



ASTRO[®] XTS[™] 5000
700/800 MHz Digital Portable Radios
Detailed Service Manual



ASTRO[®] XTS[™] 5000
700/800 MHz Digital Portable Radio
Detailed Service Manual

Foreword

The information contained in this manual relates to all ASTRO® XTS™ 5000 digital portable radios, unless otherwise specified. This manual provides sufficient information to enable qualified service shop technicians to troubleshoot and repair an ASTRO XTS 5000 digital portable radio to the component level.

For details on the operation of the radio or level 1 or 2 maintenance procedures, refer to the applicable manuals, which are available separately. A list of publications is provided in this manual in the section, [“Related Publications” on page ix](#).

Safety Information

Before operating an ASTRO XTS 5000 radio, please read the section, [“User Safety, Training, and General Information” on page xv](#) of this manual.

Manual Revisions

Changes which occur after this manual is printed are described in FMRs (Florida Manual Revisions). These FMRs provide complete replacement pages for all added, changed, and deleted items, including pertinent parts list data, schematics, and component layout diagrams.

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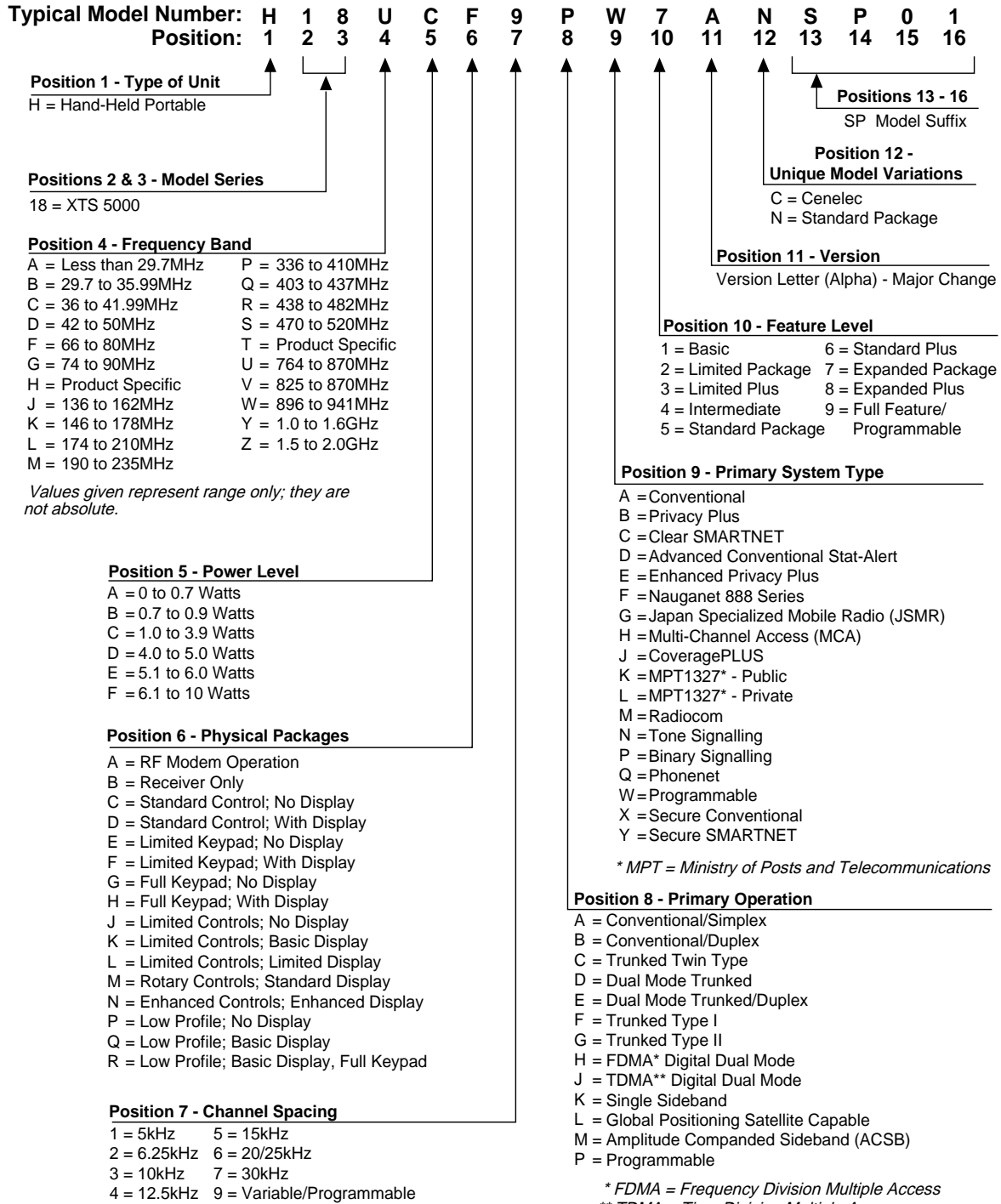
Related Publications

ASTRO XTS 5000 Digital Portable Radio Model I User Guide	68P81094C25
ASTRO XTS 5000 Digital Portable Radio Model II User Guide	68P81094C26
ASTRO XTS 5000 Digital Portable Radio Model III User Guide	68P81094C27
ASTRO XTS 5000 Digital Portable Radios Basic Service Manual	68P81094C28
Factory Mutual Approval XTS 5000 Product Listing Manual Supplement	68P81094C78

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Model Numbering, Charts, and Specifications

Portable Radio Model Numbering System



ASTRO XTS 5000 Model Chart

MODEL NUMBER			DESCRIPTION
H18UCC9PW5AN			700/800 MHz 1-3 Watts ASTRO XTS 5000 Model I
H18UCF9PW6AN			700/800 MHz 1-3 Watts ASTRO XTS 5000 Model II
H18UCH9PW7AN			700/800 MHz 1-3 Watts ASTRO XTS 5000 Model III
ITEM NUMBER			DESCRIPTION
X	X	X	NUF3577_ Board, Transceiver (700/800 MHz)
X	X	X	NTN9564_ Board, VOCON *
X	X	X	NTN8266_ Belt Clip Kit
X	X	X	HNN9031_ Battery, Nickel-Cadmium, Ultra-High Capacity
X			NTN9682_ Kit, Front Cover, Model I
	X		NTN9681_ Kit, Front Cover, Model II
		X	NTN9680_ Kit, Front Cover, Model III
X	X	X	NAF5080_ Antenna, 700/800 MHz
X	X	X	0985973B01 Assembly, B+ Connector
X	X	X	1505579Z01 Cover, Accessory Connector
X			2685567D01 Assembly, VOCON Shield, Model I
	X		2685567D02 Assembly, VOCON Shield-Keypad, Model II
		X	2685567D03 Assembly, VOCON Shield-Keypad, Model III
X	X	X	2685220D02 Shield, RF (Transceiver) Board
X	X	X	2785219D01 Assembly, Casting
X	X	X	2885866A01 Connector, Compression, 26-Pin
X	X	X	3205082E96 Gasket, Antenna O-Ring
X	X	X	3205349Z03 Seal, Main
X	X	X	3205351Z02 Seal, B+
X	X	X	3285877B02 Seal, Port
X	X	X	3385873B01 Label, Port
	X	X	7285726C01 Module, LCD Display
	X	X	7585189D01 Pad, Display Locator
	X		7585104D02 Keypad, Model II
		X	7585104D01 Keypad, Model III

Notes:

- X = Item Included
- * = The radio's model number, FLASHcode, Host code, and DSP code are required when placing an order for the VOCON Board.
 - The model number and (sometimes) the FLASHcode, can be found on the FCC label on the back of the radio.
 - The model number, Host code, DSP code, and (sometimes) the FLASHcode, can be found by putting a Model II or III radio into the Test Mode.
 - The model number, Host code, DSP code, and FLASHcode can be found by using the Programming Cable (RKN4105_ or RKN4106_) and the CPS to read a Model I, II, or III radio.

ASTRO XTS 5000 R (Ruggedized) Model Chart

MODEL NUMBER							DESCRIPTION	
H18UCC9PW5AN w/Q155FP Opt							Ruggedized 700/800 MHz 1-3 Watts ASTRO XTS 5000 Model I	
H18UCF9PW6AN w/Q155FQ Opt							Ruggedized 700/800 MHz 1-3 Watts ASTRO XTS 5000 Model II	
H18UCH9PW7AN w/Q155FR Opt							Ruggedized 700/800 MHz 1-3 Watts ASTRO XTS 5000 Model III	
H18UCC9PW5AN w/Q155GB Opt							Ruggedized Yellow 700/800 MHz 1-3 Watts ASTRO XTS 5000 Model I	
H18UCF9PW6AN w/Q155GC Opt							Ruggedized Yellow 700/800 MHz 1-3 Watts ASTRO XTS 5000 Model II	
H18UCH9PW7AN w/Q155GD Opt							Ruggedized Yellow 700/800 MHz 1-3 Watts ASTRO XTS 5000 Model III	
ITEM NUMBER							DESCRIPTION	
X	X	X	X	X	X		NUF3577_	Board, Transceiver (700/800 MHz)
X	X	X	X	X	X		NTN9564_	Board, VOCON *
X	X	X	X	X	X		NTN8266_	Belt Clip Kit
X	X	X	X	X	X		NTN8297_	Battery, Nickel-Cadmium (1525mAh)
X							NNTN4059_	Kit, Front Cover, Model I, Ruggedized
	X						NNTN4060_	Kit, Front Cover, Model II, Ruggedized
		X					NNTN4061_	Kit, Front Cover, Model III, Ruggedized
			X				NTN9685_	Kit, Yellow Front Cover, Model I, Ruggedized
				X			NTN9684_	Kit, Yellow Front Cover, Model II, Ruggedized
					X		NTN9683_	Kit, Yellow Front Cover, Model III, Ruggedized
X	X	X	X	X	X		NAF5080_	Antenna, 700/800 MHz
X	X	X	X	X	X		0985973B02	Assembly, B+ Connector
X	X	X	X	X	X		1505579Z01	Cover, Accessory Connector
X			X				2685567D01	Assembly, VoCon Shield, Model I
	X			X			2685567D02	Assembly, VoCon Shield-Keypad, Model II
		X			X		2685567D03	Assembly, VoCon Shield-Keypad, Model III
X	X	X	X	X	X		2685220D02	Shield, RF (Transceiver) Board
X	X	X	X	X	X		2785219D04	Assembly, Ruggedized Casting
X	X	X	X	X	X		2885866A01	Connector, Compression, 26-Pin
X	X	X	X	X	X		3205082E96	Gasket, Antenna O-Ring
X	X	X	X	X	X		3205349Z03	Seal, Main
X	X	X	X	X	X		3205351Z02	Seal, B+ Ruggedized
X	X	X	X	X	X		3285877B02	Seal, Port
X	X	X	X	X	X		3385873B01	Label, Port
	X	X		X	X		7285726C01	Module, LCD Display
	X	X		X	X		7585189D01	Pad, Display Locator
	X			X			7585104D02	Keypad, Model II
		X			X		7585104D01	Keypad, Model III

Notes:

X = Item Included

* = The radio's model number, FLASHcode, Host code, and DSP code are required when placing an order for the VOCON Board.

- The model number and (sometimes) the FLASHcode, can be found on the FCC label on the back of the radio.
- The model number, Host code, DSP code, and (sometimes) the FLASHcode, can be found by putting a Model II or III radio into the Test Mode.
- The model number, Host code, DSP code, and FLASHcode can be found by using the Programming Cable (RKN4105_ or RKN4106_) and the CPS to read a Model I, II, or III radio.

Specifications for 700/800 MHz Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted.

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT5806	Frequency Range:	764-870 MHz	Frequency Range:	764-870 MHz
Temperature Range:		Bandwidth:	106 MHz	RF Power:	
Operating:	-30°C to +60°C	Usable Sensitivity (typical) (12 dB SINAD):	0.20 µV	764-806 MHz:	2.5 Watts
Storage:	-40°C to +85°C	Intermodulation (typical):	-75 dB	806-870 MHz:	3 Watts
Power Supply: Nickel-Cadmium Battery (NiCd) or Nickel-Metal-Hydrate Battery (NiMH) or Lithium-Ion Battery (Li-Ion)		Selectivity (typical):		Frequency Stability (typical) (-30 to +60°C; 25°C ref.):	±0.00015%
Battery Voltage:		(25/30 kHz Channel):	-72 dB	Emission (typical conducted):	-75 dBc
Nominal:	7.5 Vdc	(12.5 kHz Channel):	-63 dB	FM Hum and Noise (typical) (Companion Receiver):	25 kHz -45 dB 12.5 kHz -40 dB
Range:	6 to 9 Vdc	Spurious Rejection (typical):	-75 dB	Distortion (typical):	1.5% (typical)
Transmit Current Drain (Typical):	1400 mA	Frequency Stability (-30+60°C; 25°C reference):	±0.00015%	Modulation Limiting:	25 kHz chnls ±5.0 kHz 12.5 kHz chnls ±2.5 kHz
Receive Current Drain (Rated Audio):	240 mA	Rated Audio:	500 mW	Emissions Designators:	20K0F1E, 16K0F3E, 11K0F3E, 8K10F1D, and 8K10F1E
Standby Current Drain:	80 mA	FM Hum and Noise (typical):			
Recommended Battery:		25 kHz -48 dB			
Ultra-High-Capacity Smart NiCd: HNN9031_		12.5 kHz -40 dB			
or Ultra-High-Capacity NiCd: NTN8294_		Distortion (typical):	1.5%		
or Extended-Capacity NiMH: NTN8293_		Channel Spacing:	12.5/25 kHz		
or Li-Ion: NTN8610_					
or Ultra-High-Capacity NiCd FM: NTN8295_*					
or Ultra-High-Capacity NiMH FM: NTN8299_*					
Optional FM (Factory Mutual) Battery:					
* FM Intrinsically Safe: Class I, II, III, Division 1, Groups C, D, E, F, and G. FM Non-incendive: Class 1, Division 2, Groups A, B, C, and D.					
Dimensions (H x W x D):					
Note: 2.44" = width at PTT; 2.34" = width at bottom; 1.83" = depth at speaker; 0.97" = depth at keypad					
Without Battery (Radio Only):					
6.58" x 2.44" x 1.83"/6.58" x 2.34" x 0.97"					
(167.13mm x 61.90mm x 46.42mm/ 167.13mm x 59.49mm x 24.56mm)					
With Battery:					
6.58" x 2.44" x 1.83"/6.58" x 2.34" x 1.65"					
(167.13mm x 61.90mm x 46.42mm/ 167.13mm x 59.49mm x 41.97mm)					
Weight: (w/ Antenna):					
Less Battery:	14.10oz. (383gm)				
With Ultra-High Cap. NiCd:	25.19oz. (693gm)				
With Li-Ion:	20.41oz. (583gm)				
With Ultra-High Cap. NiMH:	23.45oz. (644gm)				
With Extended- Cap. NiMH:	24.04oz. (682gm)				

Specifications subject to change without notice.

User Safety, Training, and General Information

READ THIS IMPORTANT INFORMATION ON SAFE AND EFFICIENT OPERATION BEFORE USING YOUR MOTOROLA HANDHELD PORTABLE TWO-WAY RADIO

The information provided in this document supersedes the general safety information contained in user guides published prior to June 2001. For information regarding radio use in a hazardous atmosphere please refer to the Factory Mutual (FM) Approval Product Listing or Instruction Card, which is included with radio models that offer this capability.

Compliance with RF Energy Exposure Standards

Your Motorola two-way radio is designed and tested to comply with a number of national and international standards and guidelines (listed below) regarding human exposure to radio frequency electromagnetic energy. This radio complies with the IEEE (FCC) and ICNIRP exposure limits for occupational/controlled RF exposure environment at duty cycles of up to 50% talk-50% listen and should be used for occupational use only. In terms of measuring RF energy for compliance with the FCC exposure guidelines, your radio radiates measurable RF energy only while it is transmitting (during talking), not when it is receiving (listening) or in standby mode. Note that the approved, supplied batteries for this radio are rated for a 5-5-90 duty cycle (5% talk-5% listen - 90% standby), even though this radio complies with the FCC occupational exposure limits at duty cycles of up to 50% talk.

Your Motorola two-way radio complies with the following RF energy exposure standards and guidelines:

- United States Federal Communications Commission, Code of Federal Regulations; 47CFR part 2 sub-part J
- American National Standards Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999 Edition
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6. Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz, 1999
- Australian Communications Authority Radiocommunications (Electromagnetic Radiation - Human Exposure) Standard 2001
- ANATEL, Brasil Regulatory Authority, Resolution 256 (April 11, 2001) "additional requirements for SMR, cellular and PCS product certification."

Operational Instructions and Training Guidelines

To ensure optimal performance and compliance with the occupational/controlled environment RF energy exposure limits in the above standards and guidelines, users should transmit no more than 50% of the time and always adhere to the following procedures:

Transmit and Receive

- To transmit (talk), push the Push-To-Talk (PTT) button; to receive, release the PTT button.

Hand-held radio operation



-Hold the radio in a vertical position with the microphone one to two inches (2.5 to 5 cm) away from the lips.

Body-worn operation

- Always place the radio in a Motorola approved clip, holder, holster, case, or body harness for this product. Use of non-Motorola-approved accessories may exceed FCC RF exposure guidelines.
- If you do not use a Motorola approved body-worn accessory and are not using the radio in the intended use position in front of the face, then ensure the antenna and the radio are kept 2.5 cm (one inch) from the body when transmitting.

Antennas & Batteries

- Use only Motorola approved supplied antenna or Motorola approved replacement antenna. Unauthorized antennas, modifications, or attachments could damage the radio and may violate FCC regulations.
- Use only Motorola approved, supplied batteries or Motorola approved replacement batteries. Use of non-Motorola-approved antennas or batteries may exceed FCC RF exposure guidelines.

Approved Accessories

- For a list of Motorola approved accessories see the appendix of this user manual.

Electromagnetic Interference/Compatibility

NOTE: Nearly every electronic device is susceptible to electromagnetic interference (EMI) if inadequately shielded, designed, or otherwise configured for electromagnetic compatibility.

Facilities

To avoid electromagnetic interference and/or compatibility conflicts, turn off your radio in any facility where posted notices instruct you to do so. Hospitals or health care facilities may be using equipment that is sensitive to external RF energy.

Aircraft

When instructed to do so, turn off your radio when on board an aircraft. Any use of a radio must be in accordance with applicable regulations per airline crew instructions.

Medical Devices

Pacemakers

The Advanced Medical Technology Association (AdvaMed) recommends that a minimum separation of 6 inches (15 centimeters) be maintained between a handheld wireless radio and a pacemaker. These recommendations are consistent with those of the U.S. Food and Drug Administration.

Persons with pacemakers should:

- ALWAYS keep the radio more than 6 inches (15 centimeters) from their pacemaker when the radio is turned ON.
- not carry the radio in the breast pocket.
- use the ear opposite the pacemaker to minimize the potential for interference.
- turn the radio OFF immediately if you have any reason to suspect that interference is taking place.

Hearing Aids

Some digital wireless radios may interfere with some hearing aids. In the event of such interference, you may want to consult your hearing aid manufacturer to discuss alternatives.

Other Medical Devices

If you use any other personal medical device, consult the manufacturer of your device to determine if it is adequately shielded from RF energy. Your physician may be able to assist you in obtaining this information.

Driver Safety

Check the laws and regulations on the use of radios in the area where you drive. Always obey them.

When using your radio while driving, please:

- Give full attention to driving and to the road.
- Use hands-free operation, if available.
- Pull off the road and park before making or answering a call if driving conditions so require.

Operational Warnings



For Vehicles With an Air Bag

Do not place a portable radio in the area over an air bag or in the air bag deployment area. Air bags inflate with great force. If a portable radio is placed in the air bag deployment area and the air bag inflates, the radio may be propelled with great force and cause serious injury to occupants of the vehicle.

Potentially Explosive Atmospheres

Turn off your radio prior to entering any area with a potentially explosive atmosphere, unless it is a radio type especially qualified for use in such areas as “Intrinsically Safe” (for example, Factory Mutual, CSA, UL, or CENELEC). Do not remove, install, or charge batteries in such areas. Sparks in a potentially explosive atmosphere can cause an explosion or fire resulting in bodily injury or even death.

NOTE: The areas with potentially explosive atmospheres referred to above include fueling areas such as below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles, such as grain, dust or metal powders, and any other area where you would normally be advised to turn off your vehicle engine. Areas with potentially explosive atmospheres are often but not always posted.

Blasting Caps and Blasting Areas

To avoid possible interference with blasting operations, turn off your radio when you are near electrical blasting caps, in a blasting area, or in areas posted: “Turn off two-way radio.” Obey all signs and instructions.

Operational Cautions



Antennas

Do not use any portable radio that has a damaged antenna. If a damaged antenna comes into contact with your skin, a minor burn can result.

Batteries

All batteries can cause property damage and/or bodily injury such as burns if a conductive material such as jewelry, keys, or beaded chains touches exposed terminals. The conductive material may complete an electrical circuit (short circuit) and become quite hot. Exercise care in handling any charged battery, particularly when placing it inside a pocket, purse, or other container with metal objects.

Intrinsically Safe Radio Information

FMRC Approved Equipment

Anyone intending to use a radio in a location where hazardous concentrations of flammable materials 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 or the bottom of the radio housing. The FM Approval mark is shown below



APPROVED



WARNING

- **Do not operate radio communications equipment in a hazardous atmosphere unless it is a type especially qualified (for example, FMRC Approved) for such use. An explosion or fire may result.**
- **Do not operate an FMRC Approved Product in a hazardous atmosphere if it has been physically damaged (for example, cracked housing). An explosion or fire may result.**
- **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.**
- **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.**
- **Turn a radio off before removing or installing a battery or accessory.**
- **Do not disassemble an 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 made 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.**

Repair of FMRC Approved Products

REPAIRS FOR MOTOROLA PRODUCTS WITH FMRC APPROVAL 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").

Repairs and service are to be done only at FM audited locations.



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

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.

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, provided there is 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.

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 FM 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 FM Product Listing. This FM Product Listing is shipped from the manufacturer with the FM Approved radio and battery combination.

Chapter 1 Introduction

1.1 General

This manual includes all the information needed to maintain peak product performance and maximum working time. This detailed level of service (component level) is typical of some service centers, self-maintained customers, and distributors. This manual is to be used in conjunction with the *ASTRO XTS 5000 Digital Portable Radios Basic Service Manual* (Motorola part number 68P81094C28), which uses the pass/fail service approach to radio problems.

First conduct the basic performance checks outlined in the Basic Service manual. This will verify the actual need for analyzing the radio and help pinpoint the functional problem area. In addition, you will become familiar with the radio test mode of operation, which is a helpful tool. If any basic receive or transmit parameters fail, then the radio should be aligned according to the radio alignment procedure.

Included in other areas of this manual are disassembly/reassembly procedures, functional block diagrams, detailed theory of operation, troubleshooting charts and waveforms, schematics and parts lists, and exploded view and parts list. You should be very familiar with these sections to aid in determining the problem circuit. Also included are component location diagrams to aid in locating individual circuit components and some IC diagrams, which point out some convenient probe points.

The “[Detailed Theory of Operation](#)” on page 4-1 contains detailed descriptions of the operations of many circuits. Once the area of the problem is located, it would be strongly advisable to review the operation of the circuit pertaining to the troubleshooting flow chart.

1.2 Notations Used in This Manual

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



DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or injury.



WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or injury.



Caution

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in equipment damage.

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

In this publication you will also find the use of the asterisk symbol (*) to indicate a negative or NOT logic true signal.

Chapter 2 Overall Characteristics

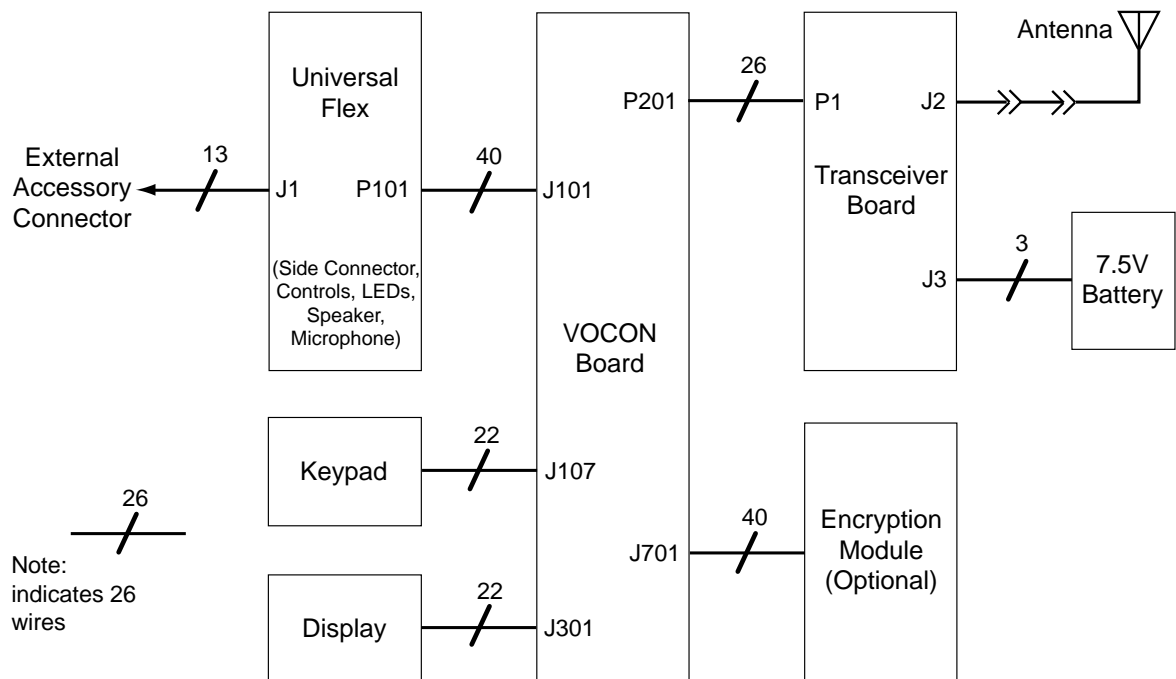
2.1 Introduction

The ASTRO XTS 5000 radio is a dual-mode (digital/analog), microcontroller-based transceiver incorporating a digital signal processor (DSP). The microcontroller handles the general radio control, monitors status, and processes commands input from the keypad or other user controls. The DSP processes the typical analog signals, and generates the standard signaling digitally to provide compatibility with existing analog systems. In addition, the DSP provides digital modulation techniques, utilizing voice encoding techniques with error correction schemes. This provides the user with enhanced range and audio quality, all in a reduced bandwidth channel requirement. It allows embedded signaling, which can mix system information and data with digital voice to support a multitude of system features.

The three ASTRO XTS 5000 radio models (I, II, and III) are available in the 700/800 MHz (764 to 869 MHz) band.

The ASTRO XTS 5000 radio (Figure 2-1) consists of the following:

- Vocoder/controller (VOCON) board
- Band-dependent transceiver (RF) board
- Universal flex assembly
- Display and keypad assemblies (models II and III only)
- Encryption board (secure models only)



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Figure 2-1. XTS 5000 Overall Block Diagram

2.1.1 Transceiver Board

Currently there is one transceiver (XCVR) board (Figure 2-2), covering the 700/800 MHz band. Other bands, VHF and UHF, will be offered later. The XCVR contains all radio frequency (RF) circuits for the radio's receiver, transmitter and frequency-generation unit.

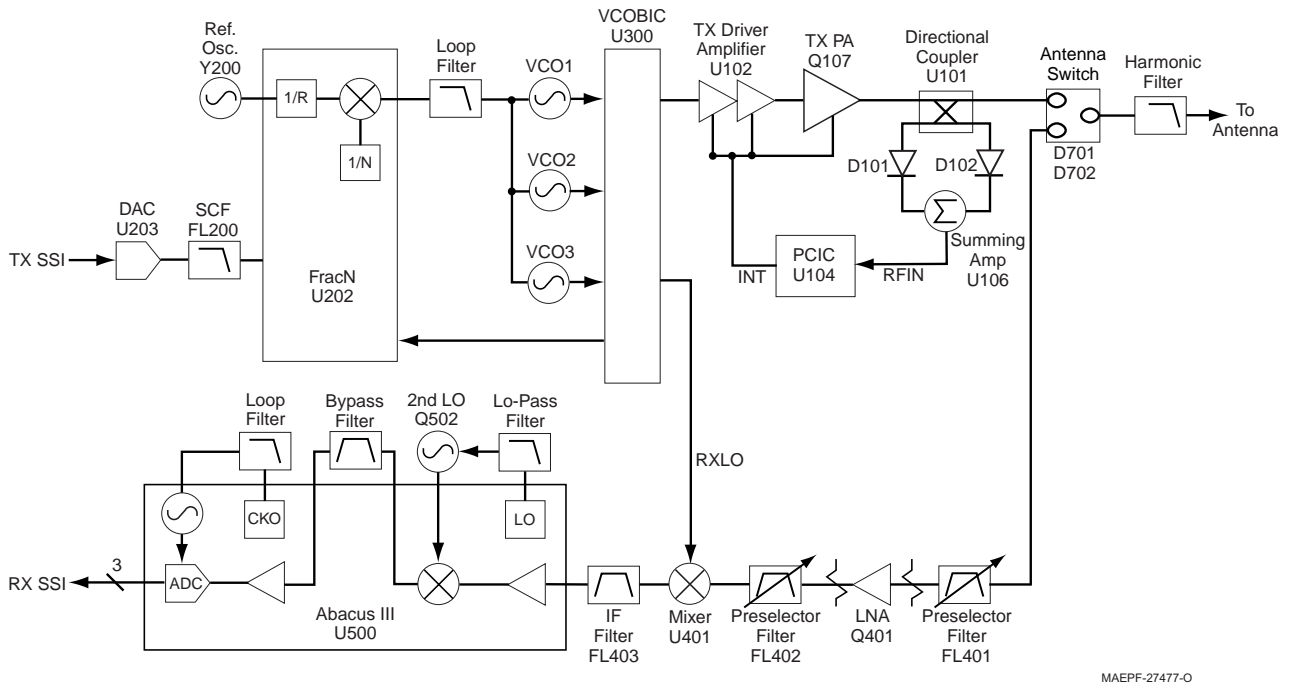


Figure 2-2. Transceiver Block Diagram (Power and Control Omitted)

2.1.2 VOCON Board

The VOCON board (Figure 2-3) includes the Patriot IC (microcontroller unit (MCU) and DSP), its memory devices, the GCAP II IC, a 5 Vdc linear regulator, the audio amplifiers, a dual EEPOT, the Flipper IC, ESD protection circuitry, and side connector interface circuitry.

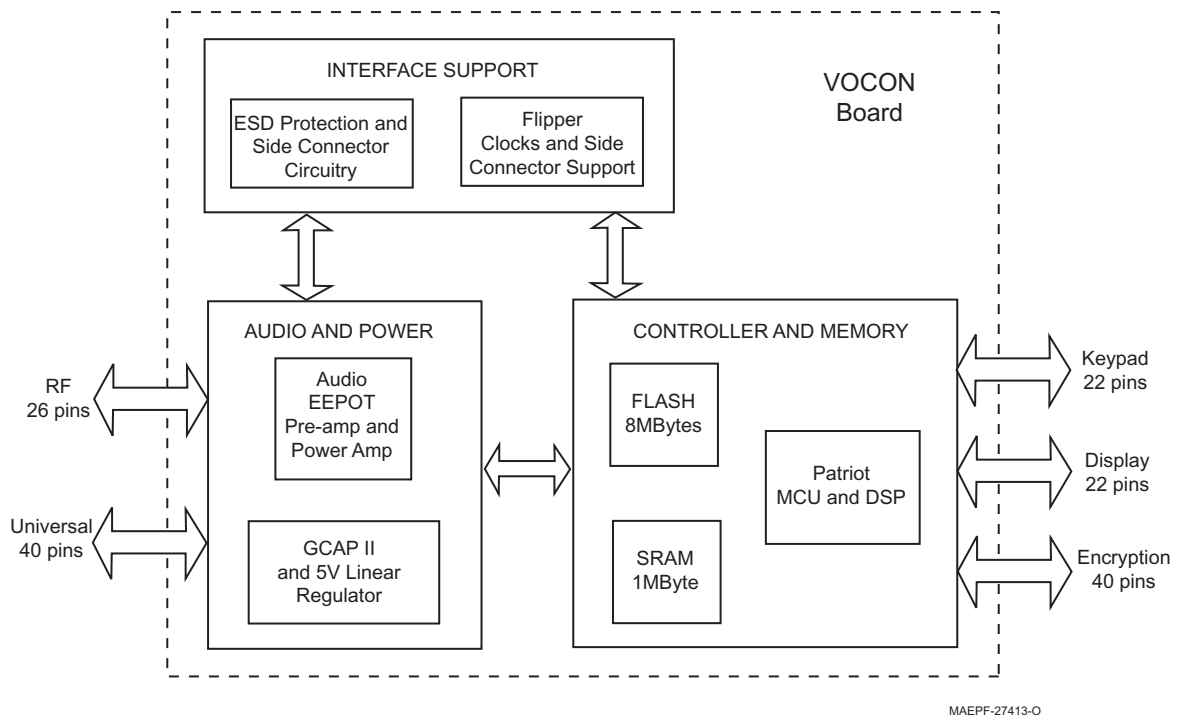


Figure 2-3. VOCON Board Interconnections

2.1.3 Universal Flex Assembly

The universal flex assembly contains the volume/on/off switch, frequency selector switch, push-to-talk (PTT) switch, monitor button, several function-selectable switches, universal connector, speaker, and microphone.

2.1.4 Display Module

The display module is a 96 pixels x 64 pixels bit-mapped, liquid-crystal display (LCD) with associated circuitry. This module uses chip-on-film technology and is not field repairable.

2.1.5 Keypad Module

The keypad module is either a 6- x 3-button (Model III) or a 2- x 3-button (Model II) module with backlighting.

2.1.6 Encryption Module

The encryption module (secure models only) connects directly to the VOCON board and interfaces directly with the vocoder digital circuitry. It contains an independent microcontroller and two custom ICs to perform digital, numerical, encryption algorithms.

The encryption modules are designed to digitally encrypt and decrypt voice and ASTRO data in ASTRO XTS 5000 radios. This section covers the following secure modules:

NTN4006A	NTN9838A
NTN9837A	NTN9839A

NOTE: The encryption modules are NOT serviceable. The information contained in this section is only intended to help determine whether a problem is due to an encryption module or the radio itself.

The encryption module uses a custom encryption IC and an encryption key variable to perform its encode/decode function. The encryption key variable is loaded into the encryption module, via the radio's universal (side) connector, from a hand-held, key variable loader (KVL). The encryption IC corresponds to the particular encryption algorithm purchased. Table 2-1 lists the encryption algorithms and their corresponding kit numbers.

Table 2-1. Encryption Module Encryption Algorithms

Kit Number	Algorithm
NTN4006A	DES, DES-XL, DES-OFB ENCRYPTION KIT-UCM
NTN9837A	DES, DES-XL, DES-OFB WITH DVP-XL ENCRYPTION KIT-UCM
NTN9838A	DVI-XL ENCRYPTION KIT-UCM
NTN9839A	DVP-XL ENCRYPTION KIT-UCM

2.2 Analog Mode of Operation

This section describes the analog receive and transmit modes of operation.

2.2.1 Receiving

The XTS 5000 transceiver has a dual-conversion superheterodyne receiver, with the Abacus III bandpass sigma-delta analog-to-digital (A/D) converter back-end IC (Figure 2-4). Detailed descriptions of the receiver subsections are discussed later in this chapter.

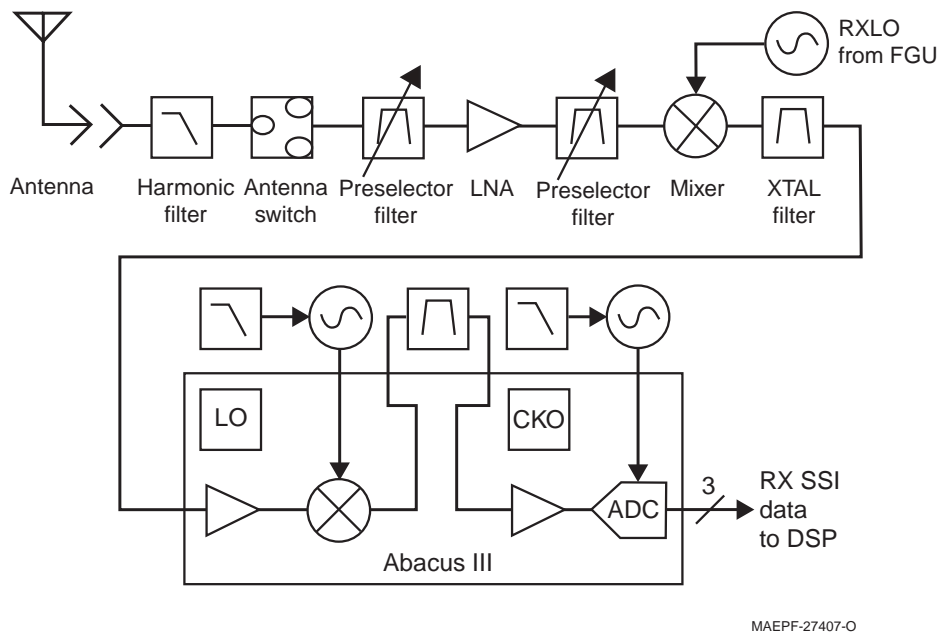


Figure 2-4. Receiver Block Diagram

In the VOCON board, the Patriot digital signal processor (DSP) processes the synchronous serial interface (SSI) data from Abacus III. Voice data is sent to the coder/decoder (CODEC) for conversion to an analog signal. The CODEC delivers the signal to the audio power amplifier (PA), which drives the speaker. Subaudible signaling information is decoded by the DSP and passed to the MCU.

2.2.2 Transmitting

When the radio is transmitting voice, microphone audio is passed through gain stages to the CODEC, where the signal is digitized. The CODEC then passes the digital data to the DSP, where pre-emphasis and low-pass (splatter) filtering are done. The DSP then sends the signal to a digital-to-analog (D/A) converter on the transceiver board.

In contrast to the way microphone audio—that is, voice—is processed for transmission, signaling information is accepted by the DSP from the MCU, coded appropriately, and passed to a D/A converter, which then handles it the same as a voice signal.

Modulation information is passed to the synthesizer along the modulation line. A modulated carrier is provided to the RF power amplifier (PA), which transmits the signal under dynamic power control.

2.3 ASTRO Mode (Digital Mode) of Operation

In the ASTRO (digital) mode of operation, the transmitted or received signal is limited to a discrete set of deviation levels, instead of continuously varying. The receiver handles an ASTRO mode signal the same way it does an analog mode signal, up to the point where the DSP decodes the received data.

In the ASTRO receive mode, the DSP uses a specific algorithm to recover information. In the ASTRO transmit mode, microphone audio is processed the same as an analog mode signal, except that an algorithm in the DSP encodes the information as deviation levels limited to discrete levels.

2.4 Transceiver Board Overview

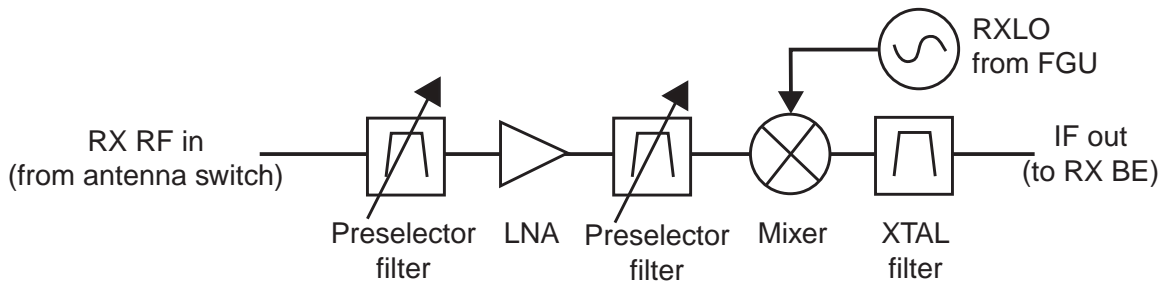
The transceiver board is divided into the following sections:

- Receiver
- Transmitter
- Frequency Generation Unit (FGU)

2.4.1 Receiver Front End

The receiver front end ([Figure 2-5](#)) tunes to the desired channel, and down converts the RF signal to the first intermediate frequency (IF). Channel selection is by way of a tunable local oscillator, RXLO, from the FGU.

The receiver front end consists of a preselector filter, an RF amplifier, a second preselector, mixer, and an IF crystal filter. The preselectors are multi-layer ceramic filters with two surface-mount varactor diodes placed on each filter. The RF amplifier is a discrete RF transistor with associated circuitry. The mixer is a double-balanced, active mixer IC, coupled by transformers. The receiver (RX) local oscillator (LO) is provided by the FGU.

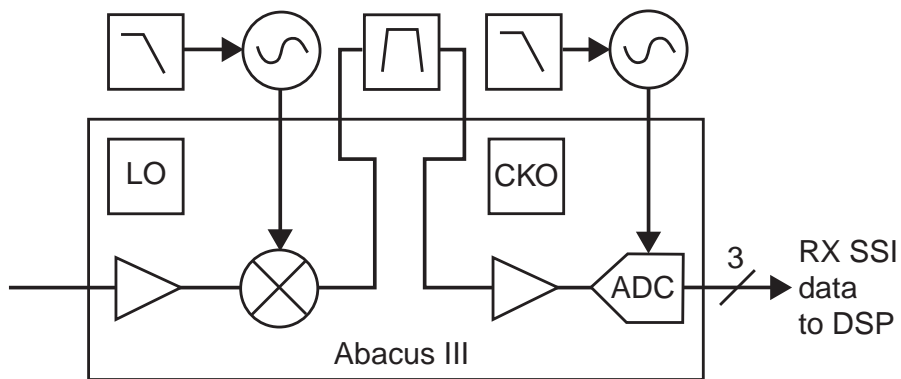


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Figure 2-5. Receiver Front End

2.4.2 Receiver Back End

The receiver back end (Figure 2-6) consists of the Abacus III (AD9874 IF digitizing subsystem) IC, and its associated circuitry.



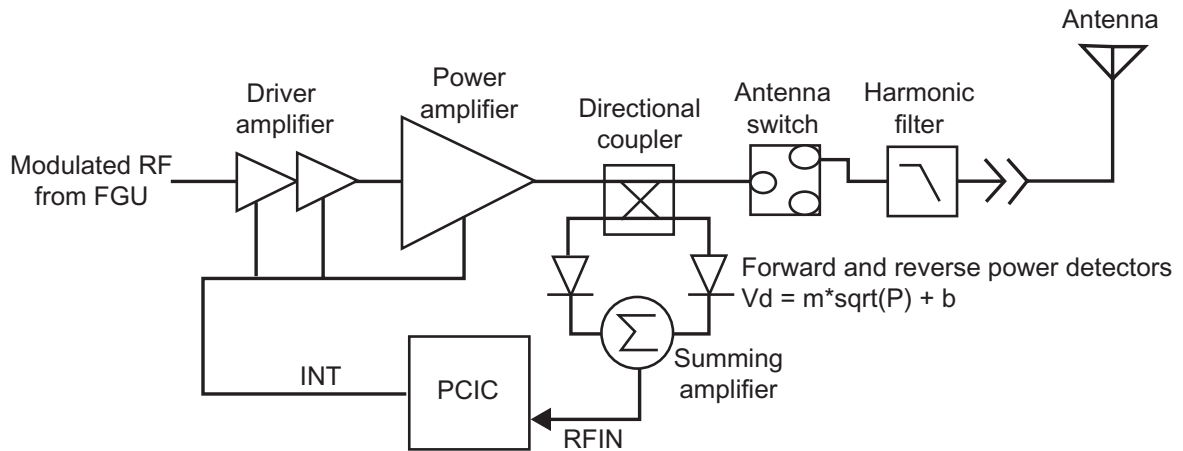
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Figure 2-6. Receiver Back End

The Abacus III IC contains a variable-gain amplifier, the second mixer, a bandpass sigma-delta A/D converter, and frequency synthesizers for the second LO and sampling clock LO. The second LO uses a discrete external loop filter and VCO. The clock oscillator has an external loop filter and resonator. The output of the Abacus III IC is SSI data to the VOCON.

2.4.3 Transmitter

The transmitter (Figure 2-7) consists of an RF driver IC that receives its input signal from the voltage-controlled oscillator (VCO) and a high power output transistor. Transmitter power is controlled by a power-control IC (PCIC) that senses the output of a directional coupler and adjusts PA control voltages to maintain a constant power level. The signal passes through an antenna switch and harmonic filter to the antenna.



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Figure 2-7. Transmitter Block Diagram

2.4.4 Frequency Generation Unit (FGU)

The frequency generation function is performed by three ICs and associated circuitry. The reference oscillator provides a frequency standard to the fractional-N frequency synthesizer (FracN) IC, which controls the voltage-controlled oscillators and a buffer IC (VCOBIC). Three VCOs generate the first LO and transmit-injection signals and buffer them to the required power level through VCOBIC.

The FracN IC incorporates frequency division and comparison circuitry to keep the VCO signals stable. The FracN IC is controlled by the MCU through a serial bus. All of the synthesizer circuitry is enclosed in rigid metal cans on the transceiver board to reduce interference effects.

2.5 VOCON Board Overview

The VOCON board (see [Figure 4-2. VOCON Board Interconnections on page 4-11](#)) is divided into the following sections:

- Controller and Memory
- Audio and Power
- Interface Support

2.5.1 Controller and Memory

The controller and memory section consists of the Patriot IC and its memory devices, the Flash memory, and the SRAM.

The Patriot IC acts as both the microcontroller unit (MCU) and the digital signal processor (DSP) for the radio. The MCU controls receive/transmit frequencies, power levels, display programming, user interface (PTT, keypad, channel select, etc.), and programming of ICs, as well as other functions. The DSP performs voice encoding and decoding, audio filtering, volume control, PL/DPL encode and alert-tone generation, squelch control, and receiver/transmitter filtering, as well as other functions.

The Patriot IC executes a stored program located in the Flash memory device. The SRAM, a volatile device, is used as working memory and shares the address and data bus with the Flash memory device.

2.5.2 Audio and Power

The audio and power section consists of the GCAP II IC, the 5 Vdc regulator, the audio pre-amplifier, the audio power amplifier, and the dual EEPOT.

The GCAP II IC contains a CODEC, amplification, filtering, and multiplexing capability for receive and transmit audio, voltage regulators, an analog-to-digital converter (ADC), and a real-time clock (RTC). The GCAP II IC is programmed by the Patriot IC.

The audio pre-amplifier and the audio power amplifier condition the received audio signal before being routed to the speaker. The dual EEPOT sets the gain of the microphone signal. These devices are programmed by the Patriot IC.

2.5.3 Interface Support

This interface support section consists of the Flipper IC, ESD protection devices, and side connector interface circuitry.

The Flipper IC contains a USB transceiver, switching logic between RS232 and boot data path, One-Wire side connector support, and several clock generators. The Flipper IC is programmed by the Patriot IC.

ESD protection devices include zener diodes and low-capacitance ESD suppressors. Side connector interface circuitry includes current-limiting resistors and noise-suppressing shunt capacitors.

Chapter 3 Radio Power

3.1 Introduction

This chapter provides a detailed circuit description of the power distribution of an ASTRO XTS 5000 radio.

3.2 General

In the ASTRO XTS 5000 radio, power (B+) is distributed to two boards (see Figure 3-1.): the transceiver (RF) board and the VOCON board. In the case of a secure model radio, B+ is also supplied to the encryption module.

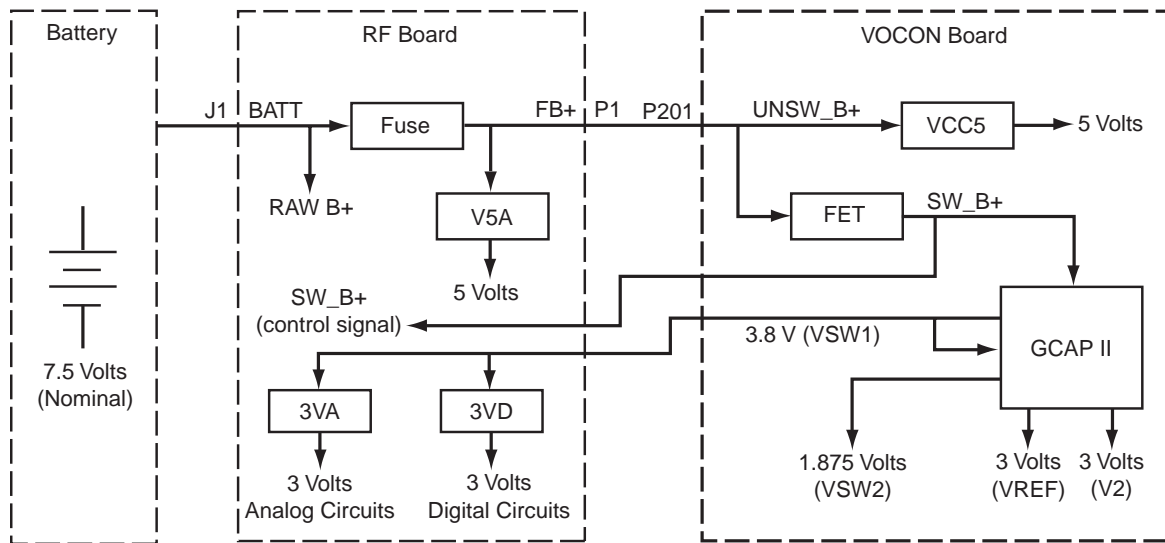
Power for the radio is provided through a battery supplying a nominal 7.5 Vdc directly to the transceiver. The following battery types and capacities are available:

Table 3-1. Conventional Batteries

Part Number	Description
NTN8294	Nickel-Cadmium, 1525 mAh
NTN8295	Nickel-Cadmium, 1525 mAh, FM Approved
NTN8297	Nickel-Cadmium, 1525 mAh, FM Approved Rugged
NTN8299	Nickel-Metal-Hydride, 1700 mAh, FM Approved
NTN8923	Nickel-Metal-Hydride, 1800 mAh
NTN8610	Lithium-Ion, 1500 mAh Slim
NTN9177	Battery Holder Clamshell, Black
NTN9183	Battery Holder Clamshell, Orange

Table 3-2. Smart Batteries

Part Number	Description
HTN9031	Nickel-Cadmium, 1525 mAh
HTN9032	Nickel-Cadmium, 1525 mAh, FM Approved
NTN9533	Lithium-Ion 2400 mAh



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Figure 3-1. DC Power Distribution

B+ from the battery is electrically switched to most of the radio, rather than routed through the on/off/volume control knob, S1. The electrical switching of B+ supports a *keep-alive* mode. Under software control, even when the on/off/volume control knob has been turned to the Off position, power remains on until the MCU completes its power-down, at which time the radio is physically powered-down.

3.3 DC Power Routing—Transceiver Board

See [Figure 9-1. Transceiver \(RF\) Board Overall Circuit Schematic on page 9-2](#) for a schematic showing the transceiver board DC power routing components.

Connector J1, the B-plus assembly, connects the battery to the transceiver board. Capacitors C1, C2, and C3 provide protection against momentary breaks at the B-plus connector due to contact bounce when the radio is dropped.

Components C5, E4, C7, and E1 form a power-line filter for signal RAWB+, which supplies battery voltage to the transmitter PA.

Transistor Q1, controlled by signal SWB+ from the VOCON board, turns on XB+, which supplies to the 5-volt linear regulator and TX_ALC block.

Fuse F901 and filter C11, L1, C10 supply fused B-plus to the VOCON board. In turn, the VOCON board supplies VSW1, regulated 3.8 Vdc, from the Global Control Audio and Power (GCAP) switching regulator to the XCVR. Switch Q99, controlled by SWB+, turns on V38 to the XCVR 3-volt linear regulators. The XCVR regulated power supplies are summarized in [Table 3-3](#).

Table 3-3. Transceiver Voltage Regulators

Ref. Desig.	IC Name	Output Signal Name	Description
U1	LP2989	V5A	Regulated 5.0 Vdc
U2	LP3985	V3D	Regulated 3.0 Vdc digital
U3	LP3985	V3A	Regulated 3.0 Vdc analog for the RX FE

3.4 DC Power Routing—VOCON Board

See Figure 9-16. VOCON Audio and DC Circuits on page 9-22 for a schematic showing the VOCON board DC power routing components.

Raw B+, or unswitched B+, (UNSW_B+) is routed to connector P1 on the transceiver board, and then on to P201 on the VOCON board. Here the UNSW B+ is forwarded to the radio's control top on/off/volume knob through connector J101 and a flex circuit, as well as to regulator U505 (VCC5).

The on/off/volume knob controls B+SENSE to Q502, which in turn controls Q501. Transistor Q501 is a solid-state power switch that provides SW B+ to the VOCON board, the audio PA, the GCAP II IC (via GCAP_B+), and back to the transceiver board.

In the case of a secure radio model, SW B+ and UNSW B+ are also supplied to the encryption module through connector J701.

Transistor Q501 is also under the control of the microcontroller unit (MCU) via Vref from U501. This allows the MCU to follow an orderly power-down sequence when it senses that B+SENSE is off. This sense is provided through MECH_SW_BAR (inverted B+SENSE, see Q508).

The digital circuits in the VOCON board are powered from regulators located in the GCAP II IC (U501) and an external 5 Vdc regulator (VCC5, U505). The GCAP II IC provides three supplies: VSW1, VSW2, and V2. These regulators are software programmable. Table 3-4 lists the supply voltages and the circuits that use these voltages.

Table 3-4. VOCON Board DC Power Distribution

Supply Name	Output Voltage	Supply Type	Unprogrammed Output Voltage	Circuits Supplied
UNSW_B+	9 to 6 Vdc 7.5 Vdc nominal	Battery	N/A	VCC5 input Mechanical switch Power switch (FET) Secure module Real-time clock battery
SW_B+	9 to 6 Vdc 7.5 Vdc nominal	Battery	N/A	VSW1 input (GCAP) Audio power amplifier Side connector SW_B+ to transceiver board GCAP IC Secure module USB circuitry

Table 3-4. VOCON Board DC Power Distribution (Continued)

Supply Name	Output Voltage	Supply Type	Unprogrammed Output Voltage	Circuits Supplied
VCC5	5Vdc	Linear Regulator	N/A	Smart battery circuitry Int. / ext. microphone bias Audio preamplifier Flipper IC Keypad / Display LEDs
VSW1	3.8 Vdc	Switching regulator software programmable	3.2 Vdc	3-Volt regulators (RF) VSW2 input V2 input
VSW2	1.8 Vdc	Switching regulator software programmable	2.2 Vdc	Patriot core FLASH IC SRAM Display
V2	3 Vdc	Switching regulator software programmable	2.775 Vdc	Patriot I/O ring Flipper IC EEPOT Display 16.8 MHz buffer

Chapter 4 Detailed Theory of Operation

4.1 Introduction

This chapter provides a detailed circuit description of the ASTRO XTS 5000 transceiver and VOCON boards. When reading the theory of operation, refer to the appropriate schematic and component location diagrams located in the back of this manual. This detailed theory of operation can help isolate the problem to a particular component.

4.2 Transceiver Board

The transceiver (XCVR) board performs the transmitter and receiver functions necessary to translate between voice and data from the VOCON board and the modulated radio frequency (RF) carrier at the antenna.

4.2.1 Interconnections

This section describes the various interconnections for the transceiver board.

4.2.1.1 Battery Connector J3

Battery connector J3 consists of three gold-plated contacts on the printed circuit board that mate with a B-plus connector assembly. Signal descriptions are in [Table 4-1](#).

Table 4-1. Battery Connector J3

Pin No.	Signal	Description
1	BATT	Battery positive terminal, nominally 7.5 Vdc
2	BSTAT	Battery status, from battery to VOCON
3	BAT_RTN	Battery negative terminal, tied to PCB ground

4.2.1.2 VOCON Connector P1

VOCON connector P1 (located on the XCVR board) consists of 26 gold-plated pads for the 26-pin compression connector, and one plated tool hole (pin 27) used for connector alignment. This is a digital interface carrying DC power, control, and data between the XCVR and VOCON boards. P1 connects through the compression connector to P201 on the VOCON board.

[Table 4-2](#) lists the connector pins, their signals, and functions. SPI refers to serial peripheral interface, which is the control bus from the microprocessor. SSI is the serial synchronous interface bus for data to and from the DSP. There is a RX SSI bus for demodulated data from the receiver and a TX SSI bus for modulation data to the transmitter.

Table 4-2. VOCON Connector P1

Pin No.	VOCON Signal	XCVR Signal	XCVR I/O	Type	Description
1	UNSW_B+	FUB+	O	dc	Fused B+ to VOCON
2	UNSW_B+	FUB+	O	dc	Fused B+ to VOCON
3	LOCK_DET*	LOCK	O	status	FGU lock detect
4	TX_SSI_DATA	TXTD	O	ssi	TX SSI data
5	SSI_CLK	RXCK	O	ssi	RX SSI clock
6	SSI_FSYNC	SSFS	O	ssi	RX SSI frame sync
7	16.8MHz	F168	O	RF	16.8 MHz reference clock
8	SW_B+	SWB+	I	dc	Switch control
9	TX_SSI_FSYNC	TXFS	I	ssi	TX SSI frame sync
10	TX_SSI_CLK	TXCK	I	ssi	TX SSI clock
11	GND	GND			
12	RX_SSI_DATA	RXDO	O	ssi	RX SSI data
13	ABACUS3_CS	ABCS	I	ssi	SPI Abacus chip select
14	GND	GND			
15	VSW1	VSW1	I	dc	Regulated 3.8 V
16	SPI_CLK_A	SPCK	I	spi	SPI clock
17	SPI_MISO_A	MISO	O	spi	SPI data out
18	EEPROM_SEL*	EECS	I	spi	SPI EEPROM chip select
19	TX_INHIBIT	TXINH	I	control	TX inhibit control for secure
20	GND	GND			
21	BAT_STATUS	BSTAT	O	dc	Battery status
22	GND	GND			
23	SPI_MOSI_A	MOSI	I	spi	SPI data I/O
24	UNI_CS	USEL	I	spi	SPI universal chip select
25	AD_CS	ADCS	I	spi	SPI ADC chip select
26	POR*	RSTL	I/O	control	asynchronous reset, active low

4.2.1.3 Antenna Port J2

Antenna port J2 is a surface-mount, miniature coaxial connector for the antenna cable.

4.2.1.4 Serial EEPROM (U907)

The serial, electrostatically erasable, programmable, read-only memory (EEPROM), U907, holds all of the transceiver tuning data. This allows transceivers to be tuned in the factory and installed in the field without retuning.

4.2.1.5 Power Conditioning Components

Power conditioning components include zener diodes, capacitors, ferrite beads, a power inductor, and the fuse. Diodes VR1 and VR2 provide over-voltage protection. Ferrite beads (designated E1, etc.) and capacitors suppress electromagnetic interference from the transceiver. The power line filter consisting of L1, C10, and C11, suppresses digital noise from the VOCON board switching power supplies that could degrade the transmitter spectral purity.

Pass transistor Q1 switches battery voltage to the XCVR when control signal SWB+ from the VOCON board is asserted high. This increases the XCVR's immunity to conducted interference that might be present on SWB+, such as from switching voltage regulators on the VOCON board.

Ground clips G1 through G12 make contact between the transceiver board ground and the radio chassis. The chassis connection is a necessary electrical reference point to complete the antenna circuit path. Shields SH201 through SH700 and the tool hole appear on the schematic to show their connection to ground.

4.2.2 Receiver Front End

See [Figure 9-3. Receiver Front End Circuit on page 9-4](#) for schematic details.

4.2.2.1 Preselector Filters

The receiver front end uses two, multi-layer, ceramic, tunable, bandpass filters to achieve its required image rejection. The first preselector filter, FL401, precedes the discrete RF amplifier. To tune the center frequency of the first filter, voltage from port DAC1 is applied to pin 3 of FL401. Pin 3 connects to the surface-mounted varactor diodes placed on each filter. A second identical filter, FL402, follows the discrete RF amplifier. The second filter is tuned by applying voltage from port DAC2 to pin 3 of FL402. Capacitors C409 and C410 are RF bypasses. Capacitors C400 and C411 are used to filter out noise from the DAC1 and DAC2 control lines.

4.2.2.2 LNA (Low-Noise Amplifier) Q401

The XTS 5000 uses a discrete RF transistor Q401 for a low-noise amplifier. Resistors R401, R403, R404, and R405 are used to DC bias the RF transistor. The feedback components R406, L402, and C404 are used to achieve gain flatness across the 700-800 MHz band and stability across all frequencies. Capacitor C402 and inductor L400 filter out low-frequency components. Capacitors C406 and C403 are used as DC blocks. Inductors L400 and L401 are used as DC feeds. Capacitor C406 and inductor L404 match the input. Capacitor C405 and inductor L403 match the output. Capacitor C401 is an RF bypass. D401 protects the amplifier by limiting strong input signals.

4.2.2.3 Mixer U401

The mixer, U401, down-converts the received RF to the first IF (intermediate frequency) of 109.65 MHz. In the 700 MHz band, the mixer uses high-side LO injection and low-side LO injection in the 800 MHz band. Transformers T401 and T403 are used as baluns to convert signals from single-ended to balanced at pins MI, MIX, LO, and LOX. Transformer T402 is used as a balun to convert a balanced output at pins MO and MOX to a single-ended output.

4.2.2.4 IF Filter FL403

The XTS 5000 uses a leadless, surface-mount, 3-pole, 3rd overtone, quartz crystal filter, FL403, centered at 109.65 MHz. This narrow bandpass filter gives the radio its adjacent-channel and alternate-channel rejection performance. Components L409, L410, C416, and C417 are used to match the input. Components C418 and L411 are used to match the output.

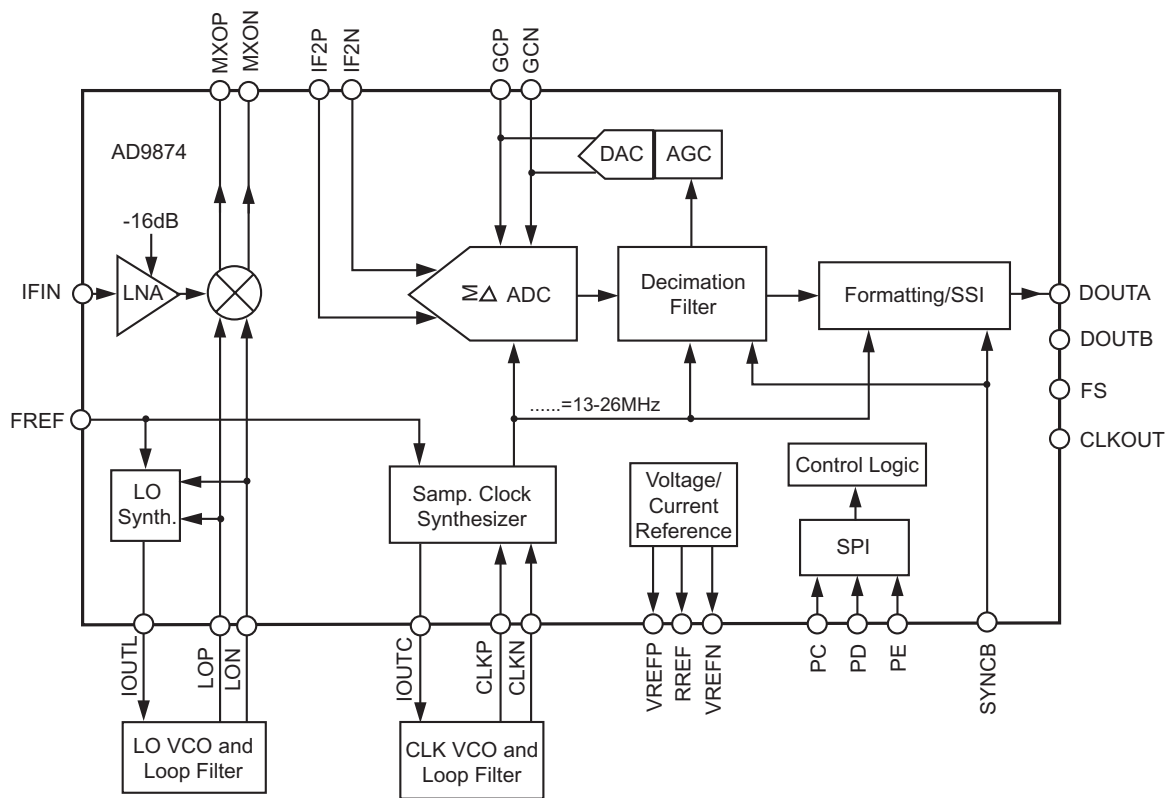
4.2.3 Receiver Back End

The receiver back end processes the down-converted IF signal to produce digital data for final processing by the VOCON DSP. See Figure 9-4. Receiver Back End Circuit on page 9-5 for schematic details.

4.2.3.1 Abacus III IC U500

The receiver back end is designed around the Abacus III (AD9874 IF digitizing subsystem) IC and its associated circuitry.

The AD9874 (see Figure 4-1) is a general-purpose, IF subsystem that digitizes a low-level 10-300 MHz IF input with a bandwidth up to 270 kHz. The signal chain of the AD9874 consists of a low-noise amplifier, a mixer, a bandpass sigma-delta A/D converter, and a decimation filter with programmable decimation factor. An automatic gain control (AGC) circuit provides the AD9874 with 12 dB of continuous gain adjustment. The high dynamic range and inherent anti-aliasing provided by the bandpass sigma-delta converter allow the AD9874 to cope with blocking signals 80 dB stronger than the desired signal. Auxiliary blocks include clock and LO synthesizers, as well as an SPI port.



MAEPF-27412-O

Figure 4-1. Abacus III (AD9874) Functional Block Diagram (from data sheet)

Input signal RXIF is the 109.65 MHz IF from crystal filter FL403 in the receiver front end. Components L547 and C542 match the input impedance from 50 ohms at RXIF to approximately 420 ohms in parallel with a 1 pF capacitance at the Abacus input IFIN. Formatted SSI data is output to the VOCON board on ports FS, DOUTA, and CLKOUT.

4.2.3.2 Second Local Oscillator

The second LO is controlled by the Abacus LO synthesizer. Signal FREF is the 16.8 MHz reference from the FGU. The second LO frequency is 107.4 MHz by default, or 111.9 MHz in special cases as needed to avoid radio self-quieters. Second LO mixes with IFIN to produce a 2.25 MHz final IF. The external VCO consists of Q502, together with its bias network and frequency-determining elements. Darlington transistor Q501 with C550 and R501 form an active power-line filter. The loop filter comprises R507, C558, C559, R505 and C512.

4.2.3.3 Sampling Clock Oscillator

The Abacus sampling clock synthesizer, at 18 MHz = 8 x 2.25 MHz, uses an internal transistor with an external resonator consisting of L503, C535 and D501 and a loop filter consisting of R514, C571, C570.

4.2.4 Transmitter

The transmitter takes modulated RF from the FGU and amplifies it to the radio's rated output power to produce the modulated transmitter carrier at the antenna. [See Figure 9-5. Transmitter and Automatic Level Control Circuits on page 9-6](#) for schematic details of the following discussion.

4.2.4.1 Power Distribution

At a transmitter power of 3 Watts, the radio consumes approximately 1200 mA. To minimize voltage drop to the power amplifiers, net RAWB+ connects to power module Q107 and the second stage of driver amplifier U102 through components having minimal series resistance—ferrite beads and chokes only. During receive, no RF or dc bias is applied, and leakage current through U102 and Q107 is less than 100 microamps. The first stage of U102 uses less than 50 mA and is supplied by TX7V, which is switched on by transistors Q101, Q102, Q103, and Q107 during TX, and switched off during RX or whenever TXINH, the transmitter inhibit control line, is high.

4.2.4.2 Driver Amplifier U102

The driver amplifier, U102, is an IC containing two LDMOS FET amplifier stages and two internal resistor bias networks. Pin 16 is the RF input. Modulated RF from the FGU, at a level of +3 dBm \pm 2 dB, is coupled through a blocking capacitor to the gate of FET-1. Components L109 and C116 form an interstage matching network from the output at VD1 (pin 14) to the second stage input at G2 (pin 11). Capacitor C113 is a dc block. The RF output from the drain of FET-2 is pins 6 (RFOUT1). Components L105 and C110 match the output impedance to 50 ohms; capacitor C107 is a dc block.

Gain control is by a voltage applied to pin 1 (VCNTRL). Typical output power is about +27 dBm (500 mW) with VCNTRL at 5.0 V.

4.2.4.3 Power Amplifier Transistor Q107

The power amplifier transistor, Q107, is an LDMOS FET housed in a high-power, surface-mount, ring package. To prevent thermal damage, it is essential that the heat sink of the power module be held in place against the radio chassis. The input impedance-matching network consists of L106, L107, C108, and C109. Bias is supplied to the drain through E101 and L101. A transmission-line structure and C137, C1111, and C112 form a low-pass, output-matching network.

Gain control is by gate bias applied through R106 and L110. Since the gate is insulated from the drain and source, gate bias current is essentially zero. Capacitor C130 is an RF bypass capacitor.

4.2.4.4 Directional Coupler U101

The directional coupler, U101, is a low-loss, dual-directional coupler with external terminating resistors. The forward- and reverse-coupled signals are used as feedback to the transmitter automatic level control (ALC) loop.

4.2.4.5 Antenna Switch

See [Figure 9-2. Antenna Switch and Harmonic Filter Circuits on page 9-3](#) for schematic details of the following discussion.

Diodes D701 and D702 form a single-pole, double-throw, positive-intrinsic-negative (PIN) diode, transmit/receive antenna switch. When the transmitter is ON, diodes D701 and D702 are forward-biased, and the signal goes from the transmitter to the antenna through the low resistance (about 1 ohm) of the PIN diode D701. The receiver also is shorted by the same low resistance of D702. In the receive mode, neither diode is biased and both behave as small-value capacitors (around 1 pF). These capacitors resonate at the signal frequency with their individual parallel inductors (L706 and L707), which creates high blocking impedances, effectively disconnecting the transmitter circuitry from the antenna.

The switch control circuit consists of transistors Q101, Q103, Q106, and associated resistors. The input signal is TXINH from the VOCON board and RXH from the PCIC. Whenever TXINH is low and RXH is high, PIN diodes are not biased and the radio is in receive mode.

When TXINH and RXH are low, the PIN diodes are ON and the radio will transmit. If TXINH goes high, the radio is *inhibited* from transmitting (a secure module control feature).

4.2.4.6 Harmonic Filter

A harmonic filter is needed to suppress transmitter harmonics in order to meet the radio's specifications for transmitter conducted and radiated emissions.

The 700/800 MHz harmonic filter uses both discrete components and transmission lines to form a low-pass filter. The pass band is up to 870 MHz, and the stop band is above 1500 MHz. Air-core inductors are used for their low losses and high-current handling capabilities. Shield SH700 is also an essential part of this circuit.

4.2.4.7 RF Detectors D101 and D102

The Schottky diodes, D101 and D102, are used as forward- and reverse-power detectors. Forward-coupled RF from the power amplifier, and reverse-coupled RF from the antenna are converted to DC voltages FWD and RVS. Detector output is a positive DC voltage, proportional to the amplitude of the RF signal at the input.

4.2.4.8 Summing Amplifier U106

This op-amp circuit is a non-inverting, unity gain buffer. Signals FWD and RVS are summed and sent to the ALC input of the PCIC. When the antenna port is loaded with a low VSWR (voltage standing wave ratio), as in normal operation, RVS is far less than FWD, the amplifier output is equal to FWD, and the radio maintains a constant output power. Under high VSWR conditions, such as when the antenna is damaged or held near a large metal surface, the amplitude of RVS becomes a large fraction of FWD, the amplifier output increases proportionally, and the radio cuts back the transmitter power by up to 50%. This reduces high battery current into a large VSWR transmitter to extend battery life.

4.2.4.9 Power-Control IC (PCIC) U104

The PCIC, U104, contains all of the digital, and most of the analog, circuits needed to control the transmitter power amplifier. Host control is through a 3-wire, smart SPI interface. Pin descriptions are shown in [Table 4-3](#).

Table 4-3. Power Control IC (U104) Pin Descriptions

Pin	Name	Description
1	RFIN	Detector voltage input to ALC
2	T1	Test point
3	CI	External capacitor for integrator time constant
4	INT	Integrator output; control voltage to amplifiers
5	CJ	External capacitor for PA rise and fall times
6, 7	VL, CL	External capacitor for PA rise and fall times
8	GND1	Ground
9	F168	Reference clock input, 2.1 MHz
10, 13	QX, CQX	External capacitor for voltage multiplier
11, 12	Q, CQ	External capacitor for voltage multiplier
14	V10	Voltage multiplier output
15	VG	Internal band-gap reference voltage
16	V45	Regulated 4.5 Vdc output
17	V5EXT	Power supply input for internal voltage regulator
18	VAR2	Buffered D/A output
19	VLIM	Test point for internal D/A No.2 voltage
20	VAR1	Buffered D/A output
21	RS	Asynchronous reset input
22	NA	Spare pin
23	RX	RX/TX mode control-bit output
24	VAR3	Buffered D/A output
25	GND2	Ground
26	CLK	SPI clock input
27	BPOS	Power supply input
28	DATA	SPI data input/output
29	CEX	SPI chip select input
30	TEMP	Temperature sensor input
31	RSET	External resistor; used to set the temperature cutback rate
32	ANO	Switched BPOS output

4.2.4.9.1 Power and Control

Since U104 is powered from switched B+, it makes its own regulated 4.5 Vdc to power the internal logic. The supply input is V5EXT at pin 17, and the output is V45 at pin 16. RX at pin 23 is the control signal to the antenna switch control circuit.

4.2.4.9.2 Voltage Multiplier

The PCIC contains an internal voltage multiplier. This multiplier produces signal V10 (pin 14), a 10-volt supply for the PCIC D/A converters (DACs). This enables the DACs outputs to reach 8 volts. The FREF signal is a 2.1 MHz clock used to switch the multiplier. The voltage multiplier is not used on the 700/800 MHz XTS 5000.

4.2.4.9.3 Automatic Level Control (ALC)

In TX mode, the PCIC disables the receiver, turns on the transmitter, and controls the TX power level. The automatic level control (ALC) circuit operates as follows:

The power level is set by programming an internal DAC to a calibrated reference voltage. D/A settings for the power set points were determined during radio tuning and stored in EEPROM. An internal op-amp compares the D/A reference voltage to the detector voltage at pin 1 (RFIN) (TP101) and produces an error signal output. This signal is buffered by another op-amp, configured as a low-pass filter, or integrator, to produce the INT output at pin 4 (TP104). This signal drives the base of voltage follower Q108.

Transistor Q108 supplies current to drive the gain control pins of amplifiers U102 and Q107. Resistors R105 and R106 determine the voltage ratio between U102 pin 2 (VCNTRL) and the Q107 gate. Transient response during key-up and key-down is controlled by the power amplifier rise and fall times. External capacitors at pins CI, CJ, and CL, along with internal programmable resistors, determine the ALC time constants.

4.2.4.9.4 Temperature Cut Back

The PCIC contains a temperature cut-back circuit to protect the power amplifier (PA) from thermal damage that might result from incorrect assembly of the radio. External sensor U103 is a linear temperature-to-voltage transducer, placed near the hottest spot in the radio: power module Q107. The output is a dc voltage at pin 2 (VOUT) proportional to the temperature at pin 3 (GND). VOUT is 750 mV at 25°C and increases by 10mV/°C. The PCIC temperature cut-back threshold is programmed to correspond to 85 or 90°C. Above this threshold, the ALC gradually cuts back the transmitter until it is fully turned off at 125°C. The slope of cut-back versus temperature is set by external resistor R111. Diode D104 clamps TEMP to a voltage not much less than VG (pin 15), about 1.3 V, to improve the transient response of the cut-back circuit.

4.2.4.9.5 D/A Outputs

In RX mode, the PCIC shuts down the transmitter, turns on the receiver, and tunes the RX front-end pre-selector filters. Signals VAR1 and VAR2 are D/A outputs to the RX FE pre-selector filters. Output voltage is in the range of about 1 to 4 V over the 700/800 MHz frequency band. In TX mode, VAR1 and VAR2 disconnect from the D/A and go to 0 Vdc, thus tuning the RX FE filters out of band.

4.2.5 Frequency Generation Unit (FGU)

See [Figure 9-6. Frequency Generation Unit \(Synthesizer\) Circuit—1 of 2 on page 9-7](#) and [Figure 9-7. Frequency Generation Unit \(VCO\) Circuit—2 of 2 on page 9-8](#) for schematic details of the following discussion.

4.2.5.1 Reference Oscillator Y200

The radio's frequency stability and accuracy derive from the Voltage-Controlled Temperature-Compensated Crystal Oscillator (VCTCXO), Y200. This 16.8 MHz oscillator is controlled by the voltage from the WARP pin of the FracN (fractional-N frequency synthesizer) IC, U202, that can be programmed through a serial peripheral interface (SPI). The oscillator output at pin 3 is coupled through capacitor C234 to the FracN synthesizer reference oscillator input and through C236 to the non-invertive input of the op-amp, U201.

Op-amp U201 buffers the 16.8 MHz output to the VOCON board. Components L205 and C214 form a low-pass filter to reduce harmonics of the 16.8 MHz.

The Digital-to-Analog Converter (DAC) IC, U203, and Switched Capacitors Filter (SCF) IC, FL200, form the interface between radio's DSP and the analog modulation input of the FracN IC.

4.2.5.2 Fractional-N Frequency Synthesizer (FracN) IC U202

The FracN IC, U202, is a Motorola-proprietary, CMOS, fractional-N frequency synthesizer with built-in dual-port modulation. The XTS5000 radio uses a low-voltage version of the device, sometimes called LVFracN, for compatibility with the 3 V logic used throughout the radio.

The FracN IC, U203, is a mixed-mode IC, containing digital and analog circuits. Separate power supply inputs are used for the various functional blocks on the IC. Inductors L203 and L204 provide isolation between supply pins 20 (AVDD) and 36 (DVDD) connected to Vdd3. Host control is through a three-wire, smart SPI interface (pins 7, 8, and 9) with a bi-directional data pin. FracN functions include frequency synthesis, reference clock generation, modulation control, voltage multiplication and filtering, and auxiliary logic outputs.

4.2.5.2.1 Synthesizer

Frequency synthesis functions include a dual-modulus prescaler, a phase detector, a programmable loop divider and its control logic, a charge pump, and a lock detector output. Fractional-N synthesizer IC principles of operation are covered in detail in the manufacturers' literature. No similar discussion will be attempted here.

4.2.5.2.2 Clocks

U202, pin 23 (XTAL1), is the 16.8 MHz reference oscillator input from the VCTCXO (Y200).

4.2.5.2.3 Modulation

To support many voice, data, and signaling protocols, XTS 5000 radios must modulate the transmitter carrier frequency over a wide audio frequency range, from less than 10 Hz up to more than 6 kHz. The FracN supports audio frequencies down to zero Hz by using dual-port modulation. The audio signal at pin 10 (MODIN) is internally divided into high- and low-frequency components, which modify both the synthesizer dividers and the external VCOs through signal MODOUT (pin 41). The IC is adjusted to achieve flat modulation frequency response during transmitter modulation balance calibration using a built-in modulation attenuator.

4.2.5.2.4 Voltage Multiplier and Superfilter

Pins 12 (VMULT3) and 11 (VMULT4) together with diode arrays D201 and D202 and their associated capacitors form the voltage multiplier. The voltage multiplier generates 11.5 Vdc to supply the phase detector and charge-pump output stage at pin 47 (VCP).

The superfilter is an active filter that provides a low-noise supply for the VCOs and VCOBIC, U300. The input is regulated 5 Vdc from Vdd5 at pin 30 (SFIN). The output is superfiltered voltage FSF at pin 28 (SFOUT).

The output from pin 15 (VMULT1) is used as a clock for the SCF IC, FL200.

4.2.5.3 Loop Filter

The components connected to pins 43 (IOUT) and 45 (IADAPT) form a 3rd-order, RC low-pass filter. Current from the charge-pump output, IOUT, is transformed to voltage VCTRL, which modulates the VCOs. Extra current is supplied by IADAPT for rapid phase-lock acquisition during frequency changes. The lock detector output pin 4 (LOCK) goes to a logic "1" to indicate when the phased-lock loop is *in lock*.

4.2.5.4 VCO Buffer IC (VCOBIC) U300

The VCOBIC, U300, is an analog IC containing two bipolar npn transistors (BJT), active bias, buffer amplifiers, and a switching circuitry. BJTs and an active bias are not being used in XTS 5000 700/800 MHz radio. Buffered outputs TX_OUT (pin 10) and RX_OUT (pin 8) are the modulated transmitter carrier and the receiver first LO; PRESC_OUT (pin 12) through the matching circuit is connected to pin 32 (PREIN) of the FracN IC, U202. Transmit/receive control is a single 5 Vdc logic input, TRB_IN (pin 19). When TRB_IN is low, the receiver buffer is active and the transmitter circuits are disabled. The converse is also true. Two transistors, Q307 and Q310, form a 3.3 Vdc-to-5 Vdc logic level shifter between the AUX3 pin of the FracN IC, U202, and VCOBIC, U300.

Transistor Q304 and its associated circuitry is an additional transmit buffer amplifier reducing the transmit VCOs *pulling*. An additional buffer is switched On and Off by the transistor Q305.

The transistors Q301, Q303, and Q308 are active devices of the three Colpitts varactor-tuned VCOs. VCOs are switched On and Off by the transistors Q302, Q306, and Q309 using AUX1, 2, and 4 outputs of the FracN IC.

The VCOBIC has three RF outputs: TX_OUT, RX_OUT, and PRESC_OUT. Bias to pin 10 (TX_OUT) is supplied through resistor R307. Components L307 and C208 form a low-pass bias supply filter.

Components L309 and C325 form a low-pass bias supply filter for the RX_OUT. Coil L310 represents a one component match for the RX_OUT impedance. C327 is a dc block, and resistors R321 and R323 attenuate an output signal to the level optimal for the mixer IC.

4.3 VOCON Board

This section provides a detailed circuit description of the ASTRO XTS 5000 VOCON board.

4.3.1 Interconnections

The VOCON board interconnection diagram (see [Figure 4-2](#)) contains three functional blocks and five connector symbols.

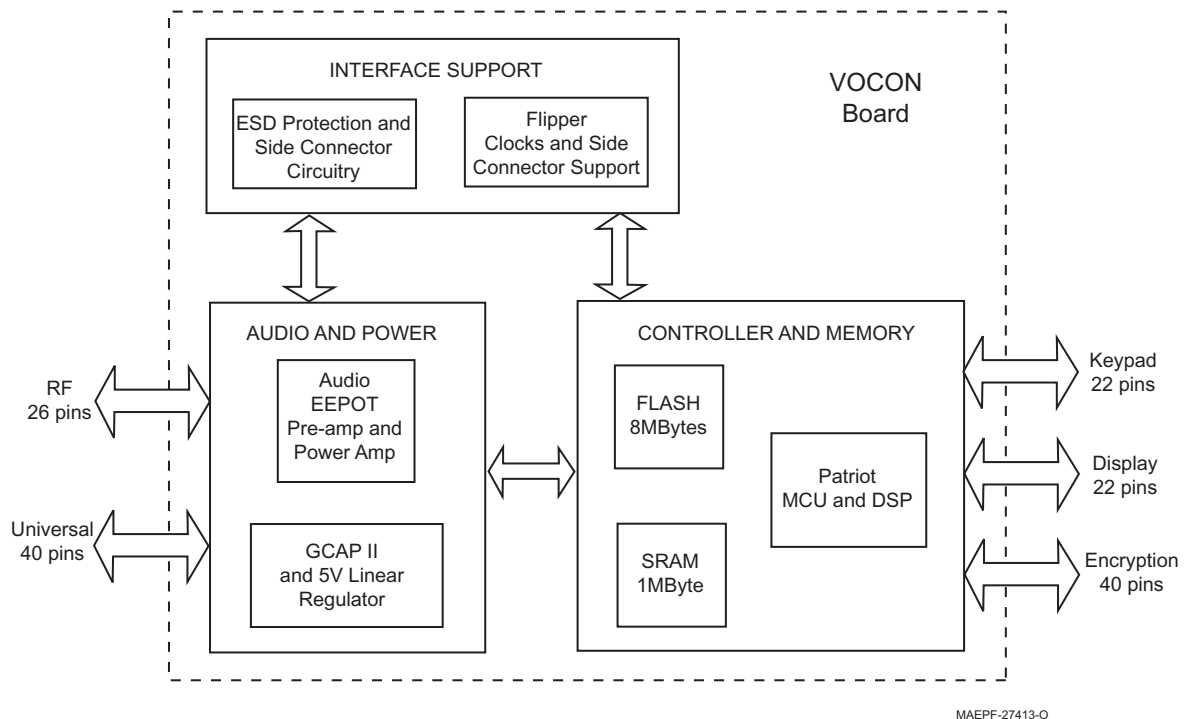


Figure 4-2. VOCON Board Interconnections

The functional blocks consist of the following:

- The Patriot (U401), the dual-core processor with the microcontroller unit (MCU) and a digital signal processor (DSP), the SRAM (U403) and Flash (U402) memory devices
- The GCAP II (U501), a 5 Vdc linear regulator (U505), the audio pre-amplifier (U502), the audio power amplifier (U503), and the EEPOT (U509)
- The digital-support IC Flipper (U301), ESD protection circuitry, and side connector interface circuitry.

See [Figure 9-10. VOCON Board Overall Schematic—1 of 2 on page 9-16](#) and [Figure 9-11. VOCON Board Overall Schematic—2 of 2 on page 9-17](#) for schematic details of the following discussion.

4.3.1.1 Universal Connector J101

This is a 40-pin connector that mates with the universal flex on the housing. A majority of the lines on the connector are for user interface: emergency & side buttons (pin 14), monitor button (pin 17), secure/clear switch (pin 23), frequency switch (pins 24, 25, 26, and 27), volume knob (pin 31), and the three-position switch (pin 34). The LEDs on the universal flex are controlled through pins 20, 21, and 22. Connections to the external accessory connector, which include serial communication data lines, external audio, and option select lines for controlling audio modes, are present at pins 1 through 13. Switched battery voltage (B+SENSE) is provided on pin 32. Most of the pins at this connector have ESD protection devices and components.

4.3.1.2 Encryption Connector J701

This 40-pin connector provides the interface between the VOCON board and the encryption module. Two voltages are provided to the encryption board: UNSWB+ and SWB+. The SAP SSI lines, serial communication data lines, and general-purpose I/O lines from the Patriot IC are included in the interface to the encryption board. A number of jumpers are present on some of the lines so that the VOCON board configuration to the encryption board can be changed depending on the encryption type present.

4.3.1.3 Keypad Module Connector P107

This 22-pin connector mates the VOCON board to the keypad module flex used on Model II and III radios. The keypad module is provided with 5 volts (pins 7 and 8) for the LEDs. The LEDs are activated by the signal at pin 6, BL_EN. The row signal lines (pins 13, 14, 15, 16, 17, 18, and 19) and column signal lines (pins 1, 2, and 3) are all at 3-volt logic levels.

4.3.1.4 RF Interface Connector P201

This is a 26-pin compression connector that interfaces between the VOCON board and the transceiver board. See [“4.2.1.2 VOCON Connector P1” on page 4-1](#) for a detailed description of the interface between the VOCON and transceiver boards through P201. Ground clip M202 is used on the bottom side of the VOCON board to contact the transceiver shield. This additional connection provides a consistent, common ground with the VOCON board and the radio chassis.

4.3.1.5 Display Module Connector P301

This 22-pin connector mates the VOCON board to the display module flex used on Model II and III radios. Two voltages are provided to the display module: 1.8 volts and 3 volts. The display's parallel data lines (pins 9, 10, 11, 12, 13, 14, 15, and 16), chip select line (pin 5), read/write line (pin 8), register select line (pin 7), and parallel/serial configuration line (pin 4) are at 1.8-volt logic levels.

4.3.2 Controller and Memory Section

The controller and memory section contains the following components:

- Patriot IC (U401)
- Static RAM (SRAM) IC (U403)
- Flash memory IC (U402).

See [Figure 9-14. VOCON Controller and Memory Circuits—1 of 2 on page 9-20](#) and [Figure 9-15. VOCON Controller and Memory Circuits—2 of 2 on page 9-21](#) for schematic details of the following discussion.

4.3.2.1 Patriot IC U401

The Patriot IC U401 is a dual-core processor that contains both a 32-bit microcontroller unit (MCU) and a 16-bit digital signal processor (DSP) in one IC package. It comes in a 256-pin, ball-grid array (BGA) package with 1mm pitch solder balls. The Patriot IC is supplied with two voltages: 1.8 volts (E401) and 3 volts (E402). The 1.8-volt supply is used as the core voltage, as well as the interface voltage to the memory devices and display. Most of the pins on the Patriot IC operate from the 3-volt supply.

Two main clocks are provided to the Patriot IC. The CKIH pin (C452) is provided a 16.8 MHz sine wave. This is the most important clock since it is internally used to generate the clocks for both the MCU and DSP cores, as well as most of the peripherals. A 3-volt peak-to-peak 32 kHz square wave (32 kHz test point) is generated by the Flipper IC U301 and supplied to the CKIL pin on the Patriot IC. While not as widely used as the 16.8 MHz clock, the 32 kHz clock is needed by some components in the Patriot including the reset circuitry.

4.3.2.1.1 Microcontroller Unit (MCU)

The MCU portion of the Patriot IC has 22.5Kx32 bits of internal RAM and 1Kx32 bits of internal ROM, which is used for the bootstrapping code. The MCU has several peripherals including an External Interface Module (EIM), the Multiple Queue Serial Peripheral Interface (MQSPI), two Universal Asynchronous Receiver/Transmitter (UART) modules, and the One-Wire Interface module. The MCU communicates internally to the DSP through the MCU/DSP Interface (MDI).

External Interface Module (EIM)

The External Interface Module (EIM) is the MCU interface to the SRAM U403 and Flash Memory U402, as well as the display. The EIM lines include 24 external address lines, 16 external bi-directional data lines, 6 chip selects lines, read/write line, and output enable line among others. All of the EIM lines operate at 1.8-volt logic levels, and the EIM operates at the MCU clock speed.

Multiple Queue Serial Peripheral Interface (MQSPI)

The Multiple Queue Serial Peripheral Interface (MQSPI) is the MCUs programming interface to other ICs. The Patriot IC has two independent SPI busses, and each has its own clock line (test points SCKA & SCKB), data-out line (test points MOSIA & MOSIB), and data-in line (test points MISOA & MISOB). There are 10 SPI chip selects (SPICS) that are programmable to either SPI A, the transceiver board SPI bus, or to SPI B, the dedicated VOCON SPI bus. The devices on the SPI A bus include the PCIC and FracN IC on the SPICS4 (R131), the Abacus III IC on SPICS5 (R126), an analog-to-digital converter (ADC) on SPICS6 (R133), and the serial EEPROM on SPICS7 (R132). The two SPI B chip selects are for the GCAP II IC U501 on SPICS2 (R539) and the Flipper IC U301 on SPICS3. All of the lines of the SPI module operate at 3-volt logic levels.

There are several devices on the transceiver board that only have one bi-directional SPI data line. Components U404, U405, and U406 are configurable by MCU GPIO pin TOUT13 (MISOA_SEL) to route the data line to the appropriate pin on the Patriot IC depending on which SPI device is being accessed.

Universal Asynchronous Receiver/Transmitter (UART)

The Patriot IC has two Universal Asynchronous Receiver/Transmitter (UART) modules. UART1 handles the RS232 lines while UART 2 is connected to the SB9600 lines. Each UART has a receive data line (URXD), a transmit data line (UTXD), and hardware flow control signals (RTS—request to send) and (CTS—clear to send). All UART lines operate at 3-volt logic levels. The translation to 5-volt logic levels for the accessory side connector is discussed in the Flipper section.

One-Wire Interface

The MCU has a One-Wire Interface module that is used to communicate to a One-Wire device like a USB cable or a smart battery using the Dallas Semiconductor protocol. This module has one external pin, OWIRE_DAT (Q504 pin 2), and it uses a 3-volt logic level.

4.3.2.1.2 Digital Signal Processor (DSP)

The DSP portion of the Patriot IC has 84Kx24 bits of program RAM and 62Kx16 bits of data RAM. The DSP has its own set of peripherals including the Baseband Interface Port (BBP), the DSP Timer module, and the Serial Audio CODEC Port (SAP). Additionally, the DSP shares some peripherals with the MCU, including the USB interface and the General Purpose Input/Output module (GPIO).

Baseband Interface Port (BBP)

The Baseband Interface Port (BBP) module is the DSP's serial synchronous interface (SSI) to the transceiver board. The BBP has independent sections for the receiver and the transmitter. The receiver BBP pins include the receive data pin SRDB (R121), the receive clock signal pin SC0B (R124), and the receive frame synchronization (sync) signal pin SC1B (R123). The transmitter's BBP pins include the transmit data pin STDB (R127), the transmit clock signal pin SCKB (R125), and the transmit frame sync signal pin SC2B (R119). All BBP lines use 3-volt logic levels.

DSP Timer Module

While the BBP receive clock and frame sync signals are supplied by the Abacus III IC from the transceiver board, the BBP transmit clock and frame sync signals are generated by the DSP Timer. The BBP receive clock, connected to the DSP Timer input pin TI0, is reference used to generate the BBP transmit clock and frame sync signals. These two signals, along with the BBP transmit data signal, are connected to the DAC on the transceiver board.

Serial Audio CODEC Port (SAP)

The Serial Audio CODEC Port (SAP) module is the DSP's serial synchronous interface (SSI) to the audio CODEC on the GCAP II IC. The SAP also interfaces with the encryption module.

The SAP interface consists of four signals including the SAP clock line pin SCKA (component R405), the SAP frame sync line pin SC2A (component R406), the SAP receive data line pin SRDA (component R402), and the transmit data line pin STDA (component R403). The SAP clock is generated by the Flipper IC U301, and is a 520 kHz, 3-volt peak-to-peak square wave. The SAP frame sync signal is also generated by the Flipper IC, and is an 8 kHz, 3-volt peak-to-peak square wave.

Universal Serial Bus (USB)

The Patriot IC USB peripheral, shared by the MCU and the DSP, provides the required buffering and protocol to communicate on the Universal Serial Bus. The Patriot IC supports USB slave functionality.

For receive data, the USB differentially decoded data comes from the Flipper IC URXD_RTS pin into the Patriot URTS1 pin, while the single-ended USB data positive signal goes to pin PA2_USB_VPIN, and the single-ended USB data minus signal goes to pin URXD1. The two data lines are used to detect the single-ended zero state.

For transmit data, the USB data comes out of the Patriot IC UTXD1 pin and goes to the Flipper IC TXD_USB_VPO pin. The USB transmit single-ended zero signal is generated from the Patriot IC PC0_USB_VMOUT pin.

General-Purpose Input/Output (GPIO) Module

The General-Purpose Input/Output (GPIO) module is shared by the MCU and the DSP. This module consists of four 16-pin bi-directional ports and a 15 pin bi-directional port. While some of the pins on these ports are being used for other functions (UART, SPI, SAP, BBP, and Interrupt pins), the remaining pins can be programmed to become GPIOs that can be used by either the DSP or the MCU. Each GPIO pin has up to 8 alternate output functions and up to 4 alternate input functions. This allows for the GPIO pins to be routed internally to pertinent Patriot IC modules. Additionally, the GPIO module adds selectable edge-triggered or level-sensitive interrupt functionality to the GPIO pins. Some examples of GPIO pins include the Audio PA control signals (EXT_SPKR_SEL, AUDIO_PA_EN, and AUDIO_MODE_SEL), the EEPROM control signals (EEPOT_INC*, EEPOT_U_D*, EEPOT_CS*, and EEPOT_CS_EXT*), and the LED control signals (RED_LED and GREEN_LED).

4.3.2.2 Static RAM (SRAM) U403

The static RAM (SRAM) IC U403 is an asynchronous, 1 MB, CMOS device that is capable of 70 ns access speed. It is supplied with 1.8 volts. The SRAM has its 19 address lines and 16 data lines connected to the EIM of the Patriot IC through the Address(23:0) and Data(15:0) busses.

The SRAM has an active-high chip select CS2 that is tied directly to the 1.8-volt supply and an active-low chip select CS1 that is connected to the EIM CS2_N pin (test point CS2). When the SRAM CS1 pin is not asserted, the SRAM is in standby mode, which reduces current consumption.

Two other control signals from the EIM that change the mode of the SRAM are the read/write signal, R/W, and the output enable signal, OE. The R/W of the EIM is connected to the SRAM EN_WE pin (test point R_W), while the OE signal from the EIM is connected to the SRAM EN_OE pin. The SRAM is in read mode when the EN_WE pin is not asserted and the EN_OE pin is asserted. The SRAM is in write mode when the EN_WE pin is asserted, regardless of the state of the EN_OE pin.

The other SRAM pins are the lower-byte enable pin LB and the upper-byte enable pin UB. These pins are used to determine which byte (LB controls data lines 0-7 and UB controls data lines 8-15) is being used when there is a read or a write request from the Patriot IC. The LB pin is controlled by the EIM EB1_N signal, while the UB pin is controlled by the EB0_N signal.

4.3.2.3 FLASH Memory U402

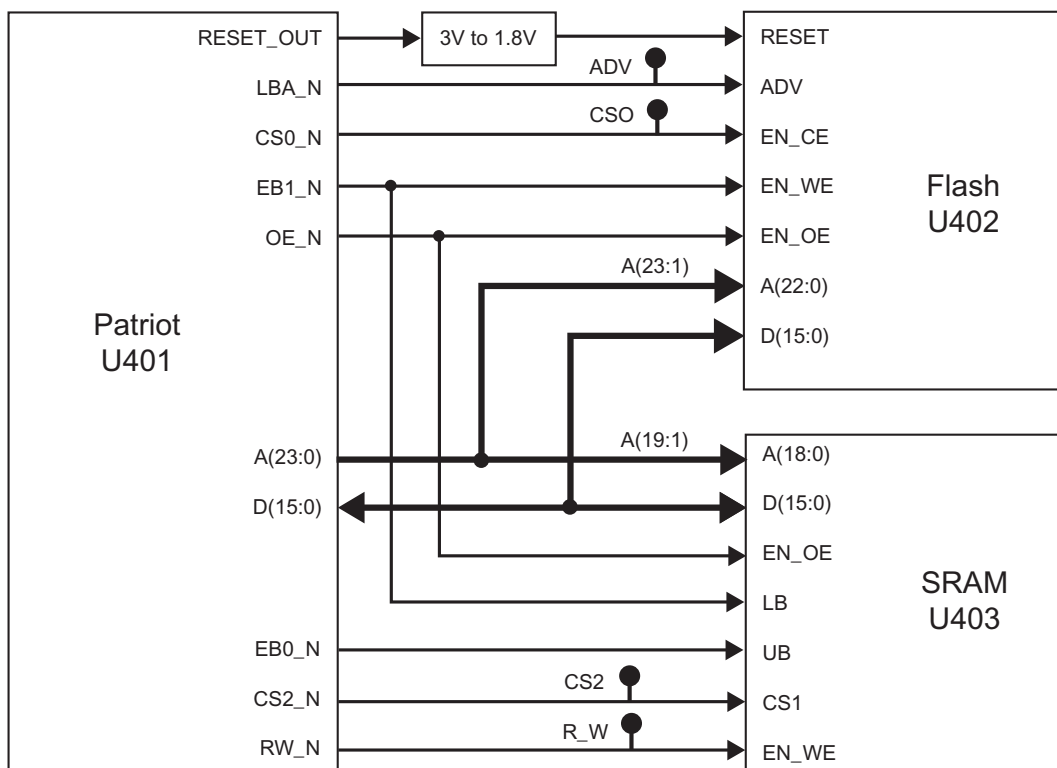
The Flash memory IC is an 8 MB CMOS device with simultaneous read/write or simultaneous read/erase operation capabilities with 70 ns access speed. It is supplied with 1.8 volts. The Flash memory has its 22 address lines and 16 data lines connected to the EIM of the Patriot IC through the Address(23:0) and Data(15:0) busses. The Flash memory contains host firmware, DSP firmware, and codeplug data with the exception of the tuning values that reside on the transceiver board's serial EEPROM. The Flash memory IC is not field repairable.

The RESET_OUT of the Patriot IC is at a 3-volt logic level. Components D401 and R401 are used to convert the voltage down to a 1.8-volt logic level, and this 1.8-volt reset signal is fed to the Flash RESET pin. When this pin is asserted (active low logic), the Flash is in reset mode. In this mode, the internal circuitry powers down, and the outputs become high-impedance connections.

The Flash active-low chip select pin, EN_CE, is connected to the active-low CS0_N pin (CS0 test point) of the EIM. When the EN_CE is not asserted, the Flash is in standby mode, which reduces current consumption.

Several other active-low control pins determine what mode the Flash memory is in: the address valid pin ADV (ADV test point) that is connected to the EIM LBA_N signal, the output enable pin EN_OE that is connected to the EIM OE_N signal, and the write enable pin EN_WE that is connected to the EIM EB1_N signal. For read mode, the ADV and EN_OE pins are asserted while the EN_WE pin is not asserted. When the EN_WE is asserted and the EN_OE pin is unasserted, the Flash operates in the write mode.

Figure 4-3 illustrates the EIM and memory ICs block diagram.



MAEPF-27414-O

Figure 4-3. Patriot EIM and Memory Block Diagram

4.3.3 Audio and Power Section

The audio and power section contains the following components:

- GCAP II IC U501
- 5-volt regulator U505
- Audio pre-amplifier U502
- Audio power amplifier U503
- EEPOT U509.

See Figure 9-16. VOCON Audio and DC Circuits on page 9-22 for schematic details of the following discussion.

4.3.3.1 GCAP II IC U501

The GCAP II IC is a mixed-signal (analog and digital) IC that provides control, audio, and voltage regulation functionality. It comes in a 100-pin, ball-grid array (BGA) package with 0.8 mm pitch solder balls. The GCAP II IC is supplied with switched battery voltage GCAP_B+ (R581).

4.3.3.1.1 Voltage Regulation

The GCAP II IC contains several voltage regulators that are used in the design of the VOCON board: VSW1, VSW2, and V2. The VSW1 regulator is a programmable switching regulator that uses the switched battery voltage as its input on pin PSRC1. The output voltage of VSW1 (R502) is programmable by the Patriot IC U401 through the SPI bus. The initial output of VSW1 is 3.2 volts, which is then programmed to 3.8 volts. The VSW1 voltage is supplied to the RF Interface connector P201 pin 15 and to the input pins of the VSW2 and V2 regulators.

The VSW2 regulator is a SPI programmable switching regulator that uses VSW1 as its input on pin PSRC2. The initial output of VSW2 (R501) is 2.2 volts, which is then programmed to 1.875 volts (referred to as 1.8 volts throughout this document). The VSW2 voltage is supplied to the Patriot IC (core voltage and the EIM voltage), the SRAM U403, the Flash memory U402, and the display module connector J301.

The V2 regulator is a SPI programmable linear regulator that uses VSW1 as its input on pin VIN2. The initial output of V2 (R560) is 2.775 volts, which is then programmed to 3 volts. The V2 voltage is supplied to the Patriot IC (I/O ring - SPI, BBP, SAP, UART, GPIO, etc.), the Flipper IC U301, the EEPOT U509, and the many discrete components that interface with the Patriot IC and the Flipper IC.

4.3.3.1.2 MCU Interface

The GCAP II IC has a four-wire, SPI connection to the Patriot IC (SPI B). The SPI B clock is connected to the SPI_CLK pin (test point SCKB). The SPI B MOSI line is connected to the SPI_DW pin (test point MOSIB). The SPI B MISO line is connected to the SPI_DR pin (test point MISOB). The GCAP SPI B chip-select signal is connected to the CE pin (R539). Through this interface, the Patriot IC can program the voltage regulators, the CODEC, the transmit and receive audio filters and amplifiers, as well as read information from the ADC and the real-time clock.

The GCAP II IC has an 8-bit ADC with general-purpose six channels and four voltage-monitoring channels. The six general-purpose analog-to-digital (A/D) channels are assigned to monitor volume (AD5); the three-position toggle switch from the universal connector J101 (AD1); the emergency, monitor, and side buttons (AD0); the battery status line (AD2); the board type indicator (AD3); and the board identification voltage (AD4). Battery voltage is also monitored by the ADC. The Patriot IC activates and reads the A/D values through the SPI bus.

The real-time clock (RTC) module of the GCAP II IC consists of several counters to determine elapsed time. The Patriot IC reads the RTC registers through the SPI bus. The RTC is supplied with voltage from a backup lithium rechargeable battery (LI_CELL) and a 32.768 kHz clock signal from the Flipper IC to the GCAP II IC XTAL1 pin.

4.3.3.1.3 Audio Circuitry

A 13-bit CODEC, internal to the GCAP II IC and programmable by the Patriot IC through the SPI bus, converts microphone audio into a digital bit stream for processing by the DSP. The CODEC also converts receive audio data that was processed by the DSP into an analog audio signal for amplification to a speaker. The CODEC interfaces to the DSP through the 4-wire SAP bus. The 520 kHz CODEC clock, generated by the Flipper IC, is on the DCLK pin. The 8 kHz CODEC frame-sync signal, also generated by the Flipper IC, is on the FSYNC pin. The CODEC transmit data signal is on the TX pin, while the CODEC receive data signal is on the RX pin. For the CODEC to operate with those clock and frame sync signals, a 13 MHz clock (R302), generated by the Flipper IC, is supplied to the GCAP CLK_IN pin.

The GCAP II IC contains internal amplification, filtering, and multiplexing functionality for both receive and transmit audio. These functions are Patriot IC-programmable through the SPI bus. The input for the internal microphone audio (R540) is the MICIN_NEG pin, while the input for the external microphone audio (R566) is the AUX_MIC_NEG pin. The output for the speaker audio is the EXTOUT pin (C533).

4.3.3.2 5-Volt Regulator U505

The 5-volt regulator uses UNSW_B+ as its input voltage. The Flipper IC WDI line controls the regulator's SHUTDOWN pin. The 5-volt supply (R503) is used by the Flipper IC U301, audio pre-amplifier U502, microphone bias circuitry (R531 & R563), Flipper IC protection diodes, bi-directional voltage translators, battery data line isolation circuitry, and ESD protection circuitry.

4.3.3.3 Audio Pre-Amplifier U502

The audio pre-amplifier U502 is a single-package, 5-pin, op-amp supplied with 5 volts. This pre-amp stage provides 8.9 dB of fixed gain, which is selected by the components R551 and R537. The input (U502 pin 4) of stage is the EXTOUT pin from the GCAP II IC, while the output (U502 pin 1) of this stage goes to the audio PA.

4.3.3.4 Audio Power Amplifier U503

The audio power amplifier (PA) U503 consists of two BTL amplifiers, complementary outputs, and control logic. Each of the amplifiers has a fixed gain of 21 dB. The MODE pin (U503 pin 4) voltage determines the operation of the amplifier. That voltage is controlled by the Patriot IC GPIO lines AUDIO_PA_EN (to Q505) and AUDIO_MODE_SEL (to Q506). [Table 4-4](#) describes how the Patriot IC GPIO lines configure the audio PA.

Table 4-4. Audio PA Status

AUDIO_PA_EN	AUDIO_MODE_SEL	Audio PA Status	MODE Voltage
0	0	Standby	$V_{\text{Mode}} > 7 \text{ V}$
0	1	Mute	$1.5 \text{ V} < V_{\text{Mode}} < 6 \text{ V}$
1	0	On	$V_{\text{Mode}} < 0.5 \text{ V}$
1	1	On	$V_{\text{Mode}} < 0.5 \text{ V}$

The SELECT pin (U503 pin 6) is used to switch the audio path between internal and external speaker. The voltage on that pin is determined by the EXT_SPKR_SEL line from the Patriot IC and the Q505 transistor. When the voltage at the SELECT pin is high (B+), the audio is routed to the internal speaker lines. When the voltage at the SELECT pin is low ($V_{select} < 0.5V$), the audio is routed to the external speaker lines.

4.3.3.5 EEPOT U509

The EEPOT is a digitally programmable potentiometer with 256 taps and a total resistance of 50 kohms. This 10-pin package contains two independent potentiometers, one for each microphone line. The EEPOT resistance values are programmed by the Patriot IC GPIOs EEPOT_INC* (U509 pin 9) and EEPOT_U_D* (U509 pin 2). The EEPOT_INC* signal increments the resistance value up or down, which depends on the EEPOT_U_D* signal. The EEPOT_CS* line (U509 pin 10) is asserted when the internal microphone gain is being changed. Similarly, the EEPOT_CS_XST* (U509 pin 1) is asserted for external microphone gain changes. The EEPOT is supplied with 3 volts.

4.3.4 Interface Support Section

The interface support section consists of the following:

- Flipper IC U301
- ESD protection circuitry
- Universal connector interface circuitry.

4.3.4.1 Flipper IC U301

See [Figure 9-13. VOCON Flipper Circuit on page 9-19](#) for schematic details of the following discussion.

The Flipper IC U301 is an application-specific, integrated circuit (ASIC) device designed for the XTS radio product line. The Flipper IC is contained in a 64-pin μ BGA package with 0.8 mm pitch solder balls. The Flipper IC is supplied with 5 volts and 3 volts, and it uses the 16.8 MHz clock (C307) as its master clock. The Flipper IC is programmable by the Patriot IC through the SPI bus.

The Flipper IC supports many functions including the radio side connector interface, bi-directional logic level translation, boot data path control, USB transceiver, One-Wire option detect support, watchdog timer, 32 kHz oscillator with CMOS output, 13 MHz reference generation for the GCAP II IC, and SSI clock and frame sync generator.

4.3.4.1.1 Side Connector Interface, Logic Level Translation, and Boot Data Path Control

The Flipper IC facilitates the interface to the radio's side connector. Some of the side connector lines are at 5-volt logic levels, so the Flipper IC converts those lines to 3-volt logic levels to interface to the Patriot IC, as well as the encryption module. These lines include the SB9600 bus busy line LH_BUSY (TP207), the RS 232 CTS (TP208) and RTS (TP209) lines, the RS232 data-out line (TP210), and the RS232 data-in line (TP211). The SB9600 data line uses an external, bi-directional, 3- to 5-volt translation circuit that includes Q303, D301, R325, R326, and R327.

Another function that the Flipper IC provides with these lines is boot data path control. The boot data path is as follows: boot data-in is multiplexed onto the RS232 data-out line while the boot data-out is multiplexed with the SB9600 data line. This alternate data path is used only to Flash code into a radio for the first time. The Patriot IC, through the SPI bus, controls this feature.

4.3.4.1.2 USB Transceiver

The USB transceiver, internal to the Flipper IC, is capable of transmitting and receiving serial data at a rate of 12 megabits per second. The differential USB data comes from the side connector, through the 22-ohm resistors R252 & R253 and the isolation switch Q301, and then to the USB_DPLUS and USB_DMINUS pins on the Flipper IC. The USB receive interface from the Flipper IC to the Patriot IC is as follows: USB_DPLUS routed to USB_VPI, USB_DMINUS routed to USB_VMI_RXD, and the differential decoded data is output at the URXD_RTS pin and goes to the Patriot IC URTS1 pin.

The USB transmitter is enabled when the USB_SUSP and USB_TXENAB signals are both driven low by the Patriot IC. The single-ended data is output from the Patriot IC on the UTXD1 pin and goes to the Flipper TXD_USB_VPO pin. The data is driven out differentially on the USB_DPLUS and USB_DMINUS pins, which go to the side connector. The Patriot IC sends the single-ended zero signal from pin PC0_USB_VMOOUT to the Flipper IC USB_FSEZ pin.

When a USB cable is detected, the USB_DIS pin (Q302 pin 2) goes high. This controls the isolation switch Q301 so that the data that is on those lines are routed to the USB transceiver. If a USB cable is not detected, the USB_DIS pin is low and the USB transceiver on the Flipper IC is isolated from the side connector. This isolation is done primarily because the RS232 data lines are 5-volt lines, so the switch protects the transceiver since it operates at 3 volts, and the USB data lines to the side connector also act as the RS232 lines.

4.3.4.1.3 One-Wire Support

New options and accessories that attach to the side connector are identified by the Patriot IC using the One-Wire protocol. The Option Select 2 pin on the side connector also serves as the One-Wire data pin (R218). This signal is connected to the ONE_WIRE_OPT pin. This pin is connected to the Patriot IC One-Wire bus ONE_WIRE_UP through an internal isolation switch controlled by a Patriot IC GPIO line to the Flipper IC ONE_WIRE_EN_X pin. This isolation is needed to prevent possible contention on the One-Wire bus when a smart battery is attached to the radio.

These new accessories are to ground pin 10, CTS (TP208), of the side connector. When this occurs, the Flipper IC pin KVL_USB_DET_X is asserted and the Patriot IC detects the change. The Patriot IC then asserts the ONE_WIRE_EN_X pin on the Flipper IC to connect the side connector One-Wire line to the Patriot IC One-Wire bus. In the case of the USB cable, the Patriot IC reads the One-Wire data from the cable and, upon determining that a USB cable is attached, programs the Flipper IC for USB mode.

4.3.4.1.4 Watchdog Timer

The Flipper IC monitors the position of the radio's on/off button on the BP_SEN_X pin, and that signal is located on Q508 pin 3. If the voltage on pin 3 is ground, then the radio is turned on. If the voltage on pin 3 is 3 volts, then the radio is off. When the radio is turned off, a counter inside the Flipper IC begins incrementing. That counter can be refreshed by the Patriot IC through the SPI bus. This is done so that the software has enough time to complete its tasks before the power is taken away from the Patriot IC. If the counter is not refreshed by the time the count is complete, the Flipper IC pin WD_OUT goes low, which shuts down the GCAP II voltage regulators. During normal radio operation, WD_OUT should be high (3 volts).

4.3.4.1.5 32 kHz Oscillator and CMOS output

The 32 kHz oscillator circuitry uses a separate voltage supply pin (VDD3_XTL) than the other 3-volt portions of the Flipper IC. This 32 kHz clock is used by the GCAP II RTC module to keep track of time. The VDD3_XTS pin is supplied with the backup lithium (Li) rechargeable battery voltage LI_CELL. The oscillator circuitry is internal to the Flipper IC, and the 32.768 kHz crystal Y301 and additional load capacitors C308 and C309 are located next to the IC.

The output of the 32 kHz oscillator is an LI_CELL voltage (approximately 3 volts peak-to-peak), 32.768 kHz square wave on pin REF32_OUT. This clock goes to two destinations: the Patriot IC CKIL pin (32 kHz test point) as a square wave and the GCAP II IC XTAL1 pin (C306) as a sine wave. Components C306 and C313 are used to filter the square wave into a sine wave before the signal goes to the GCAP II IC.

4.3.4.1.6 13 MHz Reference Generation for GCAP II

The 13 MHz reference is required by the GCAP II IC for the CODEC time base and the SSI clock generator module internal to the Flipper IC. A phase locked loop (PLL) is used to generate the 13 MHz using the 16.8 MHz clock, which is provided to the Flipper IC REF_16_IN pin (C307). An external RC loop filter network, consisting of R301, C301, and C302, is connected to the PLL_LFT pin.

The 13 MHz reference output pin, REF_13_OUT, is conditioned by the RC network of R302 and C303. The signal at REF_13_OUT is a 3-volt peak-to-peak square wave, and the RC filter produces a lower-level triangle wave that is suitable for the GCAP II IC.

The 13 MHz reference is disabled as the Flipper IC powers up. The 13 MHz reference is enabled by the Patriot IC through the SPI bus, and, during normal radio operation, this signal should be present.

4.3.4.1.7 SSI Clock and Frame Sync Generator

The Flipper IC generates the SSI clock and frame sync signals for the SAP bus used by the Patriot IC, GCAP II IC, and encryption module. These signals are generated from the 13 MHz reference. The SSI clock output pin is labeled SSI_CLK, and the frequency is 520 kHz. The SSI frame sync output pin is FRSYNC, and the frequency is 8 kHz. These signals are not active when the Flipper IC comes out of reset, so they are programmed by the Patriot IC through the SPI bus.

The Flipper IC provides four 16-bit TDM slots per frame on the SAP bus. The first slot (slot 0) begins immediately after the frame sync pulse, and this slot is used by the GCAP II IC. The SEC_SS_X pin is active for the first 8 bits of the second slot (slot 1). This signal is used by the encryption module to synchronize its input and output to the SSI frame. The other two slots are reserved for possible design additions in the future.

4.3.4.2 ESD Protection Circuitry

See [Figure 9-12. VOCON Universal Connector Circuit on page 9-18](#) for schematic details of the following discussion.

Several components on the VOCON board protect the circuitry from ESD. The side connector signal lines have ESD protection components on them since they are exposed. These protection components include:

- 5.6-volt zeners VR205, VR206, VR220, and VR221 on the SB9600 lines, RS232 lines, microphone lines, and option-select lines
- 12-volt zeners VR201, VR203, and VR209 on the internal and external speaker audio lines
- 13-volt zener VR204 on the OPTB+ line
- Low-capacitance ESD suppressors D203, D204, D205, and D206 on audio lines, USB data lines, and option-select lines.

There were also several protection diodes on lines connected to the Flipper IC. These include D302, D303, D304, D305, D306, D307, and D308. ESD protection for the battery status line is provided by a 5.6-volt zener VR501.

4.3.4.3 Universal Connector Interface Circuitry

See [Figure 9-12. VOCON Universal Connector Circuit on page 9-18](#) for schematic details of the following discussion.

Some important components on the universal connector interface are two op-amps. The first op-amp, U201, is used as a comparator for the option-select 1 line. The comparator threshold is determined by the voltage-divider network of R257 and R258. Similarly, the other op-amp, U202, is used as a comparator for the option-select 2 line. The comparator threshold is determined by the voltage-divider network of R240 and R243. The remaining components consist of current-limiting serial resistors and noise-suppressing shunt capacitors.

4.3.4.3.1 Universal Connector and Option Selects

The universal connector is located on the side of the radio. It is the external port or interface to the outside and is used for programming and interfacing to external accessories. The universal connector connects to the VOCON board at connector J101 via a flex circuit that is routed inside the external housing. Connections to the universal connector and J101 on the VOCON board are shown in [Figure 4-4](#) and [Figure 4-5](#).

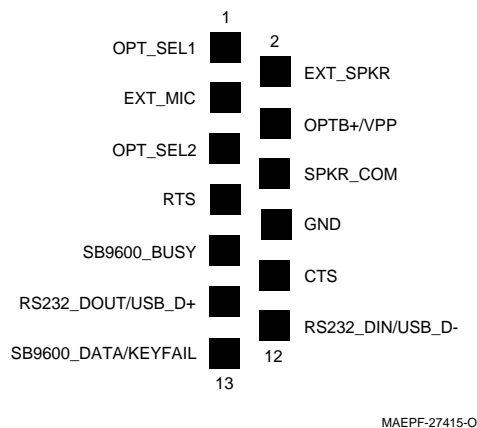


Figure 4-4. Universal (Side) Connector

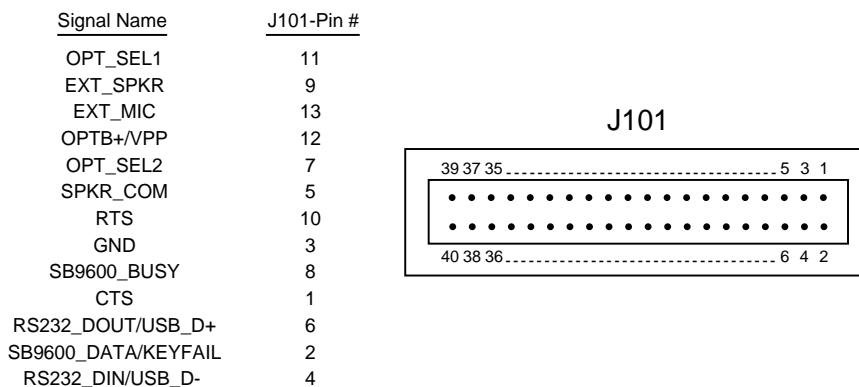


Figure 4-5. VOCON Board Connector—J101

Most of the signals are extensions of circuits described in other areas of this manual. However, there are two option select pins (see [Table 4-5](#)) used to configure special modes: Option Select 1 and Option Select 2. These pins are controlled by accessories connected to the universal connector. [Table 4-5](#) outlines their functions as defined at the universal connector. In the case of the XTS Vehicular Adapter (XTVA), Option Select 1 pin is connected to Option Select 2 pin by a diode internal to the XTVA.

Table 4-5. Option-Select Functions

Function	Option Select 1	Option Select 2
External PTT	0	0
No Function (Normal)	1	1
Man Down	1	0
External Speaker	0	1
XTVA	Diode cathode	Diode anode

4.3.4.4 Display Module

An optional, integral, 96 pixels by 64 pixels, LCD display module is available with either a 3 x 2 keypad with a navigational button (Model II radios) or 3 x 6 keypad with a navigational button (Model III radios). The display module is connected to the VOCON board through flex connector J301. The display module is not field repairable.

The display is controlled by the Patriot IC MCU core, which programs the display through the EIM data lines D0 - D7 (pins 9 through 16, respectively), the display chip select line (pin 5), the EIM read/write line (pin 8), and the EIM address 0 line (pin 7) that is used to select the register to be programmed. The Patriot IC can reset the display module through pin 6. The display is supplied with 1.8 volts (B102) to pin 17 and 3.0 volts (B101) to pin 18.

Display backlighting is controlled by the Patriot IC GPIO line BL_EN signal through components R140 and Q101. The LEDs on the display module are powered by 5 volts going through resistors R101, R102, R103, and R104.

4.3.4.5 Keypad Module

The keypad module is connected to the VOCON board through flex connector J107. The keypad is read through a row-and-column matrix made up of ROW1, ROW2, ROW3, ROW4, ROW5, ROW6, and COL1, COL2, and COL3. When a key is pressed, a row and a column are connected to each other. The Patriot IC determines a key press by a scanning algorithm. Each column line is configured as an open drain output and pulled low. The Patriot IC then scans the row pins (each row pin has an internal pull-up resistor). If a row signal is read low, then the Patriot IC determines that a key was pressed. If none of the row signal lines are low, then another column line is pulled low and the row scanning routine occurs.

The keypad backlighting is controlled by the Patriot IC GPIO BL_EN, and that signal goes to pin 6 of the J107 connector. Pins 7 and 8 are supplied with 5 volts, which is used to power the LEDs on the keypad module.

4.3.4.6 Controls and Control Top Flex

The housing assembly top controls include an on/off switch/volume control (S1), a 16-position mode-select switch with programmable two-position concentric switch (U1), a programmable three-position (A,B,C) toggle switch (S2), and a programmable top (orange) button (SW3). The side controls include three programmable, momentary, push button switches (side button 1 [SB2], side button 2 [SB3], and top side button [SB1]) and a PTT switch (SW2). These components are connected through a flex circuit to the controller at J101 (see [Figure 4-6](#)). The assembly also contains the radio's internal speaker and internal microphone.

UNSW_B+ is routed through switch S1 to provide the B+SENSE signal, which is used to activate the SW_B+ and GCAP_B+ voltages that, in turn, power up the radio. Volume control is also provided by S1, which contains a potentiometer biased between 3 volts and ground. The VOL signal is a voltage level between 3 volts and ground, depending on the position of the rotary knob. The VOL signal is fed to buffer U507 pin 3, and then the output of the buffer is voltage-divided down to 2.5 volts before the signal goes to the GCAP II IC AD5 pin. The Patriot IC reads the GCAP II IC A/D value through the SPI bus, and from this reading, the Patriot IC DSP adjusts the speaker volume.

Switch S2 is the three-position, programmable, toggle switch typically used for expanded zone/channel selection. The switch can output the following voltages: 0 volts, 1.5 volts, and 3.0 volts (measurable at R231). The switch is connected to the GCAP II IC AD1 input pin through the voltage divider network of R519 and R523. The Patriot IC reads the A/D value through the SPI bus, and it uses that reading to determine the position of the toggle switch.

The programmable top (orange) button SW3 is typically used for emergency. This button, along with programmable side buttons SB1 through SB3, is connected to a resistor divider network, biased between 3 volts and ground. This network, made up of R1, R2, and R3, provides a voltage level, controlled by which button is pressed, to pin 3 of buffer U504. The output of the buffer is voltage-divided down to 2.5 volts before the signal goes to the GCAP II IC AD0 pin. The Patriot IC reads the GCAP II IC A/D value through the SPI bus, and it uses that data to determine which button was pressed.

LED D1 is the TX/RX indicator. LEDs D2 through D6 are used for backlighting the frequency knob.

U1 is a binary-coded switch. The output pins from U1, which are connected to GPIO pins on the Patriot IC, provide a four-bit binary word (signals RTA0, RTA1, RTA2, and RTA3) to the MCU, indicating to which of the 16 positions the rotary is set. This switch provides an additional output, TG2 that is typically used for coded or clear mode selection. It is an input to the Patriot IC TOUT8_PD4 GPIO pin. Selecting clear mode pulls this signal to a logic low, and it can be monitored from R234.

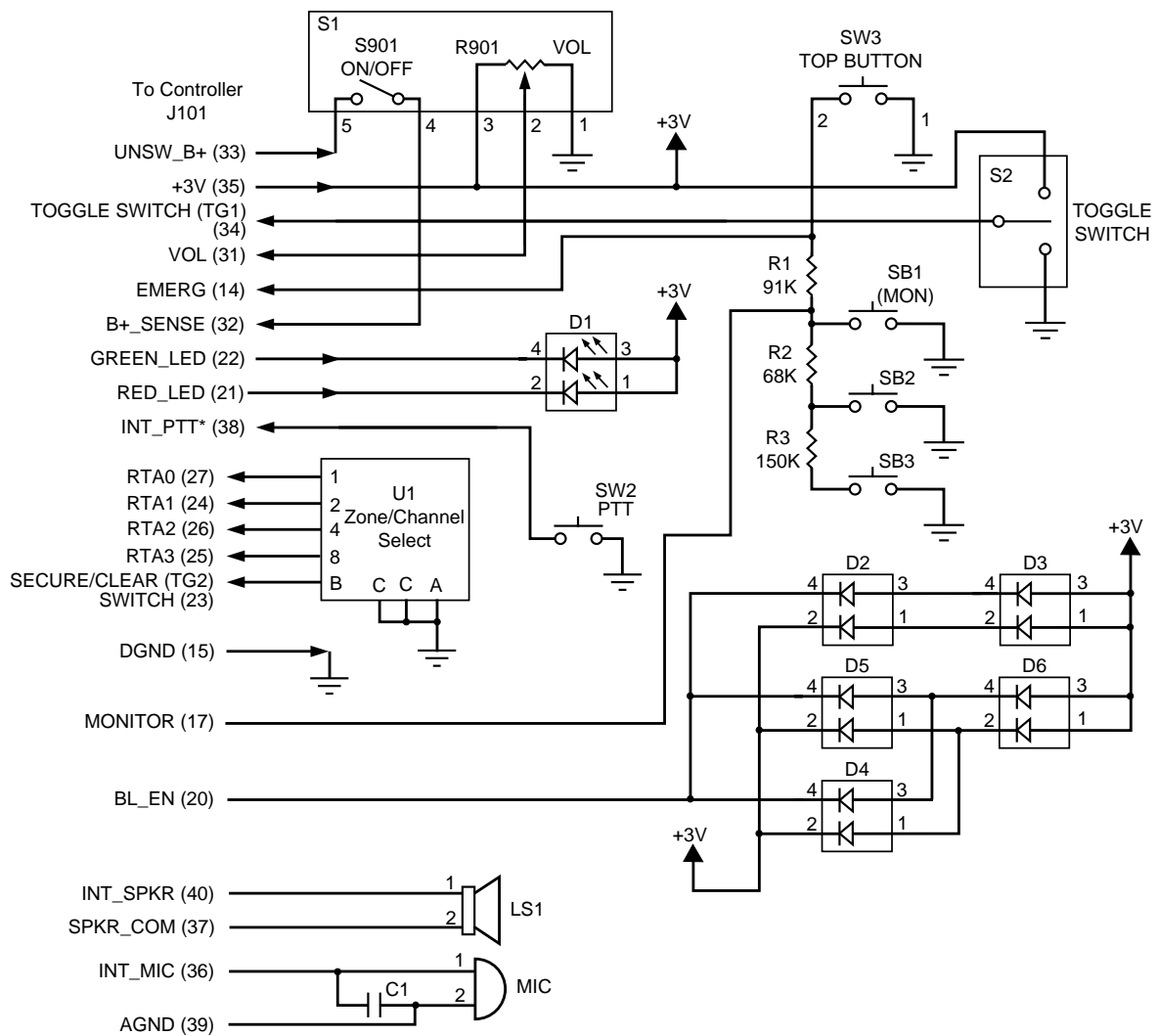


Figure 4-6. Control Top Flex

4.3.4.7 System Clocks

The Patriot IC is supplied with two clocks. The first clock, a 16.8 MHz sine wave, comes from the RF interface connector P201 pin 7. It is conditioned by the clock buffer circuit, which includes Q450, Q451, L450, C450, C452, C452, R450, R451, R452, R453, R454, and R455. The output of this buffer (C452) goes to the Patriot IC CKIH pin as well as the Flipper IC REF_16_IN (C307).

The other clock supplied to the Patriot IC is a 32.768 kHz square wave. This clock is generated by the Flipper IC internal oscillator and an external 32.768 kHz crystal Y301 and is connected to the Patriot IC CKIL pin.

4.3.5 VOCON Audio Paths

This section describes the VOCON transmit and receive audio paths. See [Figure 9-16. VOCON Audio and DC Circuits on page 9-22](#) for schematic details of the following discussion.

4.3.5.1 Transmit Audio Path

Refer to [Figure 4-7](#). The internal microphone audio enters the VOCON board through the universal connector J101 pin 36, and the internal microphone bias is set by circuitry that includes R531, R533, C519 and C521. The internal microphone signal is connected to the MICIN_NEG pin, which is the input terminal on the GCAP II IC internal op-amp A3. The gain of the A3 op-amp is set by the values of R540, R555, and the resistance of EEPOT U509 (digital potentiometer), which is programmed by Patriot IC GPIO lines.

The external microphone audio enters the VOCON board through the universal connector J101 pin 13, and the external microphone bias is set by circuitry that includes R563, R565, C547, and C548. The external microphone signal is connected to the AUX_MIC_NEG pin, which is an input terminal on the GCAP II IC internal op-amp A5. The gain of the A5 op-amp is set by the values of R566, R561, and the resistance of the EEPOT U509.

The Patriot IC, through the SPI bus, programs a multiplexer to select one of the microphone signals. Then, the selected amplified microphone signal goes through a programmable gain amplifier before it goes to the CODEC for A/D conversion. The resulting digital data is filtered and sent to the DSP on the SAP CODEC_TX line from the GCAP II IC TX pin. After additional filtering and processing, the DSP sends the data-out from the STDB pin to the RF interface connector P201 pin 4 (TX_DATA), which is connected to the DAC U203 on the transceiver board.

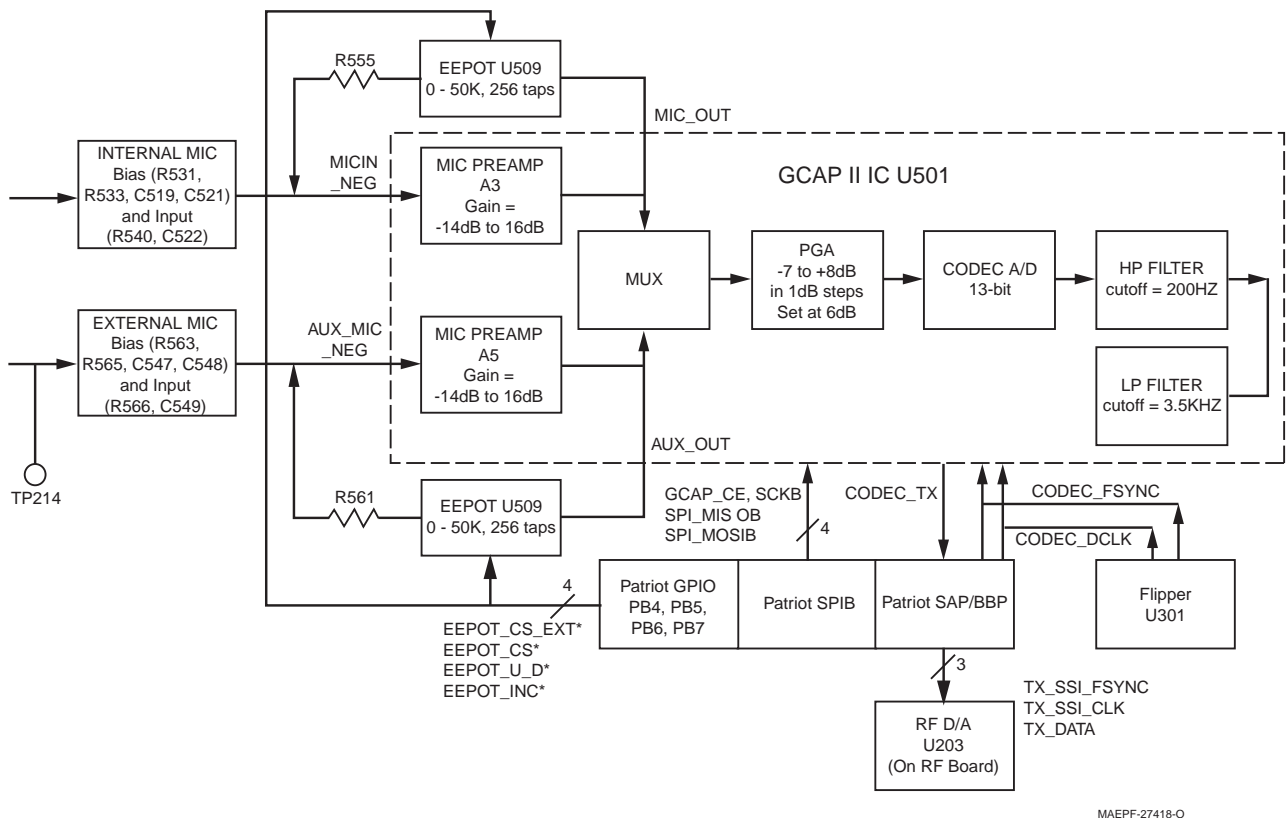
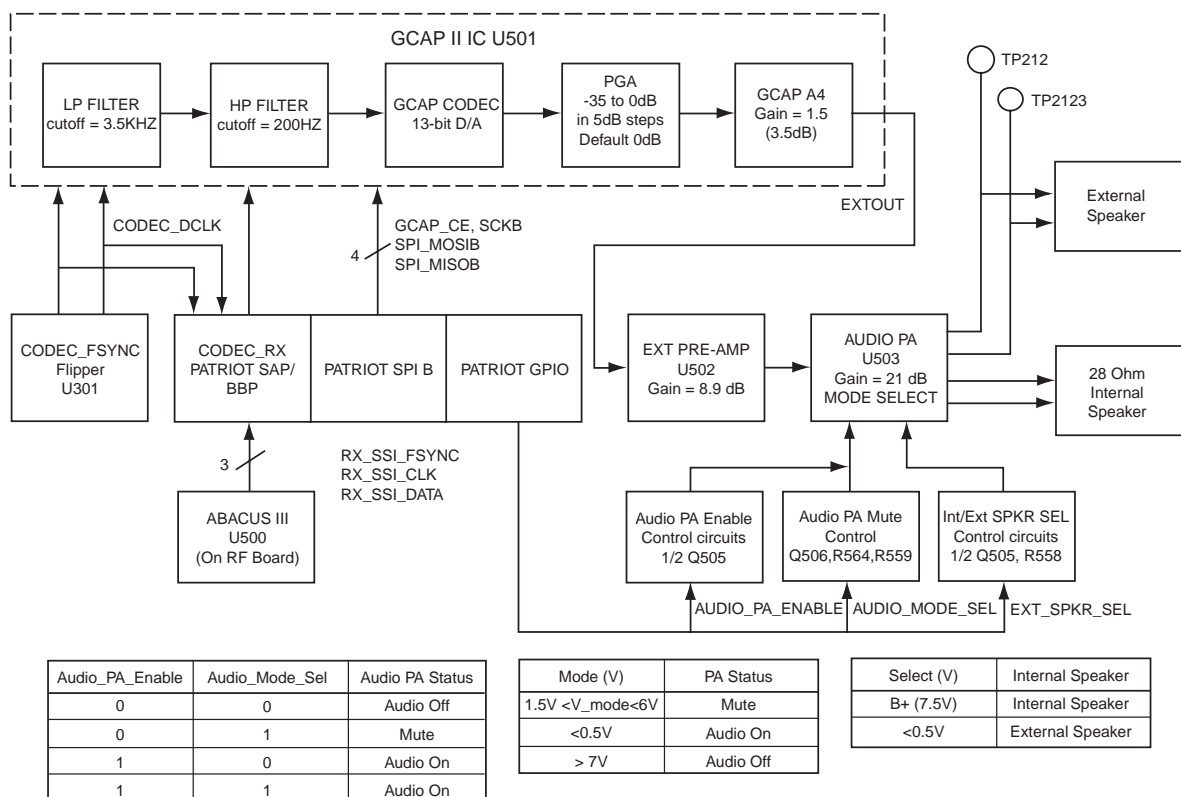


Figure 4-7. VOCON Transmit Audio Path

4.3.5.2 Receive Audio Path

Refer to Figure 4-8. The receive audio data comes from the Abacus III IC U500 through the RF interface connector P201 pin 12 (RX_DATA) to the Patriot IC SRDB pin. The DSP decodes the data and sends it out through the CODEC_RX line to the GCAP II IC RX pin. The CODEC filters and converts the digital data into an analog audio signal, which, in turn, is sent to a programmable gain amplifier. The Patriot IC programs a multiplexer to route the audio signal to the A4 amplifier, which has a fixed gain of 3.5 dB. The output of the A4 amplifier is pin EXTOUT.

From the EXTOUT pin, the audio signal goes through the pre-amplifier gain stage, the audio pre-amplifier U502, which provides 8.9 dB of gain. This amplified audio is then sent to the audio power amplifier U503, which provides 21 db of gain. The Patriot IC selects whether the amplified audio is routed to the internal speaker or the external speaker.



MAEPF-27417-O

Figure 4-8. VOCON Receive Audio Path

4.3.6 Radio Power-Up/Power-Down Sequence

The radio power-up sequence begins when the user closes the radio On/Off switch on the control top, placing 7.5 Vdc on the B+SENSE line. This voltage enables the pass element Q501 and Q502, enabling SW_B+ and GCAP_B+.

When the GCAP II IC U501 detects a low-to-high voltage transition on GCAP_B+, it turns on and enables voltage supplies VSW1, VSW2, V2 and Vref. As soon as these voltages are supplied to the board, the Flipper IC U301 drives the WDI line high to enable VCC5 from regulator U505 and to maintain the GCAP II IC in the ON state. If WDI remains low, the GCAP II IC turns off 50 ms. after turning on.

The radio power-down sequence begins by opening the radio On/Off switch, which removes the B+SENSE signal from the VOCON board. This does not immediately remove power because the GCAP II IC has control of Q502 through Vref, and U301 through WDI maintains the GCAP II IC in an active state. Both the MCU and Flipper IC monitor B+SENSE. After B+SENSE is removed, the Flipper IC waits 125 ms. before releasing WDI to allow for software cleanup; however, the software has the ability to prolong this time if it was necessary to complete its operations. When WDI is released, the GCAP II IC shuts down its supplies and the rest of the radio through Q501.

4.4 Encryption Module

The encryption module operates from two power supplies (UNSW_B+ and SW_B+). The SW_B+ is turned on and off by the radio's on/off switch. The UNSW_B+ provides power to the encryption module as long as the radio battery is in place.

Key variables are loaded into the encryption module through connector J701, pin 1. Depending on the type of encryption module, up to 16 keys can be stored in the module at a time. The key can be infinite key retention or 30-seconds key retention, depending on how the codeplug is set up.

The radio's host processor communicates with the encryption module on the Synchronous Serial Interface (SSI) bus. The SSI bus consists of five signal lines. A communications failure between the host processor and the secure module will be indicated as an *ERROR 09/10* message on the display.

To troubleshoot the encryption module, refer to the flowcharts in the chapter entitled [Troubleshooting Charts](#).

Chapter 5 Troubleshooting Procedures

5.1 Introduction

The purpose of this section is to aid in troubleshooting problems with the ASTRO XTS5000 radio. It is intended to be detailed enough to localize the malfunctioning circuit and isolate the defective component.



Caution

Most of the ICs are static sensitive devices. Do not attempt to disassemble the radio or troubleshoot a board without first referring to the following Handling Precautions section.

5.2 Handling Precautions

Complementary metal-oxide semiconductor (CMOS) devices, and other high-technology devices, are used in this family of radios. While the attributes of these devices are many, their characteristics make them susceptible to damage by electrostatic discharge (ESD) 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 this radio, and are especially important in low-humidity conditions. DO NOT attempt to disassemble the radio without observing the following handling precautions.

1. Eliminate static generators (plastics, Styrofoam, etc.) in the work area.
2. Remove nylon or double-knit polyester jackets, roll up long sleeves, and remove or tie back loose hanging neckties.
3. Store and transport all static-sensitive devices in ESD-protective containers.
4. Disconnect all power from the unit before ESD-sensitive components are removed or inserted unless otherwise noted.
5. Use a static-safeguarded workstation, which can be accomplished through the use of an anti-static kit (Motorola part number 01-80386A82). This kit includes a wrist strap, two ground cords, a static-control table mat and a static-control floor mat. For additional information, refer to Service and Repair Note SRN-F1052, "Static Control Equipment for Servicing ESD Sensitive Products," available from Literature Distribution.

Motorola Literature Distribution
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5.3 Voltage Measurement and Signal Tracing

It is always a good idea to check the battery voltage under load. This can be done by checking the OPT_B+_VPP pin at the side connector (pin 4). The battery voltage should remain at or above 7.0 Vdc. If the battery voltage is less than 7.0 Vdc, then it should be recharged or replaced as necessary prior to analyzing the radio.

In most instances, the problem circuit may be identified using a multimeter, an RF millivoltmeter, oscilloscope (preferably with 100 MHz bandwidth or more), and a spectrum analyzer.



Caution

When checking a transistor or module, either in or out of circuit, do not use an ohmmeter having more than 1.5 Vdc appearing across test leads or use an ohms scale of less than x100.

5.4 Standard Bias Table

Table 5-1 outlines some standard supply voltages and system clocks which should be present under normal operation. These should be checked as a first step to any troubleshooting procedure.

Table 5-1. Standard Operating Bias

Signal Name	Nominal Value	Tolerance	Source
13 MHz	13 MHz	±1000 ppm	C303
FLIP_32K	32.768 kHz	±400 ppm	U302, pin2
SINE32K	32.768 kHz	±400 ppm	C313
CKIH	16.8 MHz		R452
16_8MHz	16.8 MHz		C452
POR	3.0 Vdc	±5%	POR
RESET_OUT	3.0 Vdc	±5%	RESET_OUT
VSW1	3.85 Vdc	±5%	R502
VSW2	1.85 Vdc	±5%	R501
FILT_B+	7.5 Vdc	6.0-9.0 Vdc	C523
V2	3.0 Vdc	±5%	R560
GCAP_B+	7.5 Vdc	6.0-9.0 Vdc	R581
UNSW_B+	7.5 Vdc	6.0-9.0 Vdc	
SW_B+	7.5 Vdc	6.0-9.0 Vdc	R587
VCC5	5.0 Vdc	±5%	R503

5.5 Power-Up Self-Check Errors

Each time the radio is turned on, the MCU and DSP perform a series of internal diagnostics. These diagnostics consist of checking such programmable devices as the FLASH ROMs, the EEPROM, and SRAM devices.

Problems detected during the power-up self-check routines are presented as error codes on the radio's display. For non-display radios, the problem is presented at power up by a single, low-frequency tone. [Table 5-2](#) lists possible error codes, a description of each error code, and a recommended corrective action.

Table 5-2. Power-Up Self-Check Error Codes

Error Code	Description	Corrective Action
01/02	FLASH ROM codeplug Checksum Non-Fatal Error	Reprogram the codeplug
01/12	Security Partition Checksum Non-Fatal Error	Send radio to depot
01/20	ABACUS Tune Failure Non-Fatal Error	Turn radio off, then on
01/22	Tuning Codeplug Checksum Non-Fatal Error	Send radio to depot
01/81	Host ROM Checksum Fatal Error	Send radio to depot
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug
01/88	External RAM Fatal Error --Note: Not a checksum error	Send radio to depot
01/90	General Hardware Failure Fatal Error	Turn radio off, then on
01/92	Security Partition Checksum Fatal Error	Send radio to depot
01/93	FLASHport Authentication Code Failure	Send radio to depot
01/98	Internal RAM Fail Fatal Error	Send radio to depot
01/A2	Tuning Codeplug Checksum Fatal Error	Send radio to depot
02/81	DSP ROM Checksum Fatal Error	Send radio to depot
02/88	DSP RAM Fatal Error --Note: Not a checksum error	Turn radio off, then on
02/90	General DSP Hardware Failure (DSP startup message not received correctly)	Turn radio off, then on
09/10	Secure Hardware Failure (UCM equipped radios)	Turn radio off, then on
09/90	Secure Hardware Fatal Error (Type 1 equipped radios)	Turn radio off, then on

5.6 Power-Up Self-Check Diagnostics and Repair (Not for Field Use)

Table 5-3 lists additional action items that can be used for the diagnosis and resolution of the error codes listed in Table 5-2.

Table 5-3. Power-Up Self-Check Diagnostic Actions

Error Code	Diagnostic Actions
01/02	This non-fatal error will likely recover if the radio's power is cycled. In the event that this does not resolve the issue, the radio should be reflashed. As a last resort, the FLASH ROM U402 should be replaced.
01/12	The radio should be sent to the depot for reflashing of the security codeplug.
01/20	Cycling radio power should resolve this issue.
01/22	The radio should be sent to the depot for reflash of the tuning codeplug followed by retuning of the radio.
01/81	The radio should be sent to the depot for reflashing of the host code.
01/82	The radio should be sent to the depot for reflashing of the radio codeplug.
01/88	Reflashing of the radio should first be performed. If this fails to resolve the issue, then replacement of the SRAM U403 is necessary.
01/90	Cycle power to radio. Continued failure indicates a likely IC failure (GCAP, PCIC, FLIPPER, ABACUS). In this event, radio should be sent to the depot for isolation and repair of the problem IC.
01/92	The radio should be sent to the depot for reprogramming of the security codeplug.
01/93	The radio should be sent to the depot for reflashing of the host code.
01/98	Send radio to the depot for replacement of the SRAM U403.
01/A2	The radio should be sent to the depot for reflashing of the tuning codeplug followed by re-tuning of the radio.
02/81	The radio should be sent to the depot for examination and/or replacement of either the FLASH U402, or the PATRIOT MCU/DSP U401.
02/88	Cycle power to the radio. If this does not fix the problem, then the radio should be sent to the depot for reflashing of the DSP code. Continued failure requires examination and/or replacement of the SRAM U403.
02/90	Cycle power to the radio. If this fails to fix the problem, then the radio should be sent to the depot for reflashing of the DSP code. Continued failure may require replacement of U401, the PATRIOT MCU/DSP.
09/10	Cycle power to the radio. If this fails then follow instructions in the secure hardware failure troubleshooting flowchart.
09/90	Cycle power to the radio. If this fails then follow instructions in the secure hardware failure troubleshooting flowchart.

Chapter 6 Troubleshooting Charts

6.1 Introduction

This section contains detailed troubleshooting flowcharts. These charts should be used as a guide in determining the problem areas. They are not a substitute for knowledge of circuit operation and astute troubleshooting techniques. It is advisable to refer to the related detailed circuit descriptions in the theory of operation sections prior to troubleshooting a radio.

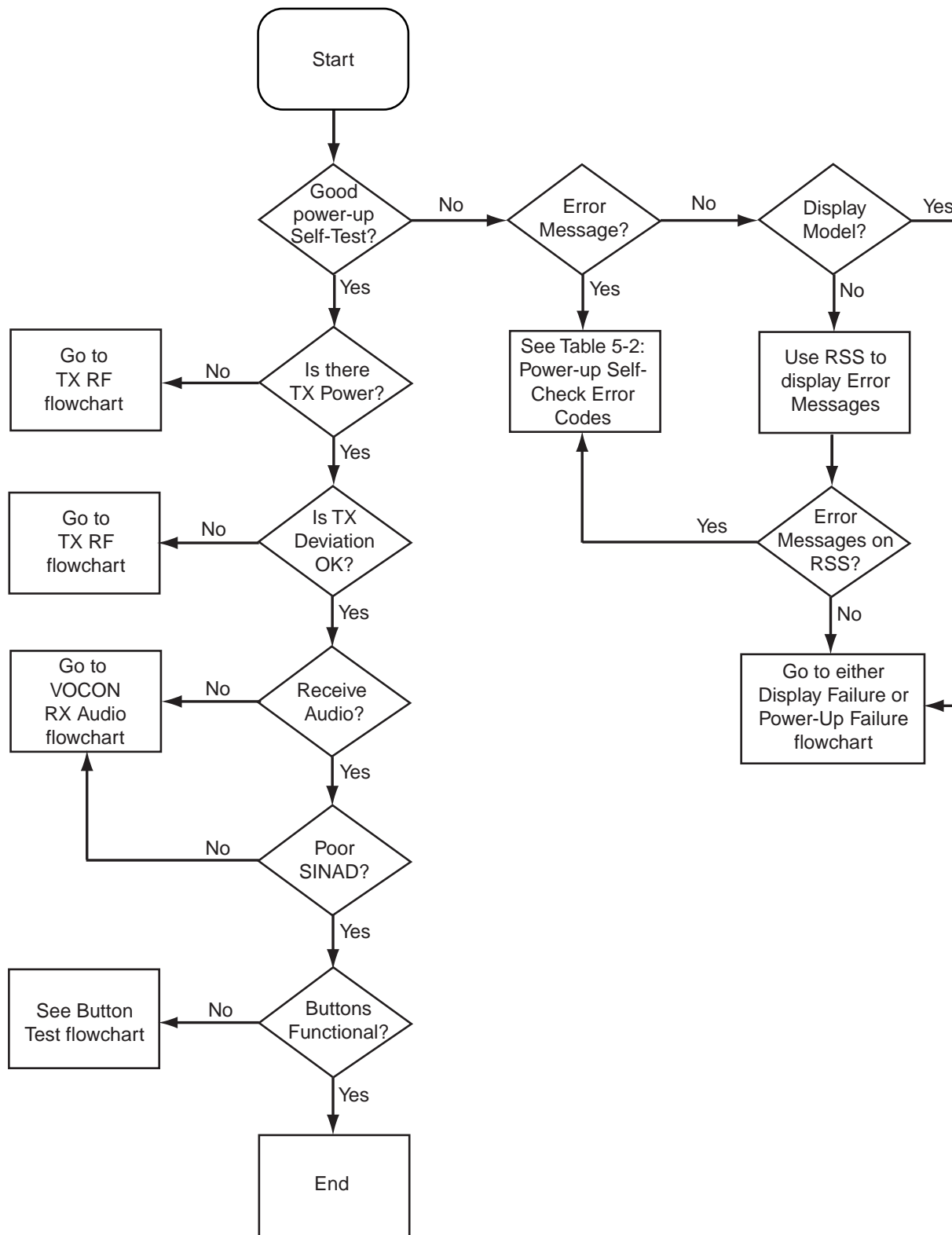
6.2 List of Troubleshooting Charts

Most troubleshooting charts (see [Table 6-1](#)) end up by pointing to an IC to replace. **It is not always noted, but it is good practice to verify supplies and grounds to the affected IC and to trace continuity to the malfunctioning signal and related circuitry before replacing any IC.** For instance, if a clock signal is not available at a destination, continuity from the source IC should be checked before replacing the source IC.

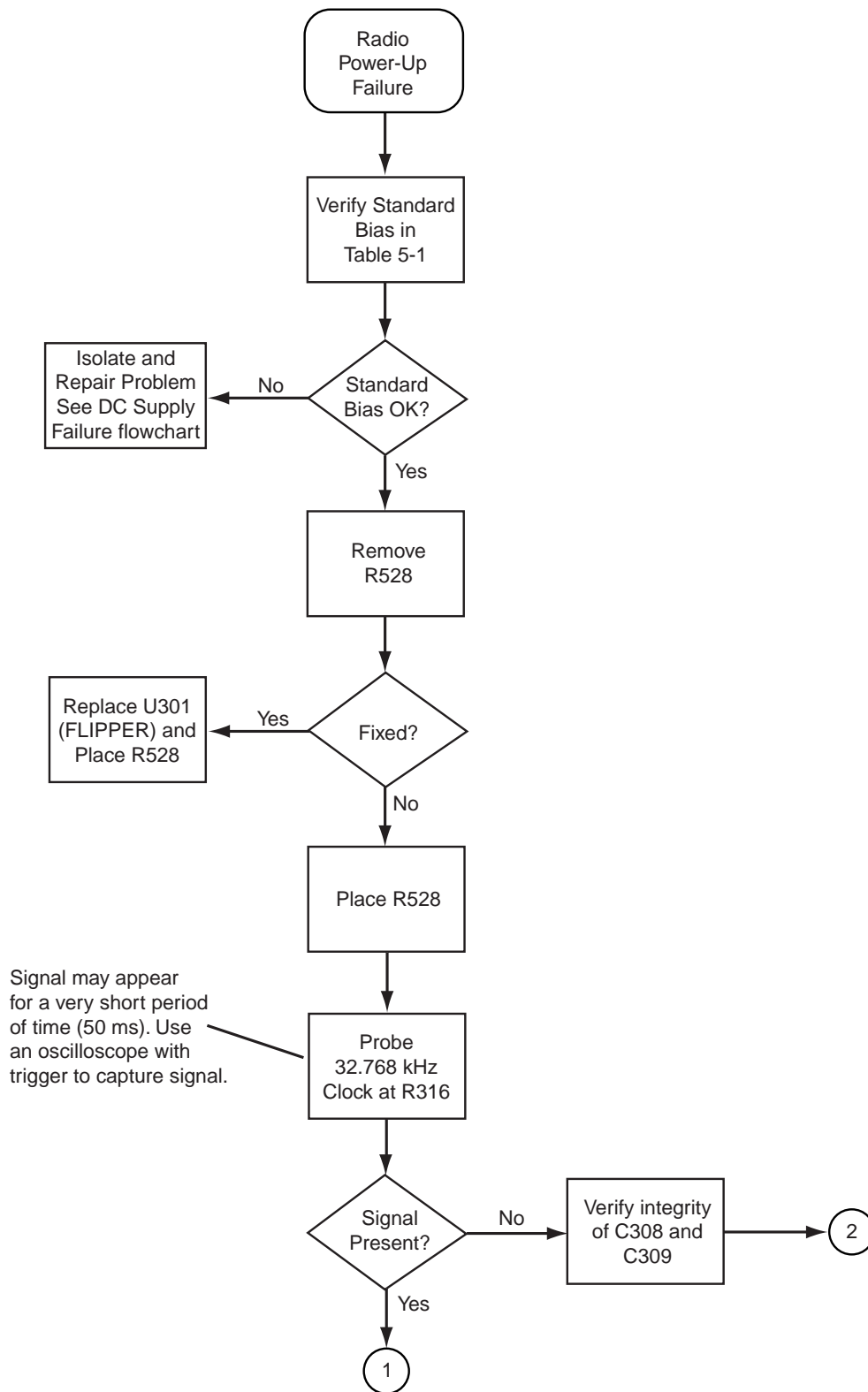
Table 6-1. Troubleshooting Charts List

Chart Title	Page Number
Main Troubleshooting Flowchart	6-2
Power-Up Failure	6-3
DC Supply Failure	6-5
Display Failure	6-8
Volume Set Error	6-11
Channel/Zone Select Error	6-12
Button Test	6-13
Top/Side Button Test	6-14
VCO TX/RX Unlock	6-15
VOCON TX Audio	6-16
VOCON RX Audio	6-18
RX RF	6-20
TX RF	6-25
Keyload Failure	6-28
Secure Hardware Failure	6-29

6.3 Main Troubleshooting Flowchart

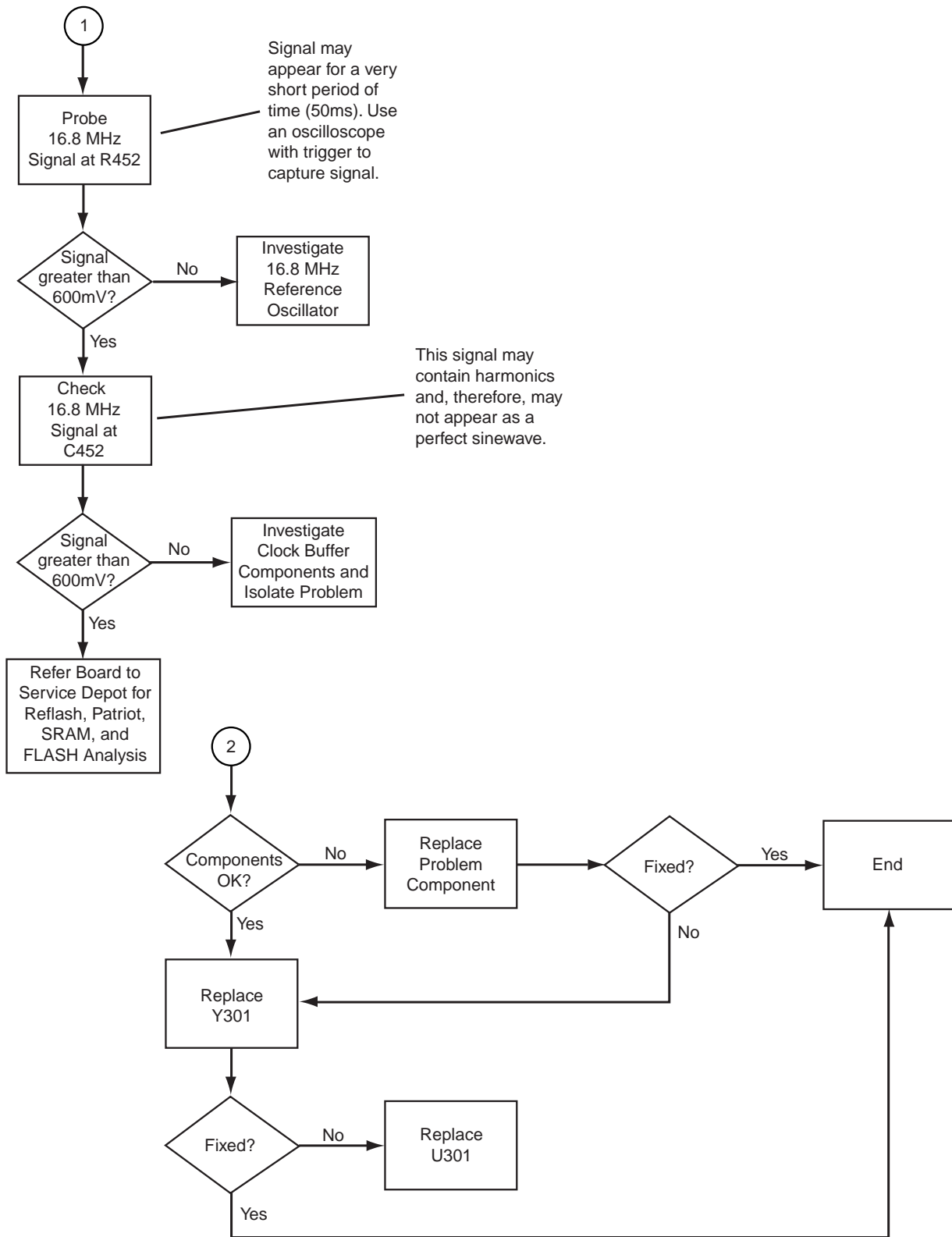


6.4 Power-Up Failure—Page 1



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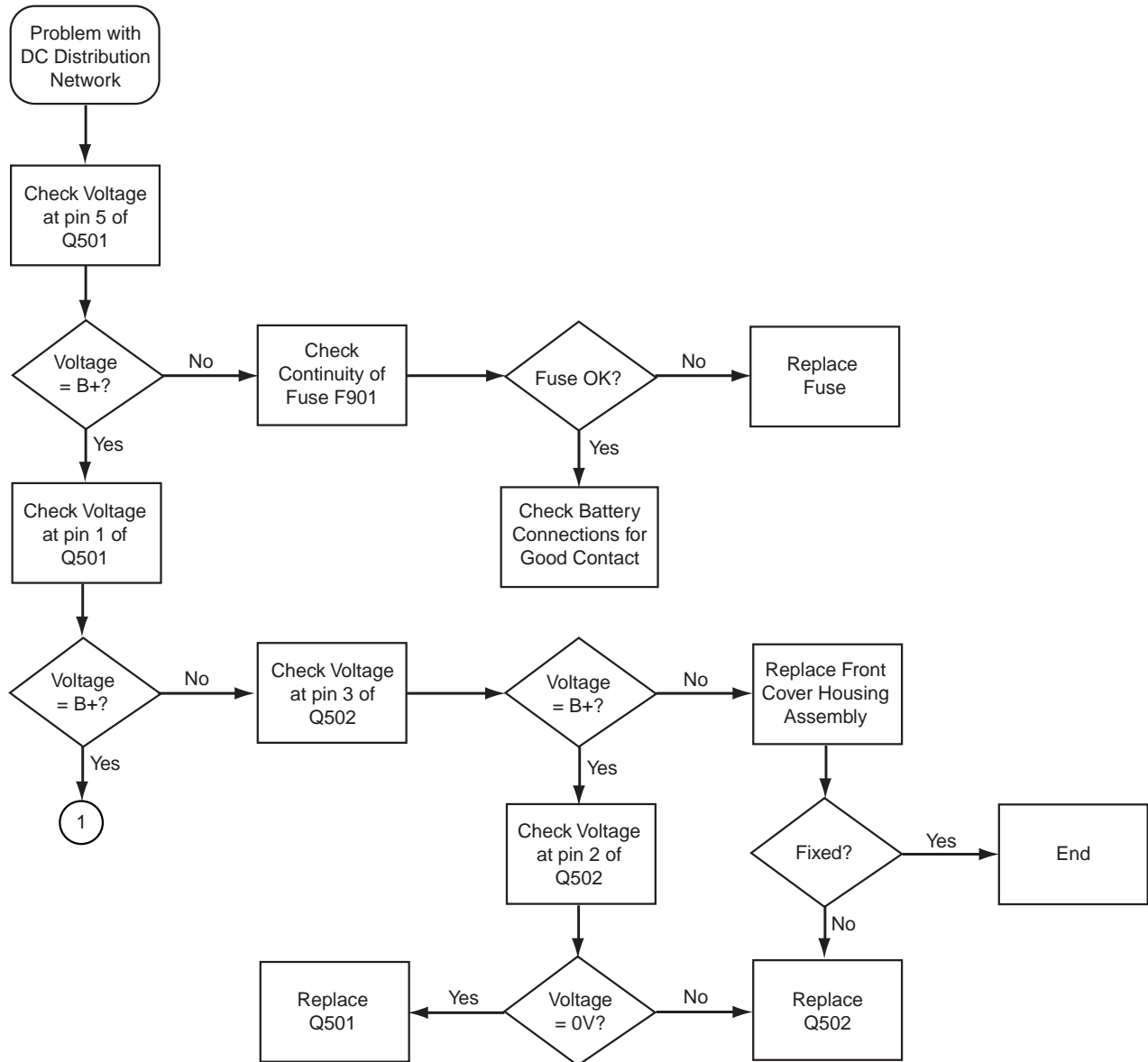
6.5 Power-Up Failure—Page 2



MAEPF-27390-O

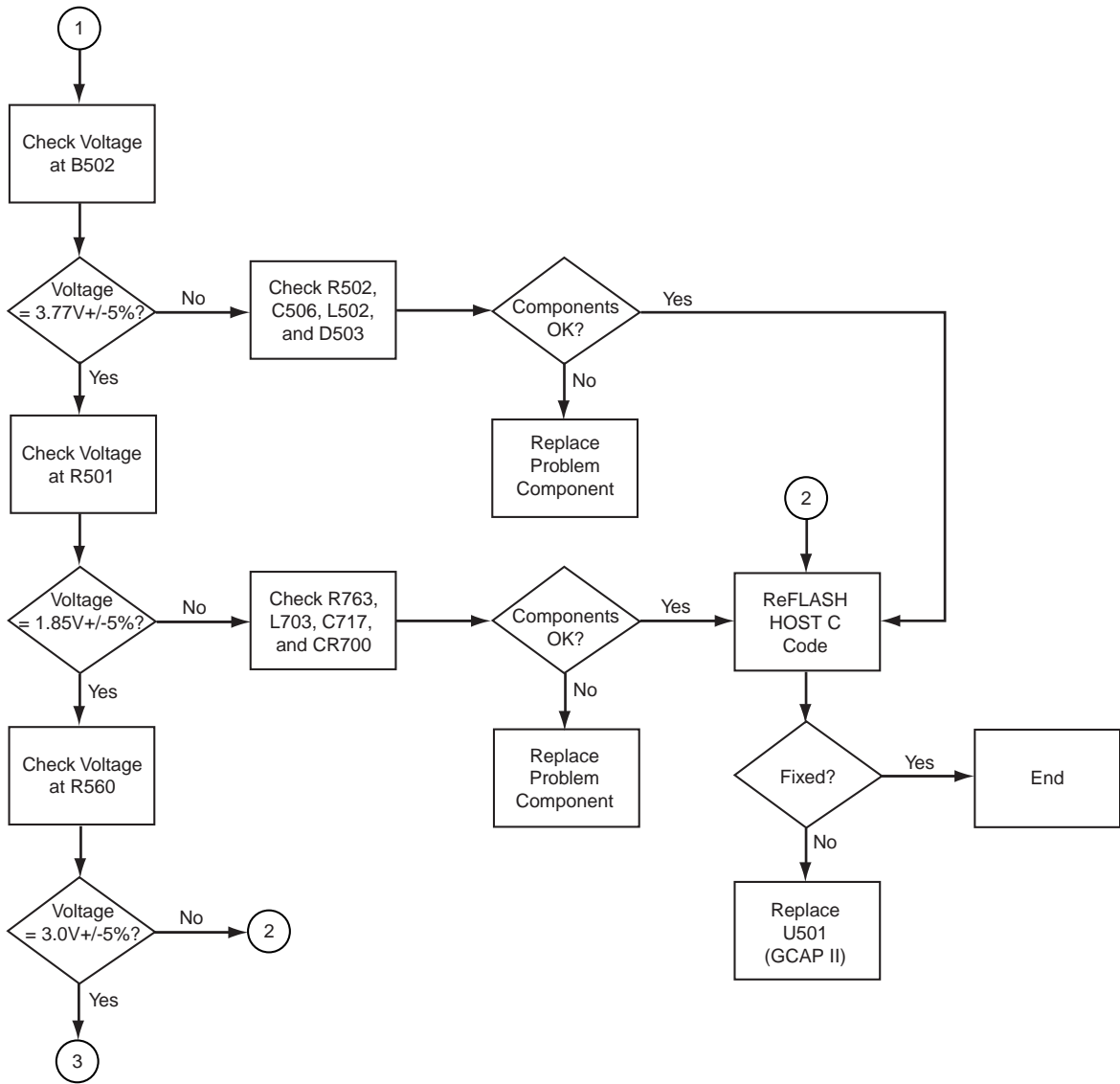
6.6 DC Supply Failure—Page 1

NOTE: Since the failure of a critical voltage supply might cause the radio to automatically power down, supply voltages should first be probed with a multimeter. If all the board voltages are absent, then the voltage test point should be retested using a rising-edge-triggered oscilloscope. If the voltage is still absent, then another voltage should be tested using the oscilloscope. If that voltage is present, then the original voltage supply in question is defective and requires investigation of associated circuitry.



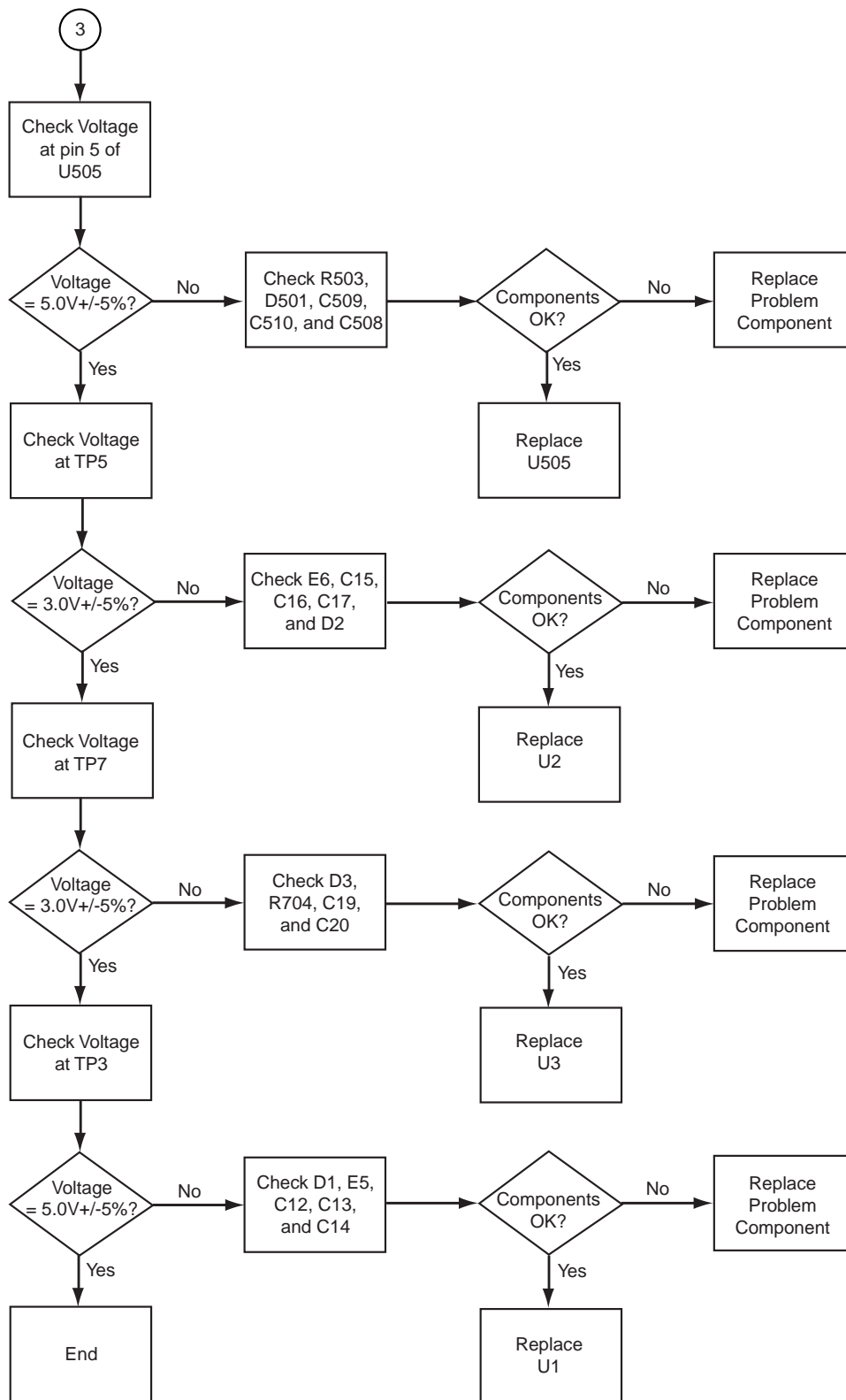
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6.7 DC Supply Failure—Page 2



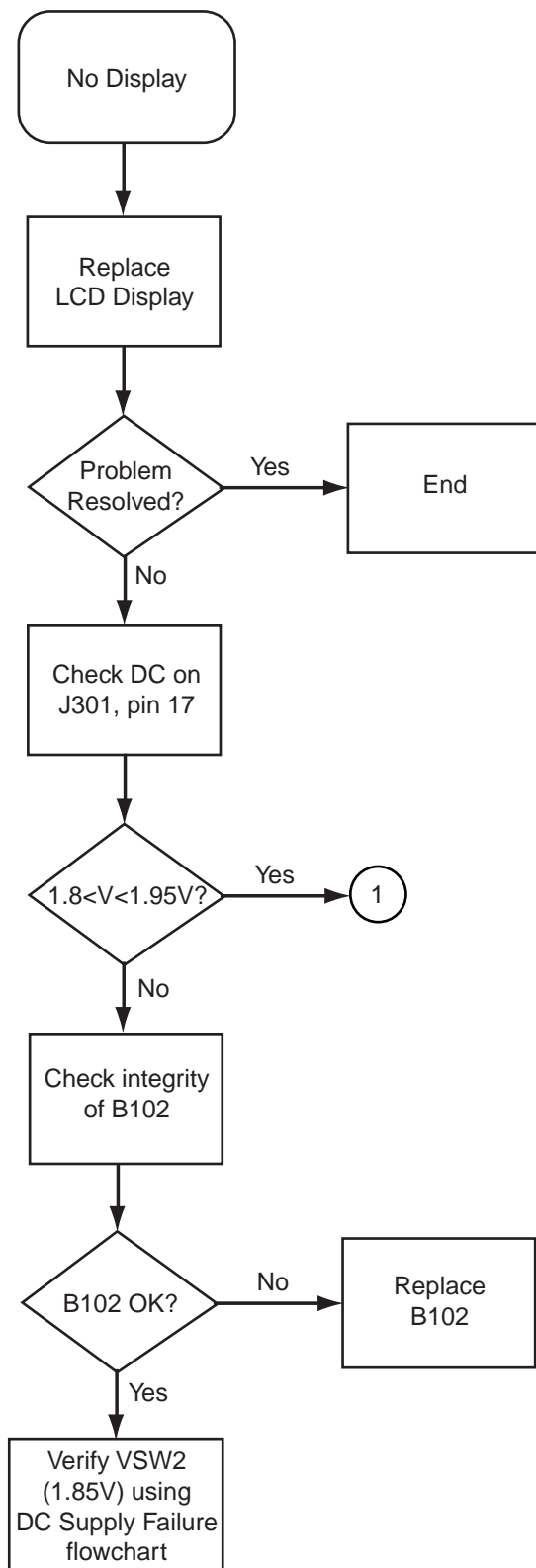
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6.8 DC Supply Failure—Page 3



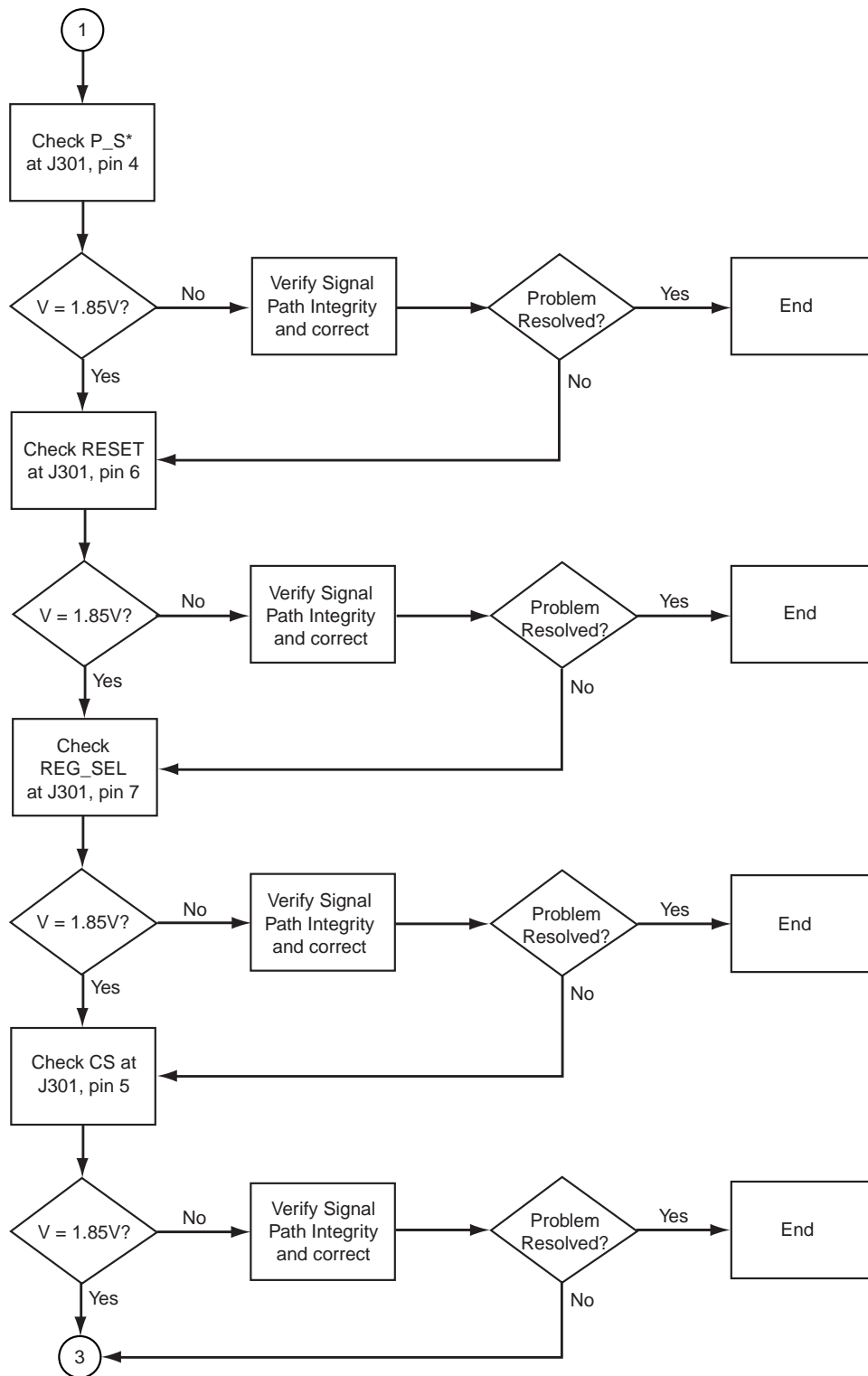
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6.9 Display Failure—Page 1



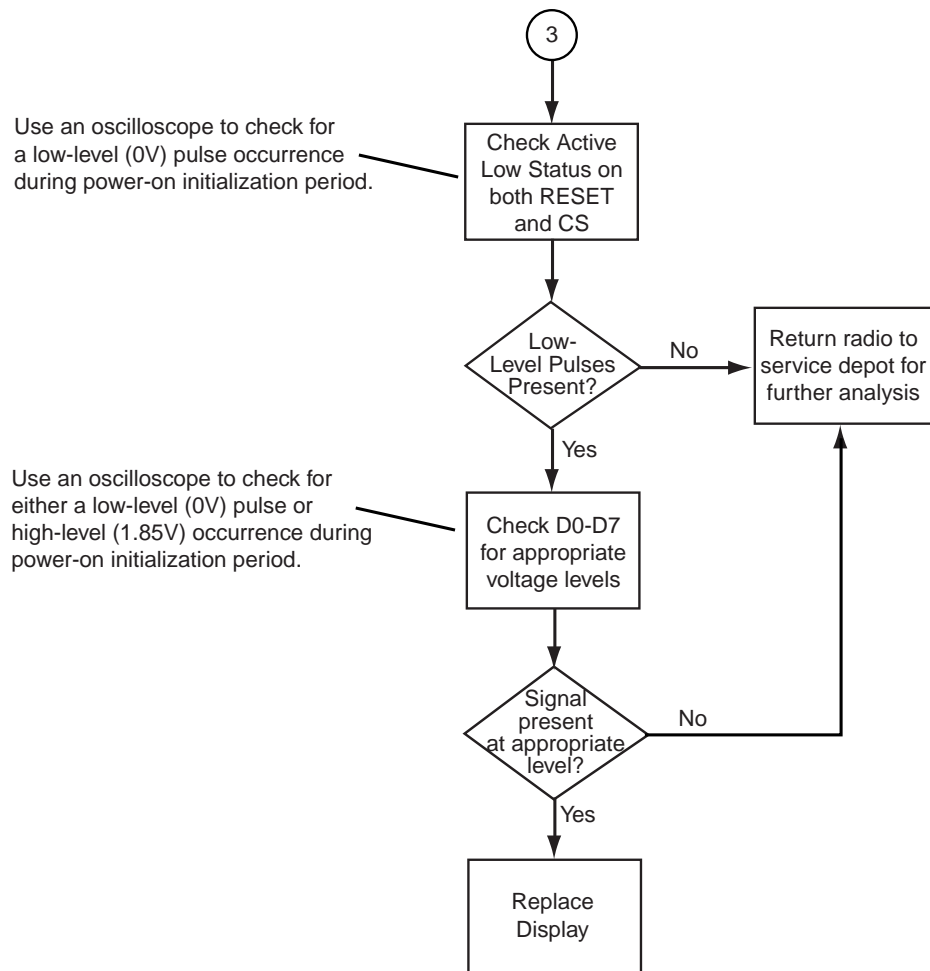
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6.10 Display Failure—Page 2



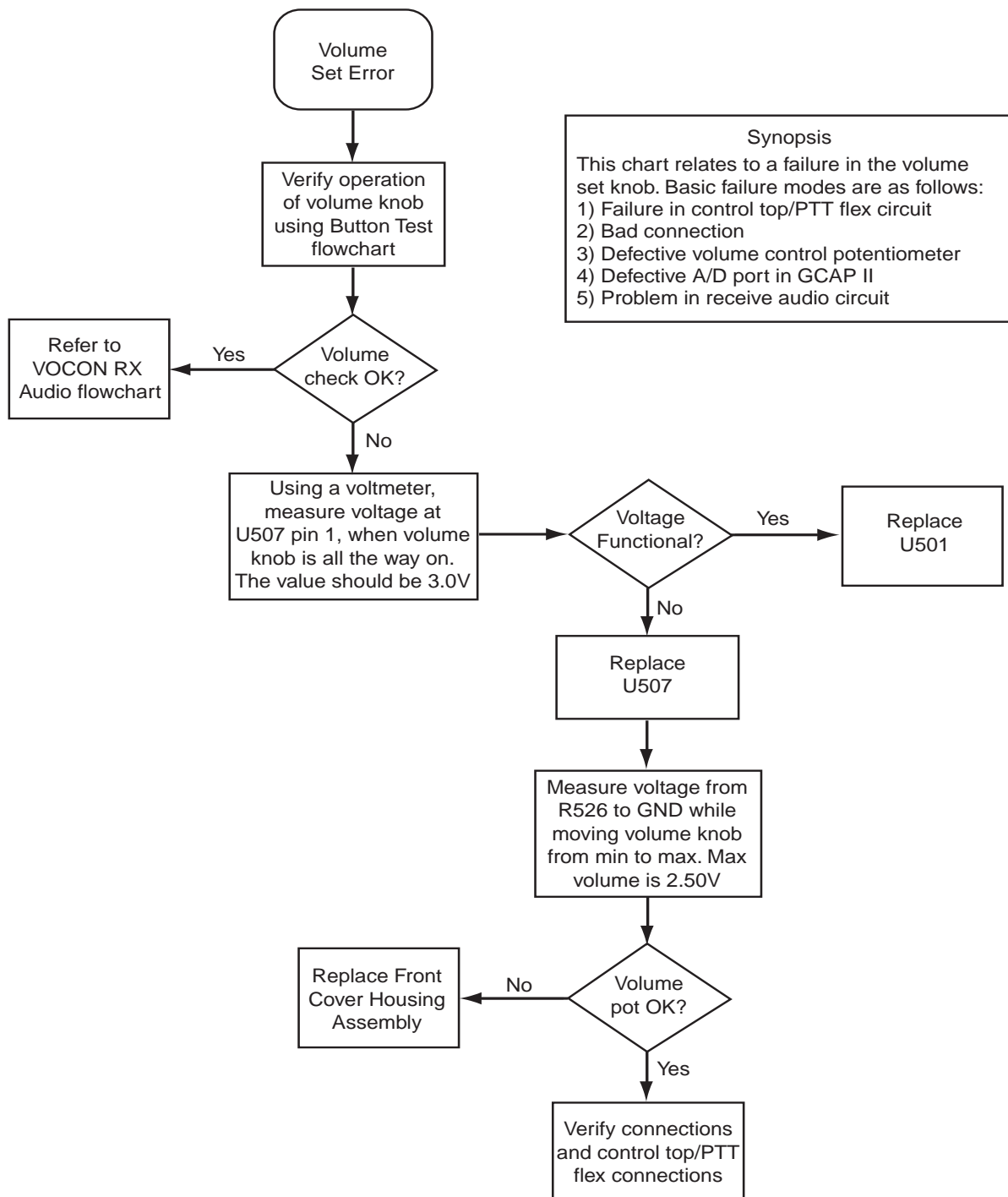
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6.11 Display Failure—Page 3



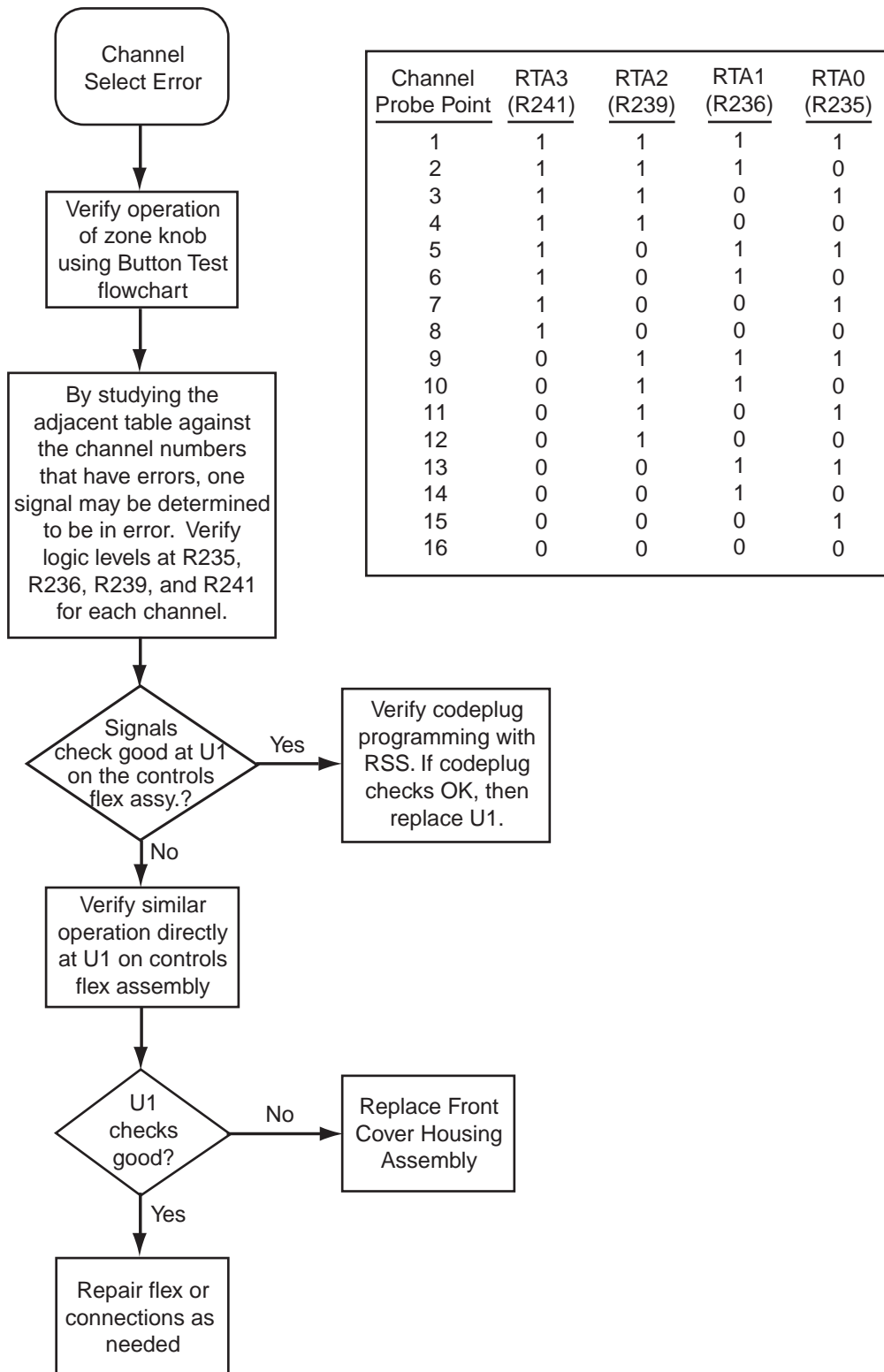
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6.12 Volume Set Error



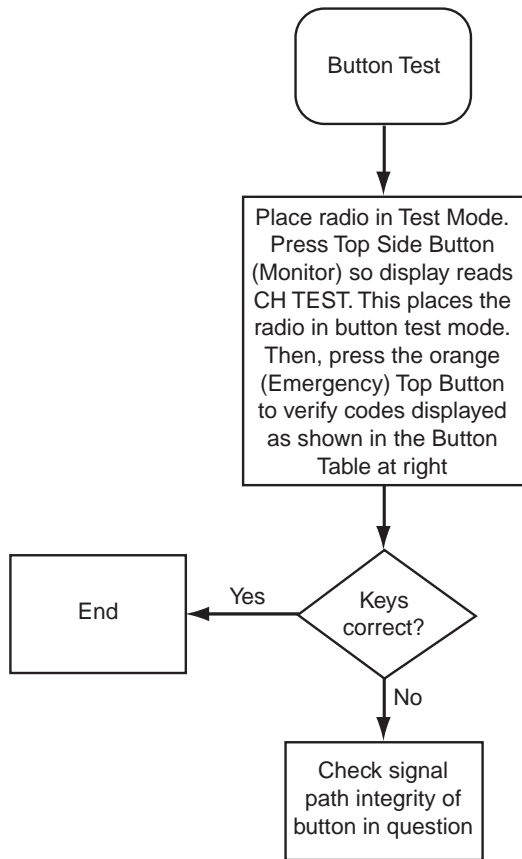
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6.13 Channel/Zone Select Error



MAEPF-27402-O

6.14 Button Test



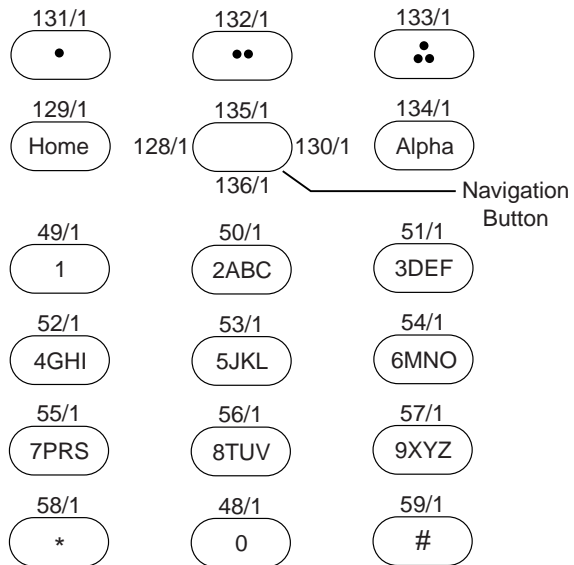
Synopsis

This chart relates to a failure in the button functions
 Basic Failure modes are as follows:

- 1) Failure in control top/PTT or keypad flex assembly
- 2) Bad Connection
- 3) Defective Switches or pads
- 4) Defective A/D port in GCAP II

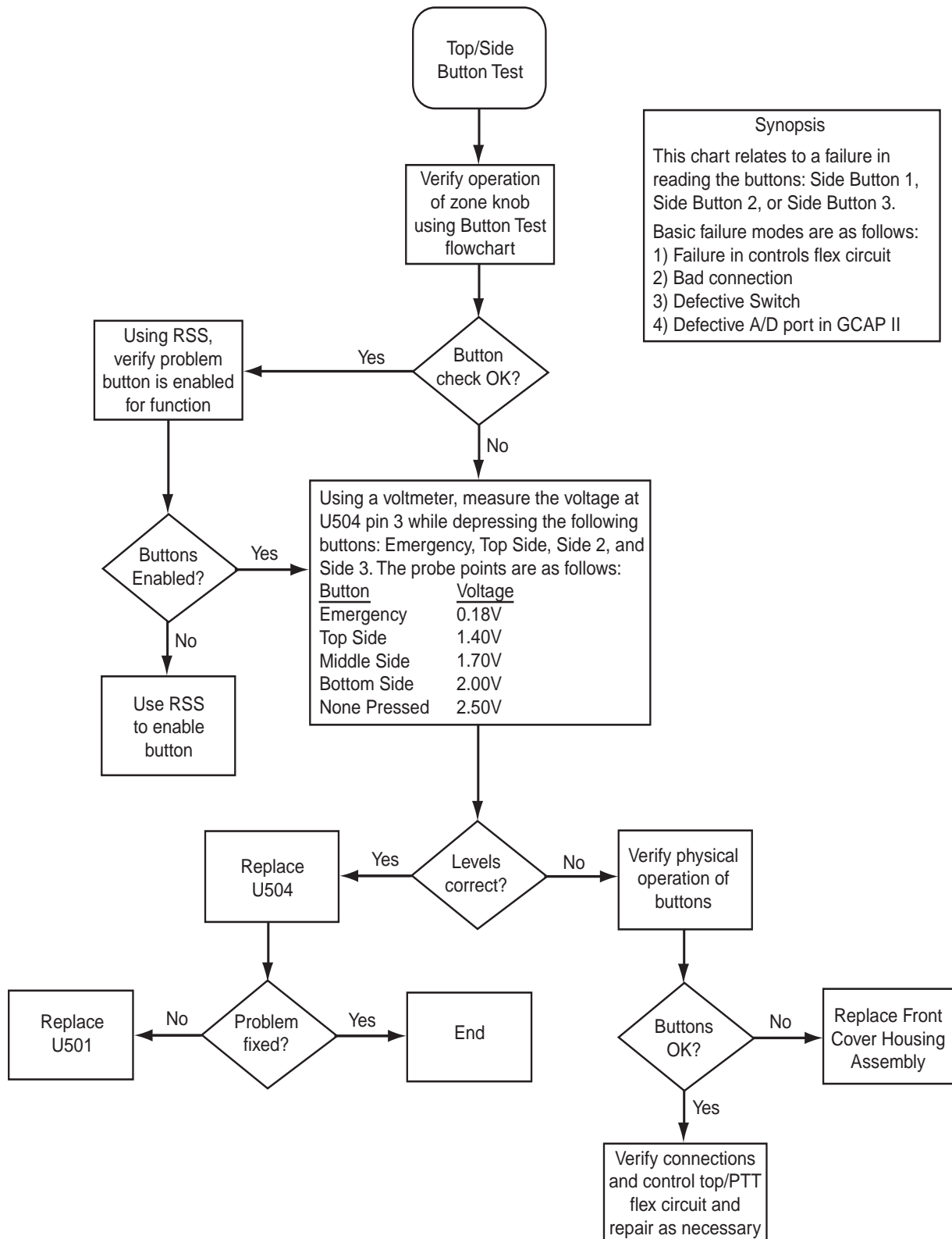
Button Table

Button	Code
PTT	1/ 0-1
Top Button (Emergency)	3/ 0-1
Side Button 1 (Monitor)	96/ 0-1
Side Button 2	97/ 0-1
Side Button 3	98/ 0-1
Channel Select (Frequency)	4/ 0-15
Volume Control Knob	0/ 0-244
Zone Select	65/ 0-2



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6.15 Top/Side Button Test

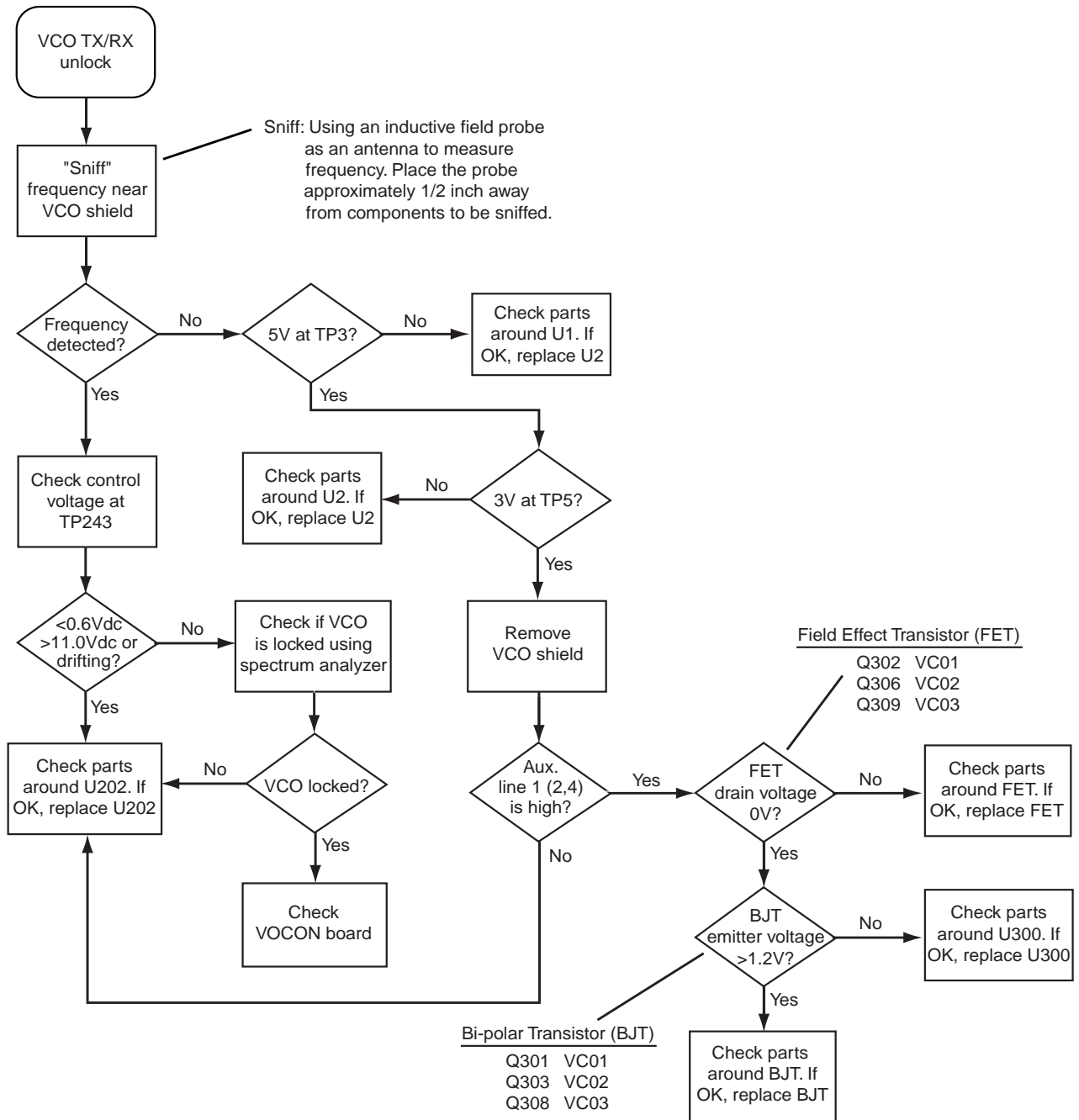


Synopsis

This chart relates to a failure in reading the buttons: Side Button 1, Side Button 2, or Side Button 3. Basic failure modes are as follows:

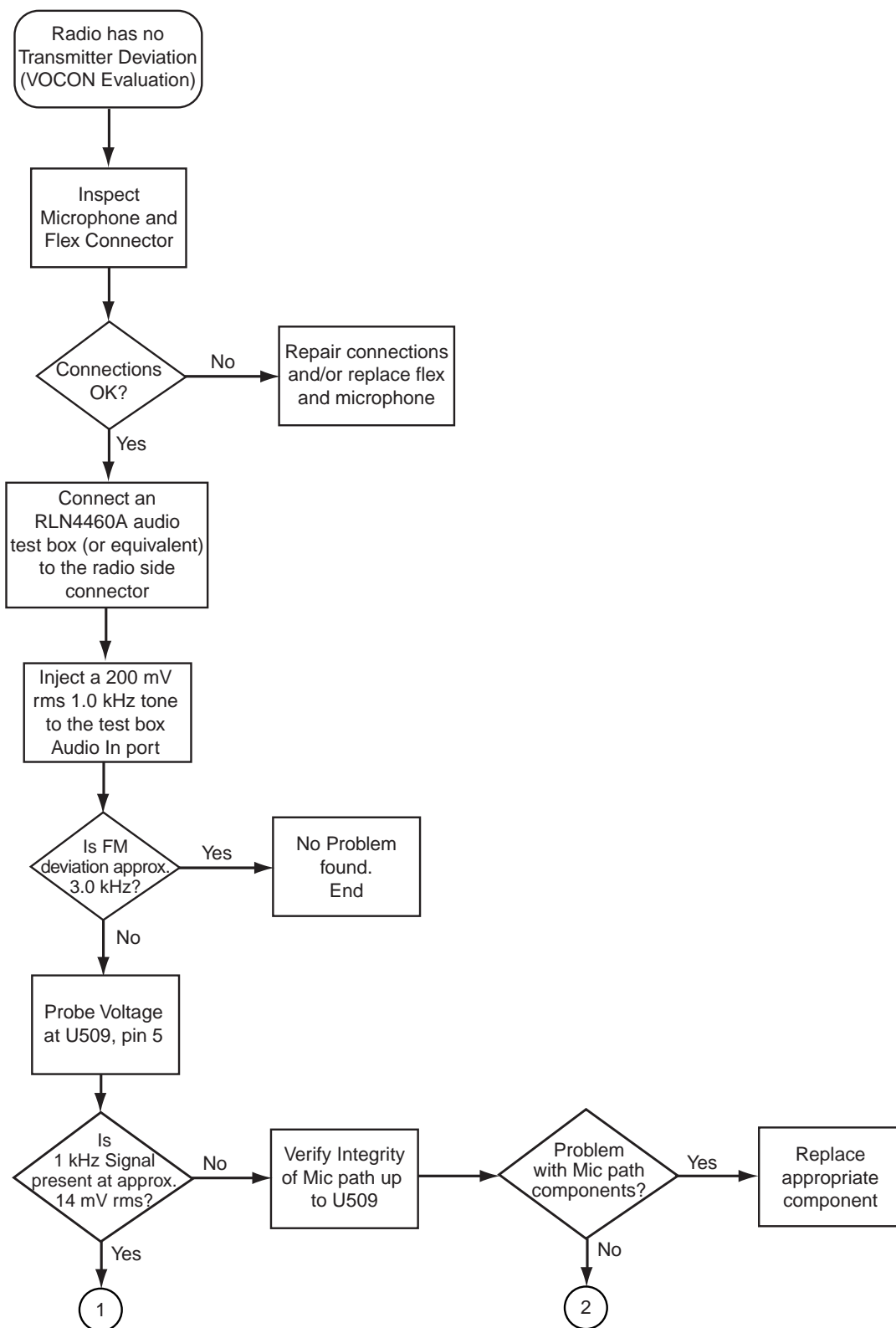
- 1) Failure in controls flex circuit
- 2) Bad connection
- 3) Defective Switch
- 4) Defective A/D port in GCAP II

6.16 VCO TX/RX Unlock



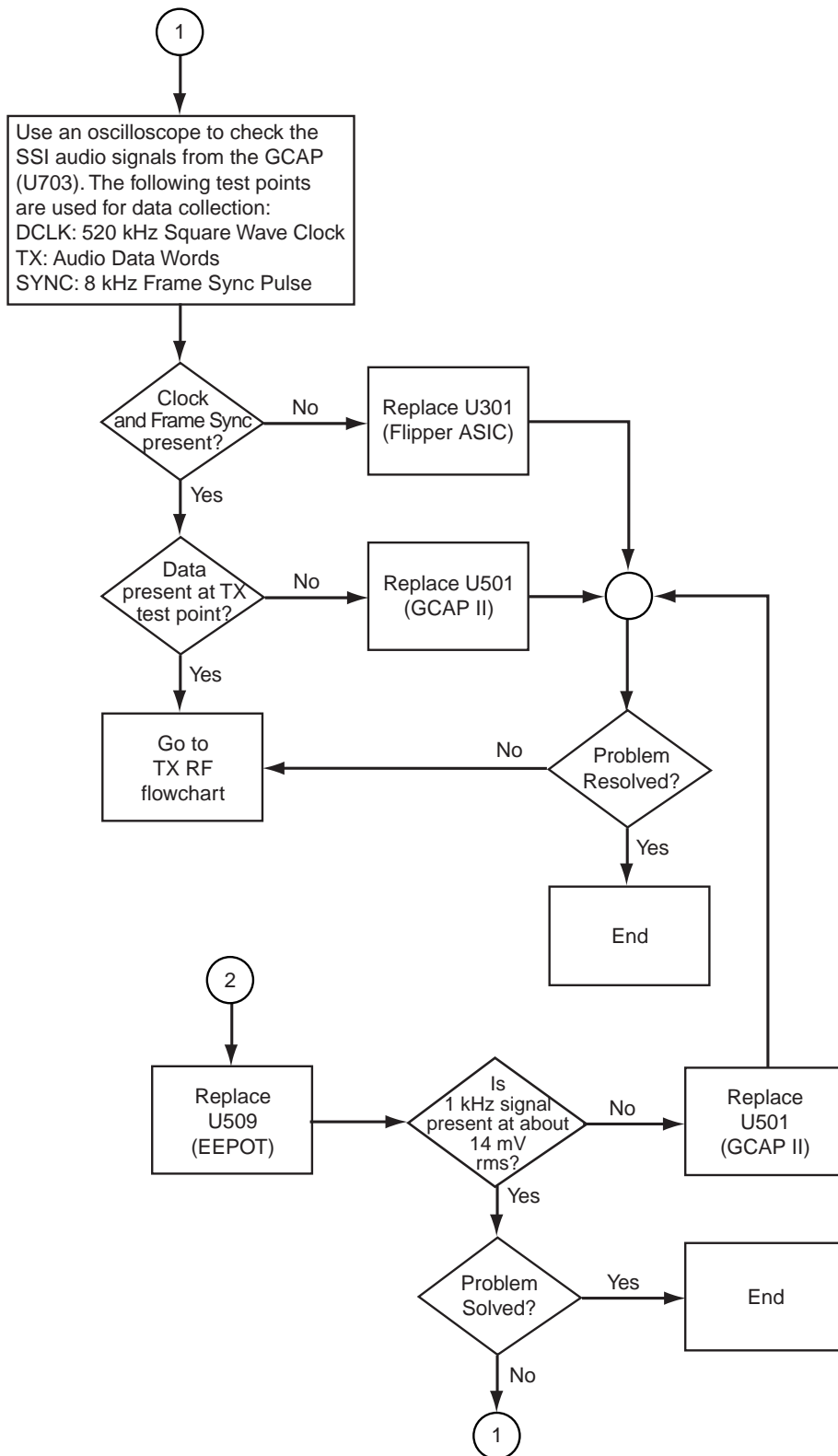
MAEPF-27398-O

6.17 VOCON TX Audio—Page 1



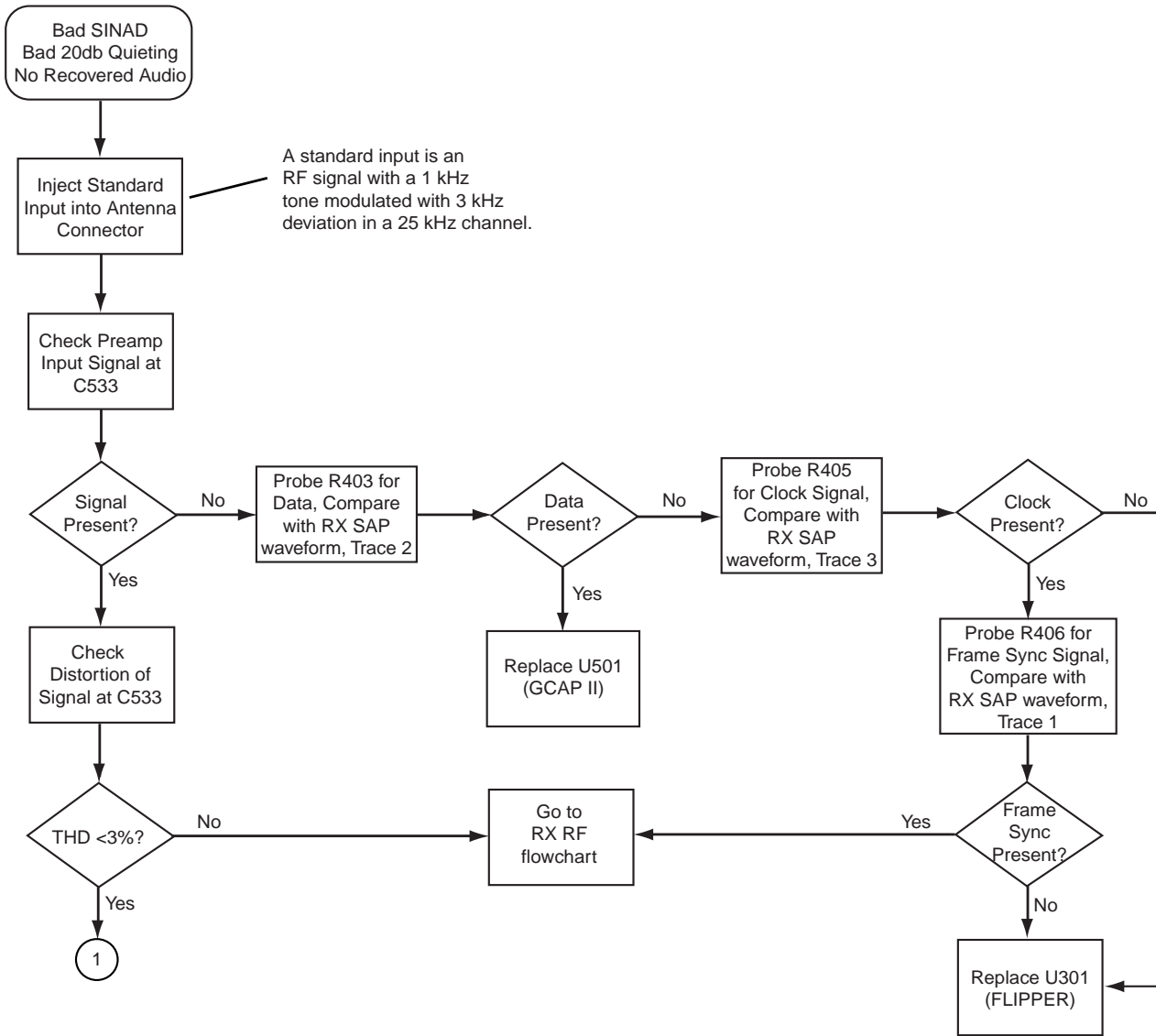
MAEPF-27396-O

6.18 VOCON TX Audio—Page 2



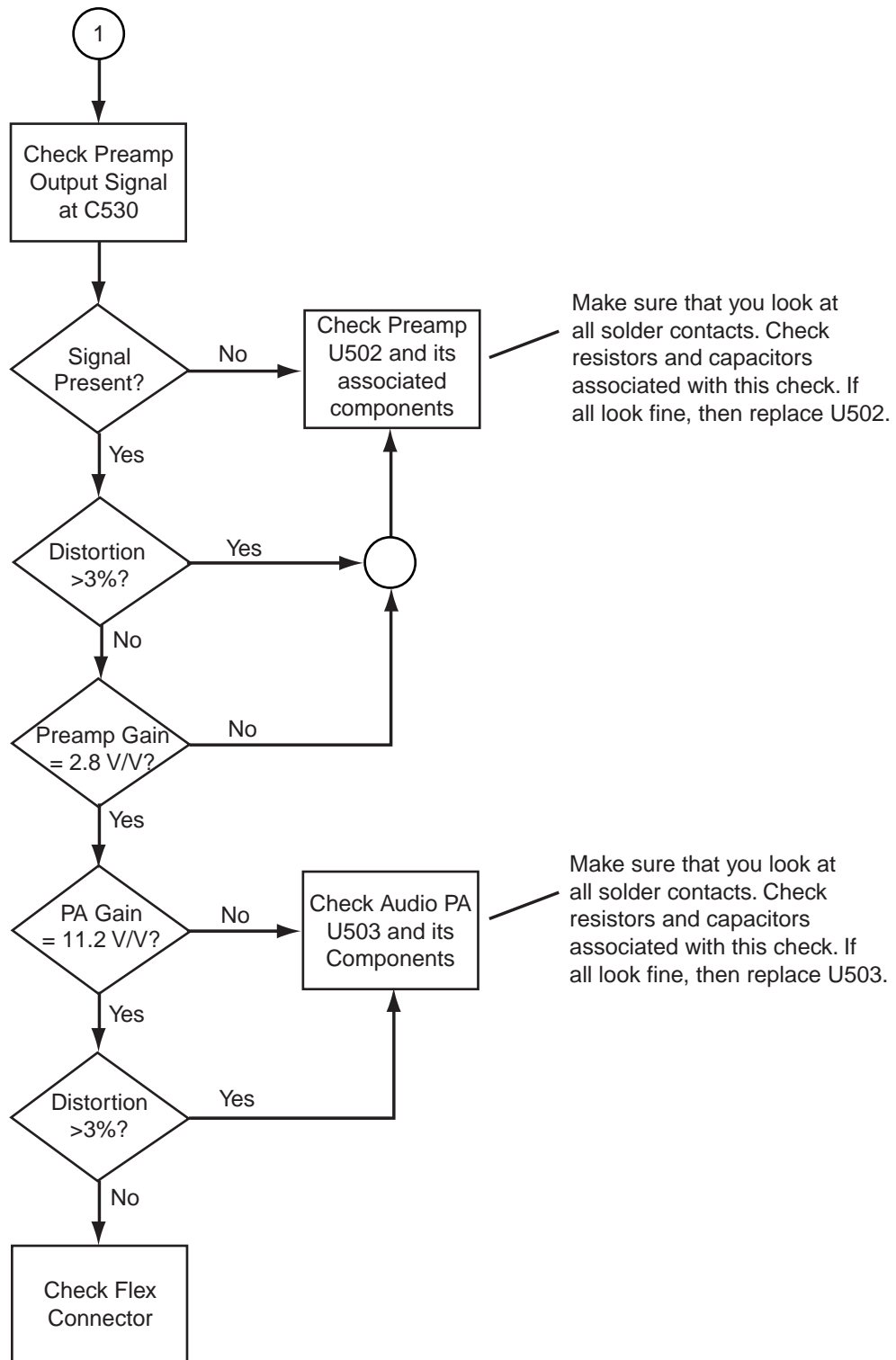
MAEPF-27397-O

6.19 VOCON RX Audio—Page 1



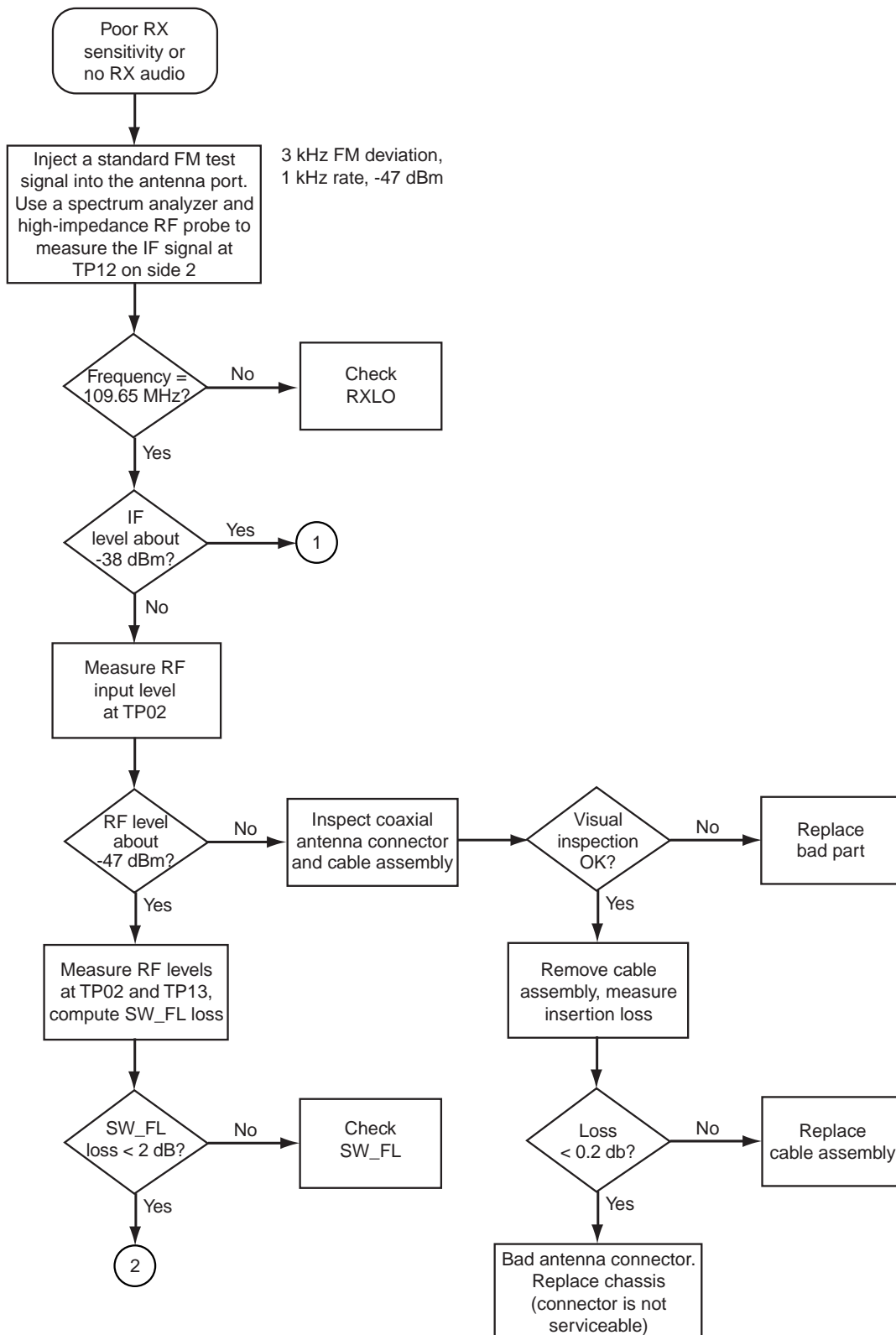
MAEPF-27394-O

6.20 VOCON RX Audio—Page 2



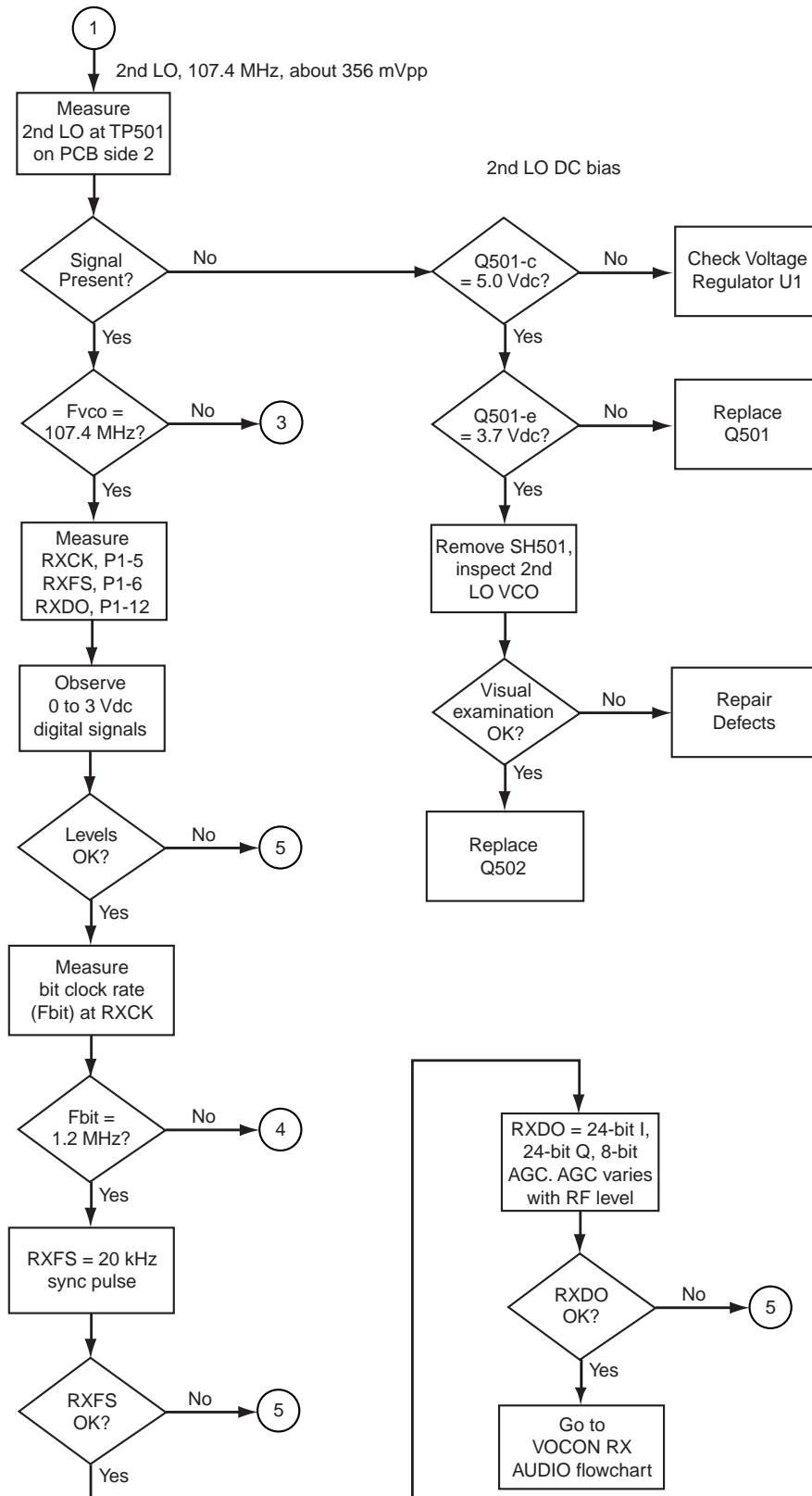
MAEPF-27395-O

6.21 RX RF—Page 1



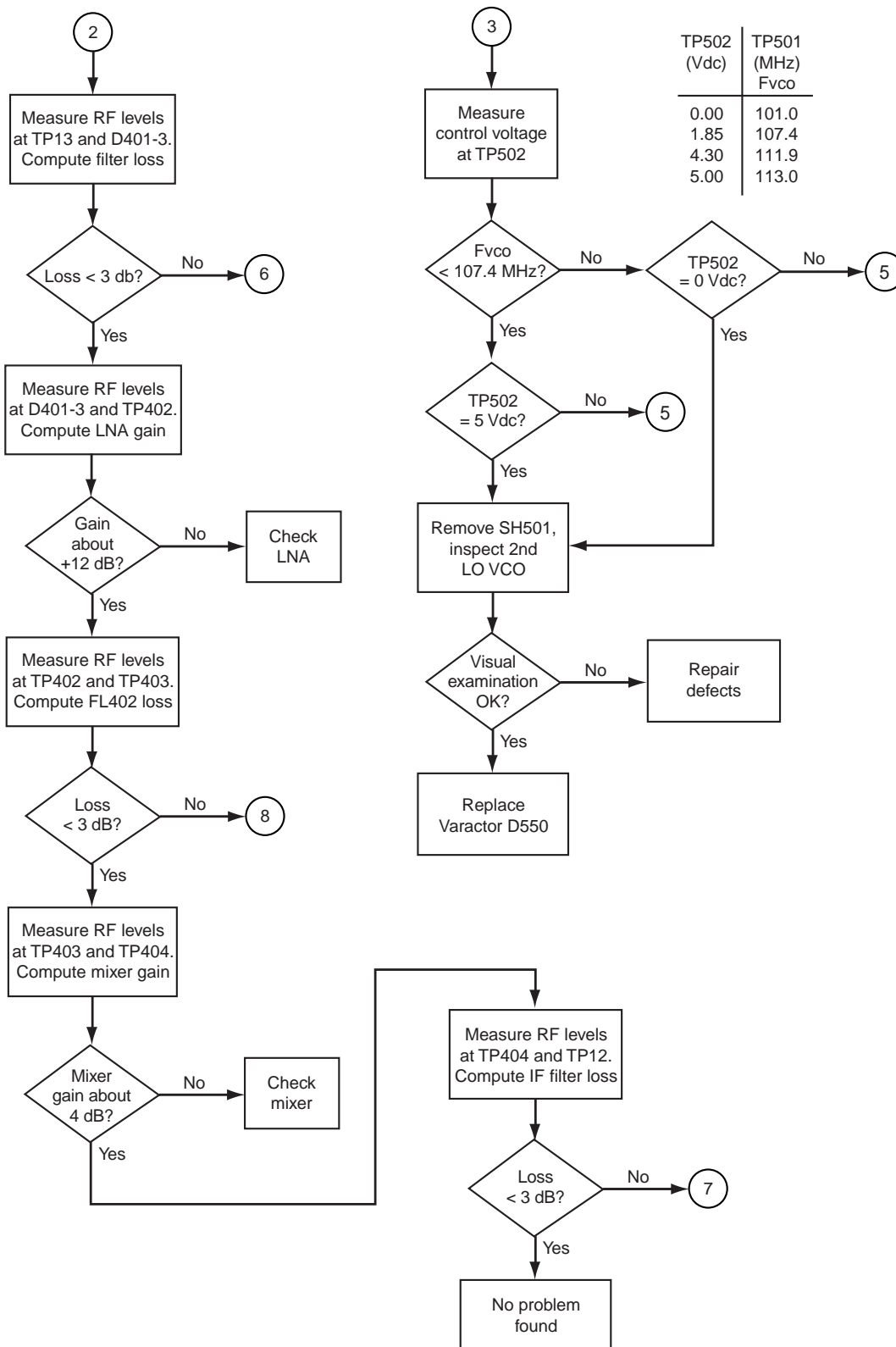
MAEPF-27470-O

6.22 RX RF—Page 2



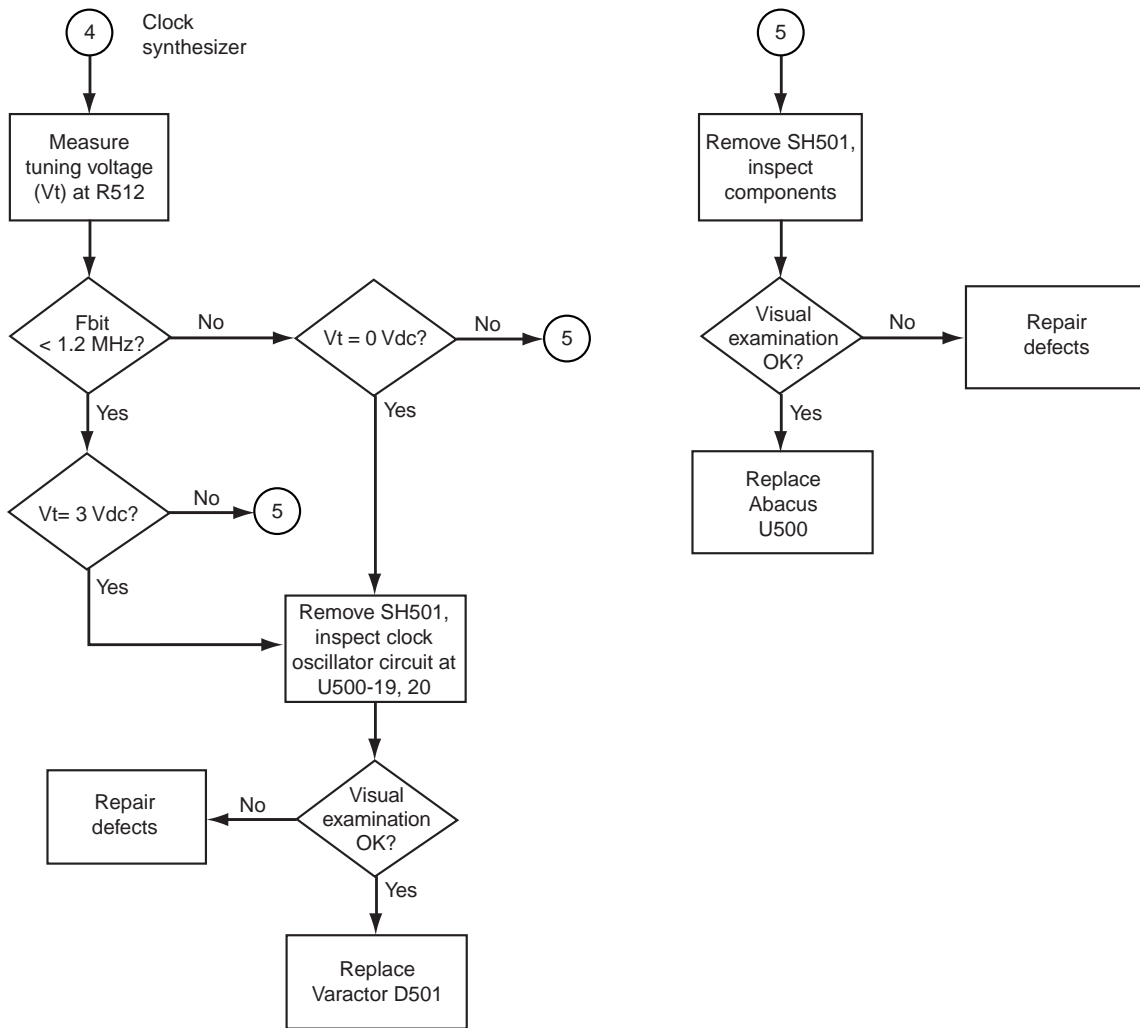
MAEPF-27471-O

6.23 RX RF—Page 3



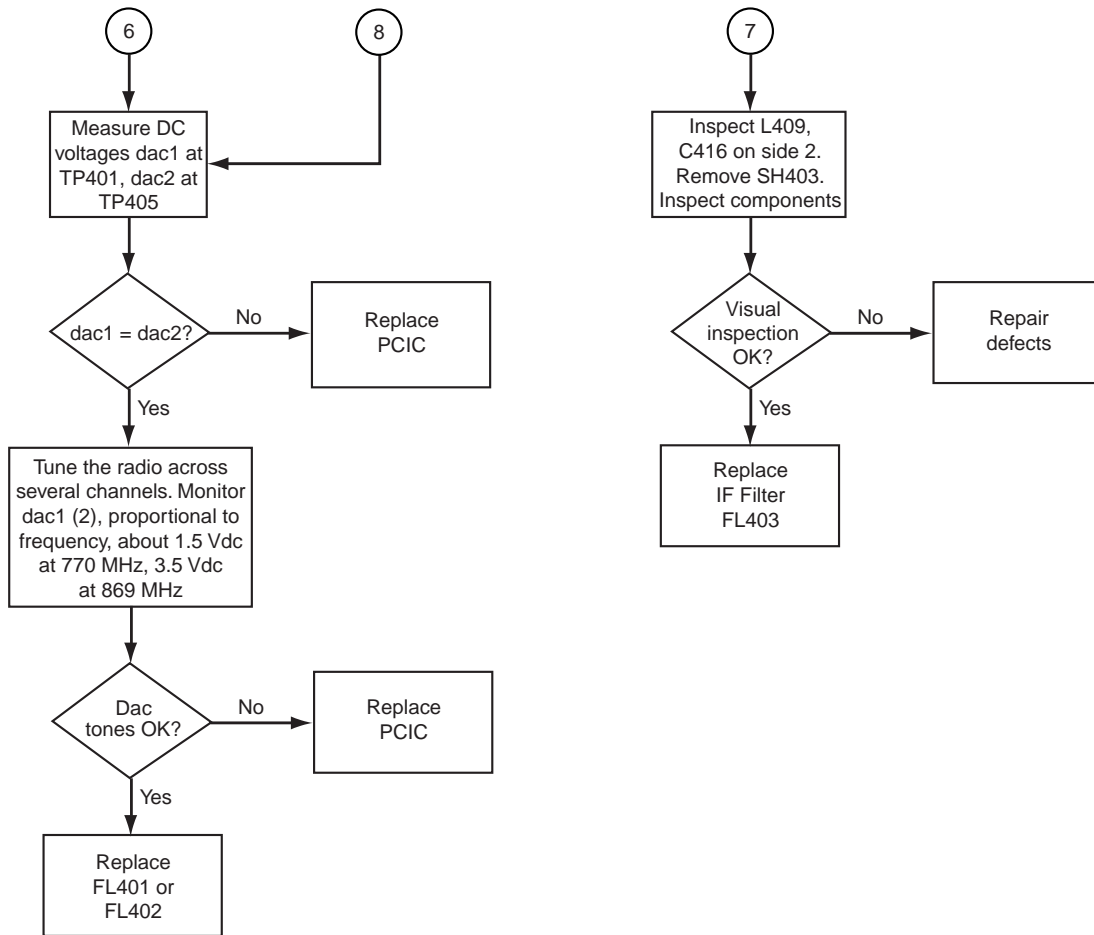
MAEPF-27472-0

6.24 RX RF—Page 4



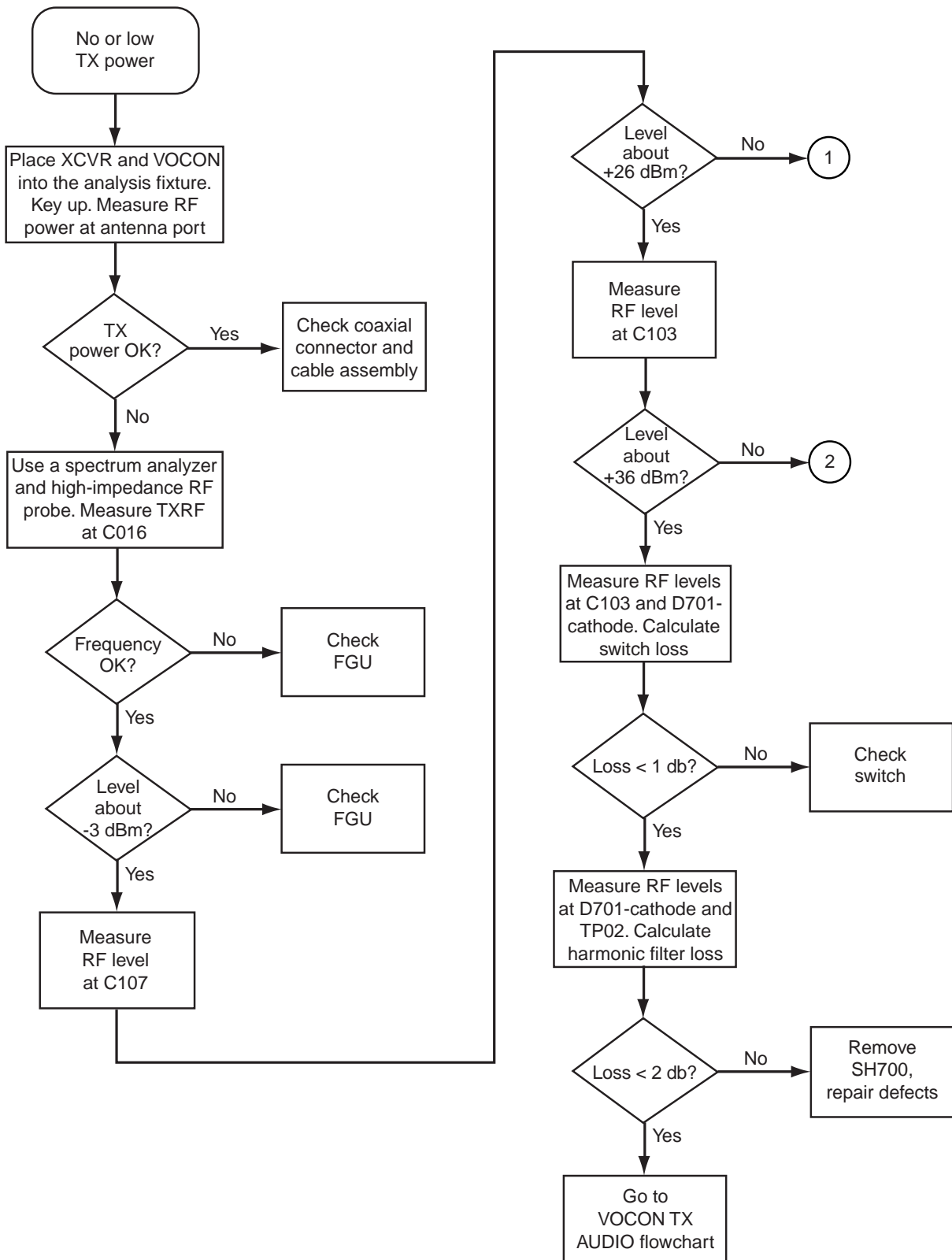
MAEPF-27473-O

6.25 RX RF—Page 5



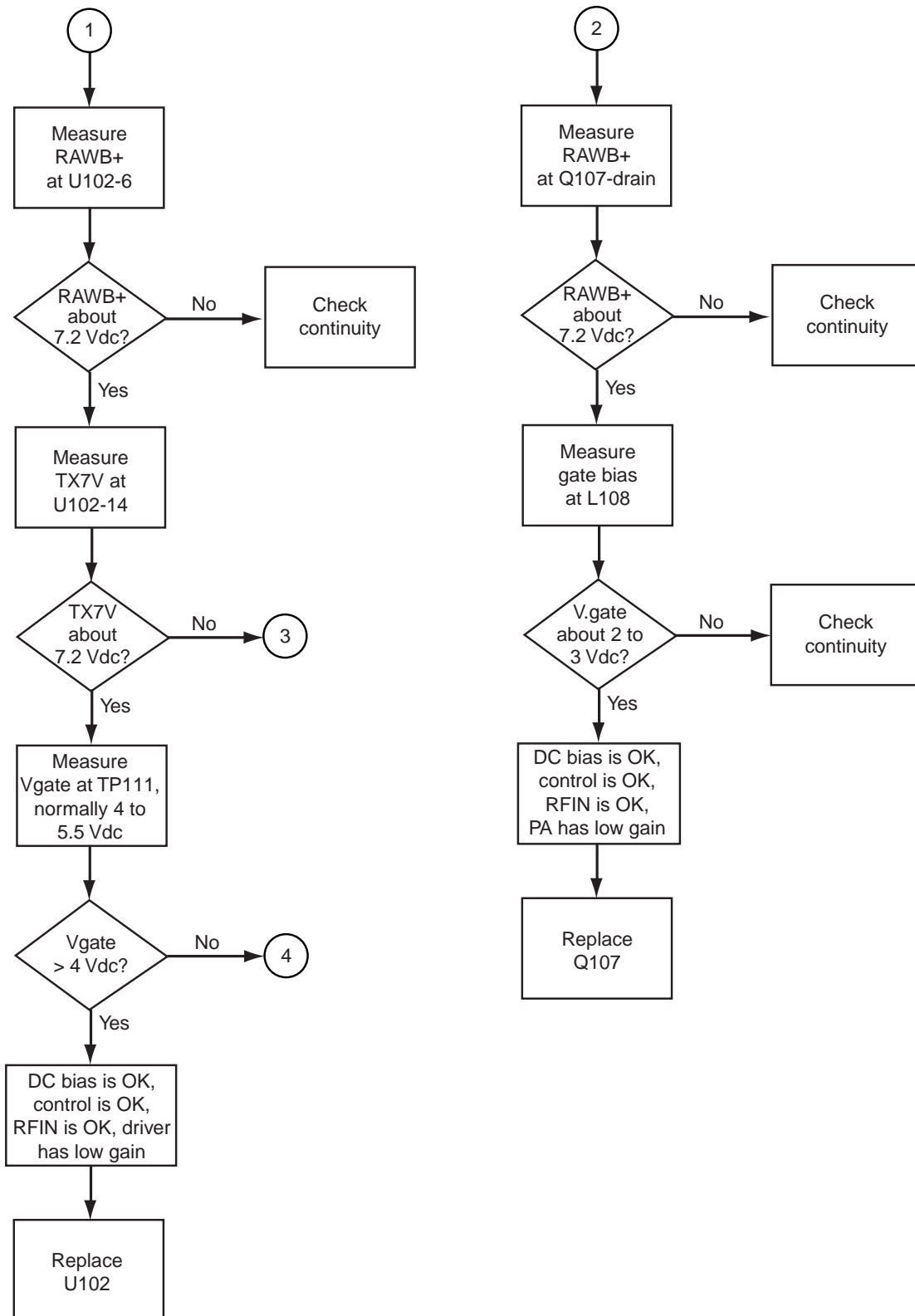
MAEPF-27474-O

6.26 TX RF—Page 1



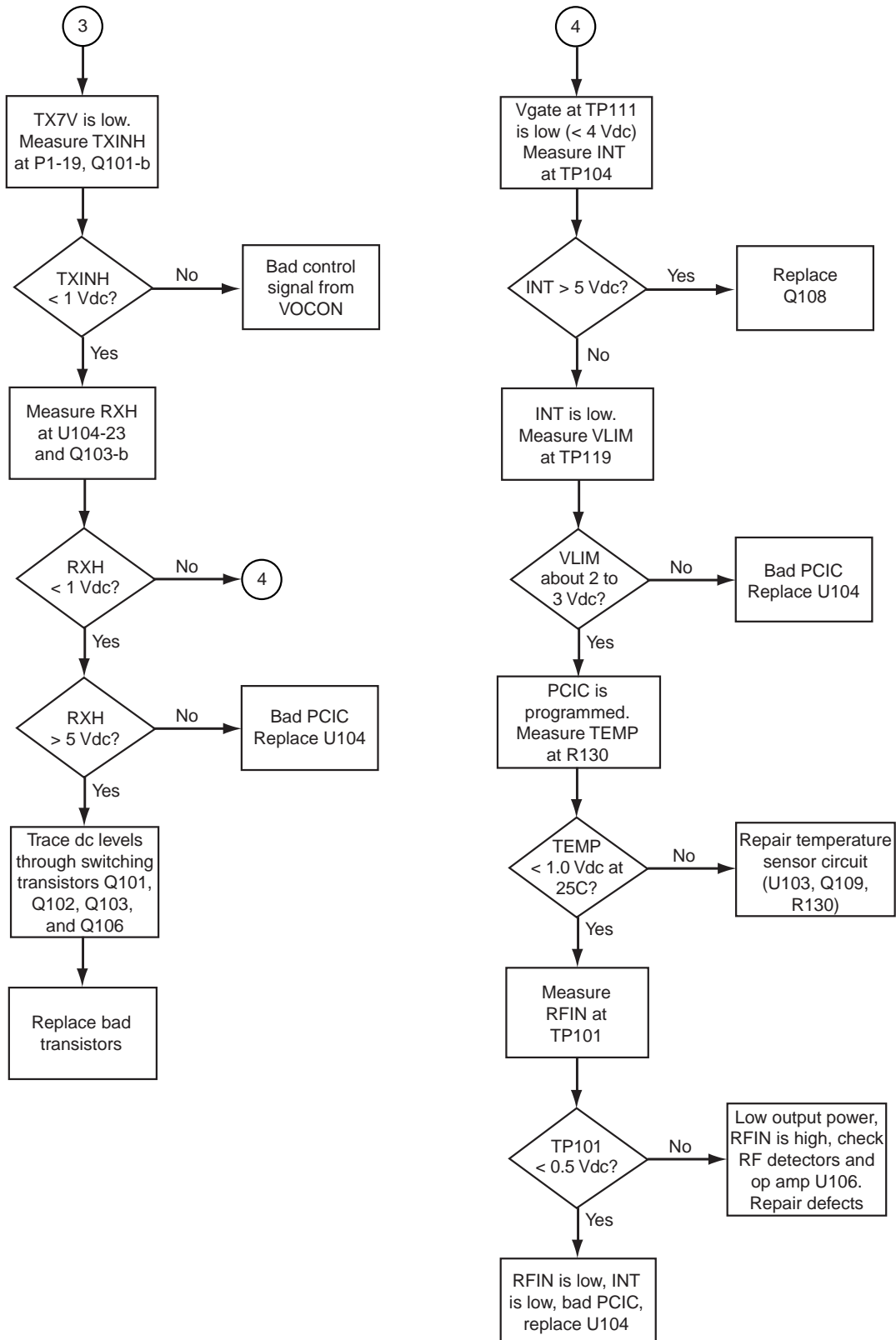
MAEPF-27475-O

6.27 TX RF—Page 2



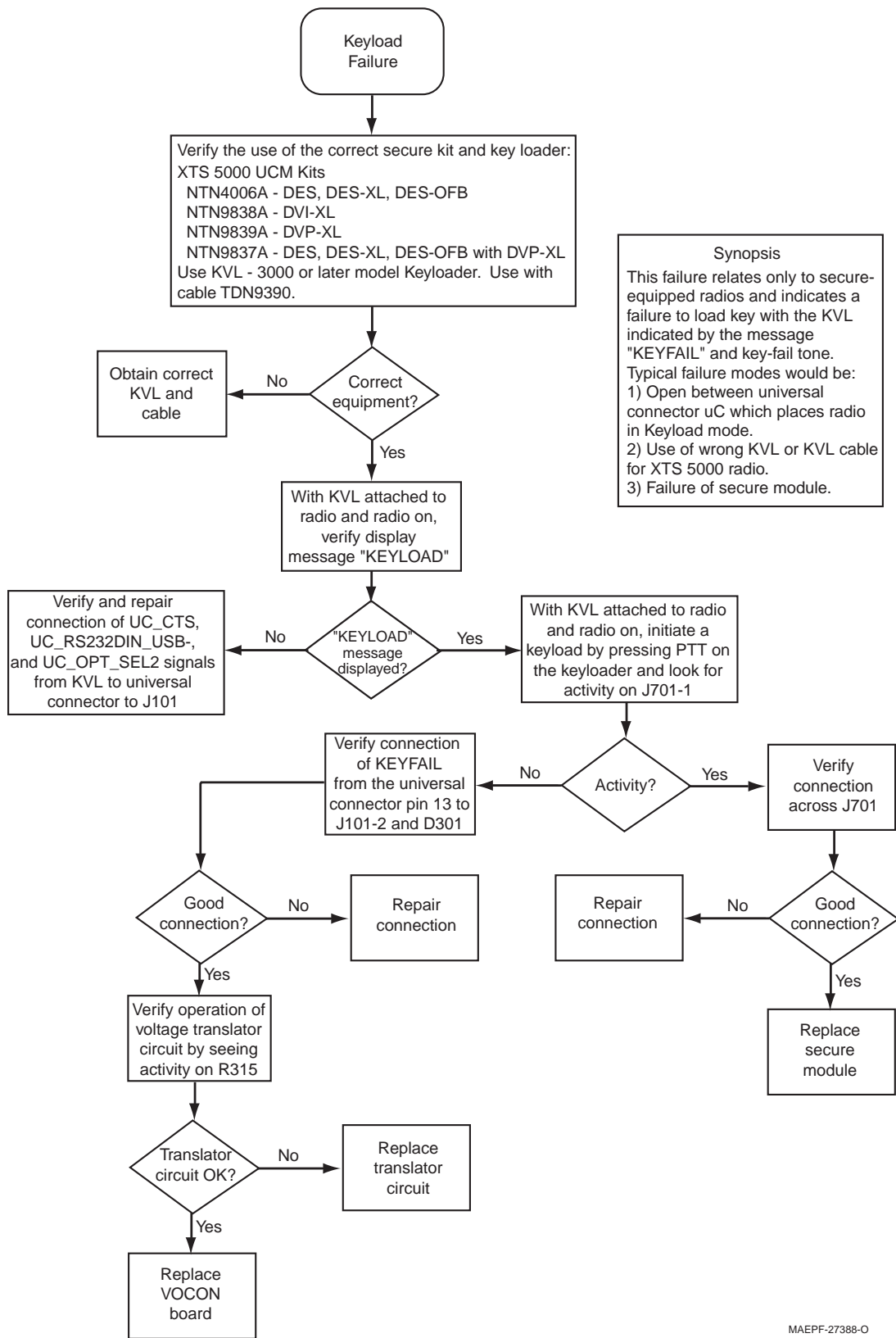
MAEPF-27420-O

6.28 TX RF—Page 3



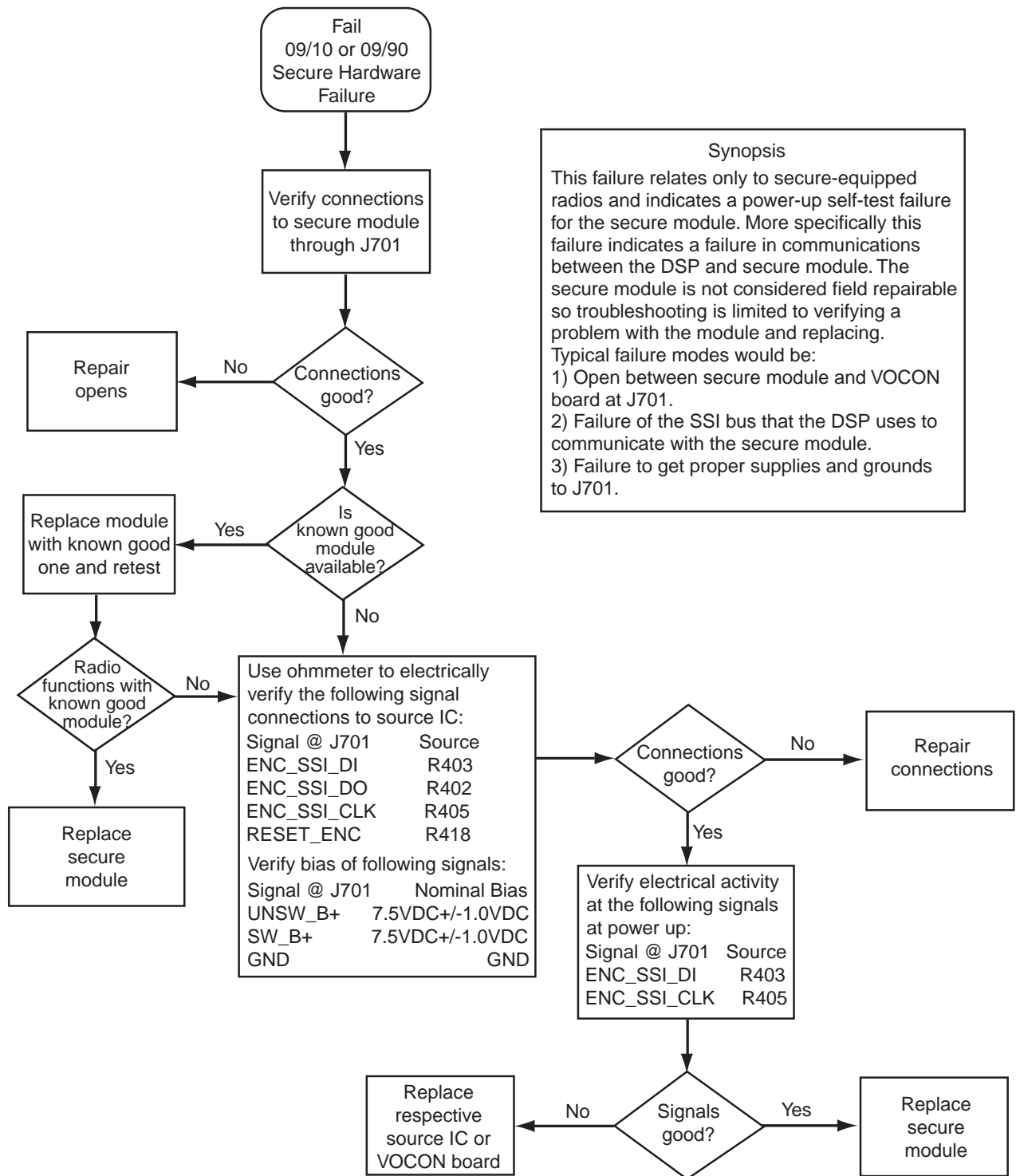
MAEPF-27476-O

6.29 Keyload Failure



MAEPF-27388-O

6.30 Secure Hardware Failure



MAEPF-27387-O

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Chapter 7 Troubleshooting Waveforms

7.1 Introduction

This section contains images of waveforms that might be useful in verifying operation of certain parts of the circuitry. These waveforms are for reference only; the actual data depicted will vary depending upon operating conditions.

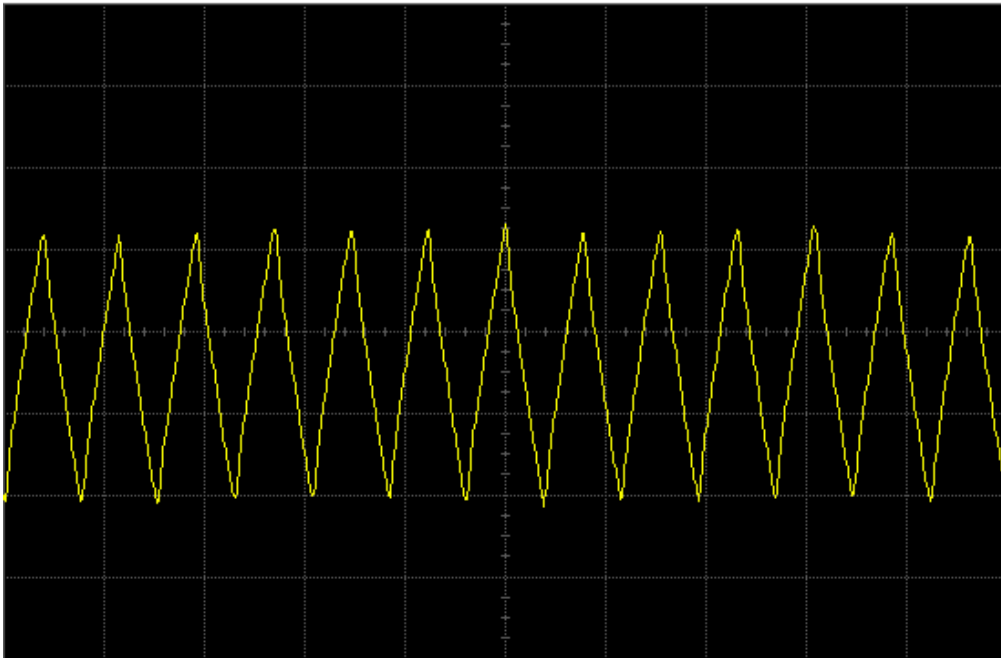
7.2 List of Waveforms

[Table 7-1](#) lists each waveform and the page on which the waveform can be found.

Table 7-1. List of Waveforms

Waveform	Page No.
13 MHz Clock	7-2
16.8 MHz Buffer Input and Output	7-3
32.768 kHz Clock Outputs	7-4
SPI B Data	7-5
RX Serial Audio Port (SAP)	7-6
Receive Baseband Interface Port (BBP)	7-7
Transmit Baseband Interface Port (BBP)	7-8

7.3 13 MHz Clock



Acquisition Sampling mode real time Configuration 4GSa/s
 Memory depth automatic Memory depth 1004pts
 Sampling rate automatic Sampling rate 1.00 GSa/s
 Averaging off
 9-bit BW Filter off Interpolation on

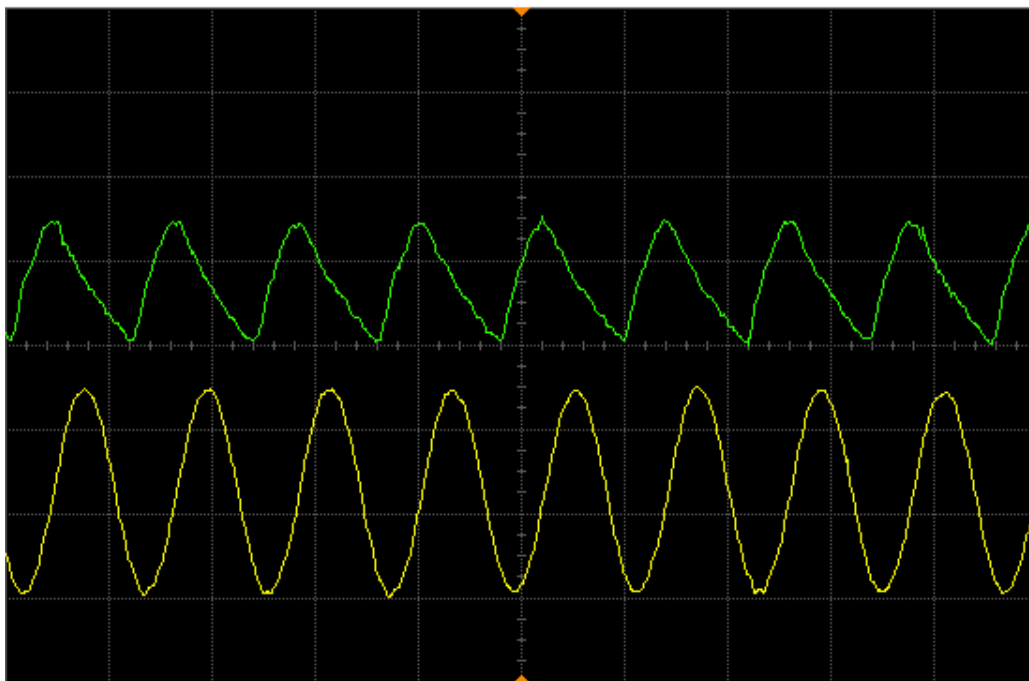
Channel 1 Scale 200 mV/div Offset 1.604 V Coupling DC Impedance 1M Ohm
 Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s
 Ext adapter None Ext coupler None
 Ext gain 1.00E+00 Ext offset 0.0E+00

Time base Scale 100 ns/div Position 92.181816 μ s Reference center

Trigger Mode edge Sweep auto
 Hysteresis normal Holdoff time 60 ns Coupling DC
 Source channel 1 Trigger level 1.379 V Slope rising

13 MHz clock from U301 to U501.
Trace 1: Trace recorded at C303.

7.4 16.8 MHz Buffer Input and Output

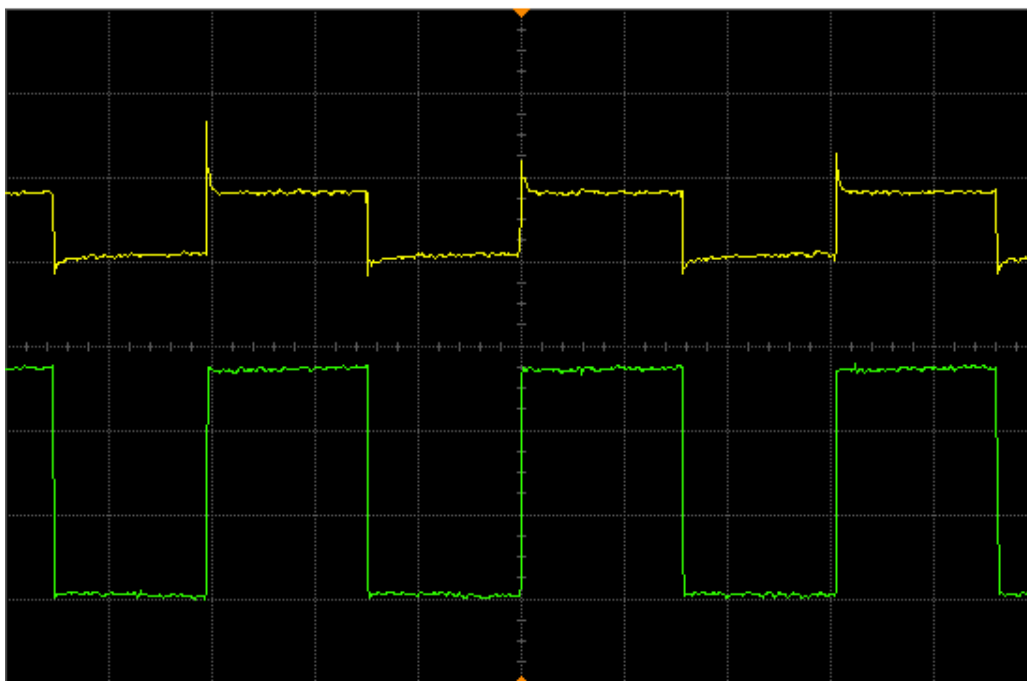


Acquisition	Sampling mode real time Configuration 4GSa/s Memory depth automatic Memory depth 1004pts Sampling rate automatic Sampling rate 2.00 GSa/s Averaging off 9-bit BW Filter off Interpolation on
Channel 1	Scale 500 mV/div Offset 1.937 V Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Channel 2	Scale 500 mV/div Offset -323 mV Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Time base	Scale 50.0 ns/div Position 0.0 s Reference center
Trigger	Mode edge Sweep auto Hysteresis normal Holdoff time 60 ns Coupling DC Source channel 2 Trigger level 50 mV Slope rising

Trace 1: Buffer input at R452.

Trace 2: Buffer output at C452.

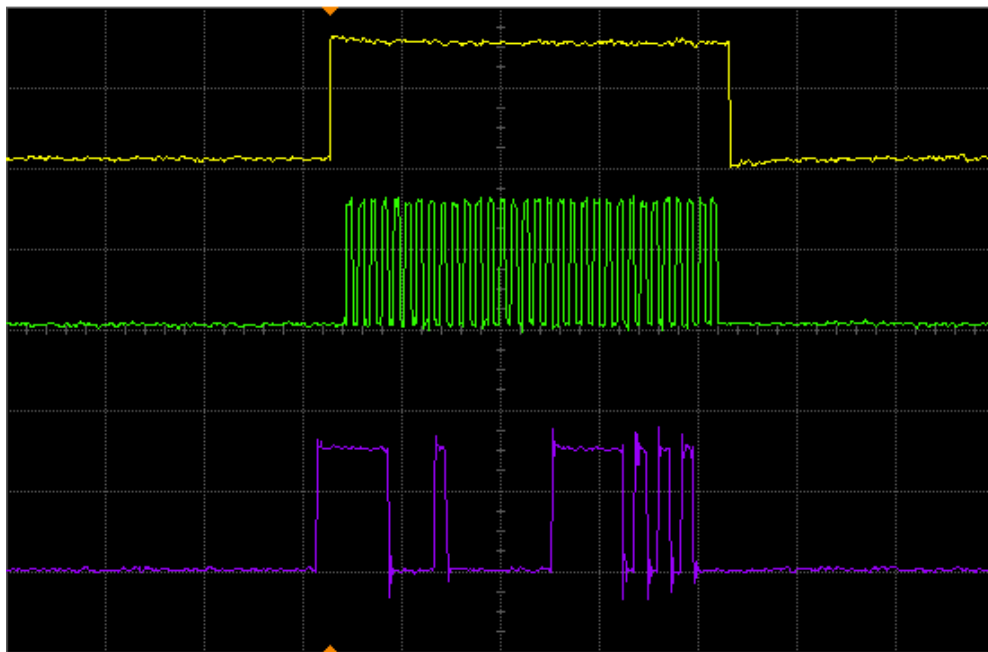
7.5 32.768 kHz Clock Outputs



Acquisition	Sampling mode real time Configuration 4GSa/s Memory depth automatic Memory depth 1004pts Sampling rate automatic Sampling rate 10.0 MSa/s Averaging off 9-bit BW Filter off Interpolation on
Channel 1	Scale 1.00 V/div Offset -1.58 V Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Channel 2	Scale 1.00 V/div Offset 2.97 V Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Time base	Scale 10.0 μ s/div Position 0.0 s Reference center
Trigger	Mode edge Sweep auto Hysteresis normal Holdoff time 60 ns Coupling DC Source channel 2 Trigger level 1.400 V Slope rising

Trace 1: Output at C313 (to real-time clock of GCAP II IC).
Trace 2: Output at U302, pin 2 (to Patriot IC CKIL input).

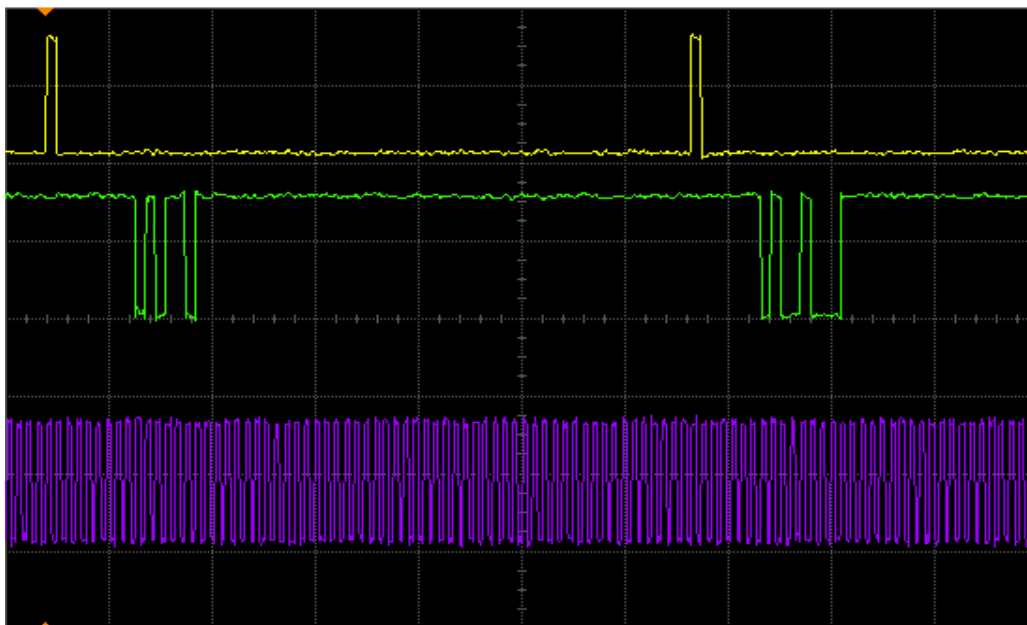
7.6 SPI B Data



Acquisition	Sampling mode real time Configuration 4GSa/s Memory depth automatic Memory depth 1004pts Sampling rate automatic Sampling rate 50.0 MSa/s Averaging off 9-bit B/W Filter off Interpolation on
Channel 1	Scale 1.99 V/div Offset -4.21 V Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Channel 2	Scale 2.00 V/div Offset -260 mV Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Channel 3	Scale 2.00 V/div Offset 5.76 V Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Time base	Scale 2.00 μ s/div Position 3.454546 μ s Reference center
Trigger	Mode edge Sweep auto Hysteresis normal Holdoff time 60 ns Coupling DC Source channel 1 Trigger level 810 mV Slope rising

Trace 1: GCAP II IC chip enable at R538 (Note active high).
Trace 2: SPI data clock at Test Point SCKB.
Trace 3: SPI data to GCAP II IC at Test Point MOSIB.

7.7 RX Serial Audio Port (SAP)



Acquisition	Sampling mode real time Configuration 4GSa/s Memory depth automatic Memory depth 1004pts Sampling rate automatic Sampling rate 5.00 MSa/s Averaging off 9-bit BW Filter off Interpolation on
Channel 1	Scale 1.99 V/div Offset -4.21 V Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Channel 2	Scale 2.00 V/div Offset -210 mV Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Channel 3	Scale 2.00 V/div Offset 5.55 V Coupling DC Impedance 1M Ohm Attenuation 10.00 : 1 Atten units ratio Skew 0.0 s Ext adapter None Ext coupler None Ext gain 1.00E+00 Ext offset 0.0E+00
Time base	Scale 20.0 μ s/div Position 92.181816 μ s Reference center
Trigger	Mode edge Sweep auto Hysteresis normal Holdoff time 60 ns Coupling DC Source channel 1 Trigger level 810 mV Slope rising

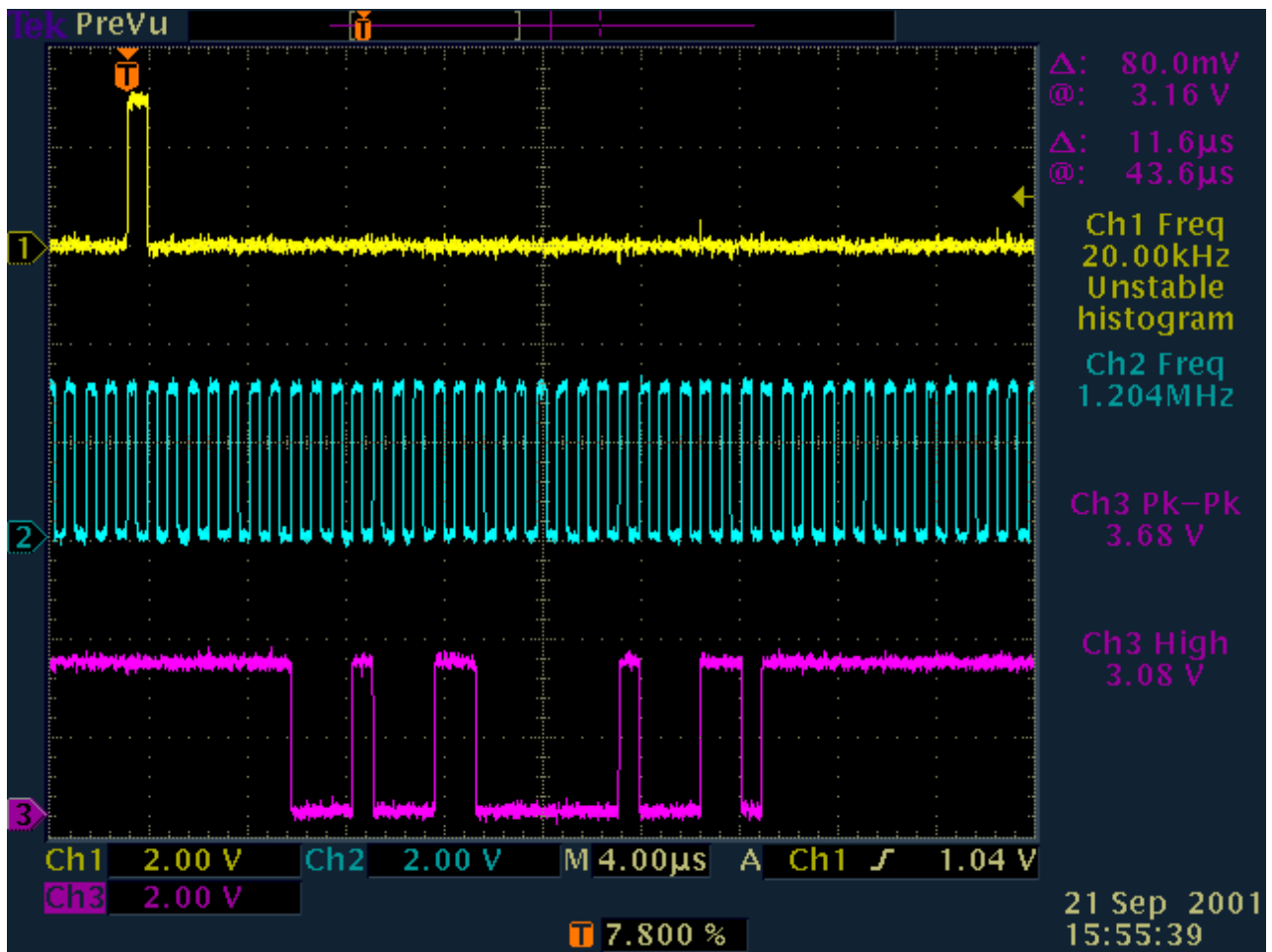
Trace 1: 8 kHz frame sync at R406 (each word is 13 bits after falling edge of FSYNC).

Trace 2: SAP data at R403 (audio data from GCAP II IC CODEC to Patriot IC DSP).

Note: Transmit is identical, except data acquired at R402.

Trace 3: 520 kHz bit clock at R405.

7.8 Receive Baseband Interface Port (RX BBP)

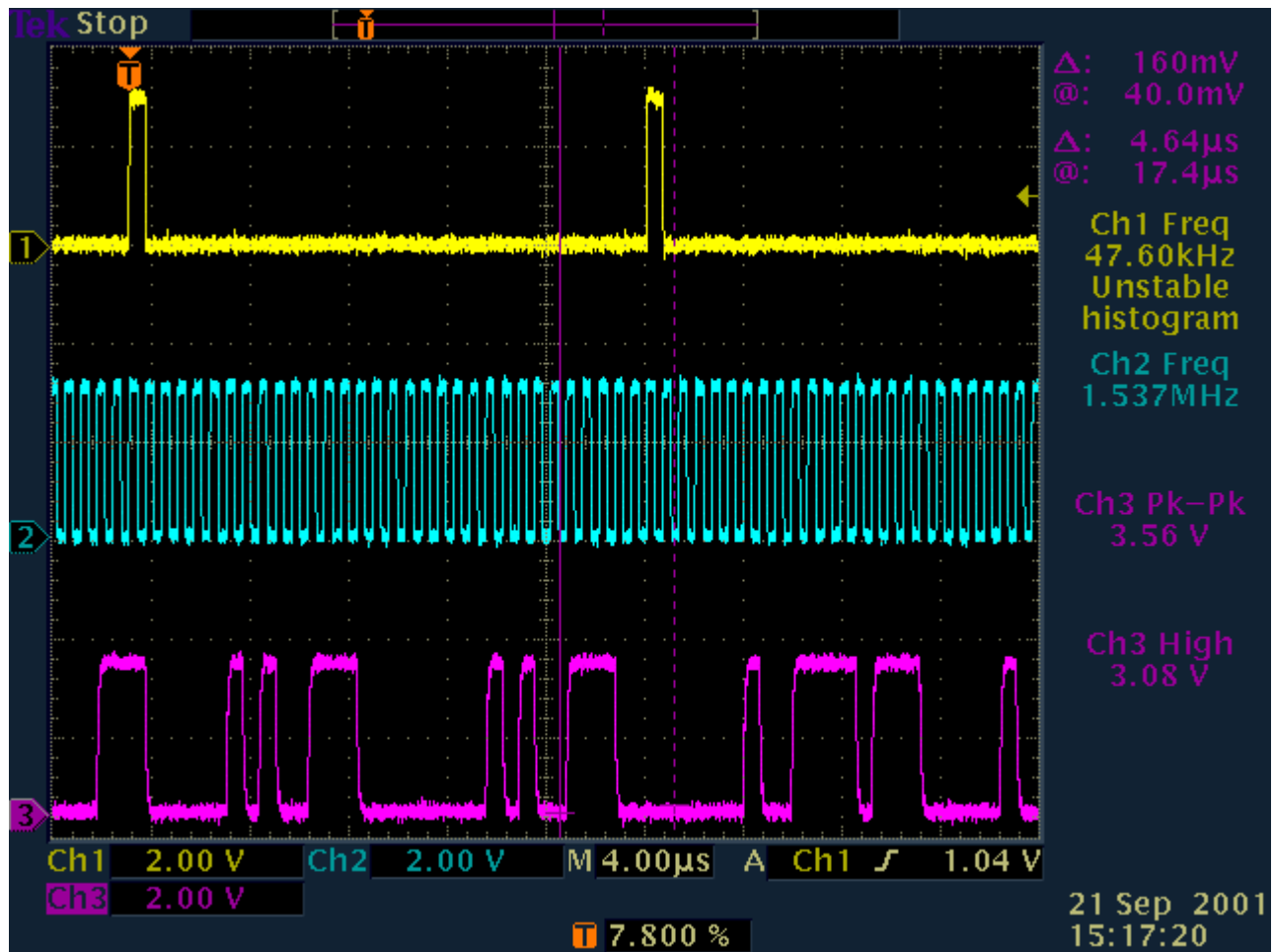


Trace 1: BBP RX frame sync signal at R123.

Trace 2: BBP RX clock signal at R124.

Trace 3: BBP RX data signal at R121.

7.9 Transmit Baseband Interface Port (TX BBP)



Trace 1: BBP TX frame sync signal at R119.

Trace 2: BBP TX clock signal at R125.

Trace 3: BBP TX data signal at R127.

Chapter 8 Troubleshooting Tables

8.1 Board and IC Signals

Due to the nature of the schematic-generating program, signal names might be different when they are not directly connected to the same point. The following tables provide a cross-reference to the various pinouts for these signals.

Table 8-1. J101 VOCON Board to Controls Flex Assembly

J101 Pin No.	Description	To/From	Side Connector Number
1	UC_CTS	TP208	10
2	UC_LHDATA_KEYFAIL	TP206	13
3	DGND03	TP202	8
4	UC_RS232DIN_USB-	R253	12
5	UC_EXT_SPKR_NEG-	TP213	6
6	UC_RS232DOUT_USB+	R252	11
7	UC_OPT_SEL2	R218	5
8	UC_SB9600_BUSY	TP207	9
9	UC_EXT_SKPR	TP212	2
10	UC_RTS	TP209	7
11	UC_OPT_SEL1	R217	1
12	UC_OPTB+_VPP	R255	4
13	UC_EXT_MIC	TP214	3
14	UC_EMERG	R233	
15	DGND15	TP202	
16	DGND16	TP202	
17	UC_MONITOR	R244	
18	DGND18	TP202	
19	DGND19	TP202	
20	UC_BL_FREQ	R206	
21	UC_RED_LED	R203	
22	UC_GREEN_LED	R204	
23	UC_TG2	R234	

Table 8-1. J101 VOCON Board to Controls Flex Assembly (Continued)

J101 Pin No.	Description	To/From	Side Connector Number
24	UC_RTA1	R236	
25	UC_RTA3	R241	
26	UC_RTA2	R239	
27	UC_RTA0	R235	
28	DGND28	TP202	
29	DGND29	TP202	
30	DGND30	TP202	
31	UC_VOLUME	R232	
32	BSENS_1	L202	
33	UNSWB+1	L201	
34	UC_TG1	R231	
35	V2A	L203	
36	UC_INT_MICU	L208	
37	C_INT_SPKR_NEG	TP213	
38	UC_INT_PTT	R216	
39	AGND39	L204	
40	UC_INT_SPKR	L205	

Table 8-2. J107 VOCON Board to Keypad Module

J107 Pin No.	Description	To/From	Accessible on VOCON?
1	KP_COLUMN0	C134	Yes
2	KP_COLUMN1	C133	Yes
3	KP_COLUMN2	C132	Yes
4	KP_GND	GROUND	Yes
5	KP_GND	GROUND	Yes
6	KP_BL_EN	C124	Yes
7	KP_5V1	C104	Yes
8	KP_5V2	C104	Yes
9	KP_GND	GROUND	Yes

Table 8-2. J107 VOCON Board to Keypad Module (Continued)

J107Pin No.	Description	To/From	Accessible on VOCON?
10	KP_GND	GROUND	Yes
11	KP_GND	GROUND	Yes
12	KP_GND	GROUND	Yes
13	KP_ROW0	C131	Yes
14	KP_ROW1	C130	Yes
15	KP_ROW2	C129	Yes
16	KP_ROW3	C128	Yes
17	KP_ROW4	C127	Yes
18	KP_ROW5	C126	Yes
19	KP_ROW6	C125	Yes
20	KP_GND	GROUND	Yes
21	KP_GND	GROUND	Yes
22	KP_GND	GROUND	Yes

Table 8-3. J701 VOCON Board to Encryption Module

J701Pin No.	Description	To/From	Accessible on VOCON?
1	KEYFAIL_LH_BDMDATA	Q303 Pin 2	Yes
2	RS232_DIN_ENC	R308	Yes*
3	CTSOUT_ENC	R309	Yes
4	RTSIN_ENC	U301 Pin H7	No
5	RS232_DOUT_UP	R317	Yes*
6	RS232_DOUT_ENC	R317	Yes*
7	SW_B+_ENC	C101	Yes
8	NC1	No Connect	N/A
9	RS232_DTR_IN_ENC	No Connect	N/A
10	RS232_RI_OUT_EN	No Connect	N/A
11	NC2	No Connect	N/A
12	CONT_3VDC_OUT_ENC	No Connect	N/A
13	RS232_DCD_ENC	No Connect	N/A

Table 8-3. J701 VOCON Board to Encryption Module (Continued)

J701Pin No.	Description	To/From	Accessible on VOCON?
14	NC3	No Connect	N/A
15	BOOT_ENC	R417	Yes*
16	TAMPER	GROUND	Yes
17	SSI_DO_CODEC_ENC	R403	Yes
18	SSI_DI_CODEC_ENC	R402	Yes
19	RTA0_ENC	R246	Yes
20	RTA1_ENC	R247	Yes
21	RTA3_ENC	R251	Yes
22	RTA2_ENC	R250	Yes
23	TG2_ENC	R234	
24	LHDATA_BDMDATA_KEYFAIL	D308 Pin 1	Yes
25	GREEN_LED_ENC	R204	Yes
26	WAKEUP	U401 Pin E1	No
27	TX_INHIBIT	NC	
28	UCM_SS	U301 Pin G4	No
29	RED_LED_ENC	R203	Yes
30	RESET_ENC	R418	Yes*
31	MONITOR	R244	
32	SPARE1_ENC	R415	Yes*
33	GROUND_ENC	GROUND	Yes
34	SPARE2_ENC	R416	Yes*
35	EMERG_ENC	R241	Yes
36	UNSW_B+_ENC	C102	Yes
37	ENC_SSI_CLK	R404	Yes
38	ENC_SSI_FS	R406	Yes
39	ENC_SSI_DI	R403	Yes
40	ENC_SSI_DOUT	R402	Yes

Table 8-4. U402 FLASH Pinouts

U402 Pin No.	Description	To/From	Comment	Accessible on Vocon?
B4	B_CLK	B_CLK		Yes
E7	CS0	CS0	Active Low	Yes
F8	EN_OE			No
C5	EN_WE			No
D6	WRITE PROTECT			No
C4	ADV	ADV		Yes
B5	RESET	D401, pin 2	3.0 V	Yes
E8	ADDRESS 1			No
D8	ADDRESS 2			No
C8	ADDRESS 3			No
B8	ADDRESS 4			No
A8	ADDRESS 5			No
B7	ADDRESS 6			No
A7	ADDRESS 7			No
C7	ADDRESS 8			No
A2	ADDRESS 9			No
B2	ADDRESS 10			No
C2	ADDRESS 11			No
A1	ADDRESS 12			No
B1	ADDRESS 13			No
C1	ADDRESS 14			No
D2	ADDRESS 15			No
D1	ADDRESS 16			No
D4	ADDRESS 17			No
B6	ADDRESS 18			No
A6	ADDRESS 19			No
C6	ADDRESS 20			No
B3	ADDRESS 21			No
C3	ADDRESS 22			No
D7	ADDRESS 23	R427		Yes
A3	GROUND			No

Table 8-4. U402 FLASH Pinouts (Continued)

U402 Pin No.	Description	To/From	Comment	Accessible on Vocon?
F1	GROUND			No
G2	GROUND			No
G8	GROUND			No
E2	DATA 15			No
F2	DATA 14			No
F3	DATA 13			No
D5	DATA 12			No
F4	DATA 11			No
F5	DATA 10			No
F6	DATA 9			No
G7	DATA 8			No
G1	DATA 7	R435		Yes
E3	DATA 6	R434		Yes
G3	DATA 5	R433		Yes
E4	DATA 4	R432		Yes
G5	DATA 3	R431		Yes
E5	DATA 2	R430		Yes
E6	DATA 1	R429		Yes
F7	DATA 0	R428		Yes
A5	VPP	D402, pin 3	1.875 V	Yes
G6	VSW2	C409	1.875 V	Yes
E1	VSW2	C409	1.875 V	Yes
G4	VSW2	C409	1.875 V	Yes
A4	VSW2	C409	1.875 V	Yes

Table 8-5. U403 SRAM Pinouts

U403 Pin No.	Description	To/From	Comment	Accessible on Vocon?
A2	EN_OE			No
G5	R_W	R_W	W = 0 V	Yes
A1	LB			No

Table 8-5. U403 SRAM Pinouts (Continued)

U403 Pin No.	Description	To/From	Comment	Accessible on Vocon?
B2	UB			No
B5	CS1	CS2 (TP)	Active Low	Yes
A6	CS2	C411	Active Low	Yes
A3	ADDRESS 1			Yes
A4	ADDRESS 2			Yes
A5	ADDRESS 3			Yes
B3	ADDRESS 4			Yes
B4	ADDRESS 5			Yes
C3	ADDRESS 6			Yes
C4	ADDRESS 7			Yes
D4	ADDRESS 8			No
H2	ADDRESS 9			No
H3	ADDRESS 10			No
H4	ADDRESS 11			No
H5	ADDRESS 12			No
G3	ADDRESS 13			No
G4	ADDRESS 14			No
F3	ADDRESS 15			No
F4	ADDRESS 16			No
E4	ADDRESS 17			No
D3	ADDRESS 18			No
H1	ADDRESS 19			No
D1	GROUND			No
E6	GROUND			No
E3	GROUND			No
H6	NOT USED			No
G2	NOT USED			No
G1	DATA 15			No
F1	DATA 14			No
F2	DATA 13			No
E2	DATA 12			No

Table 8-5. U403 SRAM Pinouts (Continued)

U403 Pin No.	Description	To/From	Comment	Accessible on Vocon?
D2	DATA 11			No
C2	DATA 10			No
C1	DATA 9			No
B1	DATA 8			No
G6	DATA 7	R435		No
F6	DATA 6	R434		No
F5	DATA 5	R433		No
E5	DATA 4	R432		No
D5	DATA 3	R431		No
C6	DATA 2	R430		No
C5	DATA 1	R429		No
B6	DATA 0	R428		No
D6	VSW2	C411	1.875 V	Yes
E1	VSW2	C411	1.875 V	Yes

Table 8-6. U401 Patriot MCU/DSP IC Pinouts

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
H10	EEPOT_INC*	C537	Active Low	Yes
J14	EXT_SPKR_SEL	Q505, pin 5		Yes
C14	AUDIO_PA_EN	R575		Yes
B14	HOST_WAKE			No
F6	BATTERY_ID	C556		Yes
E5	MECH_SW_BAR	Q508, pin 3	Active Low	Yes
J6	INT_PTT	R216	Active Low	Yes
J5	GCAP_INT	R538		Yes
J4	OPT_SEL1_IN	U201 pin 1		Yes
J3	UART_INT*			No
C16	8KHZ_INT	R406	8 kHz Pulse	Yes
G11	OPT_SEL2_IN	U202 pin 1		Yes
F1	KP_ROW0	C131		Yes

Table 8-6. U401 Patriot MCU/DSP IC Pinouts (Continued)

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
H4	KP_ROW1	C130		Yes
H6	KP_ROW2	C129		Yes
G2	KP_ROW3	C128		Yes
G11	KP_ROW4	C127		Yes
G7	KP_ROW5	C126		Yes
H7	KP_ROW6	C125		Yes
H1	SPARE1_ENC	J701, pin 32		Yes
D1	KP_COL0	C134		Yes
G5	KP_COL1	C133		Yes
F3	KP_COL2	C132		Yes
G4	ENC_RESET	J701, pin 30		Yes
F2	BOOT*	J701, pin 15		Yes
E1	WAKEUP	J701, pin 26		Yes
H6	SPARE2_ENC	J701, pin 34		Yes
G3	NOT USED			No
E7	NOT USED			No
A8	NOT USED			No
F8	MISOA_SEL	U406, pin 2	Data Line	Yes
E8	NOT USED			No
G8	NOT USED			No
C3	NOT USED			No
D4	LOCK_DET	C123	Active Low	Yes
A2	TG2	R234		Yes
B2	RTA3	R241		Yes
A3	RTA2	R239		Yes
B3	RTA1	R236		Yes
B4	RTA0	R235		Yes
A7	VSW2	E401	1.875 V	Yes
P3	VSW2	E401	1.875 V	Yes
P6	VSW2	E401	1.875 V	Yes
T9	VSW2	E401	1.875 V	Yes

Table 8-6. U401 Patriot MCU/DSP IC Pinouts (Continued)

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
N10	VSW2	E401	1.875 V	Yes
R16	VSW2	E401	1.875 V	Yes
H9	V2	E402	3.0 V	Yes
G9	V2	E402	3.0 V	Yes
E15	V2	E402	3.0 V	Yes
A16	V2	E402	3.0 V	Yes
K10	V2	E402	3.0 V	Yes
C12	V2	E402	3.0 V	Yes
D8	V2	E402	3.0 V	Yes
B7	V2	E402	3.0 V	Yes
A4	V2	E402	3.0 V	Yes
A16	V2	E402	3.0 V	Yes
H2	V2	E402	3.0 V	Yes
K3	VSW2	E401	1.875 V	Yes
R8	VSW2	E401	1.875 V	Yes
G15	VSW2	E401	1.875 V	Yes
C10	VSW2	E401	1.875 V	Yes
K12	URXD1_USB_VMI			No
L16	URTS1_XRXD			No
F13	ADTRIG			No
B16	URXD2	U303, pin 4		Yes
D14	BSY_IN_RTS			No
B12	RX_SSI_DATA	R123	Data From Abacus to DSP	Yes
C11	TX_SSI_CLK	R125	1.536 MHz	Yes
B10	RED_LED	Q201, pin 3	Active High	Yes
D10	GREEN_LED	Q201, pin 5	Active High	Yes
B11	TX_SSI_FSYNC	R119	48 kHz	Yes
J10	CODEC_TX	R402	GCAP to DSP Tx Audio Data	Yes
J15	CODEC_DCLK	R405	520 kHz	Yes

Table 8-6. U401 Patriot MCU/DSP IC Pinouts (Continued)

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
K16	CODEC_FSYNC	R406	8 kHz Pulse	Yes
D7	SPI_MISOA	MISOA	SPI A Data In	Yes
D3	SPI_MISOB	MISOB	SPI B Data In	Yes
E6	NOT USED			No
F7	NOT USED			No
D6	EEPROM_SEL*	R132	Active Low	Yes
C5	AD_CS*	R133	Active Low	Yes
A9	NOT USED			No
B8	NOT USED			No
B9	NOT USED			No
A10	NOT USED			No
G6	BT_DISABLE			No
D13	NOT USED			No
S15	BT_WAKE			No
F11	RX_SSI_CLK	R124		Yes
B15	OPT_SEL2_OUT	R256		Yes
J13	AUDIO_MODE_SEL	R257		Yes
J16	EEPOT_CS_EXT*	U509, pin 1		Yes
J12	EEPOT_U_D*	U509, pin 2		Yes
H11	EEPOT_CS*	U509, pin 10		Yes
A5	GROUND	GROUND		Yes
N6	GROUND	GROUND		Yes
P8	GROUND	GROUND		Yes
P11	GROUND	GROUND		Yes
M11	GROUND	GROUND		Yes
L15	GROUND	GROUND		Yes
H16	GROUND	GROUND		Yes
F14	GROUND	GROUND		Yes
G14	GROUND	GROUND		Yes
E13	GROUND	GROUND		Yes
B13	GROUND	GROUND		Yes

Table 8-6. U401 Patriot MCU/DSP IC Pinouts (Continued)

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
K15	GROUND	GROUND		Yes
D9	GROUND	GROUND		Yes
C8	GROUND	GROUND		Yes
B5	GROUND	GROUND		Yes
C2	GROUND	GROUND		Yes
C1	GROUND	GROUND		Yes
H3	GROUND	GROUND		Yes
K15	GROUND	GROUND		Yes
T8	GROUND	GROUND		Yes
H15	GROUND	GROUND		Yes
C9	GROUND	GROUND		Yes
B6	ABACUS_CS*	R126	Active Low	Yes
E2	UNI_SEL*	R131	Active Low	Yes
D2	FLPR_CS*		Active Low	No
E3	GCAP_CE	R539	Active High	Yes
E4	SCKB	SCKB	SPI B Clock	Yes
B1	NOT USED			No
F4	NOT USED			No
F5	SPI_MOSIB	MOSIB	SPI Data Out	Yes
C7	SCKA	SCKA	SPI A Clock	Yes
C6	MOSIA	MOSIA	SPI Data Out	Yes
G10	NOT USED			No
G16	OPT_SEL1_OUT	U201, pin 3		Yes
J11	CODEC_RX	R403	DSP to GCAP Rx Audio Data	Yes
A12	RX_SSI_FSYNC	R123	20 kHz pulse	Yes
A11	RX_SSI_CLK	R124	1.2 MHz	Yes
E9	TX_SSI_DATA	R127	Data From DSP to A/D	Yes
C15	BSY_OUT_CTS*			No
F12	UTXD2	U303, pin 1		Yes
D15	USB_SUSP			No

Table 8-6. U401 Patriot MCU/DSP IC Pinouts (Continued)

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
E14	DISPLAY_R_W*	D403, pin 3	W = 0 V	Yes
D16	NOT USED			No
G12	UCTS1_USB_SPEED*			No
K11	UTXD1_USB_VPO			No
K14	USB_VMO			No
K13	USB_TX_EN			No
D5	8 KHZ_INT		8 kHz Pulse	R406
H14	BL_EN	C124		Yes
K4	LV_DETECT	POR	3.0 V	Yes
F9	NOT USED			No
J2	NOT USED			No
A6	16_8_MHZ	C452	16.8 MHz	Yes
J7	FLIP_32K	32KHZ	32.768 kHz	Yes
G13	NOT USED			No
J11	MOD	MOD	Bootstrap mode > 2.7 V	Yes
A13	NOT USED			No
M6	NOT USED			No
R1	NOT USED			No
N3	NOT USED			No
M5	NOT USED			No
P2	NOT USED			No
P1	NOT USED			No
N1	NOT USED			No
M4	NOT USED			No
M3	NOT USED			No
M2	NOT USED			No
M1	NOT USED			No
L4	NOT USED			No
L3	NOT USED			No
L1	NOT USED			No

Table 8-6. U401 Patriot MCU/DSP IC Pinouts (Continued)

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
L2	NOT USED			No
K2	NOT USED			No
T1	NOT USED			No
R2	NOT USED			No
T2	NOT USED			No
K7	NOT USED			No
N2	NOT USED			No
L5	NOT USED			No
L6	NOT USED			No
C4	NOT USED			No
L13	NOT USED			No
D11	ONE_WIRE_EN*		Active Low	No
E16	KVL_USB_DET*		Active Low	No
F15	NOT USED			No
K5	BAT_BUS_EN*	Q507, pin 2	Active Low	Yes
H8	NOT USED			No
F16	RESET	RESET_OUT	Reset = 0 V	Yes
K6	USB_VPI			No
H12	BL_FREQ	Q202, pin 5	Active High	Yes
H13	NOT USED			No
E10	DSP_DE	DSP_DE	ONCE/JTAG	Yes
F10		MCU_DE	ONCE/JTAG	Yes
D12	TCK	TCK	ONCE/JTAG	Yes
C13	TMS	TMS	ONCE/JTAG	Yes
E11	TRST	TRST	ONCE/JTAG	Yes
A14	TDO	TDO	ONCE/JTAG	Yes
E12	TDI	TDI	ONCE/JTAG	Yes
M16	NOT USED			No
L14	NOT USED			No
P15	NOT USED			No
L11	NOT USED			No

Table 8-6. U401 Patriot MCU/DSP IC Pinouts (Continued)

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
M14	NOT USED			No
N16	NOT USED			No
L12	NOT USED			No
M12	CKO	CKO	Disabled	Yes
N15	NOT USED			No
M15	NOT USED			No
R12	ADDRESS 0	J101, pin 7		Yes
T13	ADDRESS 1			No
M10	ADDRESS 2			No
T12	ADDRESS 3			No
P13	ADDRESS 4			No
M9	ADDRESS 5			No
P10	ADDRESS 6			No
P12	ADDRESS 7			No
N9	ADDRESS 8			No
R10	ADDRESS 9			No
P9	ADDRESS 10			No
L10	ADDRESS 11			No
T10	ADDRESS 12			No
R9	ADDRESS 13			No
L9	ADDRESS 14			No
K9	ADDRESS 15			No
J9	ADDRESS 16			No
L8	ADDRESS 17			No
M8	ADDRESS 18			No
N8	ADDRESS 19			No
K8	ADDRESS 20			No
L7	ADDRESS 21			No
T7	ADDRESS 22			No
R7	ADDRESS 23	R427		Yes
R3	DATA 15			No

Table 8-6. U401 Patriot MCU/DSP IC Pinouts (Continued)

U401 Pin No.	Description	To/From	Comment	Accessible on Vocon?
T3	DATA 14			No
N4	DATA 13			No
P4	DATA 12			No
R4	DATA 11			No
J8	DATA 10			No
T4	DATA 9			No
N5	DATA 8			No
P5	DATA 7	R435		Yes
R5	DATA 6	R434		Yes
T5	DATA 5	R433		Yes
R6	DATA 4	R432		Yes
T6	DATA 3	R431		Yes
M7	DATA 2	R430		Yes
N7	DATA 1	R429		Yes
P7	DATA 0	R428		Yes
N11	R_W	R_W		Yes
T11	NOT USED			No
R14	NOT USED			No
N12	CS3*	R106	Active Low	Yes
T14	CS2	CS2	Active Low	Yes
R11	NOT USED			No
R15	CS0	CS0	Active Low	Yes
P16	OE_EN			No
M13	EB1_N			No
R13	EBO_N			No
N14	NOT USED			No
T16	WAIT	WAIT		Yes
P14	NOT USED			No
N13	ADV	ADV		Yes
T15	B_CLK	B_CLK		Yes

Table 8-7. U301 Flipper IC Pinouts

U301 Pin No.	Description	To/From	Comment	Accessible on Vocon?
E7	RXDIN_ENC_3V	R308		Yes
D5	RS232_DI_USB-	R329	RS232 Data In / USB Data -	Yes
C7	RS232_DO_USB+	R328	RS232 Data Out / USB Data +	Yes
A8	RTS	D303 pin 3	Request to Send (RS232)	Yes
D7	CTS	R303	Clear to Send (RS232)	Yes
H8	CTS_FILLREQ_3V	R306		Yes
H3	16.8 MHz	C307	16.8 MHz Clock	Yes
H6	13 MHz	R302	13 MHz Clock (OUT)	Yes
H5	PLL_LFT	C302	PLL Loop Filter	Yes
F4	CODEC_DCLK	R405	520 kHz	Yes
E5	CODEC_FSYNC	R406	8 kHz Pulse	Yes
G4	UCM_SS	J701 pin 28		Yes
G2	V2	C304	3.0 V	Yes
F1	V2	C317	3.0 V	Yes
F3	VSS3_DC	GROUND		Yes
F2	VSS3_AC	GROUND		Yes
D8	VCC5	C305	5.0 V	Yes
C8	VSS5	GROUND		Yes
A7	LI_CELL	C312	3.0-3.3 V	Yes
C6	VSS3_XTL	GROUND		Yes
A4	UART_TX	NC		No
C4	UART_RX	NC		No
G3	ONE_WIRE_UP			No
G7	KVL_USB_DET			No
G1	ONE_WIRE_EN*			No
B5	BSY_IN_RTS			No

Table 8-7. U301 Flipper IC Pinouts (Continued)

U301 Pin No.	Description	To/From	Comment	Accessible on Vocon?
C5	BSY_OUT_CTS			No
E4	UCTS1_USB_SPEED*			No
C1	USB_TXENAB			No
D1	UTXD1_USP_VPO			No
B1	USB_VMO			No
C3	URTS1_XRXD			No
C2	USB_VPI			No
D2	URXD1_USB_VMI			No
E3	USB_SUSP			No
B2	SCKB	SCKB	SPI B Clock	Yes
B3	SPI_MOSIB	MOSIB	SPI Data Write to Flipper IC	Yes
A2	SPI_MISOB	MISOA	SPI Data Read from Flipper IC	Yes
A1	FLPR_CS*			No
A3	UART_INT*			No
F5	GCAP_RESET_X	C310		Yes
H4	TEST_MODE1	GROUND		Yes
H1	TES_MODE2	GROUND		Yes
G6	OUT_DIS	GROUND		Yes
G5	SCAN_EN	GROUND		Yes
A6	XTAL32_IN			Yes
B6	XTAL32_OUT			Yes
A5	REF32_OUT	R316	32.768 kHz Square Wave	Yes
B7	BYPASS_32	GROUND		Yes
B4	BP_SEN_X	R510	0 V	Yes
D4	WD_OUT	R528	Watchdog Int to GCAP II	Yes
H2	ONE_WIRE_OPT	D306 pin 3		Yes
D6	SB96D_BDO_KF_5V	NC		No
B8	LH_BUSY	D307 pin 3	Longhorn Busy	Yes

Table 8-7. U301 Flipper IC Pinouts (Continued)

U301 Pin No.	Description	To/From	Comment	Accessible on Vocon?
D3	USB_DIS	R310		Yes
E2	USB_DPLUS	R311	USB Data Plus	Yes
E1	USB_DMINUS	R314	USB Data Minus	Yes
E8	SB96D_BDO_KF_3V	NC		No
F6	SB96D_BDO_3V	D308 pin 3		Yes
H7	RTS_FILLSEN_3V	NC		No
G8	CTS_FILLREQ_3V	R309		Yes
F8	TXDO_BDI_ENC_3V	R317		Yes
F7	TXDO_BDI_UP_3V	R317		Yes
E6	RXDIN_ENC_3V	R308		Yes

Table 8-8. U501 GCAP II IC Pinouts

U501 Pin No.	Description	To/From	Comment	Accessible on Vocon?
A2	AD4_BD_ID	R525	0 V	Yes
B2	AD3_BDTYPE	R524	1 Vdc	Yes
B3	AD2_BAT_STAT	R568		Yes
A3	AD_TG1	R523		Yes
D4	AD0_EMERG	R522		Yes
C4	LV_DETECT	R511	Active Low	Yes
B4	AD_TRIG			No
A4	CONV_BYP	C516		Yes
B5	V3	C550	Unused Voltage Regulator	Yes
A5	VIN3	C515	3.77 V	Yes
D5	VSEN1	GROUND	0 V	Yes
C5	VSIN	C515	3.77 V	Yes
C6	VSIM1	C551	Unused Voltage Regulator	Yes

Table 8-8. U501 GCAP II IC Pinouts (Continued)

U501 Pin No.	Description	To/From	Comment	Accessible on Vocon?
A6	V1	C552	Unused Voltage Regulator	Yes
B6	VIN1	B503	7.5V	Yes
D6	LI_CELL	C553	3.0-3.3V	Yes
D7	CHARGE	NC		No
A7	XTAL1	G_32K	32.768 kHz Square Wave	Yes
B7	XTAL2			No
A8	PRSC2	C514	3.77V	Yes
B8	LX2	D502	262.144 kHz Square Wave	Yes
A9	PGND1	GROUND		Yes
B9	FB2	R501	1.85V	Yes
C8	ON	R579		Yes
A10	FB1	R502	3.77V	Yes
B10	LX1	D503	262.144 kHz Square Wave	Yes
C9	PWRON	C529	At Battery Voltage Level	Yes
D8	INT_EXT	GROUND		Yes
C10	PSRC1	C531	At Battery Voltage Level	Yes
E7	WDI	R576	3.0V	Yes
D10	MOSPORTB	C529	At Battery Voltage Level	Yes
D9	ISENSE	NC		No
E8	CHRG	NC		No
E9	SQ_OUT	NC		No
E10	BPOS	C529	At Battery Voltage Level	Yes
F7	BATTERY	NC		No
F8	AUX_BAT	NC		No
F9	AUX_FET	NC		No
F10	MAIN_FET	NC		No

Table 8-8. U501 GCAP II IC Pinouts (Continued)

U501 Pin No.	Description	To/From	Comment	Accessible on Vocon?
E6	PGM2	C529	At Battery Voltage Level	Yes
G8	PGM1	C529	At Battery Voltage Level	Yes
G10	AGND1	GROUND		Yes
G9	REF	C528	3.0V	Yes
H9	PA_DRV	NC		No
H10	PA_SENSE	NC		No
G7	PGM0	GROUND		Yes
H8	LS3_RX	NC		No
J10	DGND	GROUND		Yes
K10	LS3TX_PABPOS	GROUND		Yes
K1	MIC_OUT	U509 pin 6	AC Mic Signal	Yes
G4	STANDBY	R557	3.0V	Yes
K2	AUX_OUT	U509 pin 6	AC Mic Signal	Yes
H3	AUX_MIC_NEG	C538	Virtual Ground	Yes
J3	MB_CAP	C535		Yes
H4	EXT_MIC	NC		No
K3	MIC_BIAS	C535		Yes
J4	CD_CAP	C543		Yes
K4	VAG	C544		Yes
J5	V2	R560	3.0V	Yes
K5	VIN2	R502	3.77V	Yes
G5	ON2	NC		No
H5	EXTOUT	C533	AC RX Audio Signal	Yes
K6	SPKR_OUT	NC		No
J6	SPKR_IN	NC		No
H6	SPKR_NEG	NC		No
H7	SPKR_POS	NC		No
K7	LS1IN_TG1A	GROUND		Yes
J7	LS1OUT_TG1	NC		No

Table 8-8. U501 GCAP II IC Pinouts (Continued)

U501 Pin No.	Description	To/From	Comment	Accessible on Vocon?
G6	LS2IN_TG2A	GROUND		Yes
F6	LS2OUT_TG2			No
K8	ALRT_GND			No
K9	ALRT_OUT	NC		No
J9	ALRT_VCC	NC		No
J8	SIMI_O	NC		No
A1	AD5_VOLUME	R526	0-2.5V	Yes
B1	AGND3	GROUND		Yes
C3	DWN_OUT	NC	I	No
C2	DWN_IN	GROUND		Yes
C1	CMP_OUT	NC		No
D3	DSC_INN	GROUND		Yes
D2	DSC_INP	GROUND		Yes
D1	SPI_CLK	SCKB	SPI Data Clock	Yes
E4	SPI_DR	MISOB	SPI Data Read From GCAP	Yes
E3	SPI_DW	MOSIB	SPI Data Write To GCAP	Yes
E2	SR_VCCIN	NC		No
E1	SR_VCCOUT	NC		No
F3	SR_IN	NC		No
F2	SR_OUT	NC		No
F1	INTERRUPT	R538	GCAP Interrupt	Yes
F4	CE	R539	Active High GCAP Chip EN	Yes
F5	CLK_IN	C452	13 MHz	Yes
E5	CODEC_DCLK	R405	520 kHz	Yes
G1	CODEC_TX	R402	TX Audio Data To DSP	Yes
G2	CODEC_RX	R403	RX Audio Data From DSP	Yes

Table 8-8. U501 GCAP II IC Pinouts (Continued)

U501 Pin No.	Description	To/From	Comment	Accessible on Vocon?
G3	CODEC_FSYNC	R406	8 kHz Frame Sync	Yes
H1	AGND4	GROUND		Yes
J1	AGND2	GROUND		Yes
H2	MICIN_POS	C534		Yes
J2	MICIN_NEG		Virtual Ground	No

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Chapter 9 Schematics, Board Layouts, and Parts Lists

9.1 Introduction

This chapter contains the schematics, board layouts, and parts lists for the XTS 5000 radio. Use them in conjunction with the theory of operation and the troubleshooting procedures, charts, and waveforms to isolate a problem to the component level. In the schematics, the red color denotes voltage paths, blue denotes the receive path, and green denotes the transmit path.

The following table lists the pages where the schematics and board layouts for the XTS 5000 radio are found.

9.2 List of Schematics and Board Overlays

Schematic/Board Layout	Page No.
Transceiver (RF) Board Overall Circuit Schematic	9-2
Antenna Switch and Harmonic Filter Circuits	9-3
Receiver Front End Circuit	9-4
Receiver Back End Circuit	9-5
Transmitter and Automatic Level Control Circuits	9-6
Frequency Generation Unit (Synthesizer) Circuit	9-7
Frequency Generation Unit (VCO) Circuit	9-8
Transceiver (RF) Board Layout—Side 1	9-9
Transceiver (RF) Board Layout—Side 2	9-10
VOCON Board Overall Schematic	9-16
VOCON Universal Connector Circuit	9-18
VOCON Flipper Circuit	9-19
VOCON Controller and Memory Circuits	9-20
VOCON Audio and DC Circuits	9-22
VOCON Board Layout—Side 1	9-23
VOCON Board Layout—Side 2	9-24

9.3 Transceiver (RF) Board

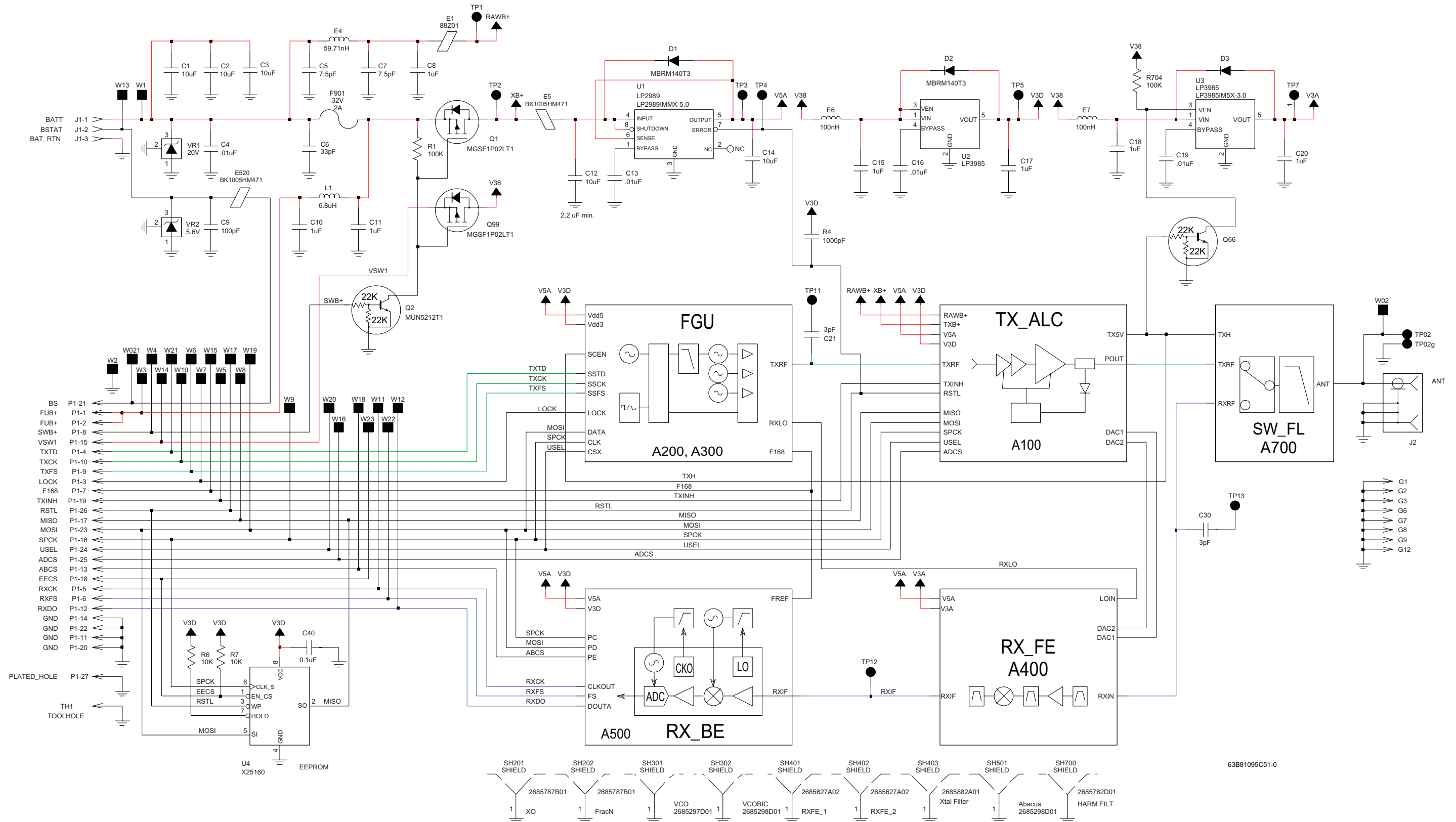
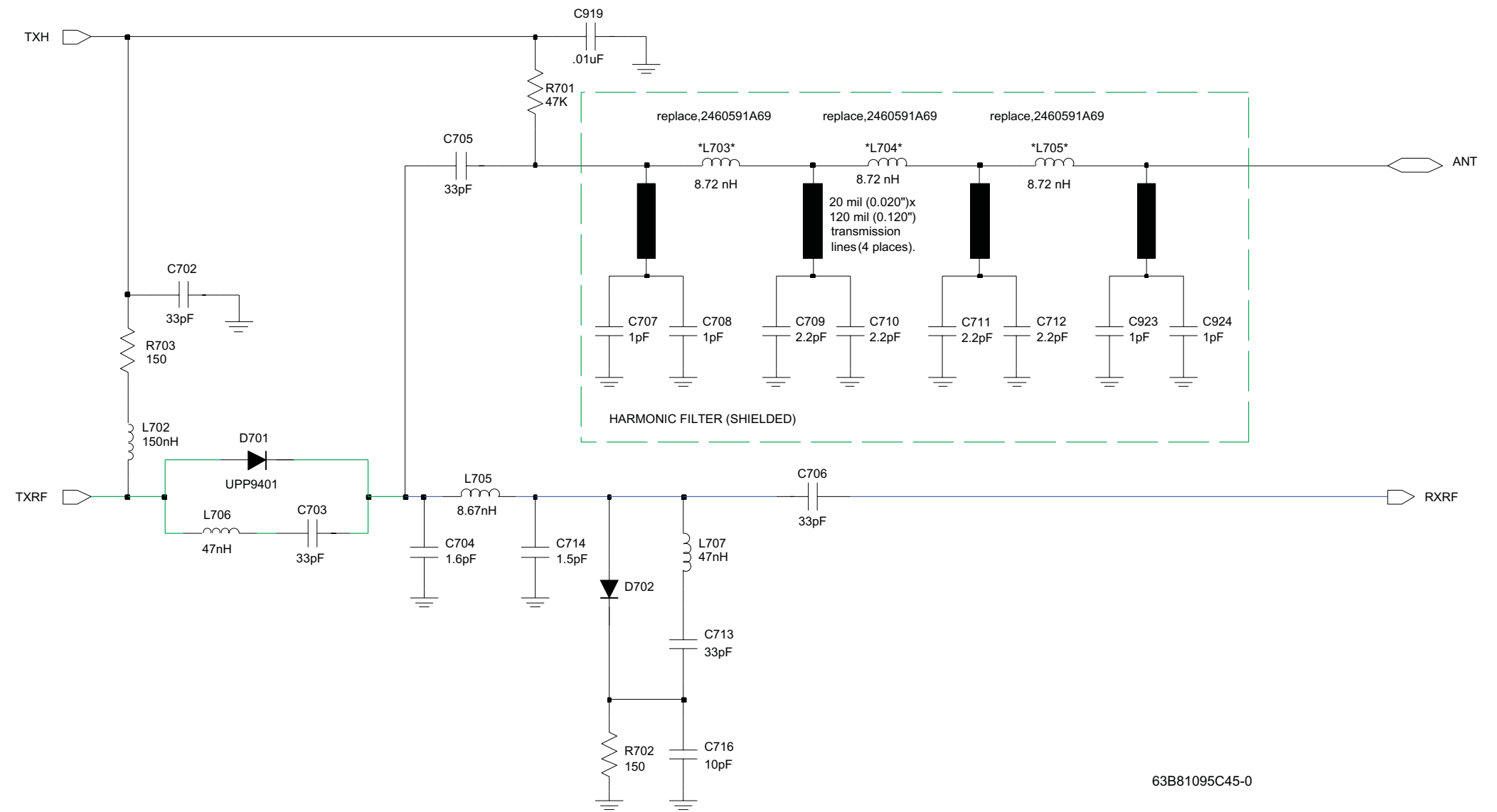


Figure 9-1. Transceiver (RF) Board Overall Circuit Schematic



63B81095C45-0

Figure 9-2. Antenna Switch and Harmonic Filter Circuits

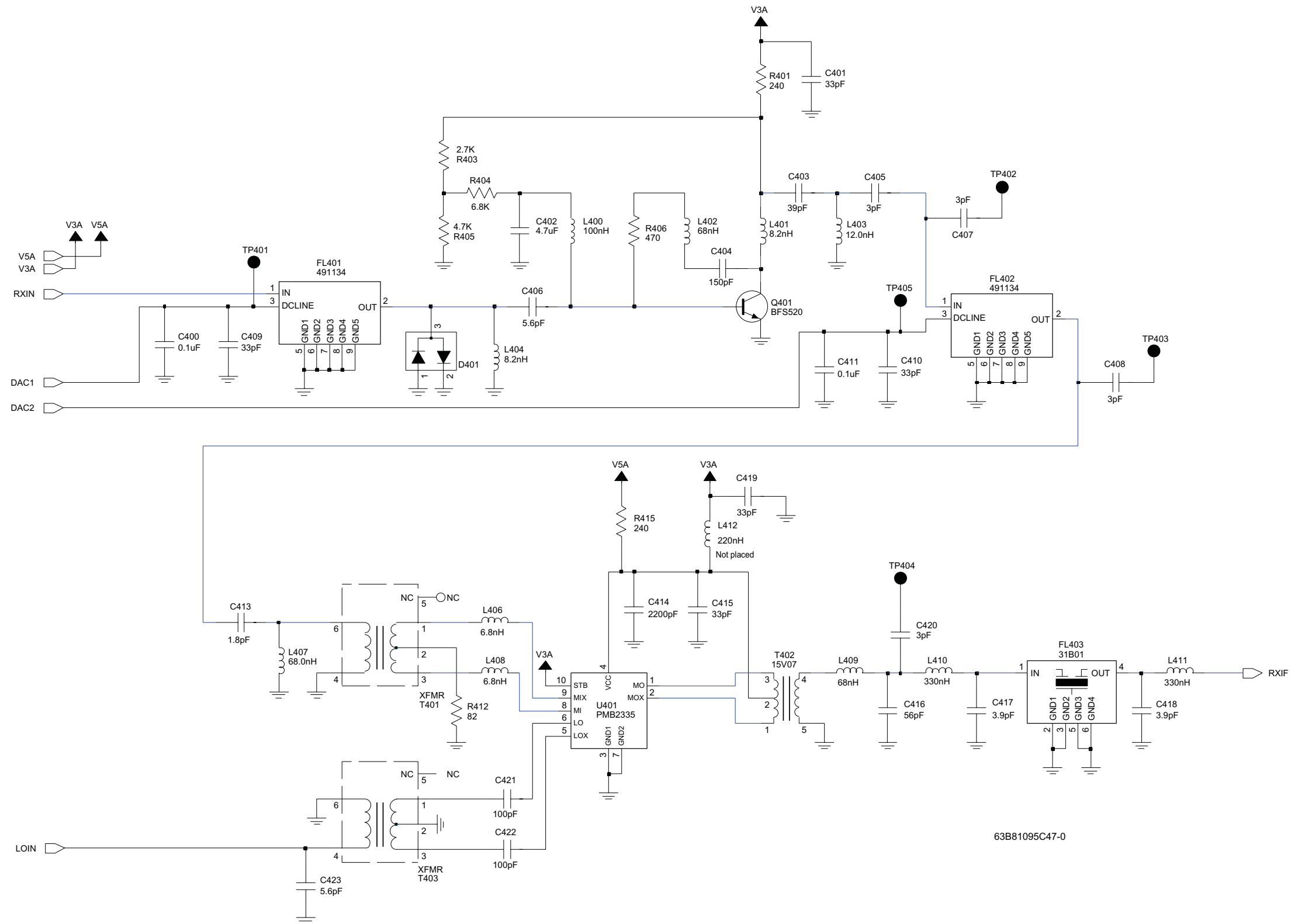


Figure 9-3. Receiver Front End Circuit

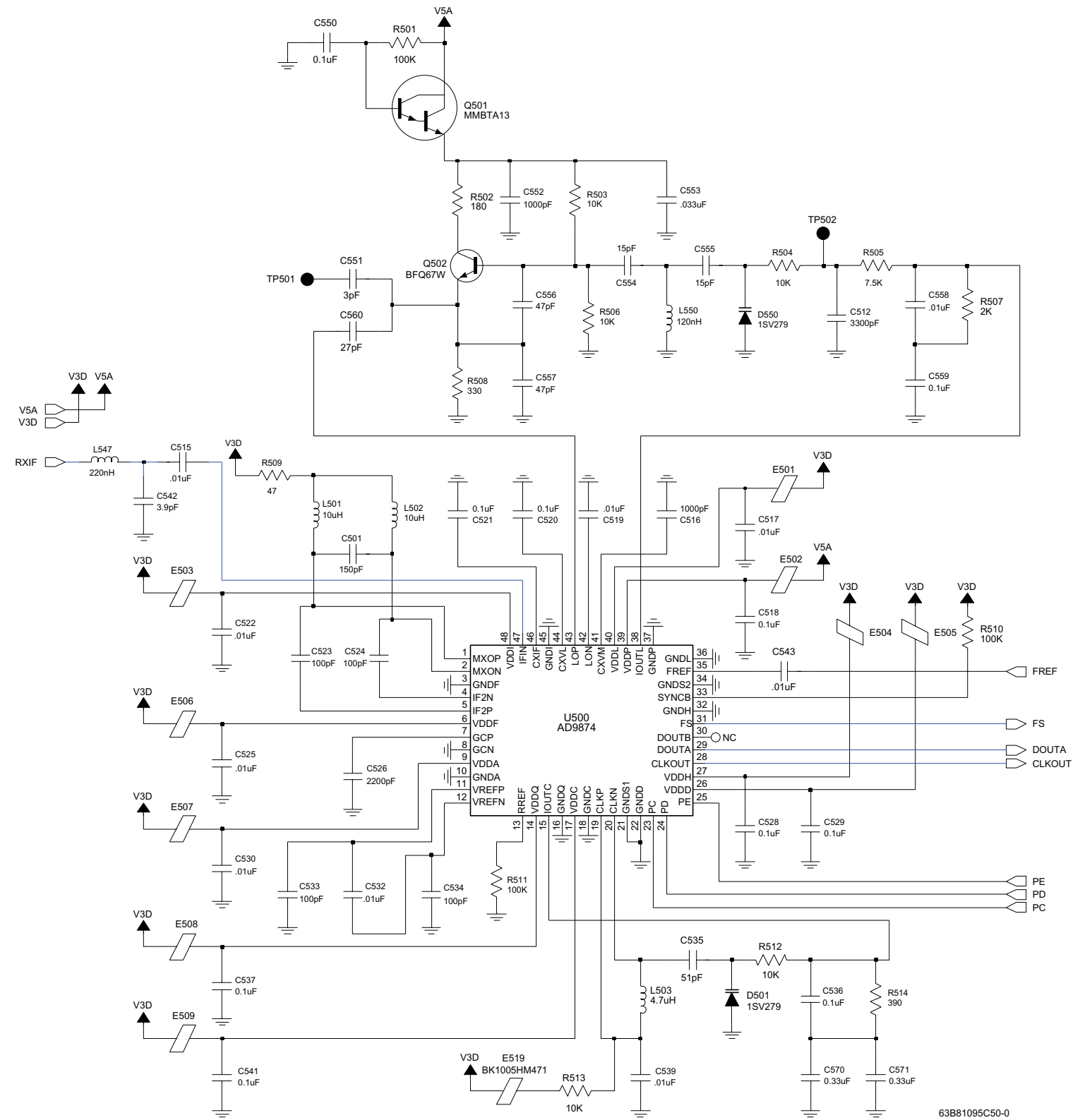


Figure 9-4. Receiver Back End Circuit

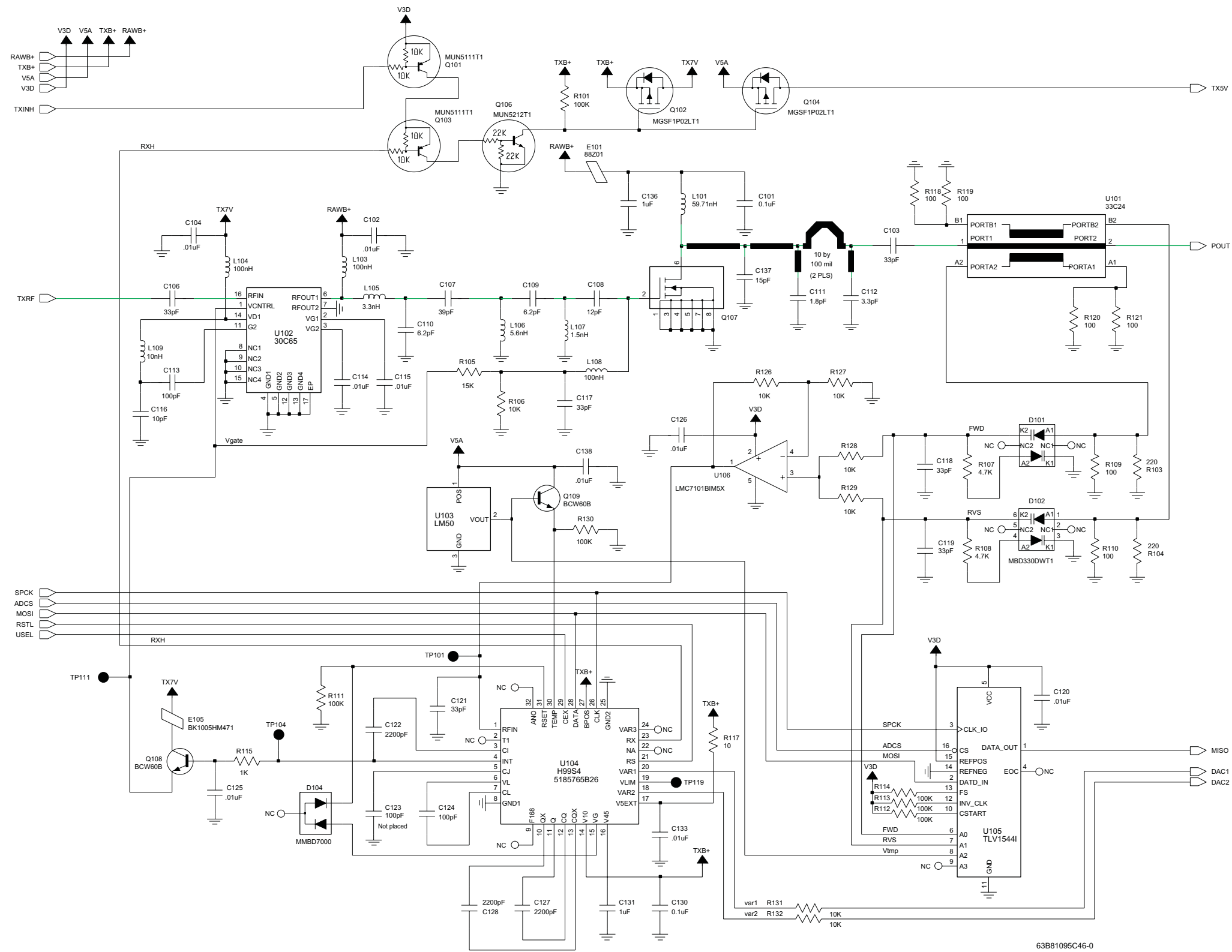


Figure 9-5. Transmitter and Automatic Level Control Circuits

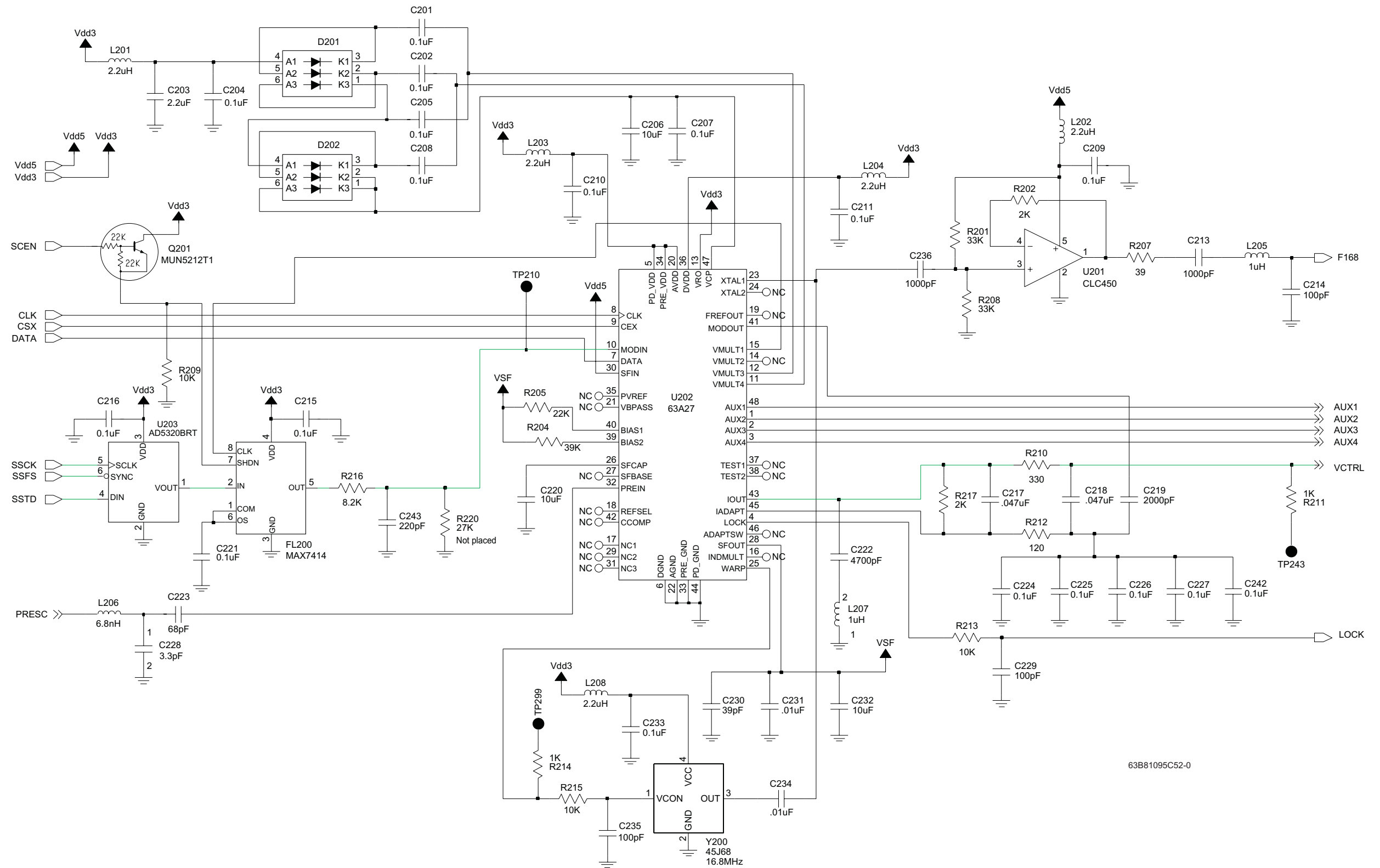


Figure 9-6. Frequency Generation Unit (Synthesizer) Circuit—1 of 2

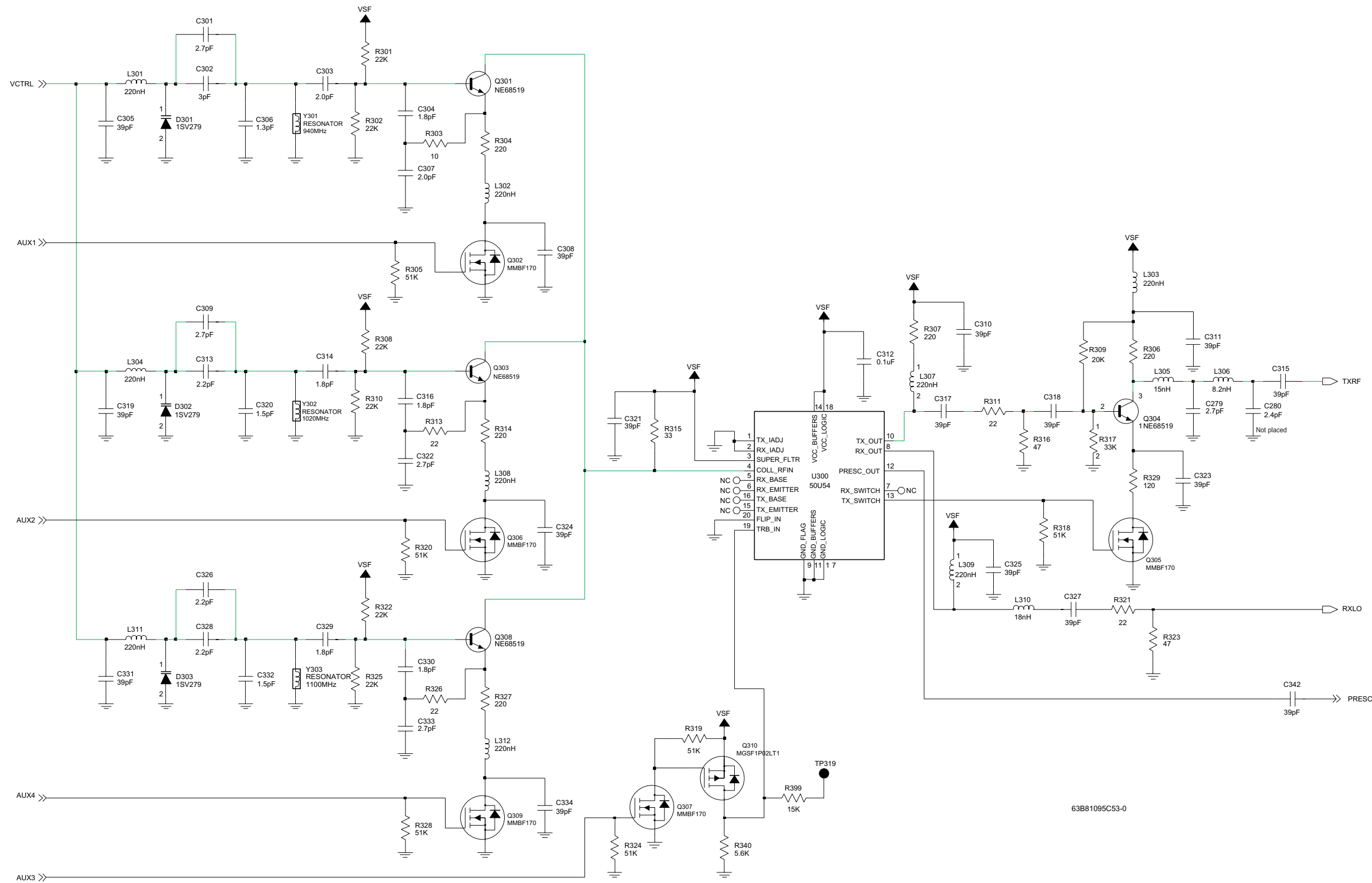


Figure 9-7. Frequency Generation Unit (VCO) Circuit—2 of 2

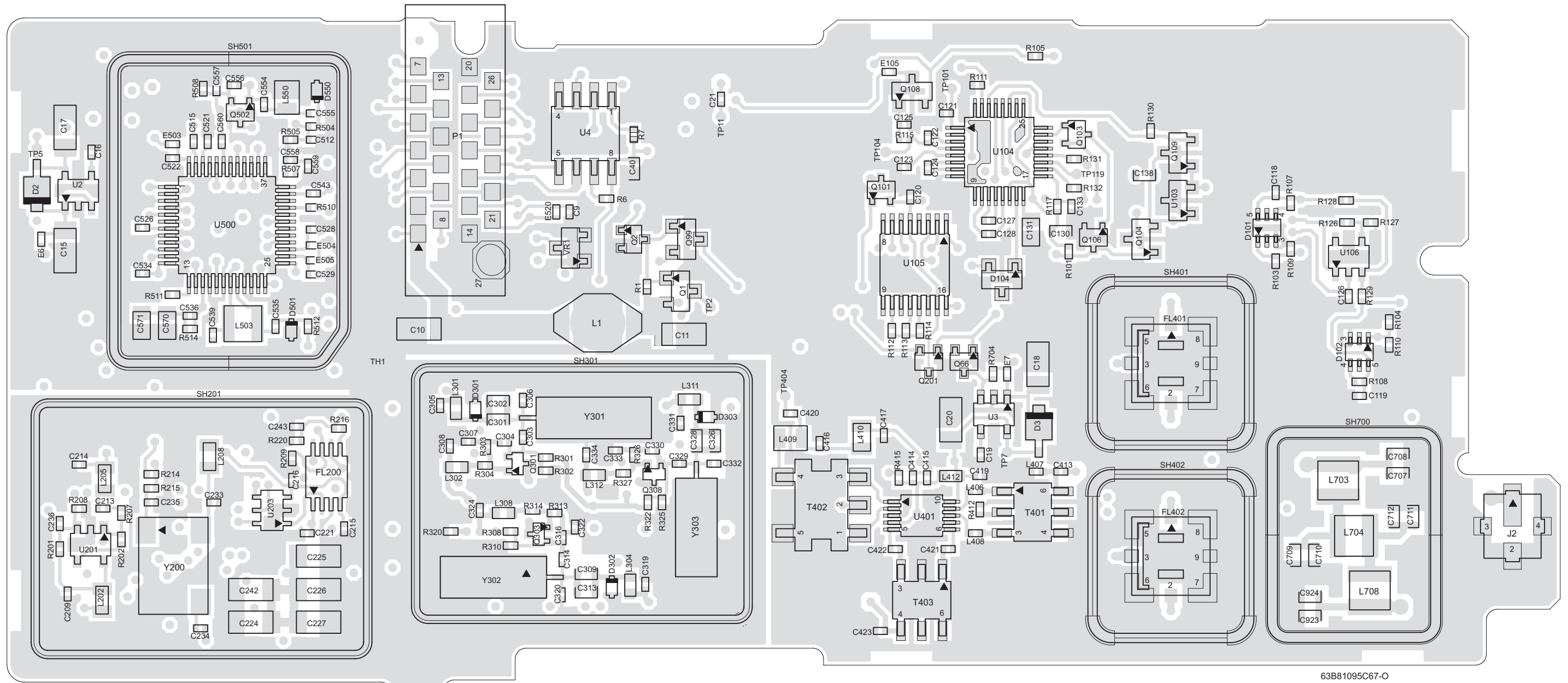


Figure 9-8. Transceiver (RF) Board Layout—Side 1

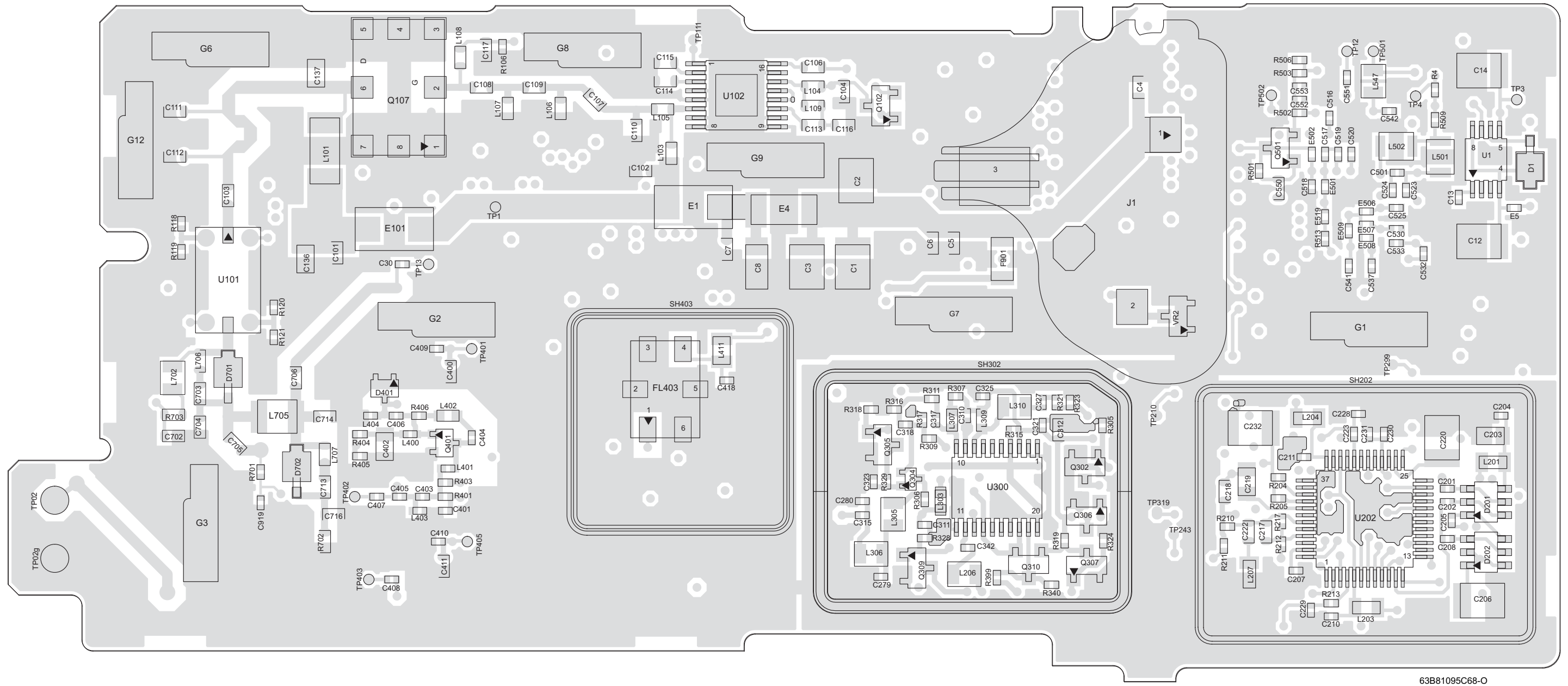


Figure 9-9. Transceiver (RF) Board Layout—Side 2

Transceiver (RF) Board Parts List

Ref. Des.	Part Number	Description
	1105033S13	RIBBON LBL
	5405569Y01	LBL BARCODE APC
	5405569Y03	LABEL BARCODE
C1	2113743T19	CAP 10UF 16V CER 3225 X5R
C10	2113743S01	CAP CER CHIP 1.0 UF 10% 16V
C101	2113932E20	CAP CER CHP .10 UF 10% 16V
C102	2113931F49	CAP CER CHP 10,000 PF 5% 50V
C103	2113930F39	CAP CER CHP 33 PF 50V 5%
C104	2113931F49	CAP CER CHP 10,000 PF 5% 50V
C106	2113930F39	CAP CER CHP 33 PF 50V 5%
C107	2113930F41	CAP CER CHP 39 PF 50V 5%
C108	2113930F29	CAP CER CHP 12 PF 50V 5%
C109	2113930F22	CAP 6.2 PF 50V +/- .25 PF 50V
C11	2113743S01	CAP CER CHIP 1.0 UF 10% 16V
C110	2113930F22	CAP 6.2 PF 50V +/- .25 PF 50V
C111	2113930F09	CAP 1.8 PF 50V +/- 0.1 PF 50V
C112	2113930F15	CAP 3.3 PF 50V +/- .25 PF 50V
C113	2113930F51	CAP CER CHP 100 PF 50V 5%
C114	2113931F49	CAP CER CHP 10,000 PF 5% 50V
C115	2113931F49	CAP CER CHP 10,000 PF 5% 50V
C116	2113930F27	CAP CER CHP 10 PF 50V 5%
C117	2113930F39	CAP CER CHP 33 PF 50V 5%
C118	2113743N38	CAP CHIP 33.0 PF 5% COG
C119	2113743N38	CAP CHIP 33.0 PF 5% COG

Ref. Des.	Part Number	Description
C12	2113743T19	CAP 10UF 16V CER 3225 X5R
C120	2113743L41	CAP CHIP 10000 PF 10% X7R
C121	2113743N38	CAP CHIP 33.0 PF 5% COG
C122	2113743L25	CAP CHIP 2200 PF 10% X7R
C123	NOTPLACED	
C124	2113743N50	CAP CHIP 100 PF 5% COG
C125	2113743L41	CAP CHIP 10000 PF 10% X7R
C126	2113743L41	CAP CHIP 10000 PF 10% X7R
C127	2113743L25	CAP CHIP 2200 PF 10% X7R
C128	2113743L25	CAP CHIP 2200 PF 10% X7R
C13	2113743L41	CAP CHIP 10000 PF 10% X7R
C130	2113932E20	CAP CER CHP .10 UF 10% 16V
C131	2113743A31	CAP CHIP 1.0UF 10% X7R
C133	2113743L41	CAP CHIP 10000 PF 10% X7R
C136	2113743A31	CAP CHIP 1.0UF 10% X7R
C137	2113742H43	CAPACITOR 15PF CERAMIC HI-Q 0805 ACCU-P
C138	2113931F49	CAP CER CHP 10,000 PF 5% 50V
C14	2113743T19	CAP 10UF 16V CER 3225 X5R
C15	2113743S01	CAP CER CHIP 1.0 UF 10% 16V
C16	2113743L41	CAP CHIP 10000 PF 10% X7R
C17	2113743S01	CAP CER CHIP 1.0 UF 10% 16V
C18	2113743S01	CAP CER CHIP 1.0 UF 10% 16V
C19	2113743L41	CAP CHIP 10000 PF 10% X7R
C2	2113743T19	CAP 10UF 16V CER 3225 X5R

Ref. Des.	Part Number	Description
C20	2113743S01	CAP CER CHIP 1.0 UF 10% 16V
C201	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C202	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C203	2113743F18	CAP CHIP 2.2 UF 16V
C204	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C205	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C206	2113743T19	CAP 10UF 16V CER 3225 X5R
C207	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C208	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C209	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C21	2113743N13	CAP CHIP 3.0 PF +/- .25PF COG
C210	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C211	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C213	2113743L17	CAP CHIP 1000 PF 10% X7R
C214	2113743N50	CAP CHIP 100 PF 5% COG
C215	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C216	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C217	2113743E12	CAP CHIP .047 UF 10% X7R
C218	2113743E12	CAP CHIP .047 UF 10% X7R
C219	2109720D20	CAP CHIP LOW DIST 2000 SOV
C220	2113743T19	CAP 10UF 16V CER 3225 X5R
C221	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C222	2113931F41	CAP CER CHP 4,700 PF 5% 50V
C223	2113743N46	QAP CHIP 68.0 PF 5% COG

Ref. Des.	Part Number	Description
C224	2109720D14	CAP CER CHIP LOW DIST .1 UF
C225	2109720D14	CAP CER CHIP LOW DIST .1 UF
C226	2109720D14	CAP CER CHIP LOW DIST .1 UF
C227	2109720D14	CAP CER CHIP LOW DIST .1 UF
C228	2113743Q14	CAP CHIP 3.3PF +/- .1 PF 20*40
C229	2113743N50	CAP CHIP 100 PF 5% COG
C230	2113743N40	CAP CHIP 39.0 PF 5% COG
C231	2113743L41	CAP CHIP 10000 PF 10% X7R
C232	2113743T19	CAP 10UF 16V CER 3225 X5R
C233	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C234	2113743L41	CAP CHIP 10000 PF 10% X7R
C235	2113743N50	CAP CHIP 100 PF 5% COG
C236	2113743L17	CAP CHIP 1000 PF 10% X7R
C242	2109720D14	CAP CER CHIP LOW DIST .1 UF
C243	2113743L01	CAP CHIP 220 PF 10% X7R
C279	2113743N12	CAP CHIP 2.7 PF +/- .25PF COG
C280	NOTPLACED	
C3	2113743T19	CAP 10UF 16V CER 3225 X5R
C30	2113743N13	CAP CHIP 3.0 PF +/- .25PF COG
C301	2113740L04	CAP CER CHIP 2.7 PF +/- 0.1PF
C302	2113740L05	CAP CER CHIP 3.0 PF +/- 0.1PF
C303	2104801Z13	CAP CER NPO 2.0PF 16V 1005 SMD
C304	2104801Z12	CAP CER NPO 1.8PF 16V 1005 SMD
C305	2113743N40	CAP CHIP 39.0 PF 5% COG
C306	2104801Z09	CAP XTS 5000 RF PCB
C307	2104801Z13	CAP CER NPO 2.0PF 16V 1005 SMD

Ref. Des.	Part Number	Description
C308	2113743N40	CAP CHIP 39.0 PF 5% COG
C309	2113740L04	CAP CER CHIP 2.7 PF +-0.1PF
C310	2113743N40	CAP CHIP 39.0 PF 5% COG
C311	2113743N40	CAP CHIP 39.0 PF 5% COG
C312	2113932E20	CAP CER CHP .10 UF 10% 16V
C313	2113740L02	CAP CER CHIP 2.2 PF +-0.1PF
C314	2104801Z12	CAP CER NPO 1.8PF 16V 1005 SMD
C315	2113743N40	CAP CHIP 39.0 PF 5% COG
C316	2104801Z12	CAP CER NPO 1.8PF 16V 1005 SMD
C317	2113743N40	CAP CHIP 39.0 PF 5% COG
C318	2113743N40	CAP CHIP 39.0 PF 5% COG
C319	2113743N40	CAP CHIP 39.0 PF 5% COG
C320	2104801Z10	CAP CER NPO 1.5PF 16V 1005 SMD
C321	2113743N40	CAP CHIP 39.0 PF 5% COG
C322	2104801Z16	CAP CER NPO 2.7PF 16V 1005 SMD
C323	2113743N40	CAP CHIP 39.0 PF 5% COG
C324	2113743N40	CAP CHIP 39.0 PF 5% COG
C325	2113743N40	CAP CHIP 39.0 PF 5% COG
C326	2113740L02	CAP CER CHIP 2.2 PF +-0.1PF
C327	2113743N40	CAP CHIP 39.0 PF 5% COG
C328	2113740L02	CAP CER CHIP 2.2 PF +-0.1PF
C329	2104801Z12	CAP CER NPO 1.8PF 16V 1005 SMD
C330	2104801Z12	CAP CER NPO 1.8PF 16V 1005 SMD
C331	2113743N40	CAP CHIP 39.0 PF 5% COG
C332	2104801Z10	CAP CER NPO 1.5PF 16V 1005 SMD
C333	2104801Z16	CAP CER NPO 2.7PF 16V 1005 SMD
C334	2113743N40	CAP CHIP 39.0 PF 5% COG
C342	2113743N40	CAP CHIP 39.0 PF 5% COG
C4	2113931F49	CAP CER CHP 10,000 PF 5% 50V

Ref. Des.	Part Number	Description
C40	2113932E20	CAP CER CHP .10 UF 10% 16V
C400	2113932E20	CAP CER CHP .10 UF 10% 16V
C401	2113743N38	CAP CHIP 33.0 PF 5% COG
C402	2113928C04	CAP CER CHIP 4.7UF 6.3V10%0805
C403	2113743N40	CAP CHIP 39.0 PF 5% COG
C404	2113743N54	CAP CHIP 150 PF 5% COG
C405	2113743N13	CAP CHIP 3.0 PF +-0.25PF COG
C406	2113743N20	CAP CHIP 5.6PF +-0.5PF COG
C407	2113743N13	CAP CHIP 3.0 PF +-0.25PF COG
C408	2113743N13	CAP CHIP 3.0 PF +-0.25PF COG
C409	2113743N38	CAP CHIP 33.0 PF 5% COG
C410	2113743N38	CAP CHIP 33.0 PF 5% COG
C411	2113932E20	CAP CER CHP .10 UF 10% 16V
C413	2104801Z12	CAP CER NPO 1.8PF 16V 1005 SMD
C414	2113743L25	CAP CHIP 2200 PF 10% X7R
C415	2113743N38	CAP CHIP 33.0 PF 5% COG
C416	2113743N44	CAP CHIP 56.0 PF 5% COG
C417	2113743N16	CAP CHIP 3.9PF +-0.25PF COG
C418	2113743N16	CAP CHIP 3.9PF +-0.25PF COG
C419	2113743N38	CAP CHIP 33.0 PF 5% COG
C420	2113743N13	CAP CHIP 3.0 PF +-0.25PF COG
C421	2113743N50	CAP CHIP 100 PF 5% COG
C422	2113743N50	CAP CHIP 100 PF 5% COG
C423	2113743N20	CAP CHIP 5.6PF +-0.5PF COG
C5	2113930F24	C~P 7.5 PF 50V +/-0.25 PF 50V
C501	2113743N54	CAP CHIP 150 PF 5% COG
C512	2113743L29	CAP CHIP 3300 PF 10% X7R

Ref. Des.	Part Number	Description
C515	2113743L41	CAP CHIP 10000 PF 10% X7R
C516	2113743L17	CAP CHIP 1000 PF 10% X7R
C517	2113743L41	CAP CHIP 10000 PF 10% X7R
C518	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C519	2113743L41	CAP CHIP 10000 PF 10% X7R
C520	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C521	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C522	2113743L41	CAP CHIP 10000 PF 10% X7R
C523	2113743N50	CAP CHIP 100 PF 5% COG
C524	2113743N50	CAP CHIP 100 PF 5% COG
C525	2113743L41	CAP CHIP 10000 PF 10% X7R
C526	2113743L25	CAP CHIP 2200 PF 10% X7R
C528	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C529	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C530	2113743L41	CAP CHIP 10000 PF 10% X7R
C532	2113743L41	CAP CHIP 10000 PF 10% X7R
C533	2113743N50	CAP CHIP 100 PF 5% COG
C534	2113743N50	CAP CHIP 100 PF 5% COG
C535	2113743N43	CAP CHIP 51.0 PF 5% COG
C536	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C537	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C539	2113743L41	CAP CHIP 10000 PF 10% X7R
C541	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C542	2113743N16	CAP CHIP 3.9PF +-0.25PF COG
C543	2113743L41	CAP CHIP 10000 PF 10% X7R

Ref. Des.	Part Number	Description
C550	2113932E20	CAP CER CHP .10 UF 10% 16V
C551	2113743N13	CAP CHIP 3.0 PF +-0.25PF COG
C552	2113743L17	CAP CHIP 1000 PF 10% X7R
C553	2113743L50	CAP CHIP 33000 PF 10%
C554	2113743N30	CAP CHIP 15.0 PF 5% COG
C555	2113743N30	CAP CHIP 15.0 PF 5% COG
C556	2113743N42	CAP CHIP 47.0 PF 5% COG
C557	2113743N42	CAP CHIP 47.0 PF 5% COG
C558	2113743L41	CAP CHIP 10000 PF 10% X7R
C559	2113928N01	CAP CER CHIP 0.1UF 10% 6.3
C560	2113743N36	CAP CHIP 27.0 PF 5% COG
C570	2113743A24	CAP CHIP .330 UF 10% 16V
C571	2113743A24	CAP CHIP .330 UF 10% 16V
C6	2113930F39	CAP CER CHP 33 PF 50V 5%
C7	2113930F24	C~P 7.5 PF 50V +/-0.25 PF 50V
C702	2113930F39	CAP CER CHP 33 PF 50V 5%
C703	2113930F39	CAP CER CHP 33 PF 50V 5%
C704	2113930F08	CAP 1.6 PF 50V +/-0.1 PF 50V
C705	2113930F39	CAP CER CHP 33 PF 50V 5%
C706	2113930F39	CAP CER CHP 33 PF 50V 5%
C707	2113930F03	CAP 1.0 PF 50V +/-0.1 PF 50V
C708	2113930F03	CAP 1.0 PF 50V +/-0.1 PF 50V
C709	2113930F11	CAP 2.2 PF 50V +/-0.25 PF 50V
C710	2113930F11	CAP 2.2 PF 50V +/-0.25 PF 50V
C711	2113930F11	CAP 2.2 PF 50V +/-0.25 PF 50V

Ref. Des.	Part Number	Description
C712	2113930F11	CAP 2.2 PF 50V +/- .25 PF 50V
C713	2113930F39	CAP CER CHP 33 PF 50V 5%
C714	2113930F07	CAP 1.5 PF 50V +/- 0.1 PF 50V
C716	2113930F27	CAP CER CHP 10 PF 50V 5%
C8	2113743S01	CAP CER CHIP 1.0 UF 10% 16V
C9	2113743N50	CAP CHIP 100 PF 5% COG
C919	2113743L41	CAP CHIP 10000 PF 10% X7R
C923	2113930F03	CAP 1.0 PF 50V +/- 0.1 PF 50V
C924	2113930F03	CAP 1.0 PF 50V +/- 0.1 PF 50V
D1	4813833A20	DIODE SCHOTTKY 1A 40V PWRMITE
D101	4802197J83	DUAL SHOTTKY DIODE MBD330DWT1
D102	4802197J83	DUAL SHOTTKY DIODE MBD330DWT1
D104	4805129M06	DIODE MMBD7000
D2	4813833A20	DIODE SCHOTTKY 1A 40V PWRMITE
D201	4802233J09	DIODE TRIPLE SOT25-RH
D202	4802233J09	DIODE TRIPLE SOT25-RH
D3	4813833A20	DIODE SCHOTTKY 1A 40V PWRMITE
D301	4809877C08	DIODE VARACTOR 1SV279 SMD
D302	4809877C08	DIODE VARACTOR 1SV279 SMD
D303	4809877C08	DIODE VARACTOR 1SV279 SMD
D401	4813825A19	DIODE SCHOTTKY BARRIER SERIES
D501	4809877C08	DIODE VARACTOR 1SV279 SMD
D550	4809877C08	DIODE VARACTOR 1SV279 SMD
D701	4805656W24	DIODE, PIN RF
D702	4805656W24	DIODE, PIN RF

Ref. Des.	Part Number	Description
E1	2405688Z01	INDUCTOR FERRITE BEAD
E101	2405688Z01	INDUCTOR FERRITE BEAD
E105	2480640Z01	SURFACE MOUNT FERRITE BEAD
E4	2460591K40	COIL AIR WOUND INDUC 59.71
E5	2480640Z01	SURFACE MOUNT FERRITE BEAD
E501	2480640Z01	SURFACE MOUNT FERRITE BEAD
E502	2480640Z01	SURFACE MOUNT FERRITE BEAD
E503	2480640Z01	SURFACE MOUNT FERRITE BEAD
E504	2480640Z01	SURFACE MOUNT FERRITE BEAD
E505	2480640Z01	SURFACE MOUNT FERRITE BEAD
E506	2480640Z01	SURFACE MOUNT FERRITE BEAD
E507	2480640Z01	SURFACE MOUNT FERRITE BEAD
E508	2480640Z01	SURFACE MOUNT FERRITE BEAD
E509	2480640Z01	SURFACE MOUNT FERRITE BEAD
E519	2480640Z01	SURFACE MOUNT FERRITE BEAD
E520	2480640Z01	SURFACE MOUNT FERRITE BEAD
E6	2409154M48	IND CER MLTILYR 1.0NH 1005
E7	2409154M48	IND CER MLTILYR 1.0NH 1005
F901	6505757V02	FUSE SURFACE MT 2AMP
FL200	9185130D01	FLTR SW CAP 3 POLE BUTTERW
FL401	9185004D01	LC FLTR, MULTILAYER CERAMIC
FL402	9185004D01	LC FLTR, MULTILAYER CERAMIC
FL403	4885631B01	XTAL FILT 3 POLE 109.65 MOTORO
G1	3905643V01	CONTACT ANT GRD

Ref. Des.	Part Number	Description
G12	3905643V01	CONTACT ANT GRD
G2	3905643V01	CONTACT ANT GRD
G3	3905643V01	CONTACT ANT GRD
G6	3905643V01	CONTACT ANT GRD
G7	3905643V01	CONTACT ANT GRD
G8	3905643V01	CONTACT ANT GRD
G9	3905643V01	CONTACT ANT GRD
J1	NOTPLACED	
J2	0905304Z01	CONN COAXIAL SMT
L1	2486085A04	COIL, 6.8 UH POWER INDUCTOR
L101	2460591K40	COIL AIR WOUND INDUC 59.71
L103	2413926H24	INDUCTOR MULITI-LAYER CERAMIC CHIP
L104	2413926H24	INDUCTOR MULITI-LAYER CERAMIC CHIP
L105	2413926H06	IND CHIP 3.3 NH +/- 0.3NH
L106	2413926H09	IND CHIP 5.6 NH +/- 0.3NH
L107	2413926F02	IND 1.5 NH +/- 0.3 NH
L108	2413926H24	INDUCTOR MULITI-LAYER CERAMIC CHIP
L109	2413926H12	CHIP INDUCTOR 10.0NH
L201	2462587Q20	IND CHIP 2,200 NH 20%
L202	2462587Q20	IND CHIP 2,200 NH 20%
L203	2462587Q20	IND CHIP 2,200 NH 20%
L204	2462587Q20	IND CHIP 2,200 NH 20%
L205	2462587Q47	IND CHIP 1,000 NH 10%
L206	2462587V21	CHIP IND 6.8 NH 5% 0805
L207	2462587Q47	IND CHIP 1,000 NH 10%
L208	2462587Q20	IND CHIP 2,200 NH 20%
L301	2409377M36	IND CHIP WW 220 NH 5% 1608
L302	2409377M36	IND CHIP WW 220 NH 5% 1608
L303	2409377M36	IND CHIP WW 220 NH 5% 1608
L304	2409377M36	IND CHIP WW 220 NH 5% 1608
L305	2462587V24	CHIP IND 15 NH 5% 0805
L306	2462587V22	CHIP IND 8.2 NH 5% 0805

Ref. Des.	Part Number	Description
L307	2409377M36	IND CHIP WW 220 NH 5% 1608
L308	2409377M36	IND CHIP WW 220 NH 5% 1608
L309	2409377M36	IND CHIP WW 220 NH 5% 1608
L310	2462587V25	CHIP IND 18 NH 5% 0805
L311	2409377M36	IND CHIP WW 220 NH 5% 1608
L312	2409377M36	IND CHIP WW 220 NH 5% 1608
L400	2409154M48	IND CER MLTILYR 1.0NH 1005
L401	2409154M12	IND MTLILYR 8.2NH 1005
L402	2409377M14	IND CHIP WW 68 NH 5% 1608
L403	2409154M14	IND CER MLTILYR 12.0NH 1005
L404	2409154M12	IND MTLILYR 8.2NH 1005
L406	2409154M11	IND MTLILYR 6.8NH 1005
L407	2409154M23	IND CER MLTILYR 68.0NH 1005
L408	2409154M11	IND MTLILYR 6.8NH 1005
L409	2462587V32	CHIP IND 68 NH 5% 0805
L410	2404574Z15	IND CHIP WW 330NH 2% 2012 SMD
L411	2404574Z15	IND CHIP WW 330NH 2% 2012 SMD
L412	NOTPLACED	
L501	2405769X05	COIL INDUCTOR
L502	2405769X05	COIL INDUCTOR
L503	2462587N76	CHIP IND 4700 NH 5%
L547	2462587V38	CHIP IND 220 NH 5% 0805
L550	2462587V35	CHIP IND 120 NH 5% 0805
L702	2462587V36	CHIP IND 150 NH 5% 0805
L703	2460591A69	COIL AIR WOUND INDUC 8.72
L704	2460591A69	COIL AIR WOUND INDUC 8.72
L705	2460591B22	COIL AIR WOUND INDUC 8.67
L706	2413926G15	IND 47.0 NH 5%
L707	2413926G15	IND 47.0 NH 5%

Ref. Des.	Part Number	Description
L708	2460591A69	COIL AIR WOUND INDUC 8.72
P1	NOTPLACED	
PCB	8485013D01	BD PC RF XCVR
Q1	4813821A47	TSTR P-CH HDTMOS 20V
Q101	4813824A42	TSTR PNP 50V BIAS RES 10K 10K
Q102	4813821A47	TSTR P-CH HDTMOS 20V
Q103	4813824A42	TSTR PNP 50V BIAS RES 10K 10K
Q104	4813821A47	TSTR P-CH HDTMOS 20V
Q106	4813824A39	TSTR NPN 50V BIAS RES 22K 22K
Q107	5185633C10	MODE 800 MHz RING
Q108	4805128M12	TSTR SOT BCW 60B (RH)
Q109	4805128M12	TSTR SOT BCW 60B (RH)
Q2	4813824A39	TSTR NPN 50V BIAS RES 22K 22K
Q201	4813824A39	TSTR NPN 50V BIAS RES 22K 22K
Q301	4805793Y01	TRANS MINI SOT NPN LOW NOISE
Q302	4805218N11	XISTOR SOT RH BST82
Q303	4805793Y01	TRANS MINI SOT NPN LOW NOISE
Q304	4805793Y01	TRANS MINI SOT NPN LOW NOISE
Q305	4805218N11	XISTOR SOT RH BST82
Q306	4805218N11	XISTOR SOT RH BST82
Q307	4805218N11	XISTOR SOT RH BST82
Q308	4805793Y01	TRANS MINI SOT NPN LOW NOISE
Q309	4805218N11	XISTOR SOT RH BST82
Q310	4813821A47	TSTR P-CH HDTMOS 20V
Q401	4805585Q19	TRANSISTOR
Q501	4805128M19	TSTR SOT23 MMBTA13 RH
Q502	4805218N63	RF TRANS SOT 323 BFQ67W
Q66	4813824A39	TSTR NPN 50V BIAS RES 22K 22K
Q99	4813821A47	TSTR P-CH HDTMOS 20V
R1	0662057N23	RES. CHIP 100K 5% 20X40

Ref. Des.	Part Number	Description
R101	0662057N23	RES. CHIP 100K 5% 20X40
R103	0662057M58	RES. CHIP 220 5% 20X40
R104	0662057M58	RES. CHIP 220 5% 20X40
R105	0662057N03	RES. CHIP 15K 5% 20X40
R106	0662057M98	RES. CHIP 10K 5% 20X40
R107	0662057M90	RES. CHIP 4700 5% 20X40
R108	0662057M90	RES. CHIP 4700 5% 20X40
R109	0662057M50	RES. CHIP 100 5% 20X40
R110	0662057M50	RES. CHIP 100 5% 20X40
R111	0662057N23	RES. CHIP 100K 5% 20X40
R112	0662057N23	RES. CHIP 100K 5% 20X40
R113	0662057N23	RES. CHIP 100K 5% 20X40
R114	0662057N23	RES. CHIP 100K 5% 20X40
R115	0662057M74	RES. CHIP 1000 5% 20X40
R117	0662057M26	RES. CHIP 10 5% 20X40
R118	0662057M50	RES. CHIP 100 5% 20X40
R119	0662057M50	RES. CHIP 100 5% 20X40
R120	0662057M50	RES. CHIP 100 5% 20X40
R121	0662057M50	RES. CHIP 100 5% 20X40
R126	0662057M98	RES. CHIP 10K 5% 20X40
R127	0662057M98	RES. CHIP 10K 5% 20X40
R128	0662057M98	RES. CHIP 10K 5% 20X40
R129	0662057M98	RES. CHIP 10K 5% 20X40
R130	0662057N23	RES. CHIP 100K 5% 20X40
R131	0662057M98	RES. CHIP 10K 5% 20X40
R132	0662057M98	RES. CHIP 10K 5% 20X40
R201	0662057N11	RES. CHIP 33K 5% 20X40
R202	0662057M81	RES. CHIP 2000 5% 20X40
R204	0662057N13	RES. CHIP 39K 5% 20X40
R205	0662057N07	RES. CHIP 22K 5% 20X40
R207	0662057M40	RES. CHIP 39 5% 20X40
R208	0662057N11	RES. CHIP 33K 5% 20X40
R209	0662057M98	RES. CHIP 10K 5% 20X40
R210	0662057M62	RES. CHIP 330 5% 20X40
R211	0662057M74	RES. CHIP 1000 5% 20X40
R212	0662057M52	RES. CHIP 120 5% 20X40
R213	0662057M98	RES. CHIP 10K 5% 20X40
R214	0662057M74	RES. CHIP 1000 5% 20X40
R215	0662057M98	RES. CHIP 10K 5% 20X40

Ref. Des.	Part Number	Description
R216	0662057M96	RES. CHIP 8200 5% 20X40
R217	0662057M81	RES. CHIP 2000 5% 20X40
R220	NOTPLACED	
R301	0662057N07	RES. CHIP 22K 5% 20X40
R302	0662057N07	RES. CHIP 22K 5% 20X40
R303	0662057M26	RES. CHIP 10 5% 20X40
R304	0662057M58	RES. CHIP 220 5% 20X40
R305	0662057N16	RES. CHIP 51K 5% 20X40
R306	0662057M58	RES. CHIP 220 5% 20X40
R307	0662057M58	RES. CHIP 220 5% 20X40
R308	0662057N07	RES. CHIP 22K 5% 20X40
R309	0662057N06	RES. CHIP 20K 5% 20X40
R310	0662057N07	RES. CHIP 22K 5% 20X40
R311	0662057M34	RES. CHIP 22 5% 20X40
R313	0662057M34	RES. CHIP 22 5% 20X40
R314	0662057M58	RES. CHIP 220 5% 20X40
R315	0662057M38	RES. CHIP 33 5% 20X40
R316	0662057M42	RES. CHIP 47 5% 20X40
R317	0662057N11	RES. CHIP 33K 5% 20X40
R318	0662057N16	RES. CHIP 51K 5% 20X40
R319	0662057N16	RES. CHIP 51K 5% 20X40
R320	0662057N16	RES. CHIP 51K 5% 20X40
R321	0662057M34	RES. CHIP 22 5% 20X40
R322	0662057N07	RES. CHIP 22K 5% 20X40
R323	0662057M42	RES. CHIP 47 5% 20X40
R324	0662057N16	RES. CHIP 51K 5% 20X40
R325	0662057N07	RES. CHIP 22K 5% 20X40
R326	0662057M34	RES. CHIP 22 5% 20X40
R327	0662057M58	RES. CHIP 220 5% 20X40
R328	0662057N16	RES. CHIP 51K 5% 20X40
R329	0662057M52	RES. CHIP 120 5% 20X40
R340	0662057M92	RES. CHIP 5600 5% 20X40
R399	0662057N03	RES. CHIP 15K 5% 20X40
R4	2113743L17	CAP CHIP 1000 PF 10% X7R
R401	0662057M59	RES CHIP 240 5% 20X40
R403	0662057M84	RES. CHIP 2700 5% 20X40
R404	0662057M94	RES. CHIP 6800 5% 20X40
R405	0662057M90	RES. CHIP 4700 5% 20X40

Ref. Des.	Part Number	Description
R406	0662057M66	RES. CHIP 470 5% 20X40
R412	0662057M48	RES. CHIP 82 5% 20X40
R415	0662057M59	RES CHIP 240 5% 20X40
R501	0662057N23	RES. CHIP 100K 5% 20X40
R502	0662057M56	RES. CHIP 180 5% 20X40
R503	0662057M98	RES. CHIP 10K 5% 20X40
R504	0662057M98	RES. CHIP 10K 5% 20X40
R505	0662057M95	RES. CHIP 7500 5% 20X40
R506	0662057M98	RES. CHIP 10K 5% 20X40
R507	0662057M81	RES. CHIP 2000 5% 20X40
R508	0662057M62	RES. CHIP 330 5% 20X40
R509	0662057M42	RES. CHIP 47 5% 20X40
R510	0662057N23	RES. CHIP 100K 5% 20X40
R511	0662057N23	RES. CHIP 100K 5% 20X40
R512	0662057M98	RES. CHIP 10K 5% 20X40
R513	0662057M98	RES. CHIP 10K 5% 20X40
R514	0662057M64	RES. CHIP 390 5% 20X40
R6	0662057M98	RES. CHIP 10K 5% 20X40
R7	0662057M98	RES. CHIP 10K 5% 20X40
R701	0662057N15	RES. CHIP 47K 5% 20X40
R702	0662057A29	CHIP RES 150 OHMS 5%
R703	0662057A29	CHIP RES 150 OHMS 5%
R704	0662057N23	RES. CHIP 100K 5% 20X40
SH201	2685787B01	SHLD FRAC-N
SH202	2685787B01	SHLD FRAC-N
SH301	2685297D01	SHLD VCO
SH302	2685298D01	SHLD VCO BUFFER
SH401	2685627A02	SHLD DUAL INDUCTOR
SH402	2685627A02	SHLD DUAL INDUCTOR
SH403	2685882A01	SHLD VCO TANK
SH501	2685298D01	SHLD VCO BUFFER
SH700	2685762D01	SHEILD HARMONIC FILTER
T401	2580541Z02	BALUN TRANSFORMER (NEW)
T402	2505515V07	XFMR JEDI MIXER 25:1
T403	2580541Z02	BALUN TRANSFORMER (NEW)
TH1	NOTPLACED	

Ref. Des.	Part Number	Description
U1	5185353D13	IC MINI SO-8 HI PRECISION REG 5V
U101	5185633C24	MODULE DIRECT COUPLER
U102	5185130C65	IC VHF/UHF/800 MHZ LDMOS DRIVER
U103	5185963A15	IC TEMPATURE SENSOR 1M50C
U104	5185765B26	IC PWR CTRL IN MOS20
U105	5185368C19	IC QUAD 10 BIT A/D CONV
U106	5185963A60	OP AMP IC
U2	5185353D14	IC SOT23-5 HI PRECISION REG 3V
U201	5186358E01	IC ANALOG OP-AMP CLC450
U202	5185963A27	IC TESTED AT25016 48 PIN GFP
U203	5185368C83	IC 12 BIT DAC
U3	5185353D14	IC SOT23-5 HI PRECISION REG 3V
U300	5105750U54	IC PKG DIE VCO BUFFER
U4	5105462G78	IC EEPROM 16K SPEI CMOS
U401	5185130C91	IC MIXER RF SOIC 10
U500	5185963A85	IC-ABACUS III-LP
VR1	4813830A33	DIODE 20V 5% 225MW MMBZ5250B_
VR2	4813830A15	DIODE 5.6V 5% 225MW MMBZ5232B_
W02	NOTPLACED	
W021	NOTPLACED	
W1	NOTPLACED	
W10	NOTPLACED	
W11	NOTPLACED	
W12	NOTPLACED	
W13	NOTPLACED	
W14	NOTPLACED	
W15	NOTPLACED	
W16	NOTPLACED	
W17	NOTPLACED	
W18	NOTPLACED	
W19	NOTPLACED	

Ref. Des.	Part Number	Description
W2	NOTPLACED	
W20	NOTPLACED	
W21	NOTPLACED	
W22	NOTPLACED	
W23	NOTPLACED	
W3	NOTPLACED	
W4	NOTPLACED	
W5	NOTPLACED	
W6	NOTPLACED	
W7	NOTPLACED	
W8	NOTPLACED	
W9	NOTPLACED	
Y200	4802245J68	OSC REF 16.8 MHZ 1.5 PPM
Y301	4805911Z16	IND COAXIAL CERAMIC SMD
Y302	4805911Z17	IND COAXIAL CERAMIC SMD
Y303	4805911Z14	IND COAXIAL CERAMIC 1100 MHZ

9.4 VOCON Board

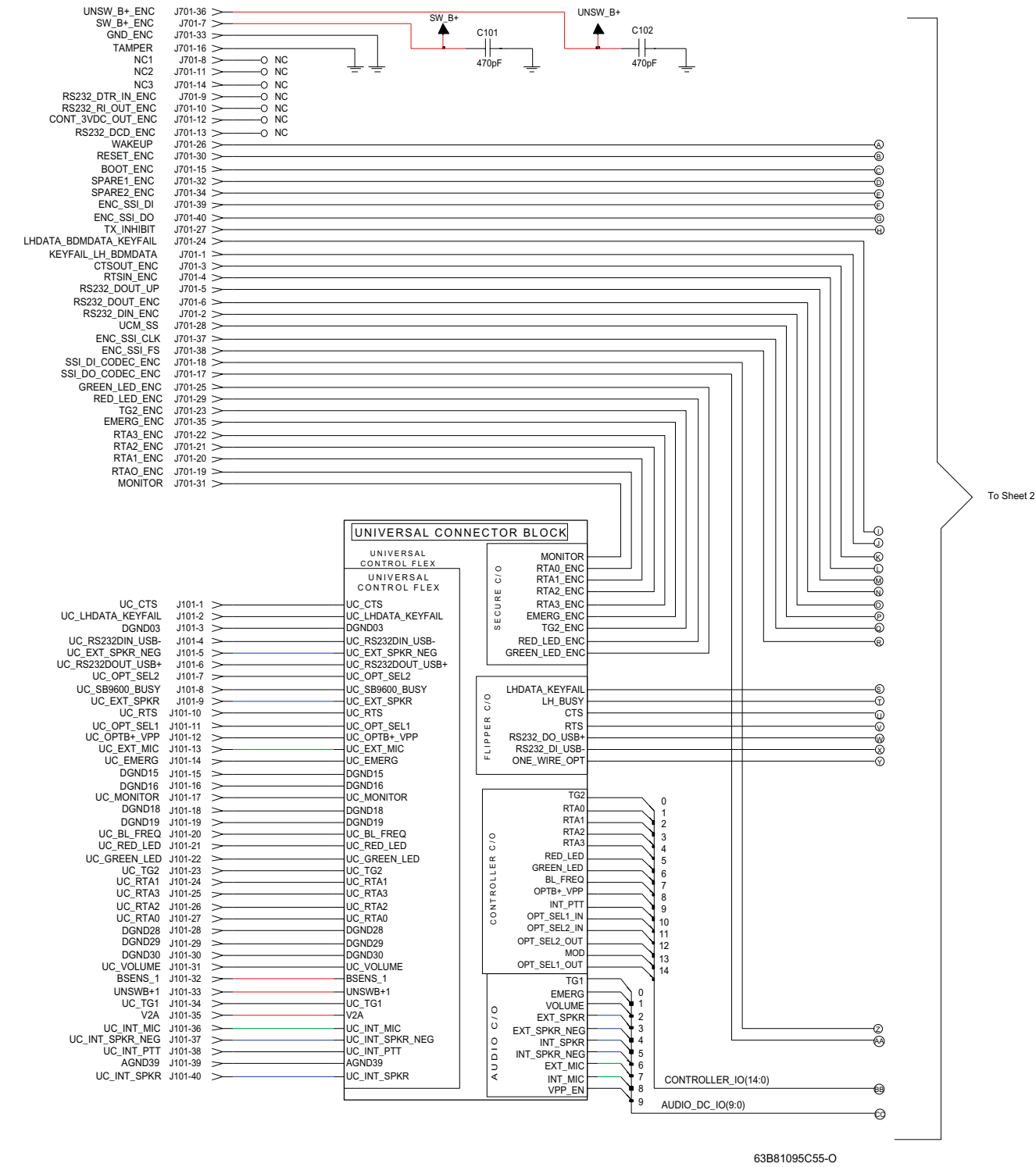


Figure 9-10. VOCON Board Overall Schematic—1 of 2

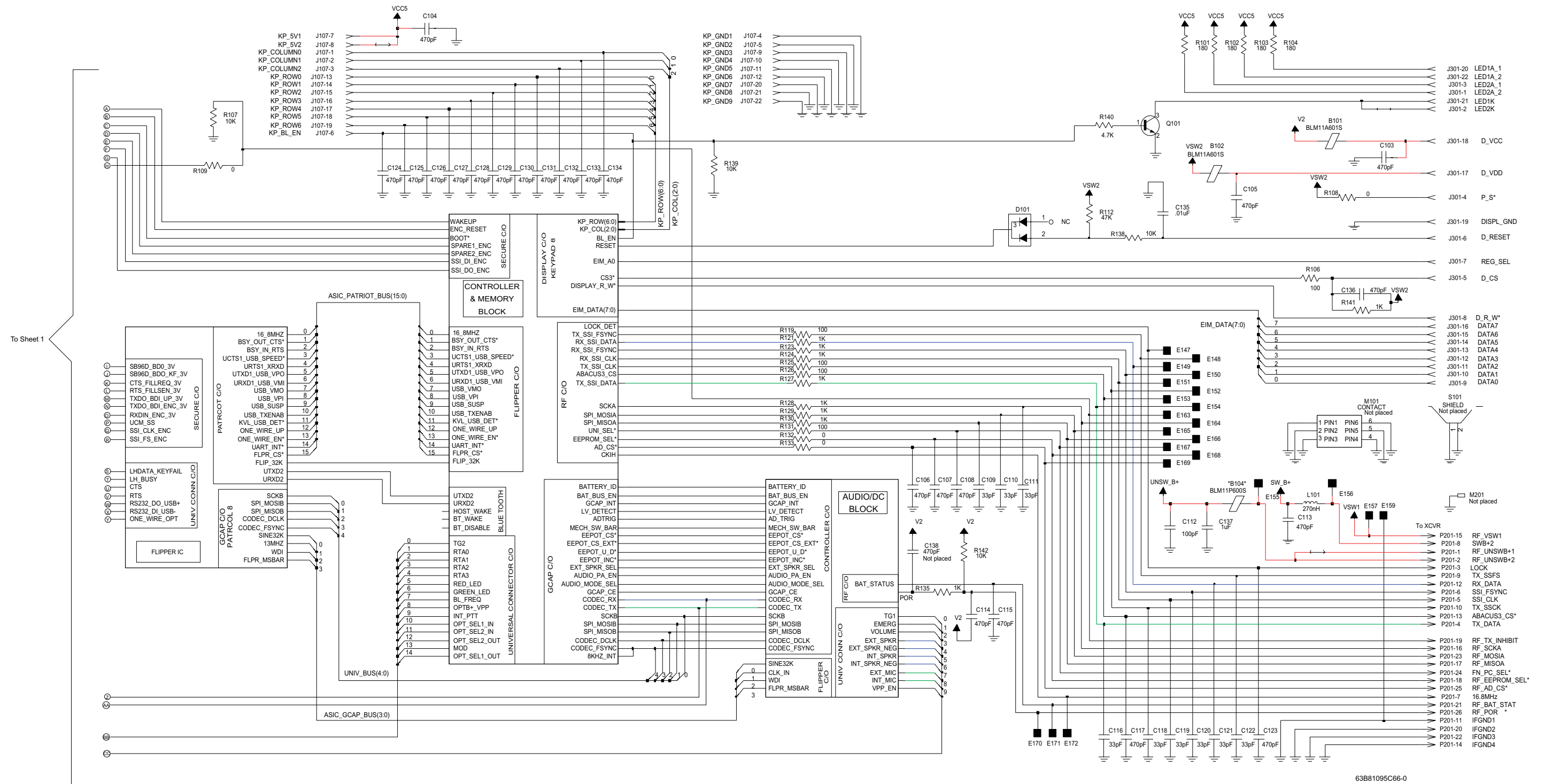


Figure 9-11. VOCON Board Overall Schematic—2 of 2

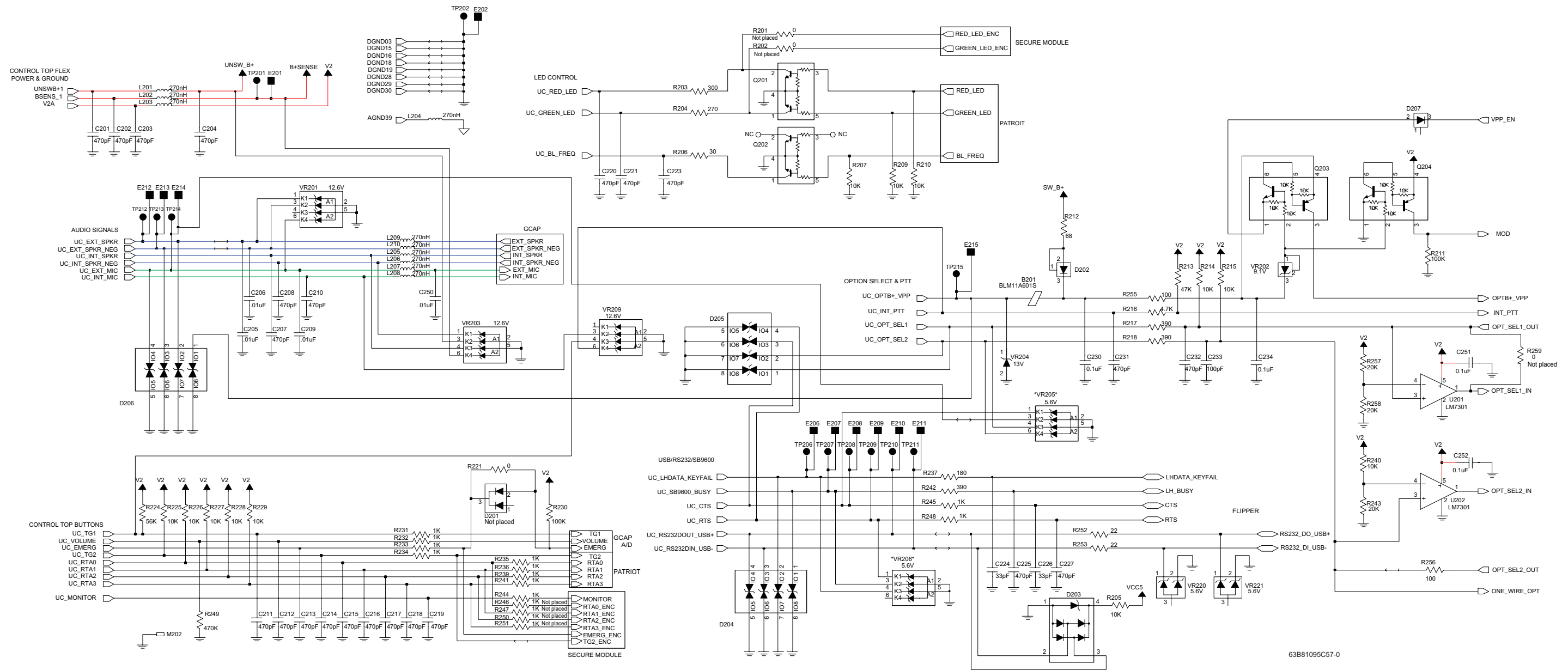


Figure 9-12. VOCON Universal Connector Circuit

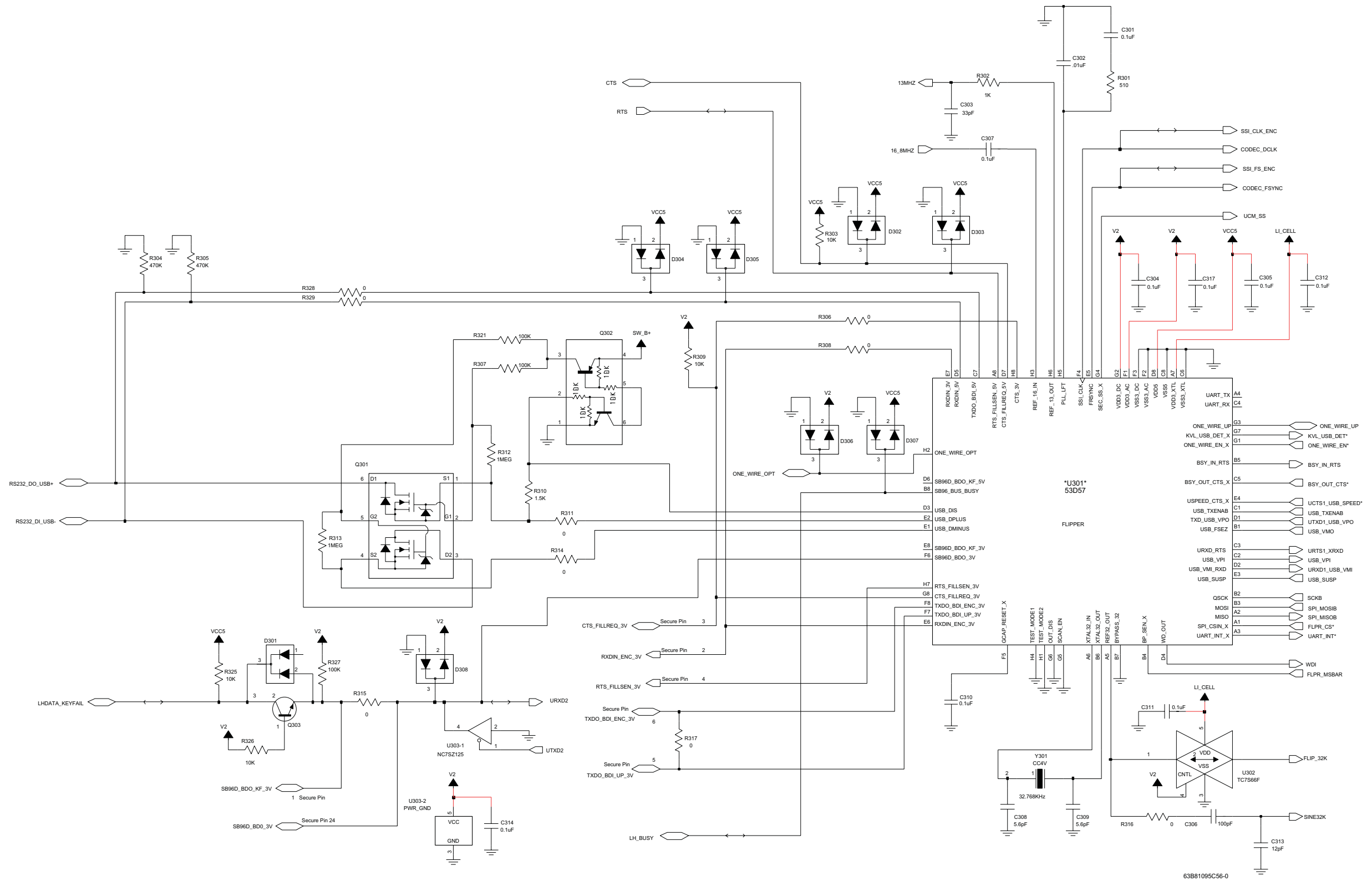


Figure 9-13. VOCON Flipper Circuit

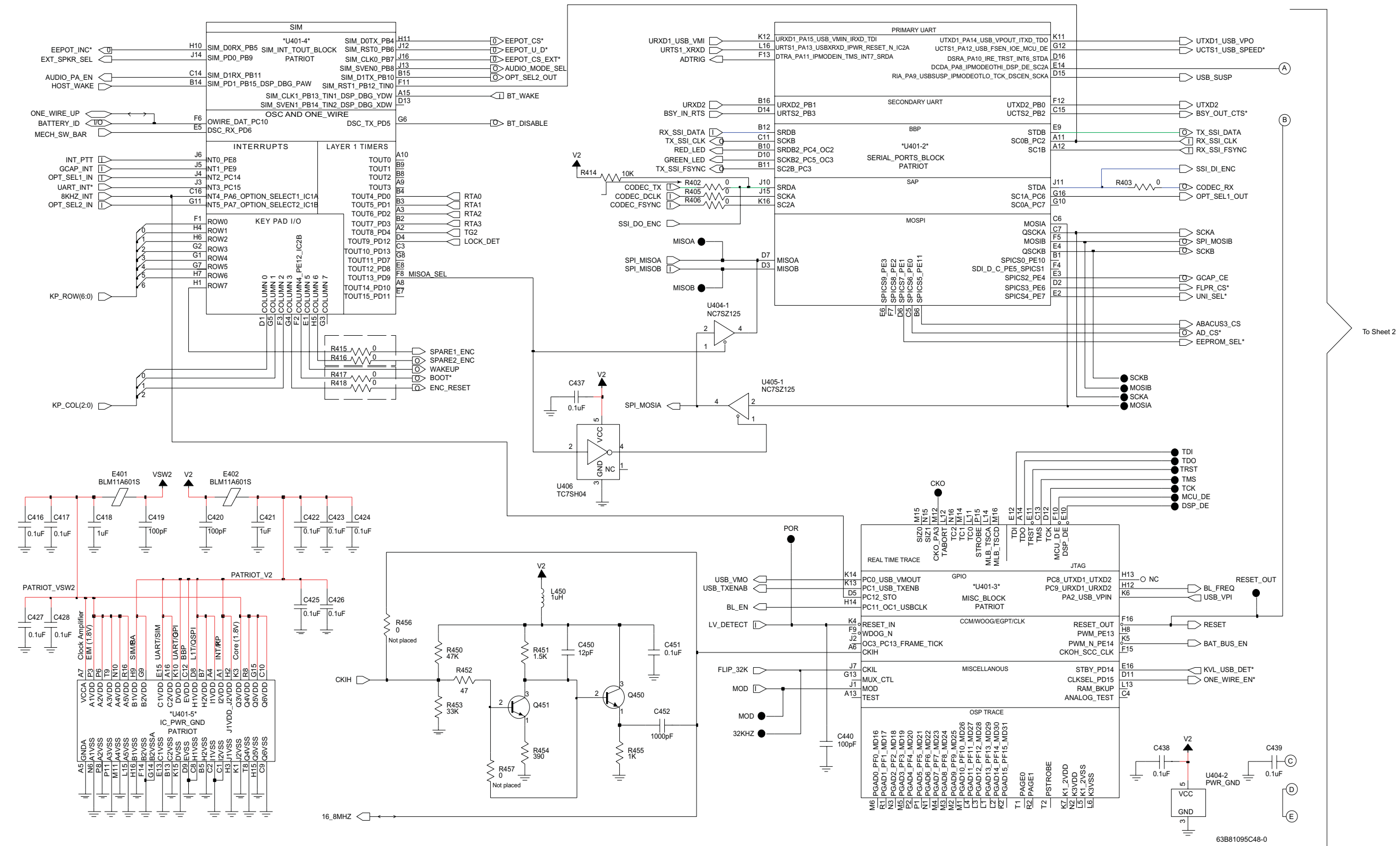


Figure 9-14. VOCON Controller and Memory Circuits—1 of 2

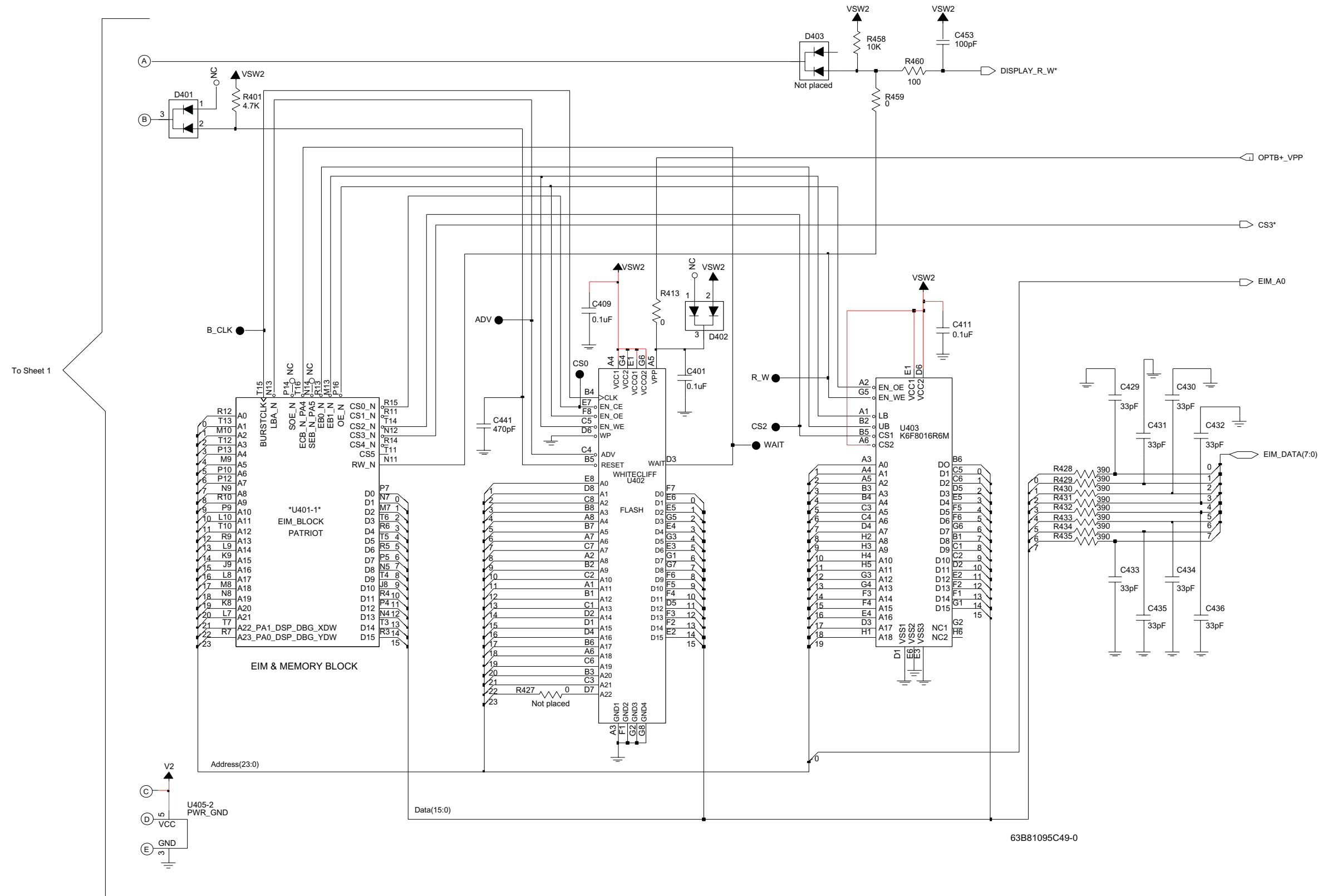


Figure 9-15. VOCON Controller and Memory Circuits—2 of 2

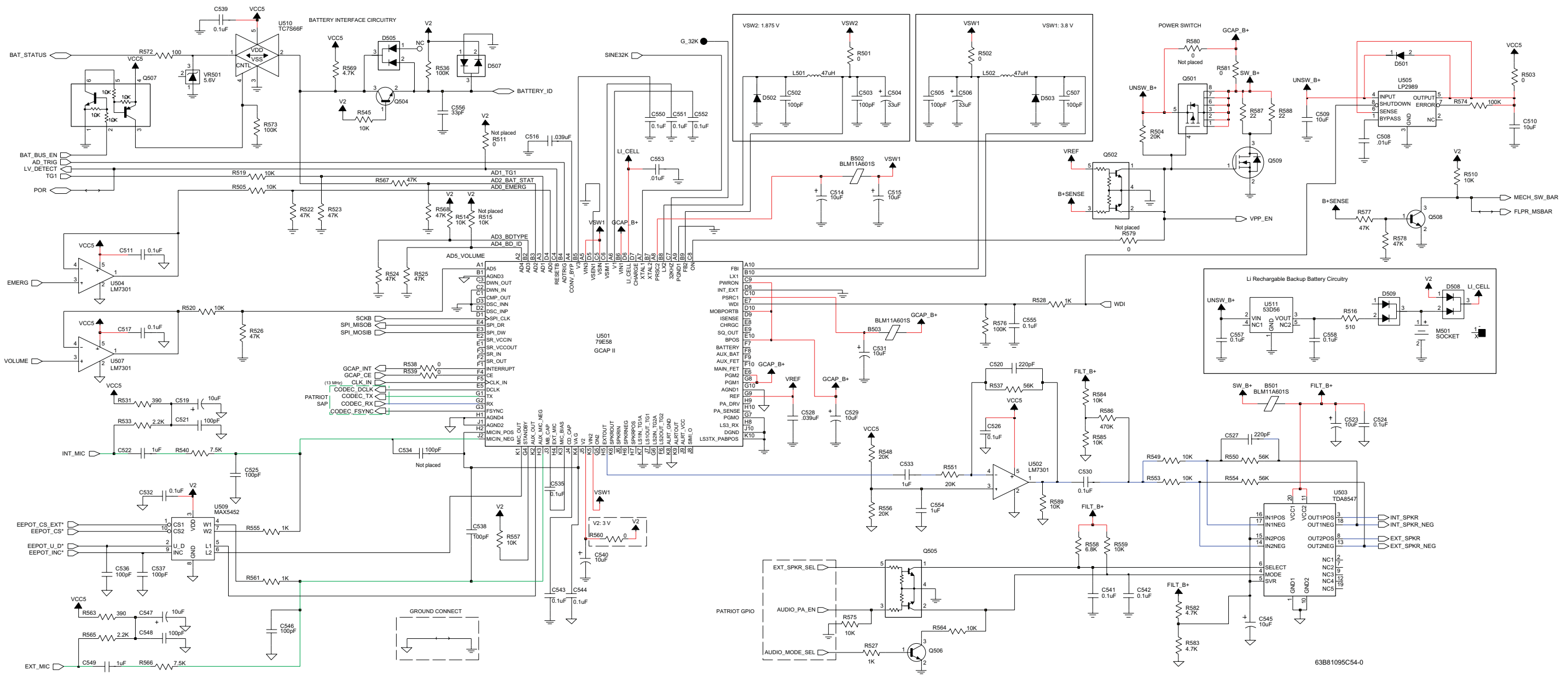
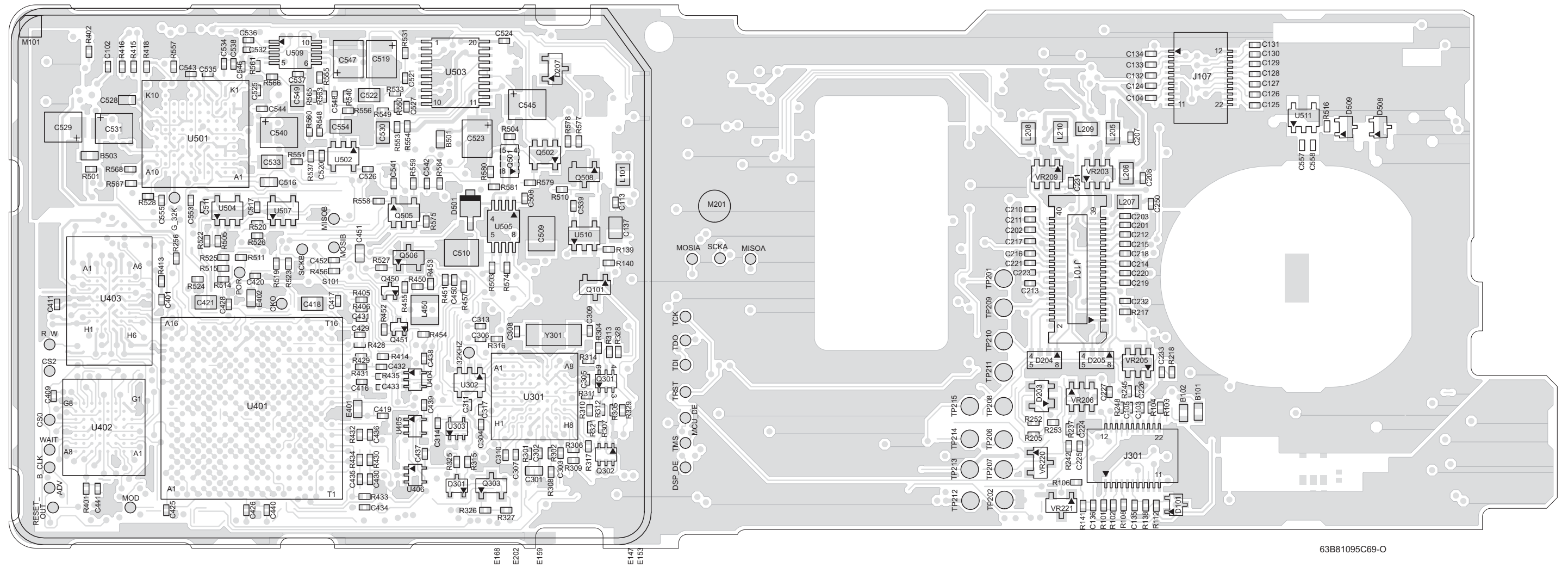
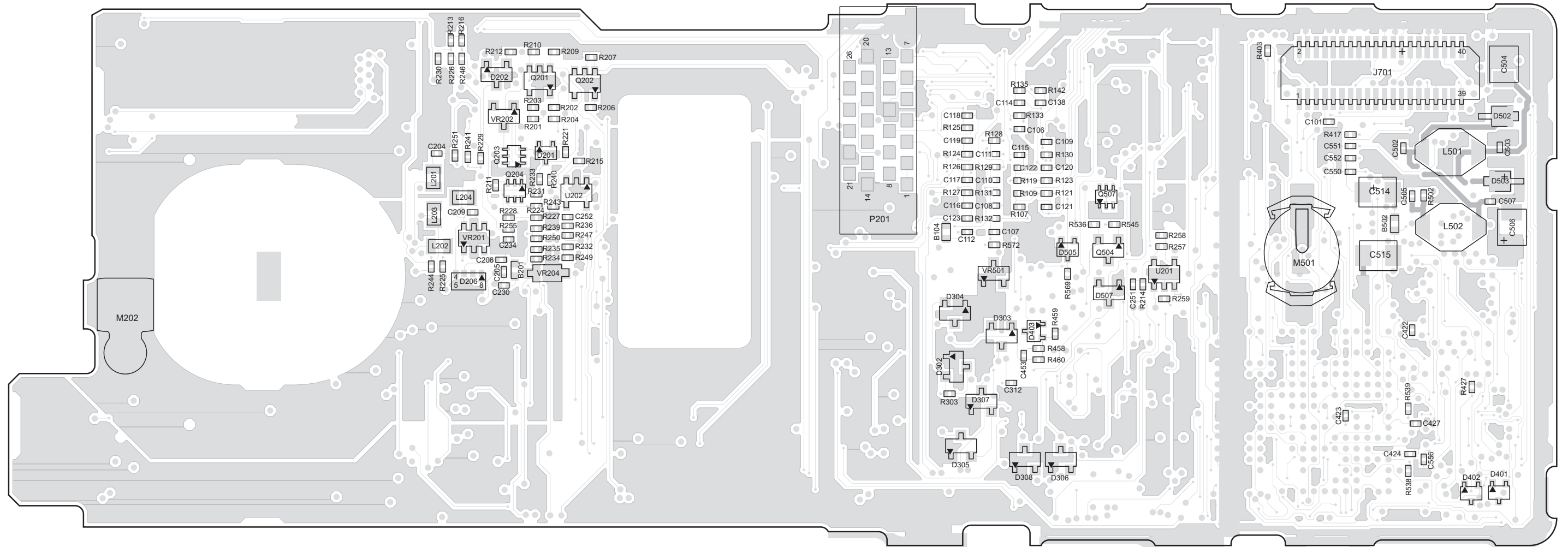


Figure 9-16. VOCON Audio and DC Circuits



63B81095C69-O
Figure 9-17. VOCON Board Layout—Side 1



63B81095C70-O

Figure 9-18. VOCON Board Layout—Side 2

VOCON Board Parts List

Ref. Des.	Part Number	Description
32KHZ	NOTPLACED	
ADV	NOTPLACED	
B_CLK	NOTPLACED	
B101	2480574F01	IND FERRITE CHIP 60OHM 0603
B102	2480574F01	IND FERRITE CHIP 60OHM 0603
B104	2462586G33	INDUCTOR CHIP FERRITE BEADS
B201	2480574F01	IND FERRITE CHIP 60OHM 0603
B501	2480574F01	IND FERRITE CHIP 60OHM 0603
B502	2480574F01	IND FERRITE CHIP 60OHM 0603
B503	2480574F01	IND FERRITE CHIP 60OHM 0603
C101	2113743L09	CAP CHIP 470 PF 10% X7R
C102	2113743L09	CAP CHIP 470 PF 10% X7R
C103	2113743L09	CAP CHIP 470 PF 10% X7R
C104	2113743L09	CAP CHIP 470 PF 10% X7R
C105	2113743L09	CAP CHIP 470 PF 10% X7R
C106	2113743L09	CAP CHIP 470 PF 10% X7R
C107	2113743L09	CAP CHIP 470 PF 10% X7R
C108	2113743L09	CAP CHIP 470 PF 10% X7R
C109	2113743N38	CAP CHIP 33.0 PF 5% COG
C110	2113743N38	CAP CHIP 33.0 PF 5% COG
C111	2113743N38	CAP CHIP 33.0 PF 5% COG
C112	2113743N50	CAP CHIP 100 PF 5% COG
C113	2113743L09	CAP CHIP 470 PF 10% X7R
C114	2113743L09	CAP CHIP 470 PF 10% X7R
C115	2113743L09	CAP CHIP 470 PF 10% X7R
C116	2113743N38	CAP CHIP 33.0 PF 5% COG
C117	2113743L09	CAP CHIP 470 PF 10% X7R
C118	2113743N38	CAP CHIP 33.0 PF 5% COG
C119	2113743N38	CAP CHIP 33.0 PF 5% COG
C120	2113743N38	CAP CHIP 33.0 PF 5% COG
C121	2113743N38	CAP CHIP 33.0 PF 5% COG
C122	2113743N38	CAP CHIP 33.0 PF 5% COG
C123	2113743L09	CAP CHIP 470 PF 10% X7R

Ref. Des.	Part Number	Description
C124	2113743L09	CAP CHIP 470 PF 10% X7R
C125	2113743L09	CAP CHIP 470 PF 10% X7R
C126	2113743L09	CAP CHIP 470 PF 10% X7R
C127	2113743L09	CAP CHIP 470 PF 10% X7R
C128	2113743L09	CAP CHIP 470 PF 10% X7R
C129	2113743L09	CAP CHIP 470 PF 10% X7R
C130	2113743L09	CAP CHIP 470 PF 10% X7R
C131	2113743L09	CAP CHIP 470 PF 10% X7R
C132	2113743L09	CAP CHIP 470 PF 10% X7R
C133	2113743L09	CAP CHIP 470 PF 10% X7R
C134	2113743L09	CAP CHIP 470 PF 10% X7R
C135	2113743L41	CAP CHIP 10000 PF 10% X7R
C136	2113743L09	CAP CHIP 470 PF 10% X7R
C137	2113743A31	CAP CHIP 1.0UF 10% X7R
C138	NOTPLACED	
C201	2113743L09	CAP CHIP 470 PF 10% X7R
C202	2113743L09	CAP CHIP 470 PF 10% X7R
C203	2113743L09	CAP CHIP 470 PF 10% X7R
C204	2113743L09	CAP CHIP 470 PF 10% X7R
C205	2113743L41	CAP CHIP 10000 PF 10% X7R
C206	2113743L41	CAP CHIP 10000 PF 10% X7R
C207	2113743L09	CAP CHIP 470 PF 10% X7R
C208	2113743L09	CAP CHIP 470 PF 10% X7R
C209	2113743L41	CAP CHIP 10000 PF 10% X7R
C210	2113743L09	CAP CHIP 470 PF 10% X7R
C211	2113743L09	CAP CHIP 470 PF 10% X7R
C212	2113743L09	CAP CHIP 470 PF 10% X7R
C213	2113743L09	CAP CHIP 470 PF 10% X7R
C214	2113743L09	CAP CHIP 470 PF 10% X7R
C215	2113743L09	CAP CHIP 470 PF 10% X7R
C216	2113743L09	CAP CHIP 470 PF 10% X7R
C217	2113743L09	CAP CHIP 470 PF 10% X7R
C218	2113743L09	CAP CHIP 470 PF 10% X7R
C219	2113743L09	CAP CHIP 470 PF 10% X7R
C220	2113743L09	CAP CHIP 470 PF 10% X7R
C221	2113743L09	CAP CHIP 470 PF 10% X7R

Ref. Des.	Part Number	Description
C223	2113743L09	CAP CHIP 470 PF 10% X7R
C224	2113743N38	CAP CHIP 33.0 PF 5% COG
C225	2113743L09	CAP CHIP 470 PF 10% X7R
C226	2113743L09	CAP CHIP 470 PF 10% X7R
C227	2113743L09	CAP CHIP 470 PF 10% X7R
C230	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C231	2113743L09	CAP CHIP 470 PF 10% X7R
C232	2113743L09	CAP CHIP 470 PF 10% X7R
C233	2113743N50	CAP CHIP 100 PF 5% COG
C234	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C250	2113743L41	CAP CHIP 10000 PF 10% X7R
C251	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C252	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C301	2113932E20	CAP CER CHP .10 UF 10% 16V
C302	2113743L41	CAP CHIP 10000 PF 10% X7R
C303	2113743N38	CAP CHIP 33.0 PF 5% COG
C304	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C305	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C306	2113743N50	CAP CHIP 100 PF 5% COG
C307	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C308	2113743N20	CAP CHIP 5.6PF +-.5PF COG
C309	2113743N20	CAP CHIP 5.6PF +-.5PF COG
C310	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C311	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C312	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C313	2113743N28	CAP CHIP 12.0 PF 5% COG
C314	2113743M24	CAP CHIP 100000 PF +80-20% Y5V

Ref. Des.	Part Number	Description
C317	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C401	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C409	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C411	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C416	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C417	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C418	2113743A31	CAP CHIP 1.0UF 10% X7R
C419	2113743N50	CAP CHIP 100 PF 5% COG
C420	2113743N50	CAP CHIP 100 PF 5% COG
C421	2113743A31	CAP CHIP 1.0UF 10% X7R
C422	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C423	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C424	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C425	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C426	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C427	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C428	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C429	2113743N38	CAP CHIP 33.0 PF 5% COG
C430	2113743N38	CAP CHIP 33.0 PF 5% COG
C431	2113743N38	CAP CHIP 33.0 PF 5% COG
C432	2113743N38	CAP CHIP 33.0 PF 5% COG
C433	2113743N38	CAP CHIP 33.0 PF 5% COG
C434	2113743N38	CAP CHIP 33.0 PF 5% COG
C435	2113743N38	CAP CHIP 33.0 PF 5% COG
C436	2113743N38	CAP CHIP 33.0 PF 5% COG
C437	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C438	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C439	2113743M24	CAP CHIP 100000 PF +80-20% Y5V

Ref. Des.	Part Number	Description
C440	2113743N50	CAP CHIP 100 PF 5% COG
C441	2113743L09	CAP CHIP 470 PF 10% X7R
C450	2113743N28	CAP CHIP 12.0 PF 5% COG
C451	2113932E20	CAP CER CHP .10 UF 10% 16V
C452	2113743L17	CAP CHIP 1000 PF 10% X7R
C453	2113743N50	CAP CHIP 100 PF 5% COG
C502	2113743N50	CAP CHIP 100 PF 5% COG
C503	2113743N50	CAP CHIP 100 PF 5% COG
C504	2311049C52	CAP TANT CHIP 33UF 10% 10V
C505	2113743N50	CAP CHIP 100 PF 5% COG
C506	2311049C52	CAP TANT CHIP 33UF 10% 10V
C507	2113743N50	CAP CHIP 100 PF 5% COG
C508	2113743L41	CAP CHIP 10000 PF 10% X7R
C509	2113743T19	CAP 10UF 16V CER 3225 X5R
C510	2113743T19	CAP 10UF 16V CER 3225 X5R
C511	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C514	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C515	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C516	2113743E11	CAP CHIP .039 UF 10% X7R
C517	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C519	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C520	2113743L01	CAP CHIP 220 PF 10% X7R
C521	2113743N50	CAP CHIP 100 PF 5% COG
C522	2113743A31	CAP CHIP 1.0UF 10% X7R
C523	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C524	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C525	2113743N50	CAP CHIP 100 PF 5% COG
C526	2113743M24	CAP CHIP 100000 PF +80-20% Y5V

Ref. Des.	Part Number	Description
C527	2113743L01	CAP CHIP 220 PF 10% X7R
C528	2113743E11	CAP CHIP .039 UF 10% X7R
C529	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C530	2113743A19	CAP CHIP .100 UF 10% X7R
C531	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C532	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C533	2113743A31	CAP CHIP 1.0UF 10% X7R
C534	NOTPLACED	
C535	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C536	2113743N50	CAP CHIP 100 PF 5% COG
C537	2113743N50	CAP CHIP 100 PF 5% COG
C538	2113743N50	CAP CHIP 100 PF 5% COG
C539	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C540	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C541	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C542	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C543	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C544	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C545	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C546	2113743N50	CAP CHIP 100 PF 5% COG
C547	2311049A57	CAP TANT CHIP A/P 10UF 10% 16V
C548	2113743N50	CAP CHIP 100 PF 5% COG
C549	2113743A31	CAP CHIP 1.0UF 10% X7R
C550	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C551	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C552	2113743M24	CAP CHIP 100000 PF +80-20% Y5V

Ref. Des.	Part Number	Description
C553	2113743L41	CAP CHIP 10000 PF 10% X7R
C554	2113743A31	CAP CHIP 1.0UF 10% X7R
C555	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C556	2113743N38	CAP CHIP 33.0 PF 5% COG
C557	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
C558	2113743M24	CAP CHIP 100000 PF +80-20% Y5V
CKO	NOTPLACED	
CS0	NOTPLACED	
CS2	NOTPLACED	
D101	4805218N57	DIODE DUAL
D201	NOTPLACED	
D202	4805129M90	DIODE SOT PKGD
D203	4802021P15	ZENER SR05
D204	4805656W39	QUAD ESD SUPPRESSOR ARRAY -41206ESDA
D205	4805656W39	QUAD ESD SUPPRESSOR ARRAY -41206ESDA
D206	4805656W39	QUAD ESD SUPPRESSOR ARRAY -41206ESDA
D207	4805129M90	DIODE SOT PKGD
D301	4805218N57	DIODE DUAL
D302	4805129M06	DIODE MMBD7000
D303	4805129M06	DIODE MMBD7000
D304	4805129M06	DIODE MMBD7000
D305	4805129M06	DIODE MMBD7000
D306	4805129M06	DIODE MMBD7000
D307	4805129M06	DIODE MMBD7000
D308	4805129M06	DIODE MMBD7000
D401	4805218N57	DIODE DUAL
D402	4805218N57	DIODE DUAL
D403	NOTPLACED	
D501	4813833A20	DIODE SCHOTTKY 1A 40V PWRMITE
D502	4813833A20	DIODE SCHOTTKY 1A 40V PWRMITE
D503	4813833A20	DIODE SCHOTTKY 1A 40V PWRMITE
D505	4805218N57	DIODE DUAL

Ref. Des.	Part Number	Description
D507	4805129M06	DIODE MMBD7000
D508	4805218N57	DIODE DUAL
D509	4805218N57	DIODE DUAL
DSP_DE	NOTPLACED	
E147	NOTPLACED	
E148	NOTPLACED	
E149	NOTPLACED	
E150	NOTPLACED	
E151	NOTPLACED	
E152	NOTPLACED	
E153	NOTPLACED	
E154	NOTPLACED	
E155	NOTPLACED	
E156	NOTPLACED	
E157	NOTPLACED	
E159	NOTPLACED	
E163	NOTPLACED	
E164	NOTPLACED	
E165	NOTPLACED	
E166	NOTPLACED	
E167	NOTPLACED	
E168	NOTPLACED	
E169	NOTPLACED	
E170	NOTPLACED	
E171	NOTPLACED	
E172	NOTPLACED	
E201	NOTPLACED	
E202	NOTPLACED	
E206	NOTPLACED	
E207	NOTPLACED	
E208	NOTPLACED	
E209	NOTPLACED	
E210	NOTPLACED	
E211	NOTPLACED	
E212	NOTPLACED	
E213	NOTPLACED	
E214	NOTPLACED	
E215	NOTPLACED	

Ref. Des.	Part Number	Description
E401	2480574F01	IND FERRITE CHIP 60OHM 0603
E402	2480574F01	IND FERRITE CHIP 60OHM 0603
G_32K	NOTPLACED	
J101	0985185D01	CONN RECEP 0.5MM PITCH 40 CKTS
J107	0987817K01	RECP BTB 0.5P 1.5 STACK SMD
J301	0987817K01	RECP BTB 0.5P 1.5 STACK SMD
J701	0980423L02	40PIN ROBIN CONN 3MM
L101	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L201	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L202	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L203	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L204	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L205	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L206	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L207	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L208	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L209	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L210	2404574Z14	IND CHIP WW 270NH 2% 2012 SMD
L450	2462587N68	CHIP IND 1000 NH 5%
L501	2486085A06	COIL 47UH SMT POWER INDUCTOR
L502	2486085A06	COIL 47UH SMT POWER INDUCTOR
M101	NOTPLACED	
M201	NOTPLACED	
M202	3985951A01	CONTACT ANTENNA GROUND
M501	0985888K02	SKT RTC BTTY LEAP
MCU_DE	NOTPLACED	

Ref. Des.	Part Number	Description
MISOA	NOTPLACED	
MISOB	NOTPLACED	
MOD	NOTPLACED	
MOSIA	NOTPLACED	
MOSIB	NOTPLACED	
P201	NOTPLACED	
PCB	8485140D01	BD VOCON XTS5000
POR	NOTPLACED	
Q101	4813824A10	TSTR NPN 40V .2A GEN PURP
Q201	4805921T09	XSTR DUAL ROHM FMG8
Q202	4805921T09	XSTR DUAL ROHM FMG8
Q204	4805723X03	TRANS DUAL NPN-PNP UMD3N ROHM
Q301	4809579E35	TSTR FET DUAL N-CHAN FDG3601N
Q302	4805723X03	TRANS DUAL NPN-PNP UMD3N ROHM
Q303	4813824A10	TSTR NPN 40V .2A GEN PURP
Q450	4805793Y01	TRANS MINI SOT NPN LOW NOISE
Q451	4805793Y01	TRANS MINI SOT NPN LOW NOISE
Q501	4885844C01	XSTR FET
Q502	4805921T09	XSTR DUAL ROHM FMG8
Q504	4813824A10	TSTR NPN 40V .2A GEN PURP
Q505	4805921T09	XSTR DUAL ROHM FMG8
Q506	4813824A10	TSTR NPN 40V .2A GEN PURP
Q507	4805723X03	TRANS DUAL NPN-PNP UMD3N ROHM
Q508	4813824A10	TSTR NPN 40V .2A GEN PURP
Q509	4805218N11	XISTOR SOT RH BST82
R_W	NOTPLACED	
R101	0662057M56	RES. CHIP 180 5% 20X40
R102	0662057M56	RES. CHIP 180 5% 20X40
R103	0662057M56	RES. CHIP 180 5% 20X40
R104	0662057M56	RES. CHIP 180 5% 20X40
R106	0662057M50	RES. CHIP 100 5% 20X40

Ref. Des.	Part Number	Description
R107	0662057M98	RES. CHIP 10K 5% 20X40
R108	0662057M01	RES. CHIP 0 5% 20X40
R109	NOTPLACED	
R112	0662057N15	RES. CHIP 47K 5% 20X40
R119	0662057M50	RES. CHIP 100 5% 20X40
R121	0662057M74	RES. CHIP 1000 5% 20X40
R123	0662057M74	RES. CHIP 1000 5% 20X40
R124	0662057M74	RES. CHIP 1000 5% 20X40
R125	0662057M50	RES. CHIP 100 5% 20X40
R126	0662057M50	RES. CHIP 100 5% 20X40
R127	0662057M74	RES. CHIP 1000 5% 20X40
R128	0662057M74	RES. CHIP 1000 5% 20X40
R129	0662057M74	RES. CHIP 1000 5% 20X40
R130	0662057M74	RES. CHIP 1000 5% 20X40
R131	0662057M50	RES. CHIP 100 5% 20X40
R132	0662057M01	RES. CHIP 0 5% 20X40
R133	0662057M01	RES. CHIP 0 5% 20X40
R135	0662057M74	RES. CHIP 1000 5% 20X40
R138	0662057M98	RES. CHIP 10K 5% 20X40
R139	0662057M98	RES. CHIP 10K 5% 20X40
R140	0662057M90	RES. CHIP 4700 5% 20X40
R141	0662057M74	RES. CHIP 1000 5% 20X40
R142	0662057M98	RES. CHIP 10K 5% 20X40
R201	NOTPLACED	
R202	NOTPLACED	
R203	0662057M61	RES. CHIP 300 5% 20X40
R204	0662057M60	RES. CHIP 270 5% 20X40
R205	0662057M98	RES. CHIP 10K 5% 20X40
R206	0662057M37	20X40 30 OMH 5% CHIP RESISTOR
R207	0662057M98	RES. CHIP 10K 5% 20X40
R209	0662057M98	RES. CHIP 10K 5% 20X40
R210	0662057M98	RES. CHIP 10K 5% 20X40
R211	0662057N23	RES. CHIP 100K 5% 20X40
R212	0662057M46	RES. CHIP 68 5% 20X40
R213	0662057N15	RES. CHIP 47K 5% 20X40
R214	0662057M98	RES. CHIP 10K 5% 20X40
R215	0662057M98	RES. CHIP 10K 5% 20X40
R216	0662057M90	RES. CHIP 4700 5% 20X40

Ref. Des.	Part Number	Description
R217	0662057M64	RES. CHIP 390 5% 20X40
R218	0662057M64	RES. CHIP 390 5% 20X40
R221	0662057M01	RES. CHIP 0 5% 20X40
R224	0662057N17	RES. CHIP 56K 5% 20X40
R225	0662057M98	RES. CHIP 10K 5% 20X40
R226	0662057M98	RES. CHIP 10K 5% 20X40
R227	0662057M98	RES. CHIP 10K 5% 20X40
R228	0662057M98	RES. CHIP 10K 5% 20X40
R229	0662057M98	RES. CHIP 10K 5% 20X40
R230	0662057N23	RES. CHIP 100K 5% 20X40
R231	0662057M74	RES. CHIP 1000 5% 20X40
R232	0662057M74	RES. CHIP 1000 5% 20X40
R233	0662057M74	RES. CHIP 1000 5% 20X40
R234	0662057M74	RES. CHIP 1000 5% 20X40
R235	0662057M74	RES. CHIP 1000 5% 20X40
R236	0662057M74	RES. CHIP 1000 5% 20X40
R237	0662057M56	RES. CHIP 180 5% 20X40
R239	0662057M74	RES. CHIP 1000 5% 20X40
R240	0662057M98	RES. CHIP 10K 5% 20X40
R241	0662057M74	RES. CHIP 1000 5% 20X40
R242	0662057M64	RES. CHIP 390 5% 20X40
R243	0662057N06	RES. CHIP 20K 5% 20X40
R244	0662057M74	RES. CHIP 1000 5% 20X40
R245	0662057M74	RES. CHIP 1000 5% 20X40
R246	NOTPLACED	
R247	NOTPLACED	
R248	0662057M74	RES. CHIP 1000 5% 20X40
R249	0662057N39	RES. CHIP 470K 5% 20X40
R250	NOTPLACED	
R251	NOTPLACED	
R252	0662057M34	RES. CHIP 22 5% 20X40
R253	0662057M34	RES. CHIP 22 5% 20X40
R255	0662057M50	RES. CHIP 100 5% 20X40
R256	0662057M50	RES. CHIP 100 5% 20X40
R257	0662057N06	RES. CHIP 20K 5% 20X40
R258	0662057N06	RES. CHIP 20K 5% 20X40
R259	NOTPLACED	
R301	0662057M67	RES. CHIP 510 5% 20X40
R302	0662057M74	RES. CHIP 1000 5% 20X40

Ref. Des.	Part Number	Description
R303	0662057M98	RES. CHIP 10K 5% 20X40
R304	0662057N39	RES. CHIP 470K 5% 20X40
R305	0662057N39	RES. CHIP 470K 5% 20X40
R306	0662057M01	RES. CHIP 0 5% 20X40
R307	0662057N23	RES. CHIP 100K 5% 20X40
R308	0662057M01	RES. CHIP 0 5% 20X40
R309	0662057M98	RES. CHIP 10K 5% 20X40
R310	0662057M78	RES. CHIP 1500 5% 20X40
R311	0662057M01	RES. CHIP 0 5% 20X40
R312	0662057N47	RES. CHIP 1.0 MEG 5% 20X40
R313	0662057N47	RES. CHIP 1.0 MEG 5% 20X40
R314	0662057M01	RES. CHIP 0 5% 20X40
R315	0662057M01	RES. CHIP 0 5% 20X40
R316	0662057M01	RES. CHIP 0 5% 20X40
R317	0662057M01	RES. CHIP 0 5% 20X40
R321	0662057N23	RES. CHIP 100K 5% 20X40
R325	0662057M98	RES. CHIP 10K 5% 20X40
R326	0662057M98	RES. CHIP 10K 5% 20X40
R327	0662057N23	RES. CHIP 100K 5% 20X40
R328	0662057M01	RES. CHIP 0 5% 20X40
R329	0662057M01	RES. CHIP 0 5% 20X40
R401	0662057M90	RES. CHIP 4700 5% 20X40
R402	0662057M01	RES. CHIP 0 5% 20X40
R403	0662057M01	RES. CHIP 0 5% 20X40
R405	0662057M01	RES. CHIP 0 5% 20X40
R406	0662057M01	RES. CHIP 0 5% 20X40
R413	0662057M01	RES. CHIP 0 5% 20X40
R414	0662057M98	RES. CHIP 10K 5% 20X40
R415	0662057M01	RES. CHIP 0 5% 20X40
R416	0662057M01	RES. CHIP 0 5% 20X40
R417	0662057M01	RES. CHIP 0 5% 20X40
R418	0662057M01	RES. CHIP 0 5% 20X40
R427	NOTPLACED	
R428	0662057M64	RES. CHIP 390 5% 20X40
R429	0662057M64	RES. CHIP 390 5% 20X40
R430	0662057M64	RES. CHIP 390 5% 20X40
R431	0662057M64	RES. CHIP 390 5% 20X40

Ref. Des.	Part Number	Description
R432	0662057M64	RES. CHIP 390 5% 20X40
R433	0662057M64	RES. CHIP 390 5% 20X40
R434	0662057M64	RES. CHIP 390 5% 20X40
R435	0662057M64	RES. CHIP 390 5% 20X40
R450	0662057N15	RES. CHIP 47K 5% 20X40
R451	0662057M78	RES. CHIP 1500 5% 20X40
R452	0662057M42	RES. CHIP 47 5% 20X40
R453	0662057N11	RES. CHIP 33K 5% 20X40
R454	0662057M64	RES. CHIP 390 5% 20X40
R455	0662057M74	RES. CHIP 1000 5% 20X40
R456	NOTPLACED	
R457	NOTPLACED	
R458	0662057M98	RES. CHIP 10K 5% 20X40
R459	0662057M01	RES. CHIP 0 5% 20X40
R460	0662057M50	RES. CHIP 100 5% 20X40
R501	0662057M01	RES. CHIP 0 5% 20X40
R502	0662057M01	RES. CHIP 0 5% 20X40
R503	0662057M01	RES. CHIP 0 5% 20X40
R504	0662057N06	RES. CHIP 20K 5% 20X40
R505	0662057M98	RES. CHIP 10K 5% 20X40
R510	0662057M98	RES. CHIP 10K 5% 20X40
R511	NOTPLACED	
R514	0662057M98	RES. CHIP 10K 5% 20X40
R515	NOTPLACED	
R516	0662057M67	RES. CHIP 510 5% 20X40
R519	0662057M98	RES. CHIP 10K 5% 20X40
R520	0662057M98	RES. CHIP 10K 5% 20X40
R522	0662057N15	RES. CHIP 47K 5% 20X40
R523	0662057N15	RES. CHIP 47K 5% 20X40
R524	0662057N15	RES. CHIP 47K 5% 20X40
R525	0662057N15	RES. CHIP 47K 5% 20X40
R526	0662057N15	RES. CHIP 47K 5% 20X40
R527	0662057M74	RES. CHIP 1000 5% 20X40
R528	0662057M74	RES. CHIP 1000 5% 20X40
R531	0662057M64	RES. CHIP 390 5% 20X40
R533	0662057M82	RES. CHIP 2200 5% 20X40
R536	0662057N23	RES. CHIP 100K 5% 20X40
R537	0662057N17	RES. CHIP 56K 5% 20X40
R538	0662057M01	RES. CHIP 0 5% 20X40

Ref. Des.	Part Number	Description
R539	0662057M01	RES. CHIP 0 5% 20X40
R540	0662057M95	RES. CHIP 7500 5% 20X40
R545	0662057M98	RES. CHIP 10K 5% 20X40
R548	0662057N06	RES. CHIP 20K 5% 20X40
R549	0662057M98	RES. CHIP 10K 5% 20X40
R550	0662057N17	RES. CHIP 56K 5% 20X40
R551	0662057N06	RES. CHIP 20K 5% 20X40
R553	0662057M98	RES. CHIP 10K 5% 20X40
R554	0662057N17	RES. CHIP 56K 5% 20X40
R555	0662057M74	RES. CHIP 1000 5% 20X40
R556	0662057N06	RES. CHIP 20K 5% 20X40
R557	0662057M98	RES. CHIP 10K 5% 20X40
R558	0662057M94	RES. CHIP 6800 5% 20X40
R559	0662057M98	RES. CHIP 10K 5% 20X40
R560	0662057M01	RES. CHIP 0 5% 20X40
R561	0662057M74	RES. CHIP 1000 5% 20X40
R563	0662057M64	RES. CHIP 390 5% 20X40
R564	0662057M98	RES. CHIP 10K 5% 20X40
R565	0662057M82	RES. CHIP 2200 5% 20X40
R566	0662057M95	RES. CHIP 7500 5% 20X40
R567	0662057N15	RES. CHIP 47K 5% 20X40
R568	0662057N15	RES. CHIP 47K 5% 20X40
R569	0662057M90	RES. CHIP 4700 5% 20X40
R572	0662057M50	RES. CHIP 100 5% 20X40
R573	0662057N23	RES. CHIP 100K 5% 20X40
R574	0662057N23	RES. CHIP 100K 5% 20X40
R575	0662057M98	RES. CHIP 10K 5% 20X40
R576	0662057N23	RES. CHIP 100K 5% 20X40
R577	0662057N15	RES. CHIP 47K 5% 20X40
R578	0662057N15	RES. CHIP 47K 5% 20X40
R579	NOTPLACED	
R580	NOTPLACED	
R581	0662057M01	RES. CHIP 0 5% 20X40
R582	0662057M90	RES. CHIP 4700 5% 20X40
R583	0662057M90	RES. CHIP 4700 5% 20X40
R584	0662057M98	RES. CHIP 10K 5% 20X40
R585	0662057M98	RES. CHIP 10K 5% 20X40
R586	0662057N39	RES. CHIP 470K 5% 20X40
R587	0662057M34	RES. CHIP 22 5% 20X40

Ref. Des.	Part Number	Description
R588	0662057M34	RES. CHIP 22 5% 20X40
R589	0662057M98	RES. CHIP 10K 5% 20X40
RESET_OUT	NOTPLACED	
S101	NOTPLACED	
SCKA	NOTPLACED	
SCKB	NOTPLACED	
TCK	NOTPLACED	
TDI	NOTPLACED	
TDO	NOTPLACED	
TMS	NOTPLACED	
TP201	NOTPLACED	
TP202	NOTPLACED	
TP206	NOTPLACED	
TP207	NOTPLACED	
TP208	NOTPLACED	
TP209	NOTPLACED	
TP210	NOTPLACED	
TP211	NOTPLACED	
TP212	NOTPLACED	
TP213	NOTPLACED	
TP214	NOTPLACED	
TP215	NOTPLACED	
TRST	NOTPLACED	
U201	5109731C15	IC OP AMP SNGL OPA237 SOT23
U202	5109731C15	IC OP AMP SNGL OPA237 SOT23
U301	5185353D57	IC FILLPER WITH IMPROVED ESD
U302	5105492X92	IC CMOS BILATERAL SWITCH
U303	5109522E53	IC SNGL BUF NC7S125P5X SC70
U401	5109841C69	IC 256 BGA 17X17 PACKAGE PATRIOT
U402	5199485A01	IC FLASH 8MBYTE BURST BGA
U403	5185368C82	"IC 1.65 TO 2.2V, 70NS, 8MBIT SRAM"
U404	5109522E53	IC SNGL BUF NC7S125P5X SC70

Ref. Des.	Part Number	Description
U405	5109522E53	IC SNGL BUF NC7S125P5X SC70
U406	5105492X03	IC SNG HI SPD L-MOS NOT GATE
U501	5109879E58	IC 4.3 GCAPII SN104616DGGMR BG
U502	5109731C15	IC OP AMP SNGL OPA237 SOT23
U503	5102463J44	IC AUDIO PA (PHILIPS_20PIN)
U504	5109731C15	IC OP AMP SNGL OPA237 SOT23
U505	5185353D13	IC MINI SO-8 HI PRECISION REG 5V
U507	5109731C15	IC OP AMP SNGL OPA237 SOT23
U509	5185353D35	IC DUAL EEPOT 256 TAP
U510	5105492X92	IC CMOS BILATERAL SWITCH
U511	5185353D56	IC 3.3V LINEAR REGULATOR MC78LC 33NTR
VR201	4813832C72	TRANS SUP QUAD 12V
VR202	4813830A22	DIODE 9.1V 5% 225MW MMBZ5239B_
VR203	4813832C72	TRANS SUP QUAD 12V
VR204	4813830C26	DIODE 13V 'H3' MMSZ5243BT1
VR205	4805656W08	DIODE ZENER QUAD
VR206	4805656W08	DIODE ZENER QUAD
VR209	4813832C72	TRANS SUP QUAD 12V
VR220	4805656W03	DIODE DUAL 5.6V ZENER
VR221	4805656W03	DIODE DUAL 5.6V ZENER
VR501	4813830A15	DIODE 5.6V 5% 225MW MMBZ5232B_
W203	4805723X03	TRANS DUAL NPN-PNP UMD3N ROHM
WAIT	NOTPLACED	
Y301	4809995L05	XTAL QUARTZ 32.768 kHz CC4V-T1
	1105033S13	RIBBON LBL
	5405569Y01	LBL BARCODE APC
	5405569Y03	LABEL BARCODE
	6003710K08	BATT COIN 3.3V LIION

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Appendix A Replacement Parts Ordering

Basic Ordering Information

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

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

Transceiver Board And Vocon Board Ordering Information

When ordering a replacement Transceiver Board or VOCON Board, refer to the applicable Model Chart in the front of this manual, read the Transceiver Board or VOCON Board note, and include the proper information with your order.

Mail Orders

Send written orders to the following addresses:

**Replacement Parts/
Test Equipment/Manuals/
Crystal Service Items:**

Motorola Inc.
United States and Canada
Accessories and Aftermarket
Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Federal Government Orders:

Motorola Inc.
United States and Canada
Accessories and Aftermarket
Division
Attention: Order Processing
7230 Parkway Drive
Landover, MD 21076

International Orders:

Motorola Inc.
United States and Canada
Accessories and Aftermarket
Division
Attention: International Order
Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Telephone Orders

United States and Canada
Accessories and Aftermarket Division:
1-800-422-4210
1-800-826-1913 (Federal Government Orders)
1-847-538-8023 (International Orders)

Service Training (VHS Video Tapes):
847-783-2522
847-783-2523 (FAX)

Fax Orders

United States and Canada
Accessories and Aftermarket Division:
847-538-8198 (Domestic)
847-576-3023 (International)

Parts Identification:
847-538-8194

Federal Government Orders:
410-712-4991(Domestic)
410-712-6200 (International)

Parts Customer Service

United States and Canada
Accessories and Aftermarket Division:
1-800-422-4210

Parts Identification:
847-538-0021

Product Customer Service

Customer Response Center
(Sales and Service Assistance):
1-800-247-2346
FAX:1-800-232-9272

Glossary

Term	Definition
A/D	Analog-to-Digital conversion. Conversion of an instantaneous dc voltage level to a corresponding digital value. <i>See also D/A.</i>
ABACUS IC	Custom integrated circuit providing a digital receiver intermediate frequency (IF) backend.
ADC	Analog-to-Digital Converter. A device that converts analog signals into digital data. <i>See also DAC.</i>
ALC	Automatic Level Control. A circuit in the transmit RF path that controls RF power amplifier output, provides leveling over frequency and voltage, and protects against high VSWR.
BBP	Baseband Interface Port. SSI (synchronous serial interface) to the transceiver board used to transfer transmit and receive audio data.
BGA	Ball Grid Array. A type of IC package characterized by solder balls arranged in a grid that are located on the underside of the package.
CODEC	COder/DECoder. A device that encodes or decodes a signal.
CPS	Customer Programming Software. Software with a graphical user interface containing the feature set of an ASTRO radio.
D/A	Digital-to-Analog conversion. Conversion of a digital signal to a voltage that is proportional to the input value. <i>See also A/D.</i>
DAC	Digital-to-Analog Converter. A device that converts digital data into analog signals. <i>See also ADC.</i>
DTMF	Dual Tone Multi-Frequency.
DPL	Digital Private-Line. A type of digital communications that utilizes privacy call, as well as memory channel and busy channel lock out to enhance communication efficiency.
DSP	Digital Signal Processor. A microcontroller specifically tailored for signal processing computations.
DSP Code	Digital Signal Processor Code. Object code executed by the Digital Signal Processor in an ASTRO subscriber radio. The DSP is responsible for computation-intensive tasks, such as decoding ASTRO signaling.
EEPOT	Electrically Programmable Digital Potentiometer.

Term	Definition
Firmware	Code executed by an embedded processor such as the Host or DSP in a subscriber radio. This type of code is typically resident in non-volatile memory and as such is more difficult to change than code executed from RAM.
FGU	F requency G eneration U nit. This unit generates ultra-stable, low-phase noise master clock and other derived synchronization clocks that are distributed throughout the communication network.
Flash	A non-volatile memory device similar to an EEPROM.
FLASHcode	A 13-digit code which uniquely identifies the System Software Package and Software Revenue Options that are enabled in a particular subscriber radio. FLASHcodes are only applicable for radios which are upgradeable through the FLASHport process.
FLASHport	A Motorola term that describes the ability of a radio to change memory. Every FLASHport radio contains a FLASHport EEPROM memory chip that can be software written and rewritten to, again and again.
Flipper IC	A custom integrated circuit providing interface support for the Patriot and GCAP II ICs.
FracN	A Motorola-proprietary, CMOS fractional-N frequency synthesizer with built-in dual-port modulation.
GCAP	G lobal C ontrol A udio and P ower.
GPIO	G eneral- P urpose I nterface O utput. Pins whose function is programmable.
Host Code	Object code executed by the Host Processor in an ASTRO subscriber radio. The Host is responsible for control-oriented tasks such as decoding and responding to user inputs.
IC	I ntegrated C ircuit. An assembly of interconnected components on a small semiconductor chip, usually made of silicon. One chip can contain millions of microscopic components and perform many functions.
IMBE	A sub-band, voice encoding algorithm used in ASTRO digital voice.
ISW	I nbound S ignaling W ord. Data transmitted on the control channel from a subscriber unit to the central control unit.
LSH	L ow S peed H andshake. 150-baud digital data sent to the radio during trunked operation while receiving audio.
MCU	M icro c ontroller U nit. Also written as μ C. A microprocessor that contains RAM and ROM components, as well as communications and programming peripherals.
MDC	M otorola D igital C ommunications.
MDI	M CU/ D S P Interface internal to the Patriot IC.

Term	Definition
MISO	Master In Slave Out. SPI data line from a peripheral to the MCU.
MOSI	Master Out Slave In. SPI data line from the MCU to a peripheral.
OMPAC	Over-Molded Pad-Array Carrier. A Motorola custom IC package, distinguished by the presence of solder balls on the bottom pads.
Open Architecture	A controller configuration that utilizes a microprocessor with extended ROM, RAM, and EEPROM.
OSW	Outbound Signaling Word. Data transmitted on the control channel from the central controller to the subscriber unit.
Patriot IC	A dual-core processor that contains an MCU and a DSP in one IC package.
PC Board	Printed Circuit board. Also referred to as PCB .
PCIC	Power Control Integrated Circuit. The power control IC is intended for closed-loop bias control of power amplifiers. The device facilitates accurate control of the current delivered to the power amplifier (PA) via a control voltage.
PL	Private Line tone squelch. A continuous sub-audible tone that is transmitted along with the carrier.
PLL	Phase-Locked Loop. A circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.
PTT	Push-To-Talk. The switch located on the left side of the radio which, when pressed, causes the radio to transmit.
Registers	Short-term data-storage circuits within the microcontroller unit or programmable logic IC.
Repeater	Remote transmit/receive facility that re-transmits received signals in order to improve communications coverage.
RESET	Reset line. An input to the microcontroller that restarts execution.
RF PA	Radio Frequency Power Amplifier. Amplifier having one or more active devices to amplify radio signals.
RSS	Radio Service Software. DOS-based software containing the feature set of an ASTRO radio.
RPT/TA	RePeaTer/Talk-Around.
RTC	Real-Time Clock. The GCAP II IC module that keeps track of elapsed time.
RX DATA	Recovered digital data line.

Term	Definition
SAP	Serial Audio CODEC Port. SSI to and from the GCAP II IC CODEC used to transfer transmit and receive audio data.
Signal Qualifier Mode	An operating mode in which the radio is muted, but still continues to analyze receive data to determine RX signal type.
Softpot	Software potentiometer. A computer-adjustable electronic attenuator.
Software	Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system.
SPI	Serial Peripheral Interface. How the microcontroller communicates to modules and ICs through the CLOCK and DATA lines.
Squelch	Muting of audio circuits when received signal levels fall below a pre-determined value.
SRAM	Static-RAM chip used for volatile, program/data memory.
SSI	Synchronous Serial Interface. DSP interface to peripherals, which consists of a clock signal line, a frame synchronization signal line, and a data line.
Standby Mode	An operating mode whereby the radio is muted but still continues to monitor data.
System Central Controllers	Main control unit of the trunked dispatch system; handles ISW and OSW messages to and from subscriber units (see ISW and OSW).
System Select	The act of selecting the desired operating system with the system-select switch (also, the name given to this switch).
TOT	Time-Out Timer. A timer that limits the length of a transmission.
TSOP	Thin Small-Outline Package. A type of dynamic random-access memory (DRAM) package that is commonly used in memory applications.
UART	Universal Asynchronous Receiver Transmitter. A microchip with programming that controls a computer's interface to its attached serial devices.
USB	Universal Serial Bus.
VCO	Voltage-Controlled Oscillator. An oscillator in which the frequency of oscillation can be varied by changing a control voltage.
VCOB IC	Voltage-Controlled Oscillator Buffer IC.
Vocoder	VOice enCODER. The DSP-based system for digitally processing the analog signals, and includes the capabilities of performing voice compression algorithms or voice encoding.

Term	Definition
VSELP	V ector S um E xcited L inear P redictive coding. A voice-encoding technique used in ASTRO digital voice.
VSWR	V oltage S tanding W ave R atio. The ratio of the maximum voltage to the minimum voltage on a transmission line. An indicator of how well an RF device's input or output impedance matches the nominal impedance of the system.

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