They are used for AUDIO _PA _ENABLE (GCB0) to switch the audio PA on and off, EXTERNAL_ALARM (GCB1) to toggle the EXTERNAL_ALARM pin on the accessory connector J400-4, B+_CONTROL (GCB2) to switch the voltage regulators (and the radio) on, HIGH_LOW_BAND (GCB4) to enable/disbale HearClear and FAST_OFF_IGN (GCB5) which forces the radio-on latch to the off condition. GCB3 is not used.

Audio Ground

VAG is the dc bias used as an audio ground for the op-amps that are external to the Audio Signalling Filter IC (ASFIC). U251 forms this bias by dividing 9V3Vwith resistors R251, R252, and buffering the 4.65 VDC result with a voltage follower. VAG emerges at pin 1 of U251. C235 is a bypass capacitor for VAG. The ASFIC generates its own 2.5V bias for its internal circuitry. C221 is the bypass for the ASFIC's audio ground dc bias.

NOTE
While there are ASFIC VAG, and BOARD VAG (U201-1), each of these are separated. They are not connected together.

Transmit Audio Circuits.

Mic Input Path

The radio provides two microphone inputs, one on the control head (internal mic audio) routed through J101-16), and one on the accessory connector J400-2 (external mic audio). The two inputs are connected in parallel. The dc bias required by the microphone is provided by resistor R205, derived from the 9V3 source and filtered by R204 and C209. The microphone audio signal is applied via R206 and C211, to the ASFIC at U201-B8.

Filter capacitor C210 provides low-pass filtering to eliminate frequency components above 3 kHz, and C211 serves as a DC blocking capacitor. The audio signal at U201-B8 should be approximately 80mV for 60% of full system deviation.

Flat Tx Audio Input Path

The FLAT_TX_AUDIO signal from accessory connector J400-5 is buffered by op-amp U202-(1-3) and fed via C205 to the ASFIC U201-D7.

PTT Sensing and TX Audio Processing

MIC PTT is sensed by the µP. PTT can also be generated by grounding pin 3 on the radio accessory connector, J400. When microphone PTT is sensed, the µP will always configure the ASFIC to enable the mic audio path. PTT can be configured to enable the EXT_MIC audio path when J400-2 is connected with an external mic audio input. Data PTT is configured to enable the flat transmit audio path (when J400-5 is configured for FLAT_TX_AUDIO).

Inside the ASFIC, the mic audio is filtered to eliminate components outside the 300-3000Hz voice band and pre-emphasize. The capacitor, C231, between ASFIC pre-emphasis out U201-C8 and ASFIC limiter in U201-E8 AC couples the signal between ASFIC blocks and prevents the DC bias at the ASFIC output U0201-H8 from shifting when the ASFIC transmit circuits are enabled. The signal is then limited to prevent the transmitter from over deviating. The limited mic audio is then routed through a summer which is used to add in signalling data, and then to a splatter filter to eliminate high frequency spectral components that could be generated by the limiter. The audio is then routed to the VCO attenuator, which is tuned in the factory or the field to set the proper amount of FM deviation. The TX audio emerges from the ASFIC at U201-H8 MOD IN, and is routed to the RF section as MOD IN.

Transmit Signalling Circuits

See Figure 8-4 for reference for the following sections. From a hardware point of view, there are three types of signalling:

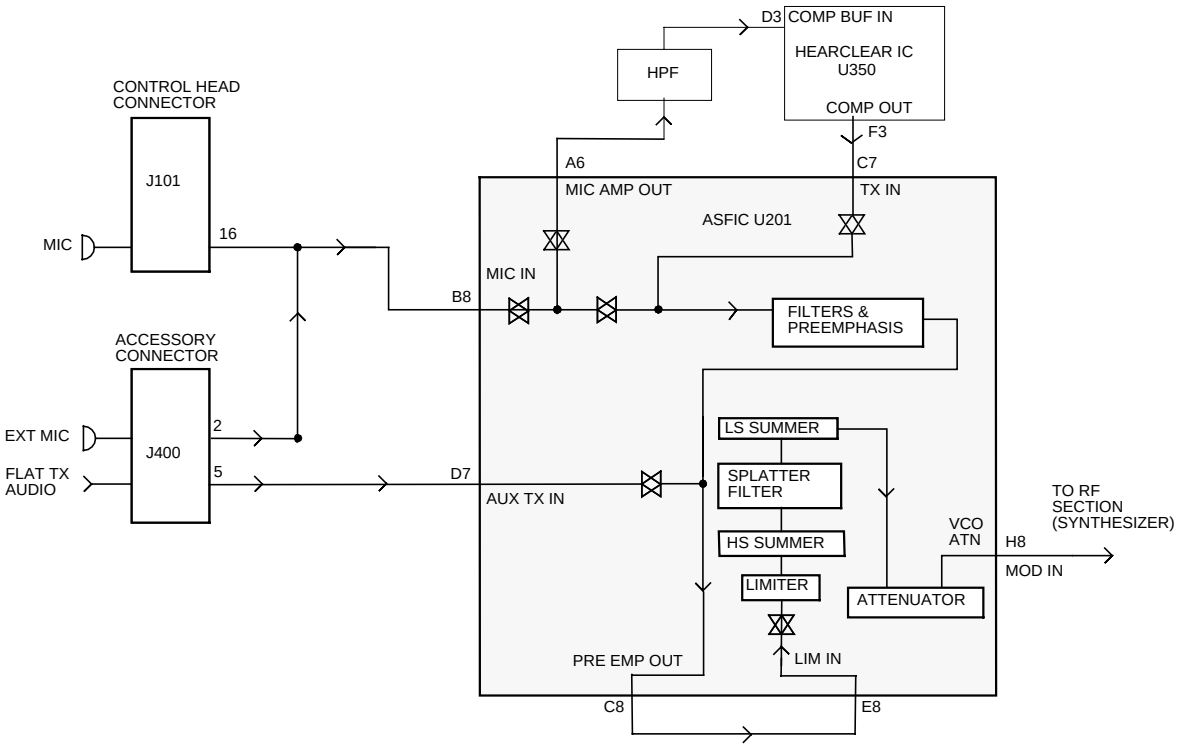


Figure 8-3. Transmit Audio Paths

- Sub-audible data (PL / DPL / LST / Connect tone) that gets summed with transmit voice or signalling,
- DTMF data for telephone communication in trunked and conventional systems, and
- Audible signalling High speed Trunking.

NOTE
The hardware supports all three types while the radio software determines which signalling type is available.

Sub-audible Data (PL/DPL)

Sub-audible data implies signalling whose bandwidth is below 300Hz. PL and DPL waveforms are used for conventional operation and connect tones for trunked voice channel operation. The trunking connect tone is simply a PL tone at a higher deviation level than PL in a conventional system. Although it is referred to as "sub-audible data," the actual frequency spectrum of these waveforms may be as high as 250 Hz, which is audible to the human ear. However, the radio receiver filters out any audio below 300Hz, so these tones are never heard in the actual system.

Only one type of sub-audible data can be generated by U201 (ASFIC) at any one time. The process is as follows, using the SPI BUS, the µP programs the ASFIC to set up the proper low-speed data deviation and select the PL or DPL filters. The µP then generates a square wave which strobes the ASFIC PL / DPL encode input PL CLK U201-C3 at twelve times the desired data rate. For example, for a PL frequency of 103 Hz, the frequency of the square wave would be 1236 Hz.

This drives a tone generator inside U201 which generates a staircase approximation to a PL sine wave or DPL data pattern. This internal waveform is then low-pass filtered and summed with voice or data. The resulting summed waveform then appears on U201-H8 (MOD IN), where it is sent to the RF board as previously described for transmit audio. A trunking connect tone would be generated in the same manner as a PL tone.

High Speed Data

High speed data refers to the 3600 baud data waveforms, known as Inbound Signalling Words (ISWs) used in a trunking system for high speed communication between the central controller and the radio. To generate an ISW, the µP first programs the ASFIC (U201) to the proper filter and gain settings. It then begins strobing U201-G1 (TRK CLK IN) with a pulse when the data is supposed to change states. U201's 5-3-2 State Encoder (which is in a 2-state mode) is then fed to the post-limiter summer block and then the splatter filter.

From that point it is routed through the modulation attenuator and then out of the ASFIC to the RF board. Microphone audio is muted during High Speed Data signalling.

Dual Tone Multiple Frequency (DTMF) Data

DTMF data is a dual tone waveform used during phone interconnect operation. It is the same type of tones which are heard when using a "Touch Tone" telephone.

There are seven frequencies, with four in the low group (697, 770, 852, 941Hz) and three in the high group (1209, 1336, 1477Hz).

The high-group tone is generated by the µP (U101-5) strobing U201-G1 at six times the tone frequency for

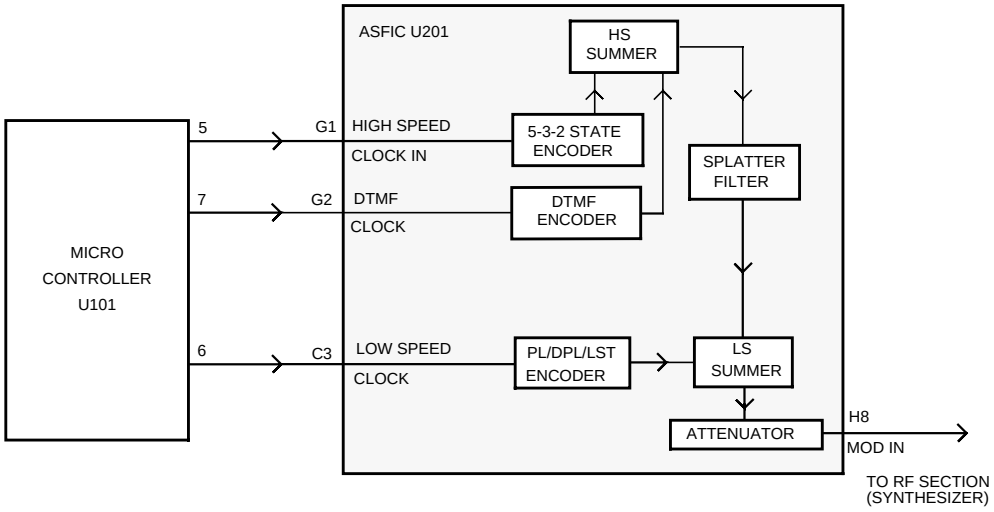


Figure 8-4. Transmit Signalling Paths

tones less than 1440Hz or twice the frequency for tones greater than 1440Hz. The low group tone is generated by the µP (U101-7) strobing U201-G2 (DTMF CLCK) at six times the tone frequency. Inside U201 the low-group and high-group tones are summed (with the amplitude of the high group tone being approximately 2 dB greater than that of the low group tone) and then pre-emphasized before being routed to the summer and splatter filter. The DTMF waveform then follows the same path as was described for high-speed data.

Receive Audio Circuits

Squelch Detect

The radio's RF circuits are constantly producing an output at the discriminator (U5201-28). This signal DET_AUDIO is routed to the ASFIC's squelch detect circuitry input SQIN (U201-H7). All of the squelch detect circuitry is contained within the ASFIC. Therefore from a user's point of view, DET_AUDIO enters the ASFIC, and the ASFIC produces two CMOS logic outputs based on the result. They are CHACT (U201-H2) and SQDET (U201-H1).

The squelch signal entering the ASFIC is amplified, filtered, attenuated, and rectified. It is then sent to a comparator to produce an active high signal on CHACT. A squelch tail circuit is used to produce SQDET (U201-H1) from CHACT. The state of CHACT and SQ DET is high (logic 1) when carrier is detected, otherwise low (logic 0).

CHACT is routed to U101-25 while SQDET adds up with LOCK_DET, weighted by resistors R113 and R114,

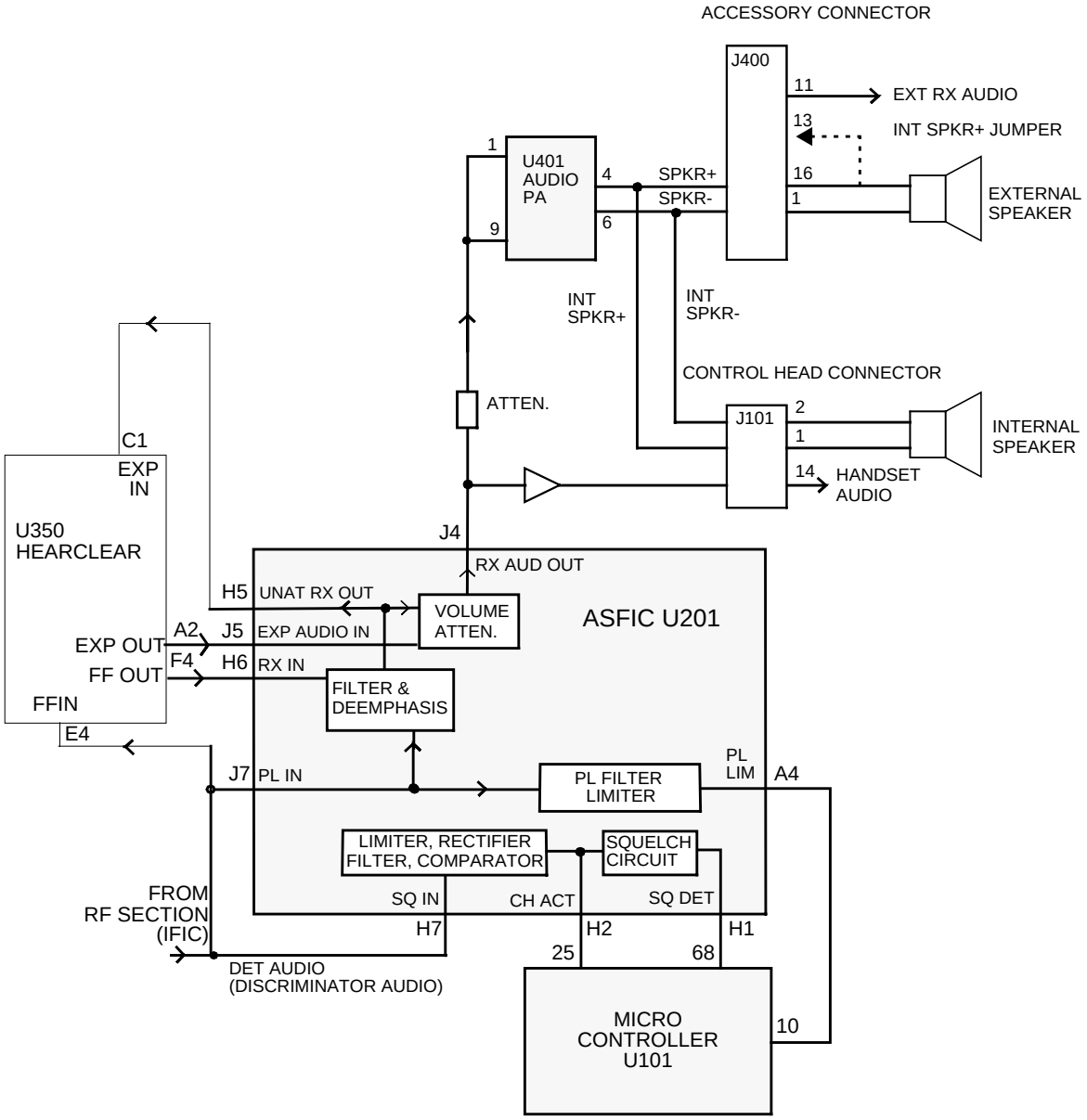


Figure 8-5. Receive Audio Paths

and is routed to an A / D converter input U101-43. From the voltage weighted by the resistors the µP determines whether SQDET, LOCK_DET or both are active.

SQDET is used to determine all audio mute / unmute decisions except for Conventional Scan. In this case CHACT is a pre-indicator as it occurs slightly faster than SQDET.

Audio Processing and Digital Volume Control

The receiver audio signal enters the controller section from the IF IC (U5201-28) on DET_AUDIO and passes through RC filter R203 and C208 which filters out IF noise. The signal is AC coupled by C207 and enters the ASFIC via PLIN U201-J7.

Inside the ASFIC, the signal goes through two paths in parallel, the audio path and the PL / DPL path.

The audio path has a programmable amplifier, whose setting is based on the channel bandwidth being received, then a LPF filter to remove any frequency components above 3000Hz and then an HPF to strip off any sub-audible data below 300Hz. Next, the recovered audio passes through a De-emphasis filter to compensate for Pre-emphasis which is used to reduce the effects of FM noise. The IC then passes the audio through the 8-bit programmable attenuator whose level is set depending on the value of the volume control. Finally the filtered audio signal passes through an output buffer within the ASFIC. The audio signal exits the ASFIC at RX_AUDIO (U201-J4).

The µP programs the attenuator, using the SPI bus, based on the volume setting. The minimum / maximum settings of the attenuator are set by codeplug parameters.

Since sub-audible signalling is summed with voice information on transmit, it must be separated from the voice information before processing. Any sub-audible signalling enters the ASFIC from the IF IC at PLIN U201-J7. Once inside it goes through the PL / DPL path.

The signal first passes through one of 2 low pass filters, either PL low pass filter or DPL / LST low pass filter. Either signal is then filtered and goes through a limiter and exits the ASFIC at PLLIM (U201-A4). At this point the signal will appear as a square wave version of the sub-audible signal which the radio received. The microprocessor, U101-10 will decode the signal directly to determine if it is the tone / code which is currently active on that mode.

Audio Amplification Speaker (+) Speaker (-)

The ASFIC's received audio signal output, U201-J4, is routed through a voltage divider formed by R401 and R402 to set the correct input level to the audio PA (U401). This is necessary because the gain of the audio PA is 46 dB, and the ASFIC output is capable of overdriving the PA unless the maximum volume is limited.

The audio then passes through C401 which provides AC coupling and low frequency roll-off. C402 provides high frequency roll-off as the audio signal is routed to pins 1 and 9 of the audio power amplifier U401.

The outputs of the Audio PA (U401 pins 4 and 6) are routed to the external speaker via the accessory connector (J400-16 EXT SPKR+, and J400-1 EXT SPKR-, respectively). One terminal of the radio's internal speaker (+) is connected to J400-13 (INT SPKR+), and the other (-) to U401-6. To enable the internal speaker, a jumper plug is inserted into J400 which connects pins 13 and 16 together. This completes the path between the audio power amp U401-4 and the internal speaker's (+) terminal.

The audio power amplifier has one inverted and one non-inverted output that produces the differential audio output OUT1 and OUT2 (U401-4 & 6). The inputs for each of these amplifiers are pins 1 and 9 respectively; these inputs are both tied to the received audio. The audio PAs DC bias is not activated until the audio PA is enabled at pin 8.

The audio PA is enabled via AUDIO_PA_ENABLE signal from the ASFIC (U201-B5). When the base of Q401 is low, the transistor is off and U401-8 is high, using pull up resistor R406, the audio PA is ON. The U401-8 must be above 8.5VDC to properly enable the device. If the voltage is between 3.3 and 6.4V, the device will be active but has its input (U401-1 / 9) off. This is a mute condition which is not employed in this radio design. R404 ensures that the base of Q401 is high on power up. Otherwise there may be an audio pop due to R406 pulling U401-8 high before the software can switch on Q401.

The audio PA can also be muted externally when in the Data Modem mode, which is selected by turning switch S401 (1-3) off. This forces analog switch control line U402-9 high via R442, changing its state. If J400-12 is pulled low, this is transferred via pins 14 and 1 of U402 to the base of Q415, turning it on and, in turn, Q401 on. This pulls U401-B low, muting the audio PA.

The EXT_SPKR+ and EXT_SPKR- outputs of the audio PA have a DC bias which varies proportionately with FLT A+ (U401-7). FLT A+ of 11V yields DC offset of 5V, and FLT A+ of 17V yields a DC offset of 8.5V. If either of these lines is shorted to ground, it is possible that the audio PA will be damaged. The audio PA contains internal short-circuit protection, however this situation should be avoided. EXT_SPKR+ and EXT_SPKR- are routed to the accessory connector (J400-16 & 1) and, via the jumper plug connecting J400-16 to 13, to the control head (connector J101-1 & 2).

Handset Audio

Certain hand-held accessories have a speaker within them which require a different voltage level than that provided by U401. For those devices HANDSET

AUDIO is available at control head microphone jack J903-8.

The received audio from the output of the ASFIC's digital volume attenuator (U201-J4) is also routed to U202-9 where it is amplified 15 dB; this is set by the 10k / 68k combination of R233 and R232. This signal is routed from the output of the op amp U202- 8 to J101-14. The control head sends this signal directly out to the microphone jack. The maximum value of this output is 6.6Vp-p.

External Rx Audio

RX Audio is also routed to the accessory connector J400-11. This audio level is fixed and not affected by the setting of the digital volume attenuator. The source of this audio is selectable as follows:

In the Data Modem mode (switch S401, 1-3 off), U402-9 is high, and FLAT_ RX_AUDIO, directly from detector U5201-28 via C230 and R236, is routed from U402 pin 10 to pin 5, amplified by U403 and applied to J400-11 via R419 and C419.

In Normal mode (switch S401 1-3 on), U402-9 is low, and GATED_RX_AUDIO, from ASFIC U201-H5 via C237 and R235, is routed from U402 pin 6 to pin 5, amplified by U403 and applied to J0400-11 via R419 and C419. The values of R235 and R236 provide the correct audio levels for GATED and FLAT_RX _AUDIO paths, respectively. The GATED_RX_AUDIO signal is PL-filtered, de-emphasized, and controlled by the squelch mute gate. The FLAT_ RX_AUDIO signal is non-de-emphasized, unmuted, and is flat between 0.6 Hz and 3 kHz. The radio is shipped configured for Normal mode operation.

Receive Signalling Circuits

Sub-audible Data (PL/DPL) and High Speed Data Decoder

The ASFIC (U201) is used to filter and limit all received data. The data enters the ASFIC at U201-J7. Inside U201 the data is filtered according to data type (HS or LS), then it is limited to a 0-5V digital level. The trunking high speed data appears at U201-G4, where it connects to the µP U101-11.

The low speed limited data output (PL, DPL, and LST) appears at U201-A4, where it connects to the µP U101-10. While receiving low speed data, the µP may output a sampling waveform depending on the sampling technique to U201-C3 between 1 and 2 kHz.

The low speed data is read by the µP at twice the frequency of the sampling waveform; a latch configuration in the ASFIC stores one bit every clock cycle. The external capacitors C223, C225, and C226 set the low frequency pole for a zero crossings detector in the limiters for PL and HS data. The hysteresis of these limiters is programmed based on the type of received data.

NOTE
During HS data, the µP may generate a sampling waveform seen at U0201-G1.

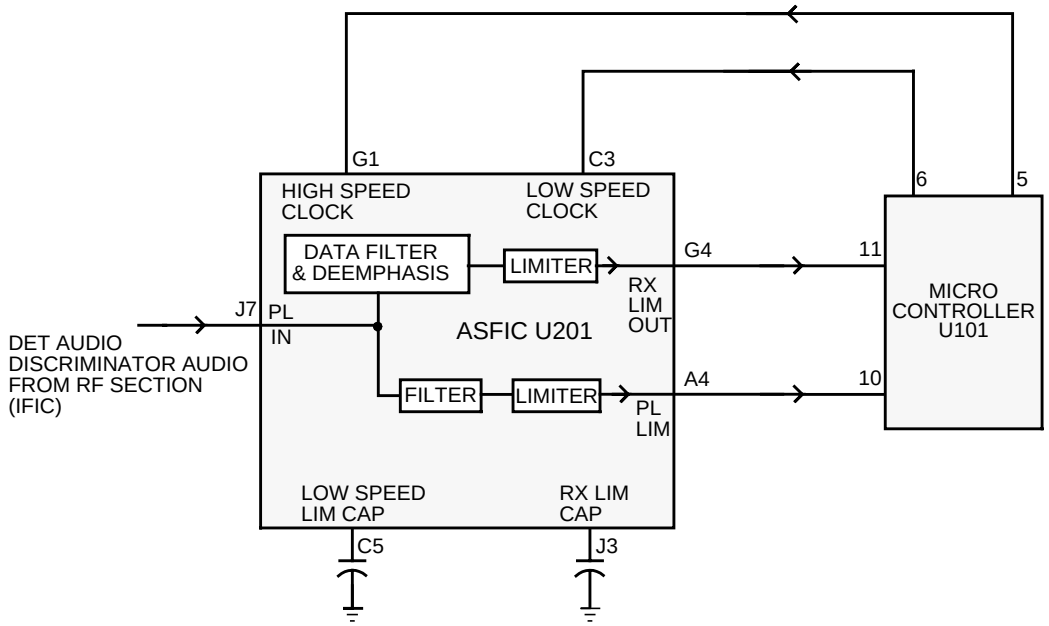


Figure 8-6. Receive Signalling Path

Alert Tone Circuits

When the software determines that it needs to give the operator an audible feedback (for a good key press, or for a bad key press), or radio status (trunked system busy, phone call, circuit failures), it sends an alert tone to the speaker.

It does so by sending SPI BUS data to U201 which sets up the audio path to the speaker for alert tones. The alert tone itself can be generated in one of two ways: internally by the ASFIC, or externally using the µP and the ASFIC.

The allowable internal alert tones are 304, 608, 911, and 1823Hz. In this case a code contained within the SPI BUS load to the ASFIC sets up the path and determines the tone frequency, and at what volume level to generate the tone. (It does not have to be related to the voice volume setting).

For external alert tones, the µP can generate any tone within the 100-3000Hz audio band. This is accomplished by the µP generating a square wave which enters the ASFIC at U201-C3.

Inside the ASFIC, this signal is routed to the alert tone generator; the output of the generator is summed into the audio chain just after the RX audio de-emphasis block. Inside U201 the tone is amplified and filtered, then passed through the 8-bit digital volume attenuator, which is typically loaded with a special value for alert tone audio. The tone exits at U201-J4 and is routed to the audio PA like receive audio.

Hear Clear IC

Hear Clear (HC) is used for 900 MHz radios. The HC has three functions within the IC which are used by the radio: 1) Compressor, 2) Flutter Fighter, and 3) Expander Circuits. There are six enable/control lines on the Hear Clear IC which determine its mode of operation. The IC ENAB line U350-C4 is tied to 9.3 so whenever the IC is placed on the board, it is always active. The remaining five lines are contolled by the ASIFIC General Control Bit Line. Table 8.1 below summarizies the logic control and the IC states.

Transmit Path for Radios with Hear Clear

For transmit, the audio signal comes from the appropriate microphone and enters the ASFIC at U200-B8. After entering the ASFIC, the signal is internally routed to U200-A6 ASFIC MIC AMP OUT, where it leaves the ASFIC and enters the Hear Clear compressor at U350-D3. The signal then exits the compressor at U350-F3, where it is routed back to the ASFIC U200-C7. C361 provides AC coupling. Inside the ASFIC, the signal goes through LPF and HPF that limits the signal between 0.3-3 kHz . The signal is then pre-emphasized and exits the ASFIC at U200-C8 and enters the ASFIC at U200-E8. Again inside the ASFIC, the signal goes through a limiter, splatter filter, and an attenuator which sets the amplitude (deviation level) of the signal.

The purpose of having a compressor in the transmit mode is twofold: 1) improve S/N ratio for low level audio, and 2) maintain the same dynamic range of 12.5 kHz bandwidth channel as obtained in the 25 KHz bandwidth.

The compresssor raises low level signals and lowers high level signals. The compressor circuit produces a signal whose output voltage at pin U350-F3 is based on the input voltage level (0200-A6) of the signal. The voltage transfer function is:

- 20 mV input == 40 mV output
- 80 mV input == 80 mV output
- 50 mV input == 110 mV output

Receive Path for Radios with Hear Clear

The audio signal enters the Hear Clear controller from BBR signal on DISC. The discriminated audio “DISC” enters the Hear Clear Flutter Fighter through C300 and C367. C300 connects the signal to FF IN (U350-E4). C367 is a beginning of a noise sampling circuit consisting of components: C367, R356, R353, C364, C363, R354 and R355, R357, and C365; and Hear Clear ports Ref, Noise Filter In, and Noise Filter Out, Noise Hold.

After exiting Hear Clear at the “FF OUT” (U350-F4), the signal enters ASFIC at RX IN (U200-H6). Within the ASFIC, the signal passes through a low filter and high pass filter limiting the audio band width to 0.3-3 kHz. It then goes through de-emphasis and exits the ASFIC at U200-H5 FILTERED AUDIO.

After exiting the ASFIC at FILTERED AUDIO, the signal passes through capacitor C350, which provides AC coupling. The signal then enters the HEAR CLEAR at EXP IN (U350-C1) and exits the HEAR CLEAR Expander at EXP OUT (U350-A2). The normalized signal is then routed back to the ASFIC through C360 for volume adjustment, entering at U200-J5 and exiting the ASFIC at U200-J4 as RX AUDIO. The audio is trhen routed to the Audio PA in the same manner as standard receive audio.

The purpose of Flutter Fighter is to sample the amount of Noise in the receive audio between 10 - 20 Khz using the Noise Filter in (U350-B5, Noise Filter Out (U350-C6) and Noise Hold (U350-D5). In addition, it monitors the rate of change of RSSI (Receive Signal Strength In) (U350-F5). The discriminated audio DISC enters into the Hear Clear Ic at ”FF IN” (U350-E4). The circuit then reduces the amount of popping Noise associated with fading. The improved audio exits the IC at ”FF OUT”(U350-F4).

The expander is used after de-emphasis but before the ASFIC volume attenuation. The purpose of the

Table 8-1. Hear Clear Enable Lines Configuration

					Logic State	
Name	**Ref. Des**	**Set By**	**TX1**	**RX1**	**TX2**	**RX2**
IC Enable	UC350-C4	9V3	1	1	X	
Flutter Fighter Enable	UC350-E3	U000-A2	X	1	X	0
LO Clamp Disable	UC350-A5	U200-A2	1	1	1	X
LO Clamp Disable	UC350-C2	U200-A2	0	0	X	0
HCI Disable	UC350-B6	U200-A2	1	1	X	1
LO Clamp Disable	UC350-D1	U200-A2	0	0	X	0

TX1: transmit mode with carrier squelch, PL or DPL

RX1: receive voice with carrier squelch, PL or DPL

TX2: transmit mode with all other data HST / MDC / DTMF etc.

RX2: refers to receive mode with all other data HST / MDC / DTMF

Logic State "X" means either 1 or a 0, i.e. 'don't care".

expander is to transpose the compressed audio back to "normal" audio. As with the compressor circuit, the expander circuit adjusts the amplitude of a signal based upon its input amplitude, NOT its frequency.

The voltage transfer function is: EXPOUT= 0.41*(EXPIN / 0.28)2.

Example :

100 mV EXPIN == 52 mV EXPOUT

191 mV EXPIN == 191 mV EXPOUT

250 mV EXPIN == 327 mV EXPOUT

NOTE
This operation is NOT a function of frequency between 300 Hz and 3 kHz .

Hear Clear Routing of Data/Signalling

While transmitting, all data and signalling bypasses the Hear Clear Compressor.

While receiving, subaudible signals PL / DPL go through the Flutter Fighter along with the audio, and is unaffected by the Flutter Fighter operation. On entering the ASFIC, the sub-audible signaling is separated from the voice and decoded. Sub-audible signaling never goes through the expander.

While receiving, data and high speed signalling (not sub-audible), the Flutter Fighter is set to "pass through mode". In this mode, the Flutter Fighter is routed from "FF IN" to "FF OUT" without any adjustment.

Accessory Connector Configurations

The configuration of the pins of accessory connector J400 can be changed to support different accessories by changing the settings of dual switch S401.

S401 (pins 2-4) is turned ON if external Ignition Sense is not used, and turned OFF if an external Ignition Sense cable is installed. The operation of the Ignition Sense circuitry is described above in the "Electronic On / Off" and "Ignition" sections of the Controller Detailed Functional Description.

S401 (pins 1 and 3) is turned ON to support Remote Desk Set, Public Address and External Alarm, and is turned OFF to configure the accessory connector for External Data Modem applications.

NOTE
The radio is shipped with Ignition Sense disabled. and Remote Desk Set, Public Address and External Alarm enabled.

Remote Desk Set

For Remote Desk Set applications, switch S401 (1-3) should be ON. This pulls the analog switch control line U402-9 low, and the switch positions of U402 are as shown in the schematic. The PTT signal from the desk set at U400-3 is routed via U402-4 and 2 and via U203 - 1 and 2 (U203 is ON since pin 4 is high via R433 and R431) to µP port U101-22. The hook signal at U400-14 is inverted by Q101 and applied to µP port U101-23. Transmit audio at U400-2 (EXTERNAL_MIC_ AUDIO) is connected in parallel with the front panel mic audio input and applied to ASFIC U201-B8. DC bias required by microphone is provided by R204 and R205. GATED_RX_AUDIO which is de-emphasized and controlled by the squelch mute gate is obtained from

ASFIC U201-H5, buffered and amplified by U403 and sent to the desk set at J400-11.

Public Address

Public address operation requires an accessory HLN9322 Public Address Switch Box and one or more HSN1000 amplified speakers. In the Public Address mode, the radio functions simply as a junction box which routes microphone audio from the front panel connector directly to the switch box via J400-2, where it is further amplified and routed to the amplified speakers. Additionally, the microphone PTT does not key the transmitter, and the microphone off-hook condition is ignored, appearing to be on-hook.

For Public Address operation, switch S401 (1-3) should be ON. This pulls the analog switch control line U402-9 low, and the switch positions of U402 are as shown in the schematic. When Public Address mode is turned on using the Switch Box, the switch box pulls J400-12 low. This signal is passed through switch U402 from pin 14 to 15, which also goes low. The hook line is pulled low by D401, forcing the microphone to appear on-hook. The control line to gate U203-4, normally high via R433, is pulled low, turning off U203 and preventing MIC PTT from being applied to the µP. Thus, microphone audio is routed to the public address speakers but the radio does not transmit, and receiver operation is maintained in the same condition it was when the microphone was on-hook.

SW_B+ from J400-9 is supplied to the switch box, where it powers the internal amplifier stages and also turns on a rely which applies battery voltage to the external amplified speakers. Thus, when the radio is turned off, all PA circuits and amplified speakers are turned off as well.

External Alarm

For External Alarm installations, switch S401 (1-3) should be ON. This pulls the analog switch control line U402-9 low, and the switch positions of U402 are as shown in the schematic. When the radio's alarm mode is enabled and the proper code has been received, ASFIC port U201-A3 goes high, turning on Q411 via U402-(11-13) and R411, saturating Q411 and pulling J400-4 low.

For External Alarm installations, switch S401 (1-3) should be OFF. This pulls the analog switch control line U402-9 high via R442, and the switch positions of U402 are the opposite from those shown in the schematic.

Data Modem

For Data Modem installations, switch S401 (1-3) should be OFF. This pulls the analog switch control line U402-9 high and the switch positions of U402 are thrown opposite of that shown in the schematic.

NOTE
All Data Modem I/O functions are active low, 0 VDC.

The reconfigured pin functions of accessories connector J400 are as follows:

J400-12 is an input to the radio which allows the data modem to mute the radio's speaker audio while data bursts are being received. The modem pulls J400-12 low, which is routed through switch U402 from pin 14 to 1, and turns on Q415 and, therefore, Q401. This pulls U401-8 low, muting the audio power amplifier.

J400-4 is an output from the radio which tells the modem that the radio is transmitting by pulling J400-4 low. Two non-simultaneous conditions are summed to recognize transmit mode under all timing conditions. If PTT is low, Q410 is off and a high is provided via R440, D403, U402 pins 12-13, and R411, to turn on Q411 and pull J400-4 low. If the transmit-enable voltage K9V1_ENABLE is high, a high is provided via D403, U402 pins 12-13, and R411, to turn on Q411 and pull J0400-4 low.

J400-15 provides system busy indication by observing the status of the AUDIO_PA_ENABLE line, which is low during active receive conditions. This low is provided to J400-15 via D402, indicating a signal is being received.

J400-3 is DATA_PTT input to the radio, routed via switch U402 pins 4 to 3, to U101-8. The ASFIC (U201) is configured for FLAT_TX_AUDIO when DATA_PTT is asserted at U101--8.

J400-5 provides a FLAT_TX_AUDIO input to the radio, via C418 and gain-reduction buffer U202 (pins 1, 2, 3), to U201-D7. This connection is always provided and is not reconfigured by the setting of switch S401 (1-3).

J400-11 provides a Flat/Unmuted RX Audio Output from the radio. This audio is obtained directly from detector U5201-28 via C230 and R236, is routed from U402 pin 10 to pin 5, amplified by U403 and applied to J400-11 via R419 and C419.

RSSI Buffer

For special applications, a DC voltage proportional to received signal strength can be provided to J400-15. This requires removal of resistor R430 and diode D402, and insertion of resistor R215. The DC signal-strength voltage is provided by detector U5201-11, buffered by U202 (pins 12, 13, 14), and routed via R215 to J400-15.

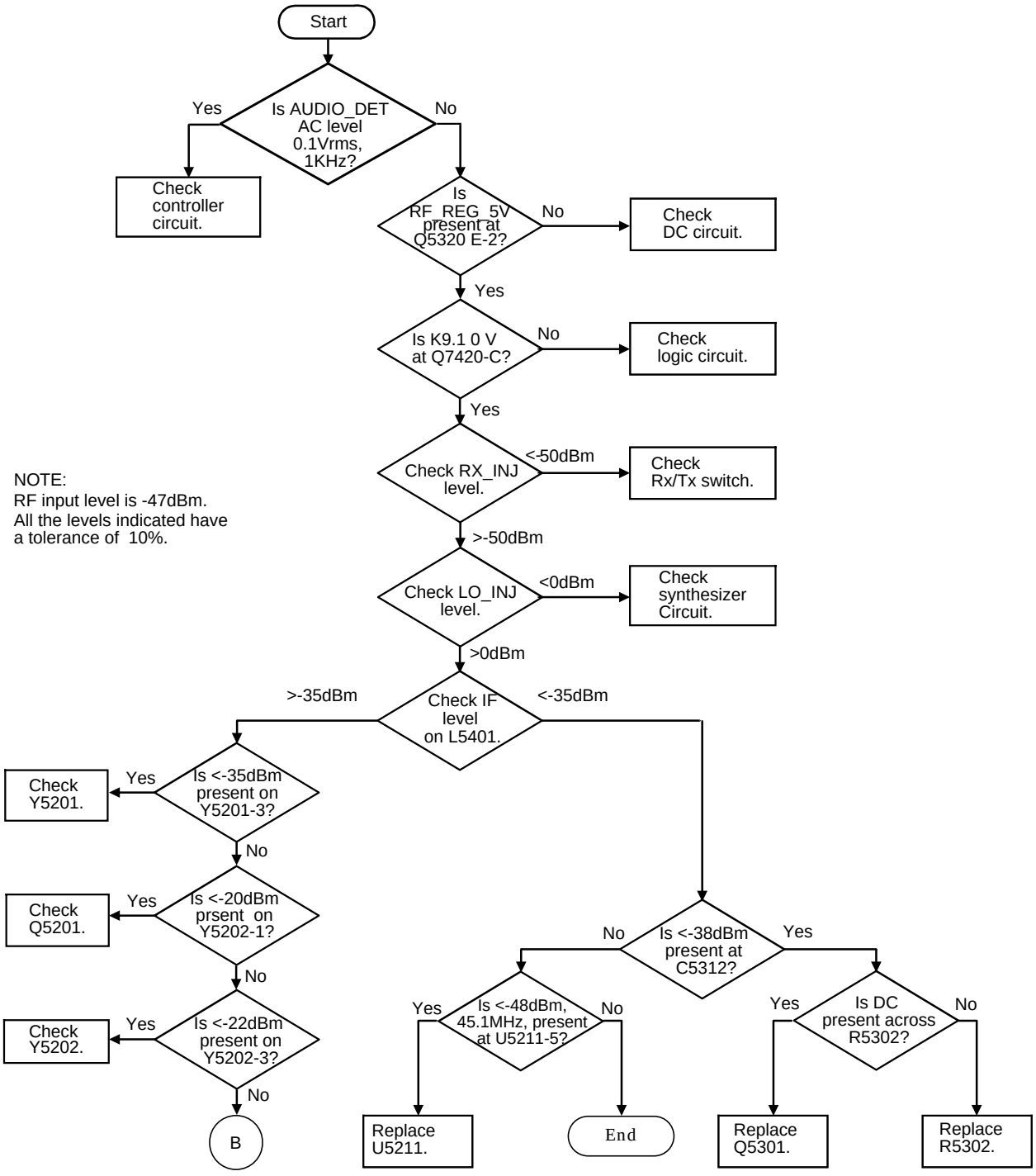
Section 9
Troubleshooting

Overview

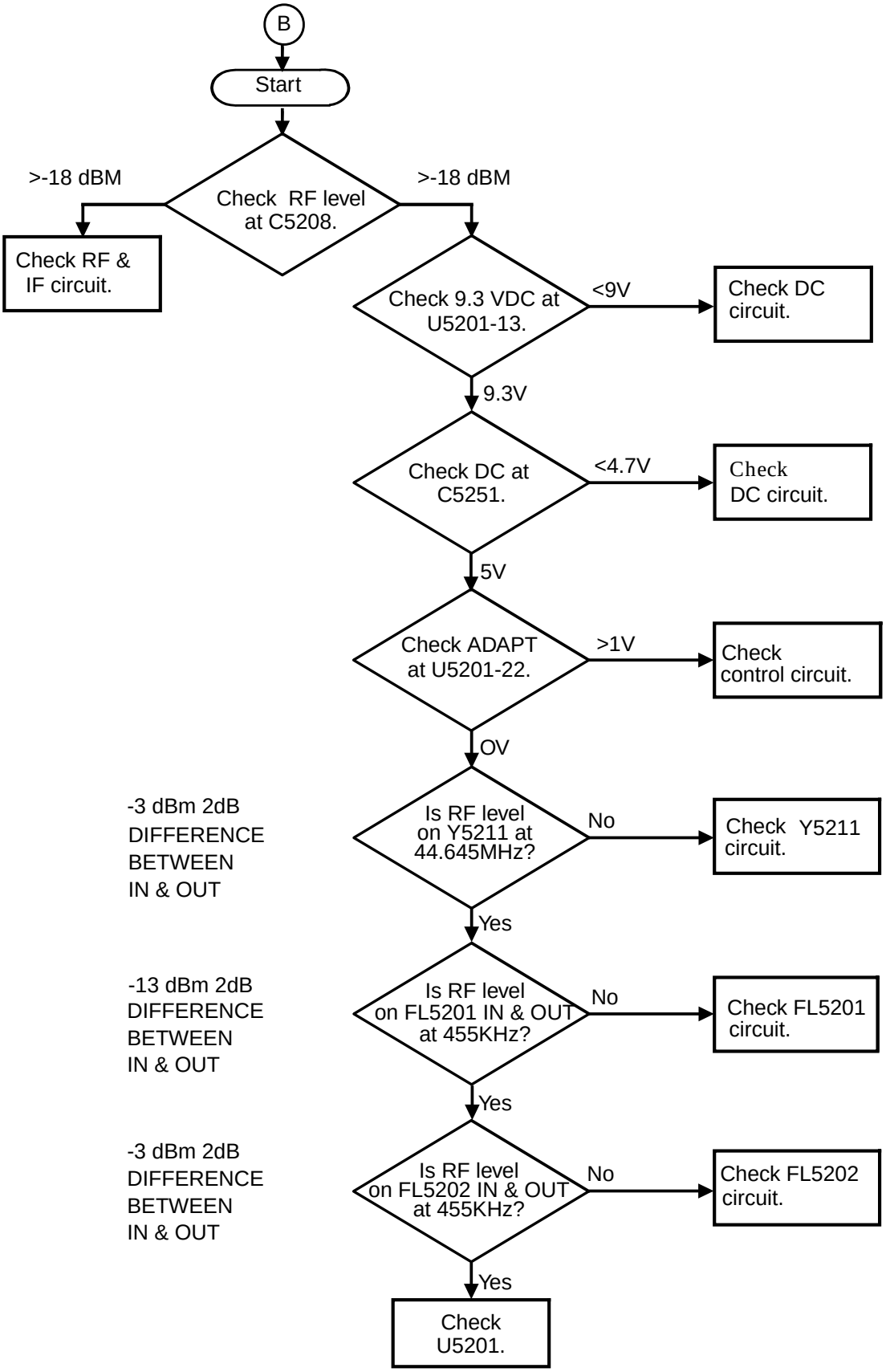
This section contains six troubleshooting tables for the following GTX components:

- Receiver
- Synthesizer
- 12W/30W Power Amplifier
- Controller
- Control Head

Troubleshooting Charts

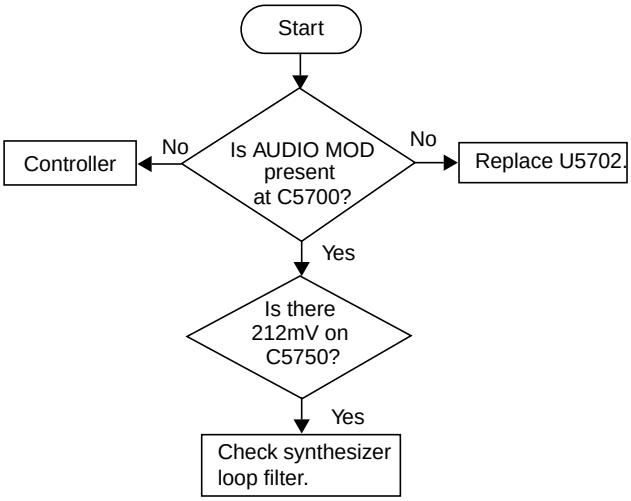


Troubleshooting Flow Chart for Receiver

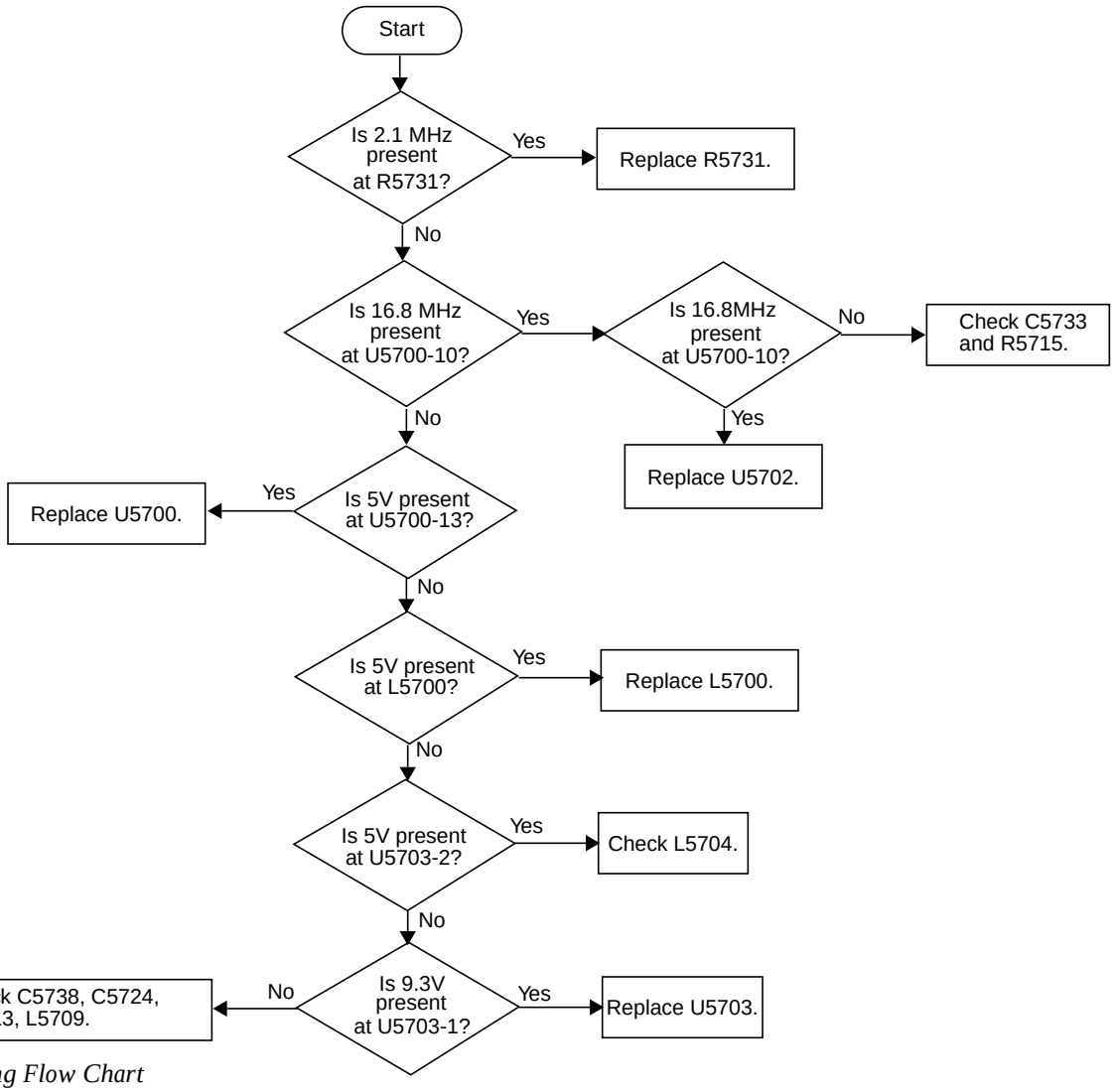


Troubleshooting Flow Chart for Receiver (cont.)

SYNTHESIZER DEVIATION

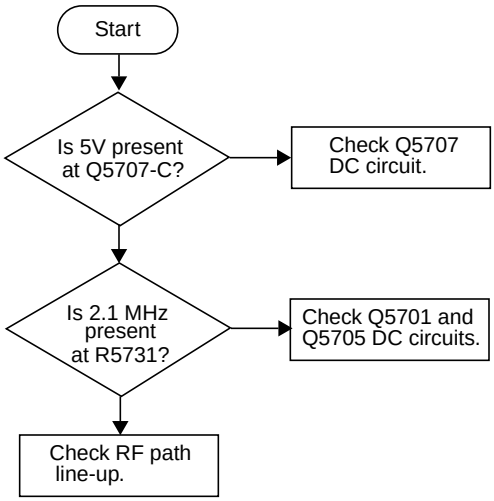


SYNTHESIZER PENDULUM

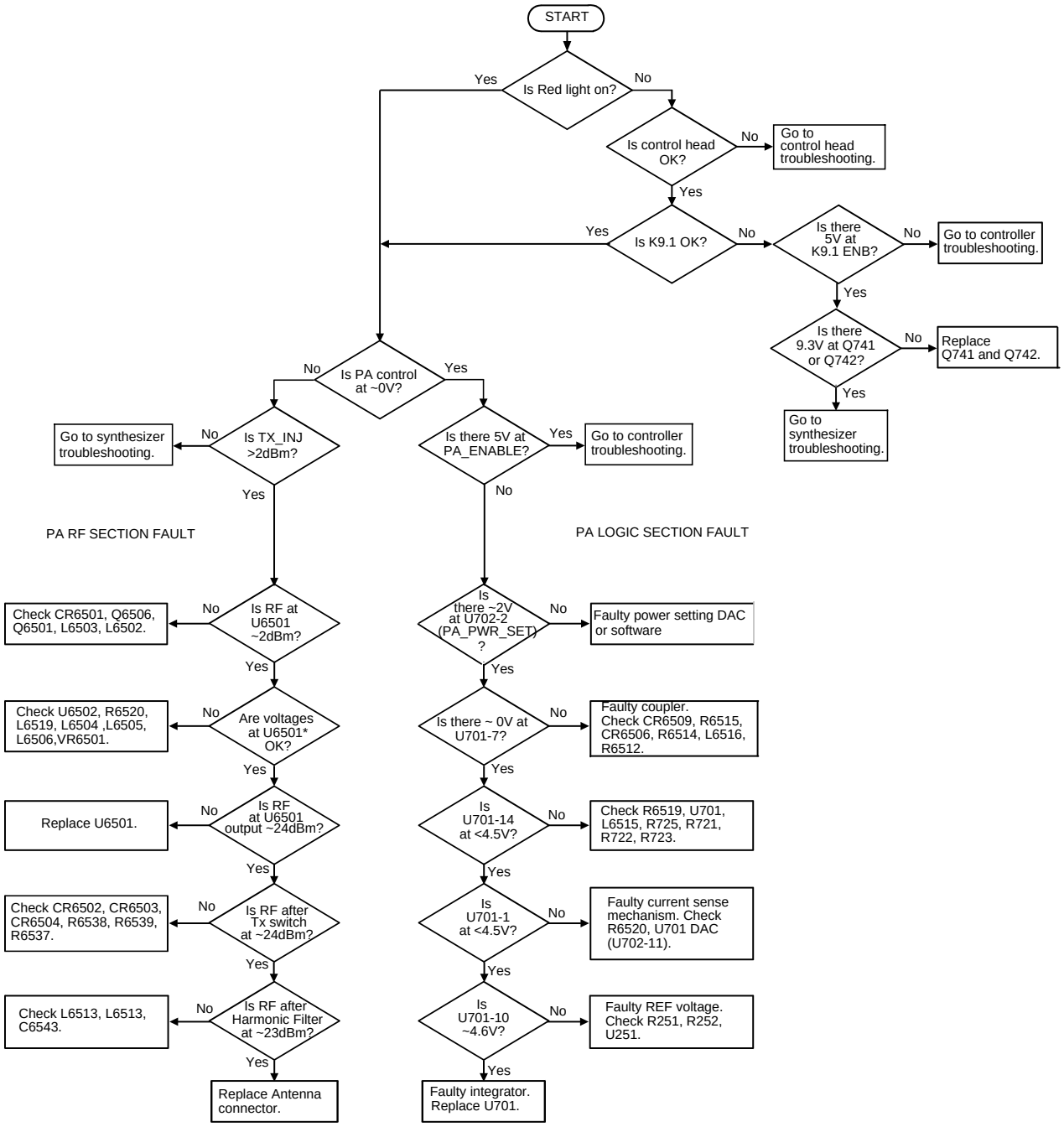


Troubleshooting Flow Chart for Synthesizer

NO Tx INJECTION



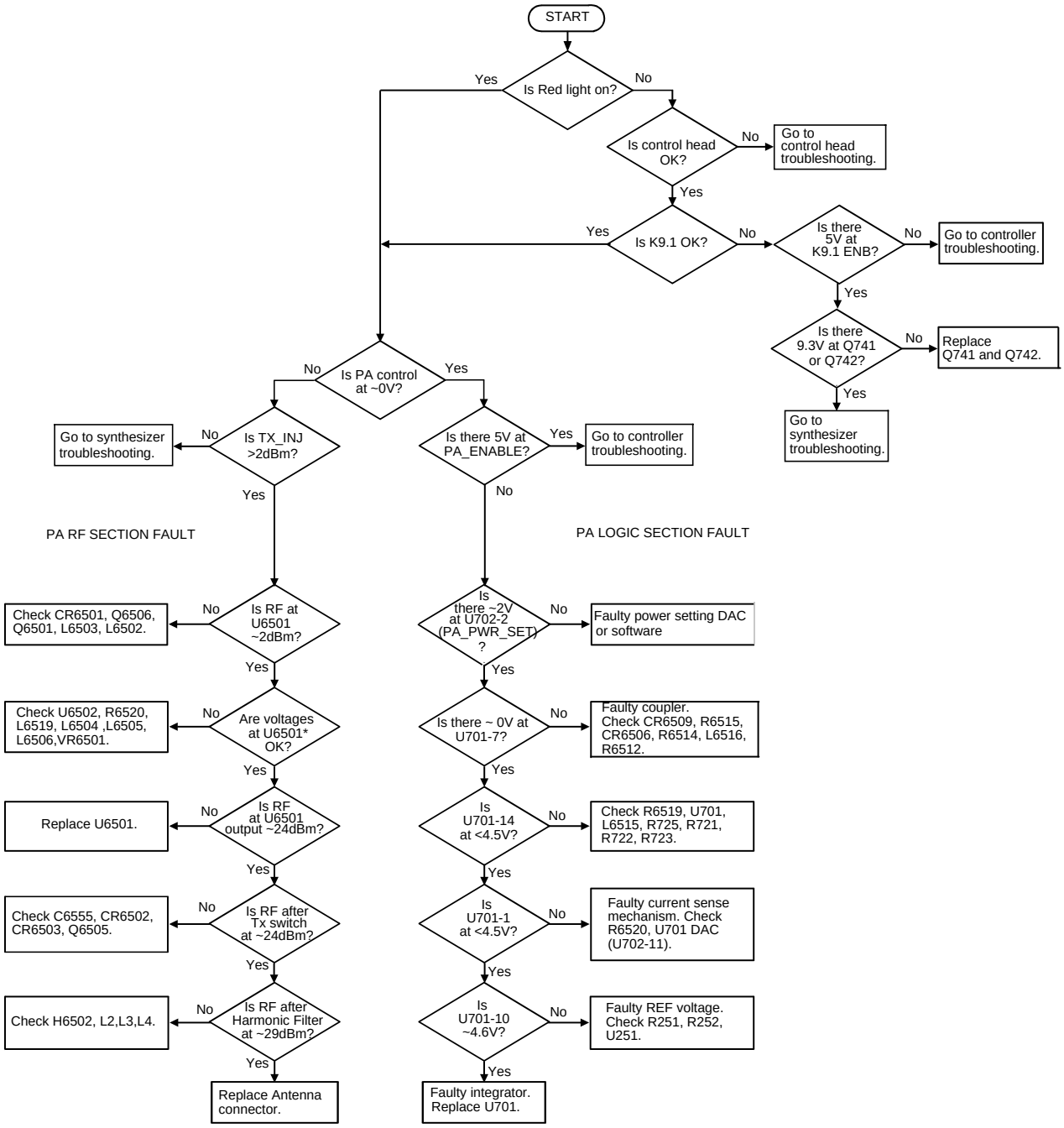
Troubleshooting Flow Chart for Synthesizer (cont.)



RF Levels were measured with an RF probe in series with 0.5pF capacitor.

*U6501 DC voltages:
Pins 3 and 4: A+-0.1V
Pin 2: 9.1V (during Tx only)

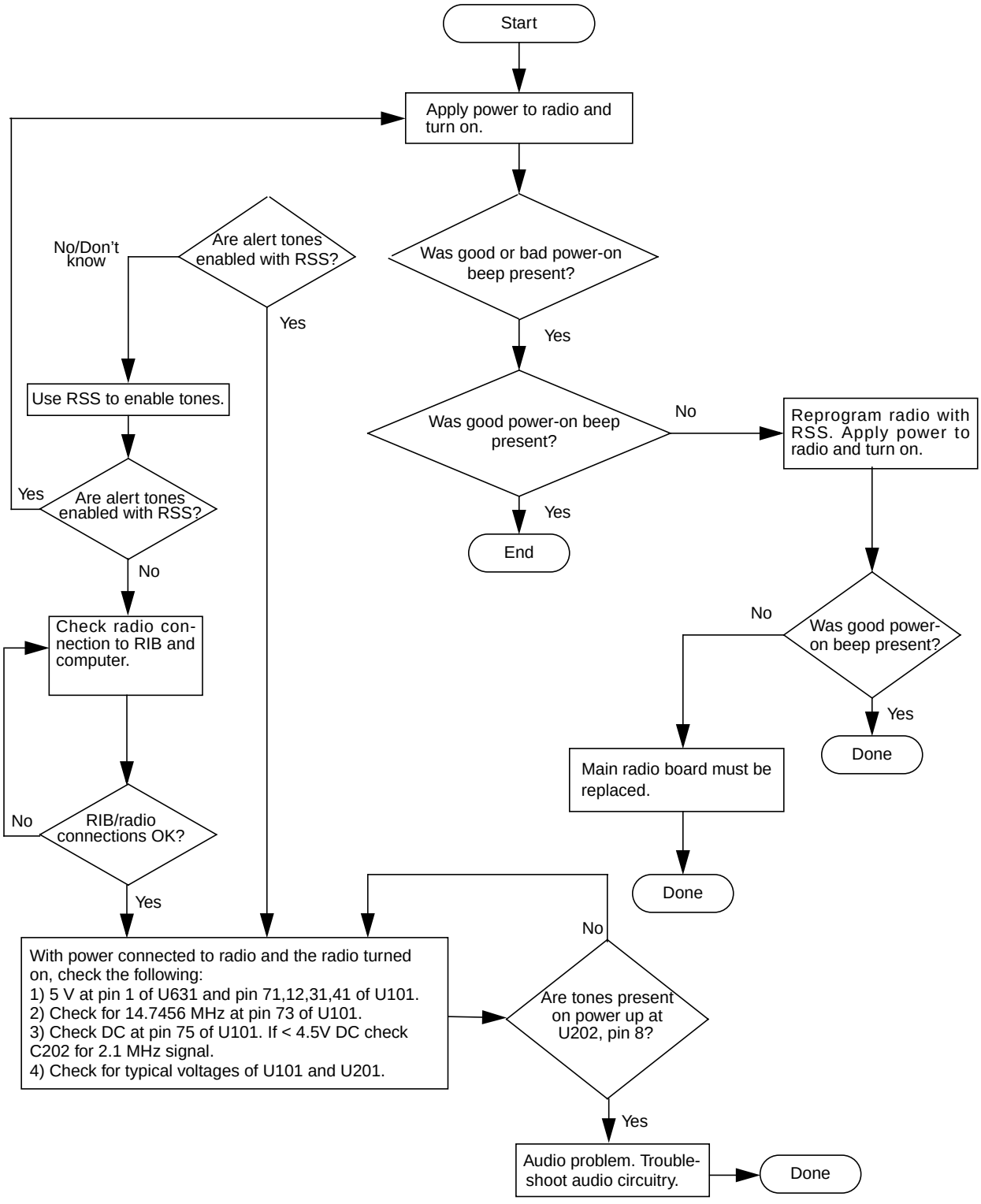
Troubleshooting Flow Chart for 12 W Power Amplifier



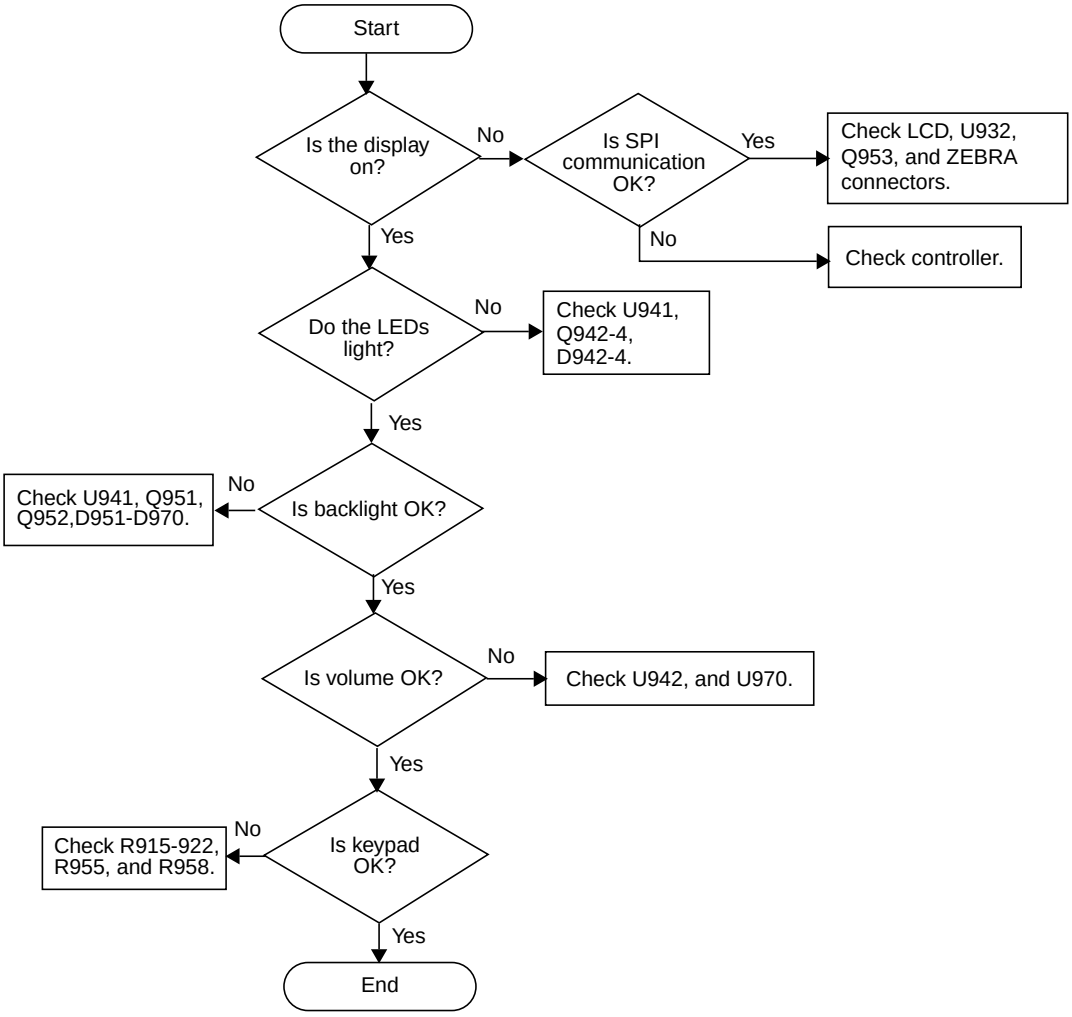
RF Levels were measured with an RF probe in series with 0.5pF capacitor.

*U6501 DC voltages:
Pins 3 and 4: A+-0.1V
Pin 2: 9.1V (during Tx only)

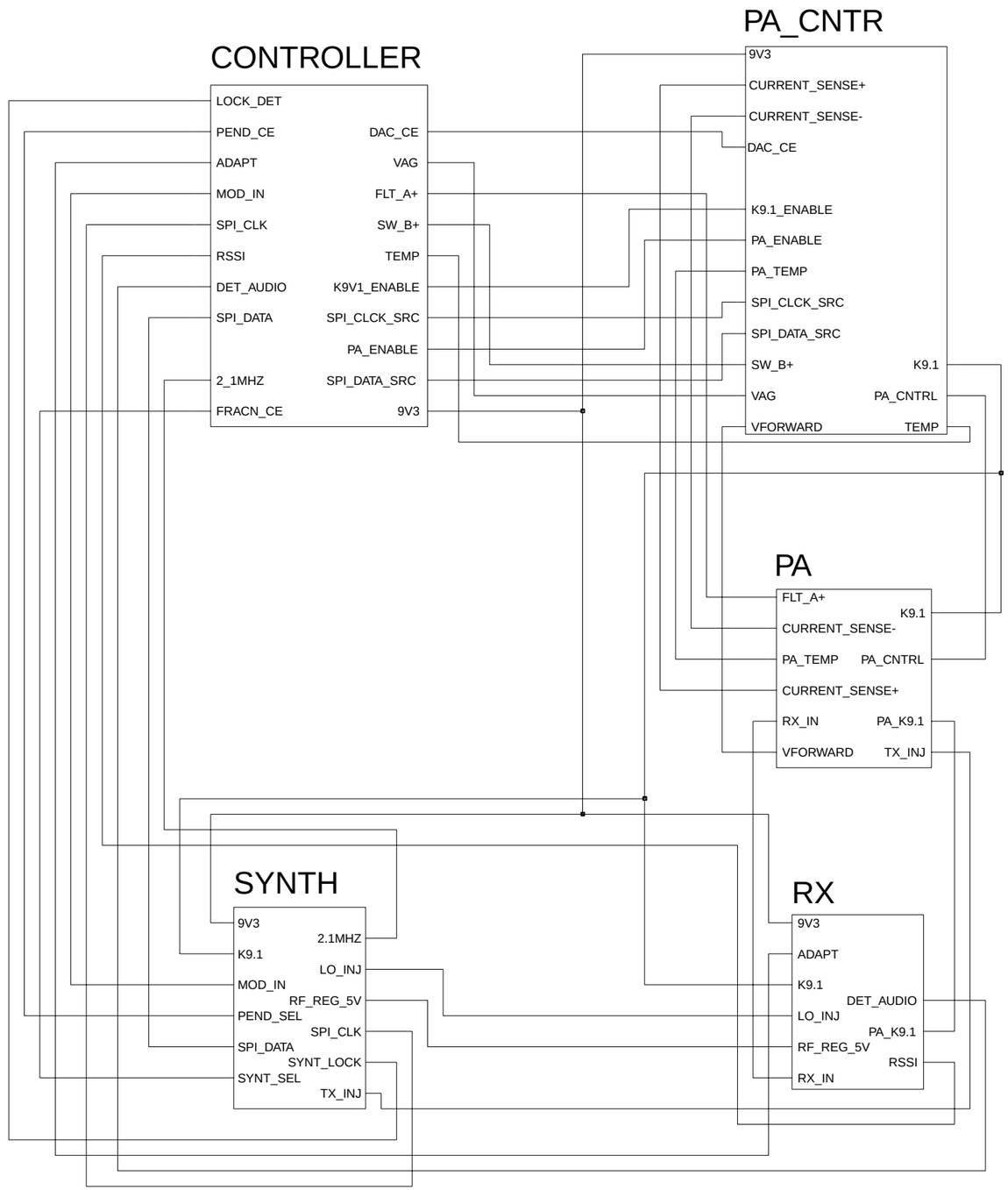
Troubleshooting Flow Chart for 30W Power Amplifier



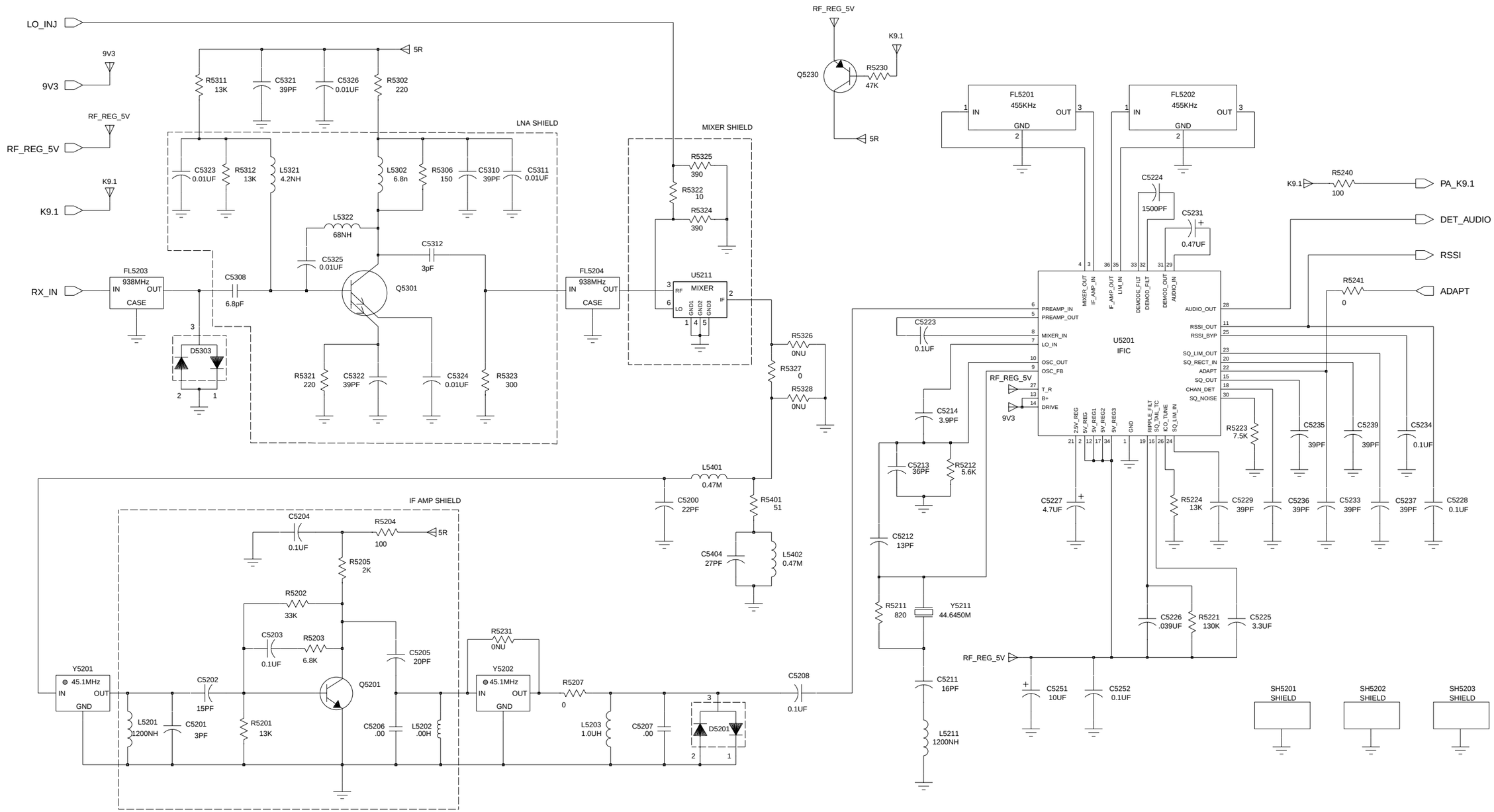
Troubleshooting Flow Chart for Controller



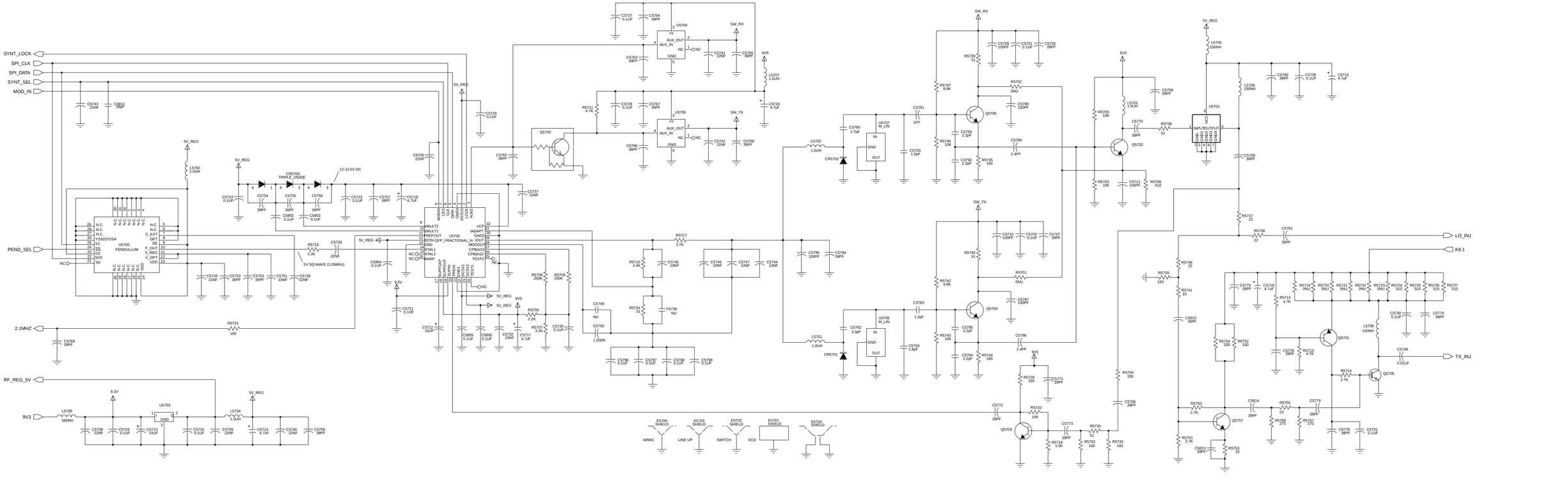
Troubleshooting Flow Chart for Control Head



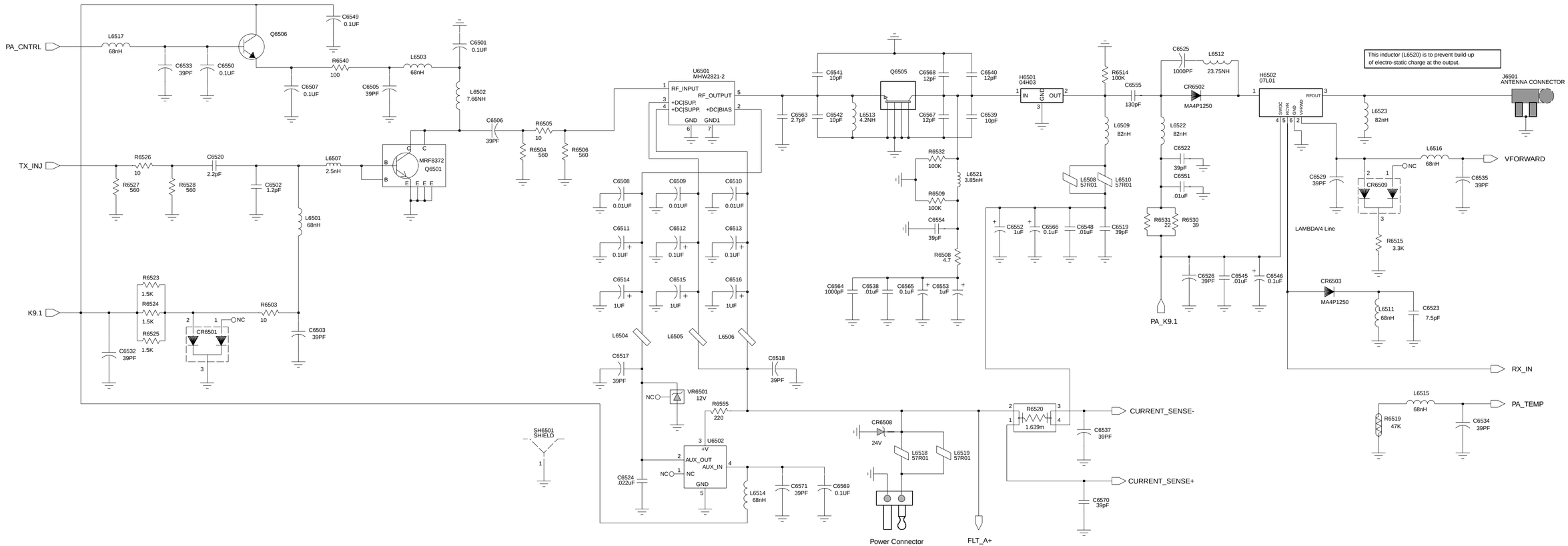
Schematic Diagram for HLF9003A, HLF9004A, HLF9009A & HLF9010A Main Boards, Radio Block Diagram Section



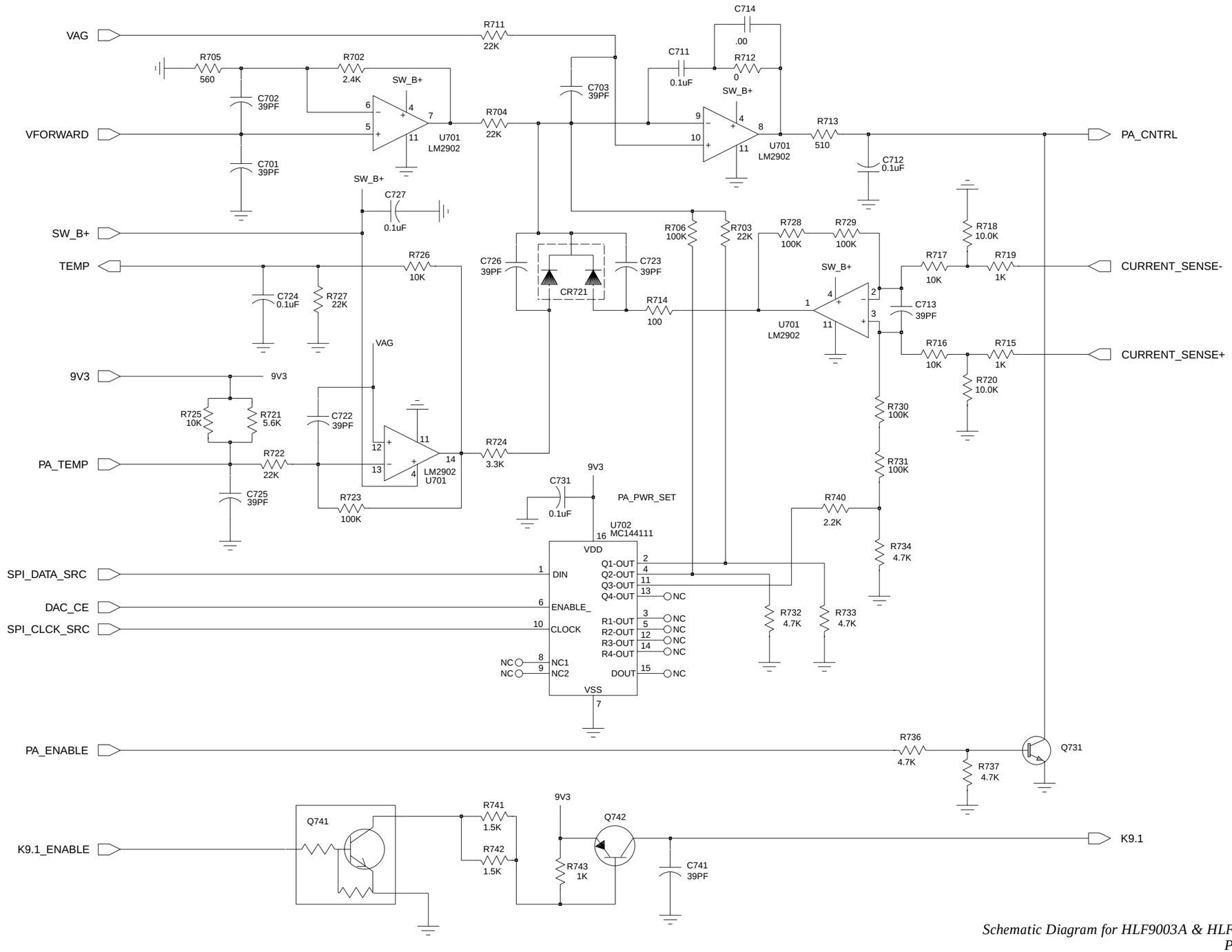
Schematic Diagram for HLF9003A, HLF9004A, HLF9009A & HLF9010A Main Boards, Receiver Section



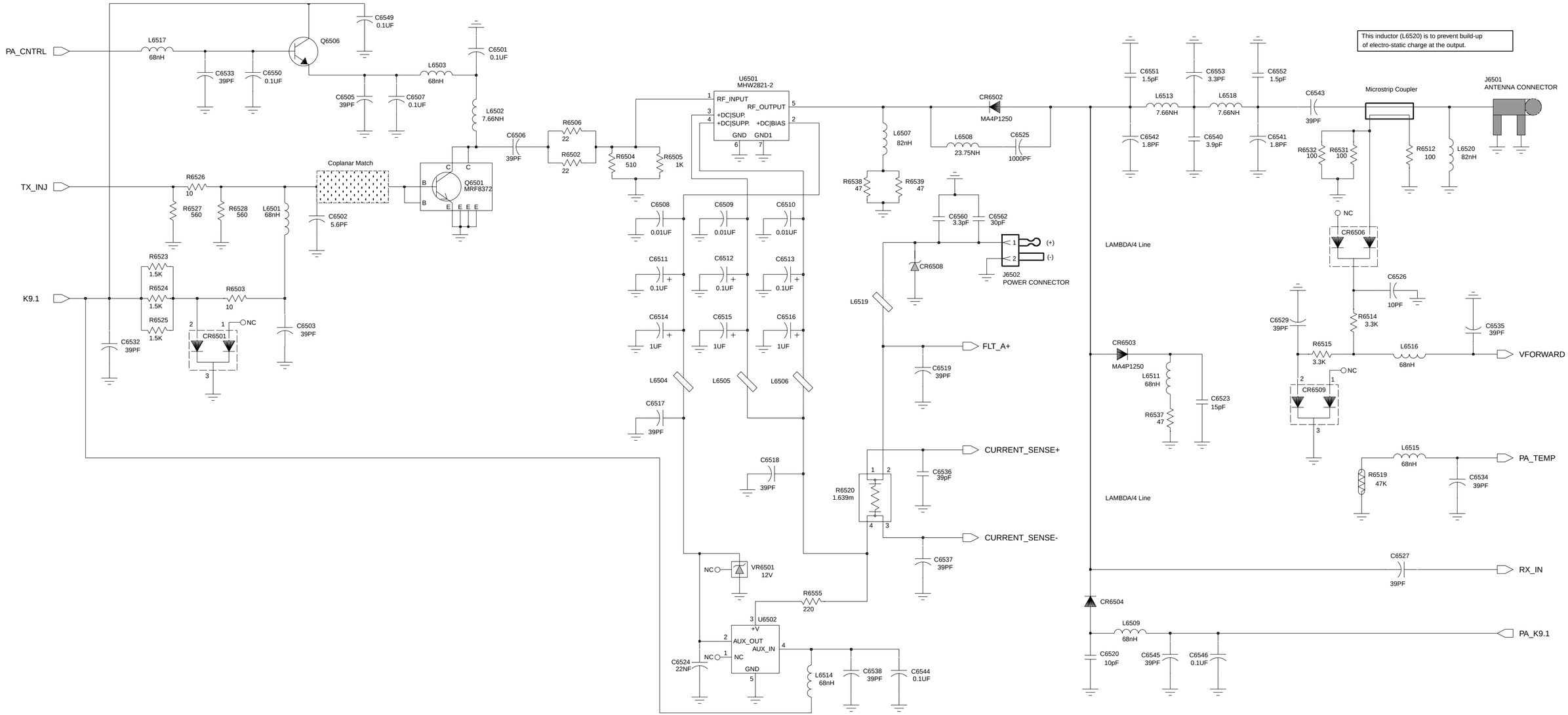
Schematic Diagram for HLF9003A, HLF9004A, HLF9009A & HLF9010A Main Boards, Synthesizer Section



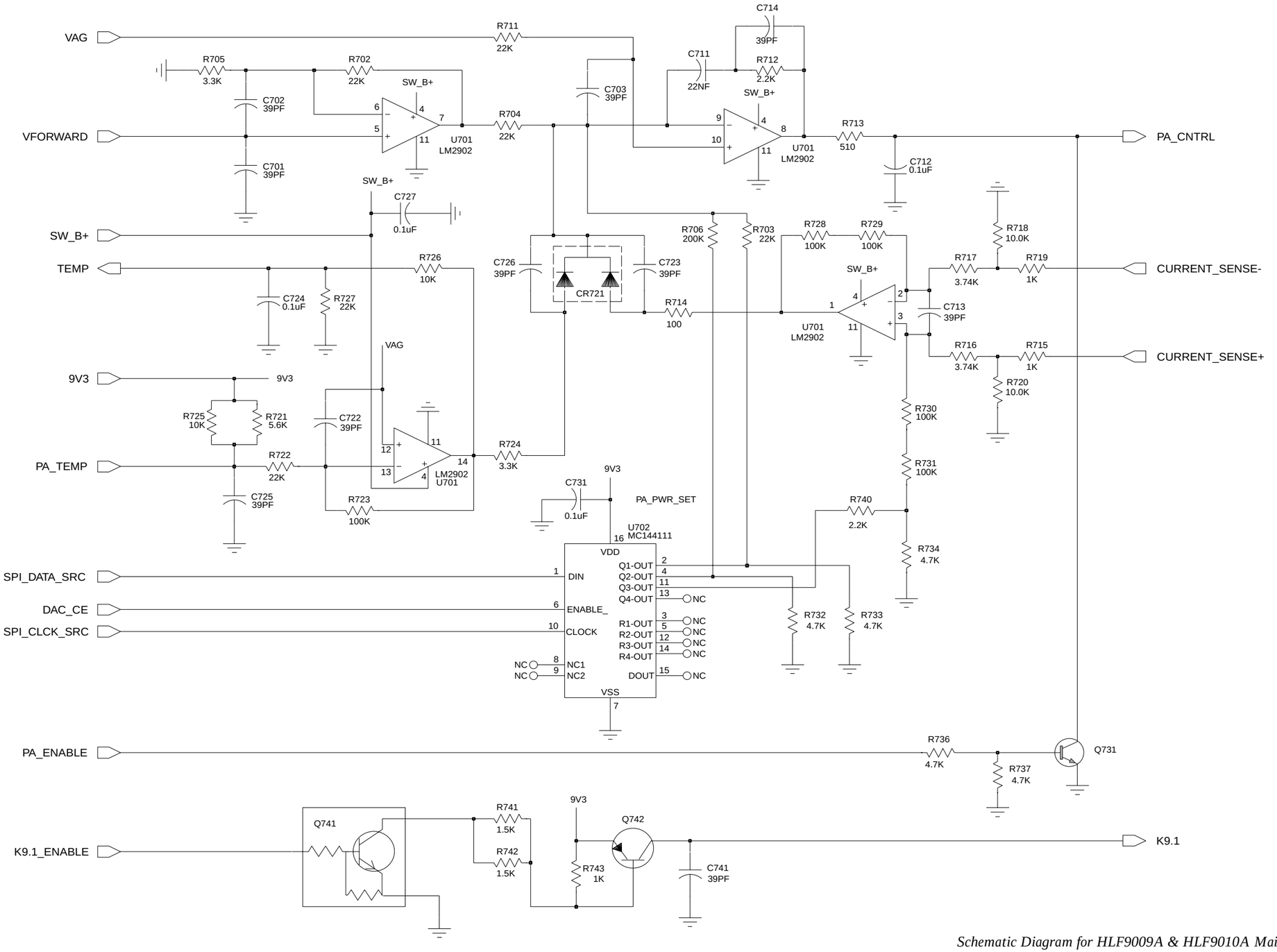
Schematic Diagram for HLF9003A & HLF9004A Main Boards, Power Amplifier Section



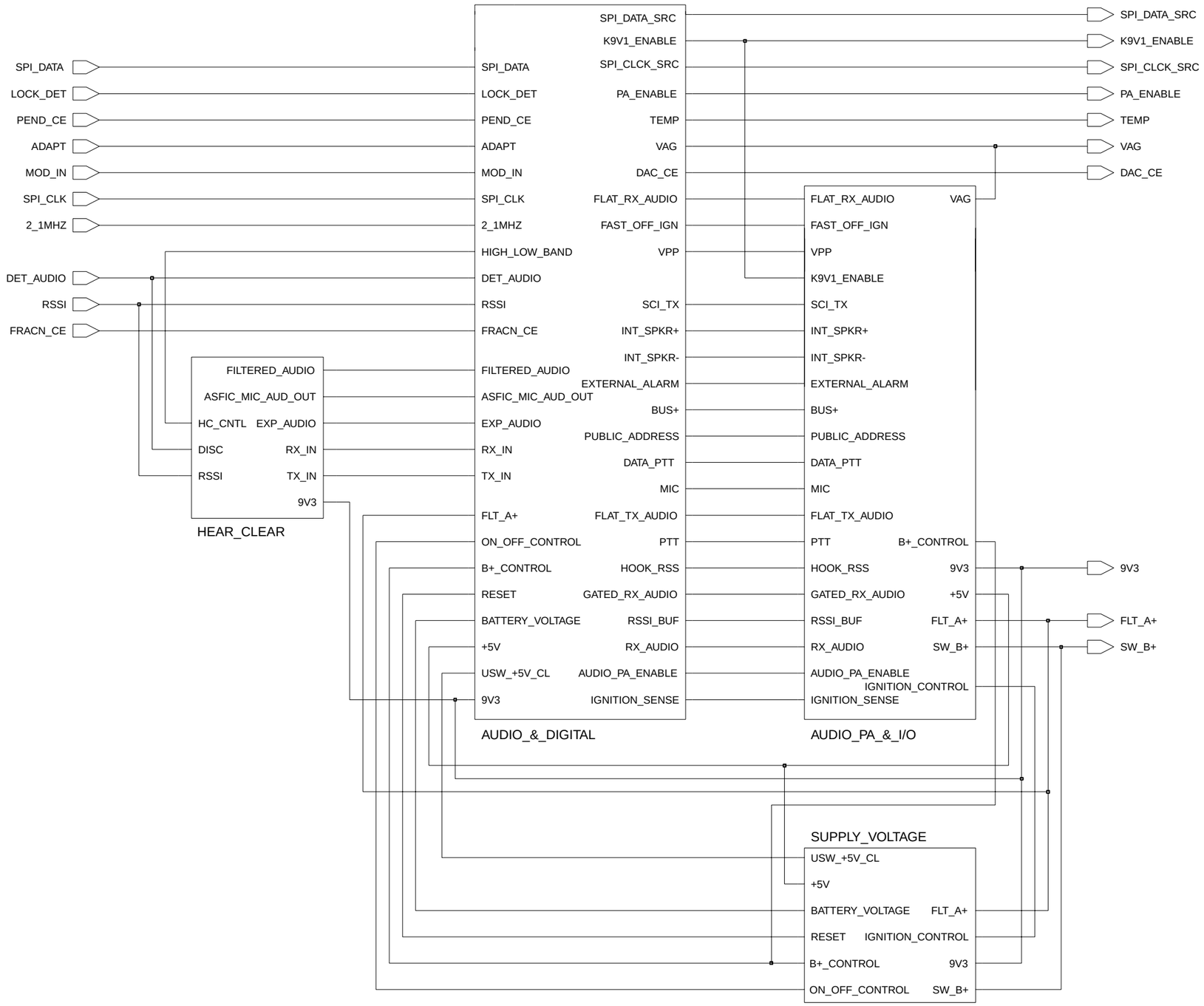
Schematic Diagram for HLF9003A & HLF9004A Main Boards, Power Control Section



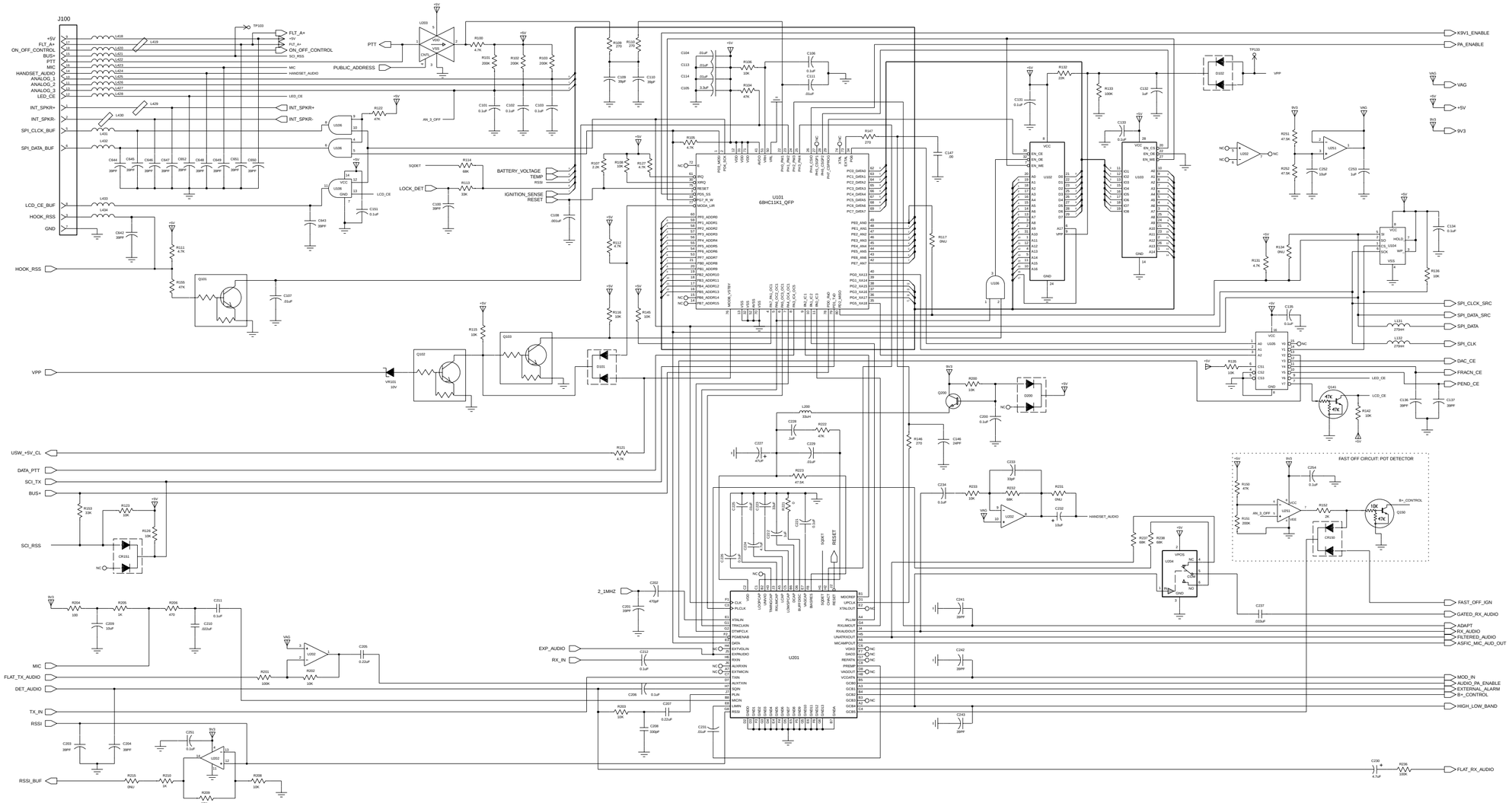
Schematic Diagram for HLF9009A & HLF9010A Main Boards, Power Amplifier Section



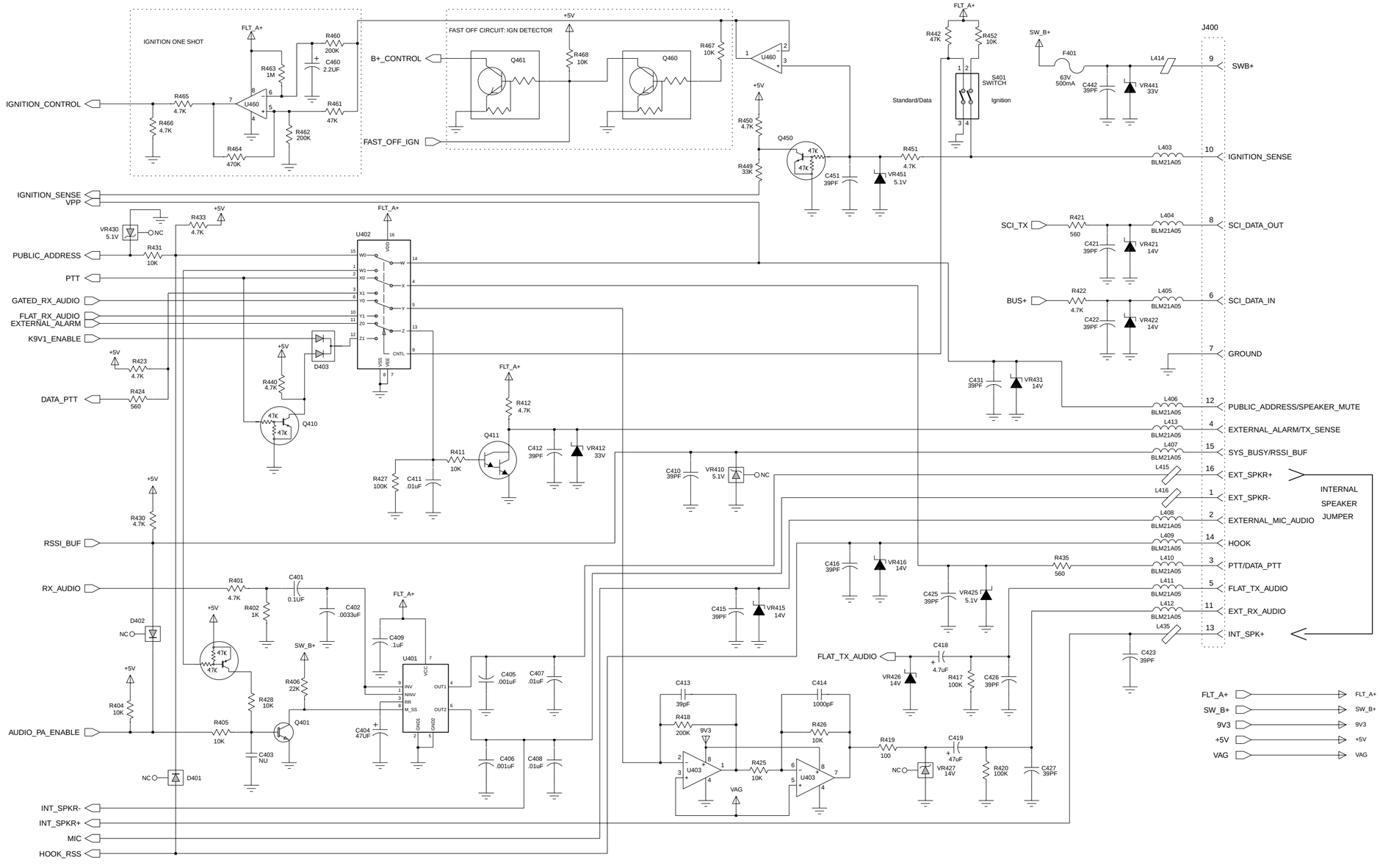
Schematic Diagram for HLF9009A & HLF9010A Main Boards, Power Control Section



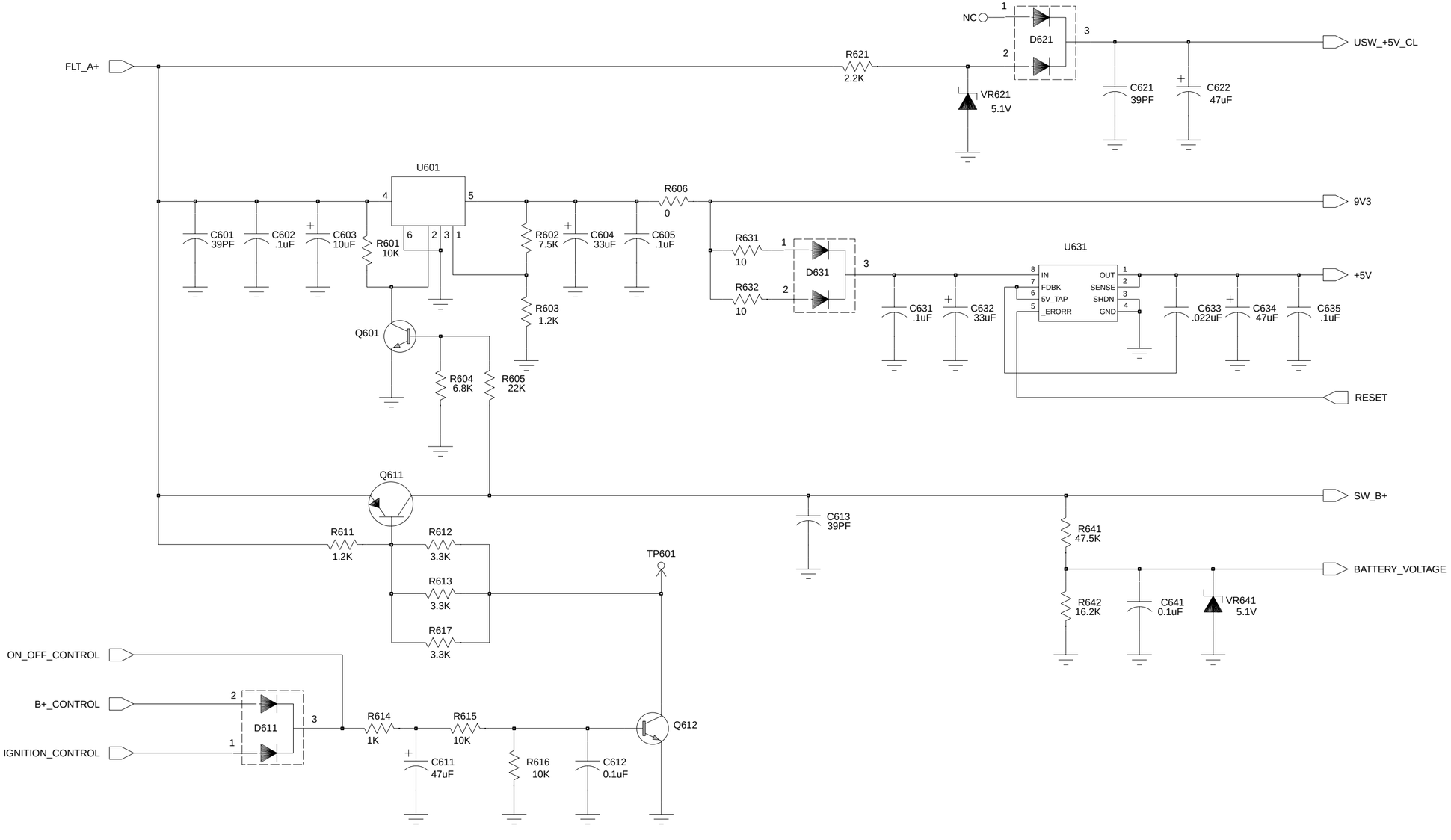
Schematic Diagram for HLF9003A, HLF9004A, HLF9009A & HLF9010A Main Boards, Controller Block Diagram



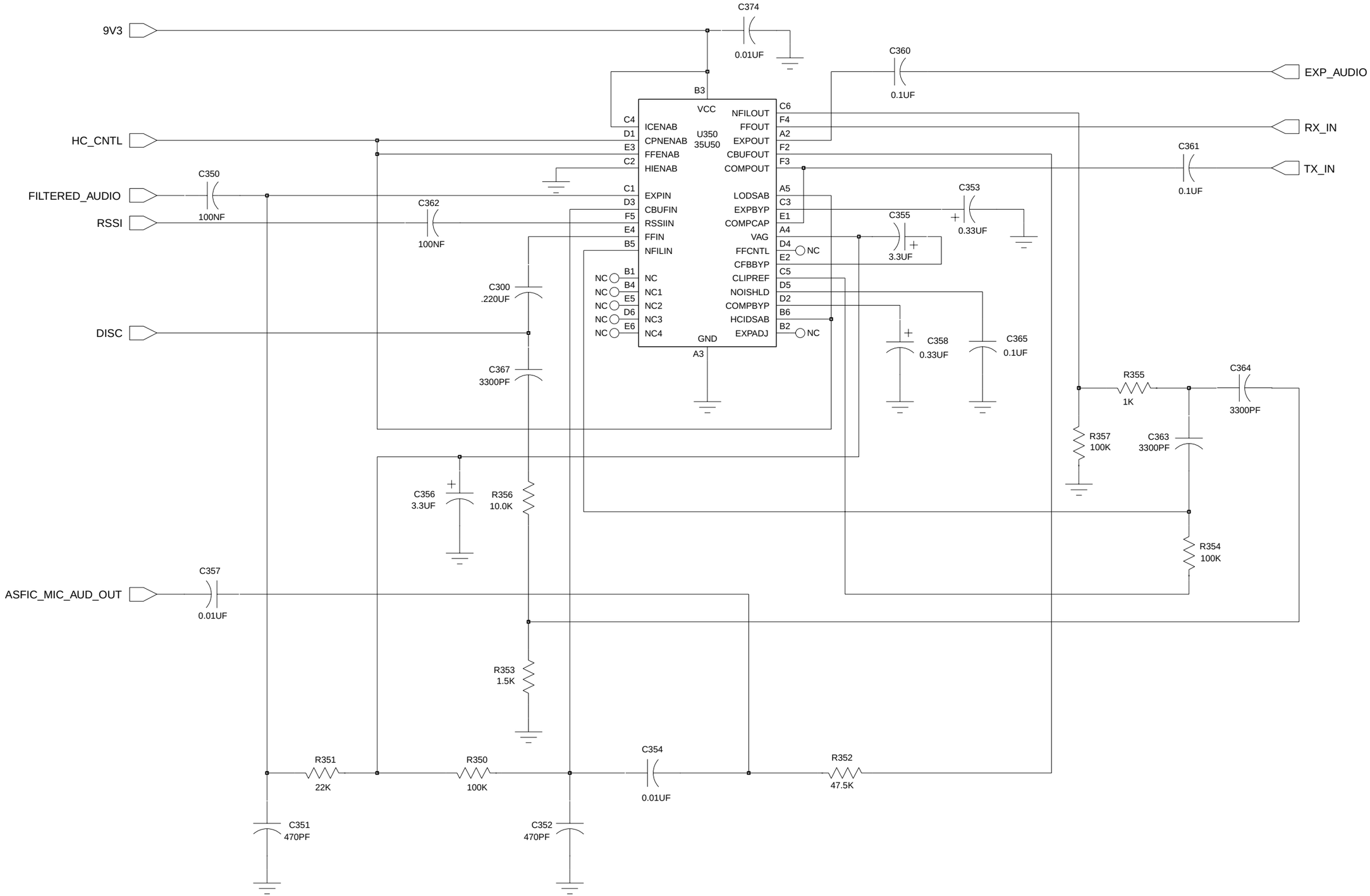
Schematic Diagram for HLF9003A, HLF9004A, HLF9009A & HLF9010A Main Boards, Audio & Digital Controller Section



Schematic Diagram for HLF9003, HLF9004A, HLF9009A & HLF9010A Main Board, Audio PA & I/O Sections



Schematic Diagram for HLF9003A, HLF9004A, HLF9009A & HLF9010A Main Boards, Supply Voltage Section



Schematic Diagram for HLF9003, HLF9004A, HLF9009A & HLF9010A Main Board, Hear Clear Section

Parts List

HLF9003 & HLF9004 Radio, 900 MHz, 30 W — PL-201021-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-15%; 50 V: unless otherwise stated
C100	2113740F41	39 pF
C101 thru 103	2113743K15	ceramic 0.1
C104	2113741F49	0.01
C105	2311049A42	tantalum 3.3 ±10%; 6 V
C106	2113743K15	ceramic 0.1
C107	2113741F49	0.01
C108	2113741F25	1000 pF
C109, 110	2113740F41	39 pF
C111	2113741F49	0.01
C113, 114	2113741F49	0.01
C131	2113743K15	ceramic 0.1
C132	2311049A07	tantalum 1 ±10%; 16 V
C133 thru 135	2113743K15	ceramic 0.1
C136, 137	2113740F41	39 pF
C146	2113740F36	24 pF
C151	2113743K15	ceramic 0.1
C200	2113743K15	ceramic 0.1
C201	2113740F41	39 pF
C202	2113741F17	470 pF
C203, 204	2113741F41	39 pF
C205	2113743F08	ceramic 0.22
C206	2113743K15	ceramic 0.1
C207	2113743F08	ceramic 0.22
C208	2113741F13	330 pF
C209	2311049J26	tantalum 10 ±20%; 16 V
C210	2113741A53	.022 ±10%
C211	2113743A19	0.1 ±10%
C212	2113743K15	ceramic 0.1
C221	2113743K15	ceramic 0.1
C222	2311049A07	tantalum 1 ±10%; 16 V
C223	2113741A57	33 nF
C224	2311049J11	tantalum 4.7 ±10%; 16 V
C225	2113741F49	0.01
C226	2113743K15	ceramic 0.1
C227	2311049J44	tantalum 47 ±20%; 10 V
C228	2311049A01	tantalum 0.1 ±10%; 35 V
C229	2113741F49	0.01
C230	2311049J11	tantalum 4.7 ±10%; 16 V
C231	2113741F49	0.01
C232	2113740F36	24 pF
C233	2113740F39	33 pF
C234	2113743K15	ceramic 0.1
C237	2113741A57	033
C241 thru 243	2113740F41	39 pF
C251	2113743K15	ceramic 0.1
C252	2311049J23	tantalum 10 ±10%; 7 V
C253	2311049A07	tantalum 1 ±10%; 16 V
C254	2113743K15	ceramic 0.1
C300	2113743A23	0.220
C350	2113741A19	100 nF
C351, 352	2113741F17	470 pF
C353	2113749A04	0.33
C354	2113741F49	0.01
C355, 356	2311049A42	tantalum 3.3 ±10%; 6 V
C357	2113741F49	0.01
C358	2311049A04	0.33
C360, 361	2113743K15	ceramic 0.1
C362	2113743J19	100 nF
C363, 364	2113741A33	3300 pF
C365	2113743K15	ceramic 0.1
C367	2113741A33	3300 pF
C374	2113741F49	0.01
C401	2113743K15	ceramic 0.1
C402	2113741F37	3.3 nF
C404	2311049J44	tantalum 47 ±20%; 10 V
C405, 406	2113741F25	1000 pF
C407, 408	2113741F49	0.01
C409	2109720D14	ceramic 0.1; low DIST
C410	2113740F41	39 pF
C411	2113741F49	0.01
C412, 413	2113740F41	39 pF
C414	2113741F25	1000 pF
C415, 416	2113740F41	39 pF
C418	2311049J11	tantalum 4.7 ±10%; 16 V
C419	2311049J44	47
C421 thru 423	2113740F41	39 pF
C425 thru 427	2113740F41	39 pF
C431	2113740F41	39 pF
C442	2113740F41	39 pF
C451	2113740F41	39 pF
C460	2311049A09	tantalum 2.2 ±10%; 20 V
C601	2113740F41	39 pF
C602	2109720D14	ceramic 0.1; low DIST
C603	2380090M24	10 ±20%; 50 V SMT
C604	2311049J40	tantalum 33 ±20%; 16 V
C605	2109720D14	ceramic 0.1; low DIST
C611	2311049C09	tantalum 47 ±10%; 16 V
C612	2113743K15	ceramic 0.1
C613	2113740F41	39 pF
C621	2113740F41	39 pF
C622	2311049J44	tantalum 47 ±20%; 10 V
C631	2109720D14	ceramic 0.1; low DIST
C632	2311049J40	tantalum 33 ±20%; 16 V
C633	2113743E07	22 nF
C634	2311049J44	tantalum 47 ±20%; 10 V
C635	2109720D14	ceramic 0.1; low DIST
C641	2113743K15	ceramic 0.1
C642 thru 652	2113740F41	39 pF
C701 thru 703	2113740F41	39 pF
C711, 712	2113743K15	ceramic 0.1
C713	2113740F41	39 pF
C722, 723	2113740F41	39 pF
C724	2113743K15	ceramic 0.1
C725, 726	2113740F41	39 pF
C727	2113743K15	ceramic 0.1
C731	2113743K15	ceramic 0.1
C741	2113740F41	39 pF
C5200	2113740F41	39 pF
C5201	2113740F14	3 pF
C5202	2113740F29	15 pF
C5203, 5204	2113743K15	ceramic 0.1
C5205	2113740F34	20 pF
C5208	2113743K15	ceramic 0.1
C5211	2113740F32	16 pF
C5212	2113740F30	13 pF
C5213	2113740F40	36 pF
C5214	2113740F17	3.9 pF
C5223	2113743K15	ceramic 0.1
C5224	2113741F29	1500 pF
C5225	2311049A15	tantalum 3.3 ±10%; 16 V
C5226	2113743K05	ceramic .039
C5227	2311049J11	tantalum 4.7 ±10%; 16 V
C5228	2113743K15	ceramic 0.1
C5229	2113740F41	39 pF
C5231	2311049A05	tantalum 0.47 ±10%; 25 V
C5233	2113740F41	39 pF
C5234	2113743K15	ceramic 0.1
C5235 thru 5237	2113740F41	39 pF
C5239	2113740F41	39 pF
C5251	2311049A57	10
C5252	2113743K15	ceramic 0.1
C5308	2113740F23	6.8 pF
C5310	2113740F41	39 pF
C5311	2113741F49	0.01
C5312	2113740F14	3 pF
C5321, 5322	2113740F41	39 pF
C5323 thru 5326	2113741F49	0.01
C5404	2113740F37	27 pF
C5700	2113743E07	ceramic .022
C5701, 5702	2113743K15	ceramic 0.1
C5703	2113740F08	1.8 pF
C5704	2113740F09	1.8 pF
C5705 thru 5708	2113741F41	39 pF
C5709 thru 5711	2113740F51	100 pF
C5712, 5713	2113749J26	tantalum 10 ±20%; 16 V
C5714 thru 5717	2311049J11	tantalum 4.7 ±10%; 16 V
C5718	2311049A14	tantalum 4.7 ±10%; 20 V
C5719	2311049J11	tantalum 4.7 ±10%; 16 V
C5720 thru 5731	2113743K15	ceramic 0.1
C5732 thru 5735	2113743E07	ceramic 22 nF
C5737 thru 5743	2113743E07	ceramic 22 nF
C5744 thru 5747	2109720D01	ceramic 10 nF; low DIST
C5748	2113741F49	0.01
C5750	2105248W02	1.2 nF
C5751	2113741A57	33 nF
C5752 thru 5776	2113740F41	39 pF
C5778, 5779	2113740F41	39 pF
C5781	2113740F15	3.3 pF
C5783	2113740F05	1.2 pF
C5784, 5785	2113740F11	2.2 pF
C5786	2113740F12	2.4 pF
C5787, 5788	2113740F51	100 pF side, entry
C5789	2113740F12	2.4 pF
C5790	2113740F13	2.7 pF
C5791	2113740F03	1 pF
C5792, 5793	2113740F11	2.2 pF
C5794	2113740F41	39 pF
C5795	2113740F51	100 pF
C5796 thru 5799	2109720D14	ceramic 0.1; low DIST
C5802, 5803	2109720D14	ceramic 0.1; low DIST
C5804 thru 5806	2113743K15	ceramic 0.1
C5810, 5811	2113740F41	39 pF
C5813, 5814	2113740F41	39 pF
C6501	2113743K15	ceramic 0.1
C6502	2109720D14	ceramic 0.1; low DIST
C6503	2113740F41	39 pF
C6505, 6506	2113740F41	39 pF
C6507	2113743K15	ceramic 0.1
C6508 thru 6510	2113741F49	0.01
C6511 thru 6513	2311049A01	tantalum 0.1 ±10%; 35 V
C6514 thru 6516	2311049A08	tantalum 1 ±10%; 35 V
C6517 thru 5719	2113740F41	39 pF
C6520	2113740F15	2.2 pF
C6522	2113740F41	39 pF
C6523	2113740F24	7.5 pF
C6524	2113743E07	ceramic .022
C6525	2113741F25	1000 pF
C6526	2113740F41	39 pF
C6529	2113740F41	39 pF
C6532 thru 6535	2113740F41	39 pF
C6537	2113740F41	39 pF
C6538	2113741F49	.01
C6539	2113740F31	15 pF
C6540	2113742B23	12 pF
C6541, 6542	2113742B22	10 pF
C6545	2113741F49	.01
C6546	2311049A01	tantalum 0.1 ±10%; 35 V
C6548	2113741F49	.01
C6549, 6550	2113743K15	ceramic 0.1
C6551	2113741F49	.01
C6552, 6553	2311049A08	1
C6554	2113740B39	39 pF
C6555	2311049A15	tantalum 3.3 ±10%; 16 V
C6563	2111078A15	2.7 pF
C6564	2113741F25	1000 pF
C6565, 6566	2311049A01	tantalum 0.1 ±10%; 35 V
C6567, 6568	2113742B23	12 pF
C6569	2113743K15	ceramic 0.1
C6570, 6571	2113740F41	39 pF
		diode: (see note 1)
CR150, 151	4813833C02	dual 70 V common cathode
CR721	4813833C02	dual 70 V common cathode
CR5700	4802233J09	triple SOT 143-RH
CR5701, 5702	4862824C01	varactor
CR6501	4813833C02	dual 70 V common cathode
CR6502, 6503	4802482J02	pin diode SMD
CR6508	4813832B35	transient suppressor SMT
CR6509	4805218N57	dual Schottky common cathode
D101, 102	4813833C02	dual 70 V common cathode
D200	4813833C02	dual 70 V common cathode
D401, 402	4880939T01	silicon SMT
D403	4813833C02	dual 70 V common cathode
D611	4813833C02	dual 70 V common cathode
D621	4813833C02	dual 70 V common cathode
D631	4813833C02	dual 70 V common cathode
D5201	4813740F41	39 pF
D5303	4880154K03	dual Schottky
		fuse:
F401	6585711L05	63 V, 500 mA SMT
		filter:
FL5201	9185747L01	455 kHz ceramic filter
FL5202	9180098D14	455 kHz ceramic filter
FL5203, 5204	9102603S25	938 MHz ceramic filter
		hybrid:
H6501	0108704H03	matching hybrid
H6502	5185807L01	harmonic filter hybrid
		connector, receptacle:
J100	0902636Y01	flexible cable, side entry
J400	2804503J01	accessory 16-pin
J6500	3080562V01	power cable
J6501	0905901V06	antenna
J6502	3080562V01	power cable
		coil, rf:
L131, 132	2462587Q40	inductor 270 nH 10%
L200	2462587P30	inductor 33 nH 10%
L403 thru 413	2402601S05	inductor BLM21A05
L414 thru 416	2484657R01	ferrite bead
L418	2402601S05	inductor BLM21A05
L419	2484657R01	ferrite bead
L420 thru 428	2402601S05	inductor BLM21A05
L429, 430	2484657R01	ferrite bead
L431 thru 434	2402601S05	inductor BLM21A05
L435	2484657R01	ferrite bead
L5201	2462587M19	inductor 1200 nH 5%, low PRO
L5203	2462587T30	inductor 1.0 uH
L5211	2483411T74	inductor 1.2 mH
L5302	2413926E09	inductor 6.8 nH 5%
L5321	2460591A01	inductor 4.2 nH
L5322	2462587T12	inductor 56 nH 5%, low PRO
L5401, 5402	2483411T69	inductor 0.47 mH
L5700 thru 5704	2462587T30	inductor 1.0 uH 5%, low PRO
L5705, 5706	2462587T17	inductor 150 nH 5%, low PRO
L5707	2462587T30	inductor 1.0 uH 5%, low PRO
L5708	2462587T17	inductor 150 nH 5%, low PRO
L5709	2462587Q44	inductor 560 nH 10%
L6501	2462587T13	inductor 68 nH 5%, low PRO
L6502	2460591A11	inductor 7.66 nH air wound
L6503	2462587T13	inductor 68 nH 5%, low PRO
L6504 thru 6506	2484657R01	ferrite bead
L6507	2484562T01	inductor 2.5 nH
L6508	2484657R01	ferrite bead
L6509	2460591R53	inductor 82 nH
L6510	2484657R01	ferrite bead
L6511	2462587T13	inductor 68 nH 5%, low PRO
L6512	2460591E24	inductor 23.75 nH air wound
L6513	2460591A01	inductor 4.2 nH
L6514 thru 6517	2462587T13	inductor 68 nH 5%, low PRO
L6518, 6519	2484657R01	ferrite bead
L6521	2409348J03	inductor 3.85 nH
L6522, 6523	2460591R53	inductor 82 nH air wound
		transistor: (see note 1)
Q101 thru 103	4880048M01	NPN DTC144EK
Q141	4880048M01	NPN DTC144EK
Q150	4882033T01	NPN DTC114YK
Q200	4880214G02	NPN MMBT3904
Q401	4880214G02	NPN MMBT3904
Q410, 411	4880048M01	NPN DTC144EK
Q415	4880494U01	PNP DTA144EKA
Q450	4880048M01	NPN DTC144EK
Q460, 461	4880048M01	NPN DTC144EK
Q601	4880214G02	NPN MMBT3904
Q611	4805128M27	PNP BSR33
Q612	4880214G02	NPN MMBT3904
Q731	4880214G02	NPN MMBT3904
Q741	4880048M01	NPN DTC144EK
Q742	4805128M27	PNP BSR33
Q5201	4813827A07	NPN MMBR941T1
Q5230	4813824A17	PNP 3906L
Q5301	4813827A18	NPN MRF9411LT1
Q5700	4880048M01	NPN DTC144EK
Q5701	4813824A17	PNP 3906L
Q5702 thru 5704	4809527E01	NPN RF NE85663
Q5705	4804188K01	NPN RF NE85634
Q5706, 5707	4809527E01	NPN RF NE85663
Q6501	4813827A26	NPN RF MRF8372
Q6505	4880225C20	NPN RF MRF847
Q6506	4813824B01	PNP 2222AT1
		resistor, fixed: +/-5%; 1/8 W: unless otherwise stated
R100	2662057A65	4.7k
R101 thru 103	2662057B05	200k
R104	2662057A89	47k
R105	2662057A65	4.7k
R106	2662057A73	10k
R107	2662057A57	2.2k
R108	2662057A73	10k
R109, 110	2662057A35	270 ohm
R111, 112	2662057A65	4.7k
R113	2662057A85	33k
R114	2662057A93	68k
R115, 116	2662057A73	10k
R121	2662057A65	4.7k
R122	2662057A89	47k
R123	2662057A73	10k
R126	2662057A73	10k
R127	2662057A65	4.7k
R131	2662057A85	4.7k
R132	2662057A81	22k
R133	2662057A97	100k
R135, 136	2662057A73	10k
R142	2662057A73	10k
R145	2662057A73	10k
R146, 147	2662057A35	270
R150	2662057A89	47k
R151	2662057B05	200k
R152	2662057A56	2k
R153	2662057A56	2k
R155	2662057A89	47k
R200	2662057A73	10k
R201	2662057A97	100k
R202, 203	2662057A73	10k
R204	2662057A73	10k
R205, 206	2662057A49	1k
R206	2662057A41	470 ohm
R208, 209	2662057A73	10k
R210	2662057A49	1k
R221	2662057B47	0 ohm
R222	2662057A89	47k
R223	2662057R92	47.5k ±1%; 1/10 W
R232	2662057A93	68k
R233	2662057A73	10k
R236	2662057A97	100k
R237, 238	2662057A93	68k
R251, 252	2662057R92	47.5k ±1%; 1/10 W
R350	2662057G13	100k
R351	2662057A81	22k
R352	2662057R92	47.5k
R353	2662057A53	5.6k
R354	2662057G13	100k
R355	2662057A73	10k
R356	2662057R60	10.0k
R357	2662057A97	100k
R401	2662057A65	4.7k
R402	2662057A49	1k
R404, 405	2662057A73	10k
R406	2662057A81	22k
R411	2662057A73	10k
R412	2662057A65	4.7k
R417	2662057A97	100k
R418	2662057B05	200k
R419	2662057A29	100 ohm
R420	2662057A97	100k
R421	2662057A63	51 ohm
R424, 425	2662057A65	4.7k
R426	2662057A63	560 ohm
R427	2662057A97	100k
R428	2662057A73	10k
R430	2662057A65	4.7k
R431	2662057A73	10k
R435	2662057A63	560 ohm
R440	2662057A65	4.7k
R442	2662057A89	47k
R449	2662057A85	33k
R450, 451	2662057A65	4.7k
R452	2662057A73	10k
R460	2662057B05	200k
R461	2662057A89	47k
R462	2662057B05	200k
R463	2662057B22	1M
R464	2662057B14	470k
R465, 466	2662057A65	4.7k
R467, 468	2662057A73	10k
R601	2662057A73	10k
R602	2662057R92	7.53k ±1%; 1/10 W
R603	2662057R31	1.21k
R604	2662057A91	6.8k
R605	2662057A81	22k
R606	2662057B47	0 ohm
R607	2662057A51	1.2k
R612, 613	2662057C87	3.3k
R614	2662057A49	1k
R615, 616	2662057A73	10k
R617	2662057C87	3.3k
R631, 632	2662057A57	2.2k
R641	2662057A01	10 ohm
R642	2662057R92	47.5k
R643	2662057R67	16.2k
R702	2662057A58	2.4k
R703, 704	2662057A81	22k
R705	2662057A43	560 ohm
R706	2662057A97	100k
R711	2662057A81	22k
R712	2662057B47	0 ohm
R713	2662057A42	510 ohm
R714	2662057A25	100 ohm
R715	2662057R30	1k ±1%; 1/10 W
R716 thru 718	2662057R60	10.0k ±1%; 1/10 W
R719	2662057A25	100 ohm
R720	2662057R60	10.0k ±1%; 1/10 W
R721	2662057A67	5.6k
R722	2662057A81	22k
R723	2662057A97	100k
R724	2662057A25	3.3k
R725, 726	2662057A73	10k
R727	2662057A81	22k
R728 thru 731	2662057A73	10k ±1%
R732 thru 734	2662057A65	4.7k
R736, 737	2662057A65	4.7k
R740	2662057A57	2.2k
R741, 742	2662057A53	1.5k
R743	2662057A49	1k
R5201	2662057A76	13k
R5202	2662057A85	33k
R5203	2662057A69	6.8k
R5204	2662057A25	100
R5205	2662057A56	2k
R5207	2662057B47	0 ohm
R5211	2662057A47	820 ohm
R5212	2662057A53	5.6k
R5221	2662057B01	130k
R5223	2662057A70	7.5k
R5224	2662057A76	13k
R5230	2662057A89	47k
R5240	6883957A65	100 ohm
R5241	2662057B47	0 ohm
R5302	2662057A73	10k
R5306	2662057A29	150 ohm
R5311, 5312	2662057A76	13k
R5321	2662057A25	220 ohm
R5322	2662057A01	10 ohm
R5323	2662057B05	300 ohm
R5324, 5325	2662057A29	390 ohm
R5327	2662057B47	0 ohm
R5401	2662057A53	5.6k
R5700	2662057A57	2.2k
R5703	2662057A73	10k
R5704	2662057A97	330 ohm
R5705	2662057A73	10k
R5706	2662057A73	510 ohm
R5707	2662057A61	3.3k
R5708, 5709	2662057B05	200k
R5710	2662057A65	4.7k
R5711 thru 5713	2662057A65	4.7k
R5714	2662057A70	7.5k
R5715	2662057A57	2.2k
R5716	2662057A58	2.4k
R5717	2662057A65	4.7k
R5718	2662057A53	1.5k
R5719	2662057A25	100 ohm
R5728	2662057A37	330 ohm
R5729	2662057A29	150 ohm
R5731 thru 5733	2662057A25	100 ohm
R5734 thru 5736	2662057A18	51 ohm
R5737, 5738	2662057A09	22 ohm
R5739, 5740	2662057A18	51 ohm
R5741	2662057A01	10 ohm
R5742	2662057A69	6.8k
R5743	2662057A73	10k
R5744, 5745	2662057A31	180 ohm
R5746	2662057A73	10k
R5747	2662057A69	6.8k
R5748	2662057A09	22 ohm
R5750, 5751	2662057A59	2.7k
R5752	2662057A37	330 ohm
R5753	2662057A13	33 ohm
R5754	2662057A37	330 ohm
R5755	2662057A57	2.2k
R5756, 5757	2662057A35	270 ohm
R6503	2662057A01	10 ohm
R6504	2662057C69	560 ohm
R6505	2662057C27	10 ohm
R6506	2662057C69	560 ohm
R6508	0683962T17	4.7 ohm
R6509	0662057G13	100k
R6514	0662057G13	100k
R6515	0662057A61	3.3k
R6519	0683631L01	therm 47k
R6520	1705603W01	shunt, 1.639 mH
R6523 thru 6525	0662057A53	1.5k
R6526	0662057A01	10
R6527, 6528	0662057A43	560
R6530	0662057A15	39
R6531	0662057A09	22
R6532	0662057G13	100k
R6540	0680158A25	100
R6555	0662057A33	220
		switch:
S401	4085797L01	2-position
		shield:
E5700	2602660J02	MMIC shield
E5701	2604668E02	VCO shield
E5702, 5703	2602660J02	buffer shield
E5704	2680526L01	synthesizer shield
SH5201	2602561V01	LNA shield
SH5202, 5203	2605417V01	mixer shield
SH6501	2680567V01	RF power module shield
		integrated circuit: (see note 1)
U101	5180421V01	MC68HC11K1
U102	5180444S61	FLASH memory
U103	5185963A21	SRAM
U104	5180444S49	EEPROM
U105	5113805A30	1 of 8 DCD/demux 74HC138
U106	5113808A07	AND quad 2 INP MC74AC08D
U201	5105835U45	ASFIC
U202	5113819A04	quad op-amp
U203	5109522E13	switch SPDT
U204	5109781E79	switch SDT
U251	5113819A03	dual op-amp
U350	5105835U50	hear clear IC
U401	5106999X01	audio PA
U402	5180173M02	switch SPDT
U403	5113818A10	dual op-amp
U460	5113818A03	dual op-amp
U601	5105625U25	9.3 V regulator LM2941
U631	5105469E65	voltage regulator LP2951AC
U701	5113819A02	quad op-amp
U702	5113811G02	DA converter 6-bit 4-ch. with SPI
U5201	5180207R01	IFIC
U5211	5185670L01	mixer DBL balanced
U5700	5105279V31	16.8 MHz ref. oscillator mode
U5701	5105109Z59	MMIC
U5702	5105457W46	frac-N synthesizer
U5703	5113816A07	regulator 5 V 500 mA MC78M05BDT
U5704, 5705	4805921T02	switch FMC2
U5706, 5707	4804122K04	microstrip low resonator
U6501	5113829D23	890-950 MHz, 18 W, 12.5 V
U6502	4805921T02	switch FMC2
		Zener diode: (see note 1)
VR101	4813830A23	10 V 5%; 225 mW MMBZ5240BL
VR410	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR412	4813830A40	33 V 5%; 225 mW MMBZ5257B
VR415, 416	4813830A27	14 V 5%; 225 mW MMBZ5244L
VR421, 422	4813830A27	14 V 5%; 225 mW MMBZ5244L
VR425	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR426, 427	4813830A27	14 V 5%; 225 mW MMBZ5244B
VR430	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR431	4813830A27	14 V 5%; 225 mW MMBZ5244L
VR441	4813830A40	33 V 5%; 225 MMBZ5257B
VR451	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR621	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR641	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR650	14813830A25	12 V 5%; 225 mW MMBZ5242B
		crystal: (see note 2)
Y5201	9102651Y01	filter 45.1 MHz
Y5202	9102651Y02	filter 45.1 MHz

HLF9003 & HLF9004 Radio, 900 MHz, 30 W — PL-201021-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
YS211	4802653Y01	resonator 44.6450 MHz

notes:
1. For optimum performance, diodes, transistors and integrated circuits must be ordered by MOTOROLA part numbers.
2. When ordering quartz crystal units or ceramic resonators, specify carrier frequency, crystal (or resonator) frequency, and crystal (or resonator) type number.

Parts List for HLF9003A & HLF9004A Main Boards

Parts List

HLF9009A & HLF9010A Radio, 900 MHz, 12 W — PL-20102-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-15%; 50 V: unless otherwise stated
C100	2113740F41	39 pF
C101 thru 103	2113743K15	ceramic 0.1
C104	2113741F49	0.01
C105	2311049A42	tantalum 3.3 ±10%; 6 V
C106	2113743K15	ceramic 0.1
C107	2113741F49	0.01
C108	2113741F25	1000 pF
C109, 110	2113740F41	39 pF
C111	2113741F49	0.01
C113, 114	2113741F49	0.01
C131	2113743K15	0.1
C132	2311049A07	tantalum 1 ±10%; 16 V
C133 thru 135	2113743K15	ceramic 0.1
C136, 137	2113740F41	39 pF
C146	2113740F36	24 pF
C151	2113743K15	ceramic 0.1
C200	2113743K15	0.1
C201	2113740F41	39 pF
C202	2113741F17	470 pF
C203, 204	2113740F41	39 pF
C205	2113743F08	ceramic 0.22
C206	2113743K15	ceramic 0.1
C207	2113743F08	ceramic 0.22
C208	2113741F13	330 pF
C209	2311049J26	tantalum 10 ±20%; 16 V
C210	2113741A53	.022 ±10%
C211, 212	2113743A09	0.1 ±10%
C221	2113743K15	ceramic 0.1
C222	2311049A07	tantalum 1 ±10%; 16 V
C223	2113741A57	33 nF
C224	2311049J11	tantalum 4.7 ±20%; 10 V
C225	2113741F49	0.01
C226	2113743K15	ceramic 0.1
C227	2311049J44	tantalum 47 ±20%; 10V
C228	2311049A01	tantalum 0.1 ±10%; 35 V
C229	2113741F49	0.01
C230	2311049J11	tantalum 4.7 ±10%; 16 V
C231	2113741F49	0.01
C232	2311049J26	10
C233	2113740F39	33 pF
C234	2113743K15	ceramic 0.1
C237	2113741A57	.033
C241 thru 243	2113740F41	39 pF
C251	2113743K15	ceramic 0.1
C252	2311049J23	tantalum 10 ±10%; 7 V
C253	2311049A07	tantalum 1 ±10%; 16 V
C254	2113743K15	ceramic 0.1
C255	2113743K15	0.220
C350	2113743A19	100 nF
C351, 352	2113741F17	470 pF
C353	2311049A04	0.33
C354	2113741F49	0.01
C355, 356	2311049A42	3.3
C357	2113741F49	0.01
C358	2311049A04	0.33
C360, 361	2113743K15	ceramic 0.1
C362	2113743A19	100 nF ±10%
C363, 364	2311741A33	3300 pF
C365	2113743K15	ceramic 0.1
C367	2113741A33	3300 pF
C374	2113741F49	0.01
C401	2113743K15	ceramic 0.1
C402	2113741F37	4.7 nF
C404	2311049J44	tantalum 47 ±20%; 10 V
C405, 406	2113741F25	1000 pF
C407, 408	2113741F49	0.01
C409	2109720D14	ceramic 0.1; low DIST
C410	2113740F41	39 pF
C411	2113741F49	0.01
C412, 413	2113740F41	39 pF
C414	2113741F25	1000 pF
C415, 416	2113740F41	39 pF
C418	2311049J11	tantalum 4.7 ±10%; 16 V
C419	2311049J44	tantalum 47 ±20%; 10 V
C421 thru 423	2113740F41	39 pF
C425 thru 427	2113740F41	39 pF
C431	2113740F41	39 pF
C442	2113740F41	39 pF
C451	2113740F41	39 pF
C460	2311049A09	tantalum 2.2 ±10%; 20 V
C601	2113740F41	39 pF

HLF9009A & HLF9010A Radio, 900 MHz, 12 W — PL-21022-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C602	2109720D14	ceramic 0.1; low DIST
C603	2380090M24	10 ±20%; 50 V SMT
C604	2311049J40	tantalum 33 ±20%; 16 V
C605	2109720D14	ceramic 0.1; low DIST
C611	2311049C05	tantalum 47 ±10%; 16 V
C612	2113743K15	ceramic 0.1
C613	2113740F41	39 pF
C621	2113740F41	39 pF
C622	2311049J44	tantalum 47 ±10%; 16 V
C631	2109720D14	ceramic 0.1
C632	2311049J40	tantalum 33 ±20%; 16 V
C633	2113743E07	22 nF
C634	2311049J44	tantalum 47 ±20%; 16 V
C635	2109720D14	ceramic 0.1
C641	2113743K15	ceramic 0.1
C642 thru 652	2113740F41	39 pF
C701 thru 703	2113740F41	39 pF
C711	2113743E07	22 nF
C712	2113743K15	ceramic 0.1
C713, 714	2113740F41	39 pF
C722, 723	2113740F41	39 pF
C724	2113743K15	ceramic 0.1
C725, 726	2113740F41	39 pF
C727	2113743K15	ceramic 0.1
C731	2113743K15	ceramic 0.1
C741	2113740F41	39 pF
C5200	2113740F35	22 pF
C5201	2113740F14	3 pF
C5202	2113740F31	15 pF
C5203, 5204	2113743K15	ceramic 0.1
C5205	2113740F34	20 pF
C5208	2113743K15	ceramic 0.1
C5211	2113740F32	16 pF
C5212	2113740F30	12 pF
C5213	2113740F40	36 pF
C5214	2113740F17	3.9 pF
C5223	2113743K15	ceramic 0.1
C5224	2113741F29	1500 pF
C5225	2311049A11	tantalum 3.3 ±10%; 16 V
C5226	2113743K05	.039
C5227	2311049J11	tantalum 4.7 ±10%; 16 V
C5228	2113743K15	ceramic 0.1
C5229	2113740F41	39 pF
C5231	2311049A05	tantalum 0.47 ±10%; 25 V
C5233	2113740F41	39 pF
C5234	2113743K15	ceramic 0.1
C5235 thru 5237	2113740F41	39 pF
C5239	2113740F41	39 pF
C5251	2311049A57	10
C5252	2113743K15	ceramic 0.1
C5308	2113740F23	6.8 pF
C5310	2113740F41	39 pF
C5311	2113741F49	0.01
C5312	2113740F14	3 pF
C5321, 5322	2113740F41	39 pF
C5323 thru 5326	2113741F49	0.01
C5404	2113740F37	27 pF
C5700	2113743E07	ceramic .022
C5701, 5702	2113743K15	ceramic 0.1
C5703	2113740F08	1.6 pF
C5704	2113740F09	1.8 pF
C5705 thru 5708	2113740F41	39 pF
C5709 thru 5711	2113740F51	100 pF
C5712, 5713	2311049J26	tantalum 10 ±20%; 16 V
C5714 thru 5717	2311049J11	tantalum 4.7 ±10%; 16 V
C5718 thru 5731	2311049A14	tantalum 4.7 ±10%; 20 V
C5734 thru 5735	2113743E07	ceramic 22 nF
C5737 thru 5743	2113743E07	ceramic 22 nF
C5744 thru 5747	2109720D01	ceramic 10 nF; low DIST
C5748	2113741F49	0.01
C5750	2105248W02	1.2 nF
C5751	2113741A57	33 nF
C5752 thru 5779	2113740F41	39 pF
C5782	2113740F15	3.3 pF
C5783	2113740F05	1.2 pF
C5784, 5885	2113740F11	2.2 pF
C5786	2113740F12	2.4 pF
C5787, 5788	2113740F51	100 pF
C5789	2113740F12	2.4 pF
C5790	2113740F13	2.7 pF
C5791	2113740F03	1 pF
C5792, 5793	2113740F11	2.2 pF
C5794	2113740F41	39 pF

HLF9009A & HLF9010A Radio, 900 MHz, 12 W — PL-21022-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C5795	2113740F51	100 pF
C5796 thru 5799	2109720D14	ceramic 0.1; low DIST
C5802, 5803	2109720D14	ceramic 0.1; low DIST
C5804 thru 5806	2113743K15	0.1
C5810, 5811	2113740F41	39 pF
C5813, 5814	2113740F41	39 pF
C6501	2113743K15	ceramic 0.1
C6502	2113740F21	5.6 pF
C6503	2113740F41	39 pF
C6505, 6506	2113740F41	39 pF
C6507	2311049J40	tantalum 33 ±20%; 16 V
C6508 thru 6510	2113741F49	0.01
C6511 thru 6513	2311049A01	tantalum 0.1 ±10%; 35 V
C6514 thru 6516	2311049A08	tantalum 1 ±10%; 35 V
C6517 thru 6519	2113740F41	39 pF
C6520	2113740F27	10 pF
C6523	2113740F31	15 pF
C6524	2113743E07	ceramic 22 nF
C6525	2113741F25	1000 pF
C6526	2113740F27	10 pF
C6527	2113740F41	39 pF
C6529	2113740F41	39 pF
C6532 thru 6538	2113740F41	39 pF
C6540	2113743K15	ceramic 0.1
C6541, 6542	2111078A09	1.8 pF
C6543	2113742B29	39 pF
C6544	2113743K15	ceramic 0.1
C6545	2113740F41	39 pF
C6546	2113743K15	ceramic 0.1
C6549, 6550	2113743K15	ceramic 0.1
C6551, 6552	2111078A06	1.5 pF
C6553	2111078A17	3.3 pF
C6560	2113740F15	3.3 pF
C6562	2113740F38	30 pF
		diode: (see note 1)
CR150, 151	4813833C02	dual 70 V common cathode
CR721	4813833C02	dual 70 V common cathode
CR5700	4802233J09	triple SOT 143-RH
CR5701, 5702	4862824C01	varactor
CR6501	4813833C02	dual 70 V common cathode
CR6502, 6503	4802482J02	pin diode SMD
CR6504	4805129M96	dual
CR6506	4805218N57	dual
CR6508	4813828B35	transient suppressor SMT
CR6509	4805218N57	dual
D101, 102	4813833C02	dual 70 V common cathode
D200	4813833C02	dual 70 V common cathode
D401, 402	4880939T01	silicon SMT
D403	4813833C02	dual 70 V common cathode
D611	4813833C02	dual 70 V common cathode
D621	4813833C02	dual 70 V common cathode
D631	4813833C02	dual 70 V common cathode
D5201	4880154K03	dual Schottky
D5303	4880154K03	dual Schottky
		fuse:
F401	6585711L05	6.3 V, 500 mA SMT
		filter:
FL5201	9185747L01	455 kHz ceramic filter
FL5202	9180098D01	455 kHz ceramic filter
FL5203, 5204	9102603S25	938 MHz ceramic filter
		connector, receptacle:
J100	0902636Y01	flexible cable, side entry
J400	2804503J01	accessory 16-pin
J6501	0905901V06	antenna
J6502	0905902V04	connector power
		coil, rf:
L131, 132	2462587Q40	inductor, 270 nH
L200	2462587P30	inductor, 33 uH 10%
L403 thru 413	2402601S05	inductor BLM21A05
L414 thru 416	2484657R01	ferrite bead
L418	2402601S05	inductor BLM21A05
L419	2484657R01	ferrite bead
L420 thru 428	2402601S05	inductor BLM21A05
L429, 430	2484657R01	ferrite bead
L431 thru 434	2402601S05	inductor BLM21A05
L435	2484657R01	ferrite bead 5%
L5201	2462587M19	inductor, 1200 nH 5%, low PRO
L5203	2462587T30	inductor, 1.0 uH 5%, low PRO

HLF9009A & HLF9010A Radio, 900 MHz, 12 W — PL-21022-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L5211	2483411T74	inductor, 1.2 mH 5%, low PRO
L5302	2413926E09	inductor, 6.8 nH 5%, low PRO
L5321	2460591A01	inductor, 4.2 nH 5%, low PRO
L5322	2462587T12	inductor, 56 nH 5%, low PRO
L5401, 5402	2483411T69	inductor, 0.47 mH 5%, low PRO
L5700 thru 5704	2462587T30	inductor, 1.0 uH 5%, low PRO
L5705, 5706	2462587T17	inductor, 150 nH 5%, low PRO
L5707	2462587T30	inductor, 1.0 uH 5%, low PRO
L5708	2462587T17	inductor, 150 nH 5%, low PRO
L5709	2462587Q44	inductor, 560 nH 10%
L6501	2462587T13	inductor, 68 nH 5%, low PRO
L6502	2460591A11	inductor, 7.66 nH air wound
L6503	2462587T13	inductor, 68 nH, 5%, low PRO
L6504 thru 6506	2484657R01	ferrite bead
L6507	2460591R53	inductor, 82 nH
L6508	2460591E24	inductor, 23.75 nH air wound
L6509	2462587T13	inductor, 68 nH 5%, low PRO
L6511	2462587T13	inductor, 68 nH 5%, low PRO
L6513	2460591A11	inductor, 7.66 nH air wound
L6514 thru 6517	2462587T13	inductor, 68 nH 5%, low PRO
L6518	2460591A11	inductor, 7.66 nH air wound
L6519	2484657R01	ferrite bead
L6520	2460591R53	inductor, 82 nH
		transistor: (see note 1)
Q101 thru 103	4880048M01	NPN DTC144EK
Q141	4880048M01	NPN DTC144EKA
Q150	4882033T01	NPN DTC114YK
Q151	4880214G02	NPN MMBT3904
Q401	4880214G02	NPN MMBT3904
Q410	4880048M01	NPN DTC144EKA
Q411	4880052M01	NPN RXT_A28_T200
Q415	4880494U01	PNP DTA144EKA
Q450	4880048M01	NPN DTC144EKA
Q460, 461	4880048M01	NPN DTC144EK
Q601	4880214G02	NPN MMBT3904
Q611	4805128M27	PNP BSR33
Q612	4880214G02	NPN MMBT3904
Q731	4880214G02	NPN MMBT3904
Q741	4880048M01	NPN DTC144EK
Q742	4805128M27	PNP BSR33
Q5201	4813827A07	NPN MMBR941LT1
Q5230	4813824A17	NPN 3906L
Q5301	4813827A18	NPN MRF9411LT1
Q5700	4880048M01	NPN DTC144EK
Q5701	4813824A17	PNP 3906L
Q5702 thru 5704	4809527E01	NPN RF NE85633-T2B_R25
Q5705	4804188K01	NPN RF NE85634
Q5706, 5707	4809527E01	NPN RF NE85633-T2B_R25
Q6501	4813827A26	NPN MRF8372
Q6506	4813824B01	NPN 2222AT
		resistor, fixed: +/-5%; 1/8 W: unless otherwise stated
R100	0662057A65	4.7k
R101 thru 103	0662057B05	200k
R104	0662057A89	47k
R105	0662057A65	4.7k
R106	0662057A73	10k
R107	0662057A57	2.2k
R108	0662057A73	10k
R109, 110	0662057A35	270
R111, 112	0662057A65	4.7k
R113	0662057A85	33k
R114	0662057A93	68k
R115, 116	0662057A73	10k
R121	0662057A65	4.7k
R122	0662057A89	47k
R123	0662057A73	10k
R126	0662057A73	10k
R127	0662057A65	4.7k
R131	0662057A65	4.7k
R132	0662057A81	22k
R133	0662057A97	100k
R135, 136	0662057A73	10k
R142	0662057A73	10k
R145	0662057A73	10k
R146, 147	0662057A35	270
R150	0662057A89	47k
R151	0662057B05	200k
R152	0662057A56	2k
R153	0662057A85	33k
R155	0662057A89	47k

HLF9009A & HLF9010A Radio, 900 MHz, 12 W — PL-21022-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R200	0662057A73	10k
R201	0662057A97	100k
R202, 203	0662057A97	100k
R204	0662057A25	100 ohm
R205	0662057A49	1k
R206	0662057A57	2.2k
R208, 209	0662057A73	10k
R210	0662057A49	1k
R221	0662057B47	0 ohm
R222	0662057A89	47k
R231	0662057R92	47.5k ±1%; 1/10 W
R232	0662057A93	68k
R233	0662057A73	10k
R236	0662057A97	100k
R237, 238	0662057A93	68k
R251, 252	0662057R92	47.5k ±1%; 1/10 W
R350	0662057G13	2k
R351	0662057A81	22k
R352	0662057A89	47.5k
R353	0662057A53	1.5k
R354	0662057G13	100k
R355	0662057P30	1k
R356	0662057R60	10.0k
R357	0662057A97	100k
R401	0662057A65	4.7k
R402	0662057A49	1k
R404, 405	0662057A73	10k
R406	0662057A81	22k
R411	0662057A65	4.7k
R412	0662057A65	4.7k
R417	0662057A97	100k
R418	0662057B05	200k
R419	0662057A25	100 ohm
R420	0662057A97	100k
R421	0662057A43	560 ohm
R422, 423	0662057A65	4.7k
R424	0662057A43	560 ohm
R425, 426	0662057A73	10k
R427	0662057A97	100k
R428	0662057A42	510
R430	0662057A65	4.7k
R431	0662057A73	10k
R433	0662057A65	4.7k
R435	0662057A43	560
R440	0662057A65	4.7k
R442	0662057A89	47k
R449	0662057B05	200k
R450, 451	0662057A65	4.7k
R452	0662057A73	10k
R460	0662057B05	200k
R461	0662057A89	47k
R462	0662057B05	200k
R463	0662057B22	1M
R464	0662057B14	470k
R465, 466	0662057A65	4.7k
R467, 468	0662057A73	10k
R601	0662057A97	100k
R602	0662057R55	7.50k ±1%; 1/10 W
R603	0662057R31	1.21k ±1%; 1/10 W
R604	0662057A65	6.8k
R605	0662057A81	22k
R606	0662057B47	0 ohm
R611	0662057A51	1.2k
R612, 613	0662057C87	3.3k
R614	0662057A49	1k
R615, 616	0662057A73	10k
R617	0662057C87	3.3k
R621	0662057A57	2.2k
R631, 632	0662057A01	10 ohm
R641	0662057R92	47.5k
R642	0662057R67	16.2k
R702 thru 704	0662057A81	22k
R705	0662057A81	22k
R706	0662057A97	100k
R711	0662057A81	22k
R712	0662057A57	2.2k
R713	0662057A42	510 ohm
R714	0662057A25	100 ohm
R715	0662057R30	1k ±1%; 1/10 W
R716, 717	0662057R45	3.74k ±1%; 1/10 W
R718	0662057R60	10k ±1%; 1/10 W
R719	0662057R30	1k ±1%; 1/10 W
R720	0662057R60	10k ±1%; 1/10 W

HLF9009A & HLF9010A Radio, 900 MHz, 12 W — PL-21022-O

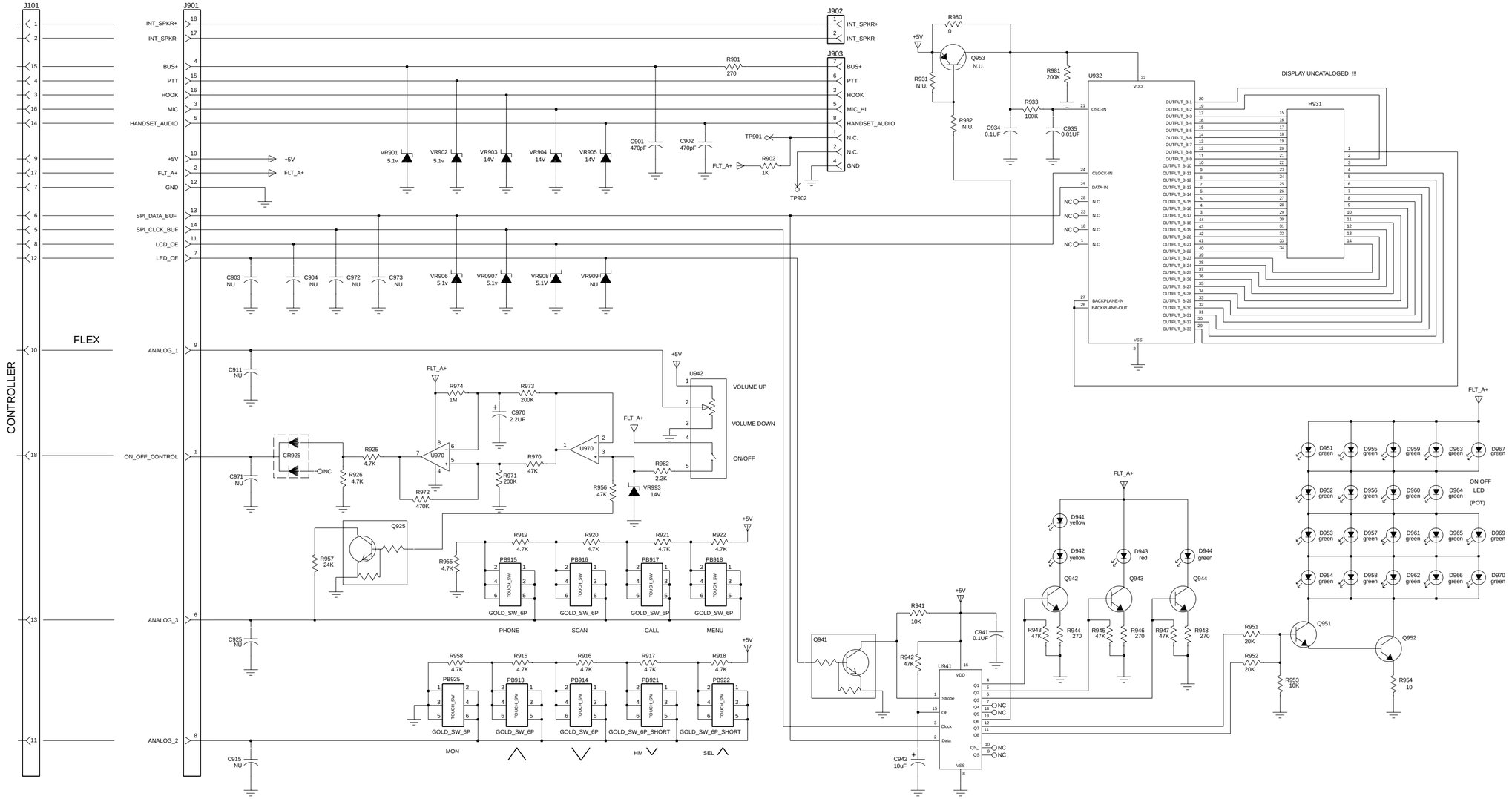
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R721	0662057A67	5.6k
R722	0662057A81	22k
R723	0662057A97	100k
R724	0662057A61	3.3k
R725, 726	0662057A73	10k
R727	0662057A57	2.2k
R728 thru 731	0662057G13	100k
R732 thru734	0662057A65	4.7k
R736, 737	0662057A65	4.7k
R740	0662057A57	2.2k
R741, 742	0662057A51	1.5k
R743	0662057A49	1k
R5201	0662057A76	13k
R5202	0662057A85	33k
R5203	0662057A69	6.8k
R5204	0662057A25	100 ohm
R5205	0662057A56	2k
R5207	0662057B47	0 ohm
R5211	0662057A42	510 ohm
R5212	0662057A67	5.6k
R5221	0662057B01	130k
R5223	0662057A70	7.5k
R5224	0662057A76	13k
R5230	0662057A89	47k
R5240	0683962F49	100 ohm
R5241	0662057B47	0 ohm
R5302	0662057A33	220 ohm
R5306	0662057A29	150 ohm
R5311, 5312	0662057A76	13k
R5321	0662057A33	220 ohm
R5322	0662057A01	10 ohm
R5323	0662057A36	300 ohm
R5324, 5325	0662057A39	390 ohm
R5327	0662057B47	0 ohm
R5401	0662057A18	51 ohm
R5700	0662057A57	2.2k
R5703	0662057A73	10k
R5704	0662057A37	330ohm
R5705	0662057A11	10k
R5706	0662057A42	510
R5707	0662057A61	3.3k
R5708, 5709	0662057B05	200k
R5710	0662057A73	10k
R5711 thru 5713	0662057A65	4.7k
R5714	0662057A59	2.7k
R5715	0662057A57	2.2k
R5716	0662057A58	2.4k
R5717	0662057A59	2.7k
R5718	0662057A53	1.5k
R5724 thru 5727	0662057A42	510 ohm
R5728	0662057A37	330 ohm
R5729	0662057A29	150 ohm
R5731 thru 5733	0662057A25	100 ohm
R5734 thru 5736	0662057A18	51 ohm
R5737, 5738	0662057A09	22 ohm
R5739, 5740	0662057A18	51 ohm
R5741	0662057A01	10 ohm
R5742	0662057A69	6.8k
R5743	0662057A73	10k
R5744, 5745	0662057A31	180
R5746	0662057A73	10k
R5747	0662057A69	6.8k
R5748	0662057A09	22 ohm
R5750, 5751	0662057A59	2.7k
R5752	0662057A37	330 ohm
R5753	0662057A13	33 ohm
R5754	0662057A73	10k
R5755	0662057A09	22 ohm
R5756, 5757	0662057A35	270 ohm
R6502	0662057A09	22 ohm
R6503	0662057A01	10 ohm
R6504	0662057A42	510 ohm
R6505	0662057A49	1k
R6506	0662057A09	22 ohm
R6512	0662057A25	100 ohm
R6514, 6515	0662057A61	3.3k
R6519	0680361L01	therm 47k
R6520	1705603W01	shunt, 1.639 mH
R6523 thru 6525	0662057A53	1.5k
R6526	0662057A01	10 ohm
R6527, 6528	0662057A43	560 ohm
R6531, 6532	0662057A25	100 ohm
R6537 thru 6539	0662057A17	47 ohm

HLF9009A & HLF9010A Radio, 900 MHz, 12 W — PL-20102-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6555	0662057A33	220 ohm
		switch:
S401	4085797L01	2-position
		shield:
SH5201	2605261V01	LNA shield
SH5202	2605417V01	mixer shield
SH5203	2605417V01	IF amplifier shield
E5700	2602660J02	MMIC shield
E5701	2604668E02	VCO shield
E5702, 5703	2602660J02	buffer shield
E5704	2680524L01	synthesizer shield
		integrated circuit: (see note 1)
U101	5180421V01	MC68HC11K1
U102	5108444S61	FLASH memory
U103	5185963A21	SRAM
U104	5108444S49	EEPROM
U105	5113805A30	1 of 8 DCD/demux 74HC138A
U106	5113808A07	AND quad 2 INP MC74AC08D
U201	5105835U45	ASFIC
U202	5113819A04	quad op-amp
U203	5109522E13	switch, SPDT
U204	5109781E79	switch, SPDT
U251	5113818A03	dual op-amp
U350	5105835U50	hear clear IC
U401	5109699X01	audio PA
U402	5180173M02	switch SPDT
U403	5113818A10	dual op-amp
U460	5113818A03	dual op-amp
U601	5105625U25	9.3 V regulator LM2941
U631	5105469E65	voltage regulator LP2951AC
U701	5113819A02	quad op-amp
U702	5113811G02	D/A converter 6-bit 4-ch. with SPI
U5201	5180207R01	IFIC
U5211	5185670L01	mixer DBL balanced
U5700	5105279V31	16.8 MHz ref. oscillator
U5701	5105109Z59	MMIC
U5702	5105457W46	frac-N sythesizer
U5703	5113816A07	regulator 5 V 500 mA MC78M05BDT
U5704, 5705	4805921T02	switch FMC2
U5706, 5707	4804122K04	microstrip line resonator
U6501	5113829D23	890-950 MHz, 18 W; 12.5 V
U6502	4805921T02	switch FMC2
		Zener diode: (see note 1)
VR101	4813830A23	10 V 5%; 225 mW MMBZ5240BL
VR410	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR412	4813830A40	33 V 5%; 225 mW MMBZ5257B
VR415, 416	4813830A27	14 V 5%; 225 mW MMBZ5244L
VR421, 422	4813830A27	14 V 5%; 225 mW MMBZ5244L
VR425	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR426, 427	4813830A27	14 V 5%; 225 mW MMBZ5244B
VR430	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR431	4813830A27	14 V 5%; 225 mW MMBZ5244L
VR441	4813830A40	33 V 5%; 225 mW MMBZ5257B
VR451	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR621	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR641	4813830A14	5.1 V 5%; 225 mW MMBZ5231B
VR650	4813830A25	12 V 5%; 225 mW MMBZ5242B
		crystal: (see note 2)
Y5201	9102651Y01	filter 45.1 MHz
Y5202	9102651Y02	filter 45.1 MHz
Y5211	4802653Y01	resonator 44.6450 MHz

notes:
1. For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.
2. When ordering quartz crystal units or ceramic resonators, specify carrier frequency, crystal (or resonator) frequency, and crystal (or resonator) type number.

Parts List for HLF9009A & HLF9010A Main Boards



Schematic Diagram for FLN8744A Control Head

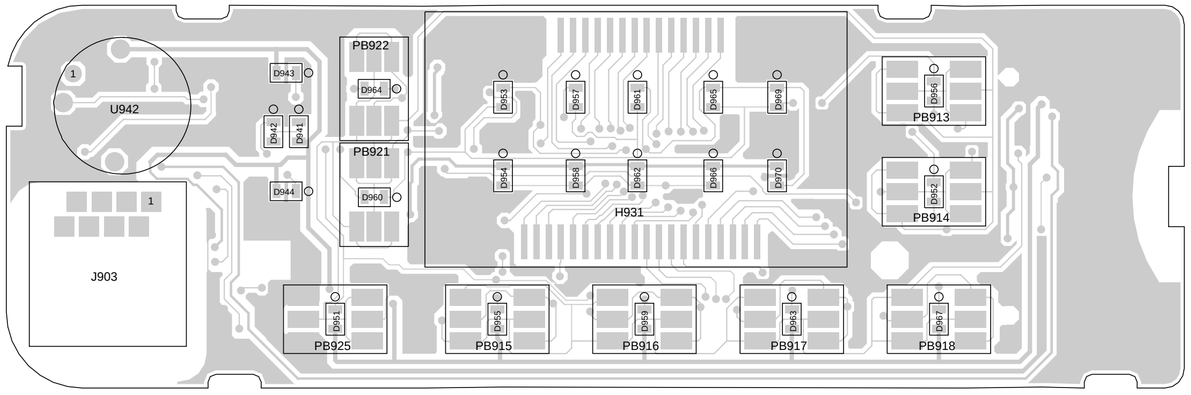
Parts List

FLN8744A Control Head Board PL-201002-O

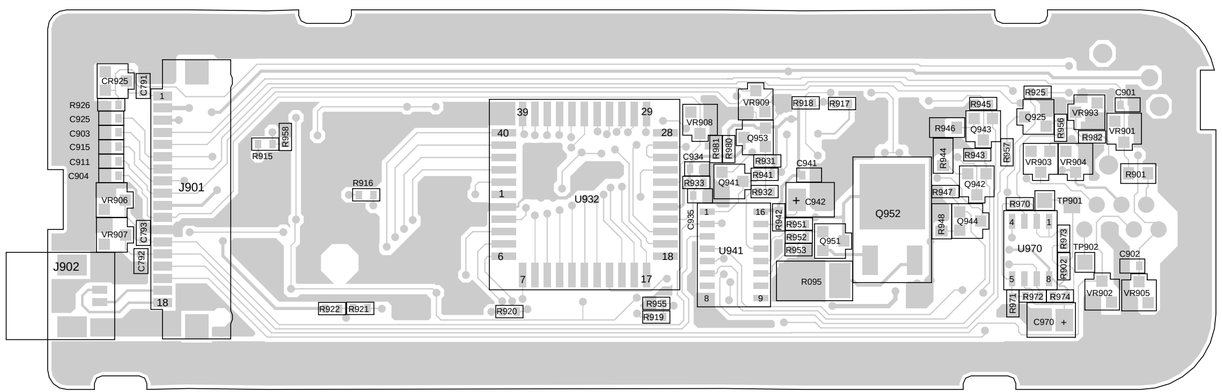
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-5%; 50 V: unless otherwise stated
C970	2311049A09	2.2
C901, 902	2113741F17	470 pF
C934	2113743K15	ceramic 0.1 pF
C935	2113741F49	0.01 pF
C941	2113743K15	ceramic 0.1
C942	2311049J23	tantalum 10 10%; 7 V
		diode: (see note)
CR925	4813833C02	dual 70 V common cathode
		light emitting diode: (see note)
D941, 942	4805729G73	yellow
D943	4805729G74	red
D944	4805729G75	green
D951 thru 967	4805729G75	green
D969, 970	4805729G75	green
H931	7202662Y01	display_LCD
		connector, receptacle:
J901	0902636Y01	connector, flex cable, side entry
J902	2809926G01	SMT header
J903	2805924V01	mic connector
		transistor: (see note)
Q925	4880048M01	NPN DIG 47k/47k
Q941	4880048M01	NPN DIG 47k/47k
Q942 thru 944	4813824A10	NPN 40 V 0.2A general purpose
Q951	4813824A10	NPN 25 V 5A
Q952	4813822A20	NPN_MJD200T4
		resistor, fixed: +/-5%; 1/8 W: unless otherwise stated
R955	0662057A65	4.7k
R956	0662057A89	47k
R957	0662057A82	24k
R958	0662057A65	4.7k
R970	0662057A89	47k
R971	0662057B05	200k
R972	0662057B14	470k
R973	0662057B05	200k
R974	0662057B22	1 Meg.
R980	0662057B47	0 ohm
R981	0662057B05	200k
R982	0662057A57	2.2k
R901	0662057C61	270 ohms
R902	0662057A49	1k
R915 thru 922	0662057A65	4.7k
R925, 926	0662057A65	4.7k
R933	0662057A97	100k
R941	0662057A73	10k
R942, 943	0662057A89	47k
R944	0662057C61	270 ohms
R945	0662057A89	47k
R946	0662057C61	270 ohms
R947	0662057A89	47k
R948	0662057C61	270 ohms
R951	0662057A80	20k
R952	0662057A80	20k
R953	0662057A73	10k
R954	0680194M01	10 ohms
		integrated circuit: (see note)
U942	1805642V01	potentiameter switch
U970	5113818A03	high performance single supply
U932	5105625U61	MM5453VX
U941	5113806A35	MC14094B
		Zener diode: (see note)
VR908	4813830A14	5.1 V 5% 225 mW MMBZ5231B
VR901 thru 907	4813830A27	14 V 5% 225 mW MMBZ5244L
VR993	4813830A27	14 V 5% 225 mW MMBZ5244L

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

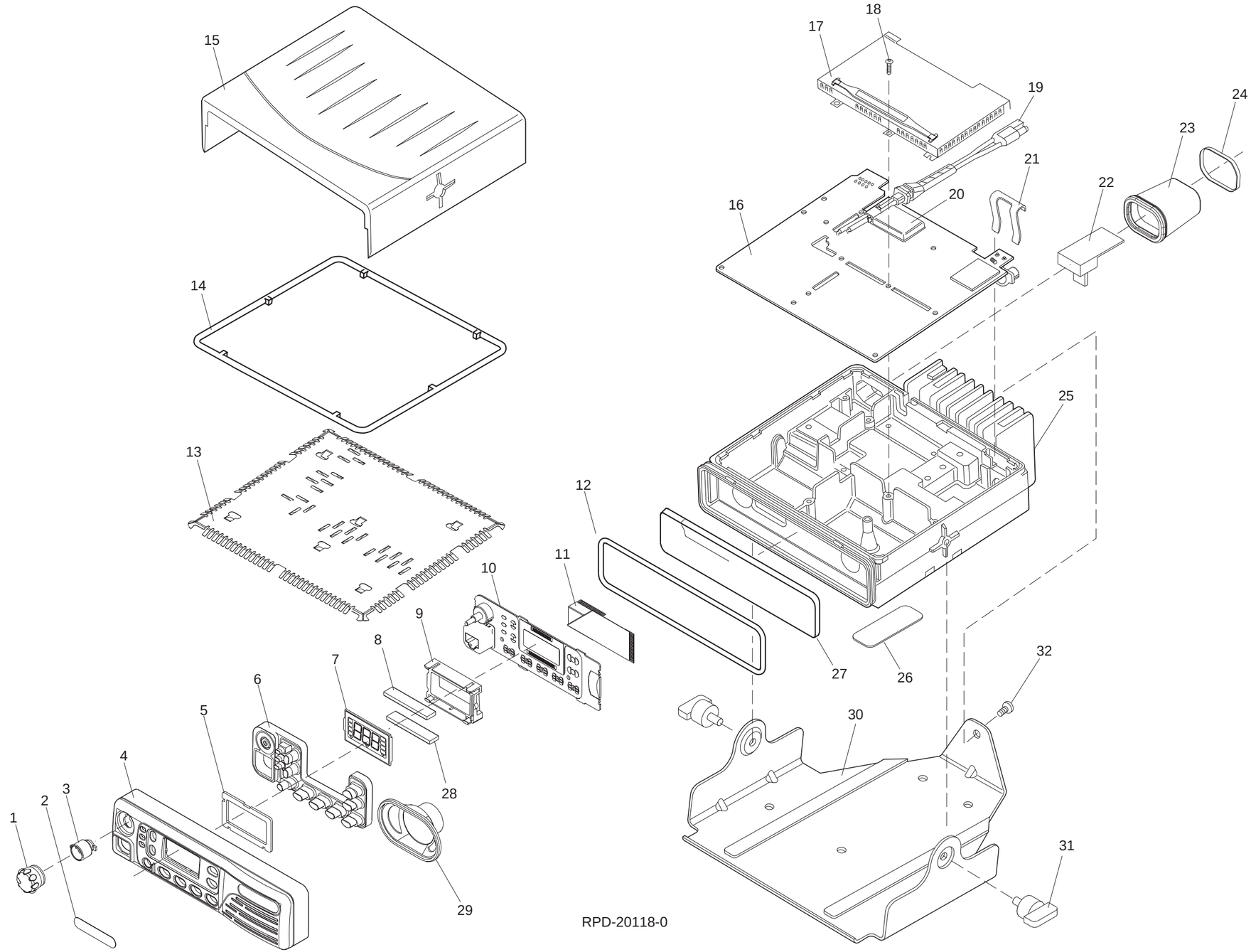
VIEWED FROM SIDE 1



VIEWED FROM SIDE 2



Circuit Board Details & Parts List for FLN8744A Control Head



Parts List

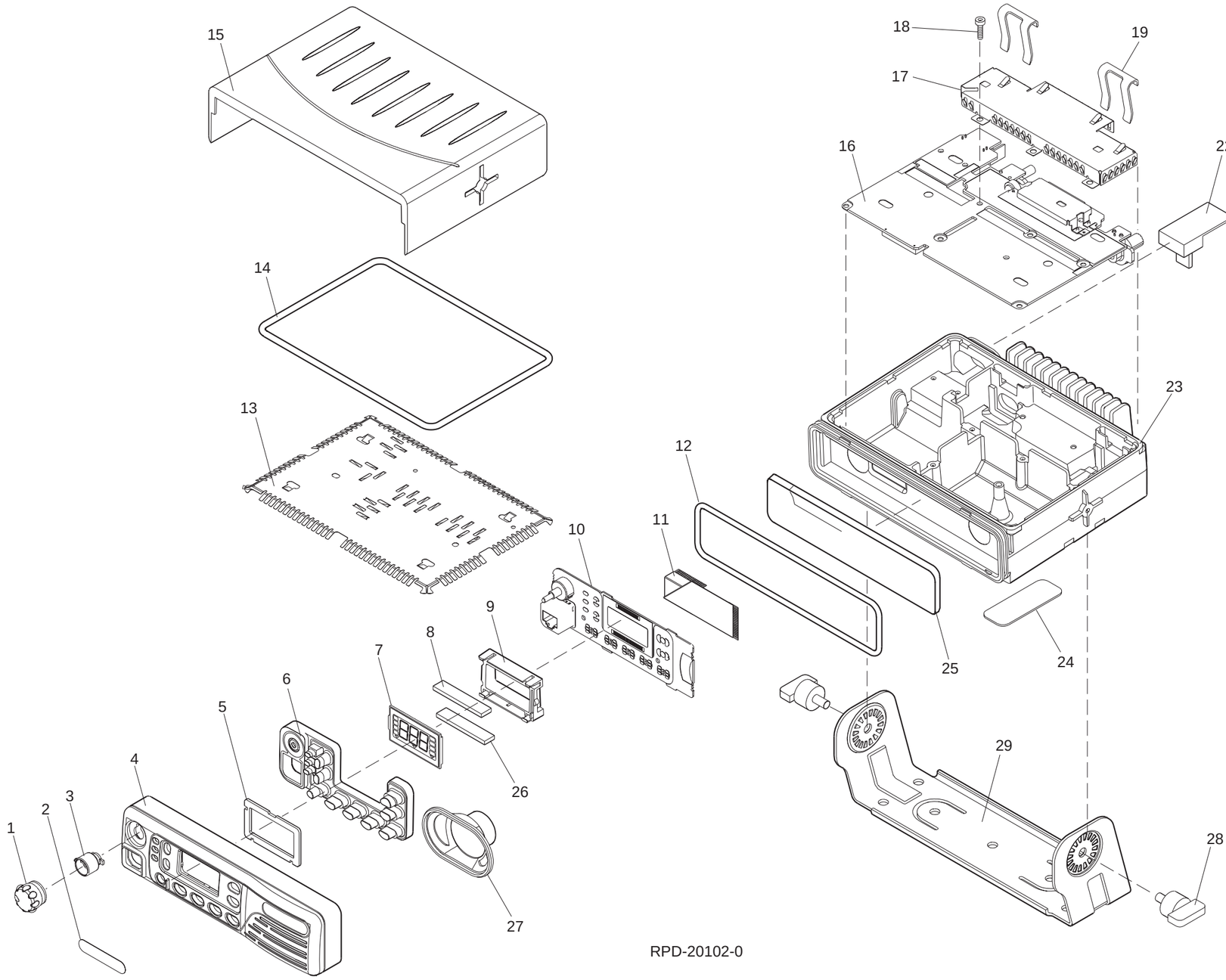
GTX Mechanical Parts List; 30 W PL-201019-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	3605422W02	exterior volume knob
2	5480643K01	logo label
3	3608147K01	interior volume knob
4	1580356K01	housing
5	3280511L01	LCD frame gasket
6	7580358K01	keypad
7	7202631Y01	LCD display
8	2802638Y02	connector
9	0780360K01	LCD frame
10	FLN8744	control head board
11	8402618Y01	flexible circuit
12	3202620Y01	control head gasket
13, 14, 15	0185808L01	assembly, cover
16	----	main board
17	0185787M01	PA shield
18	0310907A20	mechanical screw, M3x0.5x18
19	3080562V02	power cable
20	2680567V01	PM shield
21	4205938V01	clip spring
22	FHN5875	accessory kit
23	3202606Y01	accessory connector gasket
24	4280587L01	accessory clamp
25	2680547V01	chassis
26	----	FCC label
27	7585697M01	speaker pad
28	2802638Y01	connector
29	5080442U02	speaker
30, 31, 32	HLN9640	trunnion kit
non-referenced items		
	54-85743M01	LABEL

Parts List

GTX Mechanical Parts List; 12 W PL-201020-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	3605422W02	exterior volume knob
2	5480643K01	logo label
3	3608147K01	interior volume knob
4	1580356K01	housing
5	3280511L01	LCD frame gasket
6	7580358K01	keypad
7	7202631Y01	LCD display
8	2802638Y02	connector
9	0780360K01	LCD frame
10	FLN8744	control head board
11	8402618Y01	flexible circuit
12	3202620Y01	control head gasket
13	2680439K01	cover shield
14	3202619Y01	cover gasket
15	1580355K01	cover assembly
16	----	main board
17	2680519K01	PA shield
18	0310907A20	mechanical screw, M3x0.5x10
19	4205938V01	clip spring
20	4280587L01	accessory clamp
21	3202606Y01	accessory connector gasket
22	FHN5875	accessory kit
23	2780354K01	chassis
24	----	FCC label
25	7585697M01	speaker pad
26	2802638Y01	connector
27	5080442U02	speaker
28, 29	GLN7317	trunnion kit



RPD-20102-0

GTX Exploded View & Mechanical Parts List, 12 W

REPLACEMENT PARTS ORDERING

ORDERING INFORMATION

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the model number in which the part is used.

Orders for active filters, Vibrasender and Vibrasponder resonant reeds should specify type number and frequency, should identify the owner / operator of the communications system in which these items are to be used, and should include any serial numbers stamped on the components being replaced.

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