



**Professional Series**  
Two-Way Radio Detailed Service Manual

**HT1250•LS<sup>+</sup>**

**200 MHz**  
**700 MHz**

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# PRODUCT SAFETY AND RF EXPOSURE COMPLIANCE



**Caution**

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

## **ATTENTION!**

**This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements.** Before using this product, read the RF energy awareness information and operating instructions in the Product Safety and RF Exposure booklet enclosed with your radio (Motorola Publication part number 68P81095C98) to ensure compliance with RF energy exposure limits.



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# Chapter 1

## Introduction

### 1.1 Scope of Manual

This manual is intended for use by service technicians familiar with similar types of equipment. It contains service information required for the equipment described and is current as of the printing date. Changes that occur after the printing date are incorporated by a complete manual revision or alternatively, as additions.

**NOTE** Before operating or testing these units, please read the Safety Information Section in the front of this manual.

### 1.2 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 customer service.

#### 1.2.1 Warranty Period

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 sections are for guidance purposes only.

#### 1.2.2 Return Instructions

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 a Motorola warranty depot, please contact the appropriate customer service for instructions. 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.

#### 1.2.3 After Warranty Period

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

First, Motorola's Accessories and Aftermarket Division (ADD) offers a repair service to both end users and dealers at competitive prices.

Second, Motorola's service department supplies individual parts and modules that can be purchased by dealers who are technically capable of performing fault analysis and repair.

## 1.3 Related Documents

The following documents are directly related to the use and maintainability of this product.

**Table 1-1.** Related Documents

Title	Part Number
200/700 MHz Professional Radio Portable Level 1&2 Basic Service Manual- English	6864110R15

## 1.4 Technical Support

Technical support is available to assist the dealer/distributor and self-maintained customers in resolving any malfunction which may be encountered. Initial contact should be by telephone to customer resources wherever possible. When contacting Motorola technical support, be prepared to provide the product model number and the unit's serial number. The contact locations and telephone numbers are located in the Basic Service Manual listed under the Related Documents paragraph of this chapter.

### 1.4.1 Piece Parts Availability

Some replacement parts, spare parts, and/or product information can be ordered directly. If a complete Motorola part number is assigned to the part, and it is not identified as "Depot ONLY", the part is available from Motorola Accessories and Aftermarket Division (AAD). 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 a 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.

#### Parts Order Entry

7:00 A. M. to 7:00 P. M. (Central Standard Time)  
Monday through Friday (Chicago, U. S. A.)

#### To Order Parts in the United States of America:

1-800-422-4210, or 847-538-8023  
1-800-826-1913, or 410-712-6200 (U. S. Federal Government)  
TELEX: 280127  
FAX: 1-847-538-8198  
FAX: 1-410-712-4991 (U. S. Federal Government)  
(U. S. A.) after hours or weekends:  
1-800-925-4357

#### To Order Parts in Latin America and the Caribbean:

1-847-538-8023

#### Motorola Parts

Accessories and Aftermarket Division  
(United States and Canada)  
Attention: Order Processing  
2200 Galvin Dr.  
Elgin, IL 60123

#### Accessories and Aftermarket Division

Attention: Latin America and Caribbean

#### Order Processing

2200 Galvin Dr.  
Elgin, IL 60123

#### Parts Identification

1-800-422-4210 menu 3

## 1.5 Radio Model Chart and Specifications

The radio model charts and specifications are located in the Basic Service Manual listed under the Related Documents paragraph of this chapter.

## 1.6 Radio Model Information

The model number and serial number are located on a label attached to the back of your radio. You can determine the RF output power, frequency band, protocols, and physical packages from these numbers. The example below shows one portable radio model number and its specific characteristics

**Table 1-2.** Radio Model Number (Example: AAH25MDF4DP5AN)

	Type of Unit	Model Series	Freq. Band	Power Level	Physical Packages	Channel Spacing	Protocol	Feature Level	Model Revision	Model Package
AA ↑ AA = Motorola Internal Use	H ↑ H = Portable	25	M (200 MHz)  5 (700 MHz)	C 1 or 2.5 W  D 1 or 5 W	F HT1250*LS+  H HT1250*LS+	4 12.5 kHz	DP PassPort	5 Limited Keypad  6 Full Keypad	A	N





## Chapter 2

# Intrinsically Safe Radio Information

### 2.1 FMRC Approved Equipment

Anyone intending to use a radio in a location where hazardous concentrations of flammable material exist (hazardous atmosphere) is advised to become familiar with the subject of intrinsic safety and with the National Electric Code NFPA 70 (National Fire Protection Association) Article 500 (hazardous [classified] locations).

An Approval Guide, issued by Factory Mutual Research Corporation (FMRC), lists manufacturers and the products approved by FMRC for use in such locations. FMRC has also issued a voluntary approval standard for repair service ("Class Number 3605").

FMRC Approval labels are attached to the radio to identify the unit as being FM Approved for specified hazardous atmospheres. This label specifies the hazardous Class/Division/Group along with the part number of the battery that must be used. Depending on the design of the portable unit, this FM label can be found on the back of the radio housing or the bottom of the radio housing. Their Approval mark is shown below.



**WARNING: Do not operate radio communications equipment in a hazardous atmosphere unless it is a type especially qualified (e.g. FMRC Approved) for such use. An explosion or fire may result.**

**WARNING: Do not operate the FMRC Approved Product in a hazardous atmosphere if it has been physically damaged (e.g. cracked housing). An explosion or fire may result.**

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

**WARNING: Do not replace or change accessories in a hazardous atmosphere. Contact sparking may occur while installing or removing accessories and cause an explosion or fire.**

**WARNING: Do not operate the FMRC Approved Product unit in a hazardous location with the accessory contacts exposed. Keep the connector cover in place when accessories are not used.**

**WARNING: Turn radio off before removing or installing a battery or accessory.**

**WARNING: Do not disassemble the FMRC Approved Product unit in any way that exposes the internal electrical circuits of the unit.**

Radios must ship from the Motorola manufacturing facility with the hazardous atmosphere capability and FM Approval labeling. Radios will not be "upgraded" to this capability and labeled in the field.

A modification changes the unit's hardware from its original design configuration. Modifications can only be done by the original product manufacturer at one of its FMRC audited manufacturing facilities.



**WARNING: Failure to use an FMRC Approved Product unit with an FMRC Approved battery or FMRC Approved accessories specifically approved for that product may result in the dangerously unsafe condition of an unapproved radio combination being used in a hazardous location.**

Unauthorized or incorrect modification of an FMRC Approved Product unit will negate the Approval rating of the product.

## 2.2 Repair of FMRC Approved Products

### REPAIRS FOR MOTOROLA FMRC APPROVED PRODUCTS ARE THE RESPONSIBILITY OF THE USER.

You should not repair or relabel any Motorola manufactured communication equipment bearing the FMRC Approval label ("FMRC Approved Product") unless you are familiar with the current FMRC Approval standard for repairs and service ("Class Number 3605").

You may want to consider using a repair facility that operates under 3605 repair service approval.



**WARNING: Incorrect repair or relabeling of any FMRC Approved Product unit could adversely affect the Approval rating of the unit.**

**WARNING: Use of a radio that is not intrinsically safe in a hazardous atmosphere could result in serious injury or death.**

FMRC's Approval Standard Class Number 3605 is subject to change at any time without notice to you, so you may want to obtain a current copy of 3605 from FMRC. Per the December, 1994 publication of 3605, some key definitions and service requirements are as follows:

### 2.2.1 Repair

A repair constitutes something done internally to the unit that would bring it back to its original condition Approved by FMRC. A repair should be done in an FMRC Approved facility.

Items not considered as repairs are those in which an action is performed on a unit which does not require the outer casing of the unit to be opened in a manner which exposes the internal electrical circuits of the unit. You do not have to be an FMRC Approved Repair Facility to perform these actions.

### 2.2.2 Relabeling

The repair facility shall have a method by which the replacement of FMRC Approval labels are controlled to ensure that any relabeling is limited to units that were originally shipped from the Manufacturer with an FM Approval label in place. FMRC Approval labels shall not be stocked by the repair facility. An FMRC Approval label shall be ordered from the original manufacturer as needed to repair a specific unit. Replacement labels may be obtained and applied by the repair facility providing satisfactory evidence that the unit being relabeled was originally an FMRC Approved unit. Verification may include, but is not limited to: a unit with a damaged Approval label, a unit with a defective housing displaying an Approval label, or a customer invoice indicating the serial number of the unit and purchase of an FMRC Approved model.

### 2.2.3 Do Not Substitute Options or Accessories

The Motorola communications equipment certified by Factory Mutual is tested as a system and consists of the FM Approved portable, FM Approved battery, and FM Approved accessories or options, or both. This Approved portable and battery combination must be strictly observed. There must be no substitution of items, even if the substitute has been previously Approved with a different Motorola communications equipment unit. Approved configurations are listed in the FM Approval guide published by FMRC, or in the product FM Supplement. This FM Supplement is shipped with FM Approved radio and battery combination from the manufacturer. The Approval guide, or the Approval standard Class Number 3605 document for repairs and service, can be ordered directly through Factory Mutual Research Corporation located in Norwood, Massachusetts.

## Chapter 3

# Theory of Operation

### 3.1 Introduction

This chapter provides a detailed theory of operation for the radio components. Schematic diagrams for the circuits described in the following paragraphs are located in Figures 5-1 through 5-34.

### 3.2 Radio Power Distribution

A block diagram of the DC power distribution throughout the radio board is shown in Figure 3-1. Four voltage regulators are used as follows:

**Table 3-1.** Voltage Regulators

Name	200 MHz	700 MHz	Application
3.3 V Reg	U410	U410	Li-Ion backup battery charging
Vdda	U3201	U203	Analog 3.3 V source (audio, VCO, synth)
Vddd	U400	U400	Digital 3.3 V source ( $\mu$ P and memory)
5 V Reg	U3711	U202	Analog 5 V source (RF, IF, synth)

The 7.5 V battery supplies radio power (UNSWB) directly to the electronic on/off control circuit, audio power amplifier, 3.3 V Li-Ion regulator U410, transmitter PA driver and PA Final stage, the Power Control IC, and the low battery detect circuit.

When the radio on/off/volume control is turned on, the switched battery voltage SWB+ from Q400 is applied to the various regulators, antenna switch, the 20-pin accessories connector J403, the 40-pin keypad/opton board connector J400, and the transmit LED. The Vddd source from digital 3.3V regulator U400 supplies operating power to the microprocessor, EEPROM, RAM and Flash ROM IC's. The Vdda analog 3.3 V regulator (U3201 in 200 MHz models, U203 in 700 MHz models) provides operating voltage for the ASFICcmp, VCOBIC, synthesizer IC. The 5 V regulator (U3711 in 200, U202 in 700) also powers the synthesizer IC as well as the receiver front end and IF circuitry, the RX and TX (700 MHz only) VCO buffers, and the opamp audio gain stage. Some stages are supplied only during receive by 5R, switched by Q3721 (200) or Q201 (700 MHz). Regulator voltage routing is configurable by jumper placement. All models are configured with R401 and R405 placed, and R402-4 not placed.

At power up, Q400 is initially turned on by the path through Q403, CR440, and Q405. When C480 has charged, this path is disabled, and Q400 is maintained on via a logic high ASFICcmp U404 pin 37, via CR440 and Q405.

The radio turns off when either of the two following conditions occur:

- Radio on/off/volume control is turned off.
- Low battery condition is detected.

If a low battery level or loss of battery voltage is detected by the microprocessor pin 67 through either of the above conditions, the radio personality data is stored to EEPROM prior to turning off. At this point U404-37 goes low, turning off Q400.

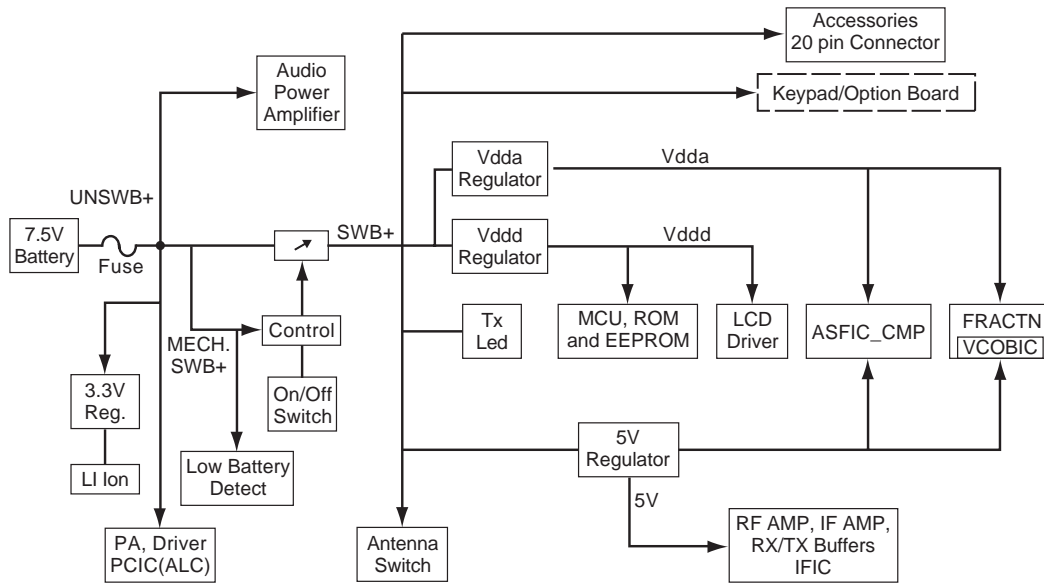


Figure 3-1. DC Power Distribution Block Diagram

### 3.3 Keypad/PassPort Option Board

The keypad/PassPort Option Board block diagram is shown in Figure 3-2. The keypad circuitry is contained on the PassPort Option Board.

Two resistive voltage divider networks form a row and column matrix. Pressing any button simultaneously grounds a tap on the row and column voltage dividers which outputs a unique row voltage and column voltage level for that button location. The row and column voltages are applied to two A/D inputs of the microprocessor (U409 pins 60 and 61). The keypad column voltage is also applied to a comparator whose threshold is set to produce an interrupt signal (KEY\_INT) whenever any key is pressed. The microprocessor then samples the voltage levels at the keypad row and keypad column A/D inputs and makes a comparison with a map table to identify the key pressed. Once the key is identified, a corresponding function is executed.

The LED\_EN is set by the codeplug. When the value is set to low, the LED lights up during power up. A high codeplug setting disables this feature.

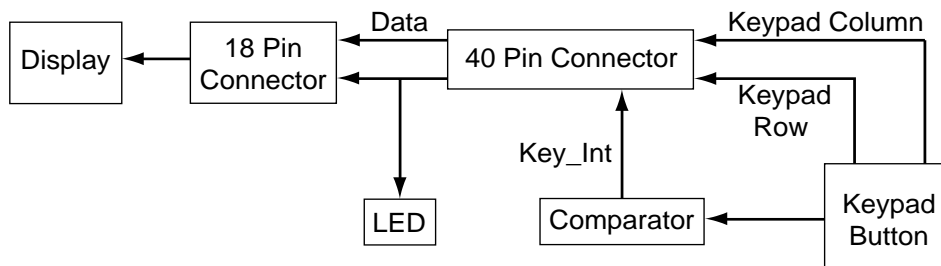


Figure 3-2. Keypad/PassPort Option Board Block Diagram

### 3.4 Controller

The controller is the central interface between the various radio functions. It is separated into MCU digital and audio/signalling functions as shown in Figure 3-3.

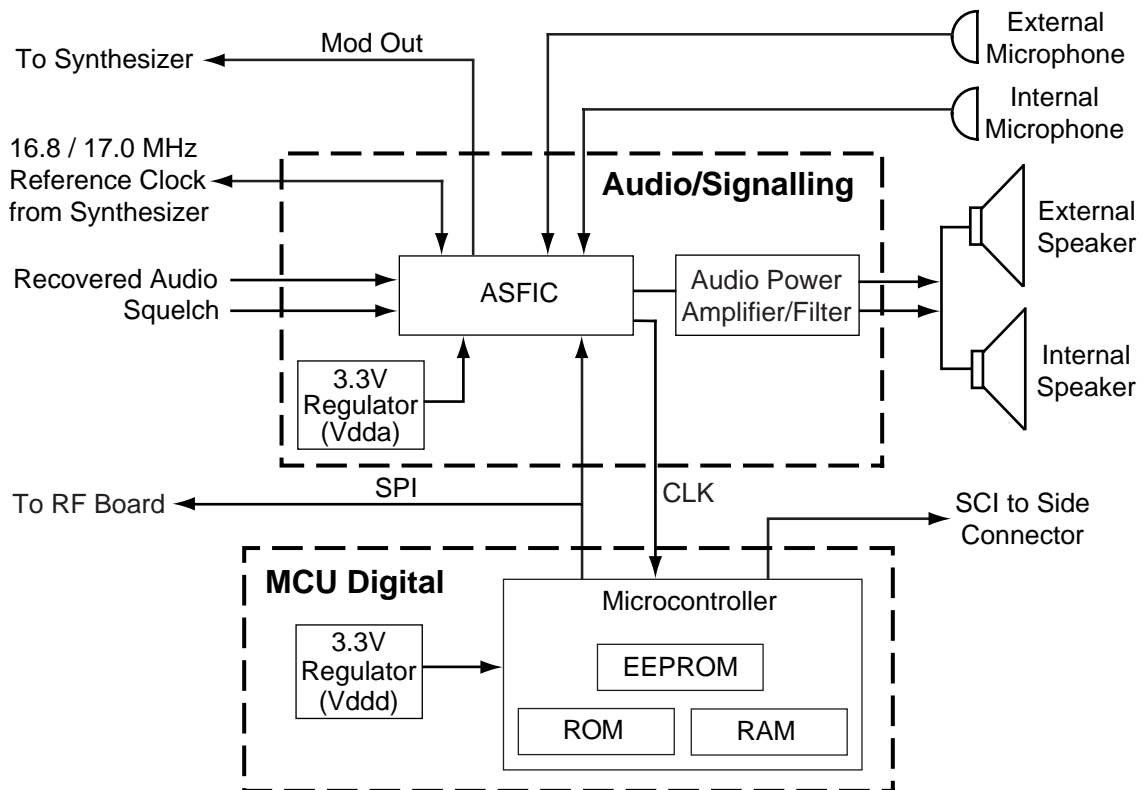


Figure 3-3. Controller Block Diagram

#### 3.4.1 MCU Digital

The digital portion of the controller consists of a microcontroller (U409) and associated EEPROM, S-RAM, and Flash ROM memories. The following memory IC's are used in all 200 MHz and 700 MHz models unless indicated otherwise in the parts lists:

Table 3-2. Radio Memory Requirements

Reference No.	Description	Type	Size
U405	Static RAM	SRM2B256	32K x 8
U406	Flash ROM	AT49HLV010	128K x 8
U407	Serial EEPROM	X25128-2.7	16K x 8

### 3.4.2 Real Time Clock

Radios with displays support a real time clock (RTC) module for purposes of message time stamping and time keeping. The RTC module resides in the microcontroller. The clock uses a back-up lithium-ion battery for operating power when the primary battery is removed.

### 3.4.3 Circuit Description

The RTC module circuit, shown in Figure 3-4, is powered by the MODB/VSTBY pin and PI6/PI7 from the crystal oscillator circuit. A clock frequency of 38.4kHz from a crystal oscillator provides the reference signal which is divided down to 1Hz in the processor.

As the RTC module is powered separately from the processor Vdd, the RTC is kept active through the MODB/VSTBY pin which provides the lithium battery back-up power when the radio is switched off.

A MOSFET transistor (Q416) switches in the battery supply when Vdd is removed. Q416 also provides isolation from BOOT\_CTRL function. The 3.3V regulator charges the Lithium battery.

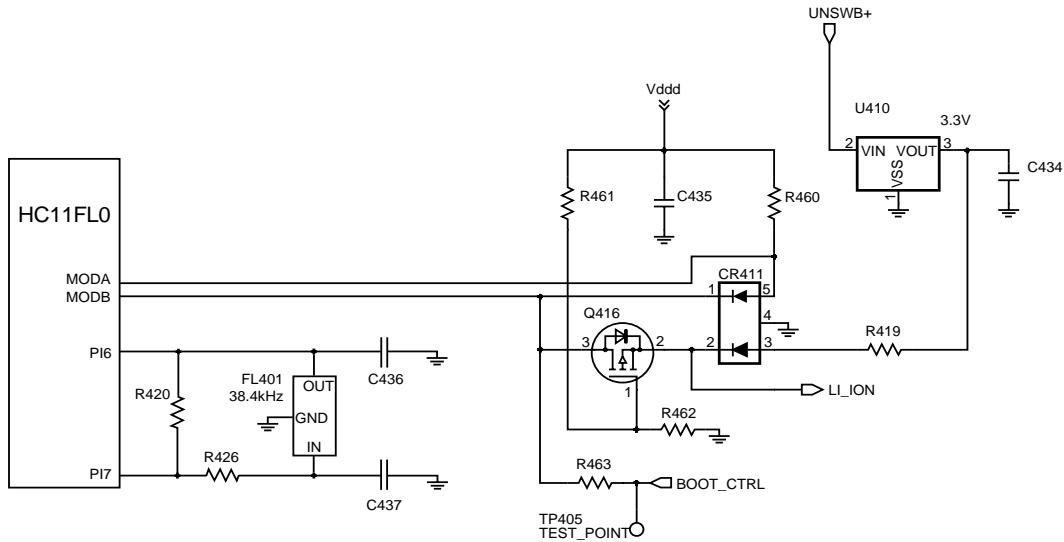


Figure 3-4. RTC Circuit

### 3.4.4 MODB/VSTBY Supply

The supply to the MODB/VSTBY pin varies depending on the conditions listed in Table 3-3.

Table 3-3. MODB/VSTBY Supply Modes

Condition	Circuit Operation
Radio On	Vddd supply voltage via CR411
Radio Off	<ul style="list-style-type: none"> <li>Vddd turned off</li> <li>Q416 gate pulled low by R462</li> <li>Q416 switched on</li> <li>U410 supplies 3.2V to MODB_VSTBY</li> </ul>
Primary battery removed	<ul style="list-style-type: none"> <li>Vddd turned off</li> <li>Q416 gate pulled low by R462</li> <li>Q416 switched on</li> <li>Lithium battery provides 3.2V to MODB_VSTBY</li> </ul>

### 3.4.5 Audio/Signaling

The audio/signalling/filter/comparing IC (ASFIC) and the audio power amplifier (Figure 3-3) form the main components of the audio/signalling section of the controller board. Inputs include a 16.8 MHz clock from the synthesizer, recovered audio and squelch, MCU control signals, and external or internal microphones. Outputs include a microprocessor clock (CLK), modulator output to the synthesizer, and amplified audio signals to an internal or external speaker.

An additional opamp gain stage (U2000 in 200 MHz models, or U851 in 700 MHz models, and associated circuitry) is included to increase the receiver audio level from the IFIC into the ASFIC audio processing IC. This is necessitated because of the low voice deviation levels encountered in trunked systems operating at 12.5 kHz channel spacing.

## 3.5 200 MHz Transmitter

The 200 MHz transmitter consists of the following basic circuits as shown in Figure 3-5.

- Power amplifier (PA).
- Antenna switch/harmonic filter.
- Antenna matching network.
- Power control integrated circuit (PCIC).

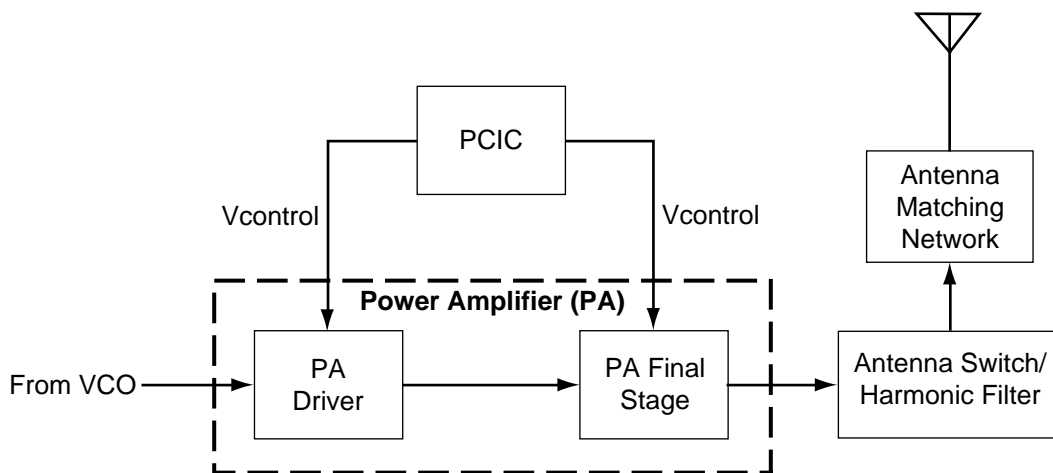


Figure 3-5. 200 MHz Transmitter Block Diagram

### 3.5.1 Power Amplifier (PA)

The 200 MHz PA consists of two LDMOS devices:

- C65 LDMOS driver IC (U3501)
- MRF1517 LDMOS PA final (Q3501)

The C65 LDMOS driver (U101) provides 2-stage amplification using a supply voltage of 7.5V. The amplifier is capable of supplying an output power of 0.5W (U3501 pins 6 & 7) with an input signal of 2mW (+3dBm) at U3501 pin 16. The current drain is typically 180mA while operating in the frequency range of 216-222 MHz.

The LDMOS PA is capable of supplying an output power of up to 6W with an input signal of 0.5W. The current drain is typically 1400 mA while operating in the frequency range of 216-222 MHz. The power output can be varied by changing the bias voltage.

### **3.5.2 Antenna Switch**

The antenna switch circuit consists of two pin diodes (D3521 and D3551), a pi network (C3531, L3551, C3550), and two current limiting resistors (R3572-3). In the transmit mode, pin 32 of PCIC U3502 goes high which applies a B+ source to the antenna switch circuit to bias the diodes "on". The shunt diode (D3551) shorts out the receiver port and the pi network. This operates as a quarter wave transmission line to transform the low impedance of the shunt diode to a high impedance at the input of the harmonic filter. In the receive mode, the diodes are both off, creating a low attenuation path between the antenna and receiver ports via L3551.

### **3.5.3 Harmonic Filter**

The harmonic filter consists of components C3531-2, C3535-6, and L3531-2. The harmonic filter is a modified Zolotarev design optimized for efficiency of the power module. This type of filter has the advantage that it can give a greater attenuation in the stop-band for a given ripple level. The harmonic filter insertion loss is typically less than 1.2 dB.

### **3.5.4 Antenna Matching Network**

Because the 200 MHz antenna is a 50-ohm design, no matching circuitry is required between the harmonic filter output and the 50-ohm SMA-style antenna connector (J3501).

### **3.5.5 Power Control Integrated Circuit (PCIC)**

The transmitter uses the PCIC (U3502) to regulate the power output of the radio. The current drain of the final device Q3501 is measured as the voltage drop across series resistor R3519. This voltage is then fed back to the automatic level control (ALC) within the PCIC to regulate the output power of the transmitter. The PCIC contains internal digital to analog converters (DACs) that provide a programmable control loop reference voltage. The PCIC internal resistors, integrators, and external capacitors (C3562-3 and C3565) control the transmitter rise and fall times to reduce the power splatter into adjacent channels.

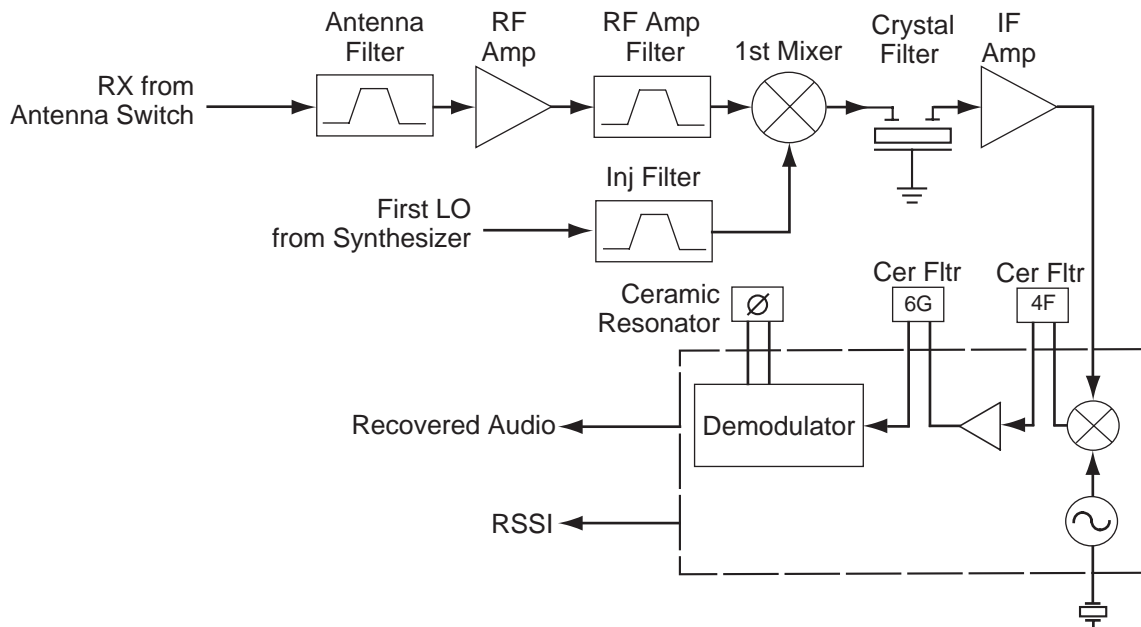
### **3.5.6 Temperature Cut Back Circuit**

Temperature sensor U3503 and associated components are part of a temperature cutback circuit. This circuit senses the printed circuit board temperature around the transmitter circuits and outputs a DC voltage to the PCIC. If the DC voltage produced exceeds the set threshold of the PCIC, the transmitter output power decreases to reduce the transmitter temperature.

## **3.6 200 MHz Receiver**

The 200 MHz receiver design is separated into two blocks, the front end and the back end. The overall block diagram of the receiver is shown in Figure 3-6. Detailed descriptions of these stages are contained in the paragraphs that follow.





**Figure 3-6.** 200 MHz Receiver Block Diagram

### 3.6.1 Receiver Front-End

The received signal from the antenna is routed through the harmonic filter and antenna switch and applied to the antenna filter, consisting of L3320-22 and C3340-47. This fixed-tuned 3-pole bandpass filter is configured to provide steeper attenuation above the passband for improved spurious rejection when high-side first injection is used. The output of this filter is coupled to RF amplifier Q3302. Diode CR3303 protects the RF amplifier by limiting excessive RF levels. Current mirror Q3303 maintains constant current operation of the RF amp vs. device and temperature variations, for optimum dynamic range and noise figure.

The output of the RF amplifier is applied to the RF amp filter comprised of L3323-4, L3341, C3352-7 and C3359, also a fixed-tuned 3-pole bandpass filter configured to provide steeper high-side attenuation. Both the antenna filter and RF amp filter have 3 dB bandwidths of 22 MHz and utilize 2% inductors and 1% capacitors for accurate and repeatable passband response.

The output of the RF amp filter is connected to the passive double-balanced mixer consisting of components T3301, T3302, and CR3301. High-side injection from the frequency synthesizer is low-pass filtered by C3373-6, C3381, and L3327-8 to remove second harmonic energy which may degrade half-IF spurious rejection performance, and applied to T3302 at a level of +5 dBm.

The IF output from T3301 is applied to a diplexer (L3325, C3361, R3332, L3281) which matches the 44.85 MHz IF signal to the crystal filter and terminates the mixer into 50Ω at all other frequencies.

### 3.6.2 Receiver Back-End

The receiver back end is a dual conversion design. High IF selectivity is provided by FL3201, a 4-pole fundamental mode 44.85 MHz crystal filter with a 3 dB bandwidth of 7.5 kHz. The output is fed to IF amplifier stage Q3200, whose input impedance is adjusted using feedback to provide a proper terminating impedance for the filter. The output of Q3200 is applied to the input of the receiver IFIC U3101. Diode CR3200 prevents overdriving the IFIC.

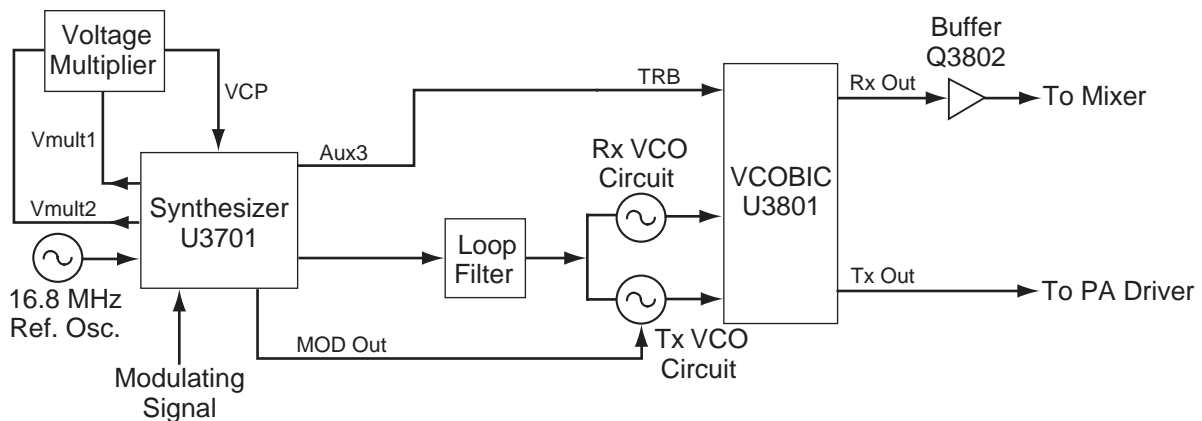
The IFIC is a low-voltage monolithic FM IF system incorporating a mixer/oscillator, two limiting IF amplifiers, quadrature detector, logarithmic received signal strength indicator (RSSI), voltage regulator and audio and RSSI op amps. The second LO frequency is determined by Y3200. Additional IF selectivity is provided by two ceramic filters, FL3204 (between the second mixer and IF amp) and FL3206 (between the IF amp and the limiter input). FL3204 is a 4 element filter with a BW6 = 12 kHz. FL3206 is a 6 element filter with a BW6 = 9 kHz. These bandwidths are optimum for 12.5 kHz channel spacing systems. Ceramic resonator Y3102 provides phase vs. frequency characteristic required by the quadrature detector, with 90 degree phase shift occurring at 455 kHz. Buffer Q3211 provides a lower driving impedance from the limiter to the resonator, improving the IF waveform and lowering distortion.

## 3.7 200 MHz Frequency Generation System

### 3.7.1 Overview

The frequency generation system, shown in Figure 3-7, is composed of two circuit blocks, the Fractional-N synthesizer IC U3701, the VCO/Buffer IC U3801, and associated circuitry. Figure 2-8 shows the peripheral interconnect and support circuitry used in the synthesizer block, and Figure 2-9 details the internal circuitry of the VCOBIC and its interconnections to the surrounding components. Refer to the schematic to identify reference designators.

The Fractional-N synthesizer is powered by regulated 5V and 3.3V provided by U3711 and U3201 respectively. 5V is applied to U3701 pins 13 and 30, and 3.3V is applied to pins 5, 20, 34 and 36. The synthesizer in turn generates a super-filtered 4.5V supply (VSF, from pin 28) to power U3801. In addition to the VCO, the synthesizer also interfaces with the logic and ASFIC circuits. Programming for the synthesizer is accomplished through the microprocessor data, clock, and chip select lines (U409 pins 100, 1 and 2 respectively). A logic high (3.3V) from U3701 pin 4 indicates to the microprocessor that the synthesizer is locked.



**Figure 3-7.** 200 MHz Frequency Generation System Block Diagram

Transmit modulation from the ASFICcmp is applied to U3701 pin 10. An electronic attenuator in the ASFICcmp adjusts overall transmitter deviation by varying the audio level applied to the synthesizer IC. Internally the audio is digitized by the Fractional-N and applied to the loop divider to provide the low-port modulation. The audio is also routed through an internal attenuator for modulation balancing purposes and is available at U3701 pin 41 (VCO\_MOD). This audio signal is routed to the VCO's modulator.

### 3.7.2 Fractional-N Synthesizer

The Fractional-N synthesizer, shown in Figure 3-8, uses a 16.8 MHz reference oscillator (Y3762) to provide a high stability reference for the system. Stability is better than 2.5 ppm over temperatures of -30 to 60 °C. Electronic frequency adjustment is achieved by an internal DAC which provides a frequency adjustment voltage from U3701 pin 25 to the reference oscillator module. The synthesizer IC U3701 further divides the 16.8 MHz signal (applied to U3701 pin 23) to 2.1 MHz, 2.225 MHz, or 2.4 MHz for use as reference frequencies. It also provides 16.8 MHz at U3701 pin 19 for use by the ASFIC. A loop filter (C3723-4, R3722-3) removes noise and spurs from the steering voltage applied to the VCO varactors, with additional filtering located in the VCO circuit.

To achieve fast locking for the synthesizer, an internal adapt charge pump provides higher current at U3701 pin 45 to quickly force the synthesizer within lock range. The required frequency is then locked by normal mode charge pump at pin 43. Both the normal and adapt charge pumps get their supply from the capacitive voltage multiplier made up of C3701-4 and D3701-2. Two 3.3V square waves from U3701 pins 14-15 provide the drive signals for the voltage multiplier, which generates 13.3V at U3701 pin 47. This voltage is filtered by C3705-6 and C3714.

One of the auxiliary outputs of the synthesizer IC (pin 48) controls transistor switch Q3721 which outputs a T5 voltage source during transmit and R5 during receive.

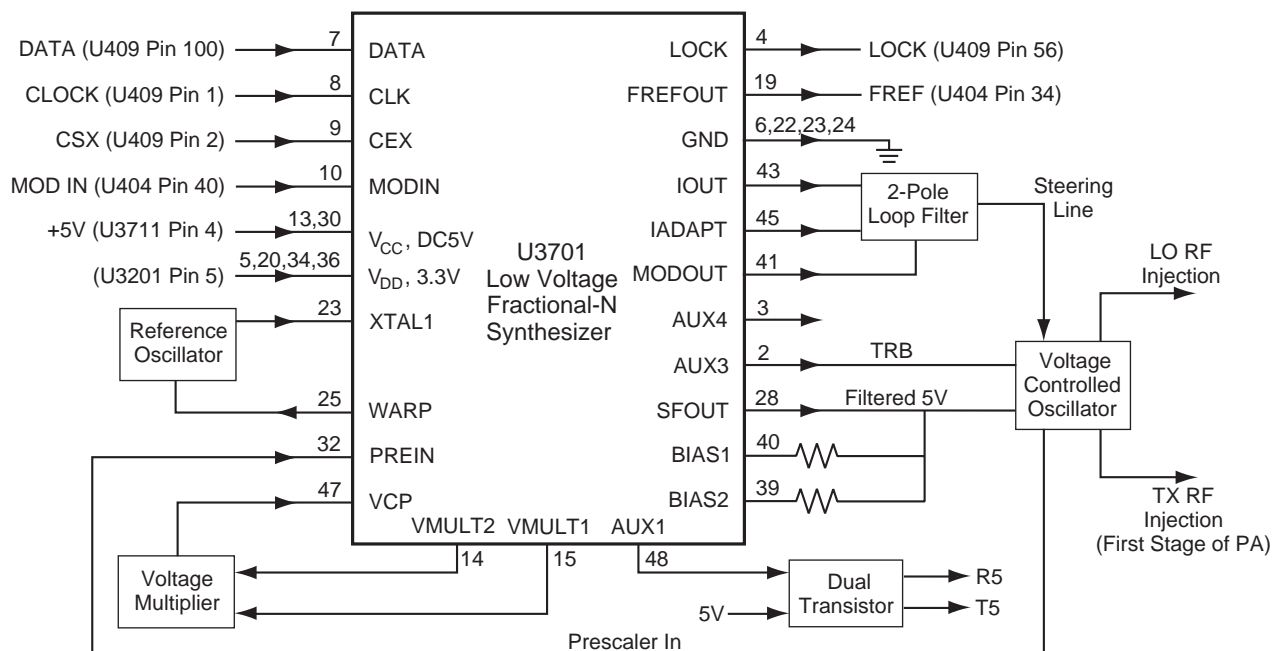


Figure 3-8. 200 MHz Synthesizer Block Diagram

### 3.7.3 Voltage Controlled Oscillator (VCO)

The VCOBIC (U3801), shown in Figure 3-9, in conjunction with the Fractional-N synthesizer (U3701) generates RF in both the receive and the transmit modes of operation. The TRB line (U3801 pin 19) determines which oscillator and buffer are enabled. A sample of the RF signal from the enabled oscillator is routed from U3801 pin 12 through a low pass filter, to the prescaler input of the synthesizer IC (U3701 pin 32). After frequency comparison in the synthesizer, a resultant DC control voltage is used to steer the VCO frequency. When the PLL is locked on frequency, this voltage can

vary between 3.5V and 9.5V. An additional loop filter pole (R3828, C3831 and C3843, further attenuate noise and spurs on the steering line voltage.

In the receive mode, the TRB line (U3801 pin 19) is low. This activates the receive VCO and the receive buffer of U3801, which operate within the range of 261.85 to 266.85 MHz. The VCO frequency is determined by tank inductor L3822, C3830 and varactor D3821. The buffered RF signal at U3801 pin 8 is further amplified by Q3802 and applied as RX\_INJ to the low-pass injection filter in the receiver front end circuit.

In the transmit mode, U3801-19 is driven high (4.4V) by U3701 pin 2, enabling the transmit VCO and buffer. The 217-222 MHz RF signal from U3801 pin 10 is applied as TX\_INJ to the input of the transmitter driver IC (U3501 pin 16) via a resistive attenuator pad. TX VCO frequency is determined by L3833, C3870 and varactor D3831. Audio from the synthesizer IC is applied as VCO\_MOD to varactor D3832 which modulates the transmit VCO.

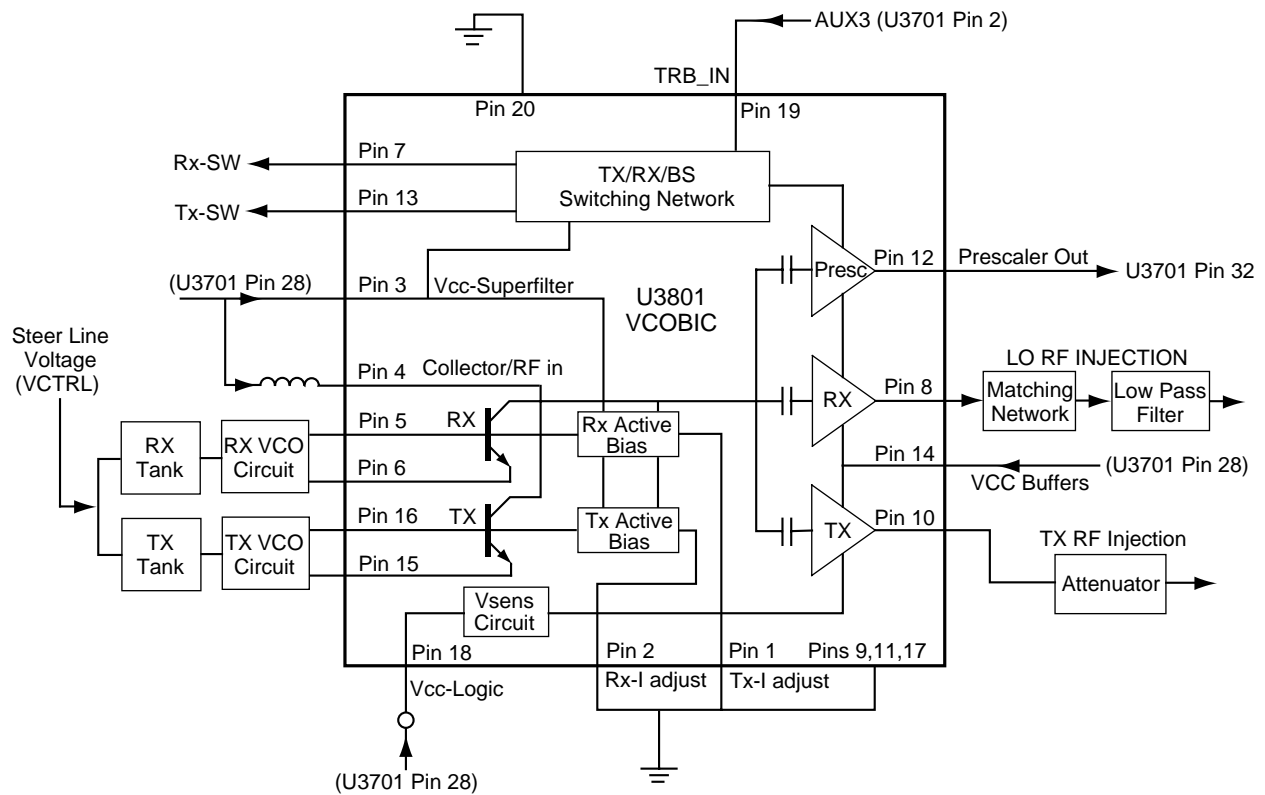
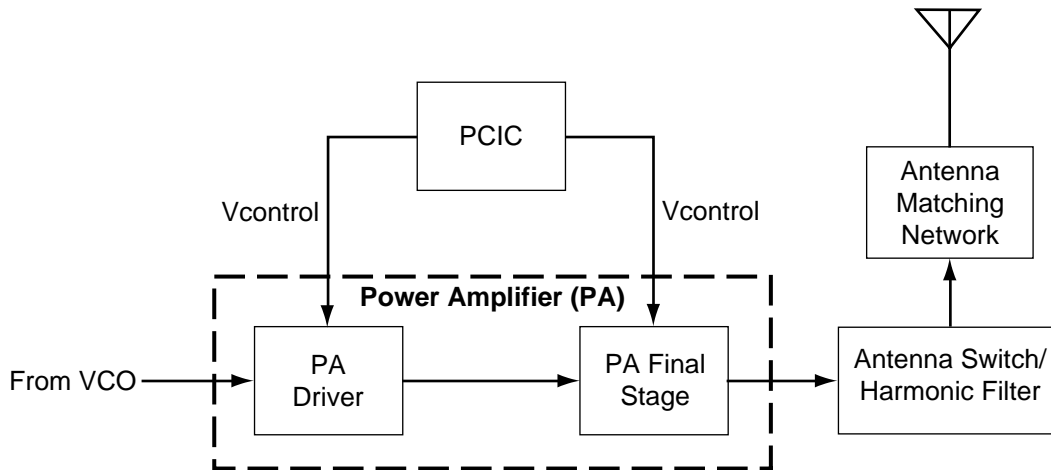


Figure 3-9. 200 MHz VCO Block Diagram

### 3.8 700 MHz Transmitter

The 700 MHz transmitter consists of the following basic circuits as shown in Figure 3-10.

- Power amplifier
- Antenna switch/harmonic filter
- Antenna matching network
- Power control integrated circuit (PCIC)



**Figure 3-10.** 700 MHz Transmitter Block Diagram

#### 3.8.1 Power Amplifier

The 700 MHz PA consists of two LDMOS devices:

- C65 LDMOS driver IC (U101)
- MRF1517 LDMOS PA final (Q101)

The C65 LDMOS driver (U101) provides 2-stage amplification using a supply voltage of 7.5V. The amplifier is capable of supplying an output power of 0.5W (U101 pins 6 & 7) with an input signal of 2mW (+3dBm) at U101 pin 16. The current drain is typically 180mA while operating in the frequency range of 746-794 MHz.

The LDMOS PA final was designed to supply an output power of 2.75W with an input signal of 0.3W. The PA current drain is typically 1050 mA while operating in the frequency range of 746-794 MHz. The PA power output can be changed by varying the C65 LDMOS driver control voltage.

#### 3.8.2 Antenna Switch

The antenna switch circuit consists of two pin diodes (CR101 and CR102), a pi network (C106-7, C109 and L103), and three current limiting resistors (R101-3). In the transmit mode, pin 32 of PCIC U102 goes high which applies a B+ source to the antenna switch circuit to bias the diodes "on". The shunt diode (CR102) shorts out the receiver port and the pi network. This operates as a quarter wave transmission line to transform the low impedance of the shunt diode to a high impedance at the input of the harmonic filter. In the receive mode, the diodes are both off, creating a low attenuation path between the antenna and receiver ports via L103.

### **3.8.3 Harmonic Filter**

The harmonic filter is a modified Zolotarev design optimized for efficiency of the PA. It consists of a combination of lumped components (C102-7, L101-2) and microstrip elements. This type of filter has the advantage that it can give a greater attenuation in the stop-band for a given ripple level. The design was optimized to meet critical attenuation requirements for the second harmonic in the 1559-1610 MHz GNSS band. The harmonic filter insertion loss is typically less than 1 dB.

### **3.8.4 Antenna Matching Network**

Because the 700 MHz antenna is a 50-ohm design, no matching circuitry is required between the harmonic filter output and the 50-ohm SMA-style antenna connector (J101).

### **3.8.5 Power Control Integrated Circuit (PCIC)**

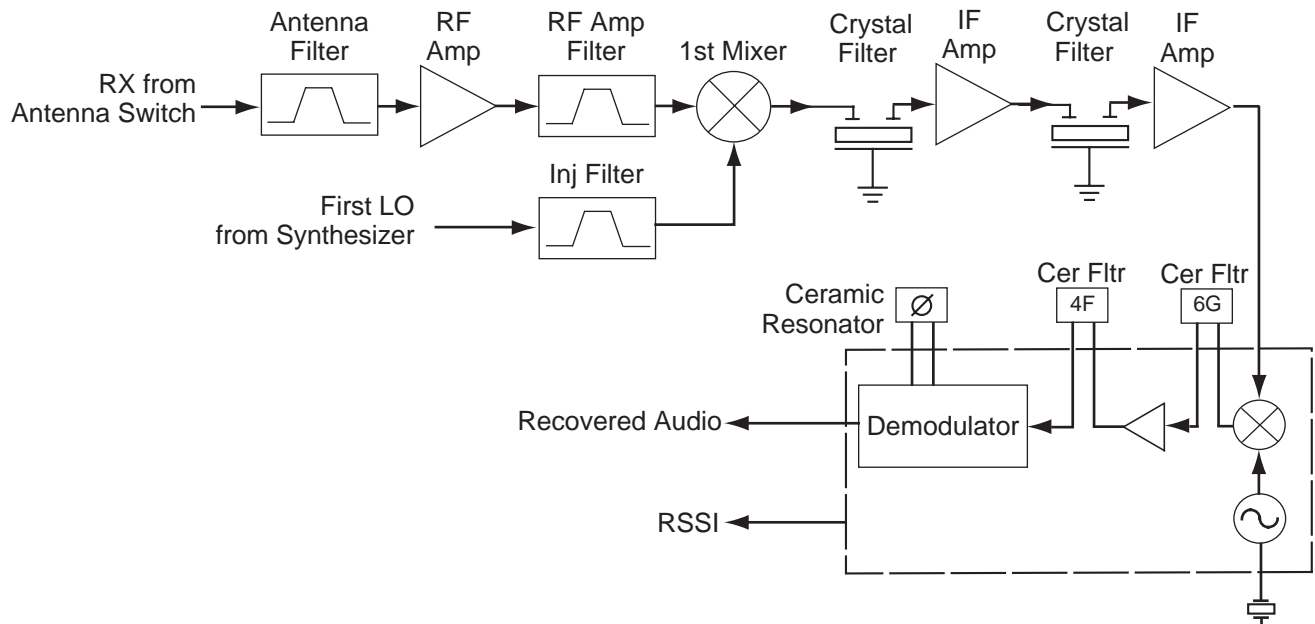
The transmitter uses the PCIC (U102) to regulate the power output of the radio. The current to the final device Q101 is supplied through resistor R116, that provides a voltage drop proportional to the final device current drain. This voltage is then fed back to the automatic level control (ALC) within the PCIC to regulate the output power of the transmitter. The PCIC contains internal digital to analog converters (DACs) that provide a programmable control loop reference voltage. The PCIC internal resistors, integrators, and external capacitors (C142, C144 and C146) control the transmitter rise and fall times to reduce the power splatter into adjacent channels.

### **3.8.6 Temperature Cut Back Circuit**

Temperature sensor U103 and associated components are part of a temperature cutback circuit. This circuit senses the printed circuit board temperature around the transmitter circuits and outputs a DC voltage to the PCIC. If the DC voltage produced exceeds the set threshold of the PCIC, the transmitter output power decreases to reduce the transmitter temperature.

## **3.9 700 MHz Receiver**

The 700 MHz receiver design is separated into two blocks, the front end and the back end. The overall block diagram of the receiver is shown in Figure 3-11. Detailed descriptions of these stages are contained in the paragraphs that follow.



**Figure 3-11.** 700 MHz Receiver Block Diagram

### 3.9.1 Receiver Front-End

The received signal from the antenna is routed through the harmonic filter and antenna switch and applied to the antenna filter FL300. This is a fixed-tuned 3-pole ceramic bandpass filter with a passband of 744 MHz to 766 MHz and an insertion loss of 2.6 dB. The output of this filter is coupled to RF amplifier Q301. Diode CR300 protects the RF amplifier by limiting excessive RF levels.

The output of the RF amplifier is applied to the RF amp filter FL301, identical to FL300. The output of FL301 is connected to the passive double-balanced mixer consisting of components T301, T302, and CR301. High-side injection from the frequency synthesizer is band-pass filtered by C317-324 and L305-6 to remove second harmonic energy which may degrade half-IF spurious rejection performance, and applied to T302 at a level of +8 dBm.

The IF output from T301 is applied to a diplexer (L303-4, C313-5 and R305) which matches the 73.35 MHz IF signal to the crystal filter and terminates the mixer into 50Ω at all other frequencies.

### 3.9.2 Receiver Back-End

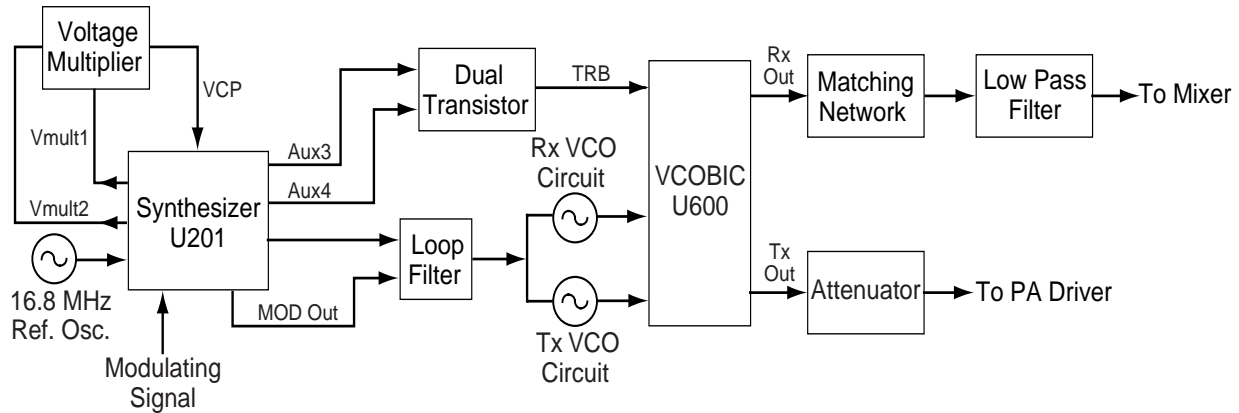
The receiver back end is a dual conversion design. The 73.35 MHz high IF consists of 2-pole crystal filter FL350, IF amp Q350, 2-pole crystal filter FL351 and IF amp Q351. Each crystal filter has a 3 dB bandwidth of 9.0 kHz and a maximum insertion loss of 2 dB. The output of Q351 is applied to the input of the receiver IFIC U350. Diode D350 prevents overdriving the IFIC.

The IFIC is a low-voltage monolithic FM IF system incorporating a mixer/oscillator, two limiting IF amplifiers, quadrature detector, logarithmic received signal strength indicator (RSSI), voltage regulator and audio and RSSI op amps. The second LO frequency is determined by Y350. Additional IF selectivity is provided by two ceramic filters, FL352 (between the second mixer and IF amp) and FL353 (between the IF amp and the limiter input). FL352 is a 6 element filter with a BW6 = 9 kHz. FL353 is a 4 element filter with a BW6 = 12 kHz. These bandwidths are optimum for 12.5 kHz channel spacing systems. Ceramic resonator Y351 provides phase vs. frequency characteristic required by the quadrature detector, with 90 degree phase shift occurring at 455 kHz. Buffer Q352 provides a lower driving impedance from the limiter to the resonator, improving the IF waveform and lowering distortion.

## 3.10 700 MHz Frequency Generation System

### 3.10.1 Overview

The frequency generation system, shown in Figure 3-12, is composed of two circuit blocks, the Fractional-N synthesizer IC U201, the VCO/Buffer IC U600, and associated circuitry. Figure 2-13 shows the peripheral interconnect and support circuitry used in the synthesizer block, and Figure 2-14 details the internal circuitry of the VCOBIC and its interconnections to the surrounding components. Refer to the schematic to identify reference designators.



**Figure 3-12.** 700 MHz Frequency Generation System Block Diagram

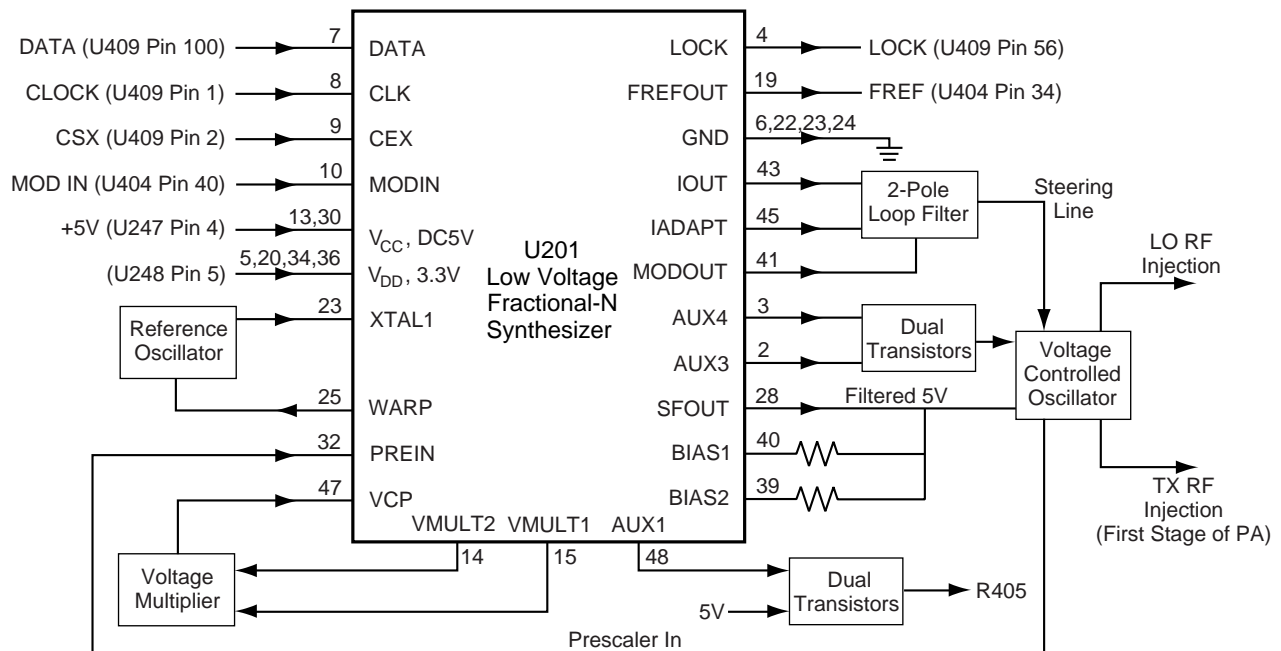
The Fractional-N synthesizer is powered by regulated 5V and 3.3V provided by U202 and U203 respectively. 5V is applied to U201 pin 30, and 3.3V is applied to pins 5, 13, 20, 34 and 36. The synthesizer in turn generates a super-filtered 4.5V supply (VSF, from pin 28) to power U600. In addition to the VCO, the synthesizer also interfaces with the logic and ASFIC circuits. Programming for the synthesizer is accomplished through the microprocessor data, clock, and chip select lines (U409 pins 100, 1 and 2 respectively). A logic high (3.3V) from U201 pin 4 indicates to the microprocessor that the synthesizer is locked.

Transmit modulation from the ASFICcmp is applied to U201 pin 10. An electronic attenuator in the ASFICcmp adjusts overall transmitter deviation by varying the audio level applied to the synthesizer IC. Internally the audio is digitized by the Fractional-N and applied to the loop divider to provide the low-port modulation. The audio is also routed through an internal attenuator for modulation balancing purposes and is available at U201 pin 41 (MODOUT). This audio signal is attenuated significantly by R211-12, and superimposed on the steering line voltage by a capacitive voltage divider (C242 and C245). This allows the same varactor used for TX VCO frequency steering to serve as the VCO's modulator.

### 3.10.2 Fractional-N Synthesizer

The Fractional-N synthesizer, shown in Figure 3-13, uses a 16.8 MHz reference oscillator (Y200) to provide a high stability reference for the system. Stability is better than 1.5 ppm over temperatures of -30 to 60 °C. Electronic frequency adjustment is achieved by an internal DAC which provides a frequency adjustment voltage from U201 pin 25 to the reference oscillator module. The synthesizer IC U201 further divides the 16.8 MHz signal (applied to U201 pin 23) to 2.1 MHz, 2.225 MHz, or 2.4 MHz for use as reference frequencies. It also provides 16.8 MHz at U201 pin 19 for use by the ASFIC. A loop filter (C241, C243-5, R213-5) removes noise and spurs from the steering voltage applied to the VCO varactors.





**Figure 3-13. 700 MHz Synthesizer Block Diagram**

To achieve fast locking for the synthesizer, an internal adapt charge pump provides higher current at U201 pin 45 to quickly force the synthesizer within lock range. The required frequency is then locked by normal mode charge pump at pin 43. Both the normal and adapt charge pumps get their supply from the capacitive voltage multiplier made up of C211-14 and CR201-2. Two 3.3V square waves from U201 pins 14-15 provide the drive signals for the voltage multiplier, which generates 12.8V at U201 pin 47. This voltage is filtered by C223-5.

One of the auxiliary outputs of the synthesizer IC (pin 48) controls transistor switch Q201 which outputs a switched R5 voltage source, present during receive mode. Another auxiliary output (pin 2) controls transistor switch Q202 which outputs a switched AU3-5V source for TX buffer stage Q601 in the VCO circuit.

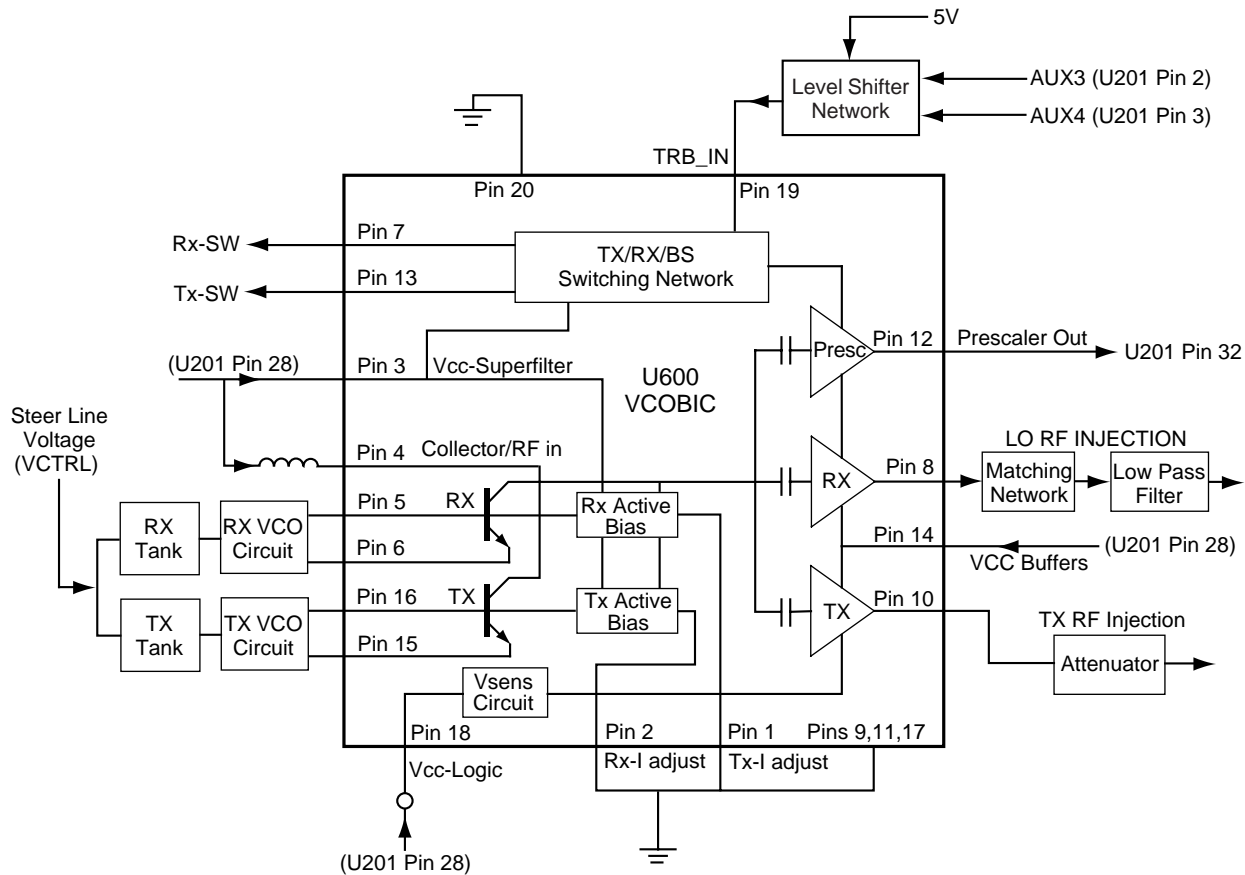
### 3.10.3 Voltage Controlled Oscillator (VCO)

The VCOBIC (U600), shown in Figure 3-14, in conjunction with the Fractional-N synthesizer (U201) generates RF in both the receive and the transmit modes of operation. The TRB line (U600 pin 19) determines which oscillator and buffer are enabled, and is controlled by the AUX4 signal from the synthesizer (U201 pin 3). Transistor Q603 level-shifts the synthesizer's 3.3V logic level to the 5V operating level of the VCOBIC. A sample of the RF signal from the enabled oscillator is routed from U600 pin 12 through a low pass filter (L203, C234 in the synthesizer circuit), to the prescaler input of the synthesizer IC (U201 pin 32). After frequency comparison in the synthesizer, a resultant DC control voltage is used to steer the VCO frequency. When the PLL is locked on frequency, this voltage can vary between 2 to 9 volts in the RX mode or 3 to 11 volts in the TX mode.

In the receive mode, the TRB line (U600 pin 19) is low. This activates the receive VCO and the receive buffer of U600, which operate within the range of 819.35 to 837.35 MHz. The RX VCO frequency is determined by ceramic tank resonator FL600, varactors CR600 and CR601, and associated components. Feedback to maintain oscillation is provided by divider C607-8 and associated components. The buffered RF signal at U600 pin 8 is further amplified by Q600 and applied as RX\_LO to the low-pass injection filter in the receiver front end circuit.

In the transmit mode, Q603 is off and U600-19 is pulled high to 5V by R655, enabling the transmit VCO and buffer. The 746-794 MHz RF signal from U600 pin 10 is applied as TX\_INJ to the input of the transmitter driver IC (U101 pin 16). TX VCO frequency is determined by ceramic tank resonator FL601, varactor CR603, and associated components. Audio modulation is superimposed on the steering line voltage, allowing varactor CR603 to also function as the modulator.

When a high impedance is applied to U3801, pin19, the VCO is operating in battery saver mode. In this case, both the receive and transmit oscillators as well as the receive transmit and prescaler buffer are turned off.



**Figure 3-14.** 700 MHz VCO Block Diagram

## 3.11 Trunked Radio Systems

Trunked systems allow a large number of users to share a relatively small number of frequencies or repeaters without interfering with each other. The airtime of all the repeaters in a trunked system is pooled, which maximizes the amount of airtime available to any one radio and minimizes channel congestion. A benefit of trunking is that the user is not required to monitor the system before transmitting.

### 3.11.1 LTR<sup>®</sup> Trunked Systems

LTR is a transmission based trunking protocol developed by the E. F. Johnson Company for primarily single site trunking applications. In transmission trunking, a repeater is used for only the duration of a single transmission. Once a transmission is completed, that repeater becomes available to other users.

### 3.11.2 PassPort<sup>®</sup> Trunked Systems

PassPort is an enhanced trunking protocol developed by Trident Microsystems that supports wide area dispatch networking. A network is formed by linking several trunked sites together to form a single system. This offers users an extended communication coverage area. Additionally, users with PassPort can seamlessly roam among all sites within the network. Seamless roaming means that the radio user does not have to manually change the position on the radio when roaming from site-to-site.

All 200 MHz and 700 MHz models feature PassPort Trunking operation, and the standard keypad board is replaced with the PassPort Trunking Controller Board (PTCB). This board also provides advanced voice storage features. Refer to Figure 3-2 for connector and signal routing from, to and through the Radio, PTCB and Liquid Crystal Display (LCD) sub-systems.

#### 3.11.2.1 Power Supplies

The radio supplies regulated V<sub>dd</sub> of 3.3 VDC. This is used to power the Low Speed Data Filter and Voice Storage circuits. The radio also supplies Switched Battery Voltage (SWB+). U612 regulates the SWB+ to 3.3V which is applied to the PTCB microcontroller U601. A filtered voltage (V<sub>dda</sub>) of V<sub>dd</sub>/2 is developed by U603-4 and is used to supply a clean reference bias for the Low Speed Data filter and Voice Storage circuits. U610 regulates the SWB+ voltage to 3.3V which is applied to the PTCB Voice Storage IC, U611, as well.

#### 3.11.2.2 Microcontroller (MCU)

PassPort Trunking operation is managed by the reprogrammable FLASH ROM based microcontroller (U601). The MCU clock oscillator uses 7.9488 MHz crystal Y601 as a stable resonator. The PTCB communicates with the main radio microcontroller by attaching to the same Serial Peripheral (SPI) bus that passes through the PTCB to the LCD on the CLK, DATA, RDY, and MISO lines. The OPT\_EN line is strobed low only for communications with U601.

The MCU includes an on-chip Analog to Digital Converter (ADC). The received and filtered sub-audible low speed trunking data waveform is applied to one of the ADC inputs. The software in the MCU decodes and acts upon the trunking data.

The MCU includes a Digital to Analog Converter (DAC). As required, the MCU software generates appropriate PassPort Low Speed Trunking Data waveforms. These are applied to the Low Speed Data Filter and then to the radio transmitter modulation point. The amplitude of this waveform and the resulting transmitted deviation is controlled by software.

### **3.11.2.3 Low Speed Data Filter**

This analog circuitry is a 4 pole, 150 Hz cutoff low pass filter comprised of U603-1, U603-2 and associated passive components. In receive mode, it removes noise and voice band signals leaving only the low speed data waveform which is applied to the ADC input of the MCU. U608-4 isolates the receive signal from the filter in transmit mode. When the radio is transmitting PassPort data, the MCU DAC low speed data waveform is applied to the input of the filter which removes harmonics that would interfere with voice and applies the resulting sub-audible data to the radio transmitter modulation point.

### **3.11.2.4 Keyboard/PassPort Option Board Circuit**

The keyboard/PassPort Option Board consists of a matrix of key switches and resistors as described in section 3.3. U605-2 monitors the column voltage and applies an interrupt signal to the radio microcontroller when any key is pressed.

### **3.11.2.5 BackLight Driver and LED's**

The logic level signal from the radio microcontroller is translated via Q611 and applied to Q610 which uses Switched Battery Voltage (SWB+) to operate the keypad backlight LED's.

### **3.11.2.6 Voice Storage**

The Voice Storage (VS) can be used to store audio signals coming from the receiver or from the microphone. Any stored audio signal can be played back over the radio's speaker or sent out via the radio's transmitter.

The PTCB hosts the Voice Storage circuitry. Voice Storage IC U611 provides all the required functionality and is powered from the regulated 3.3 volts from U610. The  $\mu$ P controls U611 via SPI bus lines CLK (U611-8), DATA (U611-10) and MISO (U611-11). To transfer data, the  $\mu$ P first selects the U611 via line VS CS and U611 pin 9. Then the  $\mu$ P sends data through line DATA and receives data through line MISO. Pin 2 (RAC) of U611 indicates the end of a message row by a low state for 12.5 ms and connects to  $\mu$ P pin 65. A low at pin 5 (INT), which is connected to  $\mu$ P pin 55, indicates that the Voice Storage IC requires service from the  $\mu$ P.

Audio, either from the radio's receiver or from one of the microphone inputs, emerges from the ASFIC CMP (U404) at pin 43, through switch U608-1 that is selected by the  $\mu$ P via ASFIC CMP pin 5 (DACR) and then enters the voice storage IC U611 at pin 25. During playback, the stored audio emerges from U611 at pin 20. To transmit the audio signal, it is fed through resistive divider R657 / R658, through switch U608-3 and through line EXT MIC. When this path is selected, the audio signal enters the ASFIC CMP at pin 48 and is processed like normal transmit audio. To play the stored audio over the radio's speaker, the audio from U611 pin 20 is buffered by op-amp U605-1, through switch U608-2 and fed via line FLAT RX SND to ASFIC CMP pin 10 (UIO). In this case, this ASFIC CMP pin is programmed as input and feeds the audio signal through the normal receiver audio path to the speaker or handset. Switches U608-2 and U608-3 are controlled by the  $\mu$ P via ASFIC CMP pin 6 (DACG) and feed the stored audio only to the ASFIC CMP port UIO when it is programmed as input.

---

# Chapter 4

## Maintenance

### 4.1 Introduction

This chapter of the manual describes:

- Preventive maintenance
- Safe handling of CMOS devices
- Repair procedures and techniques

### 4.2 Preventive Maintenance

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

### 4.3 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.

#### 4.3.1 Cleaning

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the radio. External surfaces include the front cover, housing assembly, and battery case. 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 servicing 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 (70% by volume).



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

#### 1. Cleaning External Plastic Surfaces

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

#### 2. Cleaning Internal Circuit Boards and Components

Isopropyl alcohol 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. Upon completion of the cleaning process, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, front cover, or back cover.

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

## 4.4 Safe Handling of CMOS and LDMOS

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

Handling precautions are mandatory for the circuits and are especially important in low humidity conditions. DO NOT attempt to disassemble the radio without first referring to the CMOS CAUTION paragraph in the Disassembly and Reassembly section of the basic manual (See Chapter 3).

## 4.5 General Repair Procedures and Techniques

- **Parts Replacement and Substitution**

When damaged parts are replaced, identical parts should be used. If the identical replacement component is not locally available, check the parts list for the proper Motorola part number and order the component from the nearest Motorola Communications parts center listed in the "Piece Parts" section of this manual (See Chapter 1).

- **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, care should be exercised to avoid pulling the plated circuit out of the hole.

When soldering near the 20-pin and 40-pin connectors:

- avoid accidentally getting solder in the connector.
- be careful not to form solder bridges between the connector pins.
- closely examine your work for shorts due to solder bridges.

- **Flexible Circuits**

The flexible circuits are made from a different material than the rigid boards and different techniques must be used when soldering. Excessive prolonged heat on the flexible circuit can damage the material. Avoid excessive heat and excessive bending.

For parts replacement, use the ST-1087 Temperature-Controlled Solder Station with a 600-700 degree tip, and use small diameter solder such as ST-633. The smaller size solder will melt faster and require less heat to be applied to the circuit.

To replace a component on a flexible circuit:

- grasp the edge of the flexible circuit with seizers (hemostats) near the part to be removed.
- pull gently.
- apply the tip of the soldering iron to the component connections while pulling with the seizers.

Do not attempt to puddle out components. Prolonged application of heat may damage the flexible circuit.

- **Chip Components**

Use either the RLN-4062 Hot-Air Repair Station or the Motorola 0180381B45 Repair Station for chip component replacement. When using the 0180381B45 Repair Station, select the TJ-65 mini-thermojet hand piece. On either unit, adjust the temperature control to 700 degrees F. (370 degrees C), and adjust the airflow to a minimum setting. Airflow can vary due to component density.

- To remove a chip component:
  - Use a hot-air hand piece and position the nozzle of the hand piece approximately 1/8" (0.3 cm) above the component to be removed.
  - Begin applying the hot air. Once the solder reflows, remove the component using a pair of tweezers.
  - 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:
  - Select the appropriate micro-tipped soldering iron and apply fresh solder to one of the solder pads.
  - Using a pair of tweezers, position the new chip component in place while heating the fresh solder.
  - Once solder wicks onto the new component, remove the heat from the solder.
  - Heat the remaining pad with the soldering iron and apply solder until it wicks to the component. If necessary, touch up the first side. All solder joints should be smooth and shiny.
- To replace a chip component using hot air:
  - Use the hot-air hand piece and reflow the solder on the solder pads to smooth it.
  - Apply a drop of solder paste flux to each pad.
  - Using a pair of tweezers, position the new component in place.
  - Position the hot-air hand piece approximately 1/8" (0.3 cm) above the component and begin applying heat.
  - Once the solder wicks to the component, remove the heat and inspect the repair. All joints should be smooth and shiny.

- **Shields**

Removing and replacing shields will be done with the R1319A station with the temperature control set to approximately 415°F (215°C) [445°F (230°C) maximum].

- To remove the shield:
  - Place the circuit board in the R1319A holder.
  - Select the proper heat focus head and attach it to the heater chimney.
  - Add solder paste flux around the base of the shield.
  - Position the shield under the heat-focus head.
  - Lower the vacuum tip and attach it to the shield by turning on the vacuum pump.
  - Lower the focus head until it is approximately 1/8" (0.3 cm) above the shield.
  - Turn on the heater and wait until the shield lifts off the circuit board.
  - Once the shield is off, turn off the heat, grab the part with a pair of tweezers, and turn off the vacuum pump.
  - Remove the circuit board from the R1319A circuit board holder.
- To replace the shield:
  - Add solder to the shield if necessary, using a micro-tipped soldering iron.

- Next, rub the soldering iron tip along the edge of the shield to smooth out any excess solder. Use solder wick and a soldering iron to remove excess solder from the solder pads on the circuit board.
- Place the circuit board back in the R1070's circuit board holder.
- Place the shield on the circuit board using a pair of tweezers.
- Position the heat-focus head over the shield and lower it to approximately 1/8" (0.3 cm) above the shield.
- Turn on the heater and wait for the solder to reflow.
- Once complete, turn off the heat, raise the heat-focus head and wait approximately one minute for the part to cool.
- Remove the circuit board and inspect the repair. No cleaning should be necessary.

## 4.6 Recommended Test Tools

Table 4-1. lists the recommended tools used for maintaining this family of radios. These tools are also available from Motorola.

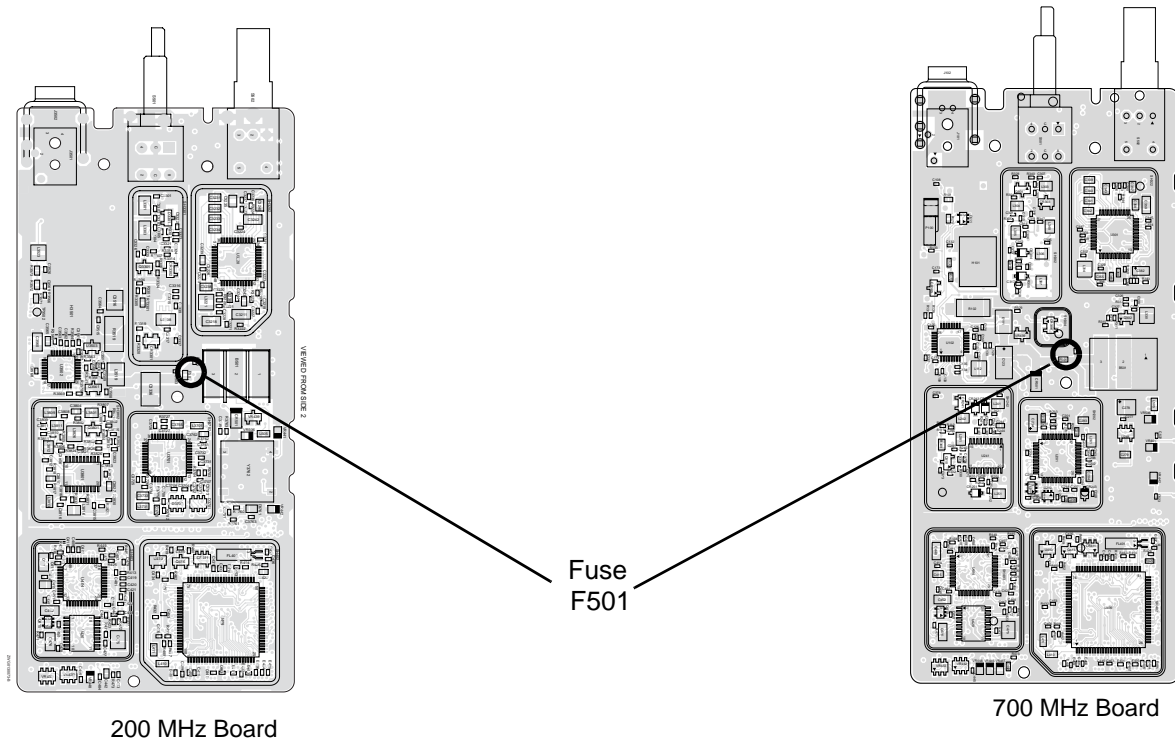
**Table 4-1.** Recommended Test Tools

Motorola Part Number	Description	Application
RSX4043	Torx Driver	Tighten and remove chassis screws.
6680387A70	T-6 Torx Bit	Removable Torx driver bit.
R1453A	Digital readout solder station	Digitally controlled soldering iron.
0180386A78	Illuminated magnifying glass with lens attachment.	
0180386A82 6684253C72 6680384A98 1010041A86  1080303E45	Anti-static grounding kit Straight prober Brush Solder (RMA type), 63/37, 0.5mm diameter 1 lb. spool SMD tool kit (included with R1319A)	Used during all radio assembly and disassembly procedures.
R1319A (110V)  or R1321A(220V)	ChipMaster Surface Mount  Rework Station	Removal and assembly of surface-mounted integrated circuits and shields includes 5 nozzels.
R1364A	Digital Heated Tweezer System	Chip component removal.
R1427A	Board Preheater	Reduces heatsink on multi level boards.
8880309B53	Rework Equipment Catalog	Contains application notes, procedures and technical rework equipment.



## 4.7 Replacing the Circuit Board Fuse

In cases where the radio fails to turn on when power is applied, the circuit board fuse should always be checked as a probable cause of the failure. The locations of the fuse for both the UHF and VHF boards are shown in Figure 4-1. The radio must be disassembled to replace the fuses as described in the Basic Service Manual (see Chapter 1 - Related Documents), then the circuit board separated from the radio chassis as described in the paragraphs that follow.



**Figure 4-1.** Circuit Board Fuse Locations

## 4.8 Removing and Reinstalling the Circuit Board

Both the 200MHz and 700 MHz circuit boards are removed from the radio chassis in the following manner:

1. Refer to the Basic Service Manual (see Chapter 1 - Related Documents) for radio disassembly, then use a Torx driver and a T-6 bit to remove the four Torx screws shown in Figure 4-2.
2. Lift the circuit board out of the radio chassis, then remove and discard the thermal pad located between the circuit board and chassis.
3. After repairs, replace the thermal pad (Motorola P/N 7580556Z01) then reinstall the circuit board into the radio chassis.
4. Reinstall and tighten the four Torx screws to secure the circuit board to the chassis.
5. Refer to the Basic Service Manual to reassemble the radio.

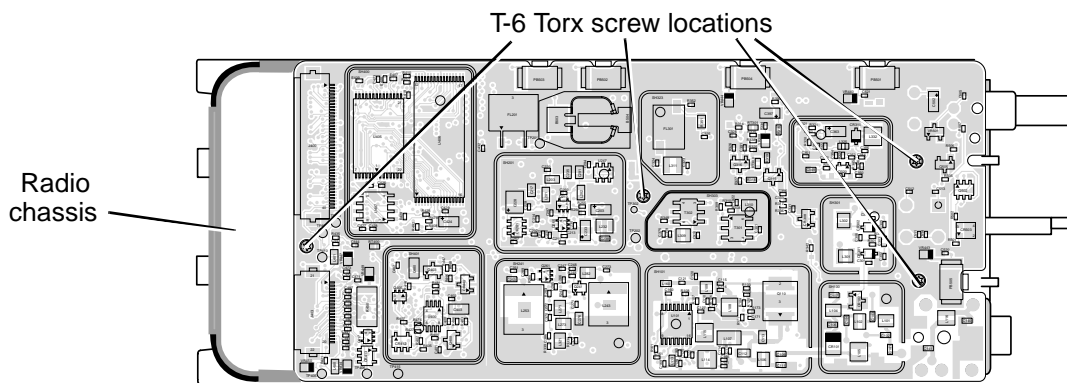


Figure 4-2. Circuit Board Removal and Reinstallation

## 4.9 Power Up Self-Test Error Codes

Turning on the radio starts a self-test routine that checks the RAM, ROM checksum, EEPROM hardware and EEPROM checksum. If these checks are successful, the radio generates two high-pitched self-test pass tones. If the self-test is not successful, one low-pitched tone is heard. Radios with displays are able to display the error codes. The displayed error codes and related corrections are as follows:

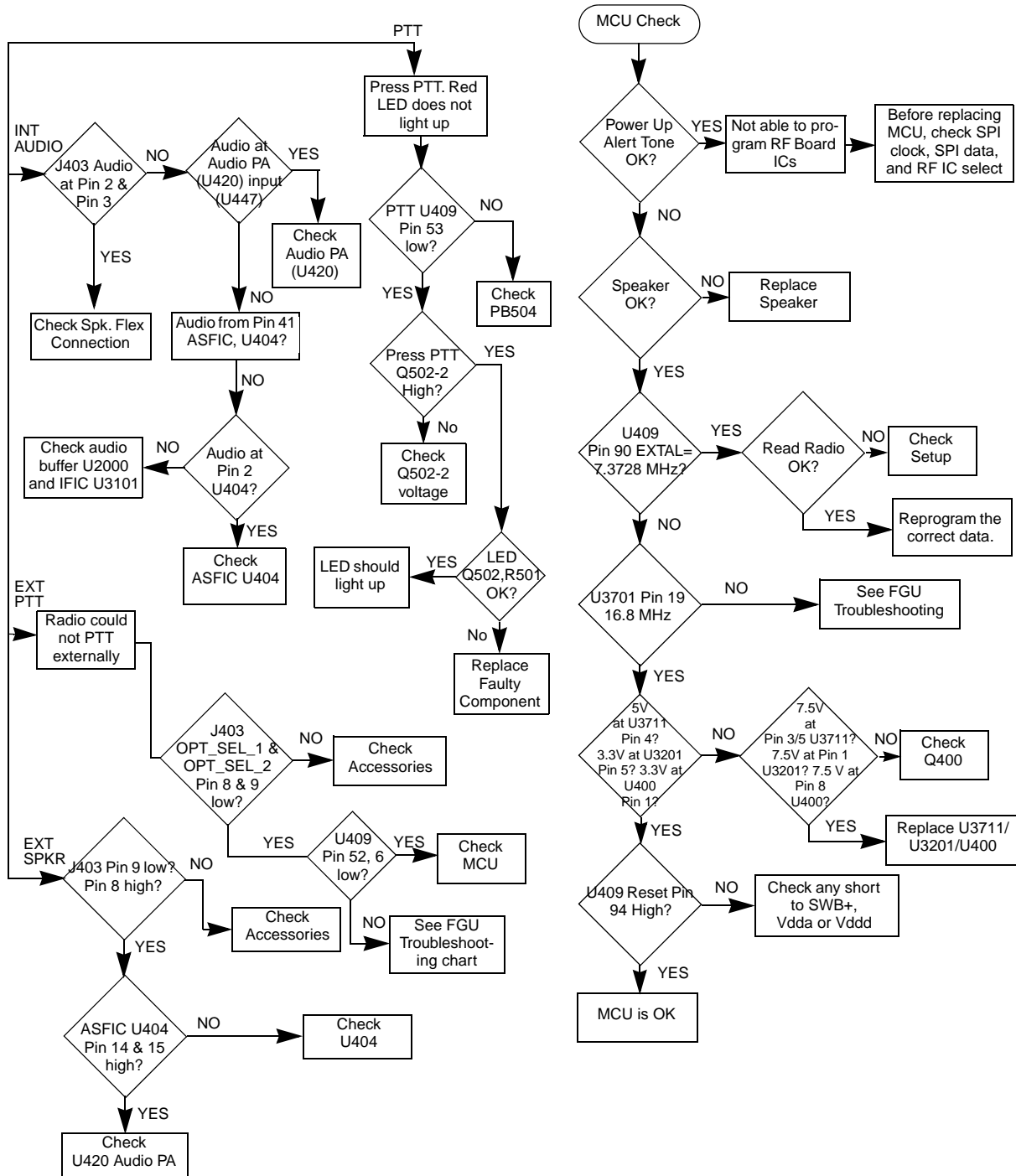
If the error code displayed is ...	Then, there is a ...	To correct the problem ...
"RAM TST ERROR"	RAM test failure.	retest the radio by turning it off and turning it on again. If message reoccurs, replace RAM (U405).
"ROM CS ERROR"	wrong ROM checksum.	replace ROM (U406).
"EEPROM HW ERROR"	codeplug structure mismatch or non existence of codeplug.	reprogram codeplug with correct version and retest radio. If message reoccurs, replace EEPROM (U407).
"EEPROM CS ERROR"	wrong codeplug checksum.	reprogram codeplug.

If the error code displayed is ...	Then, there is a ...	To correct the problem ...
No Display	improperly connected display module or damaged display module.	check connection between main board and display module or replace with new display module.

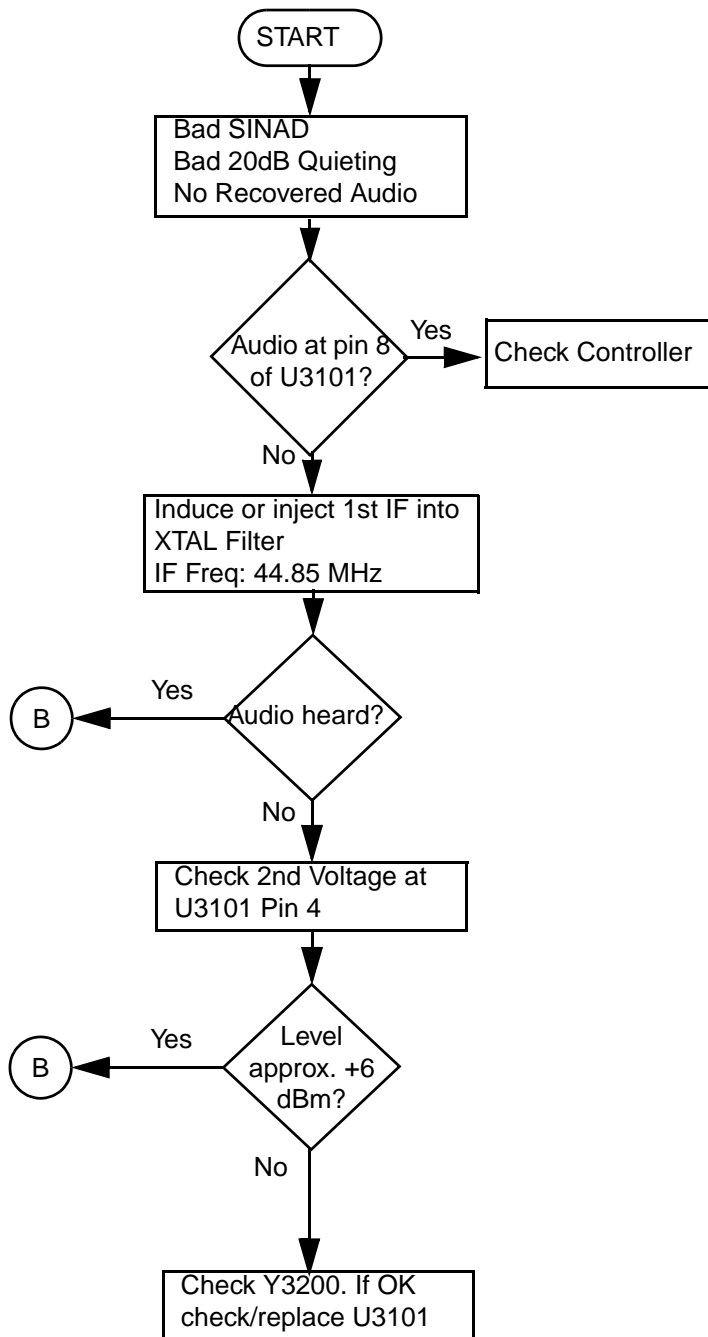
For LTR Models:

If the error code displayed is ...	Then, there is a ...	To correct the problem ...
ESN BAD	defective PTCB	return to factory for PTCB replacement.
AppCode Fail	defective PTCB firmware	reflash PTCB firmware.
EER: Watchdog	firmware failure	restart radio
Unprogrammed	programming error	use CPS to properly program radio and PTCB.
ERROR: NO PTG	no primary talk group	use CPS to program zone with a Primary Talk Group.
Backdoor	---	turn radio off and restart.

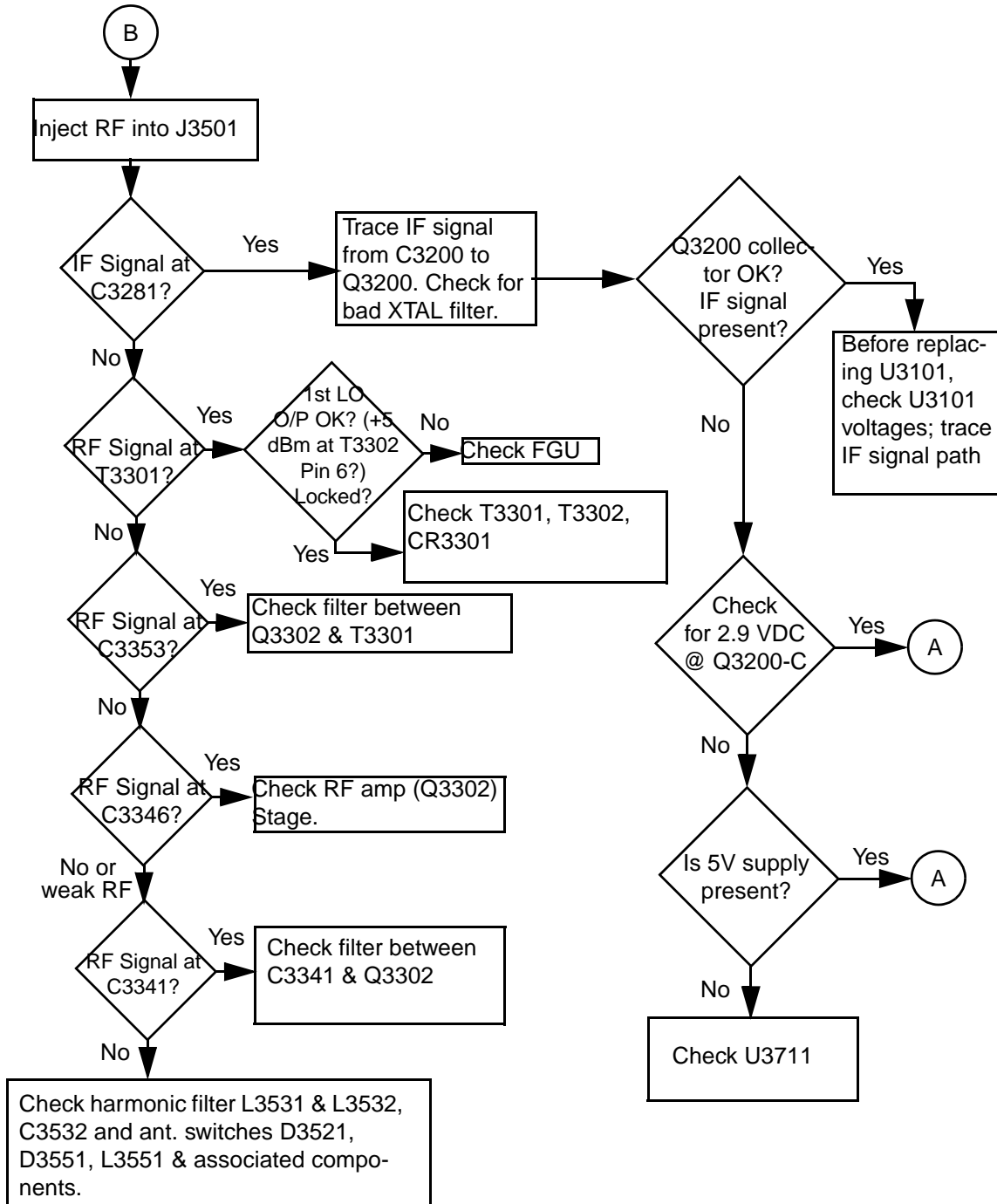
### 4.10 200 MHz Troubleshooting Charts



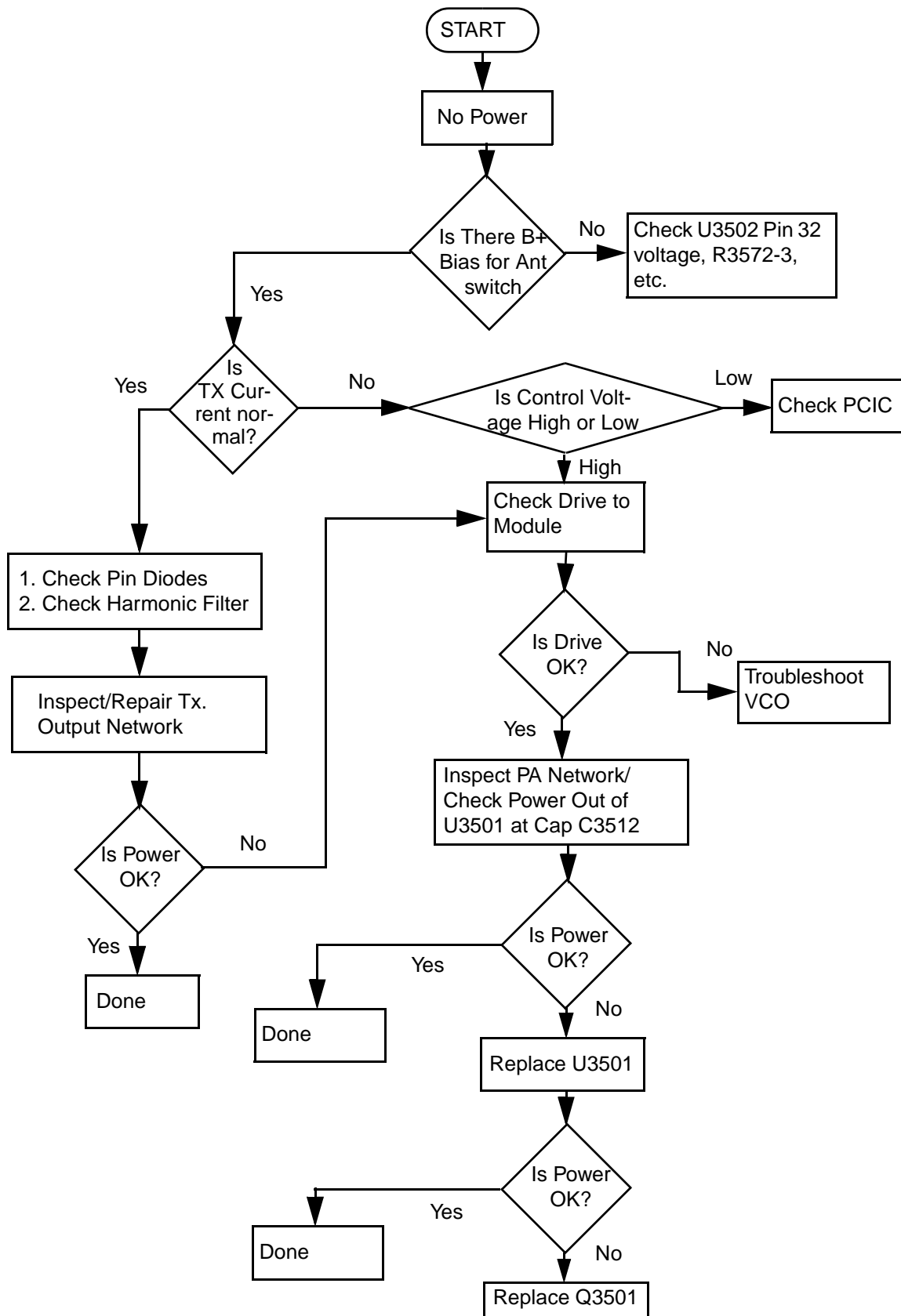
**Troubleshooting Flow Chart for Controller**



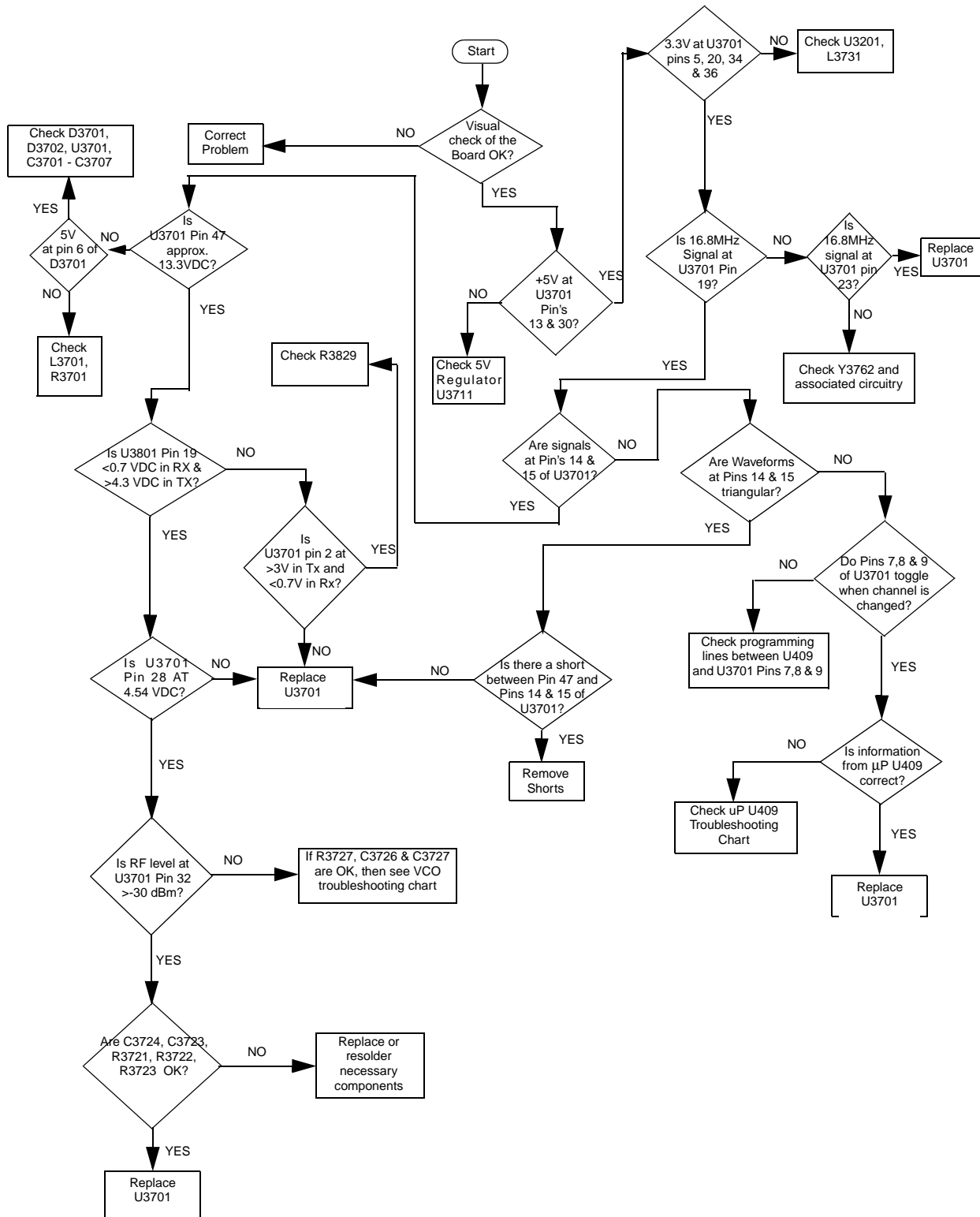
**Troubleshooting Flow Chart for Receiver (Sheet 1 of 2)**



Troubleshooting Flow Chart for Receiver (Sheet 2 of 2)

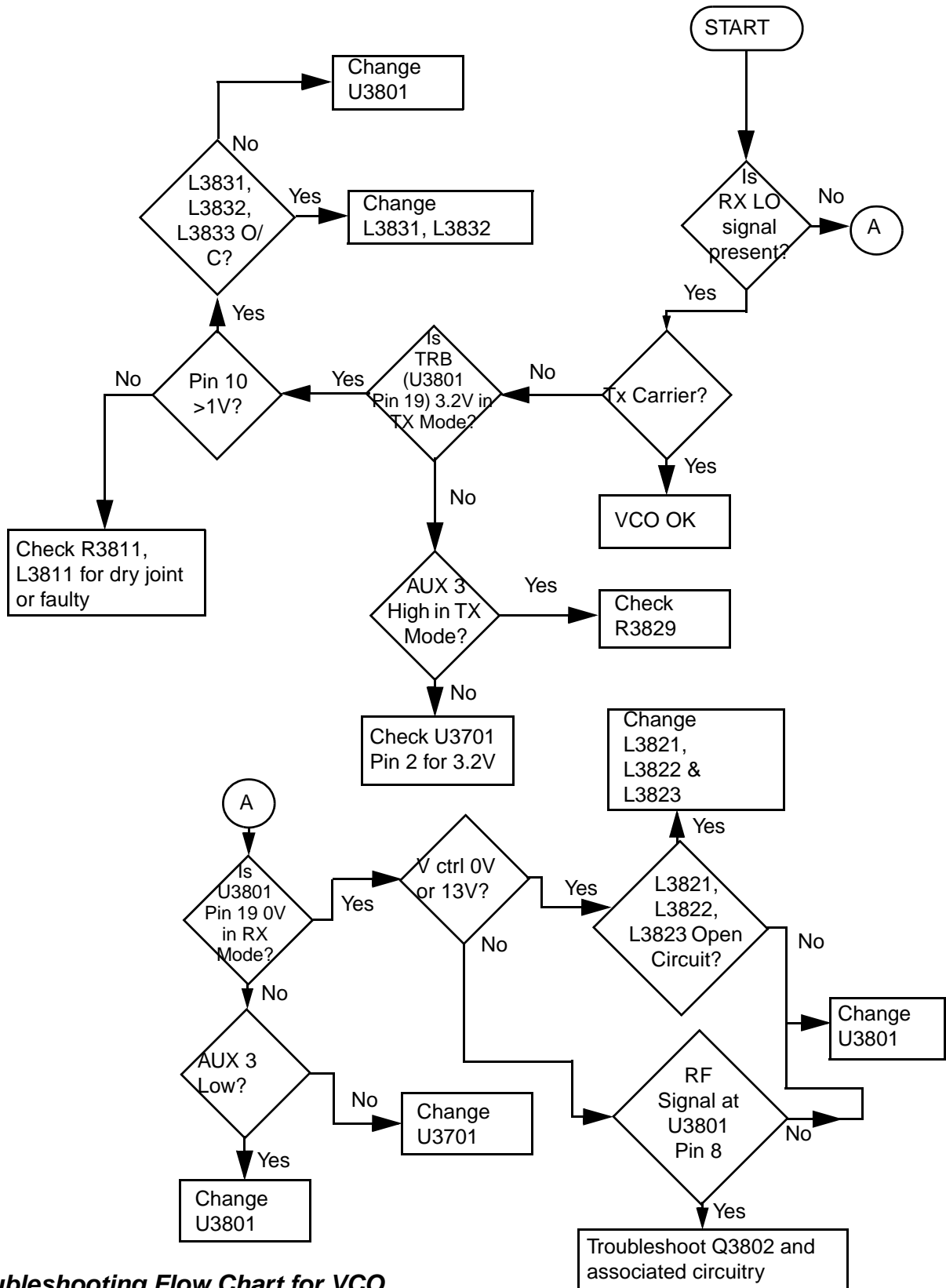


**Troubleshooting Flow Chart for Transmitter**



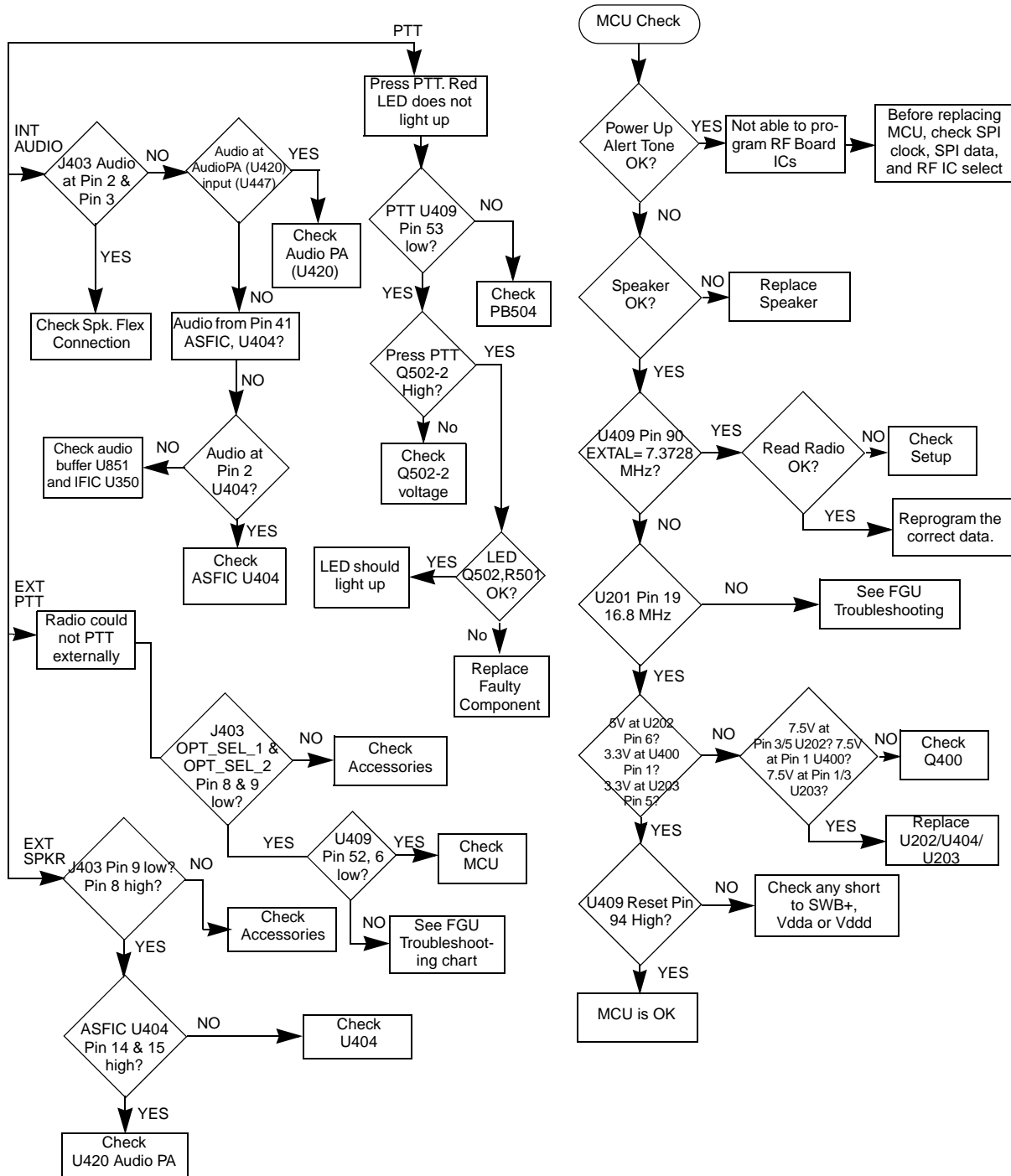
**Troubleshooting Flow Chart for Synthesizer**



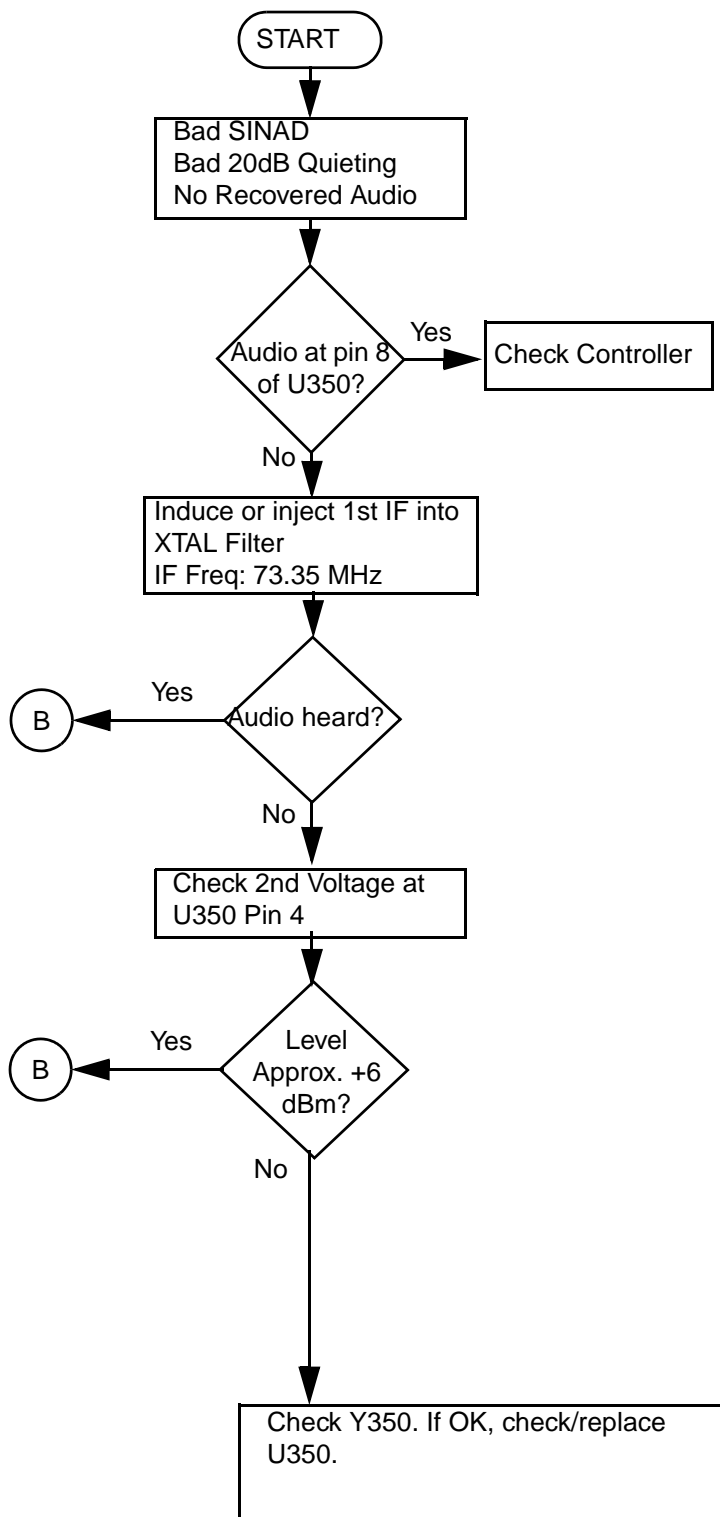


**Troubleshooting Flow Chart for VCO**

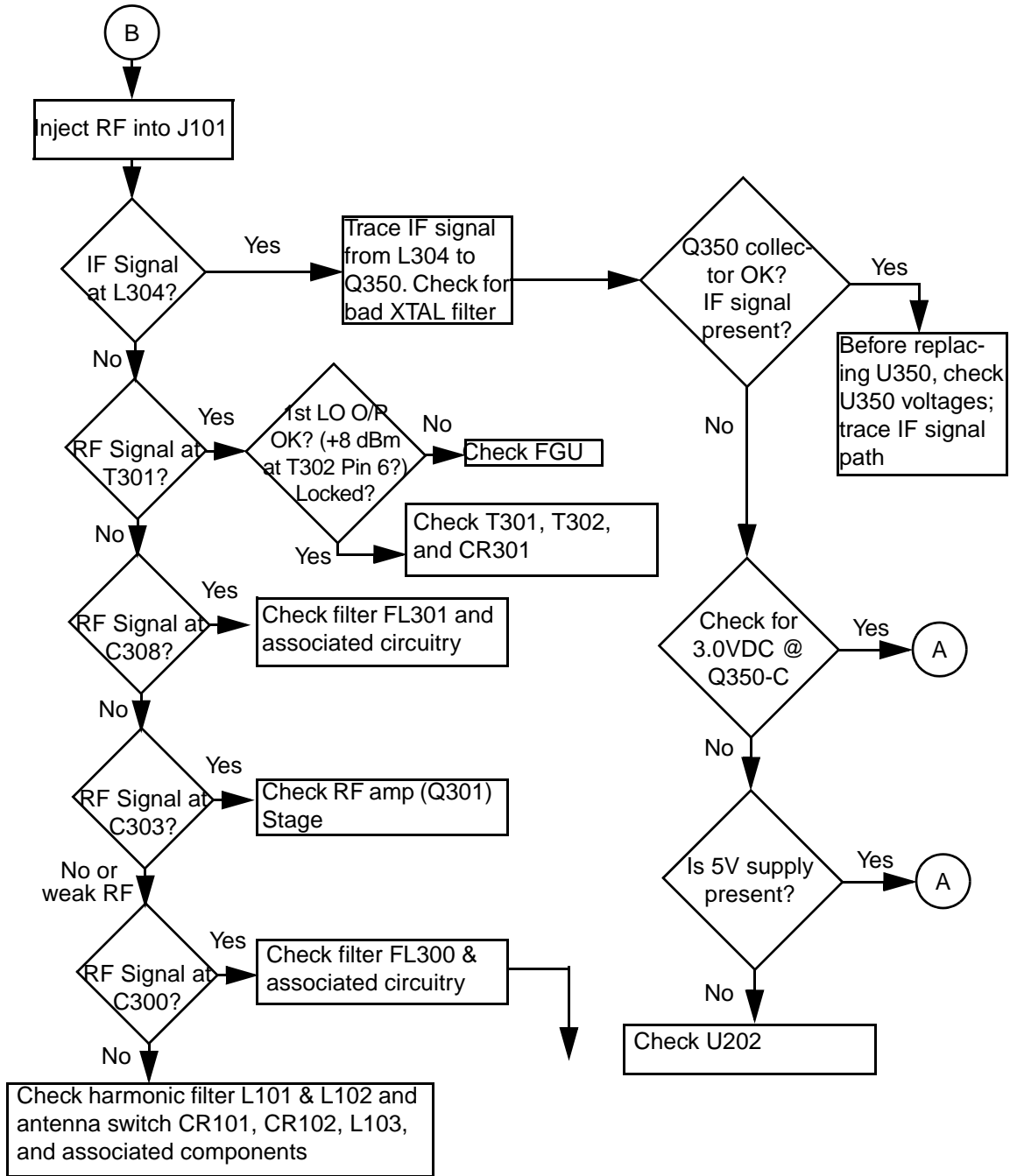
### 4.11 700 MHz Troubleshooting Charts



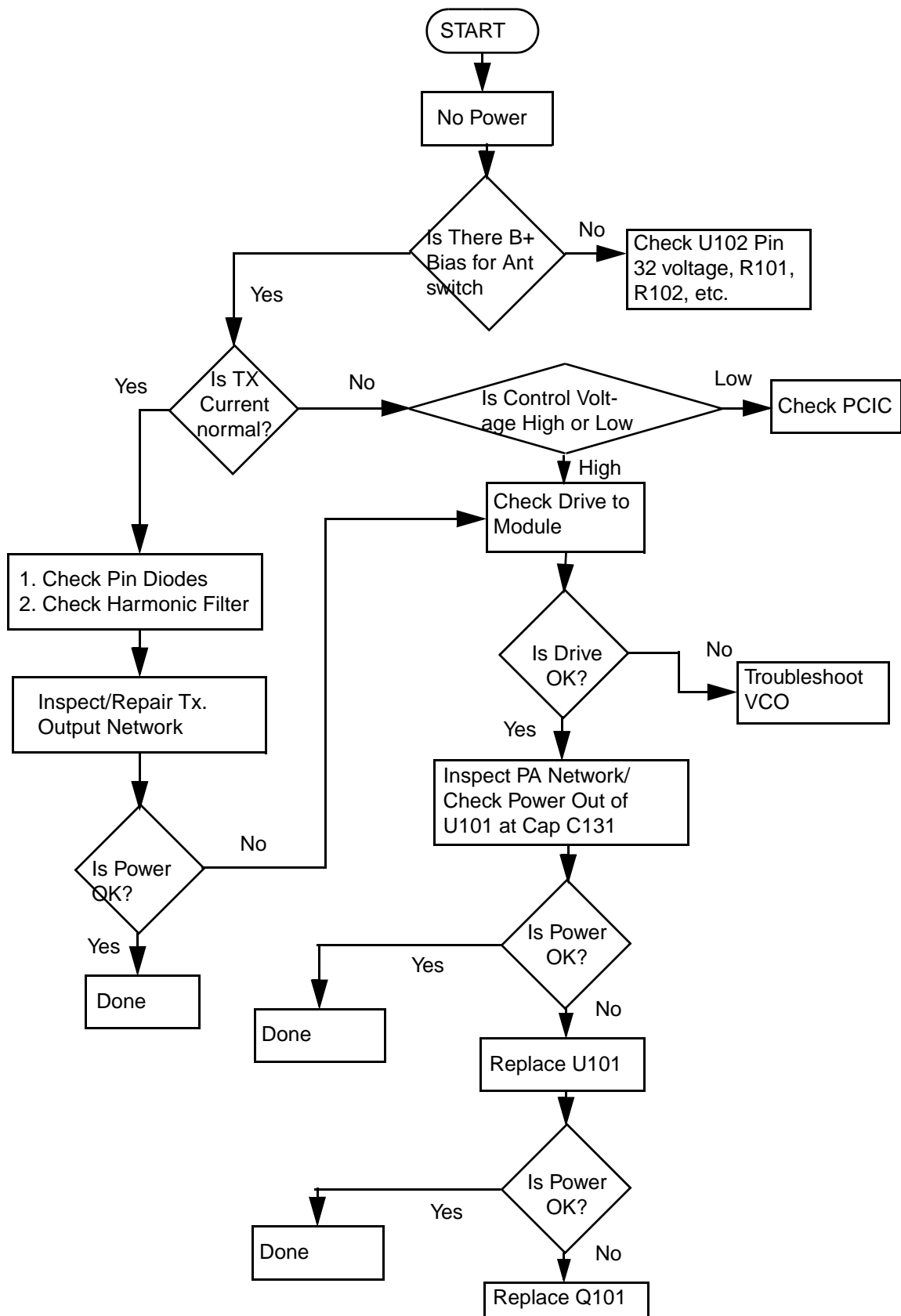
**Troubleshooting Flow Chart for Controller**



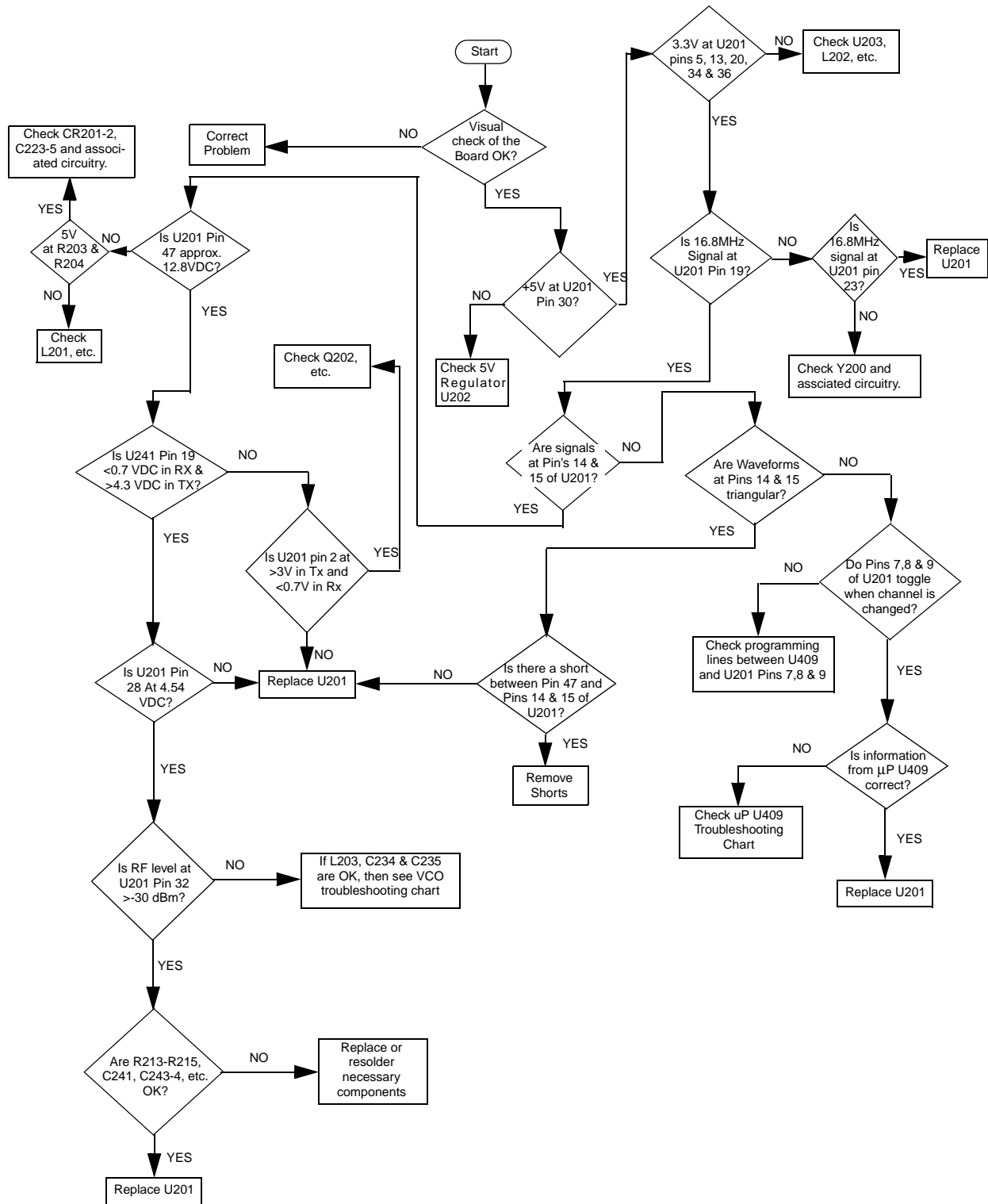
**Troubleshooting Flow Chart for Receiver (Sheet 1 of 2)**



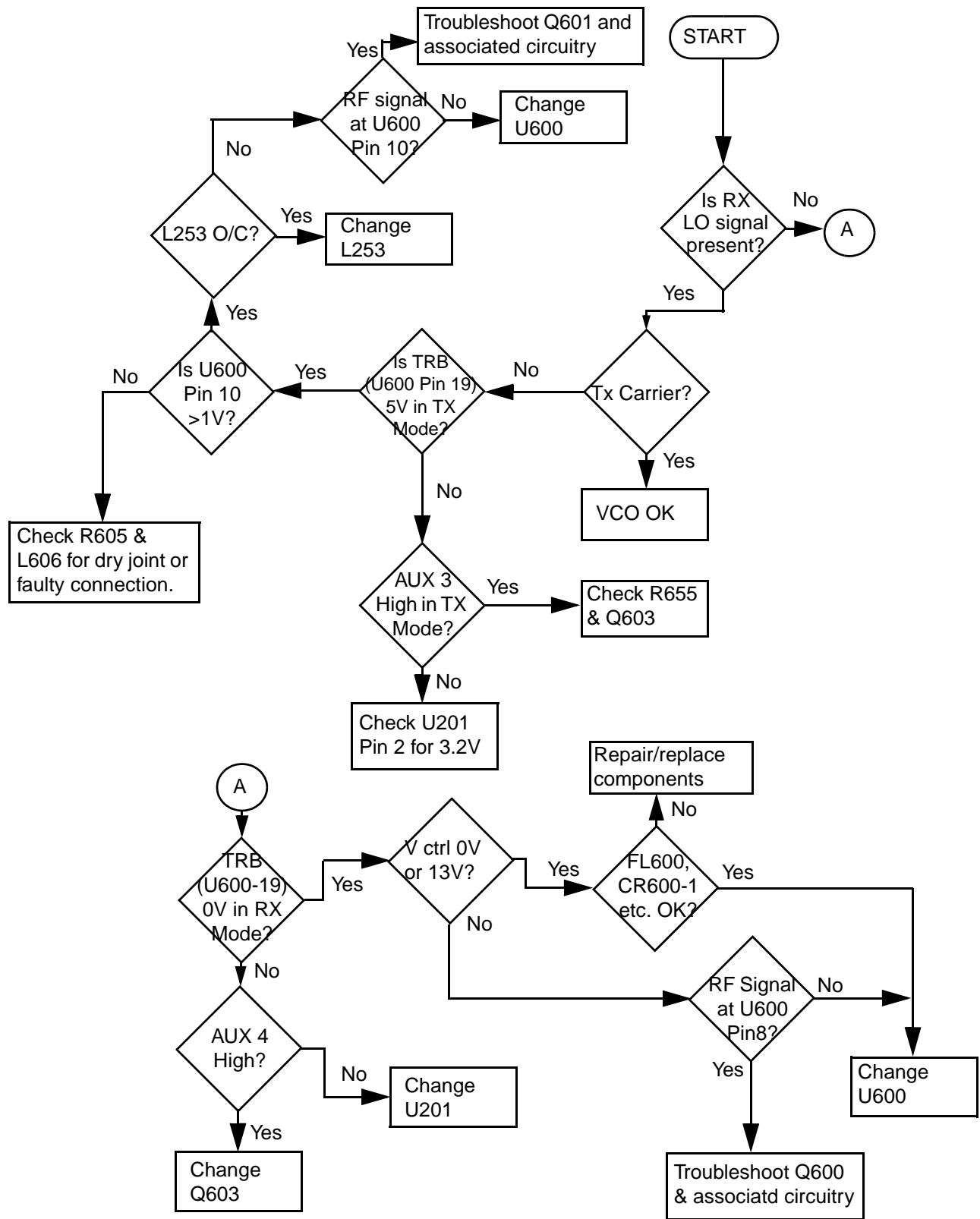
**Troubleshooting Flow Chart for Receiver (Sheet 2 of 2)**



**Troubleshooting Flow Chart for Transmitter**

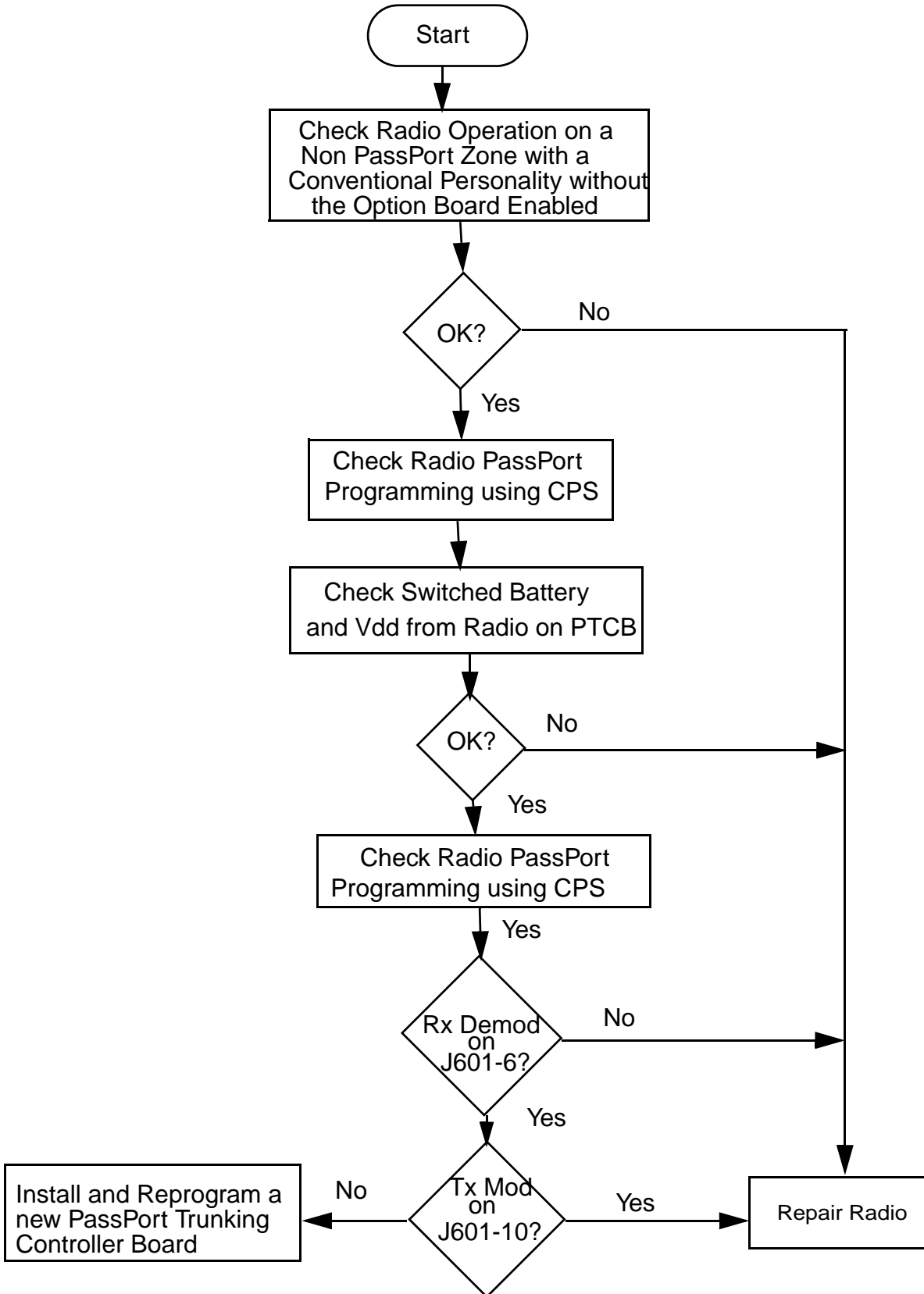


**Troubleshooting Flow Chart for Synthesizer**



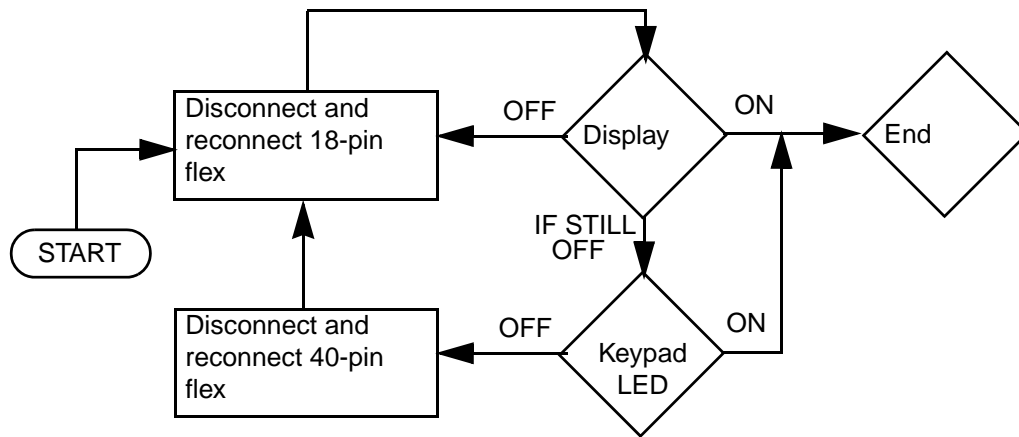
**Troubleshooting Flow Chart for VCO**

### 4.12 PassPort Trunking Troubleshooting Chart





### 4.13 Keypad Troubleshooting Chart





## Chapter 5

# Schematic Diagrams, Overlays, and Parts Lists

### 5.1 Introduction

This chapter provides schematic diagrams, overlays, and parts lists for the radio circuit boards and interface connections.

#### 5.1.1 Notes For All Schematics and Circuit Boards

\* Component is frequency sensitive. Refer to the Electrical Parts List for value and usage.

1. Unless otherwise stated, resistances are in Ohms ( $k = 1000$ ), and capacitances are in picofarads (pF) or microfarads ( $\mu\text{F}$ ).
2. DC voltages are measured from point indicated to chassis ground using a Motorola DC multimeter or equivalent. Transmitter measurements should be made with a  $1.2 \mu\text{H}$  choke in series with the voltage probe to prevent circuit loading.
3. Reference Designators are assigned in the following manner:

Circuit Block	Series (200 MHz)	Series (700 MHz)
Receiver Front End	3300	300
Receiver I-F	3100-3200	350
Frequency Synthesizer	3700	200
VCO's	3800	600
Transmitter and Power Control	3500	100
Microprocessor	400	400
Memory	400	400
RX Audio Opamp Gain Stage	600, 2000	850
ASFIC	400	400
Audio Power Amplifier	400	400
Controls and Indicators	500	500
Keypad/PassPort Board Interface	400, 4000	400, 500
Keypad/PassPort Option Board	600	600

4. Interconnect Tie Point Legend:

CLK = Clock

CSX = Chip Select Line

MECH\_SWB+ or SWB+ = Switched Battery Voltage (7.5V)

R5 = Receive Mode 5 V

SYN = Synthesizer

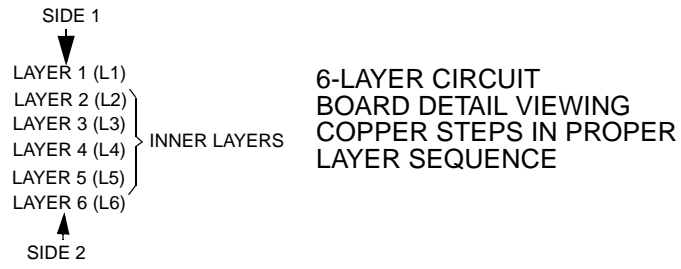
T5 = Transmit Mode 5V

UNSWB+ = Unswitched Battery Voltage (7.5V)

Vdda = Regulated 3.3 Volts (for analog)

Vddd = Regulated 3.3 Volts (for digital)

VSF = Super Filtered (4.5 V)



## 5.2 Flex Layout

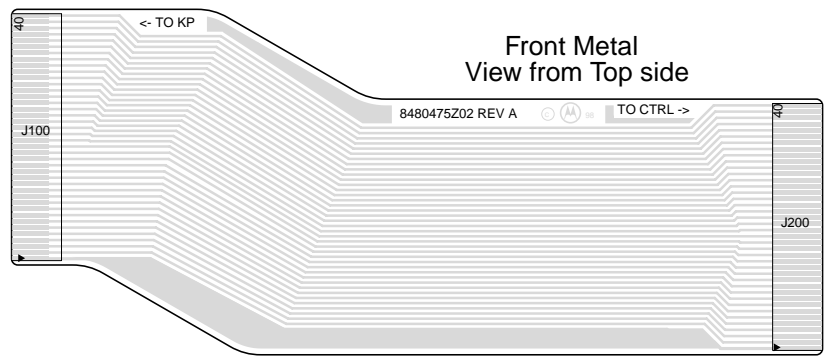


Figure 5-1. Keypad-Controller Interconnect Flex

## 5.2.1 Keypad/PassPort Controller Interconnect Flex Schematic

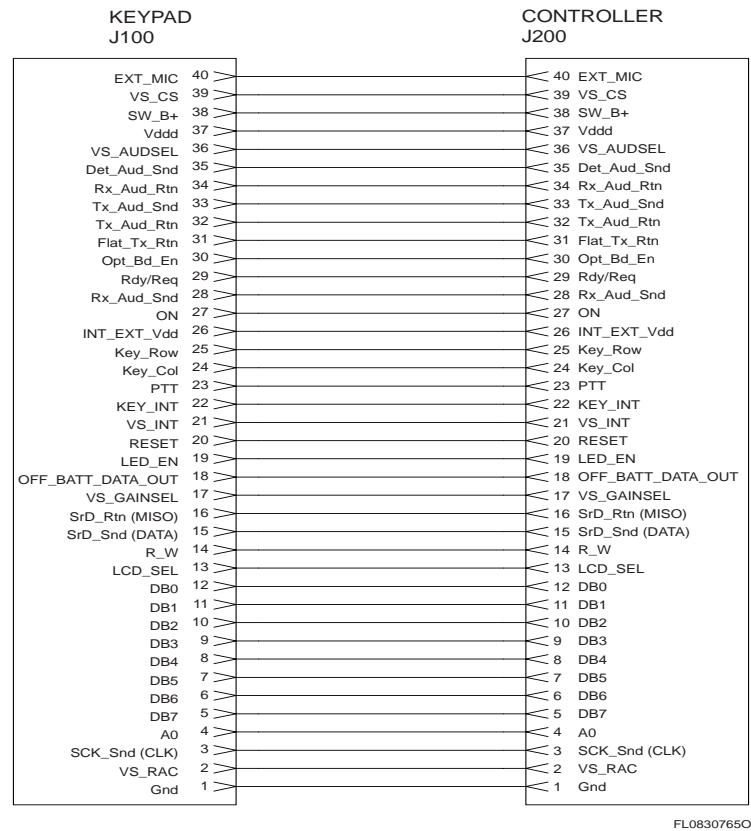


Figure 5-2. Keypad/PassPort Controller Interconnect Flex Schematic Diagram

## 5.2.2 Keypad/PassPort Controller Interconnect Flex Parts List

Reference Symbol	Motorola Part No.	Description
J100	0980521Z01	Connector, 40 pin
J200	0905505Y04	Speaker, 20 ohm

### 5.2.3 Universal Flex Connector

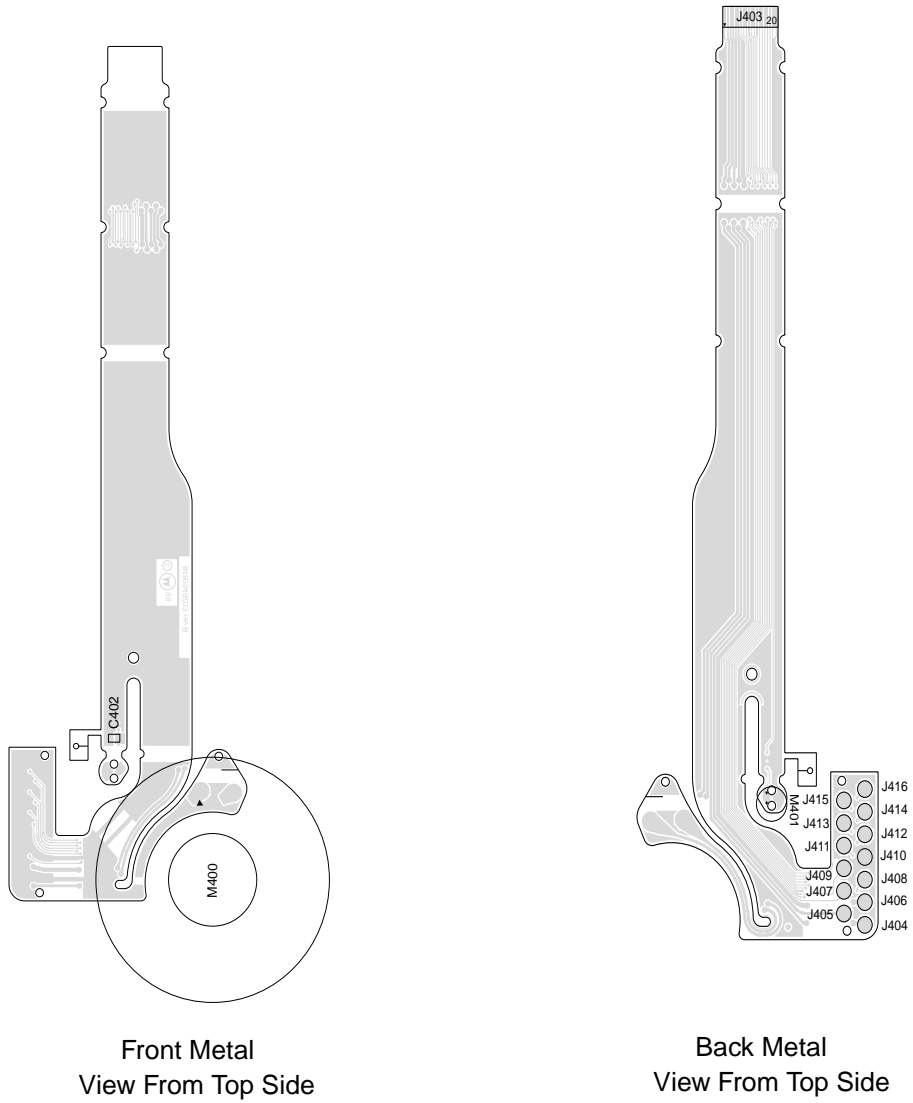


Figure 5-3. Universal Flex Connector

### 5.2.4 Universal Connector Flex Schematic

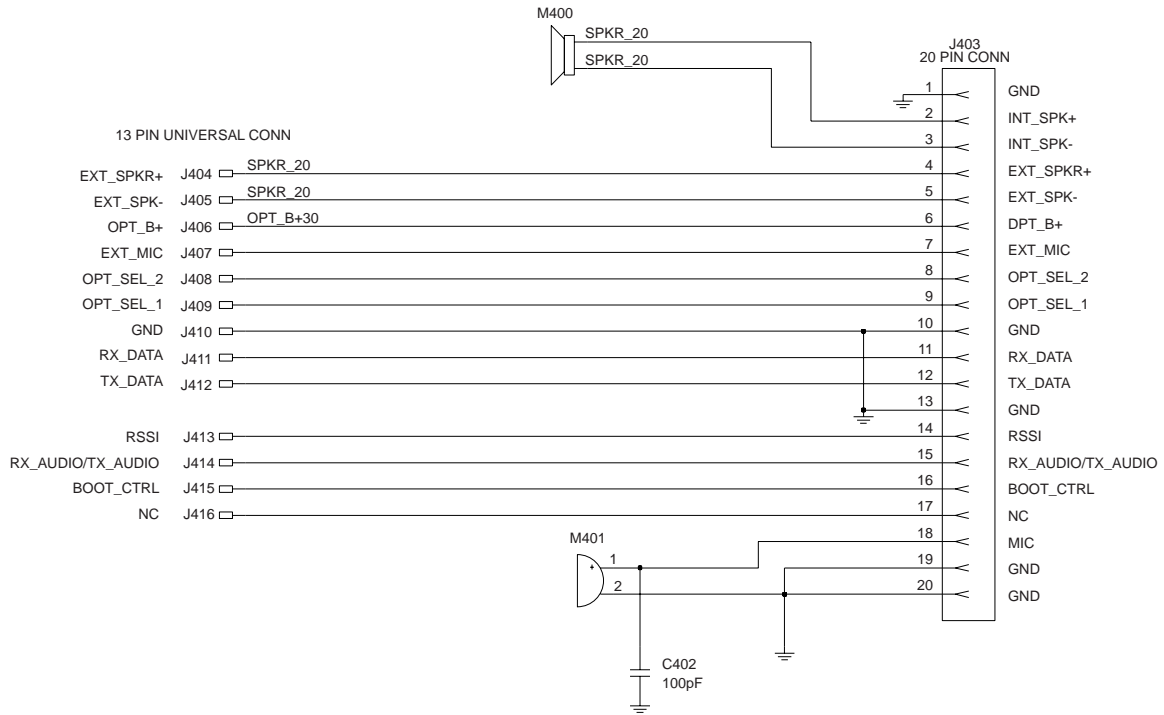


Figure 5-4. Universal Flex Connector Schematic Diagram

### 5.2.5 Universal Flex Connector Parts List

Reference Symbol	Motorola Part No.	Description
C402	2113740A55	Cap, 100pF
M400	5085962A02	Speaker, 20 ohm
M401	5013920A04	Microphone for 5000 and 7000 Series
M401	5005227J08	Microphone for 9000 Series
	8480549Z01	Flex, Speaker Microphone





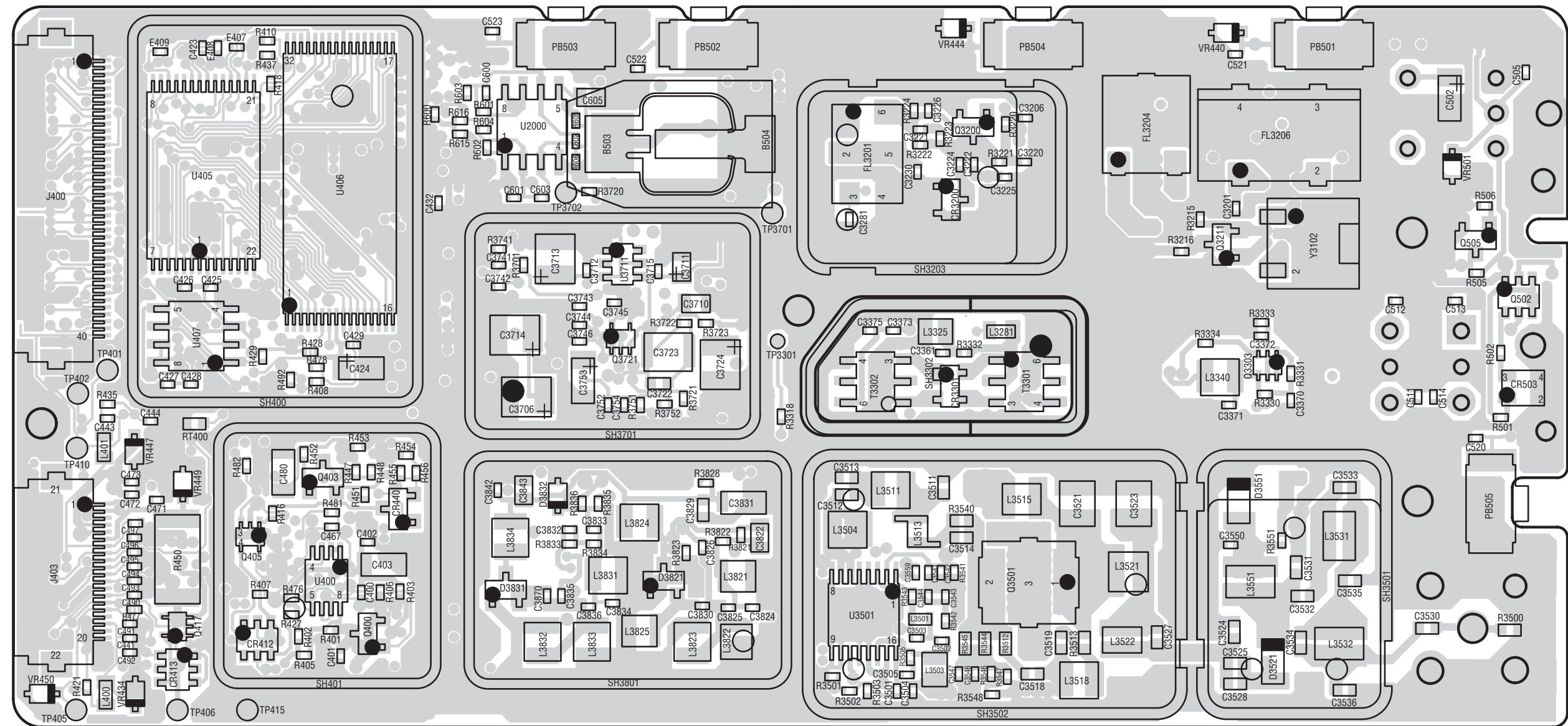


Figure 5-5. 200 MHz Main Board Bottom Side PCB 8486236Z06

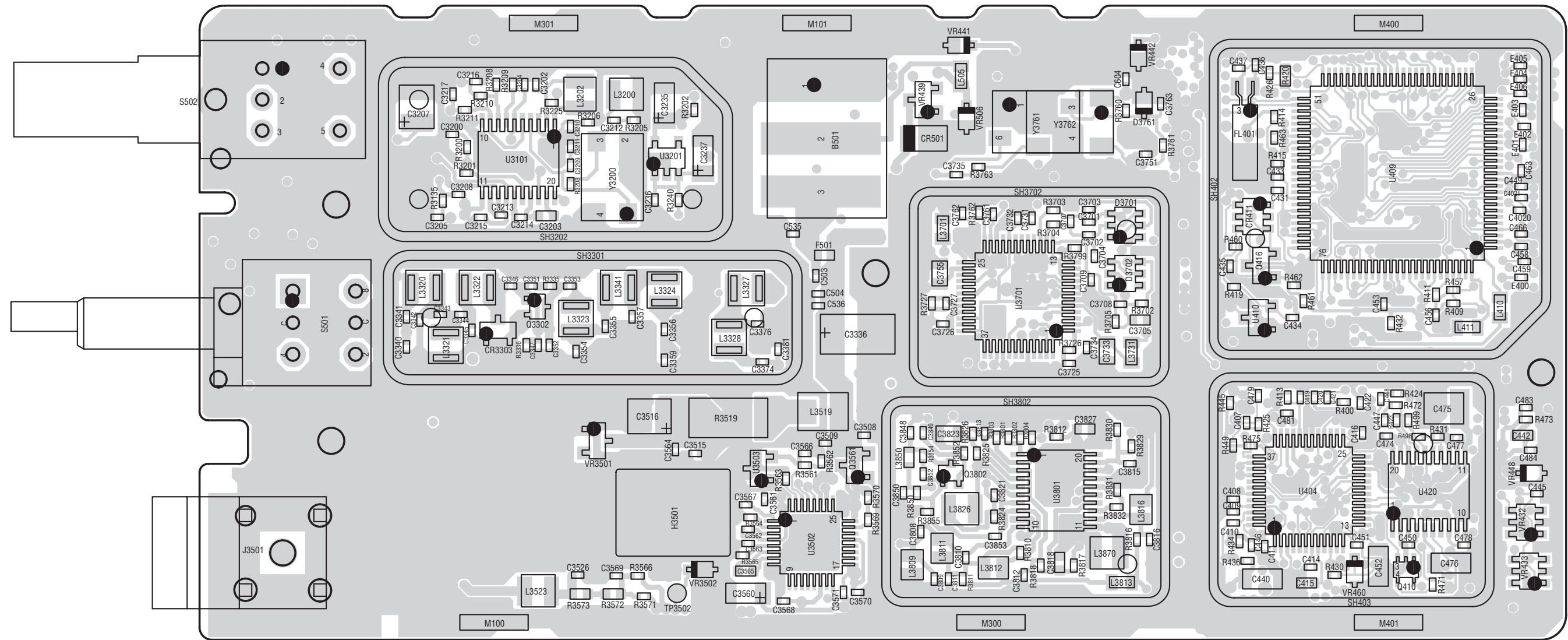


Figure 5-6. 200 MHz Main Board Top Side PCB 8486236Z06

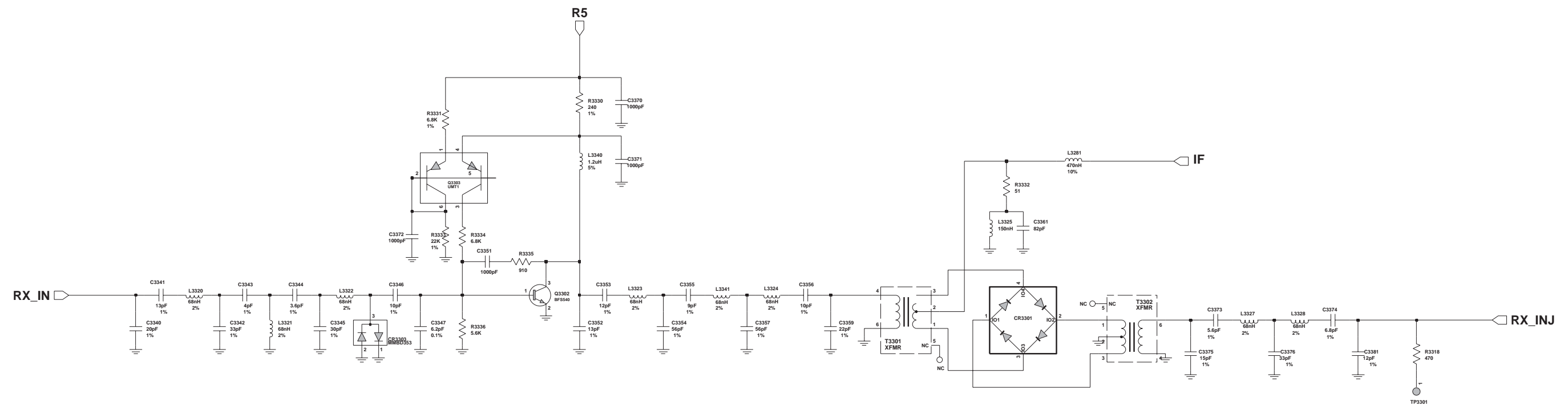


Figure 5-7. 200 MHz Receiver Front End Schematic Diagram

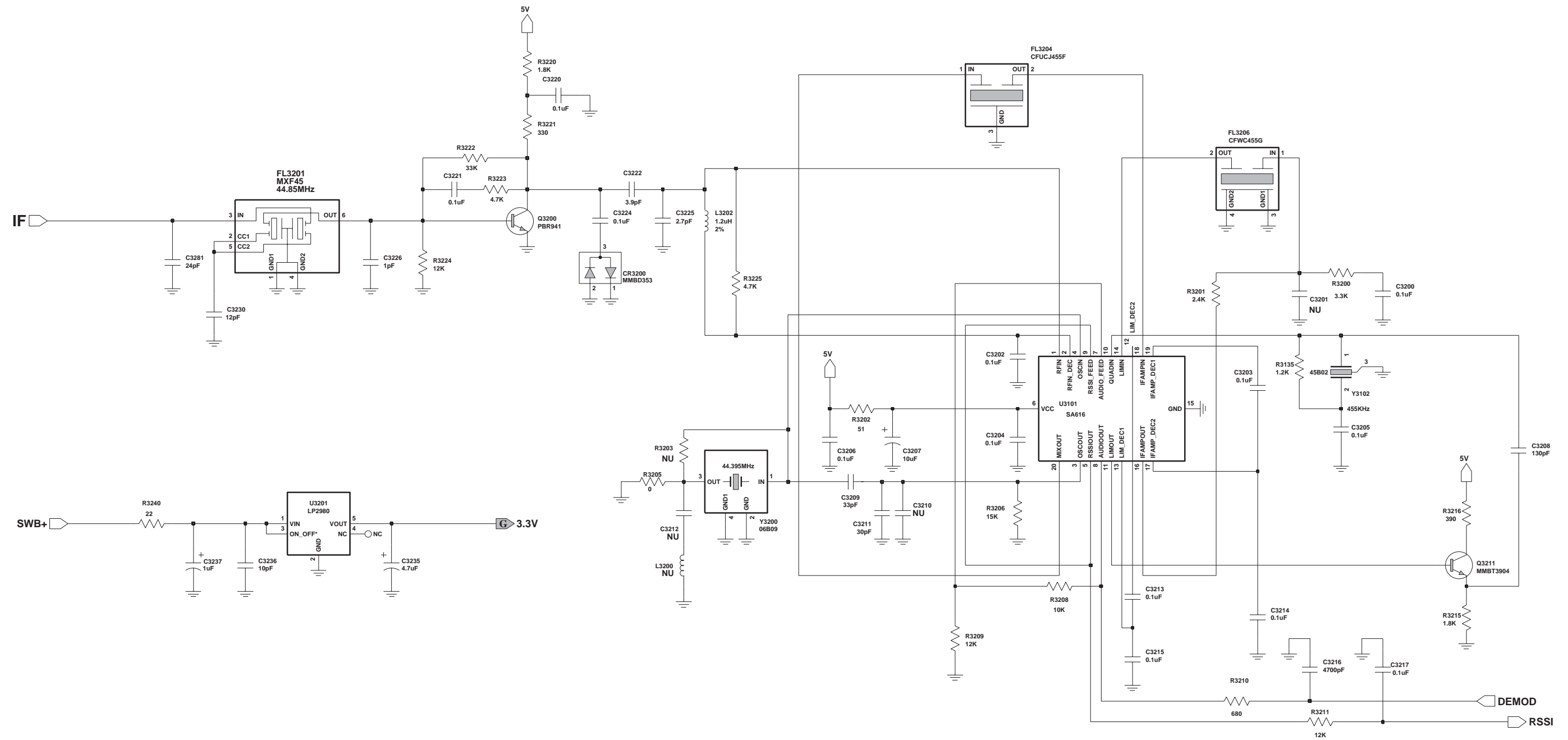


Figure 5-8. 200 MHz Receiver I-F Schematic Diagram

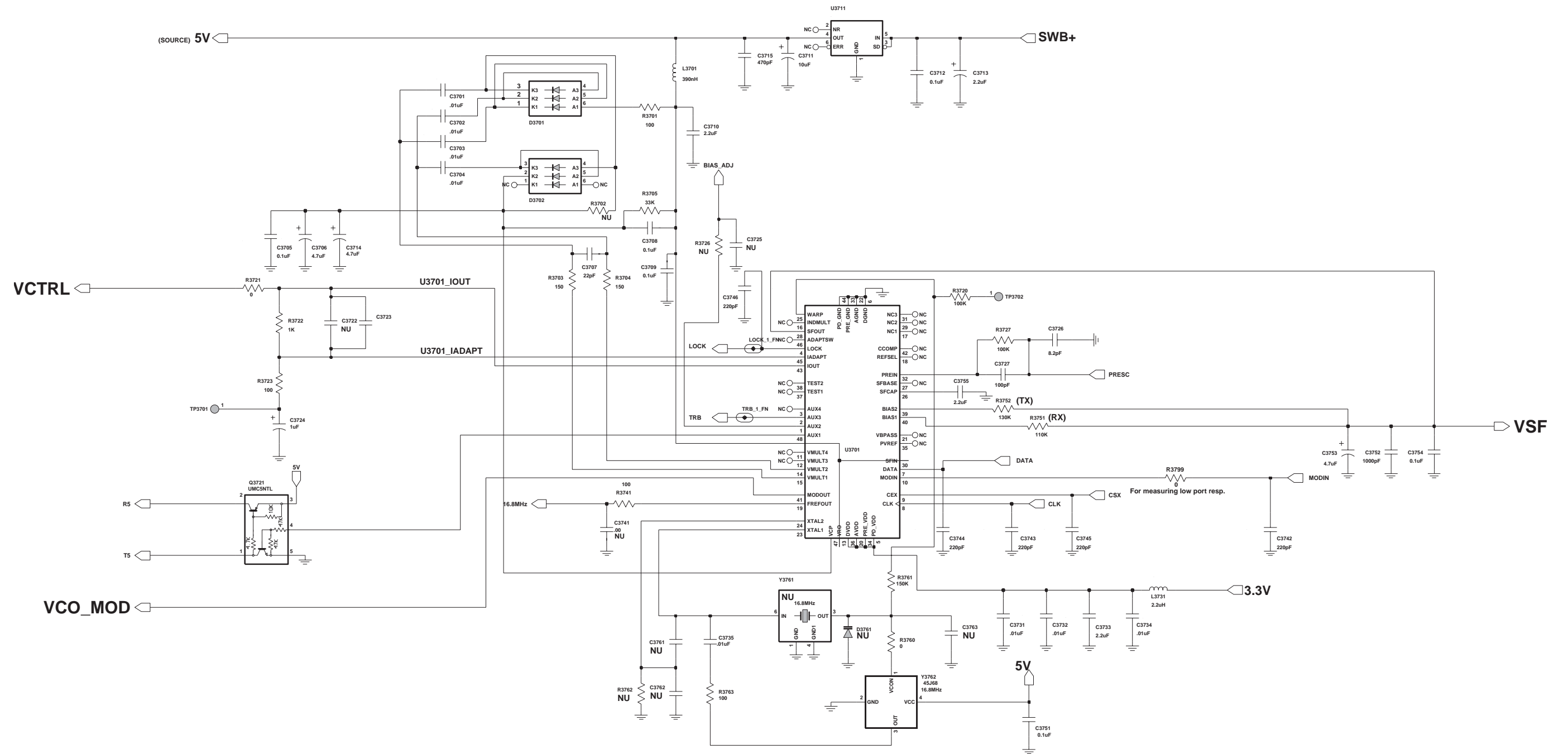


Figure 5-9. 200 MHz Frequency Synthesizer Schematic Diagram

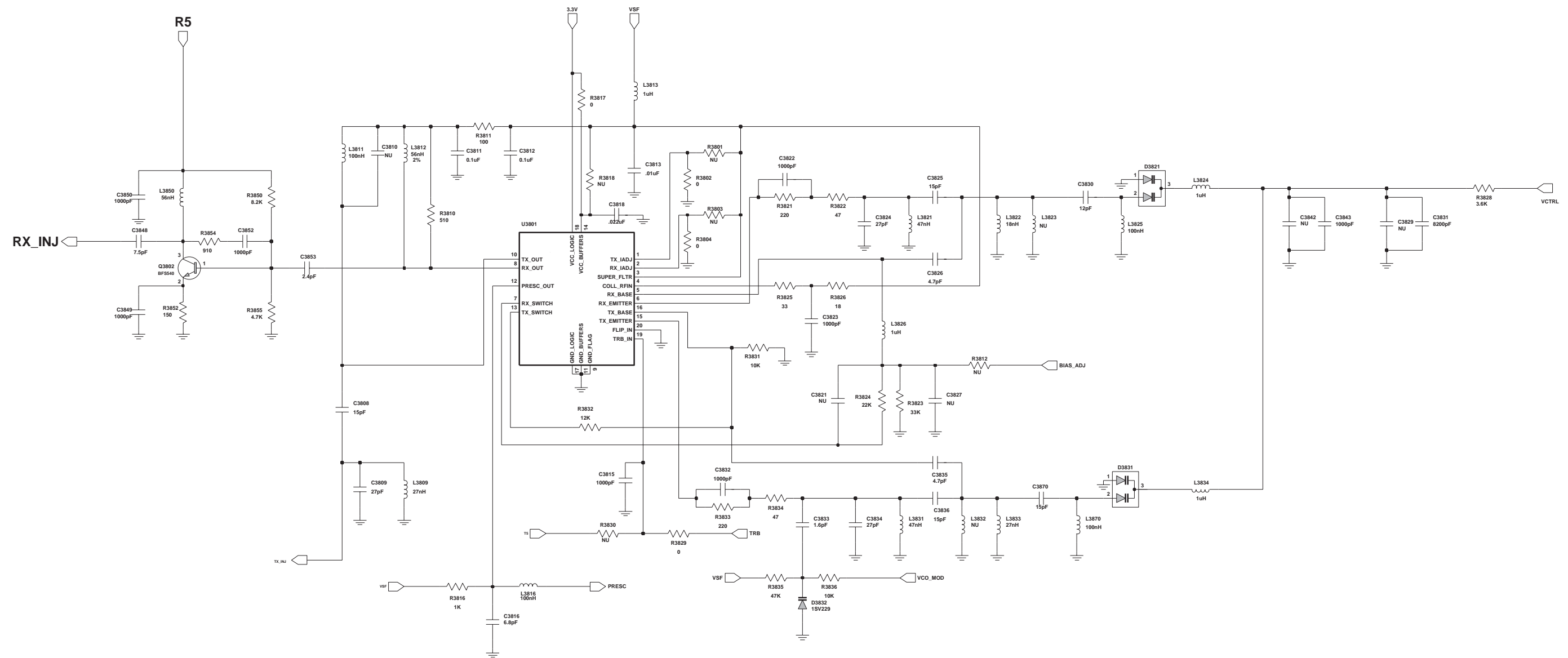


Figure 5-10. 200 MHz Voltage Controlled Oscillator Schematic Diagram

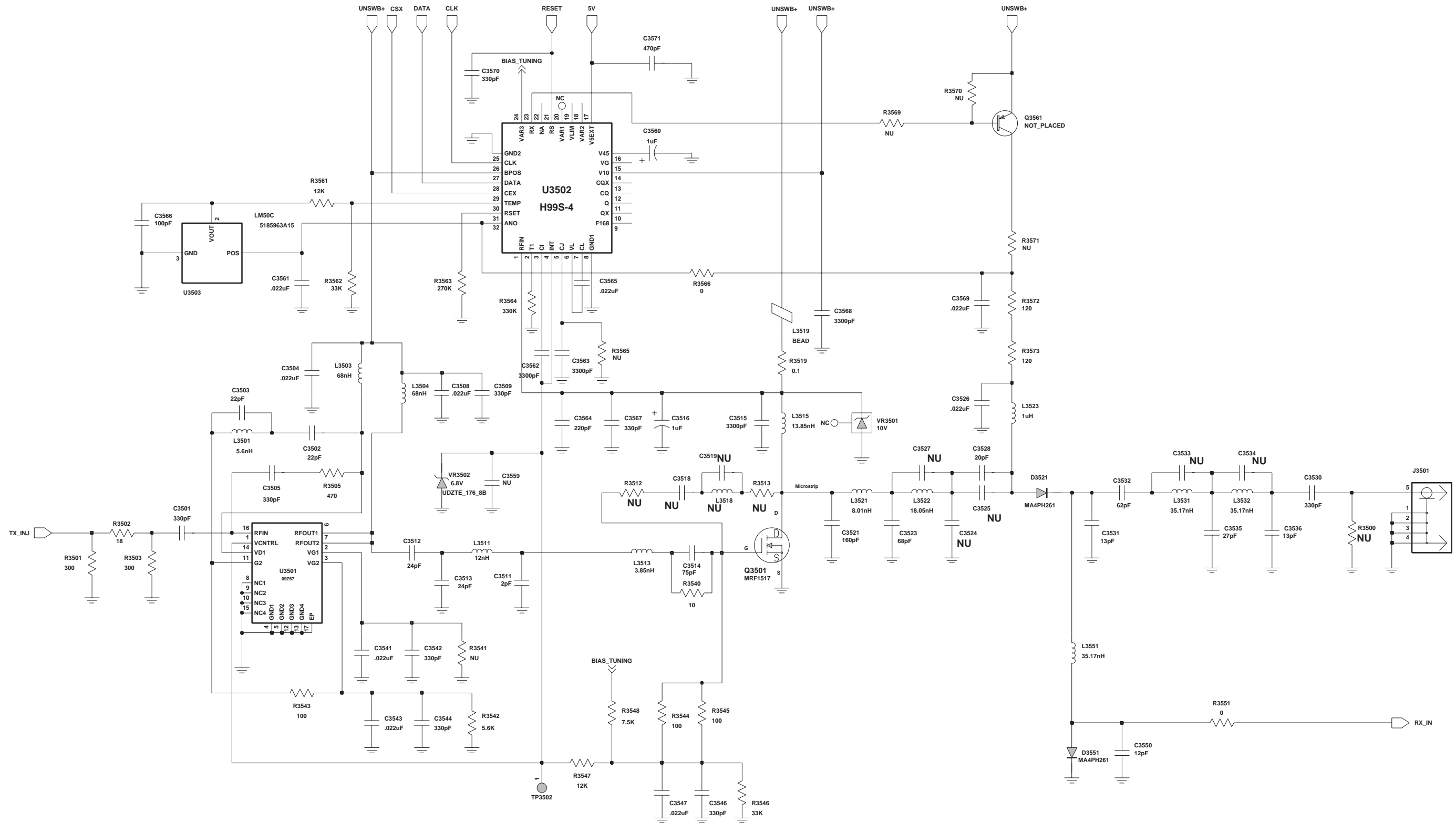


Figure 5-11. 200 MHz Transmitter and Power Control Schematic Diagram

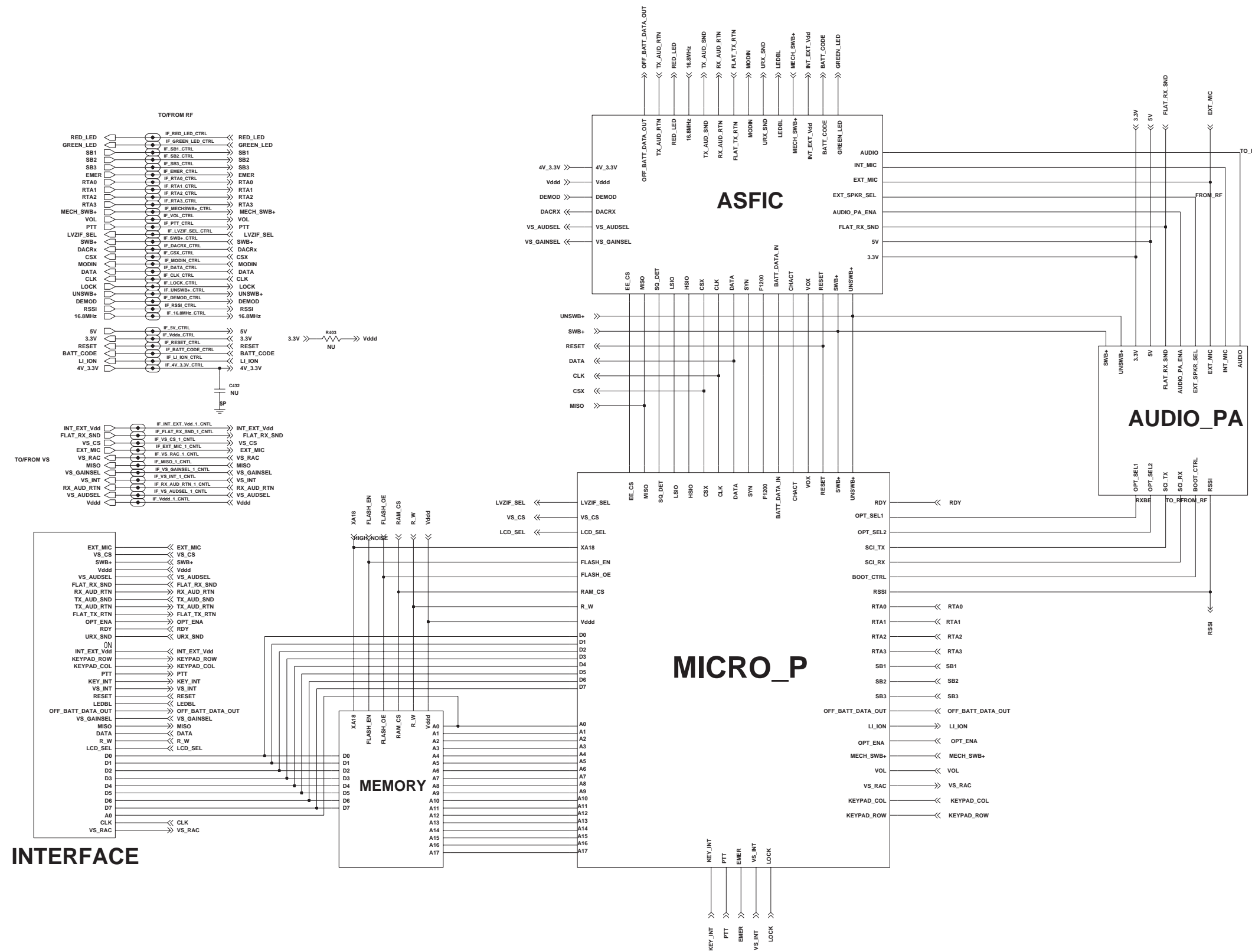


Figure 5-12. 200 MHz Controller Block Diagram



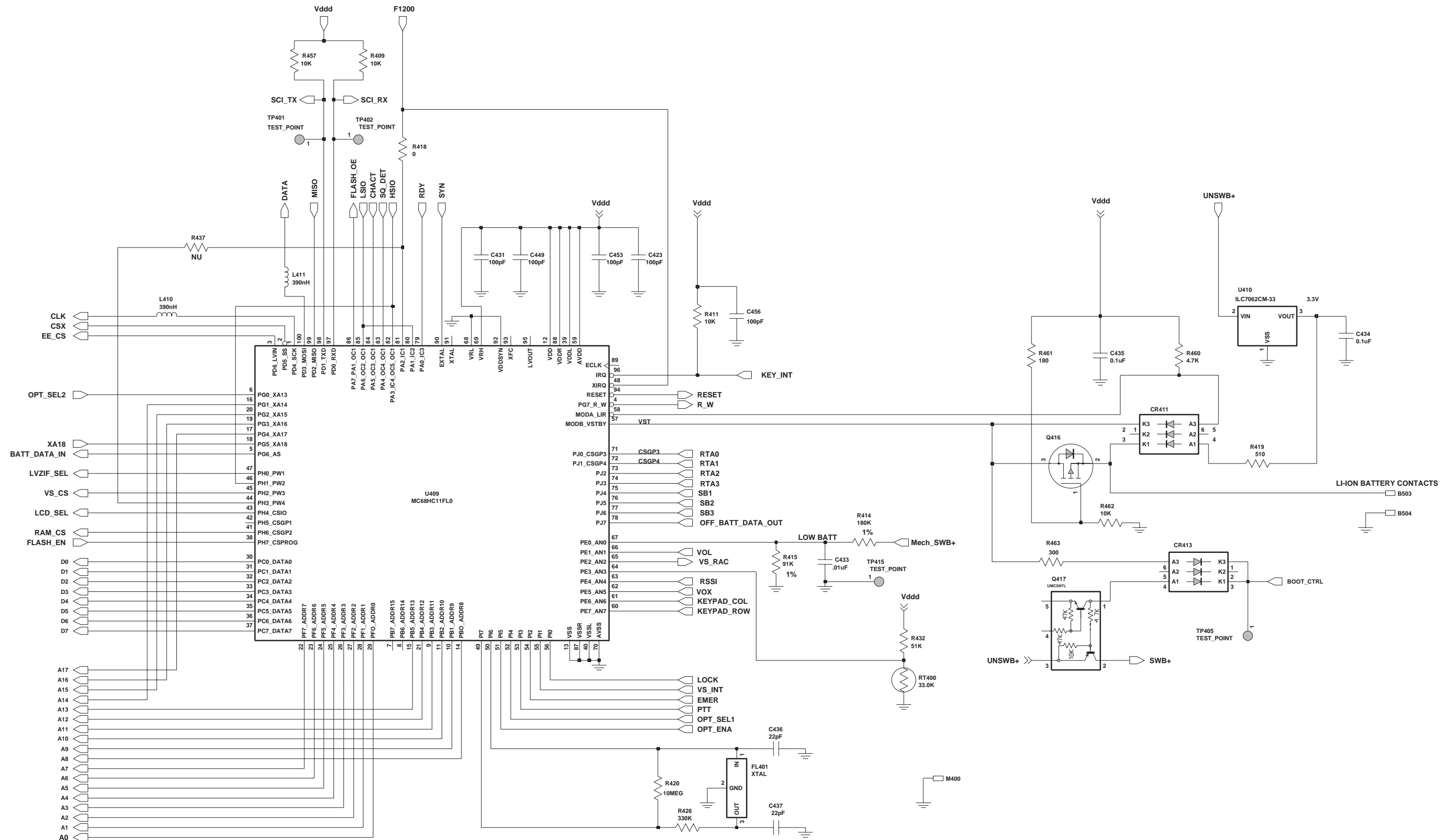


Figure 5-13. 200 MHz Microprocessor Schematic Diagram

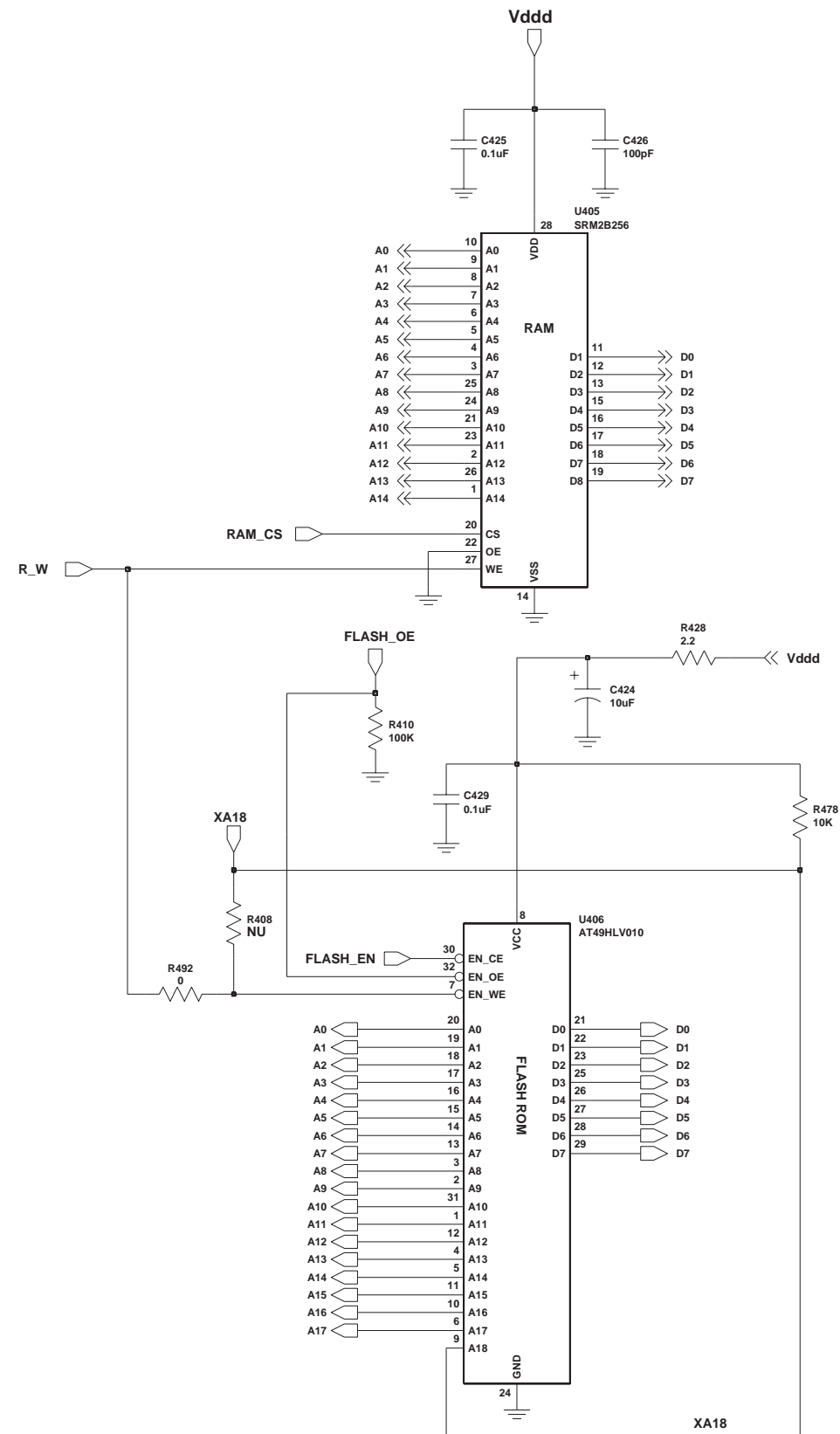


Figure 5-14. 200 MHz Memory Schematic Diagram

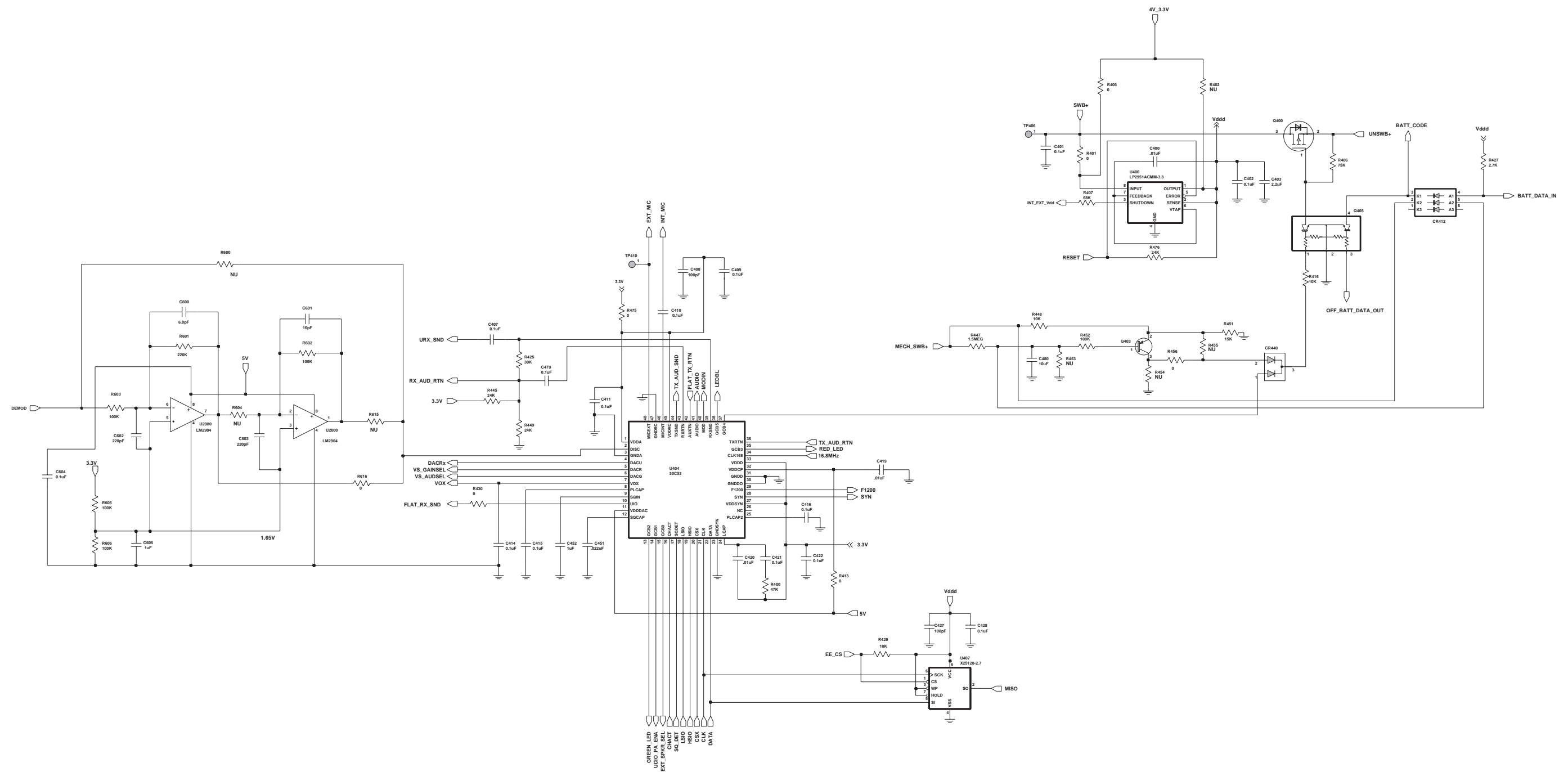


Figure 5-15. 200 MHz ASFC Schematic Diagram

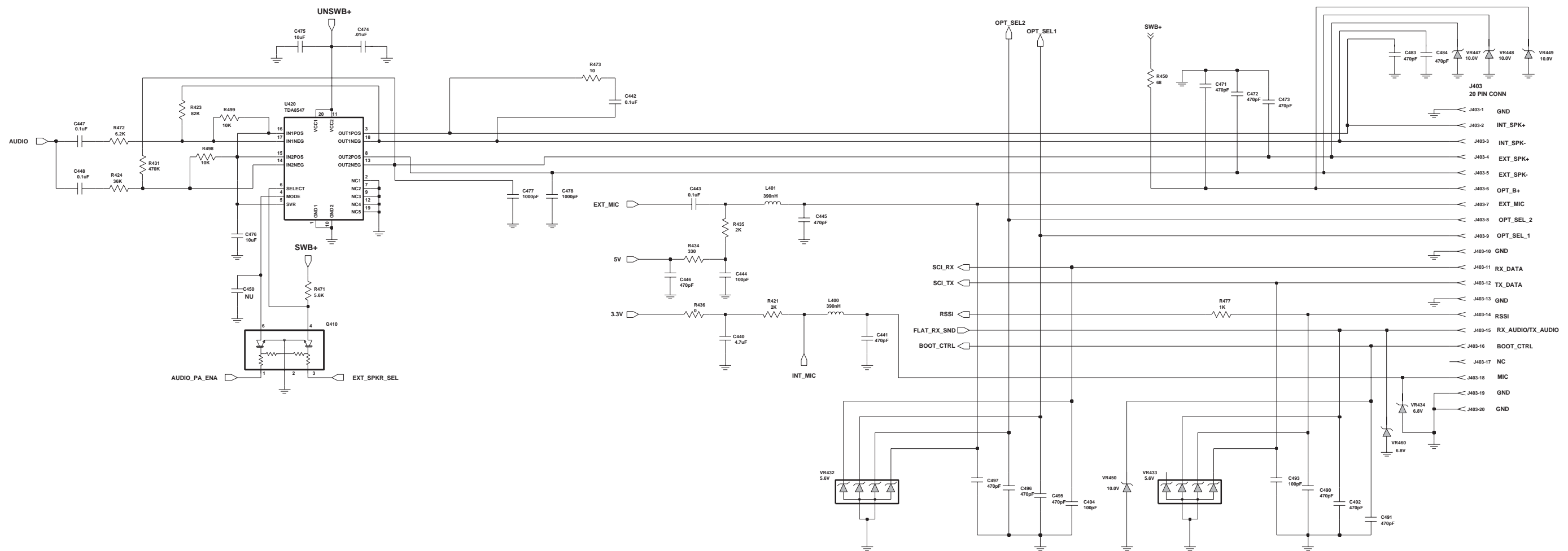


Figure 5-16. 200 MHz Audio Power Amplifier Schematic Diagram

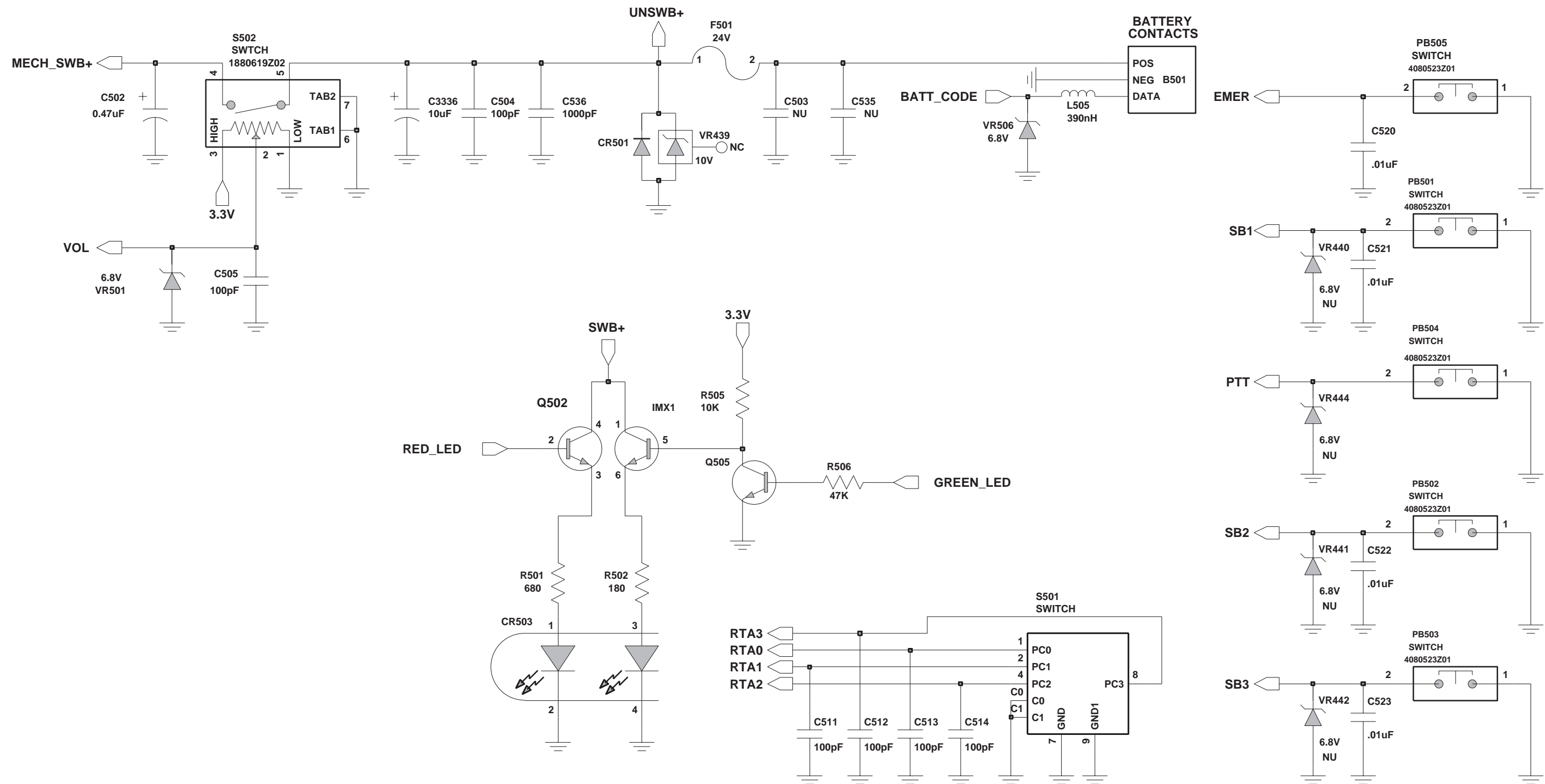


Figure 5-17. 200 MHz Control and Indicators Schematic Diagram

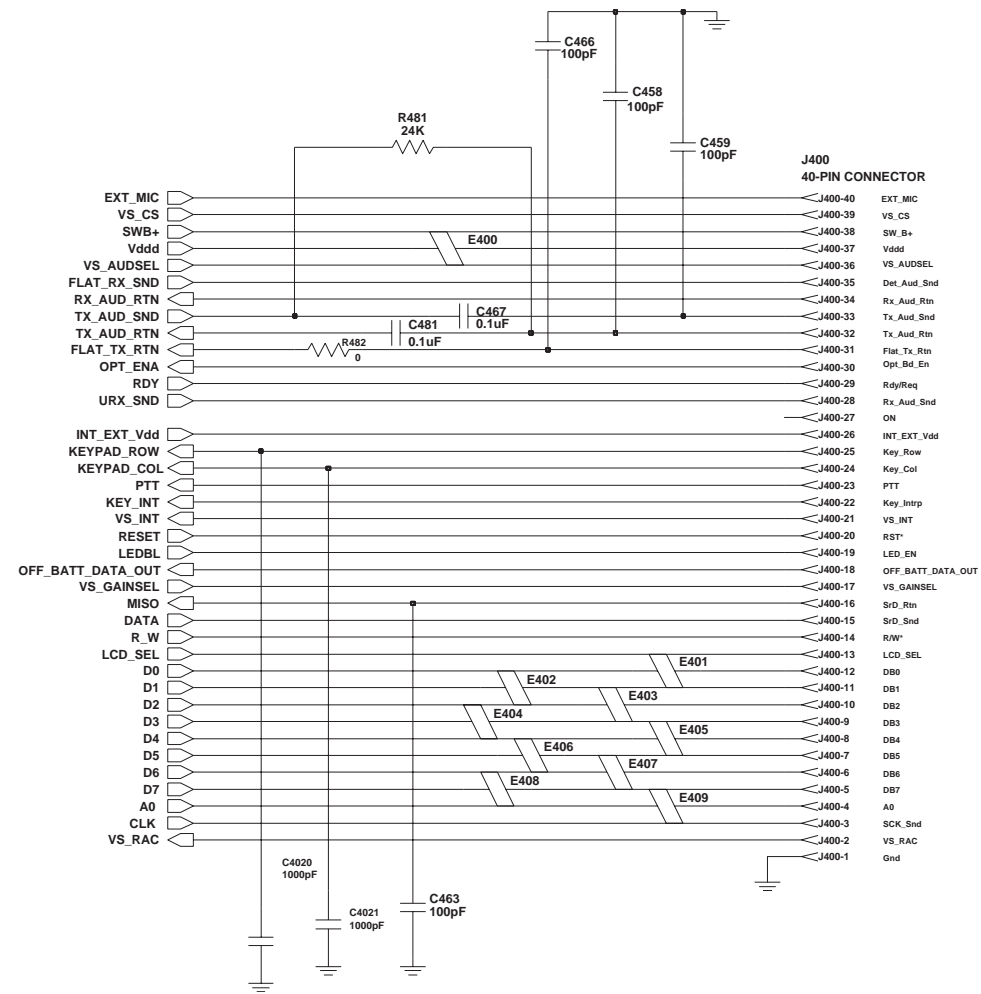


Figure 5-18. 200 MHz Keypad/PassPort Board Interface Schematic Diagram

## 200 MHz Radio Parts List (PCB 8486236Z06)

Circuit Ref	Motorola Part No.	Description
B501	0986237A02	Battery connector, 3-pin
B503	3980502Z01	Li-Ion battery contact
B504	3980501Z01	Li-Ion battery contact
C400	2113743L41	0.01 uF ±10%; 16 V
C401	2113743M24	0.1 uF +80/-20%; 16 V
C402	2113743M24	0.1 uF +80/-20%; 16 V
C403	2113743G24	2.2 uF +80/-20%; 16 V
C407	2113928N01	0.1 uF ±10%; 6.3 V
C408	2113743N50	100 pF
C409	2113743M24	0.1 uF +80/-20%; 16 V
C410	2113928N01	0.1 uF ±10%; 6.3 V
C411	2113743M24	0.1 uF +80/-20%; 16 V
C414	2113743M24	0.1 uF +80/-20%; 16 V
C415	2113743E20	0.1 uF ±10%; 16 V
C416	2113928N01	0.1 uF ±10%; 6.3 V
C419	2113743L41	0.01 uF ±10%; 16 V
C420	2113743L41	0.01 uF ±10%; 16 V
C421	2113928N01	0.1 uF ±10%; 6.3 V
C422	2113743M24	0.1 uF +80/-20%; 16 V
C423	2113743N50	100 pF
C424	2311049A59	10 uF ±10%; 6 V
C425	2113743M24	0.1 uF +80/-20%; 16 V
C426	2113743N50	100 pF
C427	2113743N50	100 pF
C428	2113743M24	0.1 uF +80/-20%; 16 V
C429	2113743M24	0.1 uF +80/-20%; 16 V
C431	2113743N50	100 pF
C432	---	not used
C433	2113743L41	0.01 uF ±10%; 16 V
C434	2113743M24	0.1 uF +80/-20%; 16 V
C435	2113743M24	0.1 uF +80/-20%; 16 V
C436	2113743N34	22 pF
C437	2113743N34	22 pF
C440	2113743G26	4.7 uF +80/-20%; 16 V
C441	2113743L09	470 pF
C442	2113743E20	0.1 uF ±10%; 16 V
C443	2113928N01	0.1 uF ±10%; 6.3 V
C444	2113743N50	100 pF
C445	2113743L09	470 pF
C446	2113743L09	470 pF
C447	2113928N01	0.1 uF ±10%; 6.3 V
C448	2113928N01	0.1 uF ±10%; 6.3 V
C449	2113743N50	100 pF
C450	---	not used
C451	2113743M08	0.022 uF +80/-20%; 16 V
C452	2113743B29	1 uF ±10%; 16 V
C453	2113743N50	100 pF
C456	2113743N50	100 pF
C458	2113743N50	100 pF

Circuit Ref	Motorola Part No.	Description
C459	2113743N50	100 pF
C463	2113743N50	100 pF
C466	2113743N50	100 pF
C467	2113928N01	0.1 uF ±10%; 6.3 V
C471	2113743L09	470 pF
C472	2113743L09	470 pF
C473	2113743L09	470 pF
C474	2113743L41	0.01 uF ±10%; 16 V
C475	2113743H14	10 uF +80/-20%; 16 V
C476	2113928D08	10 uF +80/-20%; 10 V
C477	2113743L17	1000 pF
C478	2113743L17	1000 pF
C479	2113928N01	0.1 uF ±10%; 6.3 V
C480	2113928D08	10 uF +80/-20%; 10 V
C481	2113928N01	0.1 uF ±10%; 6.3 V
C483	2113743L09	470 pF
C484	2113743L09	470 pF
C490	2113743L09	470 pF
C491	2113743L09	470 pF
C492	2113743L09	470 pF
C493	2113743N50	100 pF
C494	2113743N50	100 pF
C495	2113743L09	470 pF
C496	2113743L09	470 pF
C497	2113743L09	470 pF
C502	2311049A05	0.47 uF ±10%; 25 V
C503	---	not used
C504	2113743N50	100 pF
C505	2113743N50	100 pF
C511	2113743N50	100 pF
C512	2113743N50	100 pF
C513	2113743N50	100 pF
C514	2113743N50	100 pF
C520	2113743L41	0.01 uF ±10%; 16 V
C521	2113743L41	0.01 uF ±10%; 16 V
C522	2113743L41	0.01 uF ±10%; 16 V
C523	2113743L41	0.01 uF ±10%; 16 V
C535	---	not used
C536	2113743L17	1000 pF
C600	2113743N22	6.8 pF
C601	2113743N31	16 pF
C602	2113743L01	220 pF
C603	2113743L01	220 pF
C604	2113743M24	0.1 uF +80/-20%; 16 V
C605	2113743F16	1 uF +80/-20%; 16 V
C3200	2113743M24	0.1 uF +80/-20%; 16 V
C3201	---	not used
C3202	2113743M24	0.1 uF +80/-20%; 16 V
C3203	2113743E20	0.1 uF +10%; 16 V
C3204	2113743M24	0.1 uF +80/-20%; 16 V
C3205	2113743M24	0.1 uF +80/-20%; 16 V

Circuit Ref	Motorola Part No.	Description
C3206	2113743M24	0.1 uF +80/-20%; 16 V
C3207	2311049A57	10 uF ±10%; 16 V
C3208	2113743N53	130 pF
C3209	2113743N38	33 pF
C3210	---	not used
C3211	2113743N37	30 pF
C3212	---	not used
C3213	2113743M24	0.1 uF +80/-20%; 16 V
C3214	2113743M24	0.1 uF +80/-20%; 16 V
C3215	2113743M24	0.1 uF +80/-20%; 16 V
C3216	2113743L33	4700 pF
C3217	2113743M24	0.1 uF +80/-20%; 16 V
C3220	2113743M24	0.1 uF +80/-20%; 16 V
C3221	2113743M24	0.1 uF +80/-20%; 16 V
C3222	2113743N16	3.9 pF
C3224	2113743M24	0.1 uF +80/-20%; 16 V
C3225	2113743N12	2.7 pF
C3226	2113743N03	1 pF
C3230	2113743N28	12 pF
C3235	2311049A56	4.7 uF ±20%; 10 V
C3236	2113743N26	10 pF
C3237	2311049A07	1 uF ±10%; 16 V
C3281	2113743N35	24 pF
C3336	2311049A18	10 uF ±10%; 16 V
C3340	2109445U40	20 pF
C3341	2109445U36	13 pF
C3342	2109445U45	33 pF
C3343	2109445U28	4 pF
C3344	2109445U16	3.6 pF
C3345	2109445U44	30 pF
C3346	2109445U27	10 pF
C3347	2109445U22	6.2 pF
C3351	2113743L17	1000 pF
C3352	2109445U36	13 pF
C3353	2109445U35	12 pF
C3354	2109445U51	56 pF
C3355	2109445U33	9 pF
C3356	2109445U27	10 pF
C3357	2109445U51	56 pF
C3359	2109445U41	22 pF
C3361	2113743N48	82 pF
C3370	2113743L17	1000 pF
C3371	2113743L17	1000 pF
C3372	2113743L17	1000 pF
C3373	2109445U21	5.6 pF
C3374	2109445U23	6.8 pF
C3375	2109445U37	15 pF
C3376	2109445U45	33 pF
C3381	2109445U35	12 pF
C3501	2113743L05	330 pF
C3502	2113743N34	22 pF

Circuit Ref	Motorola Part No.	Description
C3503	2113743N34	22 pF
C3504	2113743M08	0.022 uF +80/-20%; 16 V
C3505	2113743L05	330 pF
C3508	2113743M08	0.022 uF +80/-20%; 16 V
C3509	2113743L05	330 pF
C3511	2113740F10	2 pF
C3512	2113740F36	24 pF
C3513	2113740F36	24 pF
C3514	2113740F48	75 pF
C3515	2113743L29	3300 pF
C3516	2311049A08	1 uF ±10%; 35 V
C3518	---	not used
C3519	---	not used
C3521	2111078B48	160 pF
C3523	2111078B38	68 pF
C3524	---	not used
C3525	---	not used
C3526	2113743M08	0.022 uF +80/-20%; 16 V
C3527	---	not used
C3528	2113740F34	20 pF
C3530	2113740F63	330 pF
C3531	2113740F30	13 pF
C3532	2113740F46	62 pF
C3533	---	not used
C3534	---	not used
C3535	2113740F37	27 pF
C3536	2113740F30	13 pF
C3541	2113743M08	0.022 uF +80/-20%; 16 V
C3542	2113743L05	330 pF
C3543	2113743M08	0.022 uF +80/-20%; 16 V
C3544	2113743L05	330 pF
C3546	2113743L05	330 pF
C3547	2113743M08	0.022 uF +80/-20%; 16 V
C3550	2113743N28	12 pF
C3559	---	not used
C3560	2311049A07	1 uF ±10%; 16 V
C3561	2113743M08	0.022 uF +80/-20%; 16 V
C3562	2113743L29	3300 pF
C3563	2113743L29	3300 pF
C3564	2113743L01	220 pF
C3565	2113743E07	0.022 uF ±10%; 16 V
C3566	2113743N50	100 pF
C3567	2113743L05	330 pF
C3568	2113743L29	3300 pF
C3569	2113743M08	0.022 uF +80/-20%; 16 V
C3570	2113743L05	330 pF
C3571	2113743L09	470 pF
C3701	2113743L41	0.01 uF ±10%; 16 V
C3702	2113743L41	0.01 uF ±10%; 16 V
C3703	2113743L41	0.01 uF ±10%; 16 V
C3704	2113743L41	0.01 uF ±10%; 16 V

Circuit Ref	Motorola Part No.	Description
C3705	2113743E20	0.1 uF ±10%; 16 V
C3706	2311049J11	4.7 uF ±10%; 16 V
C3707	2113743N34	22 pF
C3708	2113743M24	0.1 uF +80/-20%; 16 V
C3709	2113743M24	0.1 uF +80/-20%; 16 V
C3710	2104993J02	2.2 uF ±22%; 16 V
C3711	2311049A69	10 uF ±20%; 6.3 V
C3712	2113743M24	0.1 uF +80/-20%; 16 V
C3713	2311049A09	2.2 uF ±10%; 20 V
C3714	2311049J11	4.7 uF ±10%; 16 V
C3715	2113743L09	470 pF
C3722	---	not used
C3723	0804533C56	0.1 uF
C3724	2311049A08	1 uF ±10%; 35 V
C3725	---	not used
C3726	2113743N24	8.2 pF
C3727	2113743N50	100 pF
C3731	2113743L41	0.01 uF ±10%; 16 V
C3732	2113743L41	0.01 uF ±10%; 16 V
C3733	2104993J02	2.2 uF ±22%; 16 V
C3734	2113743L41	0.01 uF ±10%; 16 V
C3735	2113743L41	0.01 uF ±10%; 16 V
C3741	---	not used
C3742	2113743L01	220 pF
C3743	2113743L01	220 pF
C3744	2113743L01	220 pF
C3745	2113743L01	220 pF
C3746	2113743L01	220 pF
C3751	2113743M24	0.1 uF +80/-20%; 16 V
C3752	2113743L17	1000 pF
C3753	2311049A56	4.7 uF ±20%; 10 V
C3754	2113743M24	0.1 uF +80/-20%; 16 V
C3755	2104993J02	2.2 uF ±22%; 16 V
C3761	---	not used
C3762	---	not used
C3763	---	not used
C3808	2113743N30	15 pF
C3809	2113743N36	27 pF
C3810	---	not used
C3811	2113743M24	0.1 uF +80/-20%; 16 V
C3812	2113743M24	0.1 uF +80/-20%; 16 V
C3813	2113743L41	0.01 uF ±10%; 16 V
C3815	2113743L17	1000 pF
C3816	2113743N22	6.8 pF
C3818	2113743E07	0.022 uF ±10%; 16 V
C3821	---	not used
C3822	2113740A79	1000 pF
C3823	2113740A79	1000 pF
C3824	2113743N36	27 pF
C3825	2113743N30	15 pF
C3826	2113743N18	4.7 pF

Circuit Ref	Motorola Part No.	Description
C3827	---	not used
C3829	---	not used
C3830	2113743N28	12 pF
C3831	0804533C24	8200 pF
C3832	2113743L17	1000 pF
C3833	2113743N08	1.6 pF
C3834	2113743N36	27 pF
C3835	2113743N18	4.7 pF
C3836	2113743N30	15 pF
C3842	---	not used
C3843	0804533C13	1000 pF
C3848	2113743N23	7.5 pF
C3849	2113743L17	1000 pF
C3850	2113743L17	1000 pF
C3852	2113743L17	1000 pF
C3853	2109445U12	2.4 pF
C3870	2113743N30	15 pF
C4020	2113743L17	1000 pF
C4021	2113743L17	1000 pF
CR411	4802245J62	Schottky Diode
CR412	4802245J62	Schottky Diode
CR413	4802245J62	Schottky Diode
CR440	4813833C02	Dual Diode Common Cathode
CR501	4880107R01	Rectifier
CR503	4805729G49	LED Red/Yellow
CR3200	4880154K03	Dual Schottky Diode
CR3301	4886143B01	Quad Diode Mixer
CR3303	4880154 K03	Dual Schottky Diode
D3521	4880973Z02	Schottky Diode
D3551	4880973Z02	Schottky Diode
D3701	4802233J09	Triple Diode
D3702	4802233J09	Triple Diode
D3761	---	not used
D3821	4805649Q13	Dual Varactor
D3831	4805649Q13	Dual Varactor
D3832	4862824C01	Varactor
E400	2480640Z01	Ferrite Bead
E401	2480640Z01	Ferrite Bead
E402	2480640Z01	Ferrite Bead
E403	2480640Z01	Ferrite Bead
E404	2480640Z01	Ferrite Bead
E405	2480640Z01	Ferrite Bead
E406	2480640Z01	Ferrite Bead
E407	2480640Z01	Ferrite Bead
E408	2480640Z01	Ferrite Bead
E409	2480640Z01	Ferrite Bead
F501	6580542Z01	Fuse 3A
FL401	4870368G02	38.4 kHz Crystal
FL3201	9180022M10	44.85 MHz 4-Pole Crystal Filter
FL3204	9180468V04	6-Pole 455 kHz Ceramic Filter
FL3206	9180469V03	4-Pole 455 kHz Ceramic Filter

Circuit Ref	Motorola Part No.	Description
H3501	2680499Z01	Heatsink
J400	0905505Y04	40-Pin Connector
J403	0905505Y02	20-Pin Connector
J3501	2880658Z02	Antenna Connector, SMA type
L400	2462587Q42	390 nH
L401	2462587Q42	390 nH
L410	2462587Q42	390 nH
L411	2462587Q42	390 nH
L505	2462587Q42	390 nH
L3200	---	not used
L3202	2413923A25	1.2 uH
L3281	2462587Q43	470 nH
L3320	2413923C09	68 nH
L3321	2413923C09	68 nH
L3322	2413923C09	68 nH
L3323	2413923C09	68 nH
L3324	2413923C09	68 nH
L3325	2462587V36	150 nH
L3327	2413923C09	68 nH
L3328	2413923C09	68 nH
L3340	2462587N69	1.2 uH
L3341	2413923C09	68 nH
L3501	2413926H09	5.6 nH
L3503	2462587V32	68 nH
L3504	2462587N51	68 nH
L3511	2462587N42	12 nH
L3513	2409348J03	3.85 nH
L3515	2479990C03	13.85 nH
L3518	---	not used
L3519	2484657R01	Ferrite Bead
L3521	2460591A49	8.01 nH
L3522	2460591M20	18.05 nH
L3523	2462587N68	1 uH
L3531	2460591M71	35.17 nH
L3532	2460591M71	35.17 nH
L3551	2460591M71	35.17 nH
L3701	2462587Q42	390 nH
L3731	2462587Q20	2.2 uH
L3809	2462587V27	27 nH
L3811	2462587V34	100 nH
L3812	2413923B01	56 nH
L3813	2462587Q47	1 uH
L3816	2462587V34	100 nH
L3821	2409415M11	47 nH
L3822	2409415M06	18 nH
L3823	---	not used
L3824	2462587N68	1 uH
L3825	2409415M15	100 nH
L3826	2462587N68	1 uH
L3831	2462587N49	47 nH
L3832	---	not used

Circuit Ref	Motorola Part No.	Description
L3833	2462587N46	27 nH
L3834	2462587N68	1 uH
L3850	2413926H21	56 nH
L3870	2462587N53	100 nH
M100	7585651Z01	Contact
M101	7585651Z01	Contact
M300	7585651Z01	Contact
M301	7585651Z01	Contact
M400	7585651Z01	Contact
M401	7585651Z01	Contact
PB501	4080523Z01	Tactile pushbutton
PB502	4080523Z01	Tactile pushbutton
PB503	4080523Z01	Tactile pushbutton
PB504	4080523Z01	Tactile pushbutton
PB505	4080523Z01	Tactile pushbutton
Q400	4809579E18	MOSFET P-Chan TP0101T
Q403	4813824A17	MMBT3906 PNP
Q405	4802245J54	Dual NPN UMG5
Q410	4802245J54	Dual NPN UMG5
Q416	4809579E18	MOSFET P-Chan TP0101T
Q417	4809939C05	Dual NPN/PNP UMC5NTL
Q502	5180159R01	Dual NPN IMX1
Q505	4880214G02	MMBT3904 NPN
Q3200	4802197J95	PBR941 NPN
Q3211	4813824A10	MMBT3904 NPN
Q3302	4802245J95	PBR941 NPN
Q3303	4805723X02	Dual PNP UMT1
Q3501	4813828A09	MRF1517
Q3561	---	not used
Q3721	4809939C05	Dual NPN/PNP UMC5NTL
Q3802	4802245J95	Philips BFS540 NPN
R400	0662057N15	47 K
R401	0662057M01	0
R402	---	not used
R403	---	not used
R405	0662057M01	0
R406	0662057N20	75 K
R407	0662057N19	68 K
R408	---	not used
R409	0662057M98	10 K
R410	0662057N23	100 K
R411	0662057M98	10 K
R413	0662057M01	0
R414	0662057V34	180 K
R415	0662057V26	91 K
R416	0662057M98	10 K
R418	0662057M01	0
R419	0662057M67	510
R420	0662057B46	10MEG
R421	0662057M81	2 K
R423	0662057N21	82 K



Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
R424	0662057N12	36 K	R606	0662057N23	100 K	R3563	0662057N33	270 K	R3835	0662057N15	47 K
R425	0662057N10	30 K	R615	---	not used	R3564	0662057N35	330 K	R3836	0662057M98	10 K
R426	0662057N35	330 K	R616	0662057M01	0	R3565	---	not used	R3850	0662057M96	8.2 K
R427	0662057M84	2.7 K	R3135	0662057M76	1.2 K	R3566	0662057M01	0	R3852	0662057M54	150
R428	0662057M10	2.2	R3200	0662057M86	3.3 K	R3569	---	not used	R3854	0662057M73	910
R429	0662057M98	10 K	R3201	0662057M83	2.4 K	R3570	---	not used	R3855	0662057M90	4.7 K
R430	0662057M01	0	R3202	0662057M43	51	R3571	---	not used	RT400	0680590Z01	33.0 K @ 25°C
R431	0662057N39	470 K	R3203	---	not used	R3572	0662057A27	120	S501	4080710Z01	Frequency Switch
R432	0662057N16	51 K	R3205	0662057M01	0	R3573	0662057A27	120	S502	1880619Z02	Volume Potentiometer/On-Off Switch
R434	0662057M62	330	R3206	0662057N03	15 K	R3701	0662057M50	100	SH400	2680505Z01	Controller Memory Shield Bottom
R435	0662057M81	2 K	R3208	0662057V02	10 K	R3702	---	not used	SH401	2680506Z01	Controller On/Off Shield Bottom
R436	0662057M01	0	R3209	0662057V04	12 K	R3703	0662057M54	150	SH402	2680515Z01	Controller Microprocessor Shield Top
R437	---	not used	R3210	0662057M70	680	R3704	0662057M54	150	SH403	2680516Z01	Controller ASFIC/Audio PA Shield Top
R445	0662057N08	24 K	R3211	0662057N01	12 K	R3705	0662057N11	33 K	SH3202	2686081B02	Shield, IF Top
R447	0662057N51	1.5 MEG	R3215	0662057M80	1.8 K	R3720	0662057N23	100 K	SH3203	2686081B03	Shield, IF Bottom
R448	0662057M98	10 K	R3216	0662057M64	390	R3721	0662057M01	0	SH3301	2686081B01	Shield, FE Top
R449	0662057N08	24 K	R3220	0662057M80	1.8 K	R3722	0662057M74	1 K	SH3302	2680509Z01	Shield, Mixer Bottom
R450	0683962T45	68	R3221	0662057M62	330	R3723	0662057M50	100	SH3501	2686081B03	Shield, PA Harmonic Filter Bottom
R451	0662057N03	15 K	R3222	0662057N11	33 K	R3726	---	not used	SH3502	2686081B04	Shield, PA Bottom
R452	0662057N23	100 K	R3223	0662057M90	4.7 K	R3727	0662057N23	100 K	SH3701	2680511Z01	Shield, FracN Bottom
R453	---	not used	R3224	0662057N01	12 K	R3741	0662057M50	100	SH3702	2680511Z01	Shield, FracN Top
R454	---	not used	R3225	0662057M90	4.7 K	R3751	0662057N24	110 K	SH3801	2680513Z01	Shield, VCO Bottom
R455	---	not used	R3240	0662057M34	22	R3752	0662057N26	130 K	SH3802	2680514Z01	Shield, VCO Top
R456	0662057M01	0	R3318	0662057M66	470	R3760	0662057M01	0	T3301	2580541Z02	Mixer Balun
R457	0662057M98	10 K	R3330	0662057U61	240	R3761	0662057N27	150 K	T3302	2580541Z02	Mixer Balun
R460	0662057M90	4.7 K	R3331	0662057U97	6.8 K	R3762	---	not used	U400	5102463J40	3.3V Regulator
R461	0662057M56	180	R3332	0662057M43	51	R3763	0662057M50	100	U404	5185130C53	ASFIC Audio Filter IC
R462	0662057M98	10 K	R3333	0662057V11	22 K	R3799	0662057M01	0	U405	5102463J36	Static RAM 32Kx8 SRM2B256
R463	0662057M61	300	R3334	0662057M94	6.8 K	R3801	---	not used	U406	*5102463J59	Flash ROM 128Kx8 AT49HLV010
R471	0662057M92	5.6 K	R3335	0662057M73	910	R3802	0662057M01	0	U407	*5102463J64	Serial EEPROM 16Kx8 X25128-2.7
R472	0662057M93	6.2 K	R3336	0662057M92	5.6 K	R3803	---	not used	U409	5102226J56	Microcontroller
R473	0662057M26	10	R3500	---	not used	R3804	0662057M01	0	U410	5102463J57	3.3V Regulator
R475	0662057M01	0	R3501	0662057M61	300	R3810	0662057M67	510	U420	5102463J44	Audio PA
R476	0662057N08	24 K	R3502	0662057M32	18	R3811	0662057M50	100	U2000	5180932W01	LM2904 Dual Opamp
R477	0662057M74	1 K	R3503	0662057M61	300	R3812	---	not used	U3101	5186144B01	SA616 IFIC
R478	0662057M98	10 K	R3505	0662057M62	330	R3816	0662057M74	1 K	U3201	5102463J58	3.3V Regulator
R481	0662057N08	24 K	R3512	---	not used	R3817	0662057M01	0	U3501	5185130C65	LDMOS Power Amplifier
R482	0662057M01	0	R3513	---	not used	R3818	---	not used	U3502	5185765B26	Power Control IC
R492	0662057M01	0	R3519	0680539Z01	0.1	R3821	0662057M58	220	U3503	5185963A15	Temperature Sensor
R498	0662057M98	10 K	R3540	0662057A01	10	R3822	0662057M42	47	U3701	5185963A27	Low Voltage FracN
R499	0662057M98	10 K	R3541	---	not used	R3823	0662057N11	33 K	U3711	5105739X05	5V Regulator
R501	0662057M70	680	R3542	0662057M92	5.6 K	R3824	0662057N07	22 K	U3801	5105750U54	VCO Buffer IC
R502	0662057M56	180	R3543	0662057M50	100	R3825	0662057M38	33	VR432	4805656W08	5.6V Zener
R505	0662057M98	10 K	R3544	0662057A25	100	R3826	0662057M32	18			
R506	0662057N15	47 K	R3545	0662057A25	100	R3828	0662057M87	3.6 K			
R600	---	not used	R3546	0662057N11	33 K	R3829	0662057M01	0			
R601	0662057N31	220 K	R3547	0662057N01	12 K	R3830	---	not used			
R602	0662057N23	100 K	R3548	0662057M95	7.5 K	R3831	0662057M98	10 K			
R603	0662057N23	100 K	R3551	0662057M01	0	R3832	0662057N01	12 K			
R604	---	not used	R3561	0662057N01	12 K	R3833	0662057M58	220			
R605	0662057N23	100 K	R3562	0662057N11	33 K	R3834	0662057M42	47			

<b>Circuit Ref</b>	<b>Motorola Part No.</b>	<b>Description</b>
VR433	4805656W08	5.6V Zener
VR434	4802245J73	6.8V Zener
VR439	4880140L17	12V Zener
VR440	4802245J73	6.8V Zener
VR441	4802245J73	6.8V Zener
VR442	4802245J73	6.8V Zener
VR444	4802245J73	6.8V Zener
VR447	4802245J74	10V Zener
VR448	4802245J74	10V Zener
VR449	4802245J74	10V Zener
VR450	4802245J74	10V Zener
VR460	4802245J73	6.8V Zener
VR501	4802245J73	6.8V Zener
VR506	4802245J73	6.8V Zener
VR3501	4880140L15	10V Zener
VR3502	4809788E06	6.8V Zener
Y3102	9186145B02	455 KHz Discriminator
Y3200	4880606B09	44.395 MHz Crystal
Y3761	---	not used
Y3762	4802245J68	16.8 MHz Reference Oscillator

\* Motorola Depot Servicing only

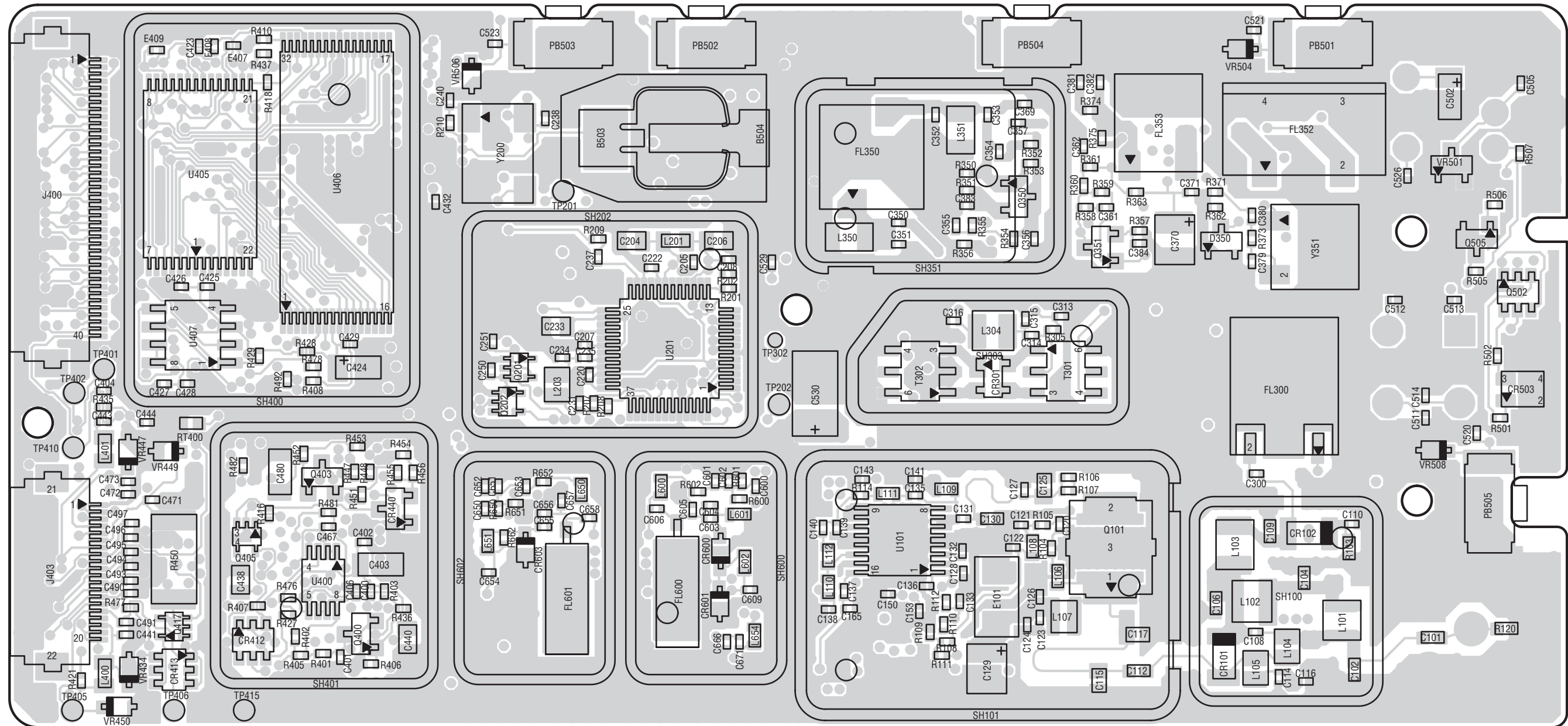


Figure 5-19. 700 MHz Main Board Bottom Side PCB 8486220Z07



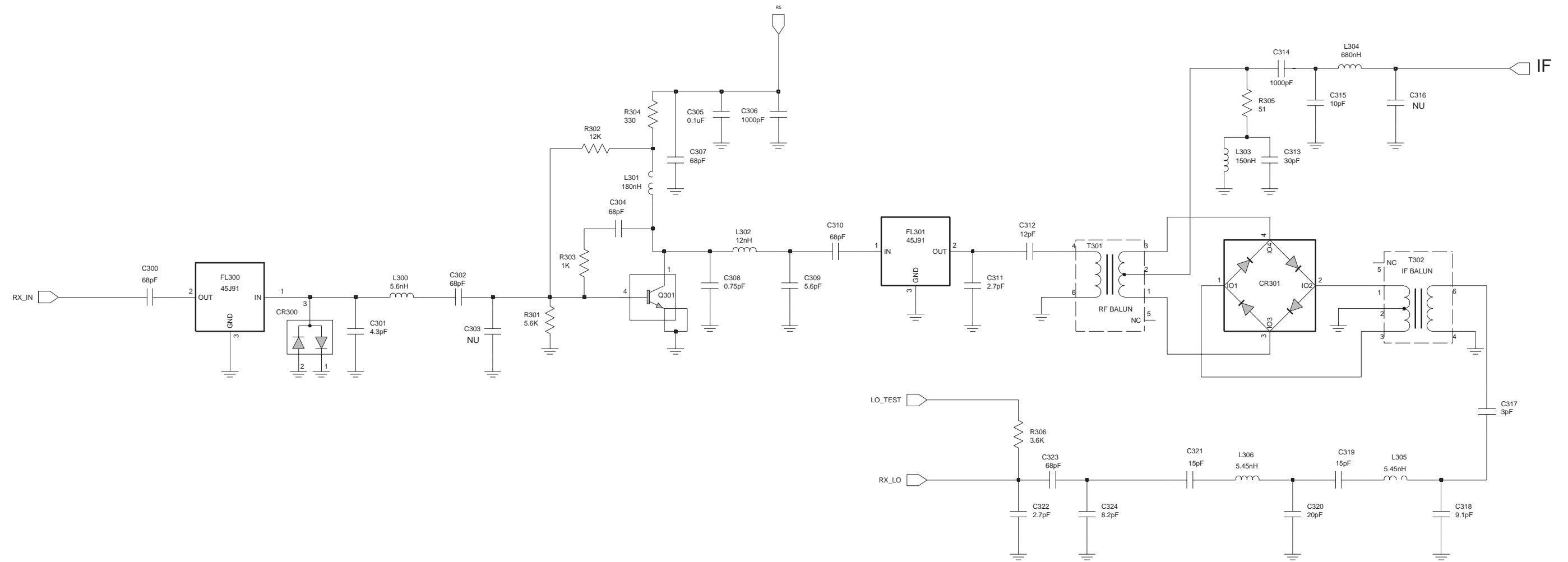


Figure 5-21. 700 MHz Receiver Front End Schematic Diagram

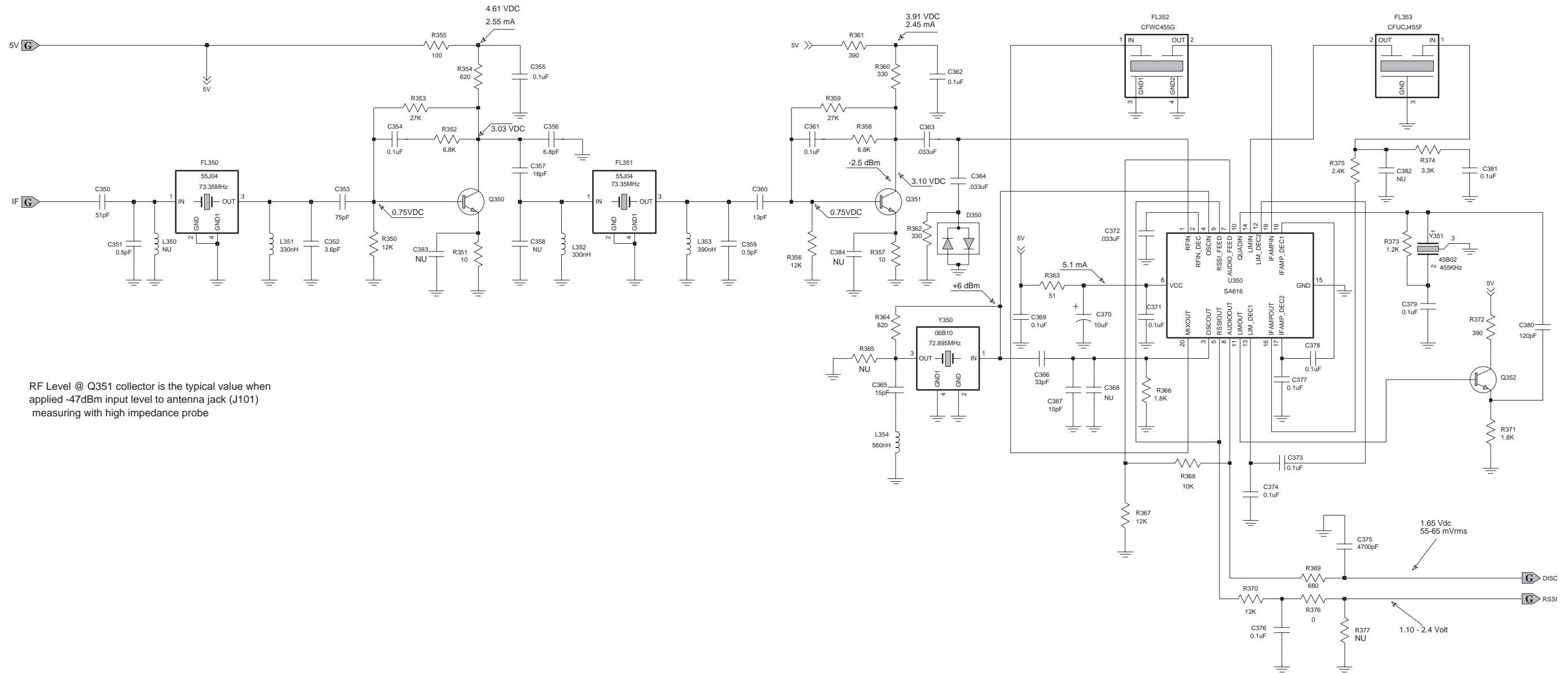


Figure 5-22. 700 MHz Receiver I-F Schematic Diagram

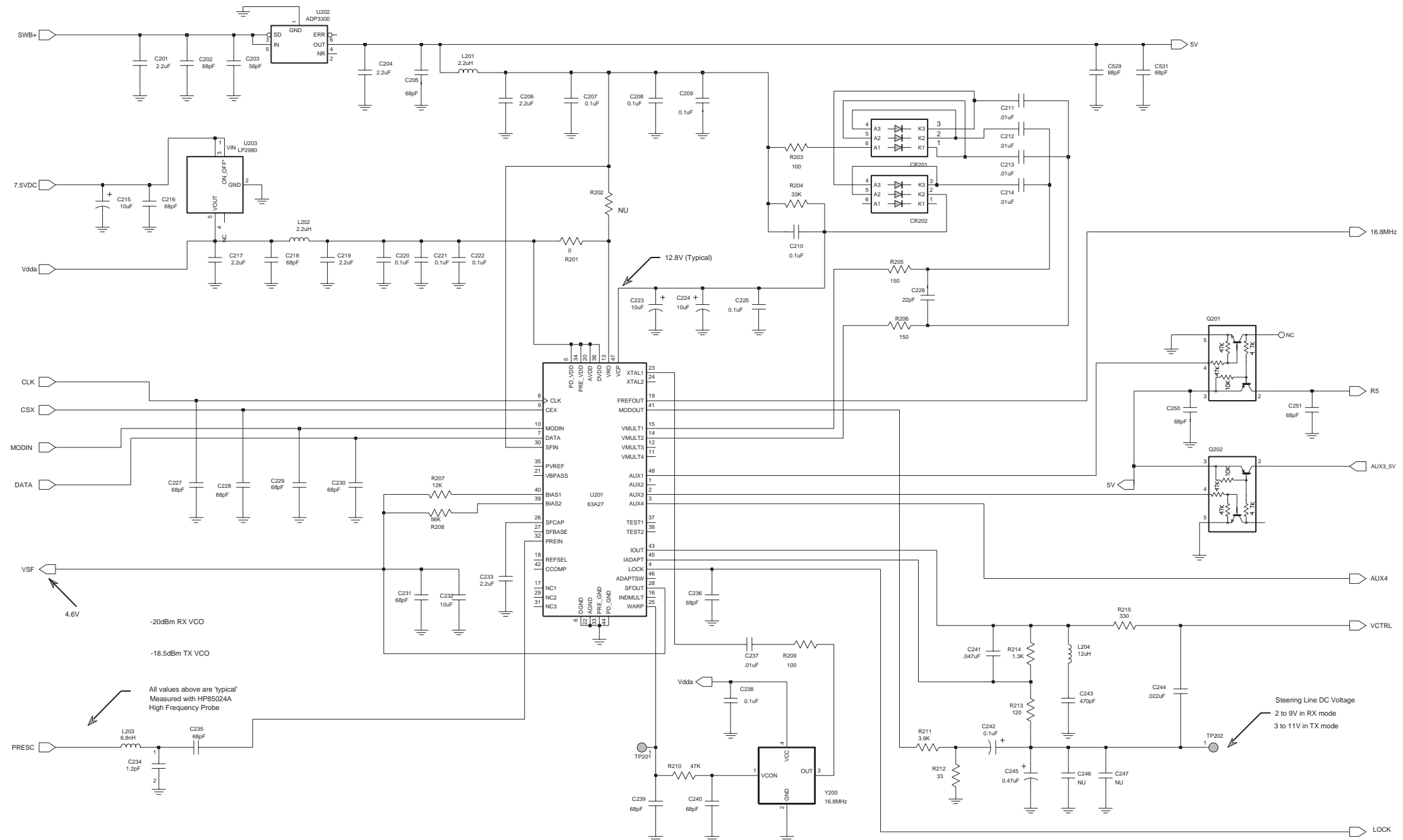


Figure 5-23. 700 MHz Frequency Synthesizer Schematic Diagram

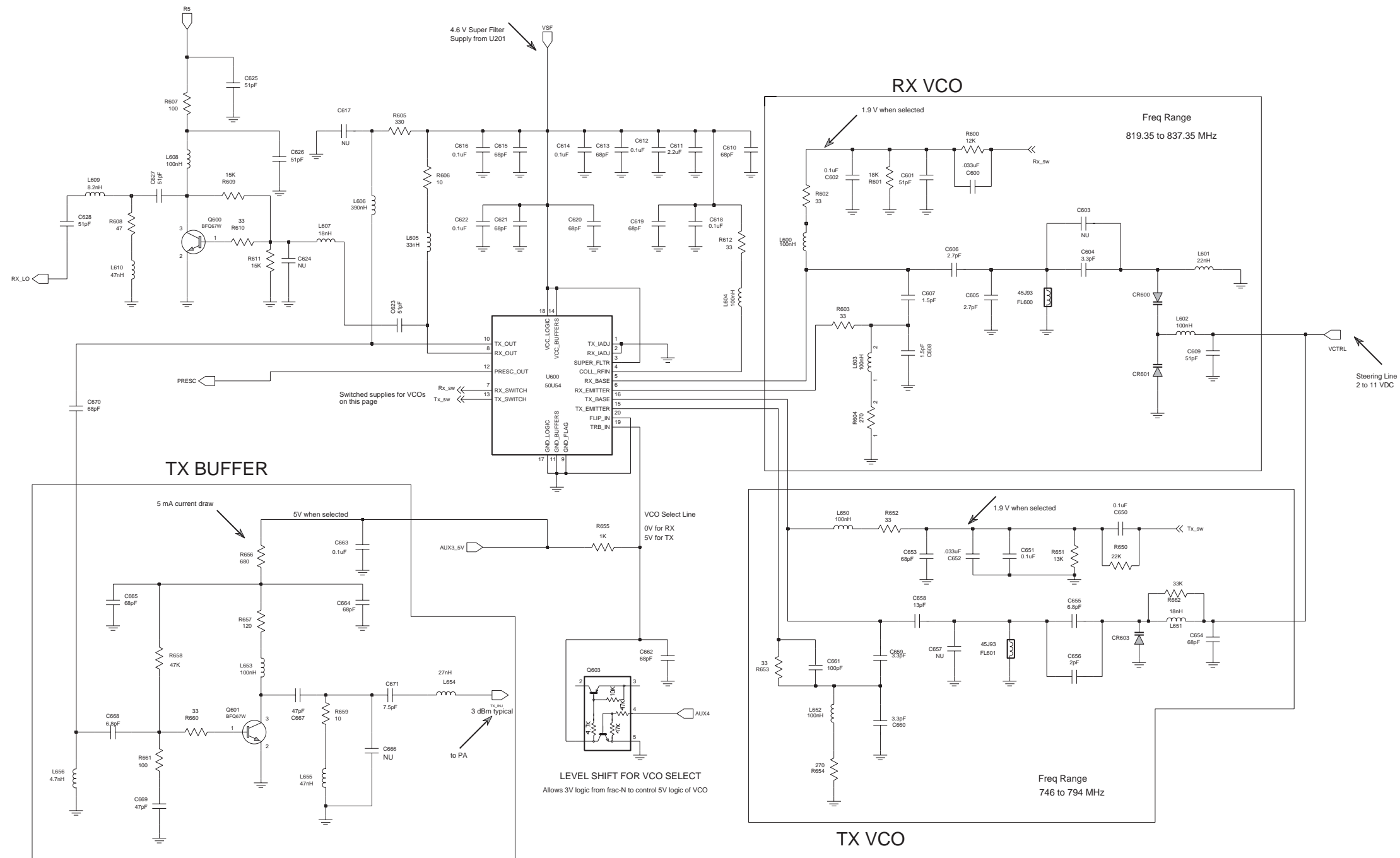


Figure 5-24. 700 MHz Voltage Controlled Oscillator Schematic Diagram



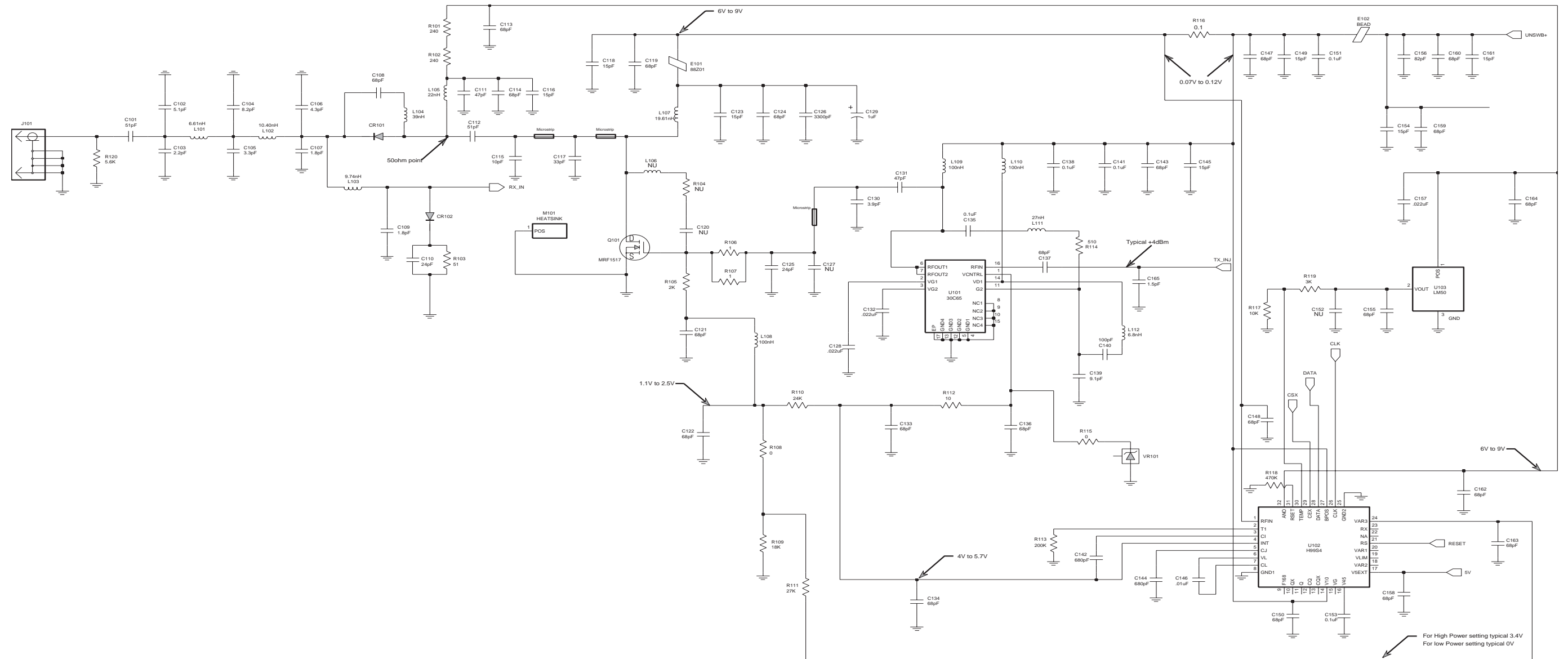


Figure 5-25. 700 MHz Transmitter and Power Control Schematic Diagram

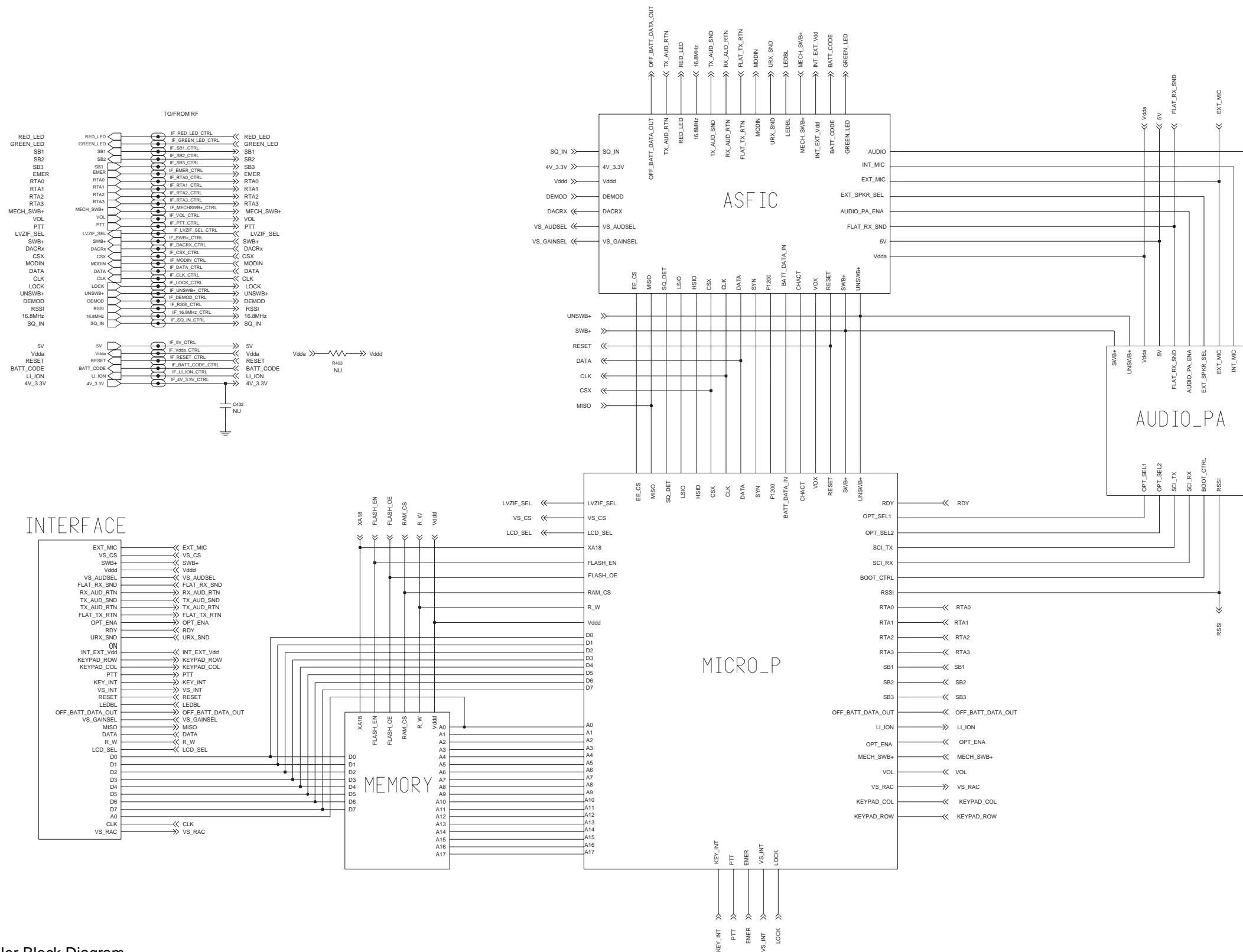


Figure 5-26. 700 MHz Controller Block Diagram

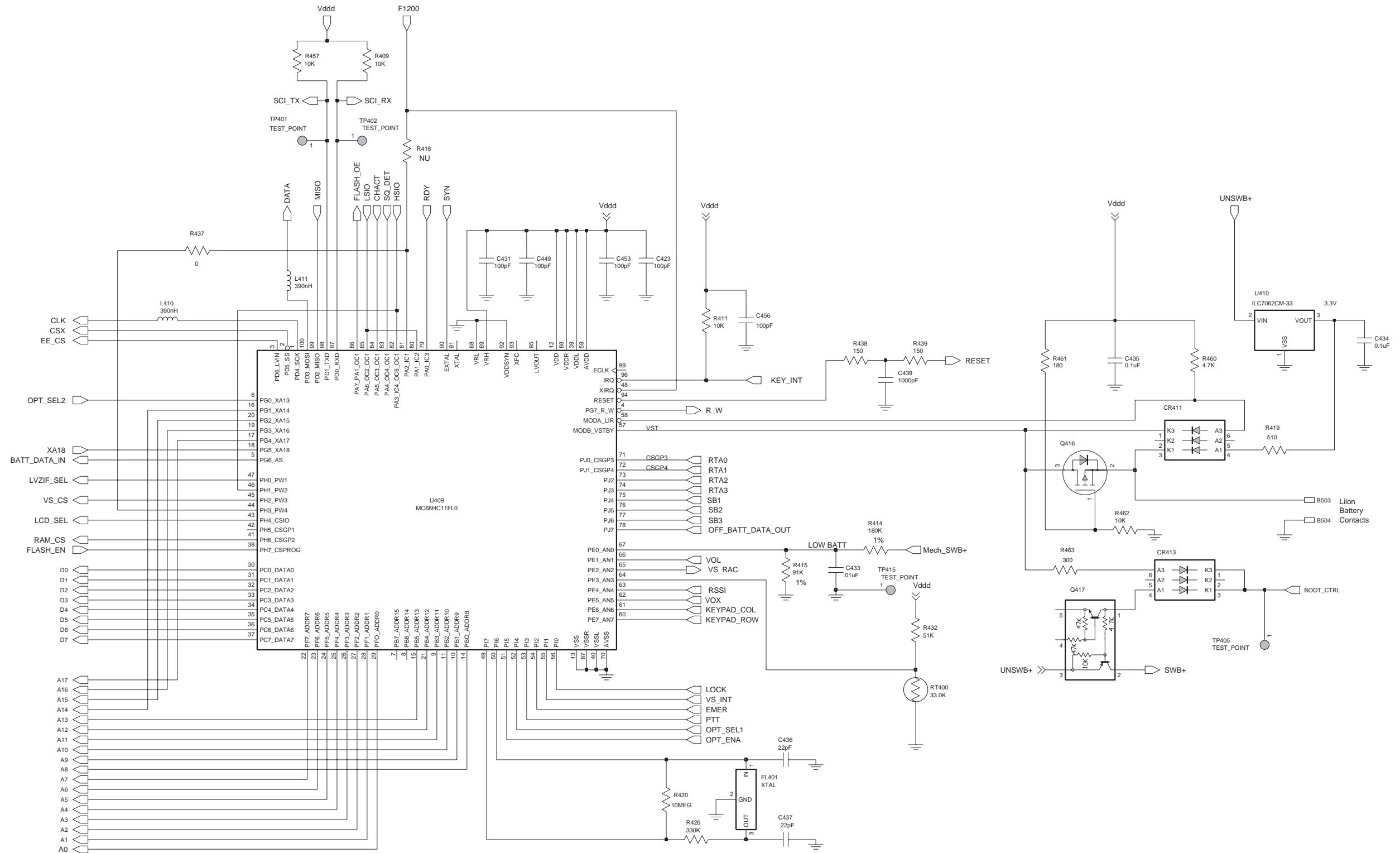


Figure 5-27. 700 MHz Microprocessor Schematic Diagram

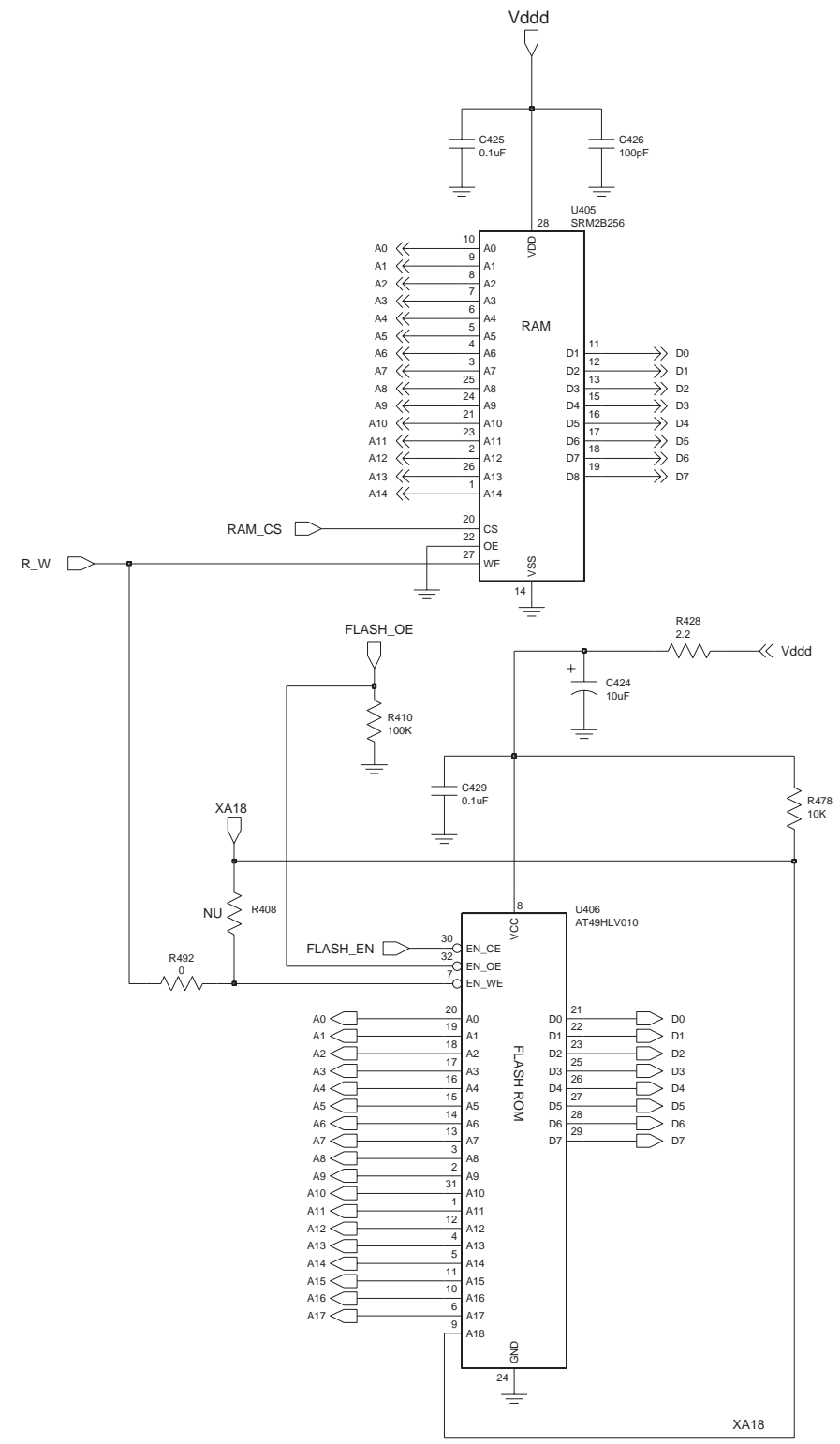


Figure 5-28. 700 MHz Memory Schematic Diagram

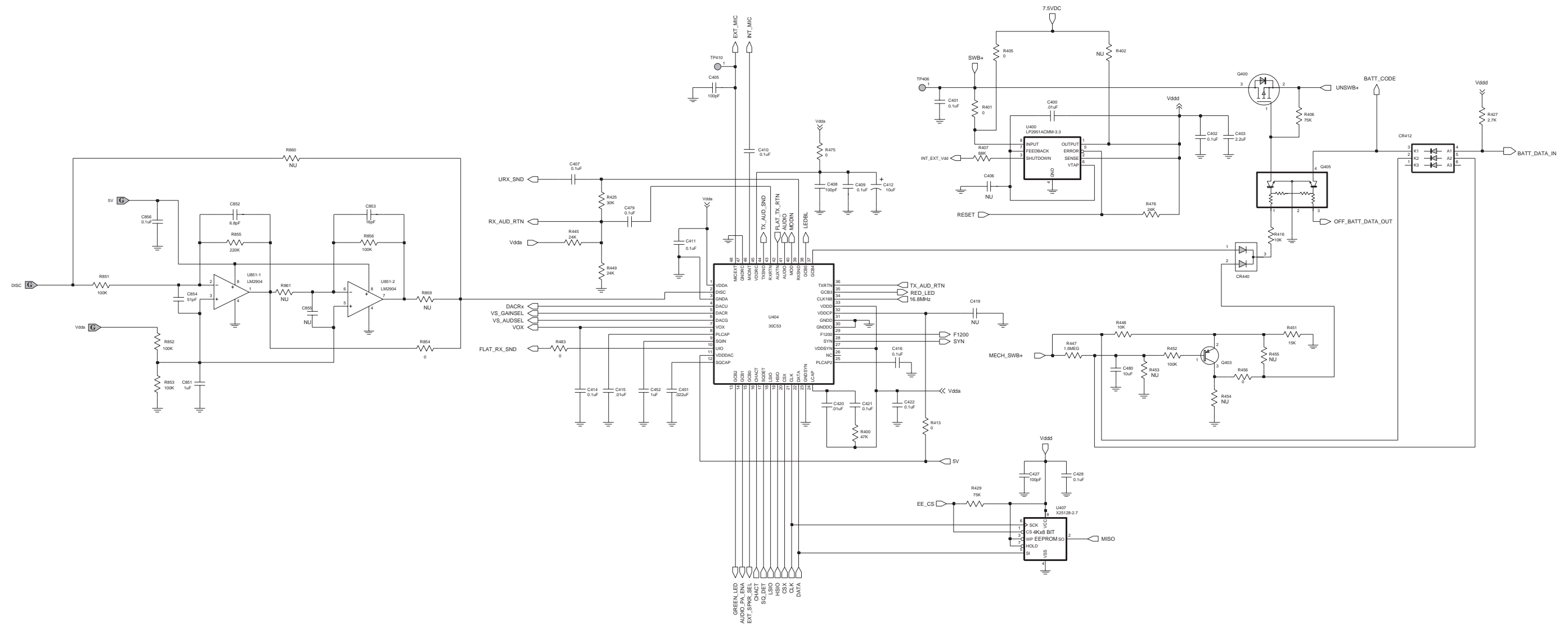


Figure 5-29. 700 MHz ASFIC Schematic Diagram

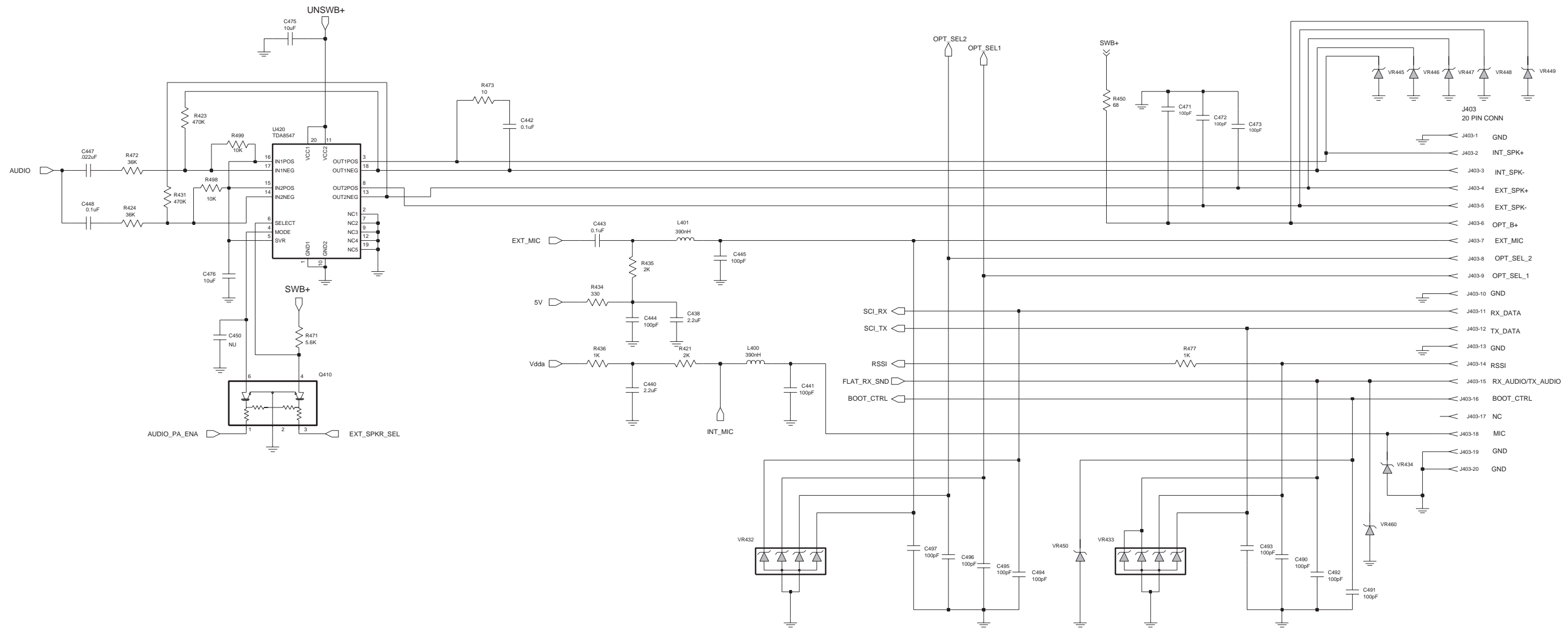


Figure 5-30. 700 MHz Audio Power Amplifier Schematic Diagram

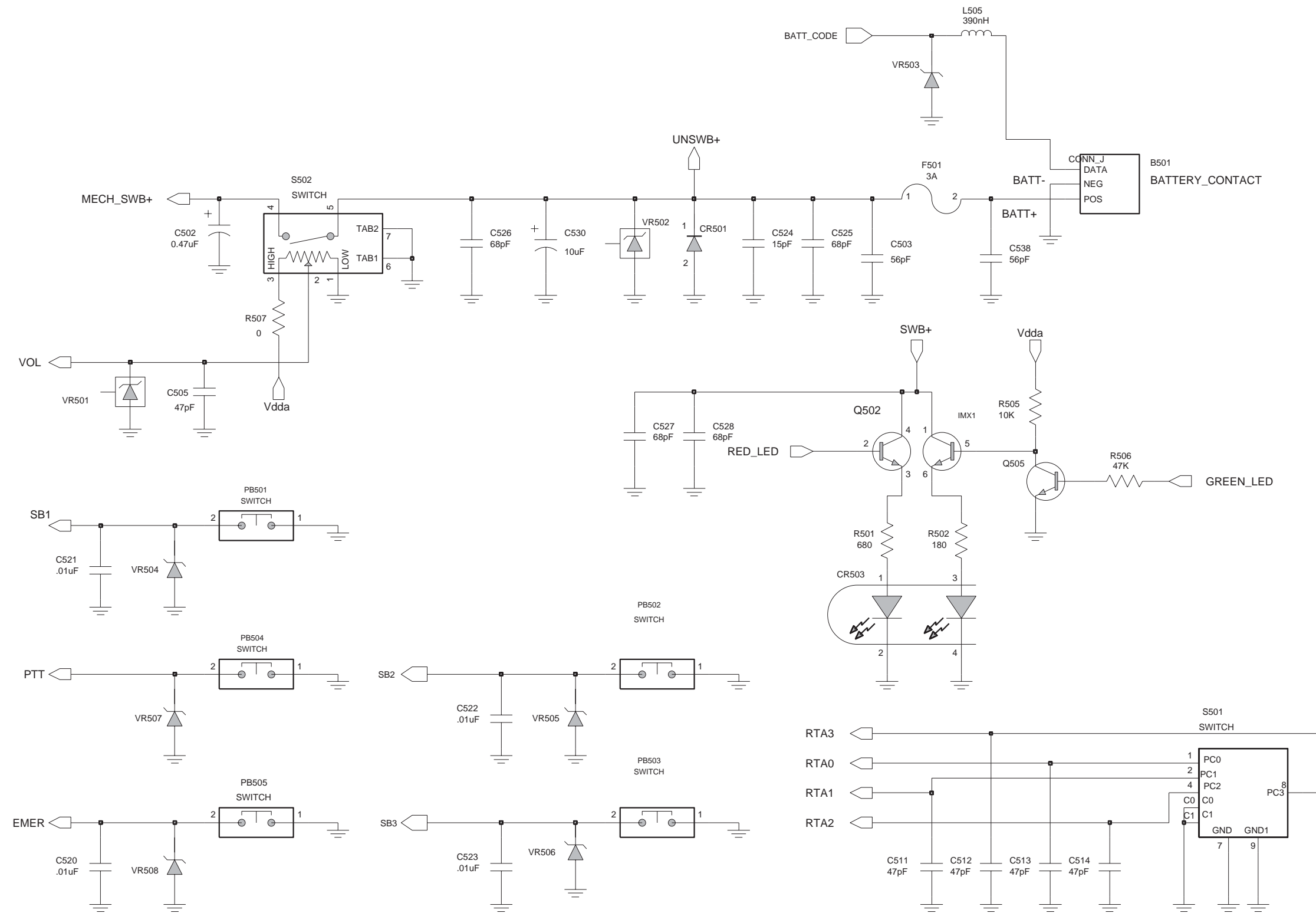


Figure 5-31. 700 MHz Controls and Indicators Schematic Diagram

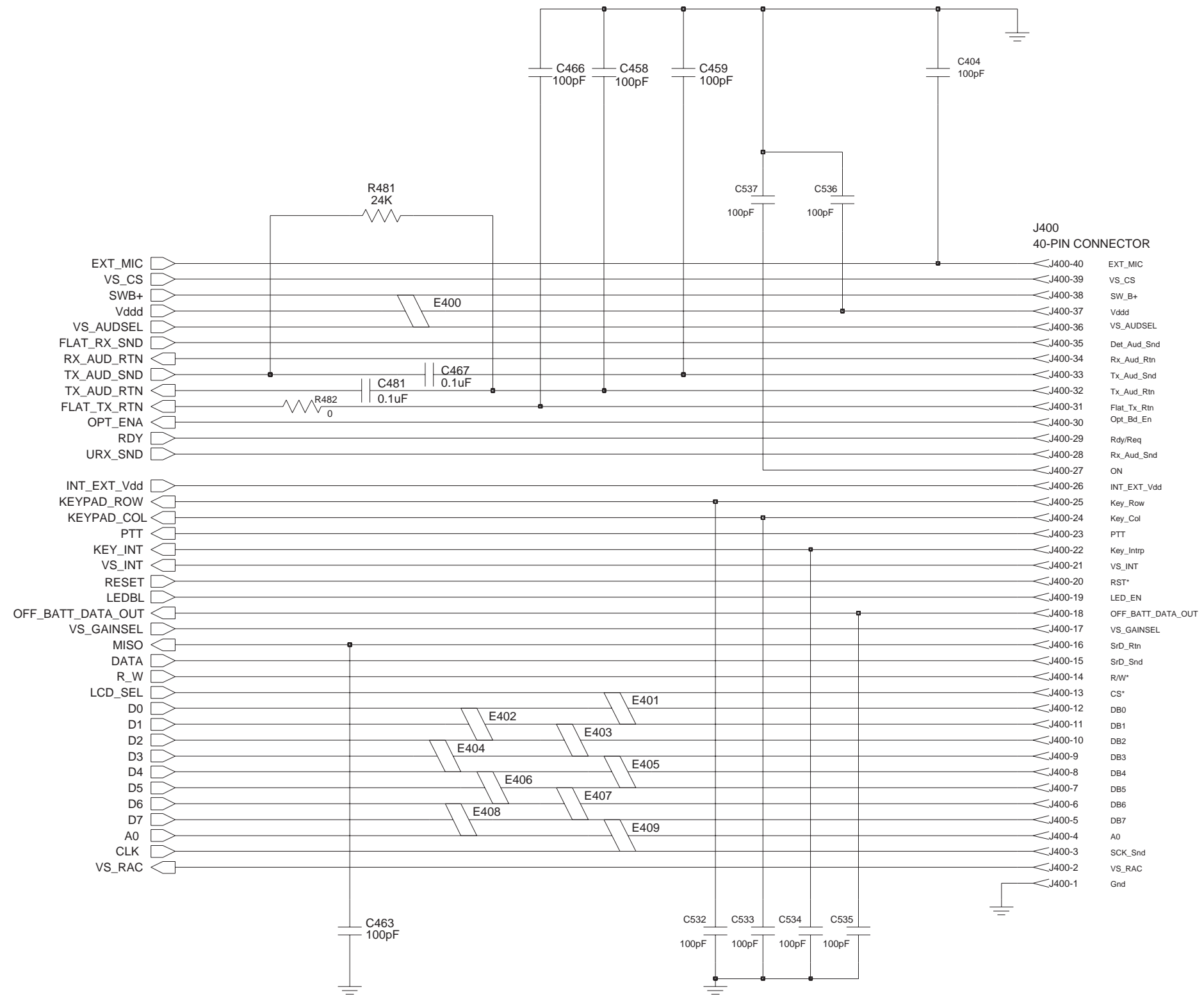


Figure 5-32. 700 MHz Keypad/PassPort Board Interface Schematic Diagram



## 700 MHz Radio Parts List (PCB 8486220Z07)

Circuit Ref	Motorola Part No.	Description
B501	0986237A02	Connector, battery, 3-pin
B503	3980502Z01	Contact, Li-Ion battery
B504	3980501Z01	Contact, Li-Ion battery
C101	2113740F44	51 pF
C102	2113740L11	5.1 pF
C103	2113740L02	2.2 pF
C104	2113740L16	8.2 pF
C105	2113740L06	3.3 pF
C106	2113740F18	4.3 pF
C107	2113740F09	1.8 pF
C108	2113743N46	68 pF
C109	2113740F09	1.8 pF
C110	2113743N35	24 pF
C111	2113743N42	47 pF
C112	2113740F44	51 pF
C113	2113743N46	68 pF
C114	2113743N46	68 pF
C115	2103689A21	10 pF
C116	2113743N30	15 pF
C117	2103689A50	33 pF
C118	2113743N30	15 pF
C119	2113743N46	68 pF
C120	---	not used
C121	2113743N46	68 pF
C122	2113743N46	68 pF
C123	2113743N30	15 pF
C124	2113743N46	68 pF
C125	2103689A47	24 pF
C126	2113743L29	3300 pF
C127	---	not used
C128	2113743M08	0.022 uF +80/-20%; 16 V
C129	2311049A08	1 uF ±10%; 35 V
C130	2113740F17	3.9 pF
C131	2113743N42	47 pF
C132	2113743M08	0.022 uF +80/-20%; 16 V
C133	2113743N46	68 pF
C134	2113743N46	68 pF
C135	2113743M24	0.1 uF +80/-20%; 16 V
C136	2113743N46	68 pF
C137	2113743N46	68 pF
C138	2113743M24	0.1 uF +80/-20%; 16 V
C139	2113743N25	9.1 pF
C140	2113743N50	100 pF
C141	2113743M24	0.1 uF +80/-20%; 16 V
C142	2113743L13	680 pF
C143	2113743N46	68 pF
C144	2113743L13	680 pF
C145	2113743N30	15 pF
C146	2113743L41	0.01 uF ±10%; 16 V

Circuit Ref	Motorola Part No.	Description
C147	2113743N46	68 pF
C148	2113743N46	68 pF
C149	2113743N30	15 pF
C150	2113743N46	68 pF
C151	2113743M24	0.1 uF +80/-20%; 16 V
C152	---	not used
C153	2113743M24	0.1 uF +80/-20%; 16 V
C154	2113743N30	15 pF
C155	2113743N46	68 pF
C156	2113743N48	82 pF
C157	2113743M08	0.022 uF +80/-20%; 16 V
C158	2113743N46	68 pF
C159	2113743N46	68 pF
C160	2113743N46	68 pF
C161	2113743N30	15 pF
C162	2113743N46	68 pF
C163	2113743N46	68 pF
C164	2113743N46	68 pF
C165	2113743N07	1.5 pF
C201	2113743F18	2.2 uF +80/-20%; 16 V
C202	2113743N46	68 pF
C203	2113743N44	56 pF
C204	2113743F18	2.2 uF +80/-20%; 16 V
C205	2113743N46	68 pF
C206	2113743F18	2.2 uF +80/-20%; 16 V
C207	2113743M24	0.1 uF +80/-20%; 16 V
C208	2113743M24	0.1 uF +80/-20%; 16 V
C209	2113743M24	0.1 uF +80/-20%; 16 V
C210	2113743M24	0.1 uF +80/-20%; 16 V
C211	2113743L41	0.01 uF ±10%; 16 V
C212	2113743L41	0.01 uF ±10%; 16 V
C213	2113743L41	0.01 uF ±10%; 16 V
C214	2113743L41	0.01 uF ±10%; 16 V
C215	2311049A57	10 uF ±10%; 16 V
C216	2113743N46	68 pF
C217	2113743F18	2.2 uF +80/-20%; 16 V
C218	2113743N46	68 pF
C219	2113743F18	2.2 uF +80/-20%; 16 V
C220	2113743M24	0.1 uF +80/-20%; 16 V
C221	2113743M24	0.1 uF +80/-20%; 16 V
C222	2113743M24	0.1 uF +80/-20%; 16 V
C223	2311049A57	10 uF ±10%; 16 V
C224	2311049A57	10 uF ±10%; 16 V
C225	2113743M24	0.1 uF +80/-20%; 16 V
C226	2113743N34	22 pF
C227	2113743N46	68 pF
C228	2113743N46	68 pF
C229	2113743N46	68 pF
C230	2113743N46	68 pF
C231	2113743N46	68 pF
C232	2113743T19	10 uF ±10%; 16 V

Circuit Ref	Motorola Part No.	Description
C233	2113743F18	2.2 uF +80/-20%; 16 V
C234	2113743N05	1.2 pF
C235	2113743N46	68 pF
C236	2113743N46	68 pF
C237	2113743L41	0.01 uF ±10%; 16 V
C238	2113743M24	0.1 uF +80/-20%; 16 V
C239	2113743N46	68 pF
C240	2113743N46	68 pF
C241	2113743E12	0.047 uF ±10%; 16 V
C242	2311049A01	0.1 uF ±10%; 35 V
C243	2113741F17	470 pF
C244	2113743E07	0.022 uF ±10%; 16 V
C245	2311049A05	0.47 uF ±10%; 25 V
C246	---	not used
C247	---	not used
C250	2113743N46	68 pF
C251	2113743N46	68 pF
C300	2113743N46	68 pF
C301	2109445U18	4.3 pF
C302	2113743N46	68 pF
C303	---	not used
C304	2113743N46	68 pF
C305	2113743M24	0.1 uF +80/-20%; 16 V
C306	2113743L17	1000 pF
C307	2113743N46	68 pF
C308	2109445U02	0.75 pF
C309	2109445U21	5.6 pF
C310	2113743N46	68 pF
C311	2113743N12	2.7 pF
C312	2113743N28	12 pF
C313	2113743N37	30 pF
C314	2113743L17	1000 pF
C315	2113743N26	10 pF
C316	---	not used
C317	2109445U14	3.0 pF
C318	2109445U26	9.1 pF
C319	2109445U37	15 pF
C320	2109445U40	20 pF
C321	2109445U37	15 pF
C322	2113743N12	2.7 pF
C323	2113743N46	68 pF
C324	2109445U25	8.2 pF
C350	2113743N43	51 pF
C351	2113743N01	0.5 pF
C352	2113743N15	3.6 pF
C353	2113743N47	75 pF
C354	2113743M24	0.1 uF +80/-20%; 16 V
C355	2113743M24	0.1 uF +80/-20%; 16 V
C356	2113743N22	6.8 pF
C357	2113743N31	16 pF
C358	---	not used

Circuit Ref	Motorola Part No.	Description
C359	2113743N01	0.5 pF
C360	2113743N29	13 pF
C361	2113743M24	0.1 uF +80/-20%; 16 V
C362	2113743M24	0.1 uF +80/-20%; 16 V
C363	2113743L50	0.033 uF ±10%; 16 V
C364	2113743L50	0.033 uF ±10%; 16 V
C365	2113743N30	15 pF
C366	2113743N38	33 pF
C367	2113743N30	15 pF
C368	---	not used
C369	2113928N01	0.1 uF ±10%; 6.3 V
C370	2311049A57	10 uF ±10%; 16 V
C371	2113928N01	0.1 uF ±10%; 6.3 V
C372	2113743L50	0.033 uF ±10%; 16 V
C373	2113928N01	0.1 uF ±10%; 6.3 V
C374	2113928N01	0.1 uF ±10%; 6.3 V
C375	2113743R33	4700 pF ±5%; 16 V
C376	2113928N01	0.1 uF ±10%; 6.3 V
C377	2113928N01	0.1 uF ±10%; 6.3 V
C378	2113928N01	0.1 uF ±10%; 6.3 V
C379	2113928N01	0.1 uF ±10%; 6.3 V
C380	2113743N52	120 pF
C381	2113928N01	0.1 uF ±10%; 6.3 V
C382	---	not used
C383	---	not used
C384	---	not used
C400	2113743L41	0.01 uF ±10%; 16 V
C401	2113743M24	0.1 uF +80/-20%; 16 V
C402	2113743M24	0.1 uF +80/-20%; 16 V
C403	2113743G24	2.2 uF +80/-20%; 16 V
C404	2113743N50	100 pF
C405	2113743N50	100 pF
C406	---	not used
C407	2113928N01	0.1 uF ±10%; 6.3 V
C408	2113743N50	100 pF
C409	2113743M24	0.1 uF +80/-20%; 16 V
C410	2113928N01	0.1 uF ±10%; 6.3 V
C411	2113743M24	0.1 uF +80/-20%; 16 V
C412	2311049A59	10 uF ±10%; 6 V
C414	2113743M24	0.1 uF +80/-20%; 16 V
C415	2109720D01	0.01 uF ±10%; 16 V
C416	2113928N01	0.1 uF ±10%; 6.3 V
C419	---	not used
C420	2113743L41	0.01 uF ±10%; 16 V
C421	2113928N01	0.1 uF ±10%; 6.3 V
C422	2113743M24	0.1 uF +80/-20%; 16 V
C423	2113743N50	100 pF
C424	2311049A59	10 uF ±10%; 6 V
C425	2113743M24	0.1 uF +80/-20%; 16 V
C426	2113743N50	100 pF
C427	2113743N50	100 pF

Circuit Ref	Motorola Part No.	Description
C428	2113743M24	0.1 uF +80/-20%; 16 V
C429	2113743M24	0.1 uF +80/-20%; 16 V
C431	2113743N50	100 pF
C432	---	not used
C433	2113743L41	0.01 uF $\pm$ 10%; 16 V
C434	2113928N01	0.1 uF $\pm$ 10%; 6.3 V
C435	2113743M24	0.1 uF +80/-20%; 16 V
C436	2113743N34	22 pF
C437	2113743N34	22 pF
C438	2113743F18	2.2 uF +80/-20%; 16 V
C439	2113743L17	1000 pF
C440	2113743F18	2.2 uF +80/-20%; 16 V
C441	2113743N50	100 pF
C442	2113743E20	0.1 uF $\pm$ 10%; 16 V
C443	2113928N01	0.1 uF $\pm$ 10%; 6.3 V
C444	2113743N50	100 pF
C445	2113743N50	100 pF
C447	2113743M08	0.022 uF +80/-20%; 16 V
C448	2113928N01	0.1 uF $\pm$ 10%; 6.3 V
C449	2113743N50	100 pF
C450	---	not used
C451	2113743M08	0.022 uF +80/-20%; 16 V
C452	2113743B29	1 uF $\pm$ 10%; 16 V
C453	2113743N50	100 pF
C456	2113743N50	100 pF
C458	2113743N50	100 pF
C459	2113743N50	100 pF
C463	2113743N50	100 pF
C466	2113743N50	100 pF
C467	2113928N01	0.1 uF $\pm$ 10%; 6.3 V
C471	2113743N50	100 pF
C472	2113743N50	100 pF
C473	2113743N50	100 pF
C475	2113743H14	10 uF +80/-20%; 16 V
C476	2113928D08	10 uF +80/-20%; 10 V
C479	2113928N01	0.1 uF $\pm$ 10%; 6.3 V
C480	2113928D08	10 uF +80/-20%; 10 V
C481	2113928N01	0.1 uF $\pm$ 10%; 6.3 V
C490	2113743N50	100 pF
C491	2113743N50	100 pF
C492	2113743N50	100 pF
C493	2113743N50	100 pF
C494	2113743N50	100 pF
C495	2113743N50	100 pF
C496	2113743N50	100 pF
C497	2113743N50	100 pF
C502	2311049A05	0.47 uF $\pm$ 10%; 25 V
C503	2113743N44	56 pF
C505	2113743N42	47 pF
C511	2113743N42	47 pF
C512	2113743N42	47 pF

Circuit Ref	Motorola Part No.	Description
C513	2113743N42	47 pF
C514	2113743N42	47 pF
C520	2113743L41	0.01 uF $\pm$ 10%; 16 V
C521	2113743L41	0.01 uF $\pm$ 10%; 16 V
C522	2113743L41	0.01 uF $\pm$ 10%; 16 V
C523	2113743L41	0.01 uF $\pm$ 10%; 16 V
C524	2113743N30	15 pF
C525	2113743N46	68 pF
C526	2113743N46	68 pF
C527	2113743N46	68 pF
C528	2113743N46	68 pF
C529	2113743N46	68 pF
C530	2311049A18	10 uF $\pm$ 10%; 16 V
C531	2113743N46	68 pF
C532	2113743N50	100 pF
C533	2113743N50	100 pF
C534	2113743N50	100 pF
C535	2113743N50	100 pF
C536	2113743N50	100 pF
C537	2113743N50	100 pF
C538	2113743N44	56 pF
C600	2113743M12	0.033 uF +80/-20%; 16 V
C601	2113743N43	51 pF
C602	2113743M24	0.1 uF +80/-20%; 16 V
C603	---	not used
C604	2113743N14	3.3 pF
C605	2113743N12	2.7 pF
C606	2113743N12	2.7 pF
C607	2113743N07	1.5 pF
C608	2113743N07	1.5 pF
C609	2113743N43	51 pF
C610	2113743N46	68 pF
C611	2113743F18	2.2 uF +80/-20%; 16 V
C612	2113743M24	0.1 uF +80/-20%; 16 V
C613	2113743N46	68 pF
C614	2113743M24	0.1 uF +80/-20%; 16 V
C615	2113743N46	68 pF
C616	2113743M24	0.1 uF +80/-20%; 16 V
C617	---	not used
C618	2113743M24	0.1 uF +80/-20%; 16 V
C619	2113743N46	68 pF
C620	2113743N46	68 pF
C621	2113743N46	68 pF
C622	2113743M24	0.1 uF +80/-20%; 16 V
C623	2113743N43	51 pF
C624	---	not used
C625	2113743N43	51 pF
C626	2113743N43	51 pF
C627	2113743N43	51 pF
C628	2113743N43	51 pF
C650	2113743M24	0.1 uF +80/-20%; 16 V

Circuit Ref	Motorola Part No.	Description
C651	2113743M24	0.1 uF +80/-20%; 16 V
C652	2113743M12	0.033 uF +80/-20%; 16 V
C653	2113743N46	68 pF
C654	2113743N46	68 pF
C655	2113743N22	6.8 pF
C656	2113743N09	2 pF
C657	---	not used
C658	2113743N29	13 pF
C659	2113743N14	3.3 pF
C660	2113743N14	3.3 pF
C661	2113743N50	100 pF
C662	2113743N46	68 pF
C663	2113743M24	0.1 uF +80/-20%; 16 V
C664	2113743N46	68 pF
C665	2113743N46	68 pF
C666	---	not used
C667	2113743N42	47 pF
C668	2113743N22	6.8 pF
C669	2113743N42	47 pF
C670	2113743N46	68 pF
C671	2113743N23	7.5 pF
C851	2113928E01	1 uF $\pm$ 10%; 10 V
C852	2113743N22	6.8 pF
C853	2113743N31	16 pF
C854	2113743N43	51 pF
C855	---	not used
C856	2113743M24	0.1 uF +80/-20%; 16 V
CR101	4880973Z02	Schottky Diode
CR102	4880973Z02	Schottky Diode
CR201	4802233J09	Triple Diode
CR202	4802233J09	Triple Diode
CR300	4880154 K03	Dual Schottky Diode
CR301	4886143B01	Quad Diode Mixer
CR411	4802245J62	Schottky Diode
CR412	4802245J62	Schottky Diode
CR413	4802245J62	Schottky Diode
CR440	4813833C02	Dual Diode Common Cathode
CR501	4880107R01	Rectifier
CR503	4805729G49	LED Red/Yellow
CR600	4862824C01	Varactor
CR601	4862824C01	Varactor
CR603	4862824C01	Varactor
D350	4880154 K03	Dual Schottky Diode
E101	2405688Z01	Ferrite Bead
E102	2484657R01	Ferrite Bead
E400	2480640Z01	Ferrite Bead
E401	2480640Z01	Ferrite Bead
E402	2480640Z01	Ferrite Bead
E403	2480640Z01	Ferrite Bead
E404	2480640Z01	Ferrite Bead
E405	2480640Z01	Ferrite Bead

Circuit Ref	Motorola Part No.	Description
E406	2480640Z01	Ferrite Bead
E407	2480640Z01	Ferrite Bead
E408	2480640Z01	Ferrite Bead
E409	2480640Z01	Ferrite Bead
F501	6580542Z01	Fuse 3A
FL300	4802245J91	3 Pole Ceramic Bandpass Filter
FL301	4802245J91	3 Pole Ceramic Bandpass Filter
FL350	4802655J04	73.35 MHz 2-Pole Crystal Filter
FL351	4802655J04	73.35 MHz 2-Pole Crystal Filter
FL352	9180469V03	4-Pole 455 kHz Ceramic Filter
FL353	9180468V04	6-Pole 455 kHz Ceramic Filter
FL401	4870368G02	38.4 kHz Crystal
FL600	4802245J93	Resonator
FL601	4802245J93	Resonator
J101	2880658Z02	Antenna Connector, SMA type
J400	0905505Y04	40-Pin Connector
J403	0905505Y02	20-Pin Connector
L101	2460591A29	6.61 nH
L102	2460591A77	10.40 nH
L103	2460591B33	9.74 nH
L104	2462587V29	39 nH
L105	2462587V26	22 nH
L106	---	not used
L107	2479990B02	19.61 nH
L108	2413926G19	100 nH
L109	2413926G19	100 nH
L110	2413926G19	100 nH
L111	2413926G12	27 nH
L112	2413926G05	6.8 nH
L201	2462587Q20	2.2 uH
L202	2462587Q20	2.2 uH
L203	2462587V21	6.8 nH
L204	2462587P25	12 uH
L300	2413926N09	5.6 nH
L301	2462587V37	180 nH
L302	2413926N13	12 nH
L303	2462587N55	150 nH
L304	2462587N64	680 nH
L305	2409348J11	5.45 nH
L306	2409348J11	5.45 nH
L350	---	not used
L351	2462587T21	330 nH
L352	2462587T21	330 nH
L353	2462587T22	390 nH
L354	2413923A13	560 nH
L400	2462587Q42	390 nH
L401	2462587Q42	390 nH
L410	2462587Q42	390 nH
L411	2462587Q42	390 nH

Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description	Circuit Ref	Motorola Part No.	Description
L505	2462587Q42	390 nH	R109	0662057N05	18 K	R368	0662057M98	10 K	R453	---	not used
L600	2413926G19	100 nH	R110	0662057N08	24 K	R369	0662057M70	680	R454	---	not used
L601	2413926G11	22 nH	R111	0662057N09	27 K	R370	0662057N01	12 K	R455	---	not used
L602	2413926G19	100 nH	R112	0662057M26	10	R371	0662057M80	1.8 K	R456	0662057M01	0
L603	2413926G19	100 nH	R113	0662057N30	200 K	R372	0662057M64	390	R457	0662057M98	10 K
L604	2413926G19	100 nH	R114	0662057M67	510	R373	0662057M76	1.2 K	R460	0662057M90	4.7 K
L605	2413926G13	33 nH	R115	0662057M01	0	R374	0662057M86	3.3 K	R461	0662057M56	180
L606	2462587V41	390 nH	R116	0680539Z01	0.1	R375	0662057M83	2.4 K	R462	0662057M98	10 K
L607	2413926G10	18 nH	R117	0662057M98	10 K	R376	0662057M01	0	R463	0662057M61	300
L608	2413926G19	100 nH	R118	0662057N39	470 K	R377	---	not used	R471	0662057M92	5.6 K
L609	2413926G06	8.2 nH	R119	0662057M85	3 K	R400	0662057N15	47 K	R472	0662057N12	36 K
L610	2413926G15	47 nH	R120	0662057A67	5.6 K	R401	0662057M01	0	R473	0662057M26	10
L650	2413926G19	100 nH	R201	0662057M01	0	R402	---	not used	R475	0662057M01	0
L651	2413926G10	18 nH	R202	---	not used	R403	---	not used	R476	0662057N08	24 K
L652	2413926G19	100 nH	R203	0662057M50	100	R405	0662057M01	0	R477	0662057M74	1 K
L653	2413926G19	100 nH	R204	0662057N11	33 K	R406	0662057N20	75 K	R478	0662057M98	10 K
L654	2413926G12	27 nH	R205	0662057M54	150	R407	0662057N19	68 K	R481	0662057N08	24 K
L655	2413926G15	47 nH	R206	0662057M54	150	R408	---	not used	R482	0662057M01	0
L656	2413926G03	4.7 nH	R207	0662057N01	12 K	R409	0662057M98	10 K	R483	0662057M01	0
M101	2680499Z01	Heatsink	R208	0662057N17	56 K	R410	0662057N23	100 K	R492	0662057M01	0
PB501	4080523Z01	Tactile Pushbutton	R209	0662057M50	100	R411	0662057M98	10 K	R498	0662057M98	10 K
PB502	4080523Z01	Tactile Pushbutton	R210	0662057N15	47 K	R413	0662057M01	0	R499	0662057M98	10 K
PB503	4080523Z01	Tactile Pushbutton	R211	0662057M88	3.9 K	R414	0662057V34	180 K	R501	0662057M70	680
PB504	4080523Z01	Tactile Pushbutton	R212	0662057M38	33	R415	0662057V26	91 K	R502	0662057M56	180
PB505	4080523Z01	Tactile Pushbutton	R213	0662057M52	120	R416	0662057M98	10 K	R505	0662057M98	10 K
Q101	4813828A09	MRF1517	R214	0662057M77	1.3 K	R418	---	not used	R506	0662057N15	47 K
Q201	4809939C05	Dual NPN/PNP UMC5NTL	R215	0662057M62	330	R419	0662057M67	510	R507	0662057M01	0
Q202	4809939C05	Dual NPN/PNP UMC5NTL	R301	0662057M92	5.6 K	R420	0662057B46	10MEG	R600	0662057N01	12 K
Q301	4802245J56	QSTB0048 NPN	R302	0662057N01	12 K	R421	0662057M81	2 K	R601	0662057N05	18 K
Q350	4802245J96	PBR941 NPN	R303	0662057M74	1 K	R423	0662057N39	470 K	R602	0662057M38	33
Q351	4802245J96	PBR941 NPN	R304	0662057M62	330	R424	0662057N12	36 K	R603	0662057M38	33
Q352	4880214G02	MMBT3904 NPN	R305	0662057M43	51	R425	0662057N10	30 K	R604	0662057M60	270
Q400	4809579E18	MOSFET P-Chan TP0101T	R306	0662057M87	3.6 K	R426	0662057N35	330 K	R605	0662057M62	330
Q403	4813824A17	MMBT3906 PNP	R350	0662057N01	12 K	R427	0662057M84	2.7 K	R606	0662057M26	10
Q405	4802245J54	Dual NPN	R351	0662057M26	10	R428	0662057M10	2.2	R607	0662057M50	100
Q410	4802245J54	Dual NPN	R352	0662057M94	6.8 K	R429	0662057N20	75 K	R608	0662057M42	47
Q416	4809579E18	MOSFET P-Chan TP0101T	R353	0662057N09	27 K	R431	0662057N39	470 K	R609	0662057N03	15 K
Q417	4809939C05	Dual NPN/PNP UMC5NTL	R354	0662057M69	620	R432	0662057N16	51 K	R610	0662057M38	33
Q502	5180159R01	Dual NPN IMX1	R355	0662057M50	100	R434	0662057M62	330	R611	0662057N03	15 K
Q505	4880214G02	MMBT3904 NPN	R356	0662057N01	12 K	R435	0662057M81	2 K	R612	0662057M38	33
Q600	4805218N63	BFQ67W NPN	R357	0662057M26	10	R436	0662057M74	1 K	R650	0662057N07	22 K
Q601	4805218N63	BFQ67W NPN	R358	0662057M94	6.8 K	R437	0662057M01	0	R651	0662057N02	13 K
Q603	4809939C05	Dual NPN/PNP UMC5NTL	R359	0662057N09	27 K	R438	0662057M54	150	R652	0662057M38	33
R101	0662057A34	240	R360	0662057M62	330	R439	0662057M54	150	R653	0662057M38	33
R102	0662057A34	240	R361	0662057M64	390	R445	0662057N08	24 K	R654	0662057M60	270
R103	0662057A18	51	R362	0662057M62	330	R447	0662057N51	1.5 MEG	R655	0662057M74	1 K
R104	---	not used	R363	0662057M43	51	R448	0662057M98	10 K	R656	0662057M70	680
R105	0662057M81	2 K	R364	0662057M72	820	R449	0662057N08	24 K	R657	0662057M52	120
R106	0662057M02	1	R365	---	not used	R450	0683962T45	68	R658	0662057N15	47 K
R107	0662057M02	1	R366	0662057M80	1.8 K	R451	0662057N03	15 K	R659	0662057M26	10
R108	0662057M01	0	R367	0662057N01	12 K	R452	0662057N23	100 K	R660	0662057M38	33

Circuit Ref	Motorola Part No.	Description
R661	0662057M50	100
R662	0662057N11	33 K
R851	0662057N23	100 K
R852	0662057N23	100 K
R853	0662057N23	100 K
R854	0662057M01	0
R855	0662057N31	220 K
R856	0662057N23	100 K
R859	---	not used
R860	---	not used
R861	---	not used
RT400	0680590Z01	33.0 K @ 25°C
S501	4080710Z02	Frequency Switch
S502	1880619Z02	Volume Potentiometer/On-Off Switch
SH100	2680507Z01	Shield, PA Bottom
SH101	2686081B04	Shield, PA Harmonic Filter Bottom
SH102	2680554Z01	Shield, PA Harmonic Filter Top
SH201	2680511Z01	Shield, FracN Top
SH202	2680511Z01	Shield, FracN Bottom
SH301	2680554Z01	Shield, FE Top
SH303	2680509Z01	Shield, FE/Mixer Bottom
SH304	2680554Z01	Shield, FE Top
SH350	2686081B02	Shield, IF Top
SH351	2686081B03	Shield, IF Bottom
SH400	2680505Z01	Controller Memory Shield Bottom
SH401	2680506Z01	Controller On/Off Shield Bottom
SH402	2680515Z01	Controller Microprocessor Shield Top
SH403	2680516Z01	Controller ASFIC/Audio PA Shield Top
SH600	2680508Z01	Shield, VCO Bottom
SH602	2680508Z01	Shield, VCO Bottom
SH603	2680514Z01	Shield, VCO Top
T301	2580541Z02	Mixer Balun
T302	2580541Z02	Mixer Balun
U101	5185130C65	LDMOS Power Amplifier
U102	5185765B26	Power Control IC
U103	5185963A15	Temperature Sensor
U201	5185963A27	Low Voltage FracN
U202	5105739X05	5V Regulator
U203	5102463J58	3.3V Regulator
U350	5186144B01	SA616 IFIC
U400	5102463J40	3.3V Regulator
U404	5185130C53	ASFIC Audio Filter IC
U405	---	not used

Circuit Ref	Motorola Part No.	Description
U406	*5102463J59	Flash ROM 128Kx8 AT49HLV010
U407	*5102463J64	Serial EEPROM 16Kx8 X25128-2.7
U409	5102226J56	Microcontroller
U410	5102463J57	3.3V Regulator
U420	5102463J44	Audio PA
U600	5105750U54	VCO Buffer IC
U851	5113818A01	LMS2904 Dual Opamp
VR101	4813830A15	5.6V Zener
VR432	4805656W08	5.6V Zener
VR433	4805656W08	5.6V Zener
VR434	4802245J73	6.8V Zener
VR445	4802245J74	10V Zener
VR446	4802245J74	10V Zener
VR447	4802245J74	10V Zener
VR448	4802245J74	10V Zener
VR449	4802245J74	10V Zener
VR450	4802245J75	12V Zener
VR460	4802245J73	6.8V Zener
VR501	4813830A18	6.8V Zener
VR502	4880140L17	12V Zener
VR503	4802245J73	6.8V Zener
VR504	4802245J73	6.8V Zener
VR505	4802245J73	6.8V Zener
VR506	4802245J73	6.8V Zener
VR507	4802245J73	6.8V Zener
VR508	4802245J73	6.8V Zener
Y200	4802245J68	16.8 MHz Reference Oscillator
Y350	4880606B10	72.895 MHz 3rd Overtone Crystal
Y351	9186145B02	455 KHz Discriminator

\* Motorola Depot Servicing only

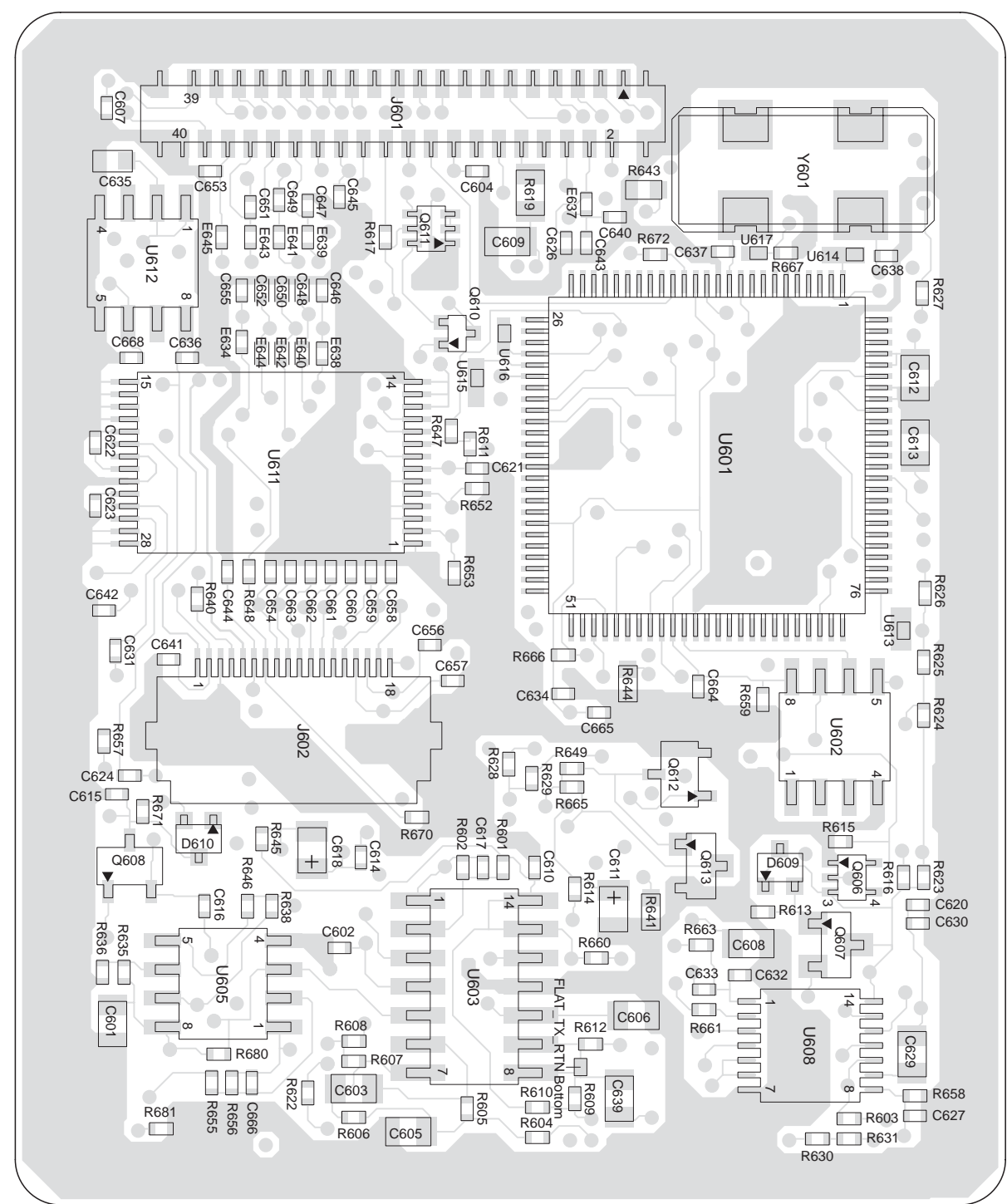
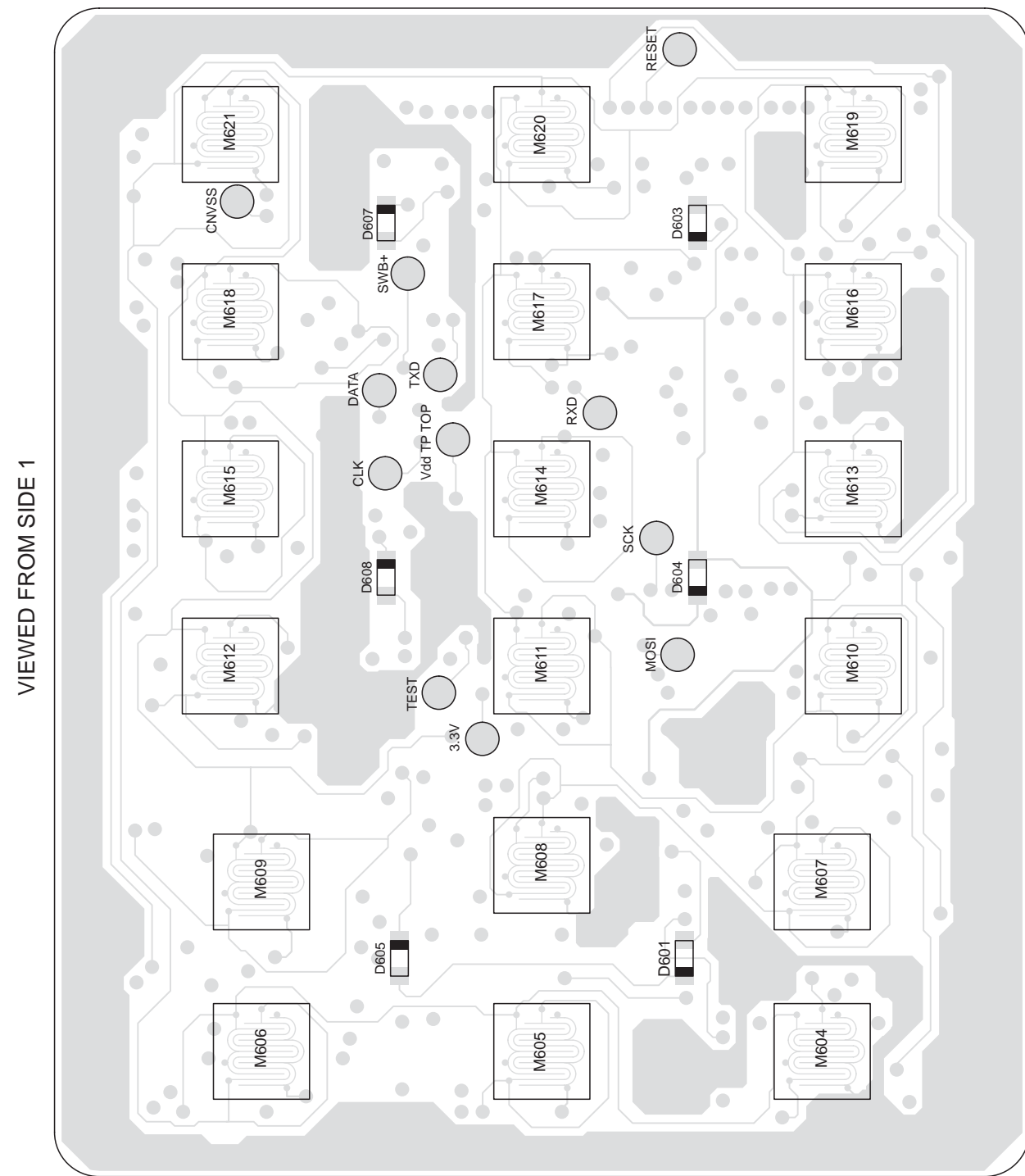


Figure 5-33. PassPort Trunking Controller PCB Board Side 1 & 2

PassPort Option Board  
Revision P15  
Mar. 27, 2002

Circuit Board Layer Description:  
Top Side: Keypads, Backlight LED's, Test/Program Fixture Pads  
Bottom Side: Microcontroller, Low Speed Data Encode/Decode Filters  
and amplifiers, Voice Storage Circuitry, Test Pads  
Note 1: Top Side Test Pads (indicated by "TP Top") are 60 mil diameter round pads  
Note 2: Bottom Side Test Pads (indicated by "Bottom") are 30 mil by 20 mil pads

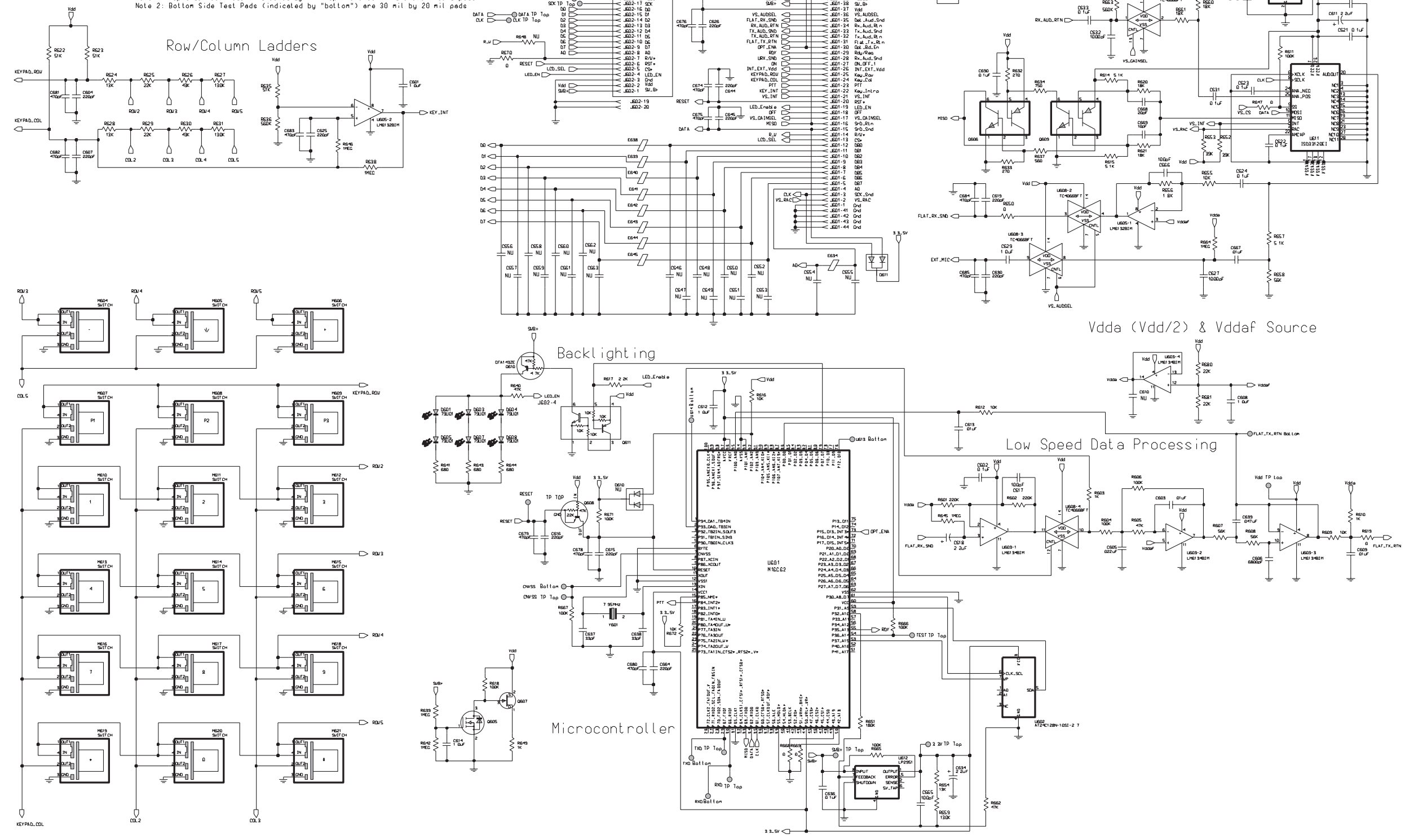


Figure 5-34. Keypad/PassPort Option Board Schematic Diagram



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