

Professional Digital Two-Way Radio System &  
SMARTNET® and Privacy Plus™ Trunked Mobile Radios

# MOTOTRBO™ Mobile

*Detailed Service Manual*

XPR™ 4380 Numeric Display Mobile

XPR™ 4580 Display Mobile





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## Foreword

This manual covers all XPR™ Series Mobiles, unless otherwise specified. This manual provides sufficient information to enable qualified service technicians to troubleshoot and repair XPR™ Series Mobiles to the component level.

For details on radio operation or basic troubleshooting, refer to the applicable manuals available separately.



**These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.**

### Product Safety and RF Exposure Compliance



**Before using this product, read the operating instructions for safe usage contained in the Product Safety and RF Exposure booklet enclosed with your radio.**

#### ATTENTION!

**This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements. Before using this product, read the RF energy awareness information and operating instructions in the Product Safety and RF Exposure booklet enclosed with your radio (Motorola Publication part number 6881095C99) to ensure compliance with RF energy exposure limits.**

**For a list of Motorola-approved antennas, and other accessories, visit the following web site which lists approved accessories: <http://www.motorola.com/governmentandenterprise>**

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## Notes



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## Document History

The following major changes have been implemented in this manual since the previous edition:

<b>Edition</b>	<b>Description</b>	<b>Date</b>
68009274001-A	Initial Release.	Nov. 2009

## Notes

# Commercial Warranty

## Limited Warranty

### MOTOROLA COMMUNICATION PRODUCTS

#### I. What This Warranty Covers And For How Long

MOTOROLA INC. ("MOTOROLA") warrants the MOTOROLA manufactured Communication Products listed below ("Product") against defects in material and workmanship under normal use and service for a period of time from the date of purchase as scheduled below:

XPR Series Digital Mobile Radios	Two (2) Years
Product Accessories	One (1) Year

The mobiles additionally ship with a standard 1-year Repair Service Advantage (RSA)(for U.S. customers) or 1-year Extended Warranty (for Canada customers). However, at the time of order, you may choose to omit these warranties. For more RSA or Extended Warranty information, please refer to the price pages or Motorola Online (<http://www.motorola.com/businessonline>) > Resource Center > Services > Service Product Offerings > Repair Service Advantage or Extended Warranty.

Motorola, at its option, will at no charge either repair the Product (with new or reconditioned parts), replace it (with a new or reconditioned Product), or refund the purchase price of the Product during the warranty period provided it is returned in accordance with the terms of this warranty. Replaced parts or boards are warranted for the balance of the original applicable warranty period. All replaced parts of Product shall become the property of MOTOROLA.

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- A. Defects or damage resulting from use of the Product in other than its normal and customary manner.
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- C. Defects or damage from improper testing, operation, maintenance, installation, alteration, modification, or adjustment.
- D. Breakage or damage to antennas unless caused directly by defects in material workmanship.
- E. A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola supplied equipment) which adversely affect performance of the Product or interfere with Motorola's normal warranty inspection and testing of the Product to verify any warranty claim.
- F. Product which has had the serial number removed or made illegible.
- G. Freight costs to the repair depot.
- H. A Product which, due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA's published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.
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- B. that MOTOROLA will have sole control of the defense of such suit and all negotiations for its settlement or compromise; and
- C. should the Product or parts become, or in MOTOROLA's opinion be likely to become, the subject of a claim of infringement of a United States patent, that such purchaser will permit MOTOROLA, at its option and expense, either to procure for such purchaser the right to continue using the Product or parts or to replace or modify the same so that it becomes noninfringing or to grant such purchaser a credit for the Product or parts as depreciated and accept its return. The depreciation will be an equal amount per year over the lifetime of the Product or parts as established by MOTOROLA.

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## VII. Governing Law

This Warranty is governed by the laws of the State of Illinois, USA.

## Notes



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# **XPR 4380/XPR 4580 Mobile Radios**

## **Detailed Service Manual**

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## Notes

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## Summary of Printed Circuit Boards and Bands available:

Table below lists all the bands available in this manual and the revision of the Printed Circuit Boards used. For details, please refer to the respective chapters.

<b>Chapter</b>	<b>Description</b>	<b>PC Board Part Number</b>	<b>Board Revision</b>
2	Numeric Display Control Head	8471214H02	A
2	Display Control Head	8415026C08	B
5	800/900 MHz, 806–941 MHz, 10–35 W	8475265H01	A

## Notes



# **XPR 4380/XPR 4580 Mobile Radios**

## **Chapter 1**

### **Service Maintainability**

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# Chapter 1 - Service Maintainability

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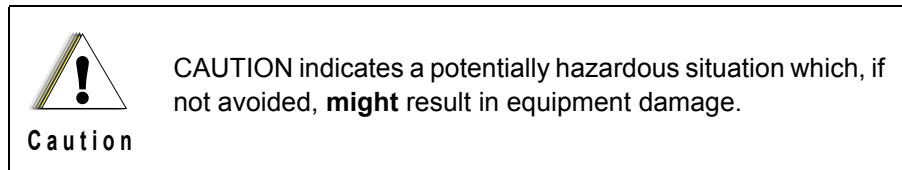
# Section 1

## INTRODUCTION

### 1.0 Notations Used in This Manual

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

**NOTE:** An operational procedure, practice, or condition that is essential to emphasize.



### 2.0 Radio Description

The XPR series mobile radios are available in the following frequency ranges and power levels.

*Table 1-1 Radio Frequency Ranges and Power Levels*

Freq. Band	Bandwidth	Power Level
800/900 MHz	806–870 MHz, 896–941 MHz	10–35 Watts 10–30 Watts

\* For frequencies 901–902, 940–941 MHz, FCC Rule Part 24 limits power to 7W ERP. Antennas HAF4025\_ and HAF4029\_ can be used with reduced power setting for these frequencies.

These digital radios are among the most sophisticated two-way radios available. They have a robust design for radio users who need high performance, quality, and reliability in their daily communications. This architecture provides the capability of supporting a multitude of legacy and advanced features resulting in a more cost-effective two-way radio communications solution.

## Notes

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## Section 2

# MAINTENANCE

### 1.0 Introduction

This chapter provides details about the following

- Preventive maintenance (inspection and cleaning).
- Safe handling of CMOS and LDMOS devices.
- Repair procedures and techniques.

### 2.0 Preventive Maintenance

Periodic visual inspection and cleaning is recommended.

#### 2.1 Inspection

Check that the external surfaces of the radio are clean, and that all external controls and switches are functional. It is not recommended to inspect the interior electronic circuitry.

#### 2.2 Cleaning Procedures

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 control head and housing assembly. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime.

**NOTE:** Internal surfaces should be cleaned only when the radio is disassembled for service or repair.

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water. The only factory recommended liquid for cleaning the printed circuit boards and their components is isopropyl alcohol (100% by volume).



**Caution**

The effects of certain chemicals and their vapors can have harmful results on certain plastics. Avoid using aerosol sprays, tuner cleaners and other chemicals.

### **Cleaning External Plastic Surfaces**

Apply the 0.5% detergent-water solution sparingly with a stiff, non-metallic, short-bristled brush to work all loose dirt away from the radio. Use a soft, absorbent, lintless cloth or tissue to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

### **Cleaning Internal Circuit Boards and Components**

Isopropyl alcohol (100%) may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the radio. Make sure that controls or tunable components are not soaked with alcohol. Do not use high-pressure air to hasten the drying process since this could cause the liquid to collect in unwanted places. Once the cleaning process is complete, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, control head and housing assembly.

**NOTE:** Always use a fresh supply of alcohol and a clean container to prevent contamination by dissolved material (from previous usage).

## **3.0 Safe Handling of CMOS and LDMOS Devices**

Complementary metal-oxide semiconductor (CMOS) devices are used in this family of radios, and are susceptible to damage by electrostatic or high voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, special precautions must be taken to prevent device damage during disassembly, troubleshooting, and repair.

Handling precautions are mandatory for CMOS circuits and are especially important in low humidity conditions.



DO NOT attempt to disassemble the radio without first referring to the following CAUTION statement.

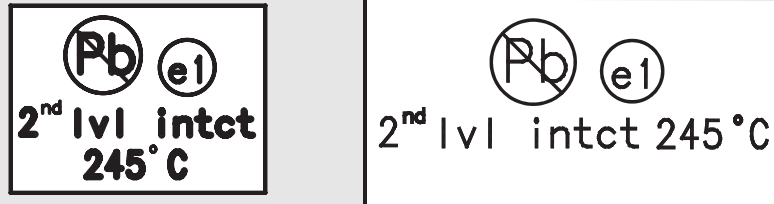
**Caution**

**This radio contains static-sensitive devices. Do not open the radio unless you are properly grounded. Take the following precautions when working on this unit:**

- Store and transport all CMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS devices into conventional plastic “snow” trays used for storage and transportation of other semiconductor devices.
- Ground the working surface of the service bench to protect the CMOS device. We recommend using a wrist strap, two ground cords, a table mat, and a floor mat.
- Wear a conductive wrist strap in series with a 100k resistor to ground. (Replacement wrist straps that connect to the bench top covering are Motorola part number 4280385A59).
- Do not wear nylon clothing while handling CMOS devices.
- Do not insert or remove CMOS devices with power applied. Check all power supplies used for testing CMOS devices to be certain that there are no voltage transients present.
- When straightening CMOS pins, provide ground straps for the apparatus used.
- When soldering, use a grounded soldering iron.
- If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

## 4.0 Repair Procedures and Techniques — General

**NOTE** Environmentally Preferred Products (EPP) (refer to the marking on the printed circuit boards — examples shown below) were developed and assembled using environmentally preferred components and solder assembly techniques to comply with the European Union's **Restriction of Hazardous Substances (ROHS) Directive 2002/95/EC** and **Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC**. To maintain product compliance and reliability, use only the Motorola specified parts in this manual.



Any rework or repair on Environmentally Preferred Products must be done using the appropriate lead-free solder wire and lead-free solder paste as stated in the following table:

*Table 2-1 Lead Free Solder Wire Part Number List*

Motorola Part Number	Alloy	Flux Type	Flux Content by Weight	Melting Point	Supplier Part number	Diameter	Weight
1088929Y01	95.5Sn/3.8Ag/0.7Cu	RMA Version	2.7-3.2%	217C	52171	0.015"	1lb spool

*Table 2-2 Lead Free Solder Paste Part Number List*

Motorola Part Number	Manufacturer Part Number	Viscosity	Type	Composition & Percent Metal	Liquid Temperature
1085674C03	NC-SMQ230	900-1000KCPs Brookfield (5rpm)	Type 3 (-325/+500)	(95.5%Sn-3.8%Ag-0.7%Cu) 89.3%	217°C

### Parts Replacement and Substitution

When damaged parts are replaced, identical parts should be used. If the identical replacement part is not locally available, check the parts list for the proper Motorola part number and order the part from the nearest Motorola Radio Products and Solutions Organization listed in Appendix A of this manual.

### Rigid Circuit Boards

The family of radios uses bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The printed through holes may interconnect multiple layers of the printed circuit. Therefore, exercise care to avoid pulling the plated circuit out of the hole.

When soldering near a connector:

- Avoid accidentally getting solder in the connector.
- Be careful not to form solder bridges between the connector pins.
- Examine your work closely for shorts due to solder bridges.

## Chip Components

Use the RLN4062 Hot-Air Repair Station for chip component replacement. Adjust the temperature control to 370°C (700°F), and adjust the airflow to a minimum setting. Airflow can vary due to component density.

- **To remove a chip component:**
  1. Use a hot-air hand piece and position the nozzle of the hand piece approximately 0.3 cm (1/8") above the component to be removed.
  2. Begin applying the hot air. Once the solder reflows, remove the component using a pair of tweezers.
  3. Using a solder wick and a soldering iron or a power desoldering station, remove the excess solder from the pads.
- **To replace a chip component using a soldering iron:**
  1. Select the appropriate micro-tipped soldering iron and apply fresh solder to one of the solder pads.
  2. Using a pair of tweezers, position the new chip component in place while heating the fresh solder.
  3. Once solder wicks onto the new component, remove the heat from the solder.
  4. 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:**
  1. Use the hot-air hand piece and reflow the solder on the solder pads to smooth it.
  2. Apply a drop of solder paste flux to each pad.
  3. Using a pair of tweezers, position the new component in place.
  4. Position the hot-air hand piece approximately 0.3 cm (1/8") above the component and begin applying heat.
  5. Once the solder wicks to the component, remove the heat and inspect the repair. All joints should be smooth and shiny.

## Shields

Removing and replacing shields is recommended to be done with an Air Blower, BOSCH GHG 600-3 or equivalent. The temperature should be set to approximately 400°C (752°F).

- **To remove the shield:**

1. Place the circuit board in the circuit board holder.
2. Add solder paste flux around the base of the shield.
3. Position the heat-focus head onto the shield.
4. Turn on the heater and wait until the shield lifts off the circuit board.
5. Once the shield is off, turn off the heat, and grab the part with a pair of tweezers.
6. Remove the circuit board from the circuit board holder.

- **To replace the shield:**

1. Add solder to the shield if necessary, using a micro-tipped soldering iron.
2. 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.
3. Place the circuit board back in the circuit board holder.
4. Place the shield on the circuit board using a pair of tweezers.
5. Position the heat-focus head over the shield.
6. Turn on the heater and wait for the solder to reflow.
7. Once complete, turn off the heat, raise the heat-focus head and wait approximately one minute for the part to cool.
8. Remove the circuit board and inspect the repair. No cleaning should be necessary.

## Section 3

# TEST EQUIPMENT AND SERVICE AIDS

### 1.0 Recommended Test Equipment

The list of equipment contained in Table 3-1 includes most of the standard test equipment required for servicing Motorola mobile radios.

*Table 3-1 Recommended Test Equipment*

Equipment	Characteristic	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	Motorola R2670, or equivalent.	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital RMS Multimeter*	100 $\mu$ V to 300 V 5 Hz to 1 MHz 10 Meg Ohm Impedance	Fluke 179 or equivalent ( <a href="http://www.fluke.com">www.fluke.com</a> )	AC/DC voltage and current measurements. Audio voltage measurements.
RF Signal Generator*	100 MHz to 1 GHz -130 dBm to +10 dBm FM Modulation 0 kHz to 10 kHz	Agilent N5181A ( <a href="http://www.agilent.com">www.agilent.com</a> ), Ramsey RSG1000B ( <a href="http://www.ramseyelectronics.com">www.ramseyelectronics.com</a> ), or equivalent	Receiver measurements
Oscilloscope*	2 Channel 50 MHz Bandwidth 5 mV/div to 20 V/div	Leader LS8050 ( <a href="http://www.leaderusa.com">www.leaderusa.com</a> ), Tektronix TDS1001b ( <a href="http://www.tektronix.com">www.tektronix.com</a> ), or equivalent	Waveform measurements
Power Meter and Sensor*	5% Accuracy 100 MHz to 500 MHz 50 Watts	Bird 43 ThruLine Watt Meter ( <a href="http://www.bird-electronic.com">www.bird-electronic.com</a> ) or equivalent	Transmitter power output measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 92EA ( <a href="http://www.boonton.com">www.boonton.com</a> ) or equivalent	RF level measurements
Power Supply	0 V to 32 V 0 A to 20 A	B&K Precision 1790 ( <a href="http://www.bkprecision.com">www.bkprecision.com</a> ) or equivalent	Voltage supply

## 2.0 Service Aids

Table 3-2 lists the service aids recommended for working on the radio. While all of these items are available from Motorola, most are standard workshop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 3-2 Service Aids

Motorola Part Number	Description	Application
RLN4460_	Test Set	Enables connection to audio/accessory jack. Allows switching for radio testing.
RVN5115_	Customer Programming Software on CD-ROM	Allows servicer to program radio parameters, tune and troubleshoot radios.
PMKN4010_	Mobile & Repeater Rear Programming Cable	Connects the radio's rear connector to a USB port for radio programming and data applications.
PMKN4016_	Mobile & Repeater Rear Accessory Programming and Test Cable	Connects the radio's rear connector to a USB port for radio programming, data applications, testing and alignment.
PMKN4018_	Mobile & Repeater Rear Accessory Connector Universal Cable	Connects the radio's rear connector to accessory devices such as desk sets. Cable contains all 26 wires and is unterminated at the user end.
HKN6184_	Mobile Front Programming Cable	Connects the radio's front connector to a USB port for radio programming and data applications.
HLN8027_	Mini UHF to BNC Adaptor	Adapts radio antenna port to BNC cabling of test equipment.
HPN4007_	Power Supply	Provides the radio with power when bench testing.
8180384Y11	Housing Eliminator	Test Fixture used to bench test the radio PCB.
6686119B01	Removal Tool	Assists in the removal of radio control head.

### 3.0 Programming Cables



Figure 3-1 Mobile Front Programming Cable HKN6184\_

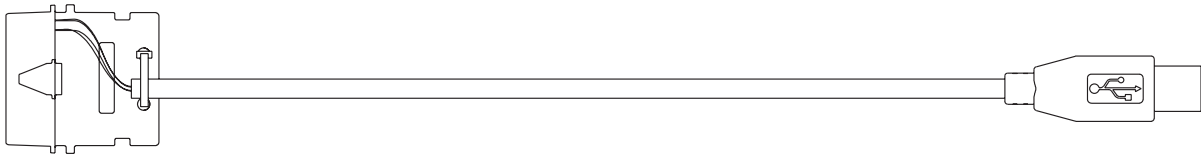


Figure 3-2 Mobile & Repeater Rear Programming Cable PMKN4010\_

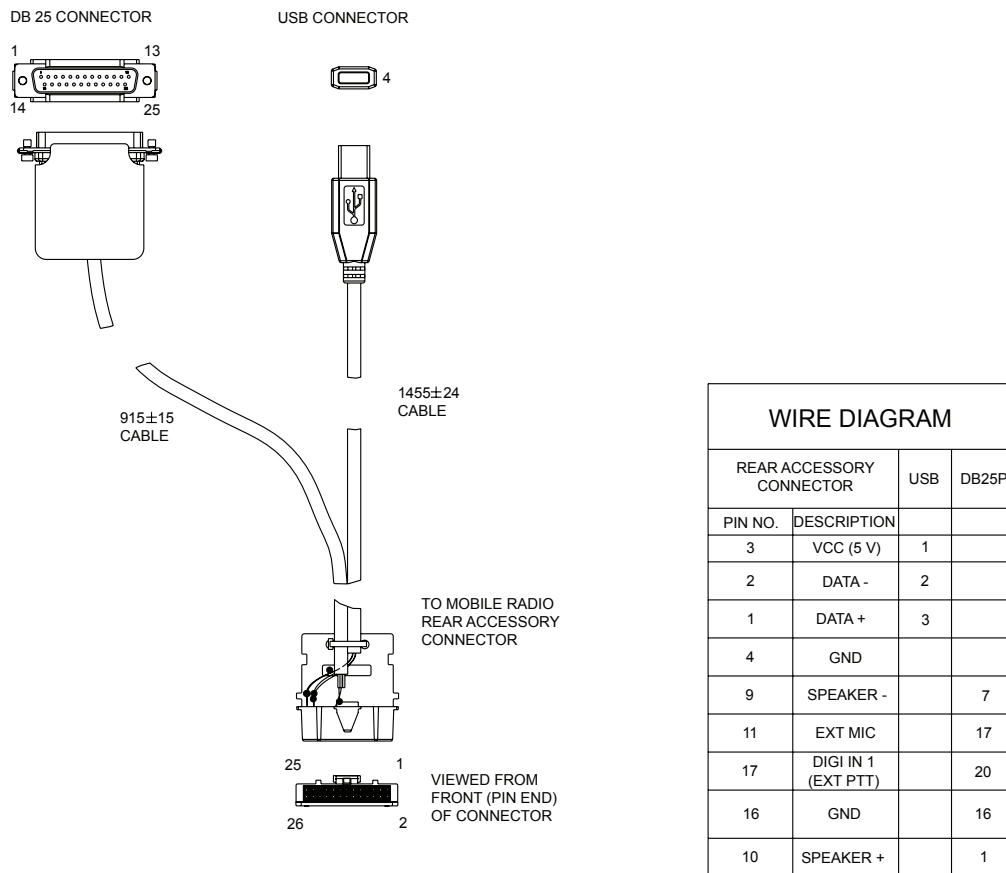


Figure 3-3 Mobile & Repeater Rear Accessory Programming and Test Cable PMKN4016\_

## Notes



## Section 4

### POWER-UP SELF-TEST

**NOTE:** This section is for reference only. If at any time one of the error codes is present, the radio should be returned to a qualified Motorola Service Center.

#### 1.0 Power-Up Error Codes (Display Model only)

Upon powering up, the radio performs certain tests to determine if its basic electronics and software are in working order. Any error detected has an associated error code that is presented on the radio display. These error codes are intended to be used by a service technician when the radio generates the Self Test Fail Tone. If these tests are successfully completed, the radio will generate the Self Test Tone.

There are two classes of detectable errors, fatal and non-fatal. If it is considered as a fatal error, then the normal radio operation will be inhibited. Fatal errors include hardware errors detected by the microprocessor and certain memory errors. These memory errors include incorrect ROM checksum, incorrect RAM checksum, and incorrect checksums of codeplug (Persistent Storage) blocks that contain operating parameters. If the codeplug block operating parameters are corrupted, operation of the unit on the proper frequency, system, and group are in question. Attempts to use this information could provide the user with a false sense of security that others are receiving his messages. Corrupted codeplug blocks of call IDs, or their associated aliases are considered non-fatal errors. While the user may be inconvenienced, normal communication is still possible.

*Table 4-1 Power-Up Self Check Error Codes*

<b>Error Code</b>	<b>Description</b>	<b>Error Type</b>	<b>Corrective Action</b>
ERROR 01/02	FLASH ROM Codeplug Checksum	NON-FATAL	•Reflash the entire codeplug.
ERROR 01/22	Tuning Codeplug Checksum	NON-FATAL	•Reflash tuning codeplug. •Retune the radio using Global Tuner.
FAIL 01/81 FAIL 02/81	Host or DSO firmware checksum	FATAL	•Reflash the firmware.
FAIL 01/82	DSP RAM1 Test Failure	FATAL	•Turn radio off and then on. •Manually put radio into bootstrap mode, and reflash firmware. •Replace radio by sending to the nearest Motorola Depot.
FAIL 01/84	DSP RAM2 Test Failure	FATAL	•Turn radio off and then on. •Manually put radio into bootstrap mode, and reflash firmware. •Replace radio by sending to the nearest Motorola Depot.

Table 4-1 Power-Up Self Check Error Codes

Error Code	Description	Error Type	Corrective Action
FAIL 01/88	External SDRAM Failure	FATAL	<ul style="list-style-type: none"> <li>•Turn radio off, and then on.</li> <li>•Manually put radio into bootstrap mode, and reflash firmware.</li> <li>•Replace the main board.</li> </ul>
FAIL 01/90	General Hardware Test Failure	FATAL	<ul style="list-style-type: none"> <li>•Turn radio off, and then on.</li> <li>•Manually put radio into bootstrap mode, and reflash firmware.</li> <li>•Replace radio by sending to the nearest Motorola Depot.</li> </ul>
FAIL 01/A0	Abacus IC Test Failure or Wrong IC Version	FATAL	<ul style="list-style-type: none"> <li>•Reflash tuning codeplug.</li> <li>•Retune the radio using Global Tuner.</li> </ul>
FAIL 01/A2	Tuning Codeplug Checksum	FATAL	<ul style="list-style-type: none"> <li>•Reflash tuning codeplug.</li> <li>•Retune the radio using Global Tuner.</li> </ul>
FAIL 01/C0	DSP ROM Test Failure	FATAL	<ul style="list-style-type: none"> <li>•Turn radio off, and then on. Manually put radio into bootstrap mode, and reflash firmware.</li> <li>•Replace radio by sending to the nearest Motorola Depot.</li> </ul>

**NOTE:** A non-display radio emits only the Self Test Fail Tone if it fails the self test.

## 2.0 Operational Error Codes

During radio operation, the radio performs dynamic tests to determine if the radio is working properly. Problems detected during these tests are presented as error codes on the radio's display. The presence of an error code should prompt a user that a problem exists and that a Motorola Authorized MOTOTRBO dealer should be contacted. Use Table 4-2 to aid in understanding particular operational error codes.

Table 4-2 Operational Error Codes

Error Code	Description	Error Type	Corrective Action
ERROR 001	Synthesizer Out of Lock Radio band mismatch	NON-FATAL	<ul style="list-style-type: none"> <li>•Reflash the tuning codeplug.</li> <li>•Reflash the entire codeplug.</li> <li>•Replace radio by sending to the nearest Motorola Depot.</li> </ul>
ERROR 002	Personality Checksum or System Block Error	NON-FATAL	<ul style="list-style-type: none"> <li>•Reflash the entire codeplug.</li> </ul>



# **XPR 4380/XPR 4580**

## **Mobile Radios**

Chapter 2

Control Head

Service Information

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## **Computer Software Copyrights**

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## Chapter 2 - Control Head Service Information

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## Notes

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## Section 1

### OVERVIEW

#### 1.0 Numeric Display Model

The Control Head contains the internal speaker, the On/Off/Volume knob, the microphone connector, several buttons to operate the radio and several indicator Light Emitting Diodes (LED) to inform the user about the radio status and channel. The switches and indicators on the Control Head are directly controlled by the processor in the radio.



## 2.0 Display Model

The Control Head contains the internal speaker, the On/Off/Volume knob, the microphone connector, several buttons to operate the radio, several indicator Light Emitting Diodes (LED) to inform the user about the radio status, and a Liquid Crystal Display (LCD) for alpha - numerical information e.g. channel number or call address name. The switches, indicators, and LCD on the Control Head are directly controlled by the processor in the radio.





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## Section 2

# THEORY OF OPERATION

### 1.0 Introduction

There are two different Control Heads supported by the XPR series radios, a Display Control Head and a Numeric Display Control Head. Information concerning the radio's Control Head interface can be found in section 1.8 of Controller Service Information section.

### 1.1 Numeric Display Control Head

The Numeric Display Control Head contains the internal speaker, the on/off switch, the volume knob, the microphone connector, several buttons to operate the radio, a two-digit LED channel indicator display and several indicator LEDs to inform the user about the radio status. The OMAP processor (U1000) inside the radio controls the LEDs and the LED channel display via a serial data bus.

#### 1.1.1 Power Supply

The power supply to the control head is taken from the radio's 9V3 voltage via connector J6001, pin 30. The voltage 9V3 is at 9.3 V and is used for the LEDs, the backlight LEDs, and is regulated to 3.3V by U6000. The regulated 3.3 V supplies power to the logic level shifters, shift registers and BCD decoders.

#### 1.1.2 Serial Peripheral Interface (SPI)

The radio communicates with the control head via its SPI bus. Four lines are connected to the shift register U6002: CLOCK (J6001, pin 24), DATA (J6001, pin 25), LED\_CS (J6001, pin 23) and RESET (J6001, pin 28). CLOCK, DATA and RESET are also connected to the shift register U6005. Additionally, one more line is connected from the radio to U6005: DISPLAY\_CS (J6001, pin 26). All 5 lines are level translated from 1.8 V to 3.3 V through U6003.

The radio sends data to the shift registers by first asserting the appropriate chip select and the data is loaded to the appropriate registers. Data is latched into the shift registers when the CS transitions from low to high.

#### 1.1.3 Switches

This control head supports two switches to control channel up/down, and two programmable switches P1 and P2. The switches are connected to the OMAP inside the radio via a 4 row by 3 column scanning matrix with only four used positions. Each of the 3 column output lines is toggled high in sequence and the 4 row input lines are monitored to detect if a button has been pressed. The OMAP processor then decodes which switch was pressed using the appropriate column and row stimulus and response information.

The momentary on-off switch is a dedicated function which is not part of the keypad matrix network. ON\_OFF\_SW signal is connected to the host radio via J6001, pin 22. When this signal is momentary grounded, on/off switch on the host radio is triggered.

### 1.1.4 Dual Seven-Segment Display

The two digit numerical display is controlled by the shift register U6005, BCD decoder/drivers U6006 and U6007. The higher 4 bits of U6005 output are decoded by U6007 and display the left digit. The lower 4 bits of U6005 output are decoded by U6006 and display the right digit. U6002 pin 4 controls on and off for the display.

### 1.1.5 Status LEDs and Backlight Circuit

All indicator LEDs (red, yellow and green) and icon LEDs are driven by current sources. LEDs on or off are set by the radio sending a data message to the control head shift register U6002 via the SPI bus. The control head shift register U6002 determines the LED state from the received data and switches the LEDs on or off via Q6004, Q6005, Q6007, Q6011, and Q6012.

Backlighting for the keys is provided by 5 LEDs driven from a constant current circuit Q6014. The backlighting can be either on or off controlled by the U6002 (pins 3 and 4).

### 1.1.6 Mobile Microphone Port (MMP) Interface

The Mobile Microphone Port (MMP) is a newly defined Motorola Accessory Port that contains audio, digital I/O, serial interfaces, and accessory supply lines; and is similar in function to Motorola's legacy microphone connectors. The multiplexing of these functions is handled by circuitry internal to the radio. The function of each pin is listed in Table 2-1.

*Table 2-1 Mobile Microphone Port Functions*

MMP Pin Number	MMP Pin Name	Function
1	ACC_ID	Accessory Identifier
2	GPIO_3 / PTT	General Purpose I/O or PTT
3	Spkr	Handset Audio
4	GPIO_2 / D-	USB D-
5	GND (Ground)	Ground
6	Opt_5V / Vbus	5 Volt Supply
7	Mic+	Mic Input
8	GPIO_1 / D+	USB D+
9	GPIO_4 / Hook	General Purpose I/O or Hook
10	GPIO_0 / PwrOn	General Purpose I/O or Power On Detect

The MMP includes 2 serial interfaces: an USB port and an ACC\_ID interface. The USB port can be used as either a device (radio is device) or as a host (radio is host). When configured as a device, the radio can be programmed or tuned using MOTOTRBO CPS or Tuner software. When configured as a host, various smart accessories can be used with the radio. See section 1.7 of Controller Service Information section for more information on the USB interface.

The ACC\_ID interface is used by accessories to provide the radio with information needed to configure the interface for that accessory. See section 1.6 of Controller Service Information section for more information on the ACC\_ID interface.

Note: The USB ports are designed to support Motorola accessories and approved applications only and will not support third party “Plug-n-Play” USB devices.

### **1.1.7 Speaker**

The control head contains a speaker for the receive audio. The receive audio signal from the audio PA (located inside the radio) is fed via connector J6001, pins 10 and 11 to the speaker connector. The speaker is connected to the speaker connector P6004. The control head speaker can be disconnected if an external speaker, connected on the MAP is used. For more details on the audio PA and audio routing see section 1.11 of Controller Service Information section.

### **1.1.8 Electrostatic Transient Protection**

Electrostatic transient protection is provided for the sensitive components in the control head by diodes VR6001, VR6002, VR6020, VR6042, VR6043, and VR6045. The diodes limit any transient voltages to tolerable levels. The associated capacitors provide Radio Frequency Interference (RFI) protection.

### **1.1.9 Volume Encoder**

The volume control is facilitated by the digital encoder S6010. Pins 1 and 3 of S6010 are connected to the radio OMAP processor (U1000) via J6001, pins 13 and 14. There are active pull-ups internal to the OMAP. When S6010 is rotated, active low pulses are generated on both pins in off-phase pattern. The phase of the two signals determines the direction of the rotation. The number of the pulses determines the magnitude of the rotation.

## **1.2 Display Control Head**

The Display Control Head contains the internal speaker, the on/off switch, the volume knob, the microphone connector, several switches to operate the radio, several indicator LEDs to inform the user about the radio status, and a dot matrix liquid crystal display (LCD) for alphanumerical information. The OMAP processor (U1000) inside the radio controls the LEDs and the LCD via serial data bus.

### **1.2.1 Power Supply**

The power supply to the control head is taken from the radio's 9V3 voltage via connector J6001, pin 30. The voltage 9V3 is at 9.3 V and is used for the LEDs, the backlight LEDs, and is regulated to 2.2 V by U6000. The regulated 2.2 V supplies power to the logic level shifters, shift registers and LCD module.

### 1.2.2 Serial Peripheral Interface (SPI)

The radio communicates with the control head via its SPI bus. Three lines are connected to the shift register U6002: CLOCK (J6001, pin 24), DATA (J6001, pin 25), and LED\_CS (J6001, pin 23). CLOCK and DATA are also connected to the LCD module via J6000. Additionally, three more lines are connected from the radio to LCD module: DISPLAY\_CS (J6001, pin 26), D/C (J6001, pin 27) and RESET (J6001, pin 28). All 6 lines are level translated from 1.8 V to 2.2 V through U6003.

The radio sends data to the shift registers by first asserting the appropriate chip select and the data is loaded to the appropriate registers. Data is latched into the shift registers when the CS transitions from low to high.

### 1.2.3 Switches

This control head supports 11 switches to control channel up/down, menu navigation, and four programmable switches P1 through P4. The switches are connected to the OMAP inside the radio via a 4 row by 3 column scanning matrix with only four used positions. Each of the 3 column output lines is toggled high in sequence and the 4 row input lines are monitored to detect if a button has been pressed. The OMAP processor then decodes which switch was pressed using the appropriate column and row stimulus and response information.

The momentary on-off switch is a dedicated function which is not part of the keypad matrix network. ON\_OFF\_SW signal is connected to the host radio via J6001, pin 22. When this signal is momentary grounded, on/off switch on the host radio is triggered.

### 1.2.4 LCD Display

The 132x34 full dot matrix LCD is controlled by the LCD controller/driver chip on the LCD module. The radio communicates with the LCD module via CLOCK (J6001, pin 24), DATA (J6001, pin 25), DISPLAY\_CS (J6001, pin 26), D/C (J6001, pin 27) and RESET (J6001, pin 28). The radio sends data to the LCD by first asserting chip select low and the data is loaded to the appropriate registers. Data is latched into the shift registers when the CS transitions from low to high. U6003 on the control head board is used to provide level shifting from the 1.8 V radio logic level to the 2.2 V LCD logic level.

### 1.2.5 Status LEDs and Backlight Circuit

All indicator LEDs (red, yellow and green) and icon LEDs are driven by current sources. LEDs on or off are set by the radio sending a data message to the control head shift register U6002 via the SPI bus. The control head shift register U6002 determines the LED state from the received data and switches the LEDs on or off via Q6004, Q6005, and Q6007.

Backlighting for the keys is provided by 18 LEDs driven from a constant current circuit Q6014. The backlighting can be either on or off controlled by a constant current circuit (Q6008, U6001 and associated parts). There are 4 levels of backlight: off, low, medium and high, which are controlled by two outputs from the shift register (U6002, pins 3 and 4). The current is controlled by transistor Q6008. The Op Amp U6001 monitors the current by measuring the voltage drop across R6019, R6020 and adjusting the bias of Q6008 to achieve the required level as set by the combined shift register outputs. The total current is distributed among all the LEDs. Resistors R6037, R6040, R6041 and R6042 provide compensation to the component variation between LEDs. They ensure the even brightness on the control head.

### 1.2.6 Mobile Microphone Port (MMP) Interface

The Mobile Microphone Port (MMP) is a newly defined Motorola accessory port that contains audio, digital I/O, serial interfaces, and accessory supply lines; and is similar in function to Motorola's legacy microphone connectors. The multiplexing of these functions is handled by circuitry internal to the radio. The function of each pin is listed in Table 2-2.

*Table 2-2 Mobile Microphone Port Functions*

MMP Pin Number	MMP Pin Name	Function
1	ACC_ID	Accessory Identifier
2	GPIO_3 / PTT	General Purpose I/O or PTT
3	Spkr	Handset Audio
4	GPIO_2 / D-	USB D-
5	GND (Ground)	Ground
6	Opt_5V / Vbus	5 Volt Supply
7	Mic+	Mic Input
8	GPIO_1 / D+	USB D+
9	GPIO_4 / Hook	General Purpose I/O or Hook
10	GPIO_0 / PwrOn	General Purpose I/O or Power On Detect

The MMP includes 2 serial interfaces: an USB port and an ACC\_ID interface. The USB port can be used as either a device (radio is device) or as a host (radio is host). When configured as a device, the radio can be programmed or tuned using MOTOTRBO CPS or Tuner software. When configured as a host, various smart accessories can be used with the radio. See section 1.7 of Controller Service Information section for more information on the USB interface.

The ACC\_ID interface is used by accessories to provide the radio with information needed to configure the interface for that accessory. See section 1.6 of Controller Service Information section for more information on the ACC\_ID interface.

Note: The USB ports are designed to support Motorola accessories and approved applications only and will not support third party "Plug-n-Play" USB devices.

### 1.2.7 Speaker

The control head contains a speaker for the receive audio. The receive audio signal from the audio PA (located inside the radio) is fed via connector J6001, pins 10 and 11 to the speaker connector. The speaker is connected to the speaker connector P6004. The control head speaker can be disconnected if an external speaker, connected on the MAP, is used. For more details on the audio PA and audio routing see section 1.11 of Controller Service Information section.

### **1.2.8 Electrostatic Transient Protection**

Electrostatic transient protection is provided for the sensitive components in the control head by diodes VR6001, VR6002, VR6020, VR6042, VR6043, and VR6045. The diodes limit any transient voltages to tolerable levels. The associated capacitors provide Radio Frequency Interference (RFI) protection.

### **1.2.9 Volume Encoder**

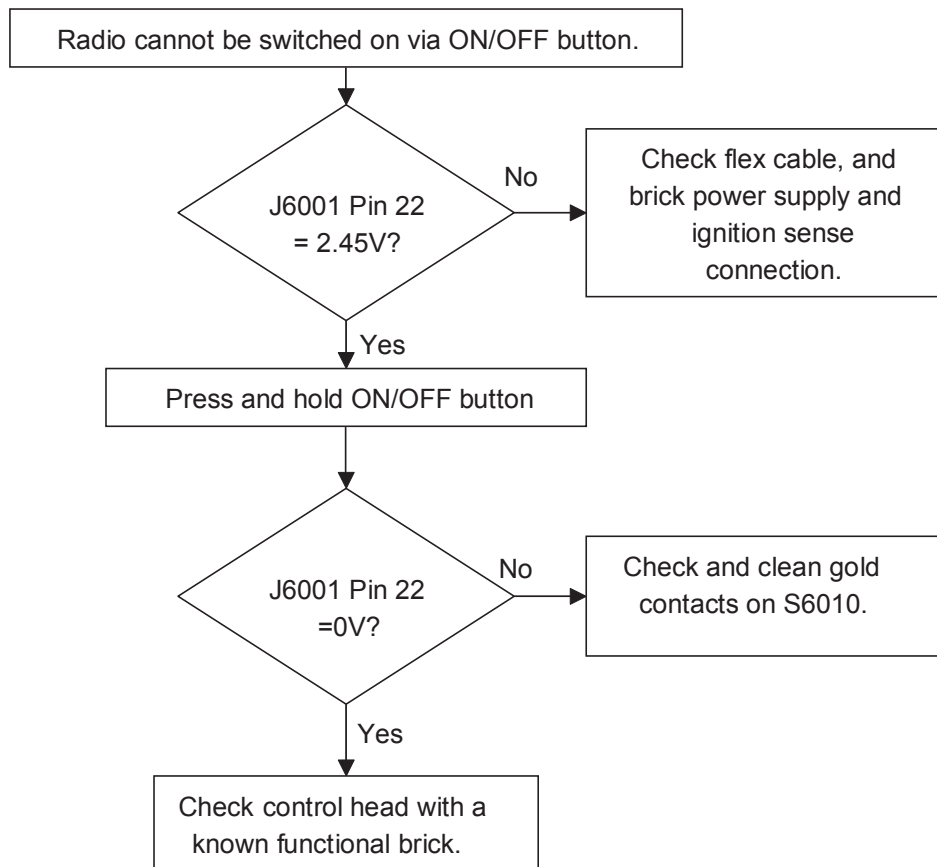
The volume control is facilitated by the digital encoder S6010. Pins 1 and 3 of S6010 are connected to the radio OMAP processor (U1000) via J6001, pins 13 and 14. There are active pull-ups internal to the OMAP. When S6010 is rotated, active low pulses are generated on both pins in off-phase pattern. The phase of the two signals determines the direction of the rotation. The number of the pulses determines the magnitude of the rotation.

## Section 3

# TROUBLESHOOTING CHARTS

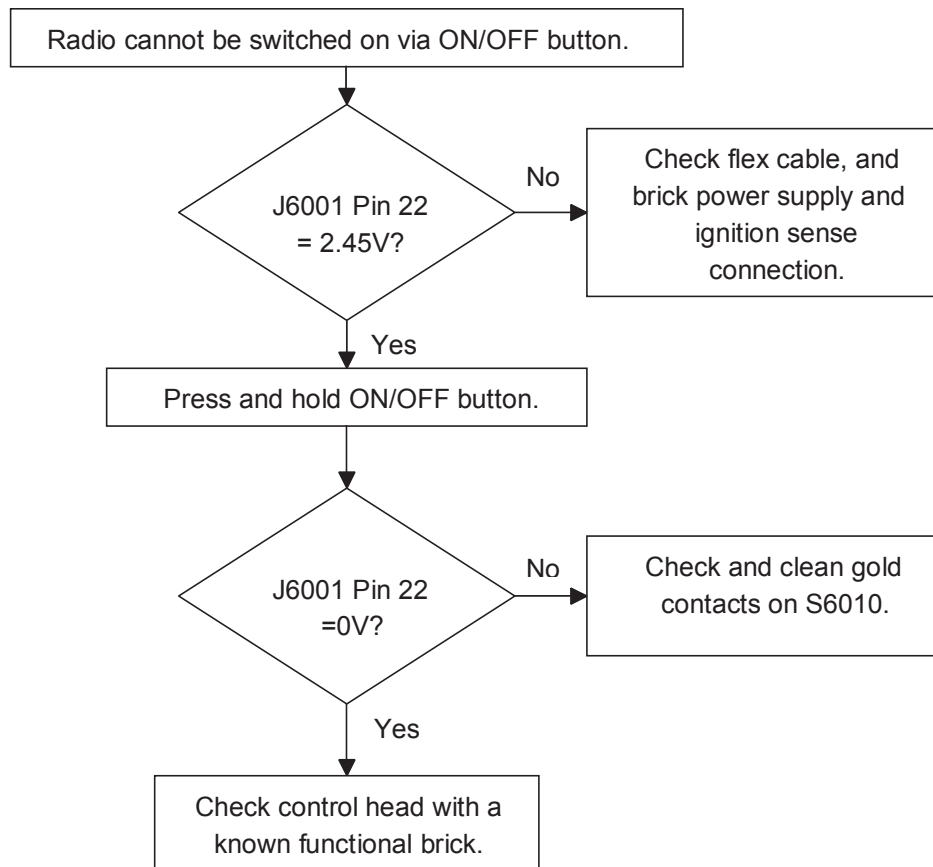
### 1.0 Numeric Display Model Control Head Troubleshooting Flow Chart

#### 1.1 On/Off



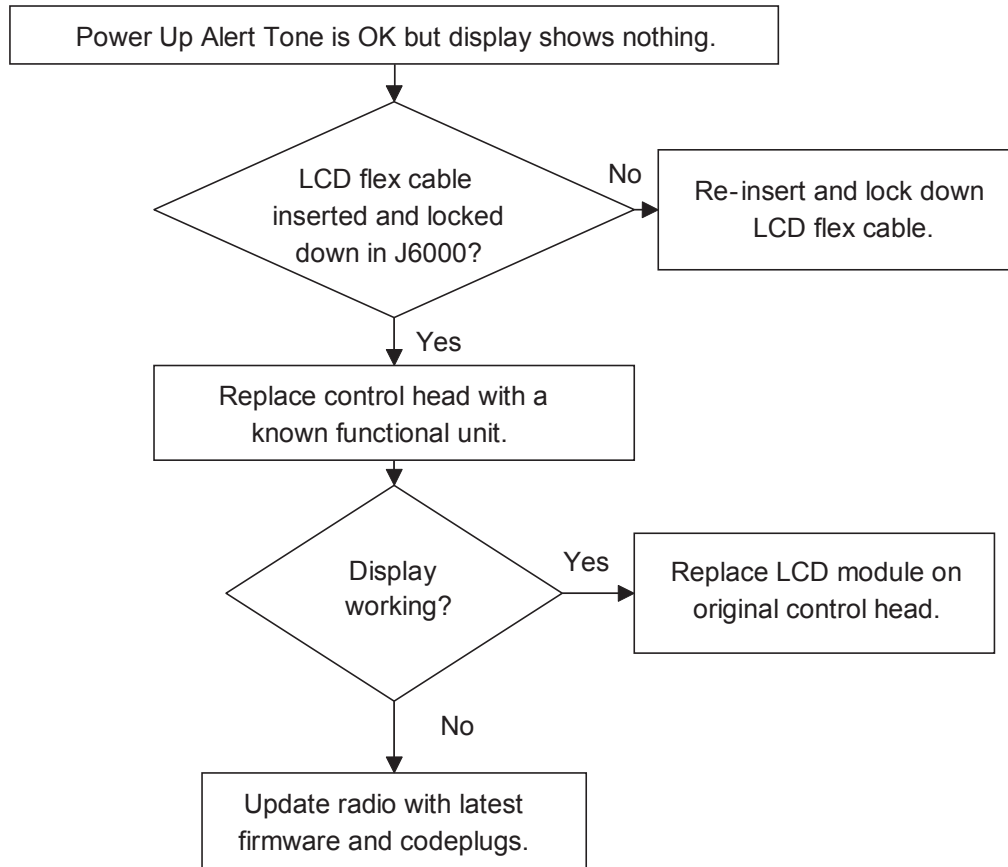
## 2.0 Display Model Control Head Troubleshooting Flow Chart

### 2.1 On/Off

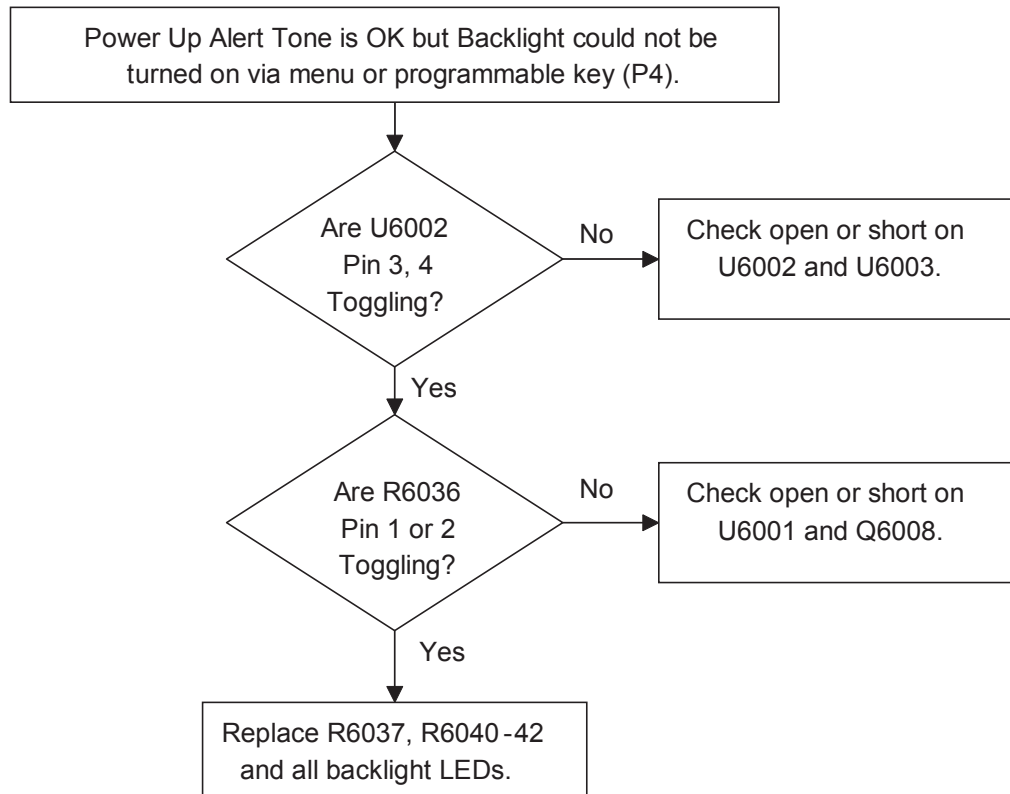




## 2.2 Display



## 2.3 Backlight



## Section 4

# CONTROL HEAD PCBS/SCHEMATICS/PARTS LISTS

### 1.0 Allocation of Schematics and Circuit Boards

*Table 4-1 Numeric Display Control Head Diagrams and Parts List*

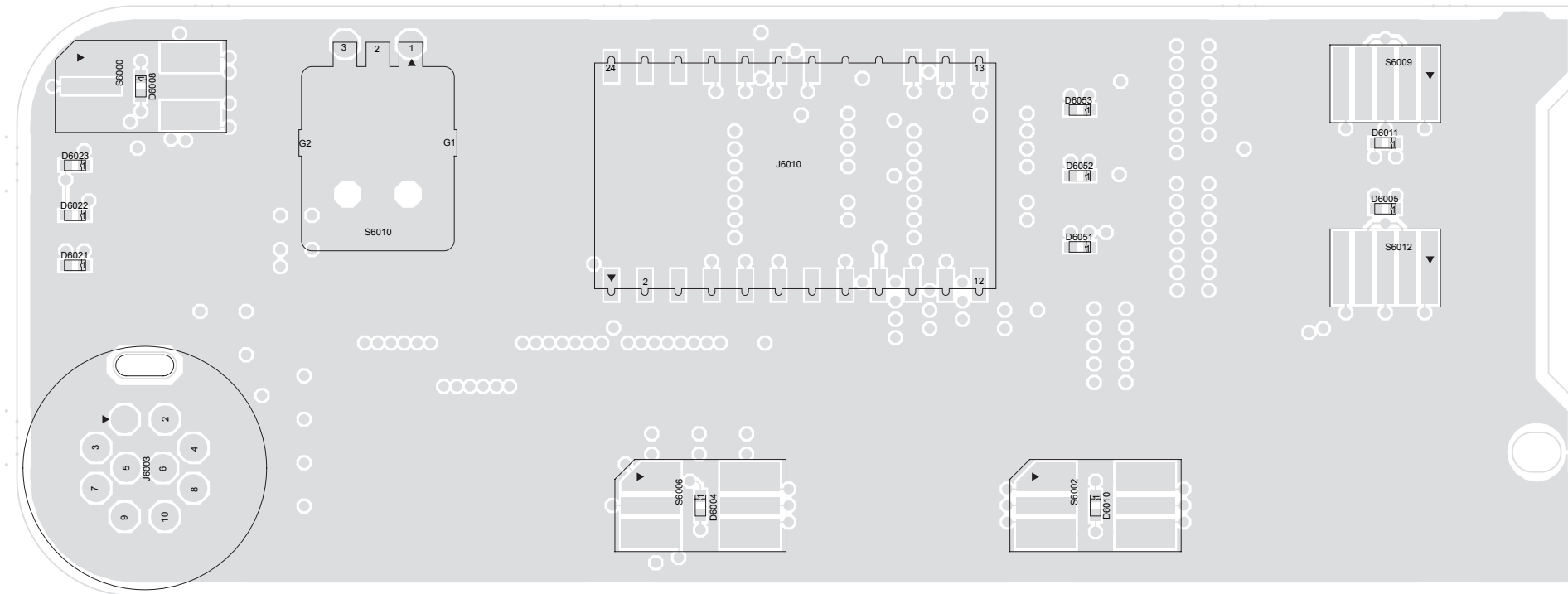
<b>PCB :</b> Numeric Display Control Head <b>8471214H02</b> Main Board Top Side <b>8471214H02</b> Main Board Bottom Side	Page 4-3 Page 4-3
<b>SCHEMATICS</b> Numeric Display Control Head Schematic Diagram	Page 4-4
<b>Parts List</b> 8471214H02	Page 4-5

*Table 4-2 Display Control Head Diagrams and Parts List*

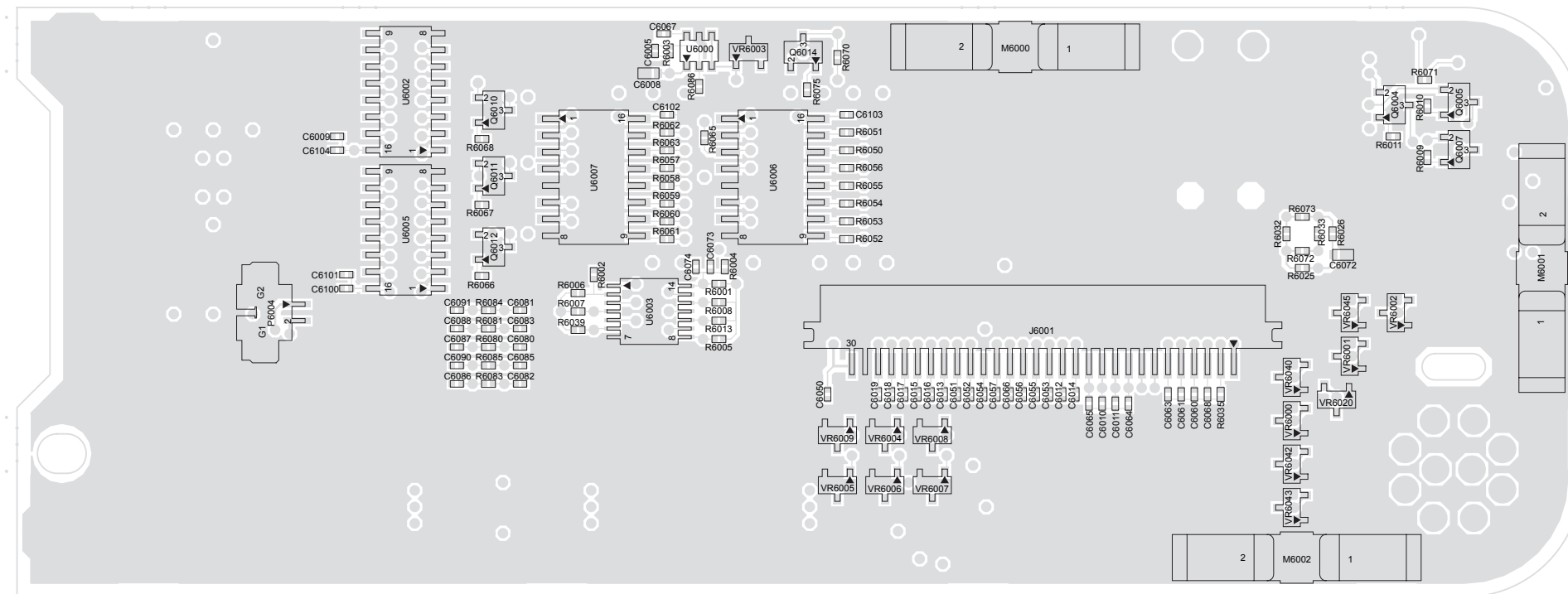
<b>PCB :</b> Display Control Head <b>8415026C08</b> Main Board Top Side <b>8415026C08</b> Main Board Bottom Side	Page 4-6 Page 4-6
<b>SCHEMATICS</b> Display Control Head Schematic Diagram	Page 4-7
<b>Parts List</b> 8415026C08	Page 4-8

## Notes

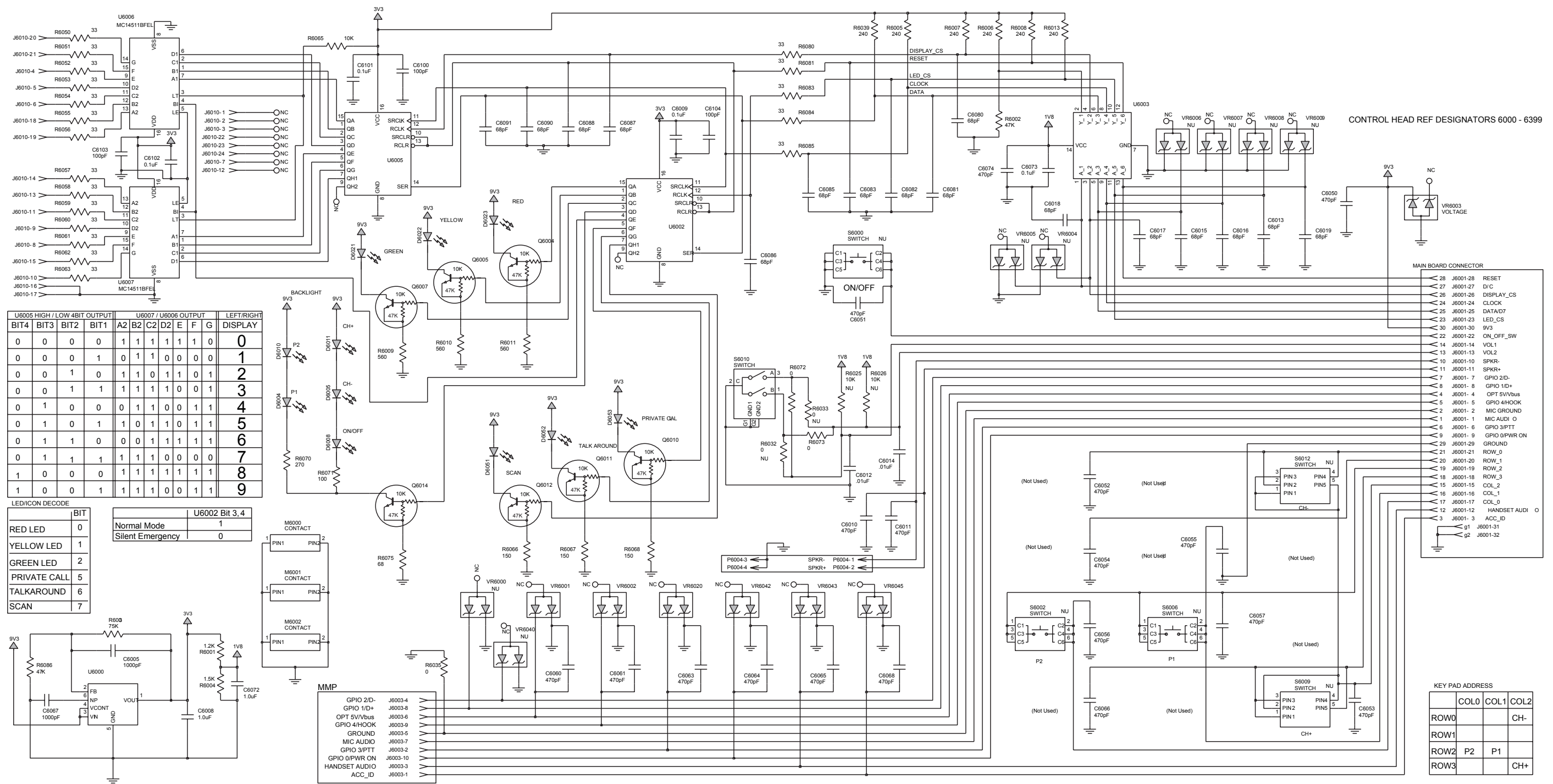
## 2.0 Numeric Display Control Head - PCB 8471214H02 / Schematics



Top Side View

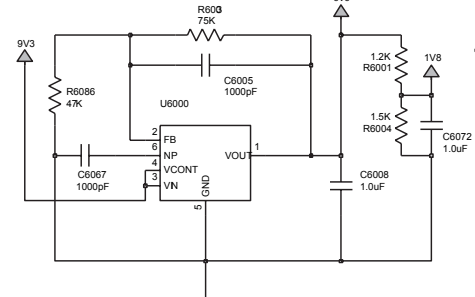


Bottom Side View



U6005 HIGH / LOW 4BIT OUTPUT				U6007 / U6006 OUTPUT				LEFT/RIGHT			
BIT4	BIT3	BIT2	BIT1	A2	B2	C2	D2	E	F	G	DISPLAY
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	0	0	1	1	9

LED/ICON DECODE		BIT	
RED LED	0	Normal Mode	1
YELLOW LED	1	Silent Emergency	0
GREEN LED	2		
PRIVATE CALL	5		
TALKAROUND	6		
SCAN	7		



MMP	
GPIO 2/D-	J6003-4
GPIO 1/D+	J6003-8
OPT 5V/Vbus	J6003-6
GPIO 4/HOOK	J6003-9
GROUND	J6003-5
MIC AUDIO	J6003-7
GPIO 3/P1TT	J6003-2
GPIO 0/PWR ON	J6003-10
HANDSET AUDIO	J6003-3
ACC_ID	J6003-1

KEY PAD ADDRESS			
	COL0	COL1	COL2
ROW0			CH-
ROW1	P2	P1	
ROW2			CH+
ROW3			

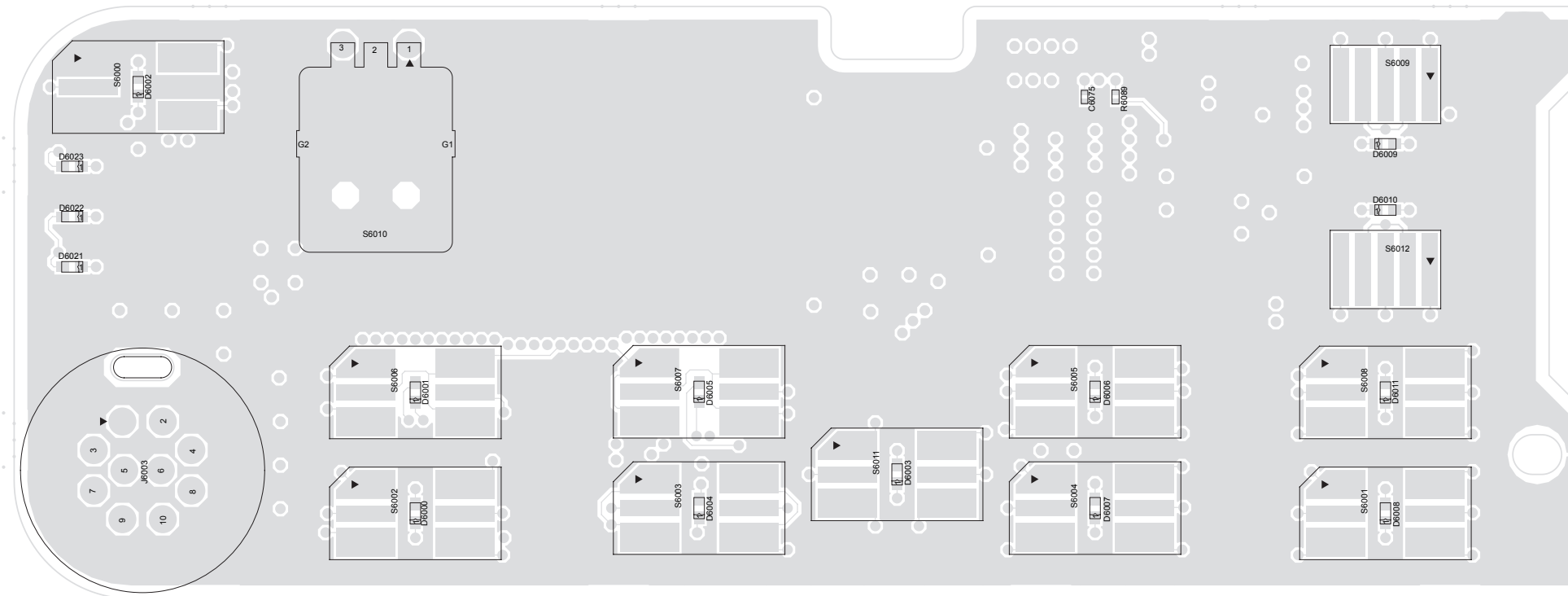
### 3.0 Numeric Display Control Head Parts List

Circuit Ref	Motorola Part No.	Description
C6005	2113945A09	1000pF
C6008	2113946S35	1.0uF
C6009	2113946B04	0.10uF
C6010	2113945A05	470pF
C6011	2113945A05	470pF
C6012	2113945B02	.01uF
C6013	2113944A36	68pF
C6014	2113945B02	.01uF
C6015	2113944A36	68pF
C6016	2113944A36	68pF
C6017	2113944A36	68pF
C6018	2113944A36	68pF
C6019	2113944A36	68pF
C6050	2113945A05	470pF
C6051	2113945A05	470pF
C6052	2113945A05	470pF
C6053	2113945A05	470pF
C6054	2113945A05	470pF
C6055	2113945A05	470pF
C6056	2113945A05	470pF
C6057	2113945A05	470pF
C6060	2113945A05	470pF
C6061	2113945A05	470pF
C6063	2113945A05	470pF
C6064	2113945A05	470pF
C6065	2113945A05	470pF
C6066	2113945A05	470pF
C6067	2113945A09	1000pF
C6068	2113945A05	470pF
C6072	2113946S35	1.0uF
C6073	2113946B04	0.10uF
C6074	2113945A05	470pF
C6080	2113944A36	68pF
C6081	2113944A36	68pF
C6082	2113944A36	68pF
C6083	2113944A36	68pF
C6085	2113944A36	68pF
C6086	2113944A36	68pF
C6087	2113944A36	68pF
C6088	2113944A36	68pF
C6090	2113944A36	68pF
C6091	2113944A36	68pF
C6100	2113944A40	100pF
C6101	2113946B04	0.10uF
C6102	2113946B04	0.10uF
C6103	2113944A40	100pF
C6104	2113944A40	100pF
D6004	4815809H04	LED GREEN

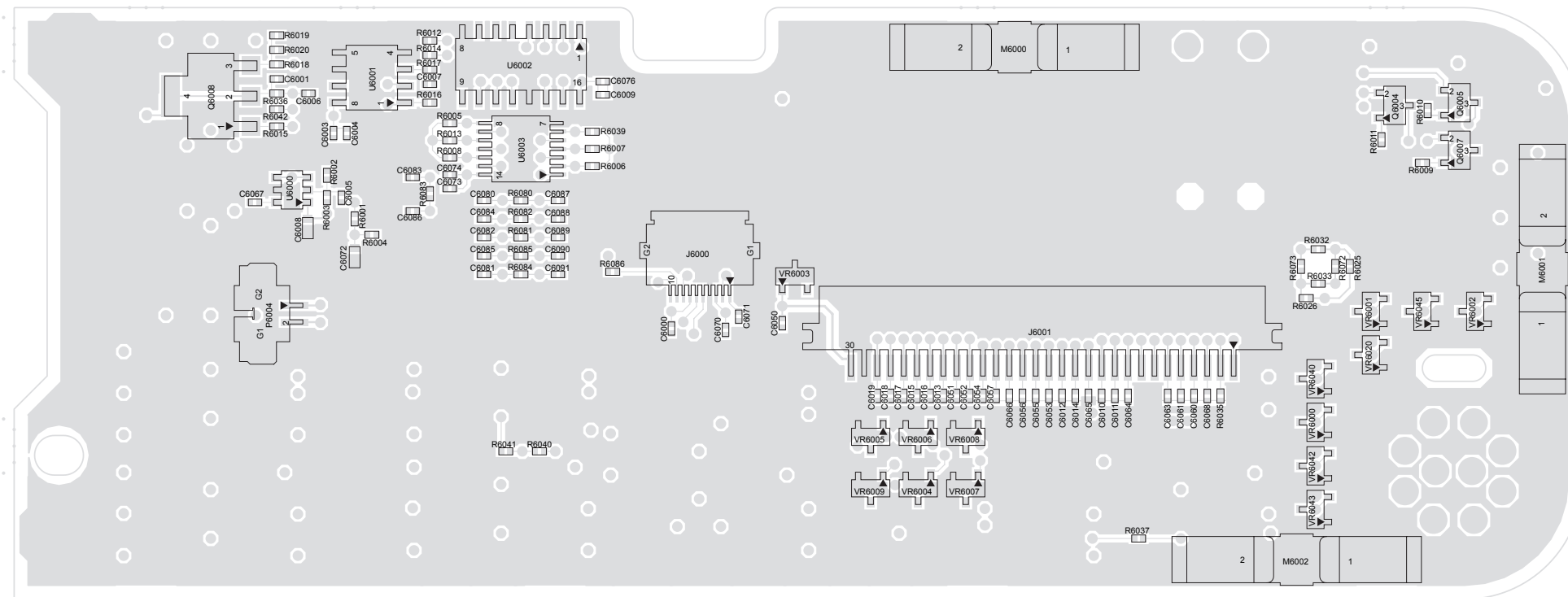
Circuit Ref	Motorola Part No.	Description
D6005	4815809H04	LED GREEN
D6008	4815809H04	LED GREEN
D6010	4815809H04	LED GREEN
D6011	4815809H04	LED GREEN
D6021	4815809H04	LED GREEN
D6022	4815809H03	LED YELLOW
D6023	4815809H02	LED RED
D6051	4815809H04	LED GREEN
D6052	4815809H04	LED GREEN
D6053	4815809H04	LED GREEN
J6001	0915555H01	30-PIN CONTROL HEAD CONNECTOR
J6003	0964501H02	10-PIN GCAI CONNECTOR
J6010	0916947H01	24-PIN SOCKET
M6000	3915452H01	GROUNDING SPRING
M6001	3915452H01	GROUNDING SPRING
M6002	3915452H01	GROUNDING SPRING
P6004	2815162H01	2-PIN SPEAKER CONNECTOR
Q6004	4815261H01	ANALOG SWITCH
Q6005	4815261H01	ANALOG SWITCH
Q6007	4815261H01	ANALOG SWITCH
Q6010	4815261H01	ANALOG SWITCH
Q6011	4815261H01	ANALOG SWITCH
Q6012	4815261H01	ANALOG SWITCH
Q6014	4815261H01	ANALOG SWITCH
R6001	0613952Q75	1.2K
R6002	0613952R17	47K
R6003	0613952R22	75K
R6004	0613952Q77	1.5K
R6005	0613952Q58	240
R6006	0613952Q58	240
R6007	0613952Q58	240
R6008	0613952Q58	240
R6009	0613952Q67	560
R6010	0613952Q67	560
R6011	0613952Q67	560
R6013	0613952Q58	240
R6025	NOT PLACED	-
R6026	NOT PLACED	-
R6032	NOT PLACED	-
R6033	NOT PLACED	-
R6035	0613952R66	0
R6039	0613952Q58	240
R6050	0613952Q37	33
R6051	0613952Q37	33
R6052	0613952Q37	33
R6053	0613952Q37	33
R6054	0613952Q37	33
R6055	0613952Q37	33
R6056	0613952Q37	33

Circuit Ref	Motorola Part No.	Description
R6057	0613952Q37	33
R6058	0613952Q37	33
R6059	0613952Q37	33
R6060	0613952Q37	33
R6061	0613952Q37	33
R6062	0613952Q37	33
R6063	0613952Q37	33
R6065	0613952R01	10K
R6066	0613952Q53	150
R6067	0613952Q53	150
R6068	0613952Q53	150
R6070	0613952Q59	270
R6071	0613952Q49	100
R6072	0613952R66	0
R6073	0613952R66	0
R6075	0613952Q45	68
R6080	0613952Q37	33
R6081	0613952Q37	33
R6083	0613952Q37	33
R6084	0613952Q37	33
R6085	0613952Q37	33
R6086	0613952R17	47K
S6010	4071276L01	VOLUME ENCODER
U6000	5115391H01	VOLTAGE REGULATOR
U6002	5115476H01	IC, SERIAL-TO-PARALLEL CONVERTER
U6003	5115502H01	LOGIC TRANSLATOR
U6005	5115476H01	IC, SERIAL-TO-PARALLEL CONVERTER
U6006	5114002A56	IC, BCD-TO-SEVEN SEGMENT LATCH/DECODER/DRIVER
U6007	5114002A56	IC, BCD-TO-SEVEN SEGMENT LATCH/DECODER/DRIVER
VR6000	NOT PLACED	-
VR6001	4813977A43	DIODE, 5.6V ZENER
VR6002	4813977A43	DIODE, 5.6V ZENER
VR6003	4813977A48	DIODE, 20V ZENER
VR6004	NOT PLACED	-
VR6005	NOT PLACED	-
VR6006	NOT PLACED	-
VR6007	NOT PLACED	-
VR6008	NOT PLACED	-
VR6009	NOT PLACED	-
VR6020	4813977A43	DIODE, 5.6V ZENER
VR6040	NOT PLACED	-
VR6042	4813977A43	DIODE, 5.6V ZENER
VR6043	4813977A43	DIODE, 5.6V ZENER
VR6045	4813977A43	DIODE, 5.6V ZENER

### 4.0 Display Control Head - PCB 8415026C08 / Schematics

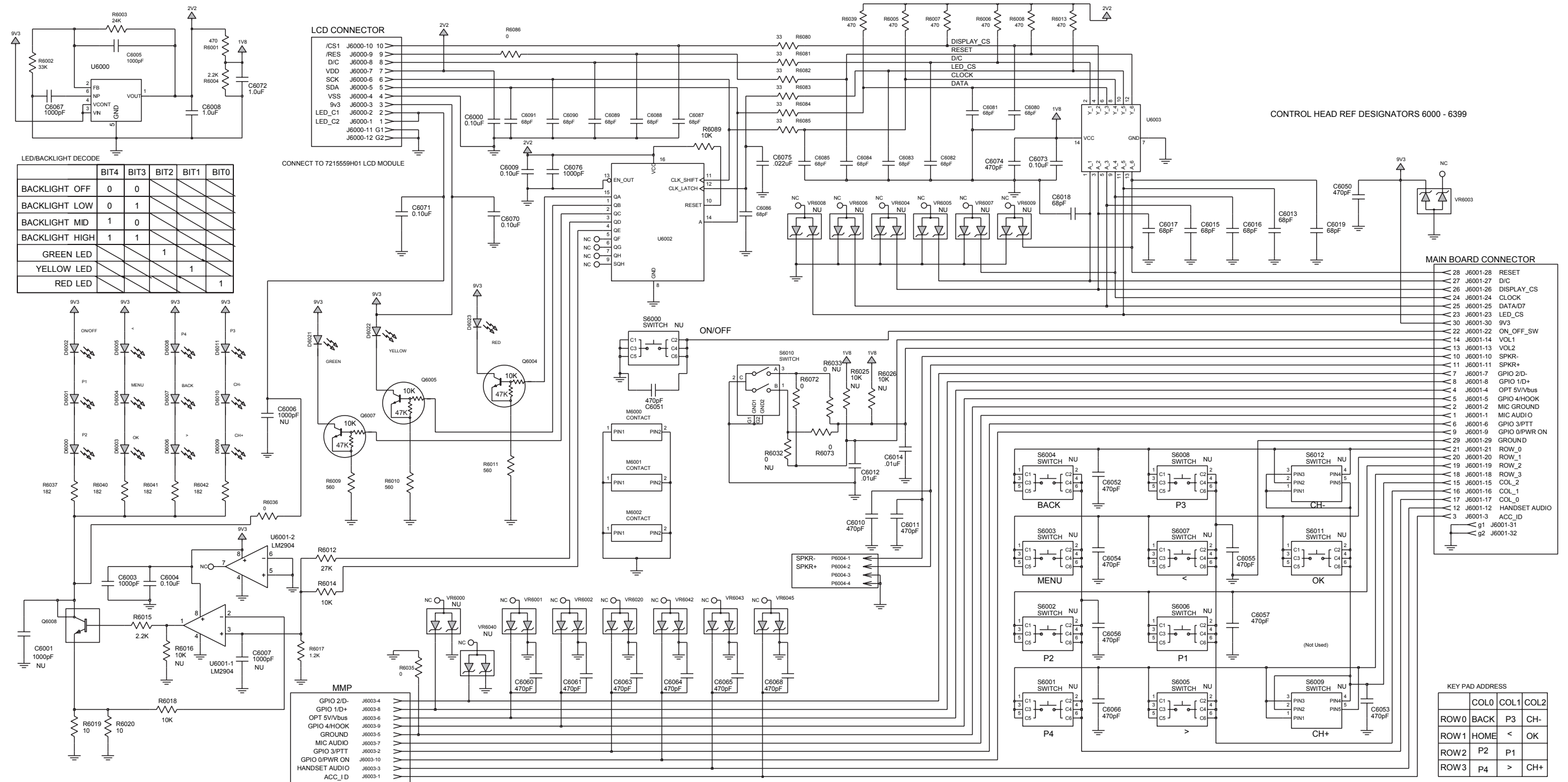


Top Side View



Bottom Side View





LED/BACKLIGHT DECODE

	BIT4	BIT3	BIT2	BIT1	BIT0
BACKLIGHT OFF	0	0			
BACKLIGHT LOW	0	1			
BACKLIGHT MID	1	0			
BACKLIGHT HIGH	1	1			
GREEN LED			1		
YELLOW LED				1	
RED LED					1

KEY PAD ADDRESS

	COL0	COL1	COL2
ROW0	BACK	P3	CH-
ROW1	HOME	<	OK
ROW2	P2	P1	
ROW3	P4	>	CH+

Display Control Head Schematic Diagram

## 5.0 Display Control Head Parts List

Circuit Ref	Motorola Part No.	Description
C6000	2113945Y02	0.10uF
C6001	NOT PLACED	-
C6003	2113945A09	1000pF
C6004	2113945Y02	0.10uF
C6005	2113945A09	1000pF
C6006	NOT PLACED	-
C6007	NOT PLACED	-
C6008	2113946S35	1.0uF
C6009	2113945Y02	0.10uF
C6010	2113945A05	470pF
C6011	2113945A05	470pF
C6012	2113945B02	0.01uF
C6013	2113944A36	68pF
C6014	2113945B02	0.01uF
C6015	2113944A36	68pF
C6016	2113944A36	68pF
C6017	2113944A36	68pF
C6018	2113944A36	68pF
C6019	2113944A36	68pF
C6050	2113945A05	470pF
C6051	2113945A05	470pF
C6052	2113945A05	470pF
C6053	2113945A05	470pF
C6054	2113945A05	470pF
C6055	2113945A05	470pF
C6056	2113945A05	470pF
C6057	2113945A05	470pF
C6060	2113945A05	470pF
C6061	2113945A05	470pF
C6063	2113945A05	470pF
C6064	2113945A05	470pF
C6065	2113945A05	470pF
C6066	2113945A05	470pF
C6067	2113945A09	1000pF
C6068	2113945A05	470pF
C6070	2113945Y02	0.10uF
C6071	2113945Y02	0.10uF
C6072	2113946S35	1.0uF
C6073	2113945Y02	0.10uF
C6074	2113945A05	470pF
C6075	2113946A02	0.022uF
C6076	2113945A09	1000pF
C6080	2113944A36	68pF
C6081	2113944A36	68pF
C6082	2113944A36	68pF
C6083	2113944A36	68pF
C6084	2113944A36	68pF
C6085	2113944A36	68pF
C6086	2113944A36	68pF
C6087	2113944A36	68pF

Circuit Ref	Motorola Part No.	Description
C6088	2113944A36	68pF
C6089	2113944A36	68pF
C6090	2113944A36	68pF
C6091	2113944A36	68pF
D6000	4815809H04	LED GREEN
D6001	4815809H04	LED GREEN
D6002	4815809H04	LED GREEN
D6003	4815809H04	LED GREEN
D6004	4815809H04	LED GREEN
D6005	4815809H04	LED GREEN
D6006	4815809H04	LED GREEN
D6007	4815809H04	LED GREEN
D6008	4815809H04	LED GREEN
D6009	4815809H04	LED GREEN
D6010	4815809H04	LED GREEN
D6011	4815809H04	LED GREEN
D6021	4815809H04	LED GREEN
D6022	4815809H03	LED YELLOW
D6023	4815809H02	LED RED
J6000	0916769H01	10-PIN FLEX CONNECTOR
J6001	0915555H01	30-PIN CONTROL HEAD CONNECTOR
J6003	0964501H02	10-PIN GCAI CONNECTOR
M6000	3915452H01	GROUNDING SPRING
M6001	3915452H01	GROUNDING SPRING
M6002	3915452H01	GROUNDING SPRING
P6004	2815162H01	2-PIN SPEAKER CONNECTOR
Q6004	4815261H01	ANALOG SWITCH
Q6005	4815261H01	ANALOG SWITCH
Q6007	4815261H01	ANALOG SWITCH
Q6008	4813973B01	NPN
R6001	0613952Q65	470
R6002	0613952R13	33K
R6003	0613952R10	24K
R6004	0613952Q81	2.2K
R6005	0613952Q65	470
R6006	0613952Q65	470
R6007	0613952Q65	470
R6008	0613952Q65	470
R6009	0613952Q67	560
R6010	0613952Q67	560
R6011	0613952Q67	560
R6012	0613952R11	27K
R6013	0613952Q65	470
R6014	0613952N01	10K
R6015	0613952Q81	2.2K
R6016	NOT PLACED	-
R6017	0613952Q75	1.2K
R6018	0613952R01	10K
R6019	0613952Q25	10

Circuit Ref	Motorola Part No.	Description
R6020	0613952Q25	10
R6025	NOT PLACED	-
R6026	NOT PLACED	-
R6032	NOT PLACED	-
R6033	NOT PLACED	-
R6035	0613952R66	0
R6036	0613952R66	0
R6037	0613952L26	182
R6039	0613952Q65	470
R6040	0613952L26	182
R6041	0613952L26	182
R6042	0613952L26	182
R6072	0613952R66	0
R6073	0613952R66	0
R6080	0613952Q37	33
R6081	0613952Q37	33
R6082	0613952Q37	33
R6083	0613952Q37	33
R6084	0613952Q37	33
R6085	0613952Q37	33
R6086	0613952R66	0
R6089	0613952R01	10K
S6010	4071276L01	VOLUME ENCODER
U6000	5115391H01	VOLTAGE REGULATOR
U6001	5114005A01	DUAL OPAMP
U6002	5114000A37	IC, SERIAL-TO-PARALLEL CONVERTER
U6003	5115502H01	LOGIC TRANSLATOR
VR6000	NOT PLACED	-
VR6001	4813977A43	DIODE, 5.6V ZENER
VR6002	4813977A43	DIODE, 5.6V ZENER
VR6003	4813977A48	DIODE, 20V ZENER
VR6004	NOT PLACED	-
VR6005	NOT PLACED	-
VR6006	NOT PLACED	-
VR6007	NOT PLACED	-
VR6008	NOT PLACED	-
VR6009	NOT PLACED	-
VR6020	4813977A43	DIODE, 5.6V ZENER
VR6040	NOT PLACED	-
VR6042	4813977A43	DIODE, 5.6V ZENER
VR6043	4813977A43	DIODE, 5.6V ZENER
VR6045	4813977A43	DIODE, 5.6V ZENER



# **XPR 4380/XPR 4580**

## **Mobile Radios**

Chapter 3

Controller

Service Information

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# Chapter 3 - Controller Service Information

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## Notes

# Section 1

## THEORY OF OPERATION

### 1.0 Controller

The Controller section consists of 4 main ICs. These are the Texas Instrument OMAP1710 Host/ DSP Processor (U1000), Flash memory (U2000), SDRAM memory (U2001) and the MAKO Audio/ Power Management (U3200) chip.

Figure 1-1 shows how the Controller interfaces with the RF section, GPS, Control Head and peripherals in an XPR series radio. The Controller, RF section, GPS, Control Head interface, Accessory interface, and Option Board interface are placed on a single Transceiver board. The physical interfaces between the Transceiver board and Option Board and between the Transceiver board and Control Head are via flex type connectors. All of the user interfaces are located on the Control Head.

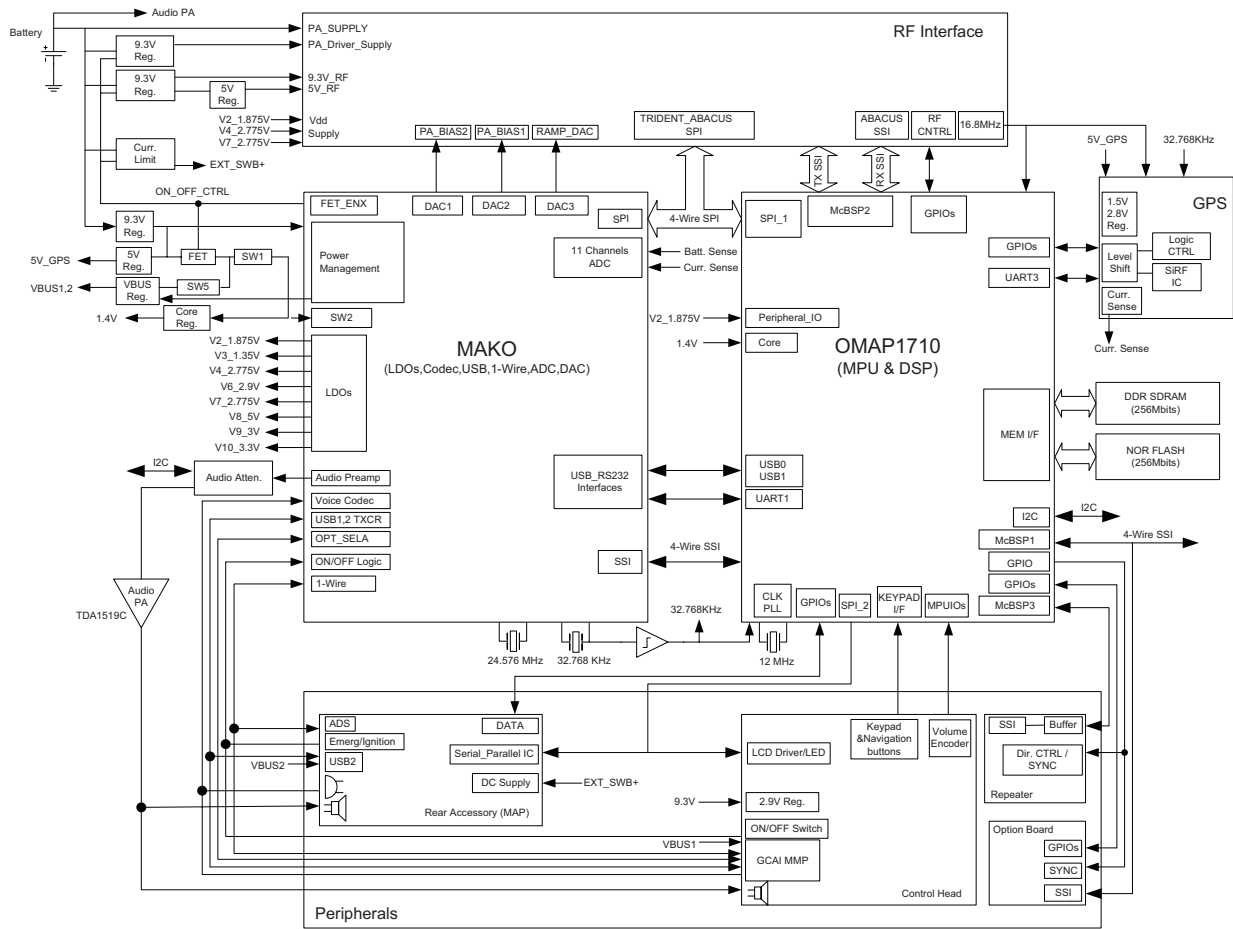


Figure 1-1 Controller Block Diagram





Voltage regulation is provided to the controller, GPS and RF sections by the following devices:

- +9.3V\_PA: U3005, U3006, and U3030
- +9.3V\_CNTRL: U3040 and U3030
- +9.3V\_SW: U3001
- +12.6V\_Ext SWB+: U3003
- +1.5V GPS RTC: U6407
- +1.4V OMAP Core: U3201
- Supplies for the Controller section: U3200 (MAKO)
- Supplies for the RF and GPS sections: U0601, U0941, U3002, U3004, U6402, and U6406

The 9V3\_PA regulator uses Op Amp U3030-1 as a controlling element. The regulated output voltage is divided by R3039 and R3040 and compared with an accurate reference voltage (5.1V DC) determined by VR3040. The Op Amp's output voltage at pin 1 varies the amount of conduction in transistors Q3032, U3005 and U3006 as necessary to keep voltages equal on pins 2 and 3 of the Op Amp. A characteristic of the Op Amp which allows the regulator to start up is the fact the output is high when both inputs are low, which occurs momentarily at turn-on. Dual diode D3030 serves two purposes. Diode D3030 is used to protect transistors U3005 and U3006 if the 9.3V\_PA line is grounded. When this happens Q3032's base can only be 0.7V DC and transistors U3005 and U3006 will be turned off. Diode D3030 also provides temperature compensation of the regulated output voltage. The 9V3\_PA supply powers the low level and driver stages of the RF power amplifier.

The MAKO and GPS regulators are powered by the 9V3\_CNTRL supply. Op Amp U3030-2 functions as a controlling element for the 9V3\_CNTRL regulator. The regulated output voltage is divided by R3045 and R3046 and compared with the reference voltage determined by VR3040. The Op Amp's output voltage at pin 7 varies the amount of conduction in transistors Q3040 and U3040 as necessary to keep equal voltages on pins 5 and 6 of the Op Amp. As is the case with the 9V3\_PA regulator, the Op Amp characteristic allows the regulator to start up when both Op Amp inputs are momentarily low at turn-on. Dual diode D3040 serves two purposes. Diode D3040 is used to protect transistor U3040 if the 9.3V\_CNTRL line is grounded. When this happens Q3040's base can only be 0.7V DC and transistor U3040 will be turned off. Diode D3030 also provides temperature compensation of the regulated output voltage.

Regulator U3001 generates the 9.3V required by most RF, power control, and audio circuits. Input and output capacitors C3005, and C3006/C3007/C3046 are used to reduce high frequency noise. R3003 and R3004 resistor divider set the output voltage to 9.3V. This regulator output is electronically enabled by 0V signal at pin 2. MAKO (U3200) FET\_ENX, Q3206, and Q3041 are used to control the on-off at U3001 pin 2.

Regulator U3003 generates the 12.6V required by external accessory device at connector J4000-7. Input and output capacitors C3012, and C3012 / C3013 are used to reduce high frequency noise. R3003 and R3004 resistor divider set the output voltage to 12.6V. This regulator output is electronically enabled by 0V signal at pin 2. MAKO (U3200) FET\_ENX, Q3206, and Q3041 are used to control the on-off at U3003 pin 2.

There are a total of eight other LDO regulators used to regulate the 9.3V supply down to specific application voltages. U0941, U3002, and U3004 are set to supply 5V output. U0601 is set to supply 3V for the Abacus III IC. U6402 and U6406 generate 2.8 V for GPS Digital IO and RF circuitry while U6407 regulator provides 1.5V for the GPS RTC module. U3201 regulator, which is capable of handling up to 1 Amp, is set to 1.4V for the OMAP core.

Switcher1 (Q3200) in conjunction with the MAKO power management IC (U3200) is a highly efficient dc-dc converter. In this application, it is configured as a synchronous buck dc-dc regulator. It generates an accurate 3.6V output, which supplies directly to the MAKO internal switcher2 circuit as well as the 1.4V regulator for the OMAP Core (U3201). A pulse width modulated (PWM) signal is output from U3200 pin G14 to Q3200 pin 4 and controls the output voltage level. External components L3200 and C3203 are needed to filter out the dc-dc converter output. R3200 (0.1 ohm) is used for current sense and over-current circuit protection with 2A threshold. MAKO switcher2 output 2.3V and supplies to the rest of MAKO internal LDOs.

Switcher5 (Q3202) circuitry is similar to Switcher1. It is also configured as a synchronous buck dc-dc regulator. It generates an accurate 5.2V output, which supplies directly to both VBUS1 and VBUS2 supplies. External components L3202 and C3212 are needed to filter out the output. Q3208 and Q3207 prevent internal voltage leakage onto VBUS\_SUPPLY (U3200 pin B13). When the radio is operated in the HOST mode, USB\_CONNECT (U3200 pin L6) is toggled HIGH (3.3V) turning on PMOS FET (Q3207) through Q3208 inverter, and thus provides 5.2V to both Q3203 and Q3204 drains. Software will enable VBUS1\_CMD and VBUS2\_CMD either VBUS1 or VBUS2 port base on the detection mechanism. Note, only one of two VBUS ports can supply up to 500mA (max) at one time. R3207 and R3208 (0.2 ohm) are used for current sense and over-current circuit protection with 800mA threshold. In device mode, USB\_CONNECT is toggled LOW to disable VBUS supply.

The MAKO power management IC (U3200) provides eight more LDOs. Some LDOs are programmable to meet the requirement for various ASIC devices. V2, V3, and V9 are programmable via SPI while V4, V5, V6, V8, and V10 are fixed. See Figure 1-2 for details.

## 1.2 Power On/Off

The radio can switch ON and OFF in one of the following three ways:

1. ON/OFF switch (No Ignition Mode)
2. Ignition Sense and ON/OFF switch (Ignition Mode)
3. Emergency

### 1.2.1 ON/OFF Switch

The On-Off push button is connected between MAKO MECH\_SW (U3200 pin E4) and ground. This pin is configured to operate as a momentary push button by tying MAKO SW\_TYPE (U3200 pin B3) to 2.5V. The MAKO will monitor this debounced signal via its internal 'Virtual Toggle Switch' (VTS). The signal changes state each time the button is pressed and released. At turn on, VTS is set as soon as the debounce logic detects a button press. At turn off, the button press is debounced for an additional two seconds before VTS is toggled back to off.

### 1.2.2 Ignition Sense

Ignition sense is initiated by applying either the car battery or separate voltage that is higher than 7V to rear accessory connector J4000 pin 25. It will drive NPN transistor (Q4006) into saturation which pulls its collector to ground and presents an active low to MAKO IGN\_X input (U3200 pin B4). When there is no voltage at J4000 pin 25, Q4006 is turned off and its collector is internally pulled high by the MAKO Vsave supply. Because of the noisy nature of ignition signal, a long debounce period of 250ms is used before it will be recognized as a valid input.

### 1.2.3 Emergency

The emergency switch, when engaged, grounds the base of Q4005 via rear accessory connector pin J4000-23. This causes Q4005 to turn off and Q4015 to turn on and pulls the collector of Q4015 to ground presenting an active low to MAKO EMERG\_PB (U3200 pin F4). An active low signal at this pin is indicating that the emergency button or switch is being pressed. When the emergency switch is disengaged, pin J4000-23 is floating and Q4005 is turned on by 5V at the base. This results in turning off Q4015. The collector of Q4015 is pulled to logic high via an MAKO internal pull-up resistor on EMERG\_PB (U3200 pin F4).

### 1.2.4 Power-Up Sequence

Figure 1-3 describes the typical power-up sequence on the mobile radio and the following events will occur sequentially.

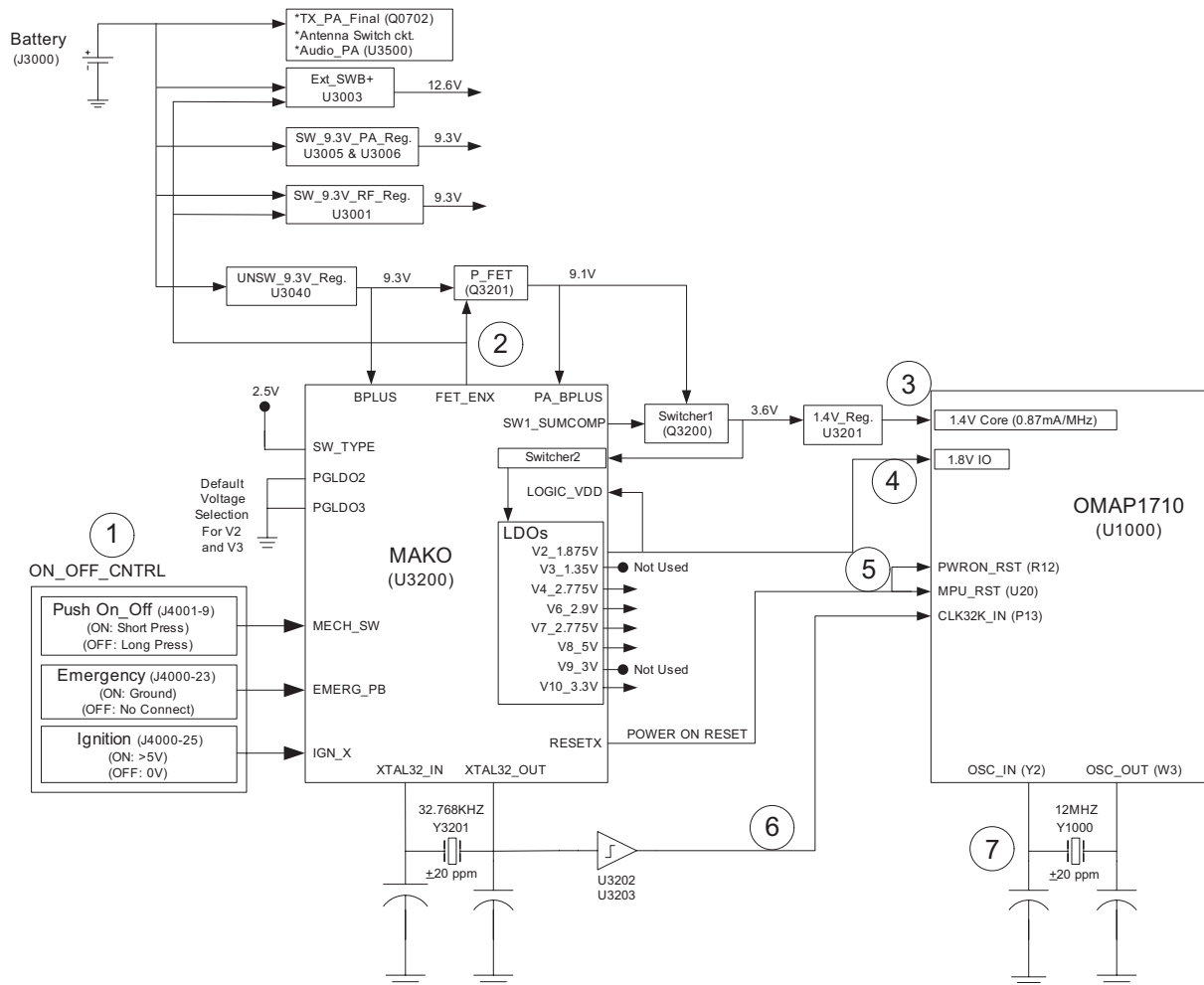


Figure 1-3 Power-Up Sequence

1. Users initiate one of the three on-off control functions (On-Off push button, Ignition or Emergency).
2. The MAKO (U3200) generates an output low at FET\_ENX (pin E2) once it detects a valid input at either Mech\_SW (pin E4), Emerg\_PB (pin F4), or IGN\_X (pin B4). Q3206 dual PNP/NPN transistor acts as double inverter between the MAKO and Q3201 power MOSFET switch as well as over voltage protection. This logic low at the gate of Q3201 results in switching 9.3V to both Q3200 switcher circuitry and 1.4V regulator (U3201).
3. Next the MAKO (U3200) asserts the RESETX (pin C5) low to the OMAP for an additional 32mS after all the DC regulators are stable. It is then de-asserted, allowing the OMAP processor to start.

### 1.2.5 Power-Down Sequence

Figure 1-4 describes the recommended power-down sequence on the mobile radio for proper shutdown. The following events will occur sequentially.

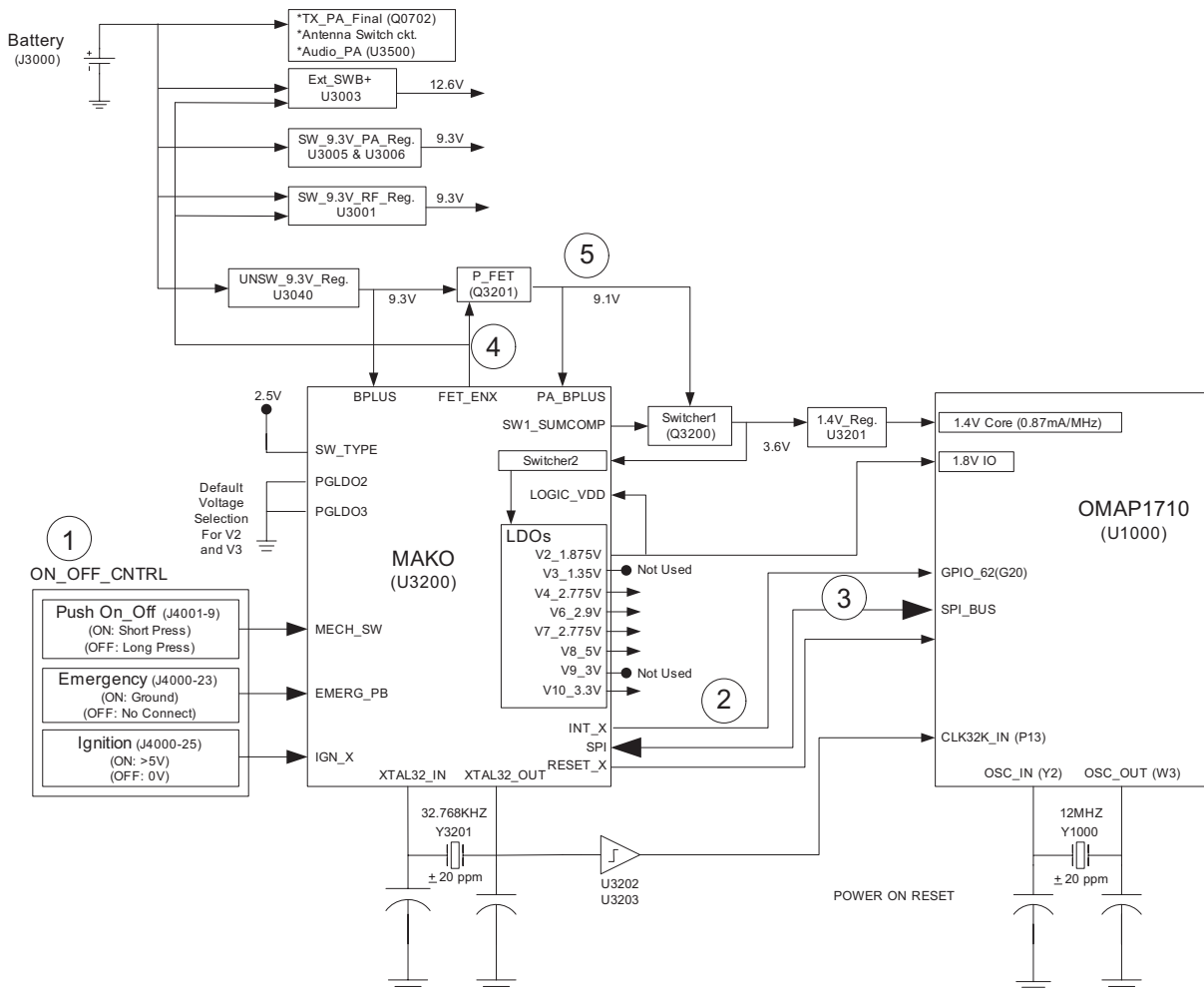


Figure 1-4 Power-Down Sequence

1. Users initiate one of the three on-off control functions (On-Off push button, Ignition and Emergency).
2. The MAKO (U3200) starts an internal 125 ms watchdog timer and sets the shutdown interrupt flag which causes the INT\_X (pin B4) interrupt output pin to assert low.
3. The OMAP (U1000) then determines by way of SPI register access that it must initiate the power down sequence.
4. The MAKO (U3200) asserts the RESETX (pin C5) to active low (system reset), turns off all MAKO DC regulators, and de-asserts the FET\_ENX (pin E2) which turns off 9.3V for the controller.

### 1.3 Clocks

Figure 1-5 illustrates the controller clocks used throughout the radio board.

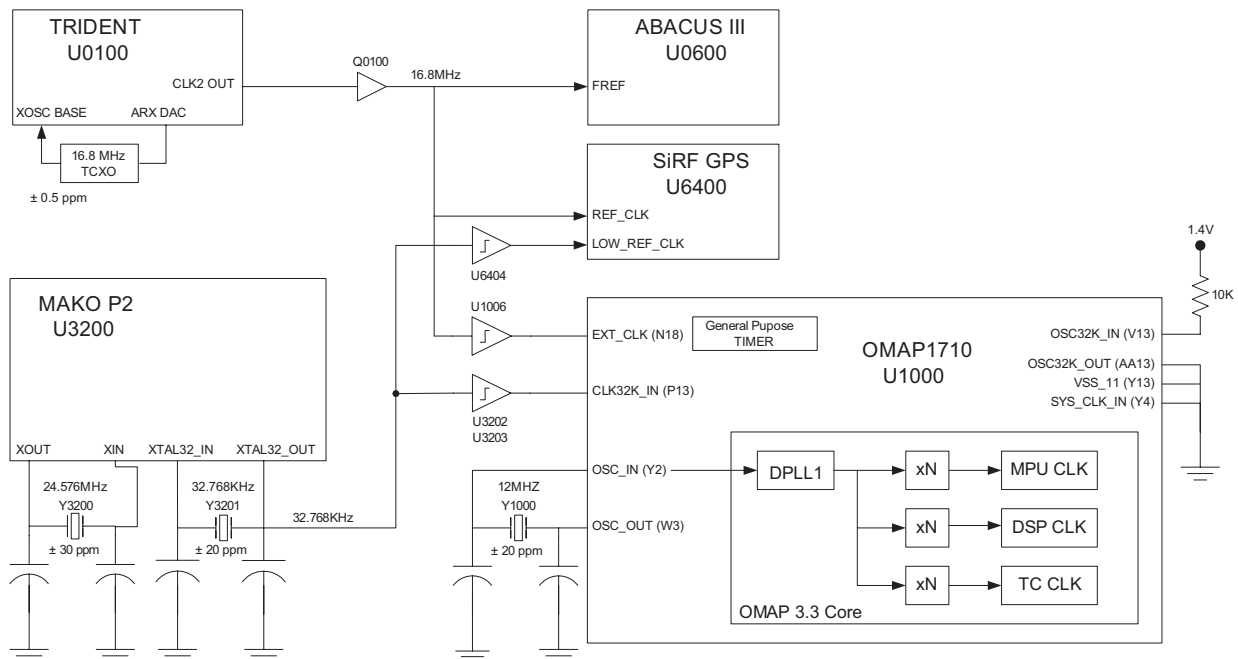


Figure 1-5 Clock Connections

The OMAP processor (U1000), which consists of an ARM and DSP core, needs three clocks for operation: a 32.768 kHz square-wave, a 12 MHz sine-wave, and a 16.8 MHz square-wave clock. The 16.8 MHz clock source is provided from the Trident TCXO with its supporting circuitry Q0100 buffer amplifier, routes to squarer-circuit U1006, and feed to EXT\_CLK (U1000 pin N18). The 32.768 kHz clock is generated by the MAKO crystal Y3201 oscillator; converted to a gated clock by U3202 and U3303 circuitry; then directly feed to OMAP CLK32\_IN (U1000 pin P13) as well as GPS IC (U6400). The OMAP needs the 32.786 kHz to determine the input reference clock (12, 13, or 19.2 MHz) applied to OSC\_IN (U1000 pin Y2). Without this 32 kHz clock, the OMAP will potentially program all the wrong dividers for USB and UART booting. The 12 MHz sine-wave is the main system reference clock for the OMAP which all the internal clocks are derived from. External pull-up on OSC32K\_IN (U1000 pin V13) and grounding both OSC32K\_OUT (pin AA1 and VSS\_11 (pin Y13) indicating that an external 32 kHz clock is used. The 24.576 MHz crystal (Y3200) oscillator is the reference clock for MAKO CODEC and SSI clock.

### 1.4 Serial Peripheral Interface (SPI)

Figure 1-6 illustrates the controller SPI used on the radio controller design.

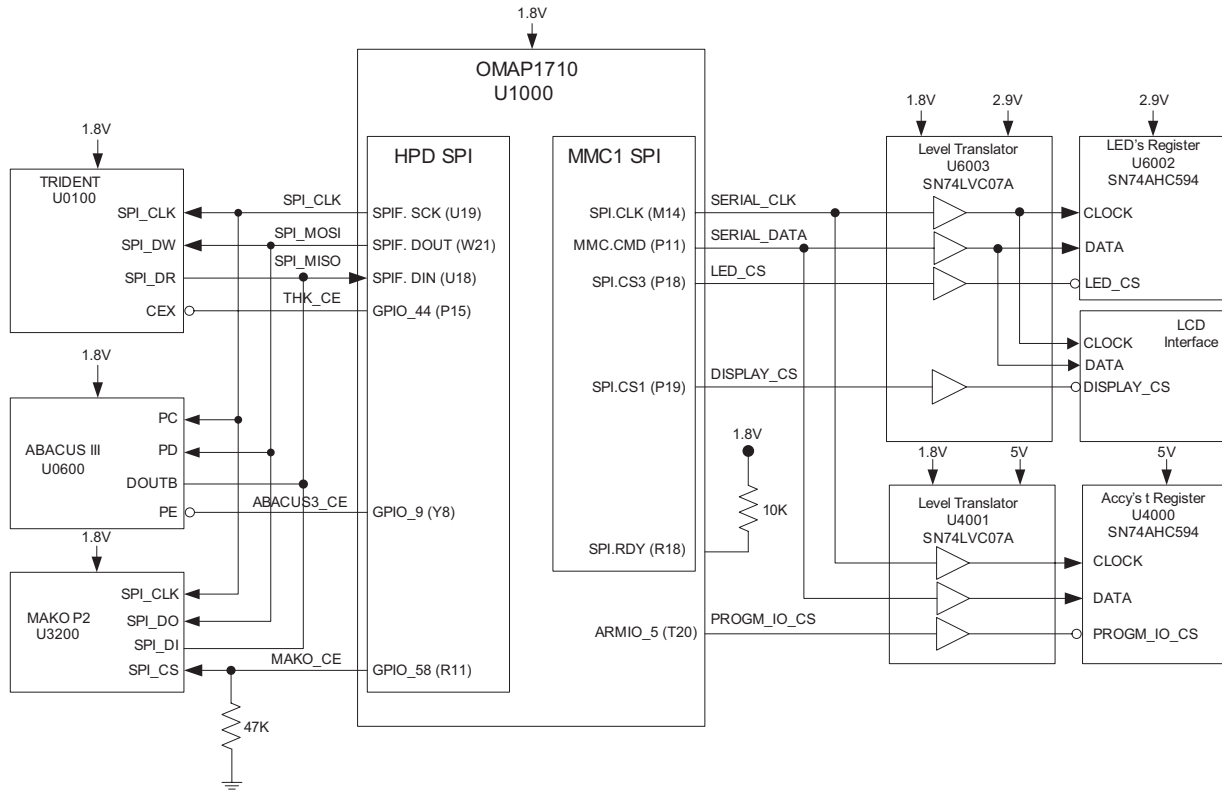


Figure 1-6 SPI Connections

The OMAP processor (U1000) has two SPI busses that it uses to communicate with the various peripheral IC's. The first is the High Performance Data (HPD) SPI bus and the second is the multi-media card (MMC) SPI.

The HPD SPI is a synchronous serial bus made up of four lines, SPI\_CLK, SPI\_MOSI, SPI\_MISO, and chip select. The SPI\_CLK line is used to control the speed of the data to/from the peripheral IC's and the OMAP processor. This clock can be adjusted to different speed based on the IC's specification.

HPD SPI module is used to interface to Trident (U0100), Abacus III (U0600), and the MAKO (U3200). This interface operates at 1.8 V logic levels. SPI\_MOSI, or commonly known as TRANSMIT Data, is a data string from the OMAP while SPI\_MISO or RECEIVE Data is data string to the OMAP.

The MMC SPI is a 3-wire bus; consisting of SERIAL\_CLK, SERIAL\_DATA, and chip select. This SPI bus is used to interface to accessory Serial-Parallel IC (U4000), the Control Head LED's and LCD driver. For accessory Serial-Parallel IC, the logic level out of the processor is level shifted from 1.8V to 5V through U4001 and pull-up resistors R4100, R4101, and R4103.

### 1.5 Serial Synchronous Interface (SSI)

Figure 1-7 illustrates the controller SSI used on the radio controller design.

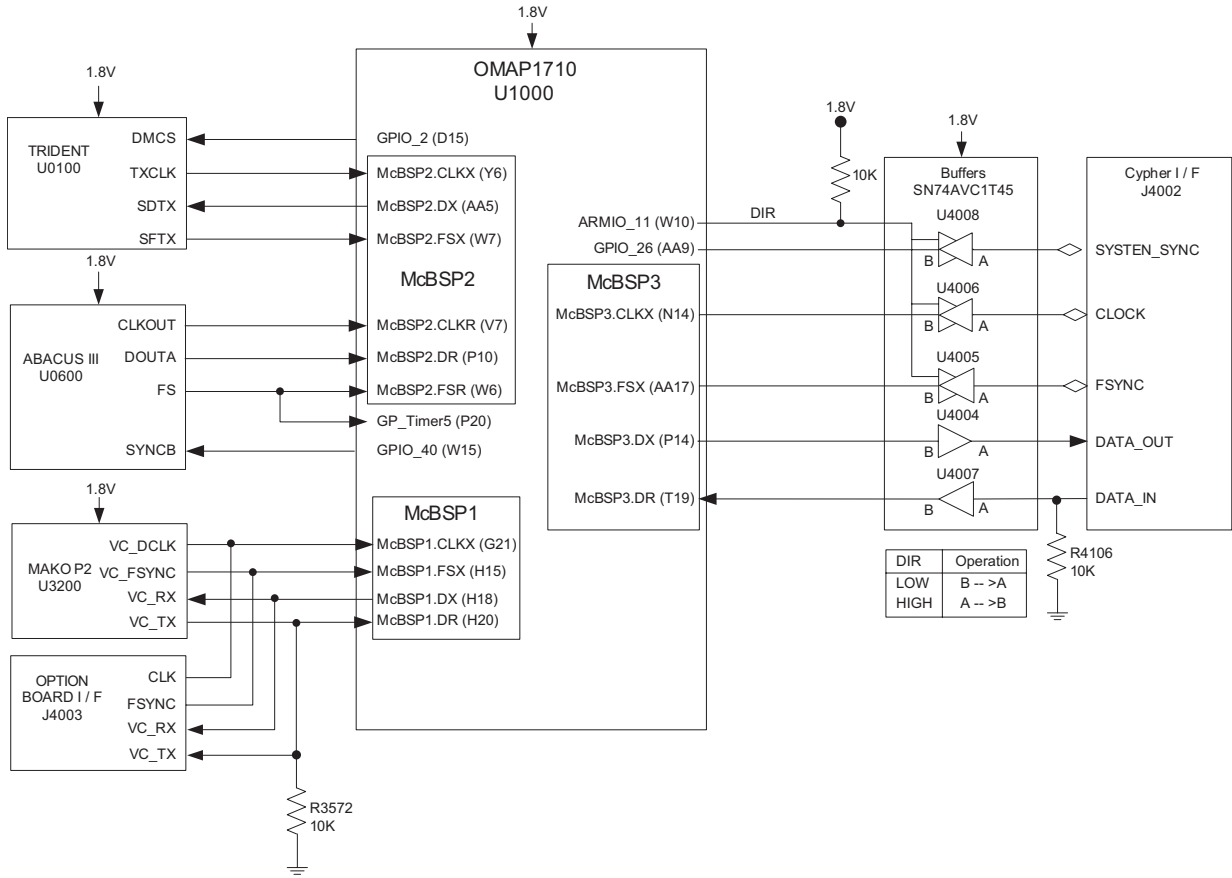


Figure 1-7 SSI Connections

The OMAP processor (U1000) has a total of three SSI or multi-channel buffer serial ports (McBSP) modules that are used to directly interface to the CODECs in the Trident, Abacus, and MAKO, as well as command/data connections to the Option Board, and between Tx and Rx radios within a Repeater.

As shown in Figure 1-7, McBSP1 is a 4-wire bus and interface to the MAKO CODEC as well as the Option Board. McBSP2 is 6-wire bus; 3-wire dedicated to the Trident Tx audio and the other 3-wire to Abacus Rx audio. McBSP3 is a 4-wire bus, and used primarily to interface between Tx and Rx radios within a Repeater.

## 1.6 ACC\_ID Interface

Smart accessories use the Accessory ID (ACC\_ID) Interface to help the radio determine which smart accessory, if any, are attached to the radio. Figure 1-8 illustrates the ACC\_ID connections used within the radio.

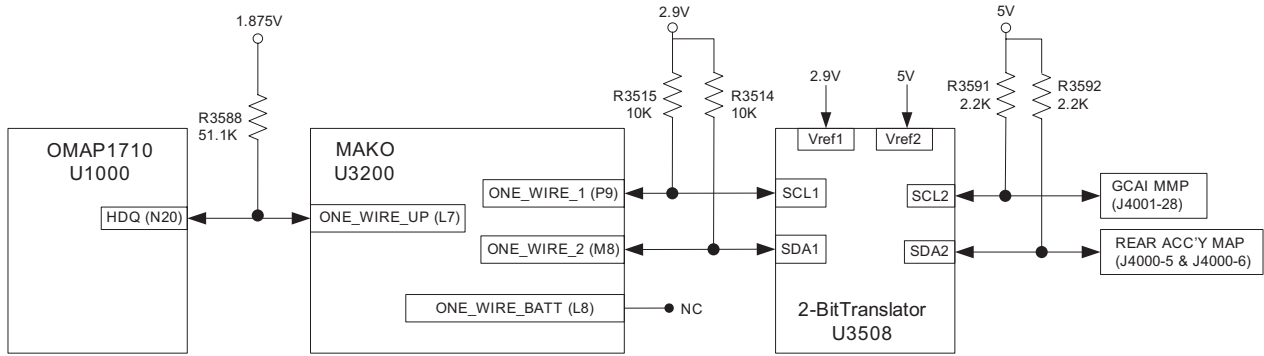


Figure 1-8 ACC\_ID Interface Connections

The MAKO (U3200) switches the ACC\_ID busses from the Control Head MMP (Mobile Microphone Port) connector and the rear MAP (Mobile Accessory Port) connector to the OMAP ACC\_ID bus. Level translator (U3508) is required to level shift between 2.9V to 5V.



## 1.7 USB Interface

The OMAP processor (U1000) supports two USB ports. The radio makes use of these USB ports to communicate with smart accessories, and connection to a host computer for radio programming via CPS and tuning via the Tuner Tool. One port is available via the MMP connector and the other via the MAP connector.

Note: The USB ports are designed to support Motorola accessories and approved applications only and will not support third party "Plug-n-Play" USB devices.

Figure 1-9 shows the details of the HSSI connections within the radio.

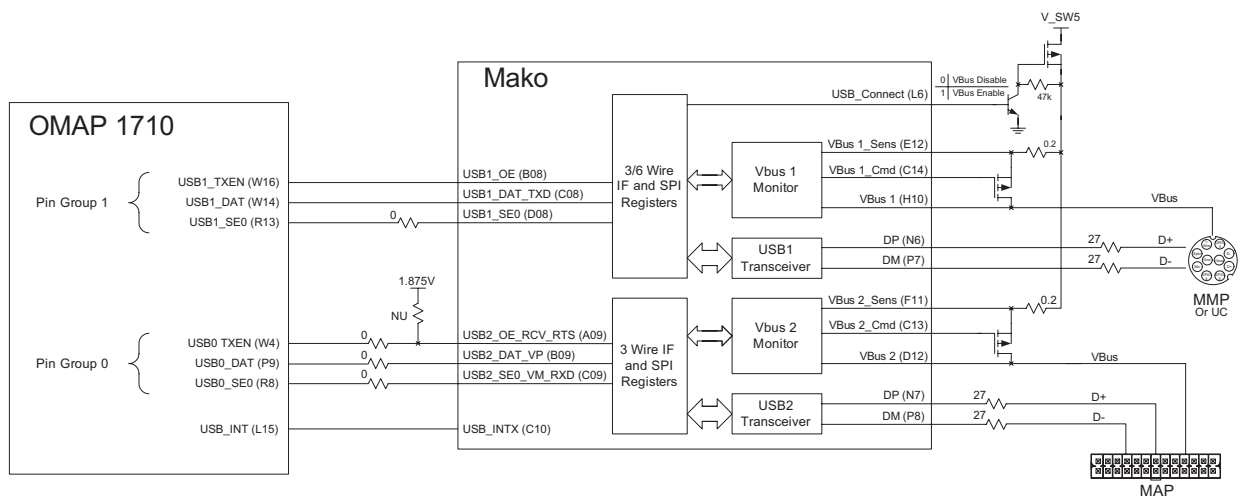


Figure 1-9 USB Interface Connections

The OMAP processor USB host controller communicates with accessories at either 1.5 Mbps or 12 Mbps data rates depending on the accessory. Either port can be used as a host or a device, the only limitation is that both ports cannot be used as a device at the same time.

The MAKO (U3200) incorporates two USB transceivers that provide the physical layer signaling for the two ports. Each transceiver generates and receives the DP and DM differential signals of the USB port. The transceiver interfaces to the OMAP processor through a three-wire interface consisting of two bi-directional signals (SE0 and DAT), and one uni-directional signal (TXEN). The MAKO also includes two bus monitors that sense the connection or removal of a device and determine whether or not to supply current to that device via Q3203 or Q3204 up to a maximum of 500 mA per port.

The USB host/device mode assignment is determined when a user attaches a USB device to the port. The accessory contains information about what the USB mode assignment should be, this information is sent to the radio via the ACC\_ID. See section 1.6 on page 1-10, for more details on the ACC\_ID implementation. When configured as a host, VBUS is turned on by the MAKO, when configured as a device, VBUS will be shut off and the external host supplies the VBUS power.

## 1.8 Control Head Interface

The Control Head interface can be broken up into 4 separate sections: Display and Indicators, Keypad, Mobile Mic Port (MMP), and Audio signals. Each of these sections will be covered in detail.

The block diagram of the Control Head is shown in Figure 1-10. Two different versions of the Control Head are currently supported: a Display Control Head with LCD display, and a Numeric Display Control Head with a 2 digit LED display and indicators. Details of the various Control Heads can be found in section, Control Head Service Information.

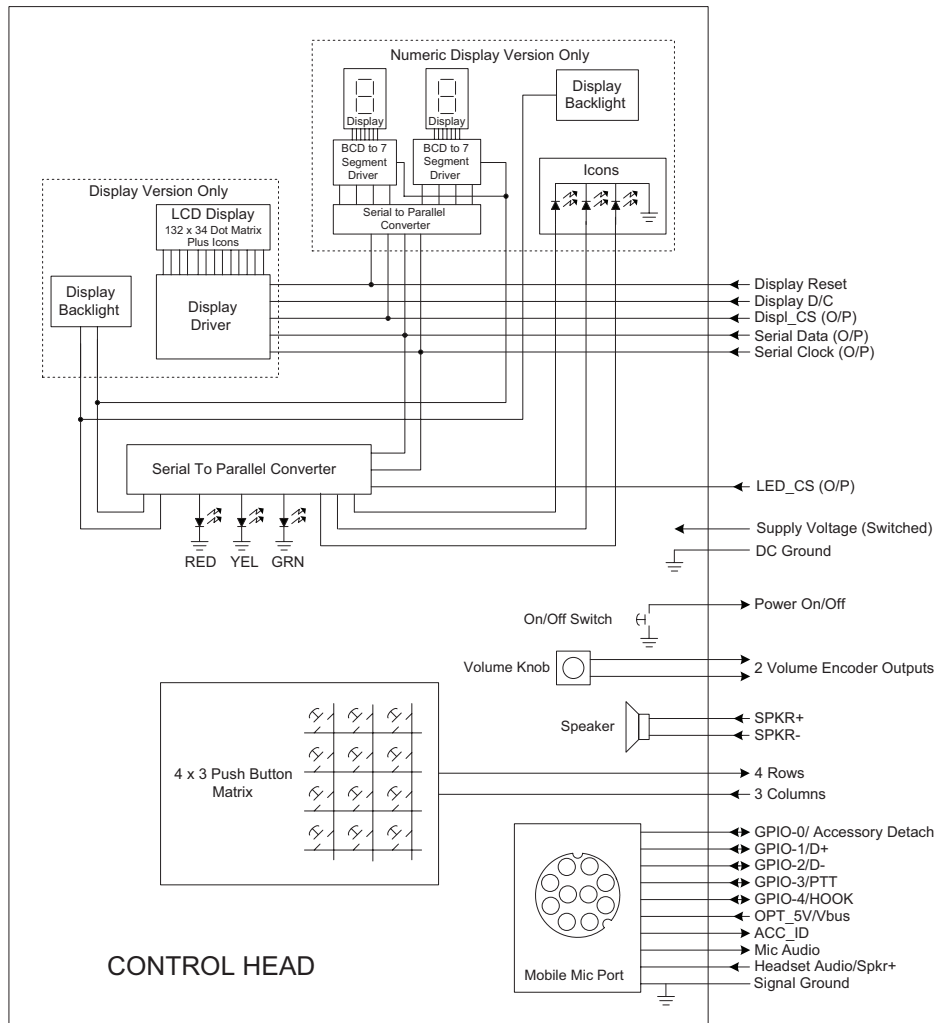


Figure 1-10 Control Head Block Diagram

### 1.8.1 Display and Indicators

The Control Head interface supports LED numeric displays and LCD full alphanumeric displays. Both types of displays, as well as the LED indicators and backlights are controlled via a serial connection with the OMAP processor (U1000). The serial interface consists of clock, data and chip select lines that are connected directly from the OMAP processor to the serial devices in the Control Head. See section Control Head Service Information for more information on the various Control Heads supported.

### 1.8.2 Keypad

The keypad interface is a standard pulsed 4 row by 3 column configuration controlled directly by the OMAP processor (U1000). Each of the 3 column output lines is toggled high in sequence and the 4 row input lines are monitored to detect if a button has been pressed. The OMAP processor then decodes which button was pressed using the appropriate column and row stimulus and response information. See section Control Head Service Information for more information on the various Control Heads supported.

### 1.8.3 Mobile Mic Port (MMP)

The Mobile Microphone Port (MMP) is a newly defined Motorola accessory port that contains audio, digital I/O, serial interfaces, and accessory supply lines; and is similar in function to Motorola's legacy microphone connectors. The multiplexing of these functions is handled by circuitry internal to the MAKO (U3200). The function of each pin is listed in Table 1-1.

*Table 1-1 Mobile Mic Port Functions*

MMP Pin Number	MMP Pin Name	MAKO Pin
1	ACC_ID	Accessory Identifier
2	GPIO_3 / PTT	General Purpose I/O or PTT
3	Spkr	Handset Audio
4	GPIO_2 / D-	USB D-
5	GND (Ground)	Ground
6	Opt_5V / Vbus	5 Volt Supply
7	Mic+	Mic Input
8	GPIO_1 / D+	USB D+
9	GPIO_4 / Hook	General Purpose I/O or Hook
10	GPIO_0 / PwrOn	General Purpose I/O or Power On Detect

The MMP includes 2 serial interfaces: an USB port and an ACC\_ID interface. The USB port can be used as either a device (radio is device) or as a host (radio is host). When configured as a device, the radio can be programmed or tuned using MOTOTRBO CPS or Tuner software. When configured as a host, various smart accessories can be used with the radio. See section 1.7 on page 1-11 for more information on the USB interface.

The ACC\_ID interface is used by accessories to provide the radio with information needed to configure the interface for that accessory. See section 1.6 on page 1-10 for more information on the ACC\_ID interface.

**Note:** The USB ports are designed to support Motorola accessories and approved applications only and will not support third party "Plug-n-Play" USB devices.

### 1.8.4 Audio Signals

The Control Head interface supports 3 audio signals from the radio: Speaker audio, Mic audio, and Handset audio. Speaker audio is a differential audio connection to the radios audio PA. It is connected in parallel with the MAP speaker terminals. Mic audio is a single ended low level audio input connected to the MMP port. The Handset audio is a single ended audio output from the radio connected to the MMP.

## 1.9 Mobile Accessory Port (MAP)

The Mobile Accessory Port (MAP) is a newly defined Motorola accessory port that contains audio, programmable digital I/O, serial interfaces, and accessory supply lines; and is similar in function to Motorola's legacy products accessory connectors.

*Table 1-2 Mobile Accessory Port Functions*

MAP Pin Number	MAP Pin Name	MAKO Pin
1	USB_D+	USB for programming or Smart Accessory
2	USB_D-	
3	V_Bus	
4	USB_Ground	
5	ACC_MAP_ID_2	Accessory Identifier
6	ACC_MAP_ID_1	
7	Ext_SWB+	Switched Battery Voltage
8	Power Ground	Ground
9	Ext_Spkr-	External Speaker
10	Ext_Spkr+	
11	Tx_Audio	Tx Audio Input
12	Audio Ground	Ground
13	Aux_Audio_Out_1	Auxiliary Audio Output
14	Rx_Audio	Rx Audio Output
15	Aux_Audio_Out_2	Auxiliary Audio Output
16	Ground	Ground
17	Prgm_In_1_(PTT)	Programmable Input with prescribed function of PTT
18	Ground	Ground
19	Prgm_IO_2 (Monitor)	Programmable Input/Output with prescribed function Monitor
20	Prgm_IO_6	Programmable Input/Output

Table 1-2 Mobile Accessory Port Functions

MAP Pin Number	MAP Pin Name	MAKO Pin
21	Prgm_IO_3 (Chan_Act)	Programmable Input/Output with prescribed function Channel Activity
22	Prgm_IO_7	Programmable Input/Output
23	Prgm_In_4 (Emergency)	Programmable Input with dedicated function for Emergency Switch
24	Prgm_IO_8	Programmable Input/Output
25	Prgm_In_5 (Ign Sense)	Programmable Input with dedicated function for Ignition Sense
26	Prgm_Out_9 (Ext_Alarm)	Programmable Output with prescribed function of External Alarm

### 1.9.1 MAP Programmable I/Os

The MAP contains 7 general purpose I/Os. One is specifically an output, 1 is specifically an input, and the remaining 5 can be either input or output. The MAP also contains 2 dedicated inputs. All input signals map directly to OMAP (U1000) GPIOs, while all outputs are controlled from the OMAP through a SPI connected shift register (U4000) referred here as the `Acc_Shift_Reg`. While 7 of the 9 I/Os are general purpose and designed to be programmable through the CPS, several have recommended functions that will be detailed below.

All of the programmable I/Os, except the dedicated inputs, use inverted logic, IE: a 1 on the connector as an input will be seen by the OMAP as a 0 and visa versa. Also, a 1 output by the OMAP through the `Acc_Shift_Reg` will be seen as a 0 output on the connector.

- `Prgm_In_1` (PTT): Programmable input that has the recommended function of Push-To-Talk (PTT). This signal connects to the OMAP GPIO\_7 (U1000 pin M15) as an input.
- `Prgm_IO_2` (Monitor): Programmable input/output that has the recommended function of Monitor. This signal connects to the OMAP GPIO\_32 (U1000 pin B17) as an input. The output for this signal is driven from `Acc_Shift_Reg` bit 0 (U4000 pin 15).
- `Prgm_IO_3` (Chan\_Act): Programmable input/output that has the recommended function of Channel Activity (Chan\_Act). This signal connects to the OMAP GPIO\_33 (U1000 pin J14) as an input. The output for this signal is driven from `Acc_Shift_Reg` bit 1 (U4000 pin 1).
- `Prgm_I_4` (Emergency): Dedicated input that is having the function of Emergency (Emerg\_Sw). This signal connects to the MAKO EMERG\_PB (U3200 pin F4) as an input.
- `Prgm_I_5` (Ign\_Sense): Dedicated input that is having the function of Ignition Sense (Ign\_Sense). This signal connects to the MAKO IGN\_X (U3200 pin B4) as an input.
- `Prgm_IO_6`: Programmable input/output. This signal connects to the OMAP ARMIO\_15 (U1000 pin E19) as an input. The output for this signal is driven from `Acc_Shift_Reg` bit 2 (U4000 pin 2).
- `Prgm_IO_7`: Programmable input/output. This signal connects to the OMAP ARMIO\_3 (U1000 pin V8) as an input. The output for this signal is driven from `Acc_Shift_Reg` bit 3 (U4000 pin 3).

- Prgm\_IO\_8: Programmable input/output. This signal connects to the OMAP GPIO\_24 (U1000 pin V5) as an input. The output for this signal is driven from Acc\_Shift\_Reg bit 4 (U4000 pin 4).
- Prgm\_Out\_9 (Ext\_Alarm): Programmable output that has the recommended function of External Alarm (Ext\_Alarm). The output for this signal is driven from Acc\_Shift\_Reg bit 5 (U4000 pin 5).

### 1.9.2 MAP Serial Interfaces

The MAP includes 2 serial interfaces: an USB port and an ACC\_ID interface. The USB port can be used as either a device (radio is device) or as a host (radio is host). When configured as a device, the radio can be programmed or tuned using MOTOTRBO CPS or Tuner software. When configured as a host, various smart accessories can be used with the radio. See section 1.7 on page 1-11 for more information on the USB interface.

The ACC\_ID interface is used by accessories to provide the radio with information needed to configure the interface for that accessory. See section 1.6 on page 1-10 for more information on the ACC\_ID interface.

Note: The USB ports are designed to support Motorola accessories and approved applications only and will not support third party "Plug-n-Play" USB devices.

### 1.9.3 MAP Audio Signals

The MAP has Speaker, Tx, Rx, and Aux audio outputs. Speaker audio is a differential output from the radio's audio PA (U3500). Tx audio is a mic/line level input audio for transmit. Rx audio is a line level output audio from the receiver. Both Rx and Tx audio are programmable as emphasized or de-emphasized audio. Aux audio provides 2 outputs that can be used for public address functions. See section 1.8.4 on page 1-14 for more information on the audio circuits.

### 1.10 Option Board Interface

The Option Board interface uses a SSI port from the OMAP processor (U1000) to transfer both data and commands in a synchronous time slotted fashion. Data, as defined here, can be either digitized audio to be processed or generated by the Option Board; or any other form of data that can be formatted into the synchronous slots. The OMAP processor SSI has data out, data in, clock, and frame sync signals associated with it. All of these signals as well as a separate system sync signal, 2 general purpose I/O's, reset, and PTT comprise all of the signals supported for this interface. This SSI port is shared with the MAKO (U3200) providing a convenient path for audio data to be processed or generated by the Option Board as shown in Figure 1-11. The entire Option Board signal descriptions are given in Table 1-3.

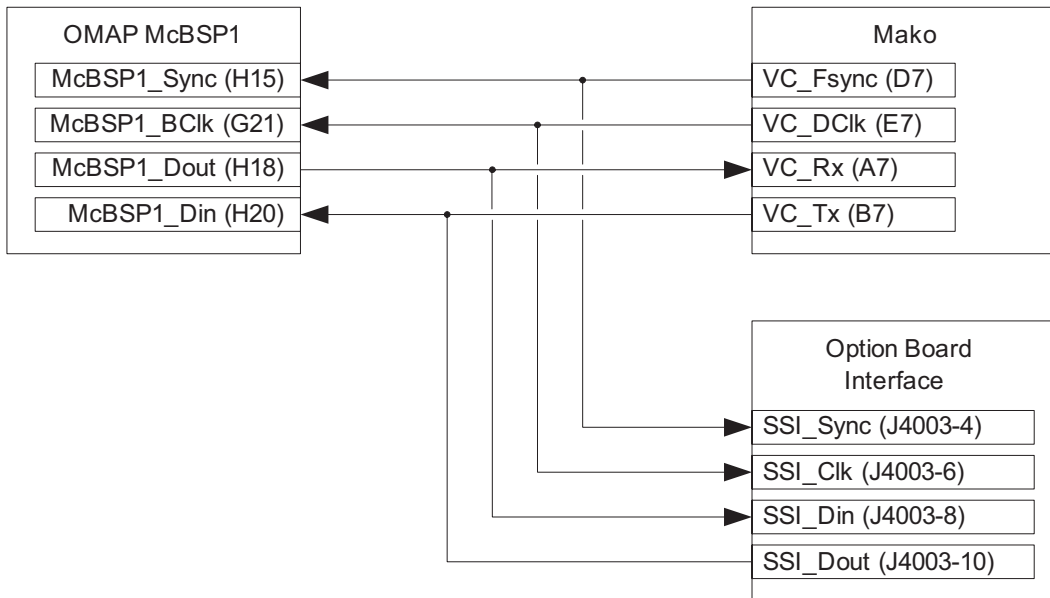


Figure 1-11 Option Board SSI Connections and Data Flow

Table 1-3 Option Board Interface Signal Functions

Signal	I/O Relative To Option Board	Function
SSI_Data_In	Input	Synchronous Serial Interface data and commands into the option board.
SSI_Data_Out	Output	Synchronous Serial Interface data and commands out of the option board.
SSI_Clk	Bidirectional	Synchronous Serial Interface clock for the SSI data in and out
SSI_Fsync	Bidirectional	Synchronous Serial Interface frame sync for the SSI data in and out
Shared_System_Sync	Input	Synchronization signal generated by the OMAP
Reset_Out	Input	OMAP reset





### 1.11.1 Receive Audio

The OMAP (U1000) provides digital audio to the MAKO through use of a Serial Synchronous Interface, SSI. The SSI bus is comprised of four lines: clock, frame sync, Rx data, and Tx data. These four lines provide data to the MAKO (U3200) using a packet frame structure consisting of four slots. The actual audio data is transferred to the MAKO in the first slot of each frame using 16-bit pulse-code modulated PCM audio.

The MAKO converts the PCM data to analog audio and applies several stages of gain and attenuation to ensure the proper level is output to the analog audio circuitry (70mV RMS under standard test conditions of 60% full deviation, 1kHz audio tone). The analog audio circuitry routes audio to several external ports for accessories including: handset audio, Rx audio, and public address (see Figure 1-12).

The normal RX audio path to the speakers is from the MAKO through an Op Amp (U3505-2) and low level mute gate (Q3502) and through digital attenuator (U3501) that provides volume control for the speaker outputs. The attenuator is controlled by the OMAP via a bidirectional I2C bus. Level shifting of the I2C bus is provided by U3503. The digital attenuator provides 256 possible levels attenuation as well as a shutdown mode for muting audio to the speakers. The attenuator is biased at half of the supply to ensure proper operation using resistors R3569 and R3575; C3536 is used to provide a strong AC ground at the bias point. The software volume implementation uses 32 positions to define the radio's range and step size and is designed to operate with a 360 degrees fully rotational volume knob. Approximately one full rotation of the front panel volume knob will correspond to a change in audio level from minimum to maximum.

From the digital attenuator, the audio signal is passed to the audio PA (U3500). This is a bridge-tied amplifier that provides a fixed gain of 40dB. The audio PA is enabled by pulling AUDIO\_PA\_ENA low allowing the voltage on pin 8 of U3500 to go to 9.8V. Pulling AUDIO\_PA\_ENA high will set the voltage on pin 8 of U3500 to about 5.3V and will mute the PA. Both the internal and external speaker outputs are in parallel; the only way to disable the internal speaker is to unplug the connector on the inside of the control head. The speaker output is calibrated to provide 7.5W into an 8-ohm load under standard test conditions.

The various accessory audio paths are selectable via CPS depending on which accessories or optional configurations are required to be supported. Please refer to Figure 1-12 to understand which components the audio should pass through to get to a particular accessory output.

### 1.11.2 Transmit Audio

Transmit audio can be sourced from either the MMP or the MAP microphone paths found on connectors J4001-30 or J4000-11 respectively. The MMP microphone carries a 9.3V bias through a 660 ohm load from R3532 and R3547 with a strong AC ground from C3524 through only a 560 ohm load from R3547. Both MMP and MAP paths are routed to the MAKO separately. The MAP microphone carries a 9.3V bias through a 660 ohm load from R3590 and R3535 with a strong AC ground from C3543 through only a 560 ohm load from R3535. Depending on whether an MMP or MAP PTT signal was activated, a single switching stage will route the correct microphone path to the necessary gain stages and ADC that will send 16-bit PCM audio to the OMAP for signal processing via the SSI bus.

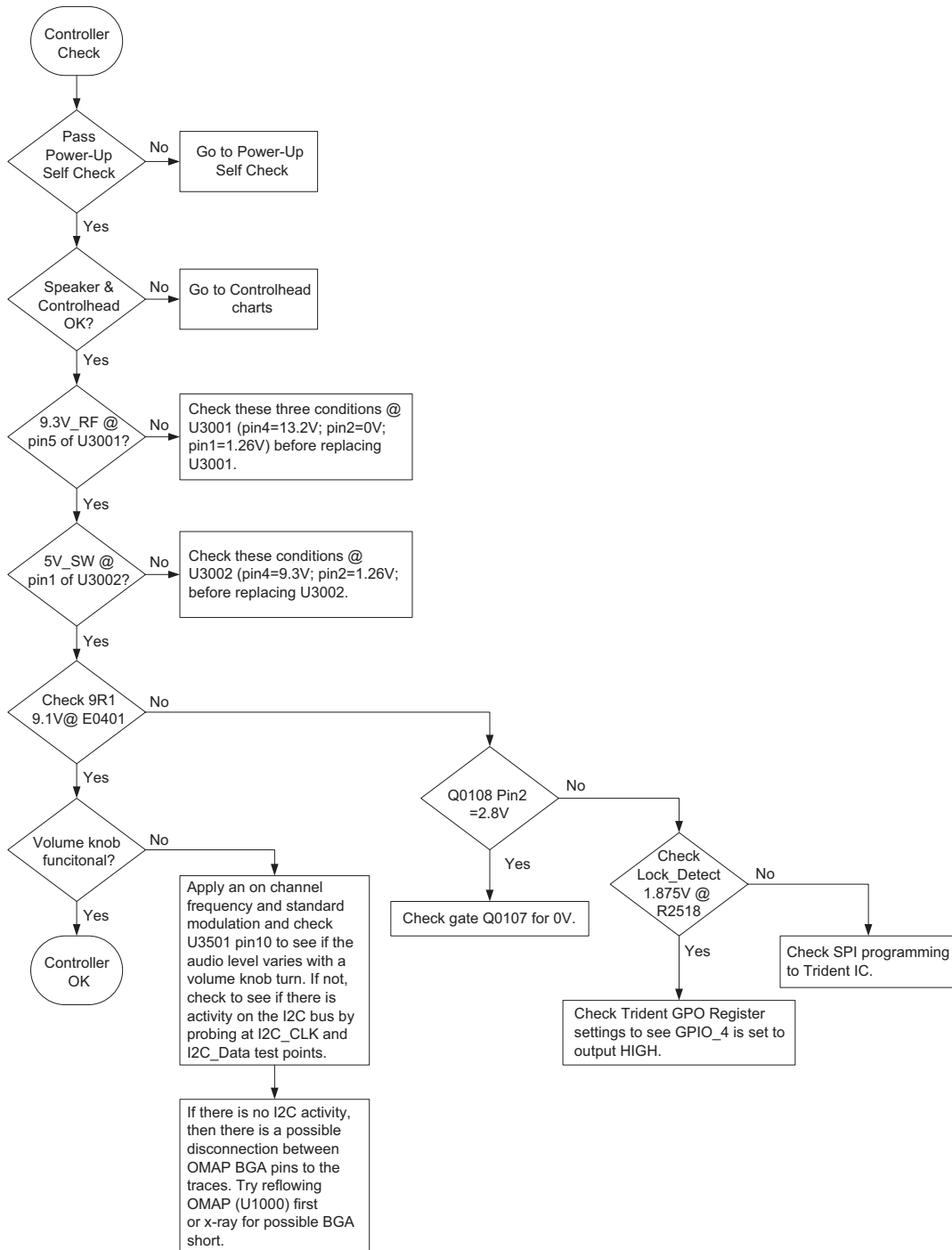
The transmit gain stages in the MAKO is calibrated based on an 80mV input under standard test conditions. The microphone sensitivity is programmable through the use of CPS.

## Notes

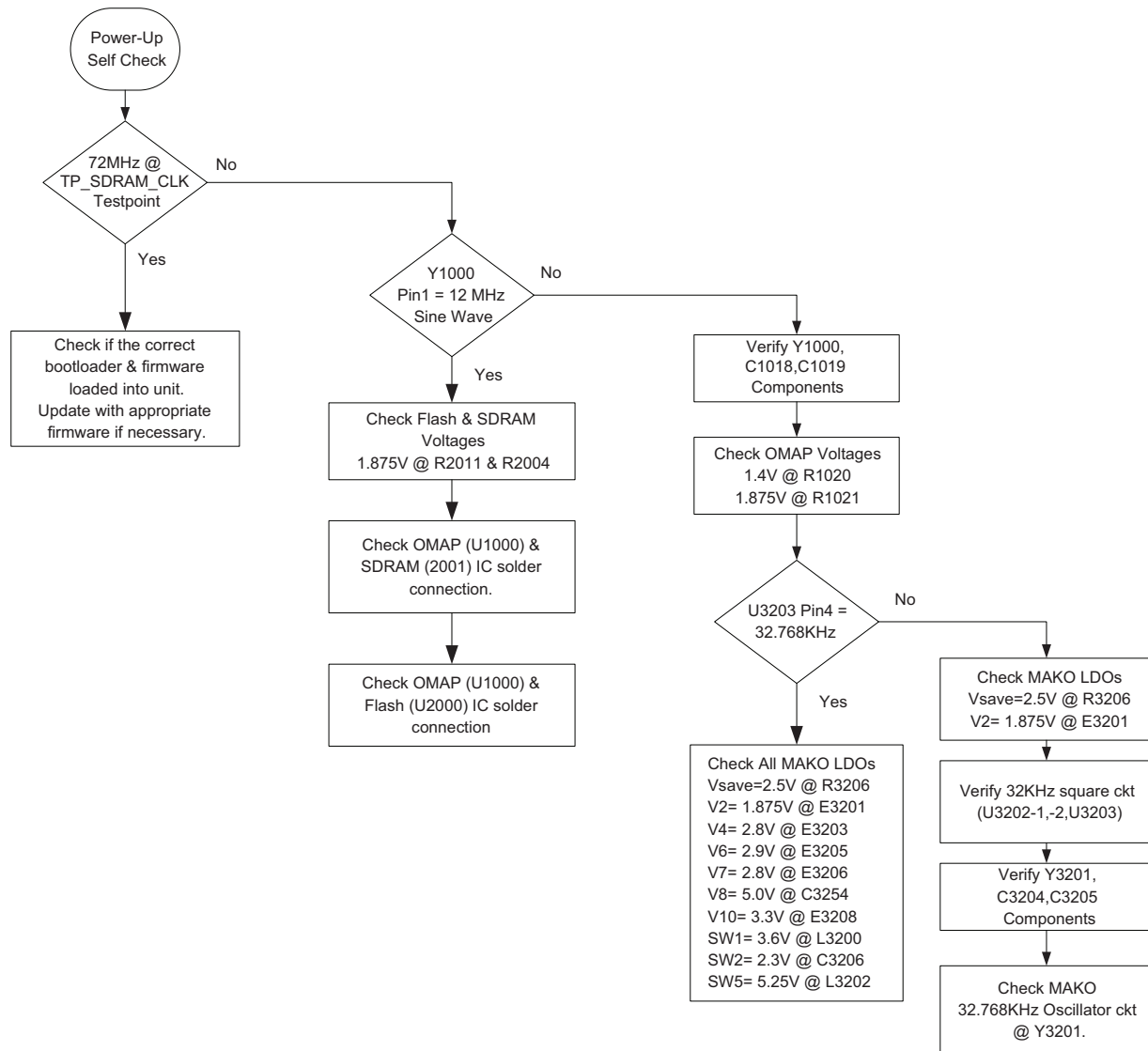
# Section 2

## TROUBLESHOOTING CHARTS

### 1.0 Controller Troubleshooting Chart



## 2.0 Power-Up Troubleshooting Chart



### 3.0 Control Head Troubleshooting Chart

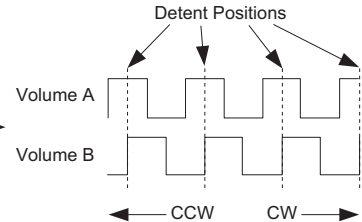
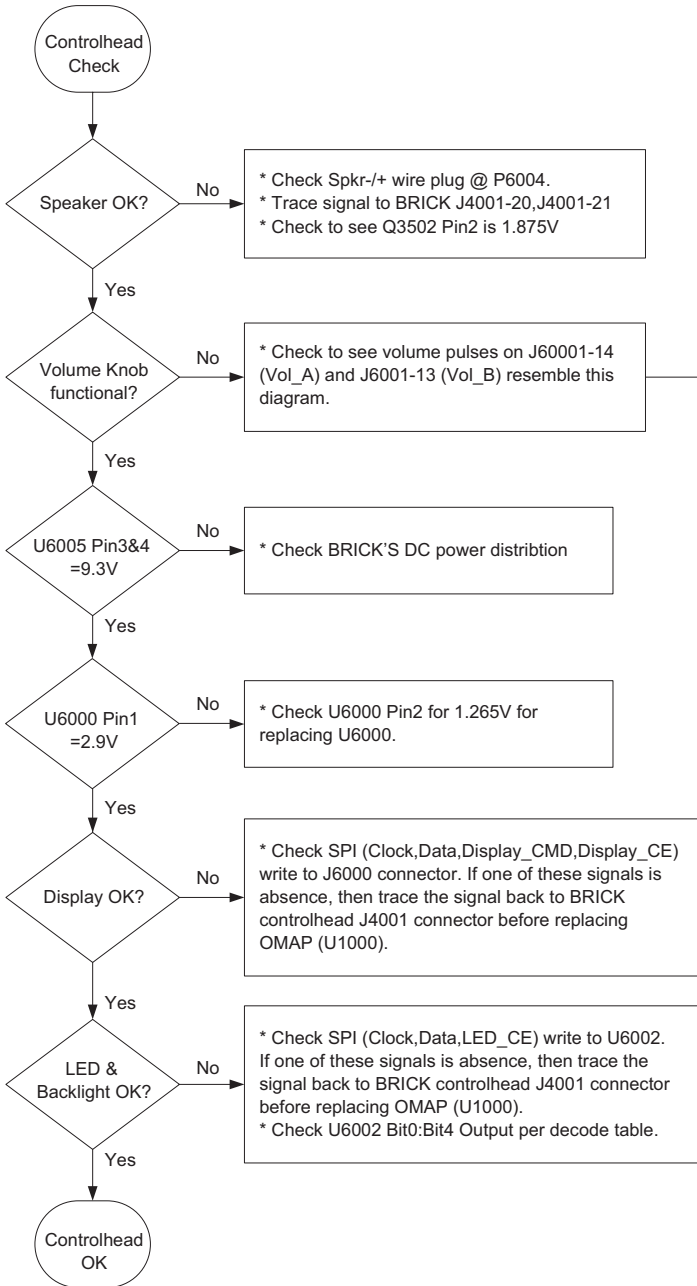
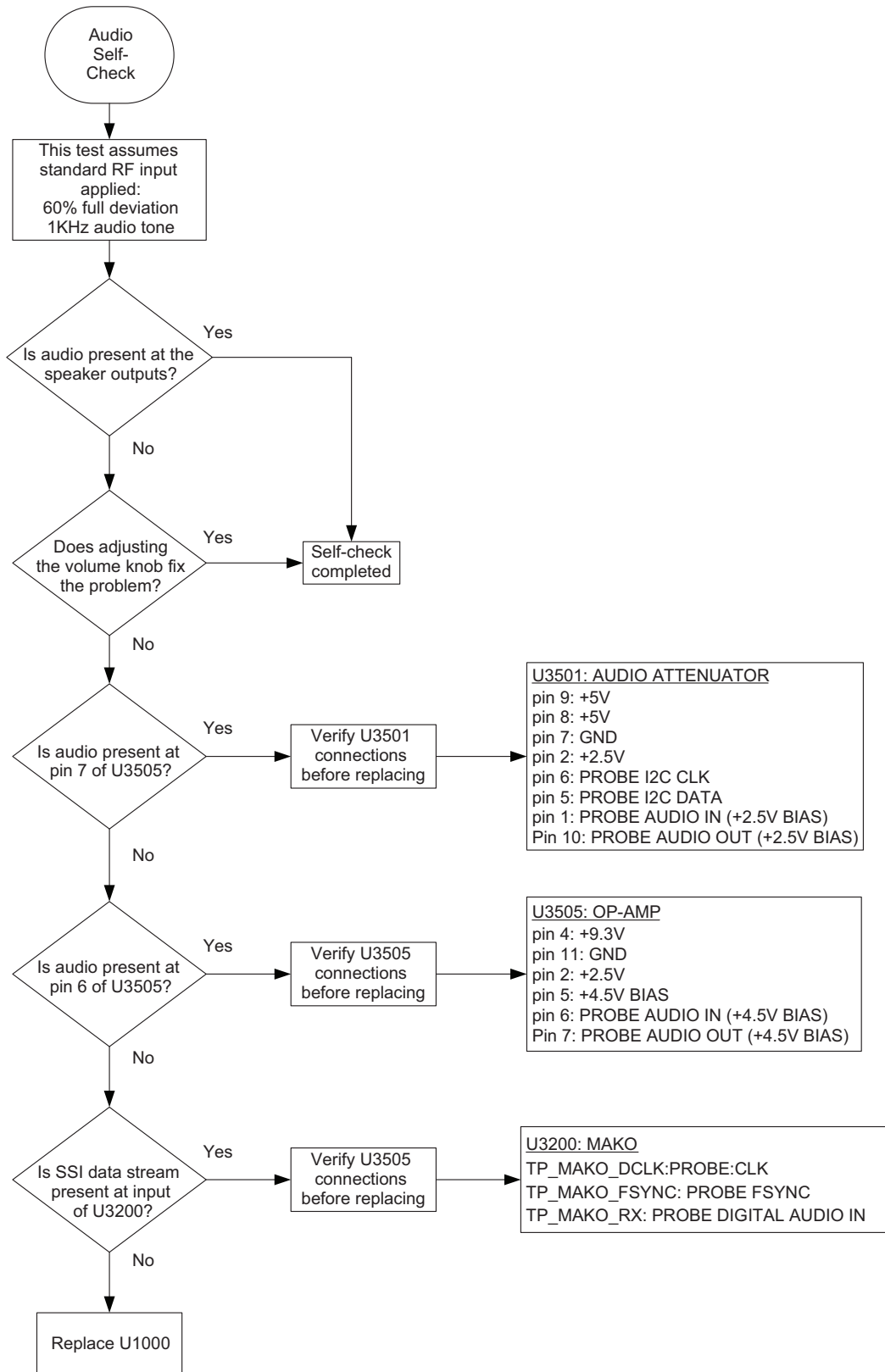


Figure 6.3.E. Volume Control Output Terminal Phase.

# 4.0 Audio Troubleshooting Chart



## Section 3

# CONTROLLER SCHEMATICS/PARTS LIST

### 1.0 Allocation of Schematics and Parts List

#### 1.1 Controller Circuits

This Chapter shows the Schematics and the Parts List for the Controller circuits.

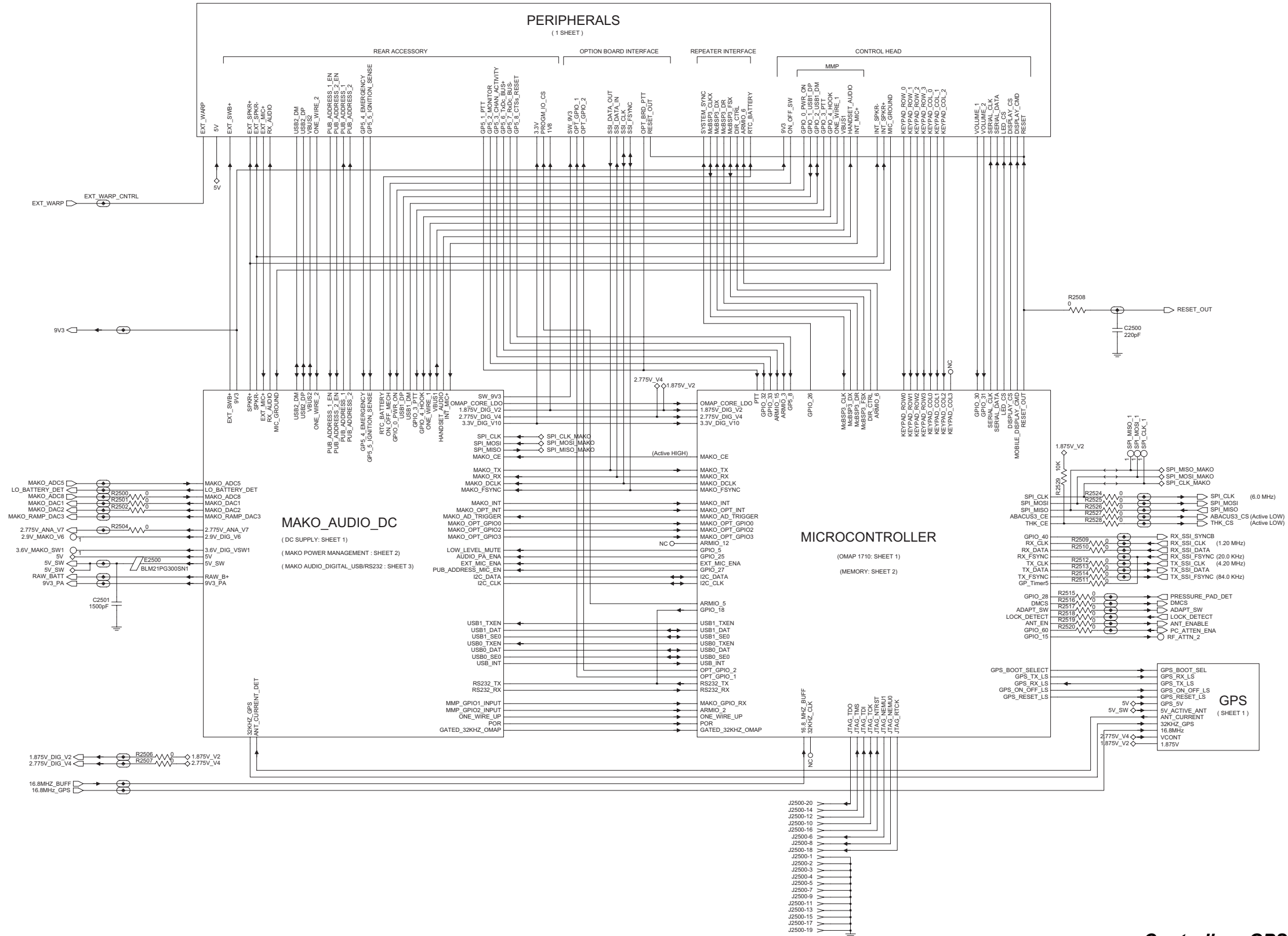
*Table 3-1 Controller GPS R3 Schematic Diagrams and Parts List*

<b>Controller R3 used on PCB: 8475265H01_P3 800/900 MHz (806-941 MHz), 10-35 W</b>	
<b>SCHEMATICS</b>	
Controller GPS	Page 3-3
DC Supply	Page 3-4
DC Distribution	Page 3-5
Peripheral (sheet 1 of 2)	Page 3-6
Peripheral (sheet 2 of 2)	Page 3-7
Microprocessor	Page 3-8
Memories	Page 3-9
Audio and USB	Page 3-10
<b>Parts List</b>	
Controller	Page 3-11

## Notes



## 2.0 Controller R3 Schematic Diagrams

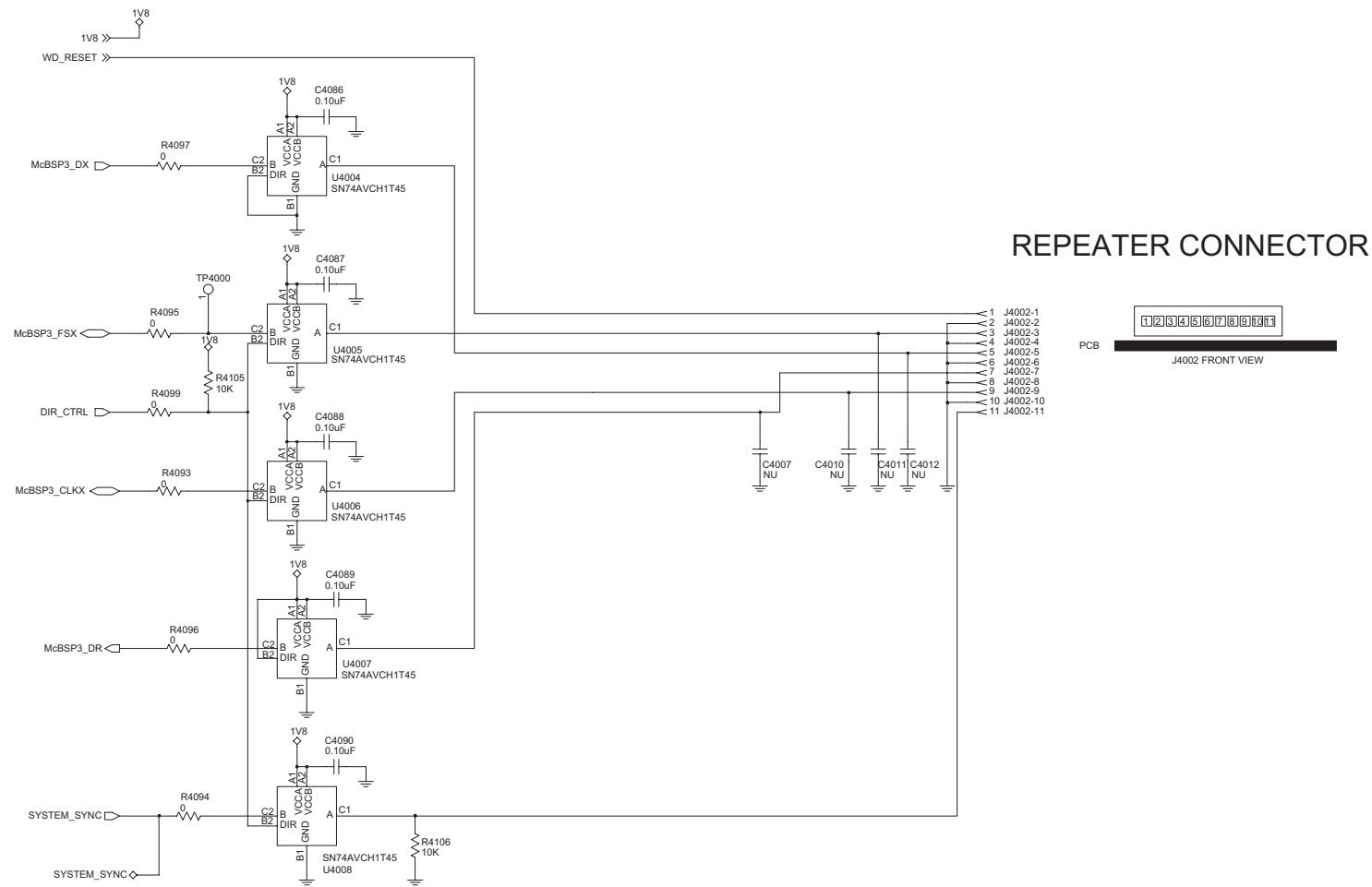


Controller - GPS Schematic Diagram

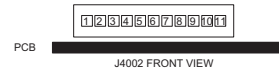




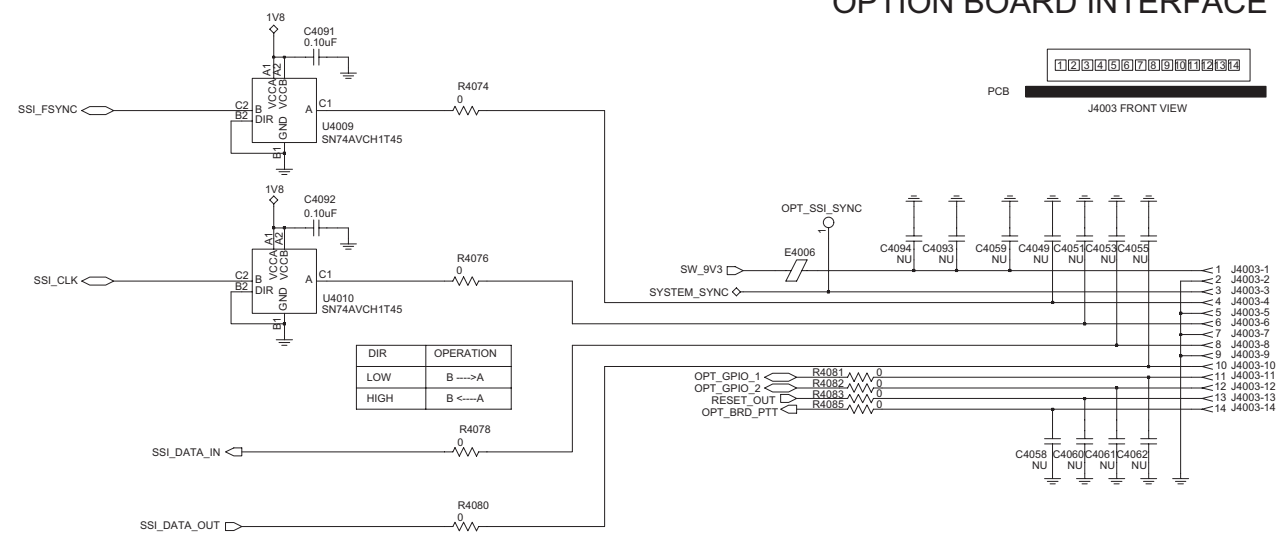




REPEATER CONNECTOR

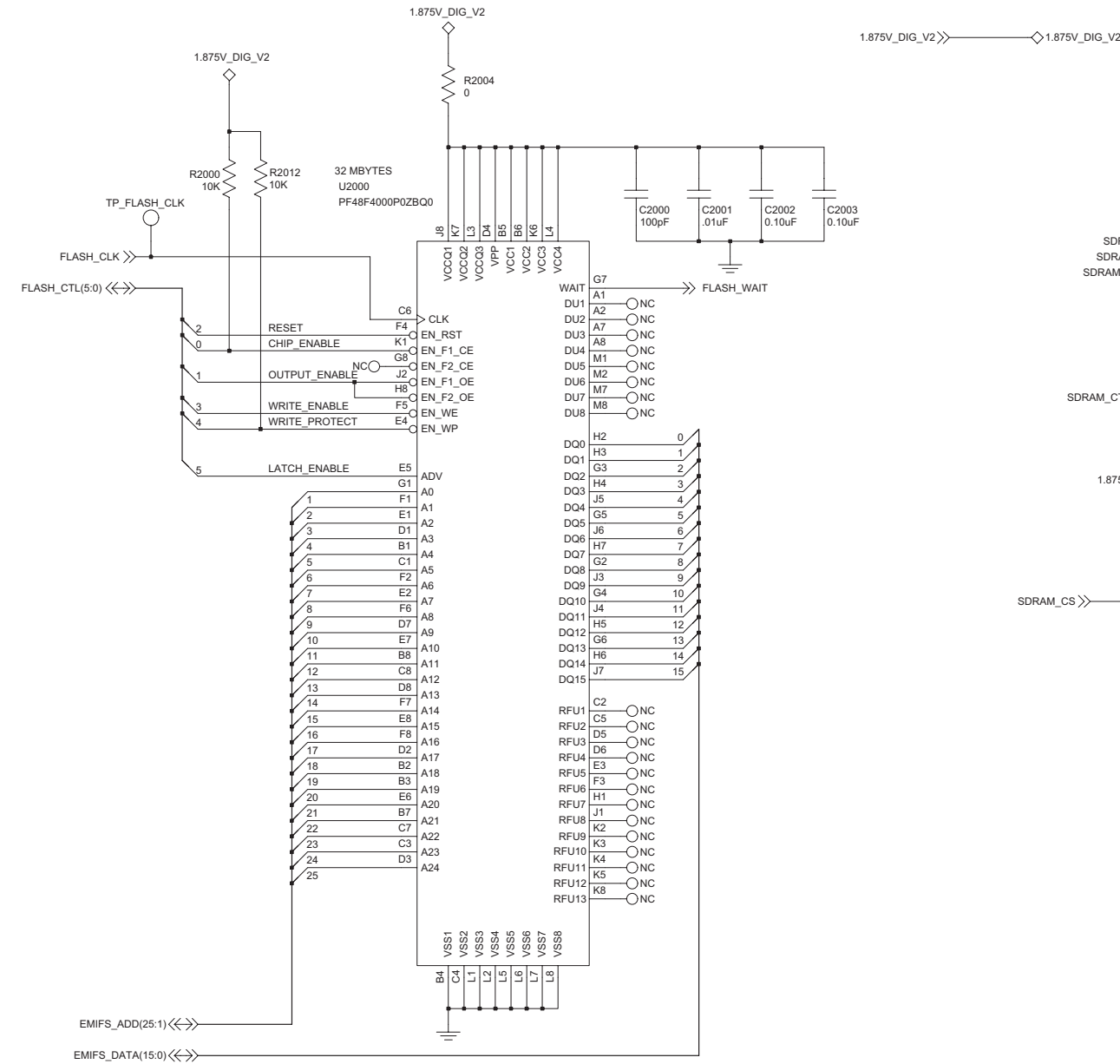


OPTION BOARD INTERFACE

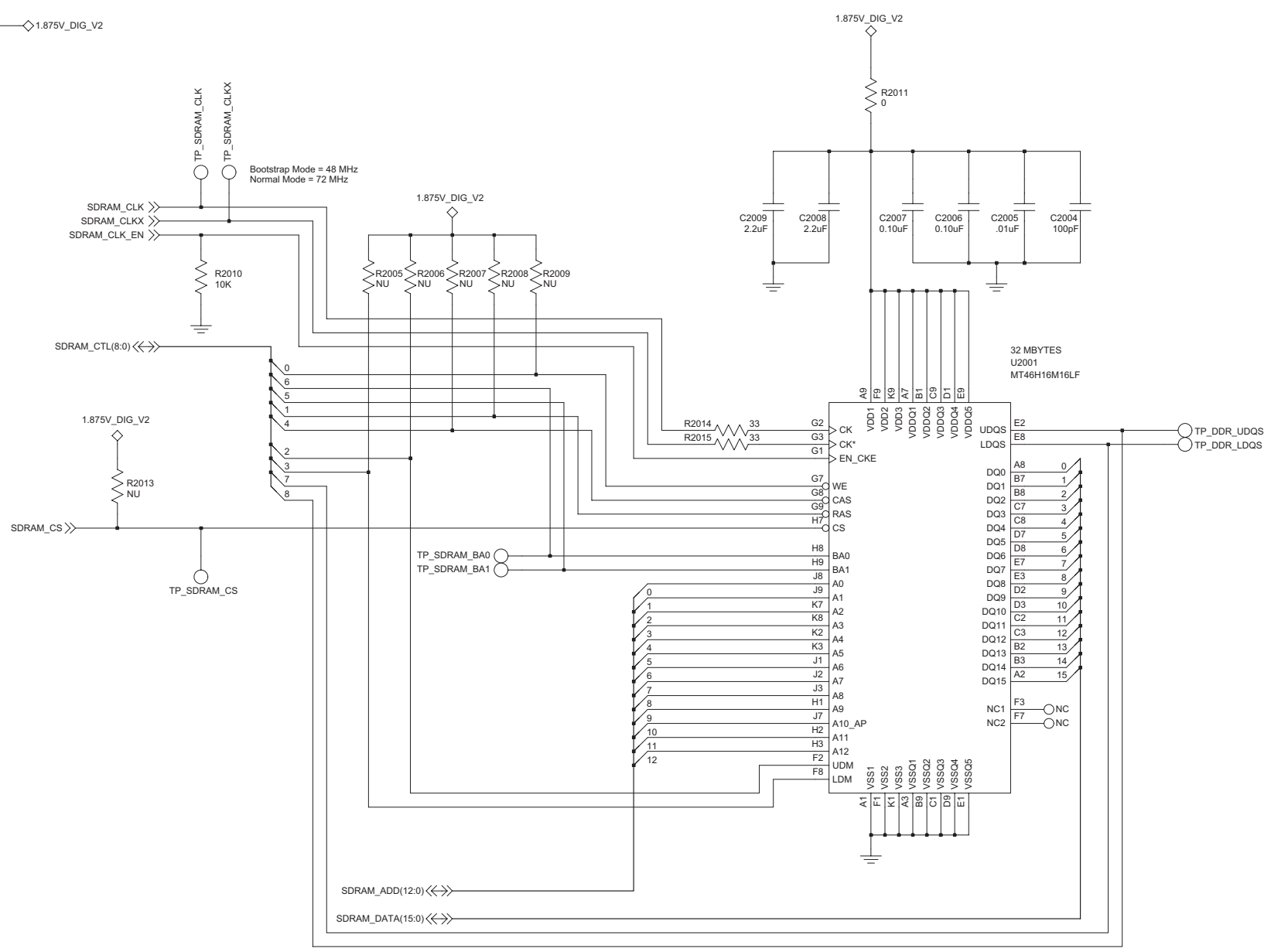




# FLASH

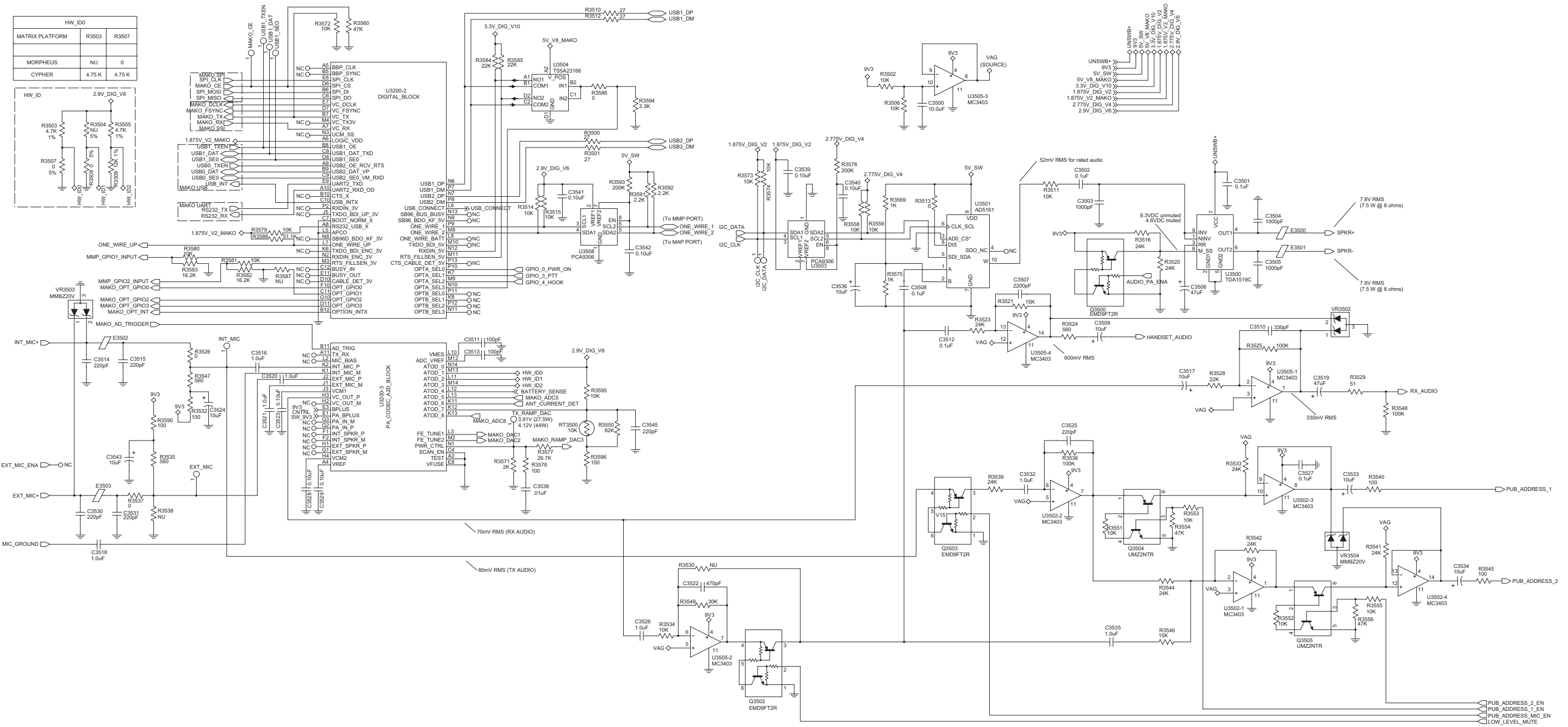


# DDR SDRAM



Controller Memories Schematic Diagram





Controller Audio and USB Schematic Diagram



**2.1 Controller R3 Parts List**

Circuit Ref	Motorola Part No.	Description
C1000	2113944A40	100pF
C1001	2113945Y02	0.10uF
C1002	2113945Y02	0.10uF
C1003	2113944A40	100pF
C1004	2113944A40	100pF
C1005	2113945Y02	0.10uF
C1006	2113945Y02	0.10uF
C1007	2113944A40	100pF
C1008	2113944A40	100pF
C1009	2113945Y02	0.10uF
C1010	2113945Y02	0.10uF
C1011	2113944A40	100pF
C1012	2113945Y02	0.10uF
C1013	2113945Y02	0.10uF
C1014	2113945Y02	0.10uF
C1015	2113945Y02	0.10uF
C1016	2113945Y02	0.10uF
C1017	2113946E02	1.0uF
C1018	2113944A28	18pF
C1019	2113944A28	18pF
C1030	2113944A28	18pF
C1031	2113945Y02	0.10uF
C1032	2113945B02	.01uF
C1033	2113945Y02	0.10uF
C1034	2113946S35	1.0uF
C1035	2113946D05	2.2uF
C1036	2113946S35	1.0uF
C1037	2113946D05	2.2uF
C1044	2113945Y02	0.10uF

Circuit Ref	Motorola Part No.	Description
C2000	2113944A40	100pF
C2001	2113945B02	.01uF
C2002	2113945Y02	0.10uF
C2003	2113945Y02	0.10uF
C2004	2113944A40	100pF
C2005	2113945B02	.01uF
C2006	2113945Y02	0.10uF
C2007	2113945Y02	0.10uF
C2008	2113946D05	2.2uF
C2009	2113946D05	2.2uF
C2500	2113944A44	220pF
C2501	2113945A10	1500pF
C3000	2113944C06	470pF
C3002	2371403L02	10uF
C3005	2113944C06	470pF
C3006	2314030E85	33uF
C3007	2113945C31	0.1uF
C3008	2113945A09	1000pF
C3009	2113945Y02	0.10uF
C3010	2113946S35	1.0uF
C3011	2113946S35	1.0uF
C3012	2113944C06	470pF
C3013	2314030J28	22uF
C3014	2113945C31	0.1uF
C3015	2113944C38	47pF
C3016	2113944A40	100pF
C3017	2113945A09	1000pF
C3018	2389289U01	10uF
C3019	2113944C06	470pF
C3020	2314030E85	33uF

Circuit Ref	Motorola Part No.	Description
C3021	2113945C31	0.1uF
C3030	2113945C02	.01uF
C3031	2113945C31	0.1uF
C3032	2113945B02	.01uF
C3040	2113944C06	470pF
C3041	2113945C02	.01uF
C3042	2113945B02	.01uF
C3043	2314030E85	33uF
C3044	2113945C31	0.1uF
C3045	NOT PLACED	-
C3046	2113945Y02	0.10uF
C3200	2113946J04	22uF
C3201	2113946D05	2.2uF
C3202	2113945Y02	0.10uF
C3203	2316410H02	68uF
C3204	2115153H21	5.6pF
C3205	2115153H21	5.6pF
C3206	2316410H01	22uF
C3207	2113945C31	0.1uF
C3208	2113946D05	2.2uF
C3209	2113945Y02	0.10uF
C3210	2113946D05	2.2uF
C3211	2113945A09	1000pF
C3212	2316410H02	68uF
C3213	2113946F03	4.7uF
C3214	2115153H45	33pF
C3215	2115153H45	33pF
C3216	2113946F03	4.7uF
C3217	2113944A44	220pF
C3218	2113945Y02	0.10uF

Circuit Ref	Motorola Part No.	Description
C3219	2113944A44	220pF
C3220	2113945Y02	0.10uF
C3221	2113944A44	220pF
C3222	2113945Y02	0.10uF
C3225	2113944A44	220pF
C3226	2113945Y02	0.10uF
C3227	2113944A44	220pF
C3228	2113945Y02	0.10uF
C3229	2113944A44	220pF
C3231	2113944A44	220pF
C3232	2113945Y02	0.10uF
C3233	2113944A44	220pF
C3234	2113946D05	2.2uF
C3237	2113946D05	2.2uF
C3238	2113946H02	10uF
C3239	2113946D05	2.2uF
C3240	2113944C45	100pF
C3243	2113946S35	1.0uF
C3247	2113946H02	10uF
C3248	2113946S35	1.0uF
C3249	2113944C45	100pF
C3252	2113946S35	1.0uF
C3254	2113946D05	2.2uF
C3257	2113946S35	1.0uF
C3260	2113946S35	1.0uF
C3261	2113944A44	220pF
C3262	2113946N03	2.2uF
C3265	2113946J04	22uF
C3266	2113946D05	2.2uF
C3269	2113946S35	1.0uF

Circuit Ref	Motorola Part No.	Description
C3270	2113946S35	1.0uF
C3272	2115153H27	10pF
C3273	NOT PLACED	–
C3274	2113944A44	220pF
C3275	2113946J03	10.0uF
C3276	2113946S35	1.0uF
C3277	2113946S35	1.0uF
C3278	2113945C31	0.1uF
C3279	2113945C31	0.1uF
C3280	2113945C31	0.1uF
C3281	2113945C31	0.1uF
C3282	2113946F03	4.7uF
C3283	2113945Y02	0.10uF
C3289	2113945Y02	0.10uF
C3290	2113945Y02	0.10uF
C3291	2113945Y02	0.10uF
C3292	2113945A09	1000pF
C3500	2113946J03	10.0uF
C3501	2113945G91	0.1uF
C3502	2113945C31	0.1uF
C3503	2113945A09	1000pF
C3504	2113945A09	1000pF
C3505	2113945A09	1000pF
C3506	2314030F30	47uF
C3507	2113945A11	2200pF
C3508	2113945C31	0.1uF
C3509	2313960D07	10uF
C3510	2113945A03	330pF
C3511	2113944A40	100pF
C3512	2113945C31	0.1uF

Circuit Ref	Motorola Part No.	Description
C3513	2113944A40	100pF
C3514	2113944A44	220pF
C3515	2113944A44	220pF
C3516	2113946S35	1.0uF
C3517	2314030M51	10uF
C3518	2113946S35	1.0uF
C3519	2314030F30	47uF
C3520	2113946S35	1.0uF
C3521	2113946S35	1.0uF
C3522	2113945A05	470pF
C3523	2113945Y02	0.10uF
C3524	2313960D07	10uF
C3525	2113944A44	220pF
C3526	2113946S35	1.0uF
C3527	2113945C31	0.1uF
C3528	2113945Y02	0.10uF
C3529	2113945Y02	0.10uF
C3530	2113944A44	220pF
C3531	2113944A44	220pF
C3532	2113946S35	1.0uF
C3533	2313960D07	10uF
C3534	2313960D07	10uF
C3535	2113946S35	1.0uF
C3536	2314030M51	10uF
C3538	2113945B02	.01uF
C3539	2113945Y02	0.10uF
C3540	2113945Y02	0.10uF
C3541	2113945Y02	0.10uF
C3542	2113945Y02	0.10uF
C3543	2313960D07	10uF

Circuit Ref	Motorola Part No.	Description
C3545	2113944A44	220pF
C4000	NOT PLACED	–
C4001	NOT PLACED	–
C4002	NOT PLACED	–
C4003	NOT PLACED	–
C4004	NOT PLACED	–
C4005	NOT PLACED	–
C4006	2113944A44	220pF
C4007	NOT PLACED	–
C4010	NOT PLACED	–
C4011	NOT PLACED	–
C4012	NOT PLACED	–
C4013	2113944A44	220pF
C4014	2113944A44	220pF
C4015	2113944A44	220pF
C4016	2113944A44	220pF
C4017	2113944A44	220pF
C4018	2113944A44	220pF
C4019	NOT PLACED	–
C4020	NOT PLACED	–
C4021	2113944A44	220pF
C4022	2113944A44	220pF
C4023	2113944A44	220pF
C4024	2113944A44	220pF
C4025	2113944A44	220pF
C4026	2113944A44	220pF
C4027	2113944A44	220pF
C4028	2113944A44	220pF
C4029	2113944A44	220pF
C4030	2113944A44	220pF

Circuit Ref	Motorola Part No.	Description
C4031	2113944A44	220pF
C4032	2113944A44	220pF
C4033	2113944A44	220pF
C4034	2113945A03	330pF
C4035	2113945A03	330pF
C4040	2113944A44	220pF
C4041	2113944A44	220pF
C4042	2113944A44	220pF
C4043	2113944A44	220pF
C4044	2113944A44	220pF
C4045	2113944A44	220pF
C4046	2113944A44	220pF
C4047	2113944A44	220pF
C4048	2113944A44	220pF
C4049	NOT PLACED	–
C4051	NOT PLACED	–
C4053	NOT PLACED	–
C4055	NOT PLACED	–
C4058	NOT PLACED	–
C4059	NOT PLACED	–
C4060	NOT PLACED	–
C4061	NOT PLACED	–
C4062	NOT PLACED	–
C4063	2113944A44	220pF
C4064	2113944A44	220pF
C4065	2113944A44	220pF
C4066	2113944A44	220pF
C4067	2113944A44	220pF
C4068	2113944A44	220pF
C4069	2113944A44	220pF

Circuit Ref	Motorola Part No.	Description
C4070	2113944A44	220pF
C4071	NOT PLACED	–
C4072	NOT PLACED	–
C4073	2113945Y02	0.10uF
C4074	NOT PLACED	–
C4075	NOT PLACED	–
C4076	NOT PLACED	–
C4084	2113945Y02	0.10uF
C4085	2113944A44	220pF
C4086	NOT PLACED	–
C4087	NOT PLACED	–
C4088	NOT PLACED	–
C4089	NOT PLACED	–
C4090	NOT PLACED	–
C4091	2113945Y02	0.10uF
C4092	2113945Y02	0.10uF
C4093	NOT PLACED	–
C4094	NOT PLACED	–
D3030	4813978P07	DIODE, SWITCHING
D3040	4813978P07	DIODE, SWITCHING
D3200	4813978C02	DIODE, SWITCHING
D4000	4866544A01	DIODE, DUAL
D4001	4866544A01	DIODE, DUAL
E2500	2480675U01	FERRITE BEAD
E3000	2485011Y01	FERRITE BEAD
E3201	2480675U01	FERRITE BEAD
E3202	2480675U01	FERRITE BEAD
E3203	2480675U01	FERRITE BEAD
E3205	2480675U01	FERRITE BEAD
E3206	2480675U01	FERRITE BEAD

Circuit Ref	Motorola Part No.	Description
E3208	2480675U01	FERRITE BEAD
E3500	2485011Y01	FERRITE BEAD
E3501	2485011Y01	FERRITE BEAD
E3502	2485011Y01	FERRITE BEAD
E3503	2485011Y01	FERRITE BEAD
E4000	2485011Y01	FERRITE BEAD
E4001	7686949J14	FERRITE BEAD
E4002	7686949J14	FERRITE BEAD
E4003	2409134J25	FERRITE BEAD
E4004	2409134J25	FERRITE BEAD
E4005	2409134J25	FERRITE BEAD
E4006	2409134J25	FERRITE BEAD
J3000	0905902V09	DC POWER CONNECTOR
J4000	0916017H01	26-PIN ACCESSORY CONNECTOR
J4001	0915555H01	30-PIN CONTROL HEAD CONNECTOR
J4002	NOT PLACED	–
J4003	0915556H01	14-PIN OPT BOARD CONNECTOR
L3200	2415005H02	22uH
L3201	2415005H02	22uH
L3202	2415005H02	22uH
Q3030	4813973M07	NPN
Q3032	4813973B01	NPN
Q3040	4813973M07	NPN
Q3041	4815263H01	ANALOG SWITCH
Q3200	5185956E76	N-CHANNEL SYNCHRONOUS MOSFET
Q3201	4813970A62	P-CHANNEL MOSFET
Q3202	5185956E76	N-CHANNEL SYNCHRONOUS MOSFET

Circuit Ref	Motorola Part No.	Description
Q3203	4805585Q23	PMOSFET
Q3204	4805585Q23	PMOSFET
Q3205	4815262H01	ANALOG SWITCH
Q3206	4815272H01	ANALOG SWITCH
Q3207	4813970A62	P-CHANNEL MOSFET
Q3208	4815261H01	ANALOG SWITCH
Q3209	4813973M07	NPN
Q3210	4813973M07	NPN
Q3500	4815272H01	ANALOG SWITCH
Q3502	4815272H01	ANALOG SWITCH
Q3503	4815272H01	ANALOG SWITCH
Q3504	4815270H01	ANALOG SWITCH
Q3505	4815270H01	ANALOG SWITCH
Q4000	4815263H01	ANALOG SWITCH
Q4001	4815263H01	ANALOG SWITCH
Q4002	4815261H01	ANALOG SWITCH
Q4003	4815263H01	ANALOG SWITCH
Q4004	4815261H01	ANALOG SWITCH
Q4005	4815263H01	ANALOG SWITCH
Q4006	4815263H01	ANALOG SWITCH
Q4007	4815263H01	ANALOG SWITCH
Q4008	4815261H01	ANALOG SWITCH
Q4009	4815263H01	ANALOG SWITCH
Q4010	4815261H01	ANALOG SWITCH
Q4011	4815263H01	ANALOG SWITCH
Q4012	4815261H01	ANALOG SWITCH
Q4013	4816023H01	PNP
Q4014	4813973A06	NPN
Q4015	4815263H01	ANALOG SWITCH
R1000	0613952Q25	10

Circuit Ref	Motorola Part No.	Description
R1001	0613952R01	10K
R1002	0613952J73	10MEG
R1005	0613952Q89	4.7K
R1006	0613952R01	10K
R1014	0613952R66	0
R1017	0613952R01	10K
R1019	0613952Q18	5.1
R1020	0613952R66	0
R1021	0613952R66	0
R1025	0613952R01	10K
R1026	0613952R17	47K
R1027	NOT PLACED	–
R1028	0613952R66	0
R1034	0613952R01	10K
R1035	NOT PLACED	–
R1036	0613952R01	10K
R1041	0613952Q73	1K
R1044	0613952R66	0
R1045	0613952R01	10K
R1046	NOT PLACED	–
R1047	0613952R66	0
R1048	0613952R66	0
R1054	0613952Q89	4.7K
R1060	0613952Q25	10
R1066	NOT PLACED	–
R1067	NOT PLACED	–
R1070	0613952R66	0
R1071	0613952R17	47K
R2000	0613952R01	10K
R2004	0613952R66	0

Circuit Ref	Motorola Part No.	Description
R2005	NOT PLACED	–
R2006	NOT PLACED	–
R2007	NOT PLACED	–
R2008	NOT PLACED	–
R2009	NOT PLACED	–
R2010	0613952R01	10K
R2011	0613952R66	0
R2012	0613952R01	10K
R2013	NOT PLACED	–
R2014	0613952Q37	33
R2015	0613952Q37	33
R2500	0613952R66	0
R2501	0613952R66	0
R2502	0613952R66	0
R2504	0613952R66	0
R2506	0613952R66	0
R2507	0613952R66	0
R2508	0613952R66	0
R2509	0613952R66	0
R2510	0613952R66	0
R2511	0613952R66	0
R2512	0613952R66	0
R2513	0613952R66	0
R2514	0613952R66	0
R2515	0613952R66	0
R2516	0613952R66	0
R2517	0613952R66	0
R2518	0613952R66	0
R2519	0613952R66	0
R2520	0613952R66	0

Circuit Ref	Motorola Part No.	Description
R2524	0613952R66	0
R2525	0613952R66	0
R2526	0613952R66	0
R2527	0613952R66	0
R2528	0613952R66	0
R2529	0613952R01	10K
R3002	0613952R01	10K
R3003	0613952M54	3.57K
R3004	0613952L73	562
R3005	0613952Q81	2.2K
R3006	0613952Q57	220
R3007	0613952N58	39.2K
R3008	0613952N12	13K
R3009	0613952N58	39.2K
R3010	0613952N12	13K
R3030	0613952R01	10K
R3032	0615871H01	0.1
R3033	0615871H01	0.1
R3034	0613952H61	330
R3035	0613952H25	10
R3036	0613952H25	10
R3037	0613959G61	330
R3038	NOT PLACED	–
R3039	0613952M30	2K
R3040	0613952M43	2.74K
R3041	0613952R25	100K
R3042	0613952H69	680
R3043	0613952H69	680
R3044	0613958S61	330
R3045	0613952M30	2K

Circuit Ref	Motorola Part No.	Description
R3046	0613952M43	2.74K
R3047	0613952R25	100K
R3048	0613952Q73	1K
R3050	0613959Q53	150
R3051	0613952G67	0
R3052	0613952G67	0
R3053	0613952R66	0
R3054	0613952R66	0
R3055	0615871H01	0.1
R3056	0615871H01	0.1
R3057	0613952R66	0
R3200	0615871H01	0.1
R3203	0615871H01	0.1
R3204	0615871H01	0.1
R3205	0613952R25	100K
R3206	0613952R66	0
R3207	0686135Z02	0.2
R3208	0686135Z02	0.2
R3209	0613952N62	43.2K
R3210	0613952N16	14.3K
R3215	0613952G67	0
R3216	0613952G67	0
R3217	NOT PLACED	–
R3218	0613952R66	0
R3219	0613952R56	2MEG
R3220	0613952R56	2MEG
R3222	0613952R33	220K
R3223	0613952R33	220K
R3224	0613952Q89	4.7K
R3225	NOT PLACED	–

Circuit Ref	Motorola Part No.	Description
R3226	0613952R13	33K
R3227	NOT PLACED	–
R3228	0613952G67	0
R3233	0613952R66	0
R3236	0613952Q73	1K
R3237	0613952R01	10K
R3238	0613952H25	10
R3239	0613952H25	10
R3240	0613952R17	47K
R3241	0613952Q18	5.1
R3243	0613952Q18	5.1
R3245	0613952G67	0
R3246	0613952M81	6.81K
R3247	0613952N69	51.1K
R3248	0613952R01	10K
R3249	0613952R01	10K
R3250	0613952R25	100K
R3252	0613952R25	100K
R3253	0613952R17	47K
R3500	0613952Q35	27
R3501	0613952Q35	27
R3502	0613952R01	10K
R3503	NOT PLACED	–
R3504	NOT PLACED	–
R3505	0613952Z48	4.7K
R3506	0613952R01	10K
R3507	0613952R66	0
R3508	0613952R66	0
R3509	0613952Z55	12K
R3510	0613952Q35	27

Circuit Ref	Motorola Part No.	Description
R3511	0613952R01	10K
R3512	0613952Q35	27
R3513	0613952R66	0
R3514	0613952R01	10K
R3515	0613952R01	10K
R3516	0613952R10	24K
R3520	0613952R10	24K
R3521	0613952R05	15K
R3523	0613952R10	24K
R3524	0613952Q67	560
R3525	0613952R25	100K
R3526	0613952R66	0
R3528	0613952R09	22K
R3529	0613952Q42	51
R3530	NOT PLACED	-
R3532	0613952Q49	100
R3533	0613952R10	24K
R3534	0613952R01	10K
R3535	0613952Q67	560
R3536	0613952R25	100K
R3537	0613952R66	0
R3538	NOT PLACED	-
R3539	0613952R10	24K
R3540	0613952Q49	100
R3541	0613952R10	24K
R3542	0613952R10	24K
R3544	0613952R10	24K
R3545	0613952Q49	100
R3546	0613952R05	15K
R3547	0613952Q67	560

Circuit Ref	Motorola Part No.	Description
R3548	0613952J25	100K
R3549	0613952R12	30K
R3550	0613952R23	82K
R3551	0613952R01	10K
R3552	0613952R01	10K
R3553	0613952R01	10K
R3554	0613952R17	47K
R3555	0613952R01	10K
R3556	0613952R17	47K
R3558	0613952R01	10K
R3559	0613952R01	10K
R3560	0613952R17	47K
R3569	0613952Q73	1K
R3571	0613952Q80	2K
R3572	0613952R01	10K
R3573	0613952R01	10K
R3574	0613952R01	10K
R3575	0613952Q73	1K
R3576	0613952Q49	100
R3577	0613952N42	26.7K
R3578	0613952R32	200K
R3579	0613952R01	10K
R3580	0613952R01	10K
R3581	0613952R01	10K
R3582	0613952N21	16.2K
R3583	0613952N21	16.2K
R3584	0613952R09	22K
R3585	0613952R09	22K
R3586	0613952R66	0
R3587	NOT PLACED	-

Circuit Ref	Motorola Part No.	Description
R3588	0613952N69	51.1K
R3590	0613952Q49	100
R3591	0613952Q81	2.2K
R3592	0613952Q81	2.2K
R3593	0613952R32	200K
R3594	0613952Q85	3.3K
R3595	0613952R01	10K
R3596	0613952H53	150
R4000	0613952Q37	33
R4001	0613952Q37	33
R4002	0613952Q37	33
R4003	0613952Q37	33
R4004	0613952Q37	33
R4005	0613952Q37	33
R4006	0613952Q65	470
R4009	0613952Q42	51
R4010	0613952Q42	51
R4011	0613952R66	0
R4012	0613952R66	0
R4023	0613952Q75	1.2K
R4030	NOT PLACED	-
R4031	0613952R01	10K
R4032	0613952R01	10K
R4033	NOT PLACED	-
R4034	0613952R01	10K
R4035	0613952R01	10K
R4040	0613952Q89	4.7K
R4041	0613952Q89	4.7K
R4042	0613952Q89	4.7K
R4043	0613952Q89	4.7K

Circuit Ref	Motorola Part No.	Description
R4044	NOT PLACED	-
R4045	0613952Q89	4.7K
R4046	0613952Q89	4.7K
R4047	0613952Q89	4.7K
R4048	0613952Q77	1.5K
R4049	0613958H83	2.7K
R4050	0613952R01	10K
R4051	0613952R39	390K
R4054	0613952R01	10K
R4055	0613952R01	10K
R4061	0613952Q37	33
R4063	0613952Q37	33
R4064	0613952Q37	33
R4065	0613952Q37	33
R4066	0613952Q37	33
R4067	0613952Q37	33
R4068	0613952Q37	33
R4069	0613952Q37	33
R4070	0613952Q37	33
R4071	0613952R66	0
R4072	0613952R01	10K
R4074	0613952R66	0
R4076	0613952R66	0
R4078	0613952R66	0
R4079	0613952R01	10K
R4080	0613952R66	0
R4081	0613952R66	0
R4082	0613952R66	0
R4083	0613952R66	0
R4085	0613952R66	0

Circuit Ref	Motorola Part No.	Description
R4086	NOT PLACED	–
R4088	0613952R01	10K
R4089	0613952R17	47K
R4090	NOT PLACED	–
R4093	NOT PLACED	–
R4094	NOT PLACED	–
R4095	NOT PLACED	–
R4096	NOT PLACED	–
R4097	NOT PLACED	–
R4098	0613952Q89	4.7K
R4099	NOT PLACED	–
R4100	0613952Q75	1.2K
R4101	0613952Q75	1.2K
R4103	0613952Q75	1.2K
R4105	NOT PLACED	–
R4106	NOT PLACED	–
RT3500	0615471H01	THERMISTOR, 10K
SP3000	1015349H03	SOLDER_PREFORM
SP3001	1015349H03	SOLDER_PREFORM
U1000	5102495J13	MICROPROCESSOR
U1006	5115001H02	IC, DUAL UNBUFFERED INVERTER
U2000	0104032J81	IC, 32MB FLASH
U2001	5188120J01	IC, 32MB SDRAM
U3001	5164015H94	VOLTAGE REGULATOR
U3002	5115391H01	VOLTAGE REGULATOR
U3003	5164015H94	VOLTAGE REGULATOR
U3004	5115391H01	VOLTAGE REGULATOR

Circuit Ref	Motorola Part No.	Description
U3005	0105959T72	PNP
U3006	0105959T72	PNP
U3030	5116525H01	DUAL OPAMP
U3040	0105959T72	PNP
U3200	5185143E77	IC, POWER MANAGEMENT
U3201	5115616H01	VOLTAGE REGULATOR
U3202	5115453H01	DUAL OPAMP
U3203	5114007A43	IC, SCHMITT TRIGGER
U3500	5102463J95	AUDIO PA
U3501	5115368H01	DIGITAL ATTENUATOR
U3502	5114016A18	QUAD OPAMP
U3503	5164852H47	IC, LEVEL TRANSLATOR
U3504	5171395L01	IC, CMOS SWITCH
U3505	5114016A18	QUAD OPAMP
U3508	5164852H47	IC, LEVEL TRANSLATOR
U4000	5115476H01	IC, SERIAL-TO-PARALLEL CONVERTER
U4001	5115502H01	LOGIC TRANSLATOR
U4004	NOT PLACED	–
U4005	NOT PLACED	–
U4006	NOT PLACED	–
U4007	NOT PLACED	–
U4008	NOT PLACED	–
U4009	5178395A01	IC, BUFFER
U4010	5178395A01	IC, BUFFER
VR3000	4813979C17	TRANSIENT SUPPRESSOR
VR3040	4813977M10	DIODE, 5.1V ZENER
VR3200	4813977M10	DIODE, 5.1V ZENER

Circuit Ref	Motorola Part No.	Description
VR3201	4813977M05	DIODE, 3.3V ZENER
VR3202	4813977M05	DIODE, 3.3V ZENER
VR3203	4813977M05	DIODE, 3.3V ZENER
VR3204	4813977M13	DIODE, 6.2V ZENER
VR3205	4813977M05	DIODE, 3.3V ZENER
VR3206	4813977M13	DIODE, 6.2V ZENER
VR3207	4813977M13	DIODE, 6.2V ZENER
VR3208	4813977M13	DIODE, 6.2V ZENER
VR3502	4813977A48	DIODE, 20V ZENER
VR3503	4813977A48	DIODE, 20V ZENER
VR3504	4813977A48	DIODE, 20V ZENER
VR4000	4813977A48	DIODE, 20V ZENER
VR4001	4813977A48	DIODE, 20V ZENER
VR4002	4813977A48	DIODE, 20V ZENER
VR4003	4813977A48	DIODE, 20V ZENER
VR4004	4813977A48	DIODE, 20V ZENER
VR4005	4813977M13	DIODE, 6.2V ZENER
VR4006	4813977M13	DIODE, 6.2V ZENER
Y1000	93012000001	12MHZ CRYSTAL
Y3200	4815028H01	24.576MHZ CRYSTAL
Y3201	4802582S80	32KHZ CRYSTAL



# **XPR 4380/XPR 4580 Mobile Radios**

Chapter 4

GPS

Service Information

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## Chapter 4 - GPS Service Information

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## Notes

## Section 1

# THEORY OF OPERATION

## 1.0 GPS Overview

This section provides a detailed theory of operation for the GPS circuit.

## 2.0 GPS Receiver

The onboard GPS receiver is based around the SiRF StarIII single-chip GPS IC. This IC combines an RF front-end with an ARM microprocessor and DSP with 200,000 effective correlators, 1 MB of SRAM, and 4 MB of flash memory into a single package. A simplified block diagram of the StarIII-based GPS design is shown below.

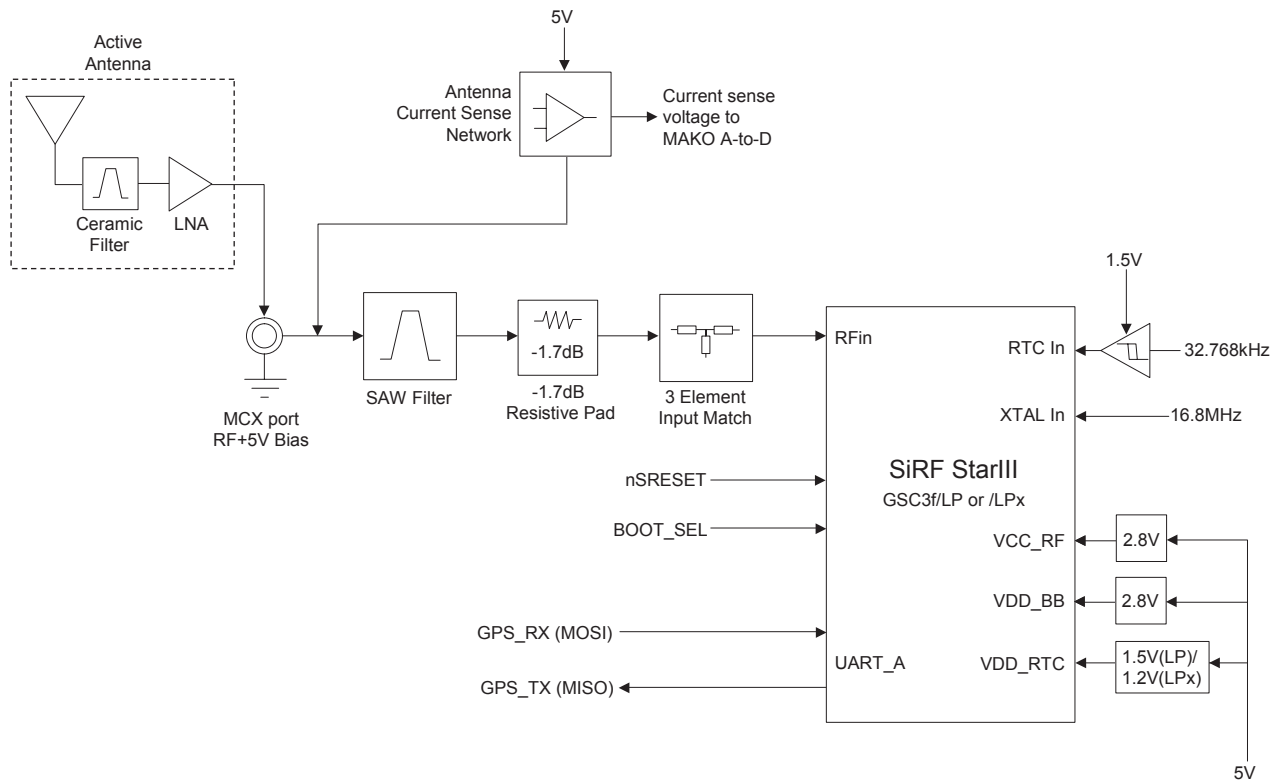


Figure 1-1 GPS Receiver Block Diagram

The design of the onboard GPS receiver can be broken down into five areas: the active antenna, RF front-end circuitry, power regulation, reference frequencies/clocks, and the GPS-Host interface.

### 3.0 GPS Antenna

The onboard GPS receiver system is designed to be used with an active GPS antenna, which provides a necessary amount of gain in front of the StarIII's RF input to improve noise figure. This antenna is typically a right-hand, circularly-polarized (RHCP), patch element integrated with a ceramic band-pass pre-filter and low-noise amplifier, yielding roughly 26 dB of overall gain. The antenna interface is an SMA port on the rear of the radio, which is connected internally to the onboard GPS circuitry via a short coaxial feed terminated into an MCX connector on the radio board. The active antenna is powered by a 5 Volt bias on the rear RF connector. This bias is supplied by regulator U3002, which is switched by the vehicle's ignition.

The current drawn by the active antenna is monitored by a current-sensing network, which uses U6405 to amplify the antenna current induced voltage drop across R6430 to output a voltage on the emitter of Q6401 to an analog-to-digital converter located on ball K11 of the MAKO IC. The resulting value can be used to flag any open or short fault-conditions in the antenna. An output voltage of 0 Volts indicates that the antenna is not connected or not being powered while a voltage greater than 4.3 Volts indicates that there is a short circuit or the antenna is drawing too much current. A nominal antenna current draw of 20 mA should produce an output of around 1.5 Volts.

### 4.0 GPS Front-End

The received signal from the antenna port is first passed through SAW filter FL6401 to attenuate any out-of-band noise. This filter has a maximum insertion loss of 1.8 dB in the GPS passband (1575.42 MHz +/-1.023 MHz) and a -3 dB bandwidth of approximately 45 MHz. The output of this filter is passed through a -1.7 dB resistive pi-pad, which is intended to limit excessively strong signals at the input of the extremely sensitive StarIII IC, as well as pad the input match slightly to compensate for part tolerance variations. This pad is not placed due to the sensitivity degradation observed. The final stage before the IC's RF input is a 3-element LC match (C6443, C6444, L6403) used to couple the 50 ohm SAW filter into the complex impedance of the StarIII IC.

### 5.0 GPS Power Regulation

The StarIII IC is powered via three separate LDO regulators supplied by an always-on 5 Volts from U3004 in the radio's main DC distribution tree. The first two regulators, U6402 and U6406, are both configured to supply 2.8 Volts to the RF and digital sections of the IC, respectively. The isolation of these two regulators ensures that digital noise does not feed back into the RF section through the DC path. These regulators are switched at pin 4 by the 2.775V\_DIG\_V4 line from the MAKO IC so that they are disabled when ignition is off. The final regulator, U6407, supplies 1.5 Volts if U6401 is the GSC3f/LP IC (0104024J41) or 1.2 Volts if U6401 is the GSC3f/LPx (0104034J14) to the RTC section of the IC and is always on to maintain RTC availability and to preserve information in the GPS IC's battery-backed RAM.

## 6.0 GPS Reference Frequencies

The RF section of the StarIII IC is supplied with a 16.8 MHz reference signal, which drives the onboard integer-N PLL synthesizer to generate the LO. This signal comes from a voltage-tunable TCXO (Y0100) located in the FGU block. The temperature stability (0.5 ppm), frequency accuracy, and phase noise characteristics of this reference are critical due to the extremely sensitive nature of the GPS receiver. The digital section of the IC is supplied with a buffered and 1.5 Volts if U6401 is the GSC3f/LP IC (0104024J41) or 1.2 Volts if U6401 is the GSC3f/LPx (0104034J14) level-shifted 32.768 kHz XTAL (Y3201), which is used as the onboard ARM microprocessor's real-time clock. The level-shifting and squaring is accomplished by Schmitt trigger IC U6404. The output of the Schmitt trigger on pin C2 is then low-pass filtered by R6464 and C6449 to reduce clock noise.

## 7.0 GPS Host Interface

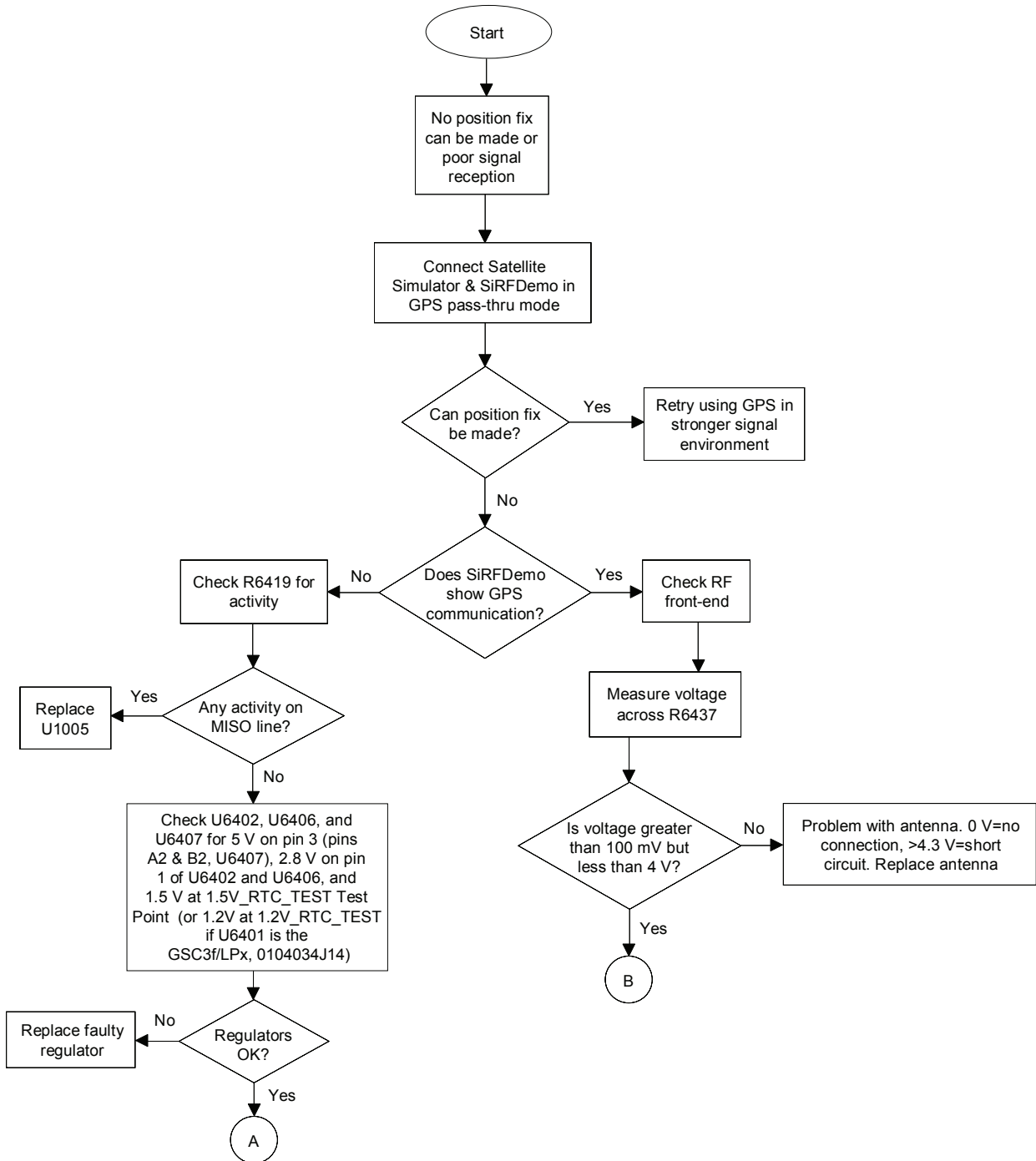
Communication between the StarIII IC and OMAP host is accomplished via one of the GPS IC's two full-duplex UART serial ports (UART\_A) at a data rate of 57.6 kbps. These lines are located at pins A6 (TX) and A5 (RX) on the StarIII. UART\_B is unused. Other control lines include nSRESET (pin J10), which is toggled by the OMAP and used as the main GPS system reset when pulled low, and BOOT\_SEL (pin G1), which is held high by the OMAP when flashing firmware to the StarIII IC.

## Notes

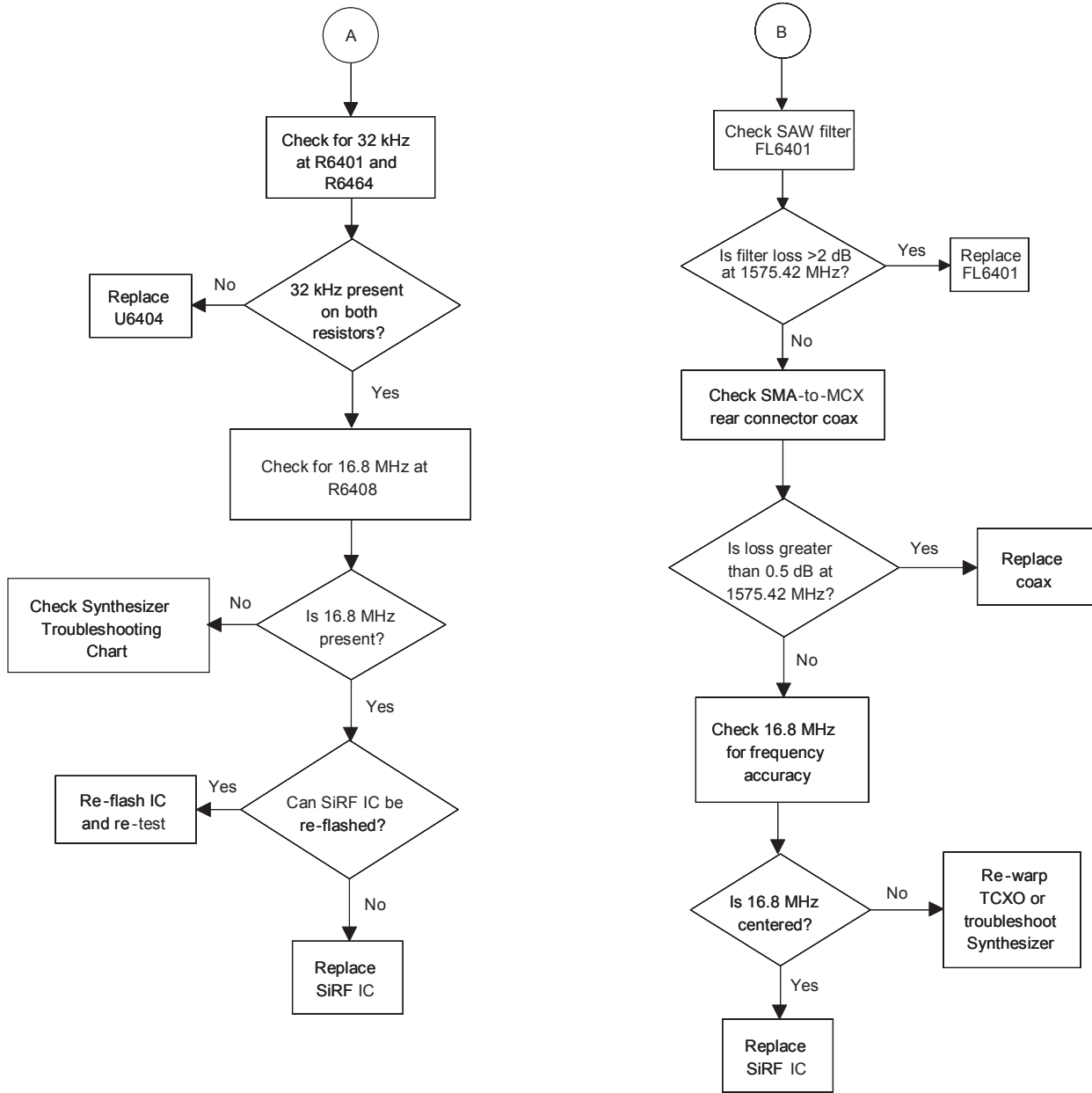
# Section 2

## TROUBLESHOOTING CHARTS

### 1.0 GPS Troubleshooting Chart (Sheet 1 of 2)



### 1.1 GPS Troubleshooting Chart (Sheet 2 of 2)





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## Section 3

### GPS SCHEMATIC/PARTS LIST

#### 1.0 Allocation of Schematic and Parts List

#### 1.1 GPS Circuits

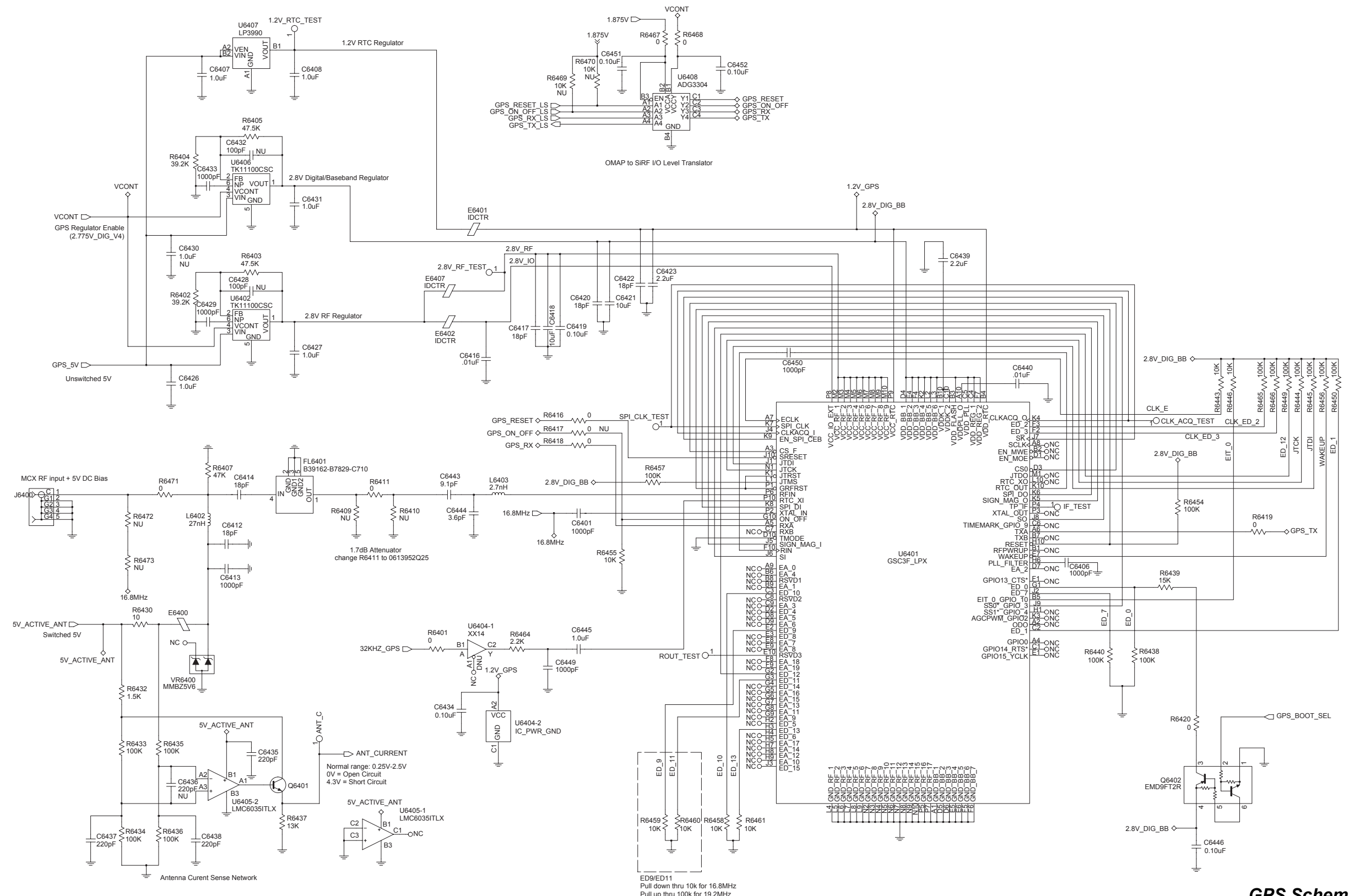
This Chapter shows the Schematic and the Parts List for the GPS circuit.

*Table 3-1 GPS Schematic Diagram and Parts List*

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## Notes

### 2.0 GPS Schematic Diagram



GPS Schematic Diagram

## 2.1 GPS Parts List

Circuit Ref	Motorola Part No	Description
C6401	2113945A09	1000pF
C6406	2113945A09	1000pF
C6407	2113946S35	1.0uF
C6408	2113946S35	1.0uF
C6412	2113944A28	18pF
C6413	2113945A09	1000pF
C6414	2113944A28	18pF
C6416	2113945B02	.01uF
C6417	2113944A28	18pF
C6418	2113946F05	10uF
C6419	2113945Y02	0.10uF
C6420	2113944A28	18pF
C6421	2113946F05	10uF
C6422	2113944A28	18pF
C6423	2113946D05	2.2uF
C6426	2113946S35	1.0uF
C6427	2113946S35	1.0uF
C6428	NOT PLACED	–
C6429	2113945A09	1000pF
C6430	NOT PLACED	–
C6431	2113946S35	1.0uF
C6432	NOT PLACED	–
C6433	2113945A09	1000pF
C6434	2113945Y02	0.10uF
C6435	2113944A44	220pF
C6436	NOT PLACED	–
C6437	2113944A44	220pF
C6438	2113944A44	220pF
C6439	2113946D05	2.2uF

Circuit Ref	Motorola Part No	Description
C6440	2113945B02	.01uF
C6443	2115153H26	9.1pF
C6444	2115153H16	3.6pF
C6445	2113946S35	1.0uF
C6446	2113945Y02	0.10uF
C6449	2113945A09	1000pF
C6450	2113945A09	1000pF
C6451	2113945Y02	0.10uF
C6452	2113945Y02	0.10uF
E6400	7686949J08	FERRITE BEAD
E6401	7686949J08	FERRITE BEAD
E6402	7686949J08	FERRITE BEAD
E6407	7686949J08	FERRITE BEAD
FL6401	9180310L38	1575.42MHZ SAW FILTER
J6400	0909901V02	GPS MCX CONNECTOR
L6402	2415429H24	27nH
L6403	2414017P06	2.7nH
Q6401	4813973M07	NPN
Q6402	4815272H01	ANALOG SWITCH
R6401	0613952R66	0
R6402	0613952N58	39.2K
R6403	0613952N66	47.5K
R6404	0613952N58	39.2K
R6405	0613952N66	47.5K
R6407	0613952R17	47K
R6409	NOT PLACED	–
R6410	NOT PLACED	–
R6411	0613952R66	0
R6416	0613952R66	0

Circuit Ref	Motorola Part No	Description
R6417	NOT PLACED	–
R6418	0613952R66	0
R6419	0613952R66	0
R6420	0613952R66	0
R6430	0613952K01	10
R6432	0613952M18	1.5K
R6433	0613952P01	100K
R6434	0613952P01	100K
R6435	0613952P01	100K
R6436	0613952P01	100K
R6437	0613952N12	13K
R6438	0613952R25	100K
R6439	0613952R05	15K
R6440	0613952R25	100K
R6443	0613952R01	10K
R6444	0613952R25	100K
R6445	0613952R25	100K
R6446	0613952R01	10K
R6449	0613952R25	100K
R6450	0613952R25	100K
R6454	0613952R25	100K
R6455	0613952R01	10K
R6456	0613952R25	100K
R6457	0613952R25	100K
R6458	0613952R01	10K
R6459	0613952R01	10K
R6460	0613952R01	10K
R6461	0613952R01	10K
R6464	0613952Q81	2.2K
R6465	0613952R25	100K

Circuit Ref	Motorola Part No	Description
R6466	0613952R25	100K
R6467	0613952R66	0
R6468	0613952R66	0
R6469	NOT PLACED	–
R6470	NOT PLACED	–
R6471	0613952R66	0
R6472	NOT PLACED	–
U6401	0104034J41	IC, GPS
U6402	5115391H01	VOLTAGE REGULATOR
U6404	5115962H01	IC, SCHMITT TRIGGER
U6405	5115453H01	DUAL OPAMP
U6406	5115391H01	VOLTAGE REGULATOR
U6407	5175237H01	1.2V VOLTAGE REGULATOR
U6408	5116324H01	IC, LEVEL TRANSLATOR
VR6400	4813977A43	DIODE, 5.6V ZENER



# **XPR 4380/XPR 4580**

## **Mobile Radios**

Chapter 5

800/900 MHz Band

(806–941 MHz)

10–35W

Service Information

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## Section 1

# THEORY OF OPERATION

## 1.0 Introduction

This chapter provides a detailed theory of operation for the RF circuits in the radio. For details of the theory of operation and troubleshooting for the associated Controller circuits, refer to the Controller Section of this manual.

## 2.0 800/900 MHz (851–870, 935–941MHz) Band Receiver Circuitry

The receiver is dual-band operating in both the 800 MHz and 900 MHz bands capable of FM, 4-level FSK and APCO C4FM demodulation. It is a dual-conversion super-heterodyne using IF frequencies 73.35 and 2.25 MHz. This configuration allows for a dynamic range of 130 dB in both analog and digital modes. The receiver in general is divided into three sections, front-end, back-end, and DSP. The overall block diagram is shown below in Figure 1-1.

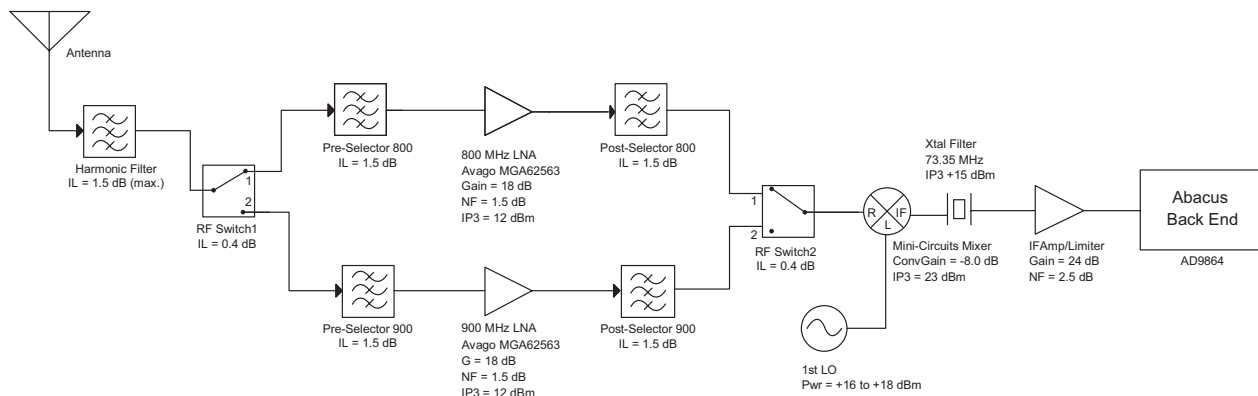


Figure 1-1 Receiver Block Diagram

## 2.1 Receiver Front-End

When the radio is receiving, RF energy is routed from the antenna through the External Connector (J0700) to a pin diode Transmit/Receive (T/R) antenna switch comprising of (D0700) and (D0702). The front-end provides rejection of any unwanted out-of-band energy and the initial frequency conversion to the first IF (Intermediate Frequency) of 73.35 MHz.

The receiver front-end has two line-ups, one to receive in the 800 MHz band and one to receive in the 900 MHz band. Band selection of the proper set of ceramic filters and LNA is achieved by the use of two SPDT RF switches (U0403) and (U0404). The band select signal from the main processor controls two transistor switches with outputs going to the RF Switch control inputs.

At 800 MHz band selection, receiving signal is routed to pre-selector filter (FL0401), LNA (U0401) and image band-pass filter (FL0402).

At 900 MHz band selection, receiving signal is routed to pre-selector filter (FL0403), LNA (U0405) and image band-pass filter (FL0404).

800/900 MHz band uses the same mixer (U0407) to frequency down conversion to IF 73.35 MHz.

The insertion loss of the filters is typically 1.5 dB while the insertion loss of the RF switches is about 0.4 dB.

Power protection of these line-ups is provided by a pair of Schottky diodes CR0400 & CR0401. These diodes allow operation at a maximum RF input power of +30 dBm.

The LNAs are biased to achieve a gain of approximately 18 dB and an IIP3 of +10 dBm minimum. The mixer has an IIP3 of approximately +23 dBm. A dual Schottky diode, (CR0400 and CR0401), is located between the first switch and the pre-selector filter to protect the LNA and mixer from high RF input levels.

The LO drive to the first mixer is +16dBm min. A 7-pole injection filter attenuates any unwanted harmonics before the signal reaches the mixer.

## 2.2 Receiver Back-End

After the first frequency conversion to 73.35 MHz, the IF signal passes through a crystal filter (FL0500) with a minimum 3 dB BW of 13 kHz. The signal is then routed through a 2-stage limiter/amplifier (Q0500 & Q0501). The limiter/amplifier stage applies low level signals while limiting signals above -30 dBm, to help achieve a dynamic range of well over 100 dB without over-driving the ADC, internal to the AD9864 IC.

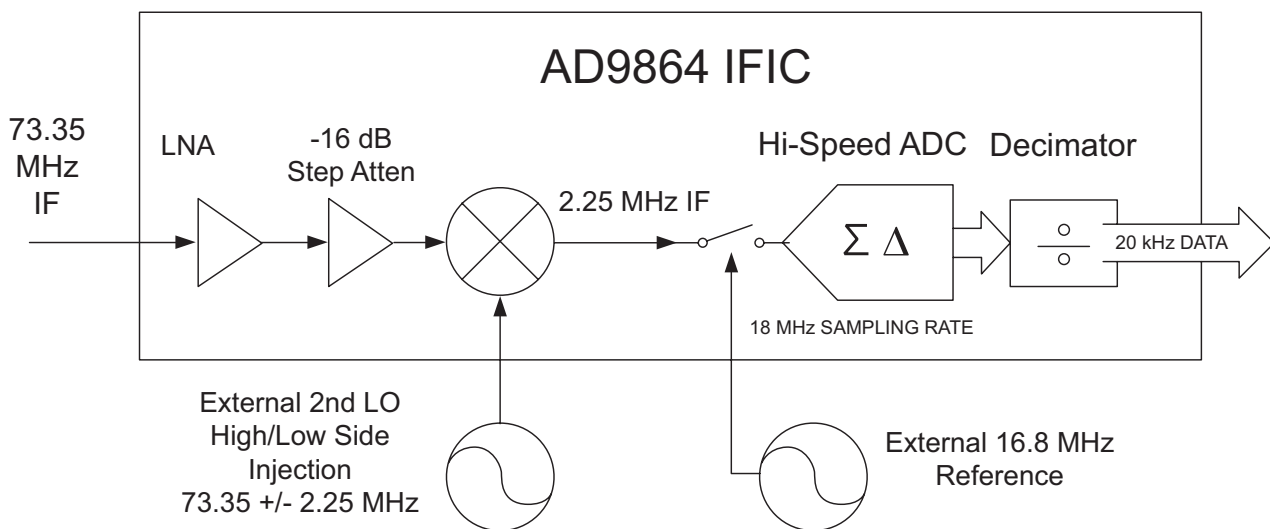


Figure 1-2 AD9864 Block Diagram

The 73.35 MHz IF signal finally reaches the AD9864 (U0600), as shown in Figure 1-2. Here another frequency down-conversion to 2.25 MHz takes place before the resultant RF voltage gets sampled by a Sigma-Delta converter. The Sigma-Delta converter is a high-speed ADC that outputs a 20 kHz data stream to the main DSP.

## 2.3 Receiver DSP (Digital Signal Processing)

Shown below in Figure 1-3 is the block diagram of the signal flow through the receiver back-end. All blocks within the dotted box represent the DSP software algorithms internal to U1000.

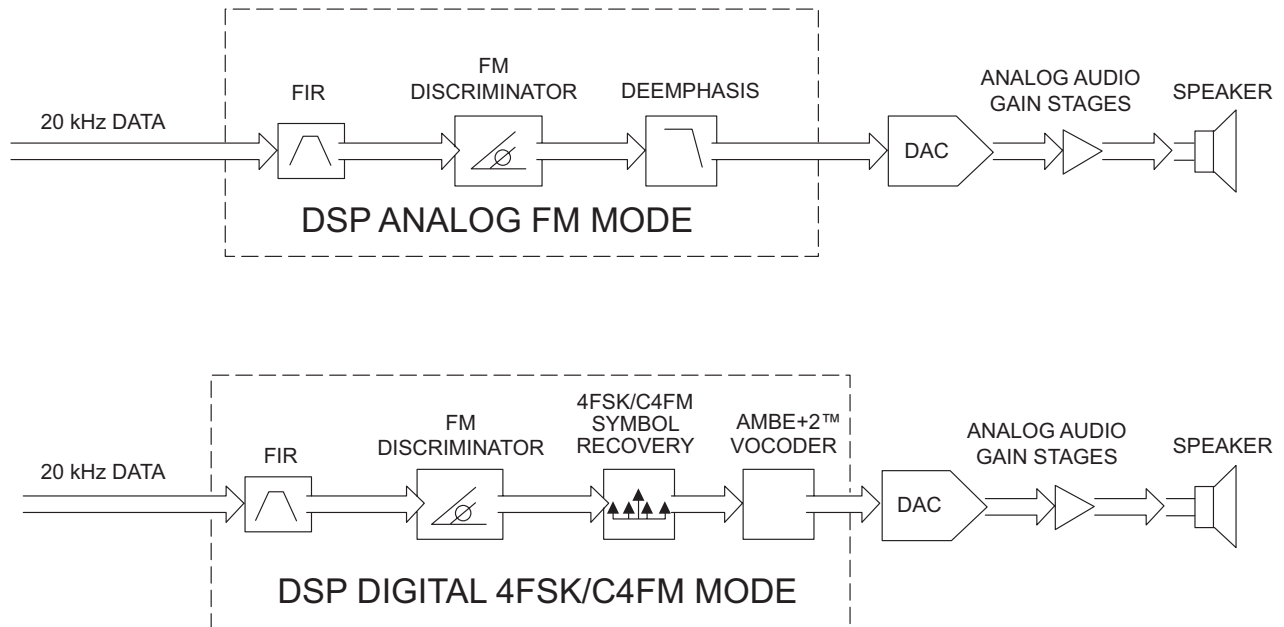


Figure 1-3 Signal Flow through Receiver Back-End

The DSP takes the incoming 20 kHz data stream and passes the information through an FIR (Finite Impulse Response) filter, which provides rejection from any in-band adjacent channel interference. The remaining filtered data is then sent through the FM Discriminator routine. This routine is primarily responsible for base-band information recovery. Depending on whether the radio is in analog or digital mode determines the kind of signal processing used. If the radio is in analog mode, the recovered base-band data is sent through FM De-emphasis and sub-audible tone (CTCSS/ CDCSS) recovery subroutines in the DSP code. If the radio is in digital mode, the recovered base-band information is sent through a Symbol Recovery routine. The resultant data is then routed through a standard AMBE+2™ vocoder for processing.

The output signal from either the analog or digital mode signal processing (still represented by hi-speed data), is sent to a DAC (U3200), which converts the data stream back into usable audio. This stage drives several additional gain stages. These gain stages consist of an I2C audio attenuator (U3501) and a high-power audio PA (U3500) providing the user with at least 3 W of power through an internal speaker and 13 W of audio to an external speaker.

### 3.0 Transmitter Power Amplifier (PA) 35 W (800MHz)/30 W (900MHz)

The Transmitter consists of the Power Amplifier (PA) circuitry and the Power Control circuitry. The Power Amplifier is responsible for delivering a replica of the VCO output amplified up to the desired output power level, free from distortion. The Power Control portion is responsible for ensuring the desired output power level is maintained in both analog and digital modes, as well as protecting the power amplifier from damage due to heat, antenna mismatch, out of range battery voltage, or mis-assembly.

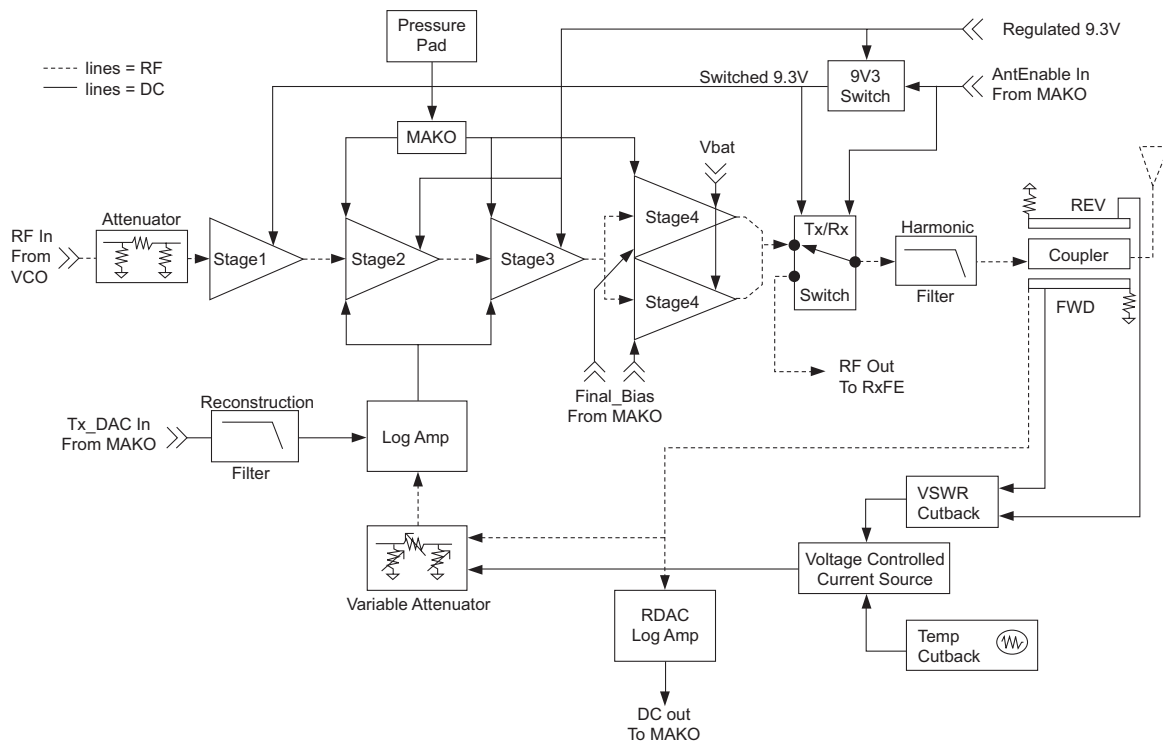


Figure 1-4 800/900 MHz Transmitter Detailed Block Diagram

#### 3.1 Power Amplifier

The radio's power amplifier (PA) is a 4 stage amplifier which amplifies the output of the VCO to the required transmit power level. The first stage consists of a fixed gain block (ADA-4743, U0700), followed by an adjustable gain LDMOS pre-driver (RD01MUS1, Q0705), an adjustable gain LDMOS driver (RD05MMP1, Q0703), and dual fixed gain LDMOS final devices (MRF6E9045, Q0709 & Q0710). A transmit / receive (TR) switch and a harmonic filter complete the transmit lineup.

#### 3.2 Input Stage (50 Ohm Fixed Gain Block)

The first amplifier stage (ADA-4743, U0700) is an integrated circuit with internal 50 ohm input and output impedance matching networks providing approximately 17dB power gain. It serves 2 purposes: 1) it provides reverse isolation between the PA and the VCO to lessen the risk of VCO load pull, and 2) it provides appropriate power to the pre-driver stage. The ADA-4743 is biased at 60mA during transmit by R0706, which is switched to 9V3 during TX by Q0701 (controlled by Antenna\_En). The ADA-4743 is preceded by a 13 dB resistive pad to improve reverse isolation still further.

### 3.3 Pre-Driver Stage

The next amplifier stage is a low power LDMOS device ( RD01MUS1, Q0705) which delivers up to 30dBm power to the driver stage. Its gain is controlled by varying the gate bias voltage, which varies the power gain up to 14dB. The gate bias voltage is controlled with the V\_cont signal and is controlled in parallel with the Driver Stage gain.

The input matching network to this stage is a high pass topology. High pass impedance matching networks are used to minimize the chances of low frequency regeneration within the amplifier. The inter-stage impedance matching network between the pre-driver and driver stages is also arranged in a high pass topology.

### 3.4 Driver Stage

The next amplifier stage is a medium power LDMOS device (RD05MMP1, Q0703) which delivers up to 38.5 dBm to the final devices. Its gain is controlled by varying the gate bias voltage and varies from low gain up to approximately 10 dB power gain. The gate bias voltage is controlled with the V\_cont signal, as well, and is controlled in parallel with the Pre-Driver Stage gain.

Series gate resistors are required to improve the bandwidth of the driver stage. The inter-stage impedance matching network between the driver and final device uses a low pass topology.

### 3.5 Final Stage

The final stage is a pair of high power LDMOS devices (MRF6E9045, Q0709 & Q0710). The packages are mounted to a copper carrier to improve thermal conductivity to the chassis, and allow a common chassis among the other frequency bands.

This stage is biased at a quiescent current of 350 mA per device and operates with a fixed gain of approximately 11dB, allowing up to 46.9 dBm output power (49 W). The quiescent currents are set by adjusting the Final\_Bias signals.

The output match uses a low pass topology and has extremely critical part location requirements. Any repairs must be done with extensive care to ensure the replaced components are placed accurately and properly soldered. Additional footprints are provided on the printed circuit board to allow for possible engineering optimizations to this match. The resistor networks at the input of each of the final elements are required to improve the bandwidth of the circuit.

If the final device is replaced, the bias voltages must be re-tuned using the Customer Programming Software (CPS). Care must be taken not to damage the device by exceeding the maximum allowed quiescent current. The maximum allowable current is 750 mA, but the design is optimized for 350 mA as stated earlier. The device can tolerate up to 5 amps for brief periods of time without damage.

### 3.6 Antenna Switch

The Antenna Switch (T/R switch) has 2 modes, transmit mode and receive mode.

*Transmit mode:* The antenna switch utilizes the switched 9.3 V from Q0713. Both PIN diodes D0700 and D0702 are turned on during key-up by forward biasing them. Forward biasing is achieved by injecting 9.3 V with Q0713 and the current is set with 2 series resistors (R0723 & R0724) and a 0.8 V drop across each diode. Q0713 maintains the current through the antenna switch diodes at 160 mA. Q0713 is enabled during transmit mode by ANT\_ENABLE asserting through Q0714 (an inverter) and associated circuitry. An RF short is formed through PIN diode D0702, providing a path to ground through the parallel pair of cap C0796 and inductor L0714. This path completes the DC bias and provides a quarter-wave open circuit, isolating the RX path. The values of C0796 and L0714 are chosen so that they are in parallel resonance at the center of the transmit band, making them appear as an open circuit so that a 50 ohm power path is maintained thru D0700 to the Harmonic filter and isolating the Tx signal from the Rx front end.

*Receive mode:* The DC current thru the PIN diodes is interrupted by turning off the switch and reverse biasing the PIN diodes. The RF path now flows from the Harmonic Filter thru inductor L0710, capacitor C0791 (to ground) and C0792. C0792 acts as a coupling capacitor, blocking DC from reaching the Rx front end.

### 3.7 Harmonic Filter

Inductors L0706, L0707, L0708 and capacitors C0735, C0736, C0737 and C0795 form a harmonic filter which is a 7<sup>th</sup> order Chebyshev low pass filter, that is used to attenuate harmonic energy from the transmitter before it reaches the antenna. The harmonic filter also prevents high level RF signals above the receiver passband from reaching the receiver circuits, improving spurious response rejection. R0713 and L0722 are used to drain any electrostatic charges that might otherwise build up on the antenna.

### 3.8 Directional Coupler

The dual directional microstrip coupler is implemented at the harmonic filter output to sample both forward and reverse directed transmitter power. RF power from the transmitter PA passes through the microstrip coupler before reaching the antenna. Forward RF power is coupled to the U0940 log detector / controller via the voltage controlled attenuator (VCA) stage. This consists of pin diodes D0901, D0902, and D0903. The log detector / controller also regulates the gain of PA stages Q0703 and Q0705 (via V\_cont) as necessary thus ensuring the forward power out of the radio is held to a constant value.

The directional coupler functions not only as part of the transmitter power regulation circuit but also functions as part of the VSWR load detection circuitry. Its physical location close to the antenna connector allows accurate VSWR sensing at the transmitter output. Forward and reverse coupled signals are rectified by D0904 and D0905 respectively. Resulting DC voltage FWD\_DETECTED is proportional to transmit RF power, while REV\_DETECTED is proportional to reflected RF power. The detected voltages are fed to the respective inputs of difference amplifier U0901. The difference amplifier output is applied to variable attenuator control stage, U0900-1. An abnormally high reflected power level may be caused by a damaged antenna. This would cause an increase in the amplifier output voltage, thereby causing a reduction in attenuation by the VCA. As a result, the controller reduces the gain of PA stages Q0703 and Q0705 to prevent damage to these devices due to an improper load.

### 3.9 Power Control

The transmitter uses a PA controller IC, U0940 to control the power output of the radio. A portion of the forward RF power from the transmitter is sampled by the directional coupler and delivered via the VCA to the RFIN port of the PA controller IC (pin 1). The PA controller, a log detector type, provides temperature stability and high accuracy control over a typical 50 dB dynamic range.

The MAKO contains a digital to analog converter (DAC) which provides a reference voltage (TX\_DAC) at the input of reconstruction filter stage U0900-2. The filtered reference voltage at the output of U0900-2 is divided by the combination of R0942 and R0946 before reaching the VSET input of the PA controller IC (pin 3). Thermistor RT0953 is used in combination with R0954 to compensate reference voltage drift at operating temperature extremes. This reference voltage level is programmable through the SPI lines of the MAKO. It is also proportional to the desired power setting of the transmitter, and is factory programmed at several points across the frequency range of the transmitter to offset frequency response variations in the transmitter's coupled power circuits.

The PA controller IC provides a dc output voltage which is to provide gate bias for PA pre-driver and driver stages. The 0 to 5 Vdc range at U0940, pin 7, is applied as V\_CONTROL to power-adjust the transmitter output power by controlling the gate bias of stages Q0703 and Q0705. Voltage divider combination R0727 and R0728 provides gate bias to Q0703 while divider combination R0750 and R0751 provides gate bias to Q0705. The ratios of each of these resistor dividers are chosen to ensure Q0703 and Q0705 are each running at its nominal design condition at rated output power. Variations in sampled forward transmitter power cause the PA controller IC to adjust the control voltage above or below its nominal value. This will raise or lower output power in order to maintain an output power level relative to the reference voltage applied to VSET.

### 3.10 Power Ramp Profile Control

In order to limit transient adjacent channel power at the transmitter's output, the ramped power should follow a raised cosine profile. The PA controller IC has a linear slope function when scaled in dB/V. To achieve the desired raised cosine profile of the output power, the ramped reference voltage provided by the MAKO DAC follows a raised cosine approximation. The MAKO DAC reference output is low pass filtered by the DAC reconstruction filter before it is applied to the VSET input of the PA controller IC.

Reconstruction filtering reduces spurious emissions in the RF spectrum as a result of the finite steps of the DAC. Loop filter capacitor C0926 in conjunction with resistor R0950 and the integrator within the PA controller IC, control the loop dynamics. Loop dynamics have been optimized to achieve sufficient speed to follow the required ramping profiles while meeting switching transient requirements over varied power levels. Accurate control of the power-rise (ramp-up) and power-decay (ramp-down) characteristics minimizes splatter into adjacent channels.

### 3.11 Thermal Protection

Thermistor RT0908 in combination with R0902 forms a voltage divider with output proportional to the sensed circuit board temperature in the vicinity of the transmitter driver and final devices. The voltage divider output is routed to an operational amplifier U0901-2 which provides a dc voltage via diode junction D0900 to control attenuation level of the VCA stage. If the case temperature threshold set by resistive divider combination R0901 and R0909 is reached, the VCA is driven to increase RFIN signal at PA controller IC (pin 1). This increase will cause the PA controller IC to adjust the PA control voltage below its nominal value to decrease transmitter output power. Temperature will be reduced by lowering transmitter output power relative to the reference voltage applied to VSET.

### 3.12 Out-of-Range Battery Protection

Transmitter power cutback under extended battery supply voltage operation is provided for by monitoring battery supply in the controller circuit of the radio in order to change VSET input of the PA controller IC (pin 3) for reduced transmitter output. This cutback starts when the battery voltage at the connector reaches 15.3 V and above. This results in a 2 dB drop in output power. There is also a low battery detect circuit that is implemented in hardware. This hardware cutback gives a 1.2 dB drop in RF power level when the battery voltage drops below 11.6 V and has about 0.6 V of hysteresis before it will return to normal power.

### 3.13 Pressure Pad Switch

The power control circuitry includes a safety switch (S0700) that consists of a conductive portion of the rubber pad which pushes the RF final transistors Q0709 and Q0710 firmly against the chassis, improving the heat-sink to the devices. When the chassis cover and rubber pad are properly assembled, the conductive portion of the pad contacts a pattern on the circuit board, electrically closing switch S0700. If the cover and pad are not in place, switch S0700 is open-circuited and the power control circuit is disabled via software in which turning off the gate bias to Q0709, Q0710, Q0703, and Q0705. This mechanism is to prevent thermal damage of the RF transistors which might occur if the transmitter is operated without adequate heat-sinking.



## 4.0 Frequency Generation Circuitry

The synthesizer subsystem consists of the reference oscillator (Y0100), the fractional-N synthesizer IC (U0100), and the Voltage Controlled Oscillator (VCO).

### 4.1 Reference Oscillator

The reference oscillator (Y0100) contains a voltage-controlled temperature compensated crystal oscillator (VC-TCXO) with a frequency of 16.8 MHz. A digital-to-analog (DAC) converter internal to U0100 and controlled by the mP via serial interface (SPI), sets the voltage at the AUX\_DAC output of U0100 (pin K6) to set the frequency of the oscillator. The output of the oscillator (pin 3 of Y0100) is applied to pin K5 (REF\_IN) of U0100.

### 4.2 Fractional-N Synthesizer

The fractional-N synthesizer IC (U0100) consists of a pre-scaler, a programmable divider with control logic, phase detector, charge pump, a D/A converter in the high frequency analog modulation path, an attenuator to balance the high and low frequency modulation paths, a serial interface for control (SPI), a serial interface for modulation (SSI), and a super filter for the regulated 8.4 Volts.

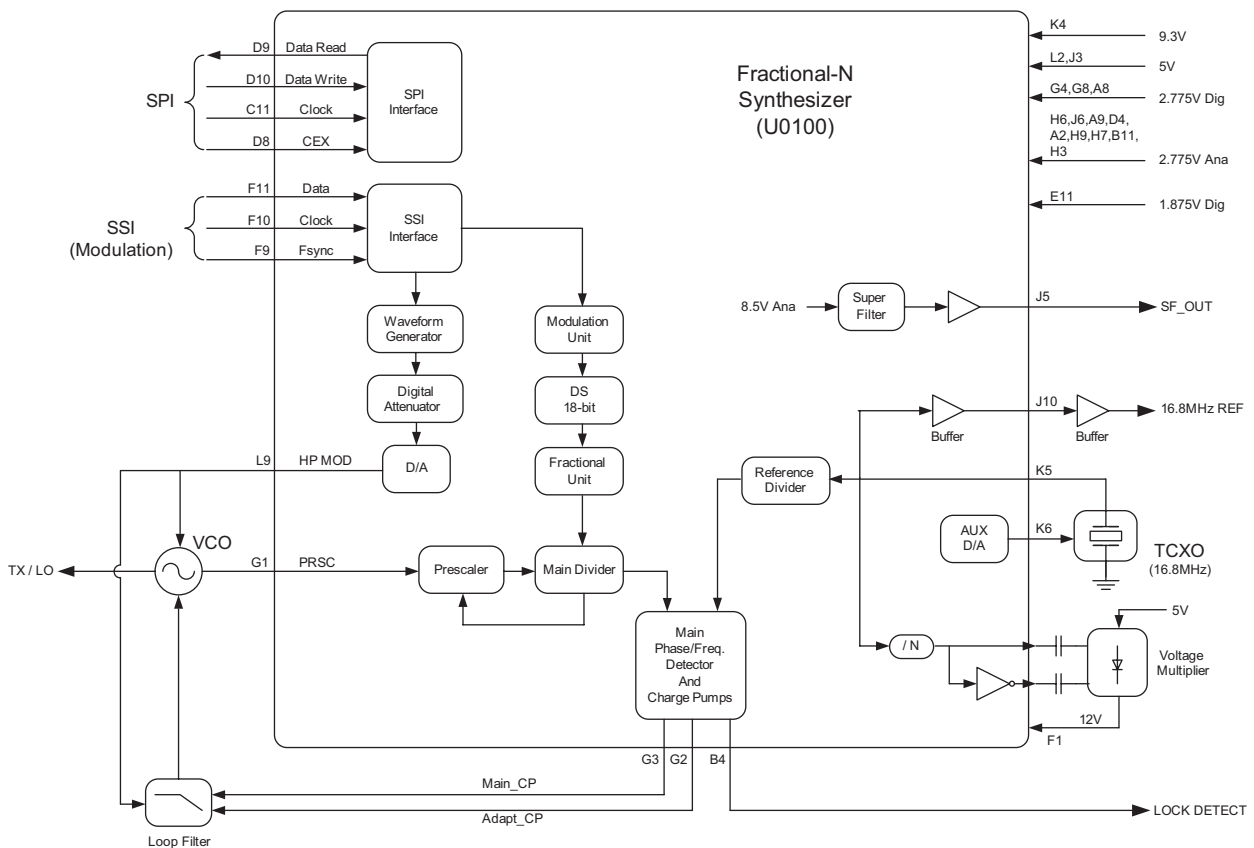


Figure 1-5 800/900 MHz Synthesizer Block Diagram

A voltage of 9.3 Volts applied to the super filter input (U0100 pin K4) supplies an output voltage of 8.4 Vdc (SF\_OUT) at pin J5. This supplies the VCO and the VCO modulation bias circuit (via R0321). The super filter supply voltage is provided by the 9.3 Volt regulator, U3001. The synthesizer is also supplied by the 5 Volt regulator (U3002) as well as two 2.775 Volt regulators and a 1.875 Volt regulator within U3200.

The output signal LOCK (U0100-B4) provides information about the lock status of the synthesizer loop. A high level (1.8V) at this output indicates a stable loop. A discrete buffer amplifier (Q0100) provides a buffered 16.8 MHz reference frequency to other parts of the radio.

The serial programming interface (SPI) is connected to the mP via the data lines SPI\_DW (U0100-D10) and SPI\_DR (U0100-D9), clock line SPI\_CLK (U0100-C11), and chip enable line CEX (U0100-D8). The serial modulation interface (SSI) is connected to the DSP via the data line SDTX (U0100-F11), clock line TXCLK (U0100-F10), and frame sync line SFTX (U0100-F9).

### 4.3 Voltage Controlled Oscillator (VCO)

The Voltage Controlled Oscillator (VCO) subsystem consists of two Colpitts oscillators (one for 800MHz and one for 900MHz band), a two-stage buffer amplifier with RF switch to route between TX injection or RX LO injection paths, oscillator bias control switches, and the modulation circuitry.

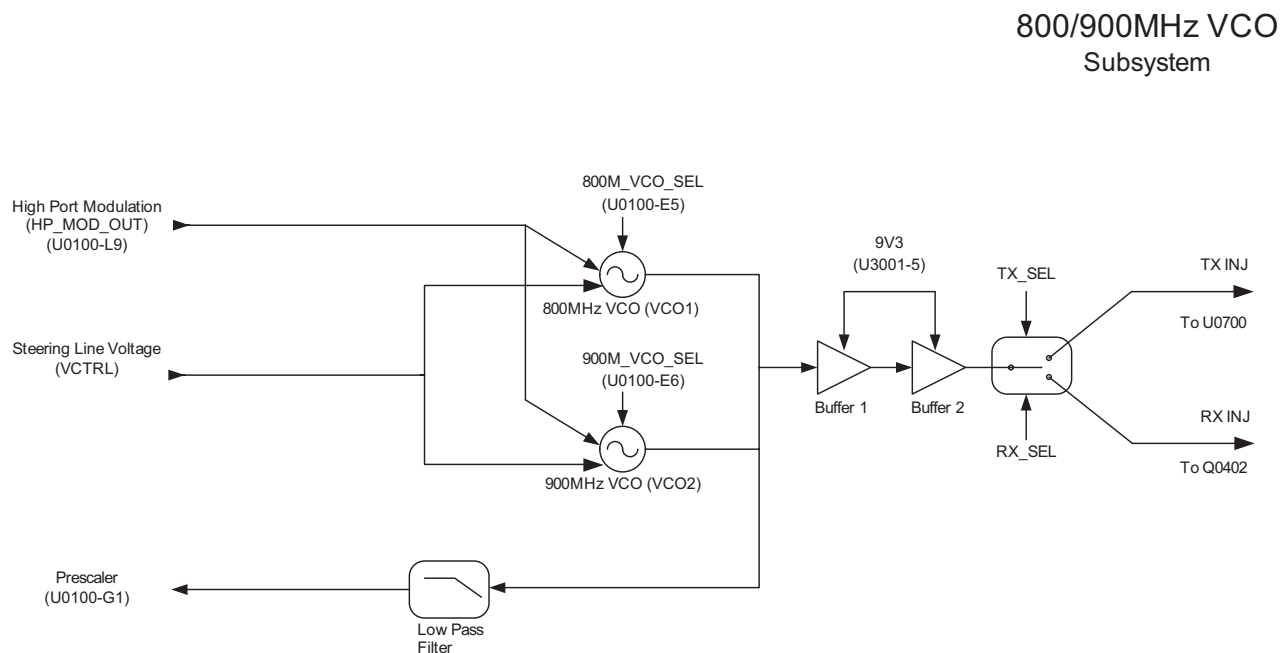


Figure 1-6 800/900 MHz VCO Block Diagram

Each varactor-tuned oscillator has a tuning range of 64MHz, sufficient to cover the RX and TX frequency ranges for both 800MHz and 900MHz bands. VCO1 (800MHz VCO) is designed to cover 806MHz to 870MHz, which is used for 800MHz TX frequencies and for 900MHz RX LO injection (low side injection). VCO2 (900MHz VCO) is designed to cover 879.35MHz to 943.35MHz, which is used for 900MHz TX frequencies and for 800MHz RX LO injection (high side injection). Two general purpose output lines (GPO1 and GPO3) from the Fractional-N Synthesizer IC (U0100-E5, E6) provide the control for independent bias selection for each oscillator (VCO1/VCO2\_SEL) via digital transistors Q0291 and Q0292. A third general purpose output line (GPO4, U0100-C5) provides selection control for the RF switch (RX/TX\_SEL) via digital transistors Q0111 and Q0106.

The 8.4 Volt super filtered output, SF\_OUT, of the Fractional-N synthesizer IC (U0100-J5) supplies the bias to the oscillators. A portion of the VCO output signal is lightly coupled through coupling capacitor C0281, routed through a low-pass filter (formed by L0281, C0282, L0283, and C0284), and fed back to the M\_PRSC input of the Fractional-N synthesizer IC (U0100-G1).

High-port modulation is scaled through a voltage divider (comprised of R0206, R0207, R0208, R0256, R0257, and R0258) and applied to the Tx modulation varactor diodes CR0205 and CR0255. The TX VCO frequency is modulated via coupling capacitors C0204 and C0254. High-port modulation is also applied to the VCO steering line (through R0139, R0140, and C0166) which modulates the main VCO tuning varactors.

The outputs of the VCOs are amplified and buffered by a 2-stage cascade design. The use of two stages for the buffer ensures the VCOs will be adequately isolated from load pull effects. Each stage uses the PBR941 configured as a common emitter amplifier. A SPDT RF (T/R) switch (Skyworks AS179-92) routes the output of the buffer to the RX or TX block.

## 4.4 Synthesizer Operation

The complete synthesizer subsystem is comprised mainly of the Fractional-N synthesizer IC, Reference Oscillator (crystal oscillator with temperature compensation), loop filter circuitry, VCO, DC supplies, and a capacitive voltage multiplier circuit. The VCO feedback signal, PRSC, is fed to pin G1 of U0100 (M\_PRSC) via a low-pass filter (L0281, C0282, L0283 and C0284) which attenuates harmonics and provides the correct level to close the phase-locked loop.

The prescaler in the synthesizer IC (U0100) is a four-level prescaler capable of dividing by 4, 5, 6, and 7. The main loop N divider is configured to be an 8-bit divider. The divide-by-N portion of the main loop is set via the SPI. The fractional portion of the divider is realized using a 3-accumulator, 24-bit fractional divider. The SPI is used to set the desired divide ratio.

The output of the prescaler is applied to the main loop divider. The output of the main divider is sent to the phase/frequency detector, which compares the main divider's output signal with the reference signal. The reference signal is generated by dividing down the signal of the reference oscillator (Y0100). This output signal of the phase/frequency detector is a pulsed signal which is then routed to the charge pumps. A capacitive voltage multiplier (formed by diode arrays D0100 and D0101, load capacitors C0186 and C0187, and supporting circuitry) generates 12V to supply the charge pumps. The main charge pump current is programmable through the SPI with its output at pin G3 of U0100 (MN\_CP). The loop filter transforms this current into a steering voltage that is then applied to the VCO.

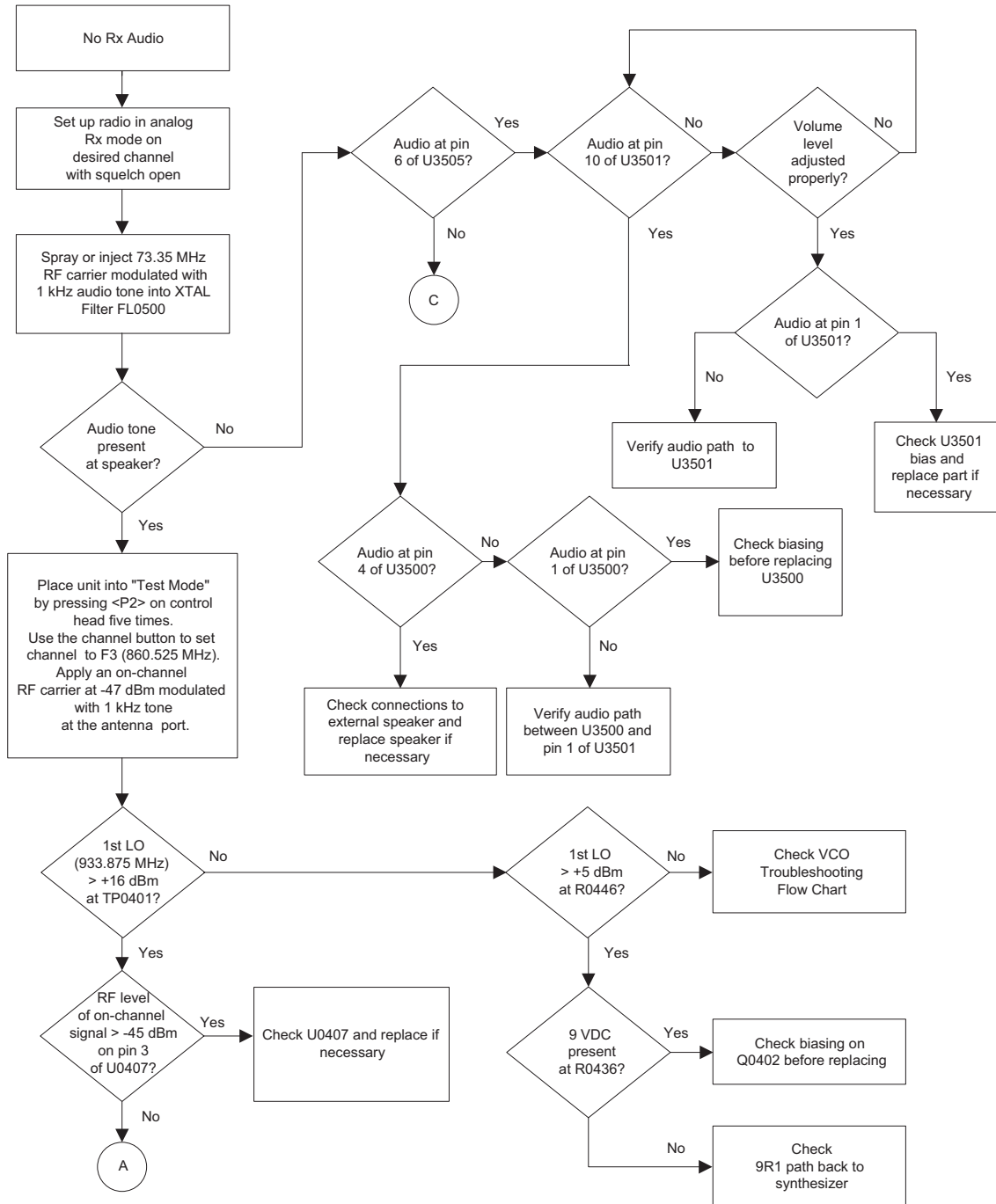
To reduce lock time when new frequency data has been loaded into the synthesizer, an adapt charge pump providing much greater current than the main charge pump is turned on for a finite amount of time to quickly charge or discharge the loop filter capacitors to steer the VCO to the desired frequency. The output of the adapt charge pump passes to the loop filter via pin G2 of U0100 (MN\_ADAPT\_CP). When the synthesizer is within the lock range and the adapt timer runs out, the adapt charge pump is powered down and the main charge pump takes over. A settled synthesizer loop is indicated by a high level at signal LOCK (U0100-B4), which is routed to the  $\mu$ P.

Modulation is performed by applying a digital data stream via the SSI bus from the DSP (U1000) to the synthesizer (U0100). In order to meet spurious and phase noise requirements, the PLL bandwidth was designed to be narrower than the full modulation bandwidth, therefore requiring the use of dual-port modulation. Internal to the synthesizer (U0100), low-port modulation is added to the fractional-N division numerator to trace out the modulation versus time while the high-port data stream passes through an interpolating waveform generator, a digital attenuator (for modulation balancing), and then gets converted to an analog signal through an 11-bit DAC before modulating the VCO. This high-port analog modulation output (HP\_MOD\_OUT, U0100-L9) is connected to the VCO modulation varactor diodes (CR0205 and CR0255) via C0219, R0206 and R0256, and to the loop filter via R0139, R0140, and C0166.

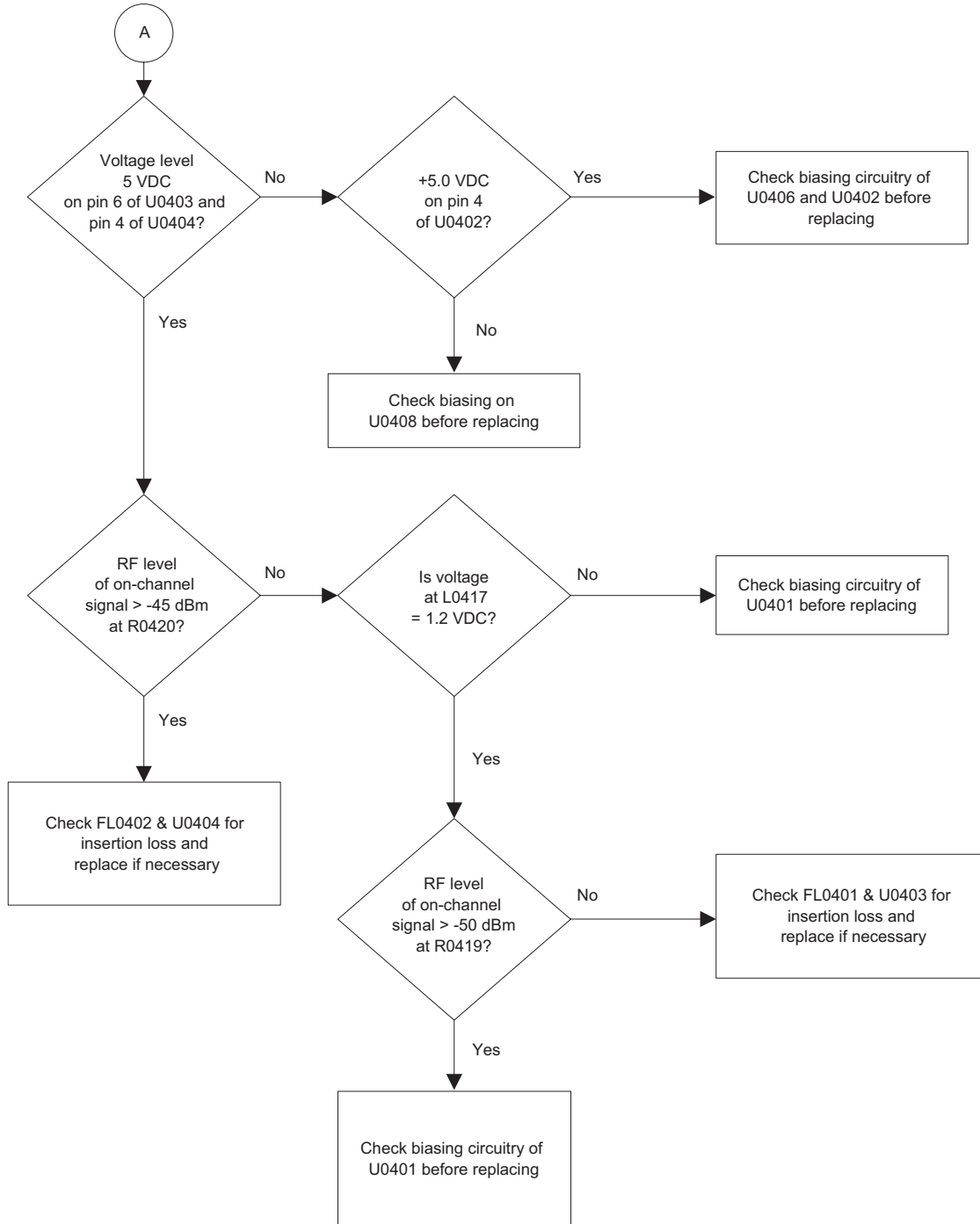
# Section 2

## TROUBLESHOOTING CHARTS

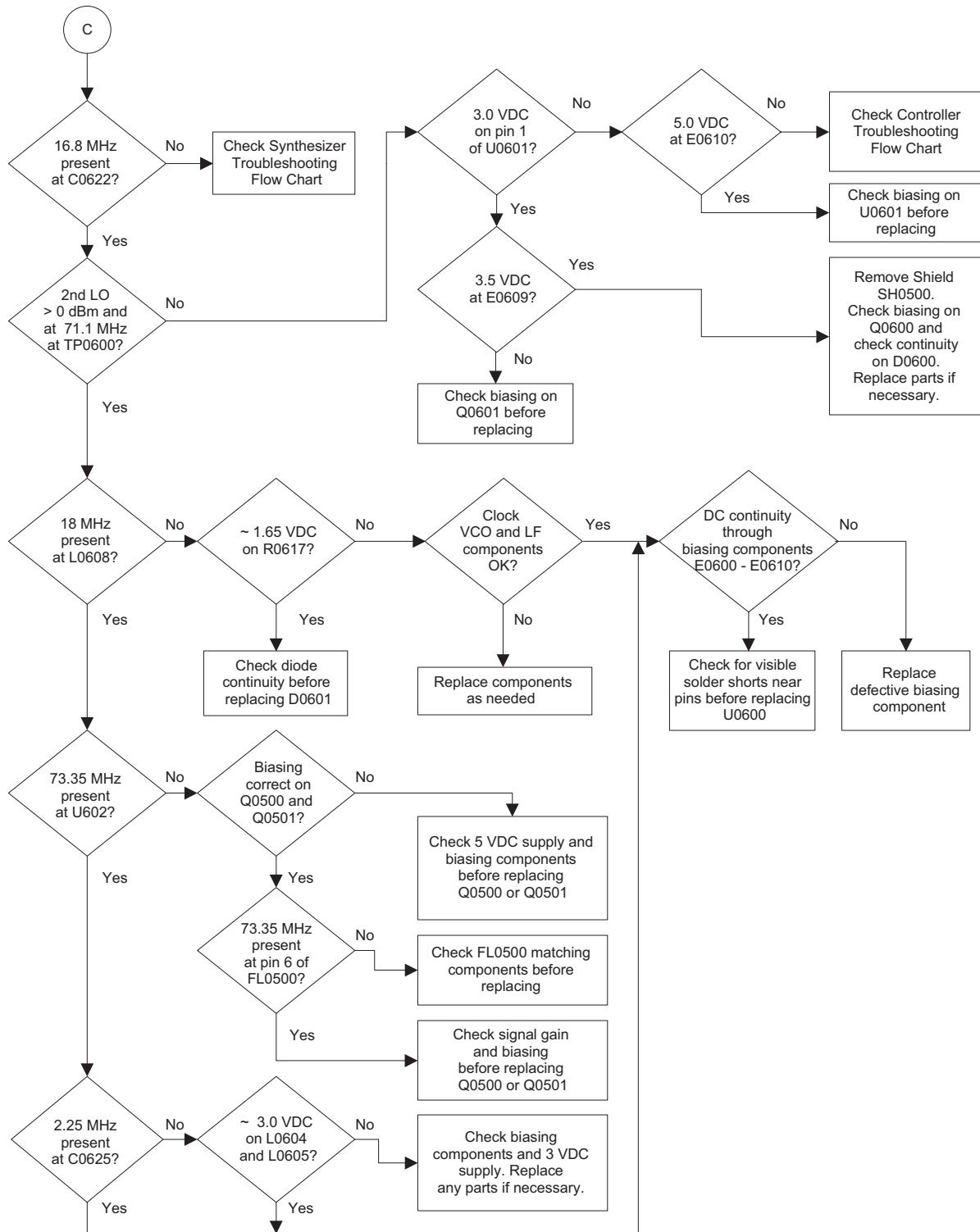
### 1.0 Troubleshooting Flow Chart for 800 MHz Receiver (Sheet 1 of 3)



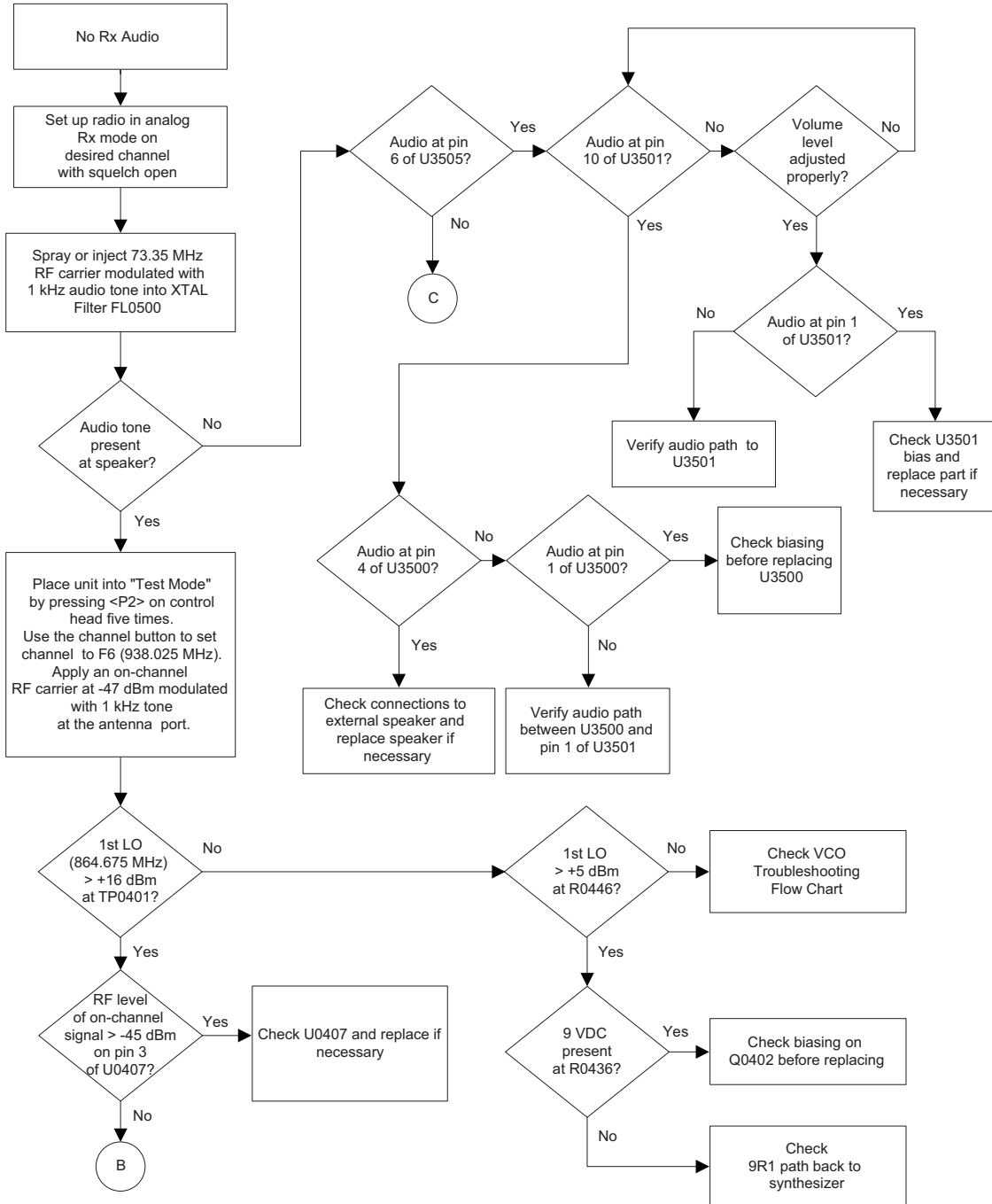
# 1.1 Troubleshooting Flow Chart for 800 MHz Receiver (Sheet 2 of 3)



### 1.2 Troubleshooting Flow Chart for 800 MHz Receiver (Sheet 3 of 3)

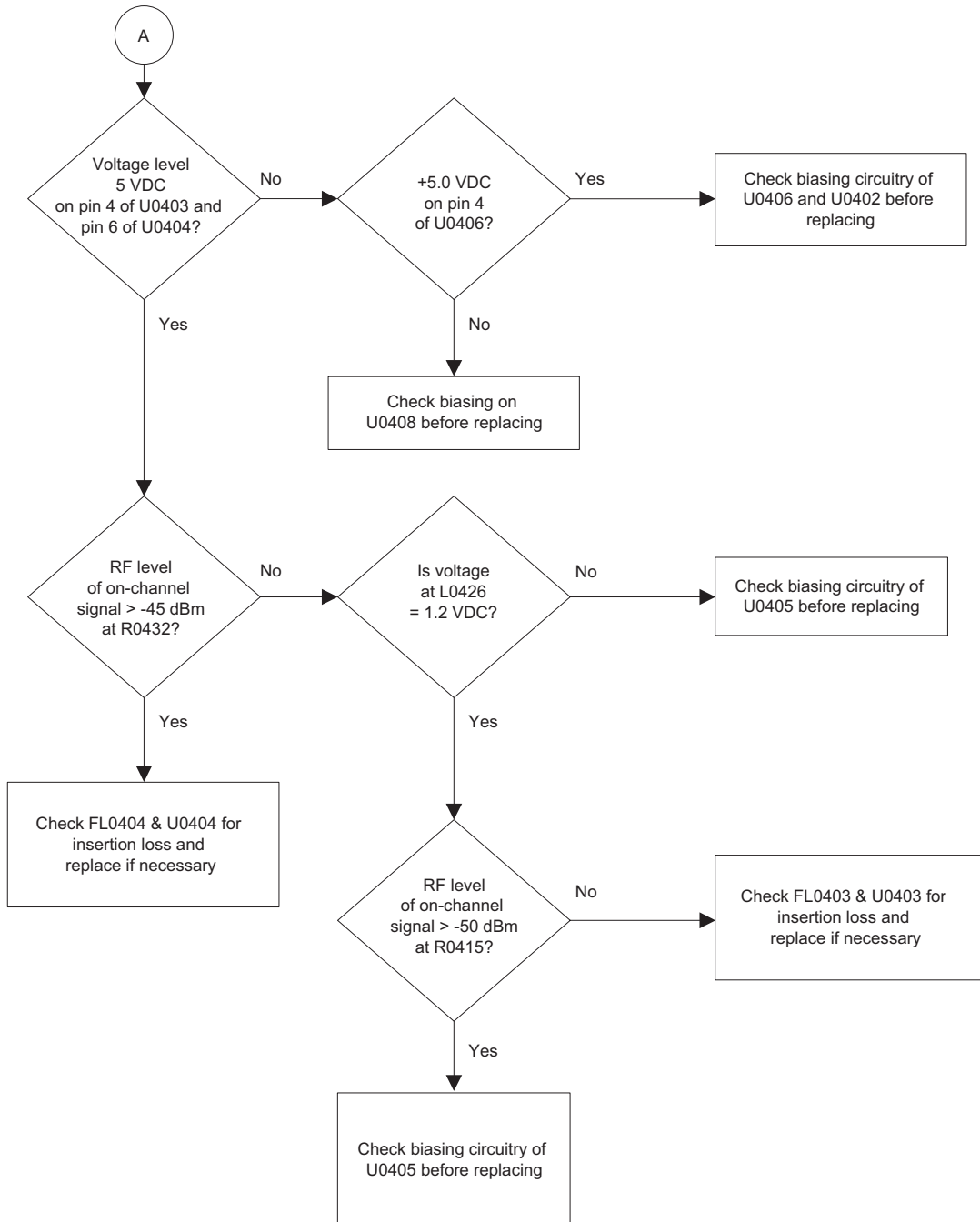


## 2.0 Troubleshooting Flow Chart for 900 MHz Receiver (Sheet 1 of 3)

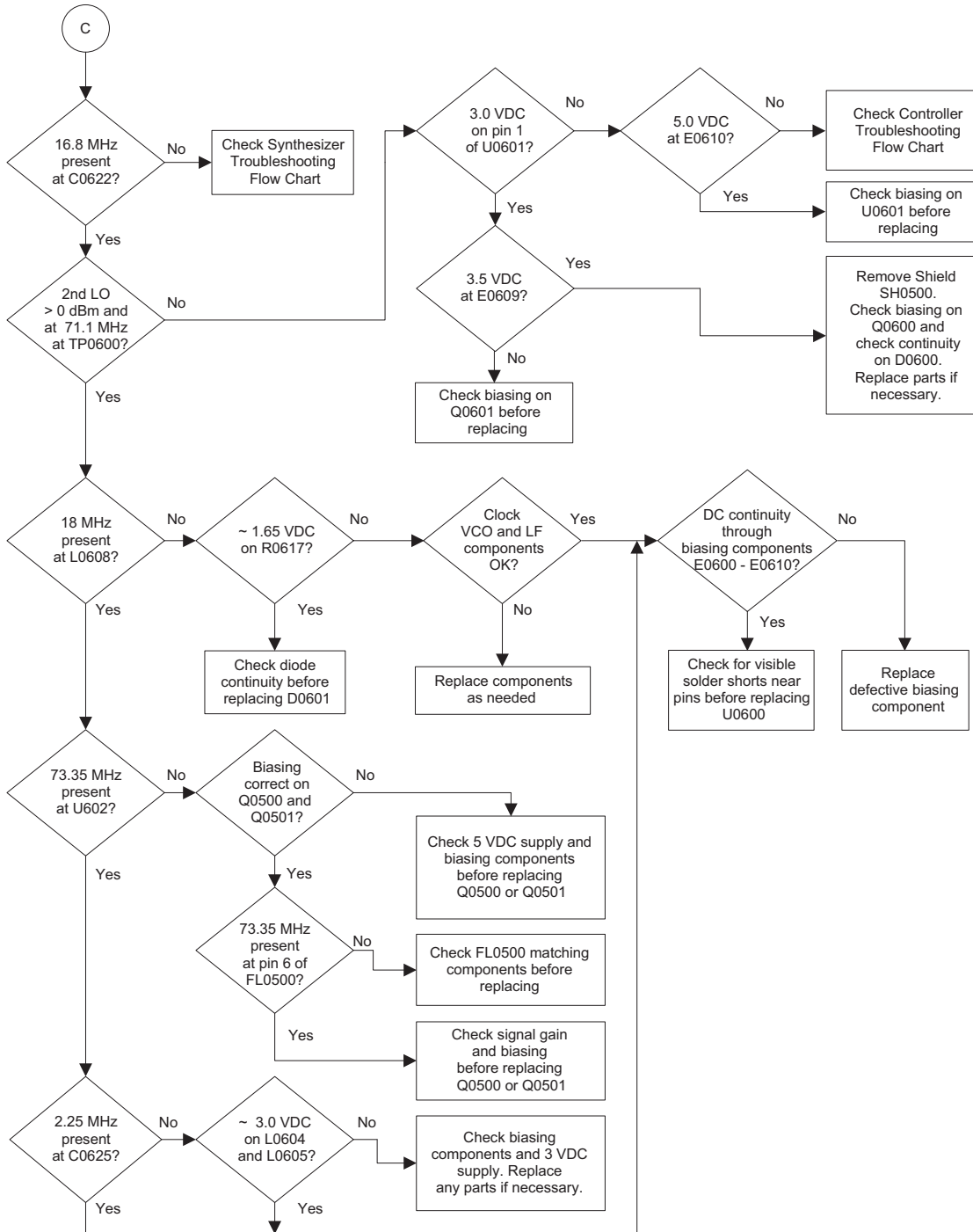




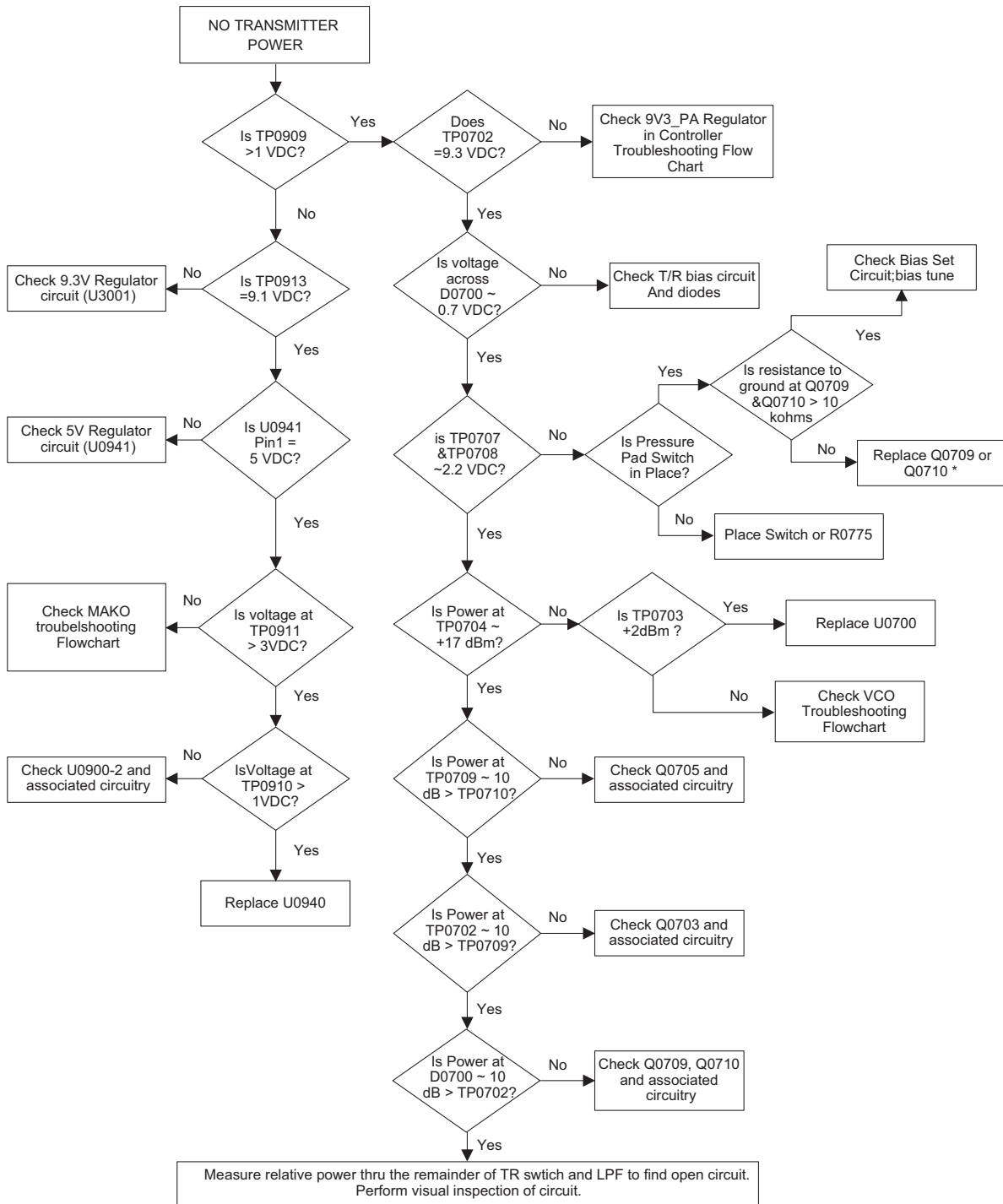
## 2.1 Troubleshooting Flow Chart for 900 MHz Receiver (Sheet 2 of 3)



## 2.2 Troubleshooting Flow Chart for 900 MHz Receiver (Sheet 3 of 3)



### 3.0 Troubleshooting Flow Chart for 800/900 MHz Transmitter



\* Note: If Q0709 or Q0710 are replaced, radio must be bias set and power set.

1) Levels are during Transmit Mode (analog), 13.6V at battery connector, 50 ohm termination on transmitter.

2) Make sure PCB is screwed into chassis during these tests to avoid damage to final device

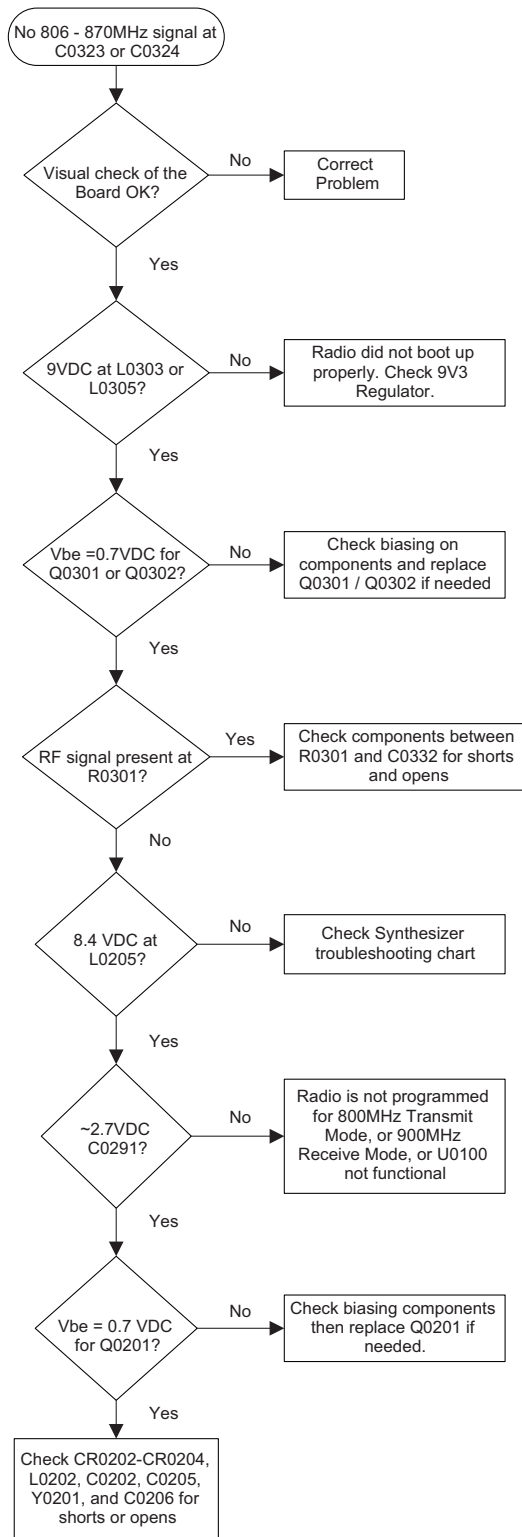
3) When making measurements within the transmitter using an RF power probe, be careful that the rating of the probe is not exceeded.

The "relative" measurements listed in the flow chart should be made with a scope probe connected to a spectrum analyzer or similar instrument to avoid damaging sensitive power probes.

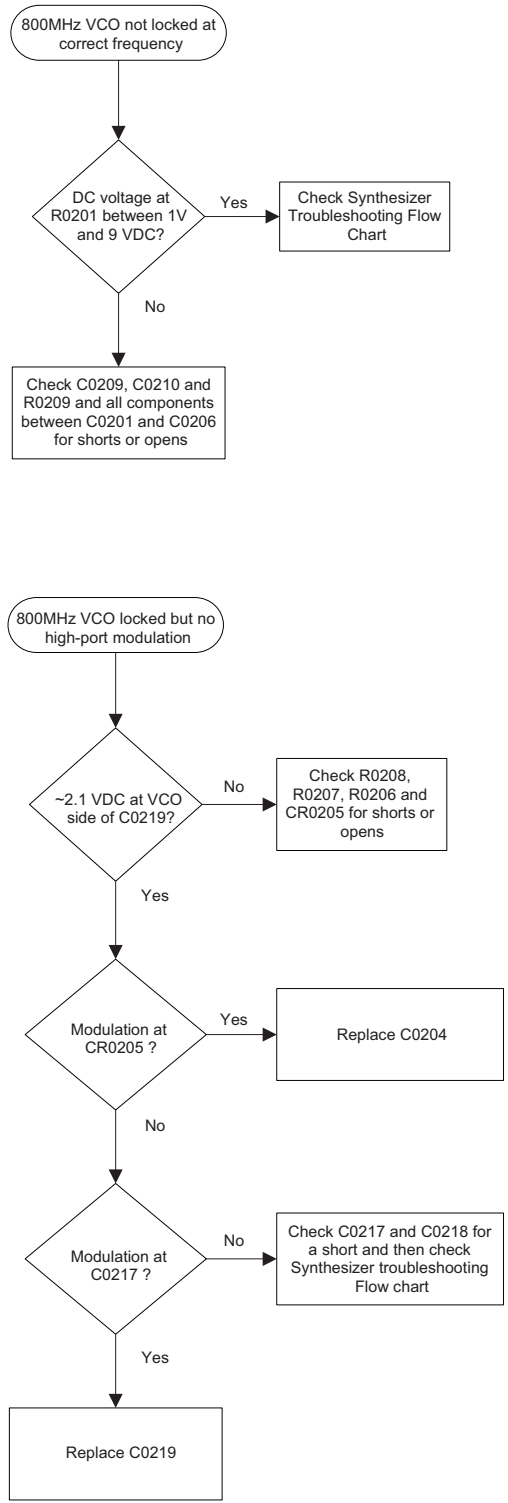
### 4.0 Troubleshooting Flow Chart for Synthesizer



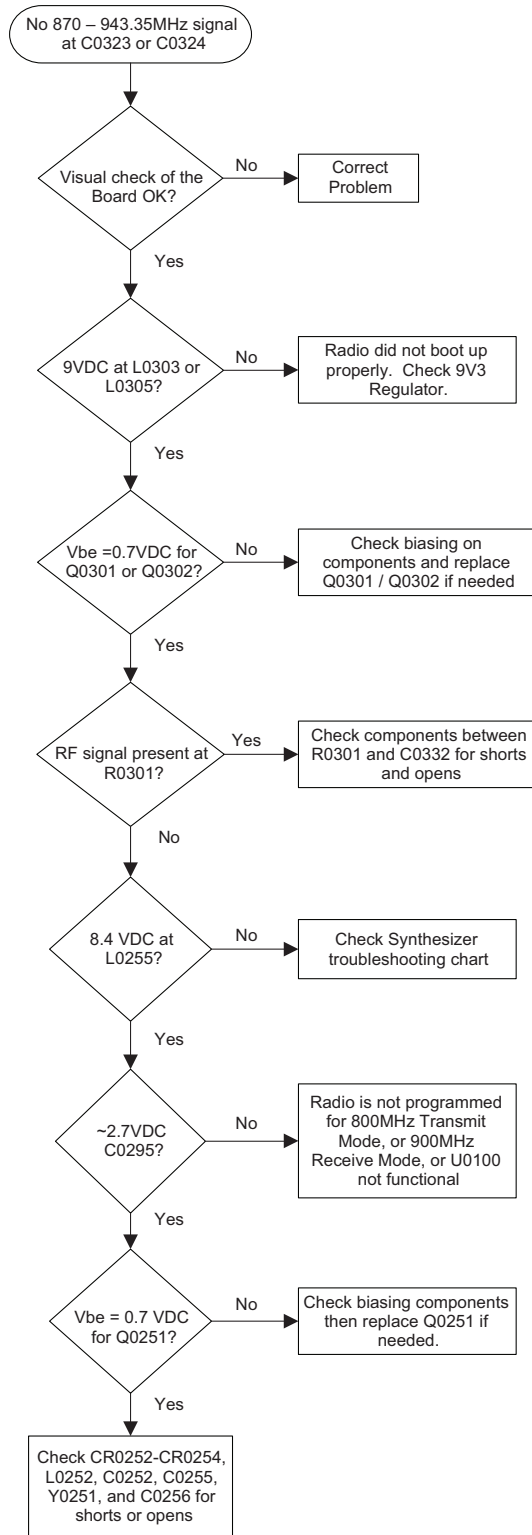
## 5.0 Troubleshooting Flow Chart for 800 MHz VCO (Sheet 1 of 2)



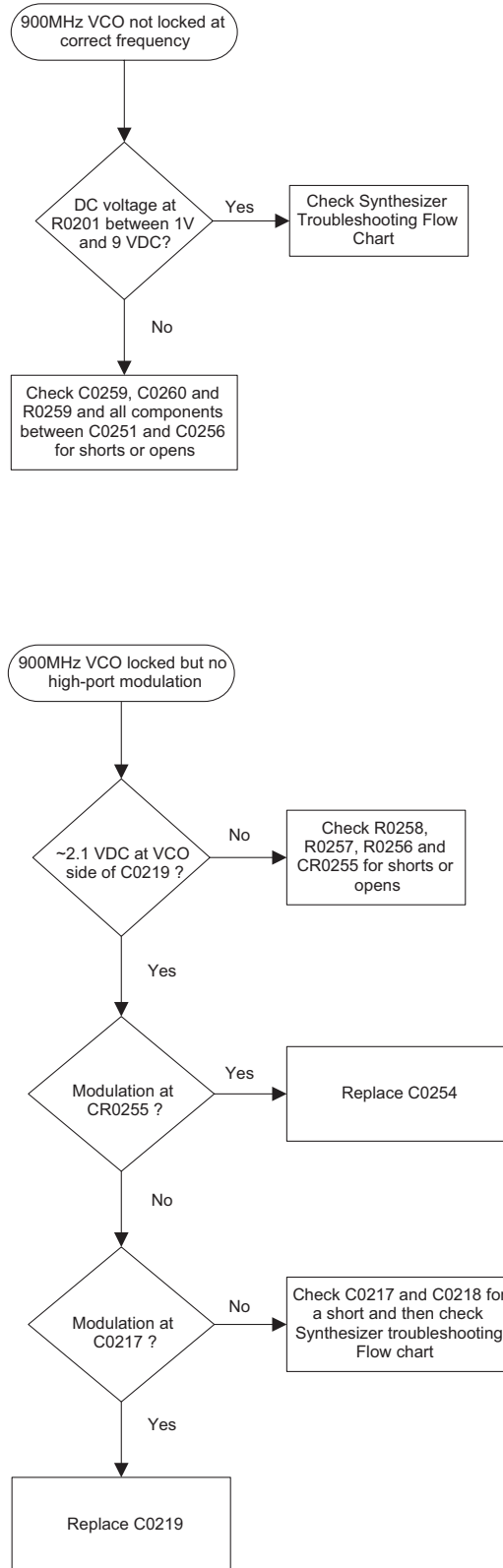
### 5.1 Troubleshooting Flow Chart for 800 MHz VCO (Sheet 2 of 2)



## 6.0 Troubleshooting Flow Chart for 900 MHz VCO (Sheet 1 of 2)



### 6.1 Troubleshooting Flow Chart for 900 MHz VCO (Sheet 2 of 2)





## Section 3

# 800/900 MHz PCB/SCHEMATICS/PARTS LIST

### 1.0 Allocation of Schematics and Circuit Boards

#### 1.1 Controller Circuits

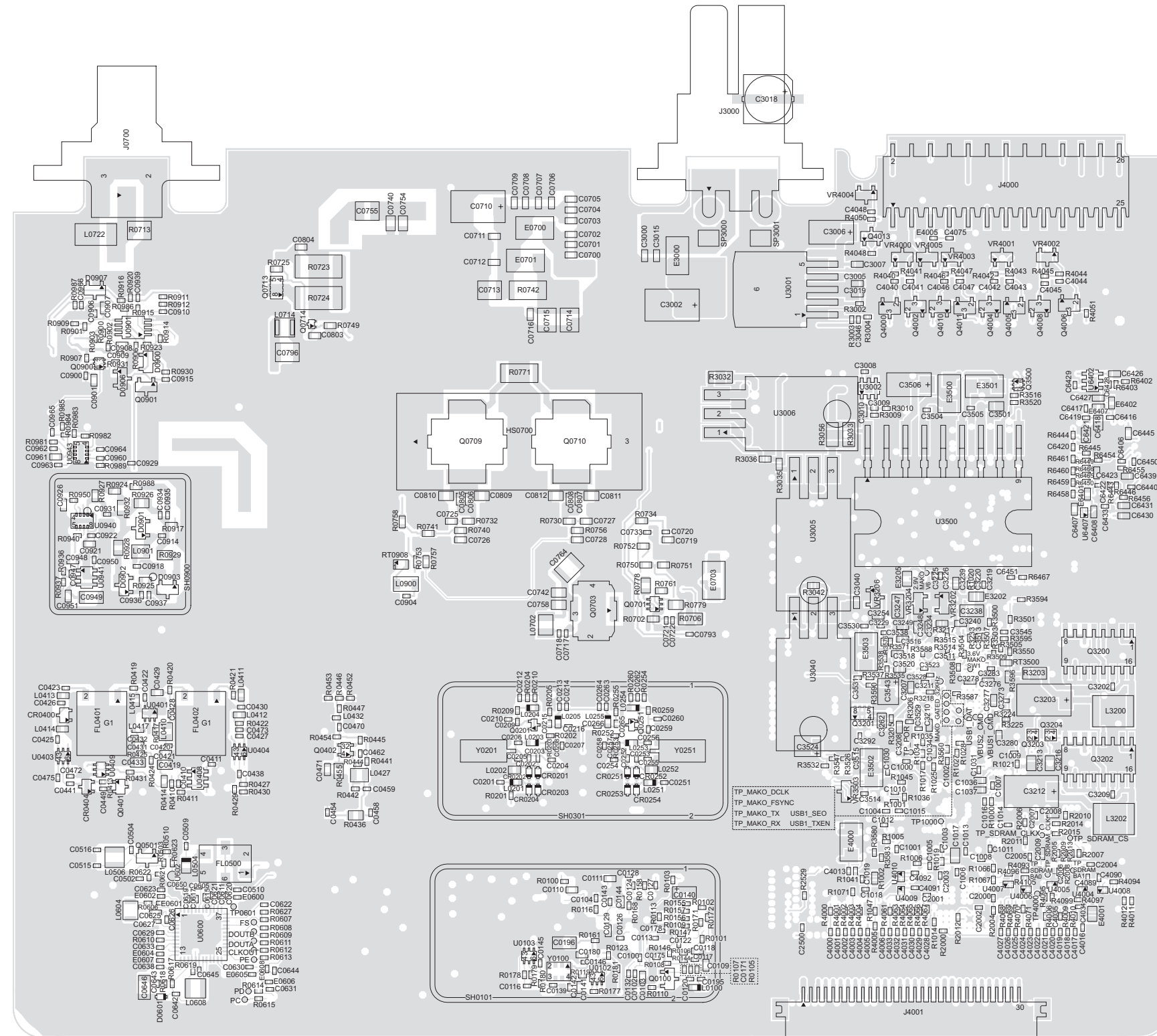
The 800/900 MHz circuits are contained on the Printed Circuit Board (PCB) which also contains the Controller circuits. This Chapter shows the schematics for the 800/900 MHz circuits only, refer to the Controller section for details of the related Controller circuits. The PCB component layouts and the Parts Lists in this Chapter show both the Controller and 800/900 MHz circuit components. The 800/900 MHz schematics and the related PCB and parts list are shown in the table below.

*Table 3-1 800/900 MHz 10-35W Diagrams and Parts List*

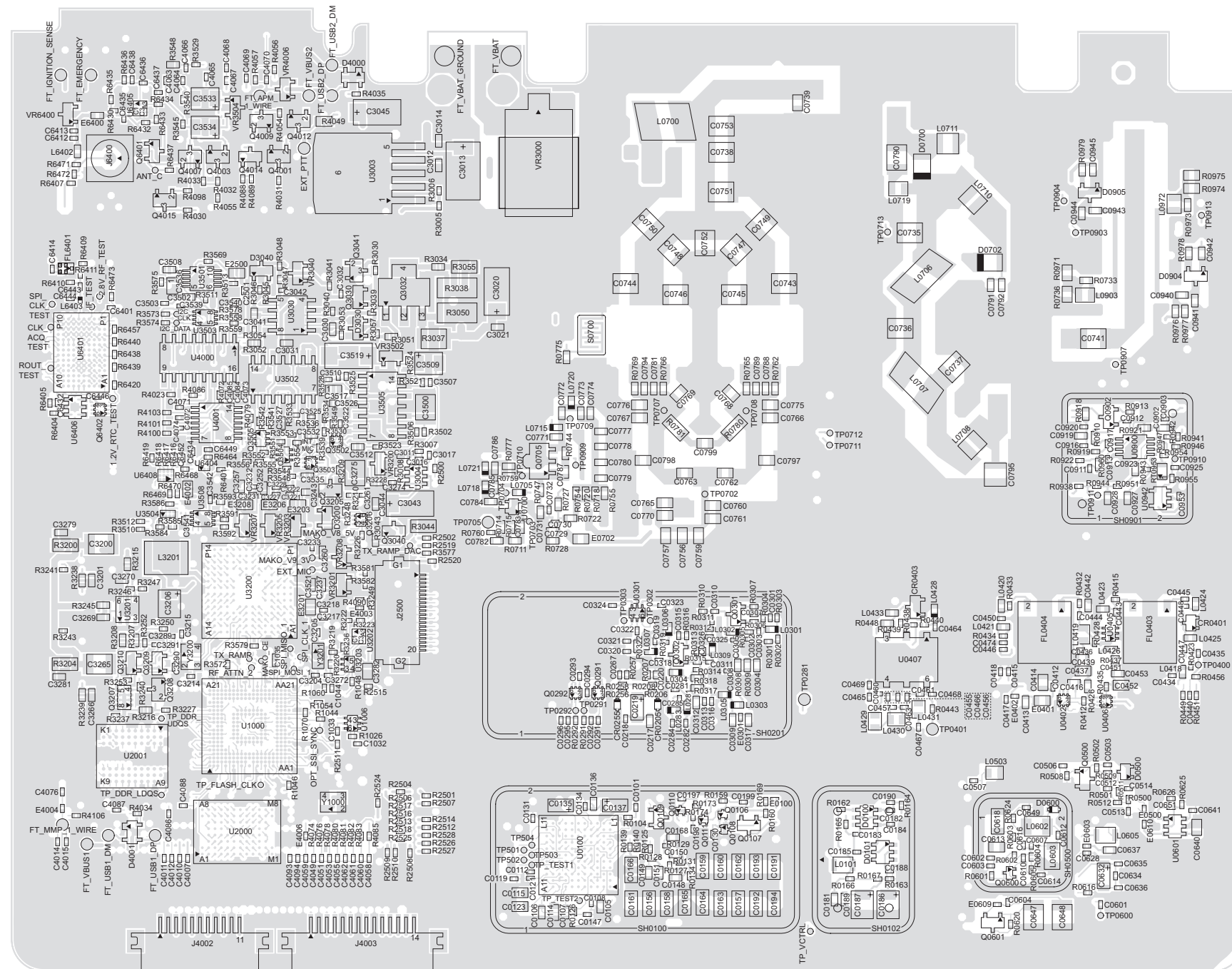
<b>PCB :</b> 8475265H01 Main Board Top Side 8475265H01 Main Board Bottom Side	Page 3-3 Page 3-4
<b>SCHEMATICS</b> Overall Receiver Front- End Receiver IF Amp Receiver Back-End Power Amplifier Power Control Synthesizer Receiver VCO Transmit VCO	<b>Page 3-5</b> <b>Page 3-6</b> <b>Page 3-7</b> <b>Page 3-8</b> <b>Page 3-9</b> <b>Page 3-10</b> <b>Page 3-11</b> <b>Page 3-12</b> <b>Page 3-13</b>
<b>Parts List</b> 8475265H01	<b>Page 3-14</b>

## Notes

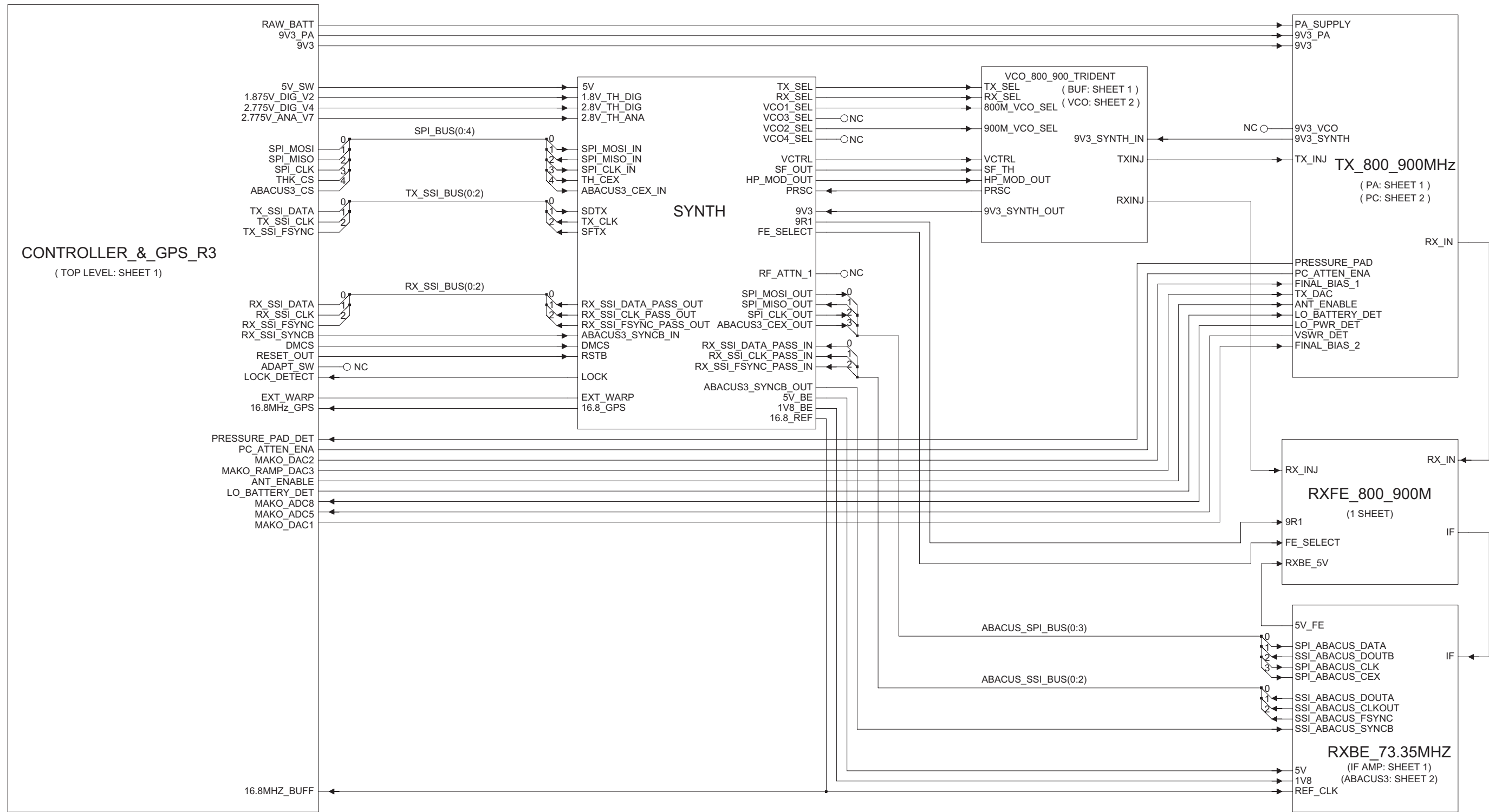
## 2.0 800/900 MHz (806–941 MHz) 10–35W PCB/Schematics/Parts List



800/900 MHz (806–941 MHz) 10–35W 8475265H01 Top Side

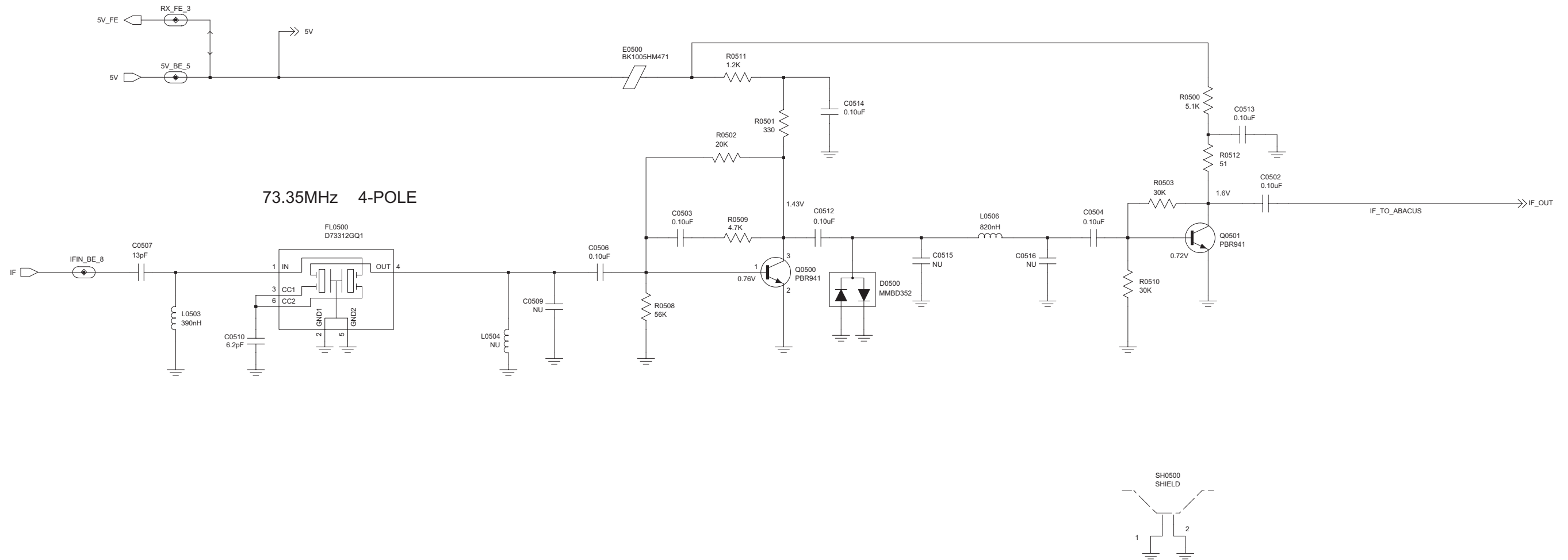


800/900 MHz (806–941 MHz) 10–35W 8475265H01 Bottom Side

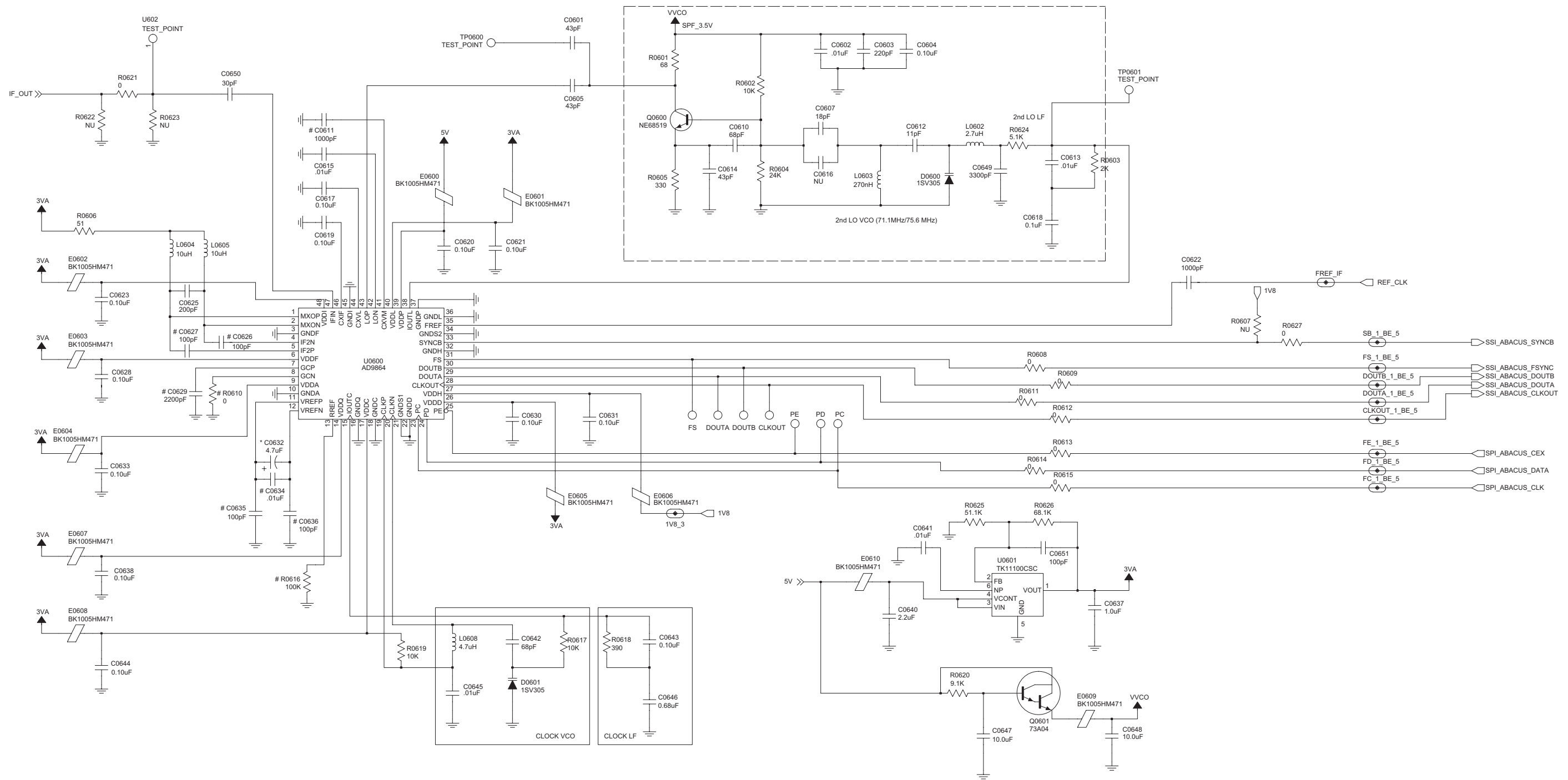


800/900 MHz (806–941 MHz) 10–35W Overall Schematic Diagram



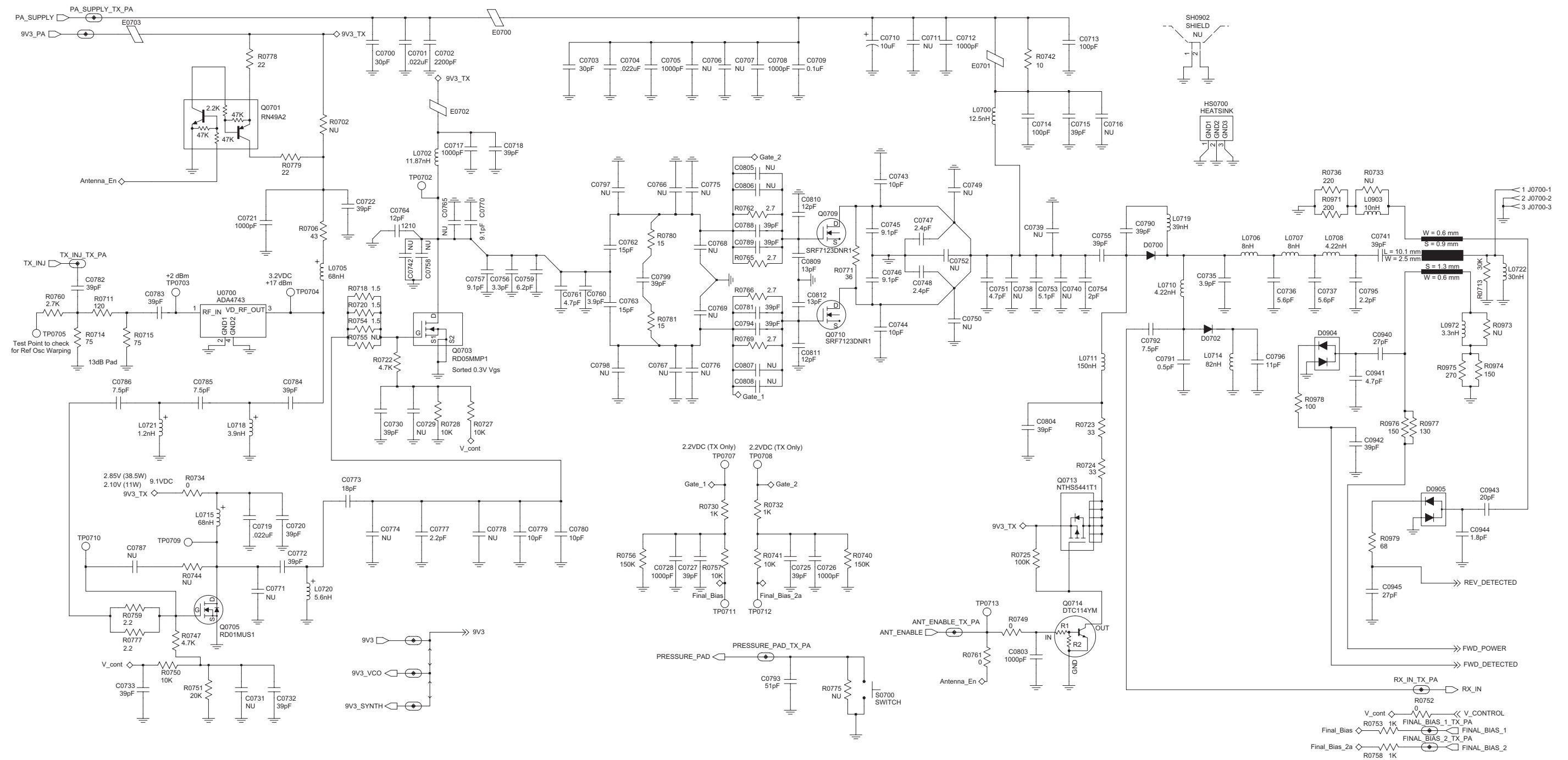


800/900 MHz (806–941 MHz) 10–35W Receiver IF Amp Schematic Diagram



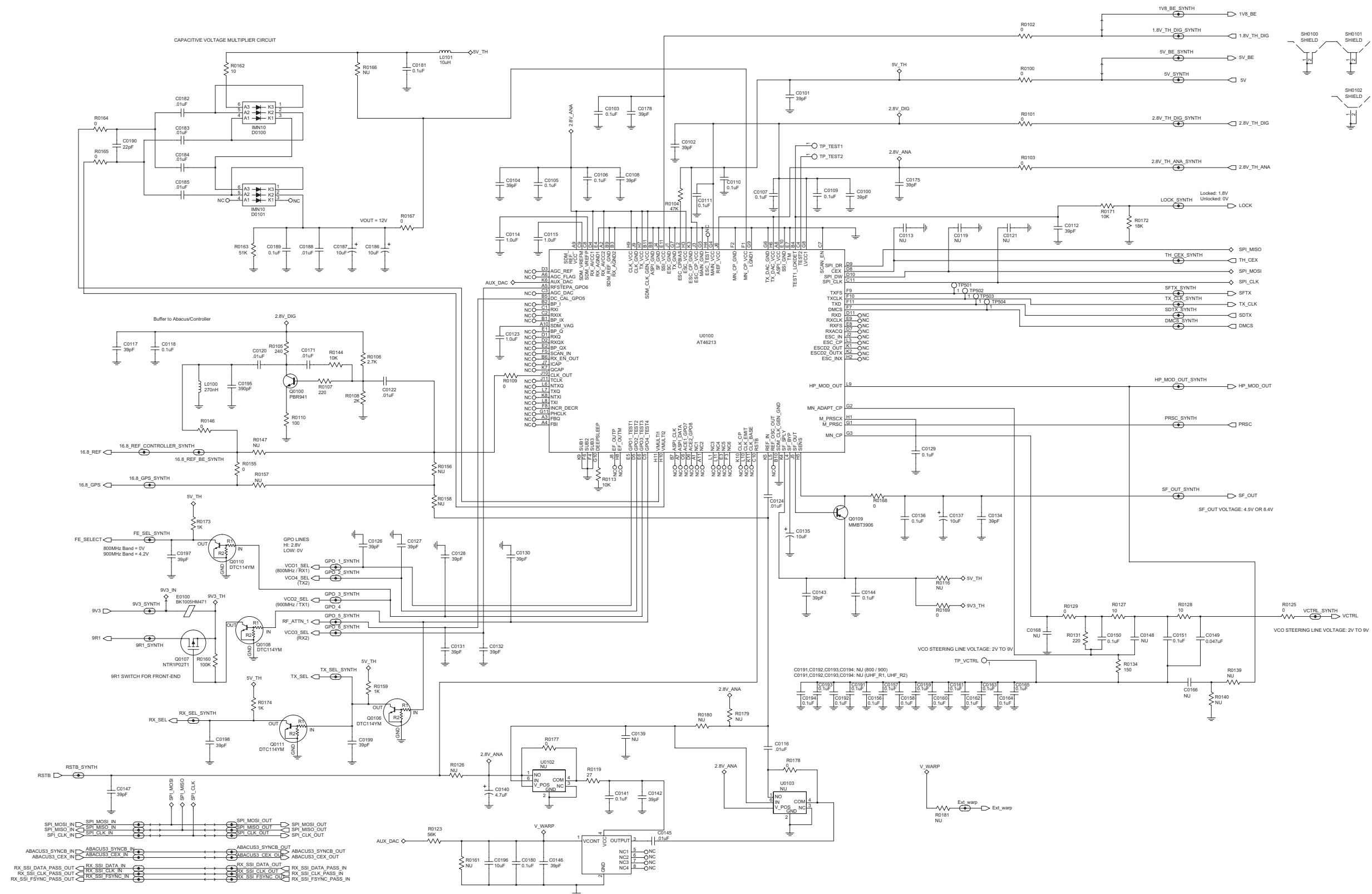
800/900 MHz (806–941 MHz) 10–35W Receiver Back-End Schematic Diagram



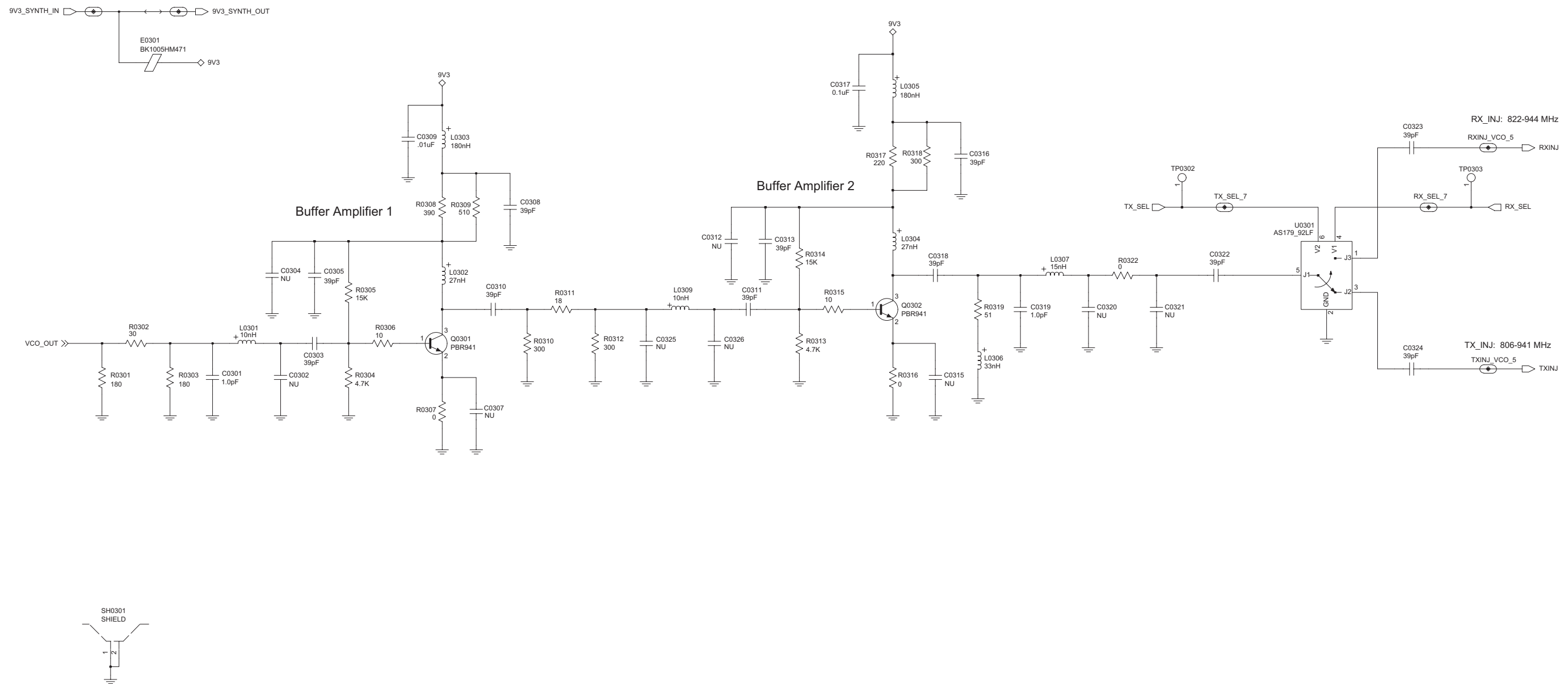


800/900 MHz (806–941 MHz) 10–35W Power Amplifier Schematic Diagram

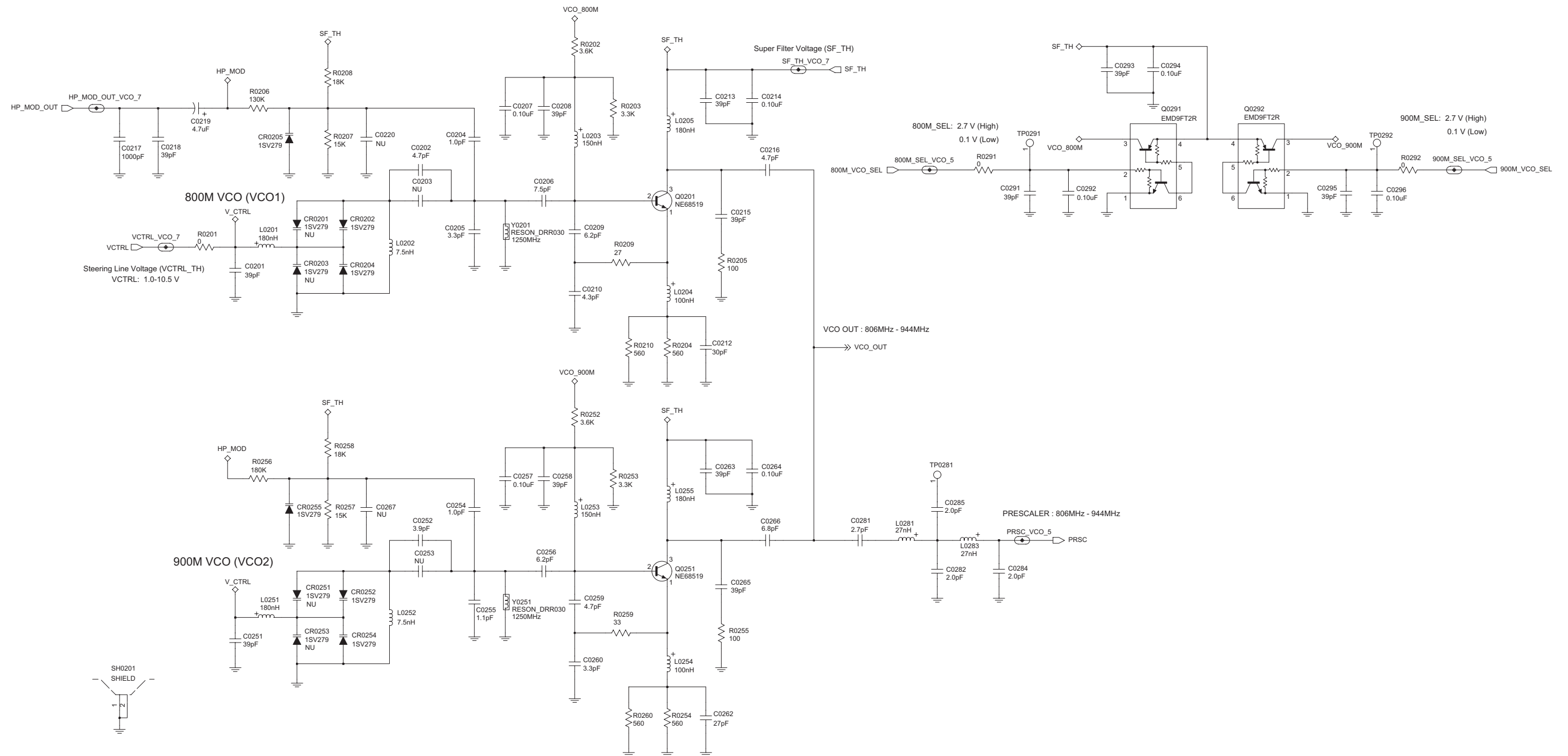




800/900 MHz (806–941 MHz) 10–35W Synthesizer Schematic Diagram



800/900 MHz (806–941 MHz) 10–35W VCO Buffer Schematic Diagram



800/900 MHz (806–941 MHz) 10–35W VCO Schematic Diagram

**800/900 MHz PCB 8475265H01 Parts List 10–35W**

Circuit Ref	Motorola Part No.	Description
C0100	2113944A32	39pF
C0101	2113944A32	39pF
C0102	2113944A32	39pF
C0103	2113945C31	0.1uF
C0104	2113944A32	39pF
C0105	2113945C31	0.1uF
C0106	2113945C31	0.1uF
C0107	2113945C31	0.1uF
C0108	2113944A32	39pF
C0109	2113945C31	0.1uF
C0110	2113945C31	0.1uF
C0111	2113945C31	0.1uF
C0112	2113944A32	39pF
C0113	NOT PLACED	–
C0114	2113946E02	1.0uF
C0115	2113946E02	1.0uF
C0116	2113945B02	.01uF
C0117	2113944A32	39pF
C0118	2113945C31	0.1uF
C0119	NOT PLACED	–
C0120	2113945B02	.01uF
C0121	NOT PLACED	–
C0122	2113945B02	.01uF
C0123	2113946E02	1.0uF
C0124	2113945B02	.01uF
C0126	2113944A32	39pF
C0127	2113944A32	39pF
C0128	2113944A32	39pF
C0129	2113945C31	0.1uF
C0130	2113944A32	39pF
C0131	2113944A32	39pF
C0132	2113944A32	39pF
C0134	2113944A32	39pF
C0135	2313960B32	10uF
C0136	2113945C31	0.1uF
C0137	2313960B32	10uF
C0139	NOT PLACED	–
C0140	2313960B30	4.7uF
C0141	2113945C31	0.1uF
C0142	2113944A32	39pF
C0143	2113944A32	39pF
C0144	2113945C31	0.1uF
C0145	2113945B02	.01uF
C0146	2113944A32	39pF
C0147	2113944A32	39pF
C0148	NOT PLACED	–
C0149	2113945C27	.047uF
C0150	2113945C31	0.1uF
C0151	2113945C31	0.1uF

Circuit Ref	Motorola Part No.	Description
C0156	2185419D06	0.1uF
C0157	2185419D06	0.1uF
C0158	2185419D06	0.1uF
C0159	2185419D06	0.1uF
C0160	2185419D06	0.1uF
C0161	2185419D06	0.1uF
C0162	2185419D06	0.1uF
C0163	2185419D06	0.1uF
C0164	2185419D06	0.1uF
C0165	2185419D06	0.1uF
C0166	NOT PLACED	–
C0168	NOT PLACED	–
C0171	2113945B02	.01uF
C0175	2113944A32	39pF
C0178	2113944A32	39pF
C0180	2113945C31	0.1uF
C0181	2113945C31	0.1uF
C0182	2113945B02	.01uF
C0183	2113945B02	.01uF
C0184	2113945B02	.01uF
C0185	2113945B02	.01uF
C0186	2313960D07	10uF
C0187	2313960D07	10uF
C0188	2113945B02	.01uF
C0189	2113945C31	0.1uF
C0190	2115153H41	22pF
C0191	NOT PLACED	–
C0192	NOT PLACED	–
C0193	NOT PLACED	–
C0194	NOT PLACED	–
C0195	2113945A04	390pF
C0196	2113946H02	10uF
C0197	2113944A32	39pF
C0198	2113944A32	39pF
C0199	2113944A32	39pF
C0201	2113944A32	39pF
C0202	2115153H19	4.7pF
C0203	NOT PLACED	–
C0204	2115153H03	1.0pF
C0205	2115153H15	3.3pF
C0206	2115153H24	7.5pF
C0207	2113945Y02	0.10uF
C0208	2113944A32	39pF
C0209	2115153H22	6.2pF
C0210	2115153H18	4.3pF
C0212	2115153H44	30pF
C0213	2113944A32	39pF
C0214	2113945Y02	0.10uF
C0215	2113944A32	39pF
C0216	2115153H19	4.7pF
C0217	2113944C51	1000pF

Circuit Ref	Motorola Part No.	Description
C0218	2113944A32	39pF
C0219	2313960B30	4.7uF
C0220	NOT PLACED	–
C0251	2113944A32	39pF
C0252	2115153H17	3.9pF
C0253	NOT PLACED	–
C0254	2115153H03	1.0pF
C0255	2115153H04	1.1pF
C0256	2115153H22	6.2pF
C0257	2113945Y02	0.10uF
C0258	2113944A32	39pF
C0259	2115153H19	4.7pF
C0260	2115153H15	3.3pF
C0262	2115153H43	27pF
C0263	2113944A32	39pF
C0264	2113945Y02	0.10uF
C0265	2113944A32	39pF
C0266	2115153H23	6.8pF
C0267	NOT PLACED	–
C0281	2115153H13	2.7pF
C0282	2115153H10	2.0pF
C0284	2115153H10	2.0pF
C0285	2115153H10	2.0pF
C0291	2113944A32	39pF
C0292	2113945Y02	0.10uF
C0293	2113944A32	39pF
C0294	2113945Y02	0.10uF
C0295	2113944A32	39pF
C0296	2113945Y02	0.10uF
C0301	2115153H03	1.0pF
C0302	NOT PLACED	–
C0303	2113944A32	39pF
C0304	NOT PLACED	–
C0305	2113944A32	39pF
C0307	NOT PLACED	–
C0308	2113944A32	39pF
C0309	2113945C02	.01uF
C0310	2113944A32	39pF
C0311	2113944A32	39pF
C0312	NOT PLACED	–
C0313	2113944A32	39pF
C0315	NOT PLACED	–
C0316	2113944A32	39pF
C0317	2113945C31	0.1uF
C0318	2113944A32	39pF
C0319	2115153H03	1.0pF
C0320	NOT PLACED	–
C0321	NOT PLACED	–
C0322	2113944A32	39pF
C0323	2113944A32	39pF
C0324	2113944A32	39pF

Circuit Ref	Motorola Part No.	Description
C0325	NOT PLACED	–
C0326	NOT PLACED	–
C0410	2115153H57	100pF
C0411	2113945B02	.01uF
C0412	2115153H47	39pF
C0413	2113945C31	0.1uF
C0414	2113946F03	4.7uF
C0415	2115153H47	39pF
C0416	2113946S35	1.0uF
C0417	2115153H47	39pF
C0418	2115153H47	39pF
C0419	2113946F03	4.7uF
C0420	2115153H47	39pF
C0421	2113945C31	0.1uF
C0422	2115153H47	39pF
C0423	2115153H10	2.0pF
C0425	2115153H10	2.0pF
C0426	2113944A23	8.2pF
C0427	2115153H47	39pF
C0428	2115153H47	39pF
C0429	2113944C12	1.8pF
C0430	NOT PLACED	–
C0431	2113945C31	0.1uF
C0432	2115153H47	39pF
C0433	2113946E02	1.0uF
C0434	2115153H47	39pF
C0435	2115153H47	39pF
C0436	2115153H47	39pF
C0437	2113946F03	4.7uF
C0438	2115153H47	39pF
C0439	2113945C31	0.1uF
C0440	NOT PLACED	–
C0441	NOT PLACED	–
C0442	2113944C12	1.8pF
C0443	2115153H47	39pF
C0444	2115153H47	39pF
C0445	2115153H10	2.0pF
C0446	2115153H47	39pF
C0447	2115153H10	2.0pF
C0448	2113944A23	8.2pF
C0449	NOT PLACED	–
C0450	NOT PLACED	–
C0451	2115153H47	39pF
C0452	2113946E02	1.0uF
C0453	2113945C31	0.1uF
C0454	2115153H47	39pF
C0455	NOT PLACED	–
C0456	NOT PLACED	–
C0457	NOT PLACED	–
C0458	2115153H47	39pF
C0459	NOT PLACED	–

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0460	2115153H39	18pF	C0628	2113945Y02	0.10uF	C0730	2113944A32	39pF	C0782	2113944C37	39pF
C0461	2115153H39	18pF	C0629	2113945A11	2200pF	C0731	NOT PLACED	–	C0783	2113944C37	39pF
C0462	2115153H47	39pF	C0630	2113945Y02	0.10uF	C0732	2113944A32	39pF	C0784	2113944C37	39pF
C0463	2115153H35	12pF	C0631	2113945Y02	0.10uF	C0733	2113944A32	39pF	C0785	2113944C27	7.5pF
C0464	2113944A40	100pF	C0632	2313960B30	4.7uF	C0735	2111078B03	3.9pF	C0786	2113944C27	7.5pF
C0465	2115153H17	3.9pF	C0633	2113945Y02	0.10uF	C0736	2111078B07	5.6pF	C0787	NOT PLACED	–
C0466	2115153H20	5.1pF	C0634	2113945B02	.01uF	C0737	2111078B07	5.6pF	C0788	2113944C37	39pF
C0467	2115153H19	4.7pF	C0635	2113944A40	100pF	C0738	NOT PLACED	–	C0789	2113944C37	39pF
C0468	2115153H14	3.0pF	C0636	2113944A40	100pF	C0739	NOT PLACED	–	C0790	2111078B32	39pF
C0469	2115153H13	2.7pF	C0637	2113946S35	1.0uF	C0740	NOT PLACED	–	C0791	2113944C61	0.5pF
C0470	2115153H20	5.1pF	C0638	2113945Y02	0.10uF	C0741	2111078B32	39pF	C0792	2113944C27	7.5pF
C0471	2113945C31	0.1uF	C0640	2113946N03	2.2uF	C0742	NOT PLACED	–	C0793	2113944A85	51pF
C0472	NOT PLACED	–	C0641	2113945B02	.01uF	C0743	2111078B13	10pF	C0794	2113944C37	39pF
C0473	NOT PLACED	–	C0642	2115153H53	68pF	C0744	2111078B13	10pF	C0795	2185400Y18	2.2pF
C0474	NOT PLACED	–	C0643	2113945Y02	0.10uF	C0745	2111078B12	9.1pF	C0796	2111078B14	11pF
C0475	2115153H47	39pF	C0644	2113945Y02	0.10uF	C0746	2111078B12	9.1pF	C0797	NOT PLACED	–
C0502	2113945Y02	0.10uF	C0645	2113945B02	.01uF	C0747	2185400Y19	2.4pF	C0798	NOT PLACED	–
C0503	2113945Y02	0.10uF	C0646	2113946G04	0.68uF	C0748	2185400Y19	2.4pF	C0799	2113944F56	39pF
C0504	2113945Y02	0.10uF	C0647	2113946J03	10.0uF	C0749	NOT PLACED	–	C0803	2113944C51	1000pF
C0506	2113945Y02	0.10uF	C0648	2113946J03	10.0uF	C0750	NOT PLACED	–	C0804	2113944C37	39pF
C0507	2115153H36	13pF	C0649	2113945A12	3300pF	C0751	2111078B05	4.7pF	C0805	NOT PLACED	–
C0509	NOT PLACED	–	C0650	2115153H44	30pF	C0752	NOT PLACED	–	C0806	NOT PLACED	–
C0510	2115153H22	6.2pF	C0651	2115153H57	100pF	C0753	2111078B06	5.1pF	C0807	NOT PLACED	–
C0512	2113945Y02	0.10uF	C0700	2113944C82	30pF	C0754	2113951B17	2pF	C0808	NOT PLACED	–
C0513	2113945Y02	0.10uF	C0701	2113945C04	.022uF	C0755	2111078B32	39pF	C0809	2113944F45	13pF
C0514	2113945Y02	0.10uF	C0702	2113944C55	2200pF	C0756	2113944F30	3.3pF	C0810	2113944F44	12pF
C0515	NOT PLACED	–	C0703	2113944C82	30pF	C0757	2113944F41	9.1pF	C0811	2113944F44	12pF
C0516	NOT PLACED	–	C0704	2113945C04	.022uF	C0758	NOT PLACED	–	C0812	2113944F45	13pF
C0601	2115153H48	43pF	C0705	2113944C51	1000pF	C0759	2113944F37	6.2pF	C0900	2113944A85	51pF
C0602	2113945B02	.01uF	C0706	NOT PLACED	–	C0760	2113944F32	3.9pF	C0901	2113945C31	0.1uF
C0603	2113944A44	220pF	C0707	NOT PLACED	–	C0761	2113944F34	4.7pF	C0902	2113945C31	0.1uF
C0604	2113945Y02	0.10uF	C0708	2113944C51	1000pF	C0762	2113944F46	15pF	C0903	2113944A85	51pF
C0605	2115153H48	43pF	C0709	2113945C31	0.1uF	C0763	2113944F46	15pF	C0904	2113944A85	51pF
C0607	2115153H39	18pF	C0710	2371403L02	10uF	C0764	2111078B15	12pF	C0906	2113944A85	51pF
C0610	2115153H53	68pF	C0711	NOT PLACED	–	C0765	NOT PLACED	–	C0907	2113945C02	.01uF
C0611	2113945A09	1000pF	C0712	2113944C51	1000pF	C0766	NOT PLACED	–	C0908	2113945C31	0.1uF
C0612	2115153H34	11pF	C0713	2111078B42	100pF	C0767	NOT PLACED	–	C0909	2113944A85	51pF
C0613	2185419D03	0.01uF	C0714	2111078B42	100pF	C0768	NOT PLACED	–	C0910	2113944A85	51pF
C0614	2115153H48	43pF	C0715	2111078B32	39pF	C0769	NOT PLACED	–	C0911	2113944A85	51pF
C0615	2113945B02	.01uF	C0716	NOT PLACED	–	C0770	2113944F41	9.1pF	C0912	2113944A85	51pF
C0616	NOT PLACED	–	C0717	2113945A09	1000pF	C0771	NOT PLACED	–	C0913	2113944A85	51pF
C0617	2113945Y02	0.10uF	C0718	2113944A32	39pF	C0772	2113944C37	39pF	C0914	2113944A85	51pF
C0618	2185419D06	0.1uF	C0719	2113945C04	.022uF	C0773	2113944C33	18pF	C0915	2113944A85	51pF
C0619	2113945Y02	0.10uF	C0720	2113944A32	39pF	C0774	NOT PLACED	–	C0916	2113944A85	51pF
C0620	2113945Y02	0.10uF	C0721	2113945A09	1000pF	C0775	NOT PLACED	–	C0917	2113945A09	1000pF
C0621	2113945Y02	0.10uF	C0722	2113944A32	39pF	C0776	NOT PLACED	–	C0918	2113944A85	51pF
C0622	2113945A09	1000pF	C0725	2113944C37	39pF	C0777	2113944C14	2.2pF	C0919	2113945C31	0.1uF
C0623	2113945Y02	0.10uF	C0726	2113944C51	1000pF	C0778	NOT PLACED	–	C0920	2113944A85	51pF
C0625	2113944C89	200pF	C0727	2113944C37	39pF	C0779	2113944C30	10pF	C0921	2113945C31	0.1uF
C0626	2113944A40	100pF	C0728	2113944C51	1000pF	C0780	2113944C30	10pF	C0922	2113944A85	51pF
C0627	2113944A40	100pF	C0729	NOT PLACED	–	C0781	2113944C37	39pF	C0923	2113944C55	2200pF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0925	2113944A85	51pF	C1031	2113945Y02	0.10uF	C3202	2113945Y02	0.10uF	C3275	2113946J03	10.0uF
C0926	2113945L41	4700pF	C1032	2113945B02	.01uF	C3203	2316410H02	68uF	C3276	2113946S35	1.0uF
C0927	2113944C02	220pF	C1033	2113945Y02	0.10uF	C3204	2115153H21	5.6pF	C3277	2113946S35	1.0uF
C0928	2113944C53	1500pF	C1034	2113946S35	1.0uF	C3205	2115153H21	5.6pF	C3278	2113945C31	0.1uF
C0929	2113944A85	51pF	C1035	2113946D05	2.2uF	C3206	2316410H01	22uF	C3279	2113945C31	0.1uF
C0931	2113944A85	51pF	C1036	2113946S35	1.0uF	C3207	2113945C31	0.1uF	C3280	2113945C31	0.1uF
C0934	2113944A85	51pF	C1037	2113946D05	2.2uF	C3208	2113946D05	2.2uF	C3281	2113945C31	0.1uF
C0935	2113944A85	51pF	C1044	2113945Y02	0.10uF	C3209	2113945Y02	0.10uF	C3282	2113946F03	4.7uF
C0936	2113944A85	51pF	C2000	2113944A40	100pF	C3210	2113946D05	2.2uF	C3283	2113945Y02	0.10uF
C0937	2113944A85	51pF	C2001	2113945B02	.01uF	C3211	2113945A09	1000pF	C3289	2113945Y02	0.10uF
C0939	2113944A85	51pF	C2002	2113945Y02	0.10uF	C3212	2316410H02	68uF	C3290	2113945Y02	0.10uF
C0940	2113944C35	27pF	C2003	2113945Y02	0.10uF	C3213	2113946F03	4.7uF	C3291	2113945Y02	0.10uF
C0941	2113944C22	4.7pF	C2004	2113944A40	100pF	C3214	2115153H45	33pF	C3292	2113945A09	1000pF
C0942	2113944C37	39pF	C2005	2113945B02	.01uF	C3215	2115153H45	33pF	C3500	2113946J03	10.0uF
C0943	2113944C80	20pF	C2006	2113945Y02	0.10uF	C3216	2113946F03	4.7uF	C3501	2113945G91	0.1uF
C0944	2113944C12	1.8pF	C2007	2113945Y02	0.10uF	C3217	2113944A44	220pF	C3502	2113945C31	0.1uF
C0945	2113944C35	27pF	C2008	2113946D05	2.2uF	C3218	2113945Y02	0.10uF	C3503	2113945A09	1000pF
C0947	2113944A40	100pF	C2009	2113946D05	2.2uF	C3219	2113944A44	220pF	C3504	2113945A09	1000pF
C0948	2113946S35	1.0uF	C2500	2113944A44	220pF	C3220	2113945Y02	0.10uF	C3505	2113945A09	1000pF
C0949	2113946G01	2.2uF	C2501	2113945A10	1500pF	C3221	2113944A44	220pF	C3506	2314030F30	47uF
C0950	2113945A09	1000pF	C3000	2113944C06	470pF	C3222	2113945Y02	0.10uF	C3507	2113945A11	2200pF
C0951	2113945C31	0.1uF	C3002	2371403L02	10uF	C3225	2113944A44	220pF	C3508	2113945C31	0.1uF
C0953	2113944A85	51pF	C3005	2113944C06	470pF	C3226	2113945Y02	0.10uF	C3509	2313960D07	10uF
C0960	NOT PLACED	–	C3006	2314030E85	33uF	C3227	2113944A44	220pF	C3510	2113945A03	330pF
C0961	NOT PLACED	–	C3007	2113945C31	0.1uF	C3228	2113945Y02	0.10uF	C3511	2113944A40	100pF
C0962	NOT PLACED	–	C3008	2113945A09	1000pF	C3229	2113944A44	220pF	C3512	2113945C31	0.1uF
C0963	NOT PLACED	–	C3009	2113945Y02	0.10uF	C3231	2113944A44	220pF	C3513	2113944A40	100pF
C0964	NOT PLACED	–	C3010	2113946S35	1.0uF	C3232	2113945Y02	0.10uF	C3514	2113944A44	220pF
C0965	NOT PLACED	–	C3011	2113946S35	1.0uF	C3233	2113944A44	220pF	C3515	2113944A44	220pF
C0966	2113944A85	51pF	C3012	2113944C06	470pF	C3234	2113946D05	2.2uF	C3516	2113946S35	1.0uF
C1000	2113944A40	100pF	C3013	2314030J28	22uF	C3237	2113946D05	2.2uF	C3517	2314030M51	10uF
C1001	2113945Y02	0.10uF	C3014	2113945C31	0.1uF	C3238	2113946H02	10uF	C3518	2113946S35	1.0uF
C1002	2113945Y02	0.10uF	C3015	2113944C38	47pF	C3239	2113946D05	2.2uF	C3519	2314030F30	47uF
C1003	2113944A40	100pF	C3016	2113944A40	100pF	C3240	2113944C45	100pF	C3520	2113946S35	1.0uF
C1004	2113944A40	100pF	C3017	2113945A09	1000pF	C3243	2113946S35	1.0uF	C3521	2113946S35	1.0uF
C1005	2113945Y02	0.10uF	C3018	2389289U01	10uF	C3247	2113946H02	10uF	C3522	2113945A05	470pF
C1006	2113945Y02	0.10uF	C3019	2113944C06	470pF	C3248	2113946S35	1.0uF	C3523	2113945Y02	0.10uF
C1007	2113944A40	100pF	C3020	2314030E85	33uF	C3249	2113944C45	100pF	C3524	2313960D07	10uF
C1008	2113944A40	100pF	C3021	2113945C31	0.1uF	C3252	2113946S35	1.0uF	C3525	2113944A44	220pF
C1009	2113945Y02	0.10uF	C3030	2113945C02	.01uF	C3254	2113946D05	2.2uF	C3526	2113946S35	1.0uF
C1010	2113945Y02	0.10uF	C3031	2113945C31	0.1uF	C3257	2113946S35	1.0uF	C3527	2113945C31	0.1uF
C1011	2113944A40	100pF	C3032	2113945B02	.01uF	C3260	2113946S35	1.0uF	C3528	2113945Y02	0.10uF
C1012	2113945Y02	0.10uF	C3040	2113944C06	470pF	C3261	2113944A44	220pF	C3529	2113945Y02	0.10uF
C1013	2113945Y02	0.10uF	C3041	2113945C02	.01uF	C3262	2113946N03	2.2uF	C3530	2113944A44	220pF
C1014	2113945Y02	0.10uF	C3042	2113945B02	.01uF	C3265	2113946J04	22uF	C3531	2113944A44	220pF
C1015	2113945Y02	0.10uF	C3043	2314030E85	33uF	C3266	2113946D05	2.2uF	C3532	2113946S35	1.0uF
C1016	2113945Y02	0.10uF	C3044	2113945C31	0.1uF	C3269	2113946S35	1.0uF	C3533	2313960D07	10uF
C1017	2113946E02	1.0uF	C3045	NOT PLACED	–	C3270	2113946S35	1.0uF	C3534	2313960D07	10uF
C1018	2113944A28	18pF	C3046	2113945Y02	0.10uF	C3272	2115153H27	10pF	C3535	2113946S35	1.0uF
C1019	2113944A28	18pF	C3200	2113946J04	22uF	C3273	NOT PLACED	–	C3536	2314030M51	10uF
C1030	2113944A28	18pF	C3201	2113946D05	2.2uF	C3274	2113944A44	220pF	C3538	2113945B02	.01uF



Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C3539	2113945Y02	0.10uF	C4053	NOT PLACED	–	C6430	NOT PLACED	–	D0903	4815024H01	DIODE, PIN
C3540	2113945Y02	0.10uF	C4055	NOT PLACED	–	C6431	2113946S35	1.0uF	D0904	4813974A21	DIODE, SCHOTTKY
C3541	2113945Y02	0.10uF	C4058	NOT PLACED	–	C6432	NOT PLACED	–	D0905	4813974A21	DIODE, SCHOTTKY
C3542	2113945Y02	0.10uF	C4059	NOT PLACED	–	C6433	2113945A09	1000pF	D0906	4813978C02	DIODE, SWITCHING
C3543	2313960D07	10uF	C4060	NOT PLACED	–	C6434	2113945Y02	0.10uF	D0907	4813977M10	DIODE, 5.1V ZENER
C3545	2113944A44	220pF	C4061	NOT PLACED	–	C6435	2113944A44	220pF	D3030	4813978P07	DIODE, SWITCHING
C4000	NOT PLACED	–	C4062	NOT PLACED	–	C6436	NOT PLACED	–	D3040	4813978P07	DIODE, SWITCHING
C4001	NOT PLACED	–	C4063	2113944A44	220pF	C6437	2113944A44	220pF	D3200	4813978C02	DIODE, SWITCHING
C4002	NOT PLACED	–	C4064	2113944A44	220pF	C6438	2113944A44	220pF	D4000	4866544A01	DIODE, DUAL
C4003	NOT PLACED	–	C4065	2113944A44	220pF	C6439	2113946D05	2.2uF	D4001	4866544A01	DIODE, DUAL
C4004	NOT PLACED	–	C4066	2113944A44	220pF	C6440	2113945B02	.01uF	E0100	2409134J25	FERRITE BEAD
C4005	NOT PLACED	–	C4067	2113944A44	220pF	C6443	2115153H26	9.1pF	E0301	2409134J25	FERRITE BEAD
C4006	2113944A44	220pF	C4068	2113944A44	220pF	C6444	2115153H16	3.6pF	E0401	2480675U01	FERRITE BEAD
C4007	NOT PLACED	–	C4069	2113944A44	220pF	C6445	2113946S35	1.0uF	E0402	2409134J25	FERRITE BEAD
C4010	NOT PLACED	–	C4070	2113944A44	220pF	C6446	2113945Y02	0.10uF	E0500	2409134J25	FERRITE BEAD
C4011	NOT PLACED	–	C4071	NOT PLACED	–	C6449	2113945A09	1000pF	E0600	2409134J25	FERRITE BEAD
C4012	NOT PLACED	–	C4072	NOT PLACED	–	C6450	2113945A09	1000pF	E0601	2409134J25	FERRITE BEAD
C4013	2113944A44	220pF	C4073	2113945Y02	0.10uF	C6451	2113945Y02	0.10uF	E0602	2409134J25	FERRITE BEAD
C4014	2113944A44	220pF	C4074	NOT PLACED	–	C6452	2113945Y02	0.10uF	E0603	2409134J25	FERRITE BEAD
C4015	2113944A44	220pF	C4075	NOT PLACED	–	CR0201	NOT PLACED	–	E0604	2409134J25	FERRITE BEAD
C4016	2113944A44	220pF	C4076	NOT PLACED	–	CR0202	4805656W87	DIODE VARACTOR 1SV279	E0605	2409134J25	FERRITE BEAD
C4017	2113944A44	220pF	C4084	2113945Y02	0.10uF	CR0203	NOT PLACED	–	E0606	2409134J25	FERRITE BEAD
C4018	2113944A44	220pF	C4085	2113944A44	220pF	CR0204	4805656W87	DIODE VARACTOR 1SV279	E0607	2409134J25	FERRITE BEAD
C4019	NOT PLACED	–	C4086	NOT PLACED	–	CR0205	4805656W87	DIODE VARACTOR 1SV279	E0608	2409134J25	FERRITE BEAD
C4020	NOT PLACED	–	C4087	NOT PLACED	–	CR0251	NOT PLACED	–	E0609	2409134J25	FERRITE BEAD
C4021	2113944A44	220pF	C4088	NOT PLACED	–	CR0252	4805656W87	DIODE VARACTOR 1SV279	E0610	2480640Z01	FERRITE BEAD
C4022	2113944A44	220pF	C4089	NOT PLACED	–	CR0253	NOT PLACED	–	E0700	2485011Y01	FERRITE BEAD
C4023	2113944A44	220pF	C4090	NOT PLACED	–	CR0254	4805656W87	DIODE VARACTOR 1SV279	E0701	2485011Y01	FERRITE BEAD
C4024	2113944A44	220pF	C4091	2113945Y02	0.10uF	CR0255	4805656W87	DIODE VARACTOR 1SV279	E0702	7671656M01	FERRITE BEAD
C4025	2113944A44	220pF	C4092	2113945Y02	0.10uF	CR0400	4813974A19	DIODE, SCHOTTKY	E0703	2485011Y01	FERRITE BEAD
C4026	2113944A44	220pF	C4093	NOT PLACED	–	CR0401	4813974A19	DIODE, SCHOTTKY	E2500	2480675U01	FERRITE BEAD
C4027	2113944A44	220pF	C4094	NOT PLACED	–	CR0403	NOT PLACED	–	E3000	2485011Y01	FERRITE BEAD
C4028	2113944A44	220pF	C6401	2113945A09	1000pF	CR0404	NOT PLACED	–	E3201	2480675U01	FERRITE BEAD
C4029	2113944A44	220pF	C6406	2113945A09	1000pF	D0100	4815011H01	DIODE ARRAY	E3202	2480675U01	FERRITE BEAD
C4030	2113944A44	220pF	C6407	2113946S35	1.0uF	D0101	4815011H01	DIODE ARRAY	E3203	2480675U01	FERRITE BEAD
C4031	2113944A44	220pF	C6408	2113946S35	1.0uF	D0500	4813974A19	DIODE, SCHOTTKY	E3205	2480675U01	FERRITE BEAD
C4032	2113944A44	220pF	C6412	2113944A28	18pF	D0600	4815096H01	DIODE VARACTOR 1SV305	E3206	2480675U01	FERRITE BEAD
C4033	2113944A44	220pF	C6413	2113945A09	1000pF	D0601	4815096H01	DIODE VARACTOR 1SV305	E3208	2480675U01	FERRITE BEAD
C4034	2113945A03	330pF	C6414	2113944A28	18pF	D0700	4802482J02	DIODE, PIN	E3500	2485011Y01	FERRITE BEAD
C4035	2113945A03	330pF	C6416	2113945B02	.01uF	D0702	4802482J02	DIODE, PIN	E3501	2485011Y01	FERRITE BEAD
C4040	2113944A44	220pF	C6417	2113944A28	18pF	D0900	4813978C02	DIODE, SWITCHING	E3502	2485011Y01	FERRITE BEAD
C4041	2113944A44	220pF	C6418	2113946F05	10uF	D0901	4815023H01	DIODE, PIN	E3503	2485011Y01	FERRITE BEAD
C4042	2113944A44	220pF	C6419	2113945Y02	0.10uF	D0902	4815024H01	DIODE, PIN	E4000	2485011Y01	FERRITE BEAD
C4043	2113944A44	220pF	C6420	2113944A28	18pF				E4001	7686949J14	FERRITE BEAD
C4044	2113944A44	220pF	C6421	2113946F05	10uF				E4002	7686949J14	FERRITE BEAD
C4045	2113944A44	220pF	C6422	2113944A28	18pF				E4003	2409134J25	FERRITE BEAD
C4046	2113944A44	220pF	C6423	2113946D05	2.2uF				E4004	2409134J25	FERRITE BEAD
C4047	2113944A44	220pF	C6426	2113946S35	1.0uF				E4005	2409134J25	FERRITE BEAD
C4048	2113944A44	220pF	C6427	2113946S35	1.0uF				E4006	2409134J25	FERRITE BEAD
C4049	NOT PLACED	–	C6428	NOT PLACED	–				E6400	7686949J08	FERRITE BEAD
C4051	NOT PLACED	–	C6429	2113945A09	1000pF				E6401	7686949J08	FERRITE BEAD

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
E6402	7686949J08	FERRITE BEAD	L0419	2414032F29	39nH	Q0109	4813973A13	PNP	Q4000	4815263H01	ANALOG SWITCH
E6407	7686949J08	FERRITE BEAD	L0420	NOT PLACED	–	Q0110	4816134H01	ANALOG SWITCH	Q4001	4815263H01	ANALOG SWITCH
FL0401	91012003001	CERAMIC FILTER	L0421	NOT PLACED	–	Q0111	4816134H01	ANALOG SWITCH	Q4002	4815261H01	ANALOG SWITCH
FL0402	91012003001	CERAMIC FILTER	L0423	NOT PLACED	–	Q0201	4885061Y01	NPN RF TRANSISTOR	Q4003	4815263H01	ANALOG SWITCH
FL0403	91012002001	CERAMIC FILTER	L0424	2415429H17	12nH	Q0251	4885061Y01	NPN RF TRANSISTOR	Q4004	4815261H01	ANALOG SWITCH
FL0404	91012002001	CERAMIC FILTER	L0425	2415429H12	8.2nH	Q0291	4815272H01	ANALOG SWITCH	Q4005	4815263H01	ANALOG SWITCH
FL0500	9116854H02	CRYSTAL FILTER	L0426	2415429H28	39nH	Q0292	4815272H01	ANALOG SWITCH	Q4006	4815263H01	ANALOG SWITCH
FL6401	9180310L38	SAW FILTER	L0427	2414015B25	8.2nH	Q0301	4802197J95	NPN RF TRANSISTOR	Q4007	4815263H01	ANALOG SWITCH
HS0700	0104031J96	HEATSINK	L0428	2414017N20	47nH	Q0302	4802197J95	NPN RF TRANSISTOR	Q4008	4815261H01	ANALOG SWITCH
J0700	0905901V11	MINI-U RF CONNECTOR	L0429	2414015B33	5.6nH	Q0401	NOT PLACED	–	Q4009	4815263H01	ANALOG SWITCH
J2500	0915064H02	–	L0430	2414015B33	5.6nH	Q0402	4885593U03	NPN RF TRANSISTOR	Q4010	4815261H01	ANALOG SWITCH
J3000	0905902V09	DC POWER CONNECTOR	L0431	2414015B33	5.6nH	Q0500	4802197J95	NPN RF TRANSISTOR	Q4011	4815263H01	ANALOG SWITCH
J4000	0916017H01	26-PIN ACCESSORY CONNECTOR	L0432	2415427H16	7.5nH	Q0501	4802197J95	NPN RF TRANSISTOR	Q4012	4815261H01	ANALOG SWITCH
J4001	0915555H01	30-PIN CONTROL HEAD CONNECTOR	L0433	NOT PLACED	–	Q0600	4885061Y01	NPN RF TRANSISTOR	Q4013	4816023H01	PNP
J4002	NOT PLACED	–	L0503	2414015B27	390nH	Q0601	4813973A04	NPN DARLINGTON	Q4014	4813973A06	NPN
J4003	0915556H01	14-PIN OPT BOARD CONNECTOR	L0504	NOT PLACED	–	Q0701	4816013H01	DUAL NPN/PNP	Q4015	4815263H01	ANALOG SWITCH
J6400	0909901V02	GPS MCX CONNECTOR	L0506	2414032B66	820nH	Q0703	4816698H04	N-CHANNEL LDMOS PRE-DRIVER	Q6401	4813973M07	NPN
L0100	2414017N29	270nH	L0602	2414032K23	2.7uH	Q0705	4816547H01	N-CHANNEL LDMOS PRE-DRIVER	R0100	0613952R66	0
L0101	2466505A01	10uH	L0603	2414032D20	270nH	Q0709	4878031A02	RF POWER AMPLIFIER, LDMOS	R0101	0613952R66	0
L0201	2414017N27	180nH	L0604	2466505A01	10uH	Q0710	4878031A02	RF POWER AMPLIFIER, LDMOS	R0102	0613952R66	0
L0202	2416540H07	7.5nH	L0605	2466505A01	10uH	Q0713	4813970A62	P-CHANNEL MOSFET	R0103	0613952R66	0
L0203	2414017N26	150nH	L0608	2414032B76	4.7uH	Q0714	4816134H01	ANALOG SWITCH	R0104	0613952R17	47K
L0204	2414017N24	100nH	L0700	2460592A02	12.5nH	Q0900	4815272H01	ANALOG SWITCH	R0105	0613952Q58	240
L0205	2414017N27	180nH	L0702	2460591C03	11.87nH	Q0901	4813973A13	PNP	R0106	0613952Q83	2.7K
L0251	2414017N27	180nH	L0705	2414017N22	68nH	Q0902	4813973M07	NPN	R0107	0613952Q57	220
L0252	2416540H07	7.5nH	L0706	2460592A04	8nH	Q3030	4813973M07	NPN	R0108	0613952Q80	2K
L0253	2414017N26	150nH	L0707	2460592A04	8nH	Q3032	4813973B01	NPN	R0109	0613952R66	0
L0254	2414017N24	100nH	L0708	2460591A01	4.22nH	Q3040	4813973M07	NPN	R0110	0613952Q49	100
L0255	2414017N27	180nH	L0710	2460591A01	4.22nH	Q3041	4815263H01	ANALOG SWITCH	R0113	0613952R01	10K
L0281	2414017N17	27nH	L0711	2414015A06	150nH	Q3200	5185956E76	N-CHANNEL SYNCHRO-NOUS MOSFET	R0116	NOT PLACED	–
L0283	2414017N17	27nH	L0714	2414015A03	82nH	Q3201	4813970A62	P-CHANNEL MOSFET	R0119	0613952Q35	27
L0301	2414017N12	10nH	L0715	2414017N22	68nH	Q3202	5185956E76	N-CHANNEL SYNCHRO-NOUS MOSFET	R0123	0613952R19	56K
L0302	2414017N17	27nH	L0718	2414017N07	3.9nH	Q3203	4805585Q23	PMOSFET	R0125	0613952R66	0
L0303	2414017N27	180nH	L0719	2414032F29	39nH	Q3204	4805585Q23	PMOSFET	R0126	NOT PLACED	–
L0304	2414017N17	27nH	L0720	2414017N09	5.6nH	Q3205	4815262H01	ANALOG SWITCH	R0127	0613952Q25	10
L0305	2414017N27	180nH	L0721	2414017N01	1.2nH	Q3206	4815272H01	ANALOG SWITCH	R0128	0613952Q25	10
L0306	2414017N18	33nH	L0722	2460591E77	30nH	Q3207	4813970A62	P-CHANNEL MOSFET	R0129	0613952R66	0
L0307	2414017N14	15nH	L0900	2414032D30	1uH	Q3208	4815261H01	ANALOG SWITCH	R0131	0613952Q57	220
L0309	2414017N12	10nH	L0901	2414032F34	100nH	Q3209	4813973M07	NPN	R0134	0613952Q53	150
L0410	2414032F29	39nH	L0903	2414032F66	10nH	Q3210	4813973M07	NPN	R0139	NOT PLACED	–
L0411	NOT PLACED	–	L0972	2414032F20	3.3nH	Q3500	4815272H01	ANALOG SWITCH	R0140	NOT PLACED	–
L0412	NOT PLACED	–	L3200	2415005H02	22uH	Q3502	4815272H01	ANALOG SWITCH	R0144	0613952R01	10K
L0413	2415429H20	18nH	L3201	2415005H02	22uH	Q3503	4815272H01	ANALOG SWITCH	R0146	0613952R66	0
L0414	2415429H12	8.2nH	L3202	2415005H02	22uH	Q3504	4815270H01	ANALOG SWITCH	R0147	NOT PLACED	–
L0415	NOT PLACED	–	L6402	2415429H24	27nH	Q3505	4815270H01	ANALOG SWITCH	R0155	0613952R66	0
L0417	2415429H28	39nH	L6403	2414017P06	2.7nH				R0156	NOT PLACED	–
L0418	2415429H28	39nH	PASTE	1085674C03	PASTE				R0157	NOT PLACED	–
			Q0100	4802197J95	NPN RF TRANSISTOR				R0158	NOT PLACED	–
			Q0106	4816134H01	ANALOG SWITCH				R0159	0613952Q73	1K
			Q0107	4813970A59	P-CHANNEL MOSFET				R0160	0613952R25	100K
			Q0108	4816134H01	ANALOG SWITCH						

Circuit Ref	Motorola Part No.	Description
R0161	NOT PLACED	–
R0162	0613952Q25	10
R0163	0613952R18	51K
R0164	0613952R66	0
R0165	0613952R66	0
R0166	NOT PLACED	–
R0167	0613952R66	0
R0168	0613952R66	0
R0169	0613952R66	0
R0171	0613952R01	10K
R0172	0613952R07	18K
R0173	0613952Q73	1K
R0174	0613952Q73	1K
R0177	0613952R66	0
R0178	0613952R66	0
R0179	NOT PLACED	–
R0180	NOT PLACED	–
R0181	NOT PLACED	–
R0201	0613952R66	0
R0202	0613952Q86	3.6K
R0203	0613952Q85	3.3K
R0204	0613952Q67	560
R0205	0613952Q49	100
R0206	0613952R28	130K
R0207	0613952R05	15K
R0208	0613952R07	18K
R0209	0613952Q35	27
R0210	0613952Q67	560
R0252	0613952Q86	3.6K
R0253	0613952Q85	3.3K
R0254	0613952Q67	560
R0255	0613952Q53	150
R0256	0613952R31	180K
R0257	0613952R05	15K
R0258	0613952R07	18K
R0259	0613952Q37	33
R0260	0613952Q67	560
R0291	0613952R66	0
R0292	0613952R66	0
R0301	0613952Q55	180
R0302	0613952Q36	30
R0303	0613952Q55	180
R0304	0613952Q89	4.7K
R0305	0613952R05	15K
R0306	0613952Q25	10
R0307	0613952R66	0
R0308	0613952H63	390
R0309	0613952H66	510
R0310	0613952Q60	300
R0311	0613952Q31	18
R0312	0613952Q60	300

Circuit Ref	Motorola Part No.	Description
R0313	0613952Q89	4.7K
R0314	0613952R05	15K
R0315	0613952Q25	10
R0316	0613952R66	0
R0317	0613952H57	220
R0318	0613952H60	300
R0319	0613952Q42	51
R0322	0613952G67	0
R0410	0613952N66	47.5K
R0411	0613952N21	16.2K
R0412	0613952Q73	1K
R0413	NOT PLACED	–
R0414	0613952G67	0
R0415	0613952R66	0
R0417	0613952Q73	1K
R0419	0613952R66	0
R0420	0613952Q36	30
R0421	0613952R66	0
R0422	0613952R66	0
R0423	0613952Q89	4.7K
R0424	0613952Q75	1.2K
R0425	0613952R01	10K
R0426	0613952G67	0
R0427	0613952R66	0
R0428	0613952Q73	1K
R0429	NOT PLACED	–
R0430	NOT PLACED	–
R0431	NOT PLACED	–
R0432	0613952Q36	30
R0433	0613952R66	0
R0434	0613952R66	0
R0435	0613952Q75	1.2K
R0436	0613958H25	10
R0437	0613952R01	10K
R0438	0613952R66	0
R0439	0613952Q42	51
R0440	NOT PLACED	–
R0441	0613952Q84	3K
R0442	0613952Q83	2.7K
R0443	0613952Q83	2.7K
R0444	0613952Q83	2.7K
R0445	0613952R66	0
R0446	0613952Q43	56
R0447	0613952R66	0
R0448	0613952G67	0
R0449	0613952Q73	1K
R0451	0613952Q73	1K
R0452	0613952Q50	110
R0453	0613952Q50	110
R0454	0613952Q75	1.2K
R0455	0613958H44	62

Circuit Ref	Motorola Part No.	Description
R0456	0613952R07	18K
R0500	0613952Q90	5.1K
R0501	0613952Q61	330
R0502	0613952R08	20K
R0503	0613952R12	30K
R0508	0613952R19	56K
R0509	0613952Q89	4.7K
R0510	0613952R12	30K
R0511	0613952Q75	1.2K
R0512	0613952Q42	51
R0601	0613952Q45	68
R0602	0613952R01	10K
R0603	0613952Q80	2K
R0604	0613952R10	24K
R0605	0613952Q61	330
R0606	0613952Q42	51
R0607	NOT PLACED	–
R0608	0613952R66	0
R0609	0613952R66	0
R0610	0613952R66	0
R0611	0613952R66	0
R0612	0613952R66	0
R0613	0613952R66	0
R0614	0613952R66	0
R0615	0613952R66	0
R0616	0613952R25	100K
R0617	0613952R01	10K
R0618	0613952Q63	390
R0619	0613952R01	10K
R0620	0613952Q96	9.1K
R0621	0613952R66	0
R0622	NOT PLACED	–
R0623	NOT PLACED	–
R0624	0613952Q90	5.1K
R0625	0613952N69	51.1K
R0626	0613952N81	68.1K
R0627	0613952R66	0
R0702	NOT PLACED	–
R0706	0613958S40	43
R0711	0613952H51	120
R0713	0613959H12	30K
R0714	0613952H46	75
R0715	0613952H46	75
R0718	0613952H05	1.5
R0720	0613952H05	1.5
R0722	0613952H89	4.7K
R0723	0613959Y37	33
R0724	0613959Y37	33
R0725	0613952J25	100K
R0727	0613952J01	10K
R0728	0613952J01	10K

Circuit Ref	Motorola Part No.	Description
R0730	0613952H73	1K
R0732	0613952H73	1K
R0733	NOT PLACED	–
R0734	0613952G67	0
R0736	0613958H57	220
R0740	0613952J29	150K
R0741	0613952J01	10K
R0742	0613959Q25	10
R0744	NOT PLACED	–
R0747	0613952H89	4.7K
R0749	0613952G67	0
R0750	0613952J01	10K
R0751	0613952J08	20K
R0752	0613952G67	0
R0753	0613952H73	1K
R0754	0613952H05	1.5
R0755	NOT PLACED	–
R0756	0613952J29	150K
R0757	0613952J01	10K
R0758	0613952H73	1K
R0759	0613952H09	2.2
R0760	0613952Q83	2.7K
R0761	0613952G67	0
R0762	0613952H11	2.7
R0765	0613952H11	2.7
R0766	0613952H11	2.7
R0769	0613952H11	2.7
R0771	0613959Q38	36
R0775	NOT PLACED	–
R0777	0613952H09	2.2
R0778	0613958H33	22
R0779	0613958H33	22
R0780	0613958S29	15
R0781	0613958S29	15
R0900	0613952R19	56K
R0901	0613952R16	43K
R0902	0613952M57	#N/A
R0903	0613952R09	22K
R0906	0613952R66	0
R0907	0613952R66	0
R0909	0613952R16	43K
R0910	0613952H73	1K
R0911	0613952M47	3.01K
R0912	0613952N45	28.7K
R0913	0613952R66	0
R0914	0613952P26	182K
R0915	0613952N90	84.5K
R0916	0613952M54	3.57K
R0917	0613952H91	5.6K
R0918	0613952H63	390
R0919	0613952R15	39K

Circuit Ref	Motorola Part No.	Description
R0920	0613952N40	25.5K
R0921	0613952H81	2.2K
R0922	0613952R14	36K
R0923	0613952R66	0
R0924	0613952H91	5.6K
R0925	0613952H91	5.6K
R0926	0613958H53	150
R0927	0613952H42	51
R0928	0613958H39	39
R0929	0613958H39	39
R0930	0613952R07	18K
R0931	0613952R66	0
R0932	0613958J74	0
R0936	0613952N66	47.5K
R0937	0613952N21	16.2K
R0938	0613952R66	0
R0940	0613952R66	0
R0941	0613952R66	0
R0942	0613952M81	6.81K
R0943	0613952N58	39.2K
R0944	0613952R66	0
R0946	0613952M51	3.32K
R0947	0613952R66	0
R0950	0613952N01	10K
R0951	0613952N62	43.2K
R0954	0613952R40	430K
R0955	0613952P01	100K
R0960	0613952H82	2.4K
R0971	0613958H56	200
R0973	NOT PLACED	–
R0974	0613958H53	150
R0975	0613958H59	270
R0976	0613952H53	150
R0977	0613952H52	130
R0978	0613952H49	100
R0979	0613952H45	68
R0981	NOT PLACED	–
R0982	NOT PLACED	–
R0983	NOT PLACED	–
R0984	NOT PLACED	–
R0985	NOT PLACED	–
R0986	0613952N81	68.1K
R0987	0613952N81	68.1K
R0988	0613952H60	300
R0989	0613952Q40	51
R1000	0613952Q25	10
R1001	0613952R01	10K
R1002	0613952J73	10MEG
R1005	0613952Q89	4.7K
R1006	0613952R01	10K
R1014	0613952R66	0

Circuit Ref	Motorola Part No.	Description
R1017	0613952R01	10K
R1019	0613952Q18	5.1
R1020	0613952R66	0
R1021	0613952R66	0
R1025	0613952R01	10K
R1026	0613952R17	47K
R1027	NOT PLACED	–
R1028	0613952R66	0
R1034	0613952R01	10K
R1035	NOT PLACED	–
R1036	0613952R01	10K
R1041	0613952Q73	1K
R1044	0613952R66	0
R1045	0613952R01	10K
R1046	NOT PLACED	–
R1047	0613952R66	0
R1048	0613952R66	0
R1054	0613952Q89	4.7K
R1060	0613952Q25	10
R1066	NOT PLACED	–
R1067	NOT PLACED	–
R1070	0613952R66	0
R1071	0613952R17	47K
R2000	0613952R01	10K
R2004	0613952R66	0
R2005	NOT PLACED	–
R2006	NOT PLACED	–
R2007	NOT PLACED	–
R2008	NOT PLACED	–
R2009	NOT PLACED	–
R2010	0613952R01	10K
R2011	0613952R66	0
R2012	0613952R01	10K
R2013	NOT PLACED	–
R2014	0613952Q37	33
R2015	0613952Q37	33
R2500	0613952R66	0
R2501	0613952R66	0
R2502	0613952R66	0
R2504	0613952R66	0
R2506	0613952R66	0
R2507	0613952R66	0
R2508	0613952R66	0
R2509	0613952R66	0
R2510	0613952R66	0
R2511	0613952R66	0
R2512	0613952R66	0
R2513	0613952R66	0
R2514	0613952R66	0
R2515	0613952R66	0
R2516	0613952R66	0

Circuit Ref	Motorola Part No.	Description
R2517	0613952R66	0
R2518	0613952R66	0
R2519	0613952R66	0
R2520	0613952R66	0
R2524	0613952R66	0
R2525	0613952R66	0
R2526	0613952R66	0
R2527	0613952R66	0
R2528	0613952R66	0
R2529	0613952R01	10K
R3002	0613952R01	10K
R3003	0613952M54	3.57K
R3004	0613952L73	562
R3005	0613952Q81	2.2K
R3006	0613952Q57	220
R3007	0613952N58	39.2K
R3008	0613952N12	13K
R3009	0613952N58	39.2K
R3010	0613952N12	13K
R3030	0613952R01	10K
R3032	0615871H01	0.1
R3033	0615871H01	0.1
R3034	0613952H61	330
R3035	0613952H25	10
R3036	0613952H25	10
R3037	0613959G61	330
R3038	NOT PLACED	–
R3039	0613952M30	2K
R3040	0613952M43	2.74K
R3041	0613952R25	100K
R3042	0613952H69	680
R3043	0613952H69	680
R3044	0613958S61	330
R3045	0613952M30	2K
R3046	0613952M43	2.74K
R3047	0613952R25	100K
R3048	0613952Q73	1K
R3050	0613959Q53	150
R3051	0613952G67	0
R3052	0613952G67	0
R3053	0613952R66	0
R3054	0613952R66	0
R3055	0615871H01	0.1
R3056	0615871H01	0.1
R3057	0613952R66	0
R3200	0615871H01	0.1
R3203	0615871H01	0.1
R3204	0615871H01	0.1
R3205	0613952R25	100K
R3206	0613952R66	0
R3207	0686135Z02	0.2

Circuit Ref	Motorola Part No.	Description
R3208	0686135Z02	0.2
R3209	0613952N62	43.2K
R3210	0613952N16	14.3K
R3215	0613952G67	0
R3216	0613952G67	0
R3217	NOT PLACED	–
R3218	0613952R66	0
R3219	0613952R56	2MEG
R3220	0613952R56	2MEG
R3222	0613952R33	220K
R3223	0613952R33	220K
R3224	0613952Q89	4.7K
R3225	NOT PLACED	–
R3226	0613952R13	33K
R3227	NOT PLACED	–
R3228	0613952G67	0
R3233	0613952R66	0
R3236	0613952Q73	1K
R3237	0613952R01	10K
R3238	0613952H25	10
R3239	0613952H25	10
R3240	0613952R17	47K
R3241	0613952Q18	5.1
R3243	0613952Q18	5.1
R3245	0613952G67	0
R3246	0613952M81	6.81K
R3247	0613952N69	51.1K
R3248	0613952R01	10K
R3249	0613952R01	10K
R3250	0613952R25	100K
R3252	0613952R25	100K
R3253	0613952R17	47K
R3500	0613952Q35	27
R3501	0613952Q35	27
R3502	0613952R01	10K
R3503	NOT PLACED	–
R3504	NOT PLACED	–
R3505	0613952Z48	4.7K
R3506	0613952R01	10K
R3507	0613952R66	0
R3508	0613952R66	0
R3509	0613952Z55	12K
R3510	0613952Q35	27
R3511	0613952R01	10K
R3512	0613952Q35	27
R3513	0613952R66	0
R3514	0613952R01	10K
R3515	0613952R01	10K
R3516	0613952R10	24K
R3520	0613952R10	24K
R3521	0613952R05	15K

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
R3523	0613952R10	24K	R3587	NOT PLACED	–	R4070	0613952Q37	33	R6440	0613952R25	100K
R3524	0613952Q67	560	R3588	0613952N69	51.1K	R4071	0613952R66	0	R6443	0613952R01	10K
R3525	0613952R25	100K	R3590	0613952Q49	100	R4072	0613952R01	10K	R6444	0613952R25	100K
R3526	0613952R66	0	R3591	0613952Q81	2.2K	R4074	0613952R66	0	R6445	0613952R25	100K
R3528	0613952R09	22K	R3592	0613952Q81	2.2K	R4076	0613952R66	0	R6446	0613952R01	10K
R3529	0613952Q42	51	R3593	0613952R32	200K	R4078	0613952R66	0	R6449	0613952R25	100K
R3530	NOT PLACED	–	R3594	0613952Q85	3.3K	R4079	0613952R01	10K	R6450	0613952R25	100K
R3532	0613952Q49	100	R3595	0613952R01	10K	R4080	0613952R66	0	R6454	0613952R25	100K
R3533	0613952R10	24K	R3596	0613952H53	150	R4081	0613952R66	0	R6455	0613952R01	10K
R3534	0613952R01	10K	R4000	0613952Q37	33	R4082	0613952R66	0	R6456	0613952R25	100K
R3535	0613952Q67	560	R4001	0613952Q37	33	R4083	0613952R66	0	R6457	0613952R25	100K
R3536	0613952R25	100K	R4002	0613952Q37	33	R4085	0613952R66	0	R6458	0613952R01	10K
R3537	0613952R66	0	R4003	0613952Q37	33	R4086	NOT PLACED	–	R6459	0613952R01	10K
R3538	NOT PLACED	–	R4004	0613952Q37	33	R4088	0613952R01	10K	R6460	0613952R01	10K
R3539	0613952R10	24K	R4005	0613952Q37	33	R4089	0613952R17	47K	R6461	0613952R01	10K
R3540	0613952Q49	100	R4006	0613952Q65	470	R4090	NOT PLACED	–	R6464	0613952Q81	2.2K
R3541	0613952R10	24K	R4009	0613952Q42	51	R4093	NOT PLACED	–	R6465	0613952R25	100K
R3542	0613952R10	24K	R4010	0613952Q42	51	R4094	NOT PLACED	–	R6466	0613952R25	100K
R3544	0613952R10	24K	R4011	0613952R66	0	R4095	NOT PLACED	–	R6467	0613952R66	0
R3545	0613952Q49	100	R4012	0613952R66	0	R4096	NOT PLACED	–	R6468	0613952R66	0
R3546	0613952R05	15K	R4023	0613952Q75	1.2K	R4097	NOT PLACED	–	R6469	NOT PLACED	–
R3547	0613952Q67	560	R4030	NOT PLACED	–	R4098	0613952Q89	4.7K	R6470	NOT PLACED	–
R3548	0613952J25	100K	R4031	0613952R01	10K	R4099	NOT PLACED	–	R6471	0613952R66	0
R3549	0613952R12	30K	R4032	0613952R01	10K	R4100	0613952Q75	1.2K	R6472	NOT PLACED	–
R3550	0613952R23	82K	R4033	NOT PLACED	–	R4101	0613952Q75	1.2K	R6473	NOT PLACED	–
R3551	0613952R01	10K	R4034	0613952R01	10K	R4103	0613952Q75	1.2K	RT0908	0615585H01	47K
R3552	0613952R01	10K	R4035	0613952R01	10K	R4105	NOT PLACED	–	RT0953	0615585H01	47K
R3553	0613952R01	10K	R4040	0613952Q89	4.7K	R4106	NOT PLACED	–	RT3500	0615471H01	THERMISTOR, 10K
R3554	0613952R17	47K	R4041	0613952Q89	4.7K	R6401	0613952R66	0	SH0100	2615362H01	SHIELD
R3555	0613952R01	10K	R4042	0613952Q89	4.7K	R6402	0613952N58	39.2K	SH0101	2615362H01	SHIELD
R3556	0613952R17	47K	R4043	0613952Q89	4.7K	R6403	0613952N66	47.5K	SH0102	2675057M01	SHIELD
R3558	0613952R01	10K	R4044	NOT PLACED	–	R6404	0613952N58	39.2K	SH0201	2615362H01	SHIELD
R3559	0613952R01	10K	R4045	0613952Q89	4.7K	R6405	0613952N66	47.5K	SH0301	2615362H01	SHIELD
R3560	0613952R17	47K	R4046	0613952Q89	4.7K	R6407	0613952R17	47K	SH0500	2615576H01	SHIELD
R3569	0613952Q73	1K	R4047	0613952Q89	4.7K	R6409	NOT PLACED	–	SH0900	2686423Z02	SHIELD
R3571	0613952Q80	2K	R4048	0613952Q77	1.5K	R6410	NOT PLACED	–	SH0901	2686425Z02	SHIELD
R3572	0613952R01	10K	R4049	0613958H83	2.7K	R6411	0613952R66	0	SP3000	1015349H03	SOLDER_PREFORM
R3573	0613952R01	10K	R4050	0613952R01	10K	R6416	0613952R66	0	SP3001	1015349H03	SOLDER_PREFORM
R3574	0613952R01	10K	R4051	0613952R39	390K	R6417	NOT PLACED	–	U0100	5164015H28	IC, FRACN
R3575	0613952Q73	1K	R4054	0613952R01	10K	R6418	0613952R66	0			SYNTHESIZER
R3576	0613952Q49	100	R4055	0613952R01	10K	R6419	0613952R66	0			
R3577	0613952N42	26.7K	R4056	NOT PLACED	–	R6420	0613952R66	0			
R3578	0613952R32	200K	R4057	0613952R66	0	R6430	0613952K01	10			
R3579	0613952R01	10K	R4061	0613952Q37	33	R6432	0613952M18	1.5K			
R3580	0613952R01	10K	R4063	0613952Q37	33	R6433	0613952P01	100K			
R3581	0613952R01	10K	R4064	0613952Q37	33	R6434	0613952P01	100K			
R3582	0613952N21	16.2K	R4065	0613952Q37	33	R6435	0613952P01	100K			
R3583	0613952N21	16.2K	R4066	0613952Q37	33	R6436	0613952P01	100K			
R3584	0613952R09	22K	R4067	0613952Q37	33	R6437	0613952N12	13K			
R3585	0613952R09	22K	R4068	0613952Q37	33	R6438	0613952R25	100K			
R3586	0613952R66	0	R4069	0613952Q37	33	R6439	0613952R05	15K			
									U0102	NOT PLACED	–
									U0103	NOT PLACED	–
									U0301	5186310Y39	SPDT RF SWITCH
									U0401	5185335Y02	LOW NOISE RF AMPLIFIER
									U0402	4815272H01	ANALOG SWITCH
									U0403	51012115001	SPDT RF SWITCH
									U0404	5186310Y39	SPDT RF SWITCH
									U0405	5185335Y02	LOW NOISE RF AMPLIFIER
									U0406	4815272H01	ANALOG SWITCH

Circuit Ref	Motorola Part No.	Description
U0407	4878197A01	DIODE RING MIXER MODULE
U0408	5115391H01	VOLTAGE REGULATOR
U0409	NOT PLACED	–
U0600	5102495J14	IC, RF ASIC
U0601	5115391H01	VOLTAGE REGULATOR
U0700	4802246J29	PA PRE-DRIVER
U0900	5115147H01	DUAL OPAMP
U0901	5115147H01	DUAL OPAMP
U0940	5180390L83	IC, PA CONTROLLER
U0941	5115391H01	VOLTAGE REGULATOR
U0942	5114004A35	VOLTAGE DETECTOR
U0943	NOT PLACED	–
U1000	5102495J13	MICROPROCESSOR
U1006	5115001H02	IC, DUAL UNBUFFERED INVERTER
U2000	0104032J81	IC, 32MB FLASH
U2001	51012031001	IC, 32MB FLASH
U3001	5164015H94	VOLTAGE REGULATOR
U3002	5115391H01	VOLTAGE REGULATOR
U3003	5164015H94	VOLTAGE REGULATOR
U3004	5115391H01	VOLTAGE REGULATOR
U3005	0105959T72	PNP
U3006	0105959T72	PNP
U3030	5116525H01	DUAL OPAMP
U3040	0105959T72	PNP
U3200	5185143E77	IC, POWER MANAGEMENT
U3201	5115616H01	VOLTAGE REGULATOR
U3202	5115453H01	DUAL OPAMP
U3203	5114007A43	IC, SCHMITT TRIGGER
U3500	5102463J95	AUDIO PA
U3501	5115368H01	DIGITAL ATTENUATOR
U3502	5114016A18	QUAD OPAMP
U3503	5164852H47	IC, LEVEL TRANSLATOR
U3504	5171395L01	IC, CMOS SWITCH
U3505	5114016A18	QUAD OPAMP
U3508	5164852H47	IC, LEVEL TRANSLATOR
U4000	5115476H01	IC, SERIAL-TO-PARALLEL CONVERTER
U4001	5115502H01	LOGIC TRANSLATOR
U4004	NOT PLACED	–
U4005	NOT PLACED	–
U4006	NOT PLACED	–
U4007	NOT PLACED	–
U4008	NOT PLACED	–
U4009	5178395A01	IC, BUFFER
U4010	5178395A01	IC, BUFFER
U6401	0104034J14	SiRF GPS IC
U6402	5115391H01	VOLTAGE REGULATOR

Circuit Ref	Motorola Part No.	Description
U6404	5115962H01	IC, SCHMITT TRIGGER
U6405	5115453H01	DUAL OPAMP
U6406	5115391H01	VOLTAGE REGULATOR
U6407	5175237H01	VOLTAGE REGULATOR
U6408	5116324H01	IC, LEVEL TRANSLATOR
VR3000	48012043001	TRANSORB
VR3040	4813977M10	DIODE, 5.1V ZENER
VR3200	4813977M10	DIODE, 5.1V ZENER
VR3201	4813977M05	DIODE, 3.3V ZENER
VR3202	4813977M05	DIODE, 3.3V ZENER
VR3203	4813977M05	DIODE, 3.3V ZENER
VR3204	4813977M13	DIODE, 6.2V ZENER
VR3205	4813977M05	DIODE, 3.3V ZENER
VR3206	4813977M13	DIODE, 6.2V ZENER
VR3207	4813977M13	DIODE, 6.2V ZENER
VR3208	4813977M13	DIODE, 6.2V ZENER
VR3502	4813977A48	DIODE, 20V ZENER
VR3503	4813977A48	DIODE, 20V ZENER
VR3504	4813977A48	DIODE, 20V ZENER
VR4000	4813977A48	DIODE, 20V ZENER
VR4001	4813977A48	DIODE, 20V ZENER
VR4002	4813977A48	DIODE, 20V ZENER
VR4003	4813977A48	DIODE, 20V ZENER
VR4004	4813977A48	DIODE, 20V ZENER
VR4005	4813977M13	DIODE, 6.2V ZENER
VR4006	4813977M13	DIODE, 6.2V ZENER
VR6400	4813977A43	DIODE, 5.6V ZENER
Y0100	4875188M01	0.5 PPM 16.8 MHZ TCXO (GPS Models Only)
Y0201	4805911Z21	T-LINE RESONATOR
Y0251	4805911Z21	T-LINE RESONATOR
Y1000	93012000001	12MHZ CRYSTAL
Y3200	4815028H01	24.576MHZ CRYSTAL
Y3201	4802582S80	32KHZ CRYSTAL
	8475265H01	PCB
	1104555J01	THERMAL RIBBON
	3385980Z01	THERMAL TRANSFER LABEL

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## Appendix A Replacement Parts Ordering

### A.1 Basic 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.

### A.2 Motorola Online

Motorola Online users can access our online catalog at

<http://motorola.com/businessonline>

To register for online access, please call 1-800-422-4210 (for U.S. and Canada Service Centers only). International customers can obtain assistance at <http://motorola.com/businessonline>

### A.3 Mail Orders

Mail orders are only accepted by the US Federal Government Markets Division (USFGMD).

Motorola  
7031 Columbia Gateway Drive  
3rd Floor - Order Processing  
Columbia, MD 21046  
U.S.A.

### A.4 Telephone Orders

Radio Products and Solutions Organization\*  
(United States and Canada)  
7:00 AM to 7:00 PM (Central Standard Time)  
Monday through Friday (Chicago, U.S.A.)  
1-800-422-4210  
1-847-538-8023 (United States and Canada)

U.S. Federal Government Markets Division (USFGMD)  
1-877-873-4668  
8:30 AM to 5:00 PM (Eastern Standard Time)

### A.5 Fax Orders

Radio Products and Solutions Organization\*  
(United States and Canada)  
1-800-622-6210  
1-847-576-3023 (United States and Canada)

USFGMD  
(Federal Government Orders)  
1-800-526-8641 (For Parts and Equipment Purchase Orders)

## **A.6 Parts Identification**

Radio Products and Solutions Organization\*  
(United States and Canada)  
1-800-422-4210

## **A.7 Product Customer Service**

Radio Products and Solutions Organisation (United States and Canada)  
1-800-927-2744

\* The Radio Products and Solutions Organization (RPSO) was formerly known as the Radio Products Services Division (RPSD) and/or the Accessories and Aftermarket Division (AAD).



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## **Appendix B Motorola Service Centers**

### **B.1 Servicing Information**

If a unit requires further complete testing, knowledge and/or details of component level troubleshooting or service than is customarily performed at the basic level, please send the radio to a Motorola Service Center as listed below.

### **B.2 Motorola Service Center**

45D Butterfield Trail  
El Paso, TX 79906  
Tel: 1-800-227-6772

### **B.3 Motorola Federal Technical Center**

4395 Nicole Drive  
Lanham, MD 20706  
Tel: 1-800-969-6680  
Fax: 1-800-784-4133

### **B.4 Motorola Canadian Technical Logistics Center**

Motorola Canada Ltd.  
8133 Warden Avenue  
Markham, Ontario, L6G 1B3  
Tel: 1-800-543-3222  
Fax: 1-888-331-9872 or 1-905-948-5970

## Notes

# Glossary

This glossary contains an alphabetical listing of terms and their definitions that are applicable to portable and mobile subscriber radio products. All terms do not necessarily apply to all radios, and some terms are merely generic in nature.

Term	Definition
<b>Analog</b>	Refers to a continuously variable signal or a circuit or device designed to handle such signals.
<b>Band</b>	Frequencies allowed for a specific purpose.
<b>CPS</b>	Customer Programming Software: Software with a graphical user interface containing the feature set of a radio.
<b>Default</b>	A pre-defined set of parameters.
<b>Digital</b>	Refers to data that is stored or transmitted as a sequence of discrete symbols from a finite set; most commonly this means binary data represented using electronic or electromagnetic signals.
<b>DPL</b>	Digital Private-Line: A type of digital communication that utilizes privacy call, as well as memory channel and busy channel lock out to enhance communication efficiency.
<b>FCC</b>	Federal Communications Commission.
<b>Frequency</b>	Number of times a complete electromagnetic-wave cycle occurs in a fixed unit of time (usually one second).
<b>GPIO</b>	General-Purpose Input/Output: Pins whose function is programmable.
<b>GPS</b>	Global Positioning System
<b>IC</b>	Integrated Circuit: An assembly of interconnected components on a small semiconductor chip, usually made of silicon. One chip can contain millions of microscopic components and perform many functions.
<b>IF</b>	Intermediate Frequency.
<b>kHz</b>	kilohertz: One thousand cycles per second. Used especially as a radio-frequency unit.
<b>LCD</b>	Liquid-Crystal Display: An LCD uses two sheets of polarizing material with a liquid-crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them.
<b>LED</b>	Light Emitting Diode: An electronic device that lights up when electricity is passed through it.
<b>MDC</b>	Motorola Digital Communications.
<b>MHz</b>	Megahertz: One million cycles per second. Used especially as a radio-frequency unit.
<b>Paging</b>	One-way communication that alerts the receiver to retrieve a message.

Term	Definition
<b>PC Board</b>	Printed Circuit Board. Also referred to as a PCB.
<b>PL</b>	Private-Line Tone Squelch: A continuous sub-audible tone that is transmitted along with the carrier.
<b>Programming Cable</b>	A cable that allows the CPS to communicate directly with the radio using USB.
<b>Receiver</b>	An electronic device that recovers information from a modulated RF signal. A receiver separates the audio signal from the RF carrier, amplifies it, and converts it back to the original sound waves.
<b>Repeater</b>	Remote transmit/receive facility that re-transmits received signals in order to improve communications range and coverage (conventional operation).
<b>RF</b>	Radio Frequency: The portion of the electromagnetic spectrum between audio sound and infrared light (approximately 10 kHz to 10 GHz).
<b>RX</b>	Receive.
<b>Signal</b>	An electrically transmitted electromagnetic wave.
<b>Spectrum</b>	Frequency range within which radiation has specific characteristics.
<b>Squelch</b>	Muting of audio circuits when received signal levels fall below a pre-determined value. With carrier squelch, all channel activity that exceeds the radio's preset squelch level can be heard.
<b>TOT</b>	Time-out Timer: A timer that limits the length of a transmission.
<b>TPL</b>	Tone Private Line
<b>Transceiver</b>	Transmitter-receiver. A device that both transmits and receives analog or digital signals. Also abbreviated as XCVR.
<b>Transmitter</b>	Electronic equipment that generates and amplifies an RF carrier signal, modulates the signal, and then radiates it into space.
<b>TX</b>	Transmit.
<b>UHF</b>	Ultra-High Frequency.
<b>USB</b>	Universal Serial Bus: An external bus standard that supports data transfer rates of 12 Mbps.
<b>USB_DM_MAP</b>	USB D- Connection at the rear accessory connector.
<b>USB_DP_MAP</b>	USB D+ Connection at the rear accessory connector.
<b>VHF</b>	Very High Frequency.
<b>VIP</b>	Vehicle Interface Port.
<b>XPR</b>	Refers to Digital Professional Radio model names in the Professional Digital Two-Way Radio System.





**MOTOROLA**

Motorola Inc.  
1301 E. Algonquin Rd.  
Schaumburg, IL 60196-1078, U.S.A.

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