

Professional Digital Two-Way Radio System

MOTOTRBO™ Mobile

Detailed Service Manual

DM 3400 Numeric Display Mobile

DM 3401 Numeric Display Mobile (with GPS)

DM 3600 Display Mobile

DM 3601 Display Mobile (with GPS)



Foreword

This manual covers all DM Series Mobiles, unless otherwise specified. This manual provides sufficient information to enable qualified service technicians to troubleshoot and repair DM 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 ICNIRP/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 6866537D37) 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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Document History

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

Edition	Description	Date
6866575D40-A	Initial edition	June 2007
6866575D40-B	Added VHF Low Power Band Information. Added issue C boards to all bands.	Nov. 2007

Notes

DM 3400/DM 3401/ DM 3600/DM 3601 Mobile Radios

Detailed Service Manual

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**DM 3400/DM 3401/
DM 3600/DM 3601
Mobile Radios**

Chapter 1

Service Maintainability

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Chapter 1 - Service Maintainability

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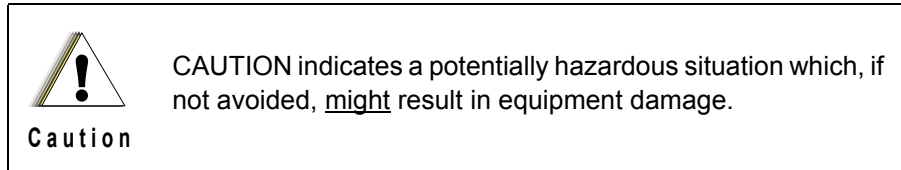
Section 1

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 DM series 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
VHF	136–174 MHz	1-25 Watts 25-45 Watts
UHF B1	403–470 MHz	1-25 Watts 25-40 Watts

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

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).

2.1 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.

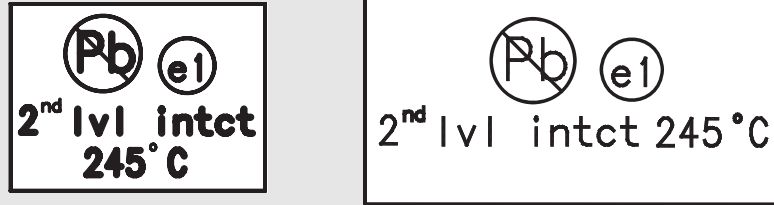
**Caution**

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.

2.2 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 (*)	Aeroflex 2975 (www.aeroflex.com), Motorola R2670, or equivalent.	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital RMS Multimeter*	100 μ V to 300 V 5 Hz to 1 MHz 10 Meg Ohm Impedance	Fluke 179 or equivalent (www.fluke.com)	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 (www.agilent.com), Ramsey RSG1000B (www.ramseyelectronics.com), or equivalent	Receiver measurements
Oscilloscope*	2 Channel 50 MHz Bandwidth 5 mV/div to 20 V/div	Leader LS8050 (www.leaderusa.com), Tektronix TDS1001b (www.tektronix.com), or equivalent	Waveform measurements
Power Meter and Sensor*	5% Accuracy 100 MHz to 500 MHz 50 Watts	Bird 43 Thruline Watt Meter (www.bird-electronic.com) or equivalent	Transmitter power output measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 92EA (www.boonton.com) or equivalent	RF level measurements
Power Supply	0 V to 32 V 0 A to 20 A	B&K Precision 1790 (www.bkprecision.com) 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.
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.
HPN4008_	Power Supply 1-25W	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_

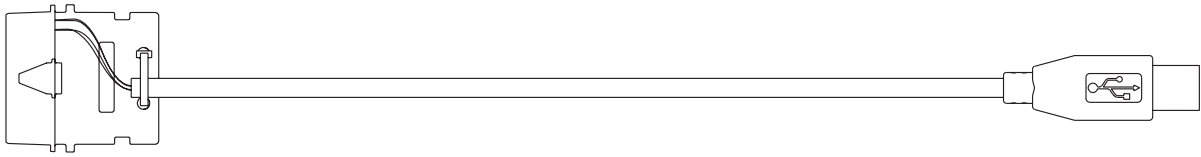


Figure 3-2 Mobile & Repeater Rear Programming Cable PMKN4010_

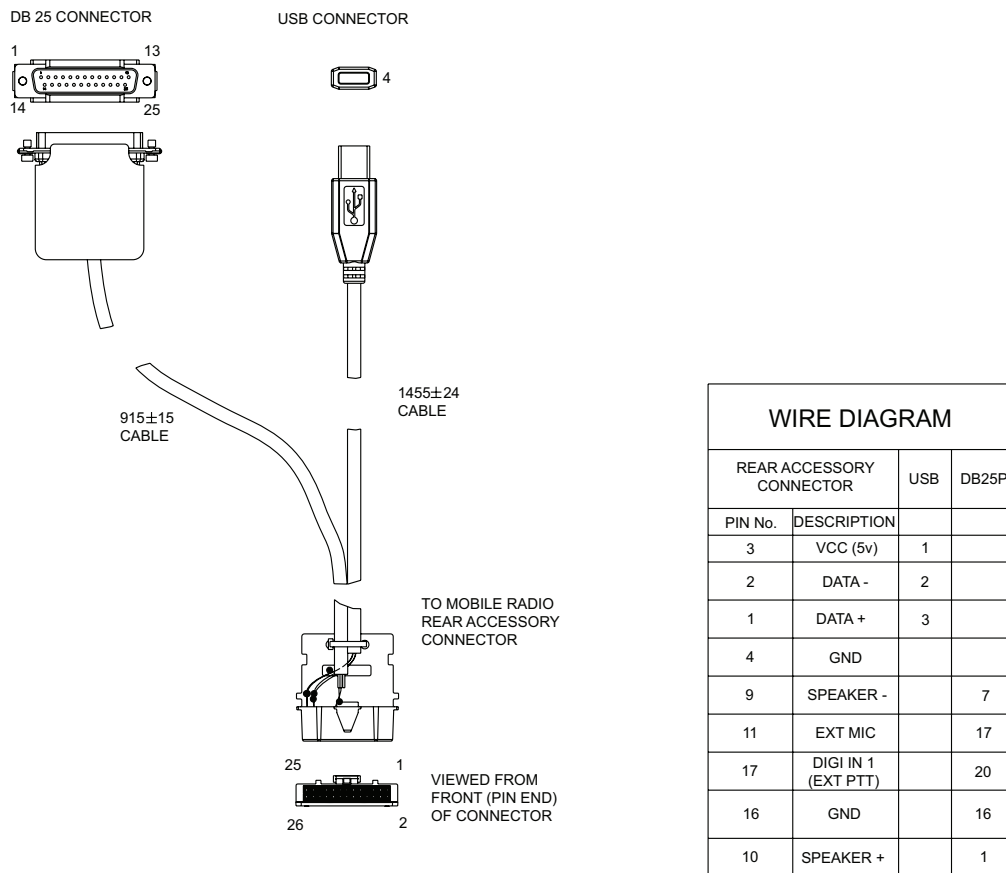


Figure 3-3 Mobile & Repeater Rear Accessory Programming and Test Cable PMKN4016_

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

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

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"> •Reflash the tuning codeplug. •Reflash the entire codeplug. •Replace radio by sending to the nearest Motorola Depot.
ERROR 002	Personality Checksum or System Block Error	NON-FATAL	<ul style="list-style-type: none"> •Reflash the entire codeplug.



**DM 3400/DM 3401/
DM 3600/DM 3601
Mobile Radios**

Chapter 2

Control Head

Service Information

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Chapter 2 - Control Head Service Information

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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.



Section 2

THEORY OF OPERATION

1.0 Introduction

There are two different Control Heads supported by the DM 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

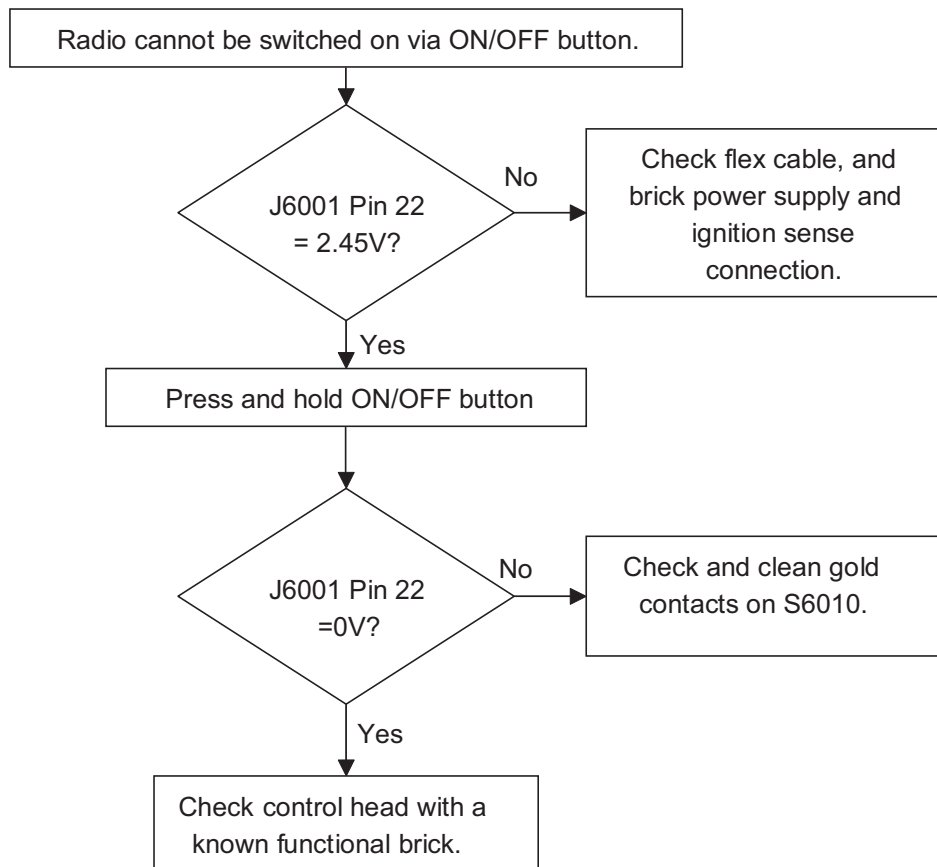
The volume control is facilitated by the digital encoder S6010. Pins 1 and 3 of S6010 are connected to the radio OMAP processor (U1000) via J6001, pins 13 and 14. There are active pull-ups internal to the OMAP. When S6010 is rotated, active low pulses are generated on both pins in off-phase pattern.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

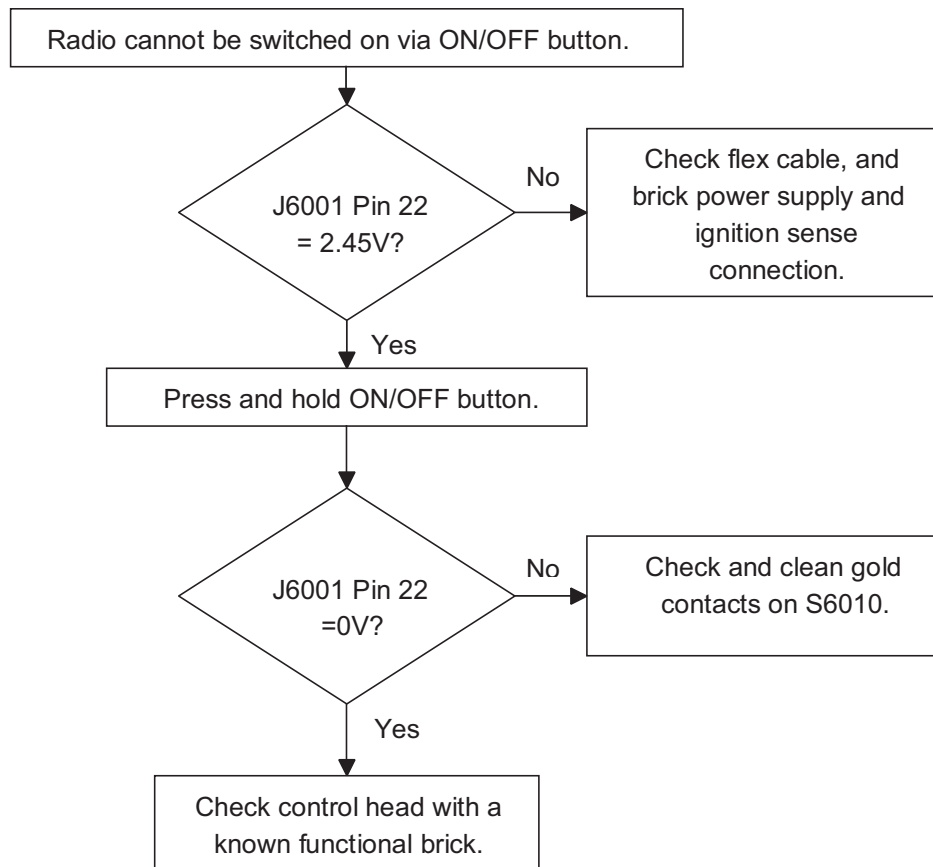
1.0 Numeric Display Model Control Head Troubleshooting Flow Chart

1.1 On/Off

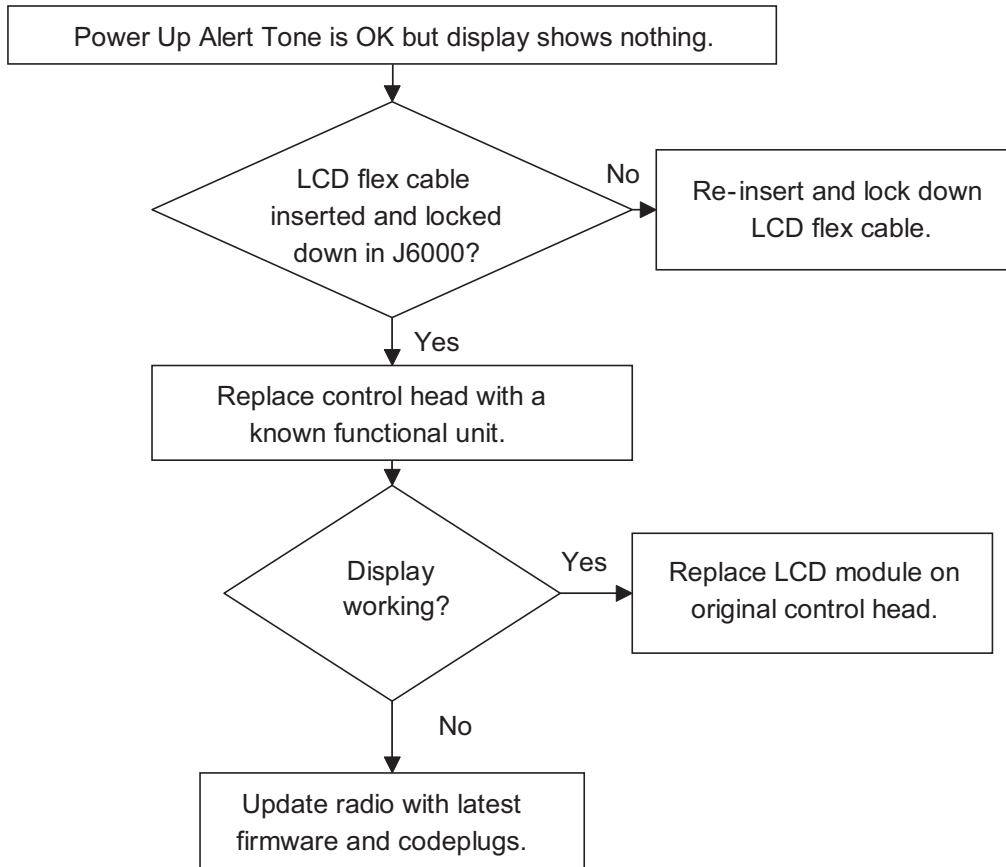


2.0 Display Model Control Head Troubleshooting Flow Chart

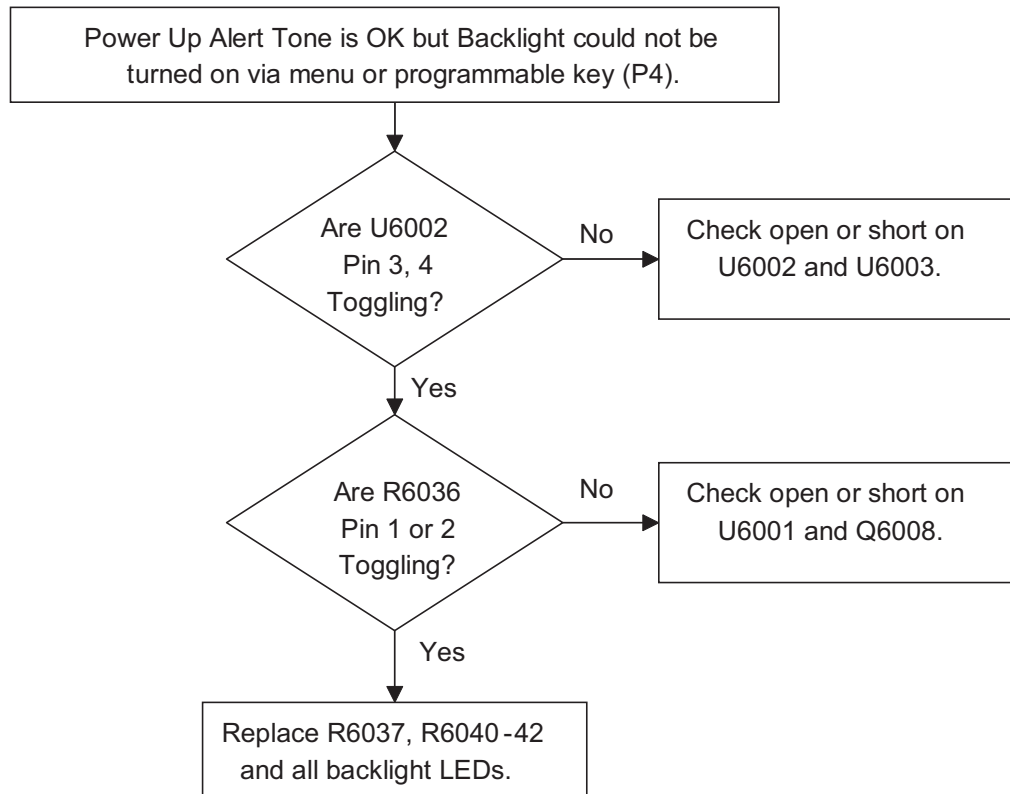
2.1 On/Off



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

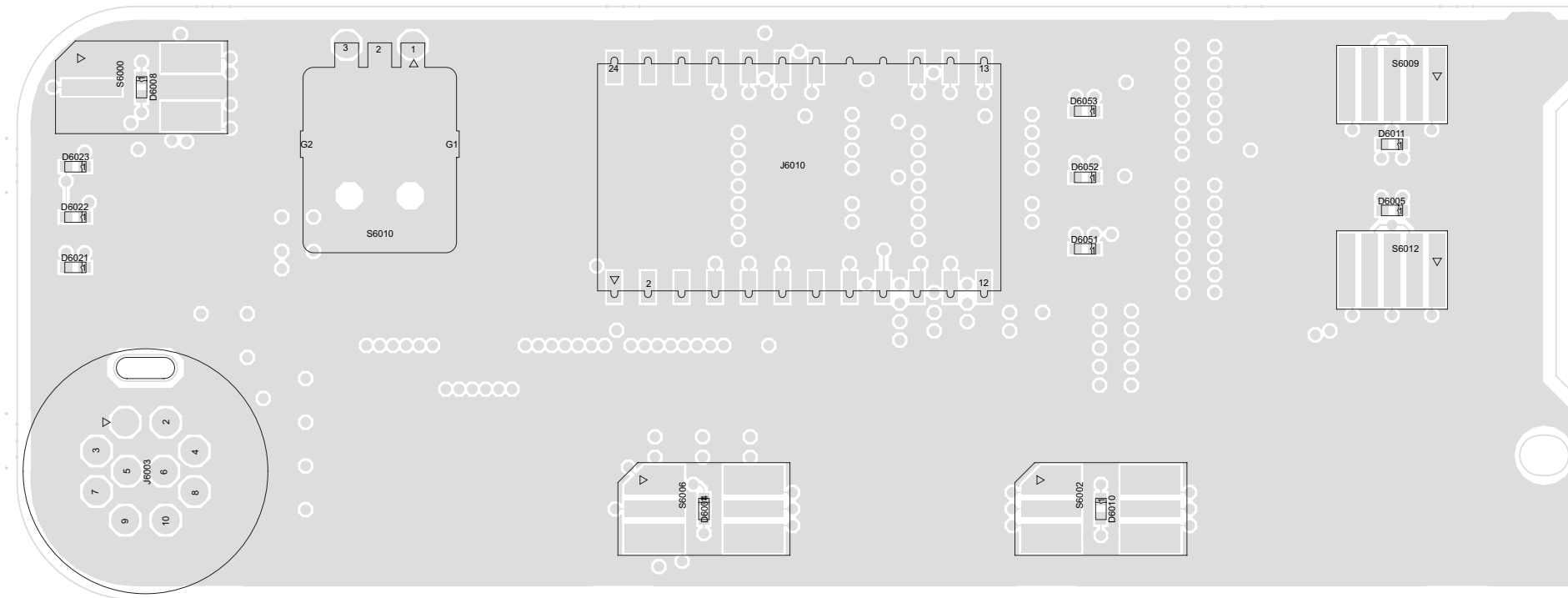
PCB : Numeric Display Control Head 8471214H02 Main Board Top Side 8471214H02 Main Board Bottom Side	Page 4-3 Page 4-3
SCHEMATICS Numeric Display Control Head Schematic Diagram	Page 4-4
Parts List 8471214H02	Page 4-5

Table 4-2 Display Control Head Diagrams and Parts List

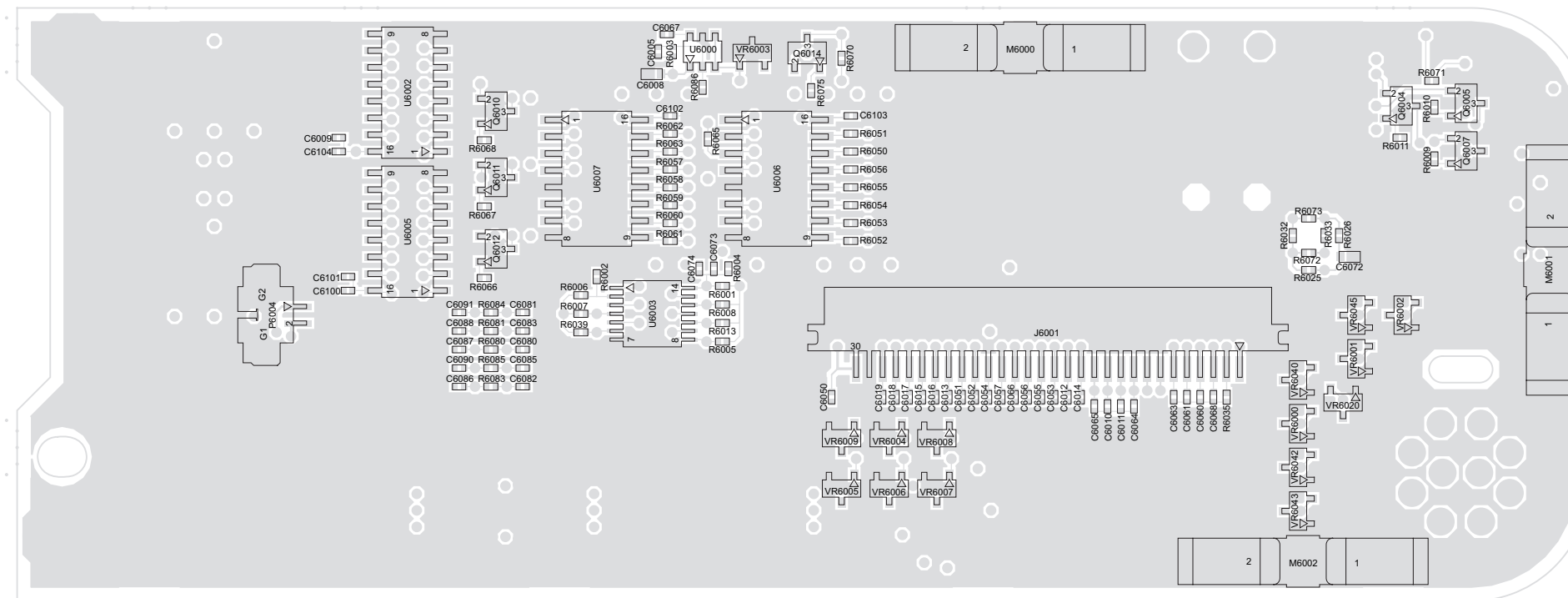
PCB : Display Control Head 8415026C08 Main Board Top Side 8415026C08 Main Board Bottom Side	Page 4-6 Page 4-6
SCHEMATICS Display Control Head Schematic Diagram	Page 4-7
Parts List 8415026C08	Page 4-8

Notes

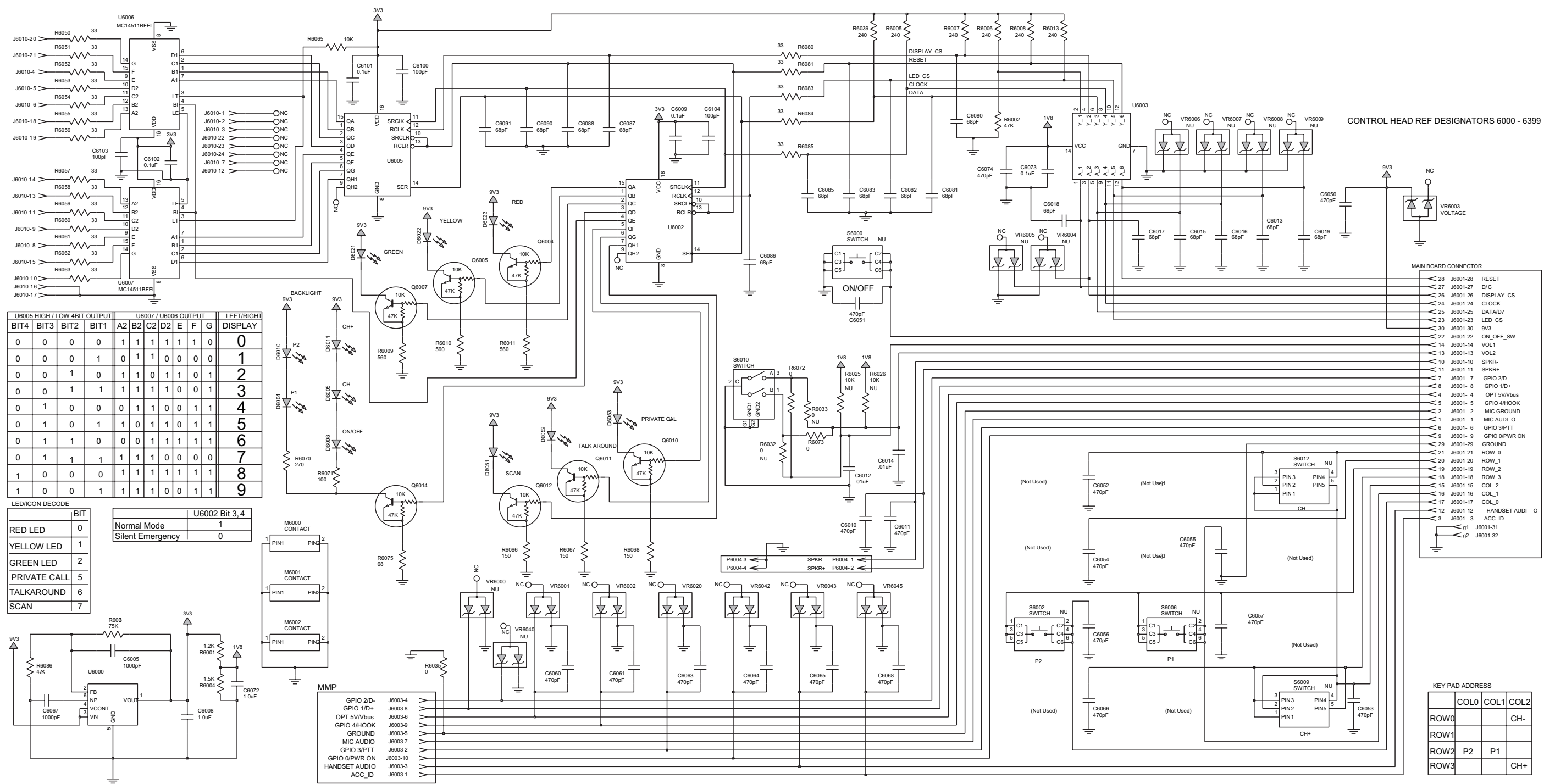
2.0 Numeric Display Control Head - PCB 8471214H02 / Schematics



Top Side View



Bottom Side View



Numeric Display Control Head Schematic Diagram

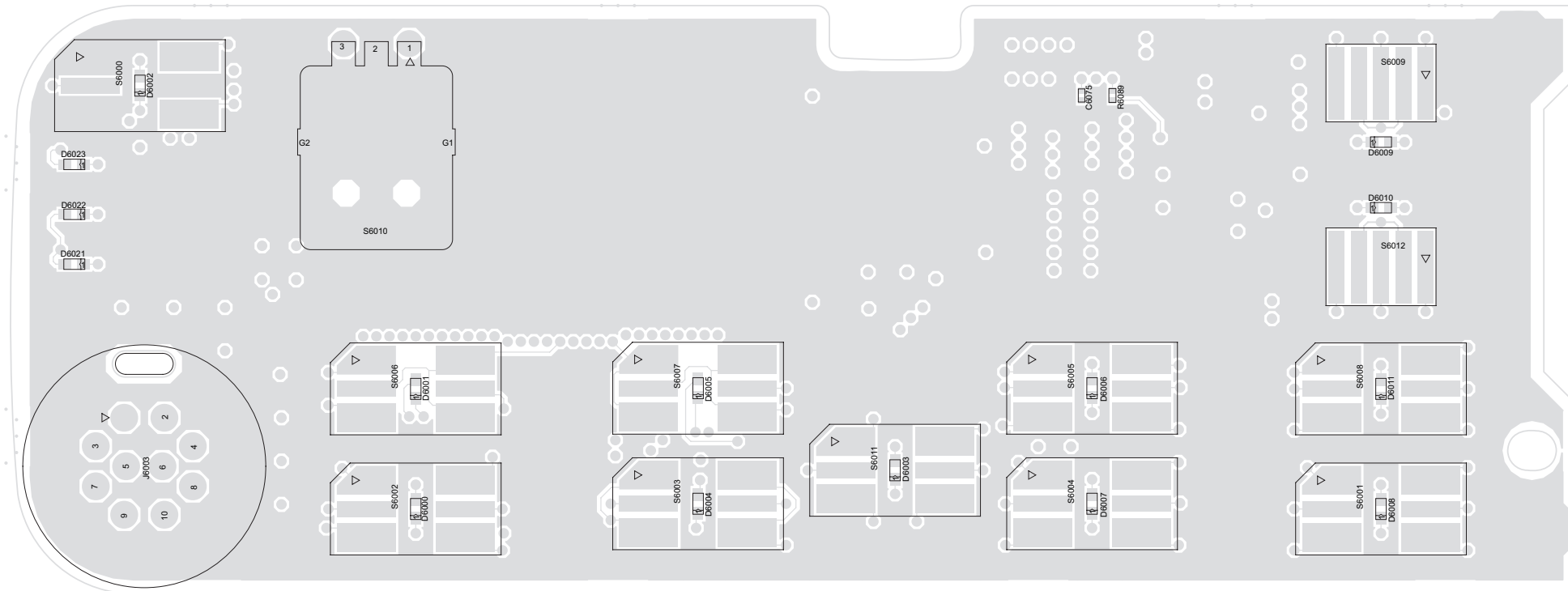
3.0 Numeric Display Control Head Parts List

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

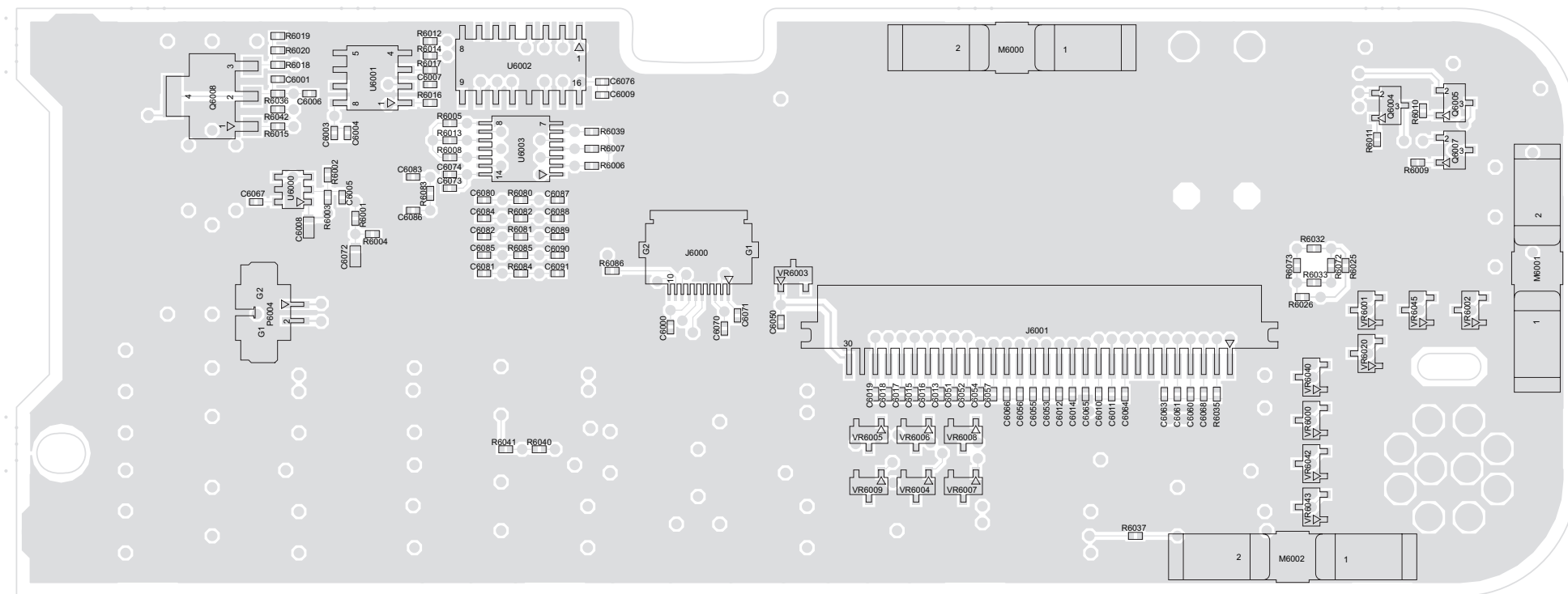
Circuit Ref	Motorola Part No.	Description
D6005	4815809H04	LED GREEN
D6008	4815809H04	LED GREEN
D6010	4815809H04	LED GREEN
D6011	4815809H04	LED GREEN
D6021	4815809H04	LED GREEN
D6022	4815809H03	LED YELLOW
D6023	4815809H02	LED RED
D6051	4815809H04	LED GREEN
D6052	4815809H04	LED GREEN
D6053	4815809H04	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	10K
R6026	NOT PLACED	10K
R6032	NOT PLACED	0
R6033	NOT PLACED	0
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	DIODE, 5.6V ZENER
VR6001	4813977A43	DIODE, 5.6V ZENER
VR6002	4813977A43	DIODE, 5.6V ZENER
VR6003	4813977A48	DIODE, 20V ZENER
VR6004	NOT PLACED	DIODE, 5.6V ZENER
VR6005	NOT PLACED	DIODE, 5.6V ZENER
VR6006	NOT PLACED	DIODE, 5.6V ZENER
VR6007	NOT PLACED	DIODE, 5.6V ZENER
VR6008	NOT PLACED	DIODE, 5.6V ZENER
VR6009	NOT PLACED	DIODE, 5.6V ZENER
VR6020	4813977A43	DIODE, 5.6V ZENER
VR6040	NOT PLACED	DIODE, 5.6V ZENER
VR6042	4813977A43	DIODE, 5.6V ZENER
VR6043	4813977A43	DIODE, 5.6V ZENER
VR6045	4813977A43	DIODE, 5.6V ZENER

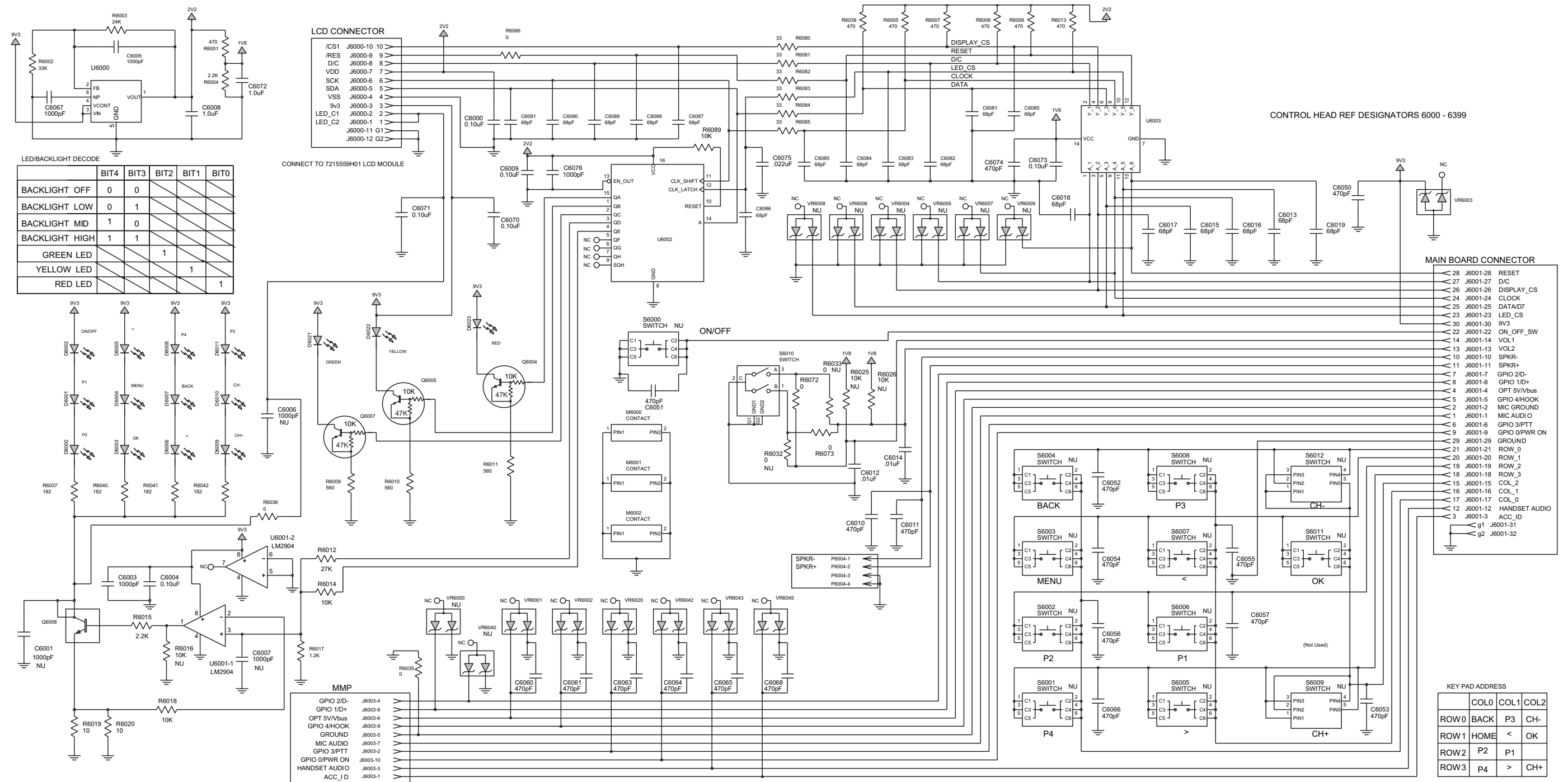
4.0 Display Control Head - PCB 8415026C08 / Schematics



Top Side View



Bottom Side View



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	1000pF
C6003	2113945A09	1000pF
C6004	2113945Y02	0.10uF
C6005	2113945A09	1000pF
C6006	NOT PLACED	1000pF
C6007	NOT PLACED	1000pF
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	10K
R6017	0613952Q75	1.2K
R6018	0613952R01	10K
R6019	0613952Q25	10

Circuit Ref	Motorola Part No.	Description
R6020	0613952Q25	10
R6025	NOT PLACED	10K
R6026	NOT PLACED	10K
R6032	NOT PLACED	0
R6033	NOT PLACED	0
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	DIODE, 5.6V ZENER
VR6001	4813977A43	DIODE, 5.6V ZENER
VR6002	4813977A43	DIODE, 5.6V ZENER
VR6003	4813977A48	DIODE, 20V ZENER
VR6004	NOT PLACED	DIODE, 5.6V ZENER
VR6005	NOT PLACED	DIODE, 5.6V ZENER
VR6006	NOT PLACED	DIODE, 5.6V ZENER
VR6007	NOT PLACED	DIODE, 5.6V ZENER
VR6008	NOT PLACED	DIODE, 5.6V ZENER
VR6009	NOT PLACED	DIODE, 5.6V ZENER
VR6020	4813977A43	DIODE, 5.6V ZENER
VR6040	NOT PLACED	DIODE, 5.6V ZENER
VR6042	4813977A43	DIODE, 5.6V ZENER
VR6043	4813977A43	DIODE, 5.6V ZENER
VR6045	4813977A43	DIODE, 5.6V ZENER



**DM 3400/DM 3401/
DM 3600/DM 3601
Mobile Radios**

Chapter 3

Controller

Service Information

Computer Software Copyrights

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Chapter 3 - Controller Service Information

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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 DM 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.

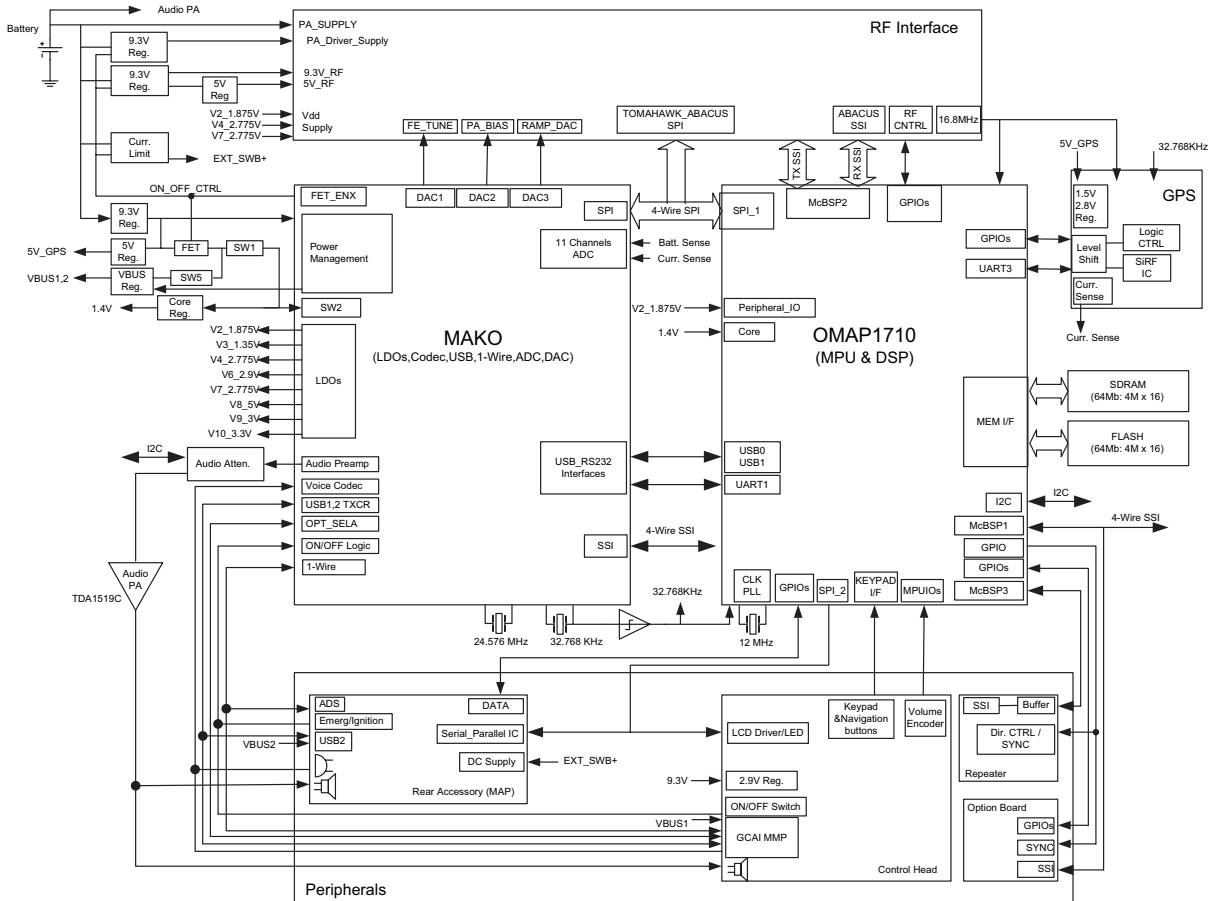


Figure 1-1 Controller Block Diagram

1.1 Radio Power Distribution

Figure 1-2 illustrates the controller DC power distribution throughout the transceiver board.

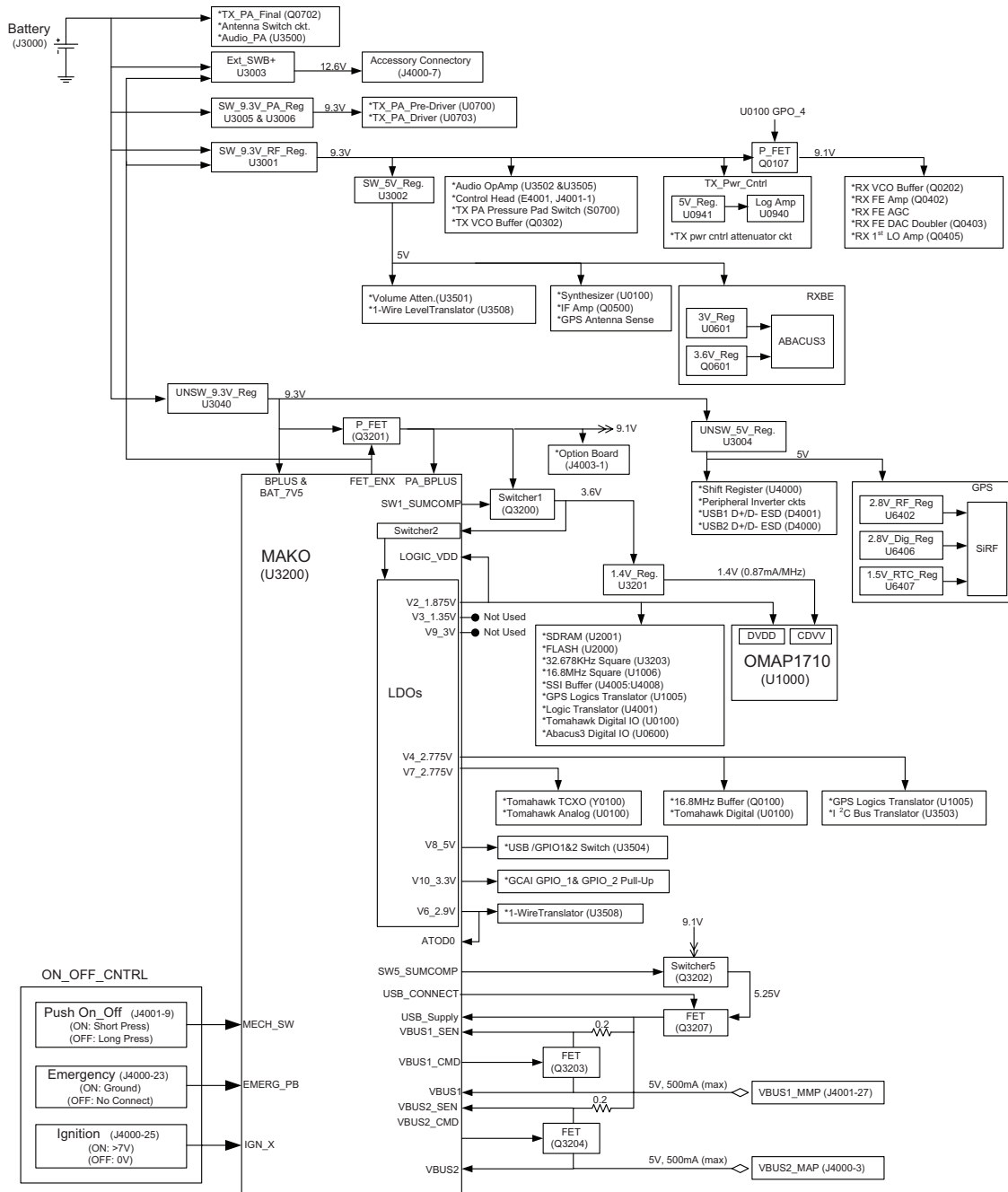


Figure 1-2 Radio Power Distribution

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 that occur sequentially.

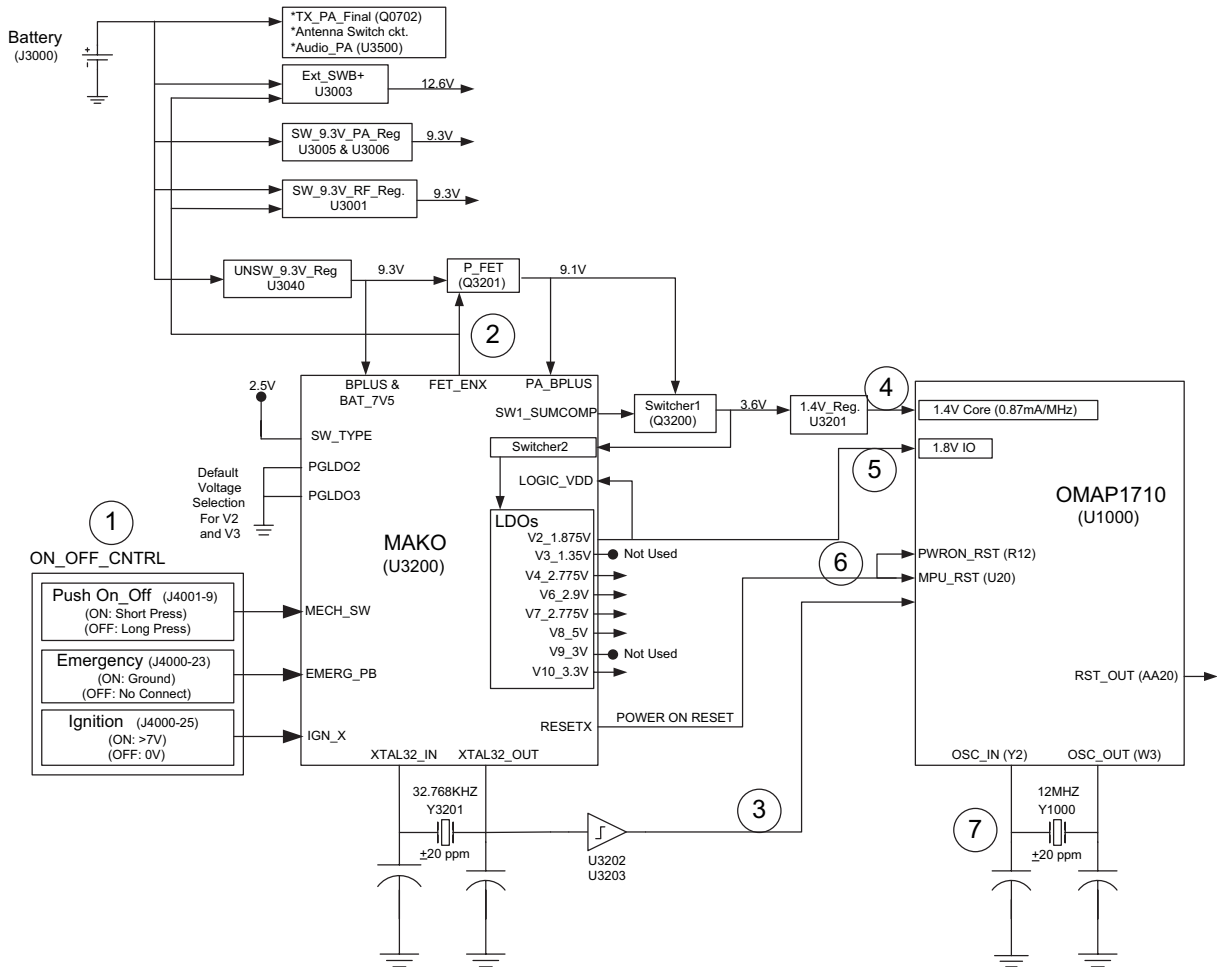


Figure 1-3 Power-Up Sequence

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.

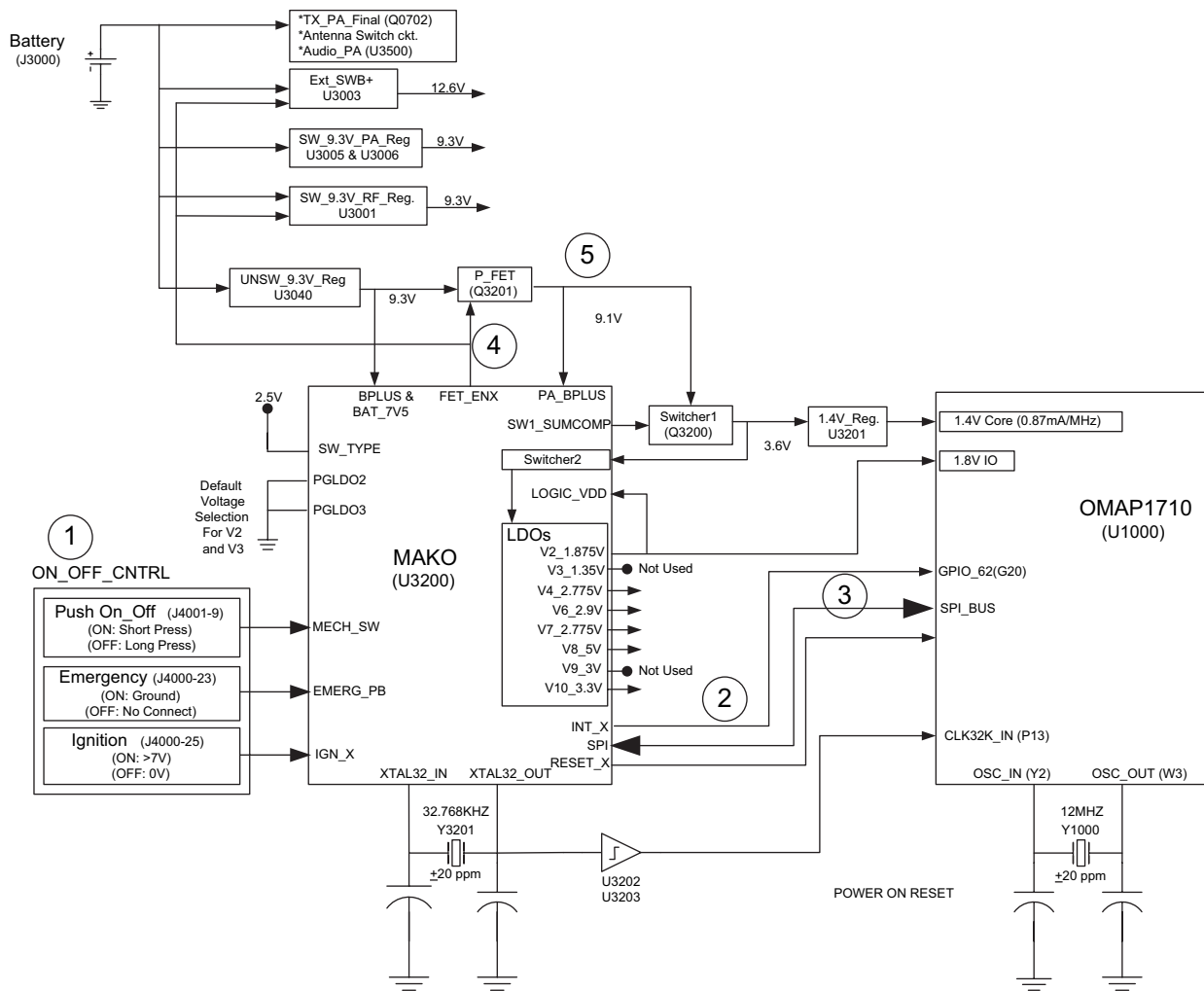


Figure 1-4 Power-Down Sequence

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.

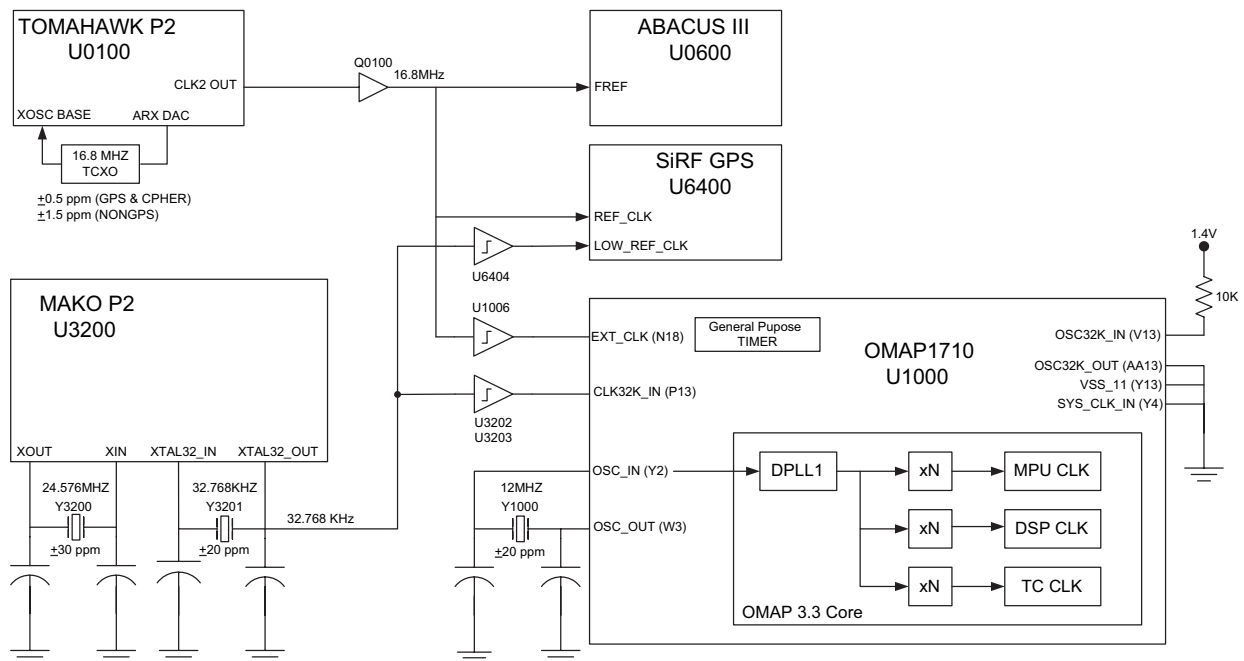


Figure 1-5 Clock Connections

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 Tomahawk 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 throughout the radio.

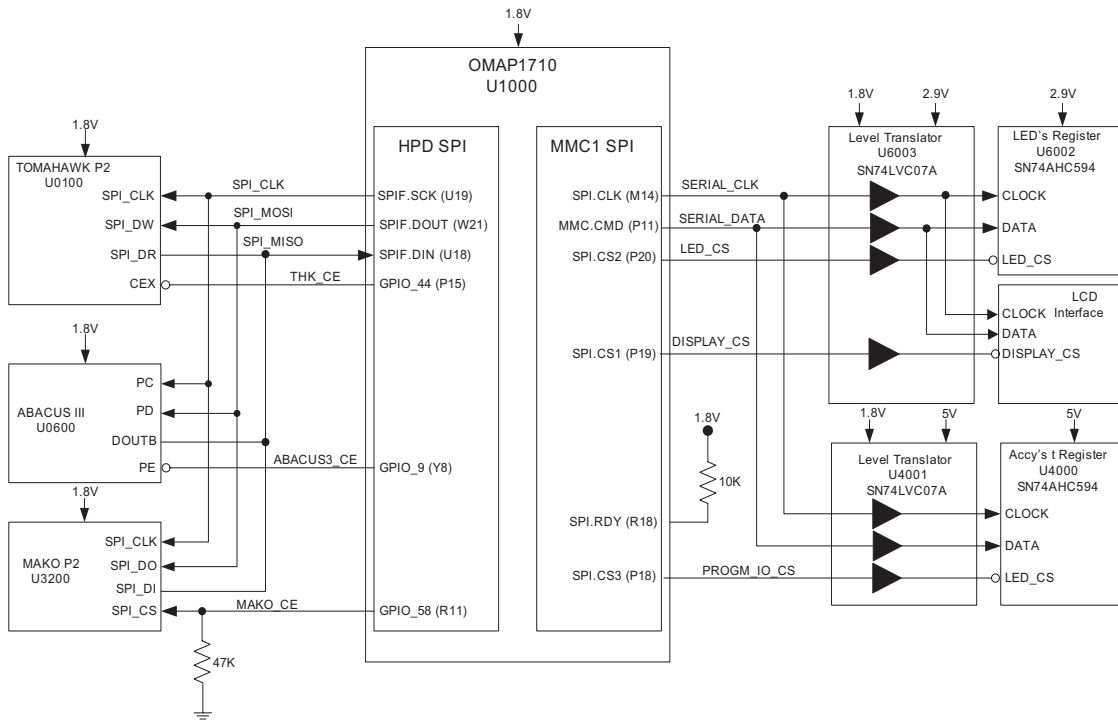


Figure 1-6 SPI Connections

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 Tomahawk (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.

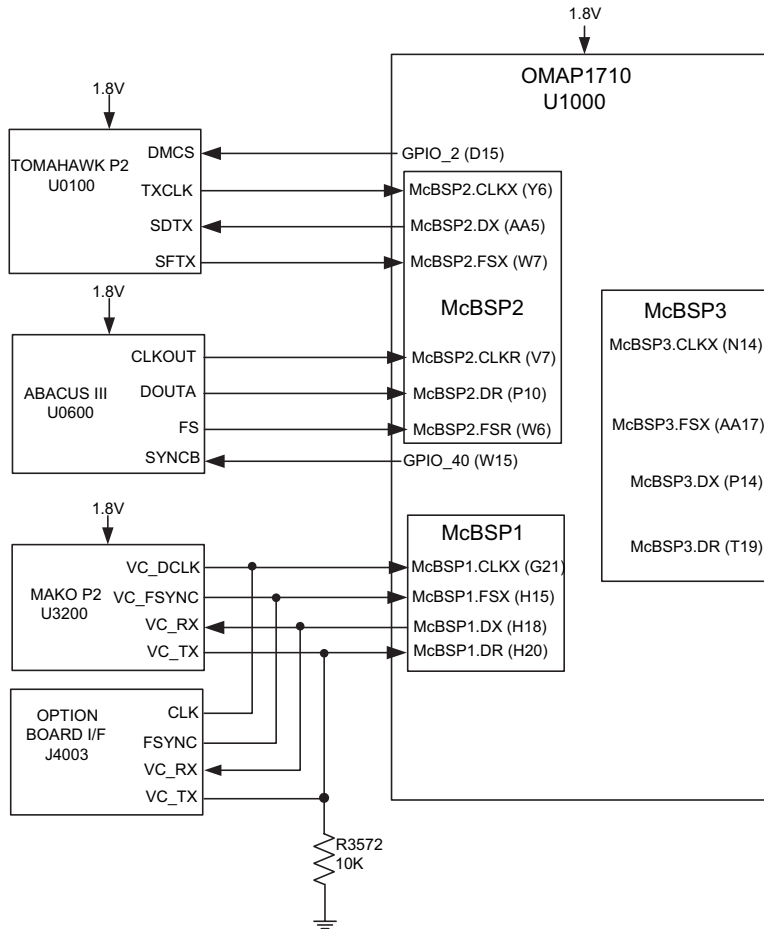


Figure 1-7 SSI Connections

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 Tomahawk, 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 Tomahawk 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.

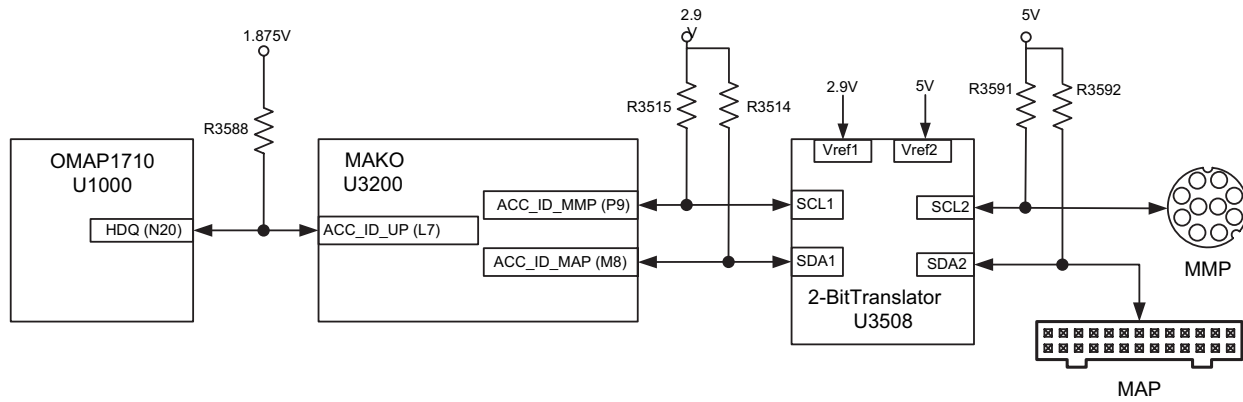


Figure 1-8 ACC_ID Interface Connections

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.

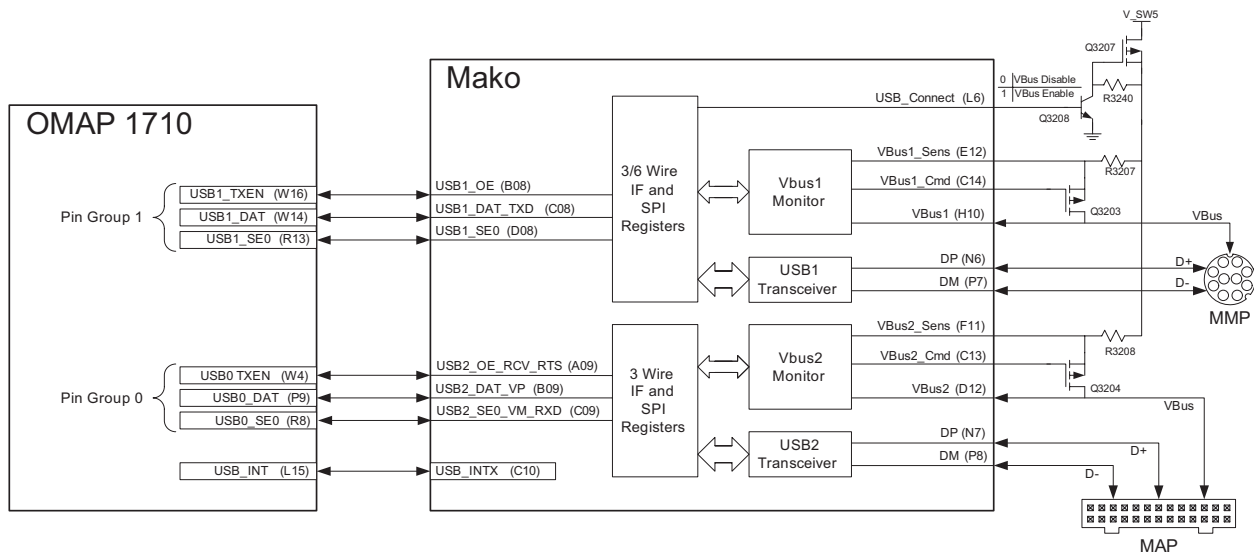


Figure 1-9 USB Interface Connections

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.

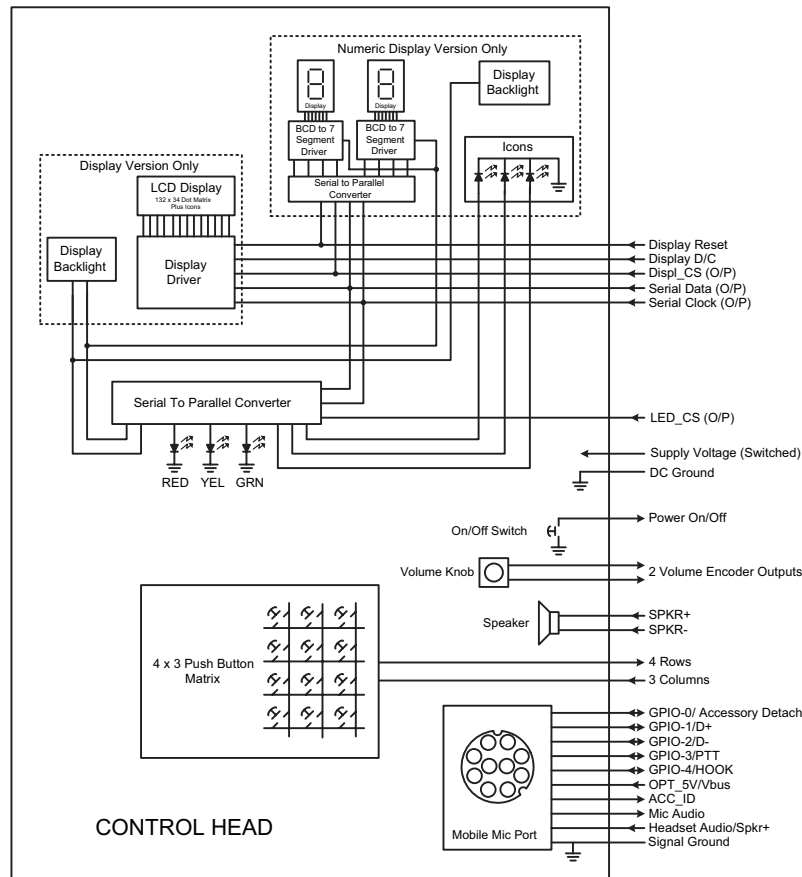


Figure 1-10 Control Head Block Diagram

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.

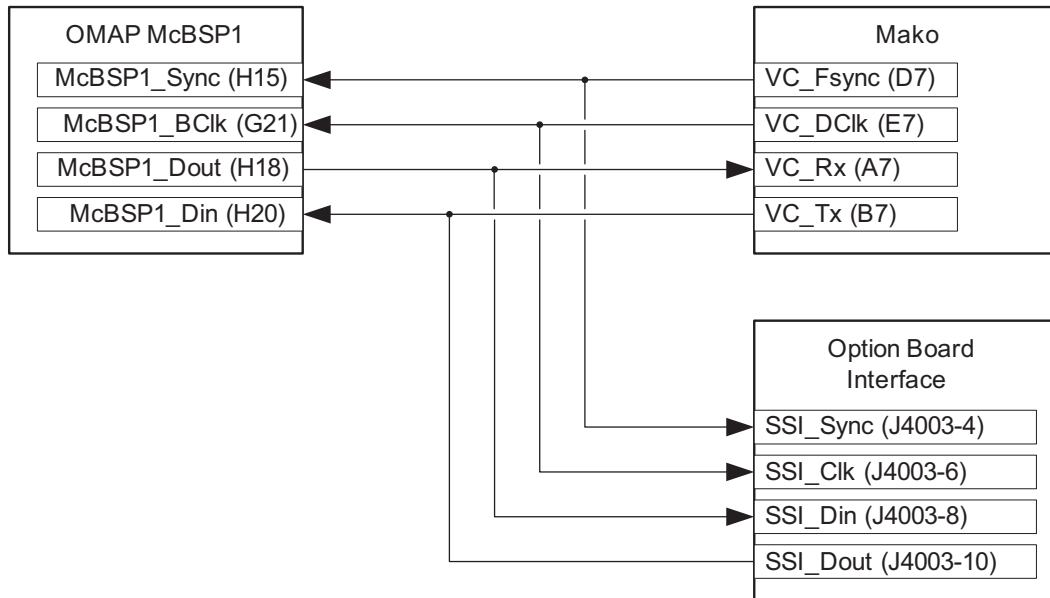


Figure 1-11 Option Board SSI Connections and Data Flow

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

Table 1-3 Option Board Interface Signal Functions

Signal	I/O Relative To Option Board	Function
Opt_GPIO_1	Bidirectional	General purpose bidirectional I/O. Can be used for signaling between the option board and the OMAP.
Opt_GPIO_2	Bidirectional	General purpose bidirectional I/O. Can be used for signaling between the option board and the OMAP.
Opt_Brd_PTT	Output	Push To Talk signal from the option board.
SW_9V3	Input	Switched supply for the option board.

1.11 Audio

The audio circuitry consists of both analog and digital audio paths. Figure 1-12 shows the basic block diagram of the audio interconnections.

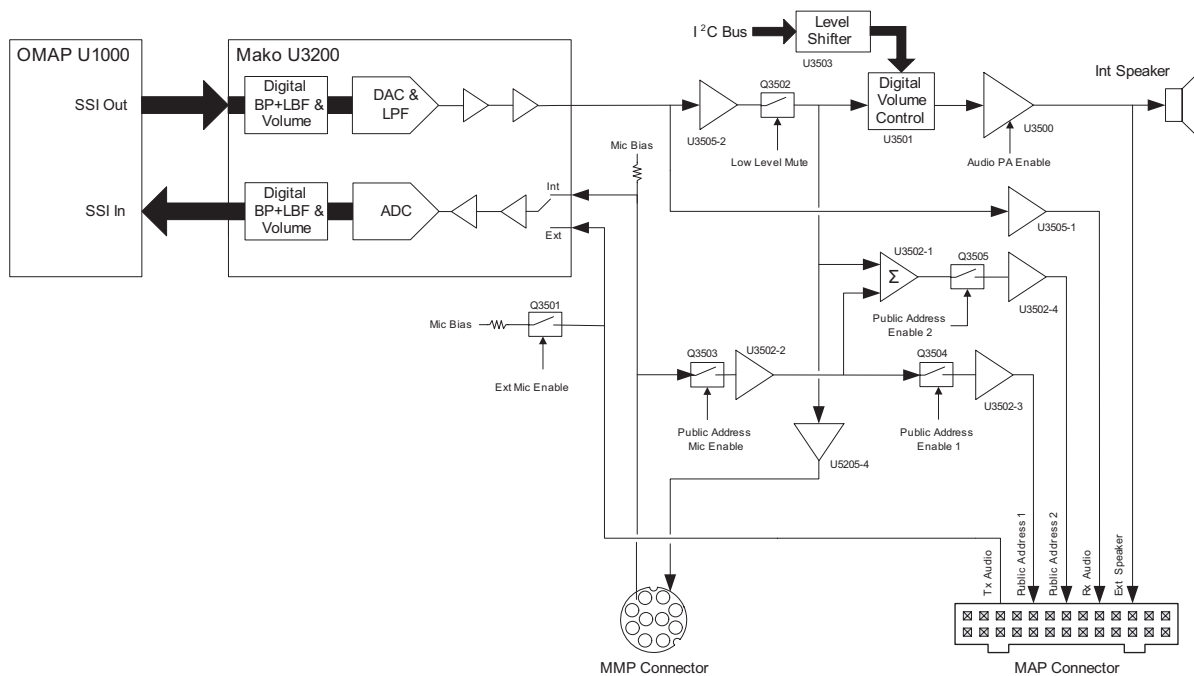


Figure 1-12 Audio Block Diagram

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 with the option of disabling the 9.3V bias on the MAP microphone path through Q3501. 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.

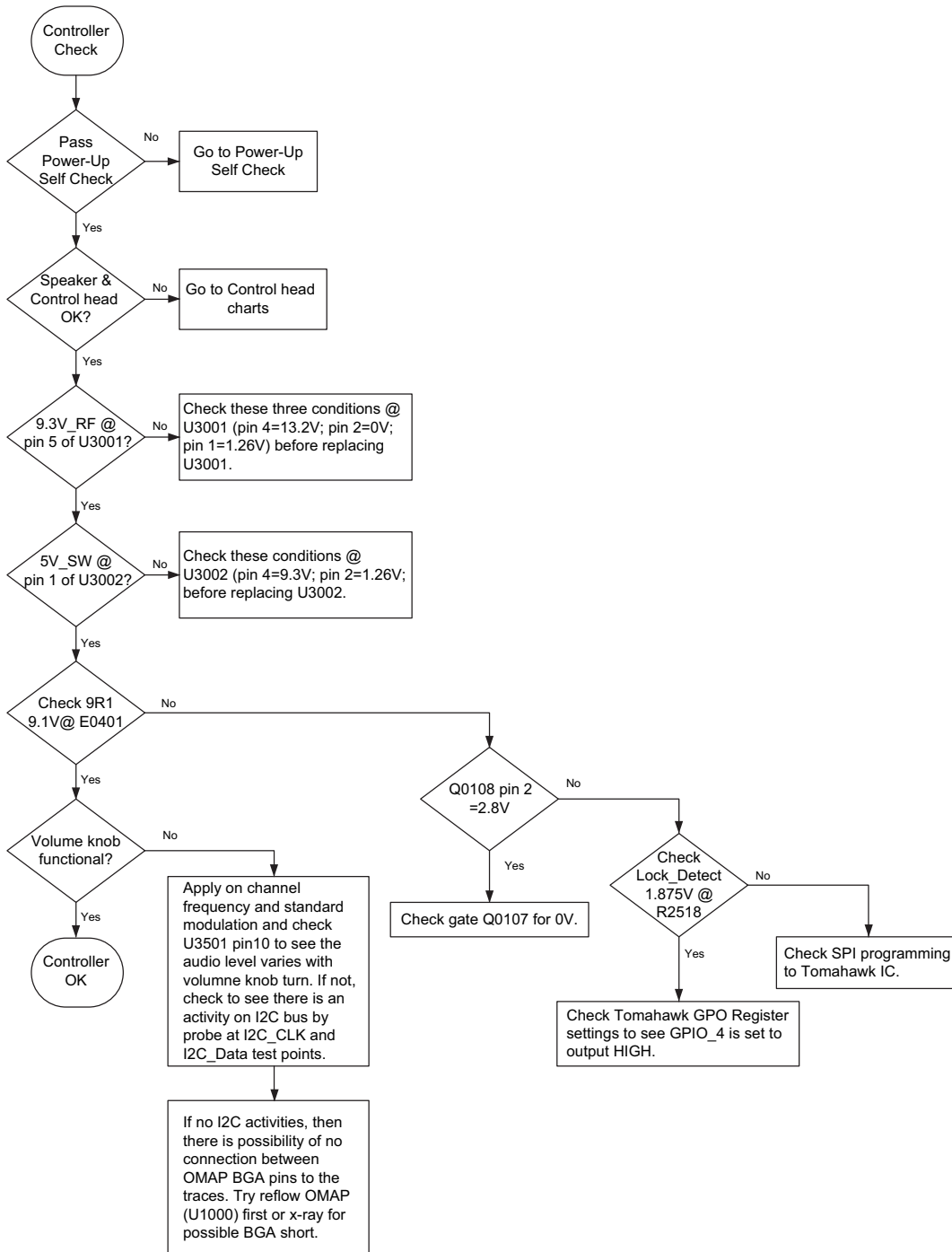
The transmit gain stages in the MAKO is calibrated based on an 80mV input under standard test conditions. The microphone sensitivity is programmable through the use of CPS.

Notes

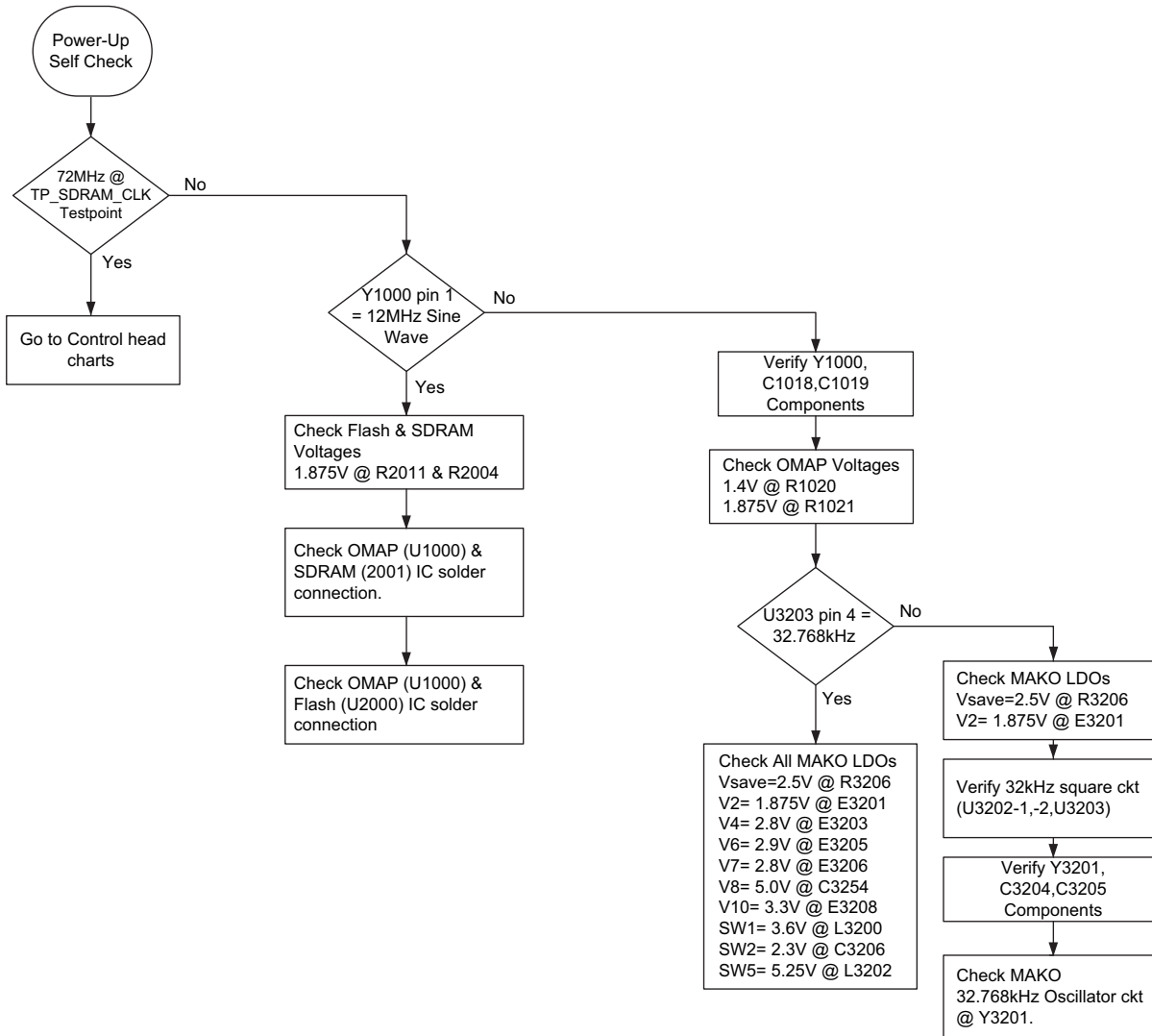
Section 2

TROUBLESHOOTING CHARTS

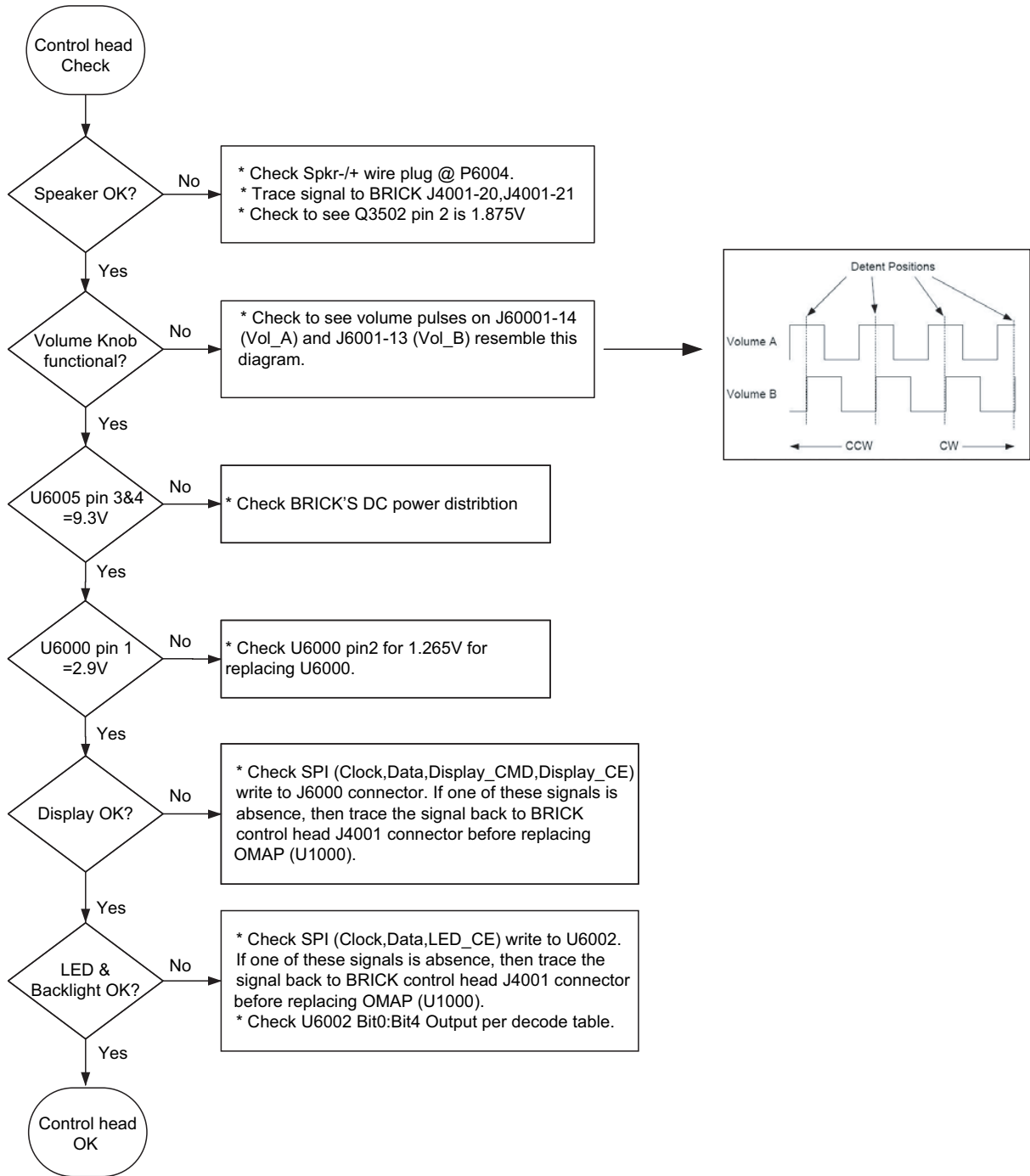
1.0 Controller Troubleshooting Chart



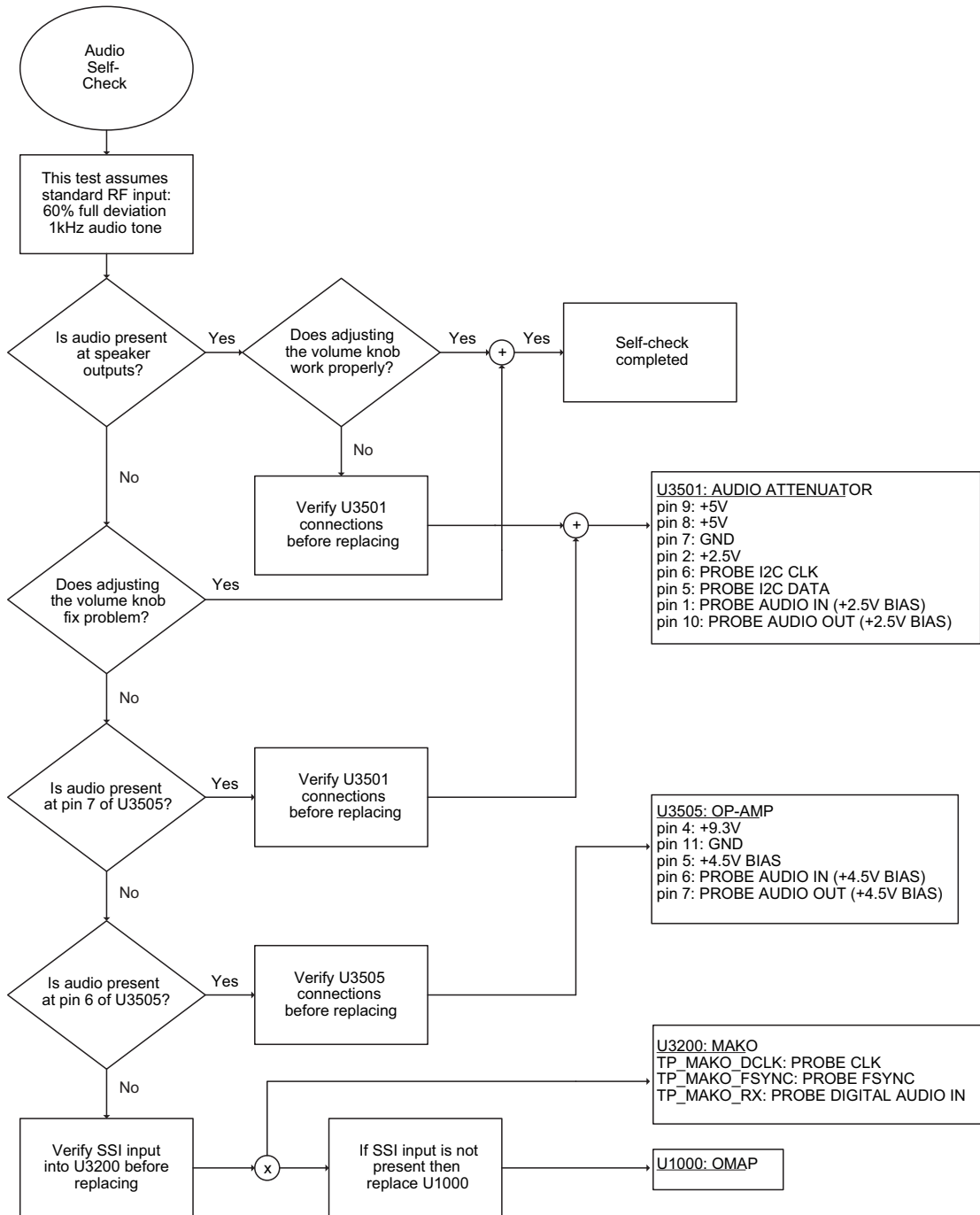
2.0 Power-Up Troubleshooting Chart



3.0 Control Head Troubleshooting Chart



4.0 Audio Troubleshooting Chart



Section 3

CONTROLLER SCHEMATICS / PARTS LISTS

1.0 Allocation of Schematics and Parts List

1.1 Controller Circuits

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

Table 3-1 Controller GPS R1 Schematic Diagrams and Parts List

Controller R1 used on PCB: 8471165L03_A UHF (403-470 MHz), 1-25 W 8486777Z12_A UHF (403-470 MHz), 25-40 W	
SCHEMATICS Controller GPS DC Supply DC Distribution Peripheral (sheet 1 of 2) Peripheral (sheet 2 of 2) Microprocessor Memories Audio and USB	Page 3-3 Page 3-4 Page 3-5 Page 3-6 Page 3-7 Page 3-8 Page 3-9 Page 3-10
Parts List Controller	Page 3-11

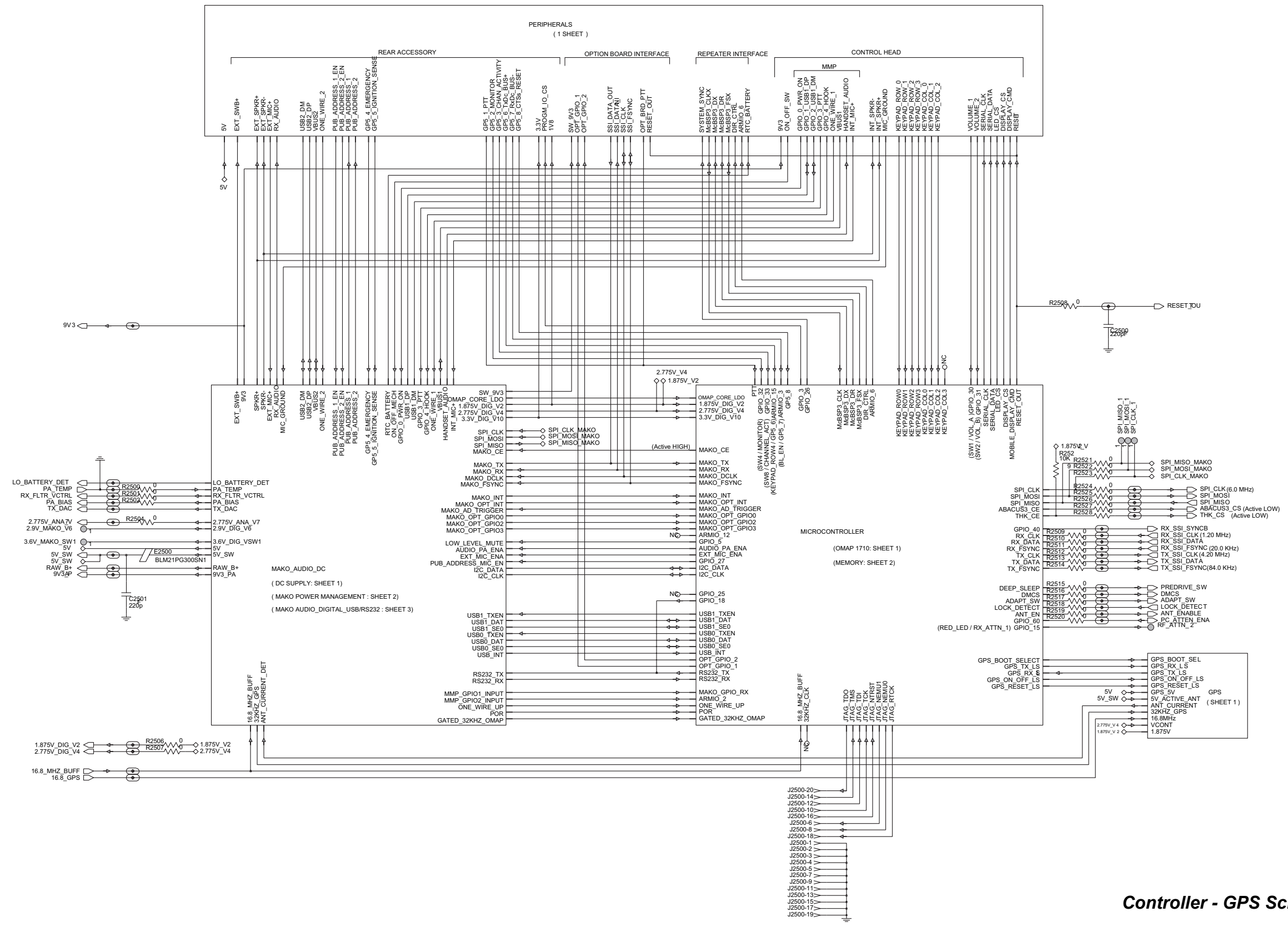
Table 3-2 Controller GPS R2 Schematic Diagrams and Parts List

Controller R2 used on PCB: 8471495L01_A VHF (136-174 MHz), 1-25 W 8478023A12_A VHF (136-174 MHz), 25-45 W	
SCHEMATICS Controller GPS DC Supply DC Distribution Peripheral (sheet 1 of 2) Peripheral (sheet 2 of 2) Microprocessor Memories Audio and USB	Page 3-17 Page 3-18 Page 3-19 Page 3-20 Page 3-21 Page 3-22 Page 3-23 Page 3-24
Parts List Controller	Page 3-25

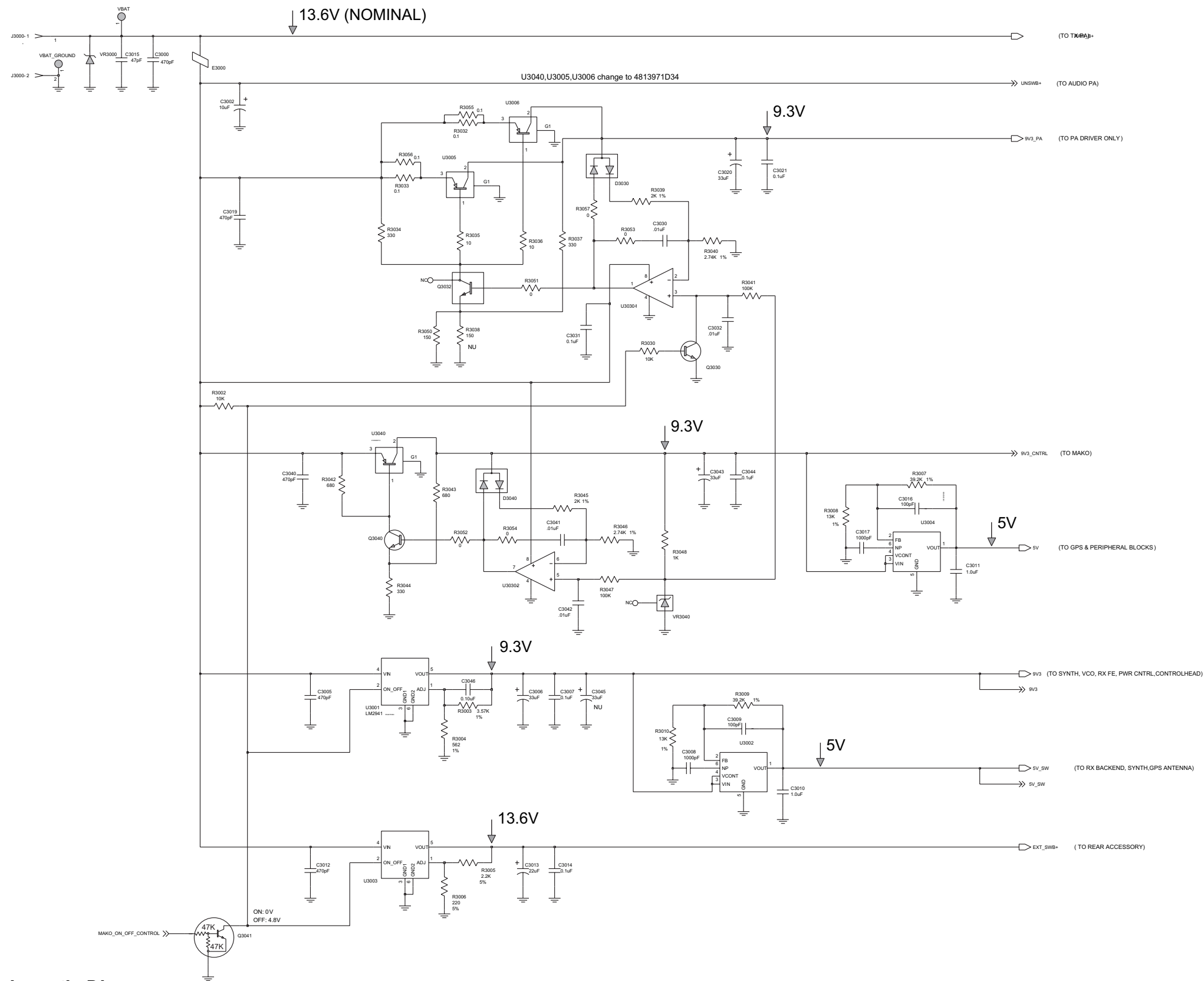
Table 3-3 Controller GPS R4 Schematic Diagrams and Parts List

Controller R4 used on PCB: 8471495L03_C VHF (136-174 MHz), 1-25 W 8478023A16_C VHF (136-174 MHz), 25-45 W 8471165L05_C UHF (403-470 MHz), 1-25 W 8486777Z14_C UHF (403-470 MHz), 25-40 W	
SCHEMATICS Controller GPS DC Supply DC Distribution Peripheral (sheet 1 of 2) Peripheral (sheet 2 of 2) Microprocessor Memories Audio and USB	Page 3-31 Page 3-32 Page 3-33 Page 3-34 Page 3-35 Page 3-36 Page 3-37 Page 3-38
Parts List Controller	Page 3-39

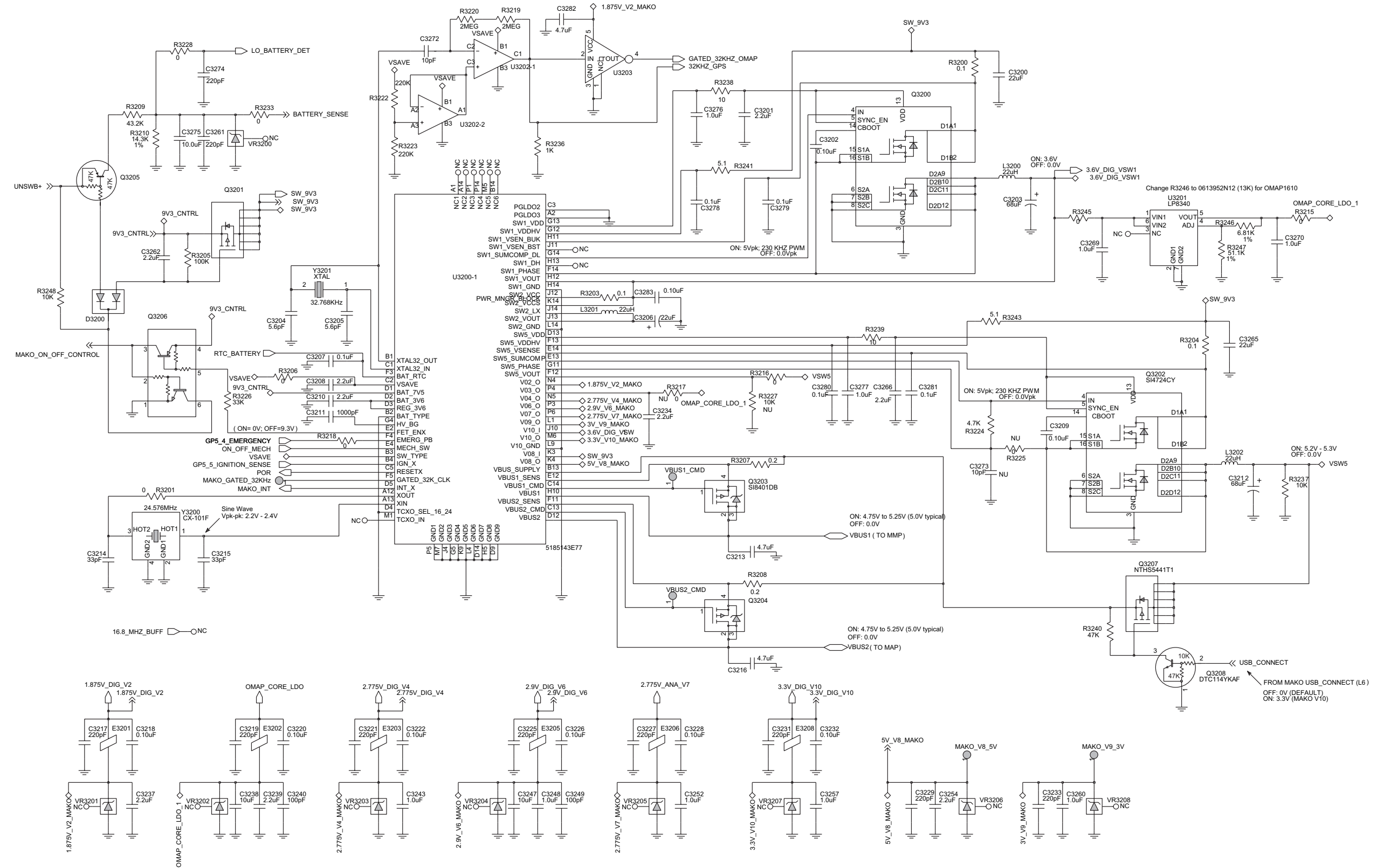
2.0 Controller R1 Schematic Diagrams



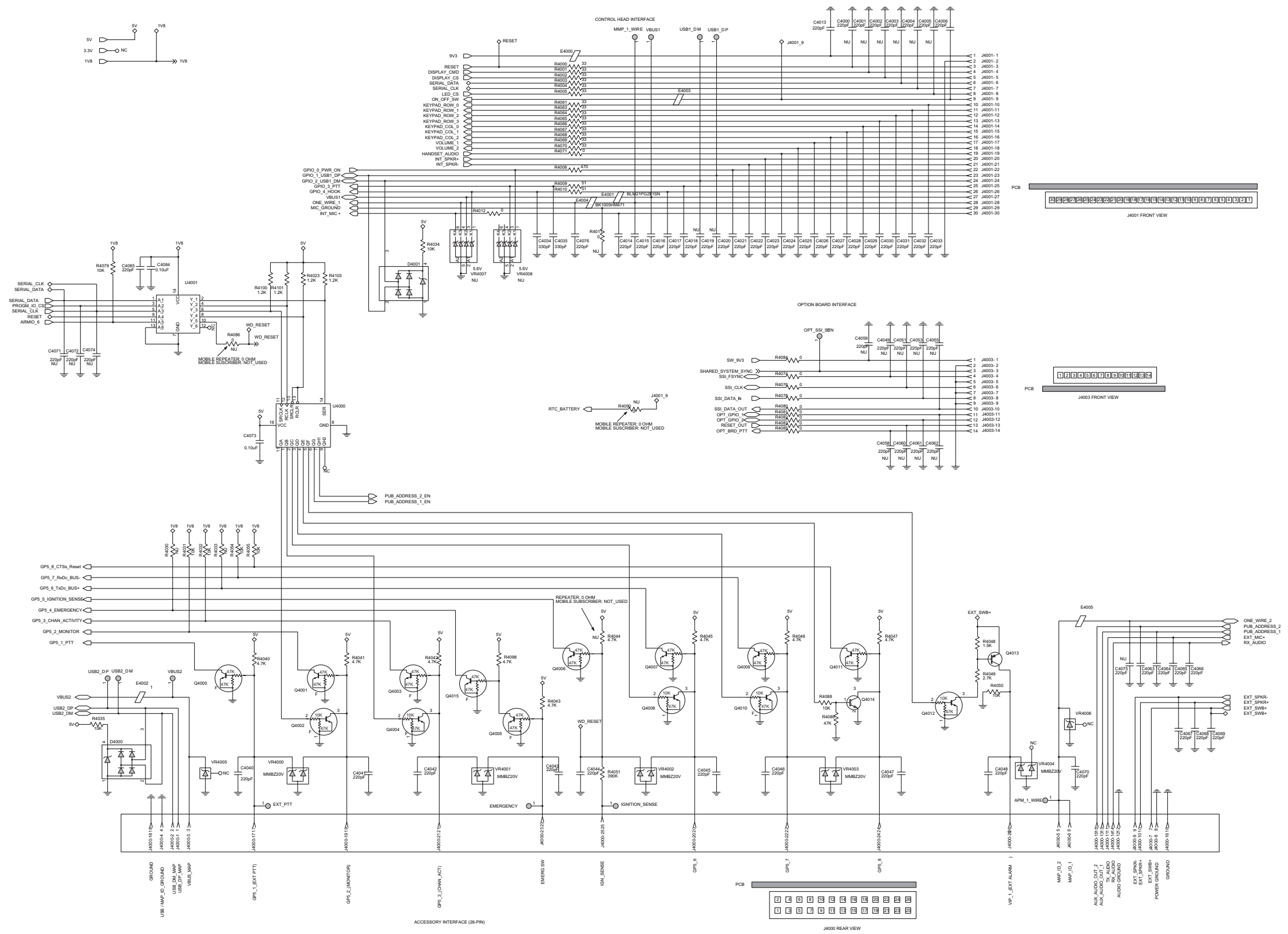
Controller - GPS Schematic Diagram



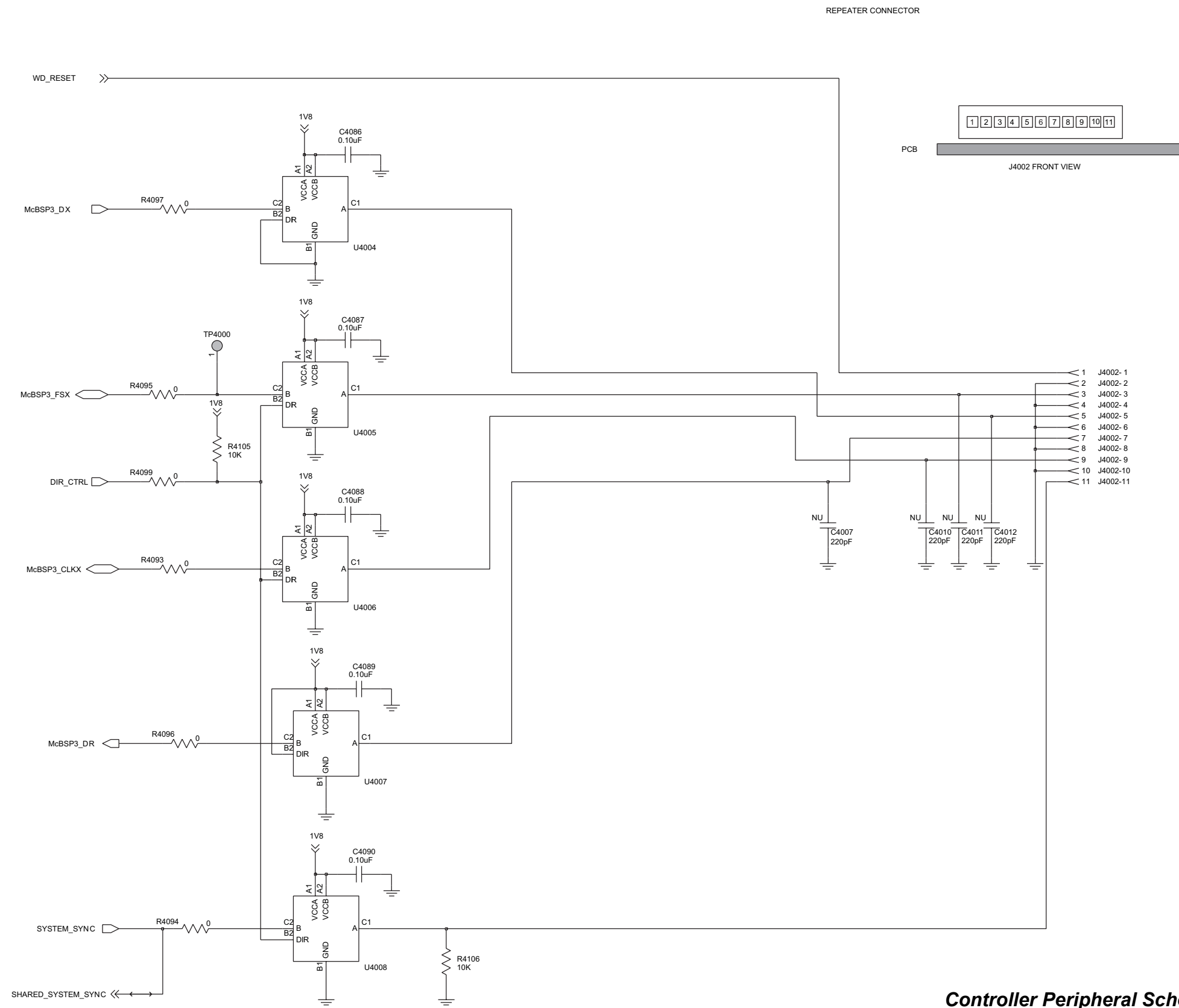
Controller DC Supply Schematic Diagram



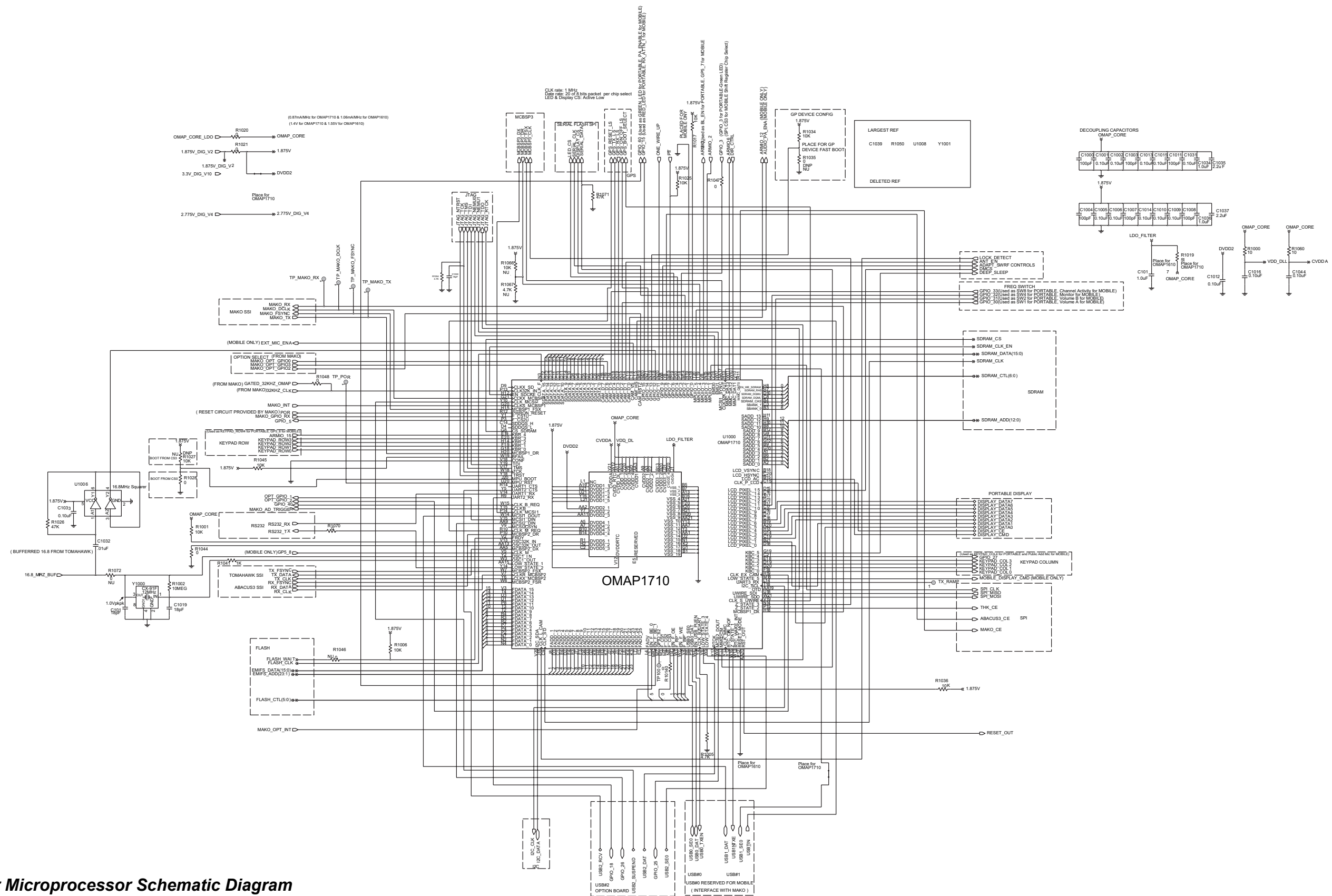
Controller DC Distribution Schematic Diagram



Controller Peripheral Schematic Diagram - (sheet 1 of 2)

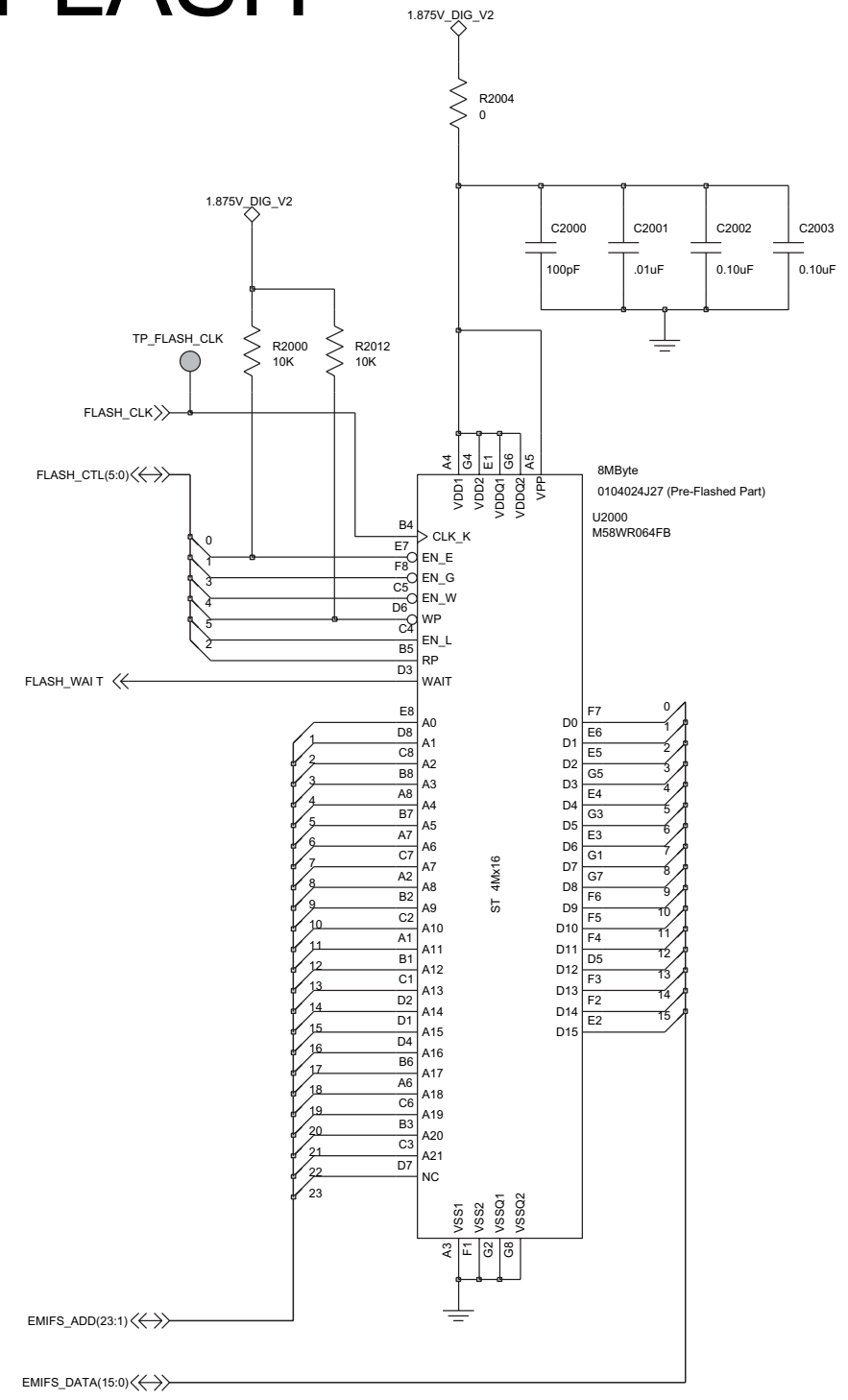


Controller Peripheral Schematic Diagram (sheet 2 of 2)

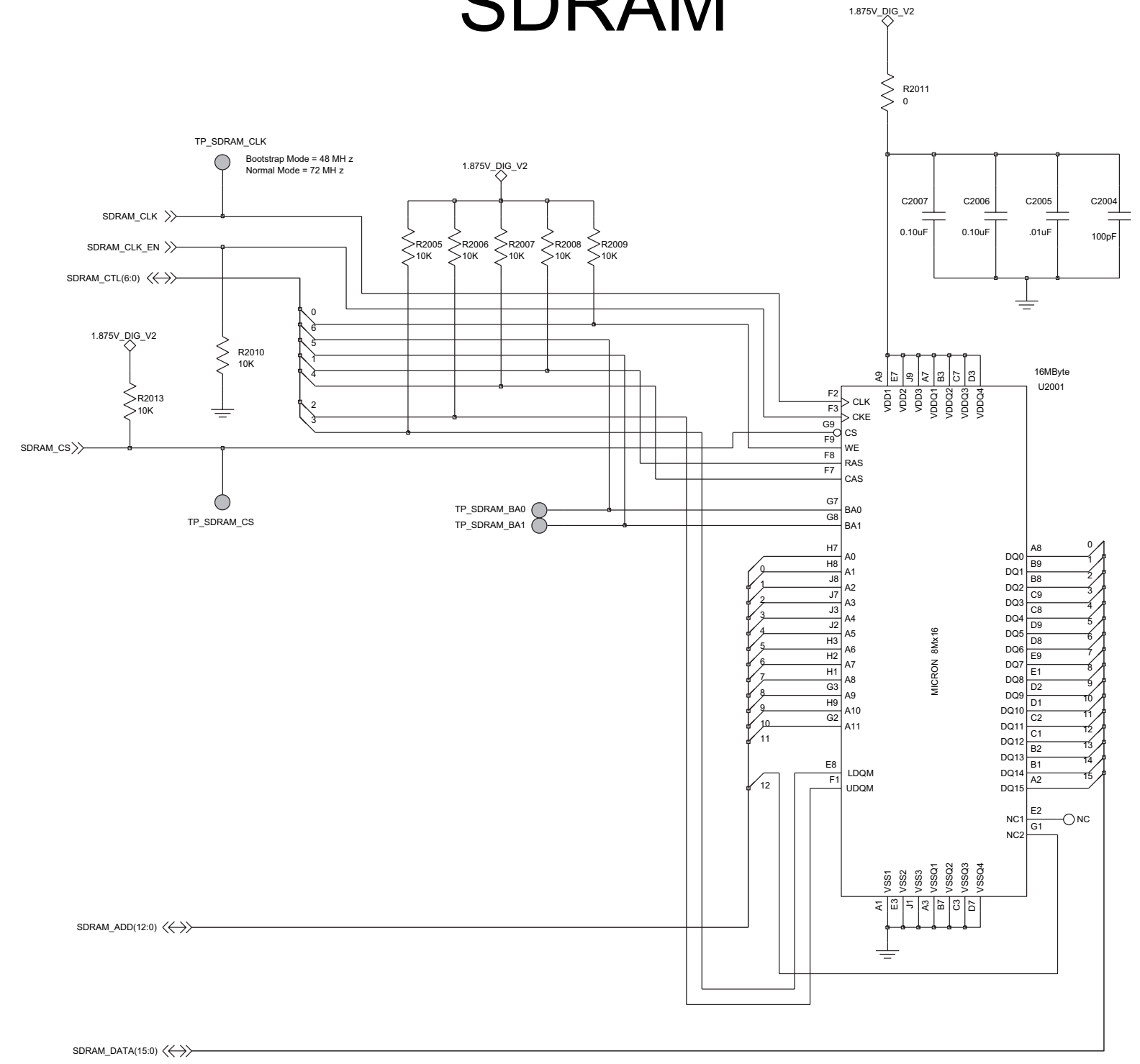


Controller Microprocessor Schematic Diagram

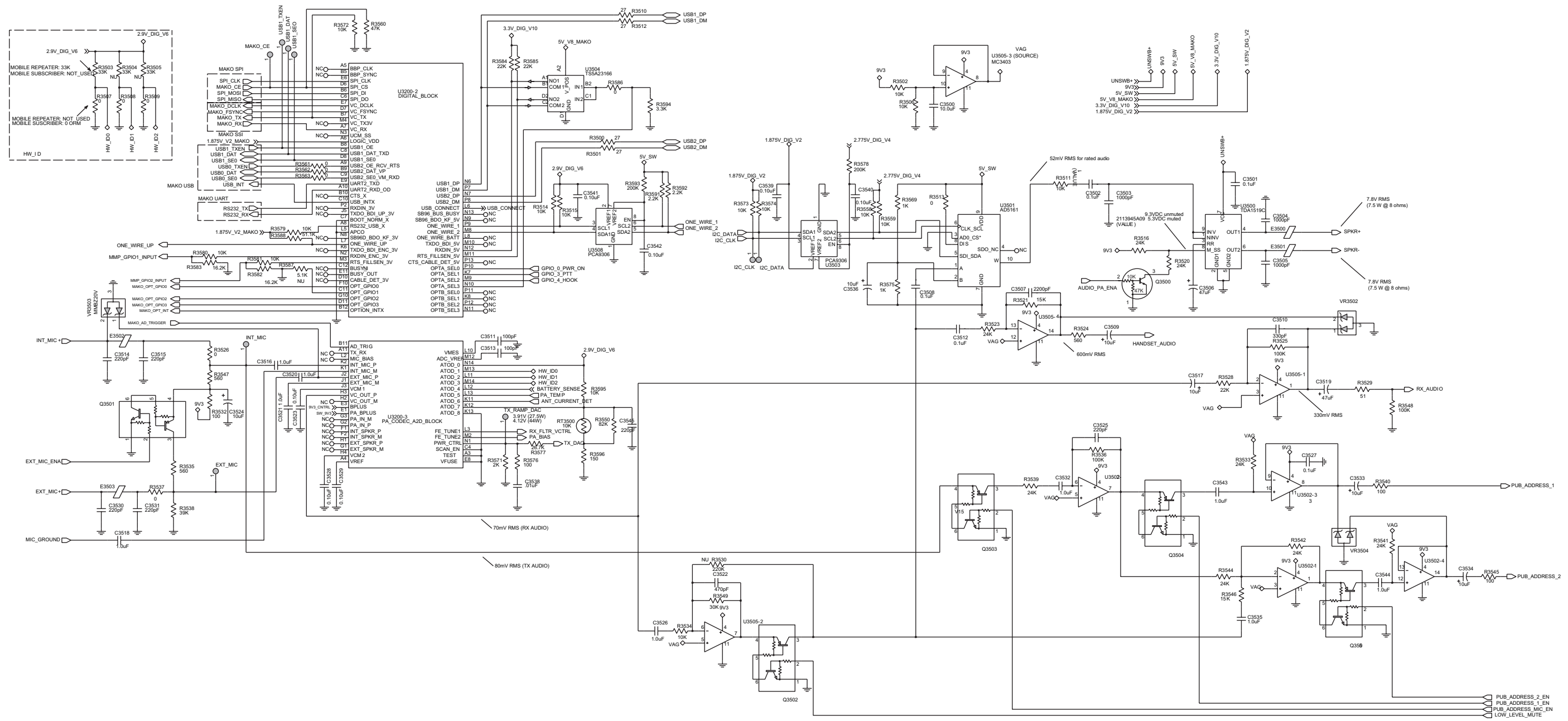
FLASH



SDRAM



Controller Memories Schematic Diagram



Controller Audio and USB Schematic Diagram

2.1 Controller R1 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
C2500	2113944A44	220pF
C2501	2113944A44	220pF
C3000	2113944C06	470pF
C3002	2371403L02	10uF
C3005	2113944C06	470pF
C3006	2314030E85	33uF
C3007	2113945C31	0.1uF
C3008	2113945A09	1000pF
C3009	2113944A40	100pF
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
C3021	2113945C31	0.1uF
C3030	2113945C02	.01uF

Circuit Ref	Motorola Part No	Description
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
C3219	2113944A44	220pF
C3220	2113945Y02	0.10uF

Circuit Ref	Motorola Part No	Description
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
C3270	2113946S35	1.0uF
C3272	2115153H27	10pF

Circuit Ref	Motorola Part No	Description
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
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
C3513	2113944A40	100pF
C3514	2113944A44	220pF
C3515	2113944A44	220pF
C3516	2113946S35	1.0uF
C3517	2314030M51	10uF
C3518	2113946S35	1.0uF

Circuit Ref	Motorola Part No	Description
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	0.01uF
C3539	2113945Y02	0.10uF
C3540	2113945Y02	0.10uF
C3541	2113945Y02	0.10uF
C3542	2113945Y02	0.10uF
C3543	2113946S35	1.0uF
C3544	2113946S35	1.0uF
C3545	2113944A44	220pF
C4000	NOT PLACED	
C4001	NOT PLACED	
C4002	NOT PLACED	
C4003	NOT PLACED	

Circuit Ref	Motorola Part No	Description
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
C4031	2113944A44	220pF
C4032	2113944A44	220pF
C4033	2113944A44	220pF
C4034	2113945A03	330pF
C4035	2113945A03	330pF

Circuit Ref	Motorola Part No	Description
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
C4070	2113944A44	220pF
C4071	NOT PLACED	
C4072	NOT PLACED	
C4073	2113945Y02	0.10uF
C4074	NOT PLACED	

Circuit Ref	Motorola Part No	Description
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	
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
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

Circuit Ref	Motorola Part No	Description
E4004	2409134J25	FERRITE BEAD
E4005	2409134J25	FERRITE BEAD
J2500	NOT PLACED	
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 OPTION 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
Q3203	4805585Q23	PMOS FET
Q3204	4805585Q23	PMOS FET
Q3205	4815262H01	ANALOG SWITCH
Q3206	4815272H01	ANALOG SWITCH
Q3207	4813970A62	P-CHANNEL MOSFET
Q3208	4815261H01	ANALOG SWITCH
Q3500	4815261H01	ANALOG SWITCH
Q3501	4815272H01	ANALOG SWITCH
Q3502	4815272H01	ANALOG SWITCH

Circuit Ref	Motorola Part No	Description
Q3503	4815272H01	ANALOG SWITCH
Q3504	4815272H01	ANALOG SWITCH
Q3505	4815272H01	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
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

Circuit Ref	Motorola Part No	Description
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
R1072	NOT PLACED	
R2000	0613952R01	10K
R2004	0613952R66	0
R2005	0613952R01	10K
R2006	0613952R01	10K
R2007	0613952R01	10K
R2008	0613952R01	10K
R2009	0613952R01	10K
R2010	0613952R01	10K
R2011	0613952R66	0
R2012	0613952R01	10K
R2013	0613952R01	10K

Circuit Ref	Motorola Part No	Description
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
R2521	0613952R66	0
R2522	0613952R66	0
R2523	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

Circuit Ref	Motorola Part No	Description
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

Circuit Ref	Motorola Part No	Description
R3055	0615871H01	0.1
R3056	0615871H01	0.1
R3057	0613952R66	0
R3200	0615871H01	0.1
R3201	0613952R66	0
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	
R3226	0613952R13	33K
R3227	NOT PLACED	
R3228	0613952G67	0
R3233	0613952R66	0
R3236	0613952Q73	1K
R3237	0613952R01	10K
R3238	0613952H25	10

Circuit Ref	Motorola Part No	Description
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
R3500	0613952Q35	27
R3501	0613952Q35	27
R3502	0613952R01	10K
R3503	NOT PLACED	
R3504	NOT PLACED	
R3505	NOT PLACED	
R3506	0613952R01	10K
R3507	0613952R66	0
R3508	0613952R66	0
R3509	0613952R66	0
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
R3523	0613952R10	24K
R3524	0613952Q67	560
R3525	0613952R25	100K

Circuit Ref	Motorola Part No	Description
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	0613952R15	39K
R3539	0613952R10	24K
R3540	0613952Q49	100
R3541	0613952R10	24K
R3542	0613952R10	24K
R3544	0613952R10	24K
R3545	0613952Q49	100
R3546	0613952R05	15K
R3547	0613952Q67	560
R3548	0613952J25	100K
R3549	0613952R12	30K
R3550	0613952R23	82K
R3558	0613952R01	10K
R3559	0613952R01	10K
R3560	0613952R17	47K
R3561	0613952R66	0
R3562	0613952R66	0
R3563	0613952R66	0
R3569	0613952Q73	1K
R3571	0613952Q80	2K

Circuit Ref	Motorola Part No	Description
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	
R3588	0613952N69	51.1K
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

Circuit Ref	Motorola Part No	Description
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
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

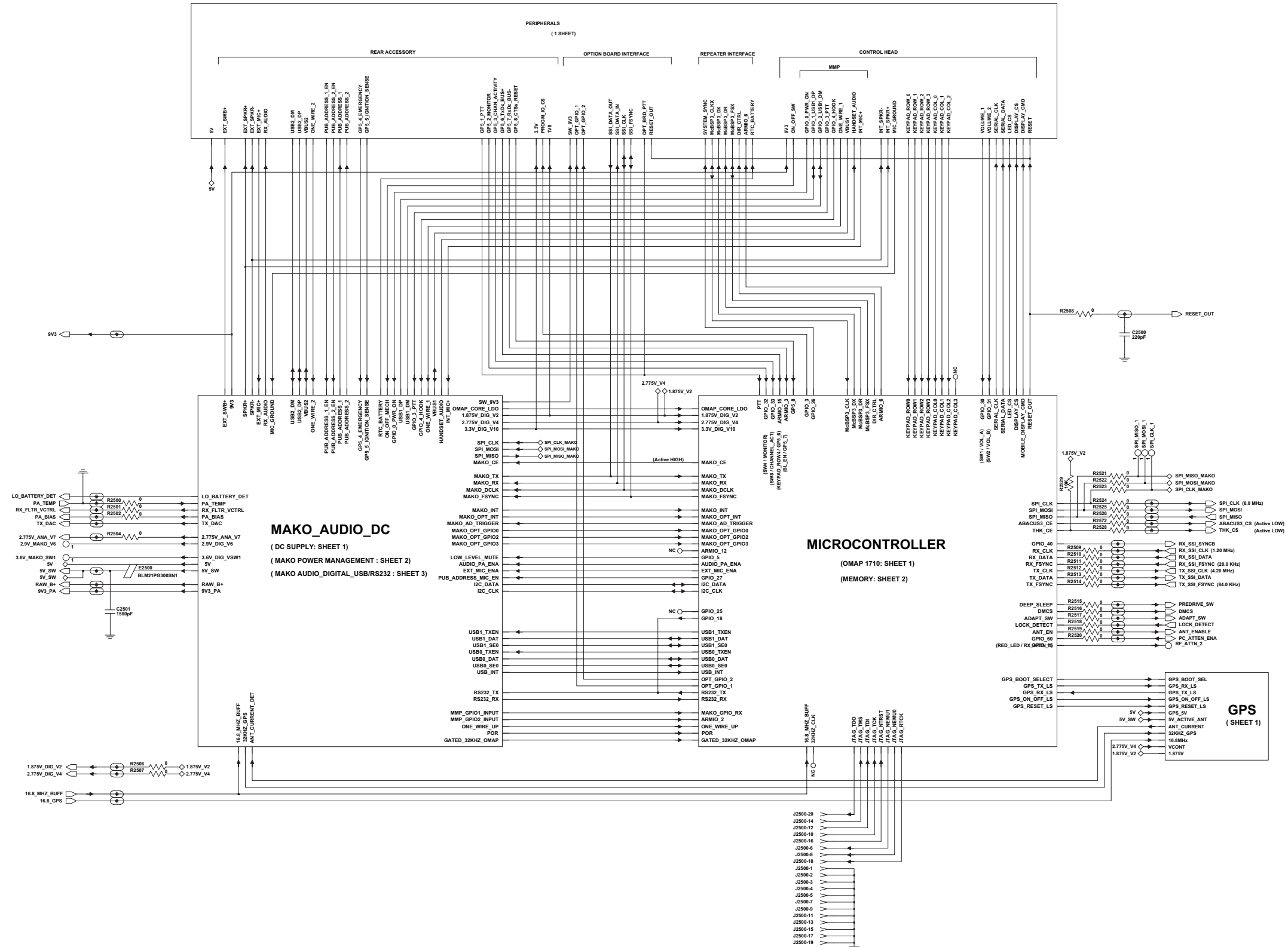
Circuit Ref	Motorola Part No	Description
R4067	0613952Q37	33
R4068	0613952Q37	33
R4069	0613952Q37	33
R4070	0613952Q37	33
R4071	0613952R66	0
R4074	0613952R66	0
R4076	0613952R66	0
R4078	0613952R66	0
R4079	0613952R01	10K
R4080	0613952R66	0
R4081	0613952R66	0
R4082	0613952R66	0
R4083	0613952R66	0
R4084	0613952R66	0
R4085	0613952R66	0
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	

Circuit Ref	Motorola Part No	Description
R4106	NOT PLACED	
RT3500	0615471H01	THERMISTOR, 10K
U1000	5102495J13	MICROPROCESSOR
U1006	5115001H02	IC, DUAL UNBUFF- FERED INVERTER
U2000	0104024J27	IC, 16MB FLASH
U2001	5185941F17	IC, 16MB SDRAM
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 TRANSLA- TOR
U4000	5115476H01	IC, SERIAL-TO-PARAL- LEL CONVERTER
U4001	5115502H01	LOGIC TRANSLATOR

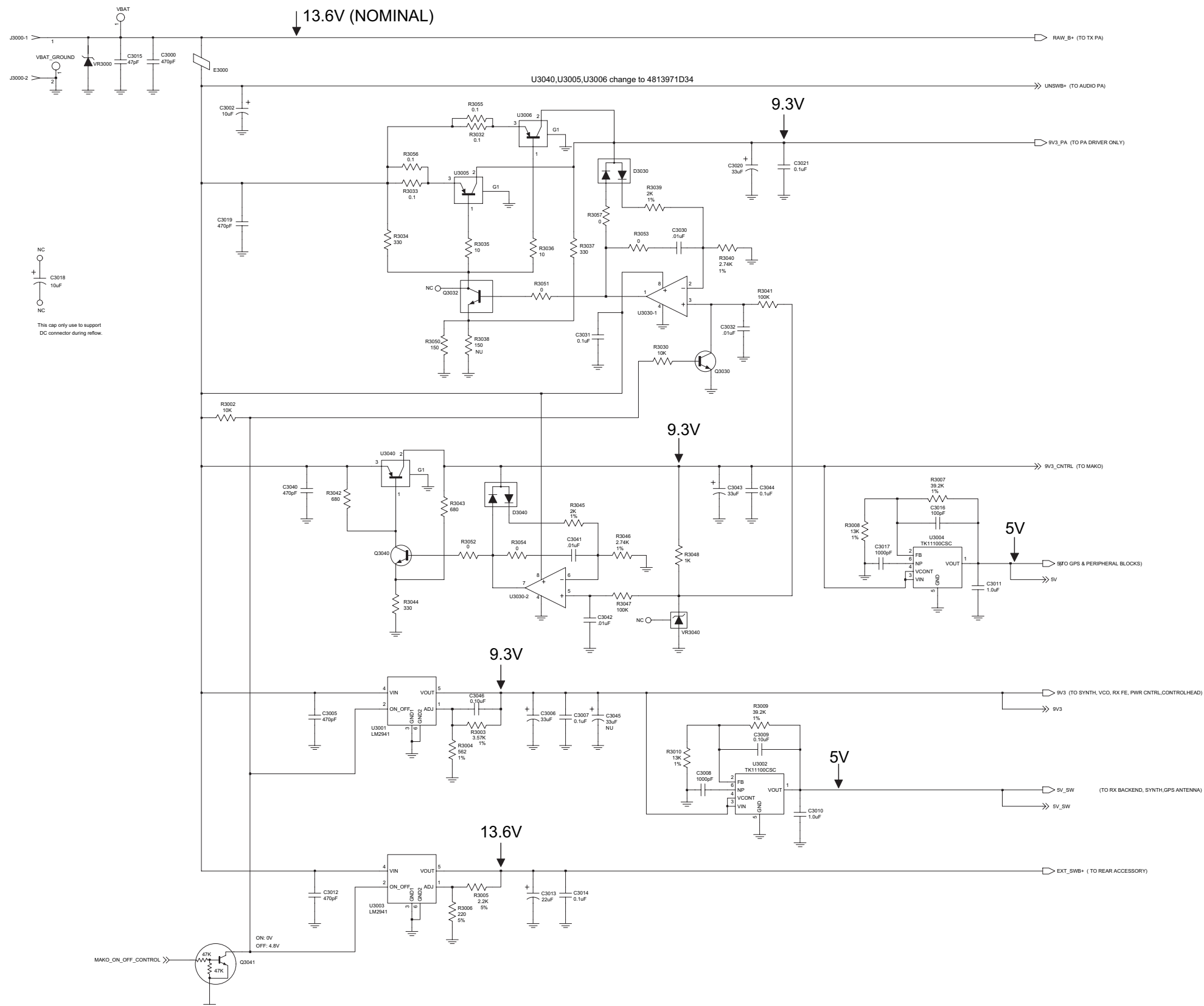
Circuit Ref	Motorola Part No	Description
U4004	NOT PLACED	
U4005	NOT PLACED	
U4006	NOT PLACED	
U4007	NOT PLACED	
U4008	NOT PLACED	
VR3000	4813979C17	TRANSIENT SUPPRESSOR
VR3040	4813977M10	DIODE, 5.1V ZENER
VR3200	4813977M10	DIODE, 5.1V ZENER
VR3201	4813977M05	DIODE, 3.3V ZENER
VR3202	4813977M05	DIODE, 3.3V ZENER
VR3203	4813977M05	DIODE, 3.3V ZENER
VR3204	4813977M05	DIODE, 3.3V 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
VR4007	NOT PLACED	
VR4008	NOT PLACED	
Y1000	4809612J45	12MHZ CRYSTAL
Y3200	4815028H01	24.576MHZ CRYSTAL

Circuit Ref	Motorola Part No	Description
Y3201	4802582S80	32KHZ CRYSTAL

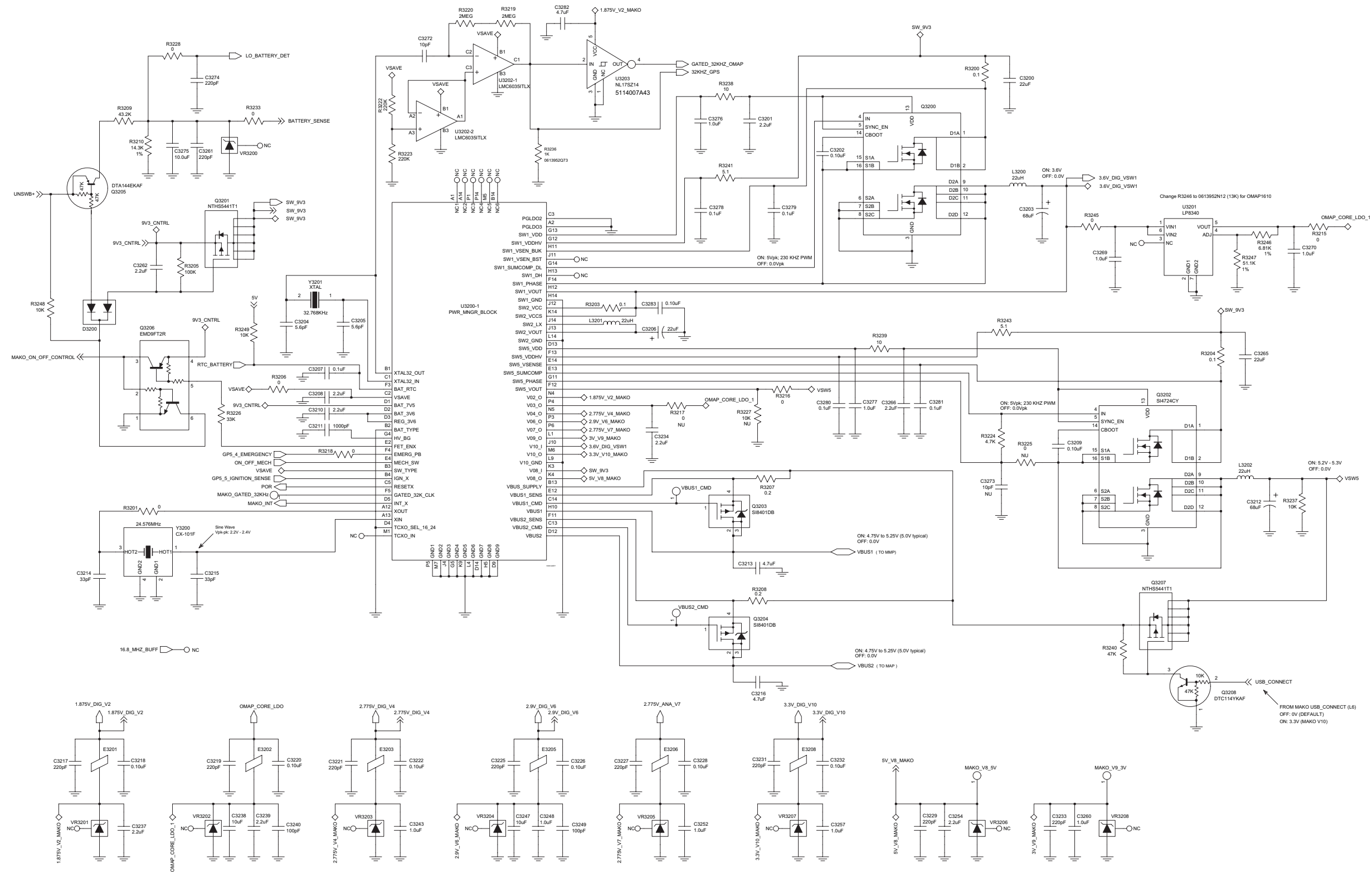
3.0 Controller R2 Schematic Diagrams



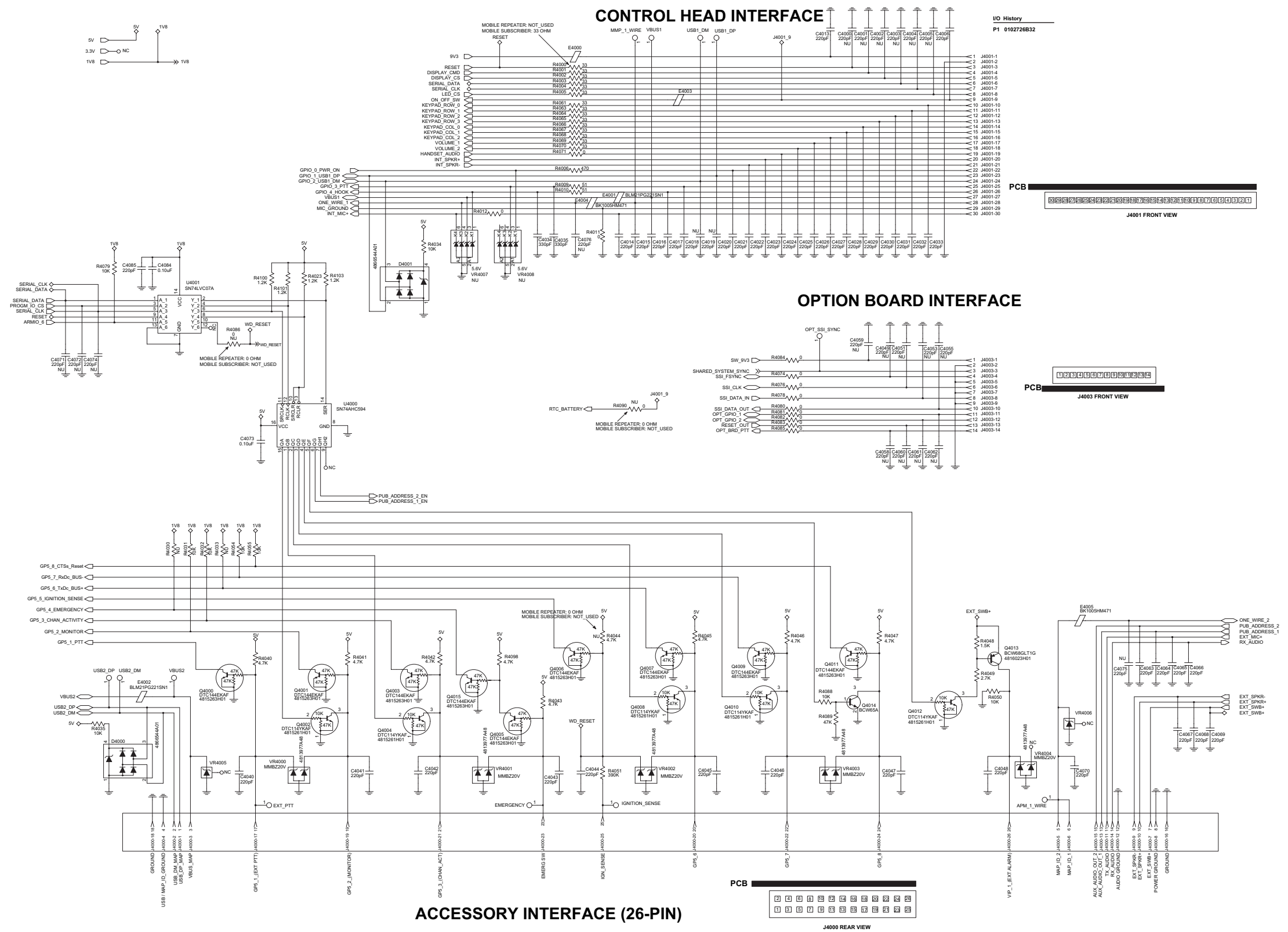
Controller - GPS Schematic Diagram



Controller DC Supply Schematic Diagram

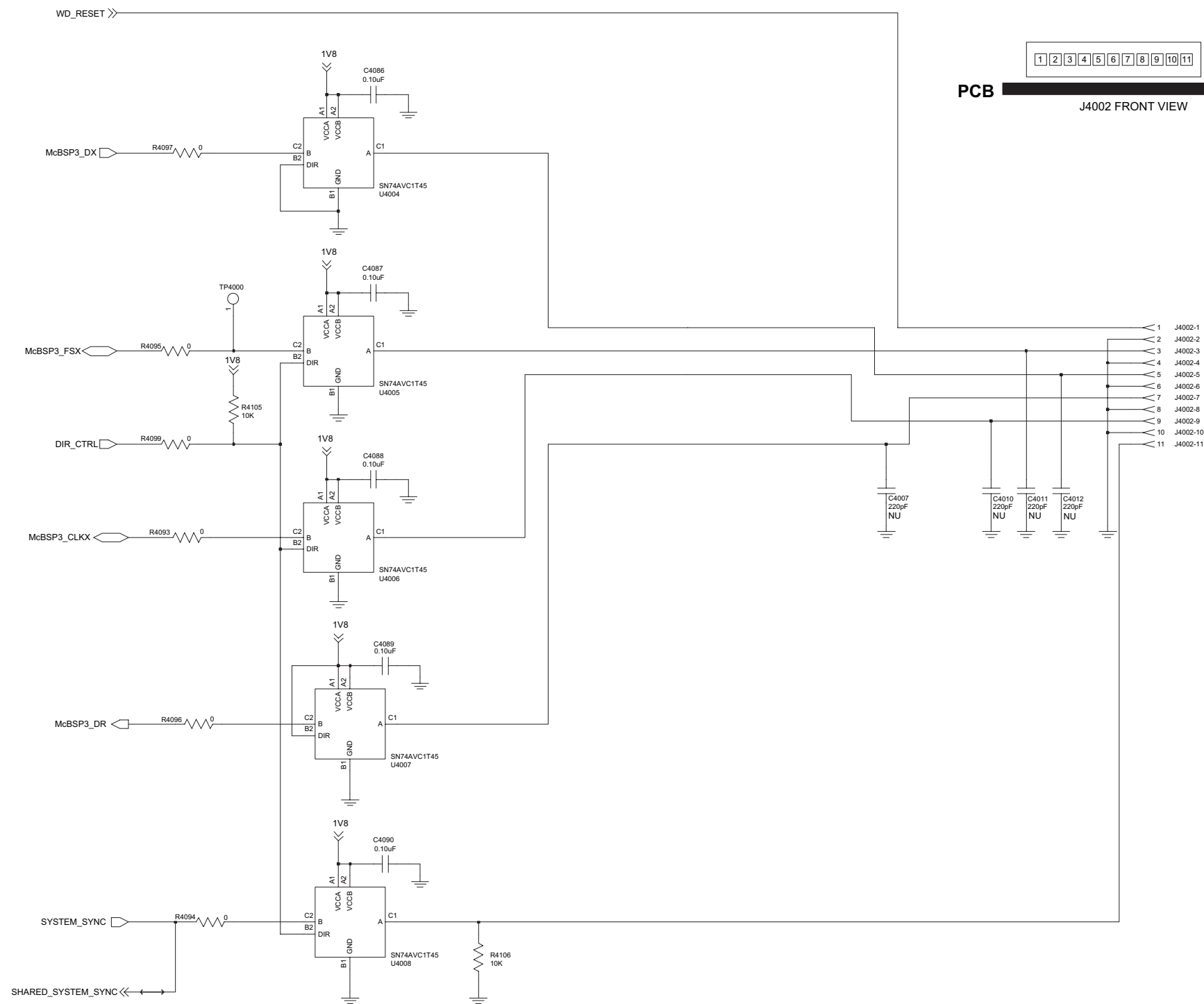


Controller DC Distribution Schematic Diagram

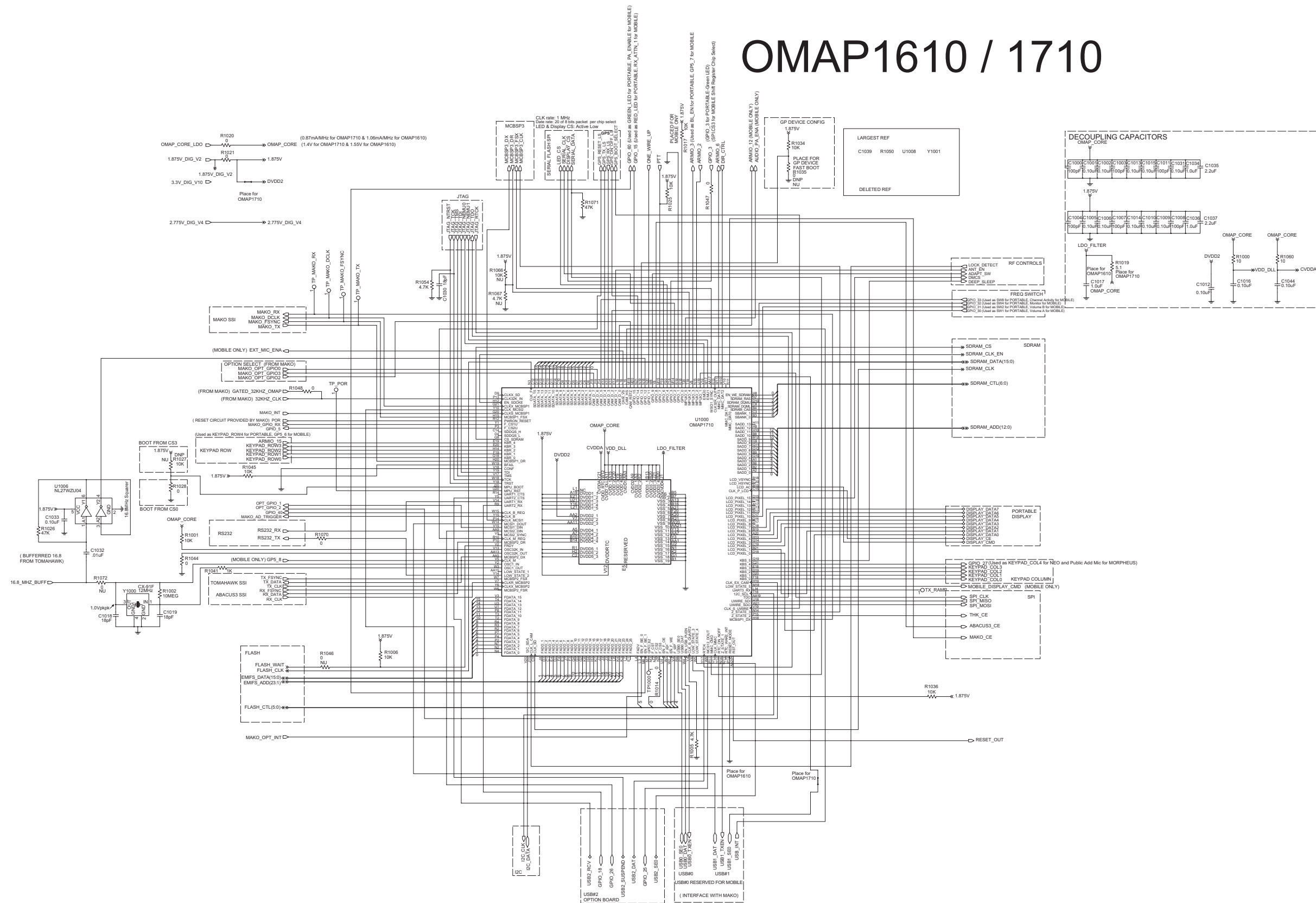


Controller Peripheral Schematic Diagram - (sheet 1 of 2)

REPEATER CONNECTOR

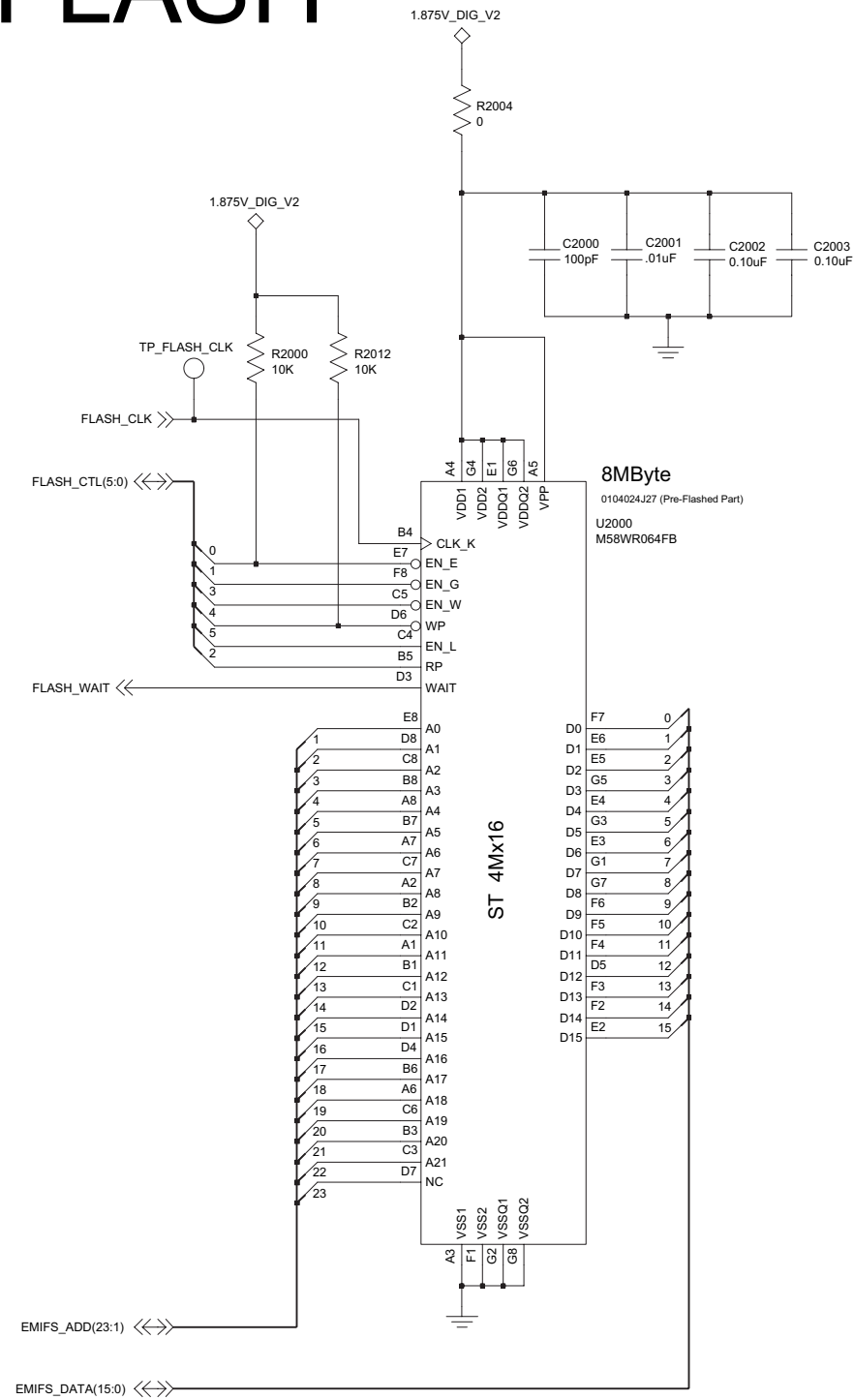


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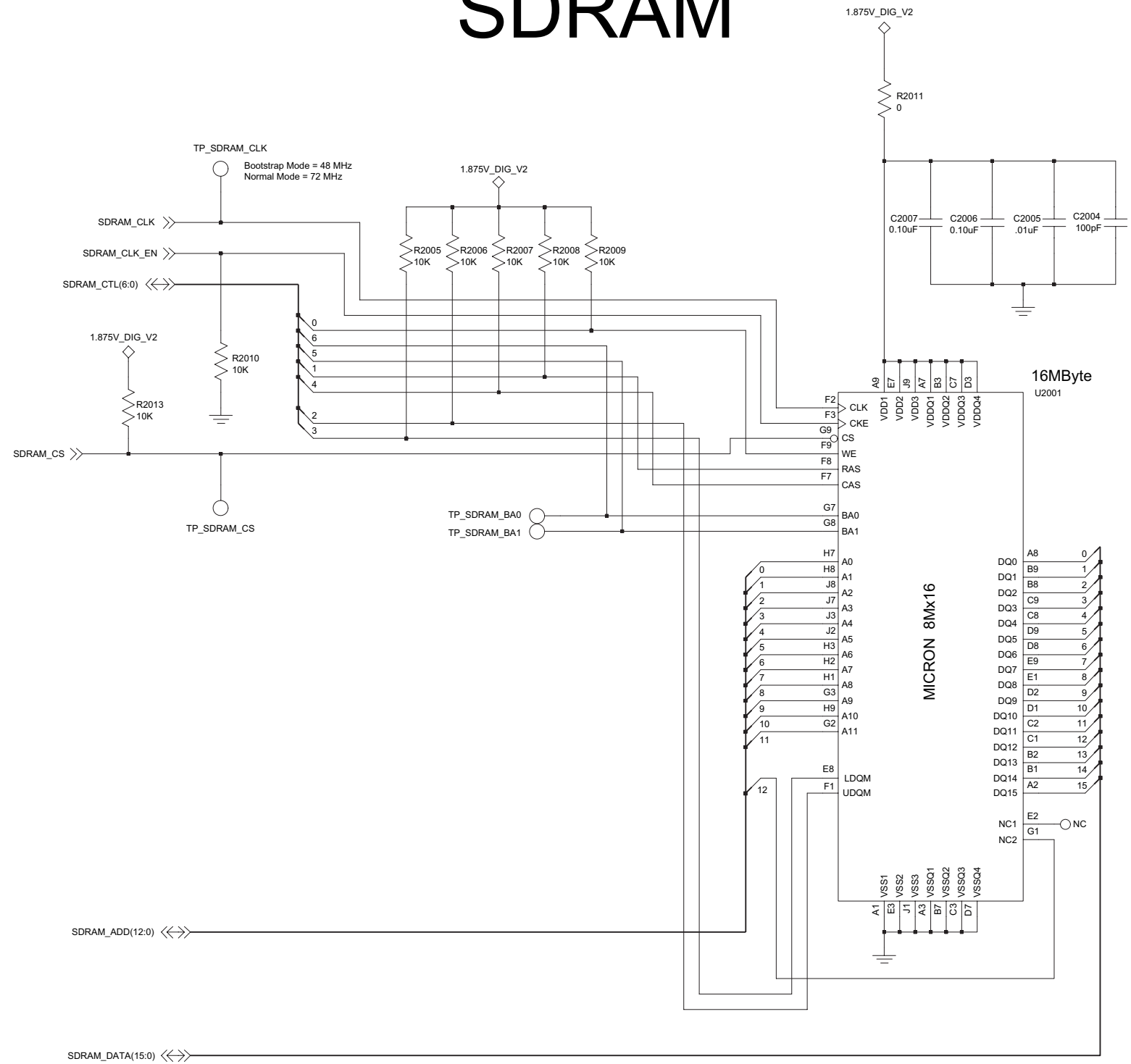


Controller Microprocessor Schematic Diagram

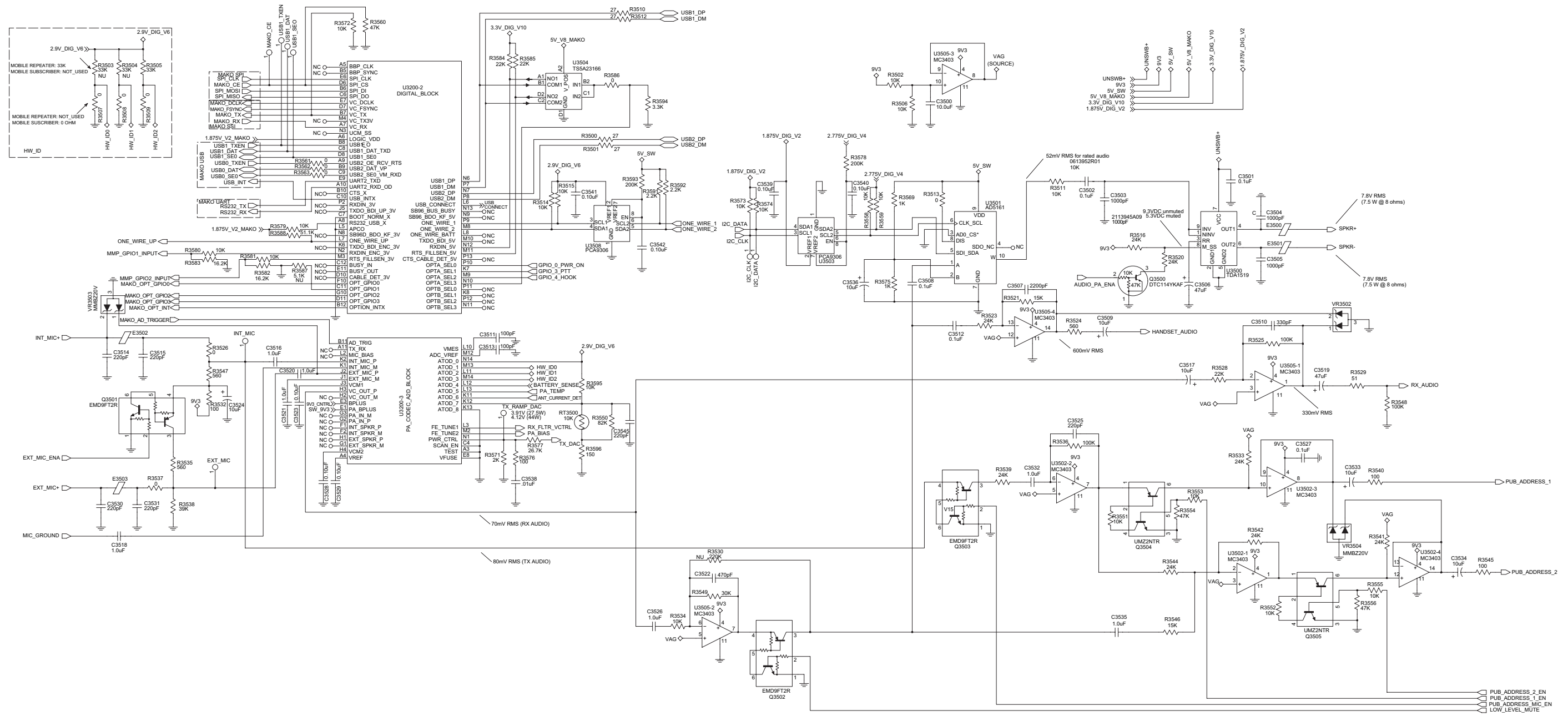
FLASH



SDRAM



Controller Memories Schematic Diagram



Controller Audio and USB Schematic Diagram

3.1 Controller R2 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
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
C3021	2113945C31	0.1uF
C3030	2113945C02	.01uF

Circuit Ref	Motorola Part No	Description
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
C3219	2113944A44	220pF
C3220	2113945Y02	0.10uF

Circuit Ref	Motorola Part No	Description
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
C3270	2113946S35	1.0uF
C3272	2115153H27	10pF

Circuit Ref	Motorola Part No	Description
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
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
C3513	2113944A40	100pF
C3514	2113944A44	220pF
C3515	2113944A44	220pF
C3516	2113946S35	1.0uF
C3517	2314030M51	10uF
C3518	2113946S35	1.0uF

Circuit Ref	Motorola Part No	Description
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
C3545	2113944A44	220pF
C4000	NOT PLACED	
C4001	NOT PLACED	
C4002	NOT PLACED	
C4003	NOT PLACED	
C4004	NOT PLACED	
C4005	NOT PLACED	

Circuit Ref	Motorola Part No	Description
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
C4031	2113944A44	220pF
C4032	2113944A44	220pF
C4033	2113944A44	220pF
C4034	2113945A03	330pF
C4035	2113945A03	330pF
C4040	2113944A44	220pF
C4041	2113944A44	220pF

Circuit Ref	Motorola Part No	Description
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
C4070	2113944A44	220pF
C4071	NOT PLACED	
C4072	NOT PLACED	
C4073	2113945Y02	0.10uF
C4074	NOT PLACED	
C4075	NOT PLACED	
C4076	NOT PLACED	

Circuit Ref	Motorola Part No	Description
C4084	2113945Y02	0.10uF
C4085	2113944A44	220pF
C4086	NOT PLACED	
C4087	NOT PLACED	
C4088	NOT PLACED	
C4089	NOT PLACED	
C4090	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
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

Circuit Ref	Motorola Part No	Description
J2500	0905505Y02	22-PIN JTAG CONNECTOR
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 BRD 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
Q3203	4805585Q23	PMOS FET
Q3204	4805585Q23	PMOS FET
Q3205	4815262H01	ANALOG SWITCH
Q3206	4815272H01	ANALOG SWITCH
Q3207	4813970A62	P-CHANNEL MOSFET
Q3208	4815261H01	ANALOG SWITCH
Q3500	4815261H01	ANALOG SWITCH
Q3501	4815272H01	ANALOG SWITCH
Q3502	4815272H01	ANALOG SWITCH
Q3503	4815272H01	ANALOG SWITCH

Circuit Ref	Motorola Part No	Description
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
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

Circuit Ref	Motorola Part No	Description
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
R1072	NOT PLACED	
R2000	0613952R01	10K
R2004	0613952R66	0
R2005	0613952R01	10K
R2006	0613952R01	10K
R2007	0613952R01	10K
R2008	0613952R01	10K
R2009	0613952R01	10K
R2010	0613952R01	10K
R2011	0613952R66	0
R2012	0613952R01	10K
R2013	0613952R01	10K
R2500	0613952R66	0

Circuit Ref	Motorola Part No	Description
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
R2521	0613952R66	0
R2522	0613952R66	0
R2523	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

Circuit Ref	Motorola Part No	Description
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

Circuit Ref	Motorola Part No	Description
R3056	0615871H01	0.1
R3057	0613952R66	0
R3200	0615871H01	0.1
R3201	0613952R66	0
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	
R3226	0613952R13	33K
R3227	NOT PLACED	
R3228	0613952G67	0
R3233	0613952R66	0
R3236	0613952Q73	1K
R3237	0613952R01	10K
R3238	0613952H25	10
R3239	0613952H25	10

Circuit Ref	Motorola Part No	Description
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
R3500	0613952Q35	27
R3501	0613952Q35	27
R3502	0613952R01	10K
R3503	NOT PLACED	
R3504	NOT PLACED	
R3505	NOT PLACED	
R3506	0613952R01	10K
R3507	0613952R66	0
R3508	0613952R66	0
R3509	0613952R66	0
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
R3523	0613952R10	24K
R3524	0613952Q67	560
R3525	0613952R25	100K

Circuit Ref	Motorola Part No	Description
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	0613952R15	39K
R3539	0613952R10	24K
R3540	0613952Q49	100
R3541	0613952R10	24K
R3542	0613952R10	24K
R3544	0613952R10	24K
R3545	0613952Q49	100
R3546	0613952R05	15K
R3547	0613952Q67	560
R3548	0613952J25	100K
R3549	0613952R12	30K
R3550	0613952R23	82K
R3551	0613952R01	RES, 10K
R3552	0613952R01	RES, 10K
R3553	0613952R01	RES, 10K
R3554	0613952R17	RES, 47K
R3555	0613952R01	RES, 10K
R3556	0613952R17	RES, 47K
R3558	0613952R01	10K
R3559	0613952R01	10K

Circuit Ref	Motorola Part No	Description
R3560	0613952R17	47K
R3561	0613952R66	0
R3562	0613952R66	0
R3563	0613952R66	0
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	
R3588	0613952N69	51.1K
R3591	0613952Q81	2.2K
R3592	0613952Q81	2.2K
R3593	0613952R32	200K
R3594	0613952Q85	3.3K
R3595	0613952R01	10K
R3596	0613952H53	150
R4000	0613952Q37	33

Circuit Ref	Motorola Part No	Description
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
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

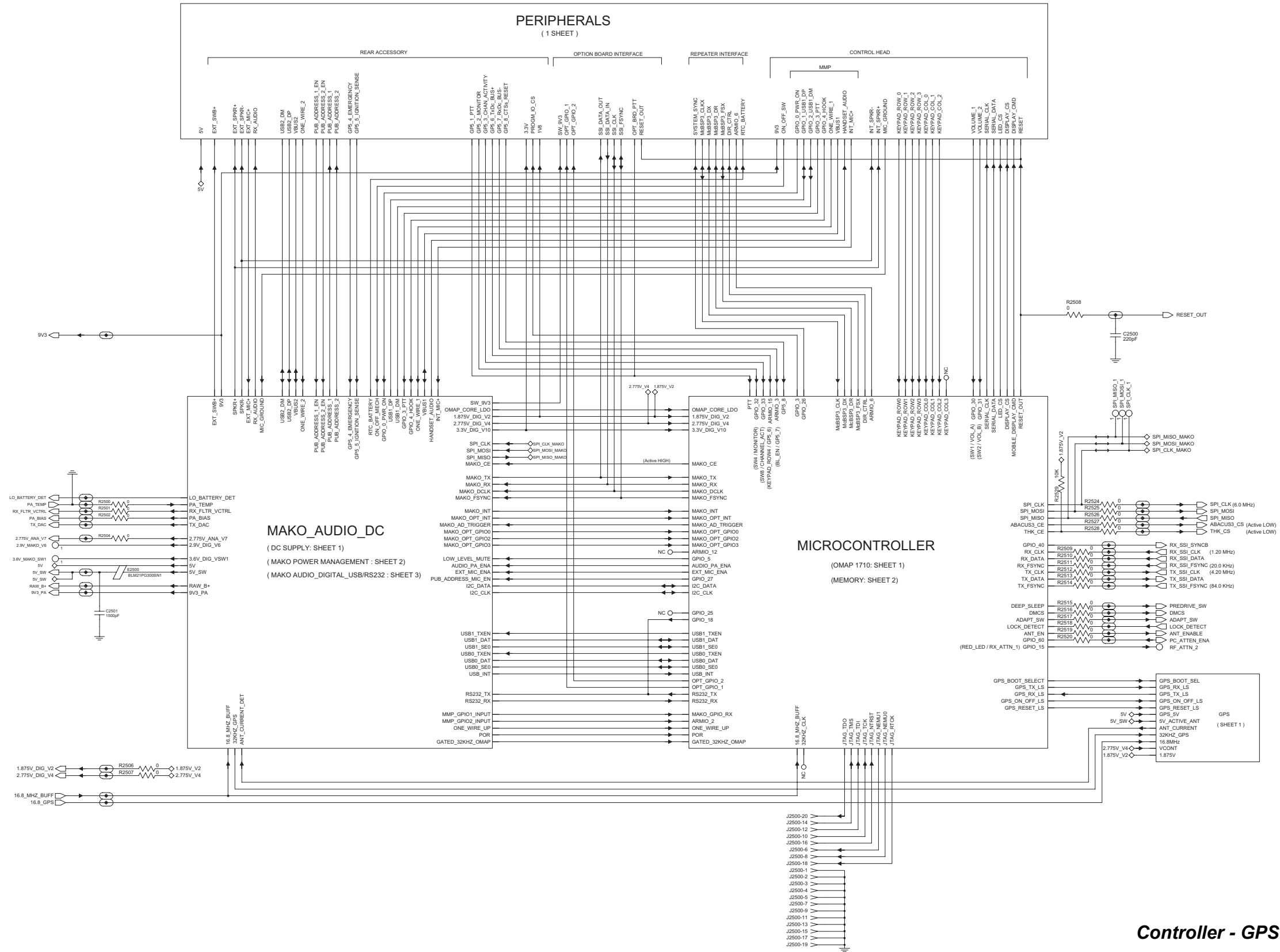
Circuit Ref	Motorola Part No	Description
R4055	0613952R01	10K
R4061	0613952Q37	33
R4063	0613952Q37	33
R4064	0613952Q37	33
R4065	0613952Q37	33
R4066	0613952Q37	33
R4067	0613952Q37	33
R4068	0613952Q37	33
R4069	0613952Q37	33
R4070	0613952Q37	33
R4071	0613952R66	0
R4074	0613952R66	0
R4076	0613952R66	0
R4078	0613952R66	0
R4079	0613952R01	10K
R4080	0613952R66	0
R4081	0613952R66	0
R4082	0613952R66	0
R4083	0613952R66	0
R4084	0613952R66	0
R4085	0613952R66	0
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	

Circuit Ref	Motorola Part No	Description
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
U1000	5102495J13	MICROPROCESSOR
U1006	5115001H02	IC, DUAL UNBUFF- FERED INVERTER
U2000	0104024J27	IC, 16MB FLASH
U2001	5185941F17	IC, 16MB SDRAM
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

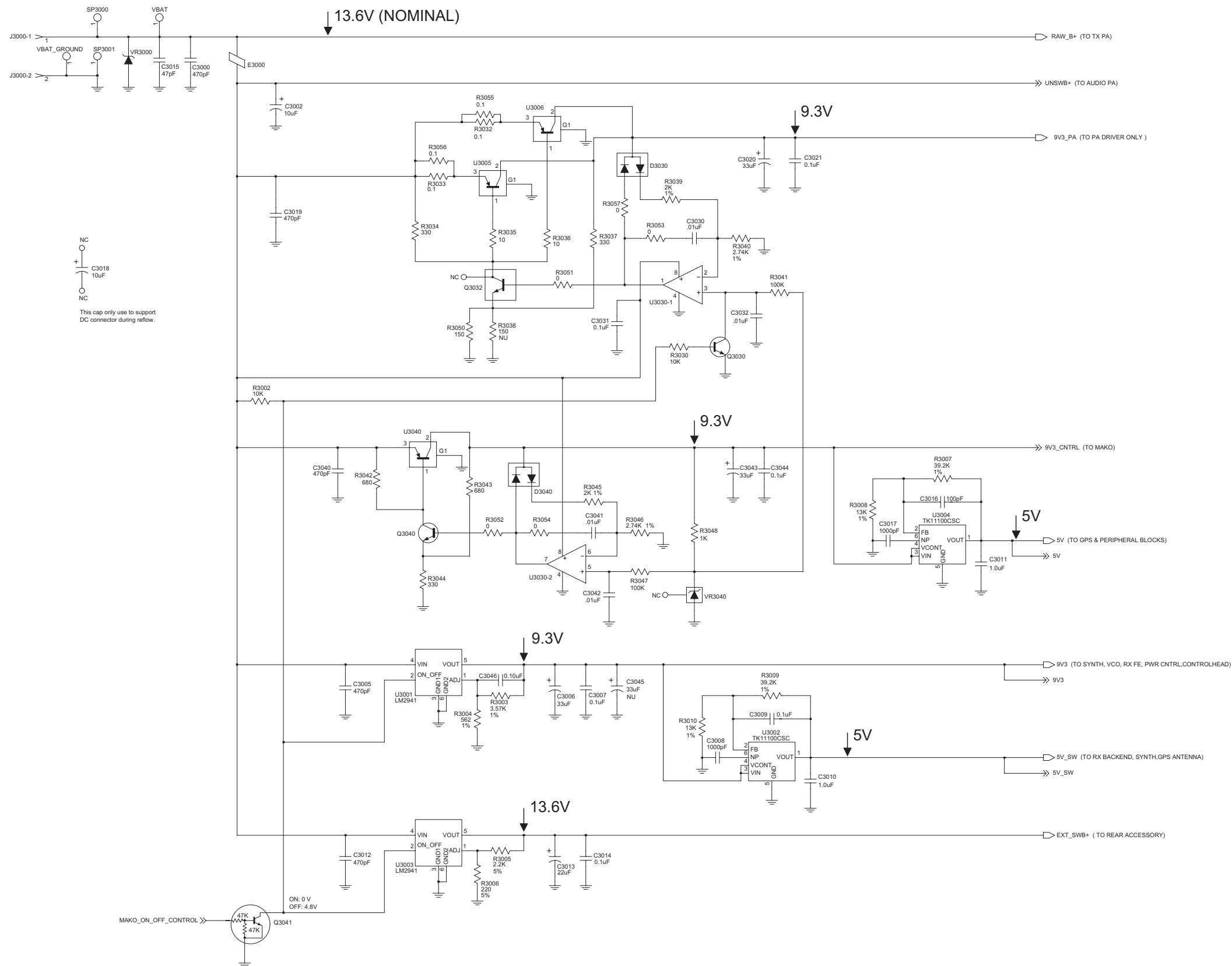
Circuit Ref	Motorola Part No	Description
U3504	5171395L01	IC, CMOS SWITCH
U3505	5114016A18	QUAD OPAMP
U3508	5164852H47	IC, LEVEL TRANSLA- TOR
U4000	5115476H01	IC, SERIAL-TO-PARAL- LEL CONVERTER
U4001	5115502H01	LOGIC TRANSLATOR
U4004	NOT PLACED	
U4005	NOT PLACED	
U4006	NOT PLACED	
U4007	NOT PLACED	
U4008	NOT PLACED	
VR3000	4813979C17	TRANSIENT SUPPRESSOR
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	4813977M05	DIODE, 3.3V 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

Circuit Ref	Motorola Part No	Description
VR4004	4813977A48	DIODE, 20V ZENER
VR4005	4813977M13	DIODE, 6.2V ZENER
VR4006	4813977M13	DIODE, 6.2V ZENER
VR4007	NOT PLACED	
VR4008	NOT PLACED	
Y1000	4809612J45	12MHZ CRYSTAL
Y3200	4815028H01	24.576MHZ CRYSTAL
Y3201	4802582S80	32KHZ CRYSTAL

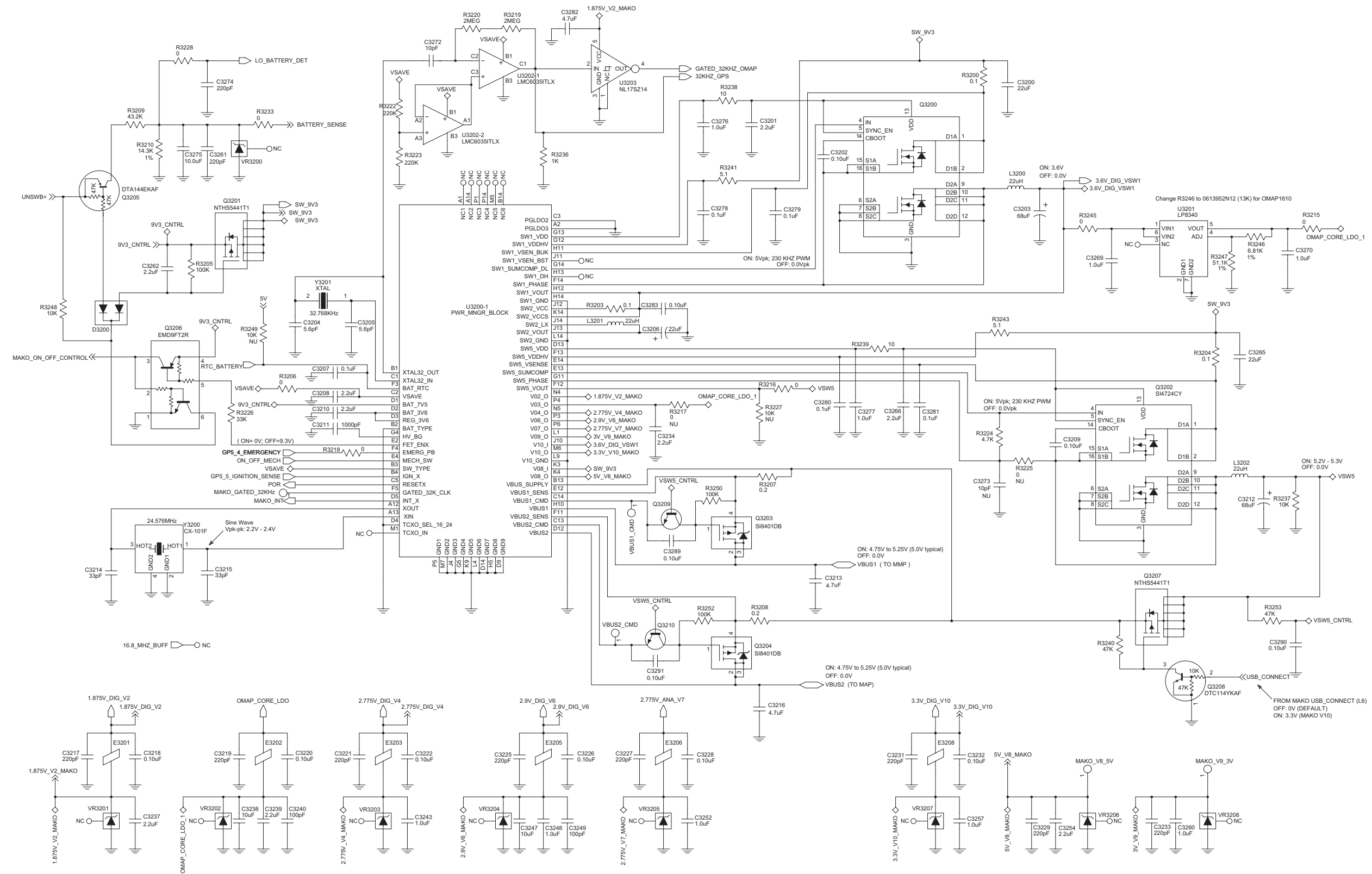
4.0 Controller R4 Schematic Diagrams



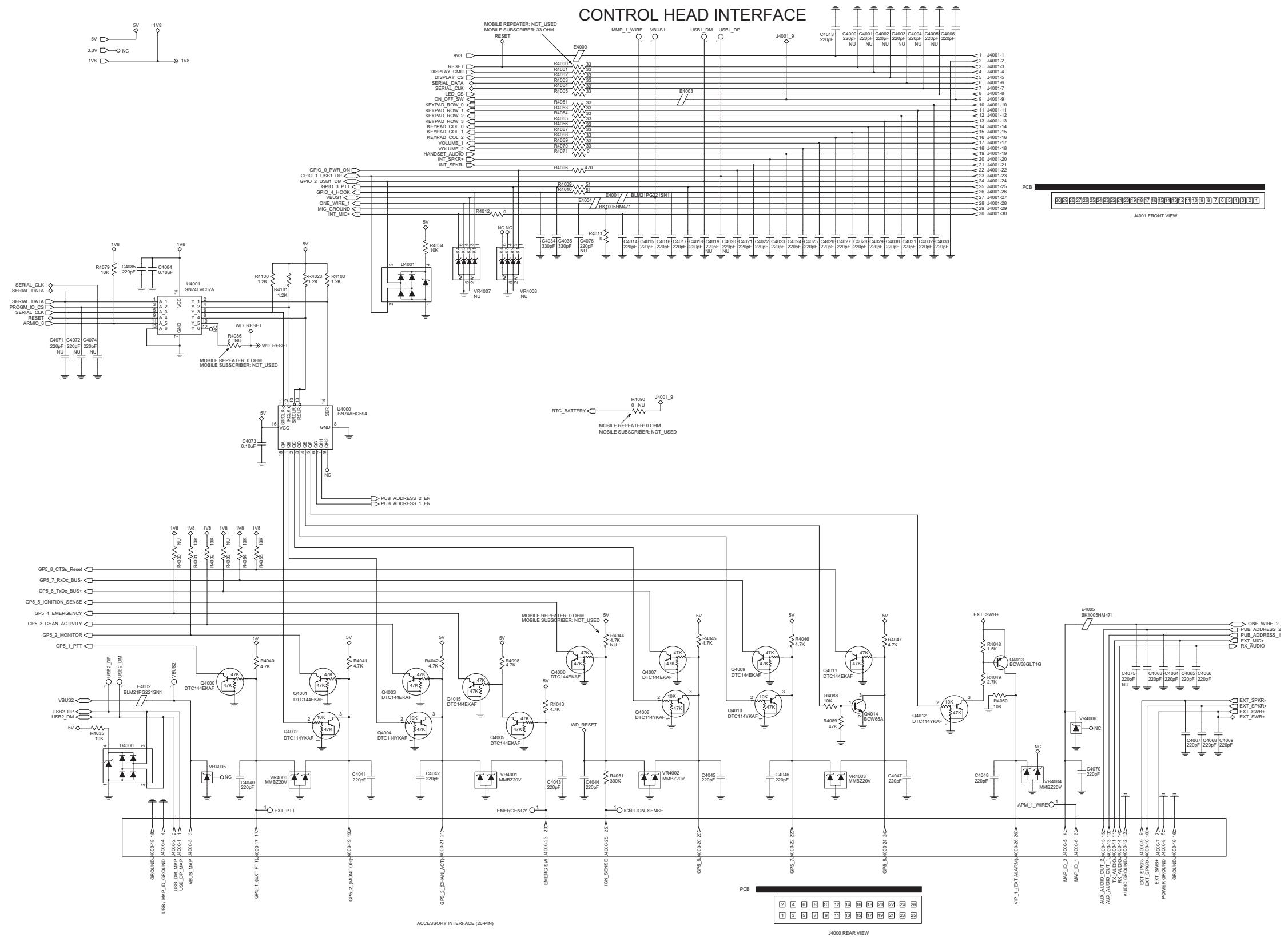
Controller - GPS Schematic Diagram



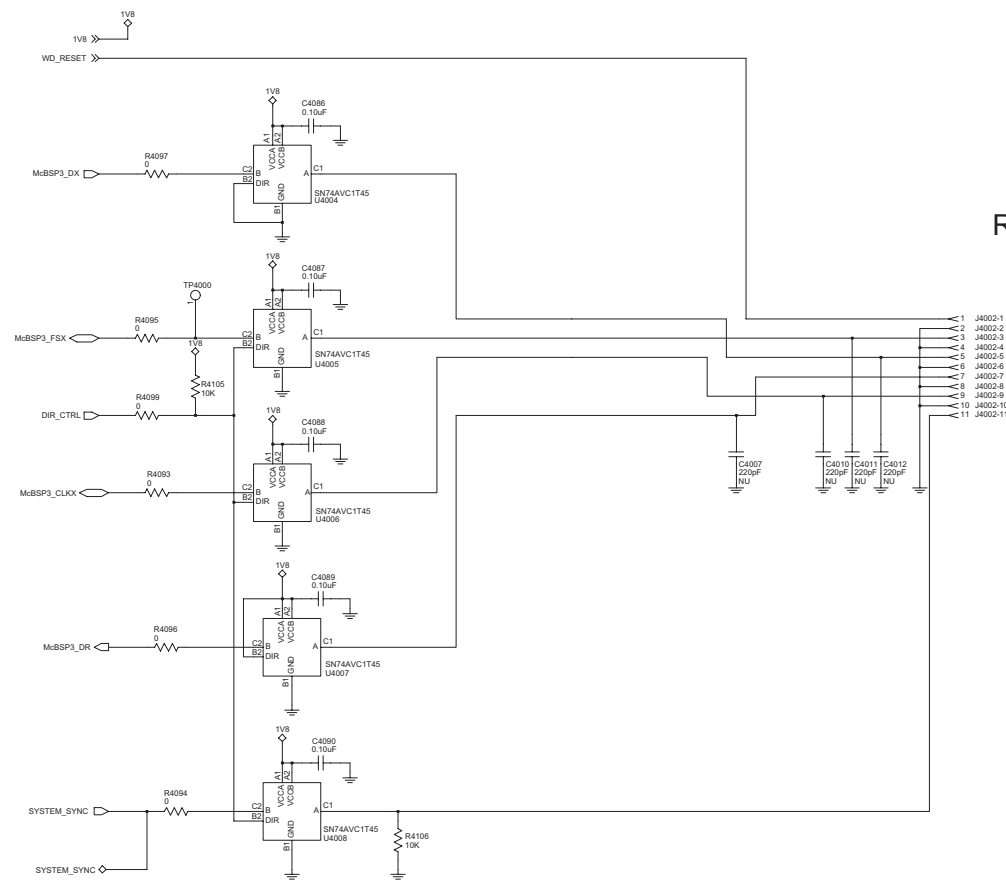
Controller DC Supply Schematic Diagram



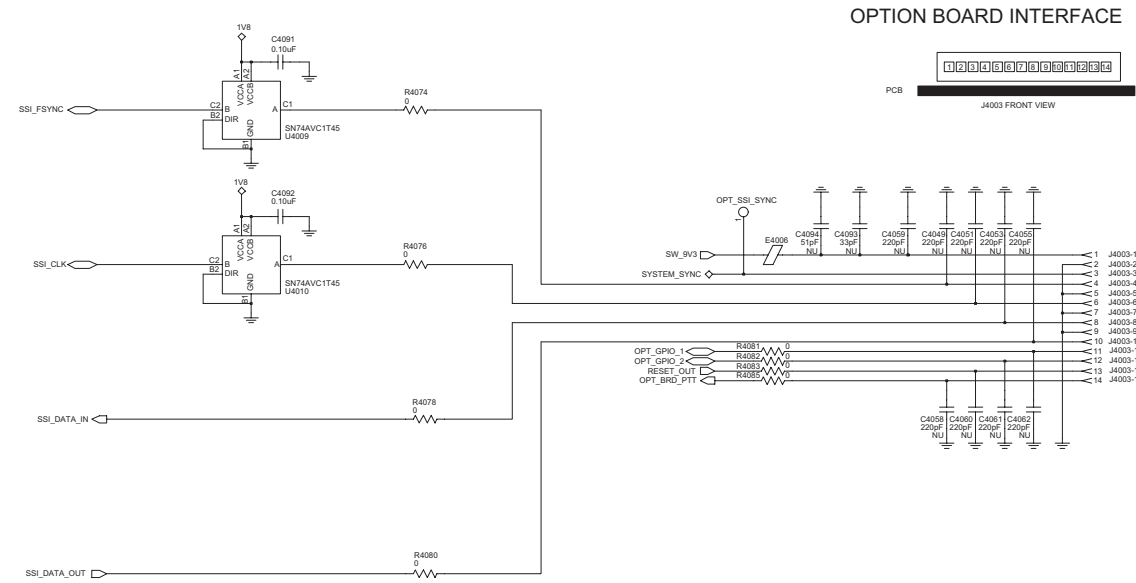
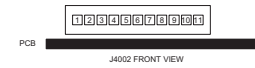
Controller DC Distribution Schematic Diagram



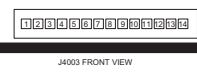
Controller Peripheral Schematic Diagram - (sheet 1 of 2)



REPEATER CONNECTOR

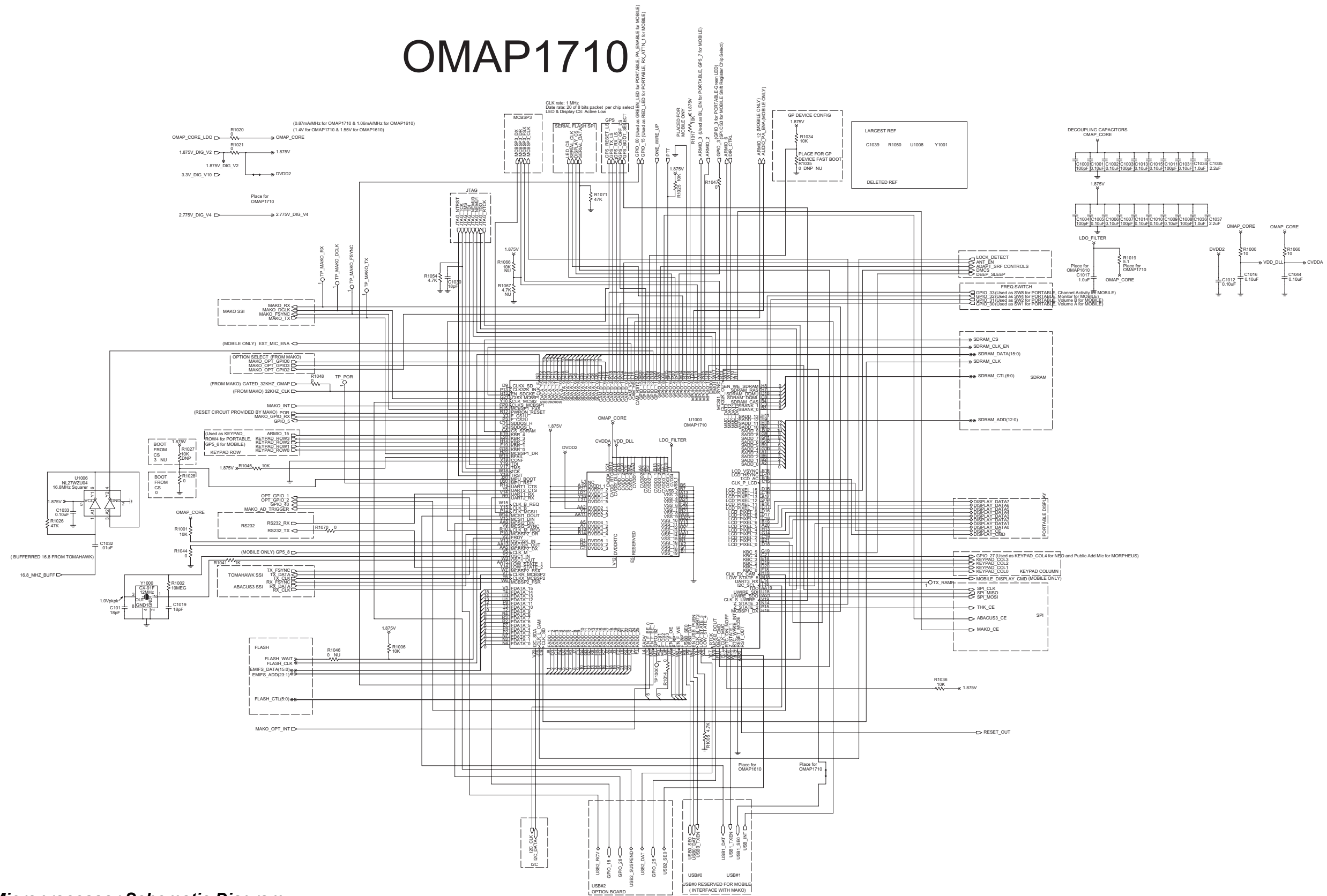


OPTION BOARD INTERFACE



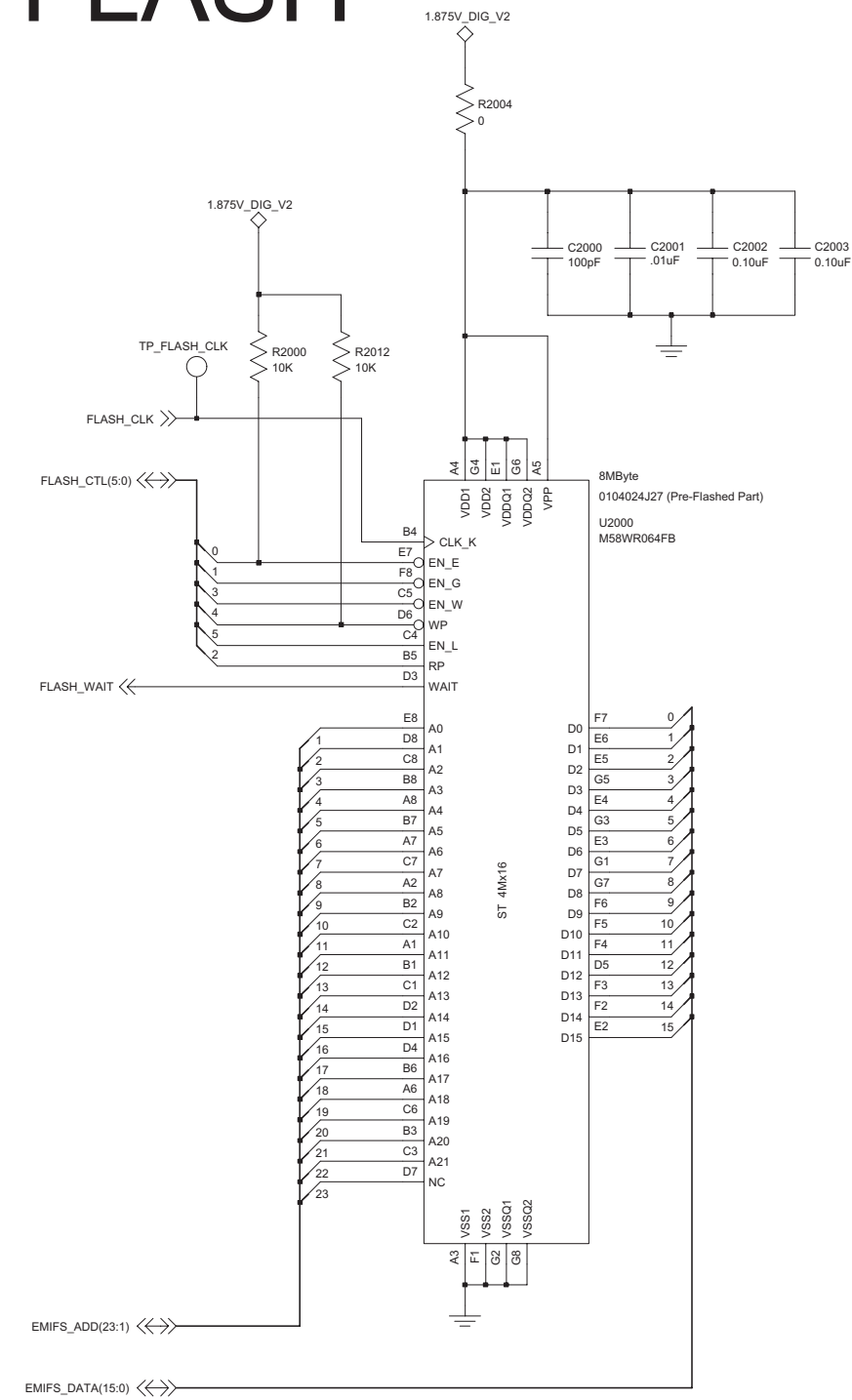
DIR	OPERATION
LOW	B → A
HIGH	B ← A

OMAP1710

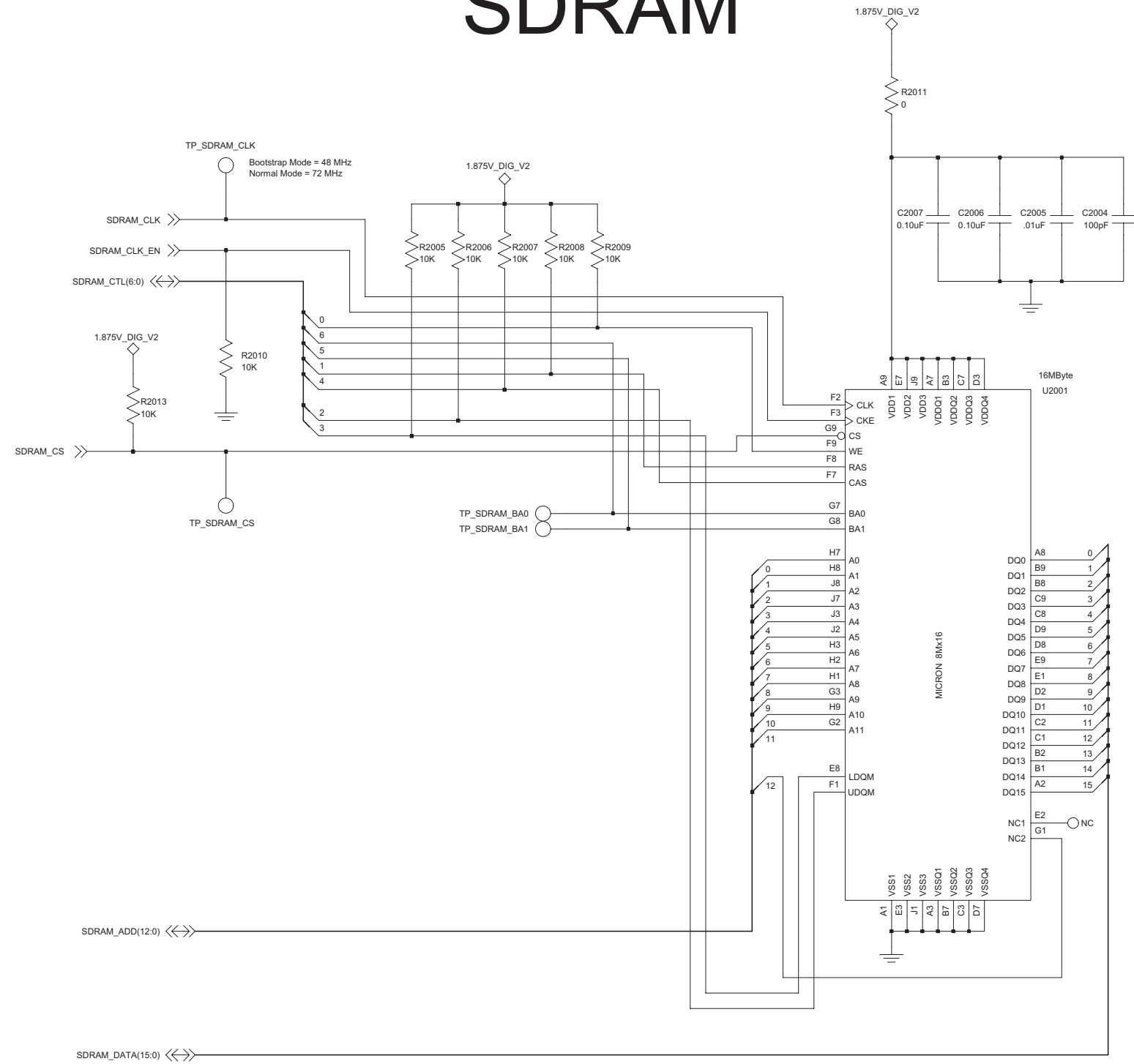


Controller Microprocessor Schematic Diagram

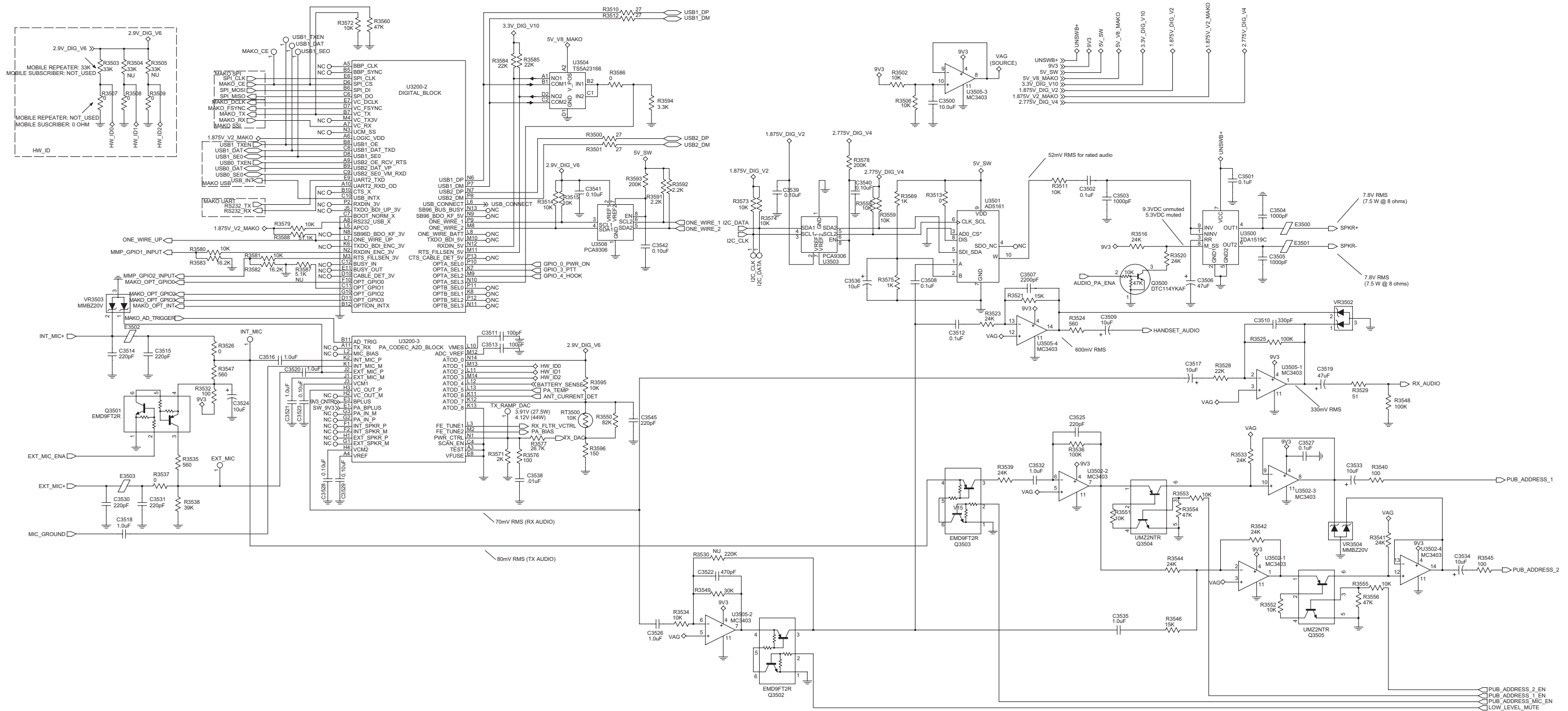
FLASH



SDRAM



Controller Memories Schematic Diagram



Controller Audio and USB Schematic Diagram

4.1 Controller R4 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	0.01uF
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	0.01uF
C2002	2113945Y02	0.10uF
C2003	2113945Y02	0.10uF
C2004	2113944A40	100pF
C2005	2113945B02	0.01uF
C2006	2113945Y02	0.10uF
C2007	2113945Y02	0.10uF
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	0.1uF
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
C3021	2113945C31	0.1uF
C3030	2113945C02	0.01uF

Circuit Ref	Motorola Part No	Description
C3031	2113945C31	0.1uF
C3032	2113945B02	0.01uF
C3040	2113944C06	470pF
C3041	2113945C02	0.01uF
C3042	2113945B02	0.01uF
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
C3219	2113944A44	220pF
C3220	2113945Y02	0.10uF

Circuit Ref	Motorola Part No	Description
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
C3270	2113946S35	1.0uF
C3272	2115153H27	10pF

Circuit Ref	Motorola Part No	Description
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
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
C3513	2113944A40	100pF
C3514	2113944A44	220pF
C3515	2113944A44	220pF

Circuit Ref	Motorola Part No	Description
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	0.01uF
C3539	2113945Y02	0.10uF
C3540	2113945Y02	0.10uF
C3541	2113945Y02	0.10uF
C3542	2113945Y02	0.10uF
C3545	2113944A44	220pF
C4000	NOT PLACED	
C4001	NOT PLACED	
C4002	NOT PLACED	

Circuit Ref	Motorola Part No	Description
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
C4031	2113944A44	220pF
C4032	2113944A44	220pF
C4033	2113944A44	220pF
C4034	2113945A03	330pF

Circuit Ref	Motorola Part No	Description
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
C4070	2113944A44	220pF
C4071	NOT PLACED	
C4072	NOT PLACED	
C4073	2113945Y02	0.10uF

Circuit Ref	Motorola Part No	Description
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
E3208	2480675U01	FERRITE BEAD
E3500	2485011Y01	FERRITE BEAD
E3501	2485011Y01	FERRITE BEAD
E3502	2485011Y01	FERRITE BEAD

Circuit Ref	Motorola Part No	Description
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
J2500	0905505Y02	22-PIN JTAG CONNECTOR
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 BRD 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
Q3203	4805585Q23	PMOS FET

Circuit Ref	Motorola Part No	Description
Q3204	4805585Q23	PMOS FET
Q3205	4815262H01	ANALOG SWITCH
Q3206	4815272H01	ANALOG SWITCH
Q3207	4813970A62	P-CHANNEL MOSFET
Q3208	4815261H01	ANALOG SWITCH
Q3209	4813973M07	ANALOG SWITCH
Q3210	4813973M07	ANALOG SWITCH
Q3500	4815261H01	ANALOG SWITCH
Q3501	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	0613952R01	10K
R2006	0613952R01	10K
R2007	0613952R01	10K
R2008	0613952R01	10K
R2009	0613952R01	10K
R2010	0613952R01	10K
R2011	0613952R66	0
R2012	0613952R01	10K
R2013	0613952R01	10K
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
R2524	0613952R66	0
R2525	0613952R66	0

Circuit Ref	Motorola Part No	Description
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

Circuit Ref	Motorola Part No	Description
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	
R3226	0613952R13	33K
R3227	NOT PLACED	

Circuit Ref	Motorola Part No	Description
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	NOT PLACED	
R3506	0613952R01	10K
R3507	0613952R66	0
R3508	0613952R66	0
R3509	0613952R66	0
R3510	0613952Q35	27
R3511	0613952R01	10K
R3512	0613952Q35	27

Circuit Ref	Motorola Part No	Description
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	0613952R15	39K
R3539	0613952R10	24K
R3540	0613952Q49	100
R3541	0613952R10	24K
R3542	0613952R10	24K
R3544	0613952R10	24K
R3545	0613952Q49	100
R3546	0613952R05	15K
R3547	0613952Q67	560
R3548	0613952J25	100K
R3549	0613952R12	30K

Circuit Ref	Motorola Part No	Description
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	
R3588	0613952N69	51.1K
R3591	0613952Q81	2.2K

Circuit Ref	Motorola Part No	Description
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
R4044	NOT PLACED	
R4045	0613952Q89	4.7K
R4046	0613952Q89	4.7K

Circuit Ref	Motorola Part No	Description
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
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
R4086	NOT PLACED	
R4088	0613952R01	10K
R4089	0613952R17	47K
R4090	NOT PLACED	

Circuit Ref	Motorola Part No	Description
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	0104024J27	IC, 16MB FLASH
U2001	5185941F17	IC, 16MB SDRAM
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

Circuit Ref	Motorola Part No	Description
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	5115865H01	IC, BUFFER
U4010	5115865H01	IC, BUFFER
VR3000	4813979C17	TRANSIENT SUPPRESSOR
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	4813977M05	DIODE, 3.3V ZENER
VR3205	4813977M05	DIODE, 3.3V ZENER

Circuit Ref	Motorola Part No	Description
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
VR4007	NOT PLACED	
VR4008	NOT PLACED	
Y1000	4809612J45	12MHZ CRYSTAL
Y3200	4815028H01	24.576MHZ CRYSTAL
Y3201	4802582S80	32KHZ CRYSTAL



**DM 3400/DM 3401/
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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.

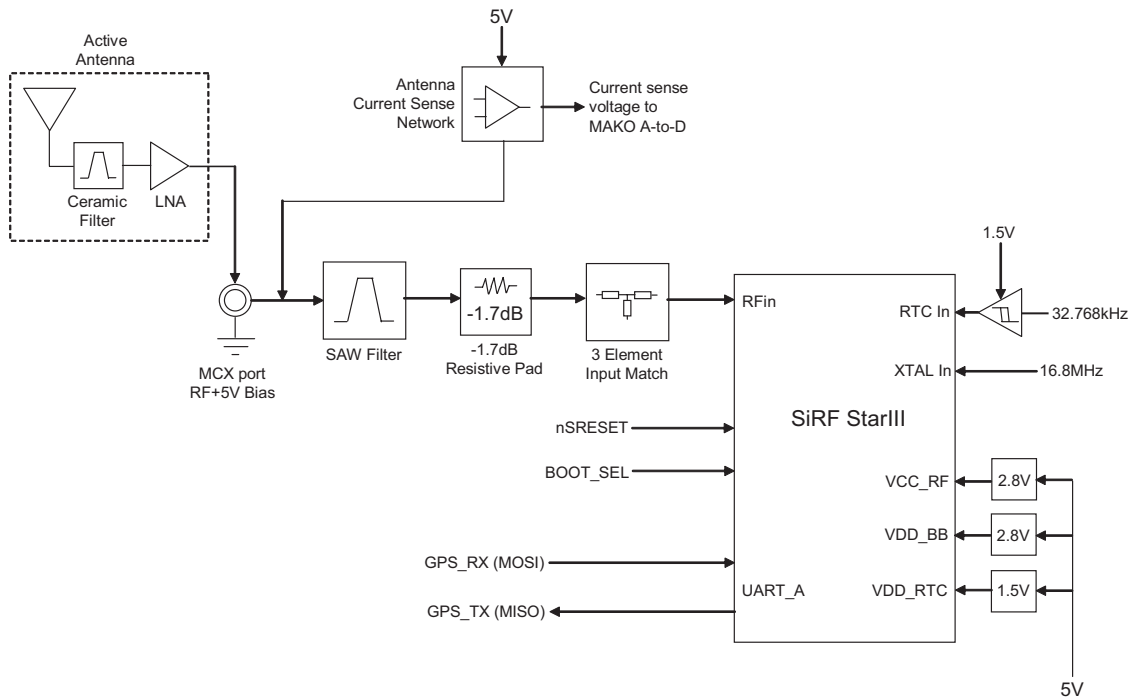


Figure 1-1 GPS Receiver Block Diagram

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 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 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

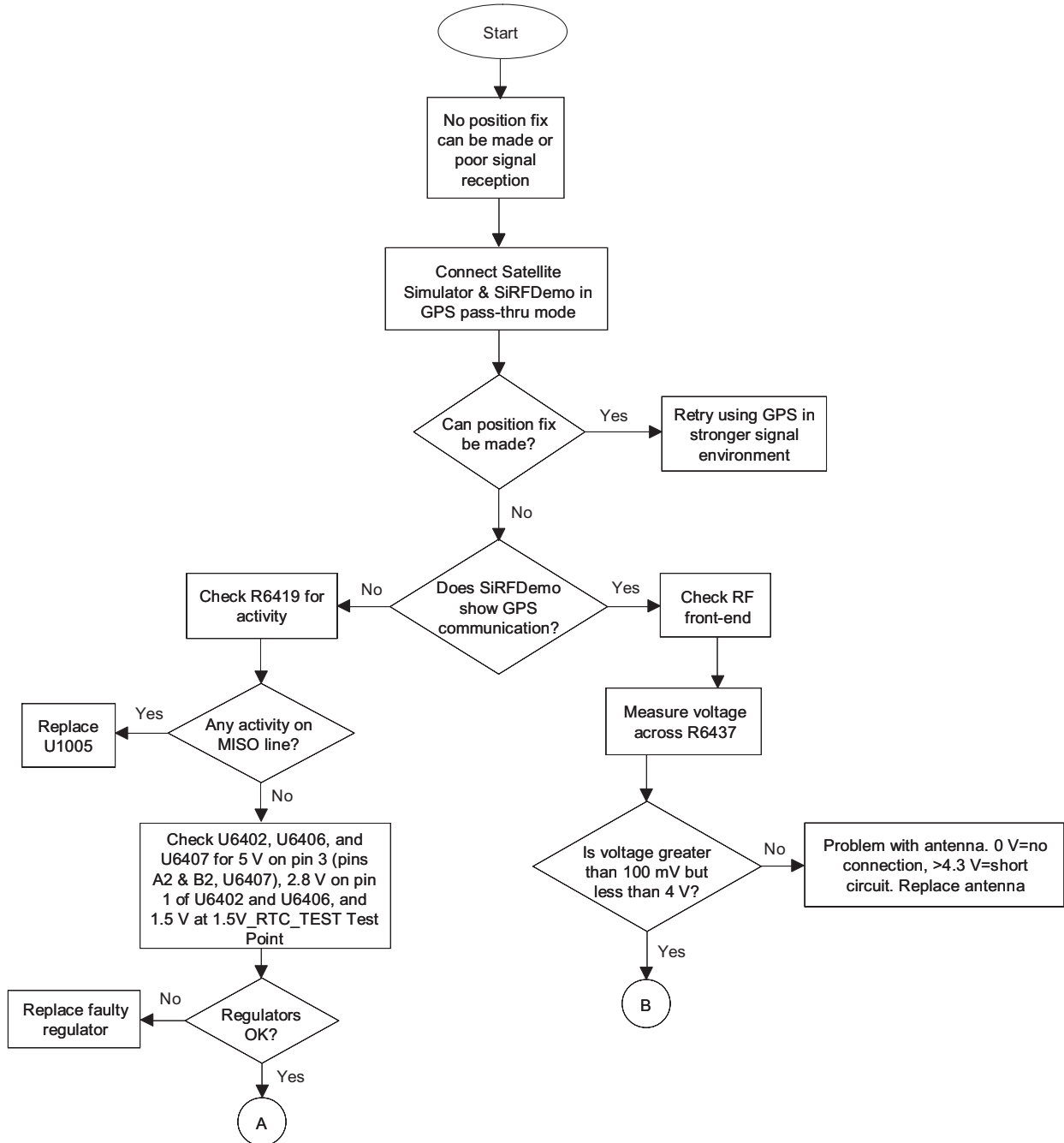
Communication between the StarIII IC and OMAP host is accomplished via one of the GPS IC's two full-duplex UART serial ports (UART_A) at a data rate of 57.6 kbps. These lines are located at pins A6 (TX) and A5 (RX) on the StarIII. UART_B is unused. Other control lines include nSRESET (pin J10), which 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

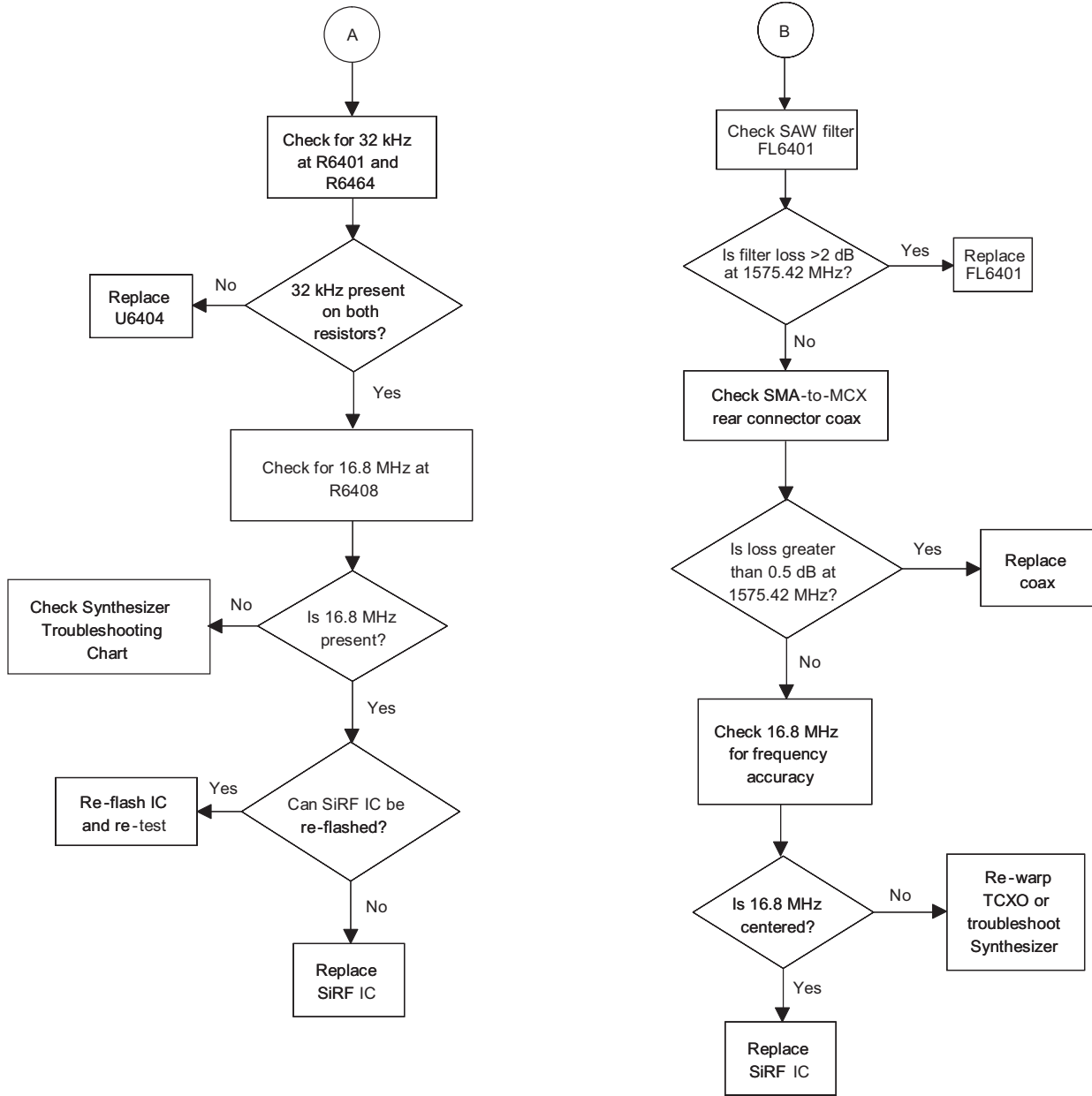
Section 2

TROUBLESHOOTING CHARTS

1.0 GPS Troubleshooting Chart (Sheet 1 of 2)



1.1 GPS Troubleshooting Chart (Sheet 2 of 2)



Section 3

GPS SCHEMATIC / PARTS LIST

1.0 Allocation of Schematic and Parts List

1.1 GPS Circuits

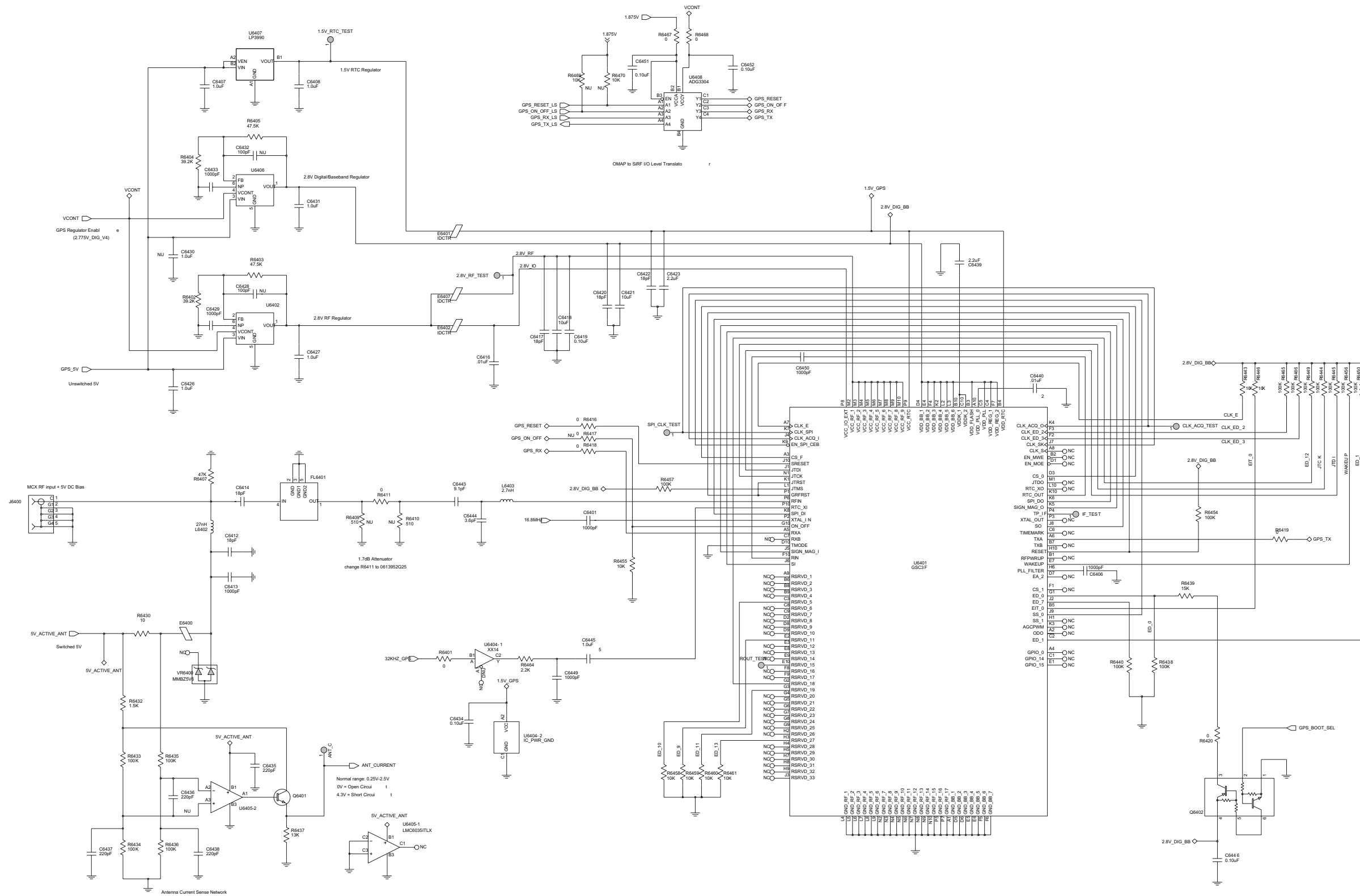
This Chapter shows the Schematic and the Parts List for the GPS circuit.

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	
U6401	0104024J41	IC, GPS
U6402	5115391H01	VOLTAGE REGULATOR
U6404	5115962H01	IC, SCHMITT TRIGGER
U6405	5115453H01	DUAL OPAMP
U6406	5115391H01	VOLTAGE REGULATOR
U6407	5115974H01	1.5V VOLTAGE REGULATOR
U6408	5116324H01	IC, LEVEL TRANSLATOR
VR6400	4813977A43	DIODE, 5.6V ZENER



**DM 3400/DM 3401/
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Chapter 5

UHF1 (403-470 MHz)

1-25W

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Section 1

THEORY OF OPERATION

1.0 Introduction

This Chapter provides a detailed theory of operation for the UHF 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 UHF1 (403-470 MHz) Receiver Circuitry

The receiver is configured as a dual-conversion superheterodyne receiver, capable of both FM and 4-level FSK demodulation. The major blocks are the front-end, the mixer, Xtal filter, and the Abacus III back-end IC. The overall block diagram is shown in Figure 1-1.

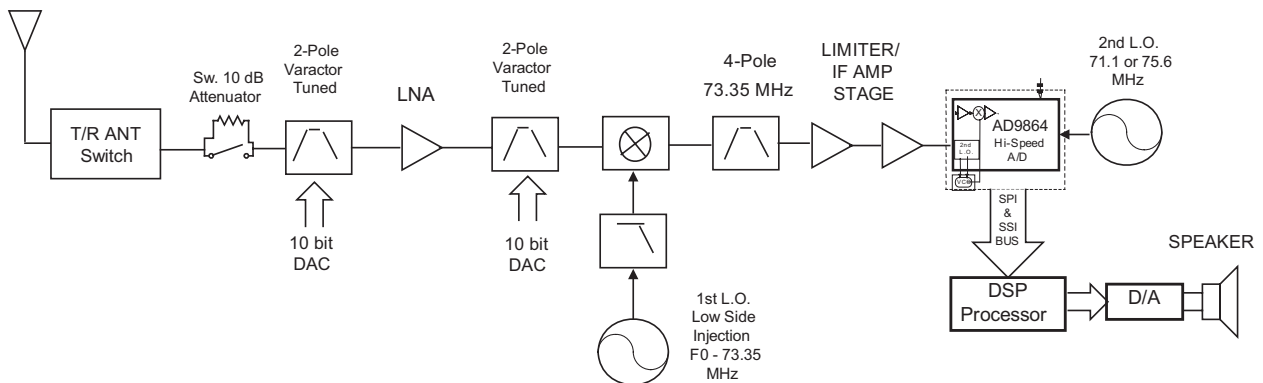


Figure 1-1 Receiver Block Diagram

2.1 Receiver Front-End

The front-end consists of a 2-pole varactor-tuned pre-selector filter, an LNA, a 2-pole varactor-tuned post-selector filter, and a passive double-balanced mixer. The received signal applied to the antenna is routed through the harmonic filter and PIN diode controlled antenna switch (D0702). A logic high level on ANT_ENABLE configures the antenna switch for Tx operation while a logic low places the switch in Rx mode. The insertion loss of the harmonic filter and antenna switch combined is approximately 0.5 dB max in Rx mode. From this point, the Rx signal is routed to the Local Distance switch (D0400/R0407), which biases on a diode in normal operation to minimize any insertion loss. Under strong signal conditions and for improved intermodulation protection from interfering signals, the switch can be turned on by the signal RF_ATTEN_1 which introduces approximately 10 dB of additional path loss. Activation of the switch can be accomplished manually by the user or left in the default setting.

The signal next reaches the pre-selector filter, which is a 2-pole, varactor-tuned filter with 5 zeros that are optimized to provide image frequency rejection. This filter, along with the similarly designed post-selector filter, provides over 75 dB of image response rejection. The 3 dB bandwidth for both filters varies across the band with a minimum of 19 MHz at 403 MHz and a maximum of 40 MHz around 436 MHz. Half-IF rejection from the filters is also frequency dependent with a minimum of approximately 10 dB achieved at the worst-case frequency of 436 MHz. Both filters have variable center frequencies that are adjusted by the FE_TUNE signal, which is derived from the output of a 10-bit DAC internal to the MAKO IC (U3200). The voltage is scaled up by a voltage doubler (Q0403) in order to provide the required linearity for the filters. Both filters are matched to the LNA (Q0402) to optimize the amplifier's noise figure (2.0 dB) and to provide an LNA gain of 15 dB to the signal. The combined gain of the filters and LNA is about 13 dB. Current source Q0401 maintains the collector current of Q0402 constant at 20 mA. The LNA, current source, Local Distance switch, and voltage doubler are all supplied by 9R1_FILT, which is derived from 9R1 after filtering.

Following the post-selector filter is the Class 2, double-balanced mixer. It is comprised of baluns T0400 and T0401 and diode ring mixer D0405. Injection amplifier Q0405 provides 10 dB of gain to the Rx VCO injection signal. Another amplifier, Q0202, located in the VCO block, also provides gain for the LO signal and isolation from high RF signals entering the mixer. The signal applied to the LO port of the mixer is +16 dBm minimum after passing through the 3-pole/1-zero, low-pass injection filter. The LO injection is low-side and mixes the signal down to an IF frequency of 73.35 MHz. The output of the mixer is connected to a diplexer network, which terminates out-of-band frequencies in 51 ohms (R0427) while appearing as high impedance to the 73.35 MHz IF signal.

2.2 Receiver Back-End

The signal entering the back-end is matched to 4-pole crystal filter, FL0500, by C0507 and L0503. The filter is centered at 73.35 MHz with a 3 dB bandwidth of 12 kHz. IF amplifiers Q0500 and Q0501 follow the crystal filter and provide both amplification and limiting to the signal. An overall gain of 25 dB is available from the composite IF amplifier to lower-level IF signals. As the signal level increases, Q0501 begins to limit and eventually saturates out at approximately -16 dBm. The purpose of the limiting is to provide protection to the AD9864 Abacus III back-end IC (U0600). At IF levels exceeding -32 dBm into U0600, the 2nd LO synthesizer internal to U0600 can be pulled, causing corruption of the I/Q data being delivered to the DSP. The block diagram for the AD9864 is shown in Figure 1-2 below.

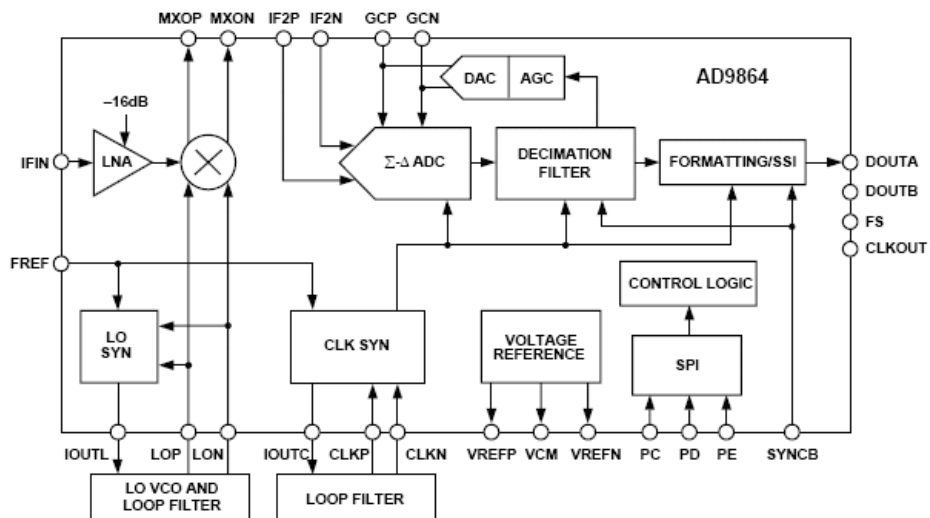


Figure 1-2 AD9864 Block Diagram

The Abacus III accepts the 73.35 MHz signal, processes it, and sends out I/Q data in 16-bit format to the DSP at a 20 kHz rate. Internal to the Abacus III is an LNA and 16 dB FE attenuator, an internal integer-N synthesizer used to control the external 2nd LO VCO, a Sigma-Delta ADC and decimation filter, and control and formatting logic for outputting the baseband I/Q data. External to U0600 is the 2nd LO VCO with active device Q0600 and its associated circuitry including the loop filter consisting of C0613, C0618, and R0603. The 2nd LO mixes the 73.35 MHz IF signal down to 2.25 MHz before being input to the ADC where it is sampled. The tank circuit (L0608, C0605, C0642, R0617) and varactor (D0601) for the internal clock synthesizer, work with the loop filter (R0618, C0643, C0646) to provide the 18 MHz clocking signal to the internal ADC, decimation filter, and SSI formatting circuitry. A 3 Volt regulator (U0601) provides a clean supply to U0600. Transistor Q0601 is configured as a super filter to provide the 2nd LO transistor with a low-noise supply. The reference clock for U0600 is 16.8_REF, which is a buffered (Q0100) 16.8 MHz clock from the synthesizer block.

Shown below in Figure 1-3 is a simplified block diagram of the signal flow through the receiver back-end and the DSP processor portion of the OMAP (U1000). All of the blocks within the dotted box represent the DSP software algorithms internal to the DSP.

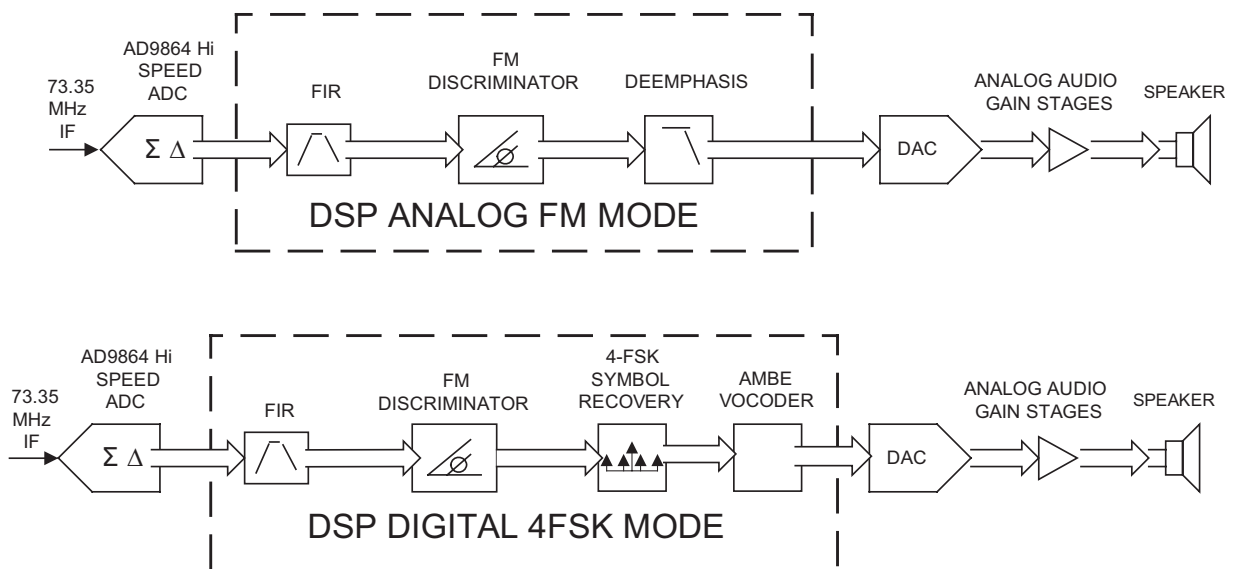


Figure 1-3 Signal Flow through Receiver Back-End

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 filter data is then sent through a decimation process further reducing its frequency to 8 kHz.

Depending on whether the radio is in Analog or Digital mode determines the type of signal processing used. If in Analog mode, the remaining 8 kHz data is sent through the FM Discriminator and De-emphasis subroutines in the DSP code. If the radio is in Digital mode, the 8 kHz data is again passed through the FM Discriminator but an additional Symbol Recovery routine is applied along with a standard AMBE Vocoder process. The data is sent to the MAKO (U3200), which provides digital to analog conversion and drives the audio gain stages. Detailed information regarding this can be found in the Audio Section of the Controller Theory of Operation.

3.0 UHF1 (403-470 MHz) Transmitter Circuitry - 25 Watt

The Transmitter consists of the power amplifier (PA) circuitry and the power control circuitry. The power amplifier provides amplification of the signal from the VCO up to the desired output power. The power control block 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, and poor assembly.

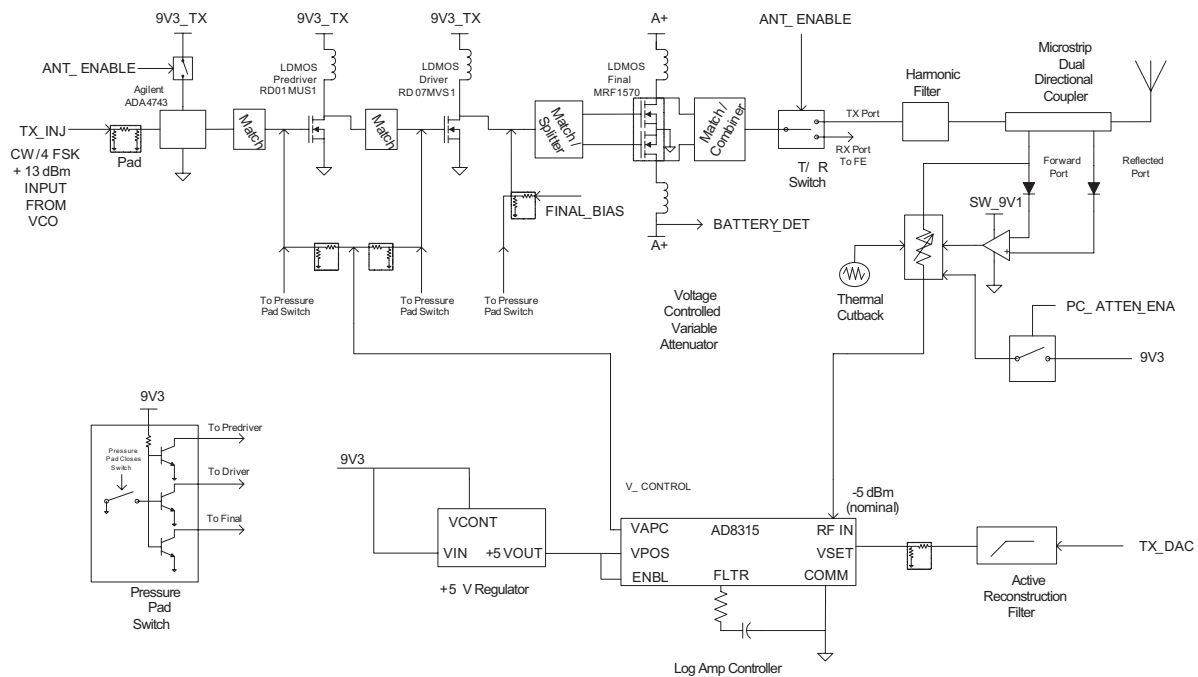


Figure 1-4 UHF 1-25 Watt Low-Power Transmitter Detailed Block Diagram

3.1 Power Amplifier

The radio's 25 Watt power amplifier (PA) is a 4-stage amplifier which amplifies the output of the VCO to the required transmit power level. The first stage is an LDMOS (Lateral Double Diffuse MOS) 50 ohm fixed-gain block (ADA-4743, U0700) followed by the adjustable gain LDMOS pre-driver (RD01MUS1, Q0705), an adjustable gain LDMOS driver (RD07MVS1, Q0703), and the fixed-gain LDMOS final device (MRF1570, Q0702). A transmit/receive (TR) switch and a harmonic filter complete the transmit lineup.

3.2 Input Stage (50 Ohm Fixed-Gain Block)

The first stage (ADA-4743, U0700) is an integrated circuit with internally matched 50 ohm input and output stages providing approximately 16.5 dB power gain. It provides reverse isolation between the PA and the VCO to lessen the risk of VCO load-pull and it also supplies appropriate power to the pre-driver stage. The ADA-4743 is biased at 60 mA during transmit by R0706, which is switched to 9V3_TX during TX operation by Q0701 (controlled by Antenna_En). The ADA-4743 is preceded by an 16 dB resistive pad to further improve reverse isolation.

3.3 Pre-Driver Stage

The next stage is a low-power, LDMOS device (RD01MUS1, Q0705), which delivers up to +27 dBm to the driver stage. Its gain is controlled by varying the gate bias voltage and varies from low gain up to approximately 14 dB power gain. The gate bias voltage is controlled in parallel with the driver stage by the V_cont signal.

The input match to this stage is a high-pass topology comprising of L0718, C0817, and L0721. High-pass matches are used where appropriate to minimize the chances of low frequency regeneration within the amplifier. R0759 and R0777 are required to improve the bandwidth of this circuit. The inter-stage match between the pre-driver and driver stages is comprised of L0720, C0786, and C0791 arranged in a high-pass topology. Additional pads are provided on the transceiver board to allow for possible engineering optimizations to this match. These are non-populated parts C0789, C0792, C0793, and C0794.

3.4 Driver Stage

The third stage is a medium-power, LDMOS device (RD07MVS1, Q0703), which delivers up to +38 dBm to the final device. Its gain is controlled by varying the gate bias voltage and varies from low gain up to approximately 11 dB of power gain. The gate bias voltage is controlled with the V_cont signal and is controlled in parallel with the pre-driver stage gain.

R0718, R0720, R0754, and R0755 are required to improve the bandwidth of the driver stage. The inter-stage match (as well as the power splitter) between the driver and final device is comprised of C0753, C0813, C0818, C0819, C0732, C0743, C0744, and C0761, and associated micro-strips on the PCB. Additional pads are provided on the printed circuit board to allow for possible engineering optimizations to this match. These are non-populated parts C0754, C0755, C0729, C0730, C0731, C0808, C0764, C0760, and C0765.

3.5 Final Stage

The final stage is a high-power, LDMOS device (MRF1570, Q0702) consisting of two parallel, high-power devices within 1 plastic package. The package is mounted to a copper carrier to improve thermal conductivity to the chassis and also to more tightly control the RF load, allowing higher and more consistent maximum output power. This stage is biased at a quiescent current of 750 mA and operates with a fixed-gain of approximately 10 dB, allowing the radio to be set to a maximum output power of 30 Watts. The quiescent current is set by adjusting the Final_Bias signal. Both elements of this transistor are fabricated on the same semiconductor die and are well matched, allowing control via a single voltage.

Both the input and output matching circuits of this stage have extremely critical part location requirements. Any repairs must be done with care to ensure the replaced components are placed accurately and properly soldered. Of particular concern are input matching capacitors C0732 and C0761 and output matching capacitors C0811 and C0812. The resistor networks at the input of each of the final elements are required to improve the bandwidth of the circuit. These resistors are R0762 through R0773.

The output matching circuit and power combiner is comprised of C0811, C0719, C0812, C0746, C0726, and C0737 and associated microstrips fabricated on the printed circuit board. Additional pads are provided on the pc board to allow for possible engineering optimizations to this match. These are non-populated parts C0720, C0721, C0747, C0748, C0727, and C0741. R0719 is added as a preventative measure against half-carrier regeneration.

If the final device fails and has to be replaced, R0719 should be carefully inspected to ensure against any damage caused by the final device. Replacement of the final device requires that the bias voltage 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 which is 1 Amp. The device can tolerate up to 5 Amps for brief periods of time without damage.

3.6 Antenna Switch

The antenna switch (TR switch) routes the signal between either the transmitter or receiver and the antenna. In transmit mode, it utilizes the existing dc feed (A+) to the final stage device (Q0702). Both PIN diodes D0700 and D0702 are turned on during key-up through forward biasing. This is achieved by pulling down the voltage at the cathode end of D0702 to approximately 12.2 Volts (0.7 Volt drop across each diode). Q0704 is configured as a current sink that maintains the current through the antenna switch diodes at 100 mA, as set by VR0700 and R0738. The current sink is enabled during transmit mode by ANT_ENABLE, which is asserted through Q0706 and associated circuitry. When the PIN diodes are conducting, an RF ground is formed at the anode of the lower PIN diode, D0702, which places L0710 and C0803 in parallel. The values of L0710 and C0803 are chosen so as to be parallel resonant at the center of the transmit band, making them appear as an open-circuit so that a 50 ohm power path is maintained through the top PIN diode to the harmonic filter.

In receive mode, DC current through the PIN diodes is interrupted by turning off the current sink. The RF path now flows from the harmonic filter, through the matching circuit formed by L0710, C0803, and the capacitive divider formed by C0767 and C0772. C0766, currently unplaced, is provided for possible future engineering optimizations to this match. The purpose of L0719 is to form a parallel resonant tank with the reverse capacitance of D0700, improving the receive path return loss at the receive input of the TR switch.

3.7 Harmonic Filter

Inductors L0706, L0707, L0708, and capacitors C0742, C0739, C0740, and C0738 form a 7-element low-pass filter to attenuate harmonic energy from the transmitter. R0713 is used to drain any electrostatic charges that might otherwise build up on the antenna. The harmonic filter also prevents high-level RF signals above the receiver pass-band from reaching the receiver circuits, improving spurious response rejection.

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 consisting of pin diodes D0901, D0902, and D0903. The log detector/controller regulates the gain of PA stages Q0703 and Q0705 (via V_cont), thus ensuring that 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 as part of the VSWR load-detection circuitry. Its physical location close to the antenna connector allows accurate VSWR sense at the transmitter output. Forward and reverse coupled signals are rectified by D0904 and D0905, respectively. DC voltage FWD_DETECTED is proportional to 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 the variable attenuator control stage, U0900-1. An abnormally high reflected power level, i.e., a damaged antenna, also causes an increase in the difference amplifier output voltage.

This causes a reduction in attenuation by the VCA. As a result, the greater RF signal applied to the log detector/controller causes the controller to reduce the gain of PA stages Q0703 and Q0705. Transmitter power is thus reduced to prevent damage to the final device due to an improper load.

3.9 Power Control

The transmitter uses 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-stable, high-accuracy control over a typical 50 dB dynamic range.

The MAKO IC 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. Reference voltage level is programmable through the SPI lines of the MAKO. This reference voltage is 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 of the transmitter's coupled power circuits.

The PA controller IC provides a dc output voltage at pin 7 (VAPC), which is divided to provide gate bias for PA pre-driver and driver stages. The 0 Volts to 5 Volts range at U0940, pin 7, is applied as V_CONTROL to power-adjust the transmitter 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. This adjusts the transmitter power output to the intended value. The ratio of each of these resistive dividers is chosen to ensure that Q0703 and Q0705 are both running at their 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 to raise or lower output power in order to maintain transmitter output power relative to the reference voltage applied to VSET.

A power control attenuator circuit was added to the 25 Watt transmitter circuitry in order to extend the range of the RF detection in the RF detector at low-power levels. This enables the power control loop to close at lower relative power levels and is needed because of the greater relative power-set range (1-25 Watt, 14 dB). The PC_ATTEN_ENA activation threshold is set in software for operation at lower power levels, typically 1-5 Watt. When the PC_ATTEN_ENA is activated, the VCA is driven to its minimum attenuation level, which increases the RF level at the AD8315 (U0940) for a given transmitter power level. The radio software adjusts the K&M tuning accordingly such that proper power-set is maintained at operating powers both above and below the activation threshold point.

3.10 Power Ramp Profile Control

In order to minimize the transient adjacent channel power at the transmitter's output, the ramped power follows 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, set the loop dynamics. The loop response has 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, form a voltage divider with the output proportional to the sensed transceiver 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 the attenuation level of the VCA stage. For the condition that the temperature threshold set by resistive divider combination R0901 and R0909 is reached, the VCA is driven to increase the RFIN signal at the PA controller IC (pin 1). This increase will cause the 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 the battery supply in the controller circuit of the radio in order to change the VSET input of the PA controller IC (pin 3) for reduced transmitter output. This feature allows transmitter PA dissipation to be limited at high-line battery supply operating conditions while limiting transmitter PA overdrive conditions at low-line battery supply operating conditions.

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 transistor Q0702 against the chassis. When the chassis cover and rubber pad are properly assembled, the conductive portion of the pad contacts a pattern on the transceiver 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, turning off the gate bias to Q0702, Q0703, and Q0705. This prevents thermal damage of the RF transistors which could 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 (Tomahawk II, U0100), and the Voltage Controlled Oscillator VCO.

4.1 Reference Oscillator

The reference oscillator (Y0100) contains a temperature compensated crystal oscillator with a frequency of 16.8 MHz. A digital-to-analog (DAC) converter internal to U0100 (Tomahawk) and controlled by the microprocessor via serial interface (SPI), sets the voltage at the AUX_DAC output of U0100 (pin H6) to set the frequency of the oscillator. The output of the oscillator (pin 3 of Y0100) is applied to pin K5 (XOSC_BASE) of U0100.

4.2 Fractional-N Synthesizer

The Tomahawk II synthesizer IC (U0100) consists of a pre-scaler, a programmable divider and divider 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 2.45 Volts.

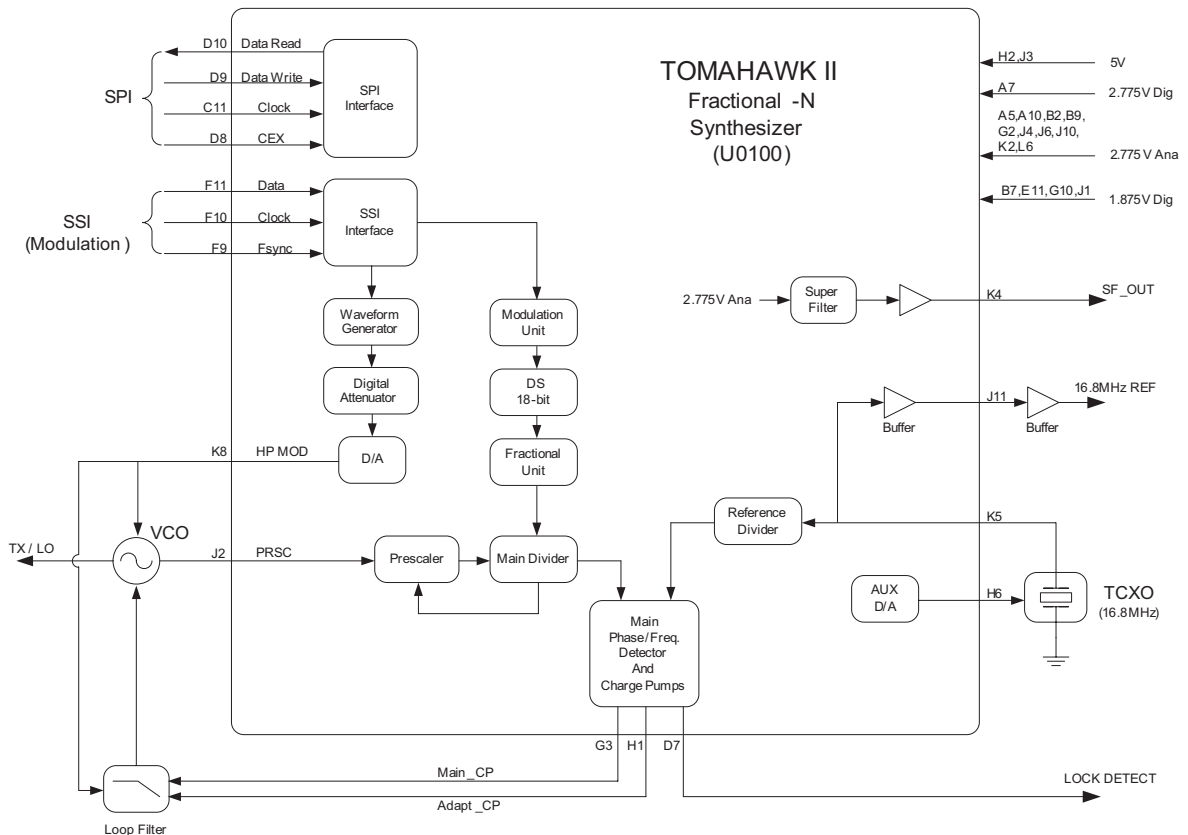


Figure 1-5 UHF Synthesizer Block Diagram

A voltage of 2.775 Volts applied to the super filter input (U0100 pin J4) supplies an output voltage of 2.45 Vdc (SF_OUT) at pin K4. This supplies the VCO and the VCO modulation bias circuit (via R0321). The super filter supply voltage is provided by the 2.775 Volt regulator within U3200. The synthesizer is also supplied by the 5 Volt regulator, U3002, another 2.775 Volt regulator within U3200, and a 1.875 Volt regulator within U3200.

The output signal LOCK (U0100-D7) provides information about the lock status of the synthesizer loop. A high level 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 microprocessor via the data lines SPI_DW (U0100-D9) and SPI_DR (U0100-D10), 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 four Colpitts oscillators (two each for Tx and Rx), a single-stage Tx buffer amplifier, a single-stage Rx buffer amplifier, oscillator bias control switches, and the modulation circuitry.

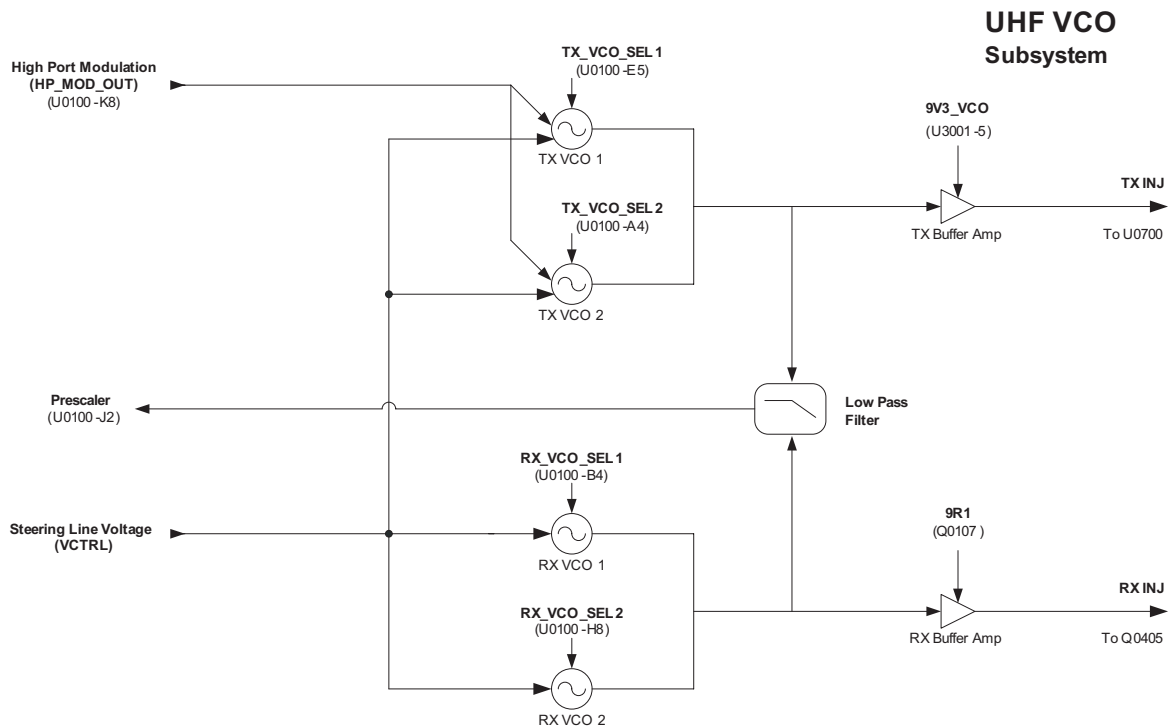


Figure 1-6 UHF VCO Block Diagram

The UHF VCO design incorporates a total of four oscillators; two varactor-tunable Colpitts oscillators each for Tx and Rx. Each oscillator has a tuning range of 33.5 MHz, sufficient to cover the Rx and Tx frequency ranges of 326.65 MHz to 396.65 MHz and 403 MHz to 470 MHz, respectively. The oscillators resonate at fundamental operating frequencies. Four (active-low logic) general purpose output lines (GPO1, GPO2, GPO3, and GPO6) from the Tomahawk IC (U0100-B4, A4, E5, and H8) provide the control for independent bias selection to each oscillator (VCO_SEL) via the PNP transistor switches U0304 and U0201. The 2.45 Volt super filtered output, SF_OUT, of the Tomahawk IC (U0100-K4) supplies the bias to the oscillators. A portion of the VCO output signal is lightly coupled through coupling capacitors C0331 and C0231, routed through a low-pass filter (formed by L0221, C0235, C0230, and C0233), and fed back to the M_PRSC input of the Tomahawk IC (U0100-J2).

High-port modulation is scaled through a voltage divider (comprised of R0319, R0320, and R0321) and applied to the Tx modulation varactor diode CR0300. The TX VCO frequency is modulated via coupling capacitors C0310 and C0344. High-port modulation is also applied to the VCO steering line (through R0139, R0140 and C0166) which modulates the main VCO tuning varactors.

A discrete single-stage Tx buffer amplifier (comprised of the NPN transistor Q0302 and surrounding components) amplifies the signal from the Tx oscillator to the level required by the first stage of the Transmitter Power Amplifier (U0700). The TX buffer amplifier also provides sufficient isolation from any undesired load-pulling from the Transmitter Power Amplifier. The bias for Q0302 is provided by the 9.3 Volt regulator U3001.

A discrete single-stage Rx buffer amplifier (comprised of the NPN transistor Q0202 and surrounding components) amplifies the signal from the Rx oscillator to the level required by the LO injection amplifier (Q0405). The Rx buffer amplifier also provides sufficient isolation from any undesired load-pulling from high input levels in the receiver front-end. GPO4 from the Tomahawk IC (U0100-D4) controls the transistor switch (comprised of Q0108 and Q0107), that enables the 9.1 Volt bias to Q0202 (via the 9.3 Volt regulator U3001).

4.4 Synthesizer Operation

The complete synthesizer subsystem is comprised mainly of the Tomahawk synthesizer IC, Reference Oscillator (crystal oscillator with temperature compensation), loop filter circuitry, VCO, and DC supplies. The VCO feedback signal, PRSC, is fed to pin J2 of U0100 (M_PRSC) via a low-pass filter (L0221, C0235, C0230, and C0233) 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). The output signal of the phase/frequency detector is a pulsed signal which is routed to 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 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 H1 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-D7), which is routed to the microprocessor. Q0102 is configured as a current source to provide a steady 1.5 mA during the adapt period. U0101 is an analog switch that opens the adapt path slightly before the end of the adapt period to prevent the current from the current source from pushing the VCO off frequency.

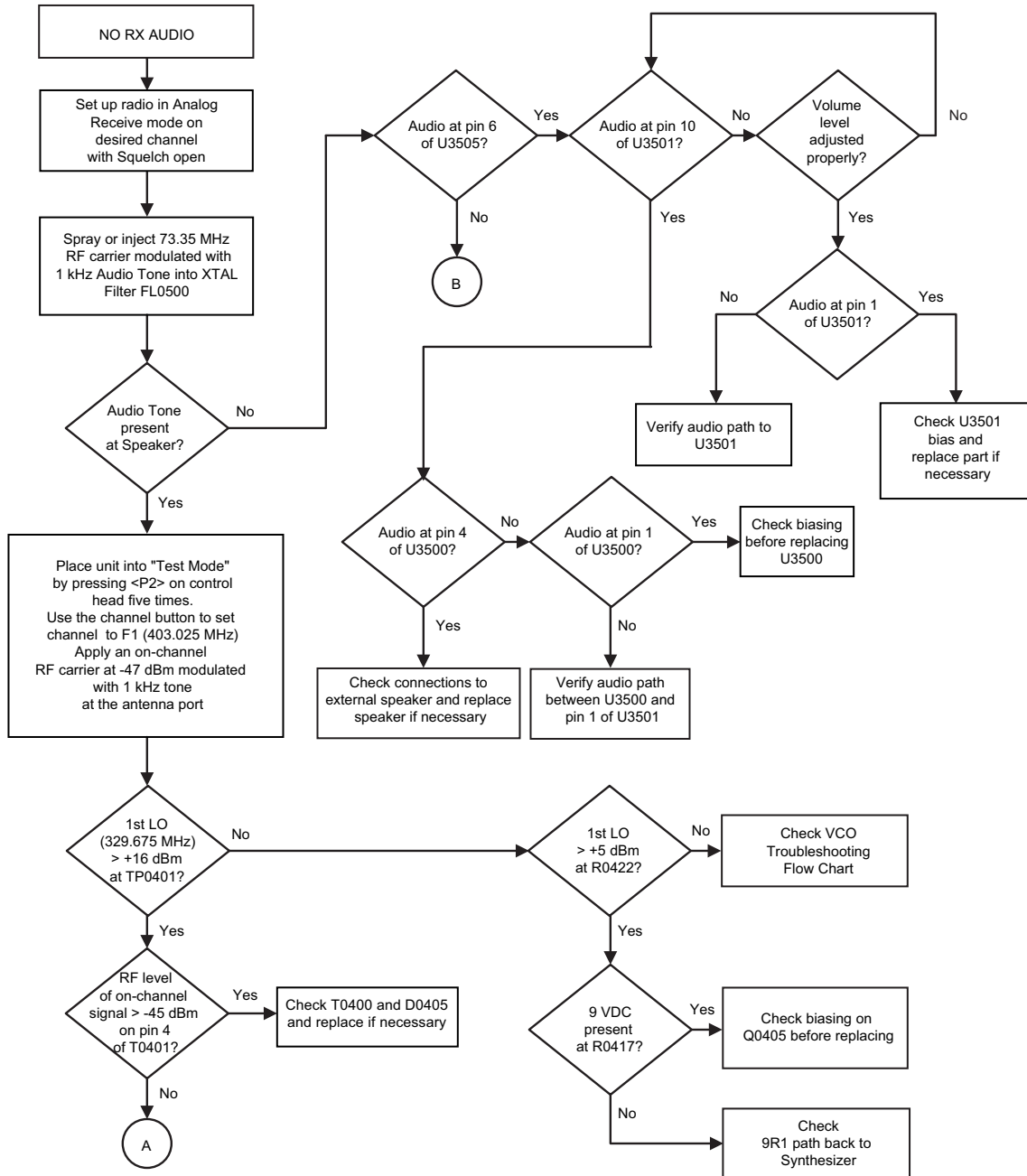
Modulation is performed by applying a digital data stream via the SSI bus from the DSP (U1000) to the synthesizer (U0100). In order to meet spurious and phase noise requirements, the PLL bandwidth was designed to be narrower than the full modulation bandwidth, therefore requiring the use of dual-port 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 a 10-bit DAC before modulating the VCO. This high-port analog modulation output (HP_MOD_OUT, U0100-K8) is connected to the VCO modulation varactor diode (CR0300) via C0360 and R0319, and to the loop filter via R0139, R0140, and C0166.

Notes

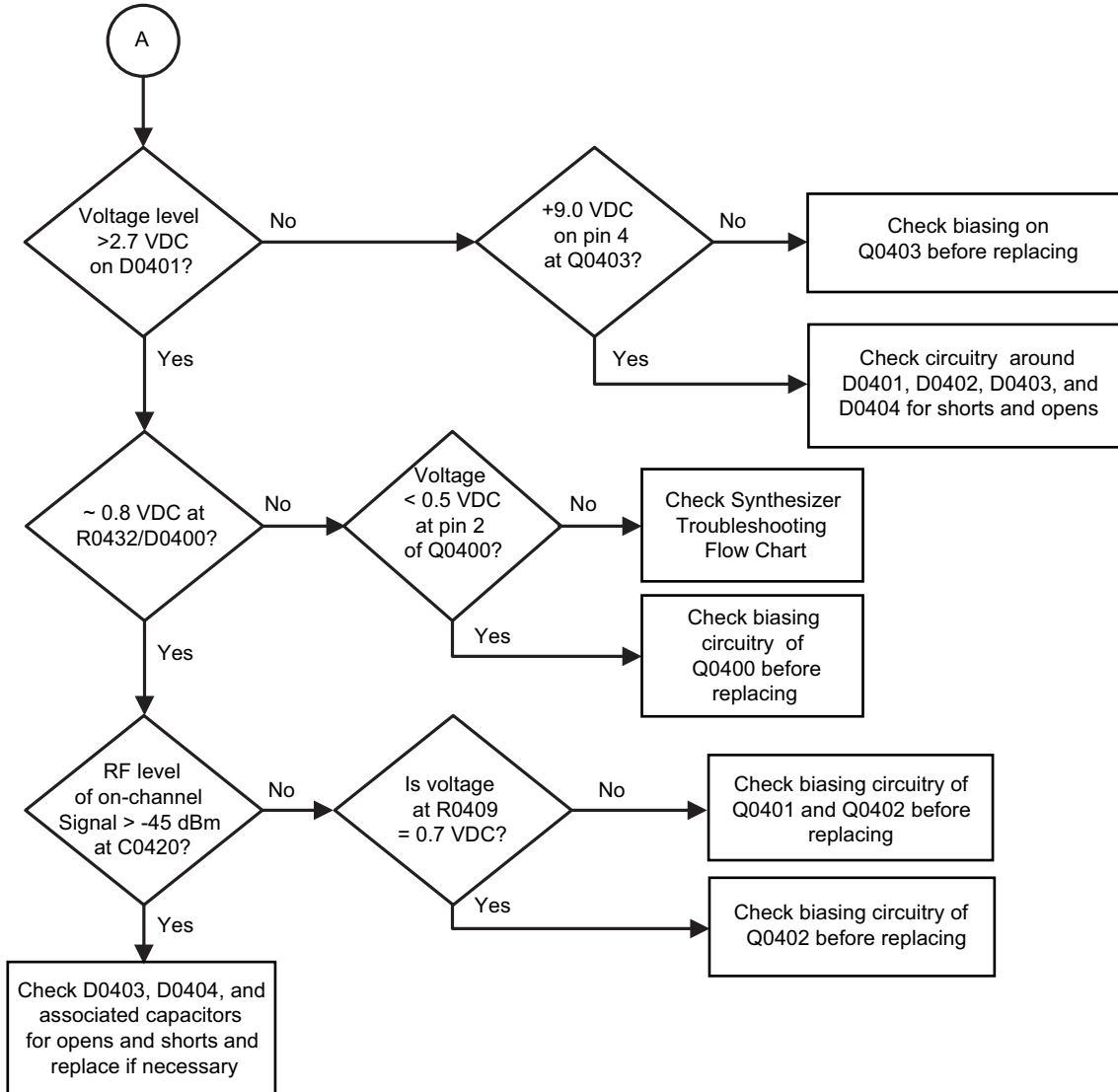
Section 2

TROUBLESHOOTING CHARTS

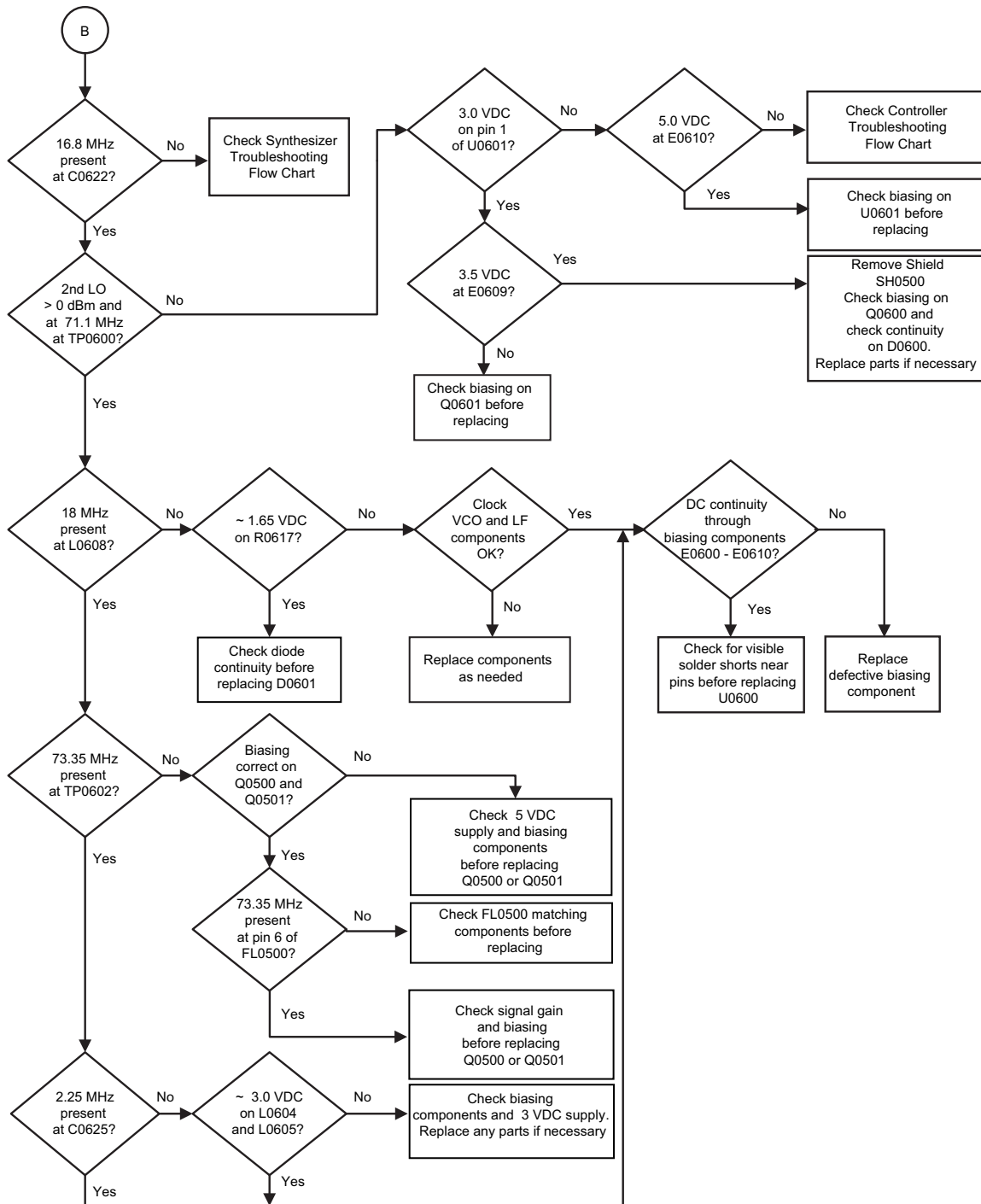
1.0 Troubleshooting Flow Chart for Receiver (Sheet 1 of 3)



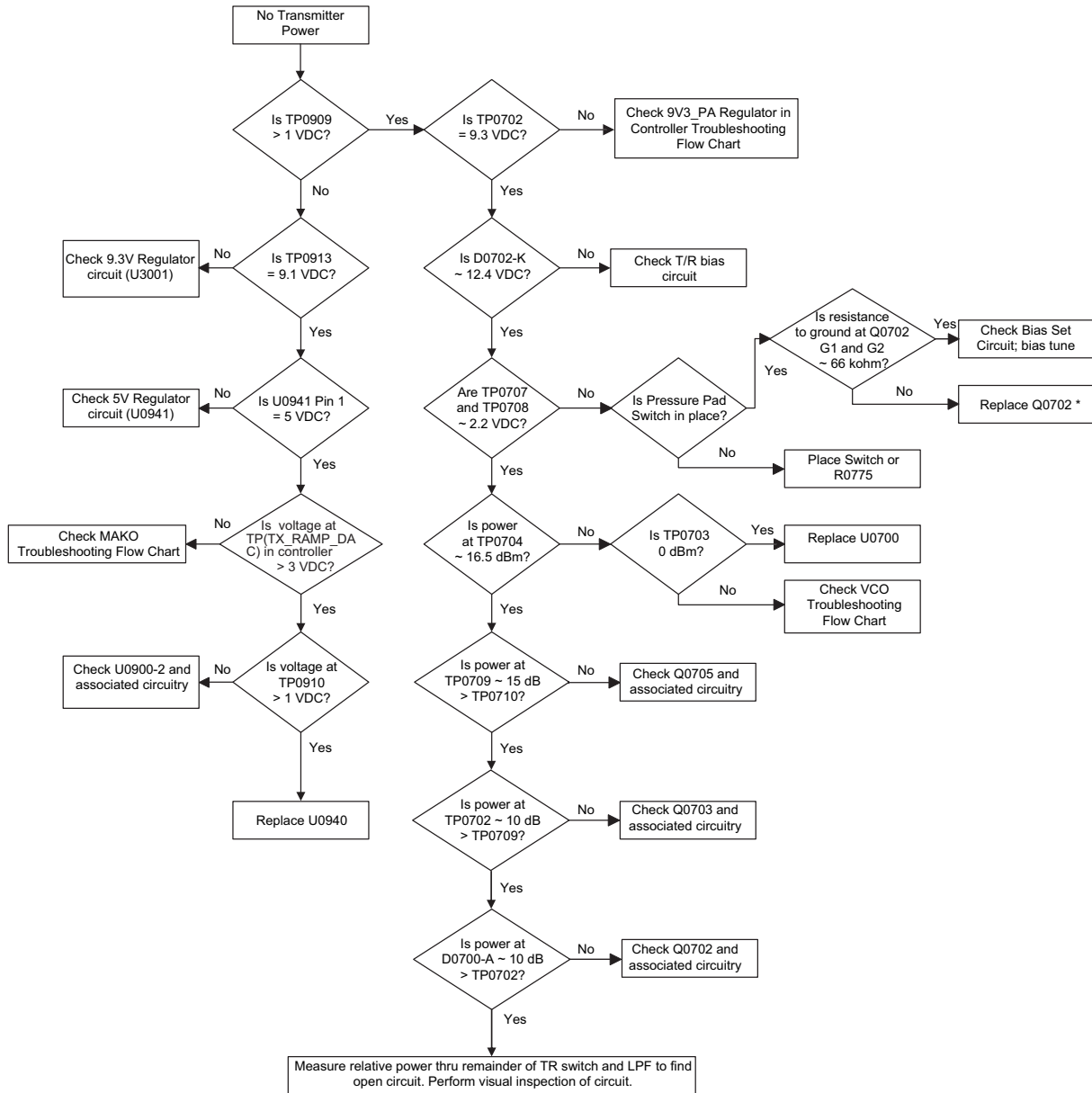
1.1 Troubleshooting Flow Chart for Receiver (Sheet 2 of 3)



1.2 Troubleshooting Flow Chart for Receiver (Sheet 3 of 3)



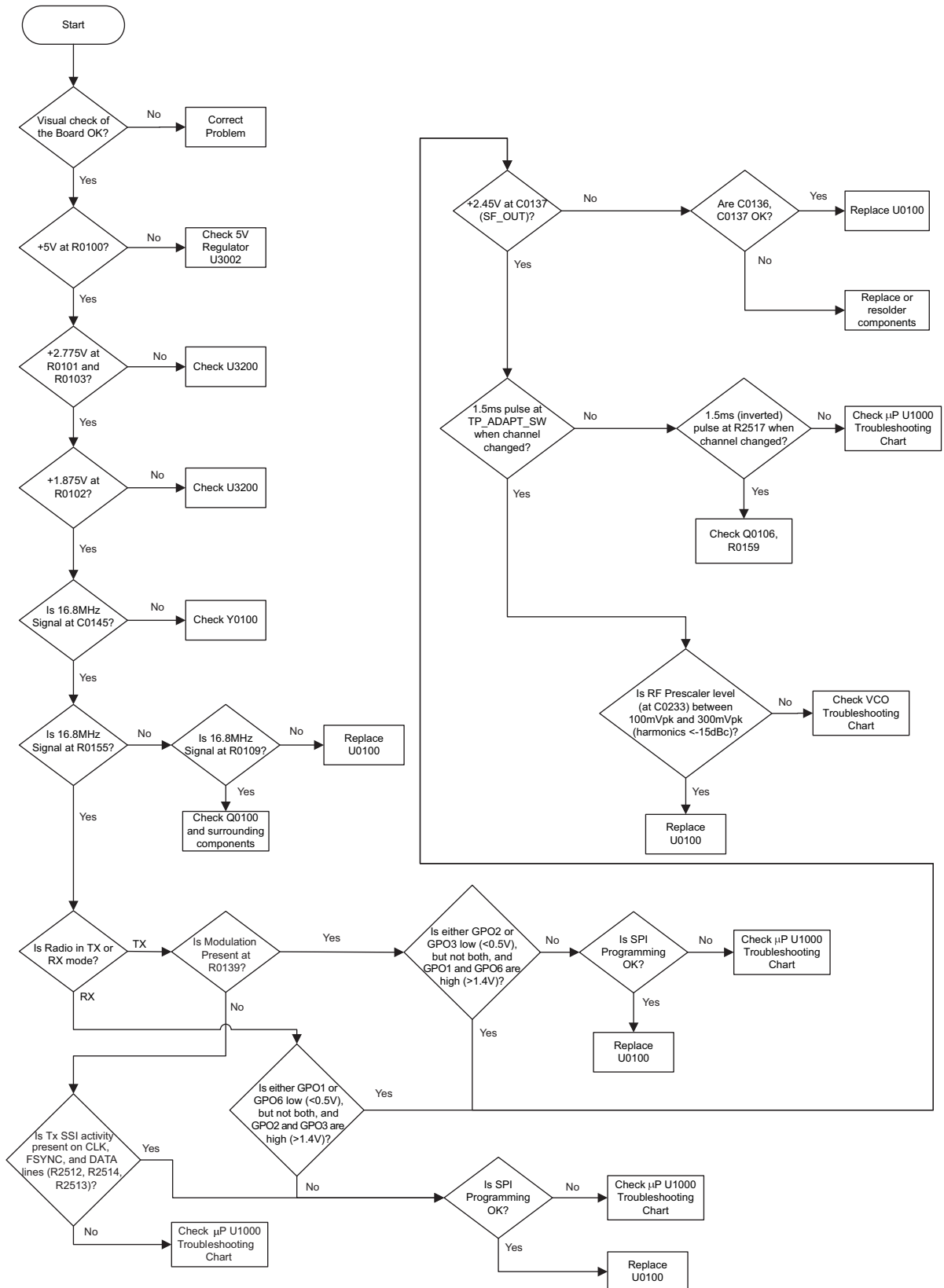
2.0 Troubleshooting Flow Chart for 25W Transmitter



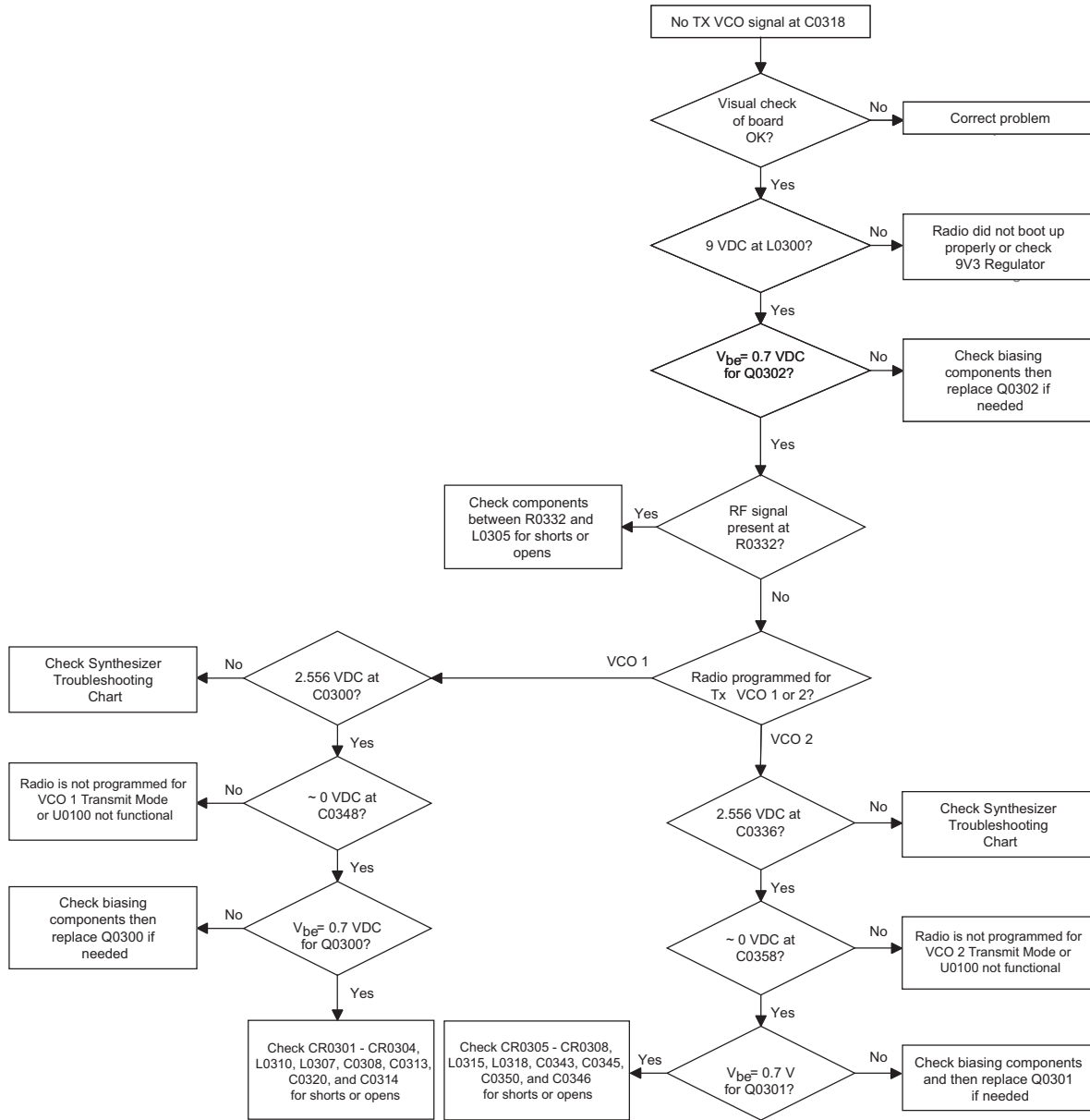
* Note: If Q0702 is replaced radio must be bias set and power set.

- 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 final device damage.
- 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.

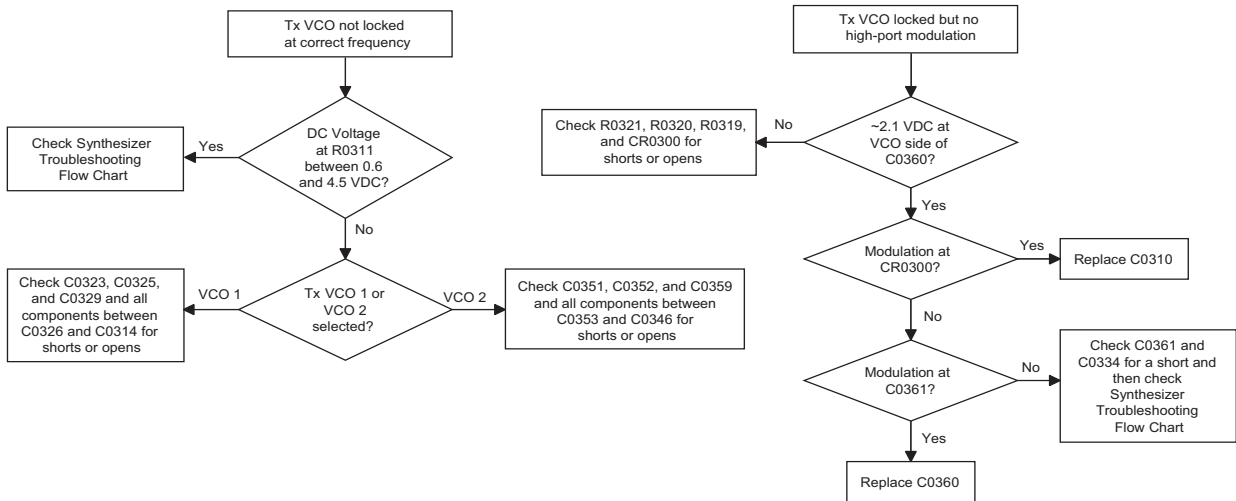
3.0 Troubleshooting Flow Chart for Synthesizer



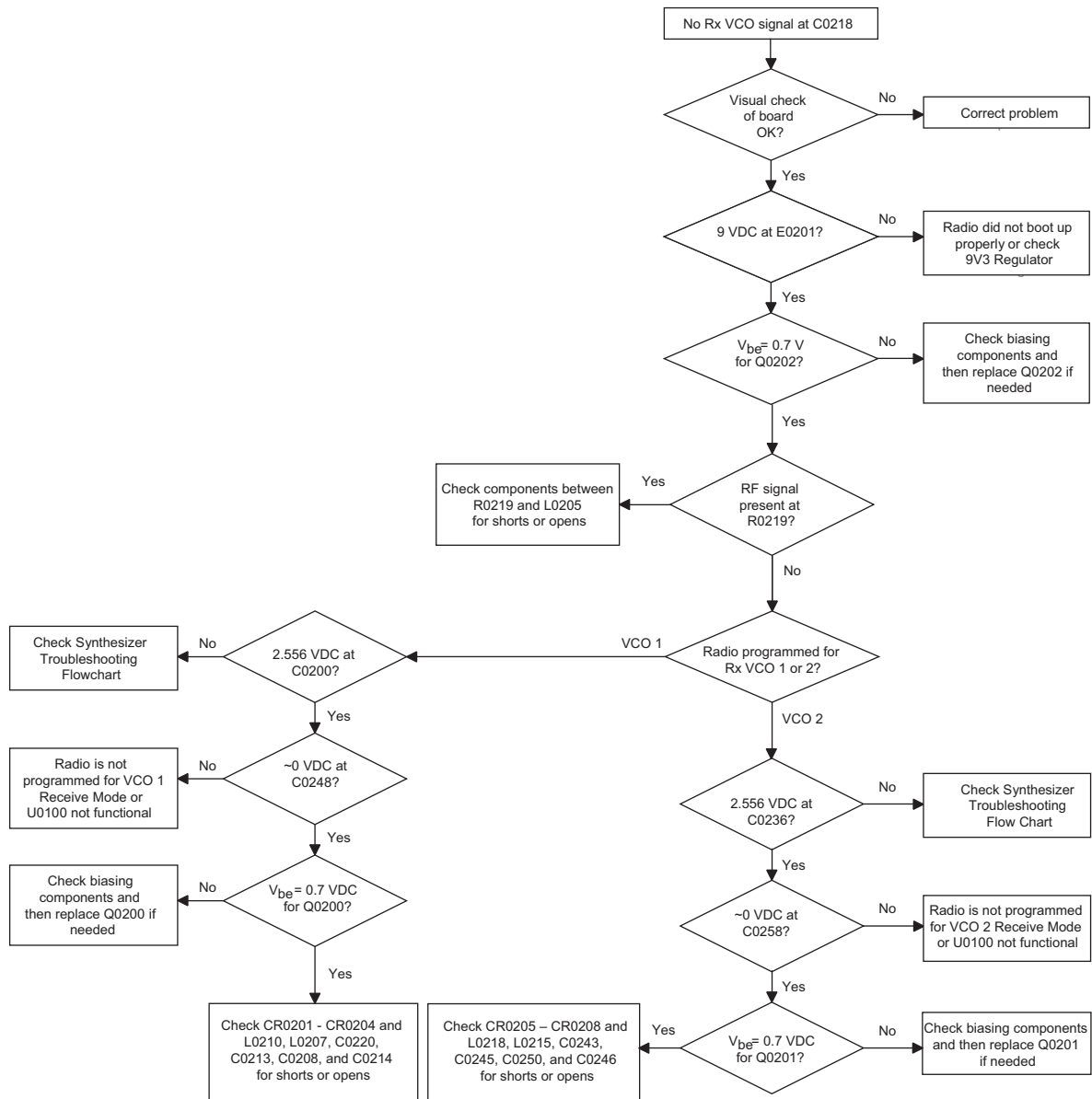
4.0 Troubleshooting Flow Chart for Tx VCO (Sheet 1 of 2)



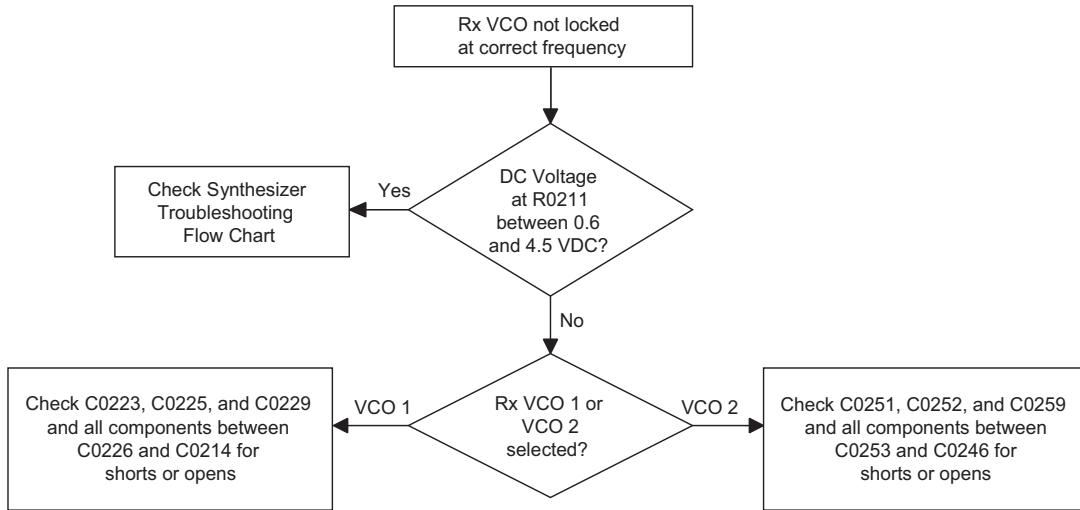
4.1 Troubleshooting Flow Chart for Tx VCO (Sheet 2 of 2)



5.0 Troubleshooting Flow Chart for Rx VCO (Sheet 1 of 2)



5.1 Troubleshooting Flow Chart for Rx VCO (Sheet 2 of 2)



Notes

Section 3

UHF1 PCB / SCHEMATICS / PARTS LISTS

1.0 Allocation of Schematics and Circuit Boards

1.1 Controller Circuits

The UHF circuits are contained on the Printed Circuit Board (PCB) which also contains the Controller circuits. This Chapter shows the schematics for the UHF 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 UHF circuit components. The UHF schematics and the related PCB and parts list are shown in the table below.

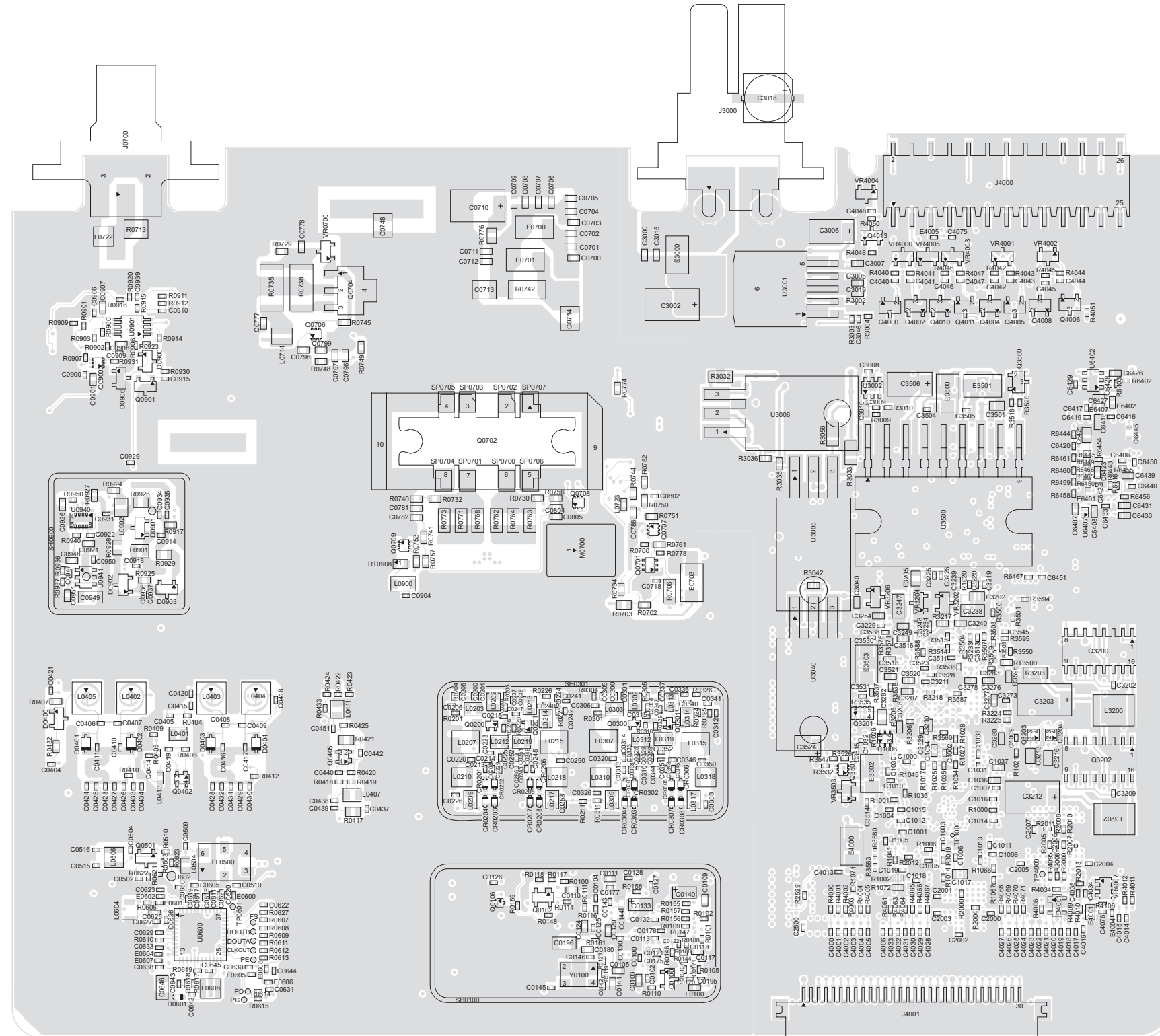
NOTE: The UHF Schematic and parts lists are the same for 8471165L03 and 8471165L05. Only the Controller circuits are different between the two PCBs.

Table 3-1 UHF1 1-25W Diagrams and Parts List

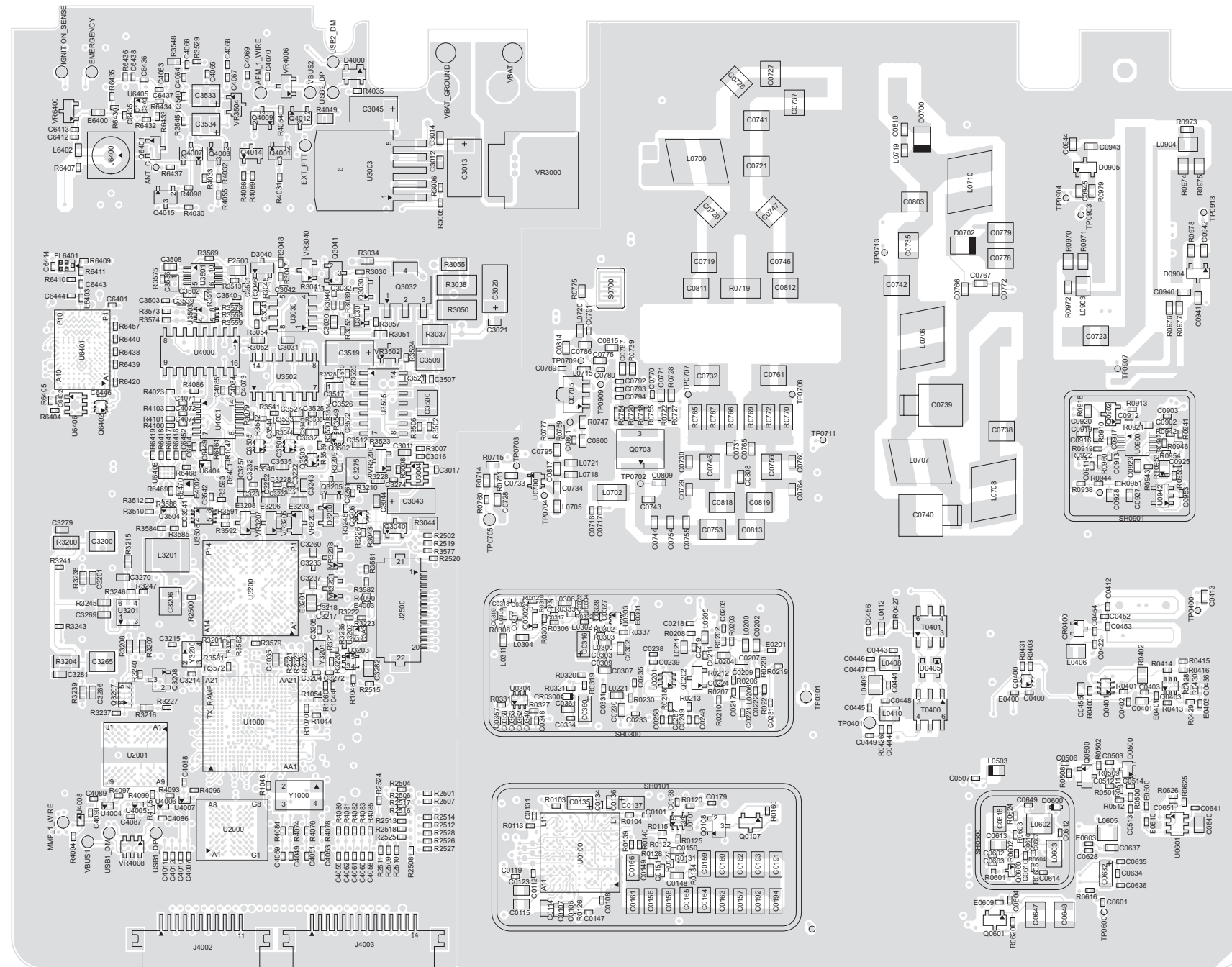
PCB :	
8471165L03 Main Board Top Side	Page 3-3
8471165L03 Main Board Bottom Side	Page 3-4
8471165L05 Main Board Top Side	Page 3-5
8471165L05 Main Board Bottom Side	Page 3-6
SCHEMATICS	
Overall	Page 3-7
Receiver Fron- End	Page 3-8
Receiver IF Amp	Page 3-9
Receiver Back-End	Page 3-10
Power Amplifier	Page 3-11
Power Control	Page 3-12
Synthesizer	Page 3-13
Receiver VCO	Page 3-14
Transmit VCO	Page 3-15
Parts List	
8471165L03 and 8471165L05	Page 3-16

Notes

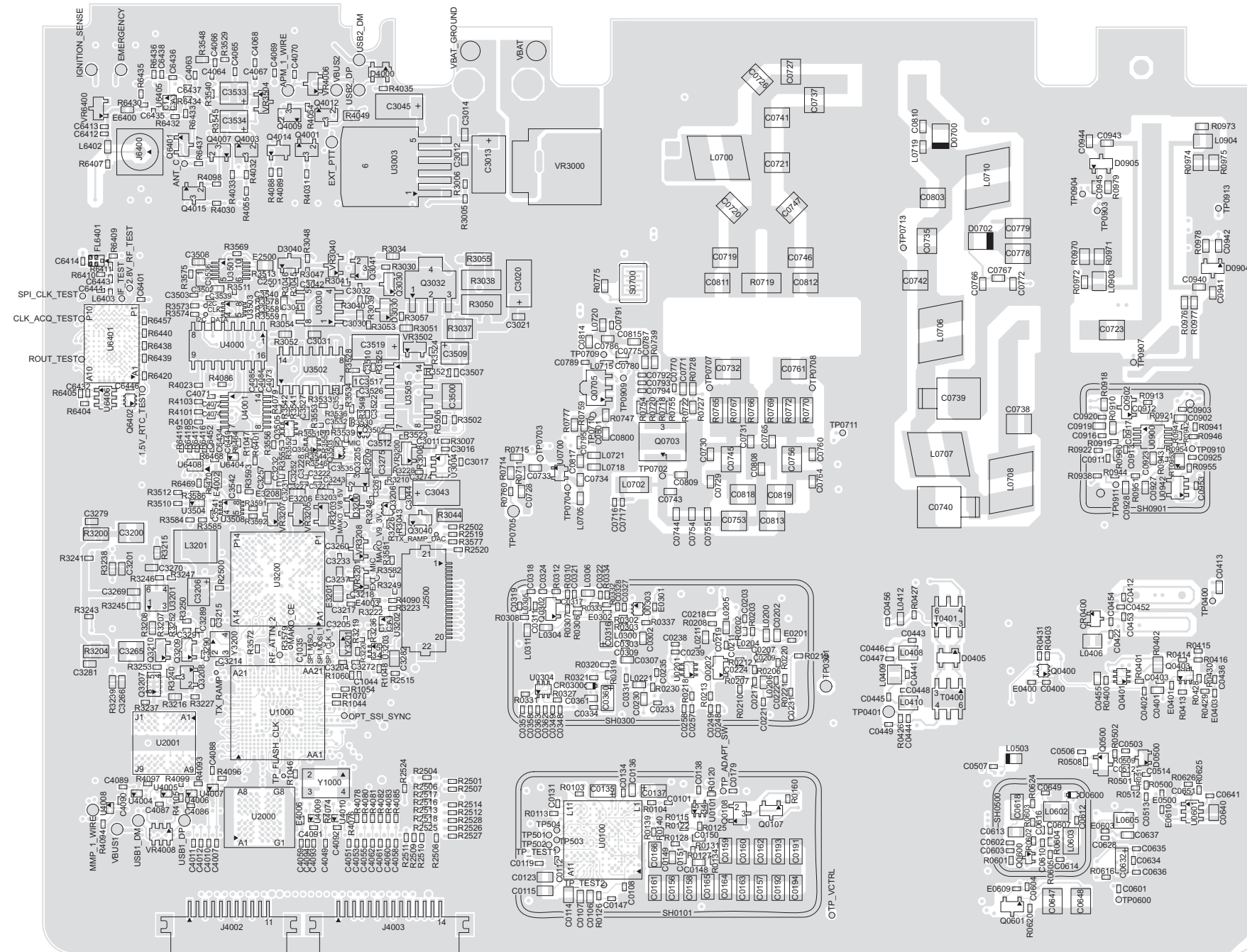
2.0 UHF1 (403-470 MHz) 1 - 25W PCB / Schematics / Parts List



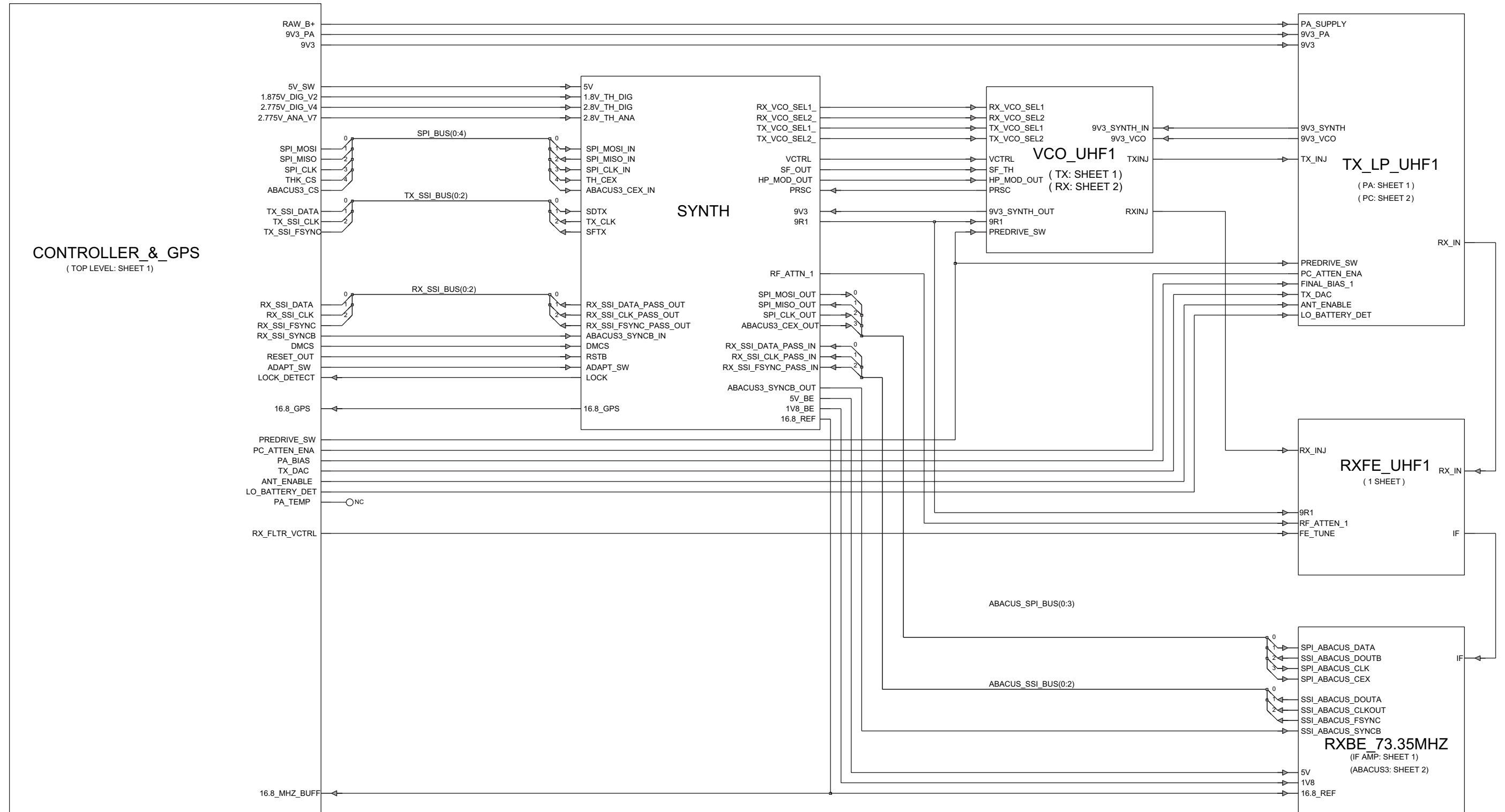
UHF1 (403-470 MHz) 1-25W 8471165L03 Top Side



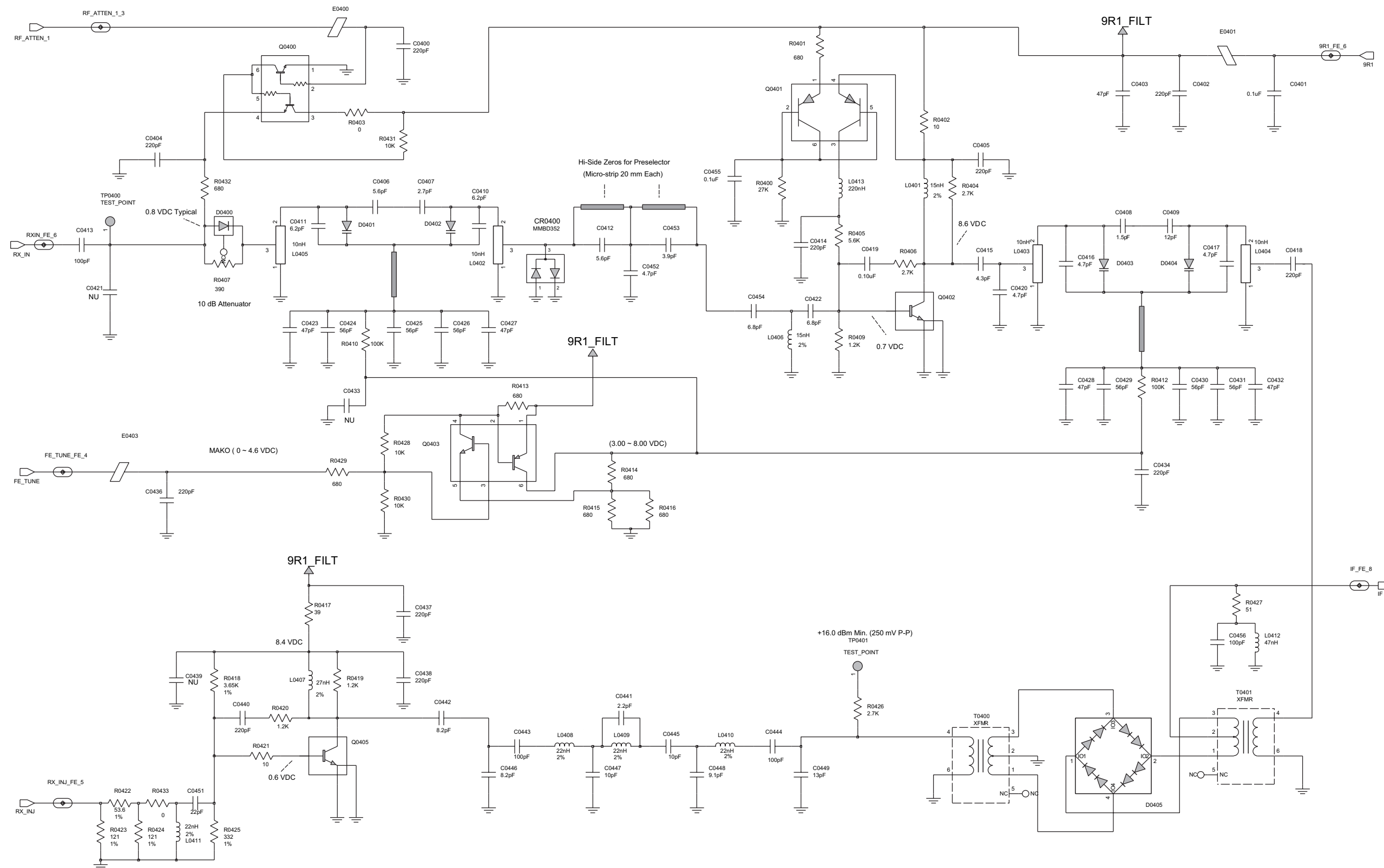
UHF1 (403-470 MHz) 1-25W 8471165L03 Bottom Side



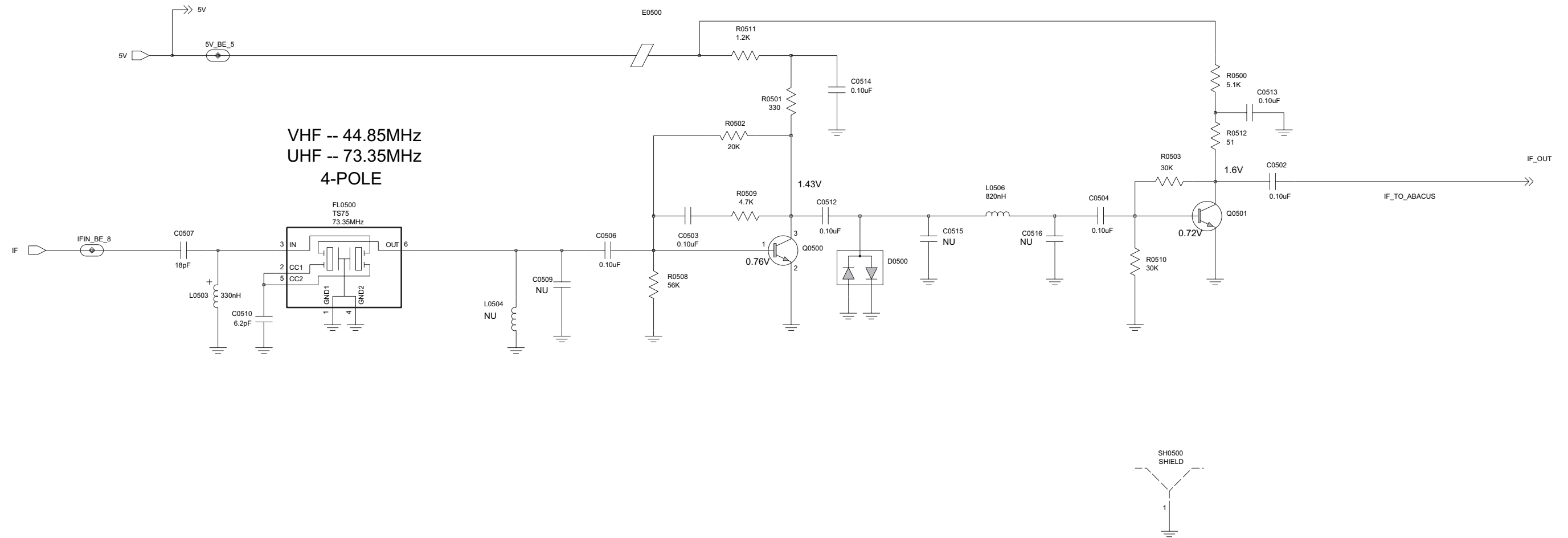
UHF1 (403-470 MHz) 1-25W 8471165L05 Bottom side



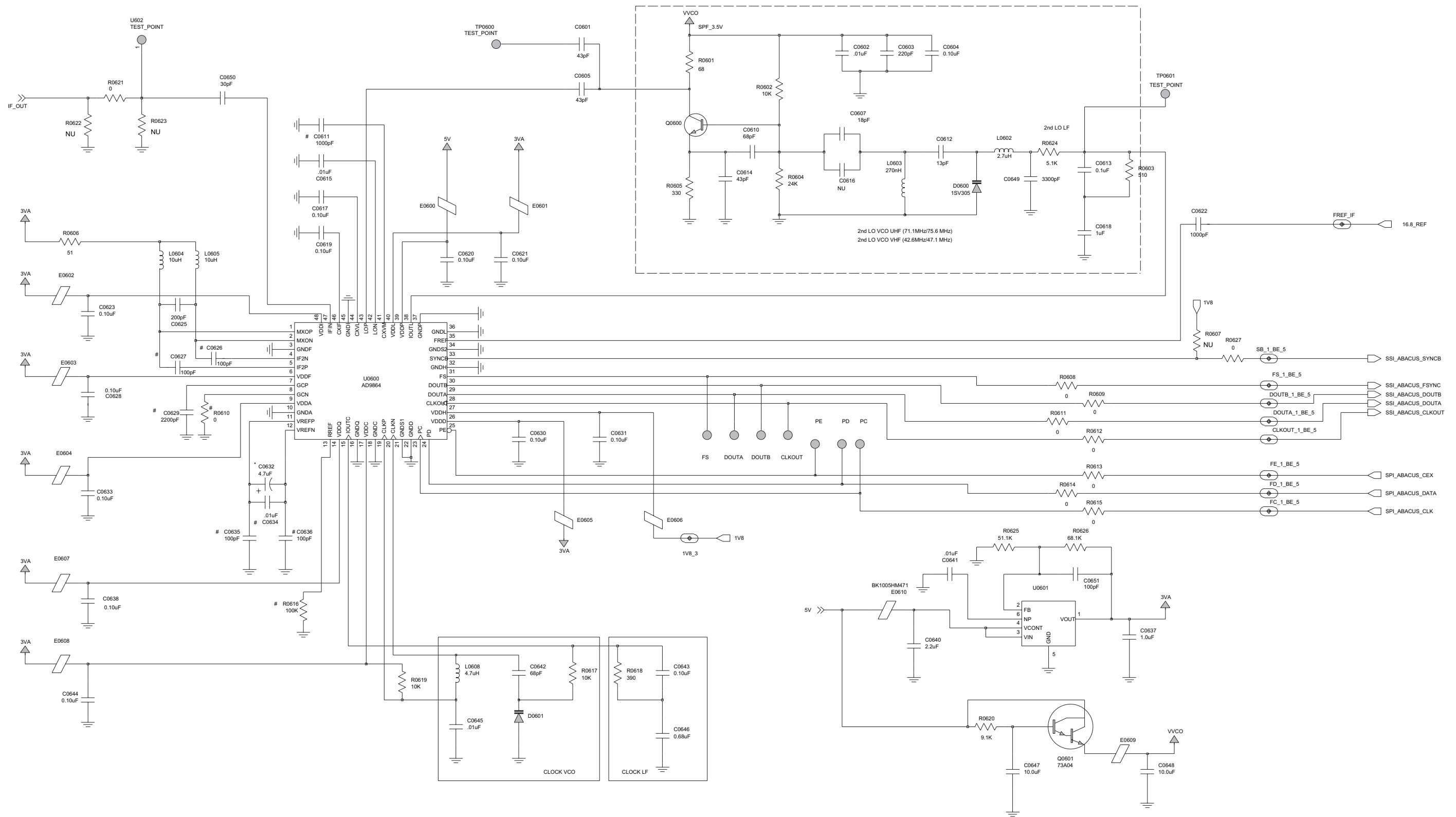
UHF1 (403-470 MHz) 1-25W Overall Schematic Diagram



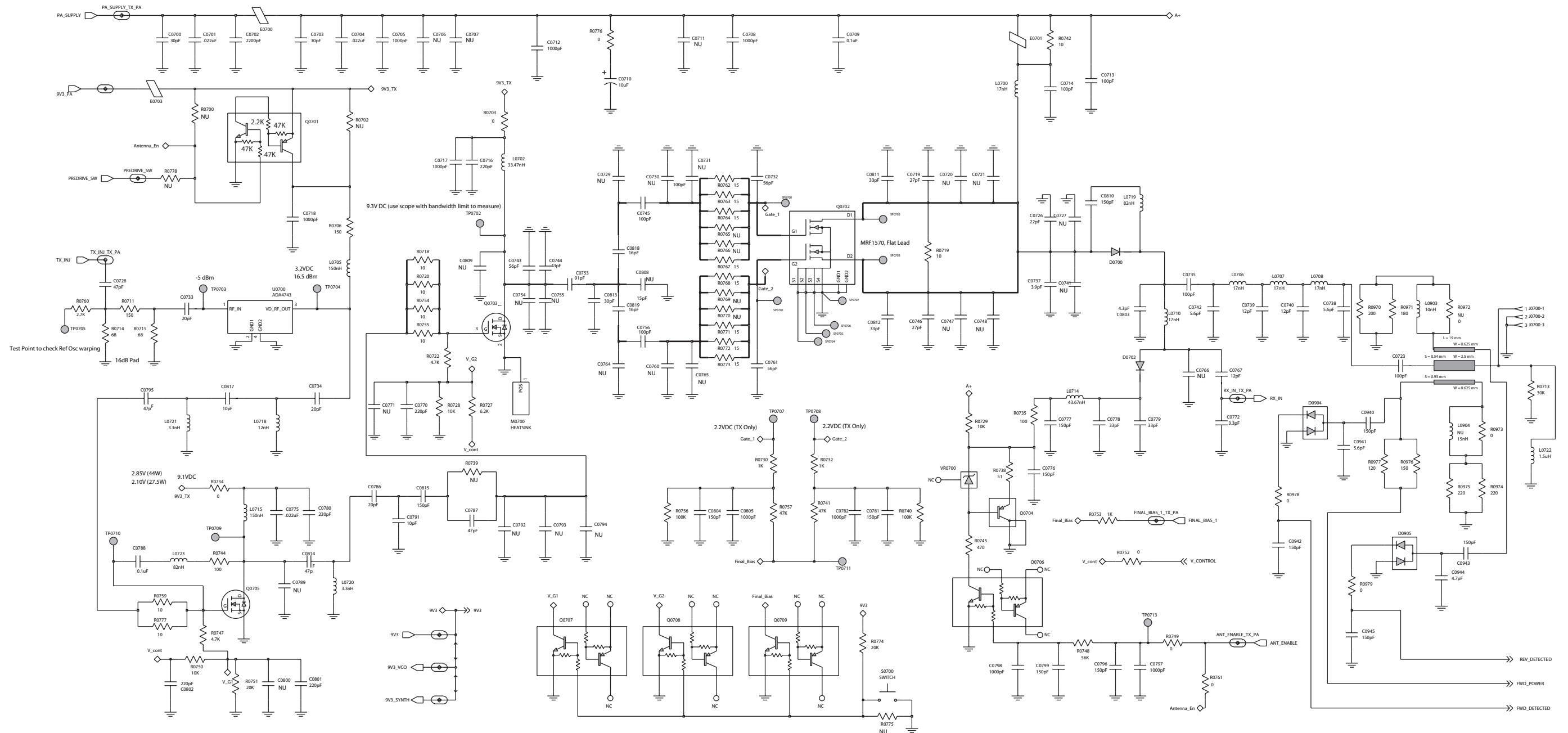
UHF1 (403-470 MHz) 1-25W Receiver Front-End Schematic Diagram



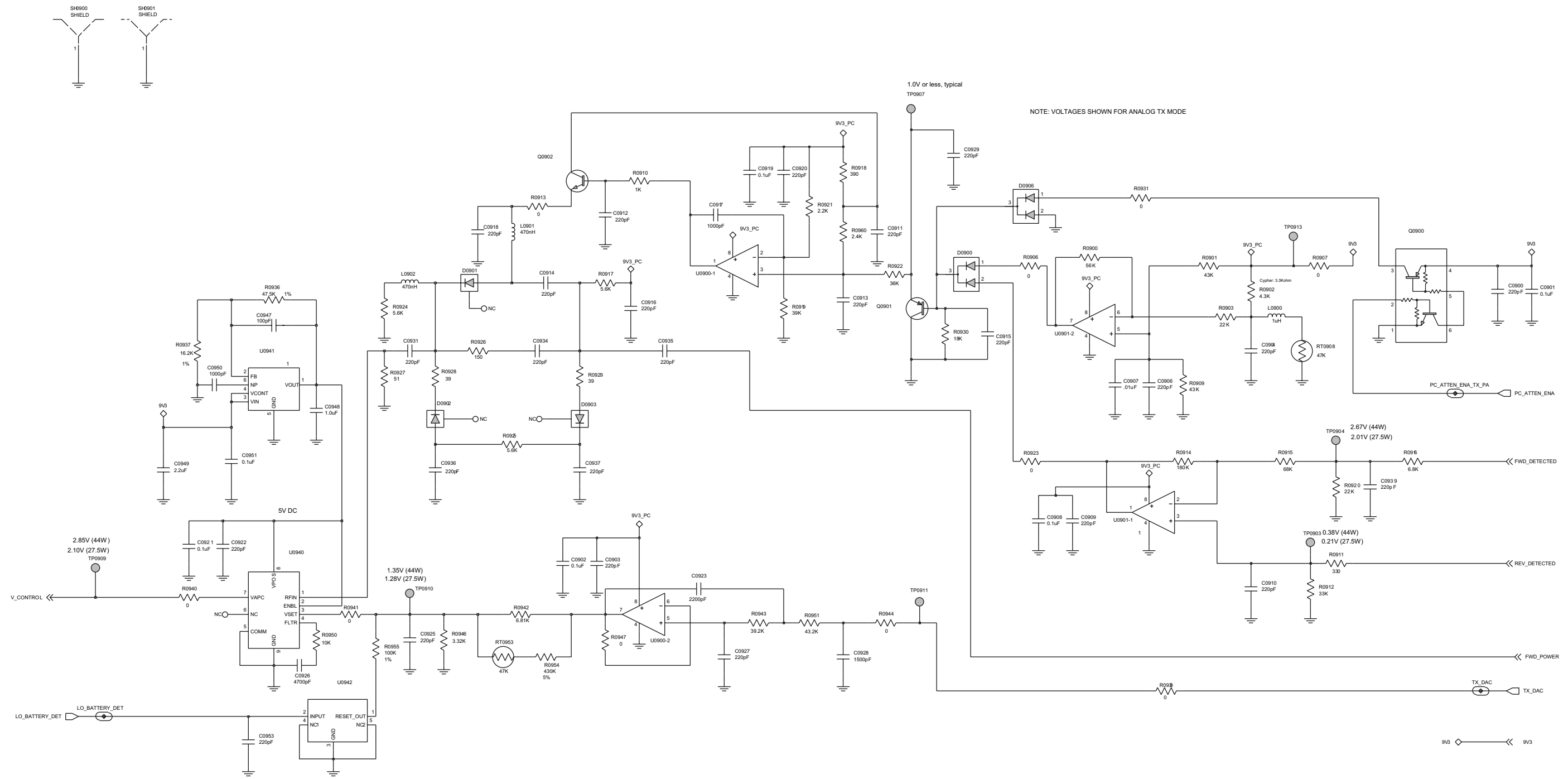
UHF1 (403-470 MHz) 1-25W Receiver IF Amp Schematic Diagram



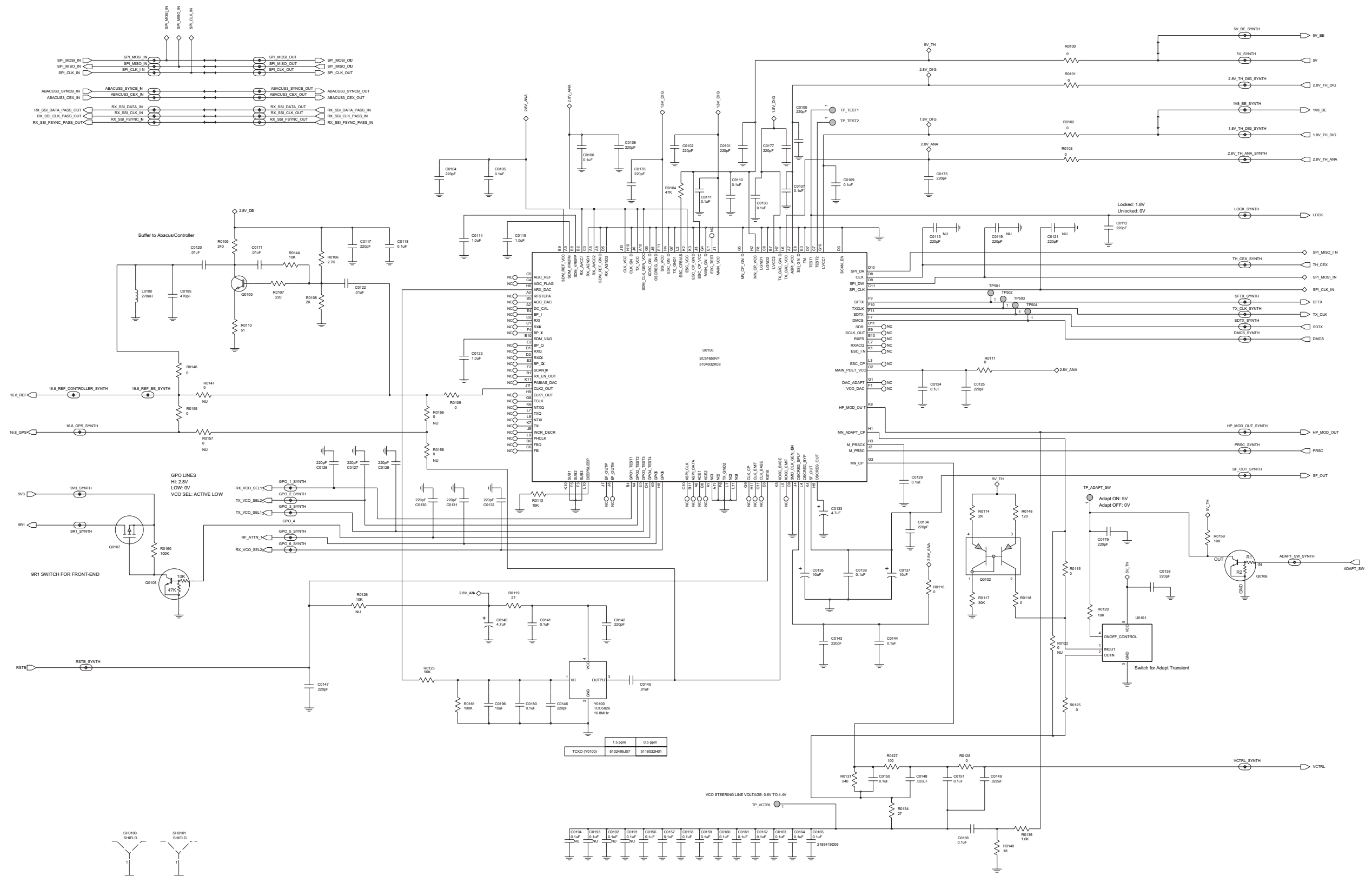
UHF1 (403-470 MHz) 1-25W Receiver Back-End Schematic Diagram



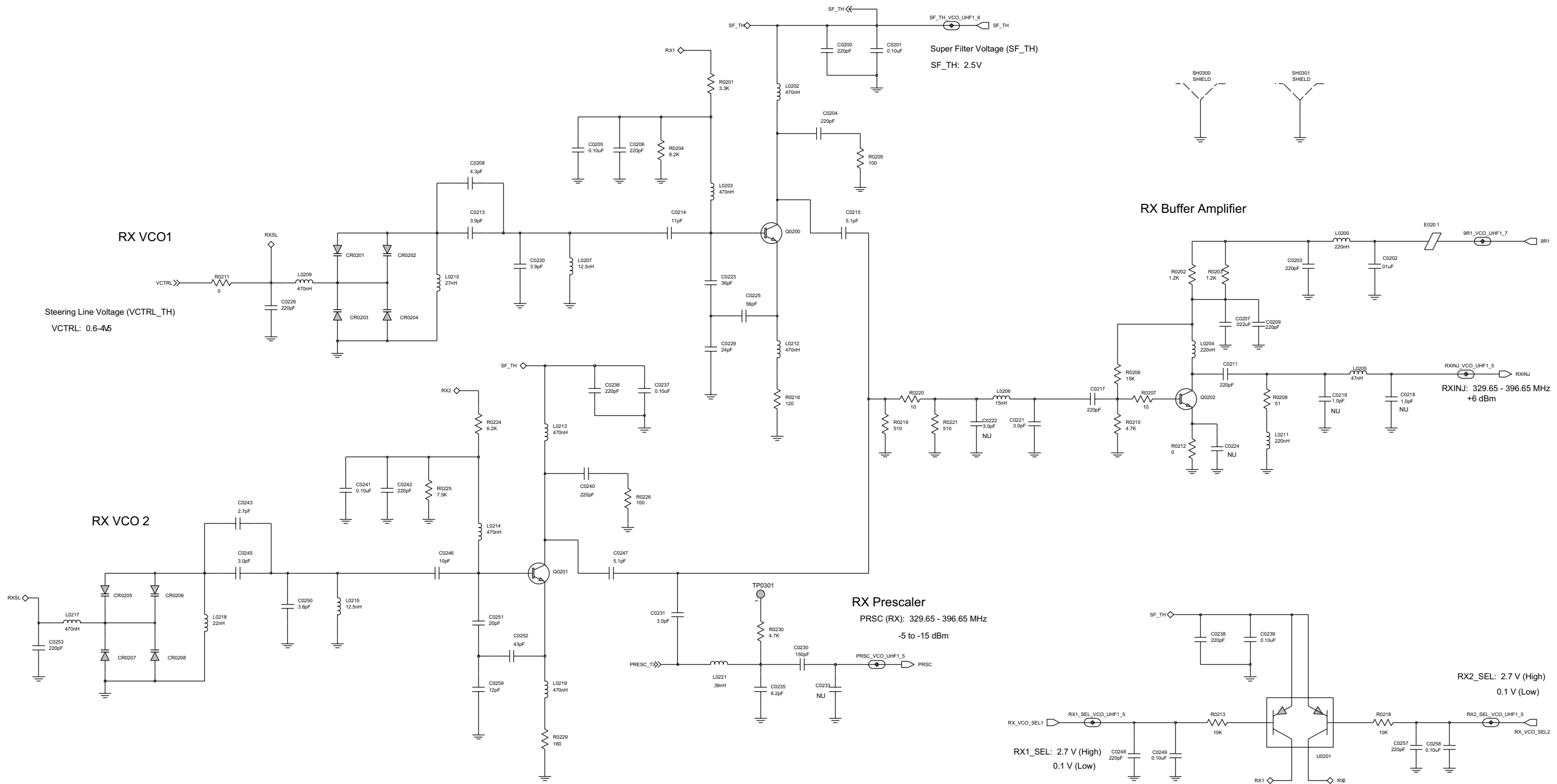
UHF1 (403-470 MHz) 1-25W Power Amplifier Schematic Diagram



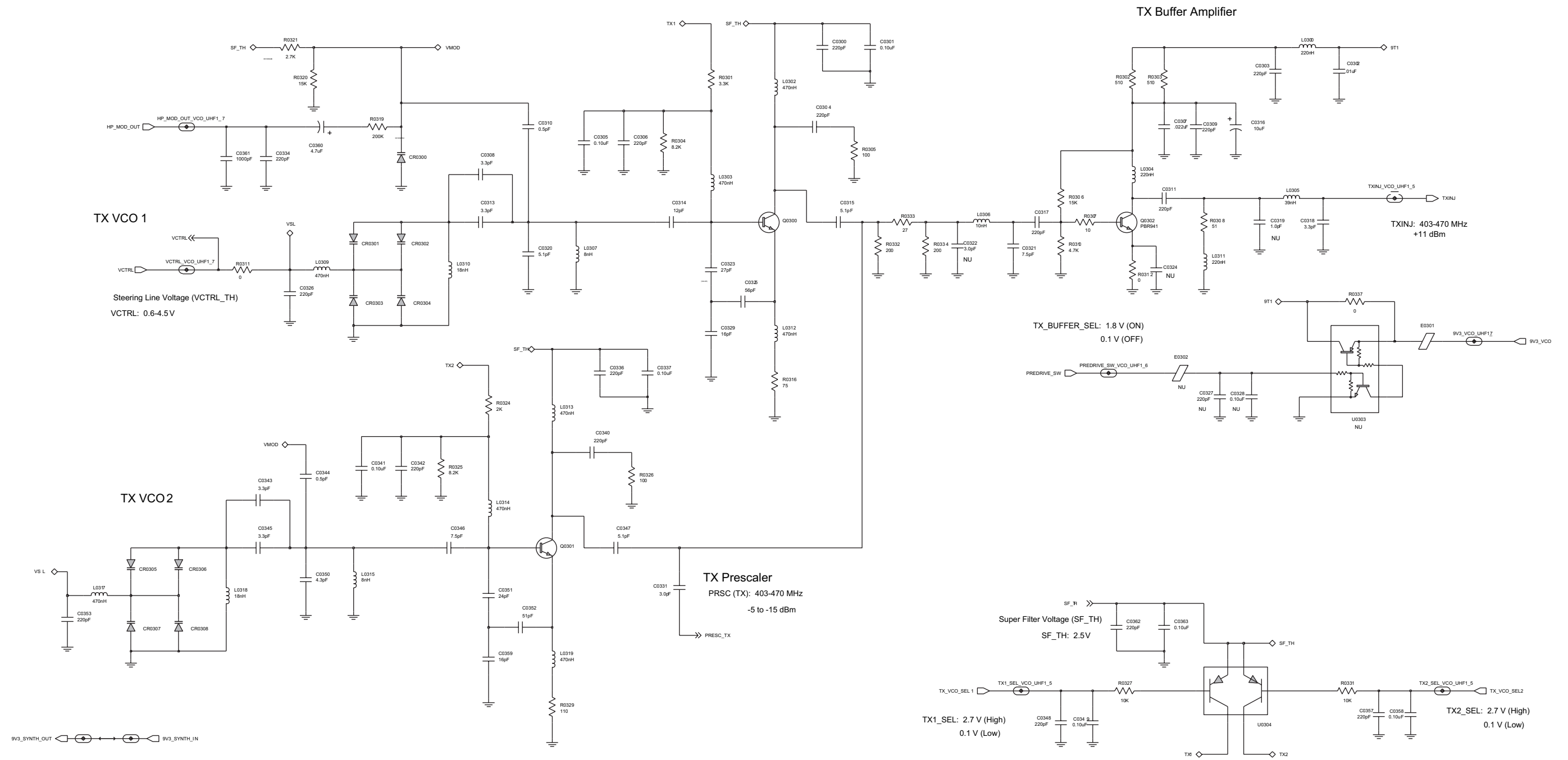
UHF1 (403-470 MHz) 1-25W Power Control Schematic Diagram



UHF1 (403-470 MHz) 1-25W Synthesizer Schematic Diagram



UHF1 (403-470 MHz) 1-25W Receiver VCO Schematic Diagram



UHF1 (403-470 MHz) 1-25W Transmit VCO Schematic Diagram

UHF1 PCB 8471165L03 and 8471165L05 Parts List 1-25W

Circuit Ref	Motorola Part No.	Description
C0100	2113944A44	220pF
C0101	2113944A44	220pF
C0102	2113944A44	220pF
C0103	2113945C31	0.1uF
C0104	2113944A44	220pF
C0105	2113945C31	0.1uF
C0106	2113945C31	0.1uF
C0107	2113945C31	0.1uF
C0108	2113944A44	220pF
C0109	2113945C31	0.1uF
C0110	2113945C31	0.1uF
C0111	2113945C31	0.1uF
C0112	2113944A44	220pF
C0113	NOT PLACED	
C0114	2113946E02	1.0uF
C0115	2113946E02	1.0uF
C0117	2113944A44	220pF
C0118	2113945C31	0.1uF
C0119	NOT PLACED	
C0120	2113945B02	.01uF
C0121	NOT PLACED	
C0122	2113945B02	.01uF
C0123	2113946E02	1.0uF
C0124	2113945C31	0.1uF
C0125	2113944A44	220pF
C0126	2113944A44	220pF
C0127	2113944A44	220pF
C0128	2113944A44	220pF
C0129	2113945C31	0.1uF
C0130	2113944A44	220pF
C0131	2113944A44	220pF
C0132	2113944A44	220pF
C0133	2313960B30	4.7uF
C0134	2113944A44	220pF
C0135	2313960B32	10uF
C0136	2113945C31	0.1uF
C0137	2313960B32	10uF
C0138	2113944A44	220pF
C0140	2313960B30	4.7uF
C0141	2113945C31	0.1uF
C0142	2113944A44	220pF
C0143	2113944A44	220pF
C0144	2113945C31	0.1uF
C0145	2113945B02	.01uF
C0146	2113944A44	220pF
C0147	2113944A44	220pF
C0148	2113945D01	.033uF
C0149	2113945C04	.022uF
C0150	2113945C31	0.1uF

Circuit Ref	Motorola Part No.	Description
C0151	2113945C31	0.1uF
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	2185419D06	0.1uF
C0171	2113945B02	.01uF
C0175	2113944A44	220pF
C0177	2113944A44	220pF
C0178	2113944A44	220pF
C0179	2113944A44	220pF
C0180	2113945C31	0.1uF
C0191	NOT PLACED	
C0192	NOT PLACED	
C0193	NOT PLACED	
C0194	NOT PLACED	
C0195	2113945A05	470pF
C0196	2113946H02	10uF
C0200	2113944A44	220pF
C0201	2113945Y02	0.10uF
C0202	2113945C02	.01uF
C0203	2113944A44	220pF
C0204	2113944A44	220pF
C0205	2113945Y02	0.10uF
C0206	2113944A44	220pF
C0207	2113945C04	.022uF
C0208	2115153H18	4.3pF
C0209	2113944A44	220pF
C0211	2113944A44	220pF
C0213	2115153H17	3.9pF
C0214	2115153H34	11pF
C0215	2115153H20	5.1pF
C0217	2113944A44	220pF
C0218	NOT PLACED	
C0219	NOT PLACED	
C0220	2115153H17	3.9pF
C0221	2115153H14	3.0pF
C0222	NOT PLACED	
C0223	2115153H46	36pF
C0224	NOT PLACED	
C0225	2115153H51	56pF
C0226	2113944A44	220pF
C0229	2115153H42	24pF
C0230	2113944C47	150pF
C0231	2115153H14	3.0pF

Circuit Ref	Motorola Part No.	Description
C0233	NOT PLACED	
C0235	2115153H22	6.2pF
C0236	2113944A44	220pF
C0237	2113945Y02	0.10uF
C0238	2113944A44	220pF
C0239	2113945Y02	0.10uF
C0240	2113944A44	220pF
C0241	2113945Y02	0.10uF
C0242	2113944A44	220pF
C0243	2115153H13	2.7pF
C0245	2115153H14	3.0pF
C0246	2115153H27	10pF
C0247	2115153H20	5.1pF
C0248	2113944A44	220pF
C0249	2113945Y02	0.10uF
C0250	2115153H16	3.6pF
C0251	2115153H40	20pF
C0252	2115153H48	43pF
C0253	2113944A44	220pF
C0257	2113944A44	220pF
C0258	2113945Y02	0.10uF
C0259	2115153H35	12pF
C0300	2113944A44	220pF
C0301	2113945Y02	0.10uF
C0302	2113945C02	.01uF
C0303	2113944A44	220pF
C0304	2113944A44	220pF
C0305	2113945Y02	0.10uF
C0306	2113944A44	220pF
C0307	2113945C04	.022uF
C0308	2115153H15	3.3pF
C0309	2113944A44	220pF
C0310	2115153H01	0.5pF
C0311	2113944A44	220pF
C0313	2115153H15	3.3pF
C0314	2115153H35	12pF
C0315	2115153H20	5.1pF
C0316	2313960B32	10uF
C0317	2113944A44	220pF
C0318	2115153H15	3.3pF
C0319	NOT PLACED	
C0320	2115153H20	5.1pF
C0321	2115153H24	7.5pF
C0322	NOT PLACED	
C0323	2115153H43	27pF
C0324	NOT PLACED	
C0325	2115153H51	56pF
C0326	2113944A44	220pF
C0327	NOT PLACED	
C0328	NOT PLACED	
C0329	2115153H38	16pF

Circuit Ref	Motorola Part No.	Description
C0331	2115153H14	3.0pF
C0334	2113944A44	220pF
C0336	2113944A44	220pF
C0337	2113945Y02	0.10uF
C0340	2113944A44	220pF
C0341	2113945Y02	0.10uF
C0342	2113944A44	220pF
C0343	2115153H15	3.3pF
C0344	2115153H01	0.5pF
C0345	2115153H15	3.3pF
C0346	2115153H24	7.5pF
C0347	2115153H20	5.1pF
C0348	2113944A44	220pF
C0349	2113945Y02	0.10uF
C0350	2115153H18	4.3pF
C0351	2115153H42	24pF
C0352	2115153H50	51pF
C0353	2113944A44	220pF
C0357	2113944A44	220pF
C0358	2113945Y02	0.10uF
C0359	2115153H38	16pF
C0360	2313960B30	4.7uF
C0361	2113944C51	1000pF
C0362	2113944A44	220pF
C0363	2113945Y02	0.10uF
C0400	2113944A44	220pF
C0401	2113945C31	0.1uF
C0402	2113944A44	220pF
C0403	2115153H49	47pF
C0404	2113944A44	220pF
C0405	2113944A44	220pF
C0406	2115153H21	5.6pF
C0407	2115153H13	2.7pF
C0408	2115153H08	1.5pF
C0409	2115153H35	12pF
C0410	2115153H22	6.2pF
C0411	2115153H22	6.2pF
C0412	2115153H21	5.6pF
C0413	2113944C45	100pF
C0414	2113944A44	220pF
C0415	2115153H18	4.3pF
C0416	2115153H19	4.7pF
C0417	2115153H19	4.7pF
C0418	2113944A44	220pF
C0419	2113945Y02	0.10uF
C0420	2115153H19	4.7pF
C0421	NOT PLACED	
C0422	2115153H23	6.8pF
C0423	2115153H49	47pF
C0424	2115153H51	56pF
C0425	2115153H51	56pF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0426	2115153H51	56pF	C0614	2115153H48	43pF	C0716	2113944A44	220pF	C0787	2113944C38	47pF
C0427	2115153H49	47pF	C0615	2113945B02	.01uF	C0717	2113945A09	1000pF	C0788	NOT PLACED	
C0428	2115153H49	47pF	C0616	NOT PLACED		C0718	2113945A09	1000pF	C0789	NOT PLACED	
C0429	2115153H51	56pF	C0617	2113945Y02	0.10uF	C0719	2111078B25	27pF	C0791	2113944A25	10pF
C0430	2115153H51	56pF	C0618	2115358H25	1uF	C0720	NOT PLACED		C0792	NOT PLACED	
C0431	2115153H51	56pF	C0619	2113945Y02	0.10uF	C0721	NOT PLACED		C0793	NOT PLACED	
C0432	2115153H49	47pF	C0620	2113945Y02	0.10uF	C0723	2111078B42	100pF	C0794	NOT PLACED	
C0433	NOT PLACED		C0621	2113945Y02	0.10uF	C0726	2111078B22	22pF	C0795	2113944C38	47pF
C0434	2113944A44	220pF	C0622	2113945A09	1000pF	C0727	NOT PLACED		C0796	2113944C47	150pF
C0436	2113944A44	220pF	C0623	2113945Y02	0.10uF	C0728	2113944C38	47pF	C0797	2113944C51	1000pF
C0437	2113944A44	220pF	C0625	2113944C89	200pF	C0729	NOT PLACED		C0798	2113944C51	1000pF
C0438	2113944A44	220pF	C0626	2113944A40	100pF	C0730	NOT PLACED		C0799	2113944C47	150pF
C0439	NOT PLACED		C0627	2113944A40	100pF	C0731	NOT PLACED		C0800	NOT PLACED	
C0440	2113944A44	220pF	C0628	2113945Y02	0.10uF	C0732	2111078B36	56pF	C0801	2113944A44	220pF
C0441	2115153H11	2.2pF	C0629	2113945A11	2200pF	C0733	2113944C80	20pF	C0802	2113944A44	220pF
C0442	2115153H25	8.2pF	C0630	2113945Y02	0.10uF	C0734	2113944C80	20pF	C0803	2111078B04	4.3pF
C0443	2115153H57	100pF	C0631	2113945Y02	0.10uF	C0735	2111078B42	100pF	C0804	2113944C47	150pF
C0444	2115153H57	100pF	C0632	2313960B30	4.7uF	C0737	2111078B03	3.9pF	C0805	2113944C51	1000pF
C0445	2115153H27	10pF	C0633	2113945Y02	0.10uF	C0738	2111078B07	5.6pF	C0808	NOT PLACED	
C0446	2115153H25	8.2pF	C0634	2113945B02	.01uF	C0739	2171388L01	12pF	C0809	NOT PLACED	
C0447	2115153H27	10pF	C0635	2113944A40	100pF	C0740	2171388L01	12pF	C0810	2113944C47	150pF
C0448	2115153H26	9.1pF	C0636	2113944A40	100pF	C0741	NOT PLACED		C0811	2111078B29	33pF
C0449	2115153H36	13pF	C0637	2113946S35	1.0uF	C0742	2111078B07	5.6pF	C0812	2111078B29	33pF
C0451	2115153H41	22pF	C0638	2113945Y02	0.10uF	C0743	2113944C39	56pF	C0813	2111078B27	30pF
C0452	2115153H19	4.7pF	C0640	2113946N03	2.2uF	C0744	2113944C84	43pF	C0814	2113944C38	47pF
C0453	2115153H17	3.9pF	C0641	2113945B02	.01uF	C0745	2111078B42	100pF	C0815	2113944C47	150pF
C0454	2115153H23	6.8pF	C0642	2115153H53	68pF	C0746	2111078B25	27pF	C0817	2113944C30	10pF
C0455	2113945C31	0.1uF	C0643	2113945Y02	0.10uF	C0747	NOT PLACED		C0818	2111078B19	16pF
C0456	2113944A40	100pF	C0644	2113945Y02	0.10uF	C0748	NOT PLACED		C0819	2111078B19	16pF
C0502	2113945Y02	0.10uF	C0645	2113945B02	.01uF	C0753	2111078B41	91pF	C0900	2113944A44	220pF
C0503	2113945Y02	0.10uF	C0646	2113946G04	0.68uF	C0754	NOT PLACED		C0901	2113945C31	0.1uF
C0504	2113945Y02	0.10uF	C0647	2113946J03	10.0uF	C0755	NOT PLACED		C0902	2113945C31	0.1uF
C0506	2113945Y02	0.10uF	C0648	2113946J03	10.0uF	C0756	2111078B42	100pF	C0903	2113944A44	220pF
C0507	2115153H39	18pF	C0649	2113945A12	3300pF	C0760	NOT PLACED		C0904	2113944A44	220pF
C0509	NOT PLACED		C0650	2115153H44	30pF	C0761	2111078B36	56pF	C0906	2113944A44	220pF
C0510	2115153H22	6.2pF	C0651	2115153H57	100pF	C0764	NOT PLACED		C0907	2113945C02	.01uF
C0512	2113945Y02	0.10uF	C0700	2113944C82	30pF	C0765	NOT PLACED		C0908	2113945C31	0.1uF
C0513	2113945Y02	0.10uF	C0701	2113945C04	.022uF	C0766	NOT PLACED		C0909	2113944A44	220pF
C0514	2113945Y02	0.10uF	C0702	2113944C55	2200pF	C0767	2113944C31	12pF	C0910	2113944A44	220pF
C0515	NOT PLACED		C0703	2113944C82	30pF	C0770	2113944A44	220pF	C0911	2113944A44	220pF
C0516	NOT PLACED		C0704	2113945C04	.022uF	C0771	NOT PLACED		C0912	2113944A44	220pF
C0601	2115153H48	43pF	C0705	2113944C51	1000pF	C0772	2113944C18	3.3pF	C0913	2113944A44	220pF
C0602	2113945B02	.01uF	C0706	NOT PLACED		C0775	2113945C04	.022uF	C0914	2113944A44	220pF
C0603	2113944A44	220pF	C0707	NOT PLACED		C0776	2113944C47	150pF	C0915	2113944A44	220pF
C0604	2113945Y02	0.10uF	C0708	2113944C51	1000pF	C0777	2113944C47	150pF	C0916	2113944A44	220pF
C0605	2115153H48	43pF	C0709	2113945C31	0.1uF	C0778	2111078B29	33pF	C0917	2113945A09	1000pF
C0607	2115153H39	18pF	C0710	2371403L02	10uF	C0779	2111078B29	33pF	C0918	2113944A44	220pF
C0610	2115153H53	68pF	C0711	NOT PLACED		C0780	2113944A44	220pF	C0919	2113945C31	0.1uF
C0611	2113945A09	1000pF	C0712	2113944C51	1000pF	C0781	2113944C47	150pF	C0920	2113944A44	220pF
C0612	2115153H36	13pF	C0713	2111078B42	100pF	C0782	2113944C51	1000pF	C0921	2113945C31	0.1uF
C0613	2113945G91	0.1uF	C0714	2111078B42	100pF	C0786	2113944C80	20pF	C0922	2113944A44	220pF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0923	2113944C55	2200pF	D0700	4802482J02	DIODE, PIN	L0300	2414017N28	220nH	L0722	2414032B70	1.5uH
C0925	2113944A44	220pF	D0702	4802482J02	DIODE, PIN	L0302	2414032F42	470nH	L0723	NOT PLACED	
C0926	2113945L41	4700pF	D0900	4813978C02	DIODE, SWITCHING	L0303	2414032F42	470nH	L0900	2414032D30	1uH
C0927	2113944C02	220pF	D0901	4815023H01	DIODE, PIN	L0304	2414017N28	220nH	L0901	2414032F42	470nH
C0928	2113944C53	1500pF	D0902	4815024H01	DIODE, PIN	L0305	2414017N19	39nH	L0902	2414032F42	470nH
C0929	2113944A44	220pF	D0903	4815024H01	DIODE, PIN	L0306	2414017N12	10nH	L0903	2414032F66	10nH
C0931	2113944A44	220pF	D0904	4813974A21	DIODE, SCHOTTKY	L0307	2415385H01	8nH	L0904	NOT PLACED	
C0934	2113944A44	220pF	D0905	4813974A21	DIODE, SCHOTTKY	L0309	2414032F42	470nH	M0700	2686201B02	HEATSINK
C0935	2113944A44	220pF	D0906	4813978C02	DIODE, SWITCHING	L0310	2414015A32	18nH	Q0100	4802197J95	NPN RF TRANSISTOR
C0936	2113944A44	220pF	E0201	2409134J25	FERRITE BEAD	L0311	2414017N28	220nH	Q0102	4815359H01	DUAL PNP
C0937	2113944A44	220pF	E0301	2409134J25	FERRITE BEAD	L0312	2414032F42	470nH	Q0106	4816134H01	ANALOG SWITCH
C0939	2113944A44	220pF	E0302	NOT PLACED		L0313	2414032F42	470nH	Q0107	4813970A59	P-CHANNEL MOSFET
C0940	2113944C47	150pF	E0400	2409134J25	FERRITE BEAD	L0314	2414032F42	470nH	Q0108	4815261H01	ANALOG SWITCH
C0941	2113944M12	5.6pF	E0401	2409134J25	FERRITE BEAD	L0315	2415385H01	8nH	Q0200	4805793Y10	NPN RF TRANSISTOR
C0942	2113944C47	150pF	E0403	2409134J25	FERRITE BEAD	L0317	2414032F42	470nH	Q0201	4805793Y10	NPN RF TRANSISTOR
C0943	2113944C47	150pF	E0500	2409134J25	FERRITE BEAD	L0318	2414015A32	18nH	Q0202	4802197J95	NPN RF TRANSISTOR
C0944	2113944M10	4.7pF	E0600	2409134J25	FERRITE BEAD	L0319	2414032F42	470nH	Q0300	4805793Y10	NPN RF TRANSISTOR
C0945	2113944C47	150pF	E0601	2409134J25	FERRITE BEAD	L0401	2414015B24	15nH	Q0301	4805793Y10	NPN RF TRANSISTOR
C0947	2113944A40	100pF	E0602	2409134J25	FERRITE BEAD	L0402	NOT PLACED		Q0302	4802197J95	NPN RF TRANSISTOR
C0948	2113946S35	1.0uF	E0603	2409134J25	FERRITE BEAD	L0403	NOT PLACED		Q0400	4815271H01	ANALOG SWITCH
C0949	2113946G01	2.2uF	E0604	2409134J25	FERRITE BEAD	L0404	NOT PLACED		Q0401	4815267H01	DUAL PNP
C0950	2113945A09	1000pF	E0605	2409134J25	FERRITE BEAD	L0405	NOT PLACED		Q0402	4885593U03	NPN RF TRANSISTOR
C0951	2113945C31	0.1uF	E0606	2409134J25	FERRITE BEAD	L0406	2414015B24	15nH	Q0403	4815270H01	DUAL NPN/PNP
C0953	2113944A44	220pF	E0607	2409134J25	FERRITE BEAD	L0407	2414015B16	27nH	Q0405	4885593U03	NPN RF TRANSISTOR
CR0201	4815096H01	DIODE VARACTOR 1SV305	E0608	2409134J25	FERRITE BEAD	L0408	2414015B15	22nH	Q0500	4802197J95	NPN RF TRANSISTOR
CR0202	4815096H01	DIODE VARACTOR 1SV305	E0609	2409134J25	FERRITE BEAD	L0409	2414015B15	22nH	Q0501	4802197J95	NPN RF TRANSISTOR
CR0203	4815096H01	DIODE VARACTOR 1SV305	E0610	2480640Z01	FERRITE BEAD	L0410	2414015B15	22nH	Q0600	4805793Y10	NPN RF TRANSISTOR
CR0204	4815096H01	DIODE VARACTOR 1SV305	E0700	2485011Y01	FERRITE BEAD	L0411	2414015B15	22nH	Q0601	4813973A04	NPN DARLINGTON
CR0205	4815096H01	DIODE VARACTOR 1SV305	E0701	2485011Y01	FERRITE BEAD	L0412	2414017N20	47nH	Q0701	4816013H01	DUAL NPN/PNP
CR0206	4815096H01	DIODE VARACTOR 1SV305	E0703	2485011Y01	FERRITE BEAD	L0413	2414017N28	220nH	Q0702	0105958T75	MRF1570 PA ASSEMBLY
CR0207	4815096H01	DIODE VARACTOR 1SV305	FL0500	9116854H01	73.35MHZ CRYSTAL FILTER	L0503	2414017K29	330nH	Q0703	4816548H01	N-CHANNEL LDMOS DRIVER
CR0208	4815096H01	DIODE VARACTOR 1SV305	J0700	0905901V12	BNC RF CONNECTOR	L0504	NOT PLACED		Q0704	4813973B02	PNP
CR0300	4815096H01	DIODE VARACTOR 1SV305	L0100	2414017N29	270nH	L0506	2414032B66	820nH	Q0705	4816547H01	N-CHANNEL LDMOS PRE-DRIVER
CR0301	4815096H01	DIODE VARACTOR 1SV305	L0200	2414017N28	220nH	L0602	2414032K23	2.7uH	Q0706	4815272H01	ANALOG SWITCH
CR0302	4815096H01	DIODE VARACTOR 1SV305	L0202	2414032F42	470nH	L0603	2414032D20	270nH	Q0707	4815272H01	ANALOG SWITCH
CR0303	4815096H01	DIODE VARACTOR 1SV305	L0203	2414032F42	470nH	L0604	2466505A01	10uH	Q0708	4815272H01	ANALOG SWITCH
CR0304	4815096H01	DIODE VARACTOR 1SV305	L0204	2414017N28	220nH	L0605	2466505A01	10uH	Q0709	4815272H01	ANALOG SWITCH
CR0305	4815096H01	DIODE VARACTOR 1SV305	L0205	2414017N20	47nH	L0608	2414032B76	4.7uH	Q0900	4815272H01	ANALOG SWITCH
CR0306	4815096H01	DIODE VARACTOR 1SV305	L0206	2414017N14	15nH	L0700	2460592A01	17nH	Q0901	4813973A13	PNP
CR0307	4815096H01	DIODE VARACTOR 1SV305	L0207	2415385H02	12.5nH	L0702	2479990G01	33.47nH	Q0902	4813973M07	NPN
CR0308	4815096H01	DIODE VARACTOR 1SV305	L0209	2414032F42	470nH	L0705	2414017N26	150nH	R0100	0613952R66	0
CR0400	4813974A19	DIODE, SCHOTTKY	L0210	2414015A21	27nH	L0706	2460592A01	17nH	R0101	0613952R66	0
D0400	4813974A06	DIODE, PIN	L0211	2414017N28	220nH	L0707	2460592A01	17nH	R0102	0613952R66	0
D0401	4885055Y01	DIODE VARACTOR 1SV229	L0212	2414032F42	470nH	L0708	2460592A01	17nH	R0103	0613952R66	0
D0402	4885055Y01	DIODE VARACTOR 1SV229	L0213	2414032F42	470nH	L0710	2460592A01	17nH	R0104	0613952R17	47K
D0403	4885055Y01	DIODE VARACTOR 1SV229	L0214	2414032F42	470nH	L0714	2479990N01	43.67nH	R0105	0613952Q58	240
D0404	4885055Y01	DIODE VARACTOR 1SV229	L0215	2415385H02	12.5nH	L0715	2414017N26	150nH	R0106	0613952Q83	2.7K
D0405	4815090H01	DIODE, MIXER	L0217	2414032F42	470nH	L0718	2414017N13	12nH	R0107	0613952Q57	220
D0500	4813974A19	DIODE, SCHOTTKY	L0218	2414015A20	22nH	L0719	2414017N23	82nH	R0108	0613952Q80	2K
D0600	4815096H01	DIODE VARACTOR 1SV305	L0219	2414032F42	470nH	L0720	2414017N06	3.3nH	R0109	0613952R66	0
D0601	4815096H01	DIODE VARACTOR 1SV305	L0221	2414017N19	39nH	L0721	2414017N06	3.3nH			

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
R0110	0613952Q42	51	R0229	0613952Q54	160	R0426	0613952Q83	2.7K	R0715	0613952H45	68
R0111	0613952R66	0	R0230	0613952Q89	4.7K	R0427	0613952Q42	51	R0718	0613952H25	10
R0113	0613952R01	10K	R0301	0613952Q85	3.3K	R0428	0613952R01	10K	R0719	0613959Q25	10
R0114	0613952Q80	2K	R0302	0613952Q66	510	R0429	0613952Q69	680	R0720	0613952H25	10
R0115	0613952R66	0	R0303	0613952Q66	510	R0430	0613952R01	10K	R0722	0613952H89	4.7K
R0116	0613952R66	0	R0304	0613952Q95	8.2K	R0431	0613952R01	10K	R0727	0613952H92	6.2K
R0117	0613952R12	30K	R0305	0613952Q49	100	R0432	0613952H69	680	R0728	0613952J01	10K
R0118	0613952R66	0	R0306	0613952R05	15K	R0433	0613952R66	0	R0729	0613952J01	10K
R0119	0613952Q35	27	R0307	0613952Q25	10	R0500	0613952Q90	5.1K	R0730	0613952H73	1K
R0120	0613952R01	10K	R0308	0613952Q42	51	R0501	0613952Q61	330	R0732	0613952H73	1K
R0122	NOT PLACED		R0310	0613952Q89	4.7K	R0502	0613952R08	20K	R0734	0613952G67	0
R0123	0613952R19	56K	R0311	0613952R66	0	R0503	0613952R12	30K	R0735	0613959Y49	100
R0125	0613952R66	0	R0312	0613952R66	0	R0508	0613952R19	56K	R0738	0613959Y42	51
R0126	NOT PLACED		R0316	0613952Q46	75	R0509	0613952Q89	4.7K	R0739	NOT PLACED	
R0127	0613952Q49	100	R0319	0613952R32	200K	R0510	0613952R12	30K	R0740	0613952J25	100K
R0128	0613952R66	0	R0320	0613952R05	15K	R0511	0613952R12	30K	R0741	0613952J17	47K
R0131	0613952Q58	240	R0321	0613952Q83	2.7K	R0512	0613952Q75	1.2K	R0742	0613959Q25	10
R0134	0613952Q35	27	R0324	0613952Q80	2K	R0601	0613952Q42	51	R0744	NOT PLACED	
R0139	0613952Q78	1.6K	R0325	0613952Q95	8.2K	R0602	0613952R01	10K	R0745	0613952H65	470
R0140	0613952Q31	18	R0326	0613952Q49	100	R0603	0613952Q66	510	R0747	0613952H89	4.7K
R0144	0613952R01	10K	R0327	0613952R01	10K	R0604	0613952R10	24K	R0748	0613952J19	56K
R0146	0613952R66	0	R0329	0613952Q50	110	R0605	0613952Q61	330	R0749	0613952G67	0
R0147	NOT PLACED		R0331	0613952R01	10K	R0606	0613952Q42	51	R0750	0613952J01	10K
R0148	0613952Q51	120	R0332	0613952Q56	200	R0607	NOT PLACED		R0751	0613952J08	20K
R0155	0613952R66	0	R0333	0613952Q35	27	R0608	0613952R66	0	R0752	0613952G67	0
R0156	NOT PLACED		R0334	0613952Q56	200	R0609	0613952R66	0	R0753	0613952H73	1K
R0157	NOT PLACED		R0337	0613952R66	0	R0610	0613952R66	0	R0754	0613952H25	10
R0158	NOT PLACED		R0400	0613952R11	27K	R0611	0613952R66	0	R0755	0613952H25	10
R0159	0613952R01	10K	R0401	0613952Q69	680	R0612	0613952R66	0	R0756	0613952J25	100K
R0160	0613952R25	100K	R0402	0613958H25	10	R0613	0613952R66	0	R0757	0613952J17	47K
R0161	0613952R25	100K	R0403	0613952R66	0	R0614	0613952R66	0	R0759	0613952H25	10
R0201	0613952Q85	3.3K	R0404	0613952Q83	2.7K	R0615	0613952R66	0	R0760	0613952Q83	2.7K
R0202	0613952Q75	1.2K	R0405	0613952Q91	5.6K	R0616	0613952R25	100K	R0761	0613952G67	0
R0203	0613952Q75	1.2K	R0406	0613952Q83	2.7K	R0617	0613952R01	10K	R0762	0613958S29	15
R0204	0613952Q95	8.2K	R0407	0613952H63	390	R0618	0613952Q63	390	R0763	0613958S29	15
R0205	0613952Q49	100	R0409	0613952Q75	1.2K	R0619	0613952R01	10K	R0764	0613958S29	15
R0206	0613952R05	15K	R0410	0613952R25	100K	R0620	0613952Q96	9.1K	R0765	NOT PLACED	
R0207	0613952Q25	10	R0412	0613952R25	100K	R0621	0613952R66	0	R0766	NOT PLACED	
R0208	0613952Q42	51	R0413	0613952Q69	680	R0622	NOT PLACED		R0767	0613958S29	15
R0210	0613952Q89	4.7K	R0414	0613952Q69	680	R0623	NOT PLACED		R0768	0613958S29	15
R0211	0613952R66	0	R0415	0613952Q69	680	R0624	0613952Q90	5.1K	R0769	NOT PLACED	
R0212	0613952R66	0	R0416	0613952Q69	680	R0625	0613952N69	51.1K	R0770	NOT PLACED	
R0213	0613952R01	10K	R0417	0613958H39	39	R0626	0613952N81	68.1K	R0771	0613958S29	15
R0216	0613952Q51	120	R0418	0613952M55	3.65K	R0627	0613952R66	0	R0772	0613958S29	15
R0218	0613952R01	10K	R0419	0613952Q75	1.2K	R0700	NOT PLACED		R0773	0613958S29	15
R0219	0613952Q66	510	R0420	0613952Q75	1.2K	R0702	NOT PLACED		R0774	0613952J08	20K
R0220	0613952Q25	10	R0421	0613958H25	10	R0703	0613958J74	0	R0775	NOT PLACED	
R0221	0613952Q66	510	R0422	0613952K71	53.6	R0706	0613958S53	150	R0776	0613958J74	0
R0224	0613952Q92	6.2K	R0423	0613952L09	121	R0711	0613952H53	150	R0777	0613952H25	10
R0225	0613952Q94	7.5K	R0424	0613952L09	121	R0713	0613959H12	30K	R0778	NOT PLACED	
R0226	0613952Q49	100	R0425	0613952L51	332	R0714	0613952H45	68	R0900	0613952R19	56K

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
R0901	0613952R16	43K	R0978	0613952G67	0
R0902	0613952Q88	4.3K	R0979	0613952G67	0
R0903	0613952R09	22K	RT0908	0615585H01	THERMISTOR, 47K
R0906	0613952R66	0	RT0953	0615585H01	THERMISTOR, 47K
R0907	0613952R66	0	SH0100	2615362H01	SHIELD
R0909	0613952R16	43K	SH0101	2615362H01	SHIELD
R0910	0613952H73	1K	SH0300	2615362H01	SHIELD
R0911	0613952Q61	330	SH0301	2615362H01	SHIELD
R0912	0613952R13	33K	SH0500	2615576H01	SHIELD
R0913	0613952R66	0	SH0900	2686423Z02	SHIELD
R0914	0613952R31	180K	SH0901	2686425Z02	SHIELD
R0915	0613952R21	68K	SP0700	1015349H01	SOLDER PREFORM
R0916	0613952Q93	6.8K	SP0701	1015349H01	SOLDER PREFORM
R0917	0613952H91	5.6K	SP0702	1015349H01	SOLDER PREFORM
R0918	0613952H63	390	SP0703	1015349H01	SOLDER PREFORM
R0919	0613952R15	39K	SP0704	1015349H01	SOLDER PREFORM
R0920	0613952R09	22K	SP0705	1015349H01	SOLDER PREFORM
R0921	0613952H81	2.2K	SP0706	1015349H01	SOLDER PREFORM
R0922	0613952R14	36K	SP0707	1015349H01	SOLDER PREFORM
R0923	0613952R66	0	T0400	2515121H01	BALUN XFMR
R0924	0613952H91	5.6K	T0401	2515121H01	BALUN XFMR
R0925	0613952H91	5.6K	U0100	5104932K08	IC, FRACN SYNTHESIZER
R0926	0613958H53	150	U0101	5114000B59	ANALOG SWITCH
R0927	0613952H42	51	U0201	4815267H01	DUAL PNP
R0928	0613958H39	39	U0303	NOT PLACED	
R0929	0613958H39	39	U0304	4815267H01	DUAL PNP
R0930	0613952R07	18K	U0600	5102495J14	IC, RF ASIC
R0931	0613952R66	0	U0601	5115391H01	VOLTAGE REGULATOR
R0936	0613952N66	47.5K	U0700	4802246J29	PA PRE-DRIVER
R0937	0613952N21	16.2K	U0900	5115147H01	DUAL OPAMP
R0938	0613952R66	0	U0901	5115147H01	DUAL OPAMP
R0940	0613952R66	0	U0940	5180390L83	IC, PA CONTROLLER
R0941	0613952R66	0	U0941	5115391H01	VOLTAGE REGULATOR
R0942	0613952M81	6.81K	U0942	5114004A35	VOLTAGE DETECTOR
R0943	0613952N58	39.2K	VR0700	4813977M11	DIODE, 5.6V ZENER
R0944	0613952R66	0	Y0100	5102495J07	1.5PPM 16.8MHZ TCXO (Non-GPS Models only)
R0946	0613952M51	3.32K	Y0100	5116032H01	0.5PPM 16.8MHZ TCXO (GPS Models only)
R0947	0613952R66	0			
R0950	0613952N01	10K			
R0951	0613952N62	43.2K			
R0954	0613952R40	430K			
R0955	0613952P01	100K			
R0960	0613952H82	2.4K			
R0970	0613958H56	200			
R0971	0613958H55	180			
R0972	NOT PLACED				
R0973	0613952G67	0			
R0974	0613958H57	220			
R0975	0613958H57	220			
R0976	0613952H53	150			
R0977	0613952H51	120			



**DM 3400/DM 3401/
DM 3600/DM 3601
Mobile Radios**

Chapter 6

UHF1 (403-470 MHz)

25-40W

Service Information

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Chapter 6 - UHF1 High Power Service Information

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Section 1

THEORY OF OPERATION

1.0 Introduction

This Chapter provides a detailed theory of operation for the UHF 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 UHF1 (403-470 MHz) Receiver Circuitry

The receiver is configured as a dual-conversion superheterodyne receiver, capable of both FM and 4-level FSK demodulation. The major blocks are the front-end, the mixer, Xtal filter, and the Abacus III back-end IC. The overall block diagram is shown in Figure 1-1.

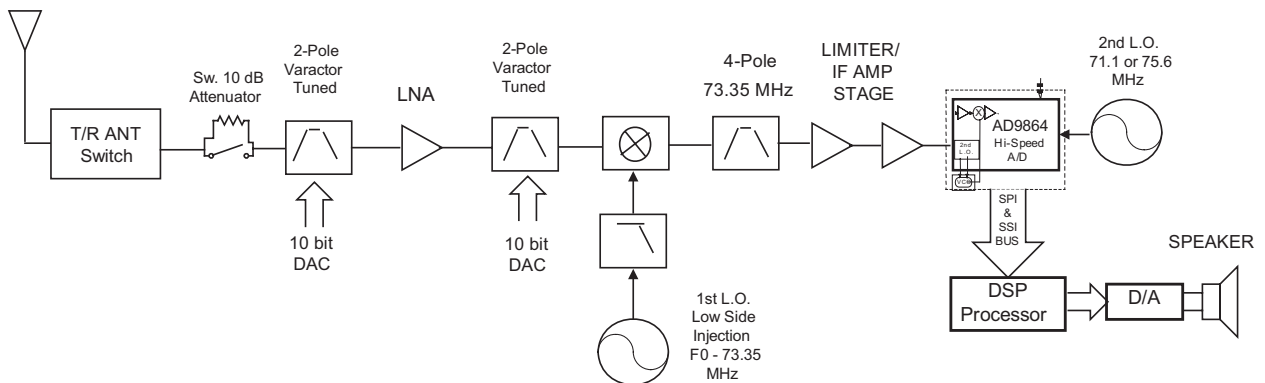


Figure 1-1 Receiver Block Diagram

2.1 Receiver Front-End

The front-end consists of a 2-pole varactor-tuned pre-selector filter, an LNA, a 2-pole varactor-tuned post-selector filter, and a passive double-balanced mixer. The received signal applied to the antenna is routed through the harmonic filter and PIN diode controlled antenna switch (D0702). A logic high level on ANT_ENABLE configures the antenna switch for Tx operation while a logic low places the switch in Rx mode. The insertion loss of the harmonic filter and antenna switch combined is approximately 0.5 dB max in Rx mode. From this point, the Rx signal is routed to the Local Distance switch (D0400/R0407), which biases on a diode in normal operation to minimize any insertion loss. Under strong signal conditions and for improved intermodulation protection from interfering signals, the switch can be turned on by the signal RF_ATTEN_1, which introduces approximately 10 dB of additional path loss. Activation of the switch can be accomplished manually by the user or left in the default setting.

The signal next reaches the pre-selector filter, which is a 2-pole varactor-tuned filter with 5 zeros that are optimized to provide image frequency rejection. This filter, along with the similarly designed post-selector filter, provides over 75 dB of image response rejection. The 3 dB bandwidth for both filters varies across the band with a minimum of 19 MHz at 403 MHz and a maximum of 40 MHz around 436 MHz. Half-IF rejection from the filters is also frequency dependent with a minimum of approximately 10 dB achieved at the worst-case frequency of 436 MHz. Both filters have variable center frequencies that are adjusted by the FE_TUNE signal, which is derived from the output of a 10-bit DAC internal to the MAKO IC (U3200). The voltage is scaled up by a voltage doubler (Q0403) in order to provide the required linearity for the filters. Both filters are matched to the LNA (Q0402) to optimize the amplifier's noise figure (2.0 dB) and to provide an LNA gain of 15 dB to the signal. The combined gain of the filters and LNA is about 13 dB. Current source Q0401 maintains the collector current of Q0402 constant at 20 mA. The LNA, current source, Local Distance switch, and voltage doubler are all supplied by 9R1_FILT, which is derived from 9R1 after filtering.

Following the post-selector filter is the Class 2, double-balanced mixer. It is comprised of baluns T0400 and T0401 and diode ring mixer D0405. Injection amplifier Q0405 provides 10 dB of gain to the Rx VCO injection signal. Another amplifier, Q0202, located in the VCO block, also provides gain for the LO signal and isolation from high RF signals entering the mixer. The signal applied to the LO port of the mixer is +16 dBm minimum after passing through the 3-pole/1-zero, low-pass injection filter. The LO injection is low-side and mixes the signal down to an IF frequency of 73.35 MHz. The output of the mixer is connected to a diplexer network, which terminates out-of-band frequencies in 51 ohms (R0427) while appearing as high impedance to the 73.35 MHz IF signal.

2.2 Receiver Back-End

The signal entering the back-end is matched to 4-pole crystal filter, FL0500, by C0507 and L0503. The filter is centered at 73.35 MHz with a 3 dB bandwidth of 12 kHz. IF amplifiers Q0500 and Q0501 follow the crystal filter and provide both amplification and limiting to the signal. An overall gain of 25 dB is available from the composite IF amplifier to lower-level IF signals. As the signal level increases, Q0501 begins to limit and eventually saturates out at approximately -16 dBm. The purpose of the limiting is to provide protection to the AD9864 Abacus III back-end IC (U0600). At IF levels exceeding -32 dBm into U0600, the 2nd LO synthesizer internal to U0600 can be pulled, causing corruption of the I/Q data being delivered to the DSP. The block diagram for the AD9864 is shown in Figure 1-2 below.

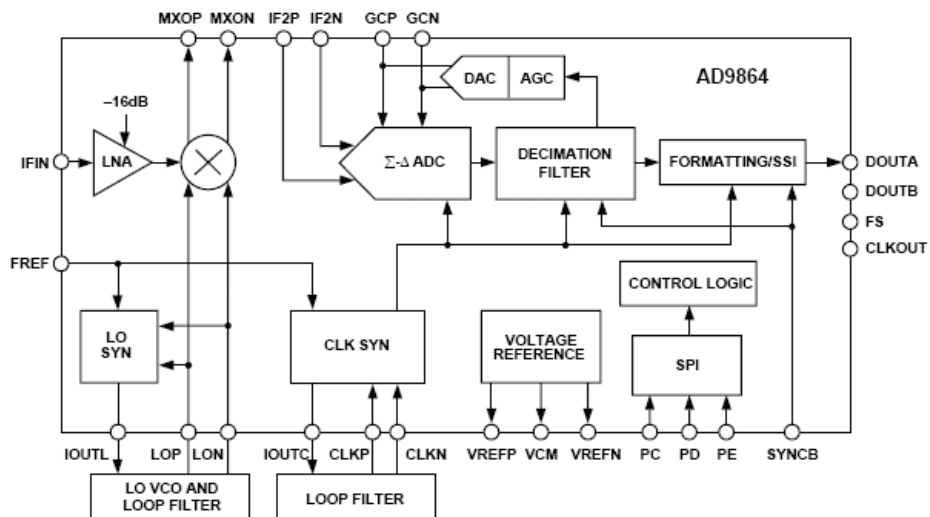


Figure 1-2 AD9864 Block Diagram

The Abacus III accepts the 73.35 MHz signal, processes it, and sends out I/Q data in 16-bit format to the DSP at a 20 kHz rate. Internal to the Abacus III is an LNA and 16 dB FE attenuator, an internal integer-N synthesizer used to control the external 2nd LO VCO, a Sigma-Delta ADC and decimation filter, and control and formatting logic for outputting the baseband I/Q data. External to U0600 is the 2nd LO VCO with active device Q0600 and its associated circuitry including the loop filter consisting of C0613, C0618, and R0603. The 2nd LO mixes the 73.35 MHz IF signal down to 2.25 MHz before being input to the ADC where it is sampled. The tank circuit (L0608, C0605, C0642, R0617) and varactor (D0601) for the internal clock synthesizer, work with the loop filter (R0618, C0643, C0646) to provide the 18 MHz clocking signal to the internal ADC, decimation filter, and SSI formatting circuitry. A 3 Volt regulator (U0601) provides a clean supply to U0600. Transistor Q0601 is configured as a super filter to provide the 2nd LO transistor with a low-noise supply. The reference clock for U0600 is 16.8_REF, which is a buffered (Q0100) 16.8 MHz clock from the synthesizer block.

Shown below in Figure 1-3, is a simplified block diagram of the signal flow through the receiver back-end and the DSP processor portion of the OMAP (U1000). All of the blocks within the dotted box represent the DSP software algorithms internal to the DSP.

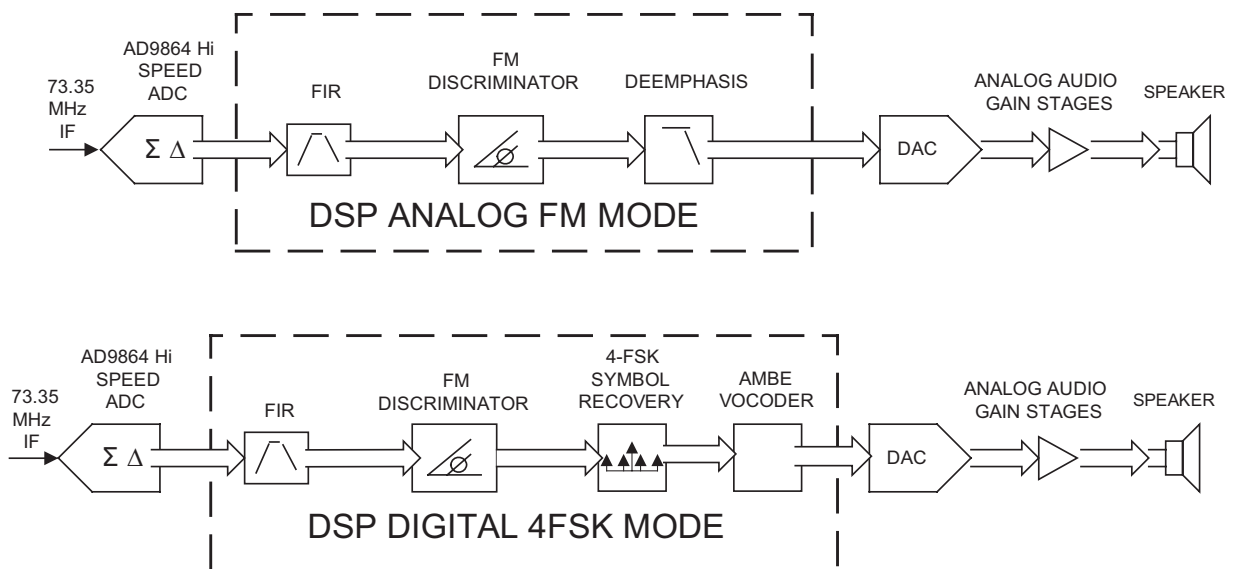


Figure 1-3 Signal Flow through Receiver Back-End

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 filter data is then sent through a decimation process further reducing its frequency to 8 kHz.

Depending on whether the radio is in Analog or Digital mode determines the type of signal processing used. If in Analog mode, the remaining 8 kHz data is sent through the FM Discriminator and De-emphasis subroutines in the DSP code. If the radio is in Digital mode, the 8 kHz data is again passed through the FM Discriminator but an additional Symbol Recovery routine is applied along with a standard AMBE Vocoding process. The data is sent to the MAKO (U3200), which provides digital to analog conversion and drives the audio gain stages. Detailed information regarding this can be found in the Audio Section of the Controller Theory of Operation.

3.0 UHF1 (403-470 MHz) Transmitter Circuitry - 40 Watt

The Transmitter consists of the power amplifier (PA) circuitry and the power control circuitry. The power amplifier provides amplification of the signal from the VCO up to the desired output power. The power control block 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, and poor assembly.

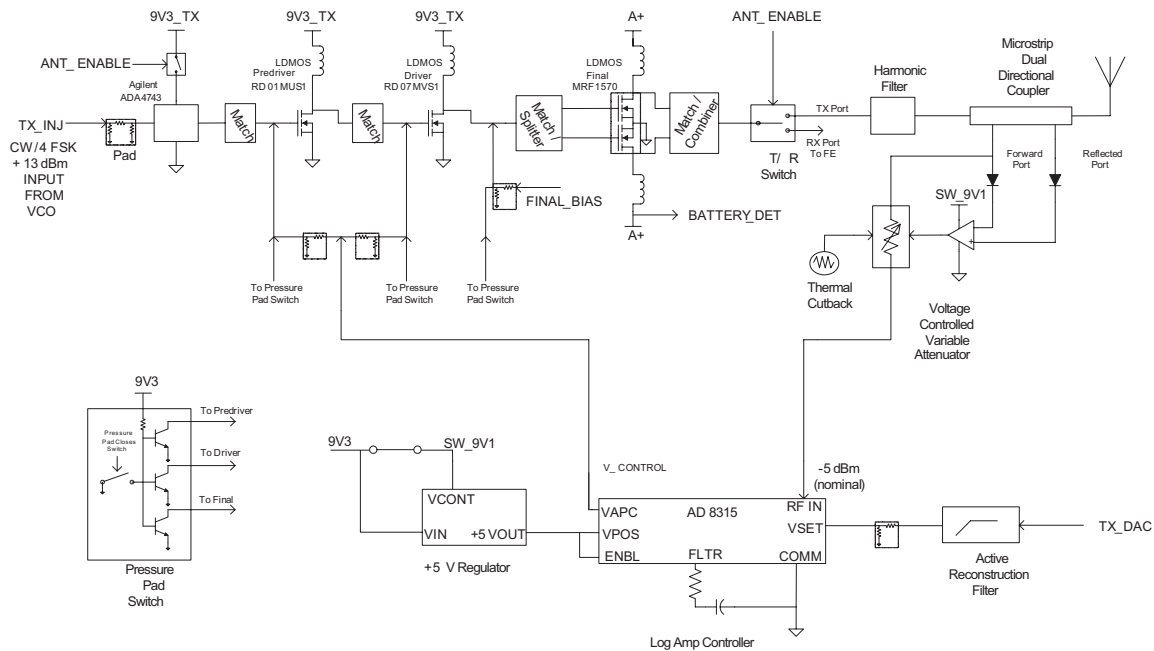


Figure 1-4 UHF 40 Watt High-Power Transmitter Detailed Block Diagram

3.1 Power Amplifier

The radio's 40 Watt power amplifier (PA) is a 4-stage amplifier which amplifies the output of the VCO to the required transmit power level. The first stage is an LDMOS (Lateral Double Diffuse MOS) 50 ohm fixed-gain block (ADA-4743, U0700) followed by the adjustable gain LDMOS pre-driver (RD01MUS1, Q0705), an adjustable gain LDMOS driver (RD07MVS1, Q0703), and the fixed-gain LDMOS final device (MRF1570, Q0702). A transmit/receive (TR) switch and a harmonic filter complete the transmit lineup.

3.2 Input Stage (50 Ohm Fixed-Gain Block)

The first stage (ADA-4743, U0700) is an integrated circuit with internally matched 50 ohm input and output stages providing approximately 16.5 dB power gain. It provides reverse isolation between the PA and the VCO to lessen the risk of VCO load-pull and it also supplies appropriate power to the pre-driver stage. The ADA-4743 is biased at 60 mA during transmit by R0706, which is switched to 9V3_TX during TX by Q0701 (controlled by Antenna_En). The ADA-4743 is preceded by an 11 dB resistive pad to further improve reverse isolation.

3.3 Pre-Driver Stage

The next stage is a low-power, LDMOS device (RD01MUS1, Q0705), which delivers up to +27 dBm to the driver stage. Its gain is controlled by varying the gate bias voltage and varies from low gain up to approximately 14 dB power gain. The gate bias voltage is controlled in parallel with the driver stage by the V_cont signal.

The input match to this stage is a high-pass topology comprised of L0718, C0817, and L0721. High-pass matches are used where appropriate to minimize the chances of low frequency regeneration within the amplifier. R0759 and R0777 are required to improve the bandwidth of this circuit. The inter-stage match between the pre-driver and driver stages is comprised of L0720, C0786, and C0791 arranged in a high-pass topology. Additional pads are provided on the transceiver board to allow for possible engineering optimizations to this match. These are non-populated parts C0789, C0792, C0793, and C0794.

3.4 Driver Stage

The third stage is a medium-power, LDMOS device (RD07MVS1, Q0703), which delivers up to +38 dBm to the final device. Its gain is controlled by varying the gate bias voltage and varies from low gain up to approximately 11 dB of power gain. The gate bias voltage is controlled with the V_cont signal and is controlled in parallel with the pre-driver stage gain.

R0718, R0720, R0754, and R0755 are required to improve the bandwidth of the driver stage. The inter-stage match (as well as the power splitter) between the driver and final device is comprised of C0753, C0813, C0818, C0819, C0732, C0743, C0744 and C0761, and associated micro-strips on the PCB. Additional pads are provided on the printed circuit board to allow for possible engineering optimizations to this match. These are non-populated parts C0754, C0755, C0729, C0730, C0731, C0808, C0764, C0760, and C0765.

3.5 Final Stage

The final stage is a high-power, LDMOS device (MRF1570, Q0702) consisting of two parallel, high-power devices within 1 plastic package. The package is mounted to a copper carrier to improve thermal conductivity to the chassis and also to more tightly control the RF load, allowing higher and more consistent maximum output power. This stage is biased at a quiescent current of 750 mA and operates with a fixed-gain of approximately 10 dB, allowing the radio to be set to a maximum output power of 48 Watts. The quiescent current is set by adjusting the Final_Bias signal. Both elements of this transistor are fabricated on the same semiconductor die and are well matched, allowing control via a single voltage.

Both the input and output matching circuits of this stage have extremely critical part location requirements. Any repair must be done with care to ensure the replaced components are placed accurately and properly soldered. Of particular concern are input matching capacitors C0732 and C0761 and output matching capacitors C0811 and C0812. The resistor networks at the input of each of the final elements are required to improve the bandwidth of the circuit. These resistors are R0762 through R0773.

The output matching circuit and power combiner is comprised of C0811, C0719, C0812, C0746, C0726, and C0737 and associated microstrips fabricated on the printed circuit board. Additional pads are provided on the PC board to allow for possible engineering optimizations to this match. These are non-populated parts C0720, C0721, C0747, C0748, C0727, and C0741. R0719 is added as a preventative measure against half-carrier regeneration. If the final device fails and has to be

replaced, R0719 should be carefully inspected to ensure against any damage caused by the final device. Replacement of the final device requires that the bias voltage 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 which is 1 Amp. The device can tolerate up to 5 Amps for brief periods of time without damage.

3.6 Antenna Switch

The antenna switch (TR switch) routes the signal between either the transmitter or receiver and the antenna. In transmit mode, it utilizes the existing dc feed (A+) to the final stage device (Q0702). Both PIN diodes D0700 and D0702 are turned on during key-up through forward biasing. This is achieved by pulling down the voltage at the cathode end of D0702 to approximately 12.2 Volts (0.7 Volt drop across each diode). Q0704 is configured as a current sink that maintains the current through the antenna switch diodes at 100 mA, as set by VR0700 and R0738. The current sink is enabled during transmit mode by ANT_ENABLE, which is asserted through Q0706 and associated circuitry. When the PIN diodes are conducting, an RF ground is formed at the anode of the lower PIN diode, D0702, which places L0710 and C0803 in parallel. The values of L0710 and C0803 are chosen so as to be parallel resonant at the center of the transmit band, making them appear as an open-circuit so that a 50 ohm power path is maintained through the top PIN diode to the harmonic filter.

In receive mode, DC current through the PIN diodes is interrupted by turning off the current sink. The RF path now flows from the harmonic filter, through the matching circuit formed by L0710, C0803, and the capacitive divider formed by C0767 and C0772. C0766, currently unplaced, is provided for possible future engineering optimizations to this match. The purpose of L0719 is to form a parallel resonant tank with the reverse capacitance of D0700, improving the receive path return loss at the receive input of the TR switch.

3.7 Harmonic Filter

Inductors L0706, L0707, L0708, and capacitors C0742, C0739, C0740, and C0738 form a 7-element low-pass filter to attenuate harmonic energy from the transmitter. R0713 is used to drain any electrostatic charges that might otherwise build up on the antenna. The harmonic filter also prevents high-level RF signals above the receiver pass-band from reaching the receiver circuits, improving spurious response rejection.

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 consisting of pin diodes D0901, D0902, and D0903. The log detector/controller regulates the gain of PA stages Q0703 and Q0705 (via V_cont), thus ensuring that 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 as part of the VSWR load-detection circuitry. Its physical location close to the antenna connector allows accurate VSWR sense at the transmitter output. Forward and reverse coupled signals are rectified by D0904 and D0905, respectively. DC voltage FWD_DETECTED is proportional to 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 the variable attenuator control stage, U0900-1. An abnormally high reflected power level, i.e., a damaged antenna, also causes an increase in the difference amplifier output voltage. This causes a

reduction in attenuation by the VCA. As a result, the greater RF signal applied to the log detector/controller causes the controller to reduce the gain of PA stages Q0703 and Q0705. Transmitter power is thus reduced to prevent damage to the final device due to an improper load.

3.9 Power Control

The transmitter uses 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-stable, high-accuracy control over a typical 50 dB dynamic range.

The MAKO IC 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. Reference voltage level is programmable through the SPI lines of the MAKO. This reference voltage is 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 of the transmitter's coupled power circuits.

The PA controller IC provides a dc output voltage at pin 7 (VAPC), which is divided to provide gate bias for PA pre-driver and driver stages. The 0 Volts to 5 Volts range at U0940, pin 7, is applied as V_CONTROL to power-adjust the transmitter 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. This adjusts the transmitter power output to the intended value. The ratio of each of these resistive dividers is chosen to ensure that Q0703 and Q0705 are both running at their 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 to raise or lower output power in order to maintain transmitter output power relative to the reference voltage applied to VSET.

3.10 Power Ramp Profile Control

In order to minimize the transient adjacent channel power at the transmitter's output, the ramped power follows 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, set the loop dynamics. The loop response has 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, form a voltage divider with the output proportional to the sensed transceiver 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 the attenuation level of the VCA stage. For the condition that the temperature threshold set by resistive divider combination R0901 and R0909 is reached, the VCA is driven to increase the RFIN signal at the PA controller IC (pin 1). This increase will cause the 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 the battery supply in the controller circuit of the radio in order to change the VSET input of the PA controller IC (pin 3) for reduced transmitter output. This feature allows transmitter PA dissipation to be limited at high-line battery supply operating conditions while limiting transmitter PA overdrive conditions at low-line battery supply operating conditions.

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 transistor Q0702 against the chassis. When the chassis cover and rubber pad are properly assembled, the conductive portion of the pad contacts a pattern on the transceiver 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, turning off the gate bias to Q0702, Q0703, and Q0705. This prevents thermal damage of the RF transistors which could 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 (Tomahawk II, U0100), and the Voltage Controlled Oscillator VCO.

4.1 Reference Oscillator

The reference oscillator (Y0100) contains a temperature compensated crystal oscillator with a frequency of 16.8 MHz. A digital-to-analog (DAC) converter internal to U0100 (Tomahawk) and controlled by the microprocessor via serial interface (SPI), sets the voltage at the AUX_DAC output of U0100 (pin H6) to set the frequency of the oscillator. The output of the oscillator (pin 3 of Y0100) is applied to pin K5 (XOSC_BASE) of U0100.

4.2 Fractional-N Synthesizer

The Tomahawk II synthesizer IC (U0100) consists of a pre-scaler, a programmable divider and divider 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 2.45 Volts.

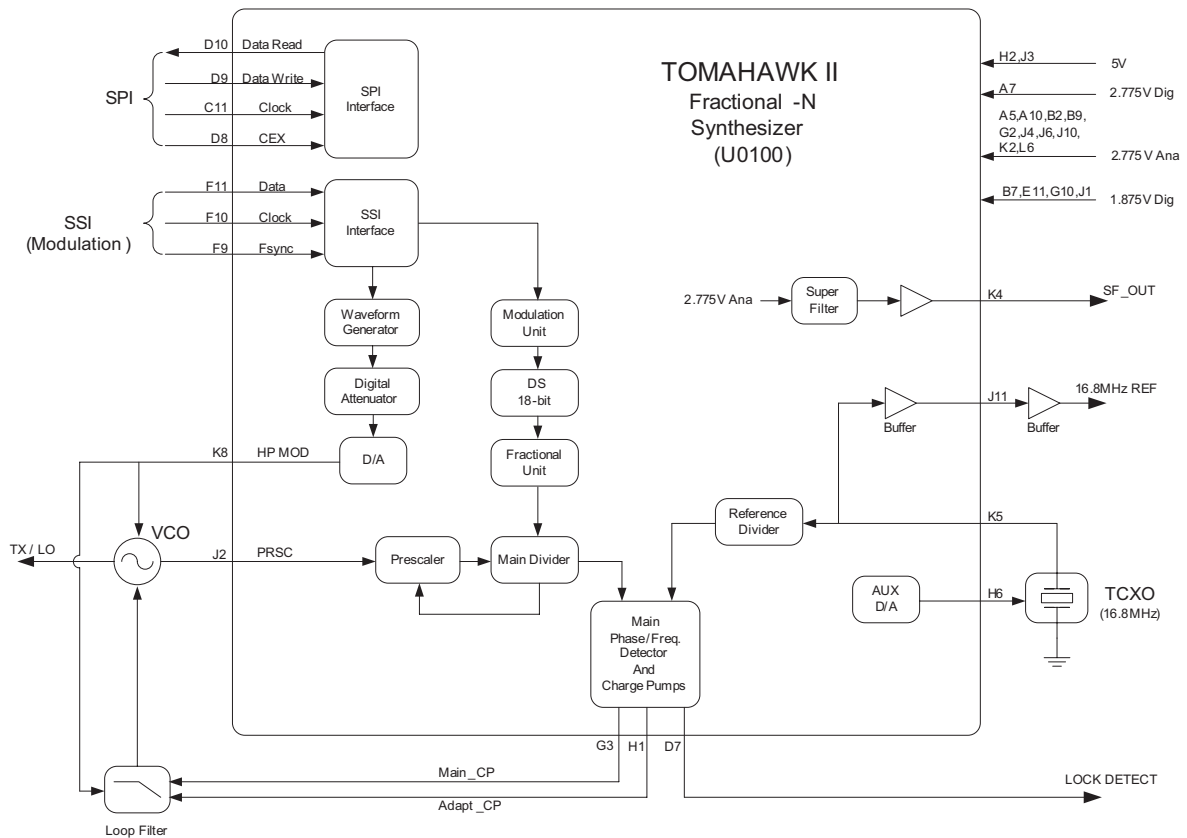


Figure 1-5 UHF Synthesizer Block Diagram

A voltage of 2.775 Volts applied to the super filter input (U0100 pin J4) supplies an output voltage of 2.45 Vdc (SF_OUT) at pin K4. This supplies the VCO and the VCO modulation bias circuit (via R0321). The super filter supply voltage is provided by the 2.775 Volt regulator within U3200. The synthesizer is also supplied by the 5 Volt regulator, U3002, another 2.775 Volt regulator within U3200, and a 1.875 Volt regulator within U3200.

The output signal LOCK (U0100-D7) provides information about the lock status of the synthesizer loop. A high level 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-D9) and SPI_DR (U0100-D10), 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 four Colpitts oscillators (two each for Tx and Rx), a single-stage Tx buffer amplifier, a single-stage Rx buffer amplifier, oscillator bias control switches, and the modulation circuitry.

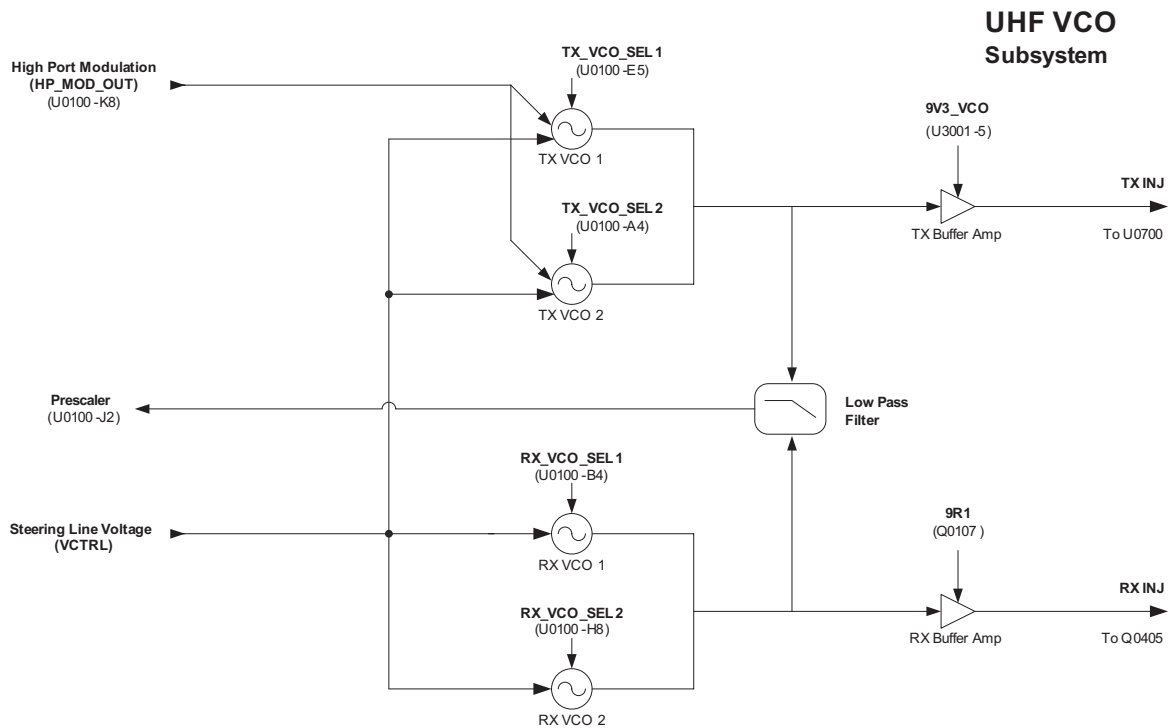


Figure 1-6 UHF VCO Block Diagram

The UHF VCO design incorporates a total of four oscillators; two varactor-tunable Colpitts oscillators each for Tx and Rx. Each oscillator has a tuning range of 33.5 MHz, sufficient to cover the Rx and Tx frequency ranges of 326.65 MHz to 396.65 MHz and 403 MHz to 470 MHz, respectively. The oscillators resonate at fundamental operating frequencies. Four (active-low logic) general purpose output lines (GPO1, GPO2, GPO3, and GPO6) from the Tomahawk IC (U0100-B4, A4, E5, and H8) provide the control for independent bias selection to each oscillator (VCO_SEL) via the PNP transistor switches U0304 and U0201. The 2.45 Volt super filtered output, SF_OUT, of the Tomahawk IC (U0100-K4) supplies the bias to the oscillators. A portion of the VCO output signal is lightly coupled through coupling capacitors C0331 and C0231, routed through a low-pass filter (formed by L0221, C0235, C0230, and C0233), and fed back to the M_PRSC input of the Tomahawk IC (U0100-J2).

High-port modulation is scaled through a voltage divider (comprised of R0319, R0320, and R0321) and applied to the Tx modulation varactor diode CR0300. The TX VCO frequency is modulated via coupling capacitors C0310 and C0344. High-port modulation is also applied to the VCO steering line (through R0139, R0140 and C0166) which modulates the main VCO tuning varactors.

A discrete single-stage Tx buffer amplifier (comprised of the NPN transistor Q0302 and surrounding components) amplifies the signal from the Tx oscillator to the level required by the first stage of the Transmitter Power Amplifier (U0700). The TX buffer amplifier also provides sufficient isolation from any undesired load-pulling from the Transmitter Power Amplifier. The bias for Q0302 is provided by the 9.3 Volt regulator U3001.

A discrete single-stage Rx buffer amplifier (comprised of the NPN transistor Q0202 and surrounding components) amplifies the signal from the Rx oscillator to the level required by the LO injection amplifier (Q0405). The Rx buffer amplifier also provides sufficient isolation from any undesired load-pulling from high input levels in the receiver front-end. GPO4 from the Tomahawk IC (U0100-D4) controls the transistor switch (comprised of Q0108 and Q0107), that enables the 9.1 Volt bias to Q0202 (via the 9.3 Volt regulator U3001).

4.4 Synthesizer Operation

The complete synthesizer subsystem is comprised mainly of the Tomahawk synthesizer IC, Reference Oscillator (crystal oscillator with temperature compensation), loop filter circuitry, VCO, and DC supplies. The VCO feedback signal, PRSC, is fed to pin J2 of U0100 (M_PRSC) via a low-pass filter (L0221, C0235, C0230, and C0233) 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). The output signal of the phase/frequency detector is a pulsed signal which is routed to 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 applied to the VCO.

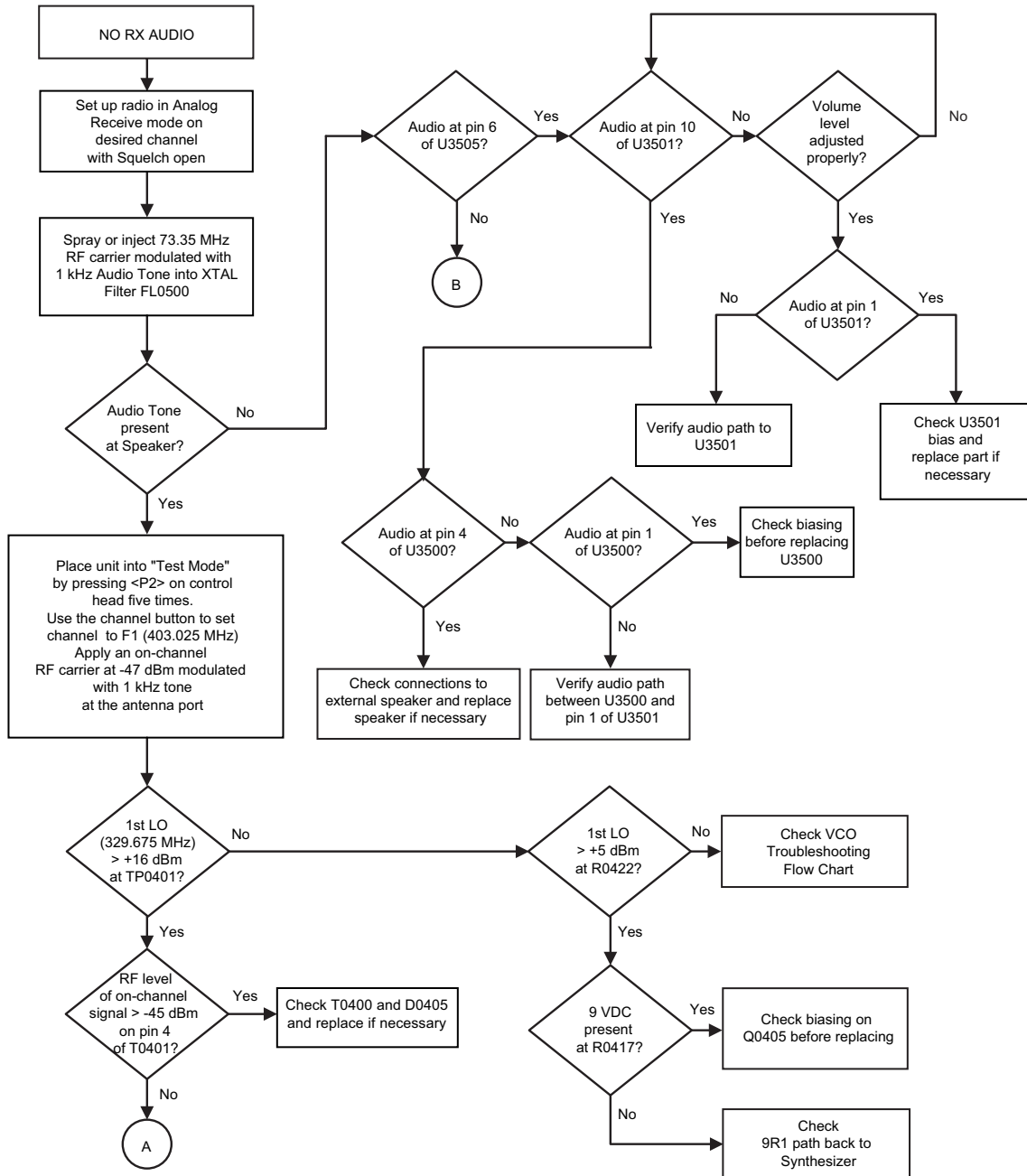
To reduce lock time when new frequency data has been loaded into the synthesizer, an adapt charge pump providing much greater current than the main charge pump is turned on for a finite amount of time to quickly charge or discharge the loop filter capacitors to steer the VCO to the desired frequency. The output of the adapt charge pump passes to the loop filter via pin H1 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-D7), which is routed to the microprocessor. Q0102 is configured as a current source to provide a steady 1.5 mA during the adapt period. U0101 is an analog switch that opens the adapt path slightly before the end of the adapt period to prevent the current from the current source from pushing the VCO off frequency.

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 a 10-bit DAC before modulating the VCO. This high-port analog modulation output (HP_MOD_OUT, U0100-K8) is connected to the VCO modulation varactor diode (CR0300) via C0360 and R0319, and to the loop filter via R0139, R0140, and C0166.

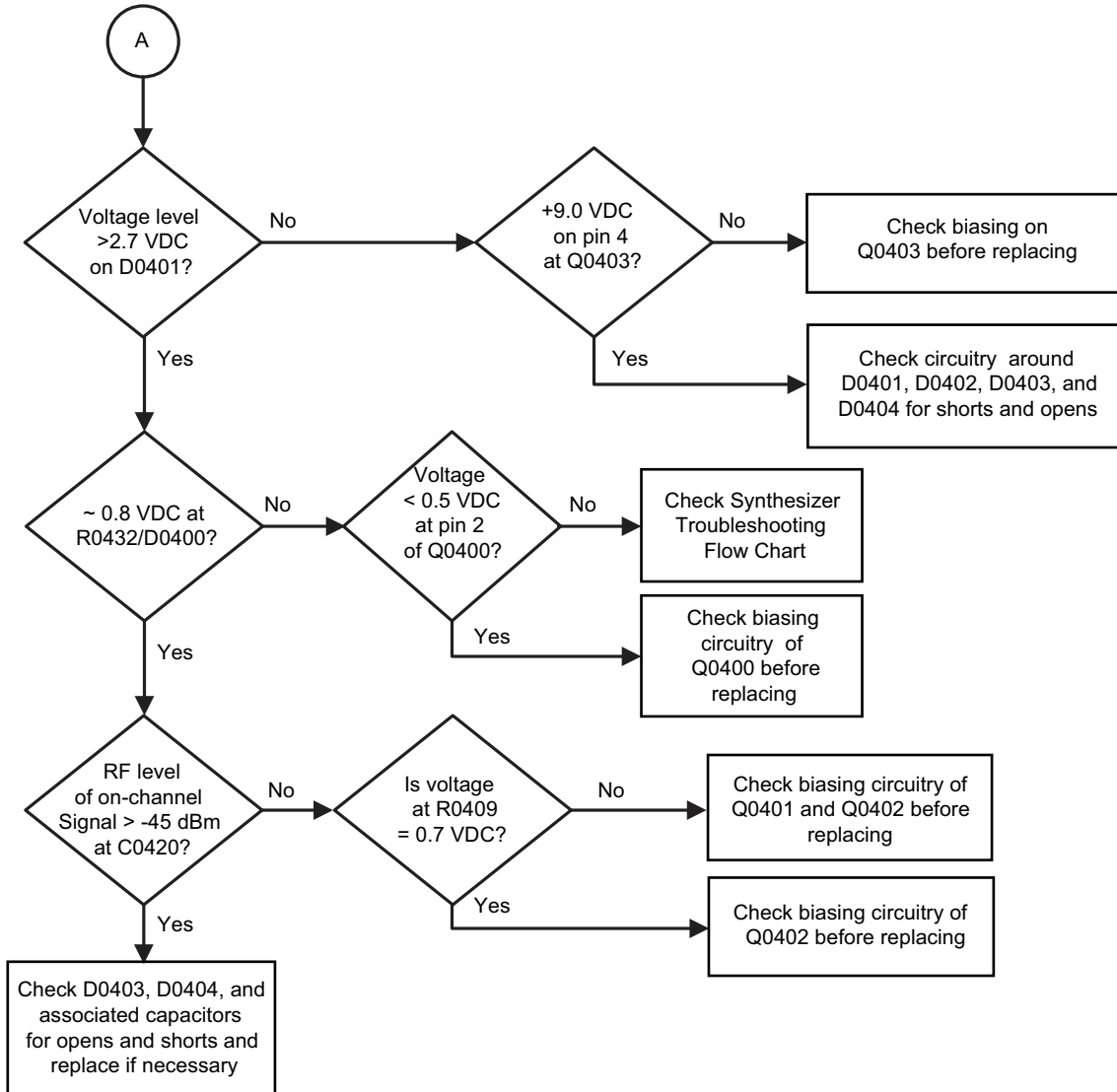
Section 2

TROUBLESHOOTING CHARTS

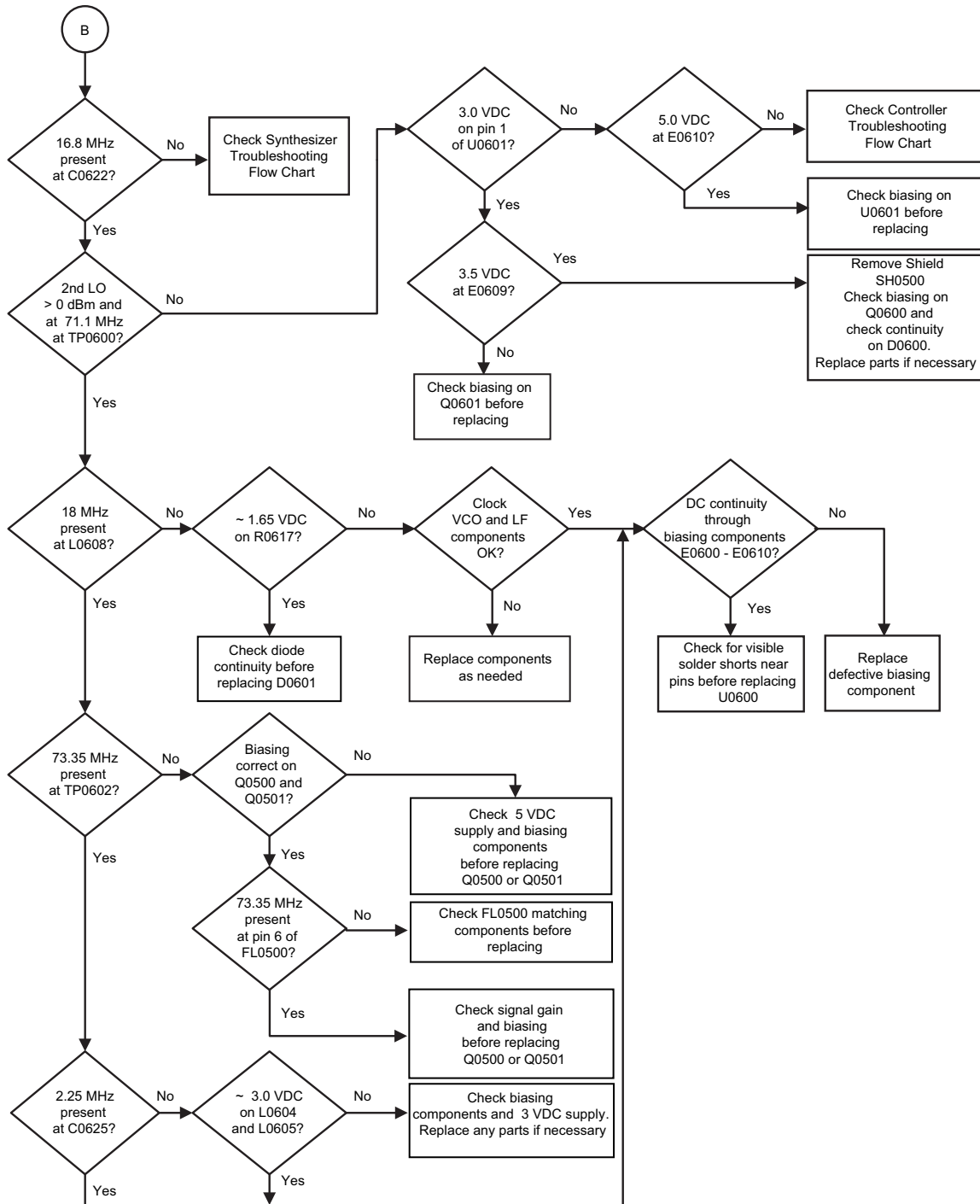
1.0 Troubleshooting Flow Chart for Receiver (Sheet 1 of 3)



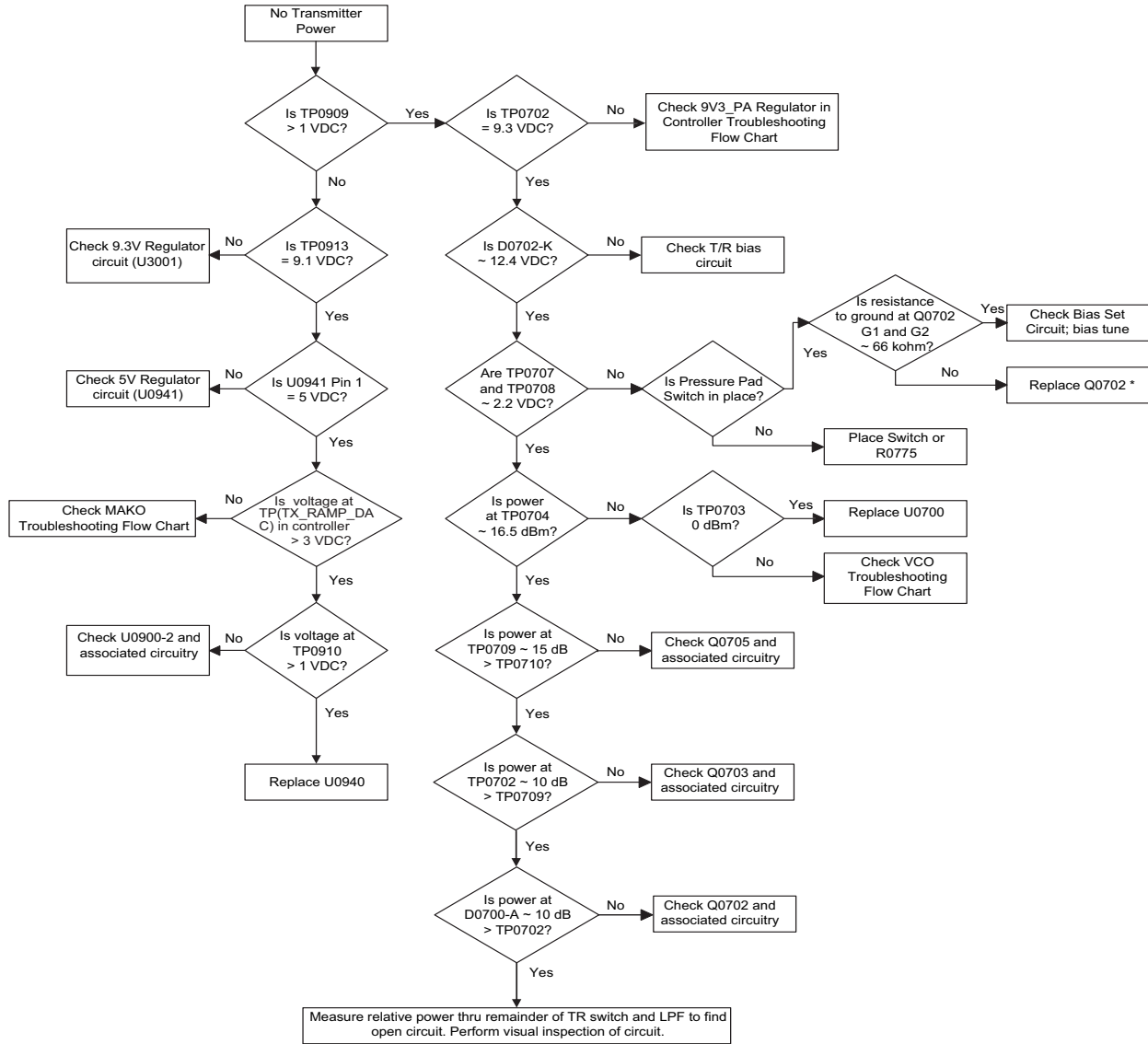
1.1 Troubleshooting Flow Chart for Receiver (Sheet 2 of 3)



1.2 Troubleshooting Flow Chart for Receiver (Sheet 3 of 3)



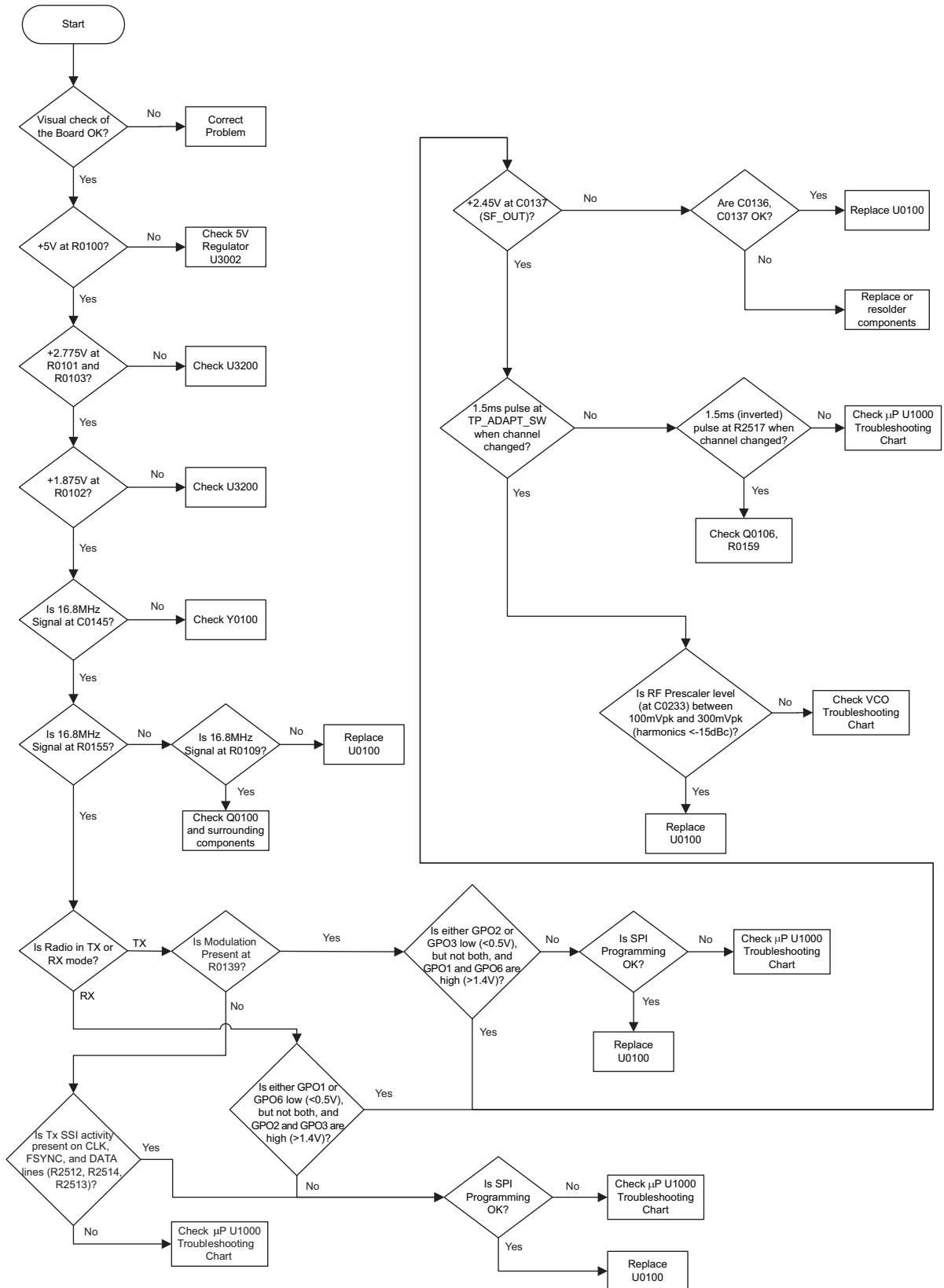
2.0 Troubleshooting Flow Chart for 40W Transmitter



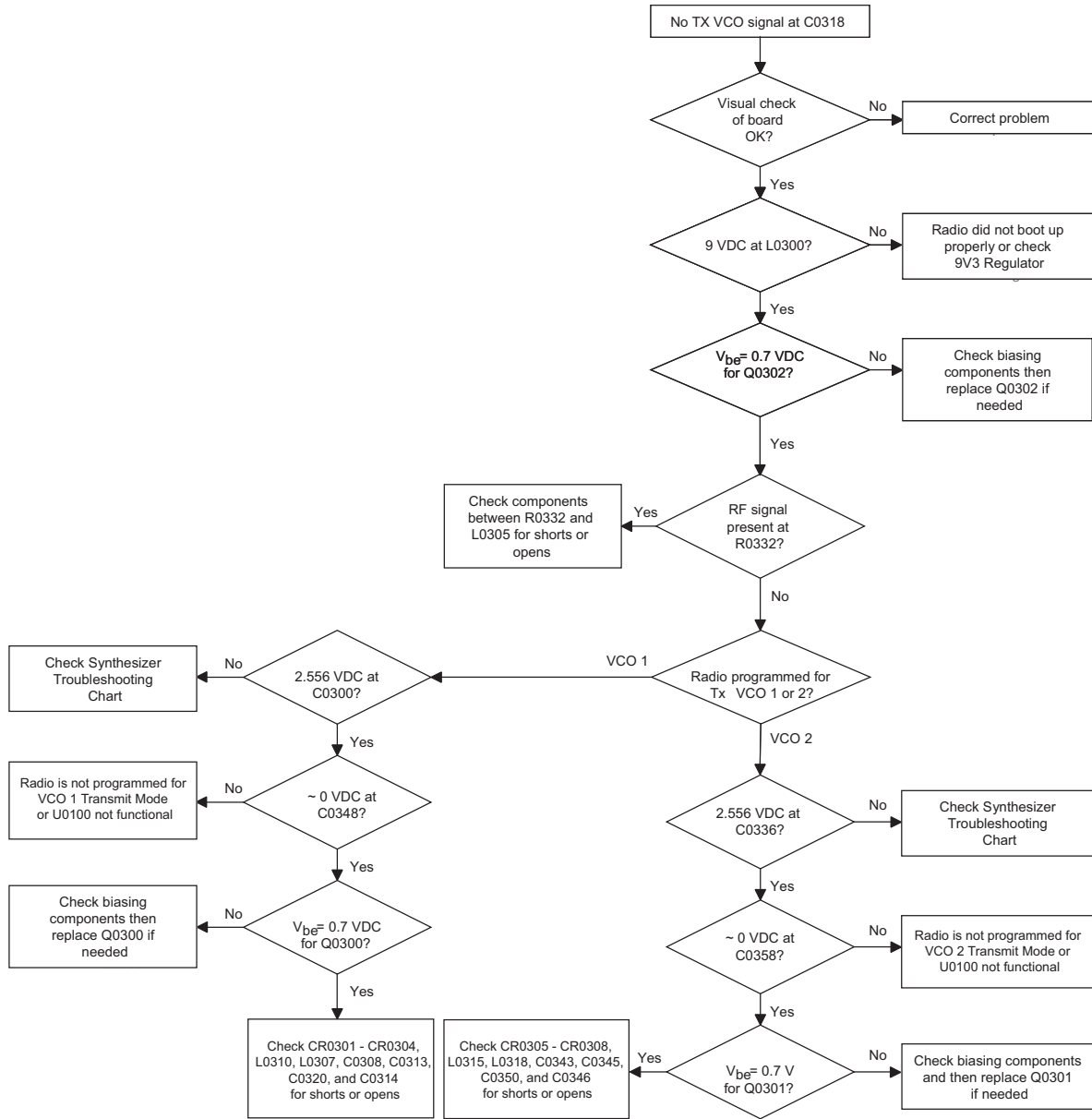
* Note: If Q0702 is replaced radio must be bias set and power set.

- 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 final device damage.
- 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.

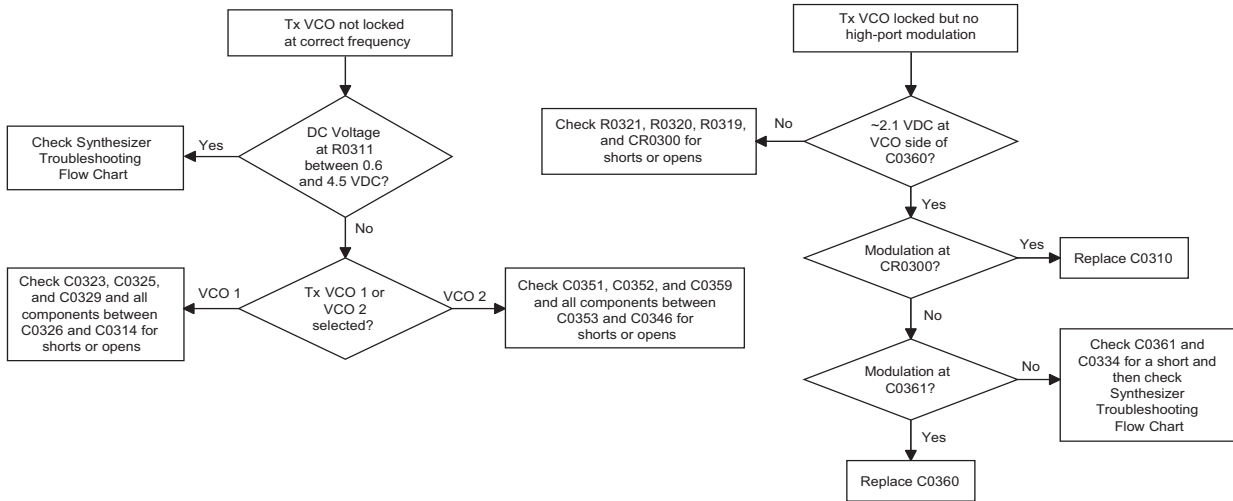
3.0 Troubleshooting Flow Chart for Synthesizer



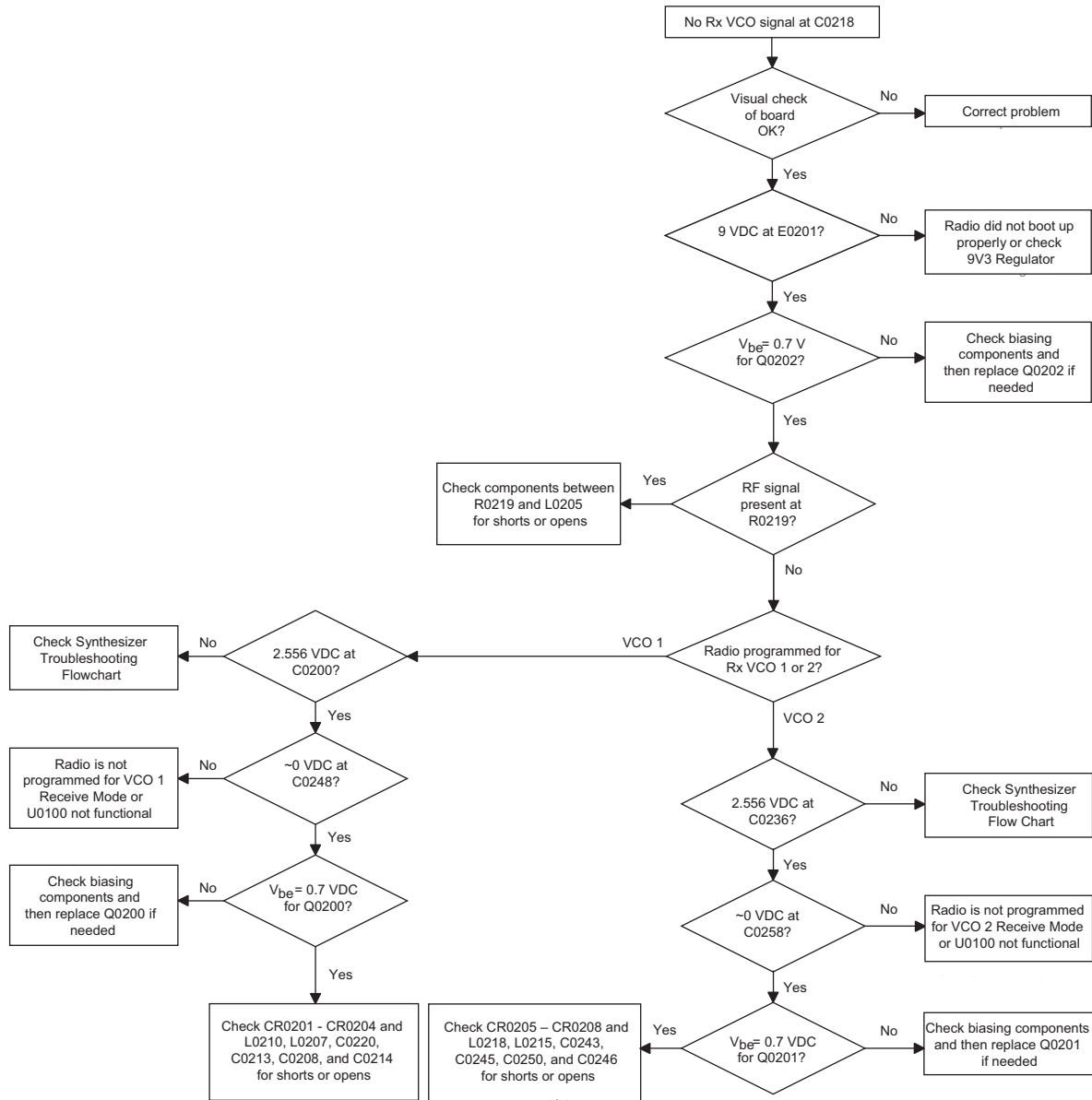
4.0 Troubleshooting Flow Chart for Tx VCO (Sheet 1 of 2)



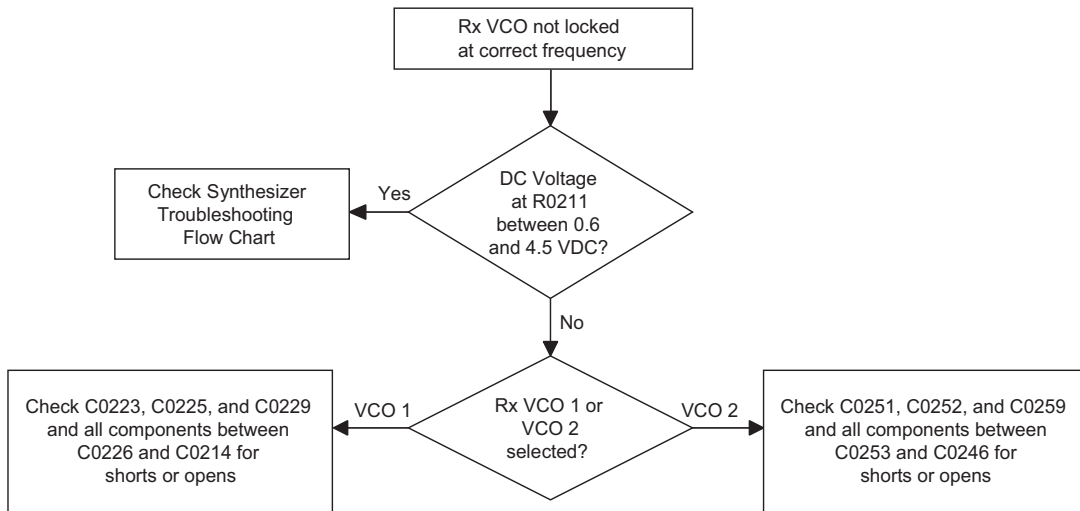
4.1 Troubleshooting Flow Chart for Tx VCO (Sheet 2 of 2)



5.0 Troubleshooting Flow Chart for Rx VCO (Sheet 1 of 2)



5.1 Troubleshooting Flow Chart for Rx VCO (Sheet 2 of 2)



Notes

Section 3

UHF1 PCB / SCHEMATICS / PARTS LISTS

1.0 Allocation of Schematics and Circuit Boards

1.1 Controller Circuits

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

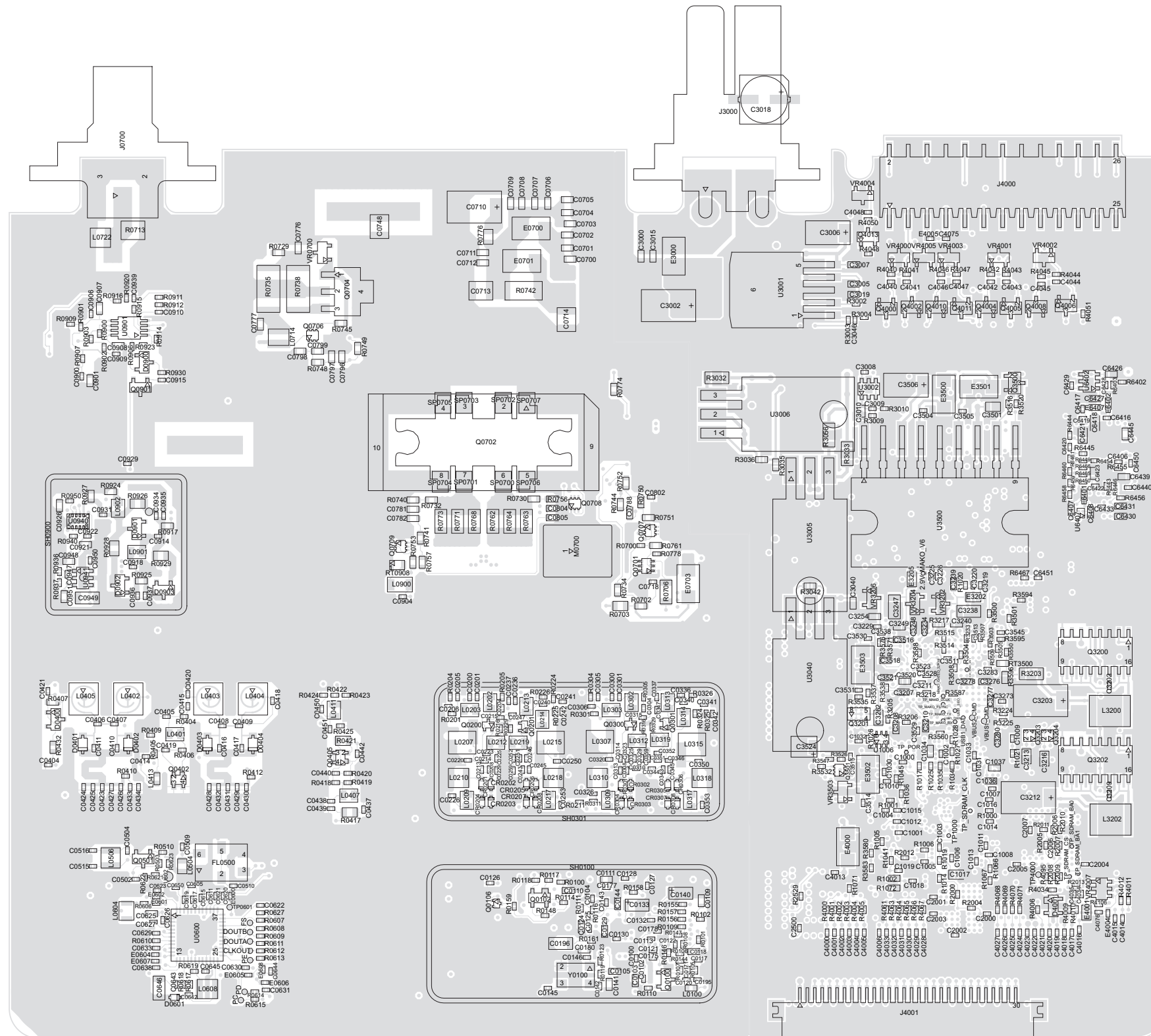
NOTE: The UHF Schematic and parts lists are the same for 8486777Z12 and 8486777Z14. Only the Controller circuits are different between the two PCBs.

Table 3-1 UHF1 25-40W Diagrams and Parts List

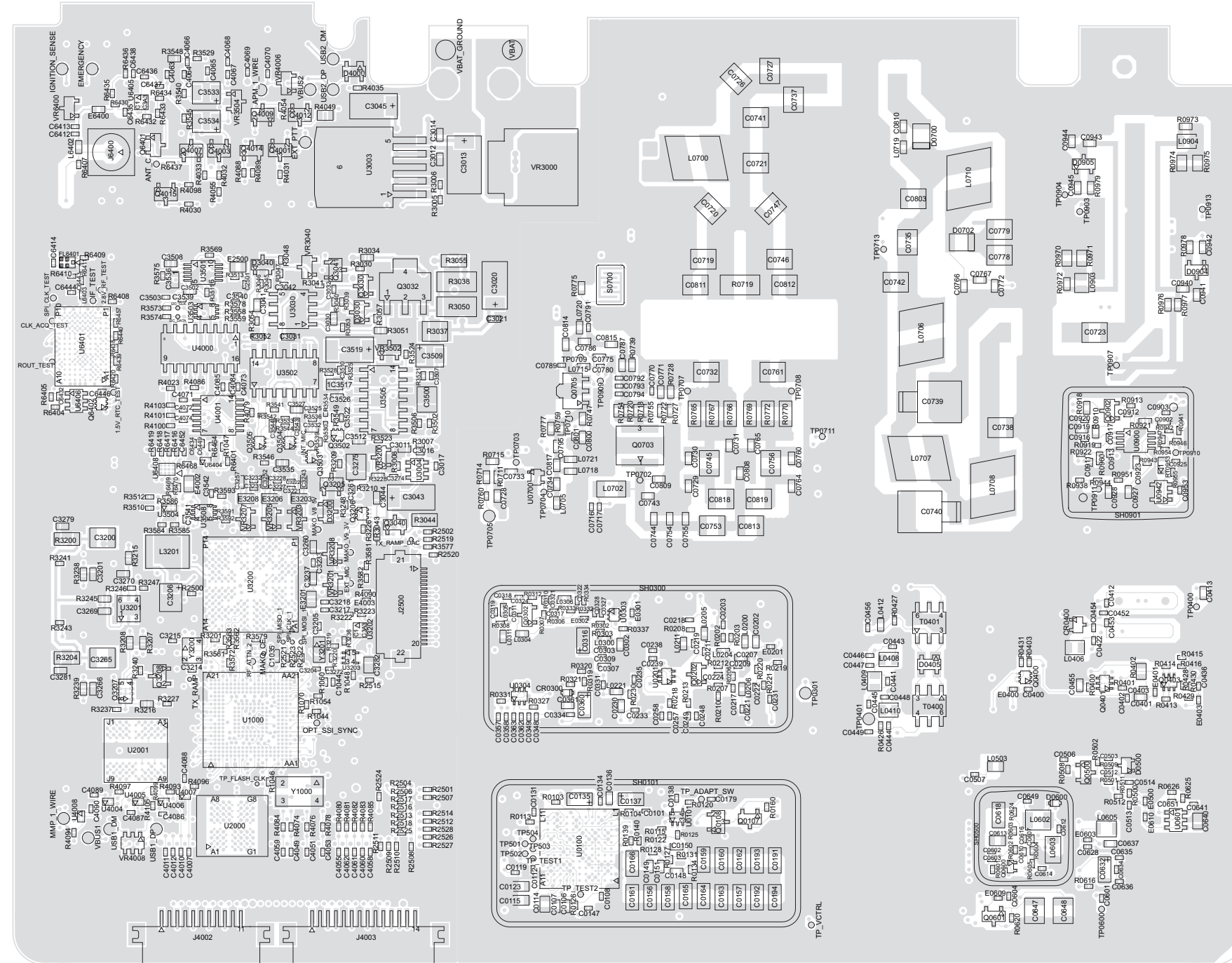
PCB:	
8486777Z12 Main Board Top Side	Page 3-3
8486777Z12 Main Board Bottom Side	Page 3-4
8486777Z14 Main Board Top Side	Page 3-5
8486777Z14 Main Board Bottom Side	Page 3-6
SCHEMATICS	
Overall	Page 3-7
Receiver Front-End	Page 3-8
Receiver IF Amp	Page 3-9
Receiver Back-End	Page 3-10
Power Amplifier	Page 3-11
Power Control	Page 3-12
Synthesizer	Page 3-13
Receiver VCO	Page 3-14
Transmit VCO	Page 3-15
Parts List	
8486777Z12 and 8486777Z14	Page 3-16

Notes

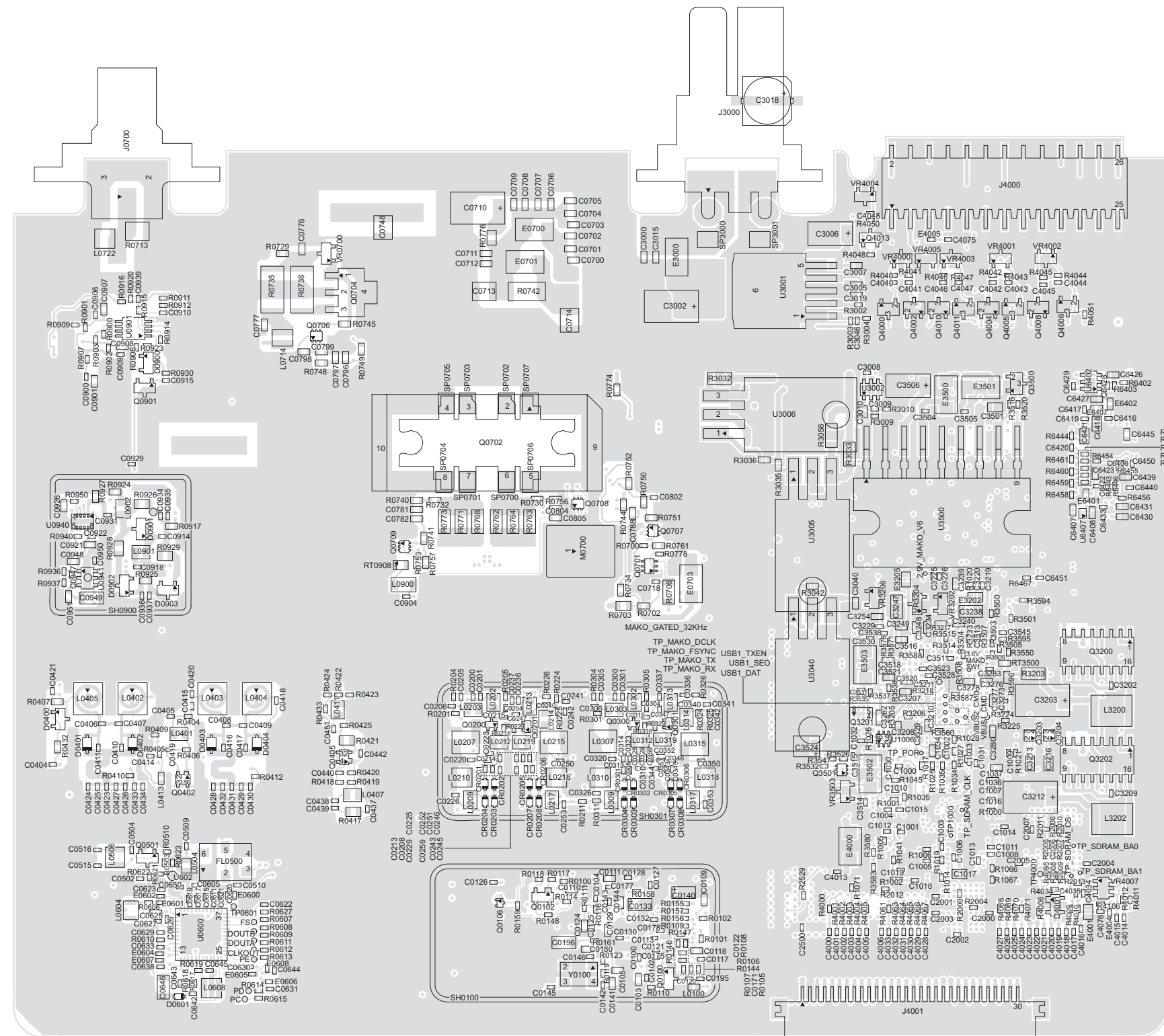
2.0 UHF1 (403-470 MHz) 25 - 40W PCB / Schematics / Parts List



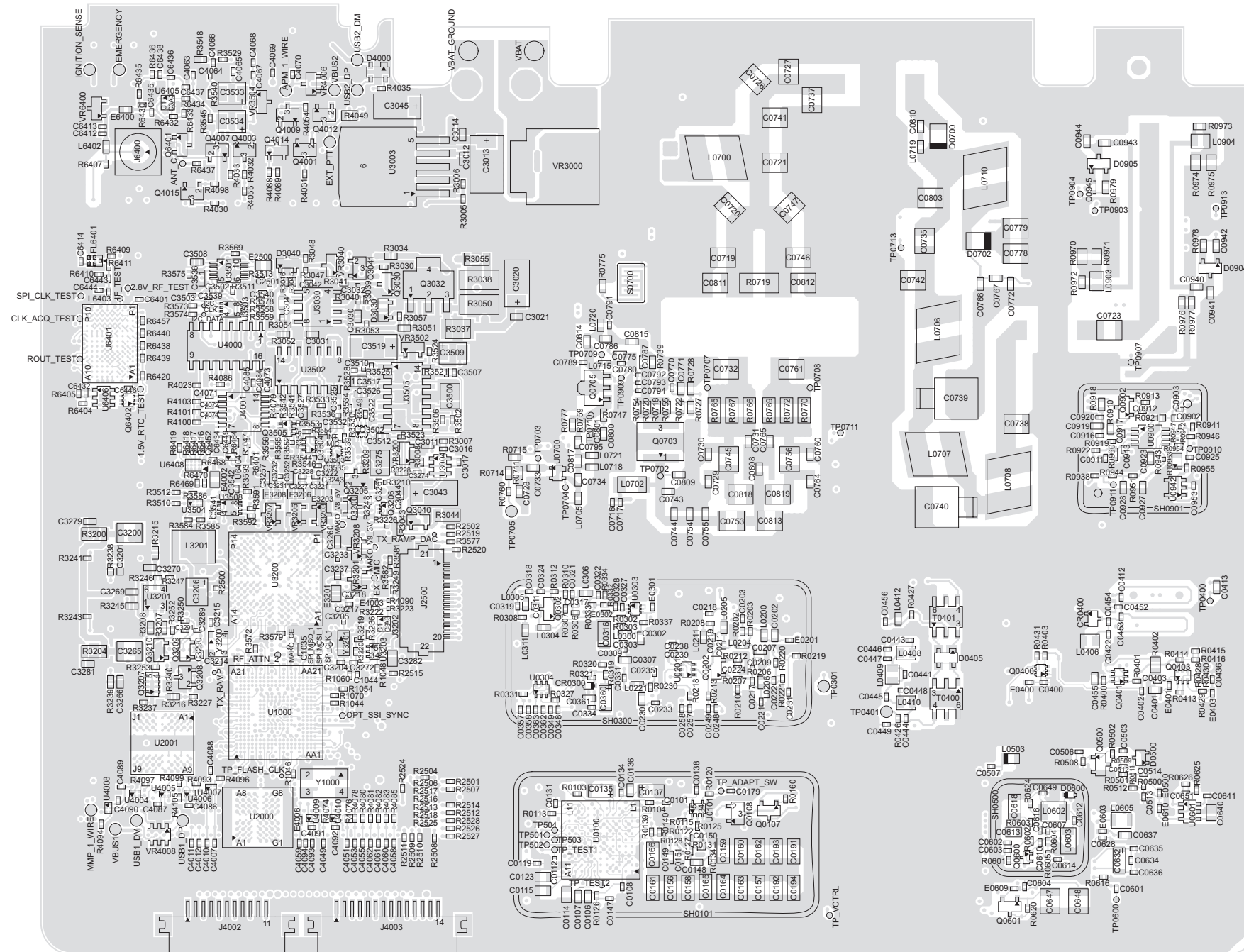
UHF1 (403-470 MHz) 25-40W 8486777Z12 Top Side



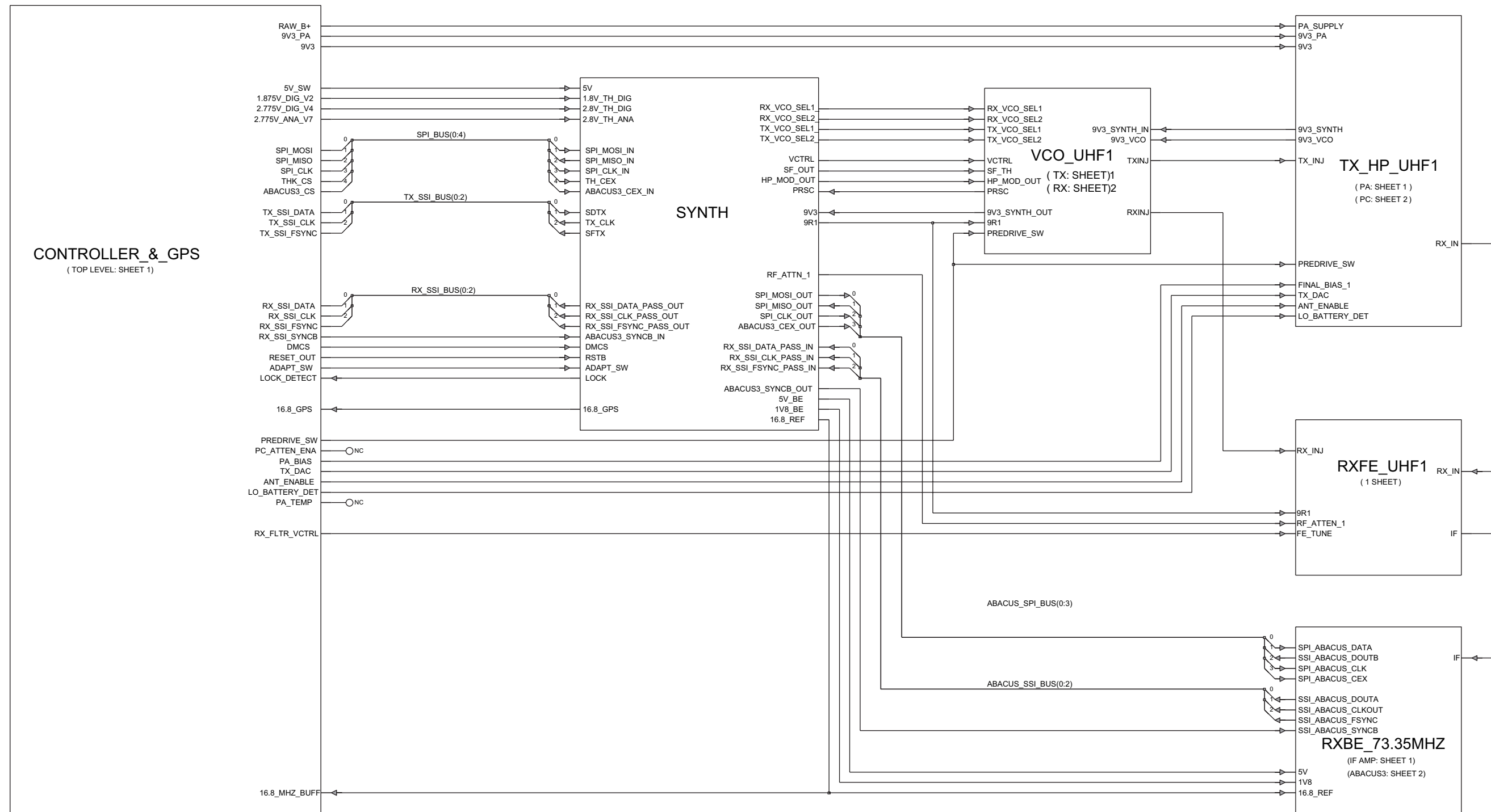
UHF1 (403-470 MHz) 25-40W 8486777Z12 Bottom Side



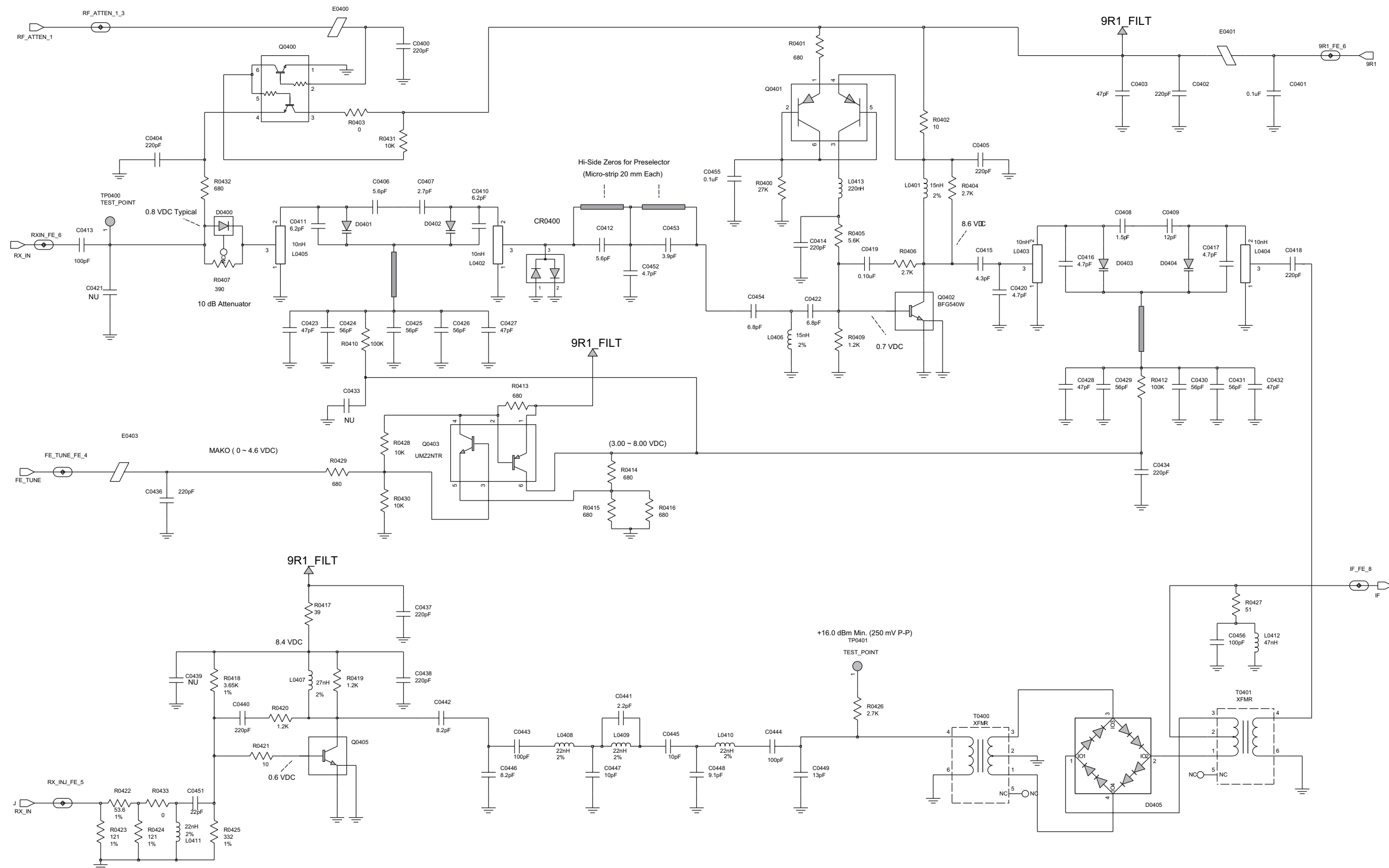
UHF1 (403-470 MHz) 25-40W 8486777Z14 Top Side



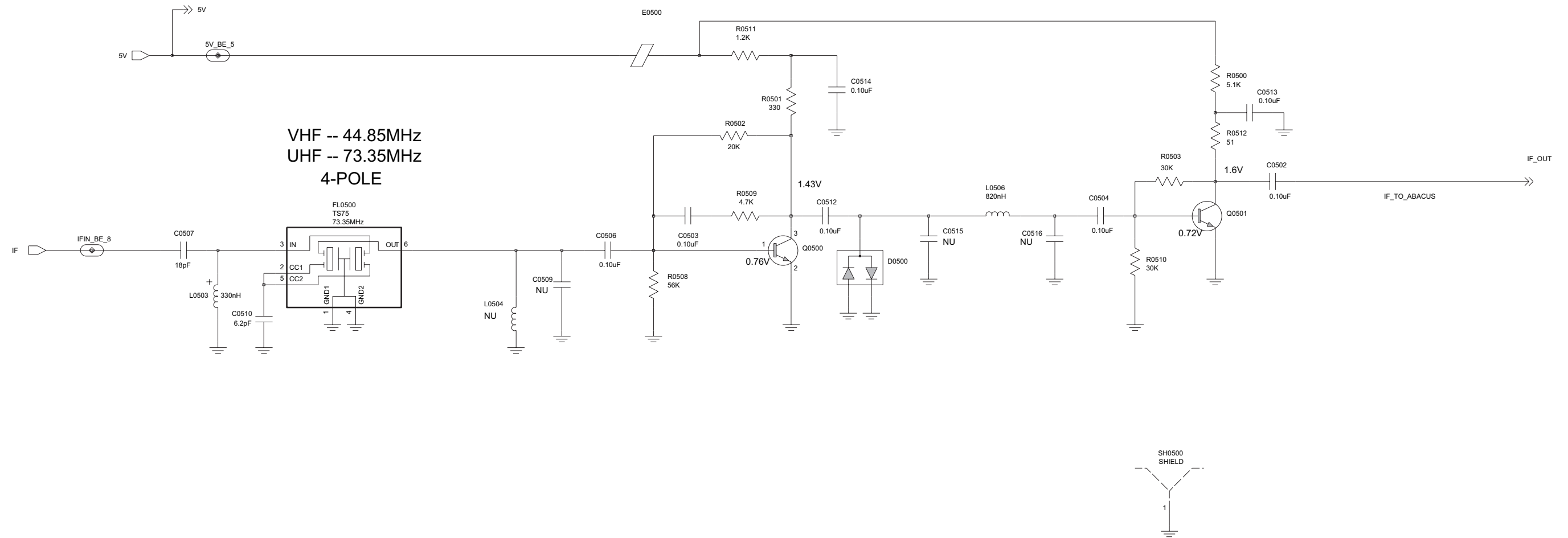
UHF1 (403-470 MHz) 25-40W 8486777Z14 Bottom side



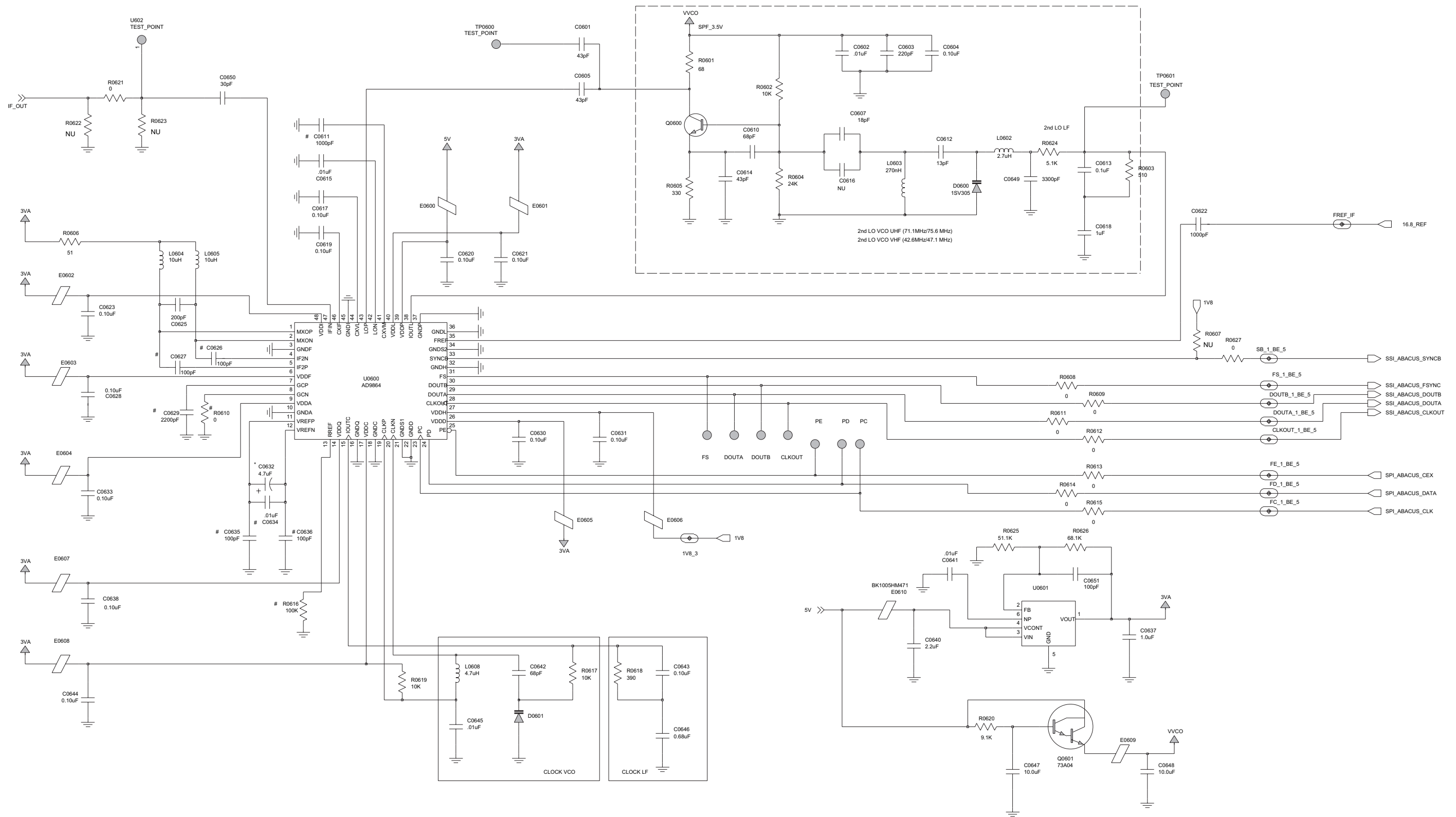
UHF1 (403-470 MHz) 25-40W Overall Schematic Diagram



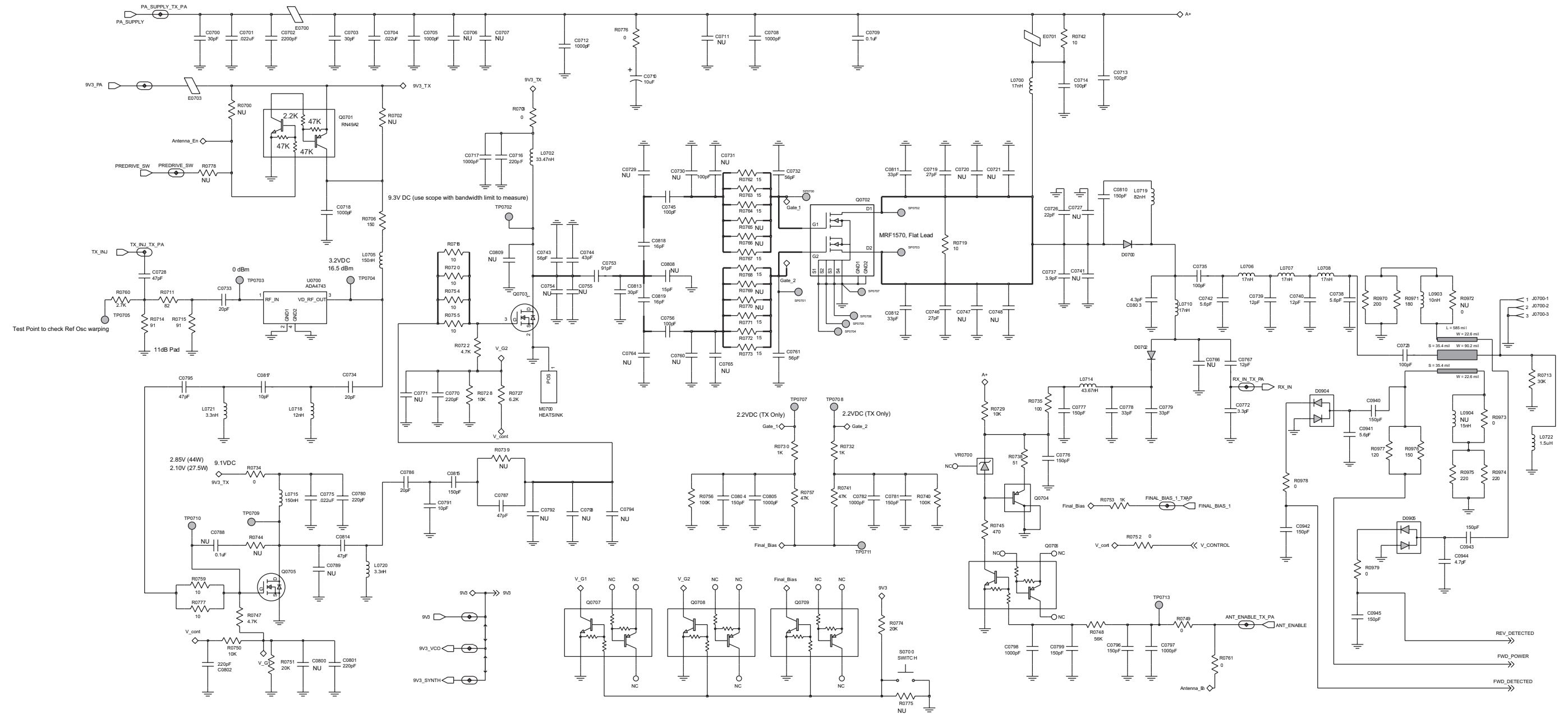
UHF1 (403-470 MHz) 25-40W Receiver Front-End Schematic Diagram



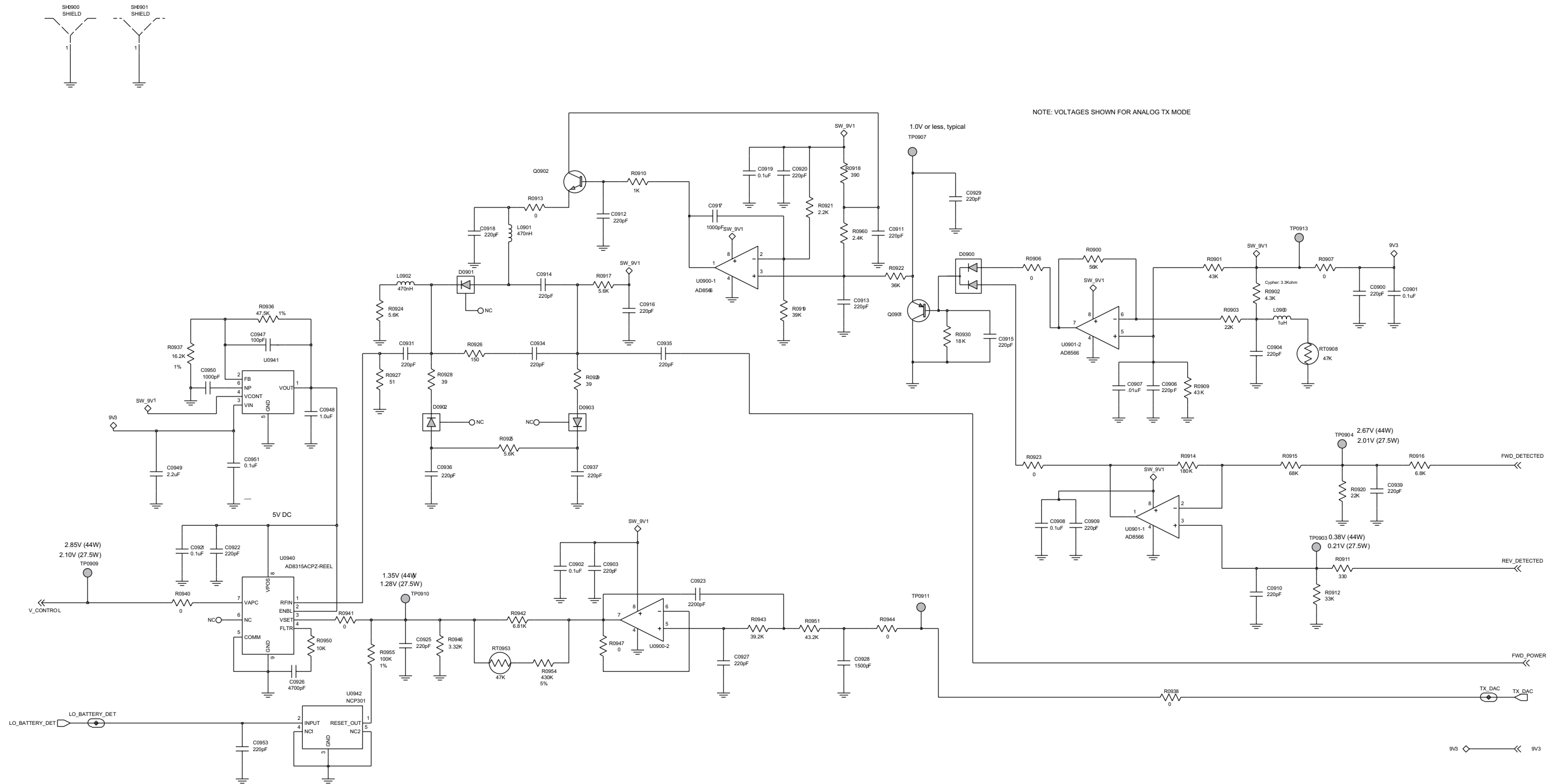
UHF1 (403-470 MHz) 25-40W Receiver IF Amp Schematic Diagram



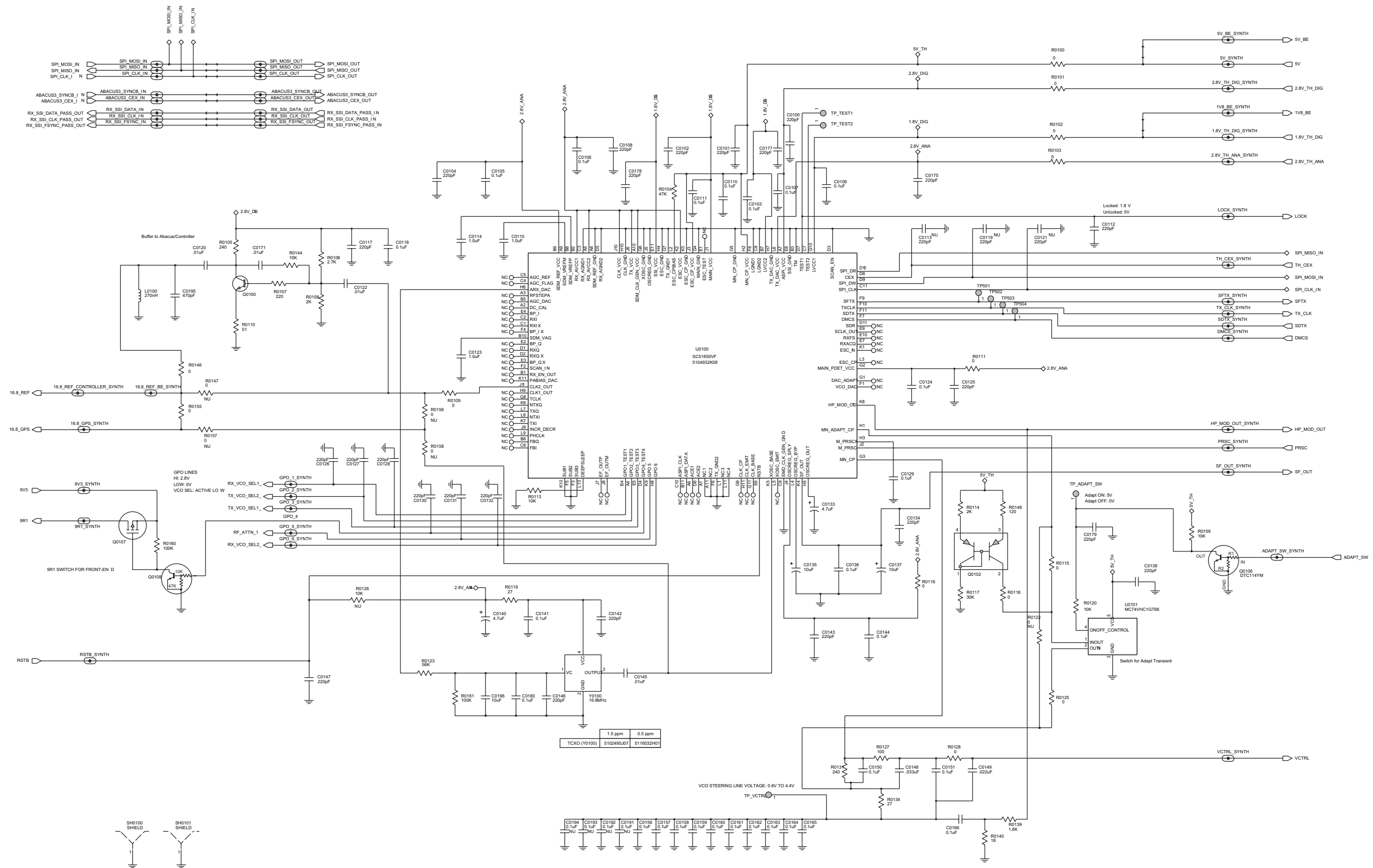
UHF1 (403-470 MHz) 25-40W Receiver Back-End Schematic Diagram



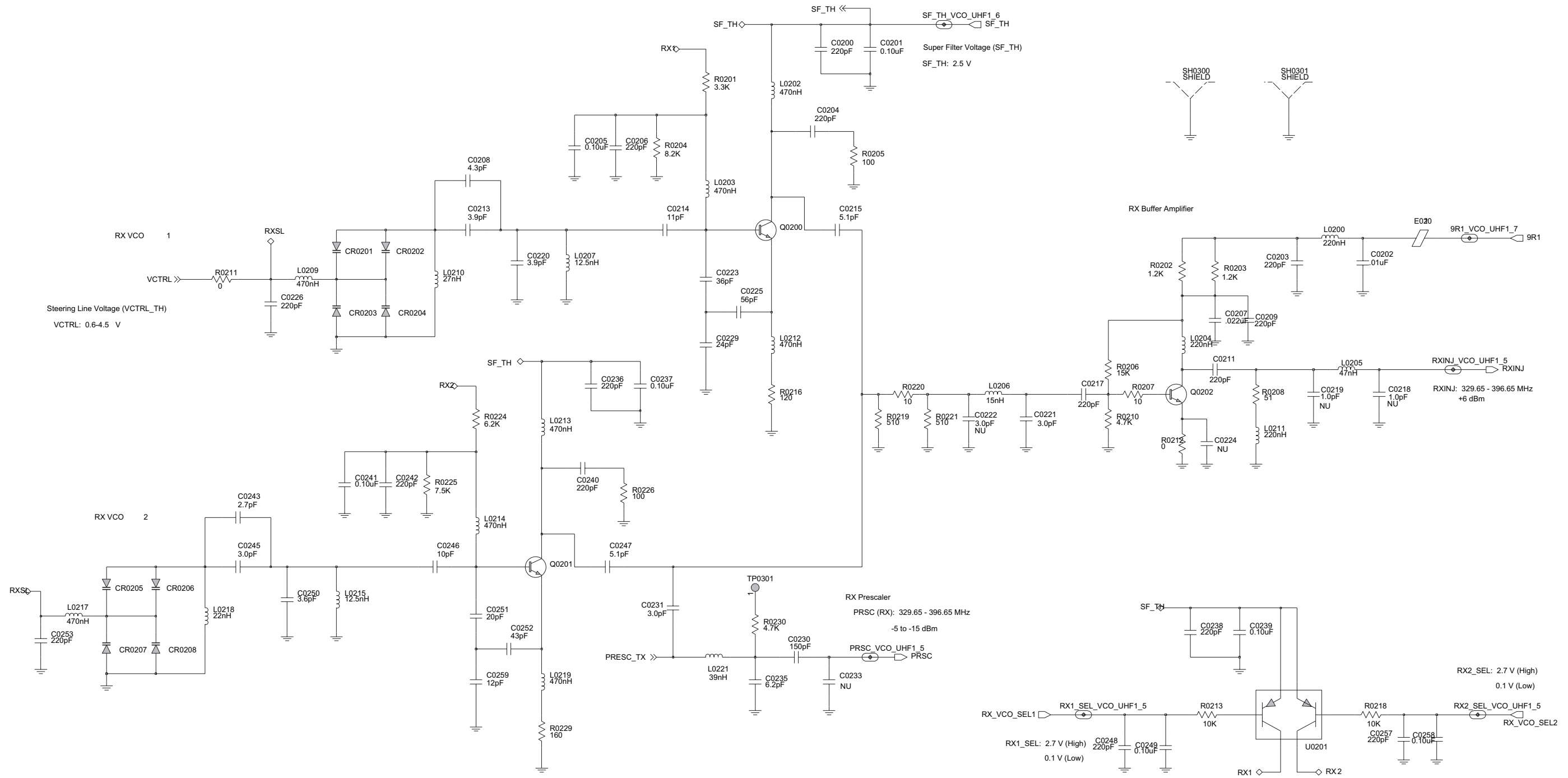
UHF1 (403-470 MHz) 25-40W Power Amplifier Schematic Diagram



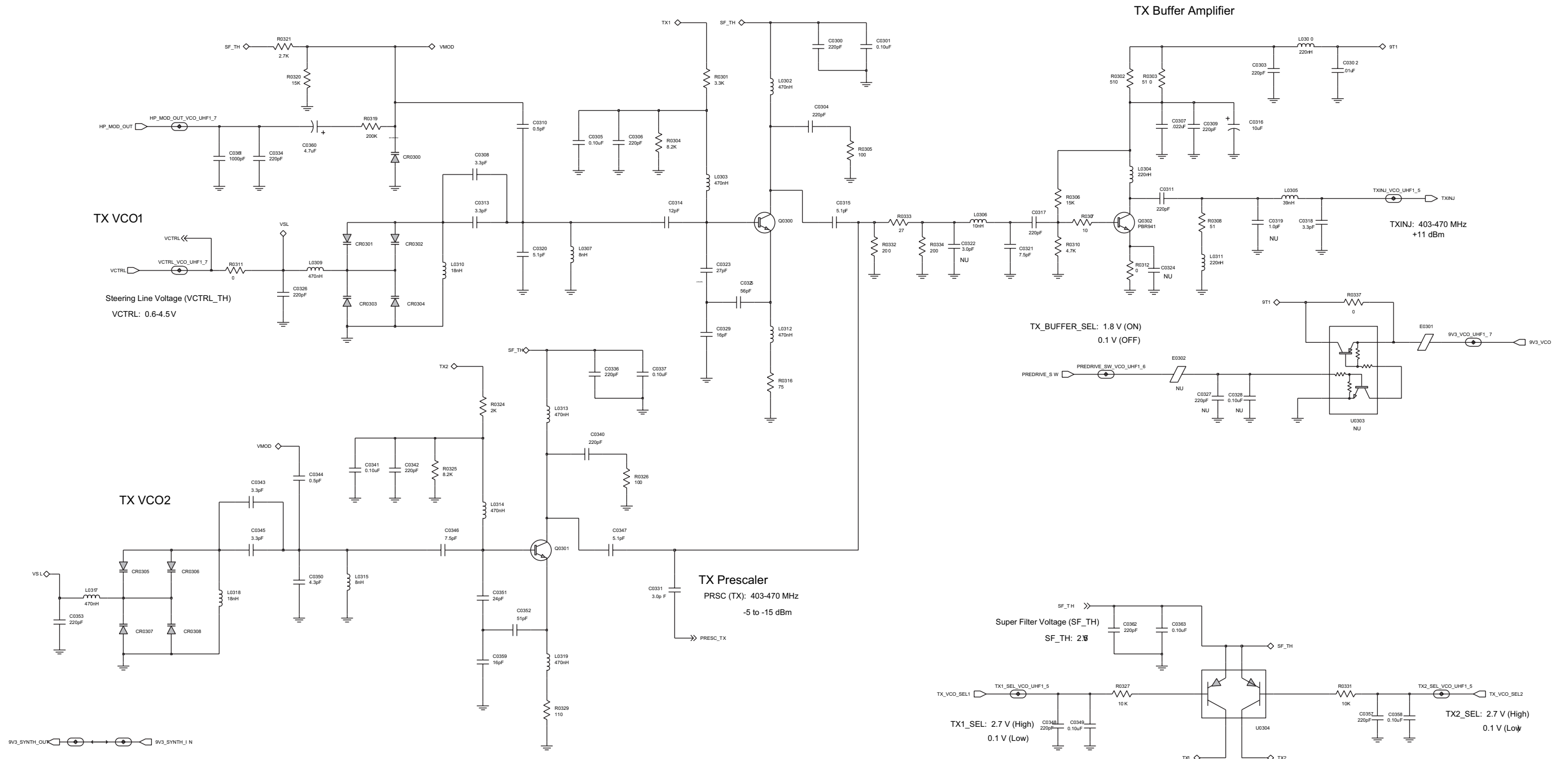
UHF1 (403-470 MHz) 25-40W Power Control Schematic Diagram



UHF1 (403-470 MHz) 25-40W Synthesizer Schematic Diagram



UHF1 (403-470 MHz) 25-40W Receiver VCO Schematic Diagram



UHF1 (403-470 MHz) 25-40W Transmit VCO Schematic Diagram

**UHF1 PCB 848677Z12 and 848677Z14 Parts
List 25-40W**

Circuit Ref	Motorola Part No.	Description
C0100	2113944A44	220pF
C0101	2113944A44	220pF
C0102	2113944A44	220pF
C0103	2113945C31	0.1uF
C0104	2113944A44	220pF
C0105	2113945C31	0.1uF
C0106	2113945C31	0.1uF
C0107	2113945C31	0.1uF
C0108	2113944A44	220pF
C0109	2113945C31	0.1uF
C0110	2113945C31	0.1uF
C0111	2113945C31	0.1uF
C0112	2113944A44	220pF
C0113	NOT PLACED	
C0114	2113946E02	1.0uF
C0115	2113946E02	1.0uF
C0117	2113944A44	220pF
C0118	2113945C31	0.1uF
C0119	NOT PLACED	
C0120	2113945B02	.01uF
C0121	NOT PLACED	
C0122	2113945B02	.01uF
C0123	2113946E02	1.0uF
C0124	2113945C31	0.1uF
C0125	2113944A44	220pF
C0126	2113944A44	220pF
C0127	2113944A44	220pF
C0128	2113944A44	220pF
C0129	2113945C31	0.1uF
C0130	2113944A44	220pF
C0131	2113944A44	220pF
C0132	2113944A44	220pF
C0133	2313960B30	4.7uF
C0134	2113944A44	220pF
C0135	2313960B32	10uF
C0136	2113945C31	0.1uF
C0137	2313960B32	10uF
C0138	2113944A44	220pF
C0140	2313960B30	4.7uF
C0141	2113945C31	0.1uF
C0142	2113944A44	220pF
C0143	2113944A44	220pF
C0144	2113945C31	0.1uF
C0145	2113945B02	.01uF
C0146	2113944A44	220pF
C0147	2113944A44	220pF
C0148	2113945D01	.033uF
C0149	2113945C04	.022uF
C0150	2113945C31	0.1uF

Circuit Ref	Motorola Part No.	Description
C0151	2113945C31	0.1uF
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	2185419D06	0.1uF
C0171	2113945B02	.01uF
C0175	2113944A44	220pF
C0177	2113944A44	220pF
C0178	2113944A44	220pF
C0179	2113944A44	220pF
C0180	2113945C31	0.1uF
C0191	NOT PLACED	
C0192	NOT PLACED	
C0193	NOT PLACED	
C0194	NOT PLACED	
C0195	2113945A05	470pF
C0196	2113946H02	10uF
C0200	2113944A44	220pF
C0201	2113945Y02	0.10uF
C0202	2113945C02	.01uF
C0203	2113944A44	220pF
C0204	2113944A44	220pF
C0205	2113945Y02	0.10uF
C0206	2113944A44	220pF
C0207	2113945C04	.022uF
C0208	2115153H18	4.3pF
C0209	2113944A44	220pF
C0211	2113944A44	220pF
C0213	2115153H17	3.9pF
C0214	2115153H34	11pF
C0215	2115153H20	5.1pF
C0217	2113944A44	220pF
C0218	NOT PLACED	
C0219	NOT PLACED	
C0220	2115153H17	3.9pF
C0221	2115153H14	3.0pF
C0222	NOT PLACED	
C0223	2115153H46	36pF
C0224	NOT PLACED	
C0225	2115153H51	56pF
C0226	2113944A44	220pF
C0229	2115153H42	24pF
C0230	2113944C47	150pF
C0231	2115153H14	3.0pF

Circuit Ref	Motorola Part No.	Description
C0233	NOT PLACED	
C0235	2115153H22	6.2pF
C0236	2113944A44	220pF
C0237	2113945Y02	0.10uF
C0238	2113944A44	220pF
C0239	2113945Y02	0.10uF
C0240	2113944A44	220pF
C0241	2113945Y02	0.10uF
C0242	2113944A44	220pF
C0243	2115153H13	2.7pF
C0245	2115153H14	3.0pF
C0246	2115153H27	10pF
C0247	2115153H20	5.1pF
C0248	2113944A44	220pF
C0249	2113945Y02	0.10uF
C0250	2115153H16	3.6pF
C0251	2115153H40	20pF
C0252	2115153H48	43pF
C0253	2113944A44	220pF
C0257	2113944A44	220pF
C0258	2113945Y02	0.10uF
C0259	2115153H35	12pF
C0300	2113944A44	220pF
C0301	2113945Y02	0.10uF
C0302	2113945C02	.01uF
C0303	2113944A44	220pF
C0304	2113944A44	220pF
C0305	2113945Y02	0.10uF
C0306	2113944A44	220pF
C0307	2113945C04	.022uF
C0308	2115153H15	3.3pF
C0309	2113944A44	220pF
C0310	2115153H01	0.5pF
C0311	2113944A44	220pF
C0313	2115153H15	3.3pF
C0314	2115153H35	12pF
C0315	2115153H20	5.1pF
C0316	2313960B32	10uF
C0317	2113944A44	220pF
C0318	2115153H15	3.3pF
C0319	NOT PLACED	
C0320	2115153H20	5.1pF
C0321	2115153H24	7.5pF
C0322	NOT PLACED	
C0323	2115153H43	27pF
C0324	NOT PLACED	
C0325	2115153H51	56pF
C0326	2113944A44	220pF
C0327	NOT PLACED	
C0328	NOT PLACED	
C0329	2115153H38	16pF

Circuit Ref	Motorola Part No.	Description
C0331	2115153H14	3.0pF
C0334	2113944A44	220pF
C0336	2113944A44	220pF
C0337	2113945Y02	0.10uF
C0340	2113944A44	220pF
C0341	2113945Y02	0.10uF
C0342	2113944A44	220pF
C0343	2115153H15	3.3pF
C0344	2115153H01	0.5pF
C0345	2115153H15	3.3pF
C0346	2115153H24	7.5pF
C0347	2115153H20	5.1pF
C0348	2113944A44	220pF
C0349	2113945Y02	0.10uF
C0350	2115153H18	4.3pF
C0351	2115153H42	24pF
C0352	2115153H50	51pF
C0353	2113944A44	220pF
C0357	2113944A44	220pF
C0358	2113945Y02	0.10uF
C0359	2115153H38	16pF
C0360	2313960B30	4.7uF
C0361	2113944C51	1000pF
C0362	2113944A44	220pF
C0363	2113945Y02	0.10uF
C0400	2113944A44	220pF
C0401	2113945C31	0.1uF
C0402	2113944A44	220pF
C0403	2115153H49	47pF
C0404	2113944A44	220pF
C0405	2113944A44	220pF
C0406	2115153H21	5.6pF
C0407	2115153H13	2.7pF
C0408	2115153H08	1.5pF
C0409	2115153H35	12pF
C0410	2115153H22	6.2pF
C0411	2115153H22	6.2pF
C0412	2115153H21	5.6pF
C0413	2113944C45	100pF
C0414	2113944A44	220pF
C0415	2115153H18	4.3pF
C0416	2115153H19	4.7pF
C0417	2115153H19	4.7pF
C0418	2113944A44	220pF
C0419	2113945Y02	0.10uF
C0420	2115153H19	4.7pF
C0421	NOT PLACED	
C0422	2115153H23	6.8pF
C0423	2115153H49	47pF
C0424	2115153H51	56pF
C0425	2115153H51	56pF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0426	2115153H51	56pF	C0614	2115153H48	43pF	C0716	2113944A44	220pF	C0787	2113944C38	47pF
C0427	2115153H49	47pF	C0615	2113945B02	.01uF	C0717	2113945A09	1000pF	C0788	NOT PLACED	
C0428	2115153H49	47pF	C0616	NOT PLACED		C0718	2113945A09	1000pF	C0789	NOT PLACED	
C0429	2115153H51	56pF	C0617	2113945Y02	0.10uF	C0719	2111078B25	27pF	C0791	2113944A25	10pF
C0430	2115153H51	56pF	C0618	2115358H25	1uF	C0720	NOT PLACED		C0792	NOT PLACED	
C0431	2115153H51	56pF	C0619	2113945Y02	0.10uF	C0721	NOT PLACED		C0793	NOT PLACED	
C0432	2115153H49	47pF	C0620	2113945Y02	0.10uF	C0723	2111078B42	100pF	C0794	NOT PLACED	
C0433	NOT PLACED		C0621	2113945Y02	0.10uF	C0726	2111078B22	22pF	C0795	2113944C38	47pF
C0434	2113944A44	220pF	C0622	2113945A09	1000pF	C0727	NOT PLACED		C0796	2113944C47	150pF
C0436	2113944A44	220pF	C0623	2113945Y02	0.10uF	C0728	2113944C38	47pF	C0797	2113944C51	1000pF
C0437	2113944A44	220pF	C0625	2113944C89	200pF	C0729	NOT PLACED		C0798	2113944C51	1000pF
C0438	2113944A44	220pF	C0626	2113944A40	100pF	C0730	NOT PLACED		C0799	2113944C47	150pF
C0439	NOT PLACED		C0627	2113944A40	100pF	C0731	NOT PLACED		C0800	NOT PLACED	
C0440	2113944A44	220pF	C0628	2113945Y02	0.10uF	C0732	2111078B36	56pF	C0801	2113944A44	220pF
C0441	2115153H11	2.2pF	C0629	2113945A11	2200pF	C0733	2113944C80	20pF	C0802	2113944A44	220pF
C0442	2115153H25	8.2pF	C0630	2113945Y02	0.10uF	C0734	2113944C80	20pF	C0803	2111078B04	4.3pF
C0443	2115153H57	100pF	C0631	2113945Y02	0.10uF	C0735	2111078B42	100pF	C0804	2113944C47	150pF
C0444	2115153H57	100pF	C0632	2313960B30	4.7uF	C0737	2111078B03	3.9pF	C0805	2113944C51	1000pF
C0445	2115153H27	10pF	C0633	2113945Y02	0.10uF	C0738	2111078B07	5.6pF	C0808	NOT PLACED	
C0446	2115153H25	8.2pF	C0634	2113945B02	.01uF	C0739	2171388L01	12pF	C0809	NOT PLACED	
C0447	2115153H27	10pF	C0635	2113944A40	100pF	C0740	2171388L01	12pF	C0810	2113944C47	150pF
C0448	2115153H26	9.1pF	C0636	2113944A40	100pF	C0741	NOT PLACED		C0811	2111078B29	33pF
C0449	2115153H36	13pF	C0637	2113946S35	1.0uF	C0742	2111078B07	5.6pF	C0812	2111078B29	33pF
C0451	2115153H41	22pF	C0638	2113945Y02	0.10uF	C0743	2113944C39	56pF	C0813	2111078B27	30pF
C0452	2115153H19	4.7pF	C0640	2113946N03	2.2uF	C0744	2113944C84	43pF	C0814	2113944C38	47pF
C0453	2115153H17	3.9pF	C0641	2113945B02	.01uF	C0745	2111078B42	100pF	C0815	2113944C47	150pF
C0454	2115153H23	6.8pF	C0642	2115153H53	68pF	C0746	2111078B25	27pF	C0817	2113944C30	10pF
C0455	2113945C31	0.1uF	C0643	2113945Y02	0.10uF	C0747	NOT PLACED		C0818	2111078B19	16pF
C0456	2113944A40	100pF	C0644	2113945Y02	0.10uF	C0748	NOT PLACED		C0819	2111078B19	16pF
C0502	2113945Y02	0.10uF	C0645	2113945B02	.01uF	C0753	2111078B41	91pF	C0900	2113944A44	220pF
C0503	2113945Y02	0.10uF	C0646	2113946G04	0.68uF	C0754	NOT PLACED		C0901	2113945C31	0.1uF
C0504	2113945Y02	0.10uF	C0647	2113946J03	10.0uF	C0755	NOT PLACED		C0902	2113945C31	0.1uF
C0506	2113945Y02	0.10uF	C0648	2113946J03	10.0uF	C0756	2111078B42	100pF	C0903	2113944A44	220pF
C0507	2115153H39	18pF	C0649	2113945A12	3300pF	C0760	NOT PLACED		C0904	2113944A44	220pF
C0509	NOT PLACED		C0650	2115153H44	30pF	C0761	2111078B36	56pF	C0906	2113944A44	220pF
C0510	2115153H22	6.2pF	C0651	2115153H57	100pF	C0764	NOT PLACED		C0907	2113945C02	.01uF
C0512	2113945Y02	0.10uF	C0700	2113944C82	30pF	C0765	NOT PLACED		C0908	2113945C31	0.1uF
C0513	2113945Y02	0.10uF	C0701	2113945C04	.022uF	C0766	NOT PLACED		C0909	2113944A44	220pF
C0514	2113945Y02	0.10uF	C0702	2113944C55	2200pF	C0767	2113944C31	12pF	C0910	2113944A44	220pF
C0515	NOT PLACED		C0703	2113944C82	30pF	C0770	2113944A44	220pF	C0911	2113944A44	220pF
C0516	NOT PLACED		C0704	2113945C04	.022uF	C0771	NOT PLACED		C0912	2113944A44	220pF
C0601	2115153H48	43pF	C0705	2113944C51	1000pF	C0772	2113944C18	3.3pF	C0913	2113944A44	220pF
C0602	2113945B02	.01uF	C0706	NOT PLACED		C0775	2113945C04	.022uF	C0914	2113944A44	220pF
C0603	2113944A44	220pF	C0707	NOT PLACED		C0776	2113944C47	150pF	C0915	2113944A44	220pF
C0604	2113945Y02	0.10uF	C0708	2113944C51	1000pF	C0777	2113944C47	150pF	C0916	2113944A44	220pF
C0605	2115153H48	43pF	C0709	2113945C31	0.1uF	C0778	2111078B29	33pF	C0917	2113945A09	1000pF
C0607	2115153H39	18pF	C0710	2371403L02	10uF	C0779	2111078B29	33pF	C0918	2113944A44	220pF
C0610	2115153H53	68pF	C0711	NOT PLACED		C0780	2113944A44	220pF	C0919	2113945C31	0.1uF
C0611	2113945A09	1000pF	C0712	2113944C51	1000pF	C0781	2113944C47	150pF	C0920	2113944A44	220pF
C0612	2115153H36	13pF	C0713	2111078B42	100pF	C0782	2113944C51	1000pF	C0921	2113945C31	0.1uF
C0613	2113945G91	0.1uF	C0714	2111078B42	100pF	C0786	2113944C80	20pF	C0922	2113944A44	220pF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0923	2113944C55	2200pF	D0700	4802482J02	DIODE, PIN	L0302	2414032F42	470nH	L0900	2414032D30	1uH
C0925	2113944A44	220pF	D0702	4802482J02	DIODE, PIN	L0303	2414032F42	470nH	L0901	2414032F42	470nH
C0926	2113945L41	4700pF	D0900	4813978C02	DIODE, SWITCHING	L0304	2414017N28	220nH	L0902	2414032F42	470nH
C0927	2113944C02	220pF	D0901	4815023H01	DIODE, PIN	L0305	2414017N19	39nH	L0903	2414032F66	10nH
C0928	2113944C53	1500pF	D0902	4815024H01	DIODE, PIN	L0306	2414017N12	10nH	L0904	NOT PLACED	
C0929	2113944A44	220pF	D0903	4815024H01	DIODE, PIN	L0307	2415385H01	8nH	M0700	2686201B02	HEATSINK
C0931	2113944A44	220pF	D0904	4813974A21	DIODE, SCHOTTKY	L0309	2414032F42	470nH	Q0100	4802197J95	NPN RF TRANSISTOR
C0934	2113944A44	220pF	D0905	4813974A21	DIODE, SCHOTTKY	L0310	2414015A32	18nH	Q0102	4815359H01	DUAL PNP
C0935	2113944A44	220pF	E0201	2409134J25	FERRITE BEAD	L0311	2414017N28	220nH	Q0106	4816134H01	ANALOG SWITCH
C0936	2113944A44	220pF	E0301	2409134J25	FERRITE BEAD	L0312	2414032F42	470nH	Q0107	4813970A59	P-CHANNEL MOSFET
C0937	2113944A44	220pF	E0302	NOT PLACED		L0313	2414032F42	470nH	Q0108	4815261H01	ANALOG SWITCH
C0939	2113944A44	220pF	E0400	2409134J25	FERRITE BEAD	L0314	2414032F42	470nH	Q0200	4805793Y10	NPN RF TRANSISTOR
C0940	2113944C47	150pF	E0401	2409134J25	FERRITE BEAD	L0315	2415385H01	8nH	Q0201	4805793Y10	NPN RF TRANSISTOR
C0941	2113944M12	5.6pF	E0403	2409134J25	FERRITE BEAD	L0317	2414032F42	470nH	Q0202	4802197J95	NPN RF TRANSISTOR
C0942	2113944C47	150pF	E0500	2409134J25	FERRITE BEAD	L0318	2414015A32	18nH	Q0300	4805793Y10	NPN RF TRANSISTOR
C0943	2113944C47	150pF	E0600	2409134J25	FERRITE BEAD	L0319	2414032F42	470nH	Q0301	4805793Y10	NPN RF TRANSISTOR
C0944	2113944M10	4.7pF	E0601	2409134J25	FERRITE BEAD	L0401	2414015B24	15nH	Q0302	4802197J95	NPN RF TRANSISTOR
C0945	2113944C47	150pF	E0602	2409134J25	FERRITE BEAD	L0402	NOT PLACED		Q0400	4815271H01	ANALOG SWITCH
C0947	2113944A40	100pF	E0603	2409134J25	FERRITE BEAD	L0403	NOT PLACED		Q0401	4815267H01	DUAL PNP
C0948	2113946S35	1.0uF	E0604	2409134J25	FERRITE BEAD	L0404	NOT PLACED		Q0402	4885593U03	NPN RF TRANSISTOR
C0949	2113946G01	2.2uF	E0605	2409134J25	FERRITE BEAD	L0405	NOT PLACED		Q0403	4815270H01	DUAL NPN/PNP
C0950	2113945A09	1000pF	E0606	2409134J25	FERRITE BEAD	L0406	2414015B24	15nH	Q0405	4885593U03	NPN RF TRANSISTOR
C0951	2113945C31	0.1uF	E0607	2409134J25	FERRITE BEAD	L0407	2414015B16	27nH	Q0500	4802197J95	NPN RF TRANSISTOR
C0953	2113944A44	220pF	E0608	2409134J25	FERRITE BEAD	L0408	2414015B15	22nH	Q0501	4802197J95	NPN RF TRANSISTOR
CR0201	4815096H01	DIODE VARACTOR 1SV305	E0609	2409134J25	FERRITE BEAD	L0409	2414015B15	22nH	Q0600	4805793Y10	NPN RF TRANSISTOR
CR0202	4815096H01	DIODE VARACTOR 1SV305	E0610	2480640Z01	FERRITE BEAD	L0410	2414015B15	22nH	Q0601	4813973A04	NPN DARLINGTON
CR0203	4815096H01	DIODE VARACTOR 1SV305	E0700	2485011Y01	FERRITE BEAD	L0411	2414015B15	22nH	Q0701	4816013H01	DUAL NPN/PNP
CR0204	4815096H01	DIODE VARACTOR 1SV305	E0701	2485011Y01	FERRITE BEAD	L0412	2414017N20	47nH	Q0702	0105958T75	MRF1570 PA ASSEMBLY
CR0205	4815096H01	DIODE VARACTOR 1SV305	E0703	2485011Y01	FERRITE BEAD	L0413	2414017N28	220nH	Q0703	4816548H01	N-CHANNEL LDMOS DRIVER
CR0206	4815096H01	DIODE VARACTOR 1SV305	FL0500	9116854H01	73.35MHZ CRYSTAL FILTER	L0503	2414017K29	330nH	Q0704	4813973B02	PNP
CR0207	4815096H01	DIODE VARACTOR 1SV305	J0700	0905901V12	BNC RF CONNECTOR	L0504	NOT PLACED		Q0705	4816547H01	N-CHANNEL LDMOS PRE-DRIVER
CR0208	4815096H01	DIODE VARACTOR 1SV305	L0100	2414017N29	270nH	L0506	2414032B66	820nH	Q0706	4815272H01	ANALOG SWITCH
CR0300	4815096H01	DIODE VARACTOR 1SV305	L0200	2414017N28	220nH	L0602	2414032K23	2.7uH	Q0707	4815272H01	ANALOG SWITCH
CR0301	4815096H01	DIODE VARACTOR 1SV305	L0202	2414032F42	470nH	L0603	2414032D20	270nH	Q0708	4815272H01	ANALOG SWITCH
CR0302	4815096H01	DIODE VARACTOR 1SV305	L0203	2414032F42	470nH	L0604	2466505A01	10uH	Q0709	4815272H01	ANALOG SWITCH
CR0303	4815096H01	DIODE VARACTOR 1SV305	L0204	2414017N28	220nH	L0605	2466505A01	10uH	Q0901	4813973A13	PNP
CR0304	4815096H01	DIODE VARACTOR 1SV305	L0205	2414017N20	47nH	L0608	2414032B76	4.7uH	Q0902	4813973M07	NPN
CR0305	4815096H01	DIODE VARACTOR 1SV305	L0206	2414017N14	15nH	L0700	2460592A01	17nH	R0100	0613952R66	0
CR0306	4815096H01	DIODE VARACTOR 1SV305	L0207	2415385H02	12.5nH	L0702	2479990G01	33.47nH	R0101	0613952R66	0
CR0307	4815096H01	DIODE VARACTOR 1SV305	L0209	2414032F42	470nH	L0705	2414017N26	150nH	R0102	0613952R66	0
CR0308	4815096H01	DIODE VARACTOR 1SV305	L0210	2414015A21	27nH	L0706	2460592A01	17nH	R0103	0613952R66	0
CR0400	4813974A19	DIODE, SCHOTTKY	L0211	2414017N28	220nH	L0707	2460592A01	17nH	R0104	0613952R17	47K
D0400	4813974A06	DIODE, PIN	L0212	2414032F42	470nH	L0708	2460592A01	17nH	R0105	0613952Q58	240
D0401	4885055Y01	DIODE VARACTOR 1SV229	L0213	2414032F42	470nH	L0710	2460592A01	17nH	R0106	0613952Q83	2.7K
D0402	4885055Y01	DIODE VARACTOR 1SV229	L0214	2414032F42	470nH	L0714	2479990N01	43.67nH	R0107	0613952Q57	220
D0403	4885055Y01	DIODE VARACTOR 1SV229	L0215	2415385H02	12.5nH	L0715	2414017N26	150nH	R0108	0613952Q80	2K
D0404	4885055Y01	DIODE VARACTOR 1SV229	L0217	2414032F42	470nH	L0718	2414017N13	12nH	R0109	0613952R66	0
D0405	4815090H01	DIODE, MIXER	L0218	2414015A20	22nH	L0719	2414017N23	82nH	R0110	0613952Q42	51
D0500	4813974A19	DIODE, SCHOTTKY	L0219	2414032F42	470nH	L0720	2414017N06	3.3nH	R0111	0613952R66	0
D0600	4815096H01	DIODE VARACTOR 1SV305	L0221	2414017N19	39nH	L0721	2414017N06	3.3nH	R0113	0613952R01	10K
D0601	4815096H01	DIODE VARACTOR 1SV305	L0300	2414017N28	220nH	L0722	2414032B70	1.5uH			

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
R0114	0613952Q80	2K	R0302	0613952Q66	510	R0429	0613952Q69	680	R0720	0613952H25	10
R0115	0613952R66	0	R0303	0613952Q66	510	R0430	0613952R01	10K	R0722	0613952H89	4.7K
R0116	0613952R66	0	R0304	0613952Q95	8.2K	R0431	0613952R01	10K	R0727	0613952H92	6.2K
R0117	0613952R12	30K	R0305	0613952Q49	100	R0432	0613952H69	680	R0728	0613952J01	10K
R0118	0613952R66	0	R0306	0613952R05	15K	R0433	0613952R66	0	R0729	0613952J01	10K
R0119	0613952Q35	27	R0307	0613952Q25	10	R0500	0613952Q90	5.1K	R0730	0613952H73	1K
R0120	0613952R01	10K	R0308	0613952Q42	51	R0501	0613952Q61	330	R0732	0613952H73	1K
R0122	NOT PLACED		R0310	0613952Q89	4.7K	R0502	0613952R08	20K	R0734	0613952G67	0
R0123	0613952R19	56K	R0311	0613952R66	0	R0503	0613952R12	30K	R0735	0613959Y49	100
R0125	0613952R66	0	R0312	0613952R66	0	R0508	0613952R19	56K	R0738	0613959Y42	51
R0126	NOT PLACED		R0316	0613952Q46	75	R0509	0613952Q89	4.7K	R0739	NOT PLACED	
R0127	0613952Q49	100	R0319	0613952R32	200K	R0510	0613952R12	30K	R0740	0613952J25	100K
R0128	0613952R66	0	R0320	0613952R05	15K	R0511	0613952Q75	1.2K	R0741	0613952J17	47K
R0131	0613952Q58	240	R0321	0613952Q83	2.7K	R0512	0613952Q42	51	R0742	0613959Q25	10
R0134	0613952Q35	27	R0324	0613952Q80	2K	R0601	0613952Q45	68	R0744	NOT PLACED	
R0139	0613952Q78	1.6K	R0325	0613952Q95	8.2K	R0602	0613952R01	10K	R0745	0613952H65	470
R0140	0613952Q31	18	R0326	0613952Q49	100	R0603	0613952Q66	510	R0747	0613952H89	4.7K
R0144	0613952R01	10K	R0327	0613952R01	10K	R0604	0613952R10	24K	R0748	0613952J19	56K
R0146	0613952R66	0	R0329	0613952Q50	110	R0605	0613952Q61	330	R0749	0613952G67	0
R0147	NOT PLACED		R0331	0613952R01	10K	R0606	0613952Q42	51	R0750	0613952J01	10K
R0148	0613952Q51	120	R0332	0613952Q56	200	R0607	NOT PLACED		R0751	0613952J08	20K
R0155	0613952R66	0	R0333	0613952Q35	27	R0608	0613952R66	0	R0752	0613952G67	0
R0156	NOT PLACED		R0334	0613952Q56	200	R0609	0613952R66	0	R0753	0613952H73	1K
R0157	NOT PLACED		R0337	0613952R66	0	R0610	0613952R66	0	R0754	0613952H25	10
R0158	NOT PLACED		R0400	0613952R11	27K	R0611	0613952R66	0	R0755	0613952H25	10
R0159	0613952R01	10K	R0401	0613952Q69	680	R0612	0613952R66	0	R0756	0613952J25	100K
R0160	0613952R25	100K	R0402	0613958H25	10	R0613	0613952R66	0	R0757	0613952J17	47K
R0161	0613952R25	100K	R0403	0613952R66	0	R0614	0613952R66	0	R0759	0613952H25	10
R0201	0613952Q85	3.3K	R0404	0613952Q83	2.7K	R0615	0613952R66	0	R0760	0613952Q83	2.7K
R0202	0613952Q75	1.2K	R0405	0613952Q91	5.6K	R0616	0613952R25	100K	R0761	0613952G67	0
R0203	0613952Q75	1.2K	R0406	0613952Q83	2.7K	R0617	0613952R01	10K	R0762	0613958S29	15
R0204	0613952Q95	8.2K	R0407	0613952H63	390	R0618	0613952Q63	390	R0763	0613958S29	15
R0205	0613952Q49	100	R0409	0613952Q75	1.2K	R0619	0613952R01	10K	R0764	0613958S29	15
R0206	0613952R05	15K	R0410	0613952R25	100K	R0620	0613952Q96	9.1K	R0765	NOT PLACED	
R0207	0613952Q25	10	R0412	0613952R25	100K	R0621	0613952R66	0	R0766	NOT PLACED	
R0208	0613952Q42	51	R0413	0613952Q69	680	R0622	NOT PLACED		R0767	0613958S29	15
R0210	0613952Q89	4.7K	R0414	0613952Q69	680	R0623	NOT PLACED		R0768	0613958S29	15
R0211	0613952R66	0	R0415	0613952Q69	680	R0624	0613952Q90	5.1K	R0769	NOT PLACED	
R0212	0613952R66	0	R0416	0613952Q69	680	R0625	0613952N69	51.1K	R0770	NOT PLACED	
R0213	0613952R01	10K	R0417	0613958H39	39	R0626	0613952N81	68.1K	R0771	0613958S29	15
R0216	0613952Q51	120	R0418	0613952M55	3.65K	R0627	0613952R66	0	R0772	0613958S29	15
R0218	0613952R01	10K	R0419	0613952Q75	1.2K	R0700	NOT PLACED		R0773	0613958S29	15
R0219	0613952Q66	510	R0420	0613952Q75	1.2K	R0702	NOT PLACED		R0774	0613952J08	20K
R0220	0613952Q25	10	R0421	0613958H25	10	R0703	0613958J74	0	R0775	NOT PLACED	
R0221	0613952Q66	510	R0422	0613952K71	53.6	R0706	0613958S53	150	R0776	0613958J74	0
R0224	0613952Q92	6.2K	R0423	0613952L09	121	R0711	0613952H47	82	R0777	0613952H25	10
R0225	0613952Q94	7.5K	R0424	0613952L09	121	R0713	0613959H12	30K	R0778	NOT PLACED	
R0226	0613952Q49	100	R0425	0613952L51	332	R0714	0613952H48	91	R0900	0613952R19	56K
R0229	0613952Q54	160	R0426	0613952Q83	2.7K	R0715	0613952H48	91	R0901	0613952R16	43K
R0230	0613952Q89	4.7K	R0427	0613952Q42	51	R0718	0613952H25	10	R0902	0613952Q88	4.3K
R0301	0613952Q85	3.3K	R0428	0613952R01	10K	R0719	0613959Q25	10	R0903	0613952R09	22K

Circuit Ref	Motorola Part No.	Description
R0906	0613952R66	0
R0907	0613952R66	0
R0909	0613952R16	43K
R0910	0613952H73	1K
R0911	0613952Q61	330
R0912	0613952R13	33K
R0913	0613952R66	0
R0914	0613952R31	180K
R0915	0613952R21	68K
R0916	0613952Q93	6.8K
R0917	0613952H91	5.6K
R0918	0613952H63	390
R0919	0613952R15	39K
R0920	0613952R09	22K
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
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
R0970	0613958H56	200
R0971	0613958H55	180
R0972	NOT PLACED	
R0973	0613952G67	0
R0974	0613958H57	220
R0975	0613958H57	220
R0976	0613952H53	150
R0977	0613952H51	120
R0978	0613952G67	0
R0979	0613952G67	0
RT0908	0615585H01	THERMISTOR, 47K
RT0953	0615585H01	THERMISTOR, 47K

Circuit Ref	Motorola Part No.	Description
SH0100	2615362H01	SHIELD
SH0101	2615362H01	SHIELD
SH0300	2615362H01	SHIELD
SH0301	2615362H01	SHIELD
SH0500	2615576H01	SHIELD
SH0900	2686423Z02	SHIELD
SH0901	2686425Z02	SHIELD
SP0700	1015349H01	SOLDER PREFORM
SP0701	1015349H01	SOLDER PREFORM
SP0702	1015349H01	SOLDER PREFORM
SP0703	1015349H01	SOLDER PREFORM
SP0704	1015349H01	SOLDER PREFORM
SP0705	1015349H01	SOLDER PREFORM
SP0706	1015349H01	SOLDER PREFORM
SP0707	1015349H01	SOLDER PREFORM
T0400	2515121H01	BALUN XFMR
T0401	2515121H01	BALUN XFMR
U0100	5104932K08	IC, FRACN SYNTHESIZER
U0101	5114000B59	ANALOG SWITCH
U0201	4815267H01	DUAL PNP
U0303	NOT PLACED	
U0304	4815267H01	DUAL PNP
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
VR0700	4813977M11	DIODE, 5.6V ZENER
Y0100	5102495J07	1.5PPM 16.8MHZ TCXO (Non-GPS Models only)
Y0100	5116032H01	0.5PPM 16.8MHZ TCXO (GPS Models only)



**DM 3400/DM 3401/
DM 3600/DM 3601
Mobile Radios**

Chapter 7

VHF (136-174 MHz)

1-25W

Service Information

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Chapter 7 - VHF Low Power Service Information

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Section 1

THEORY OF OPERATION

1.0 Introduction

This Chapter provides a detailed theory of operation for the VHF 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 VHF (136-174 MHz) Receiver Circuitry

The receiver is configured as a dual-conversion superheterodyne receiver, capable of both FM and 4-level FSK demodulation. The major blocks are the front-end, the mixer, Xtal filter, and the Abacus III back-end IC. The overall block diagram is shown in Figure 1-1.

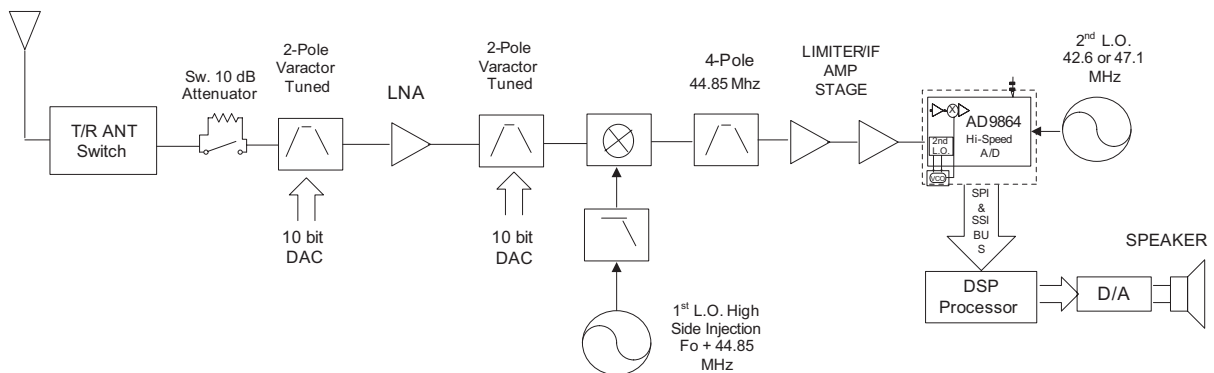


Figure 1-1 Receiver Block Diagram

2.1 Receiver Front-End

The front-end consists of a 2-pole varactor-tuned pre-selector filter, an LNA, a 2-pole varactor-tuned post-selector filter, and a passive double-balanced mixer. The received signal applied to the antenna is routed through the harmonic filter and PIN diode controlled antenna switch (D0702). A logic high level on ANT_ENABLE configures the antenna switch for Tx operation while a logic low places the switch in Rx mode. The insertion loss of the harmonic filter and antenna switch combined is approximately 0.8 dB max in Rx mode with slightly more loss at the upper end of the band. From this point, the Rx signal is routed to the Local Distance Switch (D0400/R0407), which biases on a diode in normal operation to minimize any insertion loss. Under strong signal conditions and for improved intermodulation protection from interfering signals, the switch can be turned on by the signal RF_ATTEN_1, which introduces approximately 10 dB of additional path loss. Activation of the switch can be accomplished manually by the user or left in the default setting.

The signal next reaches the pre-selector filter, which is a 2-pole varactor-tuned filter with 5 zeros that are optimized to provide image frequency rejection. This filter, and the similarly designed post-selector filter, provide over 75 dB of image response rejection. The 3 dB bandwidth for both filters varies across the band with a minimum of 32 MHz at 136 MHz and a maximum of 38 MHz around 174 MHz. Half-IF rejection from the filters is also frequency dependent with a minimum of approximately 7.5 dB achieved at the worst-case frequency of 174 MHz. Both filters have variable center frequencies that are adjusted by the FE_TUNE signal, which is derived from the output of a 10-bit DAC internal to the MAKO IC (U3200). The voltage is scaled up by a voltage doubler (Q0403) in order to provide the required linearity for the filters. Both filters are matched to the LNA (Q0402) to optimize the amplifier's noise figure (2.0 dB) and to provide an LNA gain of 16 dB to the signal. The combined gain of the filters and LNA is about 14 dB. Active bias transistor Q0401 maintains the collector current of Q0402 constant at 25 mA. The LNA, active bias circuit, Local Distance Switch, and voltage doubler are all supplied by 9R1_FILTER, which is derived from 9R1 after filtering.

Following the post-selector filter is the Class 2, double-balanced mixer. It is comprised of baluns T0400 and T0401 and diode ring mixer D0405. Injection amplifier Q0405 provides 15 dB of gain to the Rx VCO injection signal. Another amplifier, Q0202, located in the VCO block, also provides gain for the LO signal and isolation from high RF signals entering the mixer. The signal applied to the LO port of the mixer is +16 dBm minimum after passing through the 3-pole/1-zero, low-pass injection filter. The LO injection is high-side and mixes the signal down to an IF frequency of 44.85 MHz. The output of the mixer is connected to a diplexer network, which terminates out-of-band frequencies into 51 ohms (R0427) while appearing as high impedance to the 44.85 MHz IF signal.

2.2 Receiver Back-End

The signal entering the back-end is matched to 4-pole crystal filter, FL0500, by C0507 and L0503. The filter is centered at 44.85 MHz with a 3 dB bandwidth of 13.4 kHz. IF amplifiers Q0500 and Q0501 follow the crystal filter and provide both amplification and limiting to the signal. An overall gain of 24 dB is available from the composite IF amplifier to lower-level IF signals. As the signal level increases, Q0501 begins to limit and eventually saturates out at approximately -16 dBm. The purpose of the limiting is to provide protection to the AD9864 Abacus III back-end IC (U0600). An internal 16 dB attenuator is also engaged to provide attenuation to the Abacus's input signal, working with the external amplifier to limit the signal below the ADC clip point. The block diagram for the AD9864 is shown in Figure 1-2 below. At IF levels exceeding -26 dBm into U0600, the 2nd LO synthesizer internal to U0600 can be pulled, causing corruption of the I/Q data being delivered to the DSP.

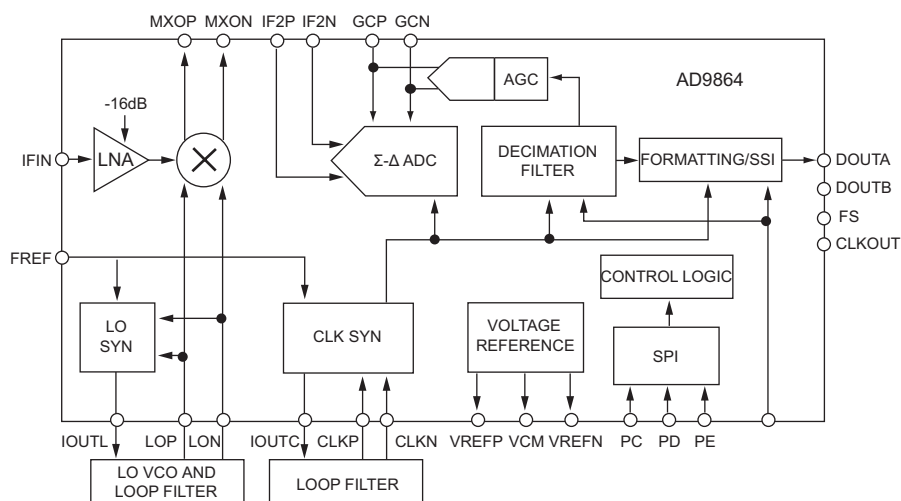


Figure 1-2 AD9864 Block Diagram

The Abacus III accepts the 44.85 MHz signal, processes it, and sends out baseband I/Q data in 16-bit format to the DSP at a 20 kHz rate. Internal to the Abacus III is an LNA and 16 dB FE attenuator, an internal integer-N synthesizer used to control the external 2nd LO VCO, a Sigma-Delta ADC and decimation filter, and control and formatting logic for outputting the baseband I/Q data. External to U0600 is the 2nd LO VCO with active device Q0600 and its associated circuitry including the loop filter consisting of C0613, C0618, and R0603. The 2nd LO mixes the 44.85 MHz IF signal down to 2.25 MHz before being input to the ADC where it is sampled. The tank circuit (L0608, C0605, C0642, R0617) and varactor (D0601) for the internal clock synthesizer, work with the loop filter (R0618, C0643, C0646) to provide the 18 MHz clocking signal to the internal ADC, decimation filter, and SSI formatting circuitry. A 3 Volt regulator (U0601) provides a clean 3 Volt supply to U0600. Transistor Q0601 is configured as a super filter to provide the 2nd LO transistor with a low noise supply. The reference clock for U0600 is 16.8_REF, which is a buffered (Q0100) 16.8 MHz clock from the synthesizer block.

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

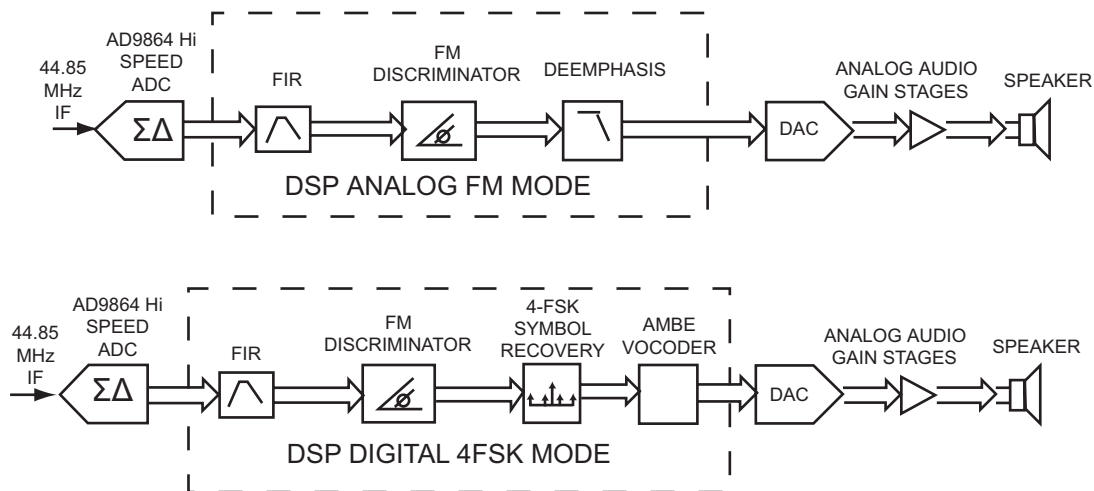


Figure 1-3 Signal Flow through Receiver Back-End

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 filter data is then sent through a decimation process further reducing its frequency to 8 kHz.

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 remaining 8 kHz data is sent through the FM Discriminator and De-emphasis subroutines in the DSP code. If the radio is in Digital mode, the remaining 8 kHz data is still sent through the FM Discriminator but an additional "Symbol Recovery" routine is applied along with a standard AMBE Vocoder process. The resultant audio (still represented by high-speed data) is sent to a DAC (U3200), which drives several 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 Watts of power through the internal speaker.

3.0 VHF (136-174 MHz) Transmitter Circuitry - 25 Watt

The Transmitter consists of the power amplifier circuitry and the power control circuitry. The power amplifier is responsible for delivering a faithful replica of the VCO output amplified up to the desired output power level, free from distortion. The power control circuitry is responsible for ensuring that 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.

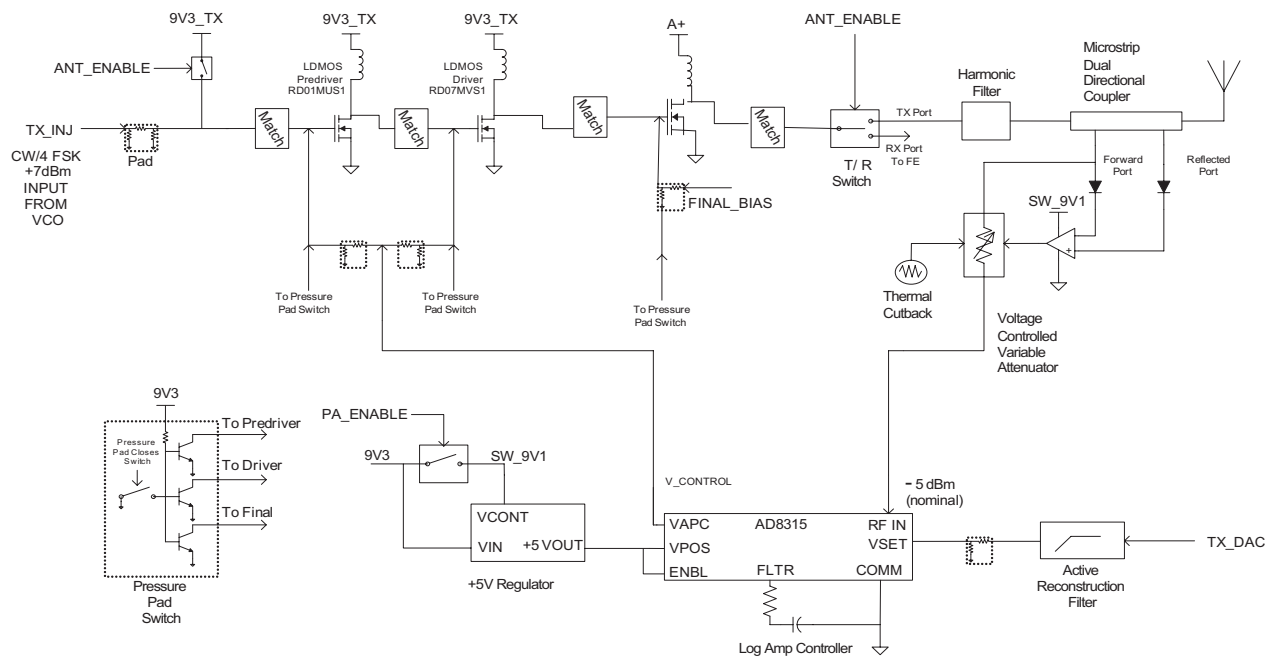


Figure 1-4 VHF 25 Watt Low-Power Transmitter Detailed Block Diagram

3.1 Power Amplifier

The radio's 25 Watt power amplifier (PA) is a 3-stage amplifier, which amplifies the output of the VCO to the required transmit power level. The first stage is an adjustable gain LDMOS pre-driver (RD01MUS1, Q0705), followed by an adjustable gain LDMOS driver (RD07MVS1, Q0703), and the fixed-gain LDMOS final device (MRF1535, Q0702). A transmit/receive (TR) switch and a harmonic filter complete the transmit lineup.

3.2 Pre-Driver Stage

Pre-driver is a low power LDMOS device (RD01MUS1, Q0705), which delivers up to +27 dBm power to the driver stage. Its gain is controlled by varying the gate bias voltage and varies from low gain up to approximately 14 dB power gain. The gate bias voltage is controlled with the V_cont signal and is controlled in parallel with the driver stage gain.

The input match to this stage is a high-pass topology comprised of L0716, L0718, and C0795. (High-pass matches are used where appropriate to minimize the chances of low frequency regeneration within the amplifier.) The inter-stage match between the pre-driver and driver stages is comprised of C0790, C0786, C0791, C0792, L0717, and L0719 arranged in a high-pass topology.

Additional footprints are provided on the printed circuit board to allow for possible engineering optimizations to this match. These are non-populated parts C0793, C0794, C0817, C0820, and C0821.

3.3 Driver Stage

The next stage is a medium-power LDMOS device (RD07MVS1, Q0703), which delivers up to +38 dBm to the final device. 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 and is controlled in parallel with the pre-driver stage gain.

R0718, R0720, R0754, and R0755 are required to improve the bandwidth of the driver stage. The inter-stage match between the driver and final device is comprised of C0819, C0746, C0754, C0745, and associated micro-strips on the PCB. Additional footprints are provided on the printed circuit board to allow for possible engineering optimizations to this match. These are non-populated parts C0753, C0755 and C0752.

3.4 Final Stage

The final stage is a high-power LDMOS device (MRF1535, Q0702). The package is mounted to a copper carrier to improve thermal conductivity to the chassis and also to more tightly control the RF load, allowing higher and more consistent maximum output power. This stage is biased at a quiescent current of 100 mA and operates with a fixed-gain of approximately 14 dB, allowing the radio to be set to a maximum output power of 35 Watts. The quiescent current is set by adjusting the Final_Bias signal.

The output match consists of C0719, C0720, C0721, C0726, C0727, C0741, C0724, C0725 and L0714 and the associated microstrip line on the PCB. The output matching circuitry of this stage has extremely critical part location requirements. Any repairs must be done with care to ensure the replaced components are placed accurately and properly soldered. Of particular concern are the output matching capacitors, C0719, C0720, C0721, C0726, and C0727. The resistor networks at the input of each of the final elements are required to improve the bandwidth of the circuit. These resistors are R0712, R0716, R0717, R0719, R0721, R0726, R0732, R0733, R0734, R0736, R0737, and R0739.

Additional footprints are provided on the printed circuit board to allow for possible engineering optimizations to this match. These are non-populated parts C0722, C0729, and C0730. If the final device is replaced, the bias voltage 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 500 mA, but the design is optimized for 100 mA as noted earlier. The device can tolerate up to 5 Amps for brief periods of time without damage.

3.5 Antenna Switch

The Antenna Switch (TR switch) has two modes of operation, transmit and receive.

Transmit mode:

The antenna switch utilizes the existing dc feed (A+) to the final stage device (Q0702). Both PIN diodes, D0700 and D0702, are turned on during key-up by forward biasing them. Forward biasing is achieved by pulling down the voltage at the cathode end of D0702 to around 12.2 Volts (0.7 Volt drop across each diode). Q0704 is configured as a current sink that maintains the current through the antenna switch diodes at 100 mA, as set by VR0700 and R0738. The current sink is enabled

during transmit mode by ANT_ENABLE asserting thru Q0706 and associated circuitry. When the PIN diodes are conducting, an RF ground is formed at the anode of the lower PIN diode D0702, which places the series L0710 and L0724 in parallel with C0803. The values of L0710, L0724, and C0803 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 the top PIN diode to the harmonic filter. To further attenuate the Tx signal from getting to the Rx front-end, a PIN diode pair (D0703) is placed in the Rx path separated from the D0702 short by a quarter wave inductor (L0730 & L0731). This diode pair shorts to ground in transmit mode so that the receiver sees as little transmitter power as possible.

Receive mode:

The DC current thru the PIN diodes is interrupted by turning off the current sink. The RF path now flows from the Harmonic Filter thru the matching circuit formed by C0803, L0710, and L0724, then to pi network C0766, L0730, L0731, and C0772. The additional shunt diodes (D0703) will be high impedance since no bias current is flowing from the switched Tx power line.

3.6 Harmonic Filter

Inductors L0720, L0721, L0706, L0707, L0708, L0709, L0722, and L0723, and capacitors C0742, C0739, C0740, C0735, and C0750, form a harmonic filter which is a 7th order low-pass filter with two notches; this 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 L0728 are used to drain any electrostatic charges that might otherwise build up on the antenna.

3.7 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 consisting of pin diodes D0901, D0902, and D0903. The log detector/controller regulates the gain of PA stages Q0703 and Q0705 (via V_cont) as necessary, thus ensuring that 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 as part of the VSWR load detection circuitry. Its physical location close to the antenna connector allows accurate VSWR sense at the transmitter output. Forward and reverse coupled signals are rectified by D0904 and D0905, respectively. Resulting DC voltage FWD_DETECTED is proportional to 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, such as may be caused by a damaged antenna, also causes an increase in the difference amplifier output voltage. An increased difference amplifier output causes a reduction in attenuation by the VCA. As a result, the increased RF signal applied to the log detector/controller causes the controller to reduce the gain of PA stages Q0703 and Q0705. Transmitter power is thus reduced to prevent damage to the final device due to an improper load.

3.8 Power Control

The transmitter uses 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-stable, high accuracy control over a typical 50 dB dynamic range.

The MAKO IC 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. Reference voltage level is programmable through the SPI lines of the MAKO. This reference voltage is 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 of the transmitter's coupled power circuits.

The PA controller IC provides a DC output voltage at pin 7 (VAPC), which is divided 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 by controlling the gate bias of stages Q0703 and Q0705. Voltage divider combination R0727 and R0728 provide gate bias to Q0703 while divider combination R0750 and R0751 provide gate bias to Q0705. This adjusts the transmitter power output to the intended value. The ratios of each of these resistor dividers are chosen to ensure that Q0703 and Q0705 are both running at their 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 to raise or lower output power in order to maintain transmitter output power relative to the reference voltage applied to VSET.

A power control attenuator circuit was added to the 25 Watt transmitter circuitry in order to extend the range of the RF detection in the RF detector at low-power levels. This enables the power control loop to close at lower relative power levels and is needed because of the greater relative power-set range (1-25 Watt, 14 dB). The PC_ATTEN_ENA activation threshold is set in software for operation at lower power levels, typically 1-5 Watt. When the PC_ATTEN_ENA is activated, the VCA is driven to its minimum attenuation level, which increases the RF level at the AD8315 (U0940) for a given transmitter power level. The radio software adjusts the K&M tuning accordingly such that proper power-set is maintained at operating powers both above and below the activation threshold point.

3.9 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.

3.10 Load Dump Protection

In order to protect the transmitter line-up in the case where extremely high voltage spike occurs, a simple load dump protection circuit is implemented. This circuit is placed at the gate of PA stage Q0703 and consists of resistors R0980, R0981, R0982 and transistor Q0710. When high voltage spike ($>29.9 V_{_}$) is sensed at power supply (A+), the base-to-emitter voltage VBE of this transistor will be above threshold voltage and this will cause the transistor to turn on. The VBE is controlled by a combination of R0980 and R0981 which form a voltage divider circuit. When Q0710 is turned on, it will drain the current from PA stage Q0703 via R0982 and thus preventing the transmission of power and keep the transmitter line-up from any damage.

3.11 Thermal Protection

Thermistor RT0908 and R0902 form a voltage divider with the 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 operational amplifier U0901-2, which provides a dc voltage via diode junction D0900 to control the attenuation level of the VCA stage. For the condition that the temperature threshold set by resistive divider combination R0901 and R0909 is reached, the VCA is driven to increase the RFIN signal at the 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. The 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 the battery supply in the controller circuit of the radio in order to change the VSET input of the PA controller IC (pin 3) for reduced transmitter output. This cutback starts when the battery voltage at the connector is 15.3 Volts or greater and has a 2 dB/V slope. In addition, a second low battery detect circuit is implemented in hardware. This hardware cutback forces a 1.2 dB drop in RF power level when the battery voltage drops below 12 Volts.

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 transistor Q0702 against the chassis. 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, turning off the gate bias to Q0702, Q0703, and Q0705. This prevents 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 (Tomahawk II, U0100), and the Voltage Controlled Oscillator VCO.

4.1 Reference Oscillator

The reference oscillator (Y0100) contains a temperature compensated crystal oscillator with a frequency of 16.8 MHz. A digital-to-analog (DAC) converter internal to U0100 (Tomahawk) and controlled by the microprocessor via serial interface (SPI), sets the voltage at the AUX_DAC output of U0100 (pin H6) to set the frequency of the oscillator. The output of the oscillator (pin 3 of Y0100) is applied to pin K5 (XOSC_BASE) of U0100.

4.2 Fractional-N Synthesizer

The Tomahawk II Synthesizer IC (U0100) consists of a pre-scaler, a programmable divider and divider 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 2.45 Volts.

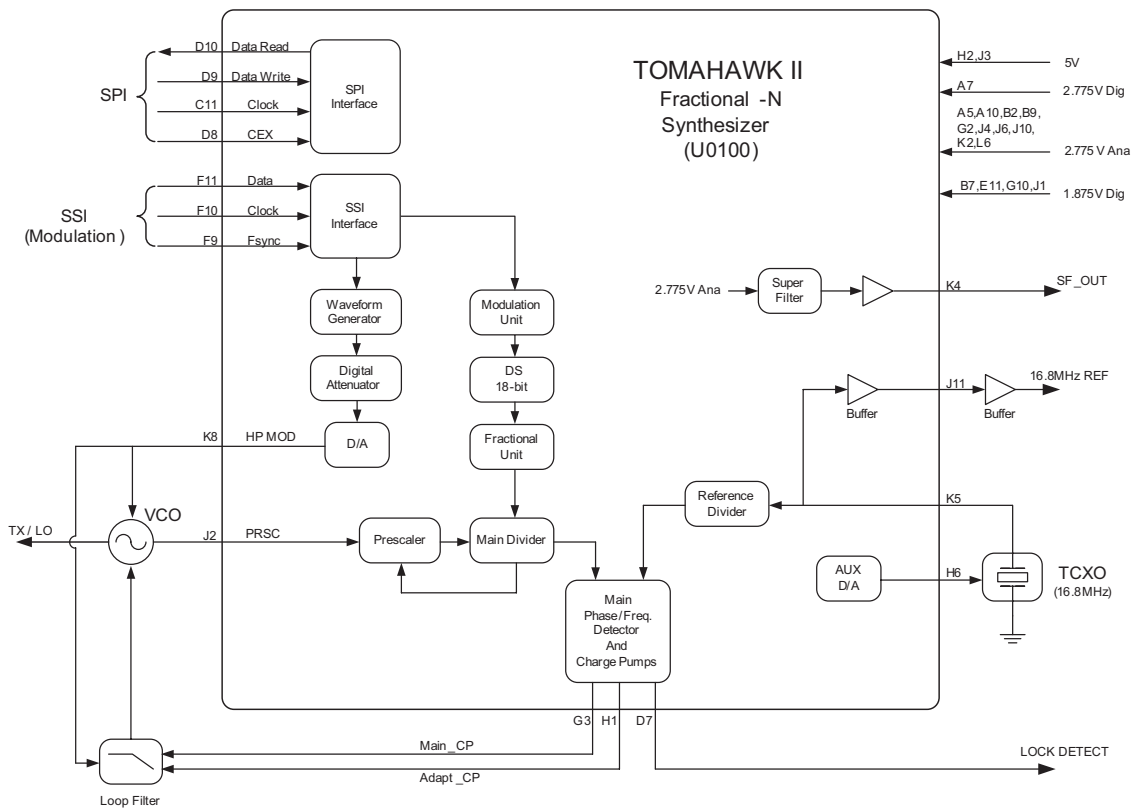


Figure 1-5 VHF Synthesizer Block Diagram

A voltage of 2.775 Volts applied to the super filter input (U0100 pin J4) supplies an output voltage of 2.45 VDC (SF_OUT) at pin K4. This supplies the VCO and the VCO modulation bias circuit (via R0321). The super filter supply voltage is provided by the 2.775 Volt regulator within U3200. The synthesizer is also supplied by the 5 Volt regulator, U3002, another 2.775 Volt regulator within U3200, and a 1.875 Volt regulator within U3200.

The output signal LOCK (U0100-D7) provides information about the lock status of the synthesizer loop. A high level 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 microprocessor via the data lines SPI_DW (U0100-D9) and SPI_DR (U0100-D10), 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 three Colpitts oscillators (two Rx and one Tx), a single-stage Tx buffer amplifier, a single-stage Rx buffer amplifier, oscillator bias control switches, and the modulation circuitry.

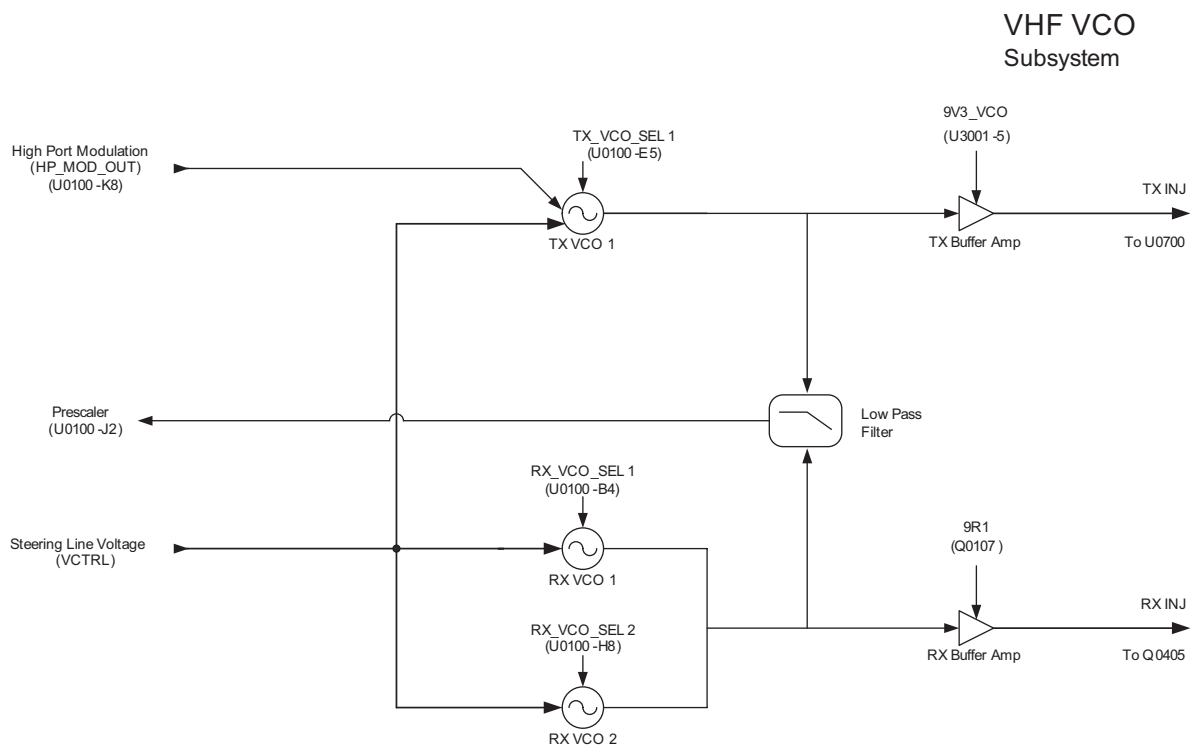


Figure 1-6 VHF VCO Block Diagram

The VHF Rx VCO design incorporates two varactor-tunable Colpitts oscillators. Each Rx oscillator has a tuning range of 19 MHz, sufficient to cover the Rx frequency range of 180.85 MHz to 218.85 MHz. A single Tx oscillator covers the frequency range of 136 MHz to 174 MHz. The oscillators resonate at fundamental operating frequencies. Three (active-low logic) general purpose output lines (GPO1, GPO3, and GPO6) from the Tomahawk IC (U0100-B4, E5, and H8) provide the control for independent bias selection to each oscillator (VCO_SEL) via the PNP transistor switches U0304 and U0201. The 2.45 Volt super filtered output, SF_OUT, of the Tomahawk IC (U0100-K4) supplies the bias to the oscillators. A portion of the VCO output signal is lightly coupled through coupling capacitors C0331 and C0231, routed through a low-pass filter (formed by L0221, C0235, L0230, C0265, and C0233), and fed back to the M_PRSC input of the Tomahawk IC (U0100-J2).

High-port modulation is scaled through a voltage divider (comprised of R0319, R0320, and R0321) and applied to the Tx modulation varactor diode CR0300. The Tx VCO frequency is modulated via coupling capacitor C0310.

A discrete single-stage Tx buffer amplifier (comprised of the NPN transistor Q0302 and surrounding components) amplifies the signal from the Tx oscillator to the level required by the first stage of the Transmitter Power Amplifier (U0700). The Tx buffer amplifier also provides sufficient isolation from any undesired load-pulling from the Transmitter Power Amplifier. The bias for Q0302 is provided by the 9.3 Volt regulator U3001.

A discrete single-stage Rx buffer amplifier (comprised of the NPN transistor Q0202 and surrounding components) amplifies the signal from the Rx oscillator to the level required by the LO injection amplifier (Q0405). The Rx buffer amplifier also provides sufficient isolation from any undesired load-pulling from high input levels in the receiver front-end. GPO4 from the Tomahawk IC (U0100-D4) controls the transistor switch (comprised of Q0108 and Q0107), that enables the 9.1 Volt bias to Q0202 (via the 9.3 Volt regulator U3001).

4.4 Synthesizer Operation

The complete synthesizer subsystem is comprised mainly of the Tomahawk Synthesizer IC, Reference Oscillator (crystal oscillator with temperature compensation), loop filter circuitry, VCO, and DC supplies. The VCO feedback signal, PRSC, is fed to pin J2 of U0100 (M_PRSC) via a low-pass filter (L0221, C0235, L0230, C0265 and C0233) 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). The output signal of the phase/frequency detector is a pulsed signal which is routed to 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 applied to the VCO.

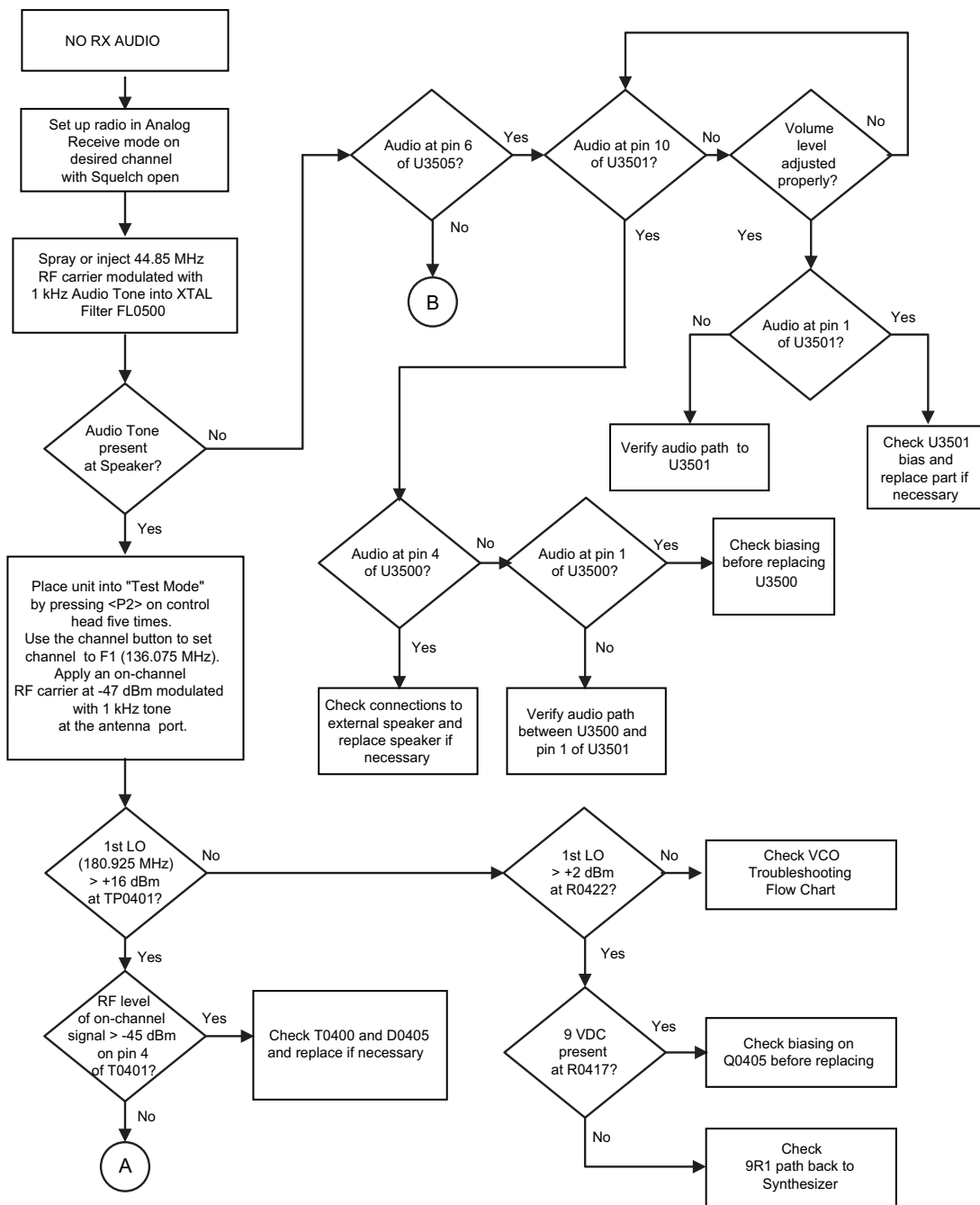
To reduce lock time when new frequency data has been loaded into the synthesizer, an adapt charge pump, providing much greater current than the main charge pump, is turned on for a finite amount of time to quickly charge or discharge the loop filter capacitors to steer the VCO to the desired frequency. The output of the adapt charge pump passes to the loop filter via pin H1 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-D7), which is routed to the microprocessor. Q0102 is configured as a current source to provide a steady 1.5 mA during the adapt period. U0101 is an analog switch that opens the adapt path slightly before the end of the adapt period to prevent the current from the current source from pushing the VCO off frequency.

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 is converted to an analog signal through a 10-bit DAC before modulating the VCO. This high-port analog modulation output (HP_MOD_OUT, U0100-K8) is connected to the VCO modulation varactor diode (CR0300) via C0360 and R0319.

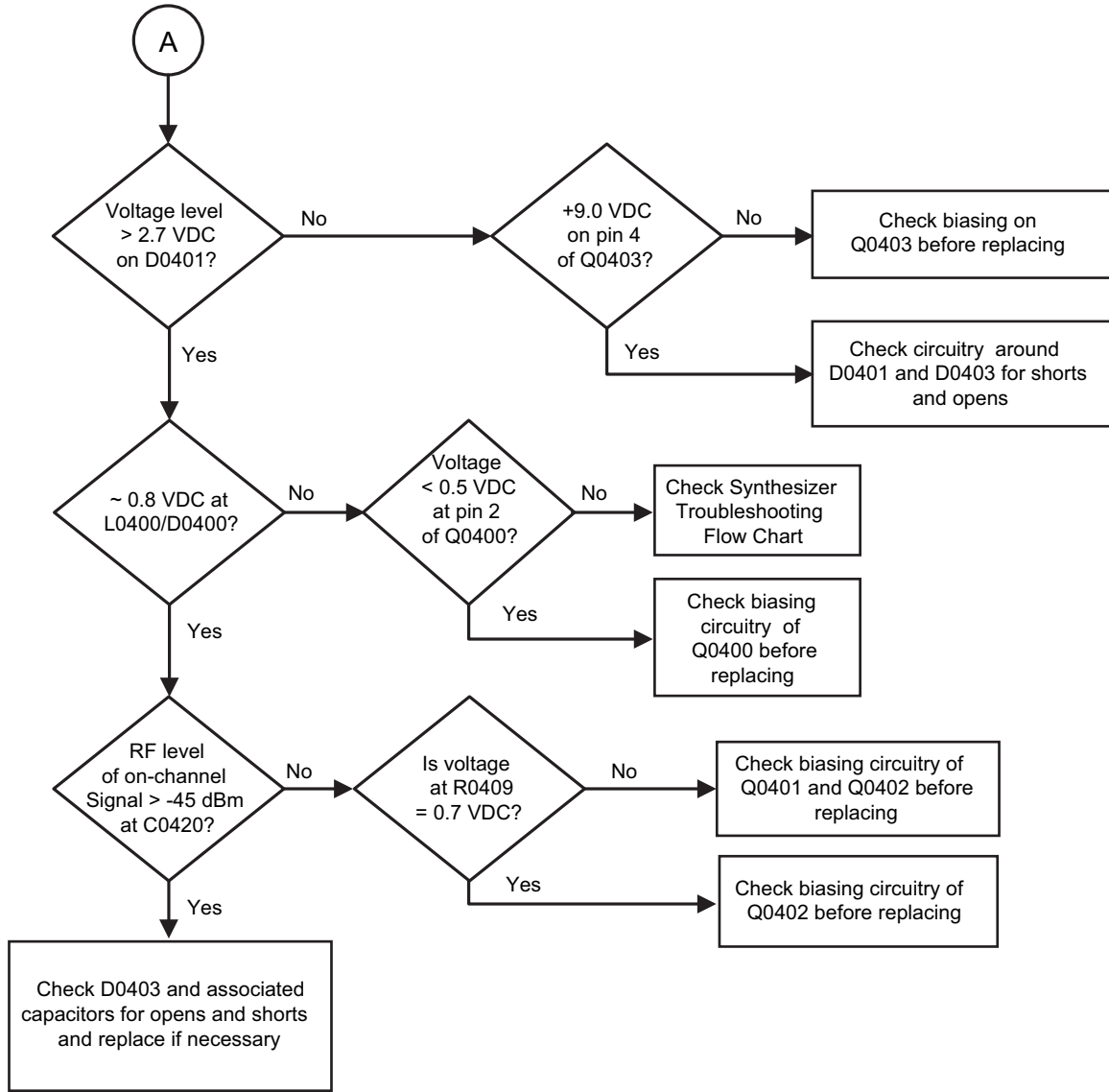
Section 2

TROUBLESHOOTING CHARTS

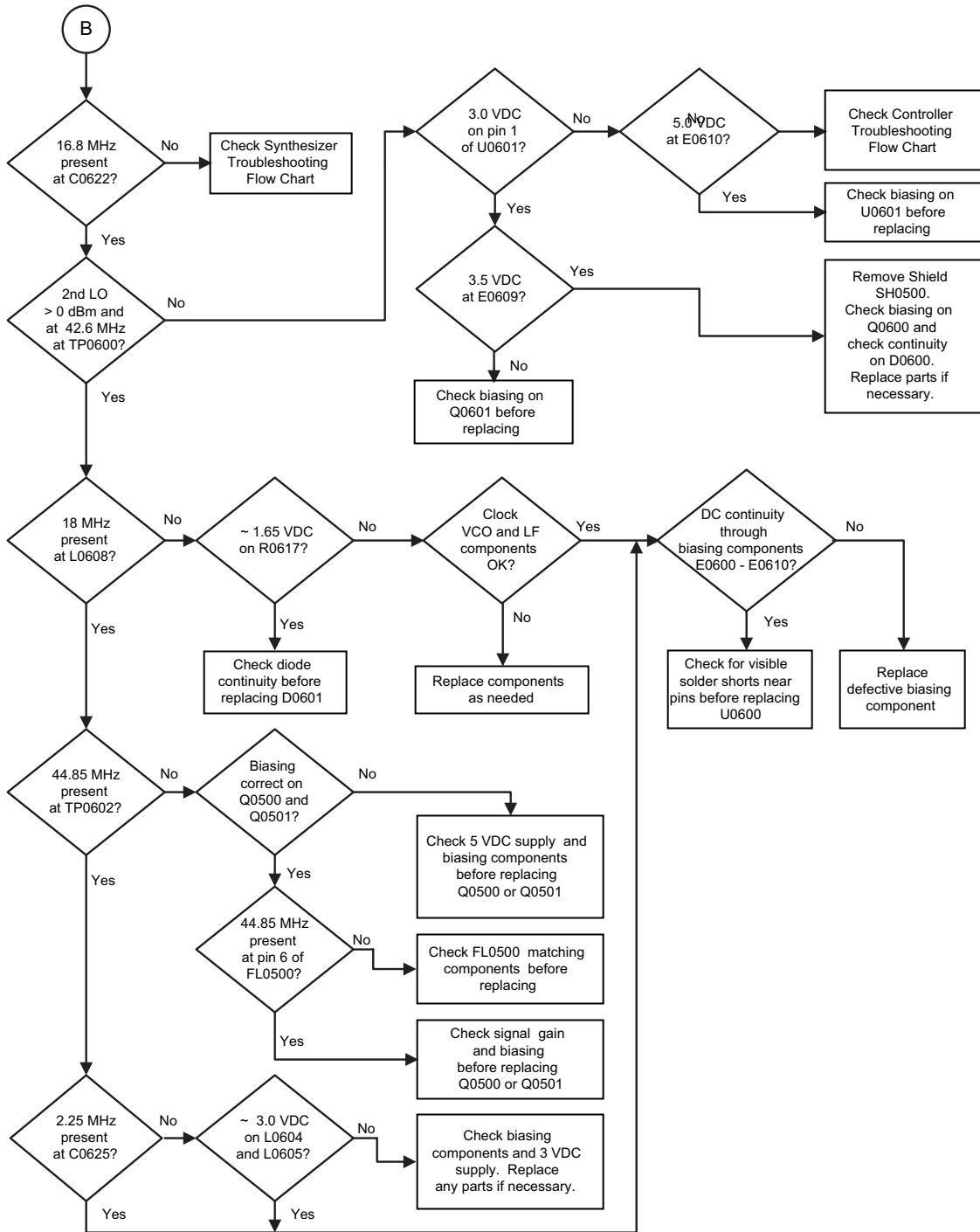
1.0 Troubleshooting Flow Chart for Receiver (Sheet 1 of 3)



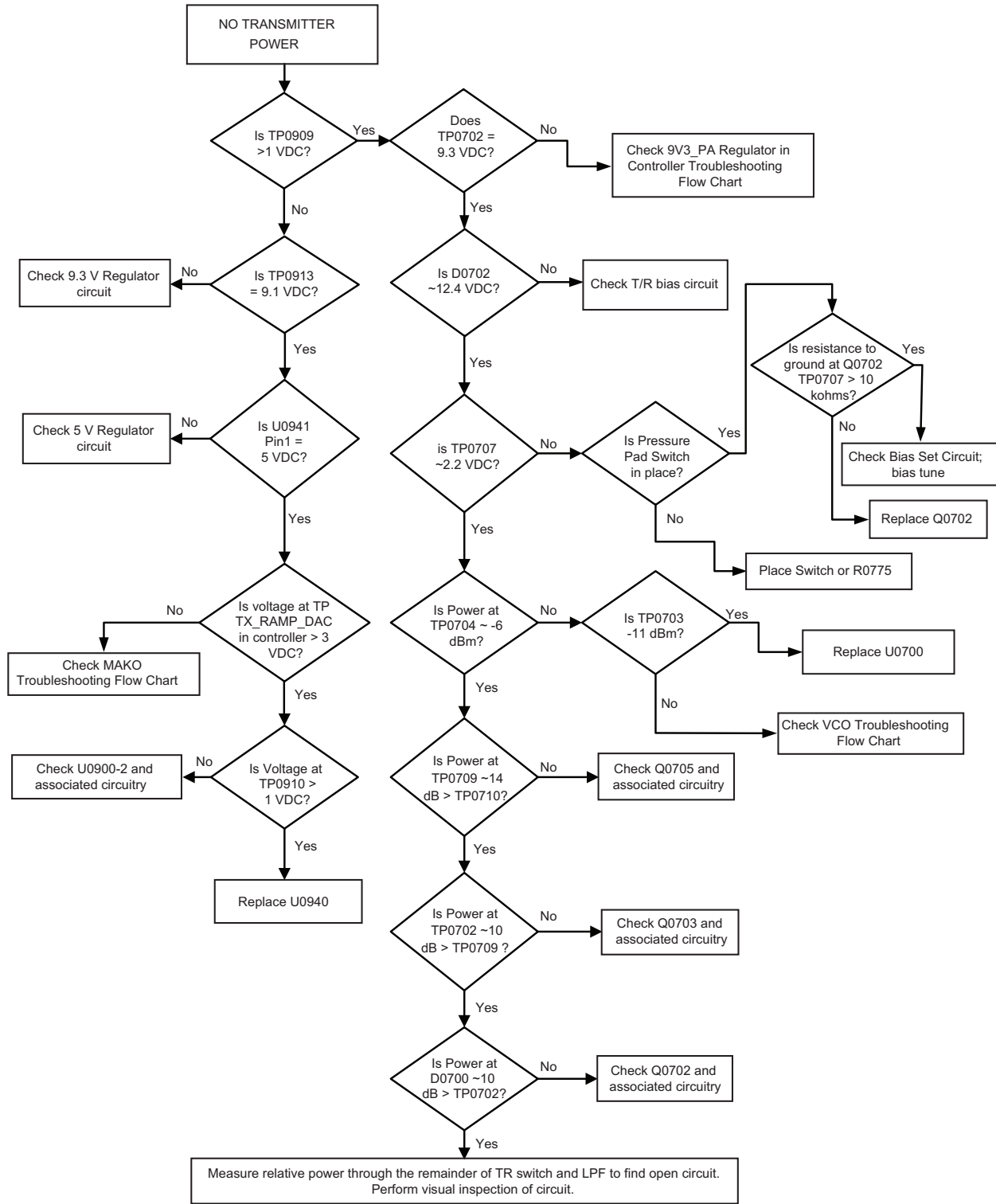
1.1 Troubleshooting Flow Chart for Receiver (Sheet 2 of 3)



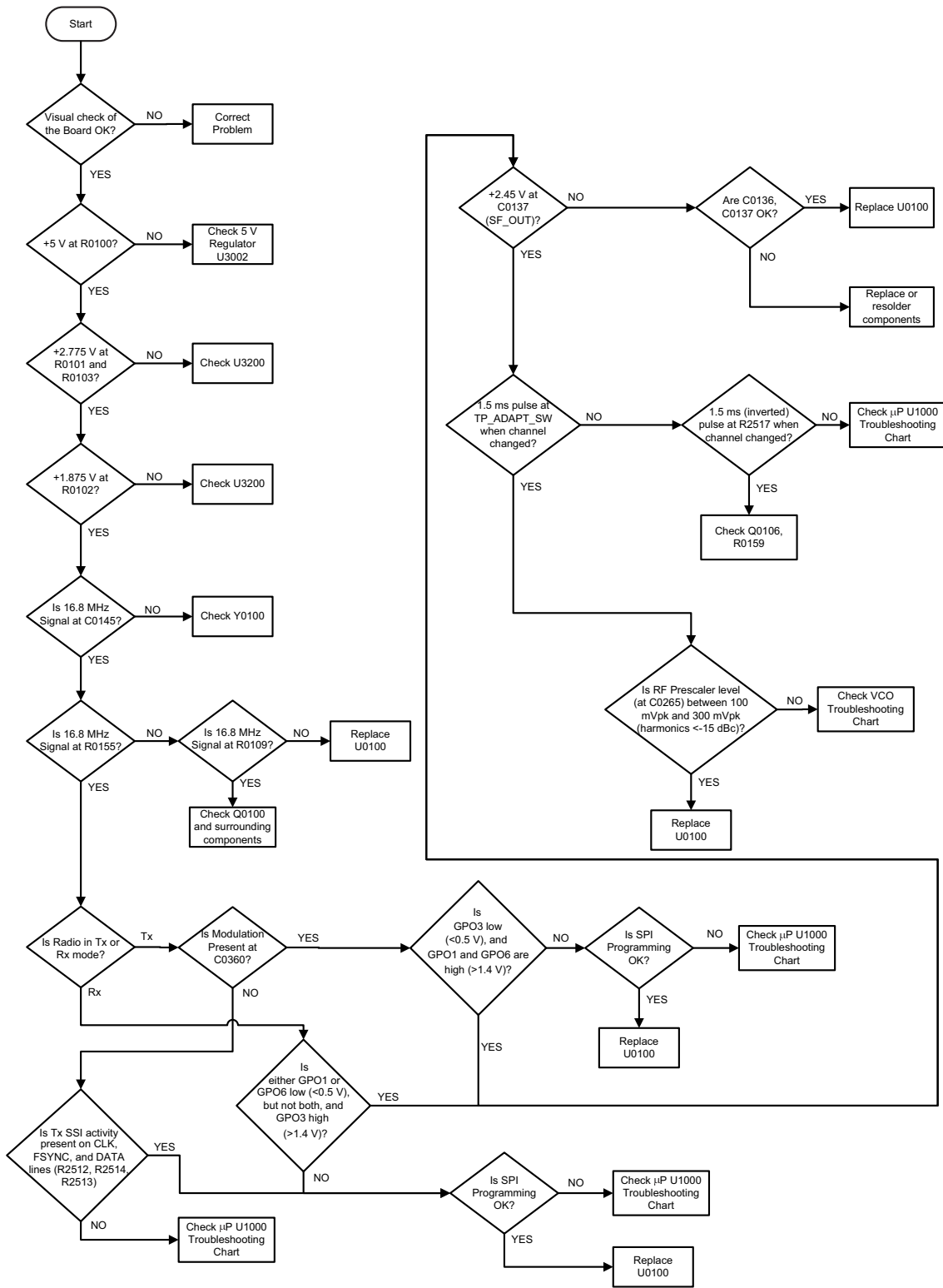
1.2 Troubleshooting Flow Chart for Receiver (Sheet 3 of 3)



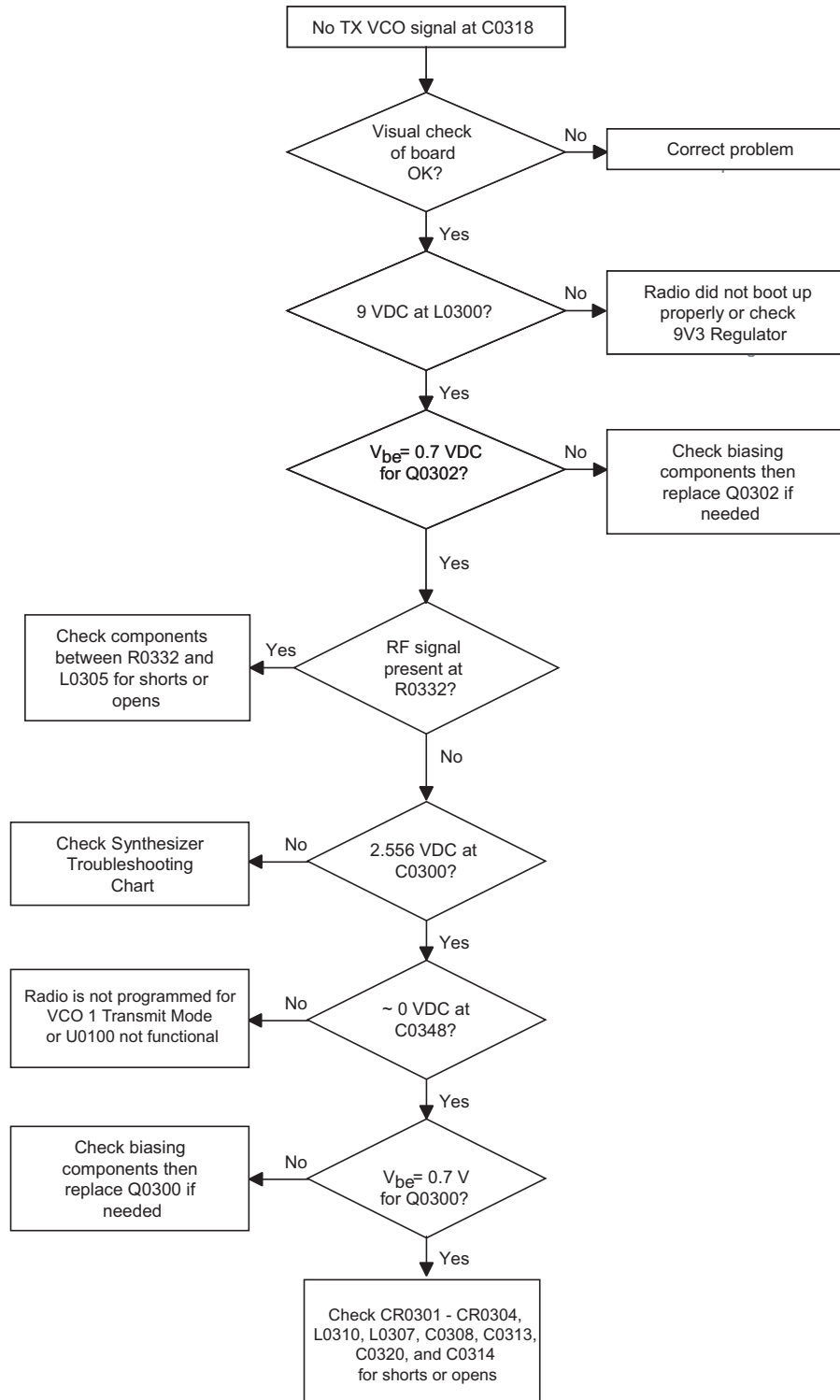
2.0 Troubleshooting Flow Chart for 25W Transmitter



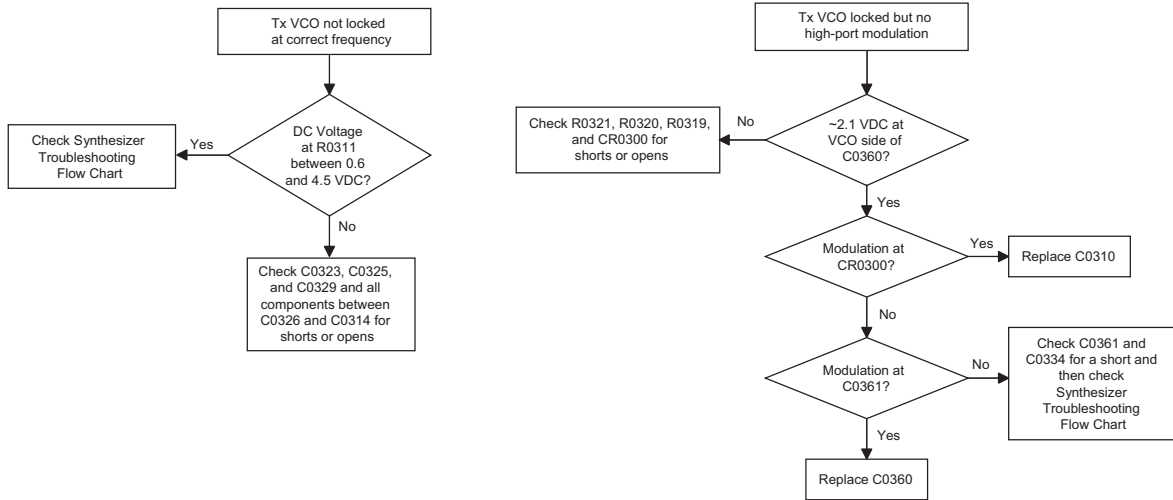
3.0 Troubleshooting Flow Chart for Synthesizer



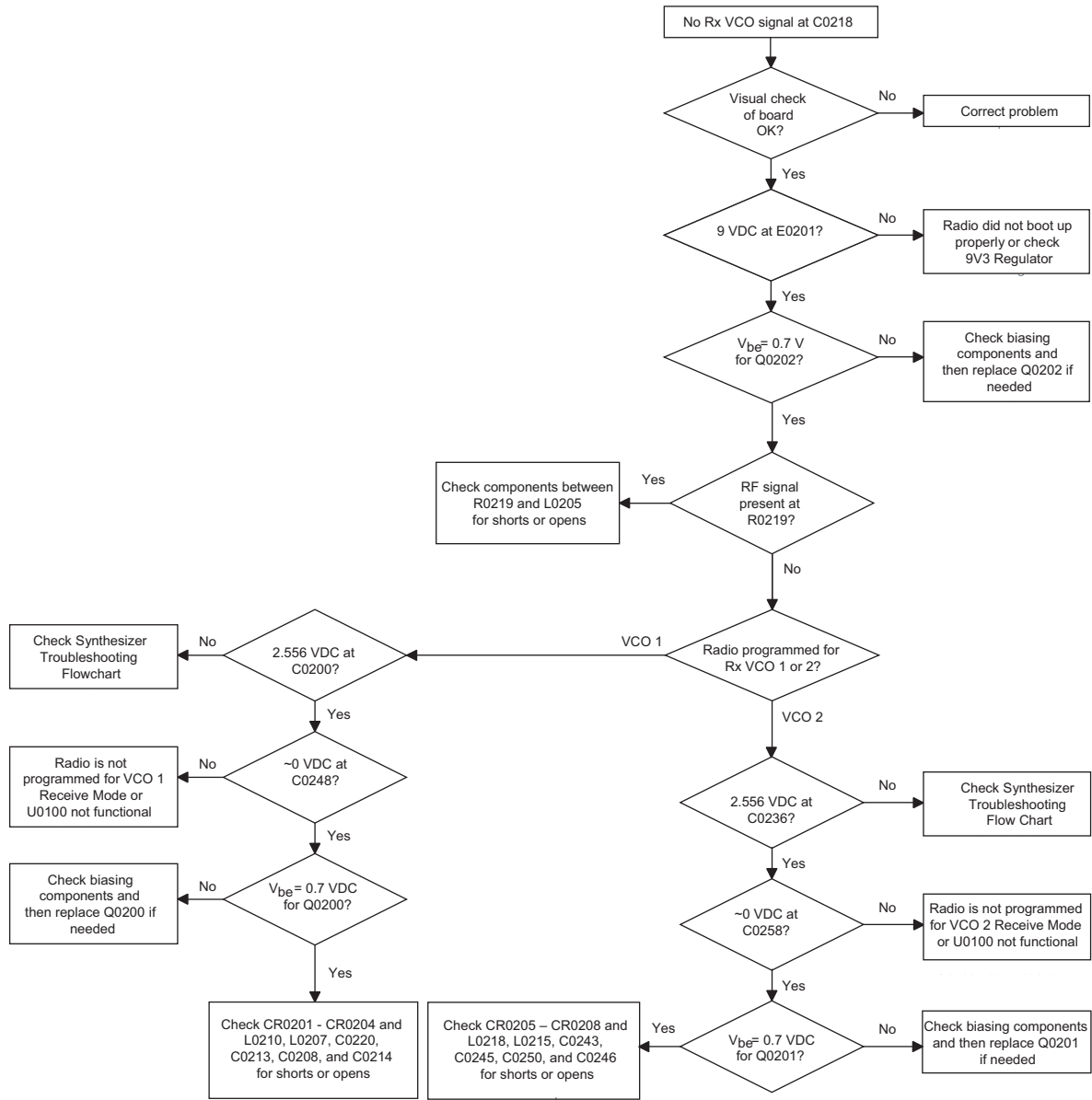
4.0 Troubleshooting Flow Chart for Tx VCO (Sheet 1 of 2)



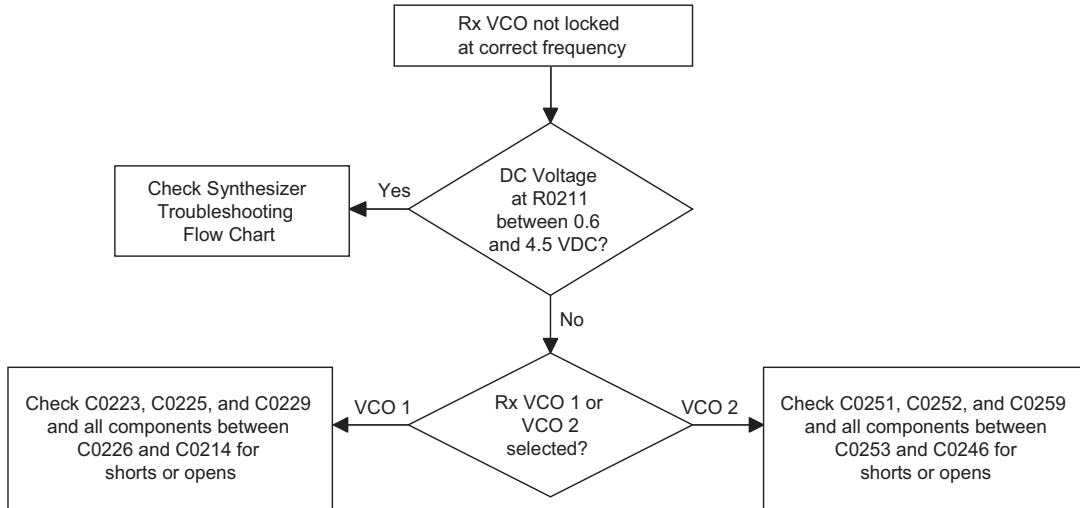
4.1 Troubleshooting Flow Chart for Tx VCO (Sheet 2 of 2)



5.0 Troubleshooting Flow Chart for Rx VCO (Sheet 1 of 2)



5.1 Troubleshooting Flow Chart for Rx VCO (Sheet 2 of 2)



Notes

Section 3

VHF PCB / SCHEMATICS / PARTS LISTS

1.0 Allocation of Schematics and Circuit Boards

1.1 Controller Circuits

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

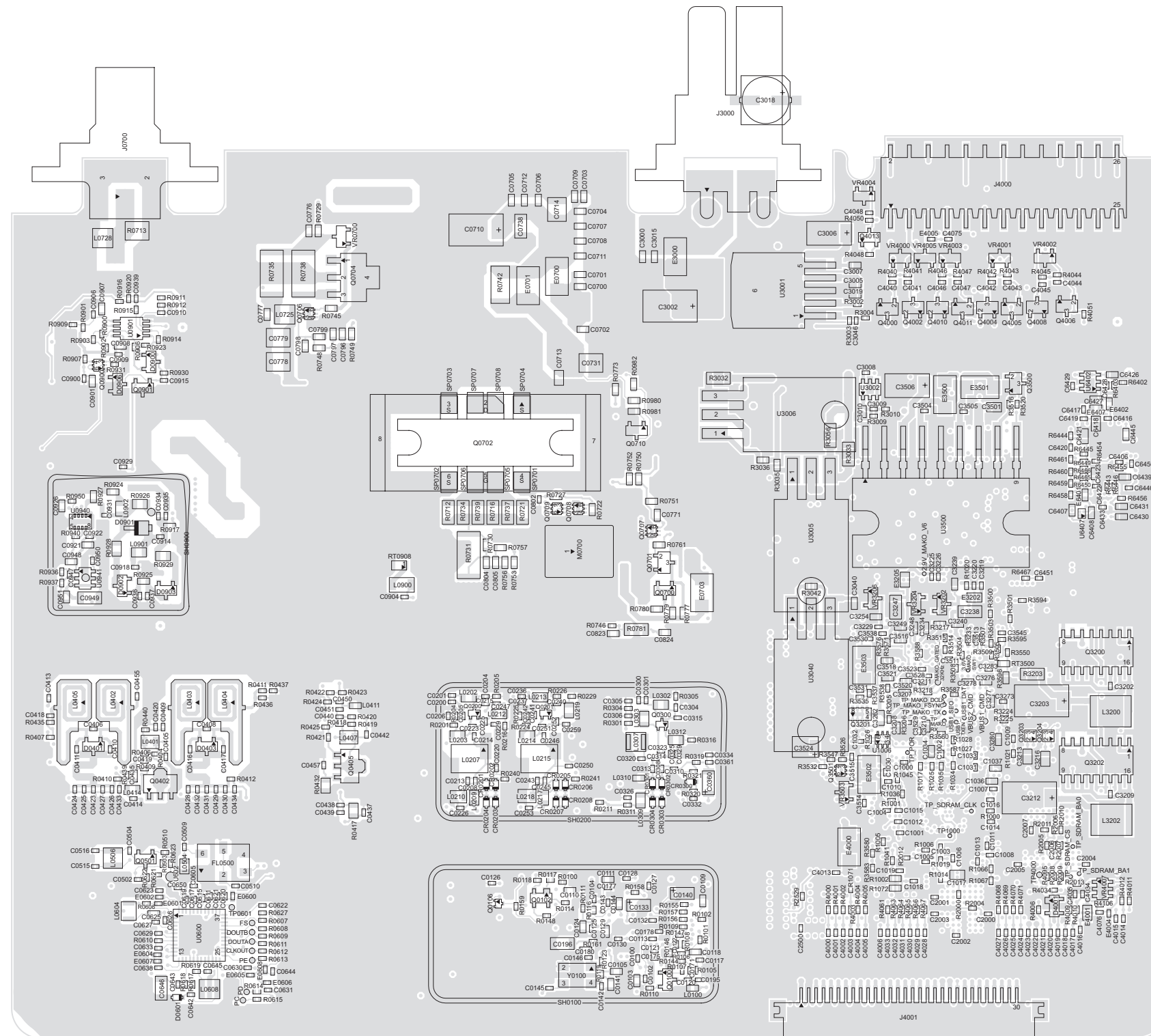
NOTE: The VHF Schematic and parts lists are the same for 8471495L01 and 8471495L03. Only the Controller circuits are different between the two PCBs.

Table 3-1 VHF 1-25W Diagrams and Parts Lists

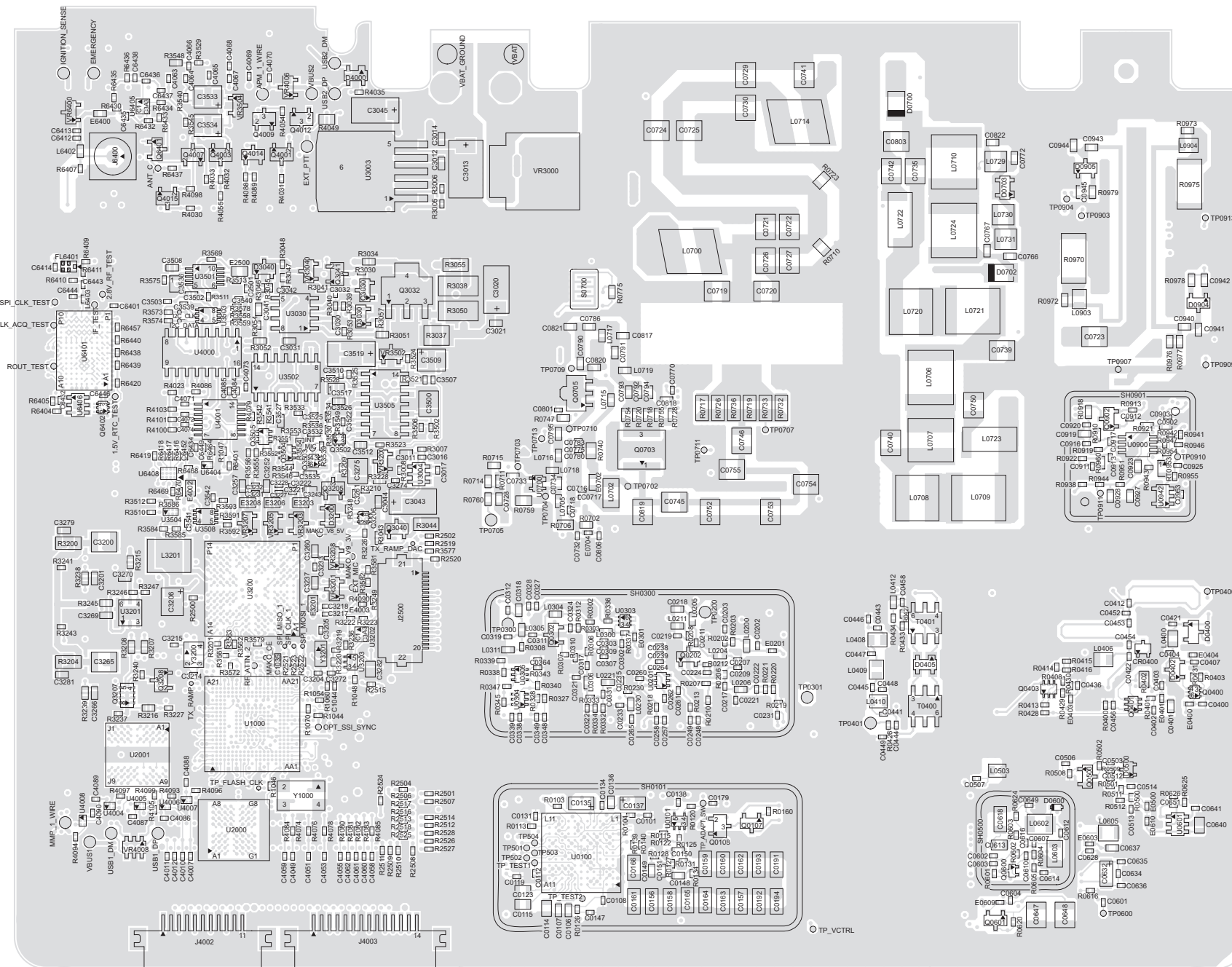
PCB:	
8471495L01 Main Board Top Side	Page 3-3
8471495L01 Main Board Bottom Side	Page 3-4
8471495L03 Main Board Top Side	Page 3-5
8471495L03 Main Board Bottom Side	Page 3-6
SCHEMATICS	
Overall	Page 3-7
Receiver Front-End	Page 3-8
Receiver IF Amp	Page 3-9
Receiver Back-End	Page 3-10
Power Amplifier	Page 3-11
Power Control	Page 3-12
Synthesizer	Page 3-13
Receiver VCO	Page 3-14
Transmit VCO	Page 3-15
Parts List	
8471495L01 and 8471495L03	Page 3-16

Notes

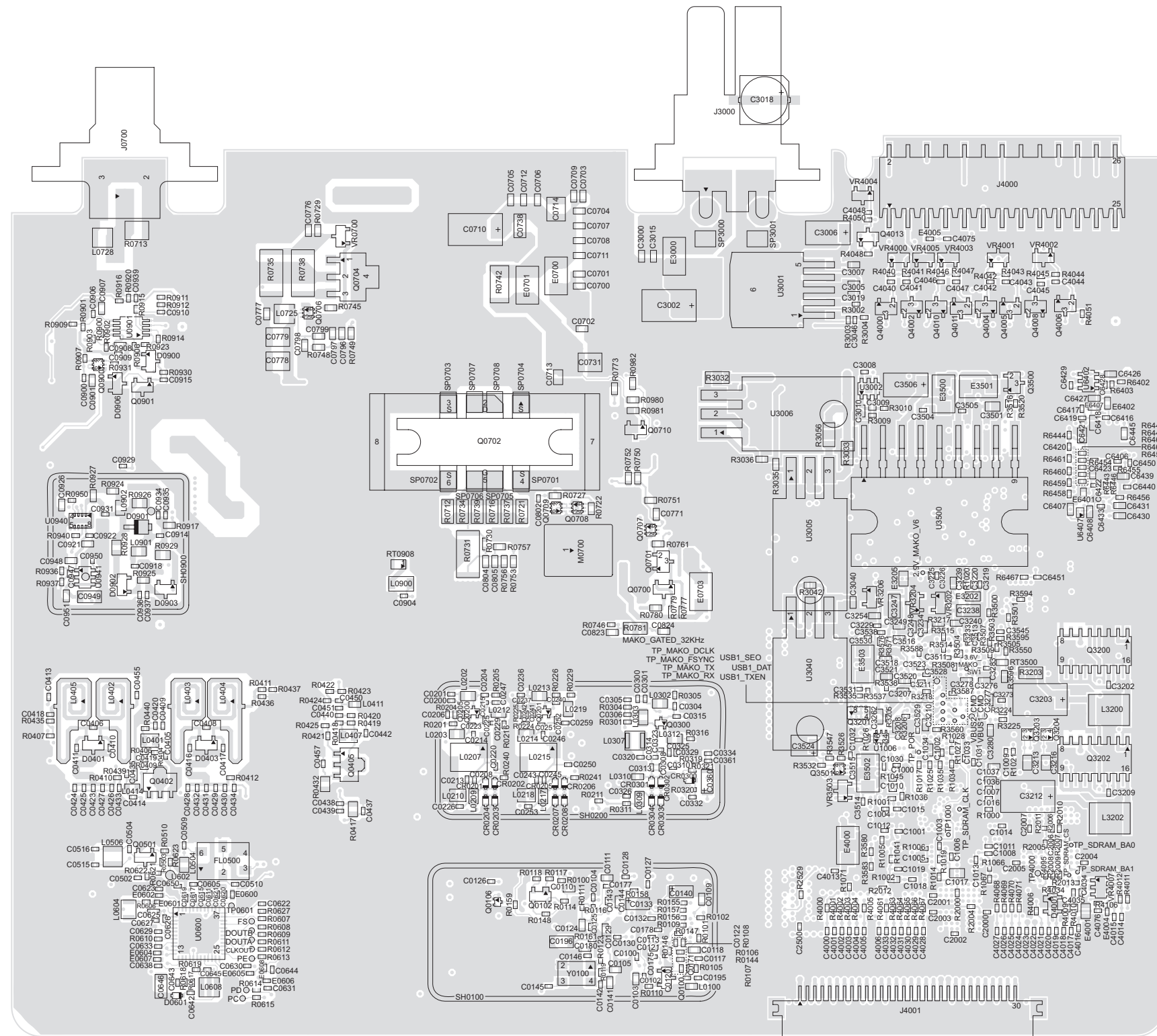
2.0 VHF (136-174 MHz) 1 - 25W PCB / Schematics / Parts List



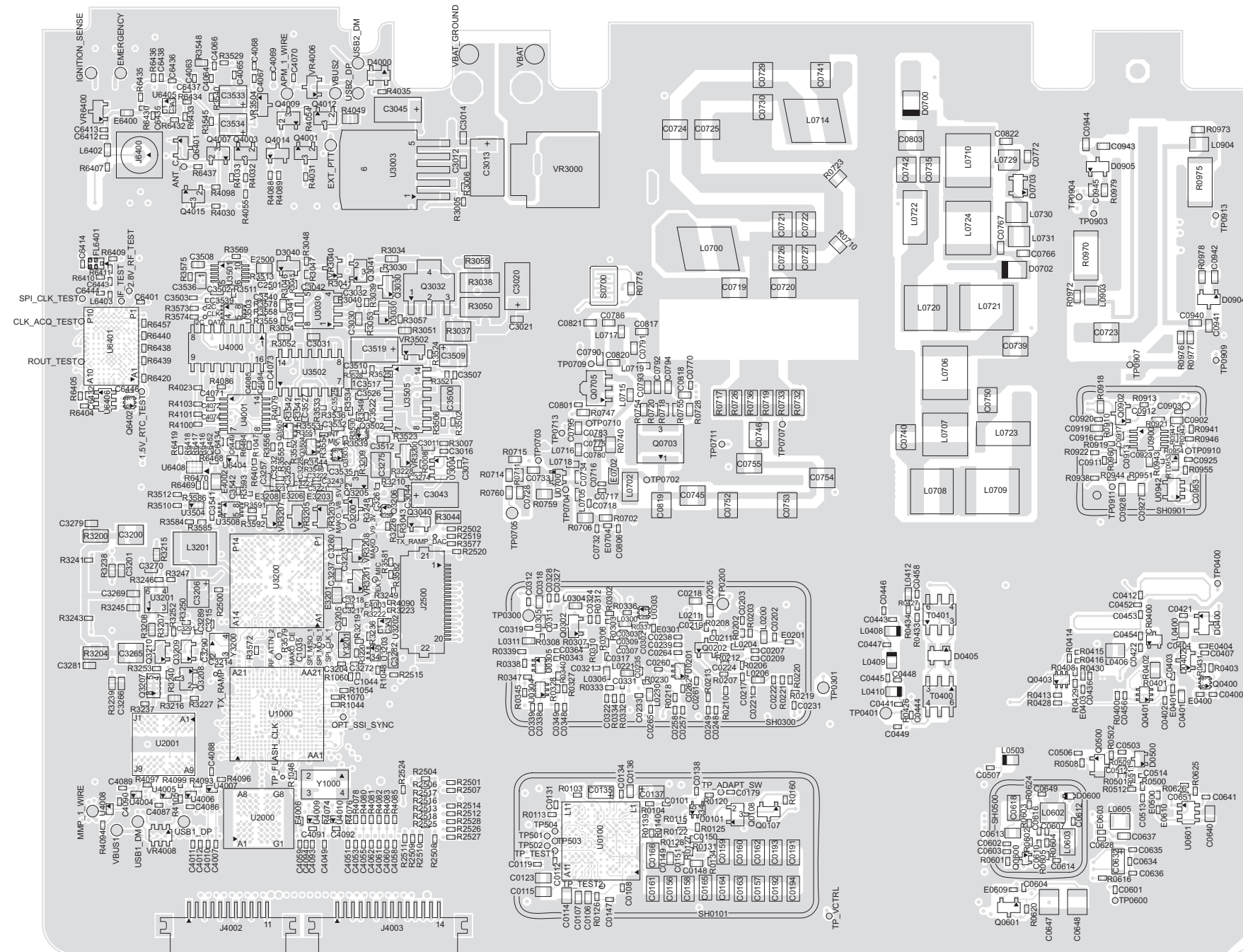
VHF (136-174 MHz) 1-25W 8471495L01 Top Side



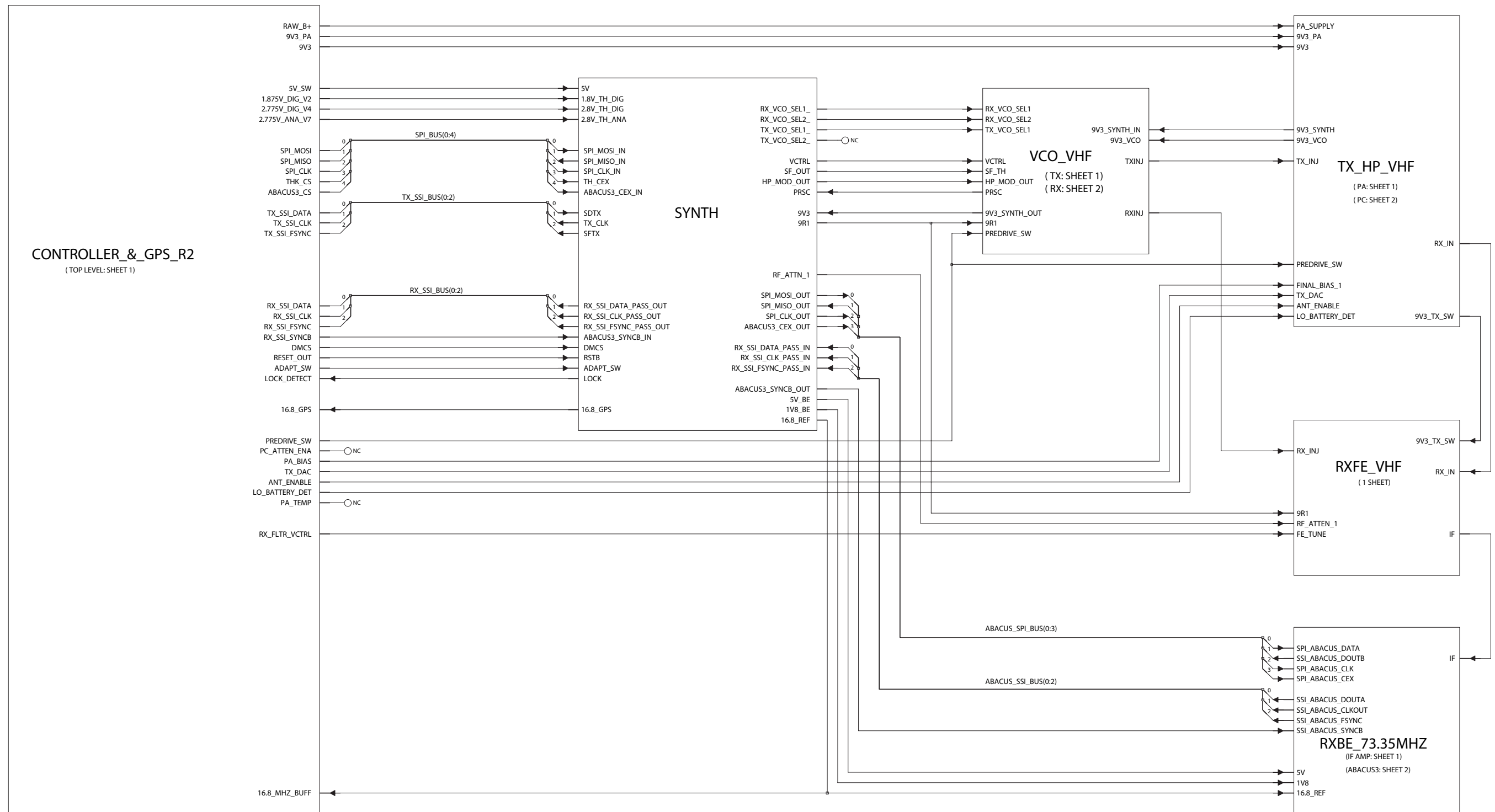
VHF (136-174 MHz) 1-25W 8471495L01 Bottom Side



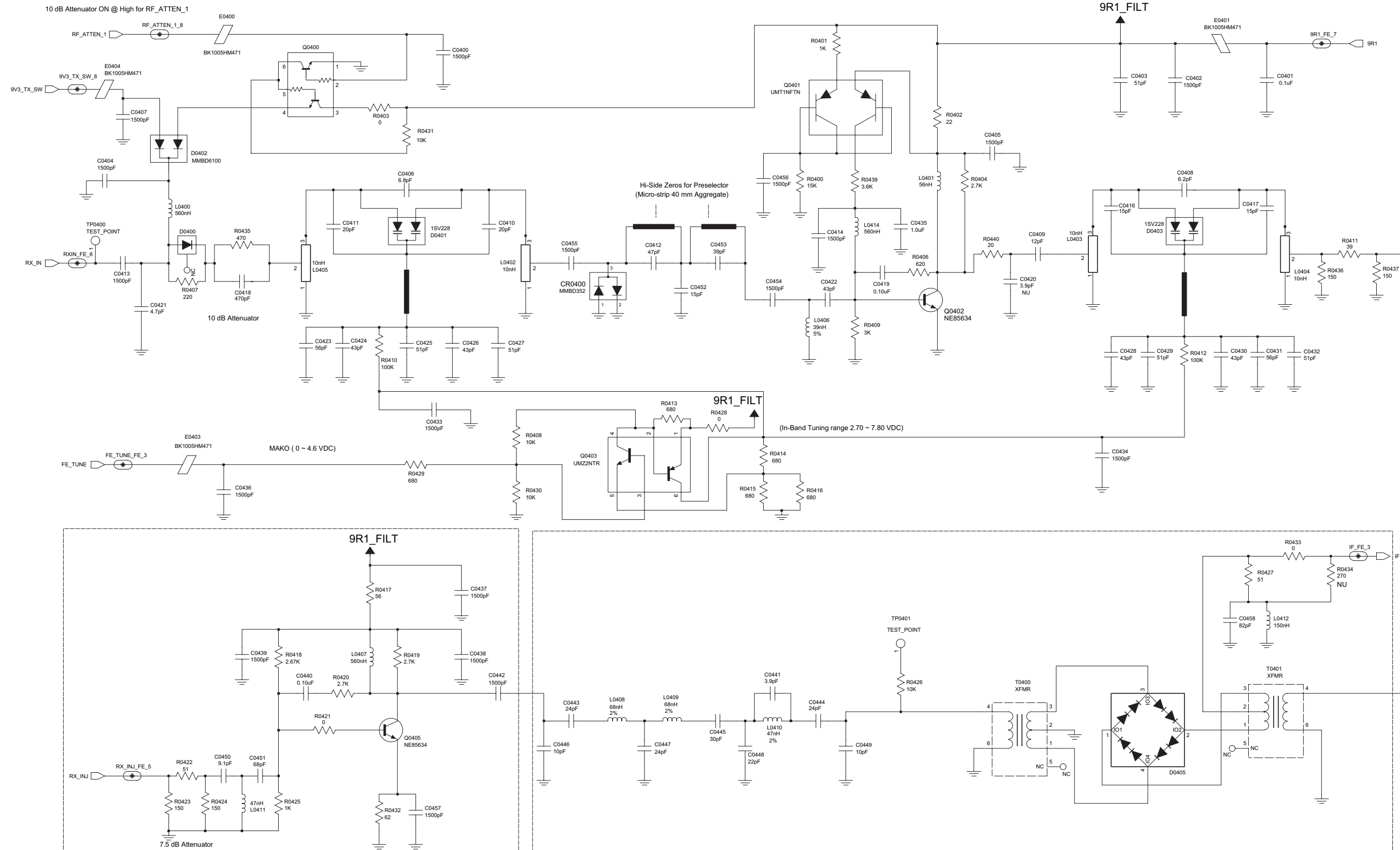
VHF (136-174 MHz) 1-25W 8471495L03 Top Side



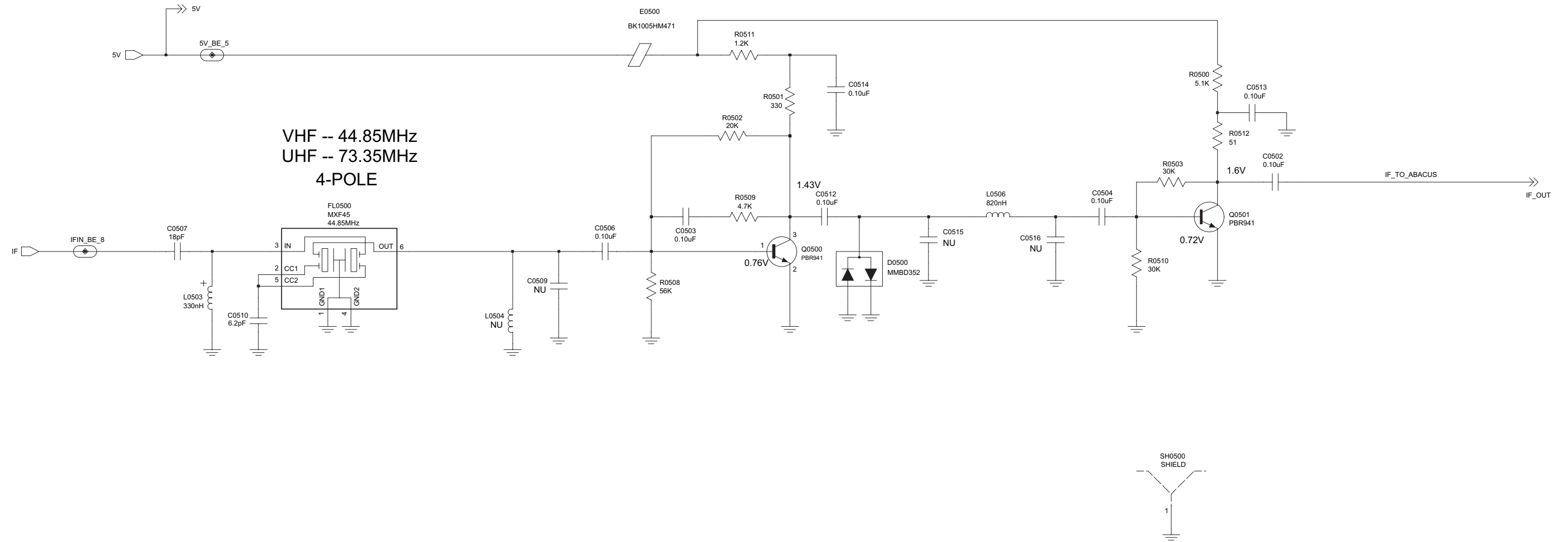
VHF (136-174 MHz) 1-25W 8471495L03 Bottom side



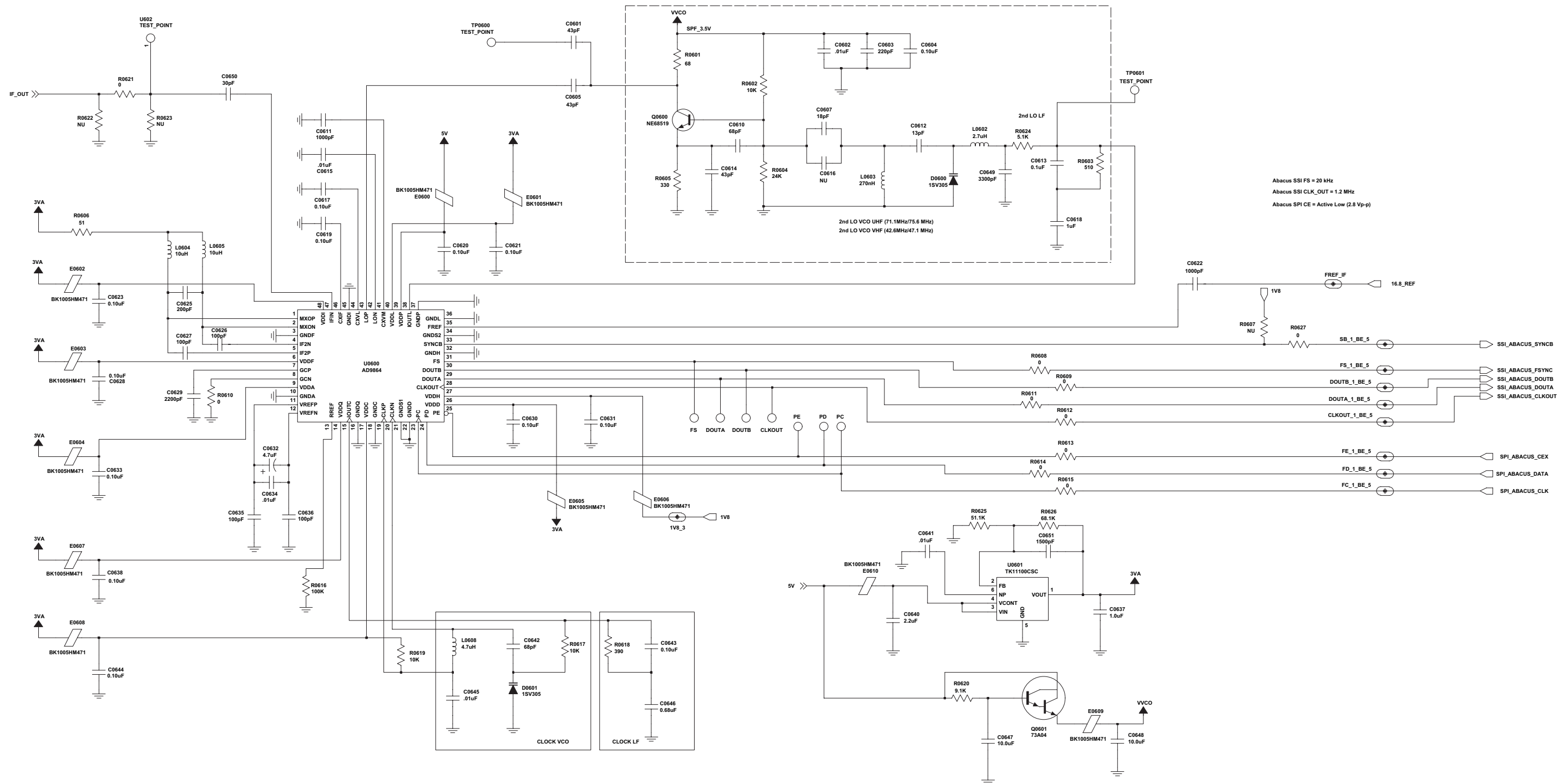
VHF (136-174 MHz) 1-25W Overall Schematic Diagram



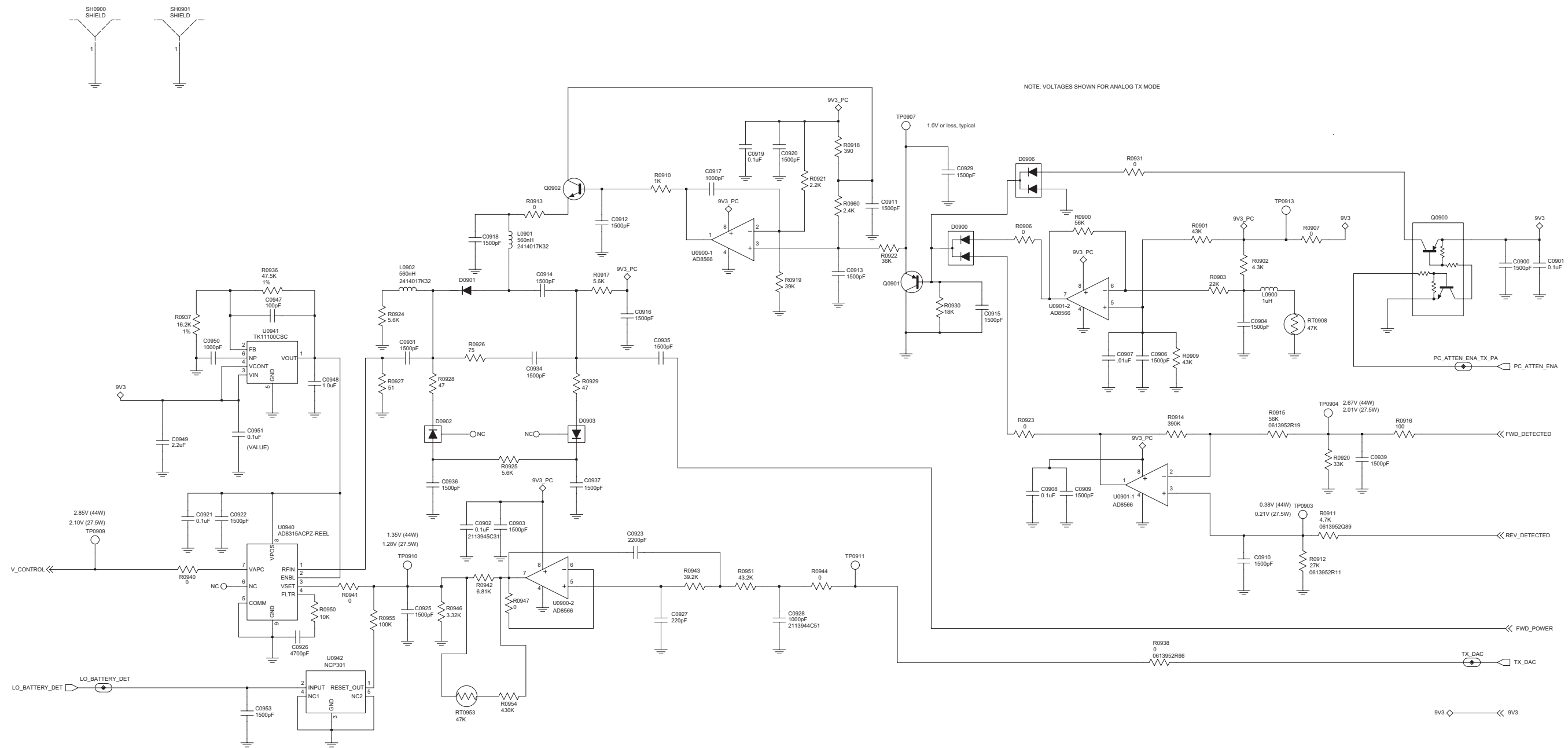
VHF (136-174 MHz) 1-25W Receiver Front-End Schematic Diagram



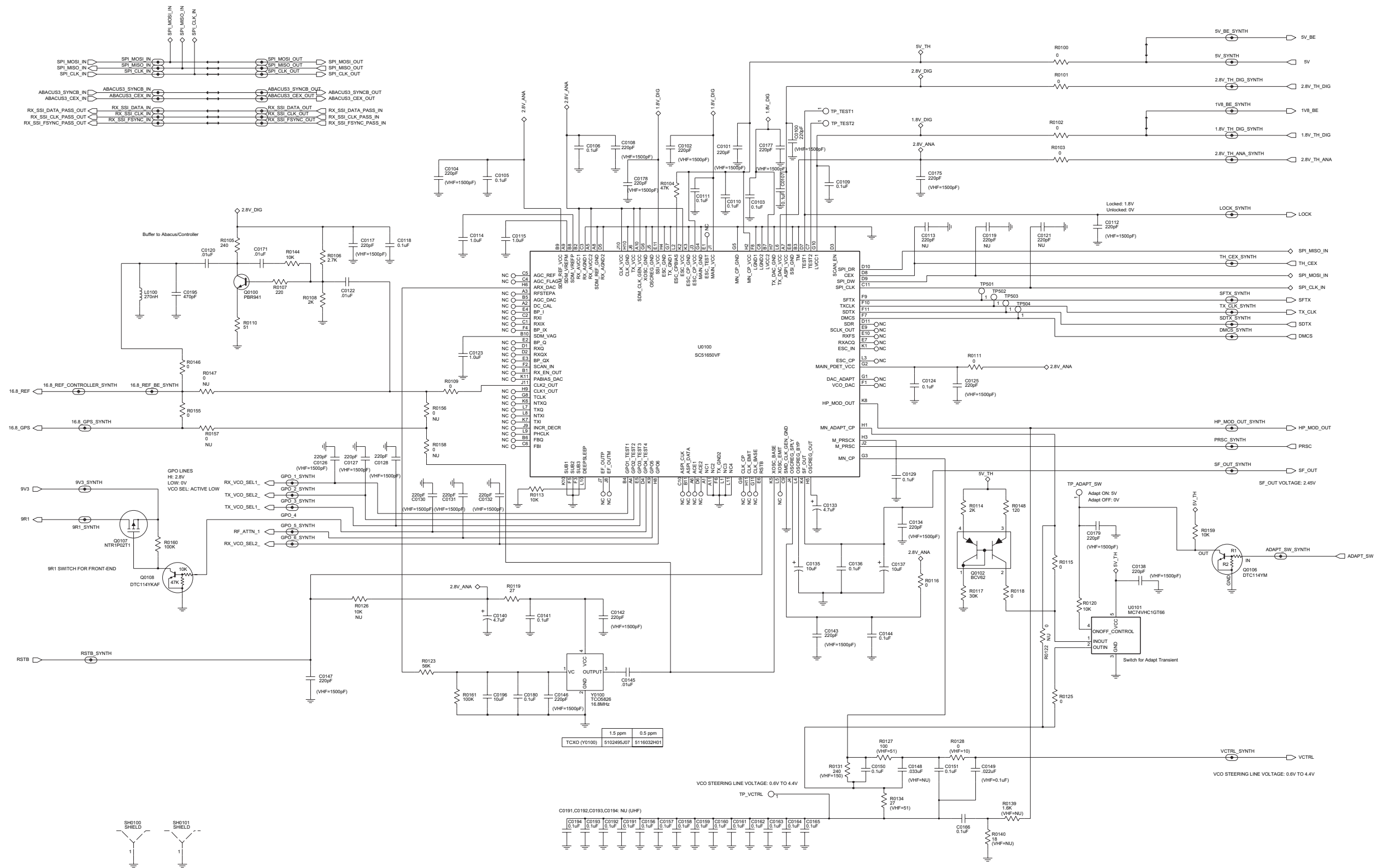
VHF (136-174 MHz) 1-25W Receiver IF Amp Schematic Diagram



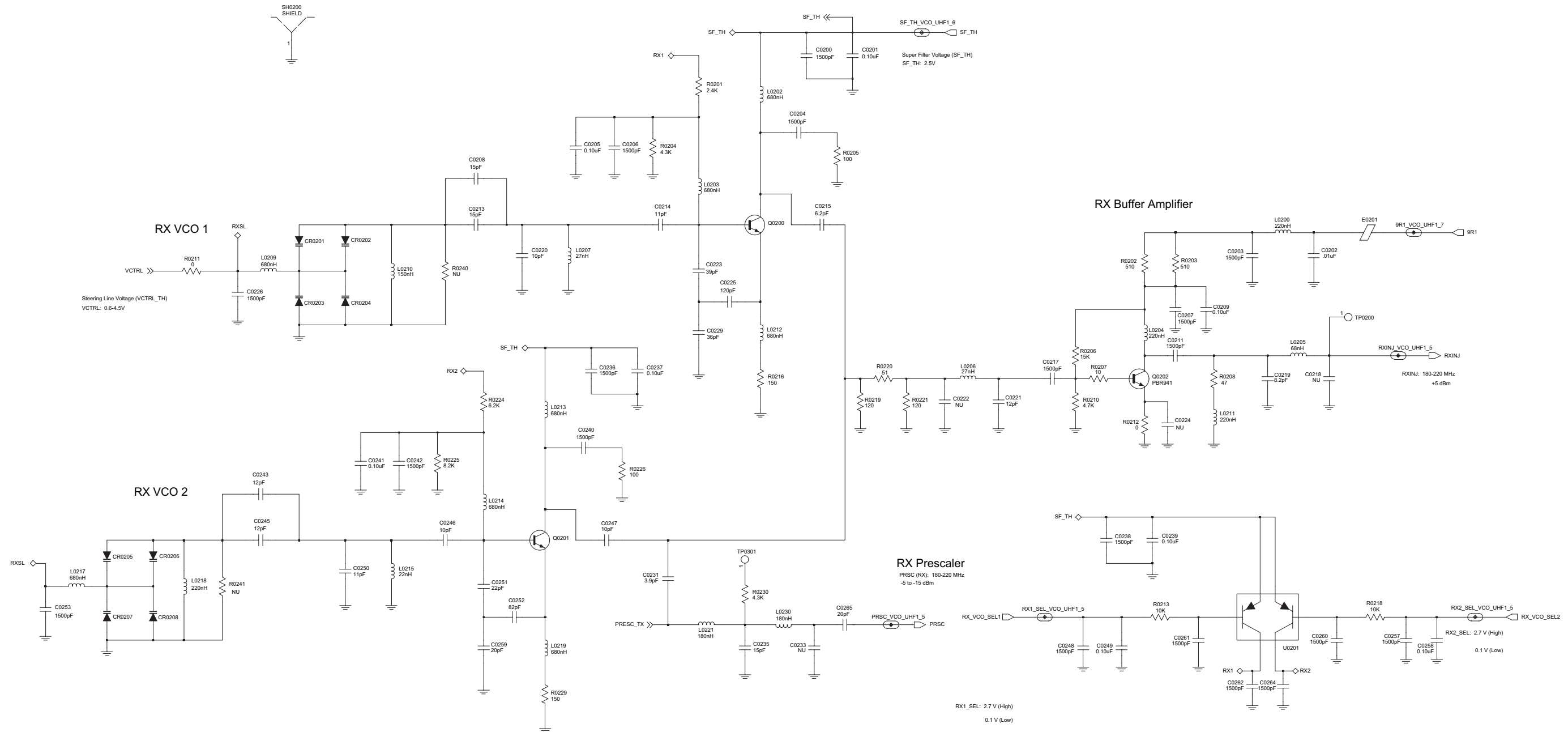
VHF (136-174 MHz) 1-25W Receiver Back-End Schematic Diagram



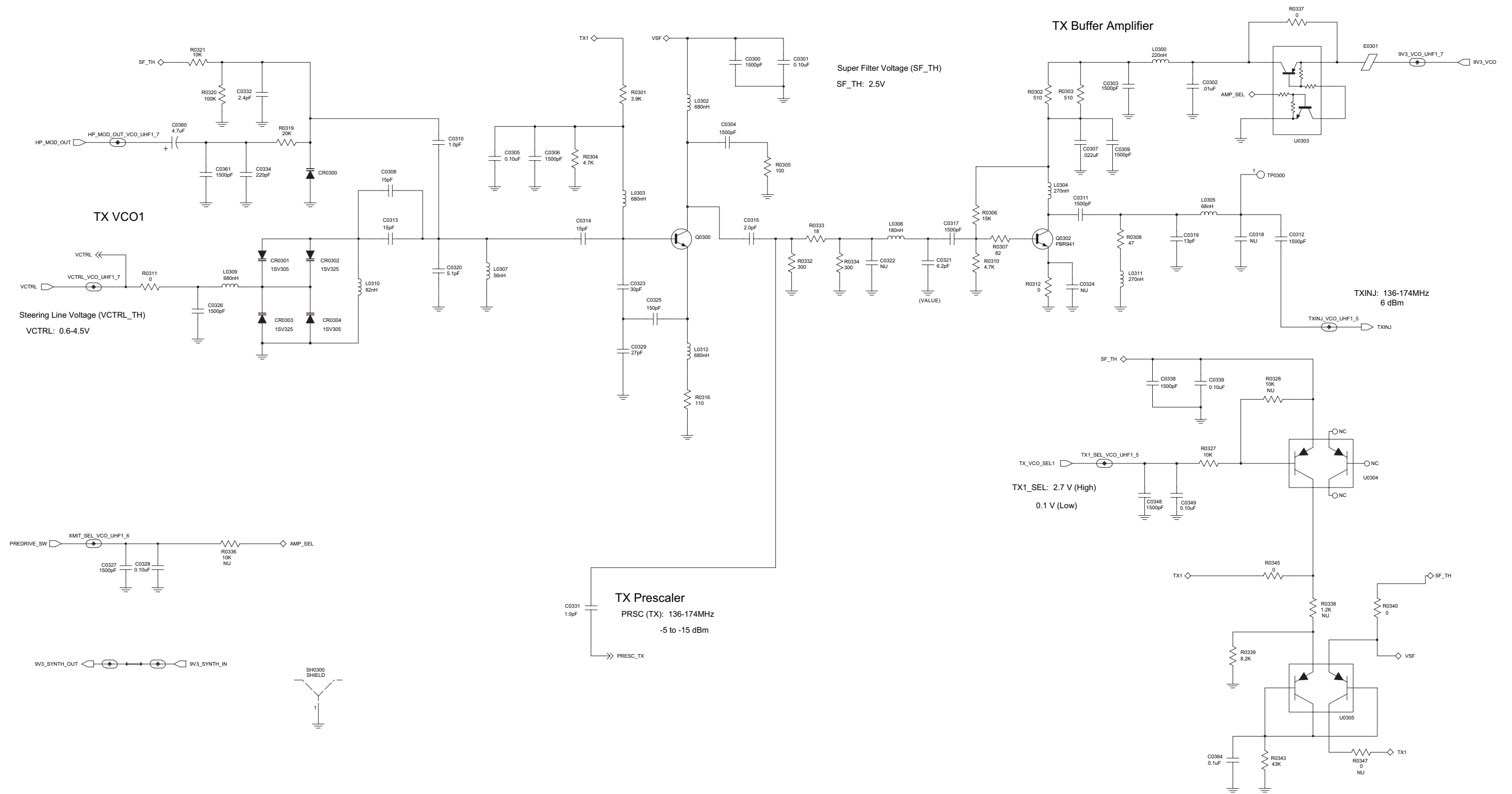
VHF (136-174 MHz) 1-25W Power Control Schematic Diagram



VHF (136-174 MHz) 1-25W Synthesizer Schematic Diagram



VHF (136-174 MHz) 1-25W Receiver VCO Schematic Diagram



VHF (136-174 MHz) 1-25W Transmit VCO Schematic Diagram

**VHF PCB 8471495L01 and 8471495L03 Parts
List 1-25W**

Circuit Ref	Motorola Part No.	Description
C0100	2113945A10	1500pF
C0101	2113945A10	1500pF
C0102	2113945A10	1500pF
C0103	2113945C31	0.1uF
C0104	2113945A10	1500pF
C0105	2113945C31	0.1uF
C0106	2113945C31	0.1uF
C0107	2113945C31	0.1uF
C0108	2113945A10	1500pF
C0109	2113945C31	0.1uF
C0110	2113945C31	0.1uF
C0111	2113945C31	0.1uF
C0112	2113945A10	1500pF
C0113	NOT PLACED	
C0114	2113946E02	1.0uF
C0115	2113946E02	1.0uF
C0117	2113945A10	1500pF
C0118	2113945C31	0.1uF
C0119	NOT PLACED	
C0120	2113945B02	.01uF
C0121	NOT PLACED	
C0122	2113945B02	.01uF
C0123	2113946E02	1.0uF
C0124	2113945C31	0.1uF
C0125	2113945A10	1500pF
C0126	2113945A10	1500pF
C0127	2113945A10	1500pF
C0128	2113945A10	1500pF
C0129	2113945C31	0.1uF
C0130	2113945A10	1500pF
C0131	2113945A10	1500pF
C0132	2113945A10	1500pF
C0133	2313960B30	4.7uF
C0134	2113945A10	1500pF
C0135	2313960B32	10uF
C0136	2113945C31	0.1uF
C0137	2313960B32	10uF
C0138	2113945A10	1500pF
C0140	2313960B30	4.7uF
C0141	2113945C31	0.1uF
C0142	2113945A10	1500pF
C0143	2113945A10	1500pF
C0144	2113945C31	0.1uF
C0145	2113945B02	.01uF
C0146	2113945A10	1500pF
C0147	2113945A10	1500pF
C0148	NOT PLACED	
C0149	2113945C31	0.1uF
C0150	2113945C31	0.1uF

Circuit Ref	Motorola Part No.	Description
C0151	2113945C31	0.1uF
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	2185419D06	0.1uF
C0171	2113945B02	.01uF
C0175	2113945A10	1500pF
C0177	2113945A10	1500pF
C0178	2113945A10	1500pF
C0179	2113945A10	1500pF
C0180	2113945C31	0.1uF
C0191	2185419D06	0.1uF
C0192	2185419D06	0.1uF
C0193	2185419D06	0.1uF
C0194	2185419D06	0.1uF
C0195	2113945A05	470pF
C0196	2113946H02	10uF
C0200	2113945A10	1500pF
C0201	2113945Y02	0.10uF
C0202	2113945B02	.01uF
C0203	2113945A10	1500pF
C0204	2113945A10	1500pF
C0205	2113945Y02	0.10uF
C0206	2113945A10	1500pF
C0207	2113945A10	1500pF
C0208	2115153H37	15pF
C0209	2113945Y02	0.10uF
C0211	2113945A10	1500pF
C0213	2115153H37	15pF
C0214	2115153H34	11pF
C0215	2115153H22	6.2pF
C0217	2113945A10	1500pF
C0218	NOT PLACED	
C0219	2115153H25	8.2pF
C0220	2115153H27	10pF
C0221	2115153H35	12pF
C0222	NOT PLACED	
C0223	2115153H47	39pF
C0224	NOT PLACED	
C0225	2115153H59	120pF
C0226	2113945A10	1500pF
C0229	2115153H46	36pF
C0231	2115153H17	3.9pF
C0233	NOT PLACED	

Circuit Ref	Motorola Part No.	Description
C0235	2115153H37	15pF
C0236	2113945A10	1500pF
C0237	2113945Y02	0.10uF
C0238	2113945A10	1500pF
C0239	2113945Y02	0.10uF
C0240	2113945A10	1500pF
C0241	2113945Y02	0.10uF
C0242	2113945A10	1500pF
C0243	2115153H35	12pF
C0245	2115153H35	12pF
C0246	2115153H27	10pF
C0247	2115153H27	10pF
C0248	2113945A10	1500pF
C0249	2113945Y02	0.10uF
C0250	2115153H34	11pF
C0251	2115153H41	22pF
C0252	2115153H55	82pF
C0253	2113945A10	1500pF
C0257	2113945A10	1500pF
C0258	2113945Y02	0.10uF
C0259	2115153H40	20pF
C0260	2113945A10	1500pF
C0261	2113945A10	1500pF
C0262	2113945A10	1500pF
C0264	2113945A10	1500pF
C0265	2115153H40	20pF
C0300	2113945A10	1500pF
C0301	2113945Y02	0.10uF
C0302	2113945B02	.01uF
C0303	2113945A10	1500pF
C0304	2113945A10	1500pF
C0305	2113945Y02	0.10uF
C0306	2113945A10	1500pF
C0307	2113945B04	.022uF
C0308	2115153H37	15pF
C0309	2113945A10	1500pF
C0310	2115153H03	1.0pF
C0311	2113945A10	1500pF
C0312	2113945A10	1500pF
C0313	2115153H37	15pF
C0314	2115153H37	15pF
C0315	2115153H10	2.0pF
C0317	2113945A10	1500pF
C0318	NOT PLACED	
C0319	2115153H36	13pF
C0320	2115153H20	5.1pF
C0321	2115153H22	6.2pF
C0322	NOT PLACED	
C0323	2115153H44	30pF
C0324	NOT PLACED	
C0325	2113944A42	150pF

Circuit Ref	Motorola Part No.	Description
C0326	2113945A10	1500pF
C0327	2113945A10	1500pF
C0328	2113945Y02	0.10uF
C0329	2115153H43	27pF
C0331	2115153H03	1.0pF
C0332	2115153H12	2.4pF
C0334	2113944A44	220pF
C0338	2113945A10	1500pF
C0339	2113945Y02	0.10uF
C0348	2113945A10	1500pF
C0349	2113945Y02	0.10uF
C0360	2313960B30	4.7uF
C0361	2113945A10	1500pF
C0364	2113946B04	0.1uF
C0400	2113945A10	1500pF
C0401	2113945C31	0.1uF
C0402	2113945A10	1500pF
C0403	2115153H50	51pF
C0404	2113945A10	1500pF
C0405	2113945A10	1500pF
C0406	2115153H23	6.8pF
C0407	2113945A10	1500pF
C0408	2115153H22	6.2pF
C0409	2115153H35	12pF
C0410	2115153H40	20pF
C0411	2115153H40	20pF
C0412	2115153H49	47pF
C0413	2113945A10	1500pF
C0414	2113945A10	1500pF
C0416	2115153H37	15pF
C0417	2115153H37	15pF
C0418	2113945A05	470pF
C0419	2113945Y02	0.10uF
C0420	NOT PLACED	
C0421	2115153H19	4.7pF
C0422	2115153H48	43pF
C0423	2115153H51	56pF
C0424	2115153H48	43pF
C0425	2115153H50	51pF
C0426	2115153H48	43pF
C0427	2115153H50	51pF
C0428	2115153H48	43pF
C0429	2115153H50	51pF
C0430	2115153H48	43pF
C0431	2115153H51	56pF
C0432	2115153H50	51pF
C0433	2113945A10	1500pF
C0434	2113945A10	1500pF
C0435	2113946S35	1.0uF
C0436	2113945A10	1500pF
C0437	2113945A10	1500pF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0438	2113945A10	1500pF	C0622	2113945A09	1000pF	C0724	2111078B31	36pF	C0805	NOT PLACED	
C0439	2113945A10	1500pF	C0623	2113945Y02	0.10uF	C0725	2111078B31	36pF	C0806	2113945A10	1500pF
C0440	2113945Y02	0.10uF	C0625	2113944C89	200pF	C0726	2111078B40	82pF	C0817	NOT PLACED	
C0441	2115153H17	3.9pF	C0626	2113944A40	100pF	C0727	2111078B14	11pF	C0818	NOT PLACED	
C0442	2113945A10	1500pF	C0627	2113944A40	100pF	C0728	2113944C06	470pF	C0819	2111078B31	36pF
C0443	2115153H42	24pF	C0628	2113945Y02	0.10uF	C0729	NOT PLACED		C0820	NOT PLACED	
C0444	2115153H42	24pF	C0629	2113945A11	2200pF	C0730	NOT PLACED		C0821	NOT PLACED	
C0445	2115153H44	30pF	C0630	2113945Y02	0.10uF	C0731	2111078B59	470pF	C0822	2113944C51	1000pF
C0446	2115153H27	10pF	C0631	2113945Y02	0.10uF	C0732	NOT PLACED		C0823	2113944C51	1000pF
C0447	2115153H42	24pF	C0632	2313960B30	4.7uF	C0733	2113944C06	470pF	C0824	NOT PLACED	
C0448	2115153H41	22pF	C0633	2113945Y02	0.10uF	C0734	2113944C06	470pF	C0900	2113945A10	1500pF
C0449	2115153H27	10pF	C0634	2113945B02	.01uF	C0735	2111078B49	180pF	C0901	2113945C31	0.1uF
C0450	2115153H26	9.1pF	C0635	2113944A40	100pF	C0738	2113955D13	2.2uF	C0902	2113945C31	0.1uF
C0451	2115153H53	68pF	C0636	2113944A40	100pF	C0739	2111078B33	43pF	C0903	2113945A10	1500pF
C0452	2115153H37	15pF	C0637	2113946S35	1.0uF	C0740	2111078B34	47pF	C0904	2113945A10	1500pF
C0453	2115153H47	39pF	C0638	2113945Y02	0.10uF	C0741	2111078B22	22pF	C0906	2113945A10	1500pF
C0454	2113945A10	1500pF	C0640	2113946N03	2.2uF	C0742	2111078B11	8.2pF	C0907	2113945C02	.01uF
C0455	2113945A10	1500pF	C0641	2113945B02	.01uF	C0745	2111078B59	470pF	C0908	2113945C31	0.1uF
C0456	2113945A10	1500pF	C0642	2115153H53	68pF	C0746	2111078B59	470pF	C0909	2113945A10	1500pF
C0457	2113945A10	1500pF	C0643	2113945Y02	0.10uF	C0750	2111078B16	13pF	C0910	2113945A10	1500pF
C0458	2115153H55	82pF	C0644	2113945Y02	0.10uF	C0752	NOT PLACED		C0911	2113945A10	1500pF
C0502	2113945Y02	0.10uF	C0645	2113945B02	.01uF	C0753	NOT PLACED		C0912	2113945A10	1500pF
C0503	2113945Y02	0.10uF	C0646	2113946G04	0.68uF	C0754	2111078B47	180pF	C0913	2113945A10	1500pF
C0504	2113945Y02	0.10uF	C0647	2113946J03	10.0uF	C0755	NOT PLACED		C0914	2113945A10	1500pF
C0506	2115153H35	12pF	C0648	2113946J03	10.0uF	C0766	2113944C35	27pF	C0915	2113945A10	1500pF
C0507	2115153H38	18pF	C0649	2113945A12	3300pF	C0767	2113944C06	470pF	C0916	2113945A10	1500pF
C0509	NOT PLACED		C0650	2115153H44	30pF	C0770	2113945A10	1500pF	C0917	2113945A09	1000pF
C0510	2115153H24	7.5pF	C0651	2113945A10	1500pF	C0771	NOT PLACED		C0918	2113945A10	1500pF
C0512	2113945Y02	0.10uF	C0700	2113944C36	33pF	C0772	2113944C30	10pF	C0919	2113945C31	0.1uF
C0513	2113945Y02	0.10uF	C0701	2113945C25	.033uF	C0775	NOT PLACED		C0920	2113945A10	1500pF
C0514	2113945Y02	0.10uF	C0702	2113944C51	1000pF	C0776	2113944C51	1000pF	C0921	2113945C31	0.1uF
C0515	NOT PLACED		C0703	2113944C36	33pF	C0777	2113944C51	1000pF	C0922	2113945A10	1500pF
C0516	NOT PLACED		C0704	2113945C25	.033uF	C0778	2111078B47	150pF	C0923	2113944C55	2200pF
C0601	2115153H48	43pF	C0705	2113944C51	1000pF	C0779	2111078B32	39pF	C0925	2113945A10	1500pF
C0602	2113945B02	.01uF	C0706	NOT PLACED		C0780	NOT PLACED		C0926	2113945L41	4700pF
C0603	2113944A44	220pF	C0707	NOT PLACED		C0783	2113945A10	1500pF	C0927	2113944C02	220pF
C0604	2113945Y02	0.10uF	C0708	2113944C51	1000pF	C0786	2113944C06	470pF	C0928	2113944C51	1000pF
C0605	2115153H48	43pF	C0709	2113945C31	0.1uF	C0790	2113944C02	220pF	C0929	2113945A10	1500pF
C0607	2115153H37	15pF	C0710	2371403L02	10uF	C0791	2113944C39	56pF	C0931	2113945A10	1500pF
C0610	2115153H51	56pF	C0711	2113945L49	.01uF	C0792	2113944C06	470pF	C0934	2113945A10	1500pF
C0611	2113945A09	1000pF	C0712	2113944C06	470pF	C0793	NOT PLACED		C0935	2113945A10	1500pF
C0612	2115153H39	18pF	C0713	NOT PLACED		C0794	NOT PLACED		C0936	2113945A10	1500pF
C0613	2113945G91	0.1uF	C0714	2111078B59	470pF	C0795	2113944C06	470pF	C0937	2113945A10	1500pF
C0614	2115153H41	22pF	C0716	NOT PLACED		C0796	2113944C47	150pF	C0939	2113945A10	1500pF
C0615	2113945B02	.01uF	C0717	2113945A09	1000pF	C0797	2113944C51	1000pF	C0940	2113944C51	1000pF
C0616	NOT PLACED		C0718	2113945A09	1000pF	C0798	2113944C51	1000pF	C0941	2113944M27	24pF
C0617	2113945Y02	0.10uF	C0719	2111078B35	51pF	C0799	2113944C47	150pF	C0942	2113944C51	1000pF
C0618	2115358H25	1uF	C0720	2111078B35	51pF	C0801	2113945A10	1500pF	C0943	2113944C51	1000pF
C0619	2113945Y02	0.10uF	C0721	2111078B40	82pF	C0802	NOT PLACED		C0944	2113944M18	10pF
C0620	2113945Y02	0.10uF	C0722	NOT PLACED		C0803	2111078B21	20pF	C0945	2113944C51	1000pF
C0621	2113945Y02	0.10uF	C0723	2111078B59	470pF	C0804	2113944C51	1000pF	C0947	2113944A40	100pF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0948	2113946S35	1.0uF	E0605	2409134J25	FERRITE BEAD	L0407	2414032F74	560nH	Q0200	4805793Y10	NPN RF TRANSISTOR
C0949	2113946G01	2.2uF	E0606	2409134J25	FERRITE BEAD	L0408	2414015B02	68nH	Q0201	4805793Y10	NPN RF TRANSISTOR
C0950	2113945A09	1000pF	E0607	2409134J25	FERRITE BEAD	L0409	2414015B02	68nH	Q0202	4802197J95	NPN RF TRANSISTOR
C0951	2113945C31	0.1uF	E0608	2409134J25	FERRITE BEAD	L0410	2414015B12	47nH	Q0300	4805793Y10	NPN RF TRANSISTOR
C0953	2113945A10	1500pF	E0609	2409134J25	FERRITE BEAD	L0411	2414017N20	47nH	Q0302	4802197J95	NPN RF TRANSISTOR
R0980	0613952J25	100K	E0610	2480640Z01	FERRITE BEAD	L0412	2414017N26	150nH	Q0400	4815271H01	ANALOG SWITCH
R0981	0613952H82	2.4K	E0700	2485011Y01	FERRITE BEAD	L0414	2414017K32	560nH	Q0401	4815267H01	DUAL PNP
R0982	0613952G67	0	E0701	2485011Y01	FERRITE BEAD	L0503	2414015B32	330nH	Q0402	4871127H01	NPN RF TRANSISTOR
CR0201	4815096H01	DIODE VARACTOR 1SV305	E0702	7671656M01	FERRITE BEAD	L0504	NOT PLACED		Q0403	4815270H01	DUAL NPN/PNP
CR0202	4815096H01	DIODE VARACTOR 1SV305	E0703	2485011Y01	FERRITE BEAD	L0506	2414032B70	1.5uH	Q0405	4871127H01	NPN RF TRANSISTOR
CR0203	4815096H01	DIODE VARACTOR 1SV305	E0704	2409134J25	FERRITE BEAD	L0602	2414032K29	8.2uH	Q0500	4802197J95	NPN RF TRANSISTOR
CR0204	4815096H01	DIODE VARACTOR 1SV305	FL0500	9180022M11	73.35MHZ CRYSTAL FILTER	L0603	2414032D28	820nH	Q0501	4802197J95	NPN RF TRANSISTOR
CR0205	4815096H01	DIODE VARACTOR 1SV305	J0700	0905901V12	BNC RF CONNECTOR	L0604	2466505A01	10uH	Q0600	4805793Y10	NPN RF TRANSISTOR
CR0206	4815096H01	DIODE VARACTOR 1SV305	L0100	2414017N29	270nH	L0605	2466505A01	10uH	Q0601	4813973A04	NPN DARLINGTON
CR0207	4815096H01	DIODE VARACTOR 1SV305	L0200	2414017N28	220nH	L0608	2414032B76	4.7uH	Q0700	4813970A59	P-CHANNEL MOSFET
CR0208	4815096H01	DIODE VARACTOR 1SV305	L0202	2414017K33	680nH	L0700	2460592A01	17nH	Q0701	4815261H01	ANALOG SWITCH
CR0300	4815096H01	DIODE VARACTOR 1SV305	L0203	2414017K33	680nH	L0702	2479990G01	33.47nH	Q0702	0104025J50	MRF1535PA ASSEMBLY
CR0301	4815096H01	DIODE VARACTOR 1SV305	L0204	2414017N28	220nH	L0705	2414017N26	150nH	Q0703	4816548H01	N-CHANNEL LDMOS DRIVER
CR0302	4815059H01	DIODE VARACTOR 1SV325	L0205	2414017N22	68nH	L0706	2485873L02	25nH	Q0704	4813973B02	PNP
CR0303	4815059H01	DIODE VARACTOR 1SV325	L0206	2414017N17	27nH	L0707	2485873L01	18nH	Q0705	4816547H01	N-CHANNEL LDMOS PRE-DRIVER
CR0304	4815096H01	DIODE VARACTOR 1SV305	L0207	2416077H12	27nH	L0708	2485873L01	18nH	Q0706	4815272H01	ANALOG SWITCH
CR0400	4813974A19	DIODE, SCHOTTKY	L0209	2414017K33	680nH	L0709	2485873L02	25nH	Q0707	4815272H01	ANALOG SWITCH
D0400	4813974A06	DIODE, PIN	L0210	2414015B06	150nH	L0710	2485873L02	25nH	Q0708	4815272H01	ANALOG SWITCH
D0401	4885094Y01	DIODE VARACTOR 1SV228	L0211	2414017N28	220nH	L0714	2460592A01	17nH	Q0709	4815272H01	ANALOG SWITCH
D0402	4813978C02	DIODE, PIN	L0212	2414017K33	680nH	L0715	2414017N26	150nH	Q0710	4813973M01	ANALOG SWITCH
D0403	4885094Y01	DIODE VARACTOR 1SV228	L0213	2414017K33	680nH	L0716	2414017N11	8.2nH	Q0900	4815272H01	ANALOG SWITCH
D0405	4815090H01	DIODE, MIXER	L0214	2414017K33	680nH	L0717	2414017N13	12nH	Q0901	4813973A13	PNP
D0500	4813974A19	DIODE, SCHOTTKY	L0215	2416077H11	22nH	L0718	2414017N22	68nH	Q0902	4813973M07	NPN
D0600	4815096H01	DIODE VARACTOR 1SV305	L0217	2414017K33	680nH	L0719	2414017N10	6.8nH	R0100	0613952R66	0
D0601	4815096H01	DIODE VARACTOR 1SV305	L0218	2414015B08	220nH	L0720	2485873L01	18nH	R0101	0613952R66	0
D0700	4802482J02	DIODE, PIN	L0219	2414017K33	680nH	L0721	2485873L02	25nH	R0102	0613952R66	0
D0702	4802482J02	DIODE, PIN	L0221	2414017N27	180nH	L0722	2415385H04	17.5nH	R0103	0613952R66	0
D0703	4886622Y06	DIODE, PIN	L0230	2414017N27	180nH	L0723	2415385H06	28nH	R0104	0613952R17	47K
D0900	4813978C02	DIODE, SWITCHING	L0300	2414017N28	220nH	L0724	2485873L02	25nH	R0105	0613952Q58	240
D0901	4815897H01	DIODE, PIN	L0302	2414017K33	680nH	L0725	2414032B69	1.2uH	R0106	0613952Q83	2.7K
D0902	4815024H01	DIODE, PIN	L0303	2414017K33	680nH	L0728	2414032B70	1.5uH	R0107	0613952Q57	220
D0903	4815024H01	DIODE, PIN	L0304	2414017N29	270nH	L0729	2414032B69	1.2uH	R0108	0613952Q80	2K
D0904	4813974A21	DIODE, SCHOTTKY	L0305	2414017N22	68nH	L0730	2414032B53	100nH	R0109	0613952R66	0
D0905	4813974A21	DIODE, SCHOTTKY	L0306	2414017N27	180nH	L0731	2414032B53	100nH	R0110	0613952Q42	51
E0201	2480640Z01	FERRITE BEAD	L0307	2414015C08	56nH	L0745	2460591A01	4.22nH	R0111	0613952R66	0
E0301	2480640Z01	FERRITE BEAD	L0309	2414017K33	680nH	L0900	2414032D30	1uH	R0113	0613952R01	10K
E0400	2409134J25	FERRITE BEAD	L0310	2414017N23	82nH	L0901	2414017K32	560nH	R0114	0613952Q80	2K
E0401	2409134J25	FERRITE BEAD	L0311	2414017N29	270nH	L0902	2414017K32	560nH	R0115	0613952R66	0
E0403	2409134J25	FERRITE BEAD	L0312	2414017K33	680nH	L0903	NOT PLACED		R0116	0613952R66	0
E0404	2409134J25	FERRITE BEAD	L0400	2414017K32	560nH	L0904	NOT PLACED		R0117	0613952R12	30K
E0500	2409134J25	FERRITE BEAD	L0401	2414032F31	56nH	M0700	2686201B02	HEATSINK	R0118	0613952R66	0
E0600	2409134J25	FERRITE BEAD	L0402	NOT PLACED		Q0100	4802197J95	NPN RF TRANSISTOR	R0119	0613952Q35	27
E0601	2409134J25	FERRITE BEAD	L0403	NOT PLACED		Q0102	4815359H01	DUAL PNP	R0120	0613952R01	10K
E0602	2409134J25	FERRITE BEAD	L0404	NOT PLACED		Q0106	4816134H01	ANALOG SWITCH	R0122	NOT PLACED	
E0603	2409134J25	FERRITE BEAD	L0405	NOT PLACED		Q0107	4813970A59	P-CHANNEL MOSFET	R0123	0613952R19	56K
E0604	2409134J25	FERRITE BEAD	L0406	2414032F29	39nH	Q0108	4815261H01	ANALOG SWITCH			

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
R0125	0613952R66	0	R0310	0613952Q89	4.7K	R0432	0613958H44	62	R0715	0613952H46	75
R0126	NOT PLACED		R0311	0613952R66	0	R0433	0613952R66	0	R0716	0613958S29	15
R0127	0613952Q42	51	R0312	0613952R66	0	R0434	NOT PLACED		R0717	0613958S29	15
R0128	0613952Q25	10	R0316	0613952Q50	110	R0435	0613952Q65	470	R0718	0613952H35	27
R0131	0613952Q53	150	R0319	0613952R08	20K	R0436	0613952Q53	150	R0719	0613958S29	15
R0134	0613952Q42	51	R0320	0613952R25	100K	R0437	0613952Q53	150	R0720	0613952H35	27
R0139	NOT PLACED		R0321	0613952R01	10K	R0439	0613952Z45	3.6K	R0721	0613958S29	15
R0140	NOT PLACED		R0327	0613952R01	10K	R0440	0613952Q32	20	R0722	0613952J07	18K
R0144	0613952R01	10K	R0328	NOT PLACED		R0500	0613952Q90	5.1K	R0723	0613958J49	1MEG
R0146	0613952R66	0	R0332	0613952Q60	300	R0501	0613952Q61	330	R0726	0613958S29	15
R0147	NOT PLACED		R0333	0613952Q31	18	R0502	0613952R08	20K	R0727	0613952J05	15K
R0148	0613952Q51	120	R0334	0613952Q60	300	R0503	0613952R12	30K	R0728	0613952H89	4.7K
R0155	0613952R66	0	R0336	NOT PLACED		R0508	0613952R19	56K	R0729	0613952J01	10K
R0156	NOT PLACED		R0337	0613952R66	0	R0509	0613952Q89	4.7K	R0730	0613952H73	1K
R0157	NOT PLACED		R0338	NOT PLACED		R0510	0613952R12	30K	R0731	NOT PLACED	
R0158	NOT PLACED		R0339	0613952Q95	8.2K	R0511	0613952Q75	1.2K	R0732	0613958S29	15
R0159	0613952R01	10K	R0340	0613952R66	0	R0512	0613952Q42	51	R0733	0613958S29	15
R0160	0613952R25	100K	R0343	0613952R16	43K	R0601	0613952Q51	120	R0734	0613958S29	15
R0161	0613952R25	100K	R0345	0613952R66	0	R0602	0613952R01	10K	R0735	0613959Y49	100
R0201	0613952Q82	2.4K	R0347	NOT PLACED		R0603	0613952Q66	510	R0736	0613958S29	15
R0202	0613952Q66	510	R0400	0613952R05	15K	R0604	0613952R10	24K	R0737	0613958S29	15
R0203	0613952Q66	510	R0401	0613952Q73	1K	R0605	0613952Q61	330	R0738	0613959Y42	51
R0204	0613952Q88	4.3K	R0402	0613958H33	22	R0606	0613952Q42	51	R0739	0613958S29	15
R0205	0613952Q49	100	R0403	0613952R66	0	R0607	NOT PLACED		R0740	0613958J74	0
R0206	0613952R05	15K	R0404	0613952Q83	2.7K	R0608	0613952R66	0	R0742	0613959Q25	10
R0207	0613952Q25	10	R0406	0613952Q68	620	R0609	0613952R66	0	R0745	0613952H65	470
R0208	0613952Q41	47	R0407	0613952Q57	220	R0610	0613952R66	0	R0746	0613952R66	0
R0210	0613952Q89	4.7K	R0408	0613952R01	10K	R0611	0613952R66	0	R0747	0613952H49	100
R0211	0613952R66	0	R0409	0613952Z43	3K	R0612	0613952R66	0	R0748	0613952J19	56K
R0212	0613952R66	0	R0410	0613952R25	100K	R0613	0613952R66	0	R0749	0613952G67	0
R0213	0613952R01	10K	R0411	0613952Q39	39	R0614	0613952R66	0	R0750	0613952J07	18K
R0216	0613952Q53	150	R0412	0613952R25	100K	R0615	0613952R66	0	R0751	0613952J11	27K
R0218	0613952R01	10K	R0413	0613952Q69	680	R0616	0613952R25	100K	R0752	0613952G67	0
R0219	0613952Q51	120	R0414	0613952Q69	680	R0617	0613952R01	10K	R0753	0613952H73	1K
R0220	0613952Q42	51	R0415	0613952Q69	680	R0618	0613952Q63	390	R0754	0613952H35	27
R0221	0613952Q51	120	R0416	0613952Q69	680	R0619	0613952R01	10K	R0755	0613952H35	27
R0224	0613952Q92	6.2K	R0417	0613958H43	56	R0620	0613952Q96	9.1K	R0756	0613952J25	100K
R0225	0613952Q95	8.2K	R0418	0613952M42	2.67K	R0621	0613952R66	0	R0757	0613952J17	47K
R0226	0613952Q49	100	R0419	0613952Q83	2.7K	R0622	NOT PLACED		R0759	0613958J74	0
R0229	0613952Q53	150	R0420	0613952Q83	2.7K	R0623	NOT PLACED		R0760	0613952J01	10K
R0230	0613952Q88	4.3K	R0421	0613952R66	0	R0624	0613952Q90	5.1K	R0761	0613952G67	0
R0240	NOT PLACED		R0422	0613952Q42	51	R0625	0613952N69	51.1K	R0773	0613952J21	68K
R0241	NOT PLACED		R0423	0613952Q53	150	R0626	0613952N81	68.1K	R0775	NOT PLACED	
R0301	0613952Q87	3.9K	R0424	0613952Q53	150	R0627	0613952R66	0	R0777	0613952J25	100K
R0302	0613952Q66	510	R0425	0613952M01	1K	R0702	NOT PLACED		R0779	0613952G67	0
R0303	0613952Q66	510	R0426	0613952R01	10K	R0706	0613958H57	220	R0780	0613952G67	0
R0304	0613952Q89	4.7K	R0427	0613952Q42	51	R0710	0613958J49	1MEG	R0781	0613958S73	1K
R0305	0613952Q49	100	R0428	0613952R66	0	R0711	0613952H51	120	R0900	0613952R19	56K
R0306	0613952R05	15K	R0429	0613952Q69	680	R0712	0613958S29	15	R0901	0613952R16	43K
R0307	0613952Q47	82	R0430	0613952R01	10K	R0713	0613959H12	30K	R0902	0613952Q88	4.3K
R0308	0613952Q41	47	R0431	0613952R01	10K	R0714	0613952H46	75	R0903	0613952R09	22K

Circuit Ref	Motorola Part No.	Description
R0906	0613952R66	0
R0907	0613952R66	0
R0909	0613952R16	43K
R0910	0613952H73	1K
R0911	0613952Q89	4.7K
R0912	0613952R11	27K
R0913	0613952R66	0
R0914	0613952R39	390K
R0915	0613952R19	56K
R0916	0613952Q49	100
R0917	0613952H91	5.6K
R0918	0613952H63	390
R0919	0613952R15	39K
R0920	0613952R13	33K
R0921	0613952H81	2.2K
R0922	0613952R14	36K
R0923	0613952R66	0
R0924	0613952H91	5.6K
R0925	0613952H91	5.6K
R0926	0613958H46	75
R0927	0613952H42	51
R0928	0613958H41	47
R0929	0613958H41	47
R0930	0613952R07	18K
R0931	0613952R66	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
R0970	0613959Y49	100
R0972	0613952G67	0
R0973	0613952G67	0
R0975	0613959Y47	82
R0976	0613952H39	39
R0977	0613952H39	39
R0978	0613952G67	0
R0979	0613952G67	0
RT0908	0615585H01	THERMISTOR, 47K
RT0953	0615585H01	THERMISTOR, 47K
SH0100	2615362H01	SHIELD

Circuit Ref	Motorola Part No.	Description
SH0101	2615362H01	SHIELD
SH0200	2615362H01	SHIELD
SH0300	2615362H01	SHIELD
SH0500	2615576H01	SHIELD
SH0900	2686423Z02	SHIELD
SH0901	2686425Z02	SHIELD
SP0701	1015349H01	SOLDER_PREFORM
SP0702	1015349H01	SOLDER_PREFORM
SP0703	1015349H01	SOLDER_PREFORM
SP0704	1015349H01	SOLDER_PREFORM
SP0705	1015349H01	SOLDER_PREFORM
SP0706	1015349H01	SOLDER_PREFORM
SP0707	1015349H01	SOLDER_PREFORM
SP0708	1015349H01	SOLDER_PREFORM
T0400	2515121H01	BALUN XFMR
T0401	2515121H01	BALUN XFMR
U0100	5104932K08	IC, FRACN SYNTHESIZER
U0101	5114000B59	ANALOG SWITCH
U0201	4815267H01	DUAL PNP
U0303	4815272H01	ANALOG SWITCH
U0304	4815267H01	DUAL PNP
U0305	4815267H01	DUAL PNP
U0600	5102495J14	IC, RF ASIC
U0601	5115391H01	VOLTAGE REGULATOR
U0700	NOT PLACED	
U0900	5115147H01	DUAL OPAMP
U0901	5115147H01	DUAL OPAMP
U0940	5180390L83	IC, PA CONTROLLER
U0941	5115391H01	VOLTAGE REGULATOR
U0942	5114004A35	VOLTAGE DETECTOR
VR0700	4813977M11	DIODE, 5.6V ZENER
Y0100	5102495J07	1.5PPM 16.8MHZ TCXO (Non-GPS Models only)
Y0100	5116032H01	0.5PPM 16.8MHZ TCXO (GPS Models only)



**DM 3400/DM 3401/
DM 3600/DM 3601
Mobile Radios**

Chapter 8

VHF (136-174 MHz)

25-45W

Service Information

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Section 1

THEORY OF OPERATION

1.0 Introduction

This Chapter provides a detailed theory of operation for the VHF 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 VHF (136-174 MHz) Receiver Circuitry

The receiver is configured as a dual-conversion superheterodyne receiver, capable of both FM and 4-level FSK demodulation. The major blocks are the front-end, the mixer, Xtal filter, and the Abacus III back-end IC. The overall block diagram is shown in Figure 1-1.

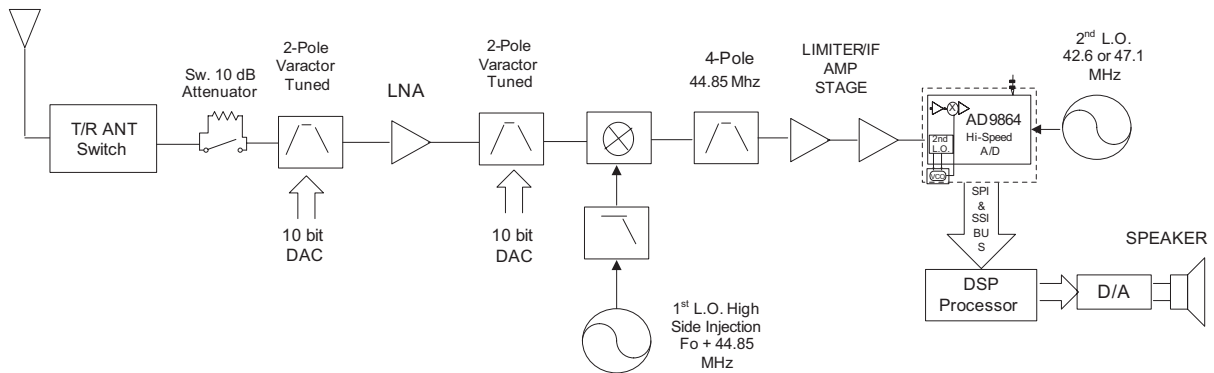


Figure 1-1 Receiver Block Diagram

2.1 Receiver Front-End

The front-end consists of a 2-pole varactor-tuned pre-selector filter, an LNA, a 2-pole varactor-tuned post-selector filter, and a passive double-balanced mixer. The received signal applied to the antenna is routed through the harmonic filter and PIN diode controlled antenna switch (D0702). A logic high level on ANT_ENABLE configures the antenna switch for Tx operation while a logic low places the switch in Rx mode. The insertion loss of the harmonic filter and antenna switch combined is approximately 0.8 dB max in Rx mode with slightly more loss at the upper end of the band. From this point, the Rx signal is routed to the Local Distance Switch (D0400/R0407), which biases on a diode in normal operation to minimize any insertion loss. Under strong signal conditions and for improved intermodulation protection from interfering signals, the switch can be turned on by the signal RF_ATTEN_1, which introduces approximately 10 dB of additional path loss. Activation of the switch can be accomplished manually by the user or left in the default setting.

The signal next reaches the pre-selector filter, which is a 2-pole varactor-tuned filter with 5 zeros that are optimized to provide image frequency rejection. This filter, and the similarly designed post-selector filter, provide over 75 dB of image response rejection. The 3 dB bandwidth for both filters varies across the band with a minimum of 32 MHz at 136 MHz and a maximum of 38 MHz around 174 MHz. Half-IF rejection from the filters is also frequency dependent with a minimum of approximately 7.5 dB achieved at the worst-case frequency of 174 MHz. Both filters have variable center frequencies that are adjusted by the FE_TUNE signal, which is derived from the output of a 10-bit DAC internal to the MAKO IC (U3200). The voltage is scaled up by a voltage doubler (Q0403) in order to provide the required linearity for the filters. Both filters are matched to the LNA (Q0402) to optimize the amplifier's noise figure (2.0 dB) and to provide an LNA gain of 16 dB to the signal. The combined gain of the filters and LNA is about 14 dB. Active bias transistor Q0401 maintains the collector current of Q0402 constant at 25 mA. The LNA, active bias circuit, Local Distance Switch, and voltage doubler are all supplied by 9R1_FILTER, which is derived from 9R1 after filtering.

Following the post-selector filter is the Class 2, double-balanced mixer. It is comprised of baluns T0400 and T0401 and diode ring mixer D0405. Injection amplifier Q0405 provides 15 dB of gain to the Rx VCO injection signal. Another amplifier, Q0202, located in the VCO block, also provides gain for the LO signal and isolation from high RF signals entering the mixer. The signal applied to the LO port of the mixer is +16 dBm minimum after passing through the 3-pole/1-zero, low-pass injection filter. The LO injection is high-side and mixes the signal down to an IF frequency of 44.85 MHz. The output of the mixer is connected to a diplexer network, which terminates out-of-band frequencies into 51 ohms (R0427) while appearing as high impedance to the 44.85 MHz IF signal.

2.2 Receiver Back-End

The signal entering the back-end is matched to 4-pole crystal filter, FL0500, by C0507 and L0503. The filter is centered at 44.85 MHz with a 3 dB bandwidth of 13.4 kHz. IF amplifiers Q0500 and Q0501 follow the crystal filter and provide both amplification and limiting to the signal. An overall gain of 24 dB is available from the composite IF amplifier to lower-level IF signals. As the signal level increases, Q0501 begins to limit and eventually saturates out at approximately -16 dBm. The purpose of the limiting is to provide protection to the AD9864 Abacus III back-end IC (U0600). An internal 16 dB attenuator is also engaged to provide attenuation to the Abacus's input signal, working with the external amplifier to limit the signal below the ADC clip point. The block diagram for the AD9864 is shown in Figure 1-2 below. At IF levels exceeding -26 dBm into U0600, the 2nd LO synthesizer internal to U0600 can be pulled, causing corruption of the I/Q data being delivered to the DSP.

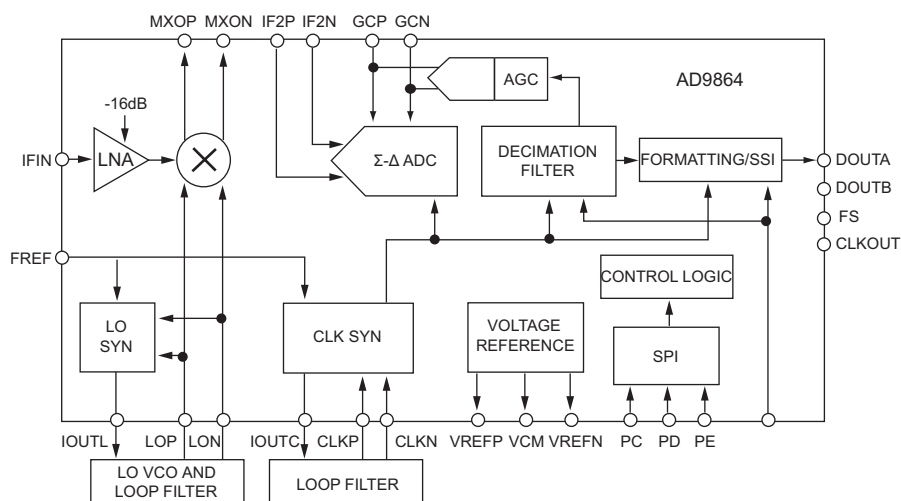


Figure 1-2 AD9864 Block Diagram

The Abacus III accepts the 44.85 MHz signal, processes it, and sends out baseband I/Q data in 16-bit format to the DSP at a 20 kHz rate. Internal to the Abacus III is an LNA and 16 dB FE attenuator, an internal integer-N synthesizer used to control the external 2nd LO VCO, a Sigma-Delta ADC and decimation filter, and control and formatting logic for outputting the baseband I/Q data. External to U0600 is the 2nd LO VCO with active device Q0600 and its associated circuitry including the loop filter consisting of C0613, C0618, and R0603. The 2nd LO mixes the 44.85 MHz IF signal down to 2.25 MHz before being input to the ADC where it is sampled. The tank circuit (L0608, C0605, C0642, R0617) and varactor (D0601) for the internal clock synthesizer, work with the loop filter (R0618, C0643, C0646) to provide the 18 MHz clocking signal to the internal ADC, decimation filter, and SSI formatting circuitry. A 3 Volt regulator (U0601) provides a clean 3 Volt supply to U0600. Transistor Q0601 is configured as a super filter to provide the 2nd LO transistor with a low noise supply. The reference clock for U0600 is 16.8_REF, which is a buffered (Q0100) 16.8 MHz clock from the synthesizer block.

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

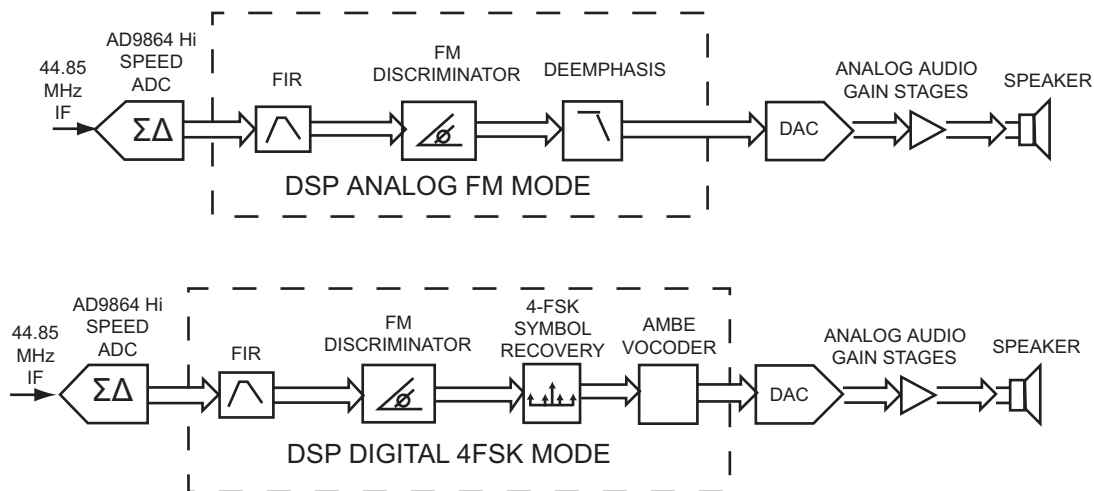


Figure 1-3 Signal Flow through Receiver Back-End

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 filter data is then sent through a decimation process further reducing its frequency to 8 kHz.

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 remaining 8 kHz data is sent through the FM Discriminator and De-emphasis subroutines in the DSP code. If the radio is in Digital mode, the remaining 8 kHz data is still sent through the FM Discriminator but an additional "Symbol Recovery" routine is applied along with a standard AMBE Vocoder process. The resultant audio (still represented by high-speed data) is sent to a DAC (U3200), which drives several 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 Watts of power through the internal speaker.

3.0 VHF (136-174 MHz) Transmitter Circuitry - 45 Watt

The Transmitter consists of the power amplifier circuitry and the power control circuitry. The power amplifier is responsible for delivering a faithful replica of the VCO output amplified up to the desired output power level, free from distortion. The power control circuitry is responsible for ensuring that 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.

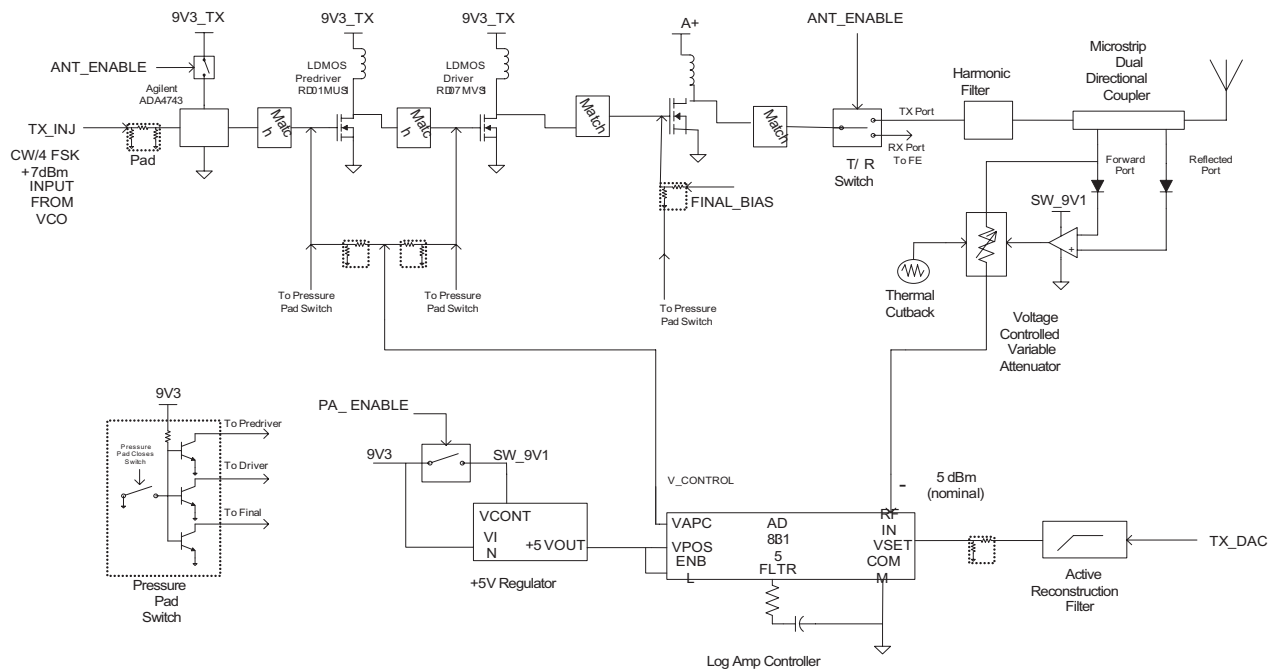


Figure 1-4 VHF 45 Watt High-Power Transmitter Detailed Block Diagram

3.1 Power Amplifier

The radio's 45 Watt power amplifier (PA) is a 4-stage amplifier, which amplifies the output of the VCO to the required transmit power level. The first stage is an LDMOS (Lateral Diffuse MOS) 50 ohm fixed-gain block (ADA-4743, U0700), followed by the adjustable gain LDMOS pre-driver (RD01MUS1, Q0705), an adjustable gain LDMOS driver (RD07MVS1, Q0703), and the fixed-gain LDMOS final device (MRF1550, Q0702). A transmit/receive (TR) switch and a harmonic filter complete the transmit lineup.

3.2 Input Stage (50 Ohm Fixed-Gain Block)

The first stage (ADA-4743, U0700) is an integrated circuit with internally matched 50 ohm input and output stages providing approximately 16.5 dB power gain. Its purpose is to provide reverse isolation between the PA and the VCO to lessen the risk of VCO load pull and to provide appropriate power to the pre-driver stage. The ADA-4743 is biased at 27 mA during transmit by R0706, which is switched to 9V3 during Tx by Q0701 (controlled by Antenna_En). The ADA-4743 is preceded by a 19 dB resistive pad to further improve reverse isolation.

3.3 Pre-Driver Stage

The next stage is a low power LDMOS device (RD01MUS1, Q0705), which delivers up to +27 dBm power to the driver stage. Its gain is controlled by varying the gate bias voltage and varies from low gain up to approximately 14 dB power gain. The gate bias voltage is controlled with the V_cont signal and is controlled in parallel with the driver stage gain.

The input match to this stage is a high-pass topology comprised of L0716, L0718, and C0795. (High-pass matches are used where appropriate to minimize the chances of low frequency regeneration within the amplifier.) The inter-stage match between the pre-driver and driver stages is comprised of C0790, C0786, C0791, C0792, L0717, and L0719 arranged in a high-pass topology. Additional footprints are provided on the printed circuit board to allow for possible engineering optimizations to this match. These are non-populated parts C0793, C0794, C0817, C0820, and C0821.

3.4 Driver Stage

The next stage is a medium-power LDMOS device (RD07MVS1, Q0703), which delivers up to +38 dBm to the final device. 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 and is controlled in parallel with the pre-driver stage gain.

R0718, R0720, R0754, and R0755 are required to improve the bandwidth of the driver stage. The inter-stage match between the driver and final device is comprised of C0819, C0746, C0752, C0754, L0745, and associated micro-strips on the PCB. Additional footprints are provided on the printed circuit board to allow for possible engineering optimizations to this match. These are non-populated parts C0753 and C0755.

3.5 Final Stage

The final stage is a high-power LDMOS device (MRF1550, Q0702). The package is mounted to a copper carrier to improve thermal conductivity to the chassis and also to more tightly control the RF load, allowing higher and more consistent maximum output power. This stage is biased at a quiescent current of 500 mA and operates with a fixed-gain of approximately 14 dB, allowing the radio to be set to a maximum output power of 54 Watts. The quiescent current is set by adjusting the Final_Bias signal.

The output match consists of C0719, C0720, C0721, C0722, C0726, C0727, C0729, C0741, and L0714 and the associated microstrip line on the PCB. The output matching circuitry of this stage has extremely critical part location requirements. Any repairs must be done with care to ensure the replaced components are placed accurately and properly soldered. Of particular concern are the output matching capacitors, C0719, C0720, C0721, C0722, C0726, C0727, and C0729. The resistor networks at the input of each of the final elements are required to improve the bandwidth of the circuit. These resistors are R0712, R0716, R0717, R0719, R0721, R0726, R0732, R0733, R0734, R0736, R0737, and R0739.

Additional footprints are provided on the printed circuit board to allow for possible engineering optimizations to this match. These are non-populated parts C0724, C0725, and C0730. If the final device is replaced, the bias voltage 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 500 mA as noted earlier. The device can tolerate up to 5 Amps for brief periods of time without damage.

3.6 Antenna Switch

The Antenna Switch (TR switch) has two modes of operation, transmit and receive.

Transmit mode:

The antenna switch utilizes the existing dc feed (A+) to the final stage device (Q0702). Both PIN diodes, D0700 and D0702, are turned on during key-up by forward biasing them. Forward biasing is achieved by pulling down the voltage at the cathode end of D0702 to around 12.2 Volts (0.7 Volt drop across each diode). Q0704 is configured as a current sink that maintains the current through the antenna switch diodes at 100 mA, as set by VR0700 and R0738. The current sink is enabled during transmit mode by ANT_ENABLE asserting thru Q0706 and associated circuitry. When the PIN diodes are conducting, an RF ground is formed at the anode of the lower PIN diode D0702, which places the series L0710 and L0724 in parallel with C0803. The values of L0710, L0724, and C0803 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 the top PIN diode to the harmonic filter. To further attenuate the Tx signal from getting to the Rx front-end, a PIN diode pair (D0703) is placed in the Rx path separated from the D0702 short by a quarter wave inductor (L0730 & L0731). This diode pair shorts to ground in transmit mode so that the receiver sees as little transmitter power as possible.

Receive mode:

The DC current thru the PIN diodes is interrupted by turning off the current sink. The RF path now flows from the Harmonic Filter thru the matching circuit formed by C0803, L0710, and L0724, then to pi network C0766, L0730, L0731, and C0772. The additional shunt diodes (D0703) will be high impedance since no bias current is flowing from the switched Tx power line.

3.7 Harmonic Filter

Inductors L0720, L0721, L0706, L0707, L0708, L0709, L0722, and L0723, and capacitors C0742, C0739, C0740, C0735, and C0750, form a harmonic filter which is a 7th order low-pass filter with two notches; this 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 L0728 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 consisting of pin diodes D0901, D0902, and D0903. The log detector/controller regulates the gain of PA stages Q0703 and Q0705 (via V_cont) as necessary, thus ensuring that 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 as part of the VSWR load detection circuitry. Its physical location close to the antenna connector allows accurate VSWR sense at the transmitter output. Forward and reverse coupled signals are rectified by D0904 and D0905, respectively. Resulting DC voltage FWD_DETECTED is proportional to 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, such as may be caused by a damaged antenna, also causes an increase in the difference amplifier output voltage. An increased difference amplifier output causes a reduction in attenuation by the VCA. As a result, the increased RF signal applied to the log detector/controller causes the controller to reduce the gain of PA stages Q0703 and Q0705. Transmitter power is thus reduced to prevent damage to the final device due to an improper load.

3.9 Power Control

The transmitter uses 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-stable, high accuracy control over a typical 50 dB dynamic range.

The MAKO IC 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. Reference voltage level is programmable through the SPI lines of the MAKO. This reference voltage is 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 of the transmitter's coupled power circuits.

The PA controller IC provides a DC output voltage at pin 7 (VAPC), which is divided 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 by controlling the gate bias of stages Q0703 and Q0705. Voltage divider combination R0727 and R0728 provide gate bias to Q0703 while divider combination R0750 and R0751 provide gate bias to Q0705. This adjusts the transmitter power output to the intended value. The ratios of each of these resistor dividers are chosen to ensure that Q0703 and Q0705 are both running at their 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 to raise or lower output power in order to maintain transmitter output power 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 and R0902 form a voltage divider with the 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 operational amplifier U0901-2, which provides a dc voltage via diode junction D0900 to control the attenuation level of the VCA stage. For the condition that the temperature threshold set by resistive divider combination R0901 and R0909 is reached, the VCA is driven to increase the RFIN signal at the 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. The 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 the battery supply in the controller circuit of the radio in order to change the VSET input of the PA controller IC (pin 3) for reduced transmitter output. This cutback starts when the battery voltage at the connector is 15.3 Volts or greater and has a 2 dB/V slope. In addition, a second low battery detect circuit is implemented in hardware. This hardware cutback forces a 1.2 dB drop in RF power level when the battery voltage drops below 11.6 Volts and exhibits about 0.6 Volts of hysteresis before returning 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 transistor Q0702 against the chassis. 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, turning off the gate bias to Q0702, Q0703, and Q0705. This prevents 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 (Tomahawk II, U0100), and the Voltage Controlled Oscillator VCO.

4.1 Reference Oscillator

The reference oscillator (Y0100) contains a temperature compensated crystal oscillator with a frequency of 16.8 MHz. A digital-to-analog (DAC) converter internal to U0100 (Tomahawk) and controlled by the microprocessor via serial interface (SPI), sets the voltage at the AUX_DAC output of U0100 (pin H6) to set the frequency of the oscillator. The output of the oscillator (pin 3 of Y0100) is applied to pin K5 (XOSC_BASE) of U0100.

4.2 Fractional-N Synthesizer

The Tomahawk II Synthesizer IC (U0100) consists of a pre-scaler, a programmable divider and divider 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 2.45 Volts.

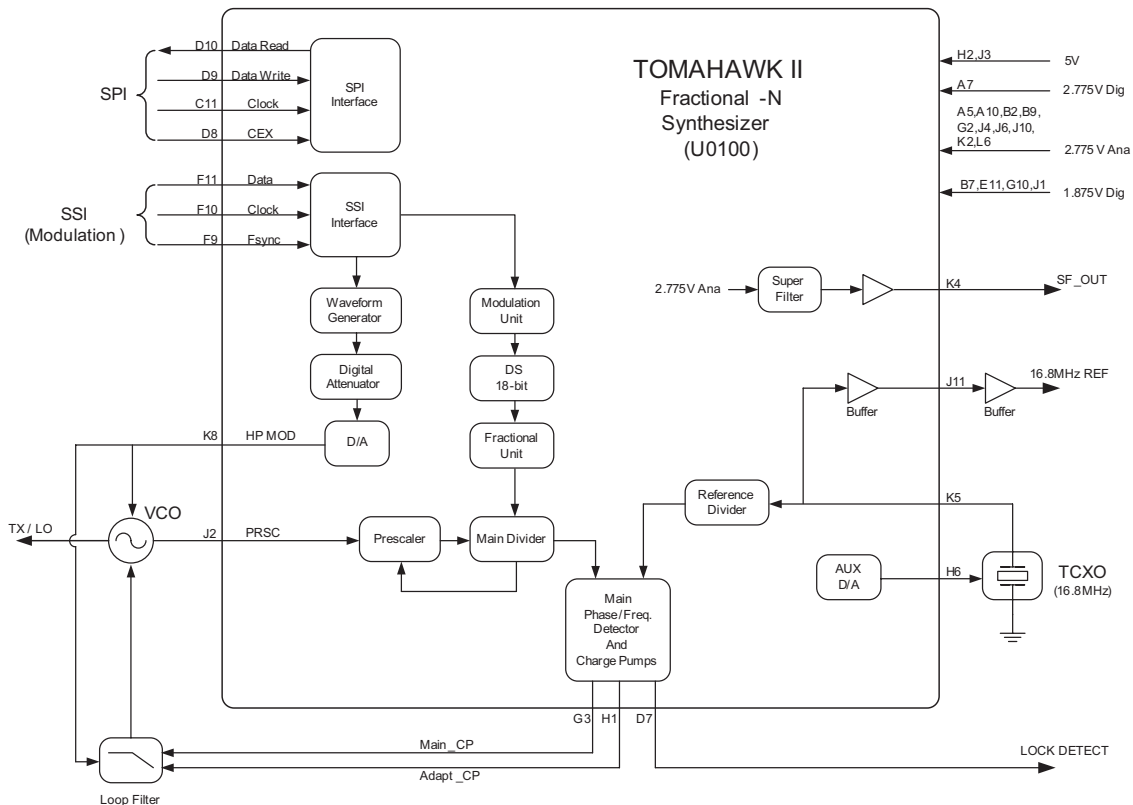


Figure 1-5 VHF Synthesizer Block Diagram

A voltage of 2.775 Volts applied to the super filter input (U0100 pin J4) supplies an output voltage of 2.45 VDC (SF_OUT) at pin K4. This supplies the VCO and the VCO modulation bias circuit (via R0321). The super filter supply voltage is provided by the 2.775 Volt regulator within U3200. The synthesizer is also supplied by the 5 Volt regulator, U3002, another 2.775 Volt regulator within U3200, and a 1.875 Volt regulator within U3200.

The output signal LOCK (U0100-D7) provides information about the lock status of the synthesizer loop. A high level 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 microprocessor via the data lines SPI_DW (U0100-D9) and SPI_DR (U0100-D10), 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 three Colpitts oscillators (two Rx and one Tx), a single-stage Tx buffer amplifier, a single-stage Rx buffer amplifier, oscillator bias control switches, and the modulation circuitry.

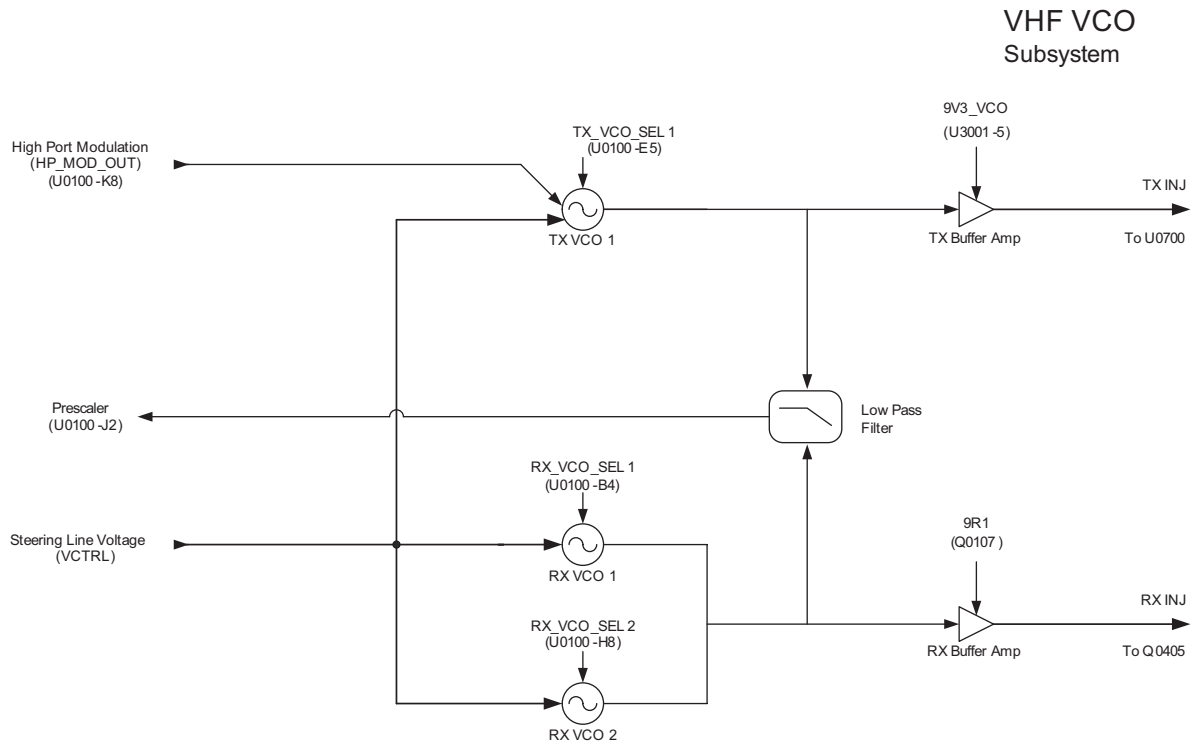


Figure 1-6 VHF VCO Block Diagram

The VHF Rx VCO design incorporates two varactor-tunable Colpitts oscillators. Each Rx oscillator has a tuning range of 19 MHz, sufficient to cover the Rx frequency range of 180.85 MHz to 218.85 MHz. A single Tx oscillator covers the frequency range of 136 MHz to 174 MHz. The oscillators resonate at fundamental operating frequencies. Three (active-low logic) general purpose output lines (GPO1, GPO3, and GPO6) from the Tomahawk IC (U0100-B4, E5, and H8) provide the control for independent bias selection to each oscillator (VCO_SEL) via the PNP transistor switches U0304 and U0201. The 2.45 Volt super filtered output, SF_OUT, of the Tomahawk IC (U0100-K4) supplies the bias to the oscillators. A portion of the VCO output signal is lightly coupled through coupling capacitors C0331 and C0231, routed through a low-pass filter (formed by L0221, C0235, L0230, C0265, and C0233), and fed back to the M_PRSC input of the Tomahawk IC (U0100-J2).

High-port modulation is scaled through a voltage divider (comprised of R0319, R0320, and R0321) and applied to the Tx modulation varactor diode CR0300. The Tx VCO frequency is modulated via coupling capacitor C0310.

A discrete single-stage Tx buffer amplifier (comprised of the NPN transistor Q0302 and surrounding components) amplifies the signal from the Tx oscillator to the level required by the first stage of the Transmitter Power Amplifier (U0700). The Tx buffer amplifier also provides sufficient isolation from any undesired load-pulling from the Transmitter Power Amplifier. The bias for Q0302 is provided by the 9.3 Volt regulator U3001.

A discrete single-stage Rx buffer amplifier (comprised of the NPN transistor Q0202 and surrounding components) amplifies the signal from the Rx oscillator to the level required by the LO injection amplifier (Q0405). The Rx buffer amplifier also provides sufficient isolation from any undesired load-pulling from high input levels in the receiver front-end. GPO4 from the Tomahawk IC (U0100-D4) controls the transistor switch (comprised of Q0108 and Q0107), that enables the 9.1 Volt bias to Q0202 (via the 9.3 Volt regulator U3001).

4.4 Synthesizer Operation

The complete synthesizer subsystem is comprised mainly of the Tomahawk Synthesizer IC, Reference Oscillator (crystal oscillator with temperature compensation), loop filter circuitry, VCO, and DC supplies. The VCO feedback signal, PRSC, is fed to pin J2 of U0100 (M_PRSC) via a low-pass filter (L0221, C0235, L0230, C0265 and C0233) 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). The output signal of the phase/frequency detector is a pulsed signal which is routed to 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 applied to the VCO.

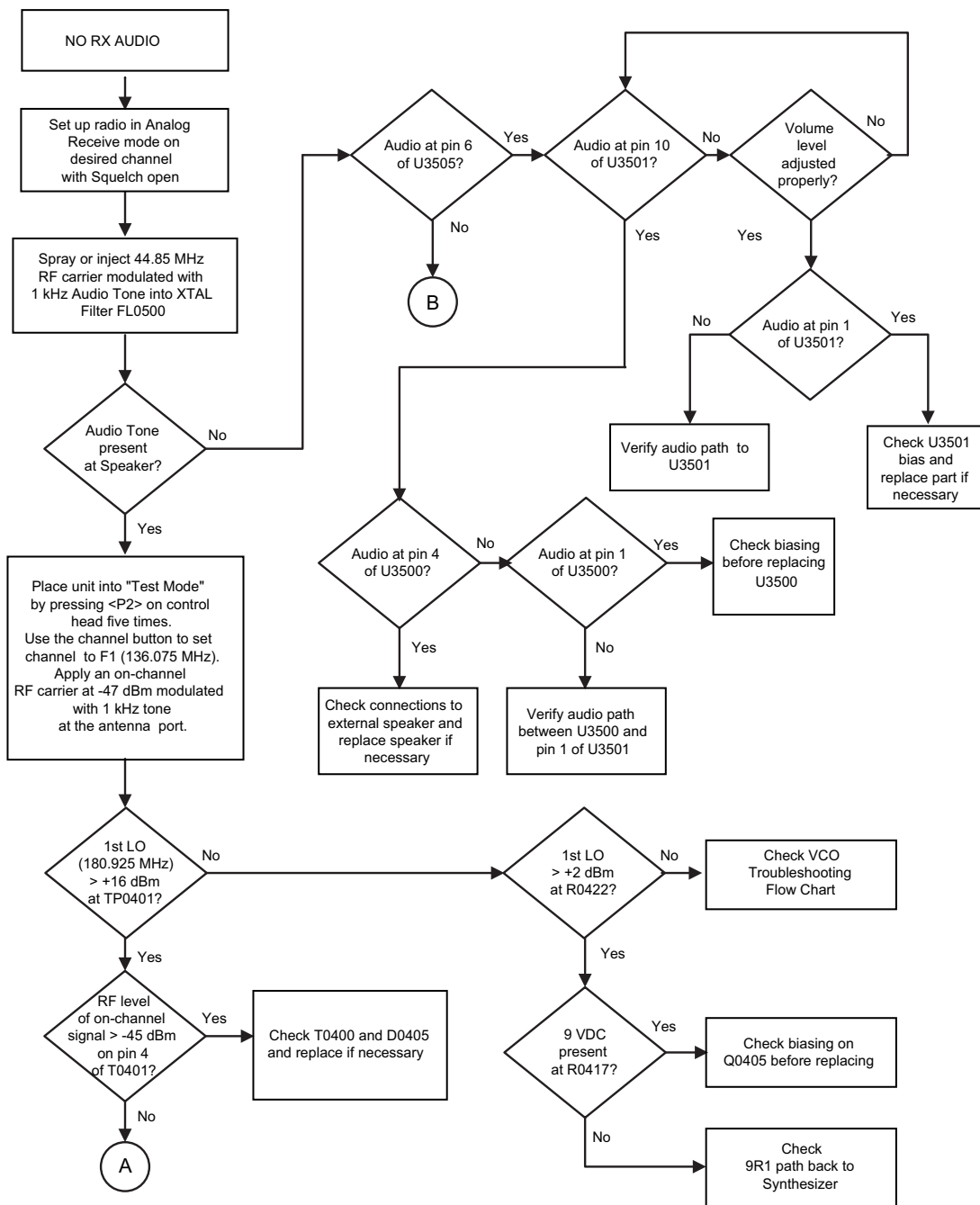
To reduce lock time when new frequency data has been loaded into the synthesizer, an adapt charge pump, providing much greater current than the main charge pump, is turned on for a finite amount of time to quickly charge or discharge the loop filter capacitors to steer the VCO to the desired frequency. The output of the adapt charge pump passes to the loop filter via pin H1 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-D7), which is routed to the microprocessor. Q0102 is configured as a current source to provide a steady 1.5 mA during the adapt period. U0101 is an analog switch that opens the adapt path slightly before the end of the adapt period to prevent the current from the current source from pushing the VCO off frequency.

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 is converted to an analog signal through a 10-bit DAC before modulating the VCO. This high-port analog modulation output (HP_MOD_OUT, U0100-K8) is connected to the VCO modulation varactor diode (CR0300) via C0360 and R0319.

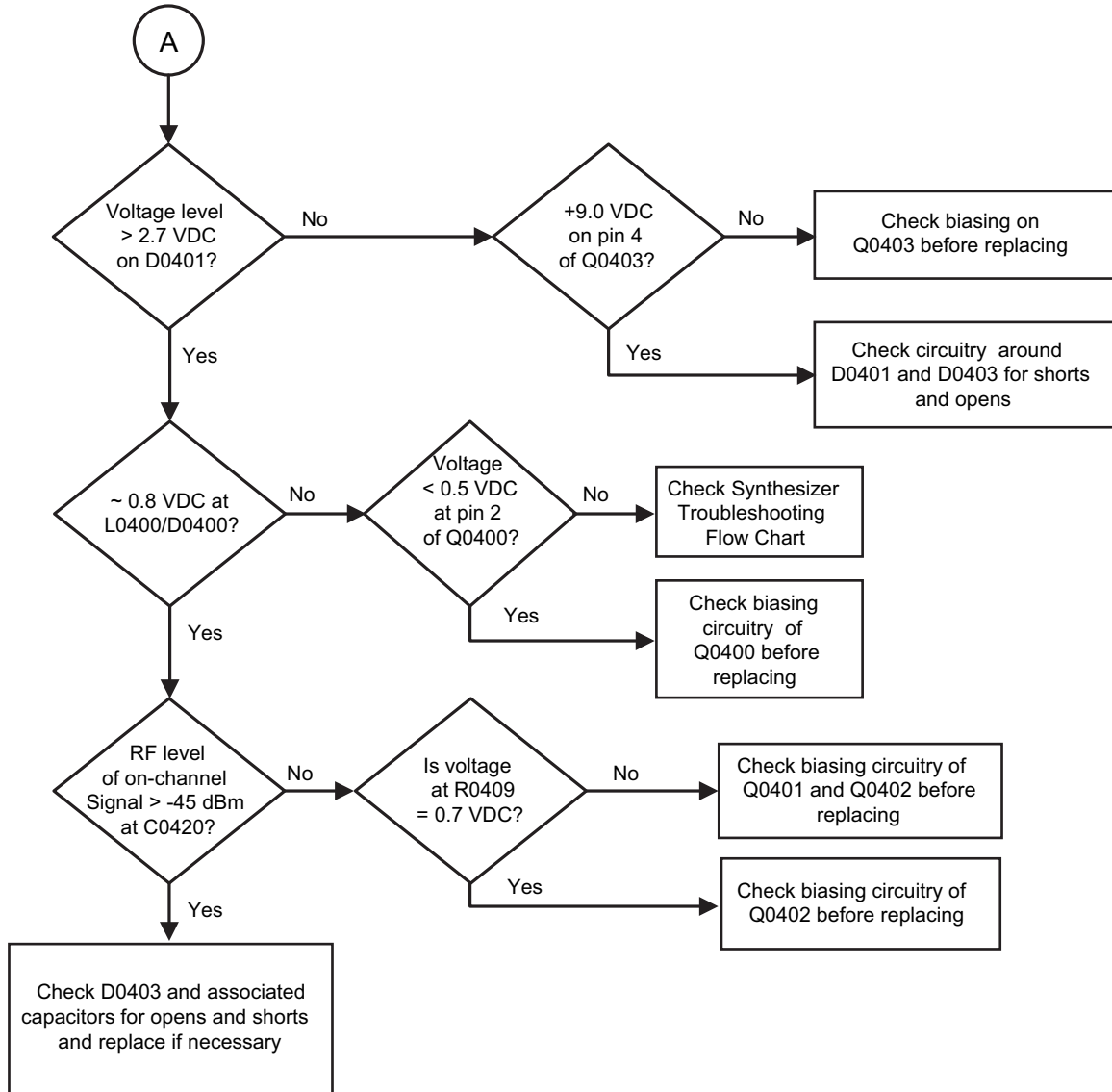
Section 2

TROUBLESHOOTING CHARTS

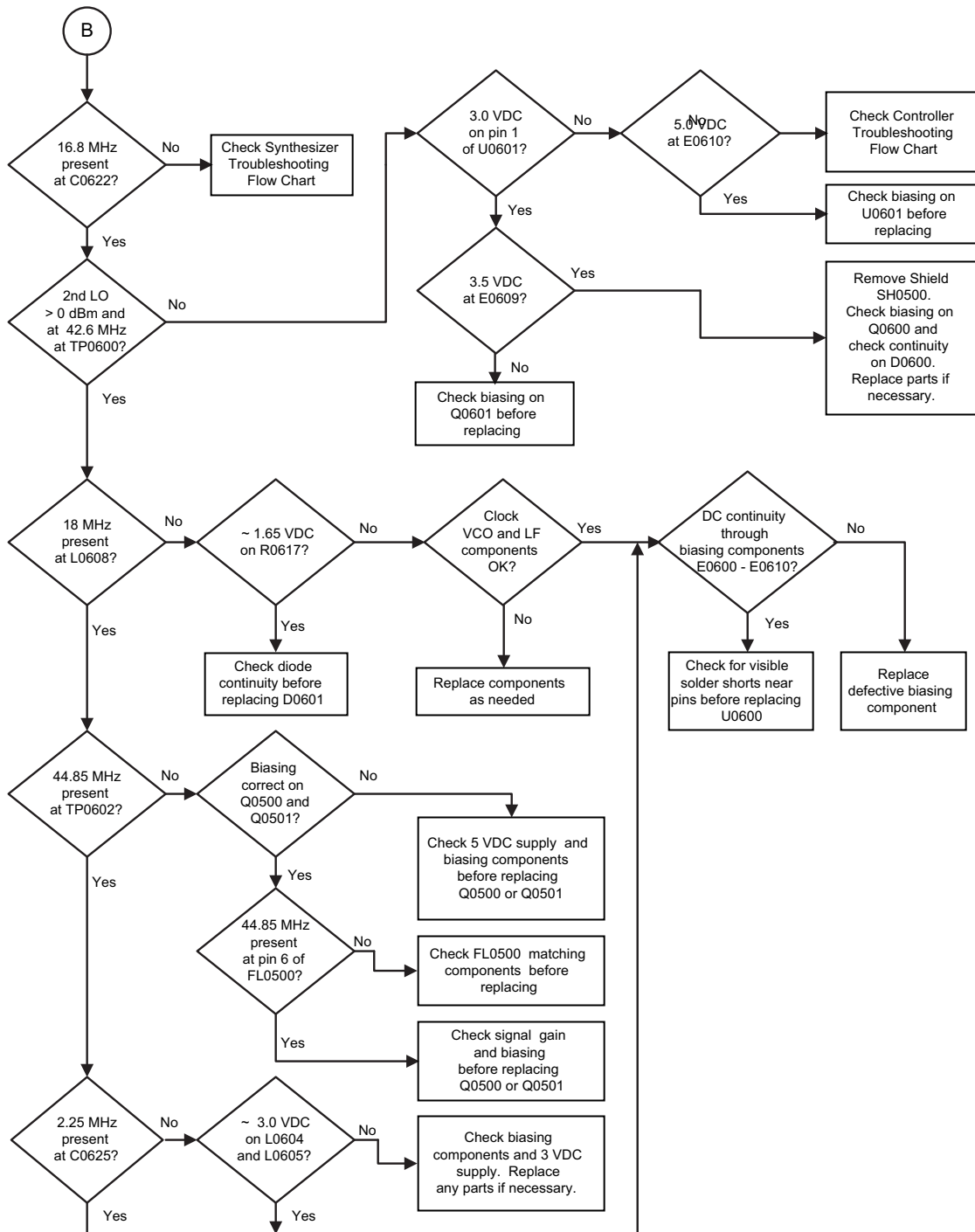
1.0 Troubleshooting Flow Chart for Receiver (Sheet 1 of 3)



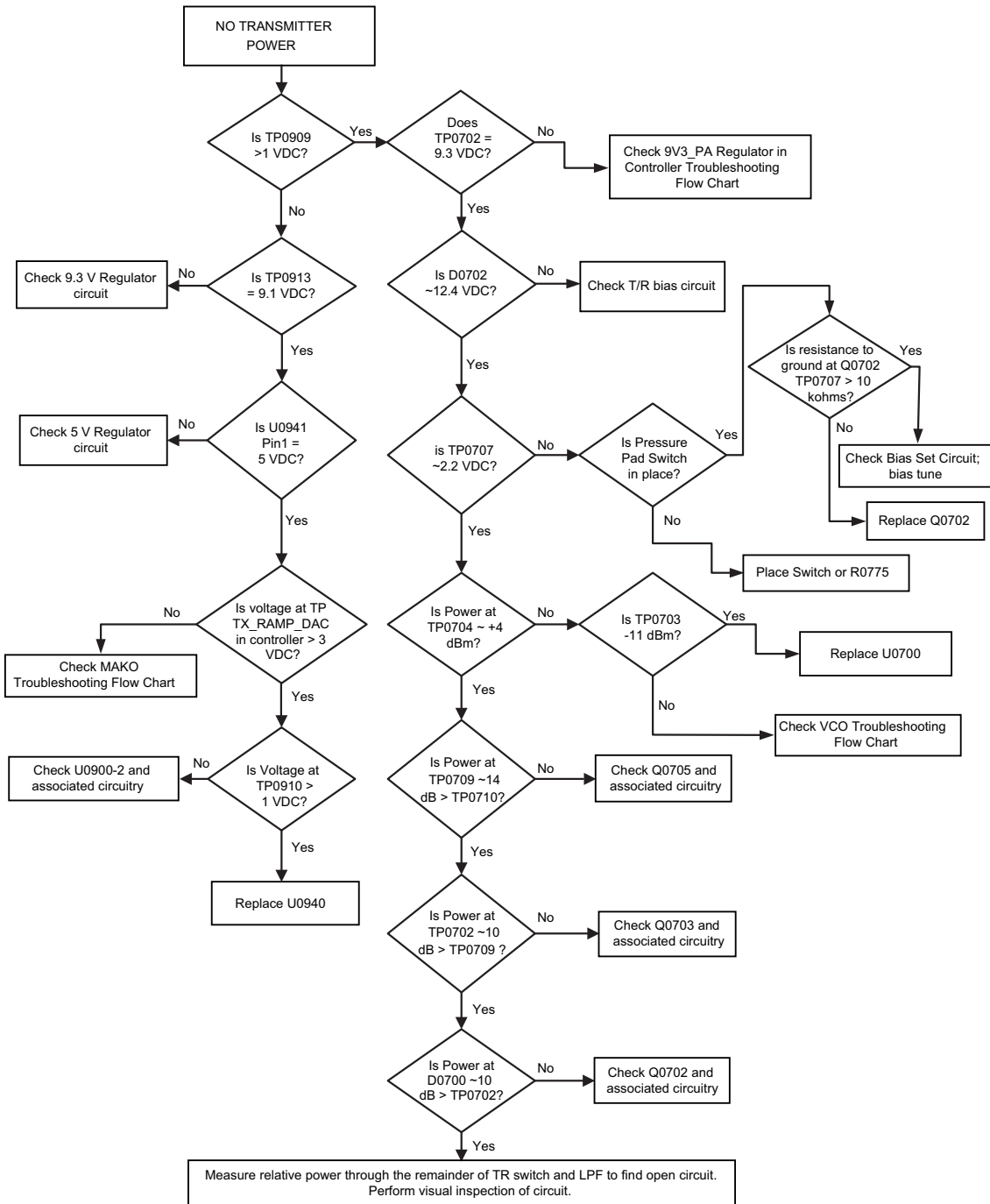
1.1 Troubleshooting Flow Chart for Receiver (Sheet 2 of 3)



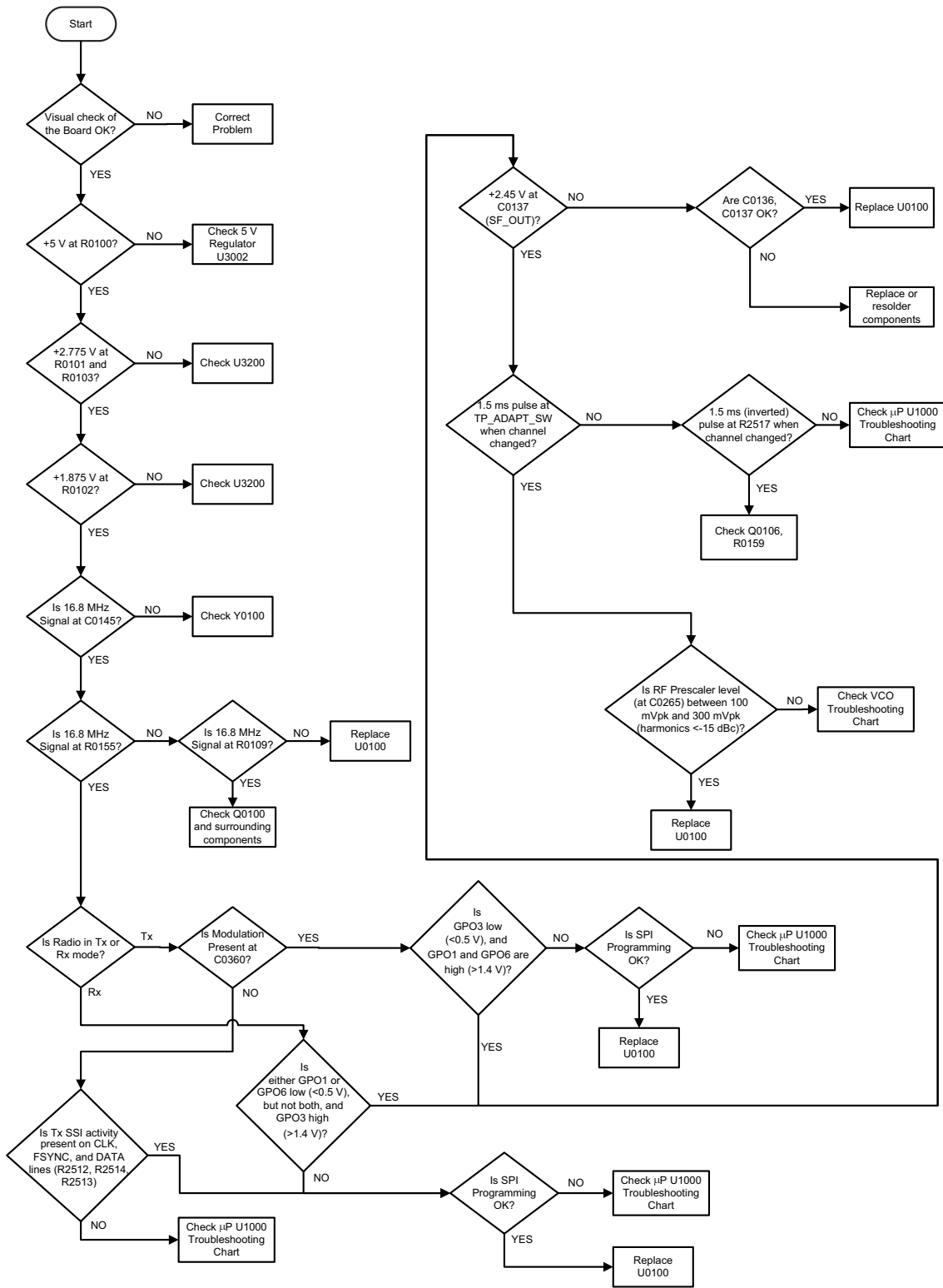
1.2 Troubleshooting Flow Chart for Receiver (Sheet 3 of 3)



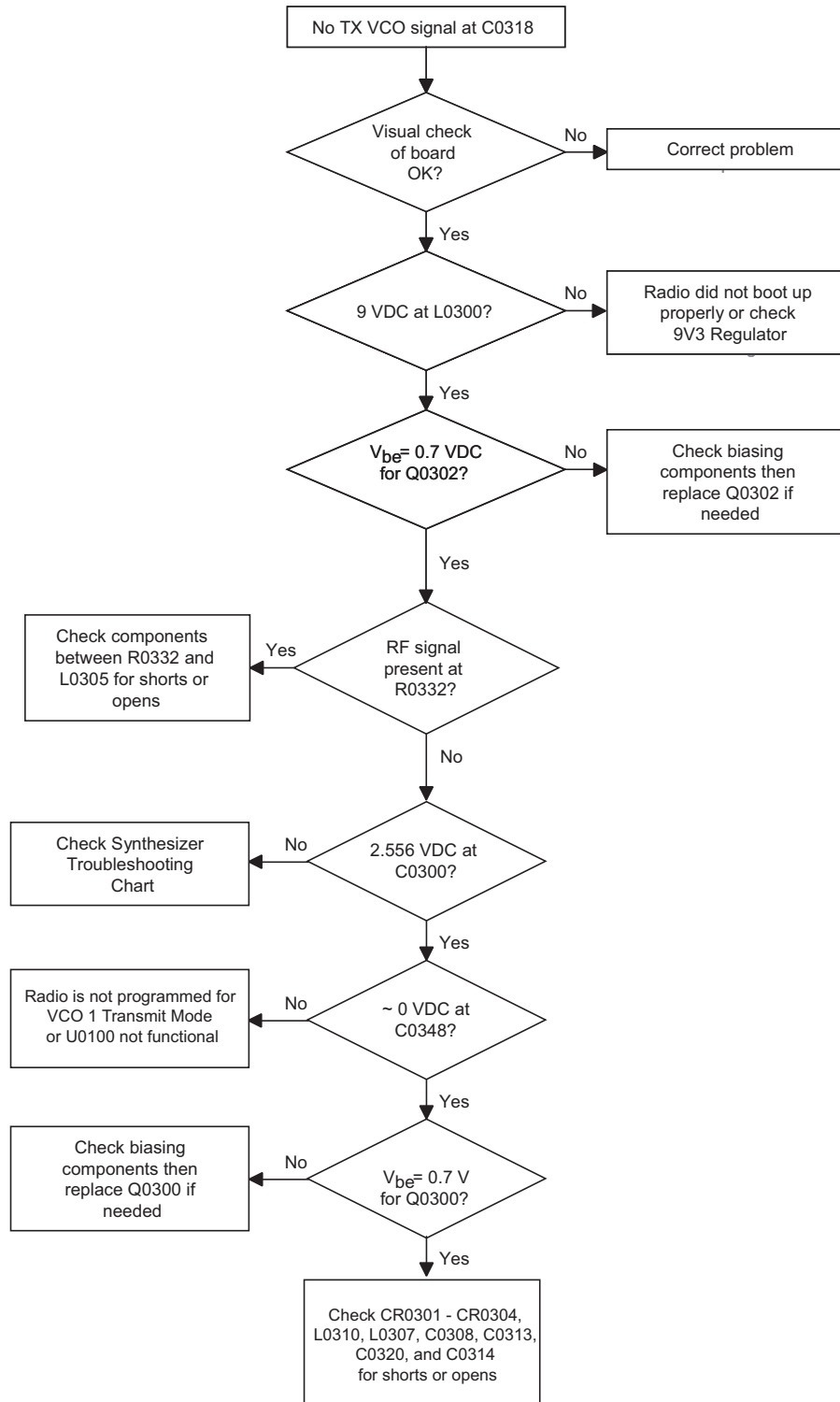
2.0 Troubleshooting Flow Chart for 45W Transmitter



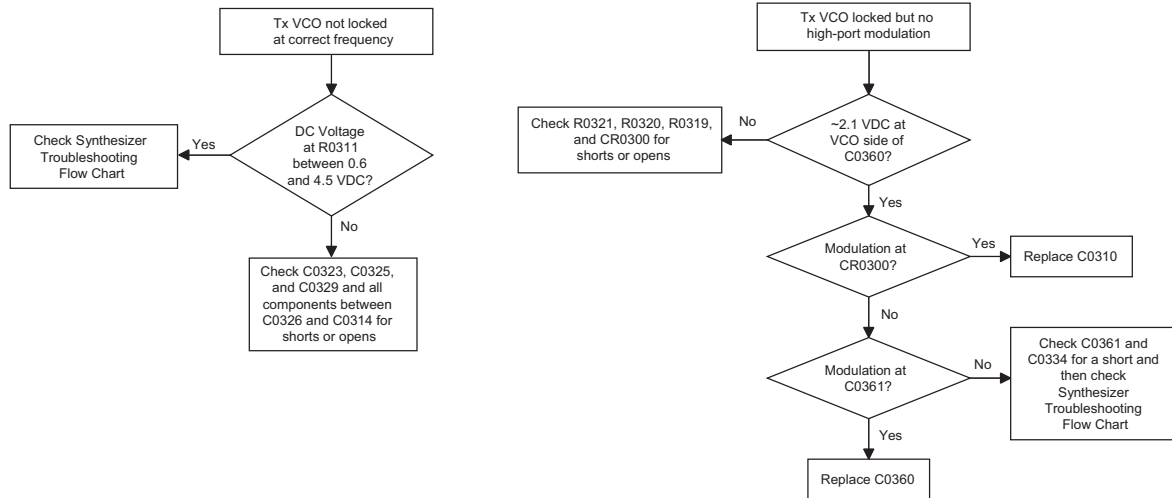
3.0 Troubleshooting Flow Chart for Synthesizer



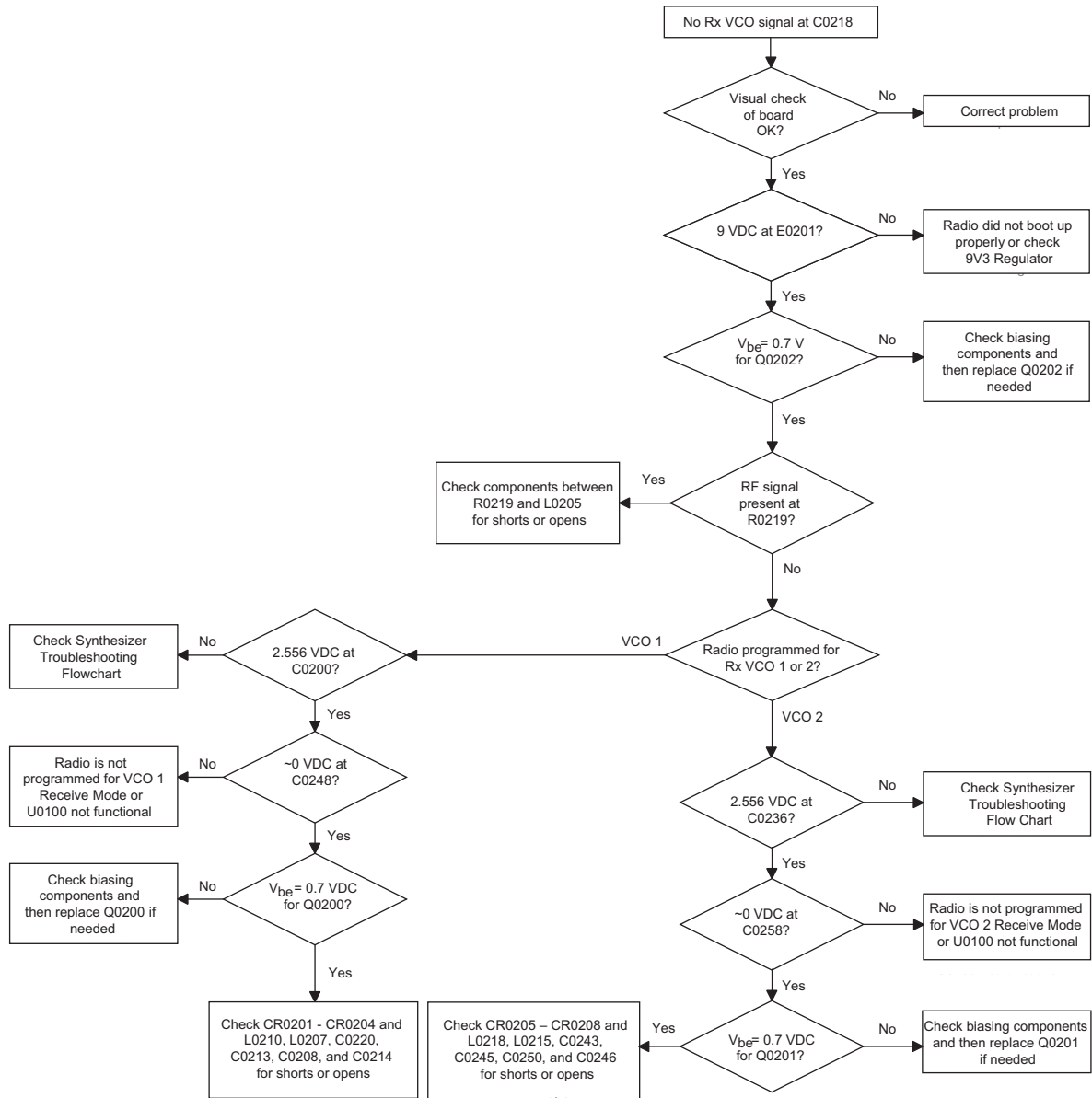
4.0 Troubleshooting Flow Chart for Tx VCO (Sheet 1 of 2)



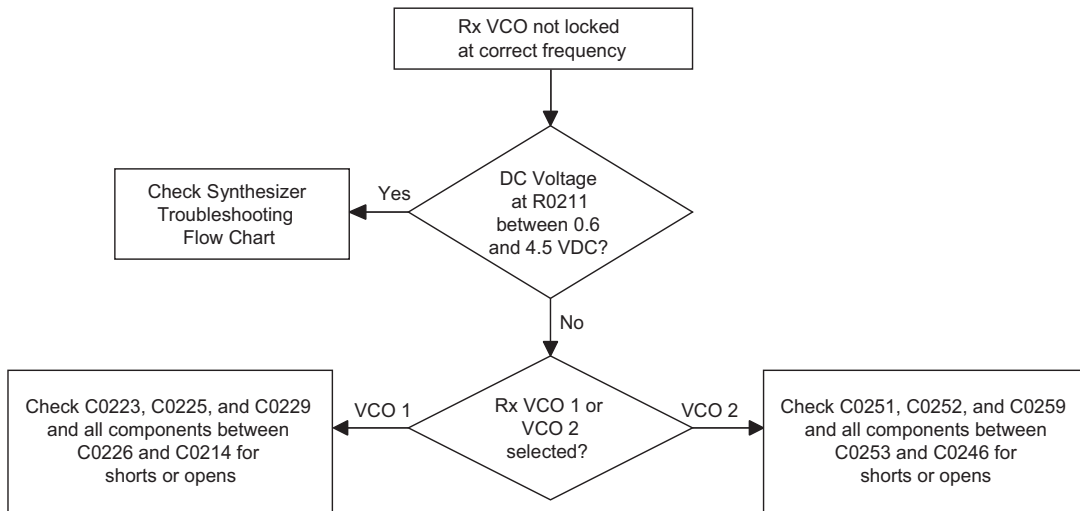
4.1 Troubleshooting Flow Chart for Tx VCO (Sheet 2 of 2)



5.0 Troubleshooting Flow Chart for Rx VCO (Sheet 1 of 2)



5.1 Troubleshooting Flow Chart for Rx VCO (Sheet 2 of 2)



Notes

Section 3

VHF PCB / SCHEMATICS / PARTS LISTS

1.0 Allocation of Schematics and Circuit Boards

1.1 Controller Circuits

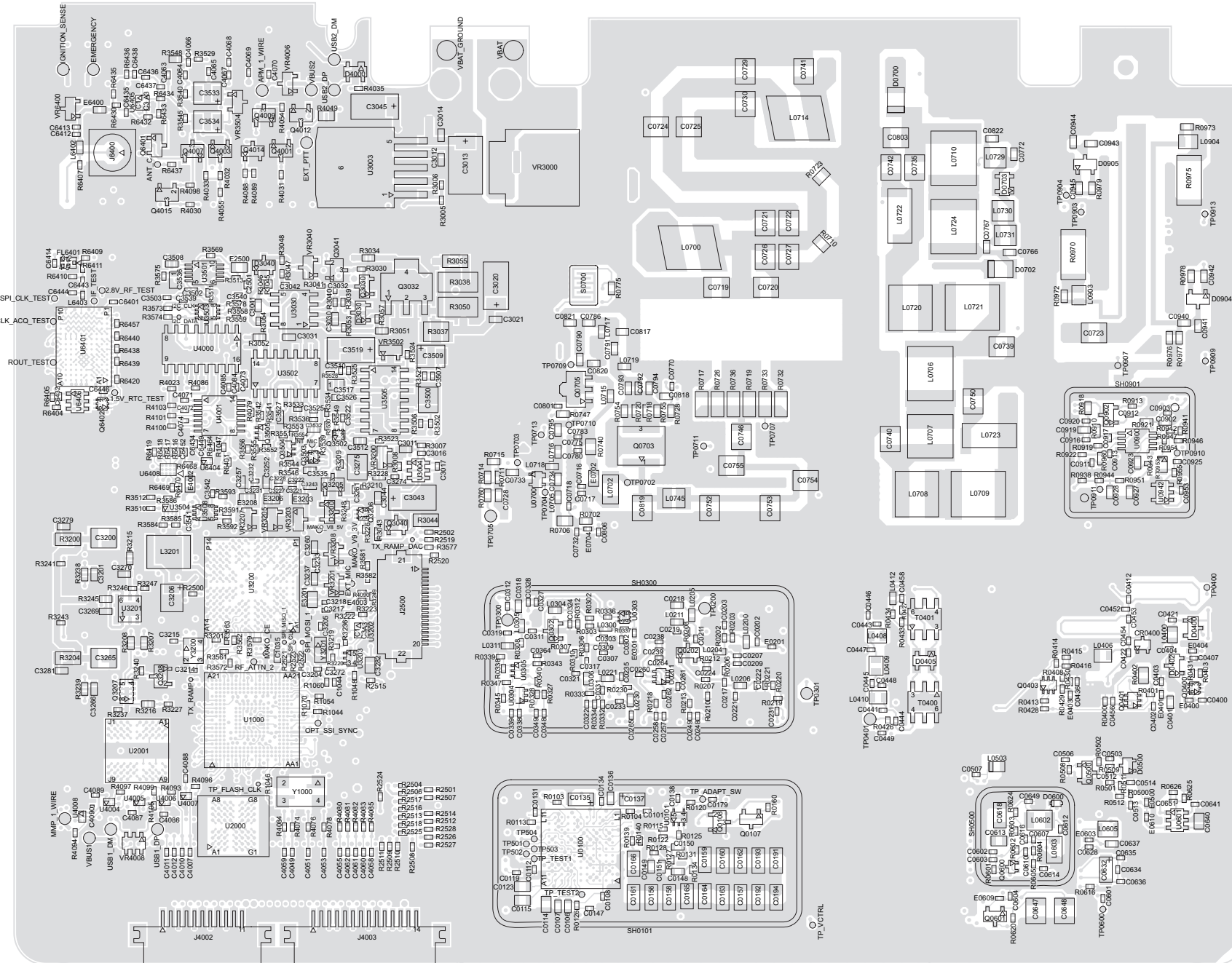
The VHF circuits are contained on the Printed Circuit Board (PCB) which also contains the Controller circuits. This Chapter shows the schematics for the VHF circuits only, refer to the Controller section for details of the related Controller circuits. The PCB component layouts in this Chapter show both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

NOTE: The VHF Schematic and parts lists are the same for 8478023A12 and 8478023A16. Only the Controller circuits are different between the two PCBs.

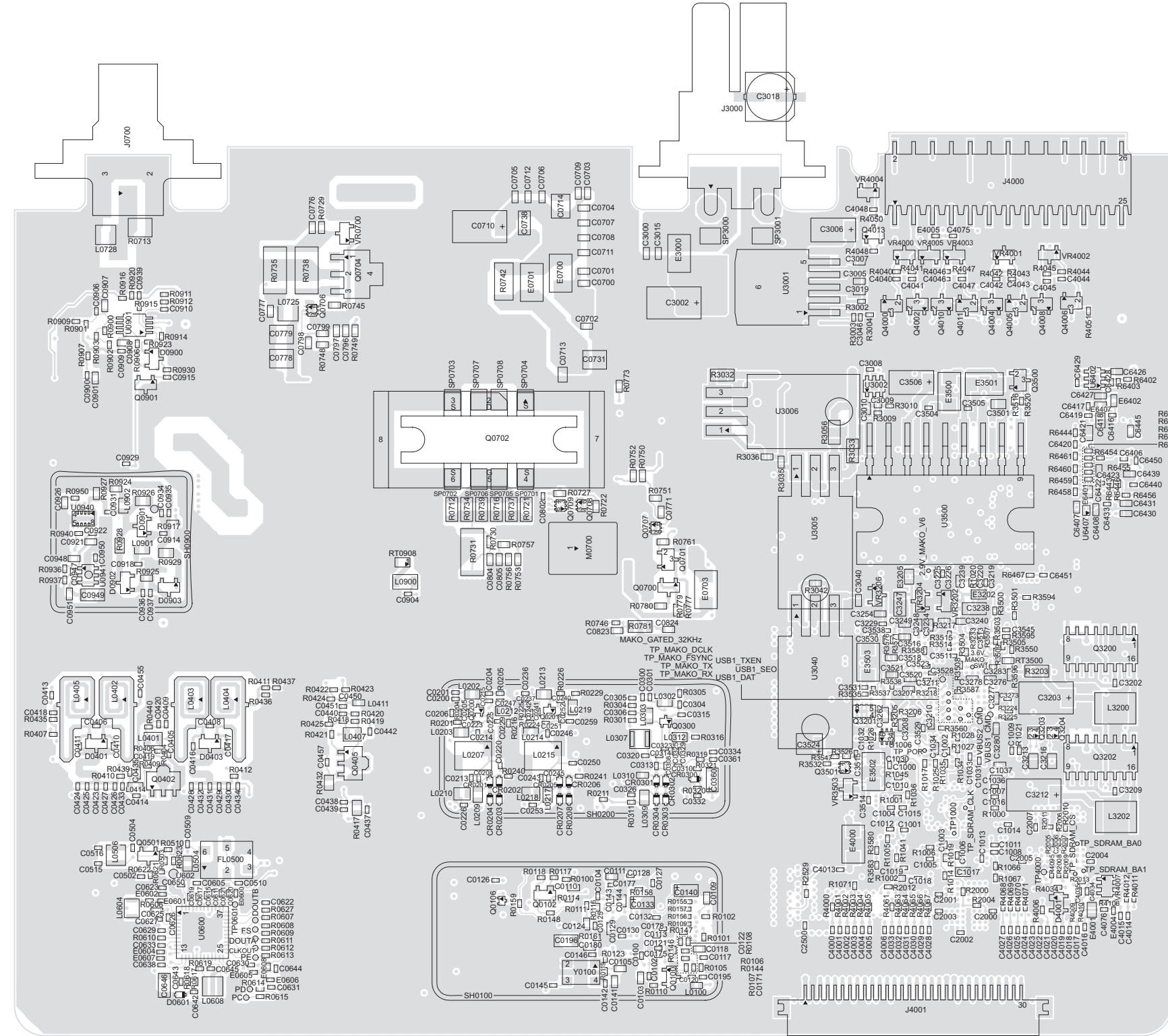
Table 3-1 VHF 25-45W Diagrams and Parts List

PCB:	
8478023A12 Main Board Top Side	Page 3-3
8478023A12 Main Board Bottom Side	Page 3-4
8478023A16 Main Board Top Side	Page 3-5
8478023A16 Main Board Bottom Side	Page 3-6
SCHEMATICS	
Overall	Page 3-7
Receiver Front-End	Page 3-8
Receiver IF Amp	Page 3-9
Receiver Back-End	Page 3-10
Power Amplifier	Page 3-11
Power Control	Page 3-12
Synthesizer	Page 3-13
Receiver VCO	Page 3-14
Transmit VCO	Page 3-15
Parts List	
8478023A12 and 8478023A16	Page 3-16

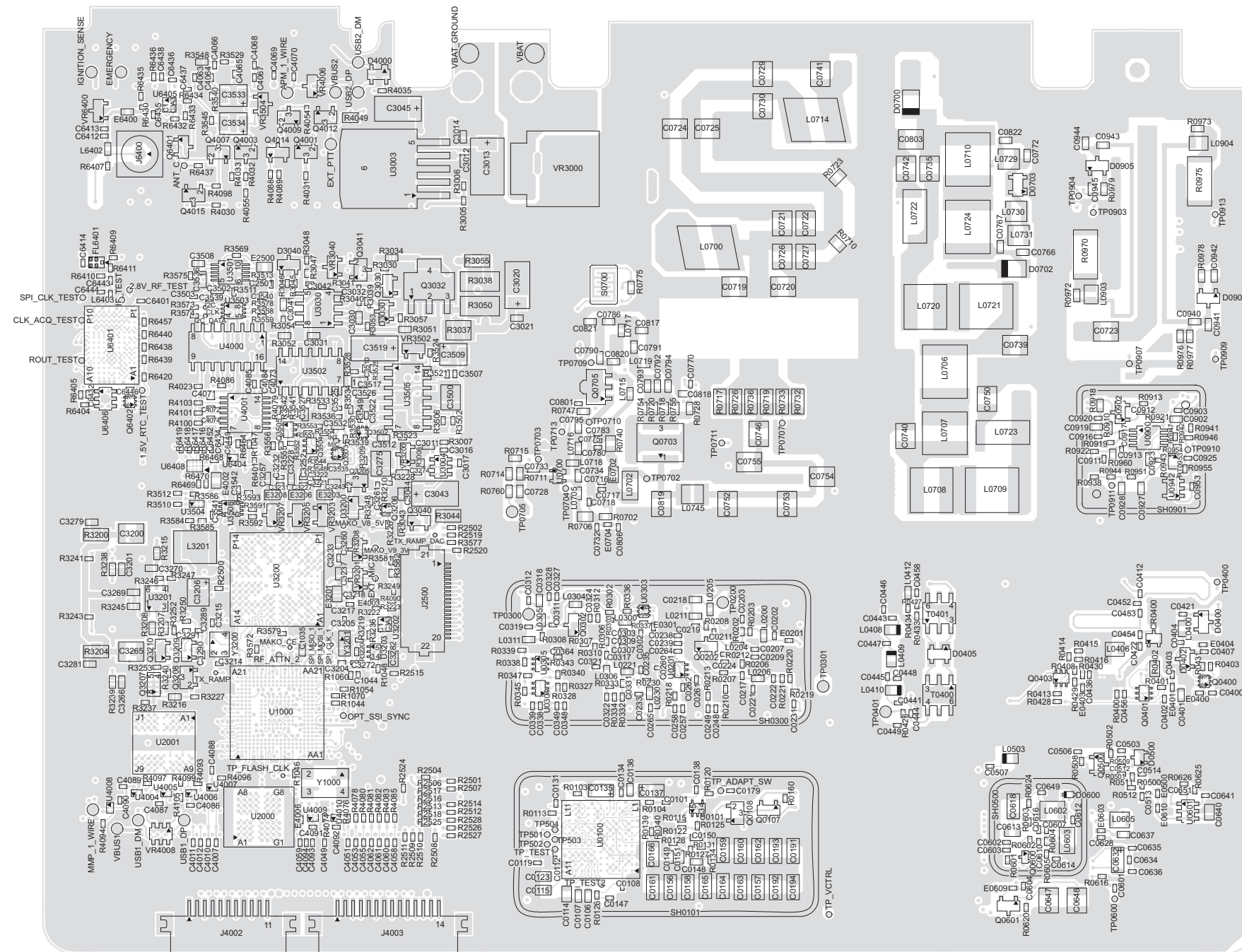
Notes



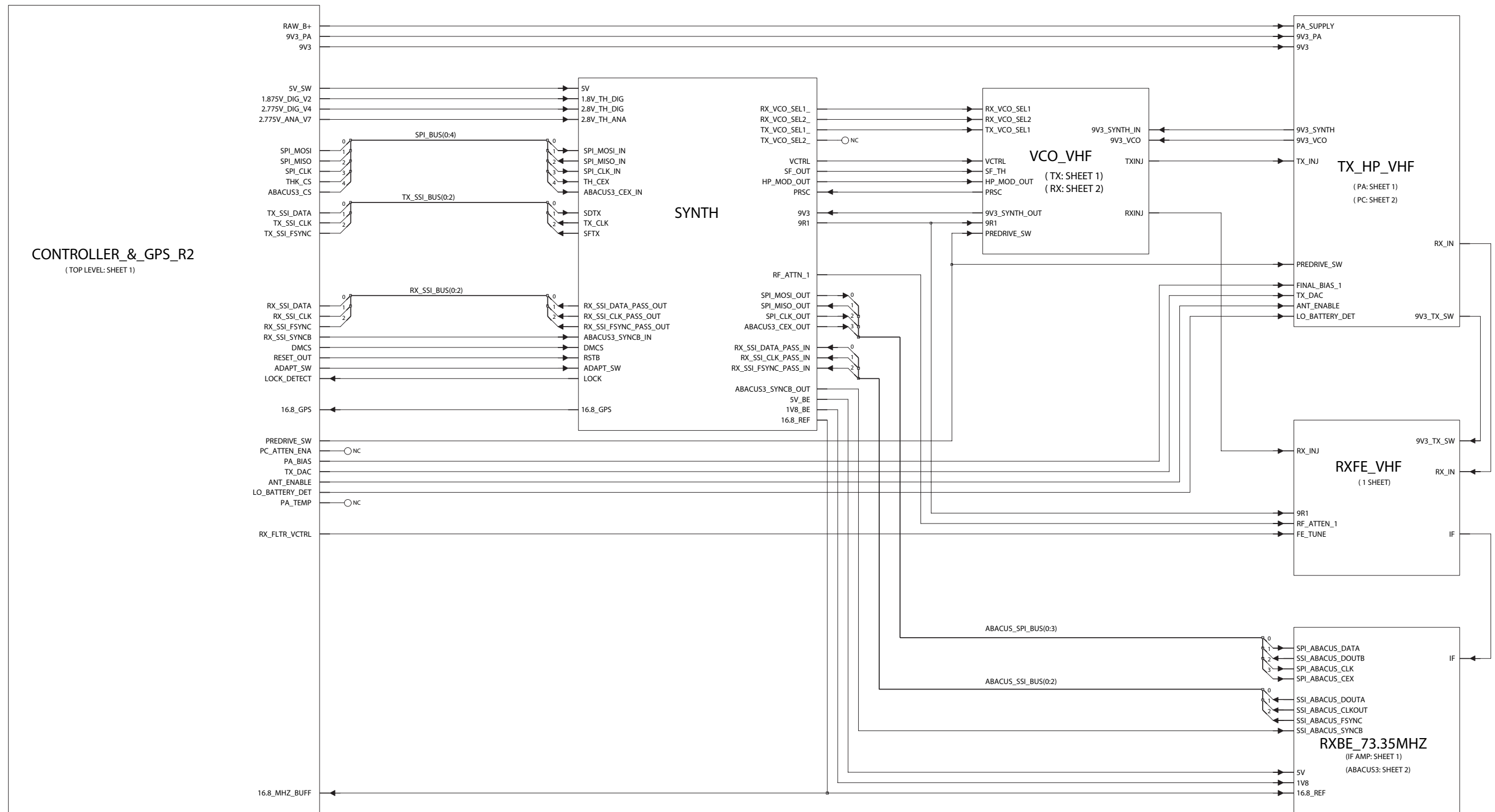
VHF (136-174 MHz) 25-45W 8478023A12 Bottom Side



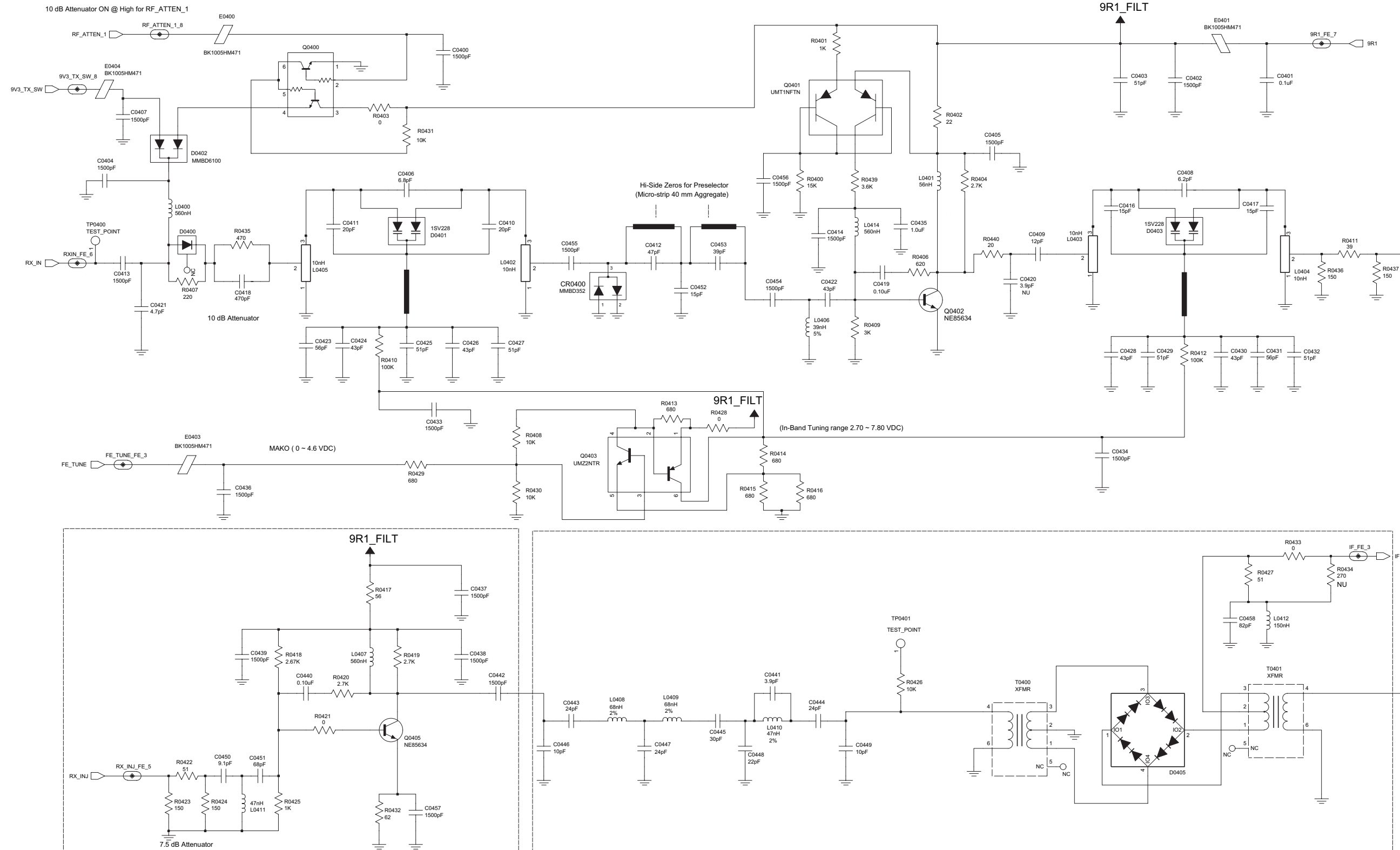
VHF (136-174 MHz) 25-45W 8478023A16 Top Side



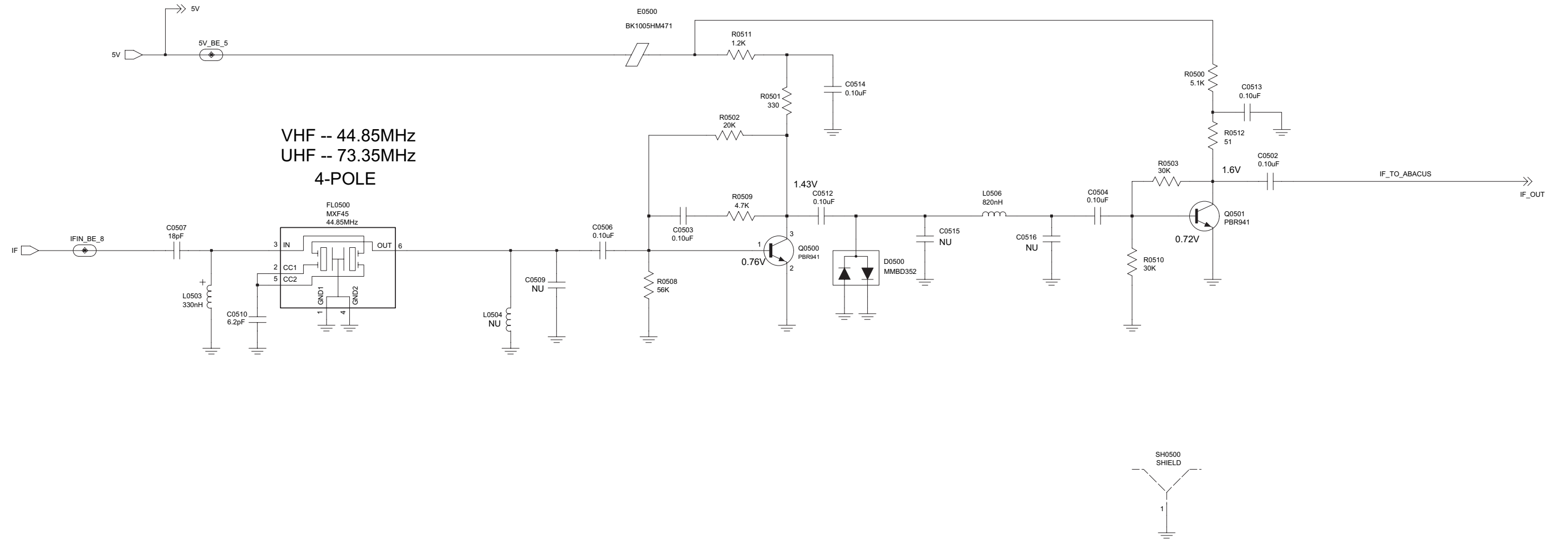
VHF (136-174 MHz) 25-45W 8478023A16 Bottom side



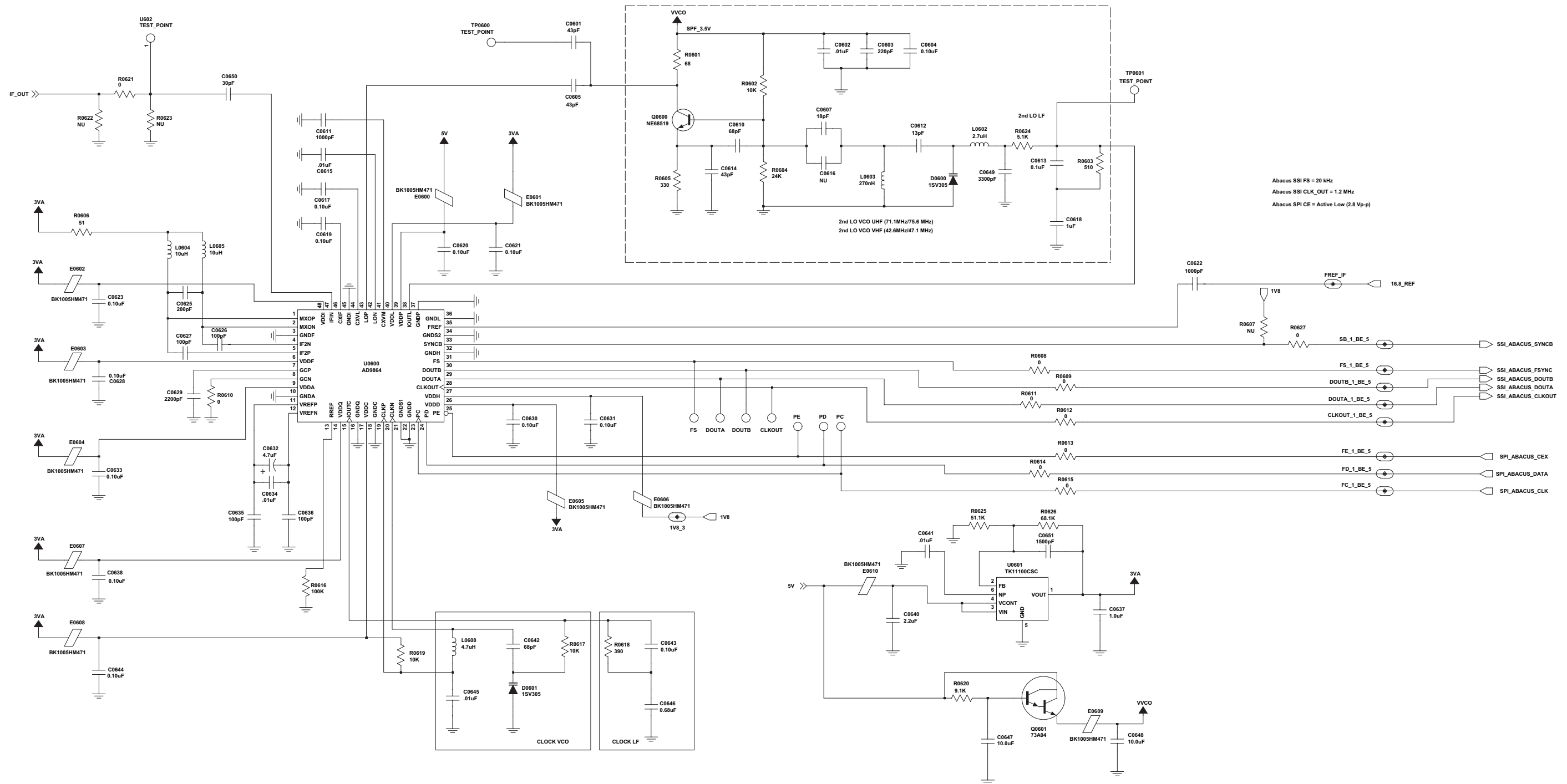
VHF (136-174 MHz) 25-45W Overall Schematic Diagram



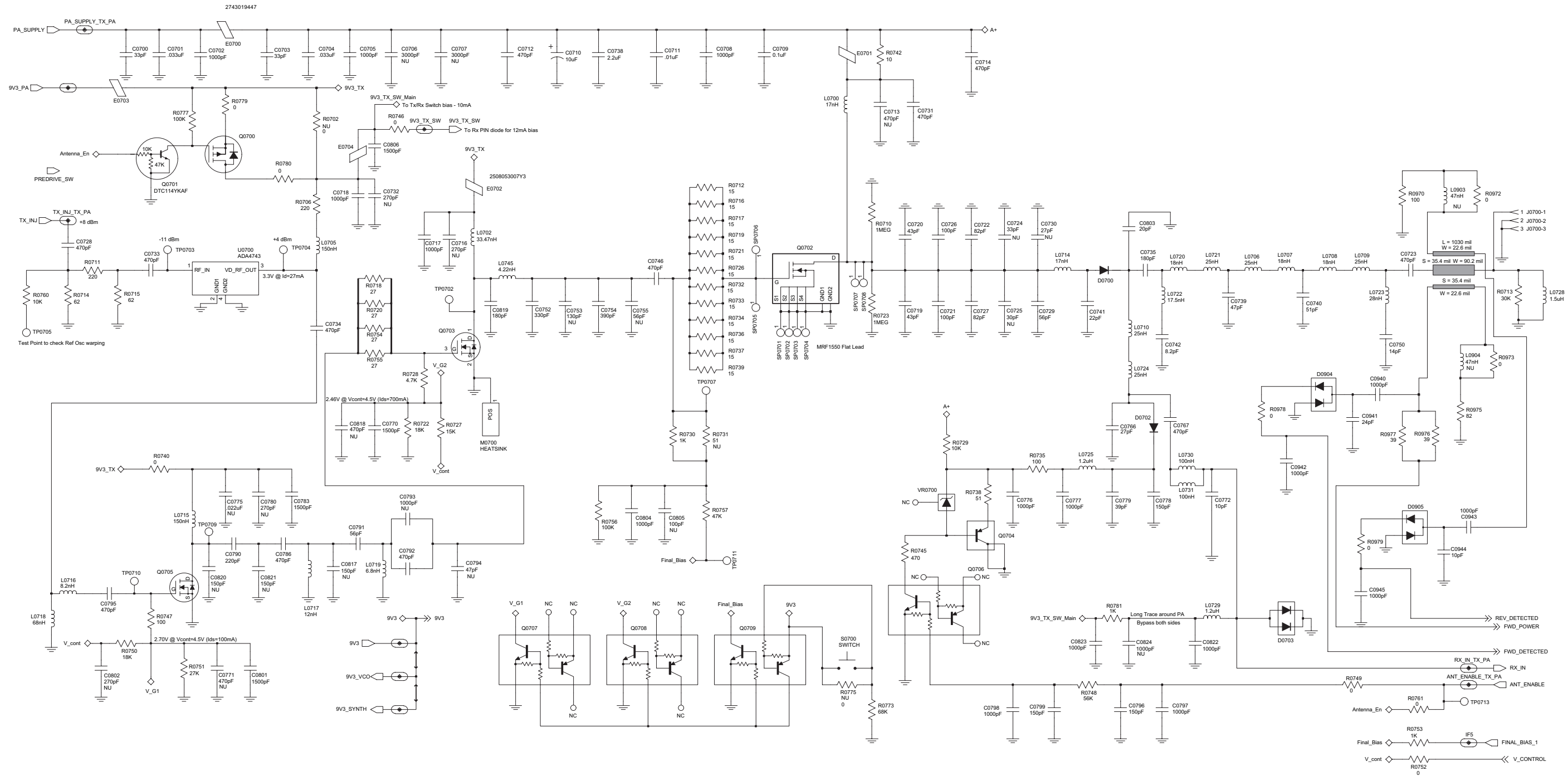
VHF (136-174 MHz) 25-45W Receiver Front-End Schematic Diagram



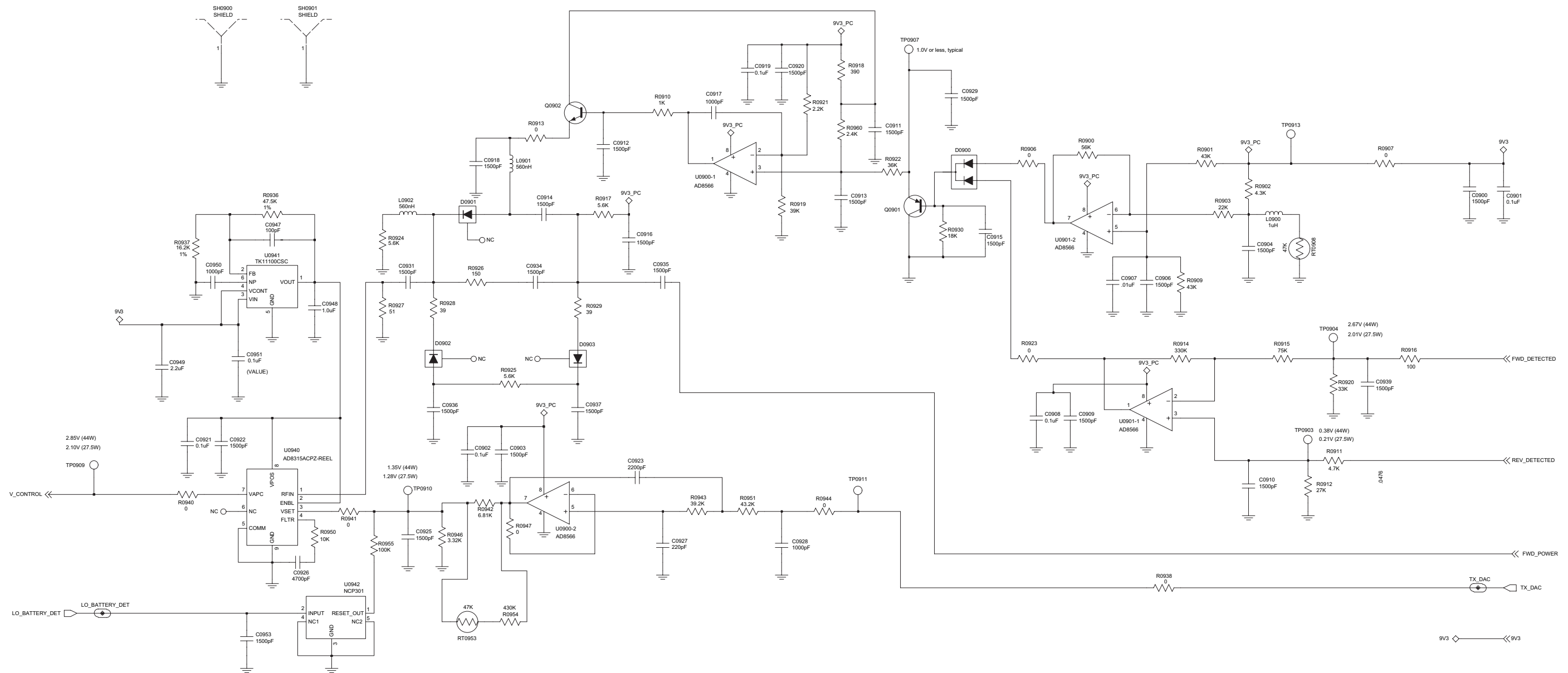
VHF (136-174 MHz) 25-45W Receiver IF Amp Schematic Diagram



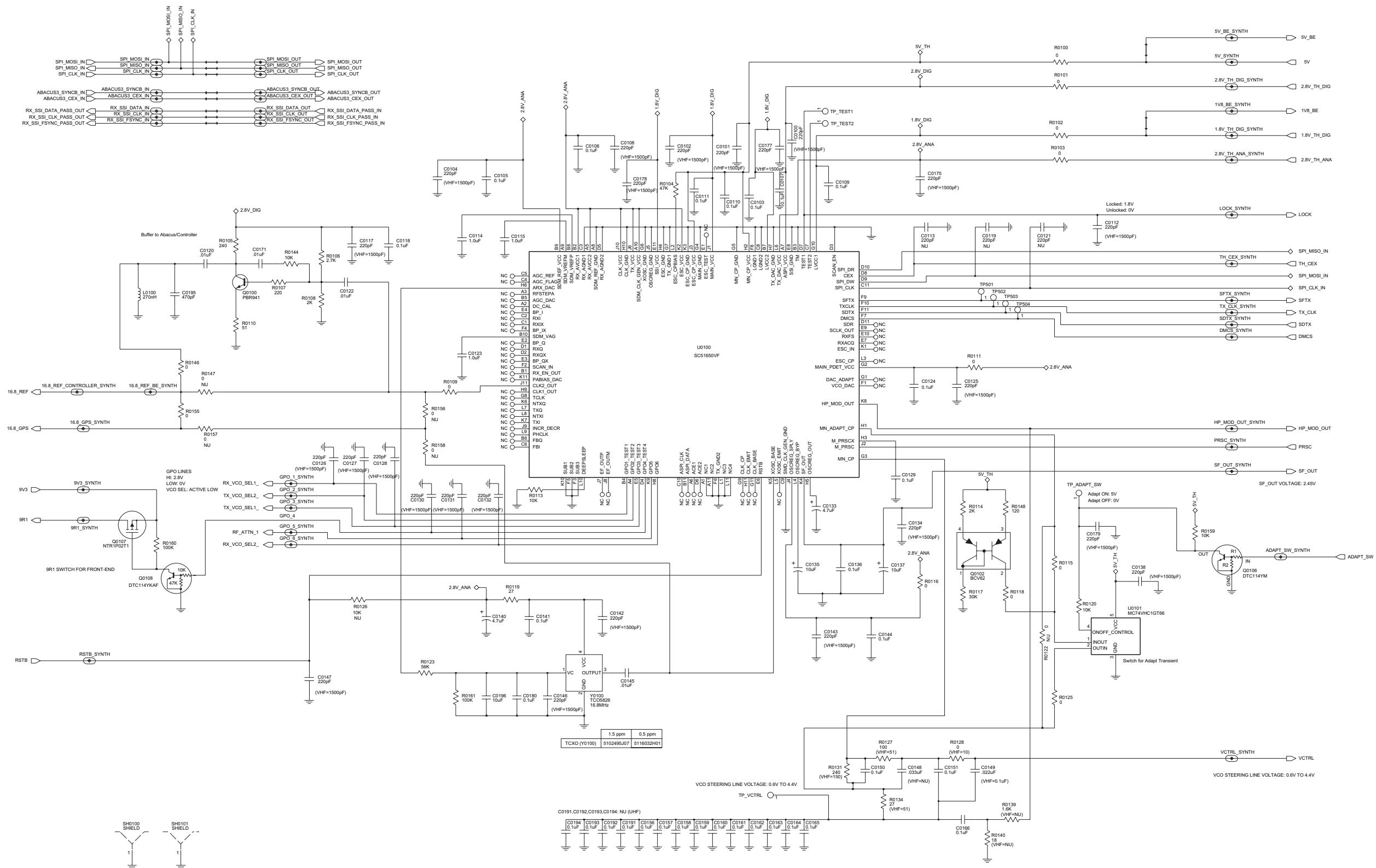
VHF (136-174 MHz) 25-45W Receiver Back-End Schematic Diagram



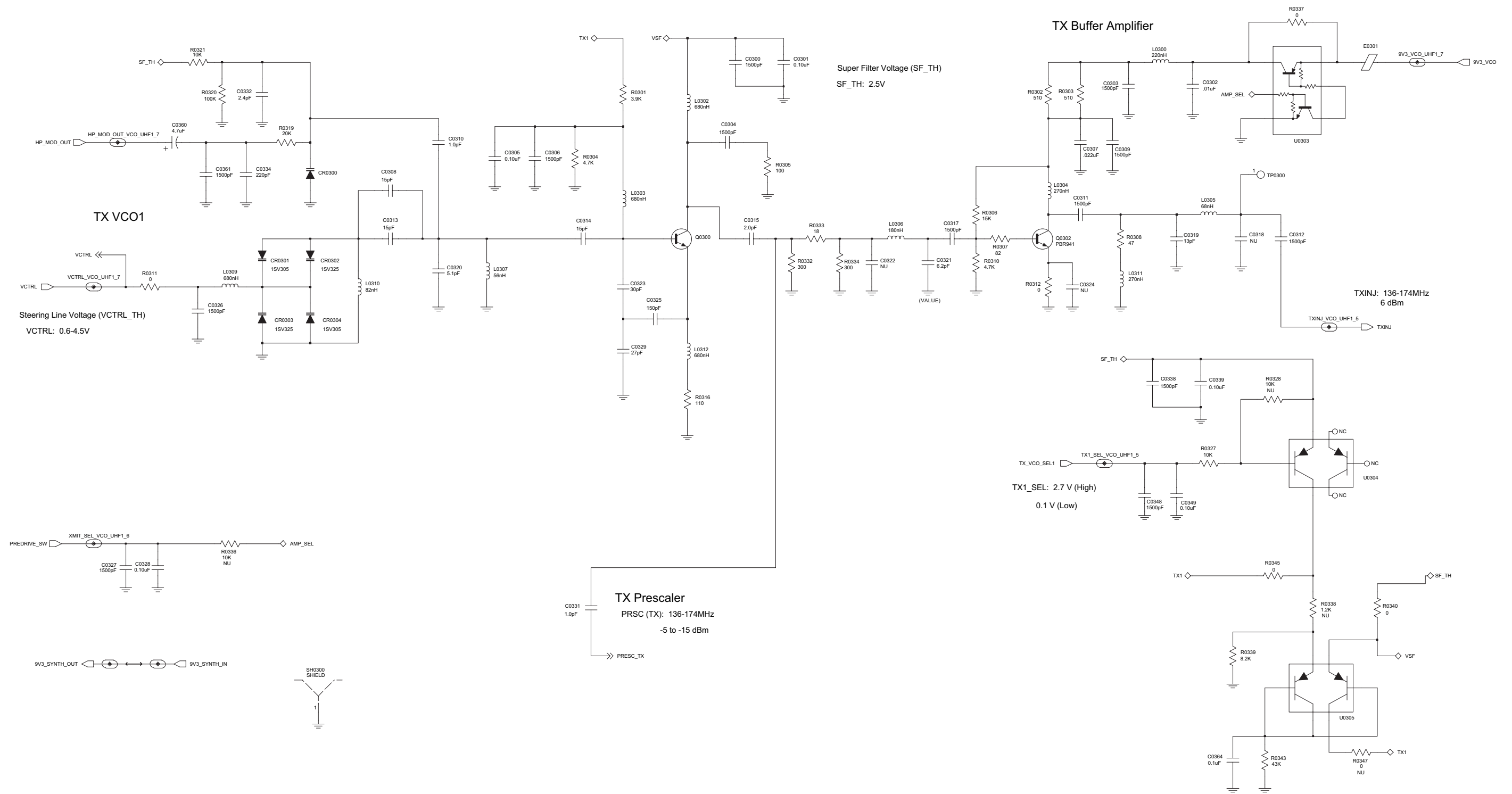
VHF (136-174 MHz) 25-45W Power Amplifier Schematic Diagram



VHF (136-174 MHz) 25-45W Power Control Schematic Diagram



VHF (136-174 MHz) 25-45W Synthesizer Schematic Diagram



VHF (136-174 MHz) 25-45W Transmit VCO Schematic Diagram

VHF PCB 8478023A12 and 8478023A16 Parts List 25-45W

Circuit Ref	Motorola Part No.	Description
C0100	2113945A10	1500pF
C0101	2113945A10	1500pF
C0102	2113945A10	1500pF
C0103	2113945C31	0.1uF
C0104	2113945A10	1500pF
C0105	2113945C31	0.1uF
C0106	2113945C31	0.1uF
C0107	2113945C31	0.1uF
C0108	2113945A10	1500pF
C0109	2113945C31	0.1uF
C0110	2113945C31	0.1uF
C0111	2113945C31	0.1uF
C0112	2113945A10	1500pF
C0113	NOT PLACED	
C0114	2113946E02	1.0uF
C0115	2113946E02	1.0uF
C0117	2113945A10	1500pF
C0118	2113945C31	0.1uF
C0119	NOT PLACED	
C0120	2113945B02	.01uF
C0121	NOT PLACED	
C0122	2113945B02	.01uF
C0123	2113946E02	1.0uF
C0124	2113945C31	0.1uF
C0125	2113945A10	1500pF
C0126	2113945A10	1500pF
C0127	2113945A10	1500pF
C0128	2113945A10	1500pF
C0129	2113945C31	0.1uF
C0130	2113945A10	1500pF
C0131	2113945A10	1500pF
C0132	2113945A10	1500pF
C0133	2313960B30	4.7uF
C0134	2113945A10	1500pF
C0135	2313960B32	10uF
C0136	2113945C31	0.1uF
C0137	2313960B32	10uF
C0138	2113945A10	1500pF
C0140	2313960B30	4.7uF
C0141	2113945C31	0.1uF
C0142	2113945A10	1500pF
C0143	2113945A10	1500pF
C0144	2113945C31	0.1uF
C0145	2113945B02	.01uF
C0146	2113945A10	1500pF
C0147	2113945A10	1500pF
C0148	NOT PLACED	
C0149	2113945C31	0.1uF
C0150	2113945C31	0.1uF

Circuit Ref	Motorola Part No.	Description
C0151	2113945C31	0.1uF
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	2185419D06	0.1uF
C0171	2113945B02	.01uF
C0175	2113945A10	1500pF
C0177	2113945A10	1500pF
C0178	2113945A10	1500pF
C0179	2113945A10	1500pF
C0180	2113945C31	0.1uF
C0191	2185419D06	0.1uF
C0192	2185419D06	0.1uF
C0193	2185419D06	0.1uF
C0194	2185419D06	0.1uF
C0195	2113945A05	470pF
C0196	2113946H02	10uF
C0200	2113945A10	1500pF
C0201	2113945Y02	0.10uF
C0202	2113945B02	.01uF
C0203	2113945A10	1500pF
C0204	2113945A10	1500pF
C0205	2113945Y02	0.10uF
C0206	2113945A10	1500pF
C0207	2113945A10	1500pF
C0208	2115153H37	15pF
C0209	2113945Y02	0.10uF
C0211	2113945A10	1500pF
C0213	2115153H37	15pF
C0214	2115153H34	11pF
C0215	2115153H22	6.2pF
C0217	2113945A10	1500pF
C0218	NOT PLACED	
C0219	2115153H25	8.2pF
C0220	2115153H27	10pF
C0221	2115153H35	12pF
C0222	NOT PLACED	
C0223	2115153H47	39pF
C0224	NOT PLACED	
C0225	2115153H59	120pF
C0226	2113945A10	1500pF
C0229	2115153H46	36pF
C0231	2115153H17	3.9pF
C0233	NOT PLACED	

Circuit Ref	Motorola Part No.	Description
C0235	2115153H37	15pF
C0236	2113945A10	1500pF
C0237	2113945Y02	0.10uF
C0238	2113945A10	1500pF
C0239	2113945Y02	0.10uF
C0240	2113945A10	1500pF
C0241	2113945Y02	0.10uF
C0242	2113945A10	1500pF
C0243	2115153H35	12pF
C0245	2115153H35	12pF
C0246	2115153H27	10pF
C0247	2115153H27	10pF
C0248	2113945A10	1500pF
C0249	2113945Y02	0.10uF
C0250	2115153H34	11pF
C0251	2115153H41	22pF
C0252	2115153H55	82pF
C0253	2113945A10	1500pF
C0257	2113945A10	1500pF
C0258	2113945Y02	0.10uF
C0259	2115153H40	20pF
C0260	2113945A10	1500pF
C0261	2113945A10	1500pF
C0262	2113945A10	1500pF
C0264	2113945A10	1500pF
C0265	2115153H40	20pF
C0300	2113945A10	1500pF
C0301	2113945Y02	0.10uF
C0302	2113945B02	.01uF
C0303	2113945A10	1500pF
C0304	2113945A10	1500pF
C0305	2113945Y02	0.10uF
C0306	2113945A10	1500pF
C0307	2113945B04	.022uF
C0308	2115153H37	15pF
C0309	2113945A10	1500pF
C0310	2115153H03	1.0pF
C0311	2113945A10	1500pF
C0312	2113945A10	1500pF
C0313	2115153H37	15pF
C0314	2115153H37	15pF
C0315	2115153H10	2.0pF
C0317	2113945A10	1500pF
C0318	NOT PLACED	
C0319	2115153H36	13pF
C0320	2115153H20	5.1pF
C0321	2115153H22	6.2pF
C0322	NOT PLACED	
C0323	2115153H44	30pF
C0324	NOT PLACED	
C0325	2113944A42	150pF

Circuit Ref	Motorola Part No.	Description
C0326	2113945A10	1500pF
C0327	2113945A10	1500pF
C0328	2113945Y02	0.10uF
C0329	2115153H43	27pF
C0331	2115153H03	1.0pF
C0332	2115153H12	2.4pF
C0334	2113944A44	220pF
C0338	2113945A10	1500pF
C0339	2113945Y02	0.10uF
C0348	2113945A10	1500pF
C0349	2113945Y02	0.10uF
C0360	2313960B30	4.7uF
C0361	2113945A10	1500pF
C0364	2113946B04	0.1uF
C0400	2113945A10	1500pF
C0401	2113945C31	0.1uF
C0402	2113945A10	1500pF
C0403	2115153H50	51pF
C0404	2113945A10	1500pF
C0405	2113945A10	1500pF
C0406	2115153H23	6.8pF
C0407	2113945A10	1500pF
C0408	2115153H22	6.2pF
C0409	2115153H35	12pF
C0410	2115153H40	20pF
C0411	2115153H40	20pF
C0412	2115153H49	47pF
C0413	2113945A10	1500pF
C0414	2113945A10	1500pF
C0416	2115153H37	15pF
C0417	2115153H37	15pF
C0418	2113945A05	470pF
C0419	2113945Y02	0.10uF
C0420	NOT PLACED	
C0421	2115153H19	4.7pF
C0422	2115153H48	43pF
C0423	2115153H51	56pF
C0424	2115153H48	43pF
C0425	2115153H50	51pF
C0426	2115153H48	43pF
C0427	2115153H50	51pF
C0428	2115153H48	43pF
C0429	2115153H50	51pF
C0430	2115153H48	43pF
C0431	2115153H51	56pF
C0432	2115153H50	51pF
C0433	2113945A10	1500pF
C0434	2113945A10	1500pF
C0435	2113946S35	1.0uF
C0436	2113945A10	1500pF
C0437	2113945A10	1500pF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0438	2113945A10	1500pF	C0622	2113945A09	1000pF	C0724	NOT PLACED		C0806	2113945A10	1500pF
C0439	2113945A10	1500pF	C0623	2113945Y02	0.10uF	C0725	NOT PLACED		C0817	NOT PLACED	
C0440	2113945Y02	0.10uF	C0625	2113944C89	200pF	C0726	2111078B42	100pF	C0818	NOT PLACED	
C0441	2115153H17	3.9pF	C0626	2113944A40	100pF	C0727	2111078B40	82pF	C0819	2111078B49	180pF
C0442	2113945A10	1500pF	C0627	2113944A40	100pF	C0728	2113944C06	470pF	C0820	NOT PLACED	
C0443	2115153H42	24pF	C0628	2113945Y02	0.10uF	C0729	2111078B36	56pF	C0821	NOT PLACED	
C0444	2115153H42	24pF	C0629	2113945A11	2200pF	C0730	NOT PLACED		C0822	2113944C51	1000pF
C0445	2115153H44	30pF	C0630	2113945Y02	0.10uF	C0731	2111078B59	470pF	C0823	2113944C51	1000pF
C0446	2115153H27	10pF	C0631	2113945Y02	0.10uF	C0732	NOT PLACED		C0824	NOT PLACED	
C0447	2115153H42	24pF	C0632	2313960B30	4.7uF	C0733	2113944C06	470pF	C0900	2113945A10	1500pF
C0448	2115153H41	22pF	C0633	2113945Y02	0.10uF	C0734	2113944C06	470pF	C0901	2113945C31	0.1uF
C0449	2115153H27	10pF	C0634	2113945B02	.01uF	C0735	2111078B49	180pF	C0902	2113945C31	0.1uF
C0450	2115153H26	9.1pF	C0635	2113944A40	100pF	C0738	2113955D13	2.2uF	C0903	2113945A10	1500pF
C0451	2115153H53	68pF	C0636	2113944A40	100pF	C0739	2111078B34	47pF	C0904	2113945A10	1500pF
C0452	2115153H37	15pF	C0637	2113946S35	1.0uF	C0740	2111078B35	51pF	C0906	2113945A10	1500pF
C0453	2115153H47	39pF	C0638	2113945Y02	0.10uF	C0741	2111078B22	22pF	C0907	2113945C02	.01uF
C0454	2113945A10	1500pF	C0640	2113946N03	2.2uF	C0742	2111078B11	8.2pF	C0908	2113945C31	0.1uF
C0455	2113945A10	1500pF	C0641	2113945B02	.01uF	C0746	2111078B59	470pF	C0909	2113945A10	1500pF
C0456	2113945A10	1500pF	C0642	2115153H53	68pF	C0750	2111078B17	14pF	C0910	2113945A10	1500pF
C0457	2113945A10	1500pF	C0643	2113945Y02	0.10uF	C0752	2111078B55	330pF	C0911	2113945A10	1500pF
C0458	2115153H55	82pF	C0644	2113945Y02	0.10uF	C0753	NOT PLACED		C0912	2113945A10	1500pF
C0502	2113945Y02	0.10uF	C0645	2113945B02	.01uF	C0754	2111078B57	390pF	C0913	2113945A10	1500pF
C0503	2113945Y02	0.10uF	C0646	2113946G04	0.68uF	C0755	NOT PLACED		C0914	2113945A10	1500pF
C0504	2113945Y02	0.10uF	C0647	2113946J03	10.0uF	C0766	2113944C35	27pF	C0915	2113945A10	1500pF
C0506	2115153H35	12pF	C0648	2113946J03	10.0uF	C0767	2113944C06	470pF	C0916	2113945A10	1500pF
C0507	2115153H38	18pF	C0649	2113945A12	3300pF	C0770	2113945A10	1500pF	C0917	2113945A09	1000pF
C0509	NOT PLACED		C0650	2115153H44	30pF	C0771	NOT PLACED		C0918	2113945A10	1500pF
C0510	2115153H24	7.5pF	C0651	2113945A10	1500pF	C0772	2113944C30	10pF	C0919	2113945C31	0.1uF
C0512	2113945Y02	0.10uF	C0700	2113944C36	33pF	C0775	NOT PLACED		C0920	2113945A10	1500pF
C0513	2113945Y02	0.10uF	C0701	2113945C25	.033uF	C0776	2113944C51	1000pF	C0921	2113945C31	0.1uF
C0514	2113945Y02	0.10uF	C0702	2113944C51	1000pF	C0777	2113944C51	1000pF	C0922	2113945A10	1500pF
C0515	NOT PLACED		C0703	2113944C36	33pF	C0778	2111078B47	150pF	C0923	2113944C55	2200pF
C0516	NOT PLACED		C0704	2113945C25	.033uF	C0779	2111078B32	39pF	C0925	2113945A10	1500pF
C0601	2115153H48	43pF	C0705	2113944C51	1000pF	C0780	NOT PLACED		C0926	2113945L41	4700pF
C0602	2113945B02	.01uF	C0706	NOT PLACED		C0783	2113945A10	1500pF	C0927	2113944C02	220pF
C0603	2113944A44	220pF	C0707	NOT PLACED		C0786	2113944C06	470pF	C0928	2113944C51	1000pF
C0604	2113945Y02	0.10uF	C0708	2113944C51	1000pF	C0790	2113944C02	220pF	C0929	2113945A10	1500pF
C0605	2115153H48	43pF	C0709	2113945C31	0.1uF	C0791	2113944C39	56pF	C0931	2113945A10	1500pF
C0607	2115153H37	15pF	C0710	2371403L02	10uF	C0792	2113944C06	470pF	C0934	2113945A10	1500pF
C0610	2115153H51	56pF	C0711	2113945L49	.01uF	C0793	NOT PLACED		C0935	2113945A10	1500pF
C0611	2113945A09	1000pF	C0712	2113944C06	470pF	C0794	NOT PLACED		C0936	2113945A10	1500pF
C0612	2115153H39	18pF	C0713	NOT PLACED		C0795	2113944C06	470pF	C0937	2113945A10	1500pF
C0613	2113945G91	0.1uF	C0714	2111078B59	470pF	C0796	2113944C47	150pF	C0939	2113945A10	1500pF
C0614	2115153H41	22pF	C0716	NOT PLACED		C0797	2113944C51	1000pF	C0940	2113944C51	1000pF
C0615	2113945B02	.01uF	C0717	2113945A09	1000pF	C0798	2113944C51	1000pF	C0941	2113944M27	24pF
C0616	NOT PLACED		C0718	2113945A09	1000pF	C0799	2113944C47	150pF	C0942	2113944C51	1000pF
C0617	2113945Y02	0.10uF	C0719	2111078B33	43pF	C0801	2113945A10	1500pF	C0943	2113944C51	1000pF
C0618	2115358H25	1uF	C0720	2111078B33	43pF	C0802	NOT PLACED		C0944	2113944M18	10pF
C0619	2113945Y02	0.10uF	C0721	2111078B42	100pF	C0803	2111078B21	20pF	C0945	2113944C51	1000pF
C0620	2113945Y02	0.10uF	C0722	2111078B40	82pF	C0804	2113944C51	1000pF	C0947	2113944A40	100pF
C0621	2113945Y02	0.10uF	C0723	2111078B59	470pF	C0805	NOT PLACED		C0948	2113946S35	1.0uF

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
C0949	2113946G01	2.2uF	E0609	2409134J25	FERRITE BEAD	L0411	2414017N20	47nH	Q0302	4802197J95	NPN RF TRANSISTOR
C0950	2113945A09	1000pF	E0610	2480640Z01	FERRITE BEAD	L0412	2414017N26	150nH	Q0400	4815271H01	ANALOG SWITCH
C0951	2113945C31	0.1uF	E0700	2485011Y01	FERRITE BEAD	L0414	2414017K32	560nH	Q0401	4815267H01	DUAL PNP
C0953	2113945A10	1500pF	E0701	2485011Y01	FERRITE BEAD	L0503	2414015B32	330nH	Q0402	4871127H01	NPN RF TRANSISTOR
CR0201	4815096H01	DIODE VARACTOR 1SV305	E0702	7671656M01	FERRITE BEAD	L0504	NOT PLACED		Q0403	4815270H01	DUAL NPN/PNP
CR0202	4815096H01	DIODE VARACTOR 1SV305	E0703	2485011Y01	FERRITE BEAD	L0506	2414032B70	1.5uH	Q0405	4871127H01	NPN RF TRANSISTOR
CR0203	4815096H01	DIODE VARACTOR 1SV305	E0704	2409134J25	FERRITE BEAD	L0602	2414032K29	8.2uH	Q0500	4802197J95	NPN RF TRANSISTOR
CR0204	4815096H01	DIODE VARACTOR 1SV305	FL0500	9180022M11	73.35MHZ CRYSTAL FILTER	L0603	2414032D28	820nH	Q0501	4802197J95	NPN RF TRANSISTOR
CR0205	4815096H01	DIODE VARACTOR 1SV305	J0700	0905901V12	BNC RF CONNECTOR	L0604	2466505A01	10uH	Q0600	4805793Y10	NPN RF TRANSISTOR
CR0206	4815096H01	DIODE VARACTOR 1SV305	L0100	2414017N29	270nH	L0605	2466505A01	10uH	Q0601	4813973A04	NPN DARLINGTON
CR0207	4815096H01	DIODE VARACTOR 1SV305	L0200	2414017N28	220nH	L0608	2414032B76	4.7uH	Q0700	4813970A59	P-CHANNEL MOSFET
CR0208	4815096H01	DIODE VARACTOR 1SV305	L0202	2414017K33	680nH	L0700	2460592A01	17nH	Q0701	4815261H01	ANALOG SWITCH
CR0300	4815096H01	DIODE VARACTOR 1SV305	L0203	2414017K33	680nH	L0702	2479990G01	33.47nH	Q0702	0105958T74	MRF1550PA ASSEMBLY
CR0301	4815096H01	DIODE VARACTOR 1SV305	L0204	2414017N28	220nH	L0705	2414017N26	150nH	Q0703	4816548H01	N-CHANNEL LDMOS DRIVER
CR0302	4815059H01	DIODE VARACTOR 1SV325	L0205	2414017N22	68nH	L0706	2485873L02	25nH	Q0704	4813973B02	PNP
CR0303	4815059H01	DIODE VARACTOR 1SV325	L0206	2414017N17	27nH	L0707	2485873L01	18nH	Q0705	4816547H01	N-CHANNEL LDMOS PRE-DRIVER
CR0304	4815096H01	DIODE VARACTOR 1SV305	L0207	2416077H12	27nH	L0708	2485873L01	18nH	Q0706	4815272H01	ANALOG SWITCH
CR0400	4813974A19	DIODE, SCHOTTKY	L0209	2414017K33	680nH	L0709	2485873L02	25nH	Q0707	4815272H01	ANALOG SWITCH
D0400	4813974A06	DIODE, PIN	L0210	2414015B06	150nH	L0710	2485873L02	25nH	Q0708	4815272H01	ANALOG SWITCH
D0401	4885094Y01	DIODE VARACTOR 1SV228	L0211	2414017N28	220nH	L0714	2460592A01	17nH	Q0709	4815272H01	ANALOG SWITCH
D0402	4813978C02	DIODE, PIN	L0212	2414017K33	680nH	L0715	2414017N26	150nH	Q0901	4813973A13	PNP
D0403	4885094Y01	DIODE VARACTOR 1SV228	L0213	2414017K33	680nH	L0716	2414017N11	8.2nH	Q0902	4813973M07	NPN
D0405	4815090H01	DIODE, MIXER	L0214	2414017K33	680nH	L0717	2414017N13	12nH	R0100	0613952R66	0
D0500	4813974A19	DIODE, SCHOTTKY	L0215	2416077H11	22nH	L0718	2414017N22	68nH	R0101	0613952R66	0
D0600	4815096H01	DIODE VARACTOR 1SV305	L0217	2414017K33	680nH	L0719	2414017N10	6.8nH	R0102	0613952R66	0
D0601	4815096H01	DIODE VARACTOR 1SV305	L0218	2414015B08	220nH	L0720	2485873L01	18nH	R0103	0613952R66	0
D0700	4802482J02	DIODE, PIN	L0219	2414017K33	680nH	L0721	2485873L02	25nH	R0104	0613952R17	47K
D0702	4802482J02	DIODE, PIN	L0221	2414017N27	180nH	L0722	2415385H04	17.5nH	R0105	0613952Q58	240
D0703	4886622Y06	DIODE, PIN	L0230	2414017N27	180nH	L0723	2415385H06	28nH	R0106	0613952Q83	2.7K
D0900	4813978C02	DIODE, SWITCHING	L0300	2414017N28	220nH	L0724	2485873L02	25nH	R0107	0613952Q57	220
D0901	4815023H01	DIODE, PIN	L0302	2414017K33	680nH	L0725	2414032B69	1.2uH	R0108	0613952Q80	2K
D0902	4815024H01	DIODE, PIN	L0303	2414017K33	680nH	L0728	2414032B70	1.5uH	R0109	0613952R66	0
D0903	4815024H01	DIODE, PIN	L0304	2414017N29	270nH	L0729	2414032B69	1.2uH	R0110	0613952Q42	51
D0904	4813974A21	DIODE, SCHOTTKY	L0305	2414017N22	68nH	L0730	2414032B53	100nH	R0111	0613952R66	0
D0905	4813974A21	DIODE, SCHOTTKY	L0306	2414017N27	180nH	L0731	2414032B53	100nH	R0113	0613952R01	10K
E0201	2480640Z01	FERRITE BEAD	L0307	2414015C08	56nH	L0745	2460591A01	4.22nH	R0114	0613952Q80	2K
E0301	2480640Z01	FERRITE BEAD	L0309	2414017K33	680nH	L0900	2414032D30	1uH	R0115	0613952R66	0
E0400	2409134J25	FERRITE BEAD	L0310	2414017N23	82nH	L0901	2414017K32	560nH	R0116	0613952R66	0
E0401	2409134J25	FERRITE BEAD	L0311	2414017N29	270nH	L0902	2414017K32	560nH	R0117	0613952R12	30K
E0403	2409134J25	FERRITE BEAD	L0312	2414017K33	680nH	L0903	NOT PLACED		R0118	0613952R66	0
E0404	2409134J25	FERRITE BEAD	L0400	2414017K32	560nH	L0904	NOT PLACED		R0119	0613952Q35	27
E0500	2409134J25	FERRITE BEAD	L0401	2414032F31	56nH	M0700	2686201B02	HEATSINK	R0120	0613952R01	10K
E0600	2409134J25	FERRITE BEAD	L0402	NOT PLACED		Q0100	4802197J95	NPN RF TRANSISTOR	R0122	NOT PLACED	
E0601	2409134J25	FERRITE BEAD	L0403	NOT PLACED		Q0102	4815359H01	DUAL PNP	R0123	0613952R19	56K
E0602	2409134J25	FERRITE BEAD	L0404	NOT PLACED		Q0106	4816134H01	ANALOG SWITCH	R0125	0613952R66	0
E0603	2409134J25	FERRITE BEAD	L0405	NOT PLACED		Q0107	4813970A59	P-CHANNEL MOSFET	R0126	NOT PLACED	
E0604	2409134J25	FERRITE BEAD	L0406	2414032F29	39nH	Q0108	4815261H01	ANALOG SWITCH	R0127	0613952Q42	51
E0605	2409134J25	FERRITE BEAD	L0407	2414032F74	560nH	Q0200	4805793Y10	NPN RF TRANSISTOR	R0128	0613952Q25	10
E0606	2409134J25	FERRITE BEAD	L0408	2414015B02	68nH	Q0201	4805793Y10	NPN RF TRANSISTOR	R0131	0613952Q53	150
E0607	2409134J25	FERRITE BEAD	L0409	2414015B02	68nH	Q0202	4802197J95	NPN RF TRANSISTOR	R0134	0613952Q42	51
E0608	2409134J25	FERRITE BEAD	L0410	2414015B12	47nH	Q0300	4805793Y10	NPN RF TRANSISTOR			

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
R0139	NOT PLACED		R0321	0613952R01	10K	R0439	0613952Z45	3.6K	R0721	0613958S29	15
R0140	NOT PLACED		R0327	0613952R01	10K	R0440	0613952Q32	20	R0722	0613952J07	18K
R0144	0613952R01	10K	R0328	NOT PLACED		R0500	0613952Q90	5.1K	R0723	0613958J49	1MEG
R0146	0613952R66	0	R0332	0613952Q60	300	R0501	0613952Q61	330	R0726	0613958S29	15
R0147	NOT PLACED		R0333	0613952Q31	18	R0502	0613952R08	20K	R0727	0613952J05	15K
R0148	0613952Q51	120	R0334	0613952Q60	300	R0503	0613952R12	30K	R0728	0613952H89	4.7K
R0155	0613952R66	0	R0336	NOT PLACED		R0508	0613952R19	56K	R0729	0613952J01	10K
R0156	NOT PLACED		R0337	0613952R66	0	R0509	0613952Q89	4.7K	R0730	0613952H73	1K
R0157	NOT PLACED		R0338	NOT PLACED		R0510	0613952R12	30K	R0731	NOT PLACED	
R0158	NOT PLACED		R0339	0613952Q95	8.2K	R0511	0613952Q75	1.2K	R0732	0613958S29	15
R0159	0613952R01	10K	R0340	0613952R66	0	R0512	0613952Q42	51	R0733	0613958S29	15
R0160	0613952R25	100K	R0343	0613952R16	43K	R0601	0613952Q51	120	R0734	0613958S29	15
R0161	0613952R25	100K	R0345	0613952R66	0	R0602	0613952R01	10K	R0735	0613959Y49	100
R0201	0613952Q82	2.4K	R0347	NOT PLACED		R0603	0613952Q66	510	R0736	0613958S29	15
R0202	0613952Q66	510	R0400	0613952R05	15K	R0604	0613952R10	24K	R0737	0613958S29	15
R0203	0613952Q66	510	R0401	0613952Q73	1K	R0605	0613952Q61	330	R0738	0613959Y42	51
R0204	0613952Q88	4.3K	R0402	0613958H33	22	R0606	0613952Q42	51	R0739	0613958S29	15
R0205	0613952Q49	100	R0403	0613952R66	0	R0607	NOT PLACED		R0740	0613958J74	0
R0206	0613952R05	15K	R0404	0613952Q83	2.7K	R0608	0613952R66	0	R0742	0613959Q25	10
R0207	0613952Q25	10	R0406	0613952Q68	620	R0609	0613952R66	0	R0745	0613952H65	470
R0208	0613952Q41	47	R0407	0613952Q57	220	R0610	0613952R66	0	R0746	0613952R66	0
R0210	0613952Q89	4.7K	R0408	0613952R01	10K	R0611	0613952R66	0	R0747	0613952H49	100
R0211	0613952R66	0	R0409	0613952Z43	3K	R0612	0613952R66	0	R0748	0613952J19	56K
R0212	0613952R66	0	R0410	0613952R25	100K	R0613	0613952R66	0	R0749	0613952G67	0
R0213	0613952R01	10K	R0411	0613952Q39	39	R0614	0613952R66	0	R0750	0613952J07	18K
R0216	0613952Q53	150	R0412	0613952R25	100K	R0615	0613952R66	0	R0751	0613952J11	27K
R0218	0613952R01	10K	R0413	0613952Q69	680	R0616	0613952R25	100K	R0752	0613952G67	0
R0219	0613952Q51	120	R0414	0613952Q69	680	R0617	0613952R01	10K	R0753	0613952H73	1K
R0220	0613952Q42	51	R0415	0613952Q69	680	R0618	0613952Q63	390	R0754	0613952H35	27
R0221	0613952Q51	120	R0416	0613952Q69	680	R0619	0613952R01	10K	R0755	0613952H35	27
R0224	0613952Q92	6.2K	R0417	0613958H43	56	R0620	0613952Q96	9.1K	R0756	0613952J25	100K
R0225	0613952Q95	8.2K	R0418	0613952M42	2.67K	R0621	0613952R66	0	R0757	0613952J17	47K
R0226	0613952Q49	100	R0419	0613952Q83	2.7K	R0622	NOT PLACED		R0760	0613952J01	10K
R0229	0613952Q53	150	R0420	0613952Q83	2.7K	R0623	NOT PLACED		R0761	0613952G67	0
R0230	0613952Q88	4.3K	R0421	0613952R66	0	R0624	0613952Q90	5.1K	R0773	0613952J21	68K
R0240	NOT PLACED		R0422	0613952Q42	51	R0625	0613952N69	51.1K	R0775	NOT PLACED	
R0241	NOT PLACED		R0423	0613952Q53	150	R0626	0613952N81	68.1K	R0777	0613952J25	100K
R0301	0613952Q87	3.9K	R0424	0613952Q53	150	R0627	0613952R66	0	R0779	0613952G67	0
R0302	0613952Q66	510	R0425	0613952M01	1K	R0702	NOT PLACED		R0780	0613952G67	0
R0303	0613952Q66	510	R0426	0613952R01	10K	R0706	0613958H57	220	R0781	0613958S73	1K
R0304	0613952Q89	4.7K	R0427	0613952Q42	51	R0710	0613958J49	1MEG	R0900	0613952R19	56K
R0305	0613952Q49	100	R0428	0613952R66	0	R0711	0613952H57	220	R0901	0613952R16	43K
R0306	0613952R05	15K	R0429	0613952Q69	680	R0712	0613958S29	15	R0902	0613952Q88	4.3K
R0307	0613952Q47	82	R0430	0613952R01	10K	R0713	0613959H12	30K	R0903	0613952R09	22K
R0308	0613952Q41	47	R0431	0613952R01	10K	R0714	0613952H44	62	R0906	0613952R66	0
R0310	0613952Q89	4.7K	R0432	0613958H44	62	R0715	0613952H44	62	R0907	0613952R66	0
R0311	0613952R66	0	R0433	0613952R66	0	R0716	0613958S29	15	R0909	0613952R16	43K
R0312	0613952R66	0	R0434	NOT PLACED		R0717	0613958S29	15	R0910	0613952H73	1K
R0316	0613952Q50	110	R0435	0613952Q65	470	R0718	0613952H35	27	R0911	0613952Q89	4.7K
R0319	0613952R08	20K	R0436	0613952Q53	150	R0719	0613958S29	15	R0912	0613952R11	27K
R0320	0613952R25	100K	R0437	0613952Q53	150	R0720	0613952H35	27	R0913	0613952R66	0

Circuit Ref	Motorola Part No.	Description
R0914	0613952R37	330K
R0915	0613952R22	75K
R0916	0613952Q49	100
R0917	0613952H91	5.6K
R0918	0613952H63	390
R0919	0613952R15	39K
R0920	0613952R13	33K
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
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
R0970	0613959Y49	100
R0972	0613952G67	0
R0973	0613952G67	0
R0975	0613959Y47	82
R0976	0613952H39	39
R0977	0613952H39	39
R0978	0613952G67	0
R0979	0613952G67	0
RT0908	0615585H01	THERMISTOR, 47K
RT0953	0615585H01	THERMISTOR, 47K
SH0100	2615362H01	SHIELD
SH0101	2615362H01	SHIELD
SH0200	2615362H01	SHIELD
SH0300	2615362H01	SHIELD
SH0500	2615576H01	SHIELD
SH0900	2686423Z02	SHIELD
SH0901	2686425Z02	SHIELD
SP0701	1015349H01	SOLDER_PREFORM
SP0702	1015349H01	SOLDER_PREFORM

Circuit Ref	Motorola Part No.	Description
SP0703	1015349H01	SOLDER_PREFORM
SP0704	1015349H01	SOLDER_PREFORM
SP0705	1015349H01	SOLDER_PREFORM
SP0706	1015349H01	SOLDER_PREFORM
SP0707	1015349H01	SOLDER_PREFORM
SP0708	1015349H01	SOLDER_PREFORM
T0400	2515121H01	BALUN XFMR
T0401	2515121H01	BALUN XFMR
U0100	5104932K08	IC, FRACN SYNTHESIZER
U0101	5114000B59	ANALOG SWITCH
U0201	4815267H01	DUAL PNP
U0303	4815272H01	ANALOG SWITCH
U0304	4815267H01	DUAL PNP
U0305	4815267H01	DUAL PNP
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
VR0700	4813977M11	DIODE, 5.6V ZENER
Y0100	5102495J07	1.5PPM 16.8MHZ TCXO (Non-GPS Models only)
Y0100	5116032H01	0.5PPM 16.8MHZ TCXO (GPS Models only)

Appendix A EMEA Regional Warranty, Service and Technical Support

A.1 Warranty and Service Support

Motorola offers long term support for its products. This support includes full exchange and/or repair of the product during the warranty period, and service/ repair or spare parts support out of warranty. Any "return for exchange" or "return for repair" by an authorized Motorola Dealer must be accompanied by a Warranty Claim Form. Warranty Claim Forms are obtained by contacting an Authorized Motorola Dealer.

A.1.1 Warranty Period and Return Instructions

The terms and conditions of warranty are defined fully in the Motorola Dealer or Distributor or Reseller contract. These conditions may change from time to time and the following notes are for guidance purposes only.

In instances where the product is covered under a "return for replacement" or "return for repair" warranty, a check of the product should be performed prior to shipping the unit back to Motorola. This is to ensure that the product has been correctly programmed or has not been subjected to damage outside the terms of the warranty.

Prior to shipping any radio back to the appropriate Motorola warranty depot, please contact Customer Resources (Please see page A-3). All returns must be accompanied by a Warranty Claim Form, available from your Customer Services representative. Products should be shipped back in the original packaging, or correctly packaged to ensure no damage occurs in transit.

A.1.2 After Warranty Period

After the Warranty period, Motorola continues to support its products in two ways.

1. Motorola's Managed Technical Services (MTS) offers a repair service to both end users and dealers at competitive prices.
2. MTS supplies individual parts and modules that can be purchased by dealers who are technically capable of performing fault analysis and repair.

A.2 European Radio Support Centre (ERSC)

The ERSC Customer Information Desk is available through the following service numbers:

Austria:	08 00 29 75 41	Italy:	80 08 77 387
Belgium:	08 00 72 471	Luxemburg:	08 00 23 27
Denmark:	80 88 05 72	Netherlands:	08 00 22 45 13
Finland:	08 00 11 49 910	Norway:	80 01 11 15
France:	08 00 90 30 90	Portugal:	08 00 84 95 70
Germany:	08 00 18 75 240	Spain:	90 09 84 902
Greece:	00 80 04 91 29 020	Sweden:	02 07 94 307
UK :	08 00 96 90 95	Switzerland:	08 00 55 30 82
Ireland:	18 00 55 50 21	Iceland:	80 08 147

Or dial the European Repair and Service Centre:
Tel: +49 30 6686 1555

Please use these numbers for repair enquiries only.

A.3 Piece Parts

Some replacement parts, spare parts, and/or product information can be ordered directly. If a complete Motorola part number is assigned to the part, it is available from Motorola Radio Products and Solutions Organization (RPSO). If no part number is assigned, the part is not normally available from Motorola. If the part number is appended with an asterisk, the part is serviceable by Motorola Depot only. If a parts list is not included, this generally means that no user-serviceable parts are available for that kit or assembly.

Orders for replacement parts, kits and assemblies should be placed directly on Motorola's local distribution/dealer organisation or via Motorola Online at: <http://emeaonline.motorola.com>

* 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).

A.4 Technical Support

Motorola Product Services is available to assist the dealer/distributors in resolving any malfunctions which may be encountered.

North Europe - Stephen Woodrow
Telephone: +44 (0) 1256 488 082
Fax: +44 01256 488 080
Email: CSW066@motorola.com

Central and East Europe - Siggy Punzenberger
Telephone: +49 (0) 6128 70 2342
Fax: +49 (0) 6128 95 1096
Email: TFG003@email.mot.com

Russia and Belarus - Oleg Machnev
Telephone: +7 495 785 0150
Fax: +7 495 785 0185
Email: COM005@email.mot.com

Germany - Customer Connect Team
Telephone: +49 (0) 30 6686 1539
Fax: +49 (0) 30 6686 1916
Email: cgiss.emea@europe.mot.com

Middle East and Africa - Wayne Holmes
Telephone: +27 11 800 7922
Fax: +27 11 800 7923
Email: radiosupport.za@motorola.com

Italy - Ugo Gentile
Telephone: +39 0 2822 0325
Fax: +39 0 2822 0334
Email: C13864@email.mot.com

France - Armand Roy
Telephone: +33 1 6935 7868
Fax: +33 1 6935 7808
Email: armand.roy@motorola.com

France - Laurent Irrmann
Telephone: +33 1 6935 7866
Fax: +33 1 6935 7808
Email: laurent.irrmann@motorola.com

A.5 Further Assistance From Motorola

You can also contact the Customer Help Desk through the following web address.
<http://www.motorola.com/governmentandenterprise/contactus>

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
Analog	Refers to a continuously variable signal or a circuit or device designed to handle such signals.
Band	Frequencies allowed for a specific purpose.
CPS	Customer Programming Software: Software with a graphical user interface containing the feature set of a radio.
Default	A pre-defined set of parameters.
DM	Refers to Digital Professional Radio model names in the MOTOTRBO Professional Digital Two-Way Radio System.
Digital	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.
DPL	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.
FCC	Federal Communications Commission.
Frequency	Number of times a complete electromagnetic-wave cycle occurs in a fixed unit of time (usually one second).
GPIO	General-Purpose Input/Output: Pins whose function is programmable.
GPS	Global Positioning System
IC	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.
IF	Intermediate Frequency.
kHz	kilohertz: One thousand cycles per second. Used especially as a radio-frequency unit.
LCD	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.
LED	Light Emitting Diode: An electronic device that lights up when electricity is passed through it.
MDC	Motorola Digital Communications.

Term	Definition
MHz	Megahertz: One million cycles per second. Used especially as a radio-frequency unit.
Paging	One-way communication that alerts the receiver to retrieve a message.
PC Board	Printed Circuit Board. Also referred to as a PCB.
PL	Private-Line Tone Squelch: A continuous sub-audible tone that is transmitted along with the carrier.
Programming Cable	A cable that allows the CPS to communicate directly with the radio using USB.
Receiver	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.
Repeater	Remote transmit/receive facility that re-transmits received signals in order to improve communications range and coverage (conventional operation).
RF	Radio Frequency: The portion of the electromagnetic spectrum between audio sound and infrared light (approximately 10 kHz to 10 GHz).
RX	Receive.
Signal	An electrically transmitted electromagnetic wave.
Spectrum	Frequency range within which radiation has specific characteristics.
Squelch	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.
TOT	Time-out Timer: A timer that limits the length of a transmission.
TPL	Tone Private Line
Transceiver	Transmitter-receiver. A device that both transmits and receives analog or digital signals. Also abbreviated as XCVR.
Transmitter	Electronic equipment that generates and amplifies an RF carrier signal, modulates the signal, and then radiates it into space.
TX	Transmit.
UHF	Ultra-High Frequency.
USB	Universal Serial Bus: An external bus standard that supports data transfer rates of 12 Mbps.
USB_DM_MAP	USB D- Connection at the rear accessory connector.
USB_DP_MAP	USB D+ Connection at the rear accessory connector.
VHF	Very High Frequency.
VIP	Vehicle Interface Port.



MOTOROLA

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