Chapter 4 Troubleshooting Procedures

4.1 Introduction

This section will aid you in troubleshooting a malfunctioning XTL 5000 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 troubleshoot or disassemble a board without first referring to the following Handling Precautions section.

4.2 Handling Precautions

Complementary metal-oxide semiconductor (CMOS) devices and other high-technology devices, are used in the XTL 5000 radio. 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.
6. Always wear a conductive wrist strap when servicing this equipment. The Motorola part number for a replacement wrist strap that connects to the table mat is 42-80385A59.

4.2.1 Parts Replacement and Substitution

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

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

4.2.2 Rigid Circuit Boards

The XTL 5000 radio uses bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, special considerations are required when soldering and unsoldering components. The printed-through holes might interconnect multiple layers of the printed circuit. Therefore, care should be exercised to avoid pulling the plated circuit out of the hole.

When soldering near module socket pins, be careful to avoid accidentally getting solder in the socket. Also, be careful not to form solder bridges between module socket pins. Closely examine your work for shorts caused by solder bridges. When removing modules with metal enclosures, be sure to unsolder the enclosure ground tabs as well as the module parts.

4.2.3 Heat-Related Precautions

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

- Using upper heat only
- Using the correct size of heat-focus head, which should be approximately the same size as the carrier being replaced
- Keeping the heat-focus head approximately 1/8 in. (3-6 mm) above the printed circuit board when removing or replacing the device

Caution

Moisture-sensitive devices (MSD) are subject to die-bond (or other interface) delamination if heated above 185°C. To ensure that delamination does not occur, the PCB should be baked for eight hours at 125°C prior to repair if an adjacent MSD could potentially be exposed to 185°C or greater temperature during repair. Use 0.250 in. as the determining distance between the component being repaired and the MSD.

4.2.4 Daughtercard Module

The daughtercard module can be removed by desoldering. However, this only should be done as a last resort since the module cannot be reliably reattached to the main board, except with a new module, and contains extremely small parts that can be easily lost. Therefore, it is recommended that when troubleshooting an XTL 5000 radio, avoid removing and replacing large sections for an expected quick fix.

4.2.4.1 SRAM

Each of the daughtercard module's three sections are attached to the module using BGA (Ball Grid Array) solder-attachment technology, and once removed, cannot be reliably reattached. Also, because of the dense grouping of the solder balls, heating of the part and doing a slight tap to fix presumed cold-solder joints usually only results in smearing the solder and shorting the solder balls.

4.2.4.2 Testing

The daughtercard module is tested prior to placement on the main board. However, this is done with proprietary software that is not available outside Motorola. Also, because of the high density of the solder balls, the pins of the three ICs are not exposed to the outside world for test probing.

4.3 Voltage Measurement and Signal Tracing

In most situations, the problem circuit may be identified using a DC voltmeter, RF millivoltmeter, and oscilloscope (preferably with 100 MHz bandwidth or more). The “Recommended Test Equipment, Service Aids, and Tools” section in the *ASTRO Digital XTL 5000 VHF/UHF Range 1/UHF Range 2/ 700–800 MHz Mobile Radio Basic Service Manual* (6881096C73) outlines the recommended tools and service aids which would be useful. Of special note are:

- 30-80370E06 Extender Cable which provides an extension cable for VOCON board connector J501 and command board connector P501
- RPX-4725C Command and Control Service Cable Kit which provides extension cables for servicing digital and analog circuits
- RPX-4724B RF Service Cable Kit which provides interface cables needed to service the RF boards

In some cases DC voltages at probe points are shown in red on the schematics. In other areas diagrams are included to show time-varying signals, which should be present under the indicated circumstances. It is recommended that a thorough check be made prior to replacement of any IC or part. If the probe point does not have a signal reasonably close to the indicated one, a check of the surrounding components should be made prior to replacing any parts.

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.

4.4 Power-Up Self-Check Errors

When the radio is turned on (power-up), the radio performs cursory tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio’s display. The presence of an error should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors inhibit user operation; non-fatal errors do not. Table 4-1 will aid in understanding particular power-up error code displays.

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

Error Code	Description	Error Type	Corrective Action
ERROR 01/02	FLASH ROM Codeplug Checksum	NON-FATAL	Re-flash the entire codeplug.
ERROR 01/12	Security Partition Checksum	NON-FATAL	Re-flash the codeplug sections.
ERROR 01/20	ABACUS Tune Failure	NON_FATAL	• Turn the radio off, then on. • Re-flash tuning (codeplug). • Replace ABACUS IC / resolder.
ERROR 01/22	Tuning Codeplug Checksum	NON-FATAL	• Re-flash tuning (codeplug). • Retune the radio using CPS.
FAIL 01/81	FLASH ROM Checksum	FATAL	Re-flash the firmware.
FAIL 01/82	FLASH ROM Codeplug Checksum	FATAL	Re-flash the codeplug or firmware.

Table 4-1. Power-Up Self-Check Error Codes (Continued)

Error Code	Description	Error Type	Corrective Action
FAIL 01/88	External RAM Error	FATAL	• Turn the radio off, then on. • Hard bootstrap and flash the firmware. • Replace the daughtercard.
FAIL 01/90	General Hardware	FATAL	• Turn the radio off, then on. • Replace the control head or flex.
FAIL 01/92	Security Partition Checksum	FATAL	Re-flash the codeplug sections.
FAIL 01/93	FlashPORT AUTHENT CODE Failure	FATAL	Re-flash the appropriate base codeplug to match the radio feature set.
FAIL 01/98	Internal RAM Failure	FATAL	• Turn the radio off, then on. • Hard bootstrap and flash the firmware. • Replace the daughtercard.
FAIL 01/AO	ABACUS IC Failure/Wrong ABACUS IC Version	FATAL	• Re-flash tuning (codeplug). • Retune the radio using CPS.
FAIL 01/A2	Tuning Codeplug Checksum	FATAL	• Re-flash tuning (codeplug). • Retune the radio using CPS.
FAIL 02/81	DSP ROM Checksum	FATAL	• Turn the radio off, then on. • Re-flash the DSP firmware (DSP is processor-dependent).
FAIL 02/88	DSP RAM Error	FATAL	• Turn the radio off, then on. • Re-flash the DSP firmware (DSP is processor-dependent).
FAIL 02/90	General DSP Hardware Failure	FATAL	• Turn the radio off, then on. • Re-flash the DSP firmware (DSP is processor-dependent). • Replace daughtercard.
FAIL 02/CO	Wrong Microprocessor Version	FATAL	• Re-flash the firmware. • Hard bootstrap and flash the firmware. • Replace the daughtercard.
ERROR 05/10	Control Head Hardware Error	NON-FATAL	• Turn the radio off, then on. • Replace the control head or flex.
FAIL 05/81	Control Head ROM Checksum Error	FATAL	Replace the control head.
ERROR 06/10	Aux Control Head Hardware Error	NON-FATAL	• Turn the radio off, then on. • Replace the control head or flex.
FAIL 06/81	Aux Control Head ROM Checksum Error	FATAL	Replace the auxiliary control head.
ERROR 08/10	Siren Hardware Error	NON-FATAL	• Turn the radio off, then on. • Check the siren cable connection.
FAIL 08/81	Siren ROM Checksum Error	FATAL	Replace the siren.
ERROR 09/10	Secure Hardware Error	NON-FATAL	Replace the secure module.

Table 4-1. Power-Up Self-Check Error Codes (Continued)

Error Code	Description	Error Type	Corrective Action
FAIL 09/90	Secure Hardware Fatal Error	FATAL	Replace the secure module.
ERROR 12/10	VRS Hardware Error	NON-FATAL	• Turn the radio off, then on. • Check the VRS cable connection.
FAIL 12/81	VRS ROM Checksum Error	FATAL	Replace the VRS.
ERROR 1C/10	Tone Remote Control (TRC) Hardware Error	NON-FATAL	• Turn the radio off, then on. • Check the TRC cable connection.
FAIL 1C/81	TRC ROM Checksum Error	FATAL	Replace the TRC.
Note: • Firmware=Radio HOST and DSP software files • Codeplug=Radio configuration software files.			

4.5 Operational Error Codes

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

Table 4-2. Operational Error Codes

Error Code	Description	Error Type	Corrective Action
FAIL 001	Synthesizer Out of Lock/ Radio band mismatch	NON-FATAL	• Re-flash the tuning (codeplug) • Re-flash the entire codeplug. • Replace the daughtercard.
FAIL 002	Personality Checksum or System Block Error	NON-FATAL	Re-flash the entire codeplug.

4.6 VHF (136–174 MHz) Band Main Board Troubleshooting

This information will help you troubleshoot the RF section of the VHF (136–174 MHz) band XTL 5000 radio. Use this information, along with the theory of operation and troubleshooting charts, to diagnose and isolate the cause of failures.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at high frequencies, measurements must be taken very carefully. Notes and cautions are added to the text to alert you to this need in areas of greatest sensitivity. However, the need for extreme care does exist in all measurements and tests.

4.6.1 Display Flashes "FAIL 001"

This display indicates a synthesizer "out-of-lock" condition. The following information will help to trouble shoot the frequency generation unit to the component level. Perform the following checks to determine the mode of the Fail 001:

1. Determine if the "out-of-lock" condition occurs in either receive mode, transmit mode, or both. Also, check other frequencies programmed in the unit if available.

2. To determine if the "out-of-lock" is frequency or VCO dependant, place the unit into RF TEST Mode, as described in the *ASTRO Digital XTL 5000 VHF/UHF Range 1/UHF Range 2/700–800 MHz Mobile Radio Basic Service Manual* (6881096C73) and step through each test channel. Table 4-3 indicates the frequency and Aux logic level for each test mode channel. In addition, Table 4-4 provides information about the frequency of operation for each VCO.

Table 4-3. Test Mode Channels

Test MODE	LV Frac-N TX Logic	TX Freq MHz	LV Frac-N RX Logic	RX Freq MHz
CHAN 1	AUX 2	136.0125	AUX 3	245.7125
CHAN 2	AUX 2	140.7625	AUX 3	250.4625
CHAN 3	AUX 2	145.5125	AUX 3	255.2125
CHAN 4	AUX 2	150.2625	AUX 3	259.9625
CHAN 5	AUX 2	154.9875	AUX 3	264.5875
CHAN 6	AUX 1	155.0125	AUX 4	264.7125
CHAN 7	AUX 1	159.7625	AUX 4	269.4625
CHAN 8	AUX 1	164.5125	AUX 4	274.2125
CHAN 9	AUX 1	169.2625	AUX 4	278.9625
CHAN 10	AUX 1	173.9875	AUX 4	283.5875

Table 4-4. VCO Frequency and Switching Logic

MODE	Frequency (MHz)	AUX1	AUX2	AUX3	AUX4
RX	245.65–264.65	LOW	LOW	HIGH	LOW
RX	264.65–283.65	LOW	LOW	LOW	HIGH
TX	155–174	HIGH	LOW	LOW	LOW
TX	136–155	LOW	HIGH	LOW	LOW

3. Continue troubleshooting by using the Fail 001 troubleshooting chart in Chapter 5.

4.6.2 VCO Hybrid Assembly

The VCO hybrid substrate is glued to the carrier board. The hybrid is not a field-repairable assembly. If a failure is indicated in this assembly, replace the entire carrier board.

4.6.3 Out-of-Lock Condition

The probable cause of an out-of-lock condition is a failure in the synthesizer circuit. If the voltages on the AUX 1*, AUX 2*, AUX3*, and AUX4* lines do not conform to required output frequency in Table 4-5, troubleshoot the synthesizer.

If the AUX 1* to AUX 4* voltages are correct but the synthesizer feedback level is not within the range indicated, troubleshoot the feedback path.

If the AUX 1* to AUX 4* voltages are correct and the synthesizer feedback level is correct but an out-of-lock condition persists, troubleshoot the synthesizer.

Table 4-5. AUX Output Frequency Requirements

Frequency Range	AUX 1	AUX 2	AUX 3	AUX 4	Output Frequency
	HI	LOW	LOW	LOW	136–155 MHz
	LOW	HI	LOW	LOW	155–174 MHz
	LOW	LOW	HI	LOW	245.65–264.65 MHz
	LOW	LOW	LOW	HIGH	264.65–283.65 MHz

4.6.4 FGU Troubleshooting Aids

The following illustrations are additional service aids for troubleshooting the frequency generation unit.

- Figure 4-1 on page 4-8 is a block diagram of the DC distribution for the frequency generation unit.
- Figure 4-2 on page 4-9 is a block diagram of the frequency generation unit.
- Table 4-6 on page 4-9 describes the function of pins on the LV Frac-N IC U3751.
- Figure 4-3 on page 4-11 is a waveform representation during programming of the LV Frac-N IC U3751.

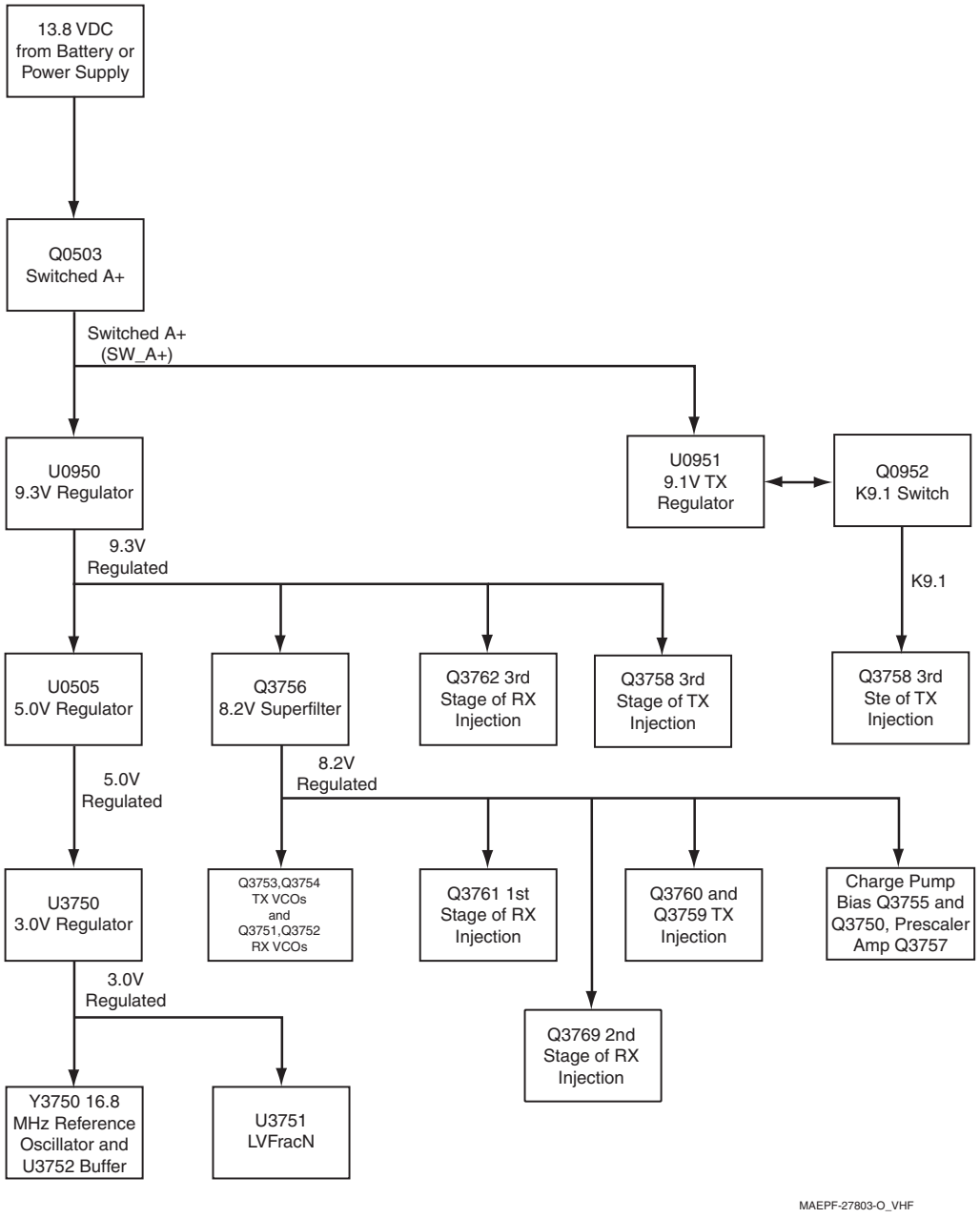


Figure 4-1. Frequency Generator Unit DC Power Supply Distribution (VHF)

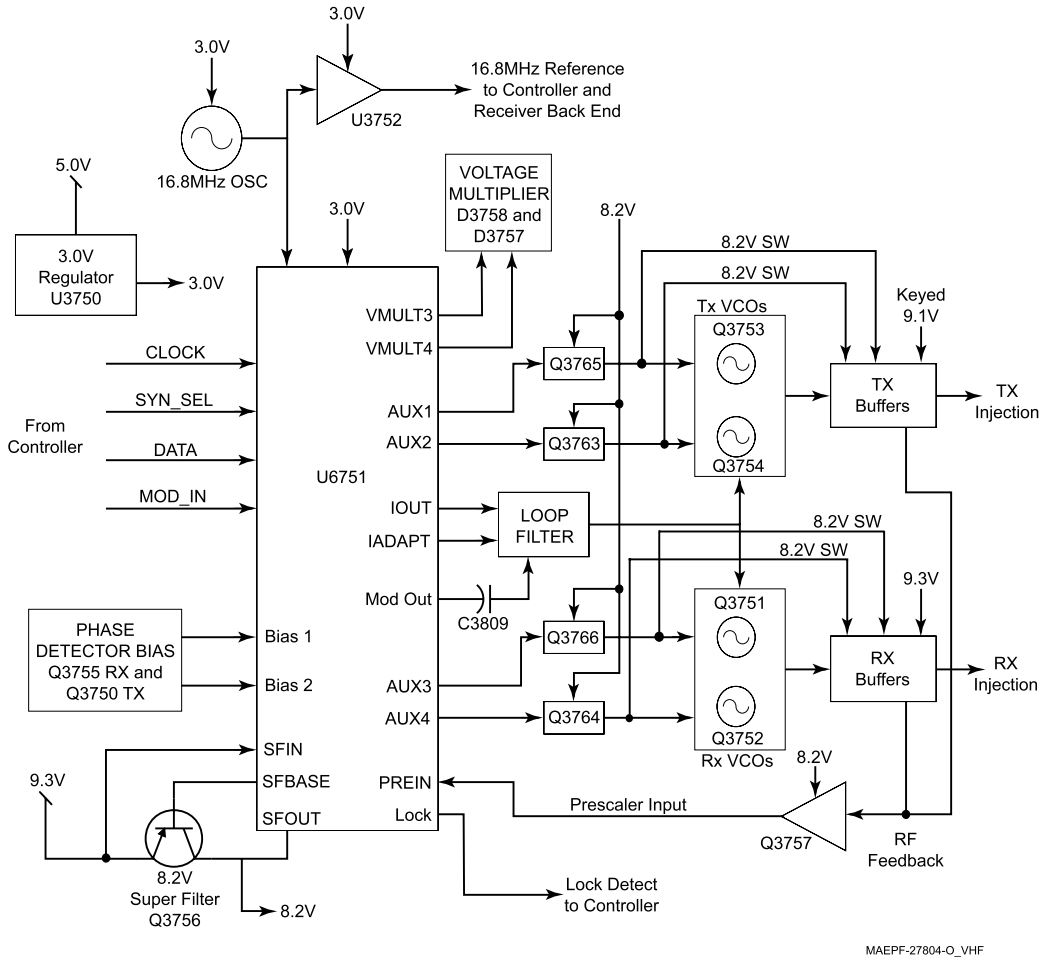


Figure 4-2. Frequency Generation Unit Block Diagram (VHF)

Table 4-6. LV Frac-N U3751 Pin Descriptions (VHF)

Pin No.	Pin Name	Description
1	AUX2	Auxiliary logic output, high selects Low TX VCO
2	AUX3	Auxiliary logic output, high selects Low RX VCO
3	AUX4	Auxiliary logic output, high selects High RX VCO
4	LOCK	Lock detect—logic high indicates in-lock condition
5	PD_VDD	3.0-V supply (phase detector)
6	GROUND	Ground (digital)
7	DATA	SPI data I/O
8	CLK	SPI clock
9	CEX	SPI enable line—active low
10	MODIN	Modulation input from controller
11	VMULT4	Multiplier clock output
12	VMULT3	Multiplier clock output

Table 4-6. LV Frac-N U3751 Pin Descriptions (VHF) (Continued)

Pin No.	Pin Name	Description
13	VRO	3.0-V supply for reference oscillator warp circuitry
14	VMULT2	Not used
15	VMULT1	Not used
16	INDMULT	Not used
17	—	No connection
18	REFSEL	Not used
19	FREFOUT	Not used
20	AVDD	3.0-V supply (analog)
21	VBPASS	Not used
22	GND	Ground (analog)
23	XTAL1	16.8 MHz reference oscillator input
24	XTAL2	Not used
25	WARP	Reference oscillator warp output
26	SFCAP	Superfilter bypass node
27	SFBASE	Superfilter control node for Q6759
28	SFOUT	Superfilter output
29	—	No connection
30	SFIN	Superfilter supply input
31	—	No connection
32	PREIN	Prescalar input
33	GROUND	Ground (prescalar)
34	PRE_VDD	3.0-V supply
35	PVREF	Not used
36	DVDD	3.0-V supply (digital)
37	TEST1	Not used
38	TEST2	Not used
39	CPB2	Phase detector bias input
40	CPB1	Phase detector bias input
41	MODOUT	Modulation output
42	CCOMP	Not used
43	IOUT	Phase detector normal mode output
44	GND	Ground (phase detector)
45	IADAPT	Phase detector adapt mode output
46	ADAPTSW	Phase detector adapt switch
47	VCP	High-voltage supply for phase detector
48	AUX1	Auxiliary logic output, high selects Low TX VCO

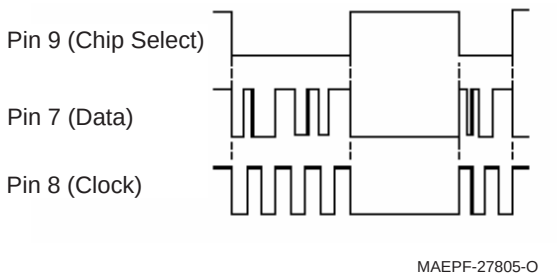


Figure 4-3. Waveform Representation During Programming of the LV Frac-N IC (U3751)

NOTE: The above waveforms are representations only.

4.6.5 No or Low Output Power (TX or RX Injection)

In addition to the schematic and theory of operation, refer to the transmitter injection troubleshooting flowchart and the receiver injection trouble shooting flowchart in Chapter 5. The charts will guide you through a sequence of tests and checks designed to isolate problems in the Transmitter or receiver injection strings.

4.6.6 No or Low Modulation

In addition to the schematic and theory of operation, refer to the transmitter no TX Audio troubleshooting flowchart in Chapter 5. The chart will guide you through a sequence of tests and checks designed to isolate problems in the Transmitter Audio section of the FGU.

4.6.7 Troubleshooting the Back-End

Refer to “5.6.4 RX Back-End—Poor SINAD or No Audio (136–174 MHz)—Part 1 of 3” on page 5-18.

4.7 UHF Range 1 (380–470 MHz) Band Main Board Troubleshooting

This information will help you troubleshoot the RF section of the UHF Range 1 (380–470 MHz) band XTL 5000 radio. Use this information, along with the theory of operation and troubleshooting charts, to diagnose and isolate the cause of failures.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at high frequencies, measurements must be taken very carefully. Notes and cautions are added to the text to alert you to this need in areas of greatest sensitivity. However, the need for extreme care does exist in all measurements and tests.

4.7.1 Display Flashes “FAIL 001”

This display indicates a synthesizer “out-of-lock” condition. The following information will help to trouble shoot the frequency generation unit to the component level. Perform the following checks to determine the mode of the Fail 001:

1. Determine if the “out-of-lock” condition occurs in either receive mode, transmit mode, or both. Also, check other frequencies programmed in the unit if available.
2. To determine if the “out-of-lock” is frequency or VCO dependant, place the unit into RF TEST Mode, as described in the *ASTRO Digital XTL 5000 VHF/UHF Range 1/UHF Range 2/700–800 MHz Mobile Radio Basic Service Manual* (6881096C73) and step through each test channel. Table 4-7 on page 4-12 indicates the frequency and Aux logic level for each test mode channel. In addition, Table 4-8 on page 4-12 provides information about the frequency of operation for each VCO.

Table 4-7. Test Mode Channels UHF Range 1 (AUX 4 is not used for VCO selection in UHF)

Test Mode	AUX (TX Logic)			TX VCO	TX Freq (MHz)	AUX (RX Logic)			RX VCO	RX Freq (MHz)	RX VCO Freq (MHz)
	1	2	3			1	2	3			
Chan 1	0	0	0	Q5825	380.0250	0	1	0	Q5901	380.0750	489.7250
Chan 2	0	0	0	Q5825	391.4750	0	1	0	Q5901	391.4250	501.0750
Chan 3	0	0	0	Q5825	408.9750	0	1	0	Q5901	408.9250	518.5750
Chan 4	0	0	0	Q5825	424.9375	1	1	0	Q5903	424.9875	534.6375
Chan 5	1	0	0	Q5826	425.0250	1	1	0	Q5903	425.0750	534.7250
Chan 6	1	0	0	Q5826	436.0250	1	1	0	Q5903	436.0750	545.7250
Chan 7	1	0	0	Q5826	455.8750	0	0	1	Q5905	455.8250	565.4750
Chan 8	1	0	0	Q5826	469.9375	0	0	1	Q5905	469.9875	579.5750

NOTE: The UHF band radios use high-side injection with an IF frequency of 109.65 MHz; therefore, the receive VCO frequencies are 109.65 MHz higher than the selected radio channel frequencies.

Table 4-8. VCO Frequency Calculation and Switching Logic (UHF Range 1)

VCO	AUX1	AUX2	AUX3	VCO Frequency
RX VCO Q5901	0	1	0	489.65 <= f < 519.65
RX VCO Q5903	1	1	0	519.65 <= f < 549.65
RX VCO Q5905	0	0	1	549.65 <= f < 579.65
TX VCO Q5825	0	0	0	380 <= f < 425
TX VCO Q5826	1	0	0	425 <= f <= 470

NOTE: If a failure is indicated in any of the VCOs, whose operation is defined in the table above, then the respective circuit should be checked to ensure proper bias is being applied to the transistor. Specifically, the transistor collector pin should be at 8.2 V and base-emitter voltage should be on the order of 0.8 V. The steering line voltage should be in the range of 2 V for the lower frequency end of operation, and on the order of 11V at the upper frequency end of operation. There could be typically +/- 1 V deviation from the above quoted numbers, which allow for tolerances in the components. A clean, steady, frequency spike should be observed on a spectrum analyzer of typically -18 dBm at the end of the resistive pad in the collector circuitry of a properly working VCO.

3. Continue troubleshooting by using the Fail 001 troubleshooting chart in Chapter 5.

4.7.2 FGU Troubleshooting Aids

The following illustrations are additional service aids for troubleshooting the frequency generation unit.

- Figure 4-4 is a block diagram of the DC distribution for the frequency generation unit.
- Figure 4-5 on page 4-14 is a block diagram of the frequency generation unit.
- Table 4-9 on page 4-14 describes the function of pins on the LV Frac-N IC U5752.
- Figure 4-6 on page 4-16 is a waveform representation during programming of the LV Frac-N IC U5752.

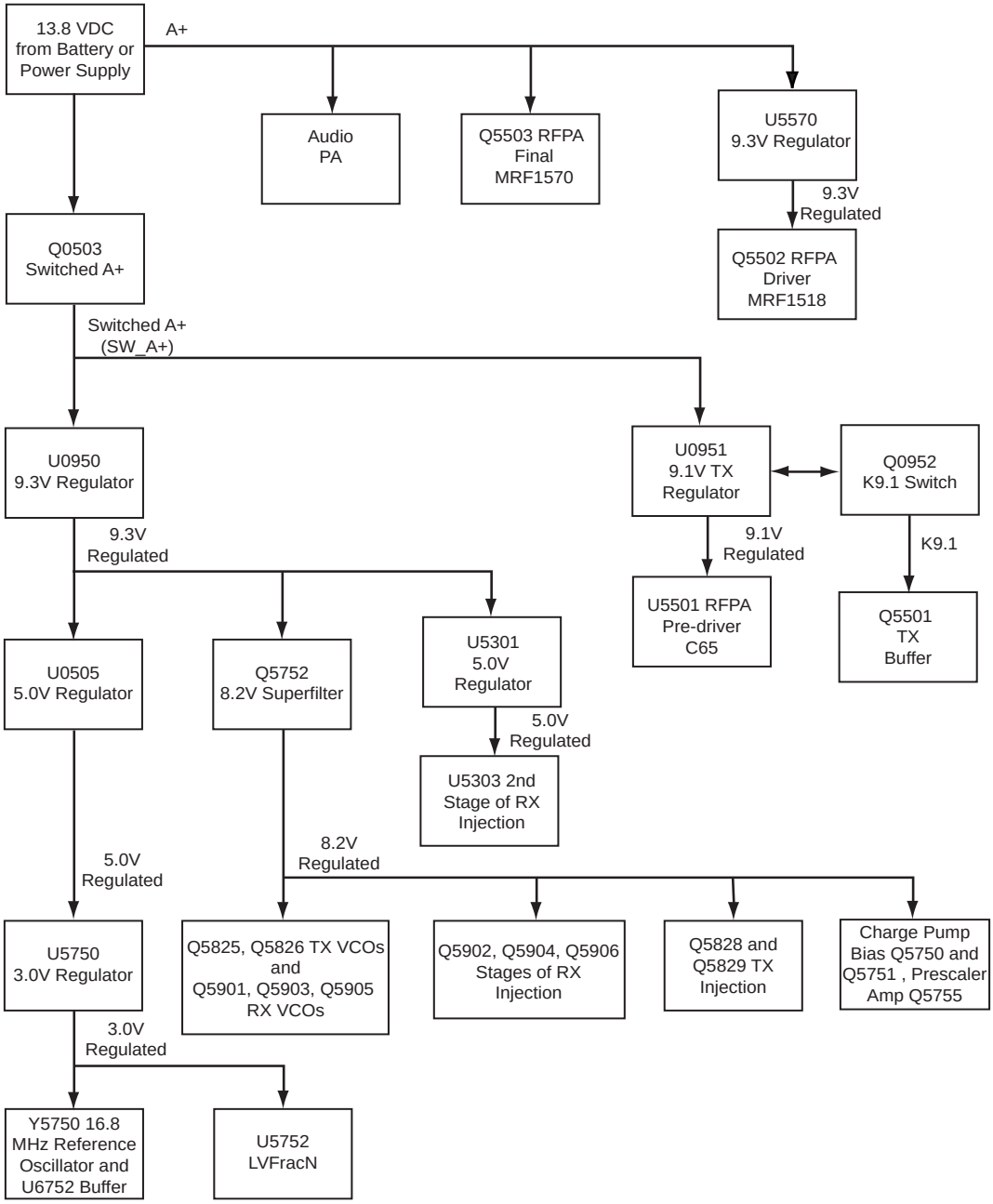


Figure 4-4. Frequency Generation Unit DC Power Supply Distribution (UHF Range 1)

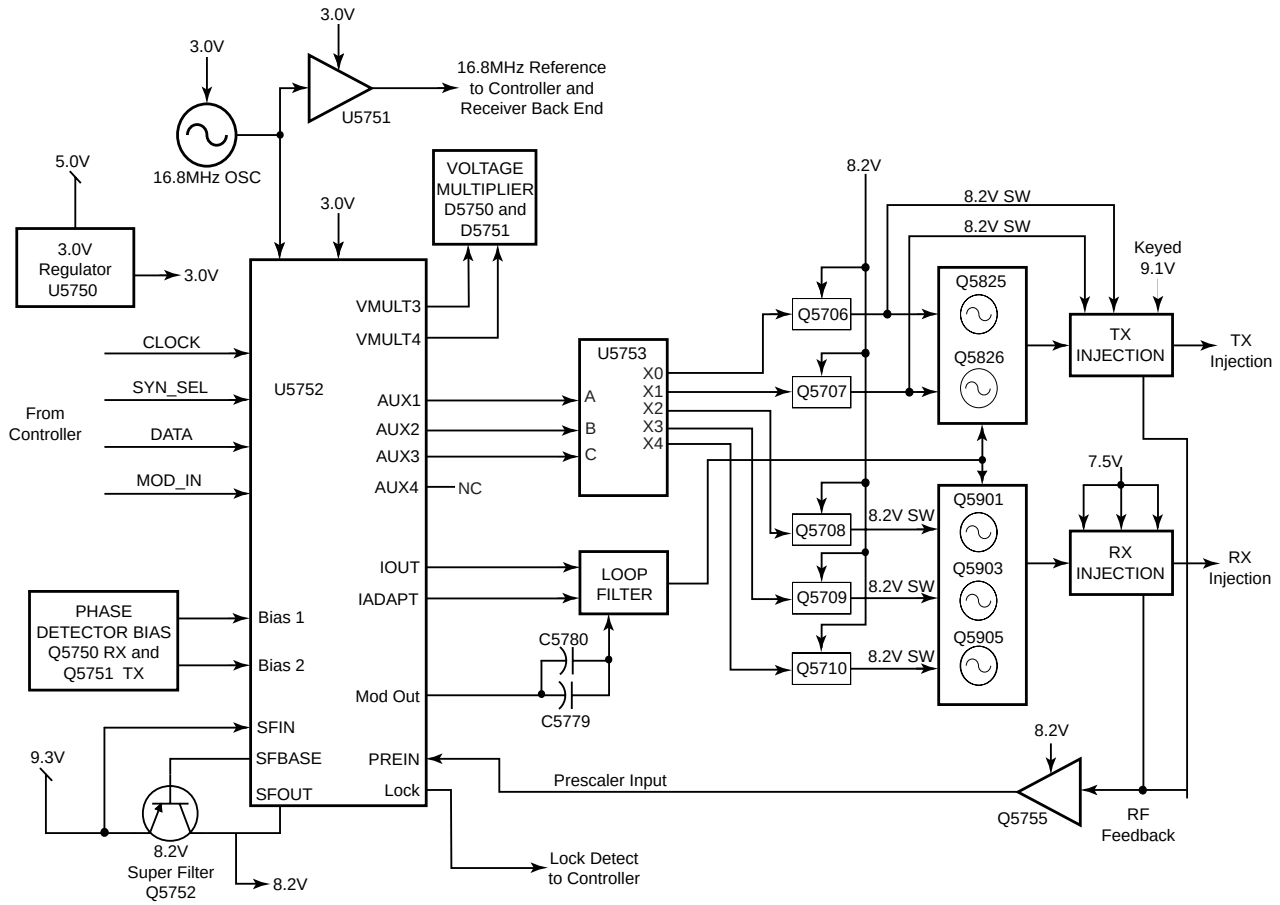


Figure 4-5. Frequency Generation Unit Block Diagram (UHF Range 1)

Table 4-9. LV Frac-N U6751 Pin Descriptions (UHF Range 1)

Pin No.	Pin Name	Description
1	AUX2	Auxiliary logic output
2	AUX3	Auxiliary logic output
3	AUX4	Auxiliary logic output
4	LOCK	Lock detect—logic high indicates in-lock condition
5	PD_VDD	3.0-V supply (phase detector)
6	GROUND	Ground (digital)
7	DATA	SPI data I/O
8	CLK	SPI clock
9	CEX	SPI enable line—active low
10	MODIN	Modulation input from controller
11	VMULT4	Multiplier clock output
12	VMULT3	Multiplier clock output
13	VRO	3.0-V supply for reference oscillator warp circuitry
14	VMULT2	Not used

Table 4-9. LV Frac-N U6751 Pin Descriptions (UHF Range 1) (Continued)

Pin No.	Pin Name	Description
15	VMULT1	Not used
16	INDMULT	Not used
17	—	No connection
18	REFSEL	Not used
19	FREFOUT	Not used
20	AVDD	3.0-V supply (analog)
21	VBPASS	Not used
22	GND	Ground (analog)
23	XTAL1	16.8 MHz reference oscillator input
24	XTAL2	Not used
25	WARP	Reference oscillator warp output
26	SFCAP	Superfilter bypass node
27	SFBASE	Superfilter control node for Q5752
28	SFOUT	Superfilter output
29	—	No connection
30	SFIN	Superfilter supply input
31	—	No connection
32	PREIN	Prescalar input
33	GROUND	Ground (prescalar)
34	PRE_VDD	3.0-V supply
35	PVREF	Not used
36	DVDD	3.0-V supply (digital)
37	TEST1	Not used
38	TEST2	Not used
39	CPB2	Phase detector bias input
40	CPB1	Phase detector bias input
41	MODOUT	Modulation output
42	CCOMP	Not used
43	IOUT	Phase detector normal mode output
44	GND	Ground (phase detector)
45	IADAPT	Phase detector adapt mode output
46	ADAPTSW	Phase detector adapt switch
47	VCP	High-voltage supply for phase detector
48	AUX1	Auxiliary logic output

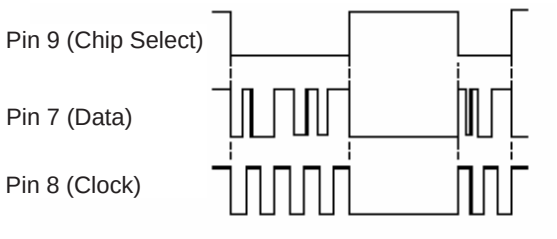


Figure 4-6. Waveform Representation During Programming of the LV Frac-N IC (U5752)

NOTE: The above waveforms are representations only.

4.7.3 Out-of-Lock Condition

The probable cause of an out-of-lock condition is a failure in the synthesizer circuit. If the voltages on the AUX lines do not conform to Table 4-8 on page 4-12, troubleshoot the synthesizer. If the AUX pins are correct, but the supply switch (Q5706, Q5707, Q5708, Q5709 or Q5710) to the in question VCO is not active with 8.2V at the VCO end, then troubleshoot the 3 to 8 multiplexer U5753 or the switch transistor packages.

If the AUX voltages are correct but the synthesizer feedback level is not within the range indicated at TP5783 (-6 to -11dBm), troubleshoot the buffer stages after the VCO. If the AUX voltages are correct and the synthesizer feedback level is correct but an out-of-lock condition persists, troubleshoot the synthesizer.

4.7.4 No or Low Output Power (TX or RX Injection)

In addition to the schematic and theory of operation, refer to the transmitter injection troubleshooting flowchart and the receiver injection trouble shooting flowchart in Chapter 5. The charts will guide you through a sequence of tests and checks designed to isolate problems in the Transmitter or receiver injection strings.

4.7.5 No or Low Modulation

In addition to the schematic and theory of operation, refer to the transmitter no TX Audio troubleshooting flowchart in Chapter 5. The chart will guide you through a sequence of tests and checks designed to isolate problems in the Transmitter Audio section of the FGU.

4.7.6 Troubleshooting the Back-End

Refer to “5.6.18 RX Back-End—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 1 of 3” on page 5-32.

4.8 UHF Range 2 (450–520 MHz) Band Main Board Troubleshooting

This information will help you troubleshoot the RF section of the UHF Range 2 (450–520 MHz) band XTL 5000 radio. Use this information, along with the theory of operation and troubleshooting charts, to diagnose and isolate the cause of failures.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at high frequencies, measurements must be taken very carefully. Notes and cautions are added to the text to alert you to this need in areas of greatest sensitivity. However, the need for extreme care does exist in all measurements and tests.

4.8.1 Display Flashes “FAIL 001”

This display indicates a synthesizer “out-of-lock” condition. The following information will help to trouble shoot the frequency generation unit to the component level. Perform the following checks to determine the mode of the Fail 001:

1. Determine if the “out-of-lock” condition occurs in either receive mode, transmit mode, or both. Also, check other frequencies programmed in the unit if available.
2. To determine if the “out-of-lock” is frequency or VCO dependant, place the unit into RF TEST Mode, as described in the *ASTRO Digital XTL 5000 VHF/UHF Range 1/UHF Range 2/700–800 MHz Mobile Radio Basic Service Manual* (6881096C73) and step through each test channel. Table 4-10 indicates the frequency and Aux logic level for each test mode channel. In addition, Table 4-11 on page 4-18 provides information about the frequency of operation for each VCO.

Table 4-10. Test Mode Channels UHF Range 2 (AUX 4 is not used for VCO selection in UHF)

Test Mode	AUX (TX Logic)			TX VCO	TX Freq (MHz)	AUX (RX Logic)			RX VCO	RX Freq (MHz)	RX VCO Freq (MHz)
	1	2	3			1	2	3			
Chan 1	1	0	0	Q5826	450.025	0	0	1	Q5905	450.075	559.725
Chan 2	1	0	0	Q5826	455.825	0	0	1	Q5905	455.625	565.275
Chan 3	1	0	0	Q5826	463.675	0	0	1	Q5905	463.625	573.275
Chan 4	1	0	0	Q5826	473.375	1	1	0	Q5903	473.325	582.975
Chan 5	1	0	0	Q5826	484.975	1	1	0	Q5903	484.925	594.575
Chan 6	0	0	0	Q5825	485.025	1	1	0	Q5903	485.075	594.725
Chan 7	0	0	0	Q5825	490.825	1	1	0	Q5903	490.875	600.525
Chan 8	0	0	0	Q5825	496.625	0	1	0	Q5901	496.675	606.325
Chan 9	0	0	0	Q5825	508.375	0	1	0	Q5901	508.325	617.975
Chan 10	0	0	0	Q5825	519.975	0	1	0	Q5901	519.925	629.575

NOTE: The UHF band radios use high-side injection with an IF frequency of 109.65 MHz; therefore, the receive VCO frequencies are 109.65 MHz higher than the selected radio channel frequencies.

Table 4-11. VCO Frequency Calculation and Switching Logic (UHF Range 2)

VCO	AUX1	AUX2	AUX3	VCO Frequency
RX VCO Q5905	0	0	1	559.65 <= f < 582.65
RX VCO Q5903	1	1	0	582.65 <= f < 605.65
RX VCO Q5901	0	1	0	605.65 <= f < 629.65
TX VCO Q5826	1	0	0	450 <= f < 485
TX VCO Q5825	0	0	0	485 <= f <= 520

NOTE: If a failure is indicated in any of the VCOs, whose operation is defined in the table above, then the respective circuit should be checked to ensure proper bias is being applied to the transistor. Specifically, the transistor collector pin should be at 8.2 V and base-emitter voltage should be on the order of 0.8 V. The steering line voltage should be in the range of 2 V for the lower frequency end of operation, and on the order of 11V at the upper frequency end of operation. There could be typically +/- 1 V deviation from the above quoted numbers, which allow for tolerances in the components. A clean, steady, frequency spike should be observed on a spectrum analyzer of typically -18 dBm at the end of the resistive pad in the collector circuitry of a properly working VCO.

3. Continue troubleshooting by using the Fail 001 troubleshooting chart in Chapter 5.

4.8.2 FGU Troubleshooting Aids

The following illustrations are additional service aids for troubleshooting the frequency generation unit.

- Figure 4-7 is a block diagram of the DC distribution for the frequency generation unit.
- Figure 4-8 on page 4-20 is a block diagram of the frequency generation unit.
- Table 4-12 on page 4-20 describes the function of pins on the LV Frac-N IC U5752.
- Figure 4-9 on page 4-22 is a waveform representation during programming of the LV Frac-N IC U5752.

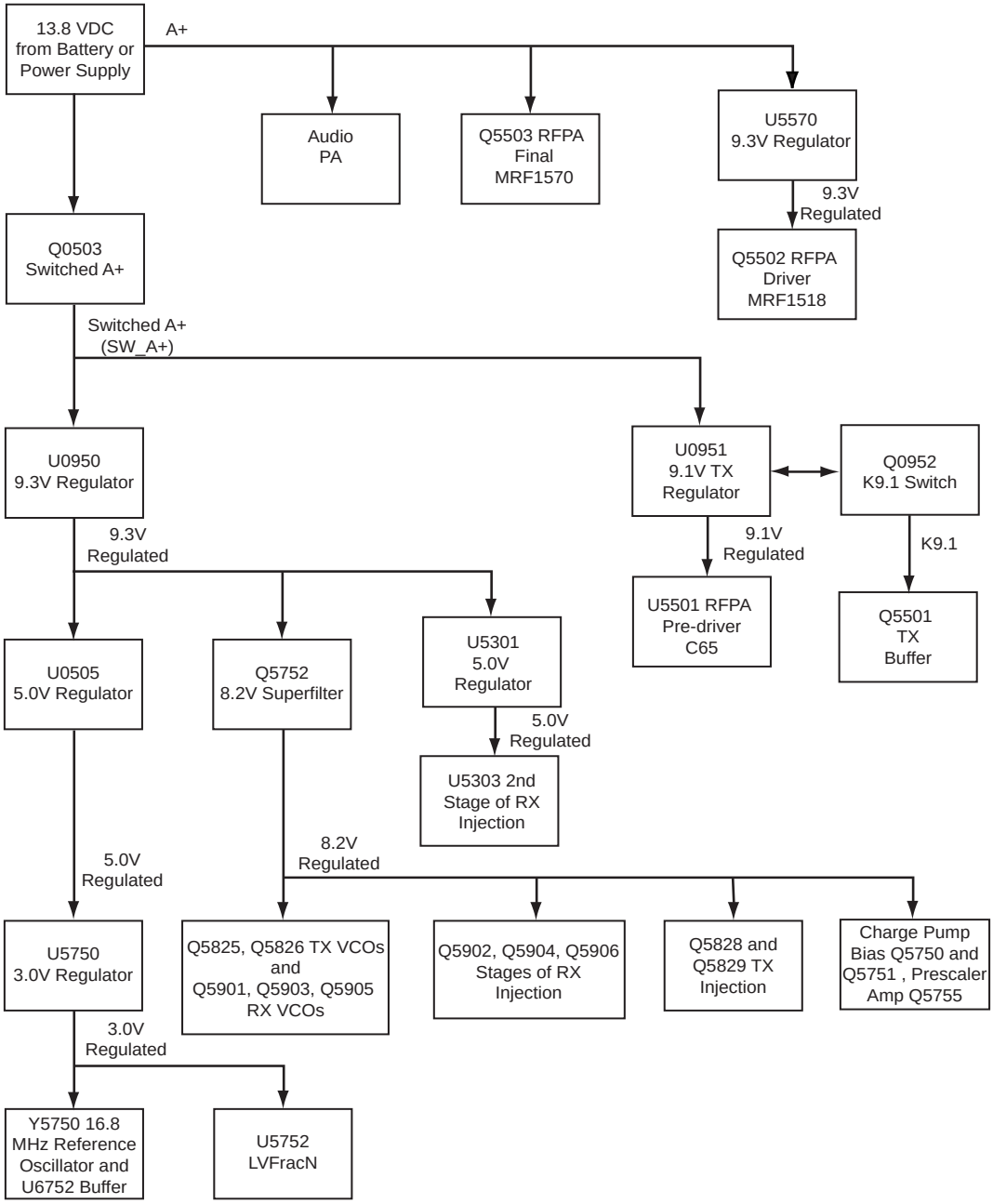


Figure 4-7. Frequency Generation Unit DC Power Supply Distribution (UHF Range 2)

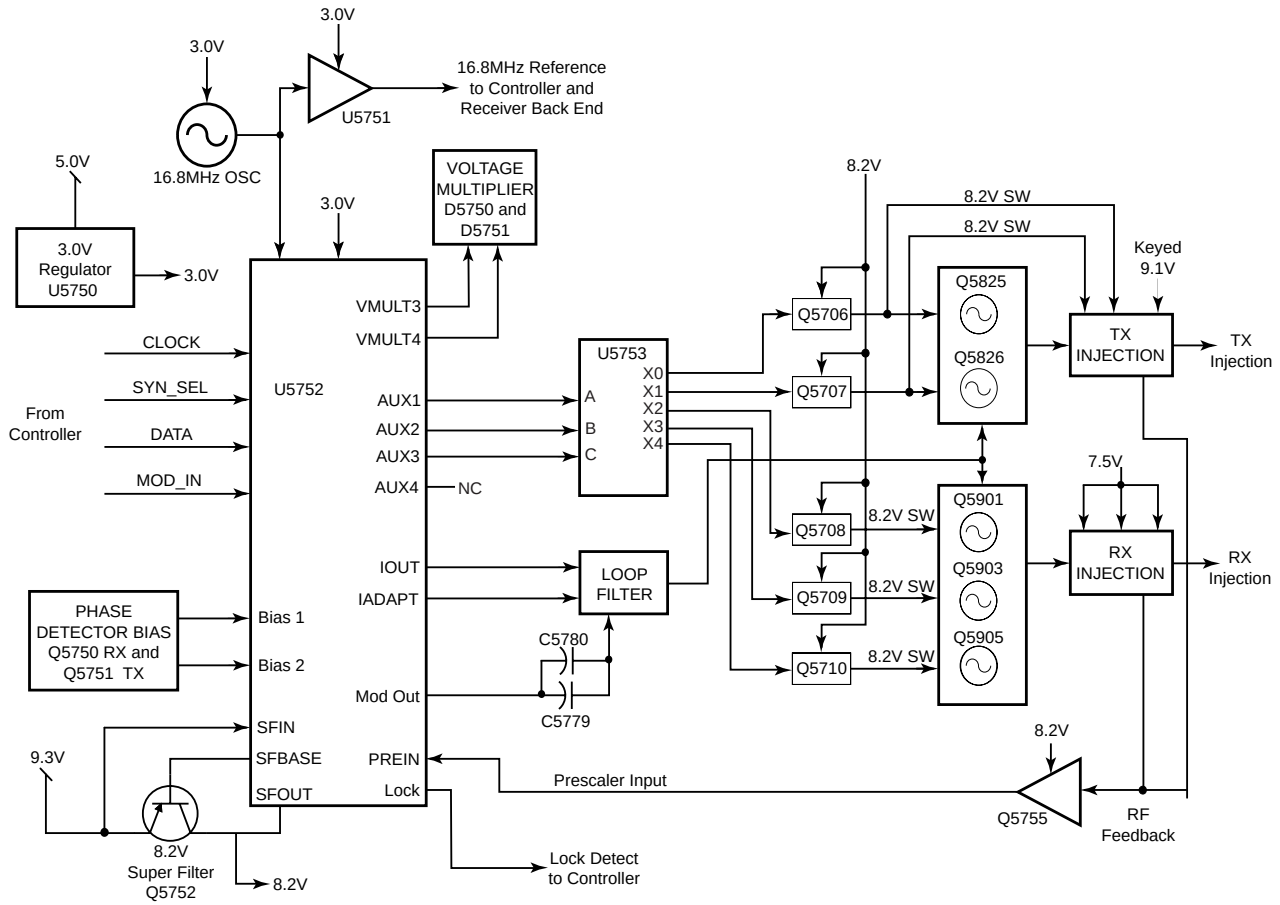


Figure 4-8. Frequency Generation Unit Block Diagram (UHF Range 2)

Table 4-12. LV Frac-N U6751 Pin Descriptions (UHF Range 2)

Pin No.	Pin Name	Description
1	AUX2	Auxiliary logic output
2	AUX3	Auxiliary logic output
3	AUX4	Auxiliary logic output
4	LOCK	Lock detect—logic high indicates in-lock condition
5	PD_VDD	3.0-V supply (phase detector)
6	GROUND	Ground (digital)
7	DATA	SPI data I/O
8	CLK	SPI clock
9	CEX	SPI enable line—active low
10	MODIN	Modulation input from controller
11	VMULT4	Multiplier clock output
12	VMULT3	Multiplier clock output
13	VRO	3.0-V supply for reference oscillator warp circuitry
14	VMULT2	Not used

Table 4-12. LV Frac-N U6751 Pin Descriptions (UHF Range 2) (Continued)

Pin No.	Pin Name	Description
15	VMULT1	Not used
16	INDMULT	Not used
17	—	No connection
18	REFSEL	Not used
19	FREFOUT	Not used
20	AVDD	3.0-V supply (analog)
21	VBPASS	Not used
22	GND	Ground (analog)
23	XTAL1	16.8 MHz reference oscillator input
24	XTAL2	Not used
25	WARP	Reference oscillator warp output
26	SFCAP	Superfilter bypass node
27	SFBASE	Superfilter control node for Q5752
28	SFOUT	Superfilter output
29	—	No connection
30	SFIN	Superfilter supply input
31	—	No connection
32	PREIN	Prescalar input
33	GROUND	Ground (prescalar)
34	PRE_VDD	3.0-V supply
35	PVREF	Not used
36	DVDD	3.0-V supply (digital)
37	TEST1	Not used
38	TEST2	Not used
39	CPB2	Phase detector bias input
40	CPB1	Phase detector bias input
41	MODOUT	Modulation output
42	CCOMP	Not used
43	IOUT	Phase detector normal mode output
44	GND	Ground (phase detector)
45	IADAPT	Phase detector adapt mode output
46	ADAPTSW	Phase detector adapt switch
47	VCP	High-voltage supply for phase detector
48	AUX1	Auxiliary logic output

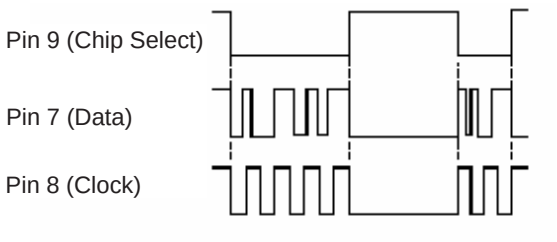


Figure 4-9. Waveform Representation During Programming of the LV Frac-N IC (U5752)

NOTE: The above waveforms are representations only.

4.8.3 Out-of-Lock Condition

The probable cause of an out-of-lock condition is a failure in the synthesizer circuit. If the voltages on the AUX lines do not conform to Table 4-11 on page 4-18, troubleshoot the synthesizer. If the AUX pins are correct, but the supply switch (Q5706, Q5707, Q5708, Q5709 or Q5710) to the in question VCO is not active with 8.2V at the VCO end, then troubleshoot the 3 to 8 multiplexer U5753 or the switch transistor packages.

If the AUX voltages are correct but the synthesizer feedback level is not within the range indicated at TP5783 (-6 to -11dBm), troubleshoot the buffer stages after the VCO. If the AUX voltages are correct and the synthesizer feedback level is correct but an out-of-lock condition persists, troubleshoot the synthesizer.

4.8.4 No or Low Output Power (TX or RX Injection)

In addition to the schematic and theory of operation, refer to the transmitter injection troubleshooting flowchart and the receiver injection trouble shooting flowchart in Chapter 5. The charts will guide you through a sequence of tests and checks designed to isolate problems in the Transmitter or receiver injection strings.

4.8.5 No or Low Modulation

In addition to the schematic and theory of operation, refer to the transmitter no TX Audio troubleshooting flowchart in Chapter 5. The chart will guide you through a sequence of tests and checks designed to isolate problems in the Transmitter Audio section of the FGU.

4.8.6 Troubleshooting the Back-End

Refer to “5.6.18 RX Back-End—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 1 of 3” on page 5-32.

4.9 700–800 MHz Main Board Troubleshooting

This information will help you troubleshoot the RF section of the 700–800 MHz XTL 5000 radio. Use this information, along with the theory of operation and troubleshooting charts, to diagnose and isolate the cause of failures.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at high frequencies, measurements must be taken very carefully. Notes and cautions are added to the text to alert you to this need in areas of greatest sensitivity. However, the need for extreme care does exist in all measurements and tests.

4.9.1 Display Flashes “FAIL 001”

This display indicates a synthesizer "out-of-lock" condition. The following information will help to trouble shoot the frequency generation unit to the component level. Perform the following checks to determine the mode of the Fail 001:

1. Determine if the "out-of-lock" condition occurs in either receive mode, transmit mode, or both. Also, check other frequencies programmed in the unit if available.
2. To determine if the "out-of-lock" is frequency or VCO dependant, place the unit into RF TEST Mode, as described in the *ASTRO Digital XTL 5000 VHF/UHF Range 1/UF Range 2/700–800 MHz Mobile Radio Basic Service Manual* (6881096C73) and step through each test channel. Table 4-13 indicates the frequency and Aux logic level for each test mode channel. In addition, Table 4-14 provides information about the frequency of operation for each VCO.

Table 4-13. Test Mode Channels (700–800 MHz)

Test MODE	LV Frac-N TX Logic	TX Oscillator	TX Freq MHz	LV Frac-N RX Logic	RX Oscillator	RX Freq MHz
CHAN 1	AUX 1	U6754 osc1	762.0125	AUX 3	U6755 osc1	762.0625
CHAN 2	AUX 1	U6754 osc1	769.0125	AUX 3	U6755 osc1	769.0625
CHAN 3	AUX 1	U6754 osc1	775.9875	AUX 3	U6755 osc1	775.9375
CHAN 4	AUX 1	U6754 osc1	794.0125	AUX 4	U6755 osc2	851.0625
CHAN 5	AUX 1	U6754 osc1	805.9875	AUX 4	U6755 osc2	860.0625
CHAN 6	AUX 2	U6754 osc2	806.0125	AUX 4	U6755 osc2	860.0625
CHAN 7	AUX 2	U6754 osc2	823.9875	AUX 4	U6755 osc2	869.9375
CHAN 8	AUX 2	U6754 osc2	851.0125	AUX 4	U6755 osc2	851.0625
CHAN 9	AUX 2	U6754 osc2	860.0125	AUX 4	U6755 osc2	860.0625
CHAN 10	AUX 2	U6754 osc2	869.8875	AUX 4	U6755 osc2	869.9375

Table 4-14. VCO Frequency Calculation and Switching Logic (700–800 MHz)

MODE	Radio Frequency (MHz)	VCO Frequency Formula	VCO Frequency (MHz)	AUX 1	AUX 2	AUX 3	AUX 4
Rx	764.0125 - 775.9875	F(U6755 osc1) = Fc + 73.35 MHz	837.3625 - 849.3375	Low	Low	HIgh	Low
Rx	851.0125 - 868.9875	F(U6755 osc2) = Fc - 73.35 MHz	777.6625 - 795.6375	Low	Low	Low	HIgh
Tx (TA)	764.0125 - 775.9875	F(U6754 osc1) = Fc	764.0125 - 775.9875	HIgh	Low	Low	Low
Tx(RPTR)	794.0125 - 805.9875	F(U6754 osc1) = Fc	794.0125 - 805.9875	HIgh	Low	Low	Low
Tx(RPTR)	806.0125 - 823.9875	F(U6754 osc2) = Fc	806.0125 - 823.9875	Low	HIgh	Low	Low

Table 4-14. VCO Frequency Calculation and Switching Logic (700–800 MHz) (Continued)

MODE	Radio Frequency (MHz)	VCO Frequency Formula	VCO Frequency (MHz)	AUX 1	AUX 2	AUX 3	AUX 4
Tx (TA)	851.0125 - 868.9875	F(U6754 osc2) = Fc	851.0125 - 868.9875	Low	HIgh	Low	Low
Tx (TA) = Talkaround Mode Tx(RPTR) = Repeater or trunked							

3. Continue troubleshooting by using the Fail 001 troubleshooting chart in Chapter 5.

4.9.2 FGU Troubleshooting Aids

The following illustrations are additional service aids for troubleshooting the frequency generation unit.

- Figure 4-10 on page 4-25 is a block diagram of the DC distribution for the frequency generation unit.
- Figure 4-11 on page 4-26 is a block diagram of the frequency generation unit.
- Table 4-15 on page 4-26 describes the function of pins on the LV Frac-N IC U6751.
- Figure 4-12 on page 4-28 is a waveform representation during programming of the LV Frac-N IC U6751.

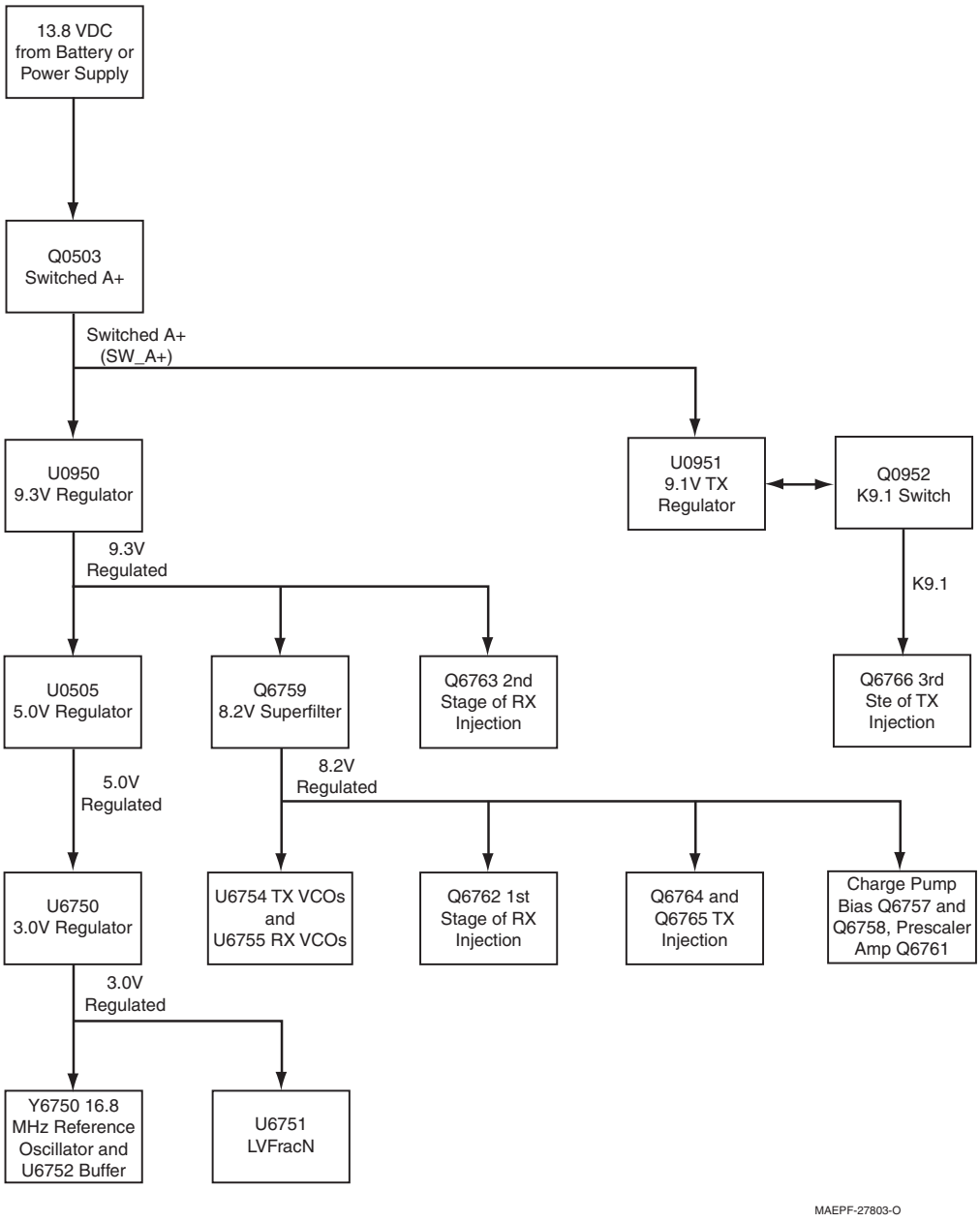


Figure 4-10. Frequency Generation Unit DC Power Supply Distribution (700–800 MHz)

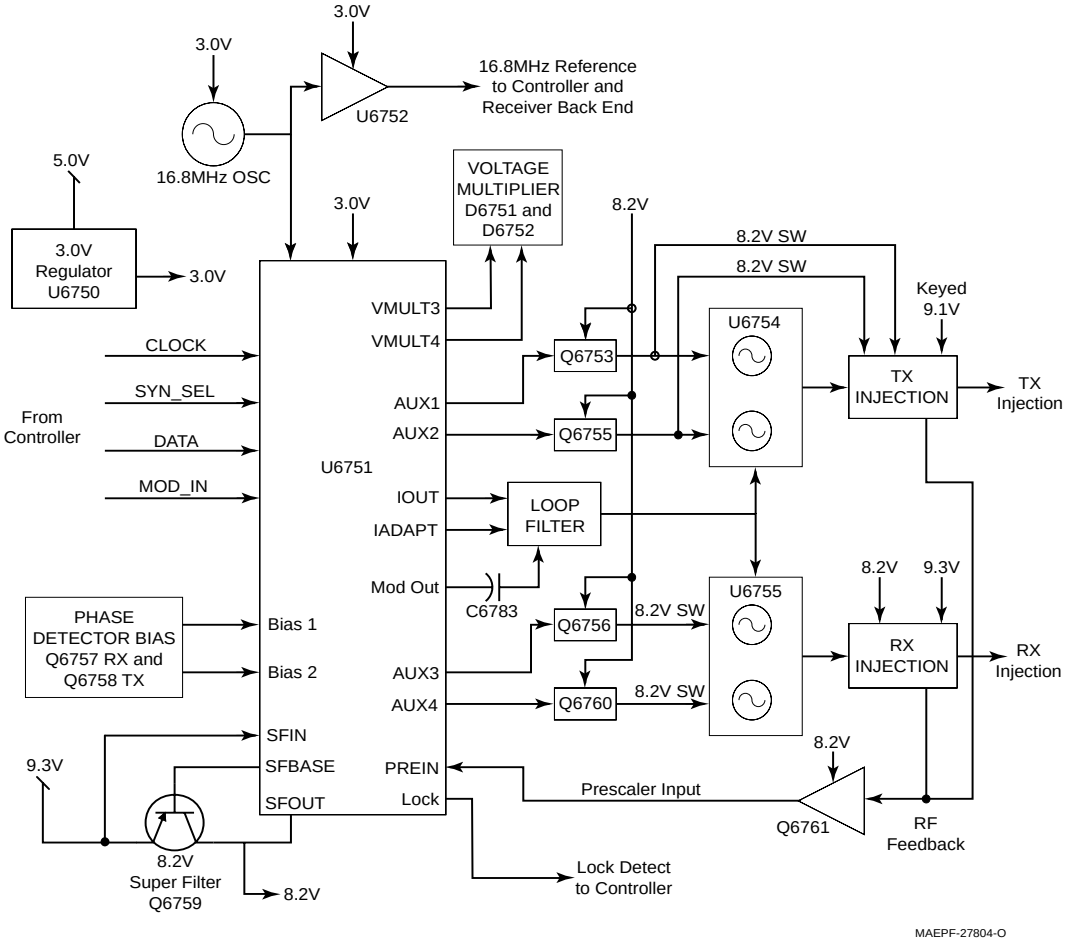


Figure 4-11. Frequency Generation Unit Block Diagram (700–800 MHz)

Table 4-15. LV Frac-N U6751 Pin Descriptions (700–800 MHz)

Pin No.	Pin Name	Description
1	AUX2	Auxiliary logic output, high selects U6754 OSC2
2	AUX3	Auxiliary logic output, high selects U6755 OSC1
3	AUX4	Auxiliary logic output, high selects U6755 OSC2
4	LOCK	Lock detect—logic high indicates in-lock condition
5	PD_VDD	3.0-V supply (phase detector)
6	GROUND	Ground (digital)
7	DATA	SPI data I/O
8	CLK	SPI clock
9	CEX	SPI enable line—active low
10	MODIN	Modulation input from controller
11	VMULT4	Multiplier clock output
12	VMULT3	Multiplier clock output

Table 4-15. LV Frac-N U6751 Pin Descriptions (700–800 MHz) (Continued)

Pin No.	Pin Name	Description
13	VRO	3.0-V supply for reference oscillator warp circuitry
14	VMULT2	Not used
15	VMULT1	Not used
16	INDMULT	Not used
17	—	No connection
18	REFSEL	Not used
19	FREFOUT	Not used
20	AVDD	3.0-V supply (analog)
21	VBPASS	Not used
22	GND	Ground (analog)
23	XTAL1	16.8 MHz reference oscillator input
24	XTAL2	Not used
25	WARP	Reference oscillator warp output
26	SFCAP	Superfilter bypass node
27	SFBASE	Superfilter control node for Q6759
28	SFOUT	Superfilter output
29	—	No connection
30	SFIN	Superfilter supply input
31	—	No connection
32	PREIN	Prescalar input
33	GROUND	Ground (prescalar)
34	PRE_VDD	3.0-V supply
35	PVREF	Not used
36	DVDD	3.0-V supply (digital)
37	TEST1	Not used
38	TEST2	Not used
39	CPB2	Phase detector bias input
40	CPB1	Phase detector bias input
41	MODOUT	Modulation output
42	CCOMP	Not used
43	IOUT	Phase detector normal mode output
44	GND	Ground (phase detector)
45	IADAPT	Phase detector adapt mode output
46	ADAPTSW	Phase detector adapt switch
47	VCP	High-voltage supply for phase detector
48	AUX1	Auxiliary logic output, high selects U6754 OSC1

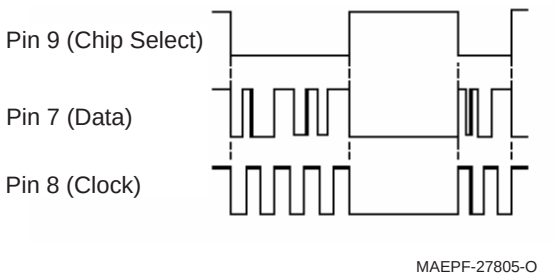


Figure 4-12. Waveform Representation During Programming of the LV Frac-N IC (U6751)

NOTE: The above waveforms are representations only.

4.9.3 No or Low Output Power (TX or RX Injection)

In addition to the schematic and theory of operation, refer to the transmitter injection troubleshooting flowchart and the receiver injection trouble shooting flowchart in Chapter 5. The charts will guide you through a sequence of tests and checks designed to isolate problems in the Transmitter or receiver injection strings.

4.9.4 No or Low Modulation

In addition to the schematic and theory of operation, refer to the transmitter no TX Audio troubleshooting flowchart in Chapter 5. The chart will guide you through a sequence of tests and checks designed to isolate problems in the Transmitter Audio section of the FGU.

4.9.5 Troubleshooting the Back-End

Refer to “5.6.36 RX Back-End—Poor SINAD or No Audio (700–800 MHz)—Part 1 of 3” on page 5-50.

4.10 Standard Bias Tables

Table 4-16, below, outlines some standard supply voltages and system clocks that should be present during normal operation. These should be checked as a first step to any troubleshooting procedure.

Table 4-16. Standard Operating Bias: Power Lines

Nominal Value	Signal Name	Range/State	Probe Locations
13.8 V	A+ (at DC connector)	11.0 to 16.6 V	J0401-20, TP0414
13.8 V	IGNITION	11.0 to 16.6 V	J0401-19, J0401-21
13.8 V	SW_A+ (on board only)	11.0 to 16.6 V	U0500-4, Q0503
13.8 V	SW_B+ (from C.H.)	11.0 to 16.6 V	TP0413, J0401-17
2.83 V	SW_B+_SENSE	No change	U0604-7
2.5 V	SW_B+_ON_OFF (on board only)	2 to 3 V	Q0505-1, Q0504-1
9.1 V	9.3V_ABACUS	No change	U0505-1
9.1 V	9.3V	No change	TP0951, TP0950

Table 4-16. Standard Operating Bias: Power Lines (Continued)

Nominal Value	Signal Name	Range/State	Probe Locations
9.18 V	9V	No change	U0500-5
5 V	5V_ABACUS	No change	U0505-3
5 V	VCC_5	No change	J0401-23, U0507-8, U0503-3, U0502-8, U0501-8
3 V	VCC_3	No change	U0962-5
2.85 V	LV_DETECT	When A+ drops too far below 9 V, this line goes to 0 V	U0504-1
2.85 V	STO (at microprocessor)	No change	TP0500
2.85 V	VCC_2.85	No change	U0501-1
1.86 V	Vpp	No change	TP0400
1.85 V	VCC_1.8	1.84 to 1.87 V	U0507-1
1.55 V	VCC_1.55	No change	U0502-1
1.42 V	VAG	No change	U0206-1, U0201-3

Note: Do not KEY UP unless the board is inside a chassis.

.

Table 4-17. Standard Operating Bias: Clock and Control Lines

Nominal Value	Signal Name	Range/State	Probe Locations
(See “Chapter 6 Troubleshooting Waveforms” on page 6-1)	SB9600__BUS +	Idle=High (4 V to 5 V)	J0402-3, J2-2
	SB9600__BUS -	Idle=Low (0 V)	J0402-5, J2-3
	SB9600__BUSY	Idle=Low (0 V)	J0402-4, J2-9
	SB9600__RESET	Idle=Low (0 V)	J0402-6, J2-8
Note: Use chassis as GND when measuring on an oscilloscope.			
(See “Chapter 6 Troubleshooting Waveforms” on page 6-1)	USB_PWR	5.1 V	J0402-12, J2-12
	USB_DATA +		J0402-11, J2-7
	USB_DATA -		J402-13, J2-6
Note: Use chassis as GND when measuring on an oscilloscope.			
(See “Chapter 6 Troubleshooting Waveforms” on page 6-1)	RS232__UARTA_TX	Output voltage level is the same as BOOT TX	TP0407, J2-7
	RS232__UARTA_RX	Input level depends on inputting device's levels	TP0408, J2-9
	RS232__UARTA_CTS	Flow control line—not used always	TP0409, J2-8

Table 4-17. Standard Operating Bias: Clock and Control Lines (Continued)

Nominal Value	Signal Name	Range/State	Probe Locations
	RS232__UARTA_RTS	Flow control line—not used always	TP0410, J2-10
Note: Use chassis as GND when measuring on an oscilloscope.			
Approx. 0 V	Emergency	Idle = deactivated = grounded	J2-15, J0402-28, TP0403
1.88 V	Emergency	Activated = ungrounded	J2-15, J0402-28, TP0403
Approx. 0 V	Emergency_sense	Deactivated	U508-4
2.85 V	Emergency_sense	Activated	U508-4
(See “Chapter 6 Troubleshooting Waveforms” on page 6-1)	Boot_TX	Same as UARTA_TX	J0401-26, P502-10
	Boot_RX	Same as UARTA_RX	J0401-25, P502-2
2.85 V	Cable_Detect	No prog. cable inserted	U0402-4
0 V	Cable_Detect	Prog. cable inserted at P502	U0402-4
3.5 V	Boot_Data_enable	No prog. cable inserted	
0 V	Boot_Data_enable	Prog. cable inserted at P502	U0402-2
0 V	Opt_B+_bootsel_Vpp	No prog. cable inserted	J0401-22, TP0401
8 V	Opt_B+_bootsel_Vpp	Prog. cable inserted @ P502	J0401-22, TP0401
(See “6.2.5 32 kHz Clock Waveform” on page 6-4)	32 kHz		U0102-4
(See “6.2.4 16.8 MHz Clock Waveform” on page 6-3)	16.8 Mhz		C0911 near U0903

Note: Do not KEY UP unless the board is inside a chassis.

Table 4-18. Standard Operating Bias: Audio Lines

Nominal Value	Signal Name	Range/State	Probe Locations
9.2 V	Mic_Hi	When microphone connected (expects 80 mV input) (line has microphone bias)	TP0402, J0401-4

Table 4-18. Standard Operating Bias: Audio Lines (Continued)

Nominal Value	Signal Name	Range/State	Probe Locations
9.2 V	Mic_Hi	When microphone disconnected	TP0402, J0401-4
13 V to 16 V	Mic_Hi	When programming cable inserted	TP0402, J0401-4
Note: Do not press the PTT unless the PCB is inside a chassis even for a moment to check a line. Permanent RF hardware damage can occur to the board due to no heatsinking.			
9.2 V	Aux_Mic = [A(tx)] (transmit audio)	Expects 300 mV input (APCO default) Expects 80 mV input (motorcycle use)	J0401-6, J2-23
2.84 V	Aux_PTT = [PTT]	Idle = High Active = Low Hard-wired PTT, which will mute or unmute Aux_Mic line	J0402-24, J2-16
1.4 Vdc to 25 Vdc (needs ext. cap)	Aux_TX (audio input)	300 mV line-level (no mic bias)	J0401-7
0 V	Aux_RX (audio input)	300 mV line-level (Audio PA In)	J0401-8
Note: The Mic_Hi audio overrides Aux_TX/Aux_Mic audio, and the speaker is always muted.			
0 V	Speaker +	Muted (output)	J2-21, U204-4
	Speaker -	Muted (output)	J2-20, U204-6
26v peak-to-peak @volume= 15+	Speaker +	Unmuted (output)	J2-21, U204-4
	Speaker -	Unmuted (output)	J2-20, U204-6
Note: Never ground speaker lines. They are differential, not single-sided. Use an oscilloscope probe on "Spk+" and oscilloscope-probe GND on "Spk-".			
2.85 V	Monitor	Idle = High Activate = Low	J2-22
2.84 V	Audio_PA_Enable		Q0200-1
1.3 V	RX_Filt_Audio = [A(rx)] (receive audio/audio output)	300 mV line-level output	J2-21, TP0204
0 V or 5 V	Chan_Act = [A(p)] (qualified audio presence)	Idle = Low (0v) Active = High (5 V)	J2-13
	HUB	This pin causes the control head to send SB9600 message to the radio, indicating when HUB is attached	P502-3

Note: Do not KEY UP unless the board is inside a chassis.

Table 4-19. Standard Operating Bias: VIP Lines (Dash Configuration)

Nominal Value	Signal Name	Range/State	Probe Locations
NA	VIP_OUT_1_5v	Not accessible	J0401-13
NA	VIP_OUT_2_5v	Not accessible	J0401-14
NA	VIP_IN_1_5v	Not accessible	J0401-15
NA	VIP_IN_2_5v	Not accessible	J0401-16
SW_B+ level	VIP_OUT_1_12v	Deactivate = relay closed	J0401-11, J2-18
0.3 V to 0.5 V		Activate = relay open	
SW_B+ level	VIP_OUT_2_12v	Deactivate = relay closed	J0401-12, J2-19
0.3 V to 0.5 V		Activate = relay open	

Note: The voltage levels on the microprocessor side are at 2.85 V levels. The microprocessor is not designed to drive the relay, but instead, is intended to drive the transistors inside the control head or on the interconnect board. Be careful when changing jumpers.

Note: The impedance of the relay is why the SW_B+ does not damage the VIP line. Never connect SW_B+ directly to a VIP line.

Table 4-20. Standard Operating Bias: VIP Lines (Standard Remote Configuration)

Nominal Value	Signal Name	Range/State	Probe Locations
	VIP_OUT_1_5v	Access only by custom pin-out	J0401-13
	VIP_OUT_2_5v	Access only by custom pin-out	J0401-14
5 V	VIP_IN_1_5v	Idle = deactivate = 5 V bias	J0401-15
0 V		Activate = ground	
5 V	VIP_IN_2_5v	Idle = deactivate = 5 V bias	J0401-16
0 V		Activate = ground	
SW_B+ level	VIP_OUT_1_12v	Deactivate = relay closed	J0401-11, J2-18
0.3 V to 0.5 V		Activate = relay open	
SW_B+ level	VIP_OUT_2_12v	Deactivate = relay closed	J0401-12, J2-19
0.3 V to 0.5 V		Activate = relay open	

Note: VIP_IN programmed by CPS. Requires custom pin-out to gain access.

Table 4-21. Standard Operating Bias: VIP Lines (W3 Remote Configuration)

Nominal Value	Signal Name	Range/State	Probe Locations
	VIP_OUT_1_5v	Access only by custom pin-out	J0401-13
	VIP_OUT_2_5v	Access only by custom pin-out	J0401-14
NA	VIP_IN_1_5v	Not supported with W3	J0401-15
NA	VIP_IN_2_5v	Not supported with W3	J0401-16
SW_B+ level	VIP_OUT_1_12v	Deactivate = relay closed	J0401-11, J2-18
0.3 V to 0.5 V		Activate = relay open	
SW_B+ level	VIP_OUT_2_12v	Deactivate = relay closed	J0401-12, J2-19
0.3 V to 0.5 V		Activate = relay open	

Note: When using the W3 control head and interconnect board, the main board VIP_OUT lines are pass-through-only lines.

4.11 Receiver Front-End (RXFE)

This section provides band-specific troubleshooting procedures for the receiver front-end.

4.11.1 VHF (136–174 MHz) Band

Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, you can use the troubleshooting flowcharts in "Chapter 5. Troubleshooting Charts" that will guide you through a sequence of tests and checks designed to isolate problems.

Prior to troubleshooting, it is important to review the theory of operation including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at a high frequency, measurements must be taken carefully.

4.11.2 UHF Range 1 (380–470 MHz) Band

Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, you can use the troubleshooting flowcharts in "Chapter 5. Troubleshooting Charts" that will guide you through a sequence of tests and checks designed to isolate problems.

Prior to troubleshooting, it is important to review the theory of operation including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at 400 MHz, measurements must be taken carefully.

4.11.3 UHF Range 2 (450–520 MHz) Band

Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, you can use the troubleshooting flowcharts in "Chapter 5. Troubleshooting Charts" that will guide you through a sequence of tests and checks designed to isolate problems.

Prior to troubleshooting, it is important to review the theory of operation including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at 400 MHz, measurements must be taken carefully.

4.11.4 700–800 MHz Band

Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, you can use the troubleshooting flowchart in "Chapter 5. Troubleshooting Charts" that will guide you through a sequence of tests and checks designed to isolate problems.

Prior to troubleshooting, it is important to review the theory of operation including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at 800 MHz, measurements must be taken carefully.

4.12 Power Amplifier Procedures

This section provides band-specific troubleshooting procedures for the RF power amplifier (RFPA).

4.12.1 VHF (136–174 MHz) Band

Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

Prior to troubleshooting, be sure to review the theory of operation including any precautions and troubleshooting methods.

4.12.1.1 50-Watt Power Amplifiers

In addition to the schematic and theory, this section includes troubleshooting information that will help you test and check the circuits to localize and isolate problems.

4.12.1.2 General Troubleshooting and Repair Notes

Most of the common transmitter symptoms are caused by either failure of the power amplifier or a failure in the control circuitry. The initial troubleshooting effort should be toward isolating the problem to one of those two areas. If either the control voltage or keyed 9.4 V are zero, then the problem is likely to be in the control circuit. If those voltages are present, then the problem is more likely in the power amplifier circuit.

If for diagnostic reasons, a chip component needs to be removed to facilitate testing, such as a series capacitor removed to allow for signal insertion, then the component(s) returned to the circuit should be new parts. The application of a soldering iron to many chip components will tend to cause leaching which could lead to failure.

After a PA board is replaced, or if any power control circuitry components are replaced, readjust the power according to instructions in the *ASTRO Digital XTL 5000 VHF/UHF Range 1/UHF Range 2/ 700–800 MHz Mobile Radio Basic Service Manual*.

NOTE: Due to the high frequency of operation, it is imperative that you use specified Motorola parts when component replacement is necessary. At these frequencies, second and third order properties of the components are very important and are part of the circuit's design. Substitute components may not work. It is also critical that you use great care when replacing parts. Excessive solder or flux, longer than original leads on coax connectors, misorientation of parts, and other commonly benign imperfections may cause the radio's performance to degrade.

4.12.2 UHF Range 1 (380–470 MHz) Band

In addition to the schematic (“7.3 HUE4039A/HUE4043A (UHF Range 1) Main Board” on page 7-72) and theory of operation (“3.6.2 UHF Range 1 (380-470 MHz) Band” on page 3-31), refer to the RFPA troubleshooting flowcharts in “5.6.23 No TX Audio (380–470 MHz and 450–520 MHz)” on page 5-37. These flowcharts will guide you through a sequence of tests and checks designed to isolate problems in the RFPA stages.

See section “4.12.4 700–800 MHz Band” on page 4-35, for more information on troubleshooting the RF power amplifier circuitry.

4.12.3 UHF Range 2 (450–520 MHz) Band

In addition to the schematic (“7.4 HUE4040A (UHF Range 2) Main Board” on page 7-132) and theory of operation (“3.6.3 UHF Range 2 (450-520 MHz) Band” on page 3-37), refer to the RFPA troubleshooting flowcharts in “5.6.23 No TX Audio (380–470 MHz and 450–520 MHz)” on page 5-37. These flowcharts will guide you through a sequence of tests and checks designed to isolate problems in the RFPA stages.

See section “4.12.4 700–800 MHz Band” on page 4-35, for more information on troubleshooting the RF power amplifier circuitry.

4.12.4 700–800 MHz Band

In addition to the schematic ("Chapter 7. Schematics, Component Location Diagrams, and Parts Lists") and theory of operation ("Chapter 3. Theory of Operation"), refer to the RFPA troubleshooting flowcharts in "Chapter 5. Troubleshooting Charts". These flowcharts will guide you through a sequence of tests and checks designed to isolate problems in the RFPA stages.

Use the following information as a guide for troubleshooting the RF power amplifier circuitry:

- Read the theory of operation before troubleshooting.
- To avoid damage to the RFPA, only key the transmitter with the main board installed in the chassis and the internal screws completely installed and secured with the proper torque setting.
- The chassis eliminator, which allows access to both sides of the main board is useful for transmitter troubleshooting. Keying the transmitter for an extended period of time while using the chassis eliminator can cause damage to the radio. Therefore, be sure to cool the radio by forcing air through the chassis eliminator cooling fins.
- To avoid personal injury from high RF voltages and currents, exercise extreme care while troubleshooting the transmitter power amplifier.
- Set the A+ supply to 13.6 V with the current limit set to 15 A.
- Calibrate the power meter regularly using the manufacturer's suggested calibration method.

- If a component is removed for troubleshooting, replace the removed part, regardless of its condition, with a new part.
- To reinstall the main board into the chassis, follow the reassembly instruction in the *ASTRO Digital XTL 5000 VHF/UHF Range 1/UHF Range 2/700–800 MHz Mobile Radio Basic Service Manual*.
- Apply new thermal pads if the current thermal pad are damaged. Follow the instructions in the *ASTRO Digital XTL 5000 VHF/UHF Range 1/UHF Range 2/700–800 MHz Mobile Radio Basic Service Manual*.
- Use Motorola-specified parts when component replacement is required.
- When instructed to inspect parts, look for any package damage and/or solder defects.

Chapter 5 Troubleshooting Charts

5.1 Introduction

This chapter contains detailed troubleshooting flowcharts and tables. These 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 chapter prior to troubleshooting a radio.

5.2 List of Troubleshooting Charts

Most troubleshooting flowcharts (see Table 5-1) end by pointing to an IC to replace. Before replacing any IC, it is good practice to verify power supplies and grounds to the affected IC and trace continuity to the malfunctioning signal and related circuitry. For example, if a clock signal is not available at a destination IC, continuity from the source IC should be checked before replacing the source IC.

Table 5-1. List of Troubleshooting Charts

Table 5-1. List of Troubleshooting Charts (Continued)

Description	Page
RFPA Power Control—No VGBIAS	5-45
700–800 MHz	
No 16.8 MHz Reference Oscillator Frequency	5-46
Poor RX Sensitivity or No RX Audio	5-47
RX IF—Poor SINAD or No Audio	5-49
RX Back-End—Poor SINAD or No Audio	5-50
Low or No RX Injection Signal	5-53
Low or No TX Injection Signal	5-54
No TX Audio	5-55
TX or RX VCO Unlock (Fail 001)	5-56
RF Power Amplifier (RFPA)—No or Low TX Power Output	5-58
RFPA Power Control—No K9.1V	5-63
RFPA Power Control—No VGBIAS	5-64
RFPA Power Control—No or Low TX RFPA_CNTRL	5-65

NOTE: The term μC might be used in some of the following troubleshooting charts; μC = MCU or microprocesor.

5.3 Troubleshooting Tables

5.3.1 For Mid Power models

This section contains troubleshooting tables that can help you isolate a problem in your radio.

Table 5-2. XTL 5000 Troubleshooting Table (700–800 MHz, 380-470 MHz and 136-174 MHz)

Symptom	Check Section	Troubleshooting Procedure	Component
No TX Modulation	Controller Block	With 80 mV rms, 1 kHz injected to the MIC_HI line and CPS mic gain level set to 0 (default), check the following levels.	
		• 80 mVrms at TP0200, U0209-4, J0401-4.	• Absence of signal may indicate failure with U0209 (MUX), or U0201 (Op-Amp)
		• 36 mV rms at TP0201.	• Absence of signal may indicate failure with U0209 (MUX), or U0201 (Op-Amp)
		• 20 mV rms at U0201-1, TP0202.	• Absence of signal may indicate failure with U0202 (EPOT), or U0201 (Op-Amp)
		• 36 mV rms at U0201-7, TP0203.	• Absence of signal may indicate failure with U0202 (EPOT), or U0201 (Op-Amp)
		• 36 mV rms at U0200-17.	• Absence of signal may indicate failure with U0200 (Codec)
		• > 150 mV rms at U0900-1.	• Absence of signal may indicate failure with U0901 (Urchin), U0900 (Modulation DAC), or U0001 (Microprocessor Board)
		• > 150 mV rms at FL0900-5.	• Absence of signal may indicate failure with U0901 (Urchin), or FL0900 (Filter)
		• > 150 mV rms at U0902-14	• Absence of signal may indicate failure with U0902 (MUX)
		• > 150 mV rms at R6782	• Presence of signal may indicate a aproblem in RF section
	Flex/Control Head	Check that MIC_HI is getting to controller at VR0412, VR0421, C0438, C0207, C0234, or R0204	Absence of signal may indicate failure with flex, control head, VR0412, or VR0421

Table 5-2. XTL 5000 Troubleshooting Table (700–800 MHz, 380-470 MHz and 136-174 MHz) (Continued)

Symptom	Check Section	Troubleshooting Procedure	Component
No Keyloading	Controller	Connect proper KVL keyloader and cable and begin keyloading by pressing the PTT on the keyloader • Check data activity (5 V levels) on Boot_TX/Keyfail* line - J0401-25, U0401-5, or C0430. • Check data activity (5 V levels) at U0401-6. • Check data activity (5 V levels) at J0501-14	• Absence of data may indicate failure with keyloader, cable, control head, control head flex, J0401, or VR0417. • Absence of signal may indicate failure with U0401 (MUX) or Q0404 • Absence of signal may indicate failure with J0501; Presence of signal may indicate failure of secure interface board or UCM/ Secure module, which would need replacing
Radio Dead, Display Does Not Light Up	Blown Fuse	Check fuse in red lead of power cable (or green lead if used)	Absence of signal may indicate failure with J0401, J0402, VR0412, or VR0402
	Controller Section	• Check for IGNITION at J0401-20, J0402-18, VR0402, VR0412 • Check for A+ at Q0503, VR0950, J0401-19,21, or TP0414	• Absence of signal may indicate failure with J0401, J0402 • Absence of signal may indicate failure with J0950, J0401
	Flex/Control Head	Check for SW_B+_CH at J0401-17, TP0413, or pin 21 of P502 (on control head)	Absence of signal may indicate failure with flex, control head
Radio Dead, Display Lights Up	Regulators	• Check for SW_B+ at Q0503, U0500-4, U0950-4, U0951-4 • Check for 9.3 V at U0500-5, U0950-5, U0951-5. • Check for 5 V at U0503-5, 3 V at U0962-3, 2.85 V at U0501-1, 1.85 V at U0507-1, 1.55 V at U0502-1	• Absence of signal may indicate failure with Q0503 • Absence of signal may indicate failure with U0500, U0950, or U0951 (9 V Regulators) • Absence of signal may indicate failure with U0503, U0962, U0501, U0507, or U0502 (5 V, 3 V, 2.85 V, 1.85 V, and 1.55 V Regulators)
	Flex/Control Head	Check for SW_B+_CH at J0401-17, TP0413, or pin 21 of P502 (on control head)	Absence of signal may indicate failure with flex, control head
	SB9600	Check for logic transitions at J0401-31 thru 34, J0402-3 thru 6, or U0606-4,7,9,12	Absence of signal may indicate failure with U0606 MUX), VR0408, VR0418, Q0610-Q0613, U0001 (Microprocessor Board), control-head flex, or rear accessory flex

Table 5-2. XTL 5000 Troubleshooting Table (700–800 MHz, 380-470 MHz and 136-174 MHz) (Continued)

Symptom	Check Section	Troubleshooting Procedure	Component
Radio Dead, Display Lights Up	Clocks	Check for 32 kHz clock at U0102-4, and 16.8 MHz clock at C0106, C0911	Presence of signals may indicate failure with U0001 (Microprocessor Board). Absence of signals may indicate failure with U0102 (Inverter) or with FGU reference oscillator circuit
	A+	Check A+ to the Control Head J0401-19, 20	• Absence of voltage F0400 may be blown.
No RX Audio/ Receive Does not Unsquelch	Controller Block	(Inject 1 kHz tone, 3 kHz deviation into radio antenna, set volume to rated audio.	
		• Check for speaker leads shorted to ground, or at U0204-4, 6.	• Short may indicate failure with VR0400, VR0412, or U0204
		• Check for > 30 mV rms audio at audio PA input, U0204-1,9.	• Presence of signal may indicate failure with U0204 (Audio PA)
		• Check for > 30 mV rms audio at U0206-8 or TP0205.	• Presence of signal may indicate failure with U0206 (Log-POT)
		• Check for > 30 mV rms audio at U0210-6 or U0200-2.	• Presence of signal may indicate failure with U0210 (MUX); Absence of signal may indicate failure with U0200 (CODEC), or U0001 (Microprocessor Board)
		• Check that U0204-8 is >10 V	• Absence of >10V may indicate failure with Q0200 or U0001
	Regulators	See description for *No VOCON Powerup*	
	ABACUS Circuit (380-470 MHz, 450-520 MHz)	• Check for 20 kHz Frame Sync pulse signal at testpoint FS (U5002-31)	• Absence of signal causes no receive. Possible U5002 (ABACUS) failure or U0001 (Microprocessor Board) failure
		• Check for 1.2 MHz Clock square wave at testpoint CLKOUT (U5002-28)	• Absence of signal causes no receive. Possible U5002 (ABACUS) failure or U0001 (Microprocessor Board) failure
		• Check for random data pattern at testpoint DOUTA (U5002-29)	• Absence of signal causes no receive. Possible U5002 (ABACUS) failure or U0001 (Microprocessor Board) failure
		• Check for Clock Oscillator at R5025 (18 MHz)	• Absence of Clock signal causes no receive. Possible U5002 (ABACUS), Clock VCO, or U0001 (Microprocessor Board) failure
		• Check for Local Oscillator at C5058 (71.1 MHz or 75.6 MHz)	• Absence of LO signal causes no receive. Possible U5002 (ABACUS), or LO VCO

Table 5-2. XTL 5000 Troubleshooting Table (700–800 MHz, 380-470 MHz and 136-174 MHz) (Continued)

Symptom	Check Section	Troubleshooting Procedure	Component
No RX Audio/ Receive Does not Unsquelch (cont.)	ABACUS Circuit (700-800 MHz)	• Check for 20 kHz Frame Sync pulse signal at testpoint FS (U6000-31) • Check for 1.2 MHz Clock square wave at testpoint CLKOUT (U6000-28) • Check for random data pattern at testpoint DOUTA (U6000-29) • Check for Clock Oscillator at R6003 (18 MHz) • Check for Local Oscillator at C6026 (71.1 MHz or 75.6 MHz)	• Absence of signal causes no receive. Possible U6000 (ABACUS) failure or U0001 (Microprocessor Board) failure • Absence of signal causes no receive. Possible U6000 (ABACUS) failure or U0001 (Microprocessor Board) failure • Absence of signal causes no receive. Possible U6000 (ABACUS) failure or U0001 (Microprocessor Board) failure • Absence of Clock signal causes no receive. Possible U6000 (ABACUS), Clock VCO, or U0001 (Microprocessor Board) failure • Absence of LO signal causes no receive. Possible U6000 (ABACUS), or LO VCO
Radio Will Not Turn Off	On/Off Switch (Control Head)	Check for SW_B+_CH at 0 V at J0401-17, TP0413	A high voltage may indicate failure with the control head
Radio Will Not Turn Off (continued)	Emergency Circuit	Check for 0 V at Timer U0506-3, U0508-2,4	A high voltage may indicate failure with U0506, or that the EMERGENCY line is not grounded by the rear accessory cable
	SW_B+ Sense Circuit	Check that U0604-7 is low (0 V) and that SOFT TURN OFF is low (0 V) at D0501	Absence of this voltage may indicate failure with U0604 (Op-Amp) or with U0001 (Microprocessor Board)

5.3.2 For High Power models and UHF R2 Mid Power

This section contains troubleshooting tables that can help you isolate a problem in your radio.

Table 5-3. XTL 5000 Troubleshooting Table (136-174 MHz, 380-470 MHz and 450-520 MHz Mid Power)

Symptom	Check Section	Troubleshooting Procedure	Component
No TX Modulation	Controller Block	With 80 mV rms, 1 kHz injected to the MIC_HI line and CPS mic gain level set to 0 (default), check the following levels.	
		• 80 mVrms at TP0200, U0209-4, J0401-57.	• Absence of signal may indicate failure with U0209 (MUX), or U0201 (Op-Amp)
		• 80 mV rms at TP0201.	• Absence of signal may indicate failure with U0209 (MUX), or U0201 (Op-Amp)
		• 2.5 Vdc at U0201-8.	• Absence of DC bias may indicate failure with U0201 (Op-Amp)
		• 80 mV rms at U0201-7, U0201-7, TP0203.	• Absence of signal may indicate failure with U0202 (EPOT), or U0201 (Op-Amp)
		• 36 mV rms at U0200-17.	• Absence of signal may indicate failure with U0200 (Codec)
		• > 150 mV rms at U0900-1.	• Absence of signal may indicate failure with U0901 (Urchin), U0900 (Modulation DAC), or U0001 (Microprocessor Board)
		• > 150 mV rms at FL0900-5.	• Absence of signal may indicate failure with U0901 (Urchin), or FL0900 (Filter)
		• > 150 mV rms at U0902-14	• Absence of signal may indicate failure with U0902 (MUX)
		• > 150 mV rms at R6782	• Presence of signal may indicate a aproblem in RF section
	Flex/Control Head	Check that MIC_HI is getting to controller at VR0412, VR0421, C0438, C0207, C0234, or R0204	Absence of signal may indicate failure with flex, control head, VR0412
No Keyloading	Controller	Connect proper KVL keyloader and cable and begin keyloading by pressing the PTT on the keyloader	
		• Check data activity (5 V levels) on Boot_TX/Keyfail* line - J0401-44.	• Absence of data may indicate failure with keyloader, cable, control head, control head flex, J0401.
		• Check data activity (5 V levels) at J0501-14	• Absence of signal may indicate failure with J0501; Presence of signal may indicate failure of secure interface board or UCM/ Secure module, which would need replacing

Table 5-3. XTL 5000 Troubleshooting Table (136-174 MHz, 380-470 MHz and 450-520 MHz Mid Power)

Symptom	Check Section	Troubleshooting Procedure	Component
Radio Dead, Display Does Not Light Up	Blown Fuse	Check fuse in red lead of power cable (or green lead if used)	Absence of signal may indicate failure with J0401, J0402, VR0412, or VR0402
	Controller Section	• Check for IGNITION at J0401-27, 28	• Absence of signal may indicate failure with J0401
		• Check for A+ at Q0503, VR0950, J0401-19,21, or TP0414	• Absence of signal may indicate failure with J0950, J0401 or VR0950
	Flex/Control Head	Check for SW_B+_CH at J0401-33,34, TP0413, or pin 21 of P502 (on control head)	Absence of signal may indicate failure with flex, control head
Radio Dead, Display Lights Up	Regulators	• Check for SW_B+ at Q0503, U0500-4, U0950-4, U0951-4 • Check for 9.3 V at U0500-5, U0950-5, U0951-5.	• Absence of signal may indicate failure with Q0503 • Absence of signal may indicate failure with U0500, U0950, or U0951 (9 V Regulators)
		• Check for 5 V at U0503-5, 3 V at U0962-3, 2.85 V at U0501-1, 1.85 V at U0507-1, 1.55 V at U0502-1	• Absence of signal may indicate failure with U0503, U0962, U0501, U0507, or U0502 (5 V, 3 V, 2.85 V, 1.85 V, and 1.55 V Regulators)
	Flex/Control Head	Check for SW_B+_CH at J0401-33,34, TP0413, or pin 21 of P502 (on control head)	Absence of signal may indicate failure with flex, control head
	SB9600	Check for logic transitions at J0401-13 thru 16, or U0606-4,7,9,12	Absence of signal may indicate failure with U0606 MUX), VR0408, VR0418, Q0610-Q0613, U0001 (Microprocessor Board), control-head flex, or rear accessory flex
Radio Dead, Display Lights Up	Clocks	Check for 32 kHz clock at U0102-4, and 16.8 MHz clock at C0106, C0911	Presence of signals may indicate failure with U0001 (Microprocessor Board). Absence of signals may indicate failure with U0102 (Inverter) or with FGU reference oscillator circuit
	Remote	Check for A+ at J6	Check F0400. Check the flex.

Table 5-3. XTL 5000 Troubleshooting Table (136-174 MHz, 380-470 MHz and 450-520 MHz Mid Power)

Symptom	Check Section	Troubleshooting Procedure	Component
No RX Audio/ Receive Does not Unsquelch	Controller Block	(Inject 1 kHz tone, 3 kHz deviation into radio antenna, set volume to rated audio.	
		• Check for speaker leads shorted to ground, or at U0204-4, 6.	• Short may indicate failure with VR0400, VR0412, or U0204
		• Check for > 30 mV rms audio at audio PA input, U0204-1,9.	• Presence of signal may indicate failure with U0204 (Audio PA)
		• Check for > 30 mV rms audio at U0206-8 or TP0205.	• Presence of signal may indicate failure with U0206 (Log-POT)
		• Check for > 30 mV rms audio at U0210-6 or U0200-2.	• Presence of signal may indicate failure with U0210 (MUX); Absence of signal may indicate failure with U0200 (CODEC), or U0001 (Microprocessor Board)
		• Check that U0204-8 is >10 V	• Absence of >10V may indicate failure with Q0200 or U0001
	Regulators	See description for *No VOCON Powerup*	
	ABACUS Circuit (380-470 MHz, 450-520 MHz)	• Check for 20 kHz Frame Sync pulse signal at testpoint FS (U5002-31)	• Absence of signal causes no receive. Possible U5002 (ABACUS) failure or U0001 (Microprocessor Board) failure
		• Check for 1.2 MHz Clock square wave at testpoint CLKOUT (U5002-28)	• Absence of signal causes no receive. Possible U5002 (ABACUS) failure or U0001 (Microprocessor Board) failure
		• Check for random data pattern at testpoint DOUTA (U5002-29)	• Absence of signal causes no receive. Possible U5002 (ABACUS) failure or U0001 (Microprocessor Board) failure
		• Check for Clock Oscillator at R5025 (18 MHz)	• Absence of Clock signal causes no receive. Possible U5002 (ABACUS), Clock VCO, or U0001 (Microprocessor Board) failure
		• Check for Local Oscillator at C5058 (71.1 MHz or 75.6 MHz)	• Absence of LO signal causes no receive. Possible U5002 (ABACUS), or LO VCO

Table 5-3. XTL 5000 Troubleshooting Table (136-174 MHz, 380-470 MHz and 450-520 MHz Mid Power)

Symptom	Check Section	Troubleshooting Procedure	Component
No RX Audio/ Receive Does not Unsquelch (cont.)	ABACUS Circuit (700-800 MHz)	• Check for 20 kHz Frame Sync pulse signal at testpoint FS (U6000-31) • Check for 1.2 MHz Clock square wave at testpoint CLKOUT (U6000-28) • Check for random data pattern at testpoint DOUTA (U6000-29) • Check for Clock Oscillator at R6003 (18 MHz) • Check for Local Oscillator at C6026 (71.1 MHz or 75.6 MHz)	• Absence of signal causes no receive. Possible U6000 (ABACUS) failure or U0001 (Microprocessor Board) failure • Absence of signal causes no receive. Possible U6000 (ABACUS) failure or U0001 (Microprocessor Board) failure • Absence of signal causes no receive. Possible U6000 (ABACUS) failure or U0001 (Microprocessor Board) failure • Absence of Clock signal causes no receive. Possible U6000 (ABACUS), Clock VCO, or U0001 (Microprocessor Board) failure • Absence of LO signal causes no receive. Possible U6000 (ABACUS), or LO VCO
Radio Will Not Turn Off	On/Off Switch (Control Head)	Check for SW_B+_CH at 0 V at J0401-17, TP0413	A high voltage may indicate failure with the control head
Radio Will Not Turn Off (continued)	Emergency Circuit	Check for 0 V at Timer U0506-3, U0508-2,4	A high voltage may indicate failure with U0506, or that the EMERGENCY line is not grounded by the rear accessory cable
	SW_B+ Sense Circuit	Check that U0604-7 is low (0 V) and that SOFT TURN OFF is low (0 V) at D0501	Absence of this voltage may indicate failure with U0604 (Op-Amp) or with U0001 (Microprocessor Board)

Table 5-4. XTL 5000 Receiver Troubleshooting Table (VHF Band)

Symptom	Check Section	Troubleshooting Procedure	Component
Poor Sensitivity	Front-end	• Check 2.85 V on pin 4 and 0 V on pin 5 of U3250	• U3250.
		• Check transistors Q3250, Q3252 VCE levels. Levels should be ~ 5 V	• Q3250, Q3252 (only Q3252 in STD mode).
		• Using a RF probe, check for 20 dBm on TP6771	• FGU section.
		• Verify that all Front-end components are well soldered	• Visual inspection of soldering.
	Back-end	• Check for VCE level of 8 V at IF amplifier	• Q3401.
		• Verify that ABACUS is well soldered	• Visual inspection of U3000 leads soldering.
		Check ABACUS for: • Reference clock 16.8 MHz • Synthesizer frequency 107.4 MHz or 111.9 MHz	 • R3822. • C3846.
Poor Reception	Back-end	Check ABACUS DC voltages: • 2.7-3 V on pins 1, 2, 6, 9, 14, 17, 40 • 5 V at on 39	• U3000.
		• Check Second Local Oscillator for voltage of 0.5-4.7 V	• U3000 pin 38.
		• Check second IF for 2.25 MHz	• C3047.

5.4 Troubleshooting Test Points

The following figures show the location of the main board test points for measuring voltages and viewing waveforms.

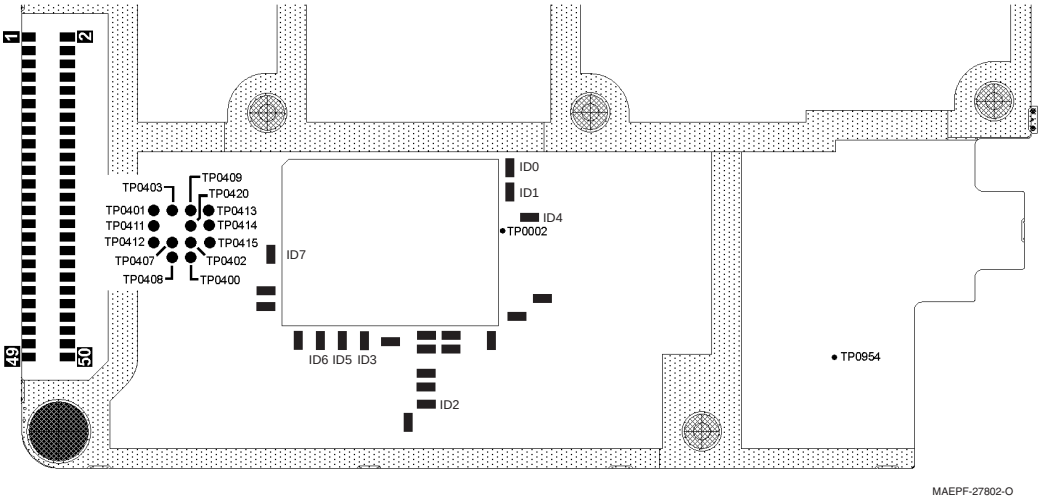


Figure 5-1. Main Board Test Points—Top Side (for Mid Power)

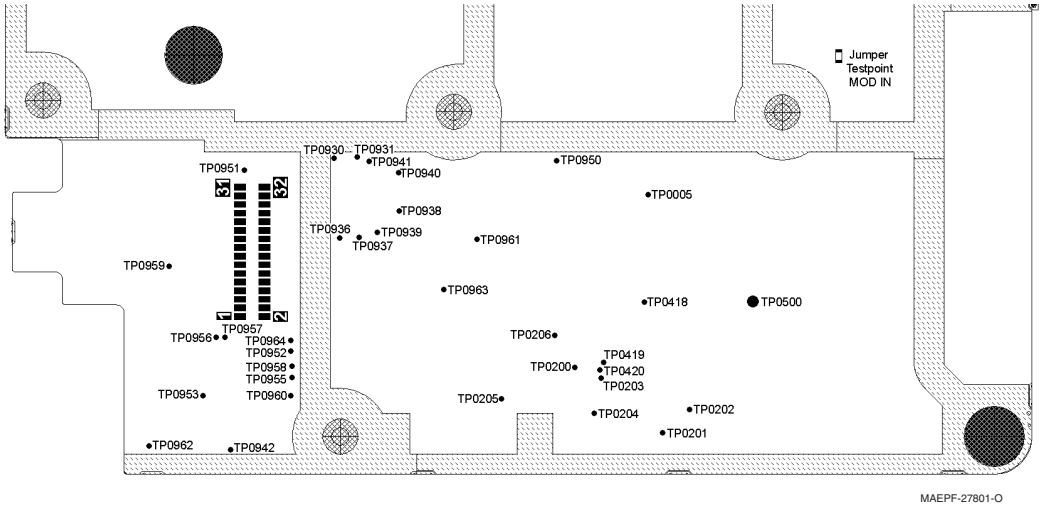


Figure 5-2. Main Board Test Points—Bottom Side (for Mid Power)

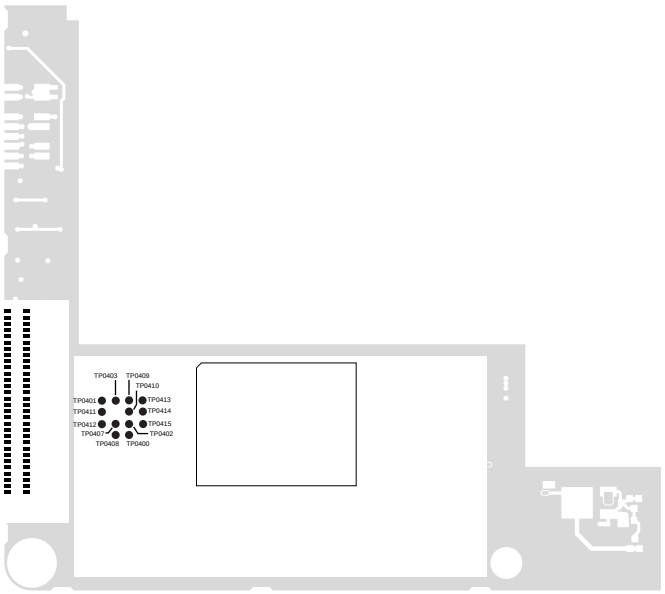


Figure 5-3. Main Board Test Points—Top Side (for High Power)

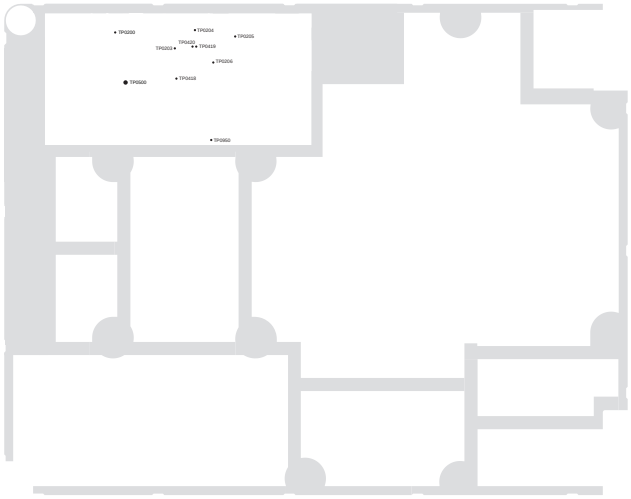


Figure 5-4. Main Board Test Points—Bottom Side (for High Power)

5.5 Board ID Jumper Configuration

The following jumper table (Table 5-5 on page 5-14) is provided for troubleshooting and determining what board revision you have. This can be helpful in the event a jumper was placed incorrectly or was removed during a repair and the radio is not functioning correctly.

This table provides two types of information:

- RF band of the radio
- Overall revision of the main board and controller section

The table indicates what the logic levels are, as well as how they correlate to the placement or removal of a jumper to accomplish the logic level. This is because some of the board ID resistors are on Pull-Up I/O pins and some are on Pull-Down I/O pins. Therefore, the placement or removal of a resistor for a Pull-Up I/O is the opposite of what must be done for the placement or removal of a resistor for a Pull-Down I/O.

Refer to the troubleshooting testpoints chapter for a general idea of where the board ID pins are located. Refer to the board layout for the exact location with respect to all nearby components before attempting to place or remove any jumpers.

Table 5-5. Board ID Jumper Configuration

Board ID2 R0103 Pull-Up	Board ID1 R0102 Pull-Up	Board ID0 R0101 Pull-Up		Band
0 = NP	0 = NP	0 = NP	<-->	700 / 800_35W
0 = NP	0 = NP	1 = Place	<-->	VHF_50W
0 = NP	1 = Place	0 = NP	<-->	UHF_40W
0 = NP	1 = Place	1 = Place	<-->	UHF_R2_45W
1 = Place	0 = NP	0 = NP	<-->	UHF_R1_100W
1 = Place	0 = NP	1 = Place	<-->	VHF_R1_100W

Board ID7 R0125 Pull-Down	Board ID6 R0110 Pull-Down	Board ID5 R0111 Pull-Down	Board ID4 R0123 Pull-Down	Board ID3 R0104 Pull-Up		Con-troller	700-800 MHz	VHF1 50W	UHF1 40W	UHF2 45W
0 = Place	0 = Place	0 = Place	0 = Place	0 = Place	<-->	Reserved				
0 = Place	0 = Place	0 = Place	0 = Place	1 = NP	<-->	Reserved				
0 = Place	0 = Place	0 = Place	1 = NP	0 = Place	<-->	Reserved				REV0/ REVA
0 = Place	0 = Place	0 = Place	1 = NP	1 = NP	<-->	Reserved				
0 = Place	0 = Place	1 = NP	0 = Place	0 = Place	<-->	Reserved	Reserved	Reserved	Reserved	Reserved
0 = Place	0 = Place	1 = NP	0 = Place	1 = NP	<-->	REV0	REV0	Reserved	Reserved	Reserved
0 = Place	0 = Place	1 = NP	1 = NP	0 = Place	<-->	REVA	NA	Reserved	Reserved	Reserved
0 = Place	0 = Place	1 = NP	1 = NP	1 = NP	<-->	REVA	NA	NA	REV0	
0 = Place	1 = NP	0 = Place	0 = Place	0 = Place	<-->	REVB	REVA	REV0	REVA	

Note: NP = Not Placed

5.6 Flowcharts

This section contains the troubleshooting flowcharts that can help you isolate a problem in your radio.

5.6.1 Poor RX Sensitivity or No RX Audio (136–174 MHz)—Part 1 of 2

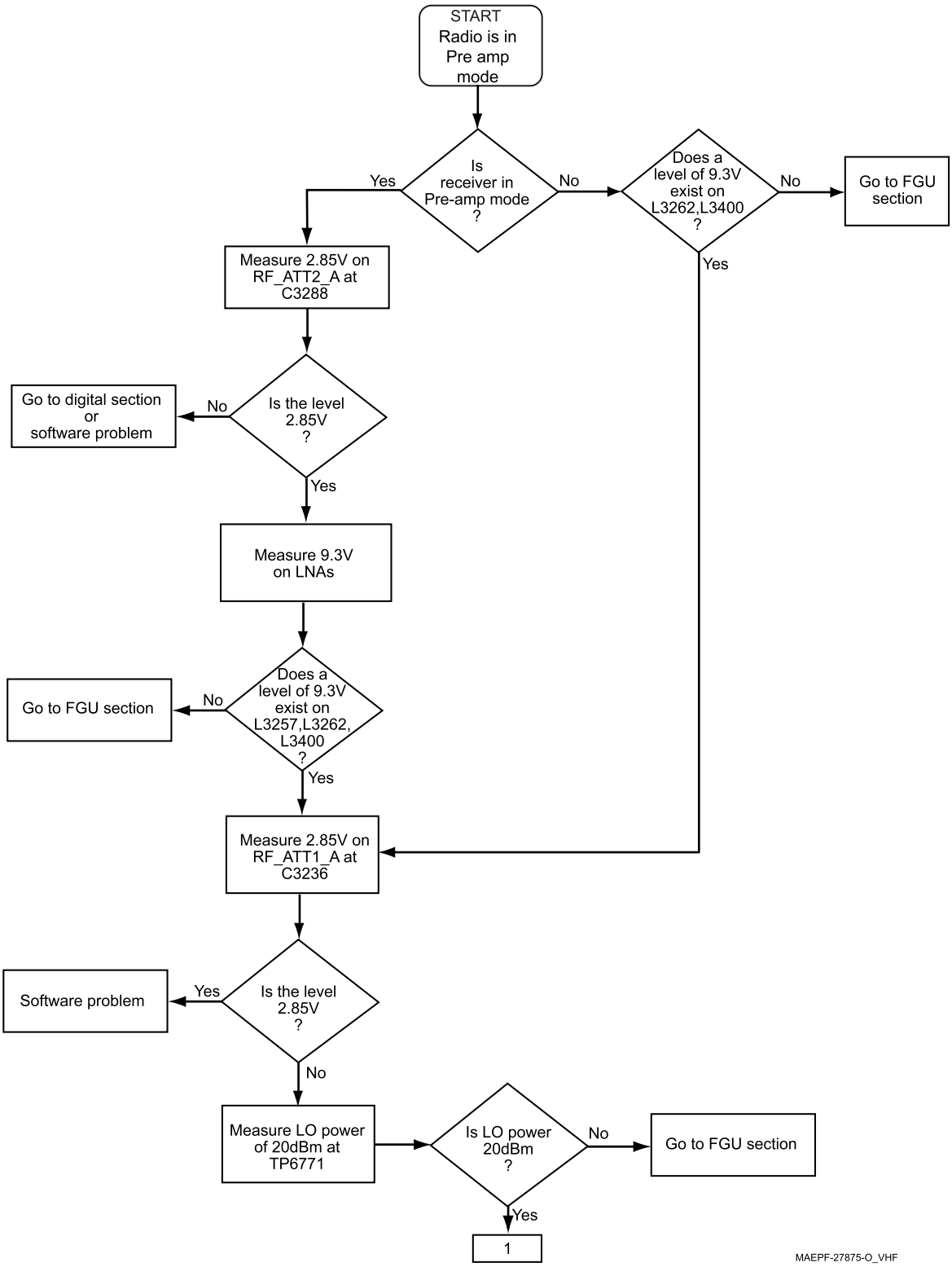


Figure 5-5. Poor RX Sensitivity or No RX Audio (136–174 MHz)—Part 1 of 2

5.6.2 Poor RX Sensitivity or No RX Audio (136–174 MHz)—Part 2 of 2

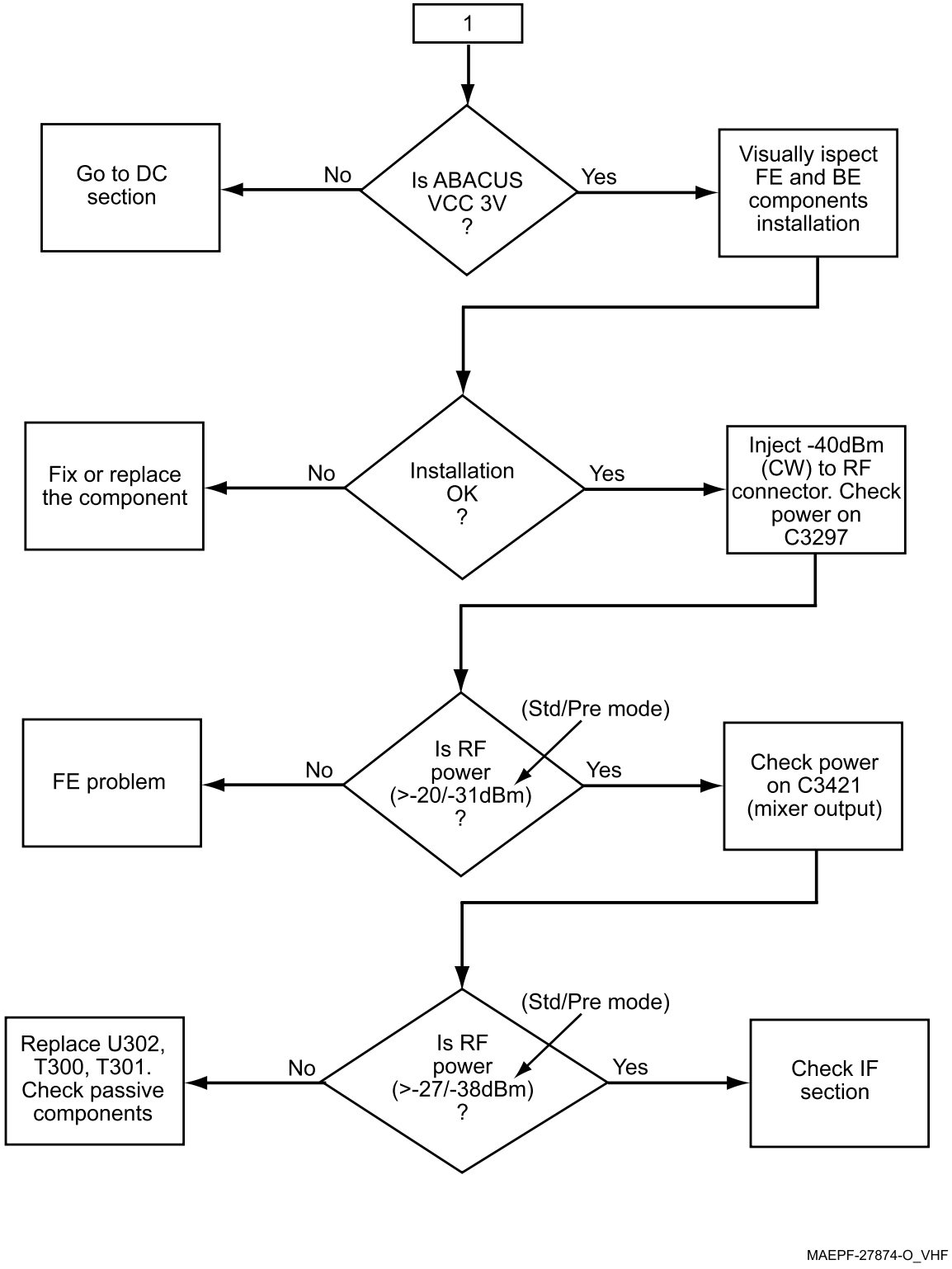


Figure 5-6. Poor RX Sensitivity or No RX Audio (136–174 MHz)—Part 2 of 2

5.6.3 RX IF—Poor SINAD or No Audio (136–174 MHz)

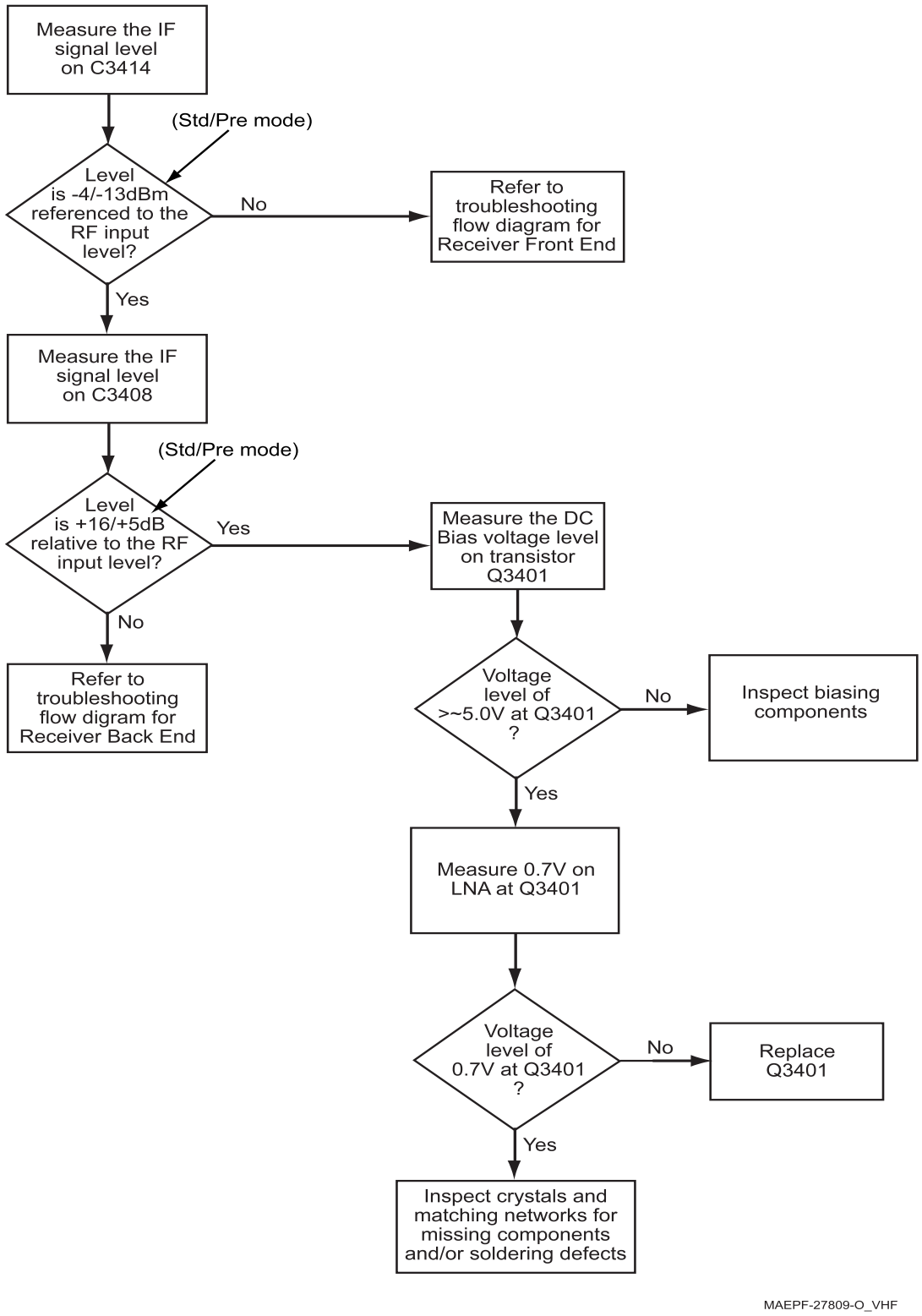


Figure 5-7. RX IF—Poor SINAD or No Audio (136–174 MHz)

5.6.4 RX Back-End—Poor SINAD or No Audio (136–174 MHz)—Part 1 of 3

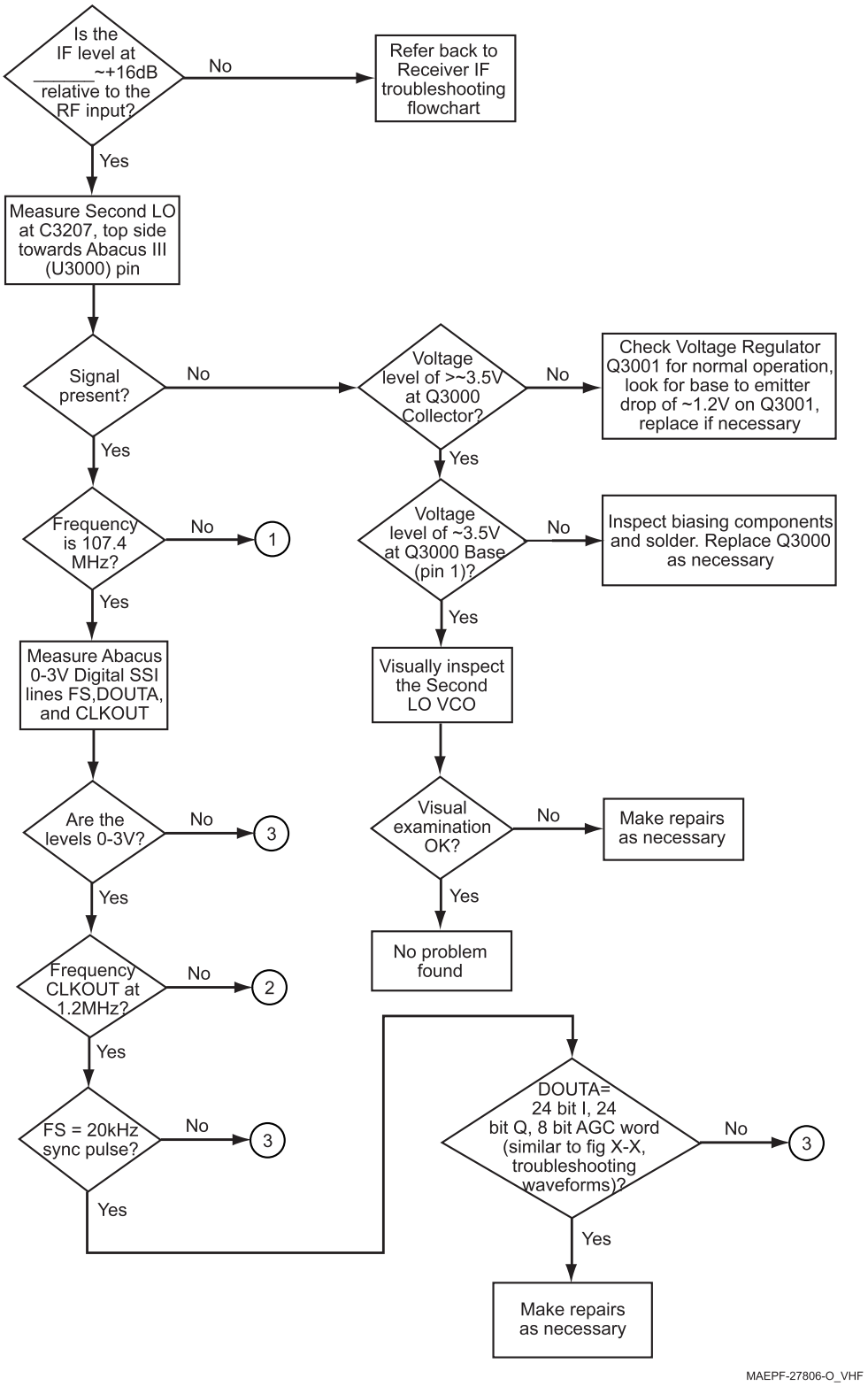


Figure 5-8. RX Back-End—Poor SINAD or No Audio (136–174 MHz)—Part 1 of 3

5.6.5 RX Back-End—Poor SINAD or No Audio (136–174 MHz)—Part 2 of 3

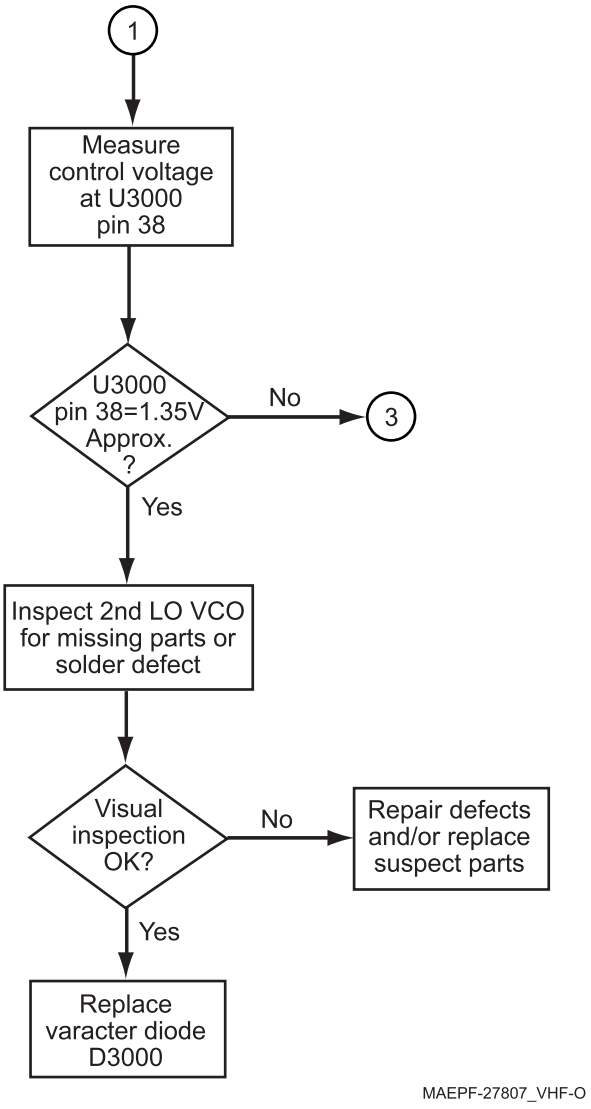


Figure 5-9. RX Back-End—Poor SINAD or No Audio (136–174 MHz)—Part 2 of 3

5.6.6 RX Back-End—Poor SINAD or No Audio (136–174 MHz)—Part 3 of 3

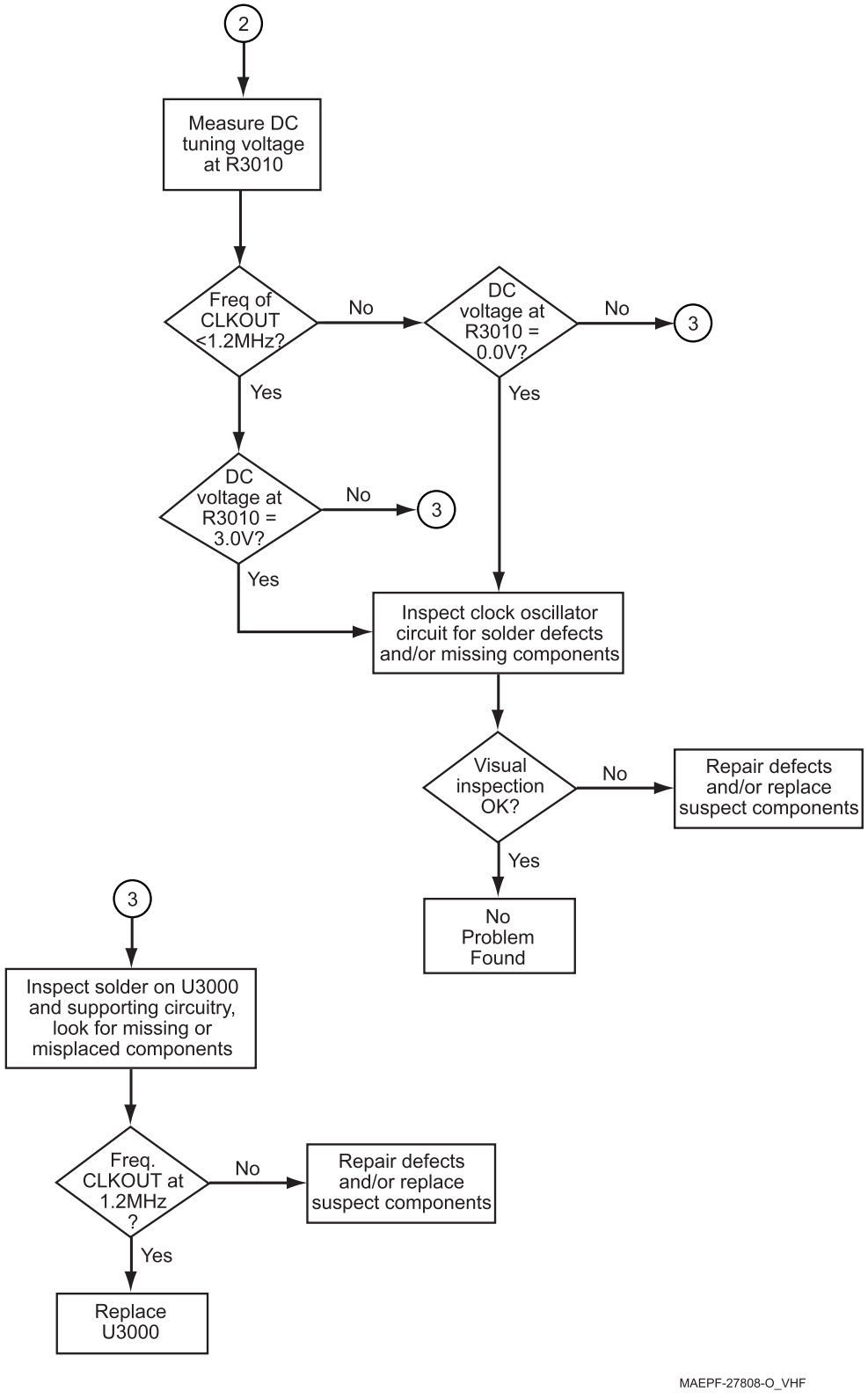


Figure 5-10. RX Back-End—Poor SINAD or No Audio (136–174 MHz)—Part 3 of 3

5.6.7 Low or No RX Injection Signal (136–174 MHz)

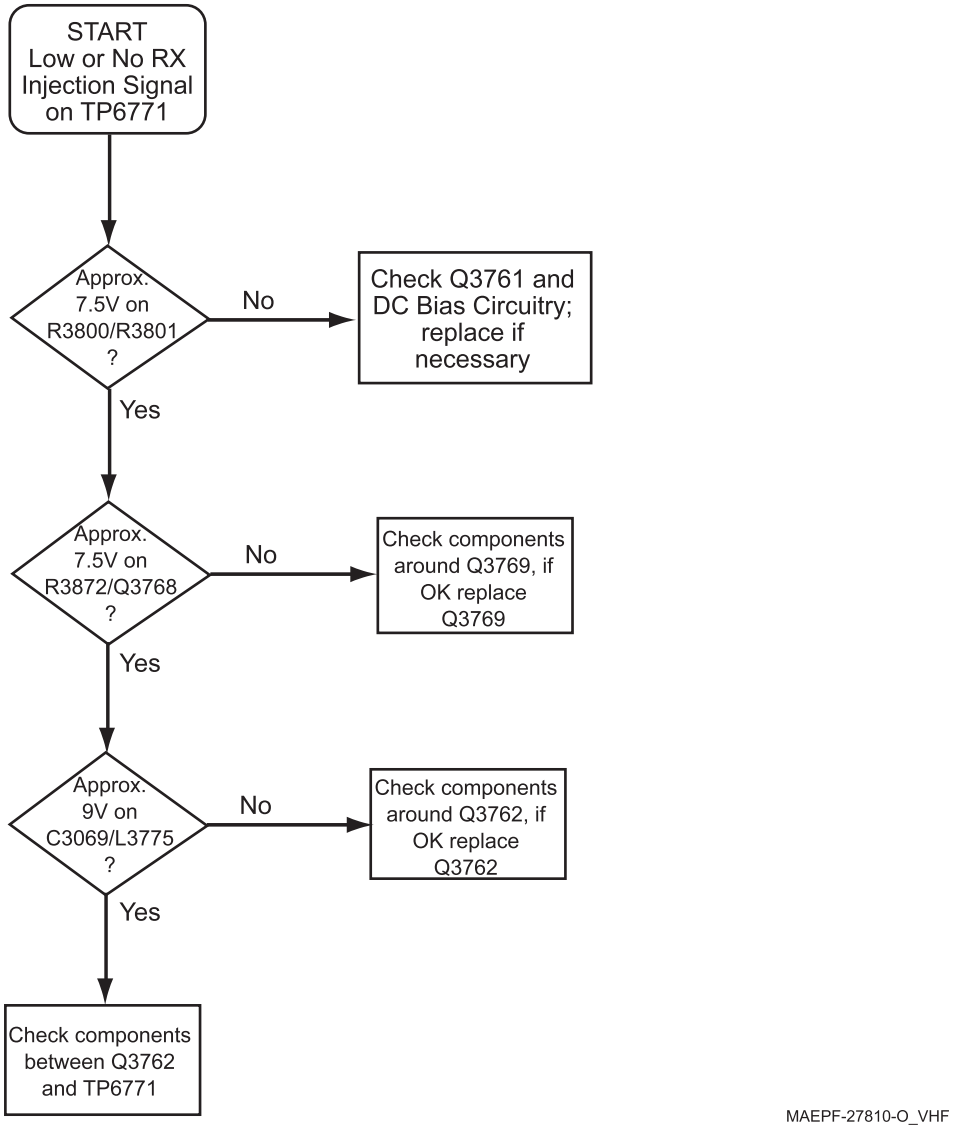


Figure 5-11. Low or No RX Injection Signal (136–174 MHz)

5.6.8 Low or No TX Injection Signal (136–174 MHz)

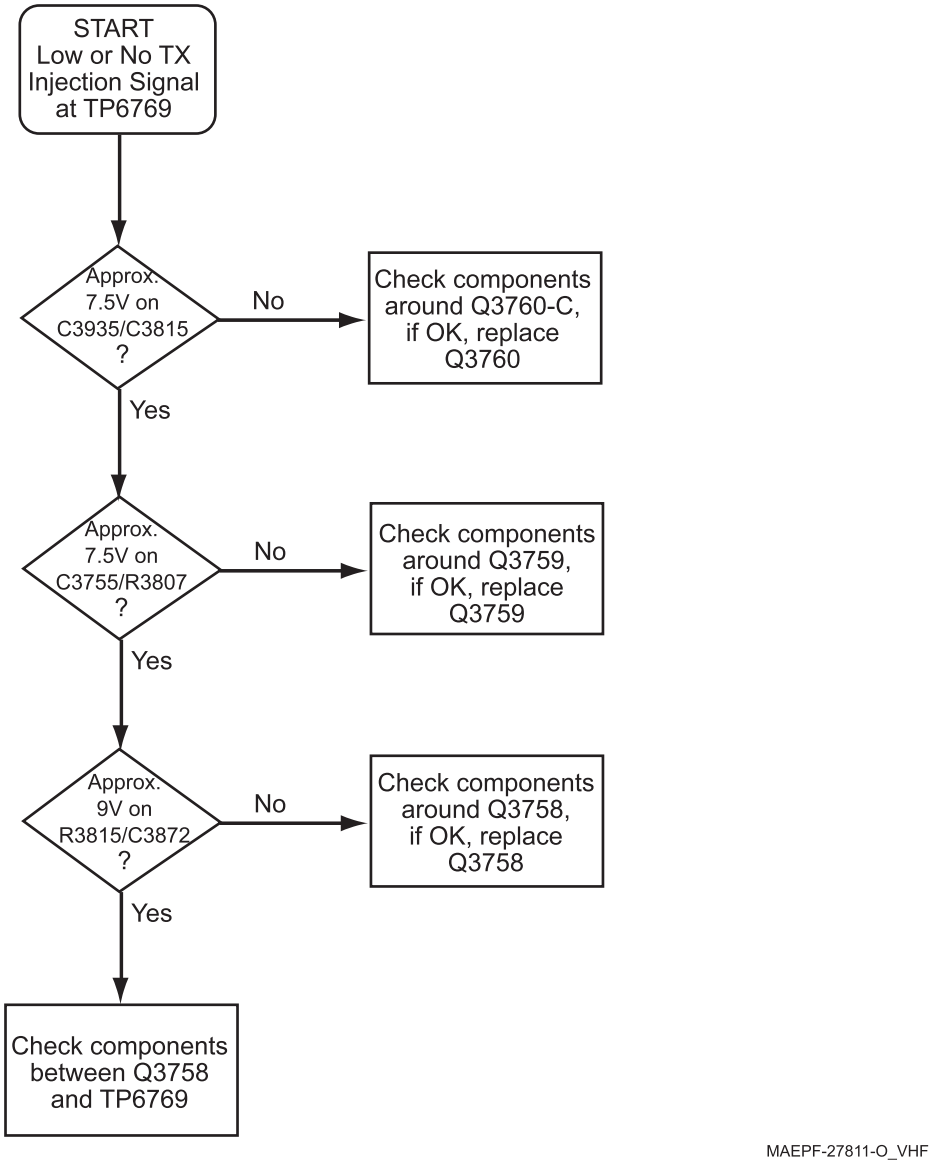


Figure 5-12. Low or No TX Injection Signal (136–174 MHz)

5.6.9 TX or RX VCO Unlock (Fail 001) (136–174 MHz)—Part 1 of 2

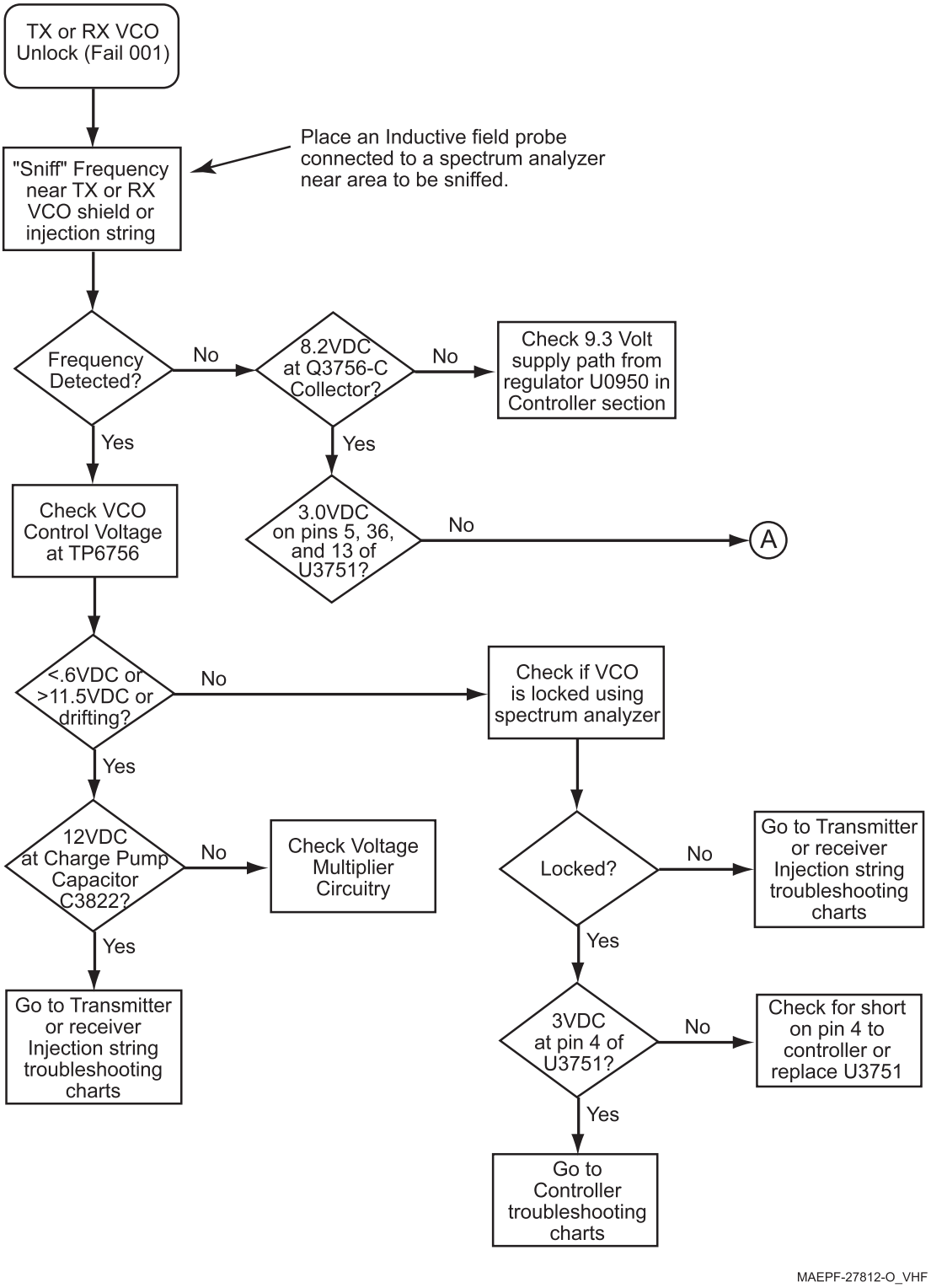


Figure 5-13. TX or RX VCO Unlock (Fail 001) (136–174 MHz)—Part 1 of 2

5.6.10 TX or RX VCO Unlock (Fail 001) (136–174 MHz)—Part 2 of 2

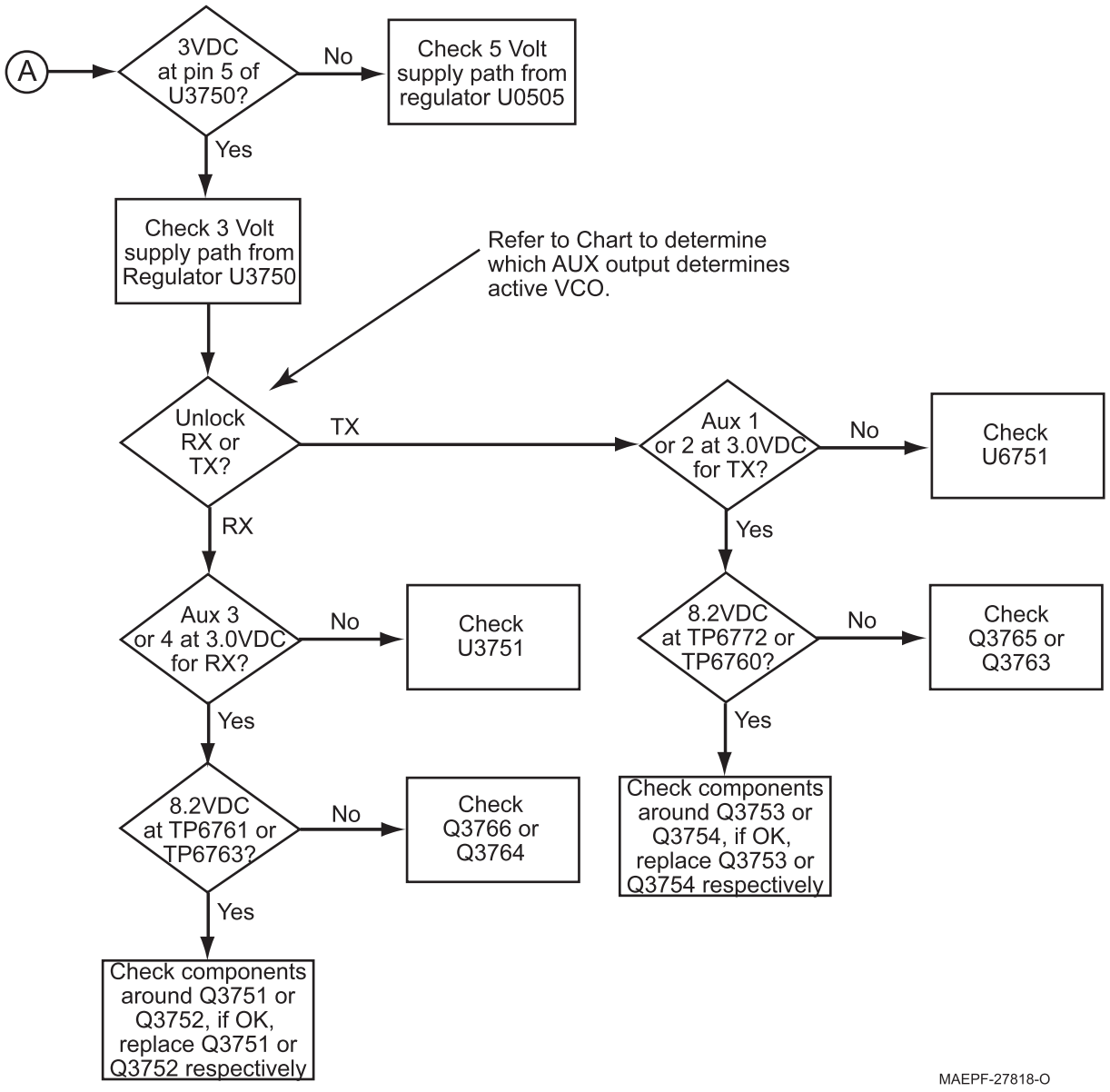


Figure 5-14. TX or RX VCO Unlock (Fail 001) (136–174 MHz)—Part 2 of 2

5.6.11 No Output Power at TX Mode (136–174 MHz)

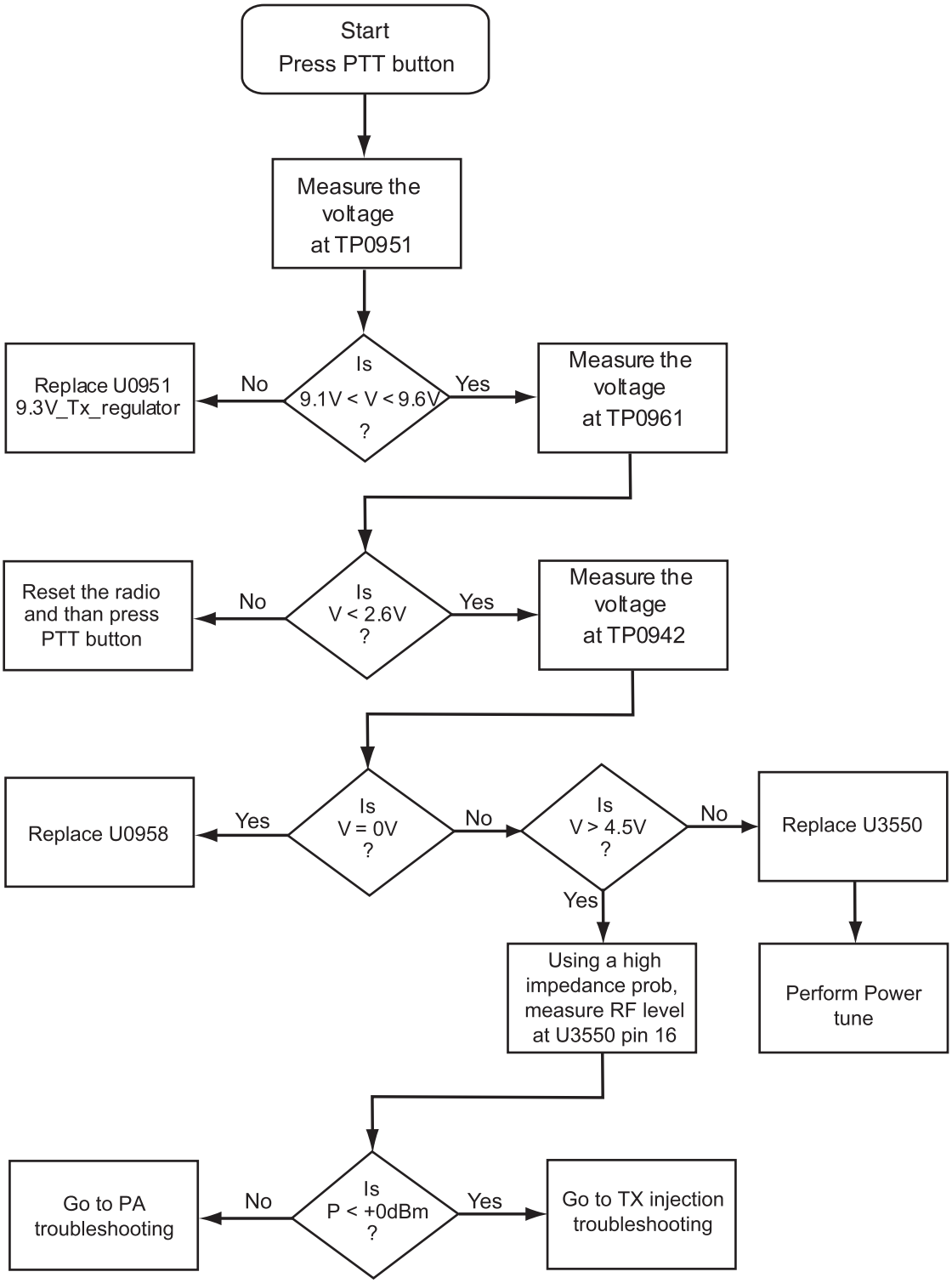


Figure 5-15. No Output Power at TX Mode (136–174 MHz)

5.6.12 No Output Power and IDC < 2A at TX Mode (136–174 MHz)

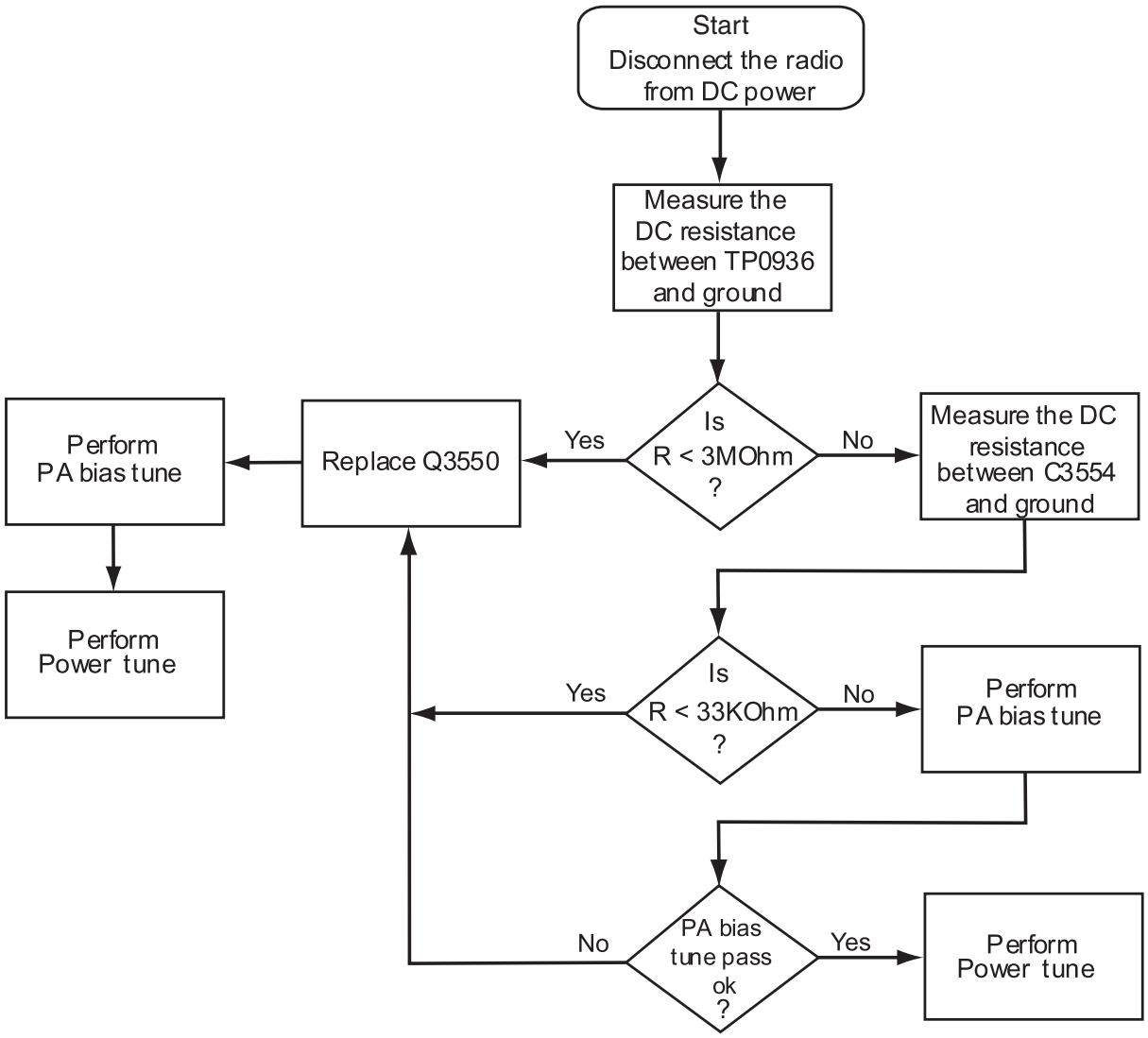
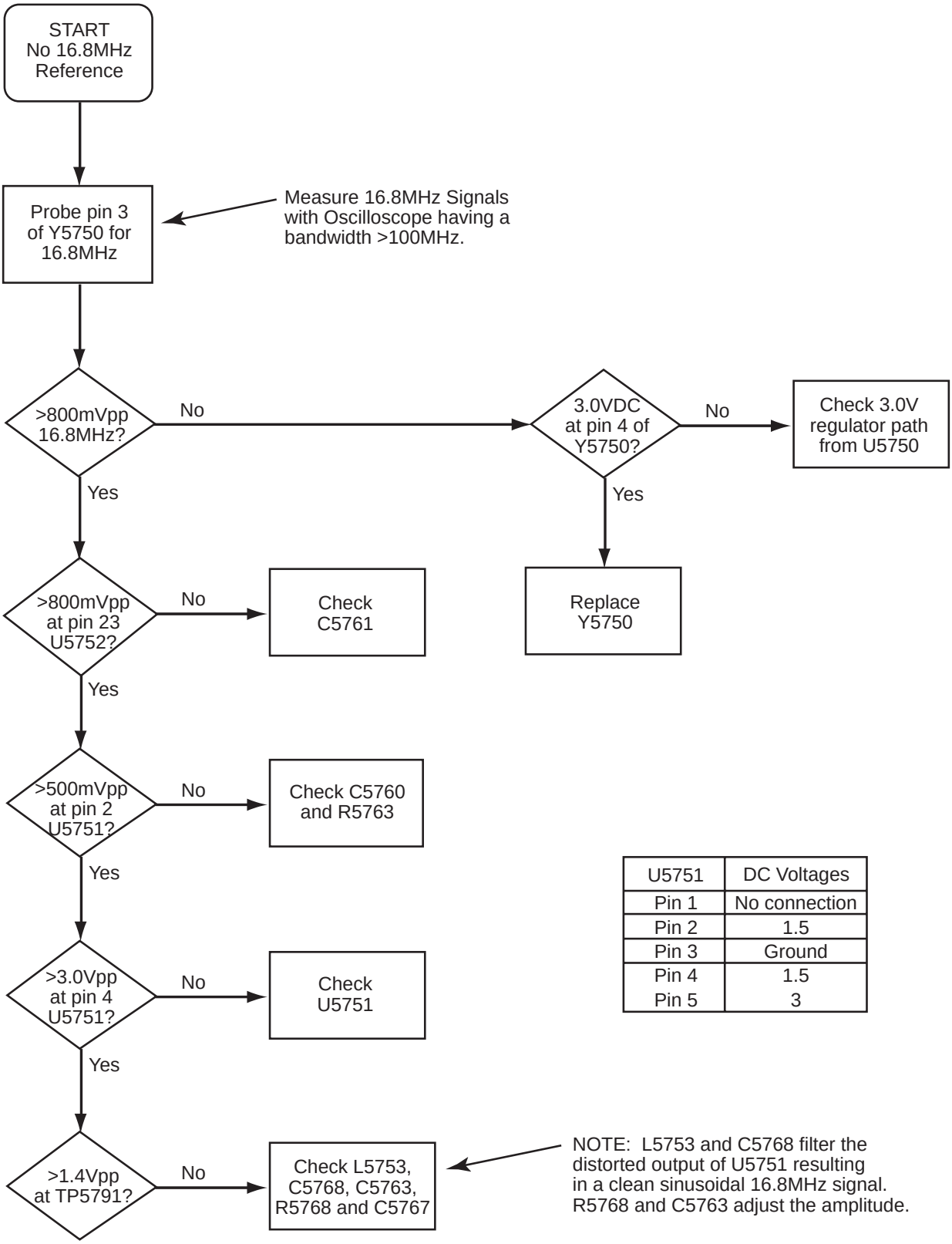


Figure 5-16. No Output Power and IDC < 2A at TX Mode (136–174 MHz)

5.6.13 No 16.8 MHz Reference Oscillator Frequency (380–470 MHz and 450–520 MHz)



U5751	DC Voltages
Pin 1	No connection
Pin 2	1.5
Pin 3	Ground
Pin 4	1.5
Pin 5	3

Figure 5-17. No 16.8 MHz Reference Oscillator Frequency (380–470 MHz and 450–520 MHz)

5.6.14 Poor RX Sensitivity or No RX Audio (380–470 MHz and 450–520 MHz)—Part 1 of 2

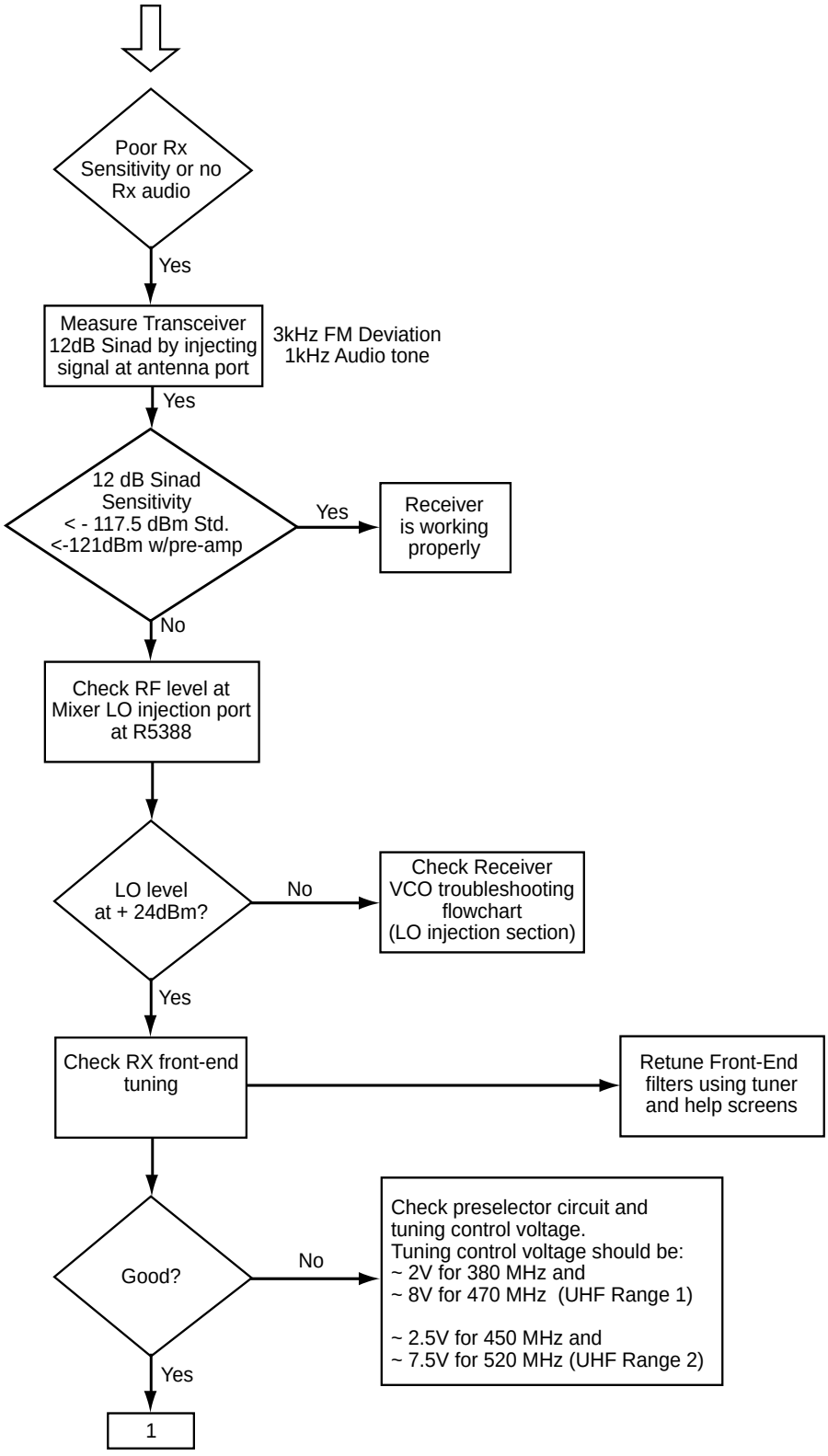


Figure 5-18. Poor RX Sensitivity or No RX Audio (380–470 MHz and 450–520 MHz)—Part 1 of 2

5.6.15 Poor RX Sensitivity or No RX Audio (380–470 MHz and 450–520 MHz)—Part 2 of 2

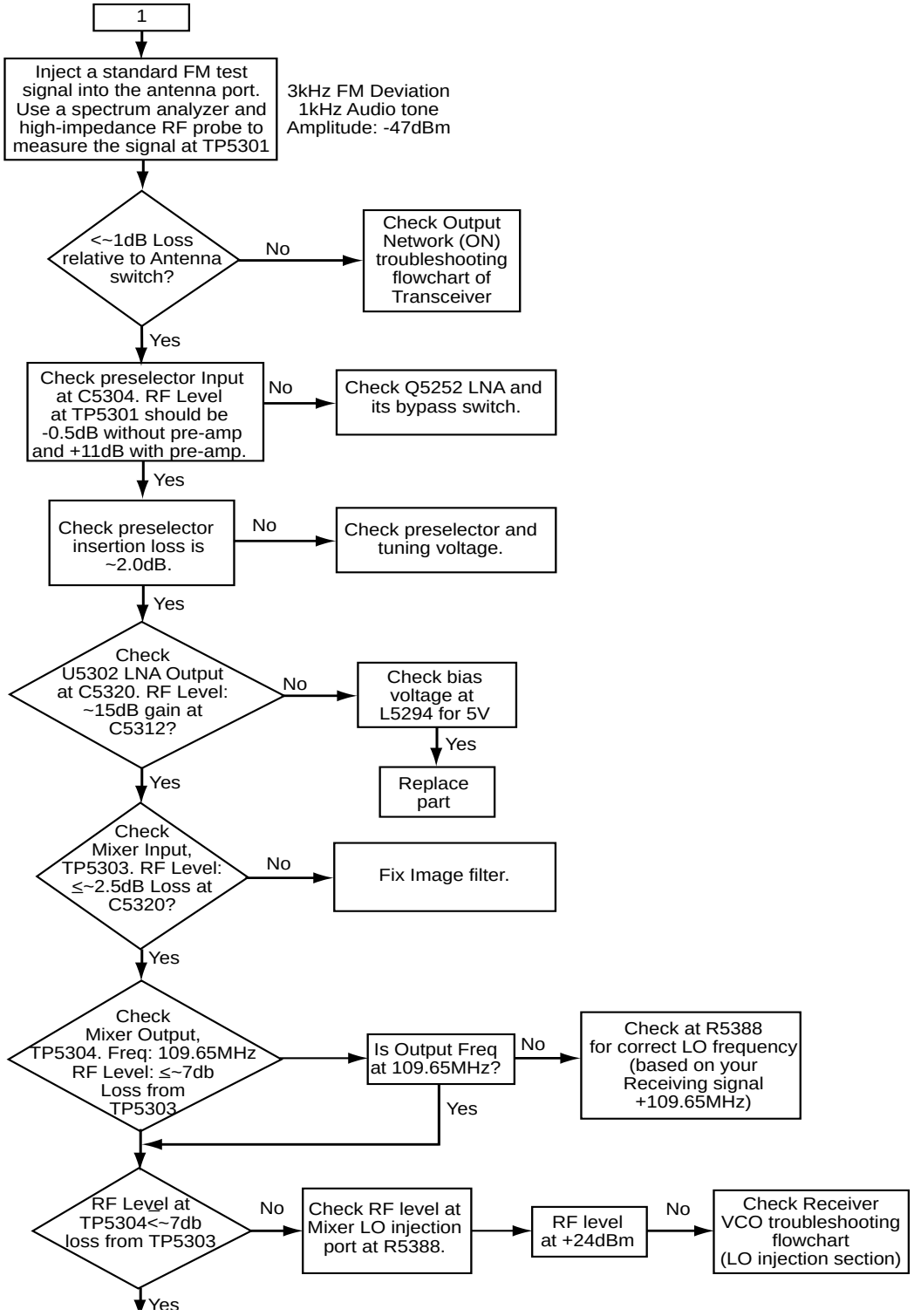


Figure 5-19. Poor RX Sensitivity or No RX Audio (380–470 MHz and 450–520 MHz)—Part 2 of 2

5.6.16 RX IF—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 1 of 2

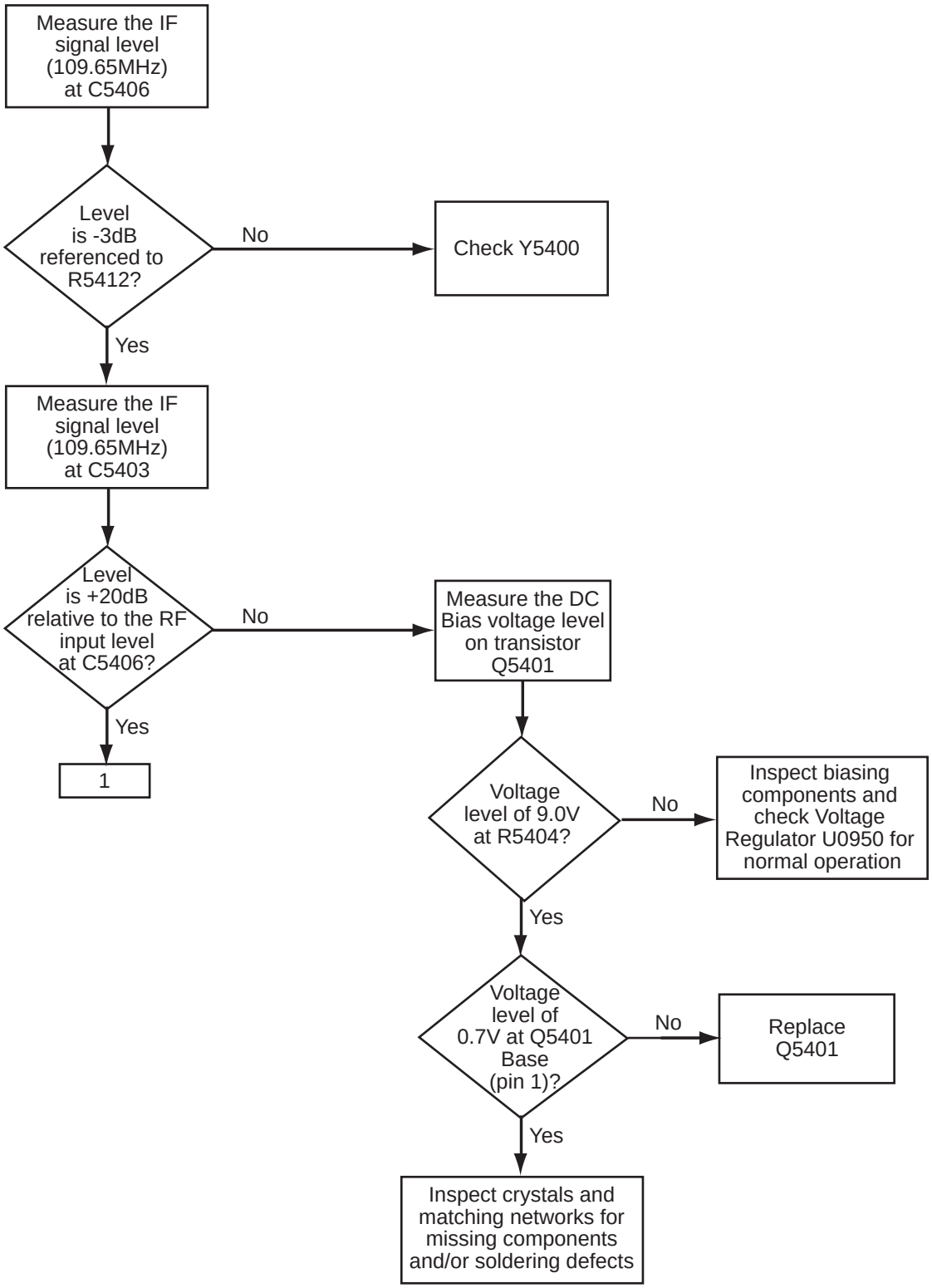


Figure 5-20. RX IF—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 1 of 2

5.6.17 RX IF—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 2 of 2

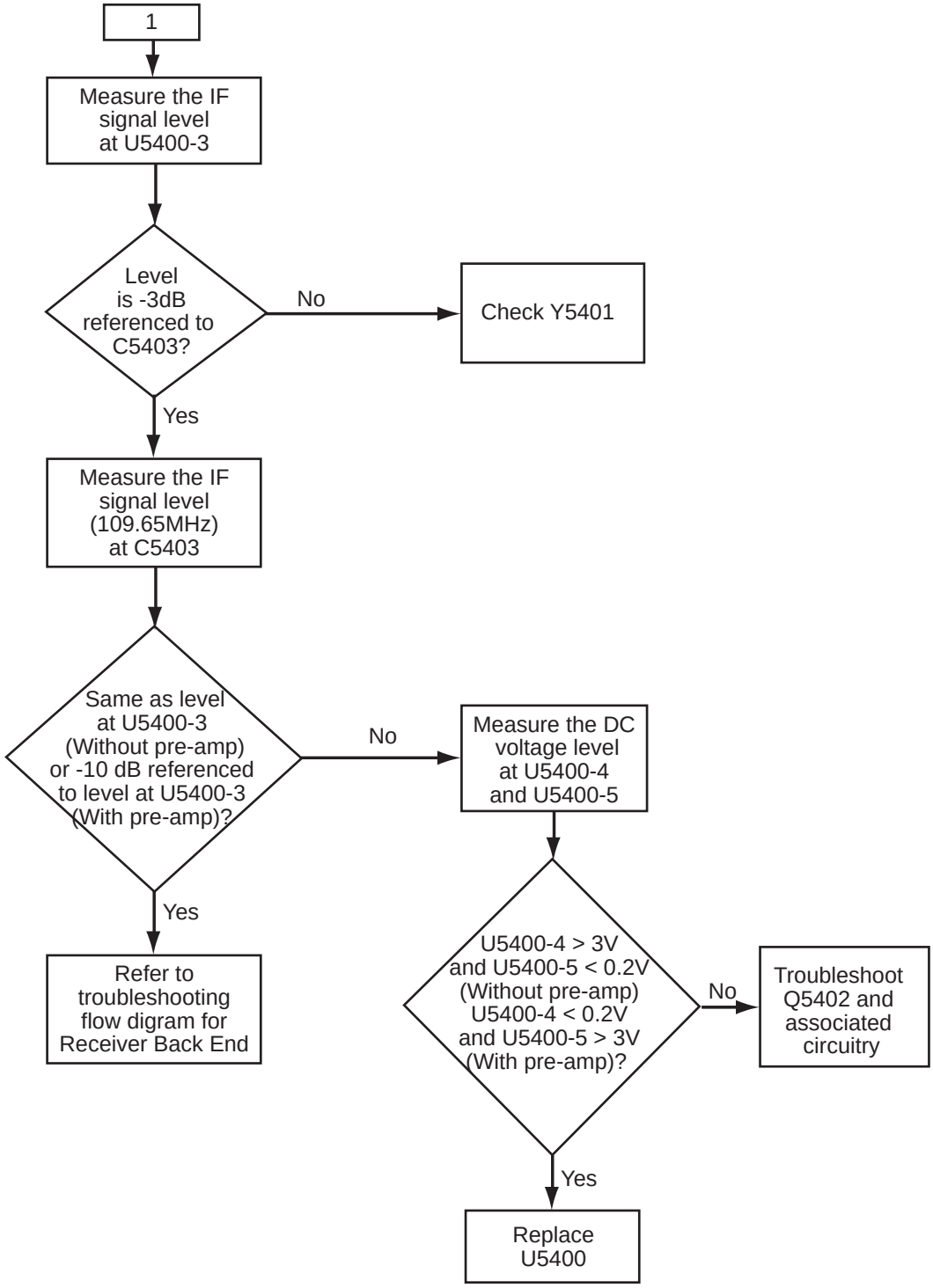


Figure 5-21. RX IF—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 2 of 2

5.6.18 RX Back-End—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 1 of 3

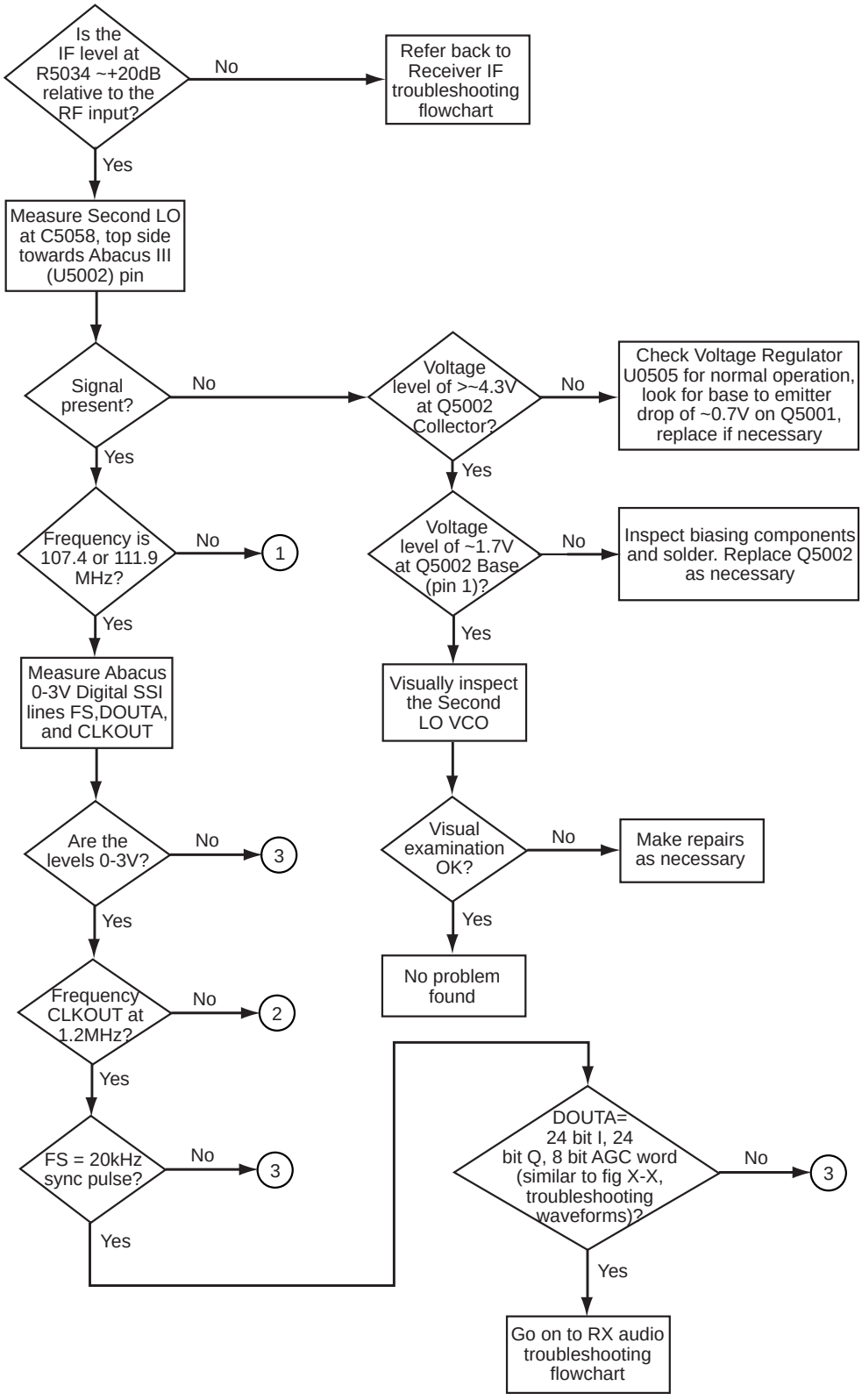


Figure 5-22. RX Back-End—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 1 of 3

5.6.19 RX Back-End—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 2 of 3

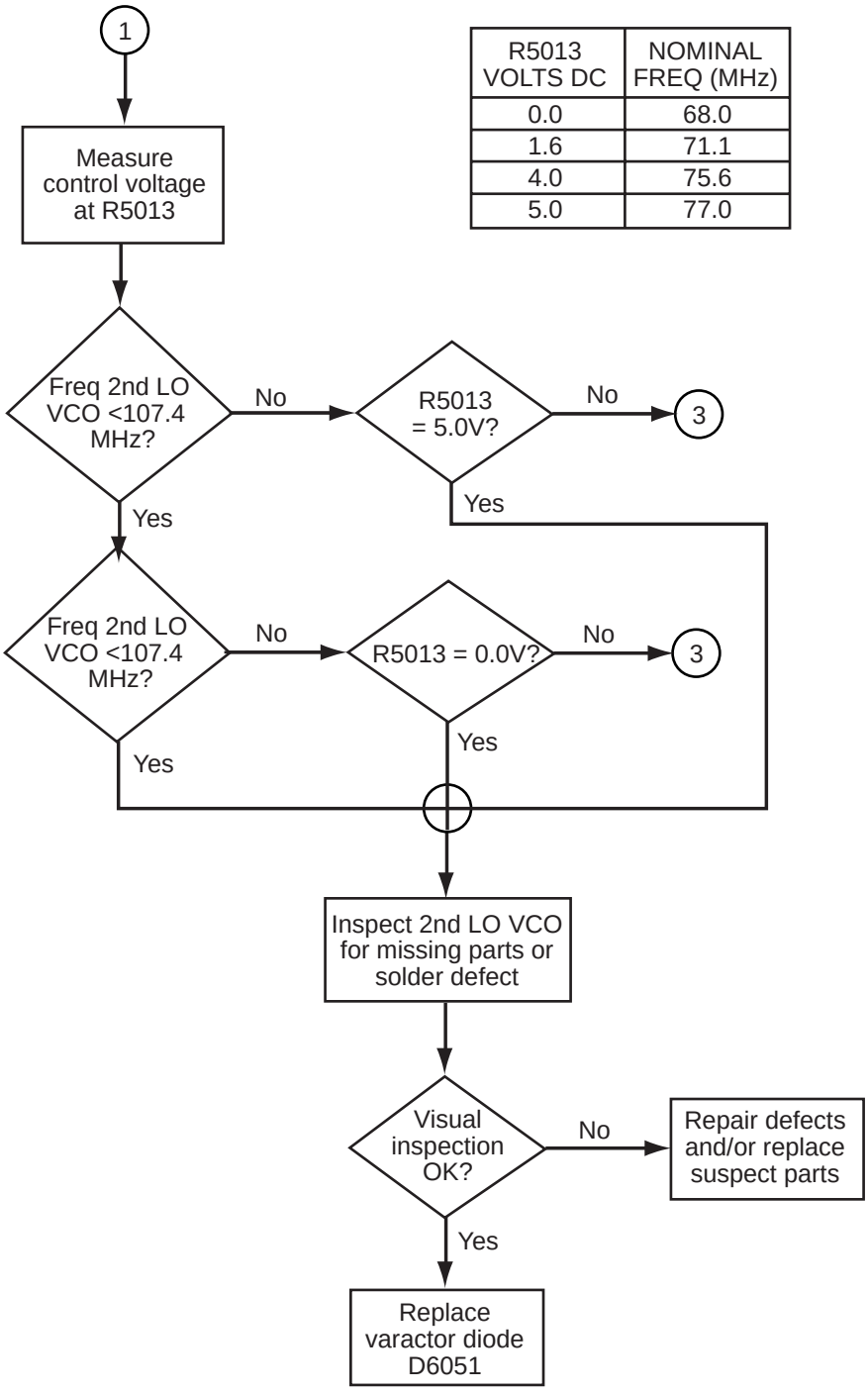


Figure 5-23. RX Back-End—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 2 of 3

5.6.20 RX Back-End — Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 3 of 3

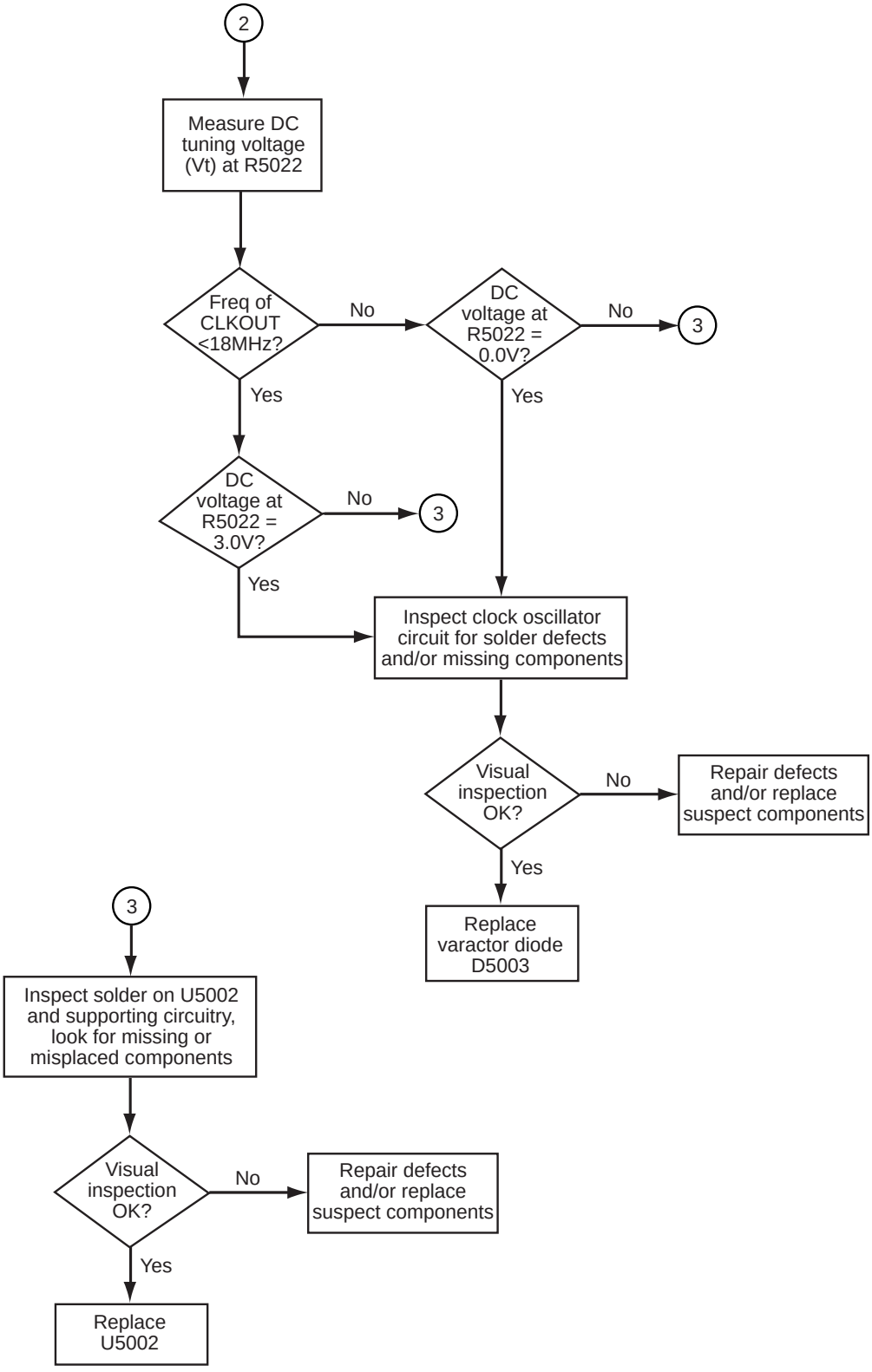


Figure 5-24. RX Back-End—Poor SINAD or No Audio (380–470 MHz and 450–520 MHz)—Part 3 of 3

5.6.21 Low or No RX Injection Signal (380–470 MHz and 450–520 MHz)

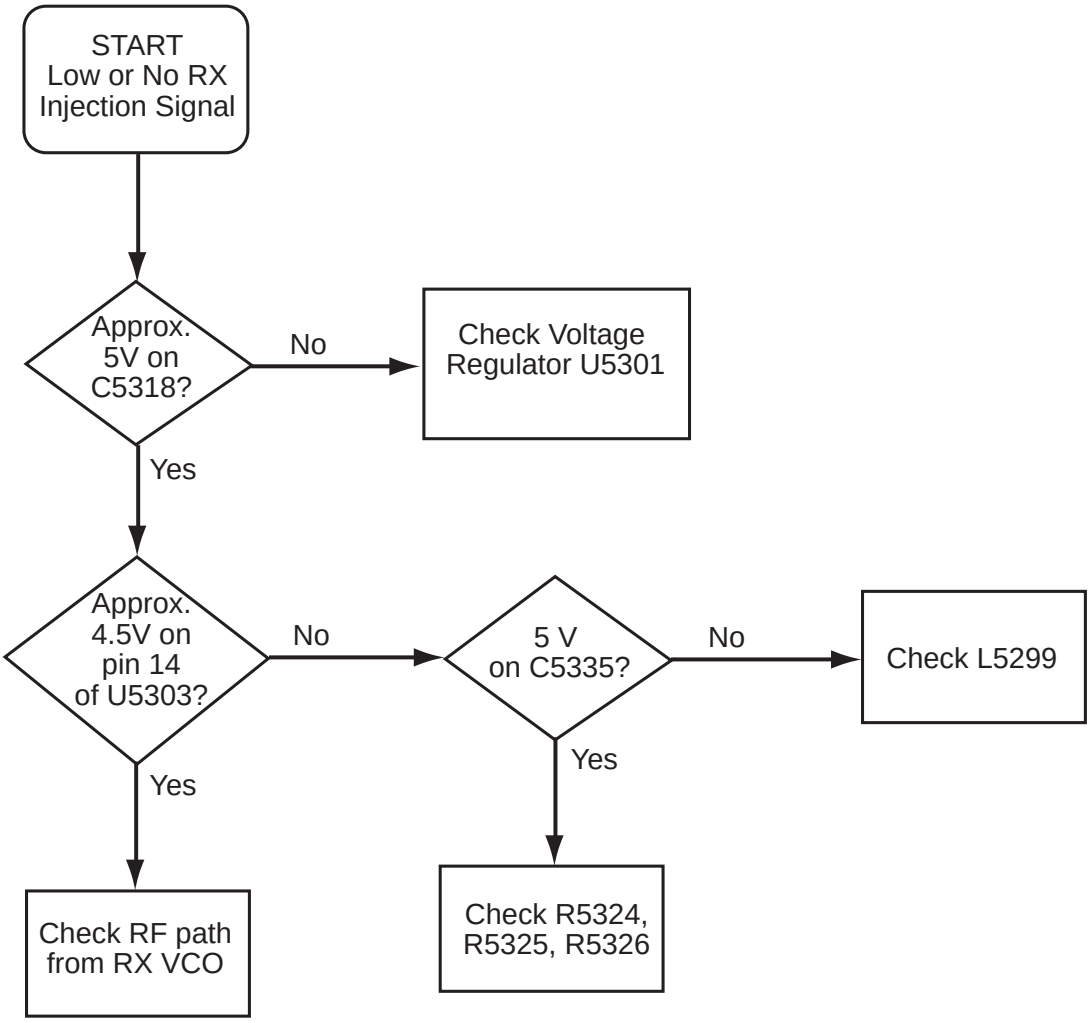


Figure 5-25. Low or No RX Injection Signal (380–470 MHz and 450–520 MHz)

5.6.22 Low or No TX Injection Signal (380–470 MHz and 450–520 MHz)

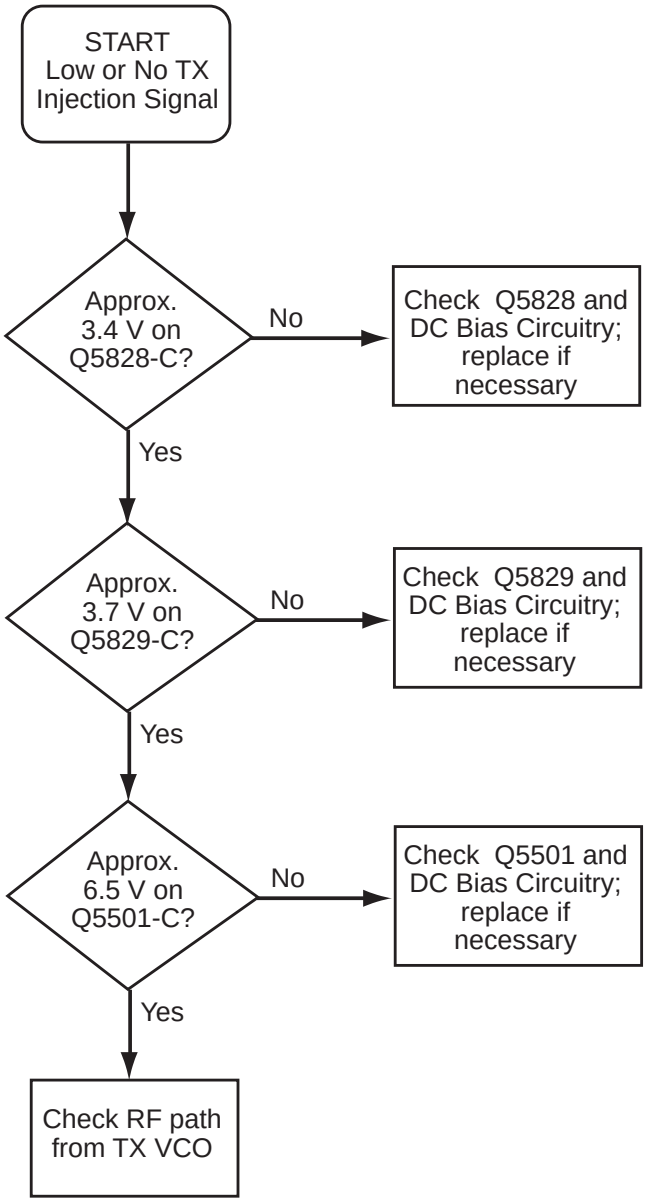


Figure 5-26. Low or No TX Injection Signal (380–470 MHz and 450–520 MHz)

5.6.23 No TX Audio (380–470 MHz and 450–520 MHz)

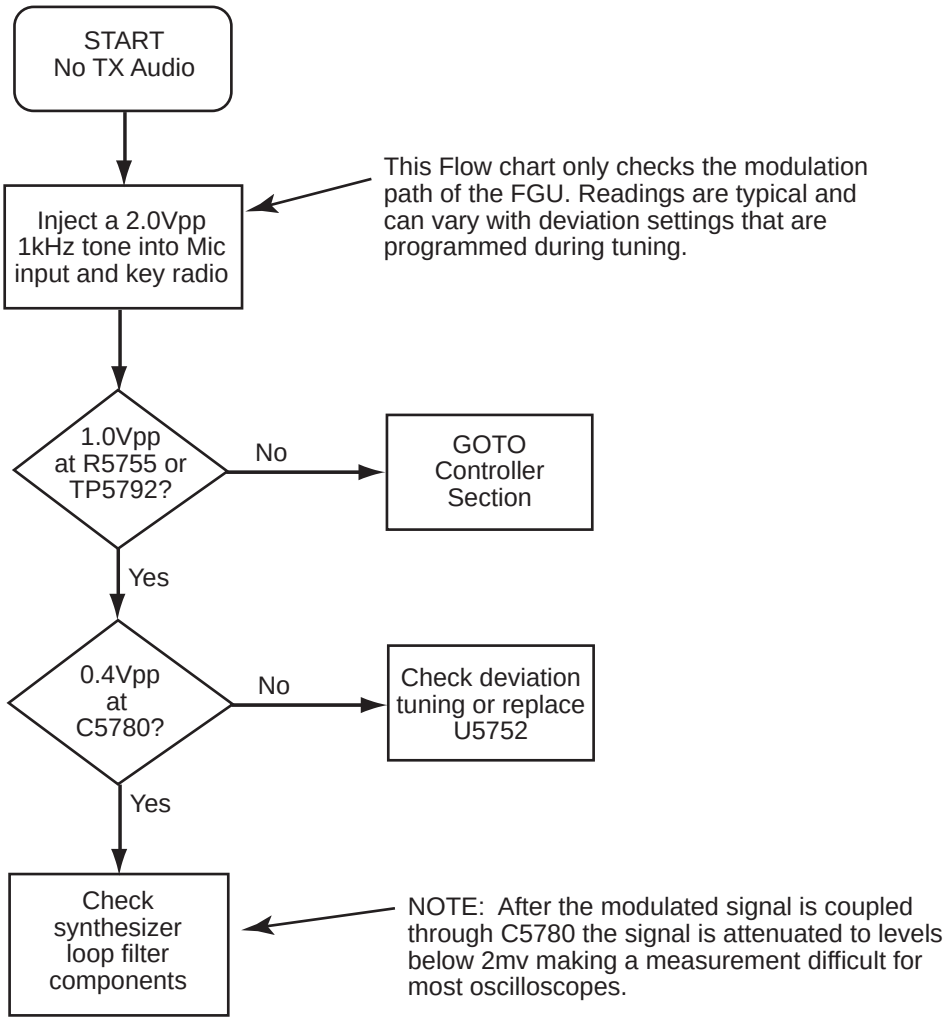


Figure 5-27. No TX Audio (380–470 MHz and 450–520 MHz)

5.6.24 TX or RX VCO Unlock (Fail 001) (380–470 MHz and 450–520 MHz)—Part 1 of 2

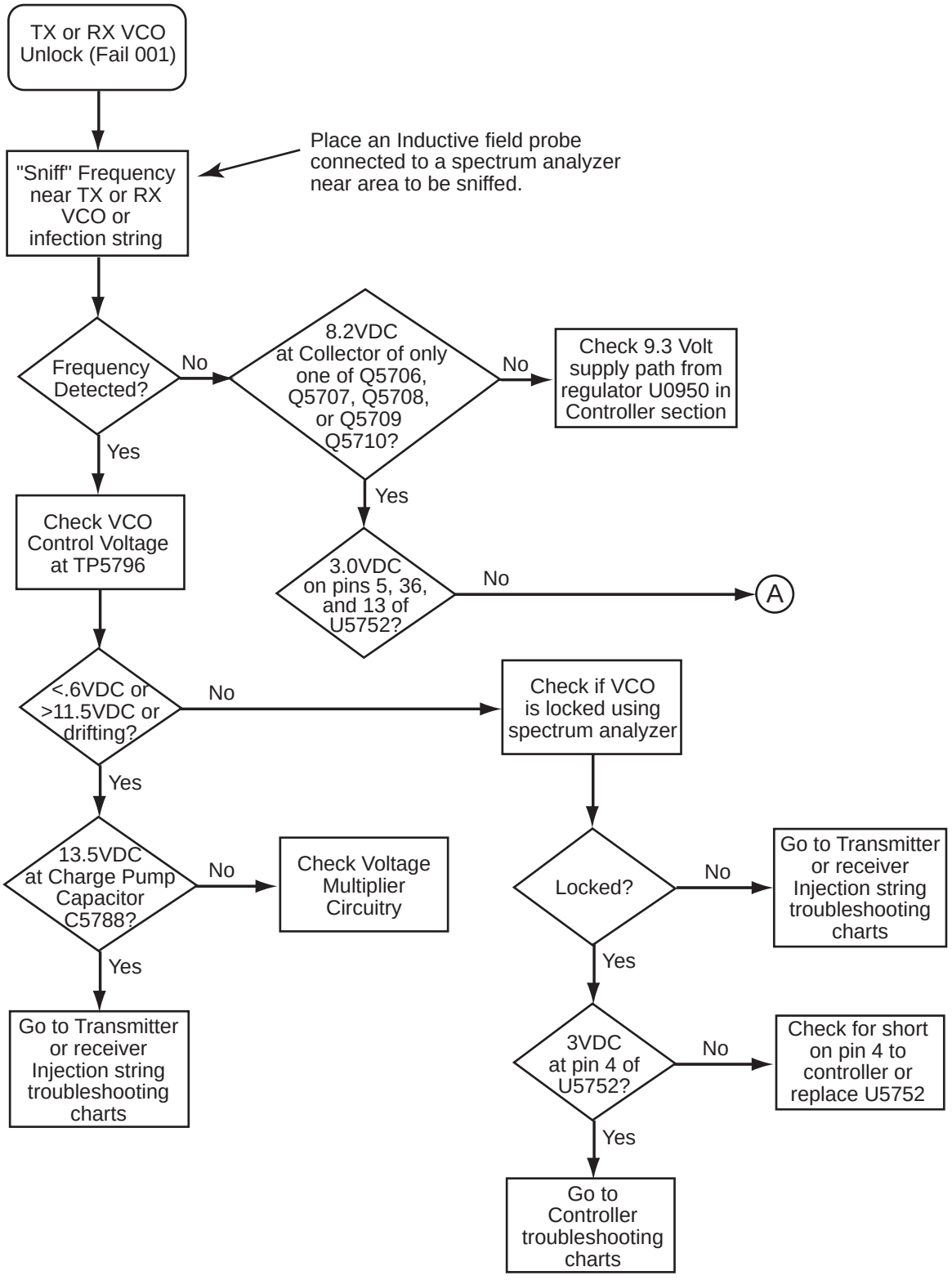


Figure 5-28. TX or RX VCO Unlock (Fail 001) (380–470 MHz and 450–520 MHz)—Part 1 of 2

5.6.25 TX or RX VCO Unlock (Fail 001) (380–470 MHz and 450–520 MHz)—Part 2 of 2

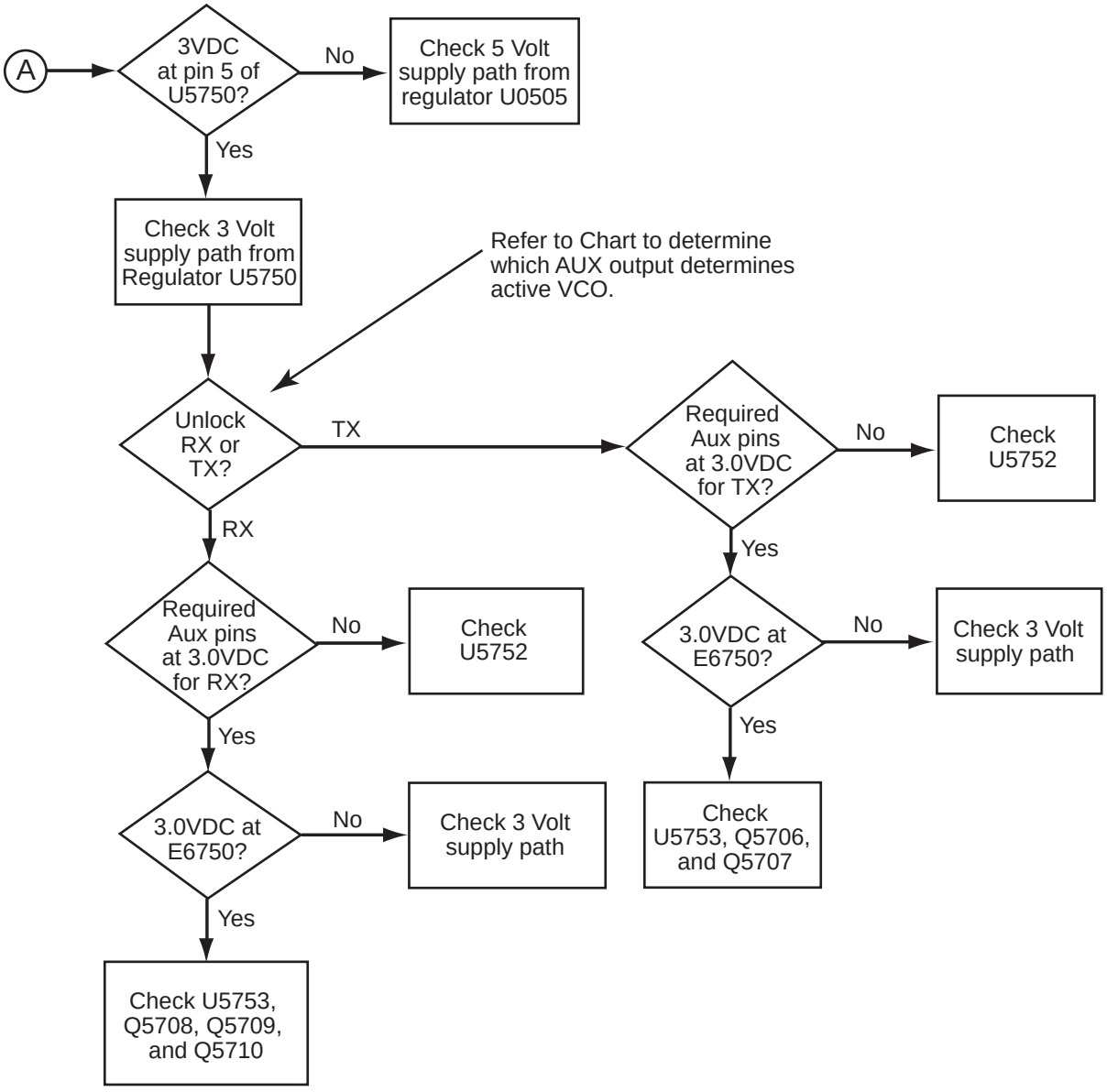


Figure 5-29. TX or RX VCO Unlock (Fail 001) (380–470 MHz and 450–520 MHz)—Part 2 of 2

5.6.26 RF Power Amplifier (RFPA)—No or Low TX Power Output (380–470 MHz and 450–520 MHz)—Part 1 of 5

NOTE: For each flowchart step in which reference is made to a note, be sure to refer to that specific note (located on page 61 of this flowchart) for guidance in performing the actual troubleshooting procedure. Also, RFPA DC voltages are shown in Table 5-6 on page 5-44.

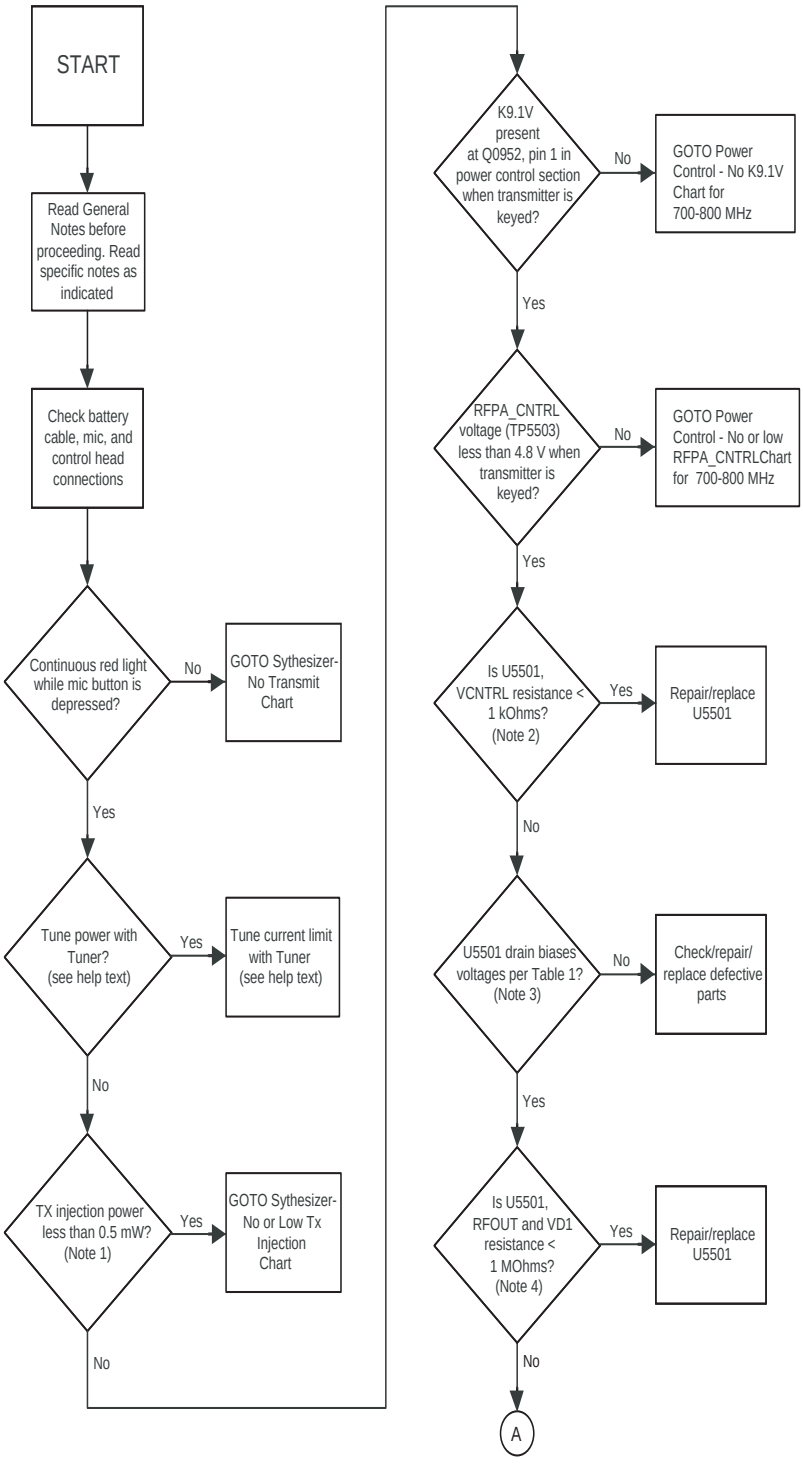


Figure 5-30. RF Power Amplifier (RFPA)—No or Low TX Power Output (380–470 MHz and 450–520 MHz)—Part 1 of 5

5.6.27 RF Power Amplifier (RFPA)—No or Low TX Power Output (380–470 MHz and 450–520 MHz)—Part 2 of 5

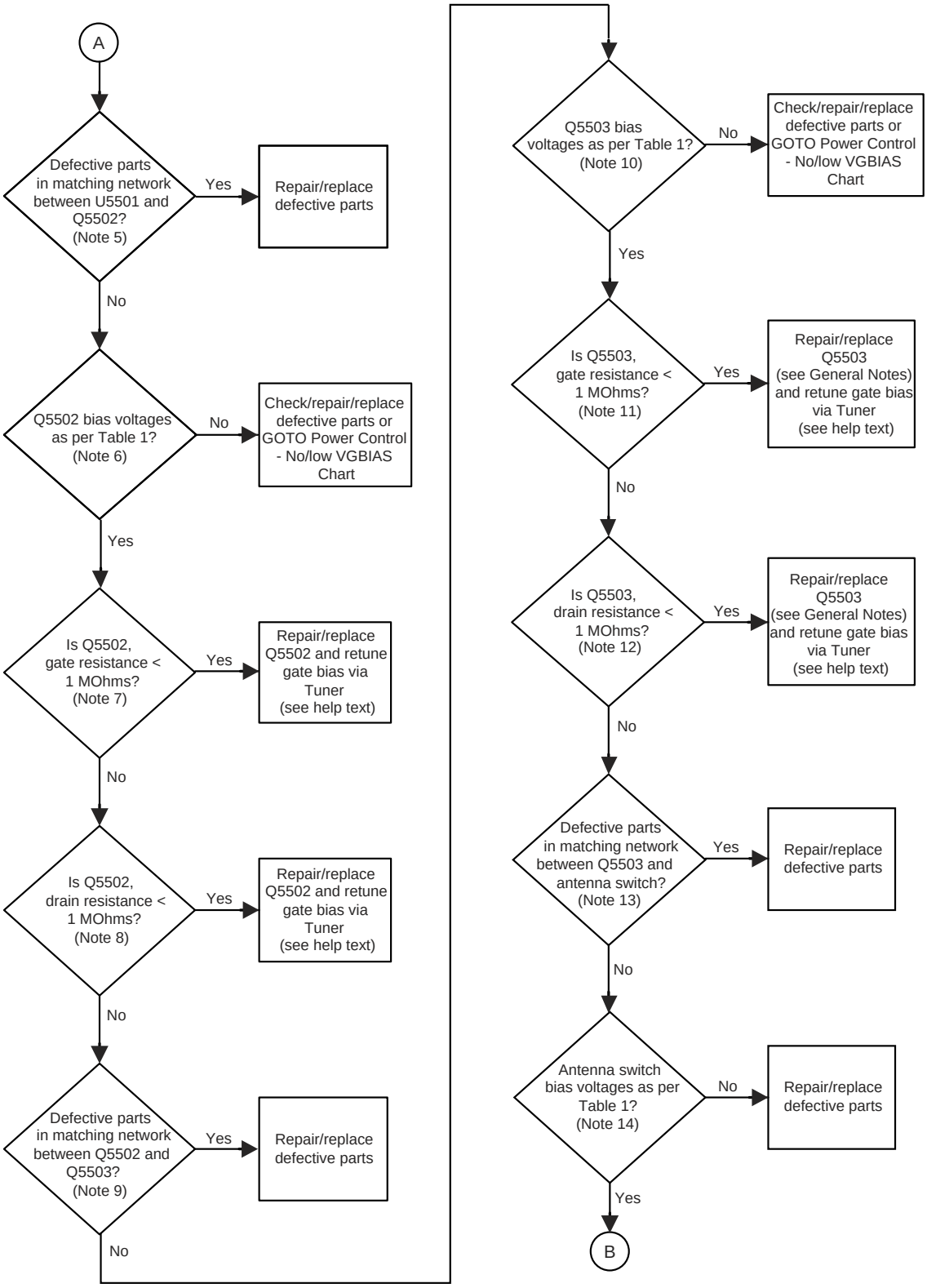


Figure 5-31. RF Power Amplifier (RFPA)—No or Low TX Power Output (380–470 MHz and 450–520 MHz)—Part 2 of 5

5.6.28 RF Power Amplifier (RFPA)—No or Low TX Power Output (380–470 MHz and 450–520 MHz)—Part 3 of 5

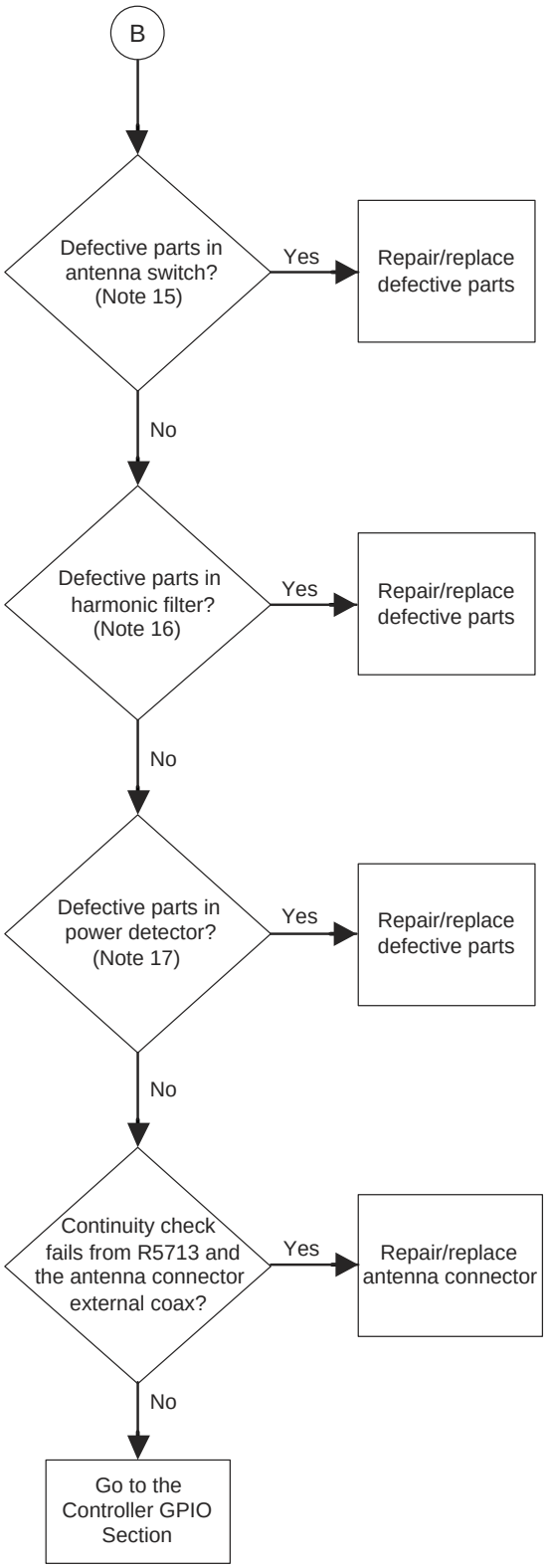


Figure 5-32. RF Power Amplifier (RFPA)—No or Low TX Power Output (380–470 MHz and 450–520 MHz)—Part 3 of 5

5.6.29 RF Power Amplifier (RFPA)—No or Low TX Power Output (380–470 MHz and 450–520 MHz)—Part 4 of 5

Specific Notes:

1. Remove C5508 and solder the center conductor of a small 50-ohm, coaxial cable to TP5502. Solder ground to the gold shield track adjacent to TP5502. Attach an RF milliwatt meter, key the transmitter, and measure TX_INJ power. Then, remove the coaxial cable and replace C5508. Remove the solder added to shield track.
2. Remove R0977 in the power control section, and measure the resistance between VCNTRL (TP5503) and ground. Replace R0977.
3. If U5501, VD1, is incorrect, inspect the bias feed circuitry (L5502 and C5505) and interstage match components (L5503, C5509, and C5507). If U5501, RFOUT, is incorrect, inspect the bias feed circuitry (L5505 and C5517).
4. Remove L5502 and measure the resistance between VD1 (U5501 pin 14) and ground. Replace L5502. Remove L5505 and measure the resistance between RFOUT (U5501 pin 6) and ground. Replace L5505.
5. Inspect C5566, C5516, C5518, and R5511-15.
6. If the Q5502 gate bias is incorrect, inspect the bias feed circuitry (R5516, L5525, C5556, and R5527). If the bias feed circuitry is functional, then go to the Power Control—No or low VGBIAS flowchart. If the Q5502 drain bias is incorrect, inspect the bias feed circuitry (L5508, C5526-27, R5517, E5501, and R5574). Check U5570, Q5770, and associated circutry.
7. Remove R5516 and measure the resistance between Q5502 gate and ground. Replace R5516.
8. Remove L5508 and measure the resistance between Q5502 drain and ground. Replace L5508.
9. Inspect C5559-60, C5535, C5538, R5530, R5533-34, and R5536.
10. If the Q5503 pin 7 gate bias is incorrect, inspect the bias feed circuitry (R5520, C5539, C5557, and R5525). If the gate bias feed circuitry is functional, then go to the Power Control—No or low VGBIAS flowchart. If the Q5503 pin 6 gate bias is incorrect, inspect the bias feed circuitry (R5521, C5540, C5558, and R5526). If the bias feed circuitry is functional, then go to the Power Control—No or low VGBIAS flowchart. If the Q5503 pins 2 and 3 common drain bias is incorrect, inspect the bias feed circuitry (L5510, C5549-50, R5522-23, and E5502).
11. Remove R5520 and measure the resistance between Q5503 pin 7 gate and ground. Replace R5520. Remove R5521 and measure the resistance between Q5503 pin 6 gate and ground. Replace R5521.
12. Remove L5510 and measure the resistance between Q5503 pins 2 and 3 drain and ground. Replace L5510.
13. Inspect R5535, C5542-43, C5545-48, and C5551-53.
14. If the antenna switch bias voltages are incorrect, inspect R5524, L5701-4, and R5701, as well as perform diode checks on D5701-3.
15. Inspect the remaining antenna switch parts (C5701-10).
16. Inspect L5706-8, L5712-13, C5708, C5711-14, C5719-20, R5713, and R5718.
17. Inspect D5704, R5707-8, R5702-4, and C5715-16.

5.6.30 RF Power Amplifier (RFPA)—No or Low TX Power Output (380–470 MHz and 450–520 MHz)—Part 5 of 5

Table 5-6. RFPA DC Voltages

Description	Location	Voltage (Vdc) (380–470 MHz)	Voltage (Vdc) (450–520 MHz)
A+ = 13.6 Vdc			
U5501, VD1	U5501 pin 14	9.0–9.3	9.0–9.3
U5501, RFOUT	U5501 pins 6 and 7	9.0–9.3	9.0–9.3
Q5502 Gate Bias	R5516/C5525 node	1.8–2.0	1.8–2.1
Q5502 Drain Bias	L5508/R5517 Node	9.0–9.3	9.0–9.3
Q5503 Gate Bias 1	R5520/C5539 node	2.0–2.2	1.4–1.9
Q5503 Gate Bias 2	R5521/C5540 node	2.0–2.2	1.4–1.9
Q5503 Drain Bias	L5510/R5523 Node	13.0–13.6	13.0–13.6
Antenna Switch Bias Voltage 1	L5701/C5702 node	~4.7	~5.95
Antenna Switch Bias Voltage 2	D5701/D5702 node	~4.0	~5.0
Antenna Switch Bias Voltage 3	D5703/R5701 node	~3.3	~3.3

5.6.31 RFPA Power Control—No VGBIAS (380–470 MHz and 450–520 MHz)

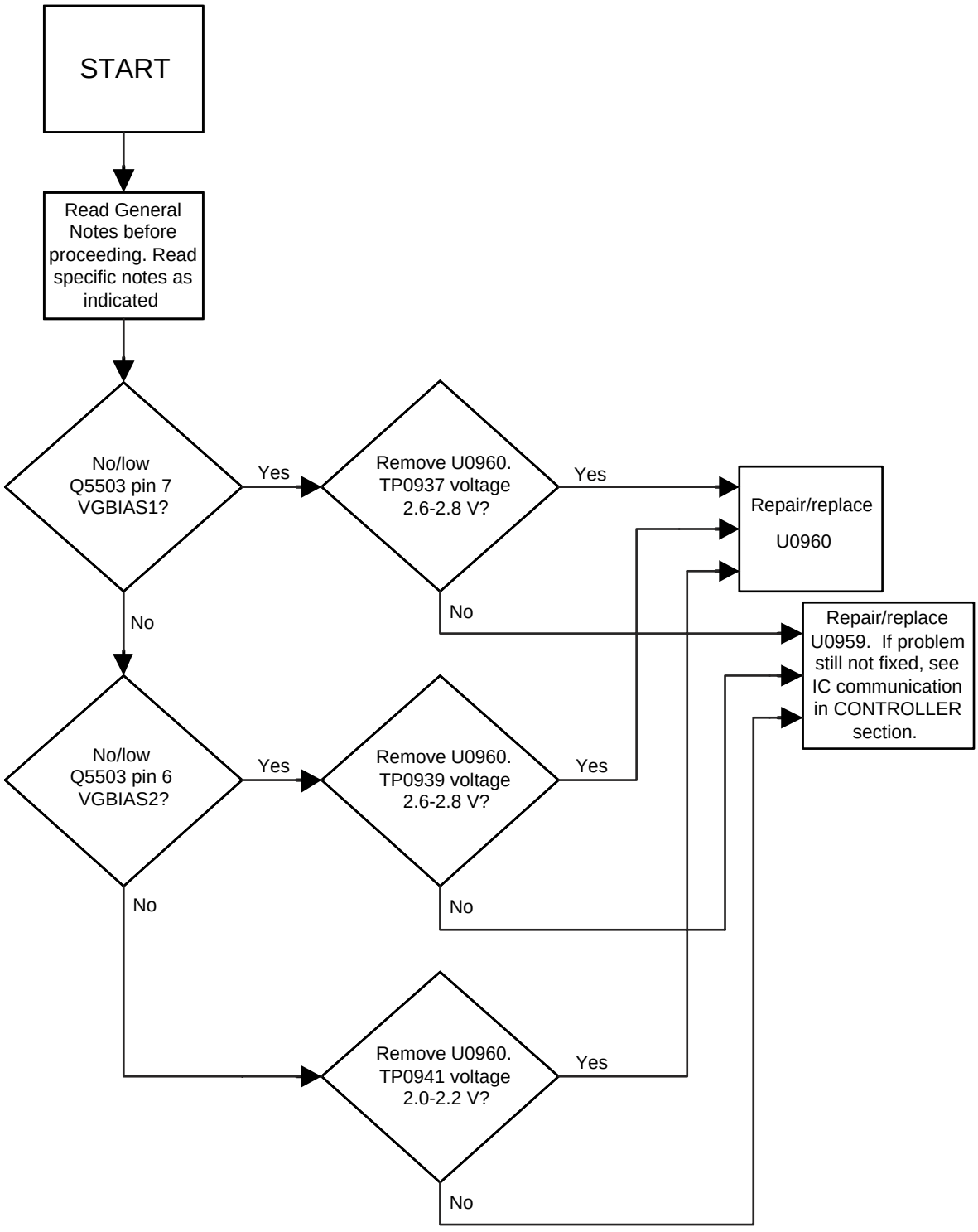
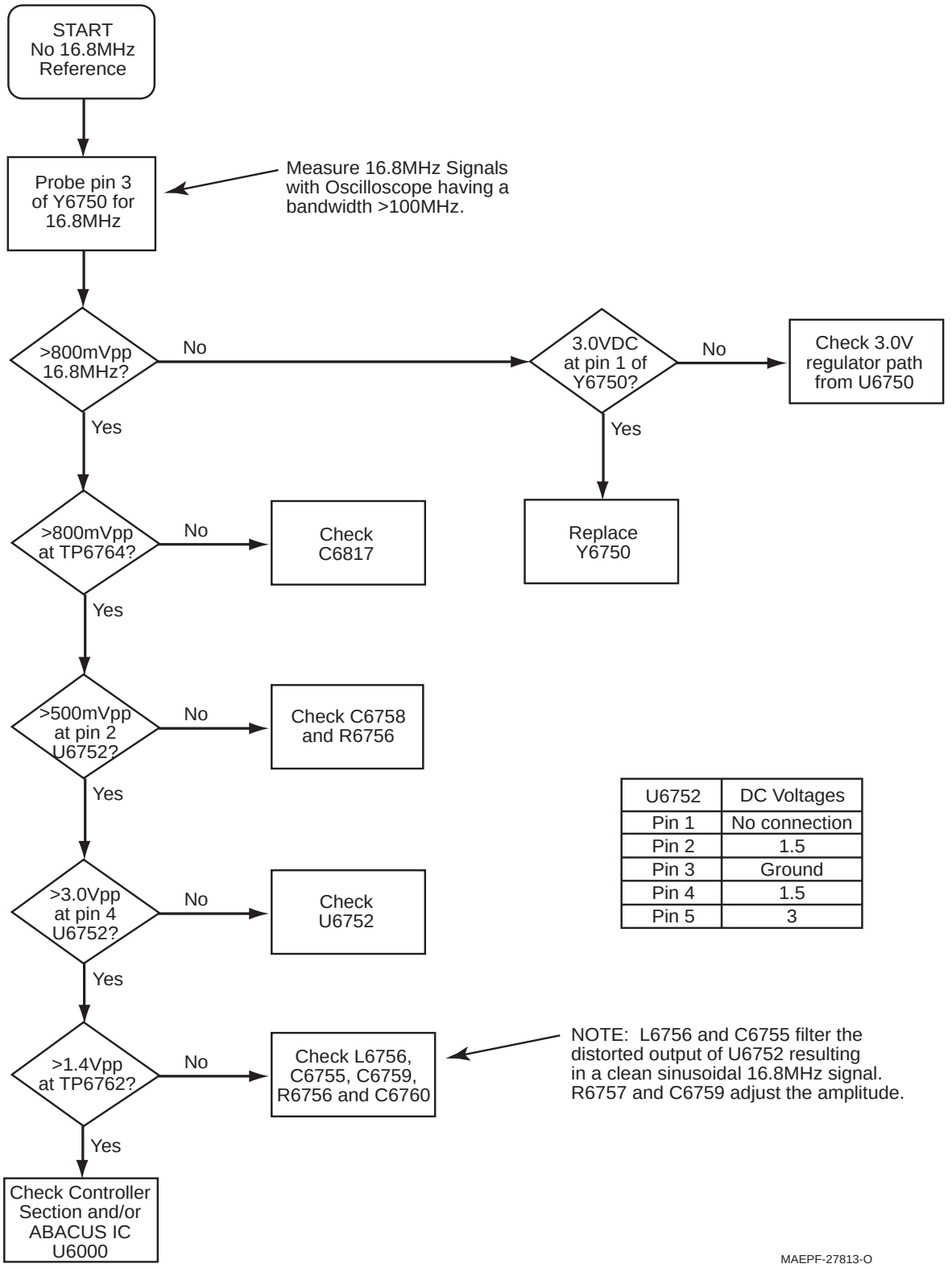


Figure 5-33. RFPA Power Control—No VGBIAS (380–470 MHz and 450–520 MHz)

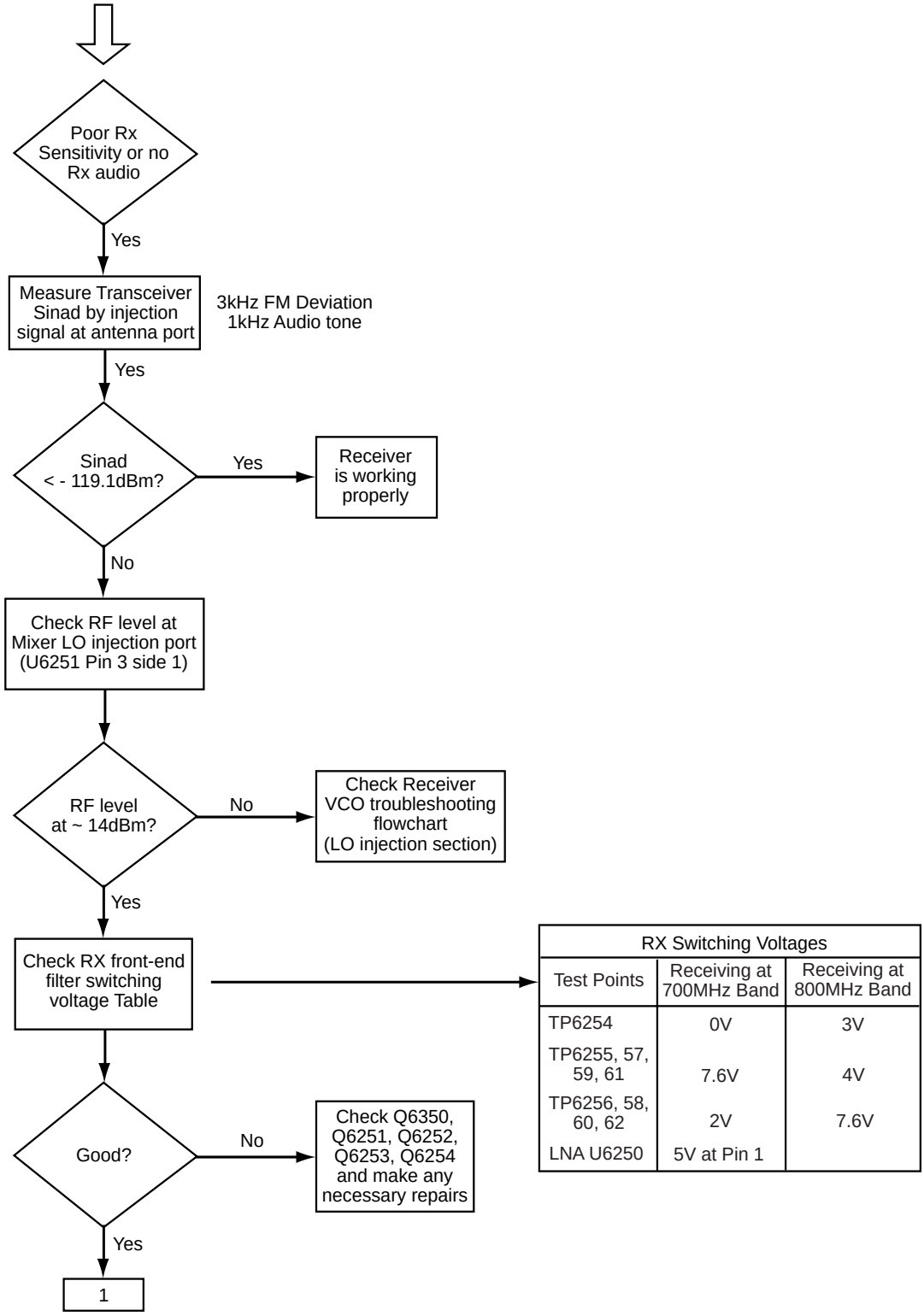
5.6.32 No 16.8 MHz Reference Oscillator Frequency (700–800 MHz)



U6752	DC Voltages
Pin 1	No connection
Pin 2	1.5
Pin 3	Ground
Pin 4	1.5
Pin 5	3

Figure 5-34. No 16.8 MHz Reference Oscillator Frequency (700–800 MHz)

5.6.33 Poor RX Sensitivity or No RX Audio (700–800 MHz)—Part 1 of 2



RX Switching Voltages

Test Points	Receiving at 700MHz Band	Receiving at 800MHz Band
TP6254	0V	3V
TP6255, 57, 59, 61	7.6V	4V
TP6256, 58, 60, 62	2V	7.6V
LNA U6250	5V at Pin 1	

Figure 5-35. Poor RX Sensitivity or No RX Audio (700–800 MHz)—Part 1 of 2

5.6.34 Poor RX Sensitivity or No RX Audio (700–800 MHz)—Part 2 of 2

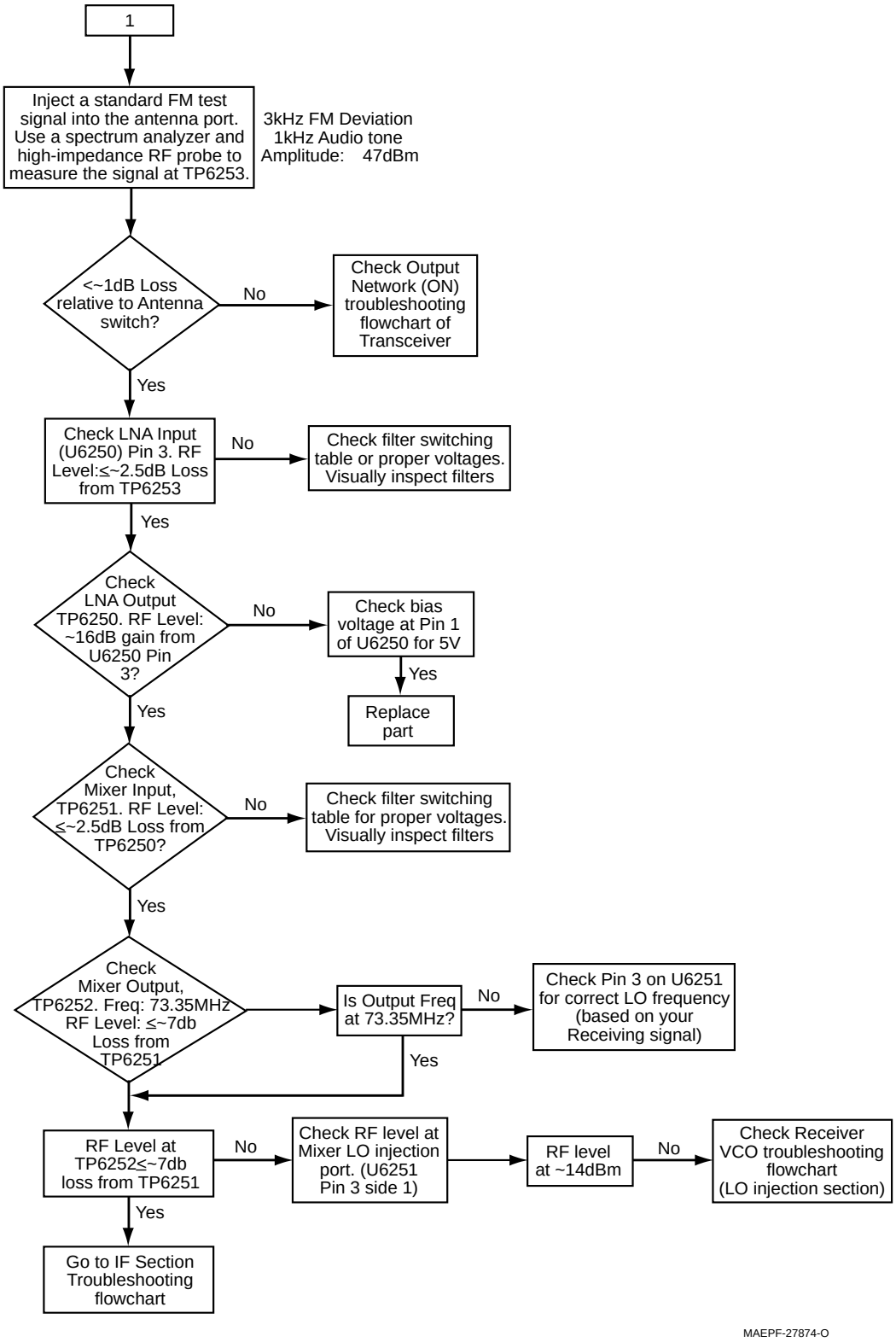


Figure 5-36. Poor RX Sensitivity or No RX Audio (700–800 MHz)—Part 2 of 2

5.6.35 RX IF—Poor SINAD or No Audio (700–800 MHz)

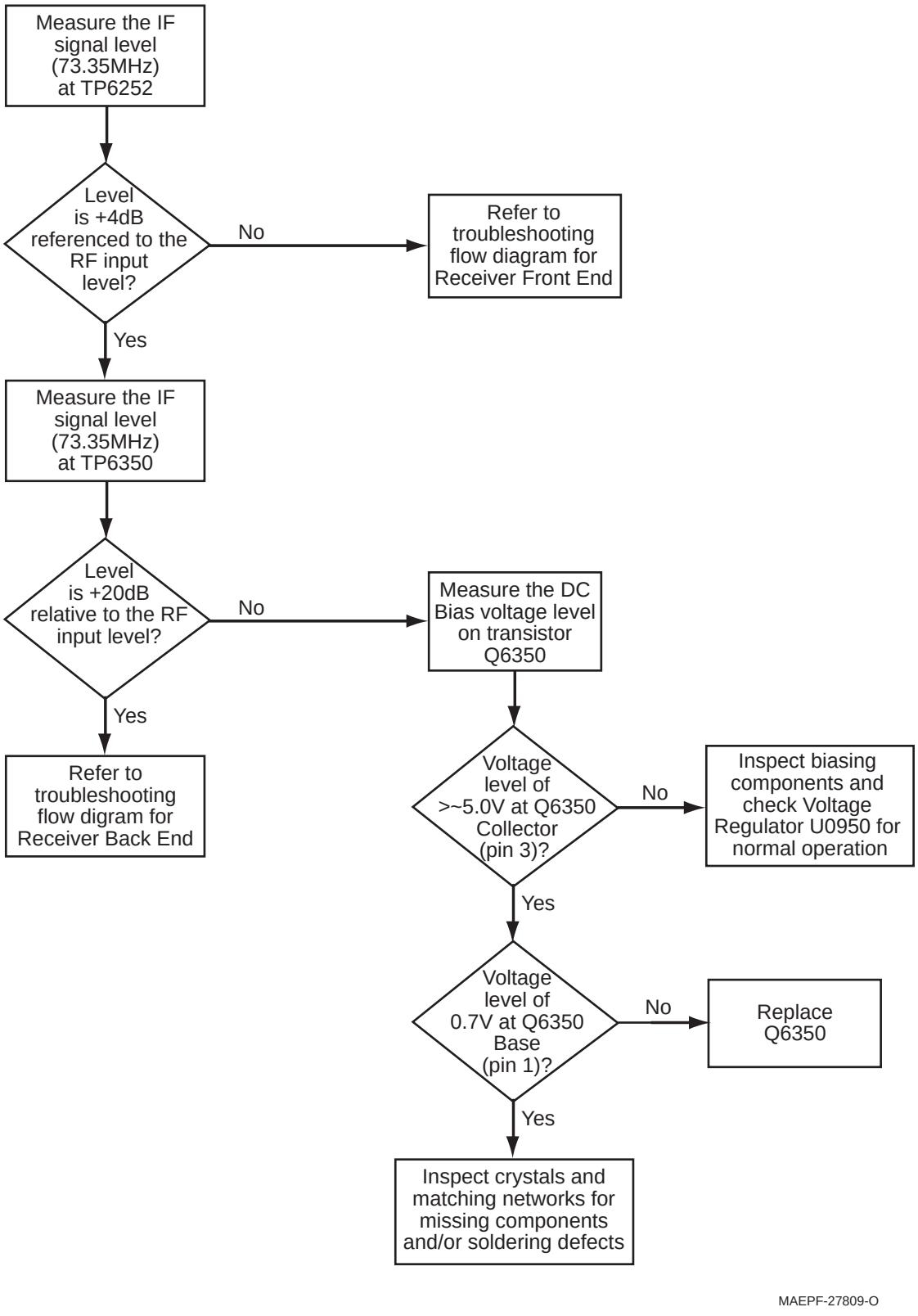


Figure 5-37. RX IF—Poor SINAD or No Audio (700–800 MHz)

5.6.36 RX Back-End—Poor SINAD or No Audio (700–800 MHz)—Part 1 of 3

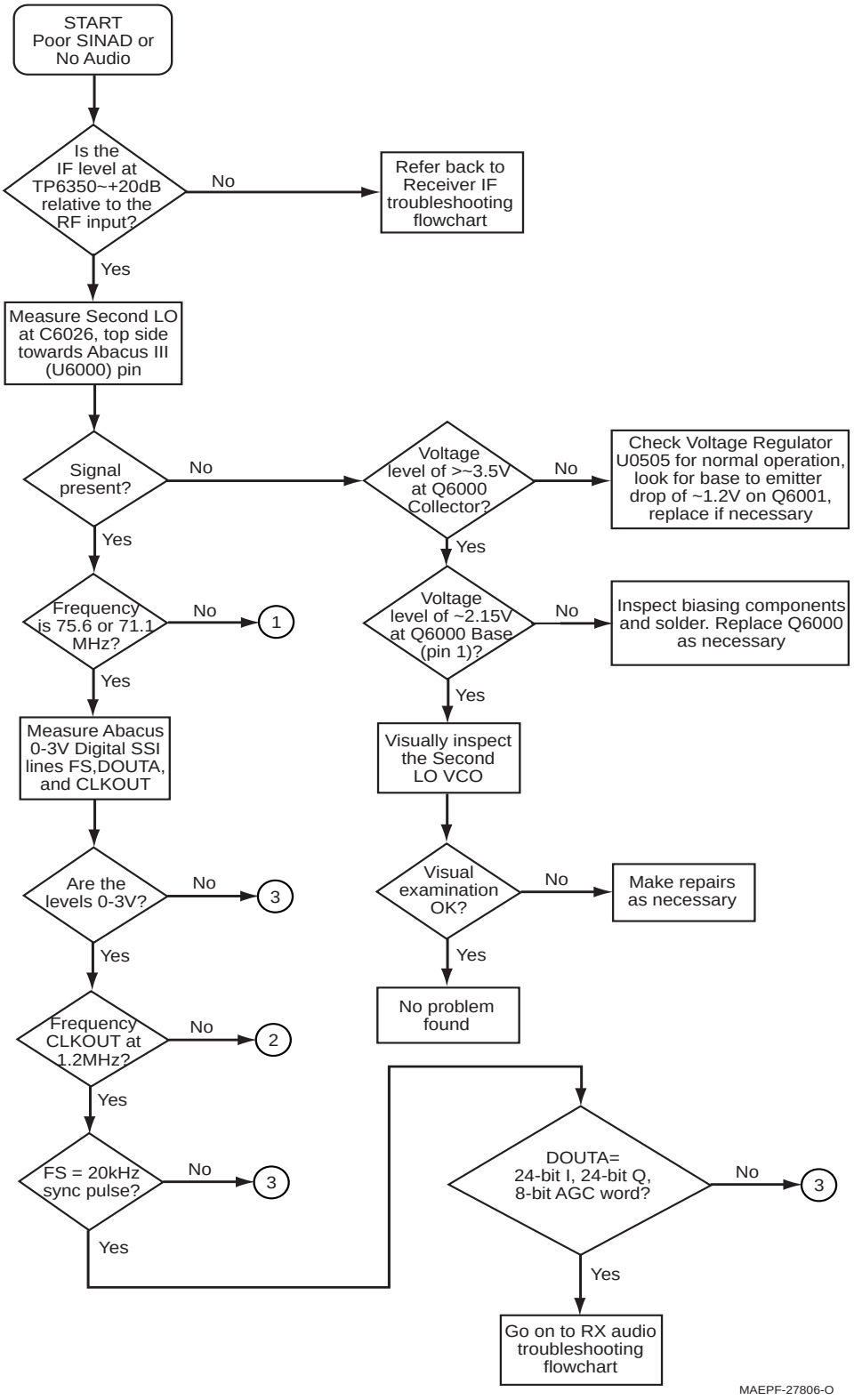


Figure 5-38. RX Back-End—Poor SINAD or No Audio (700–800 MHz)—Part 1 of 3

5.6.37 RX Back-End—Poor SINAD or No Audio (700–800 MHz)—Part 2 of 3

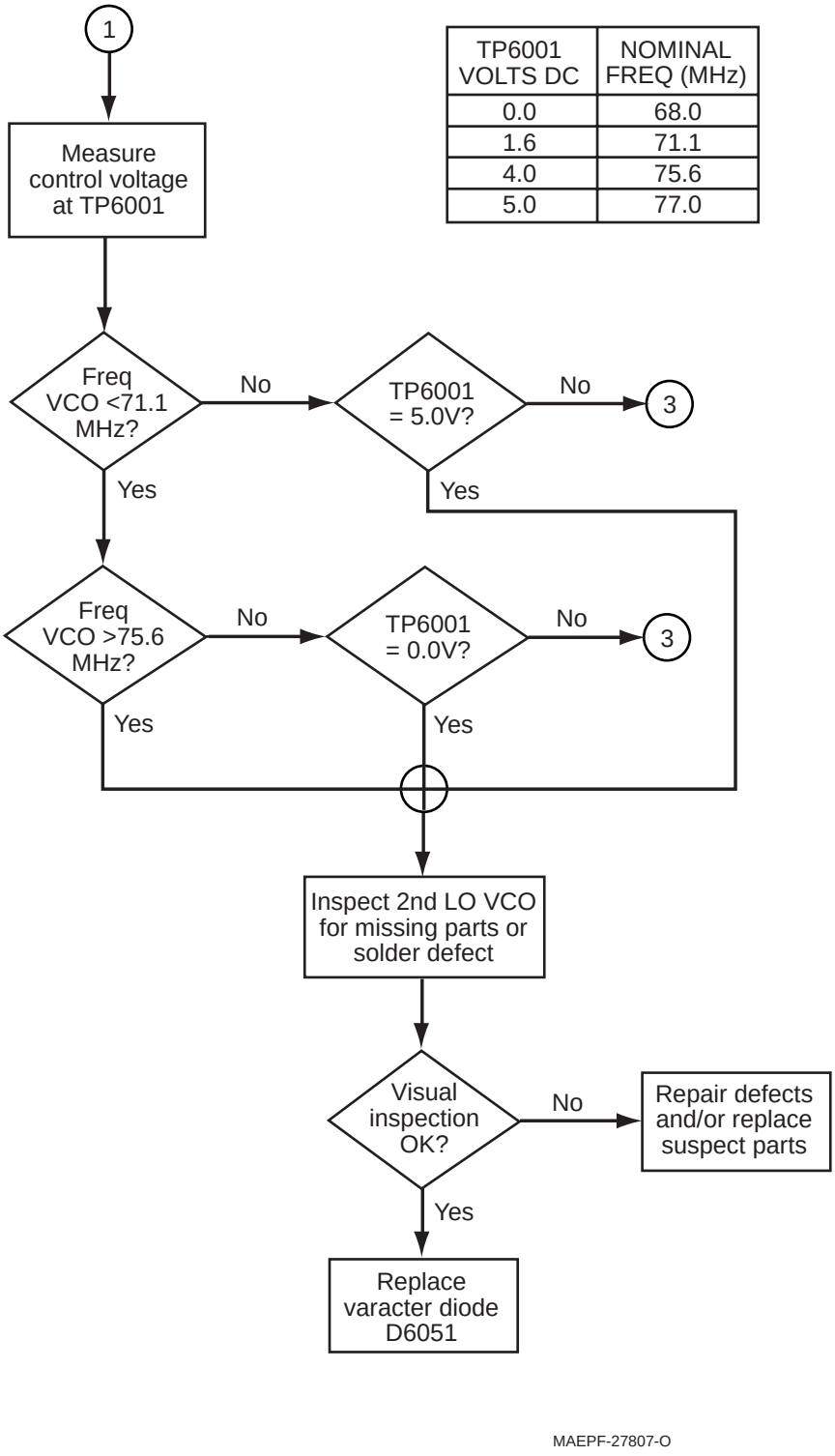


Figure 5-39. RX Back-End—Poor SINAD or No Audio (700–800 MHz)—Part 2 of 3

5.6.38 RX Back-End—Poor SINAD or No Audio (700–800 MHz)—Part 3 of 3

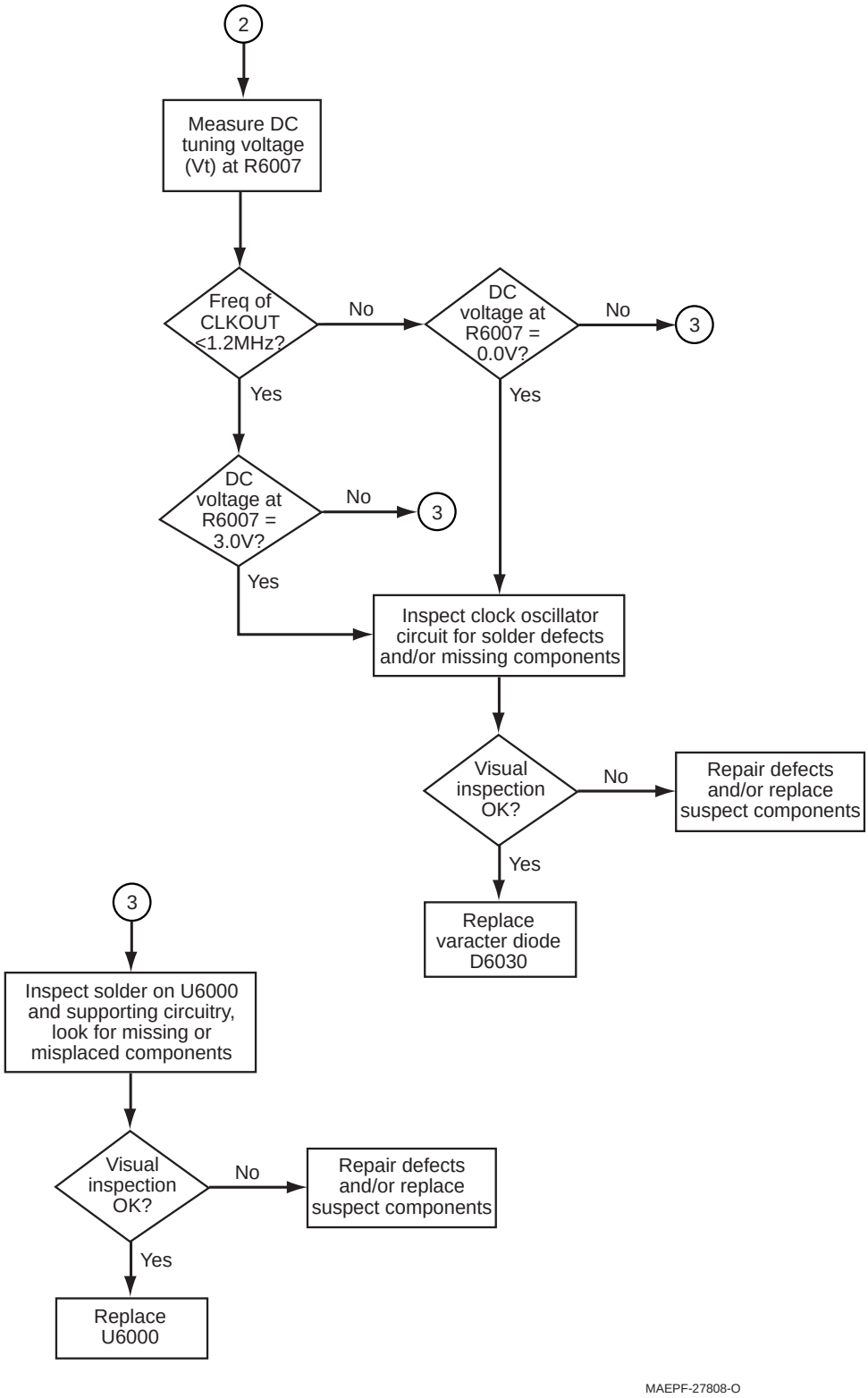


Figure 5-40. RX Back-End—Poor SINAD or No Audio (700–800 MHz)—Part 3 of 3

5.6.39 Low or No RX Injection Signal (700–800 MHz)

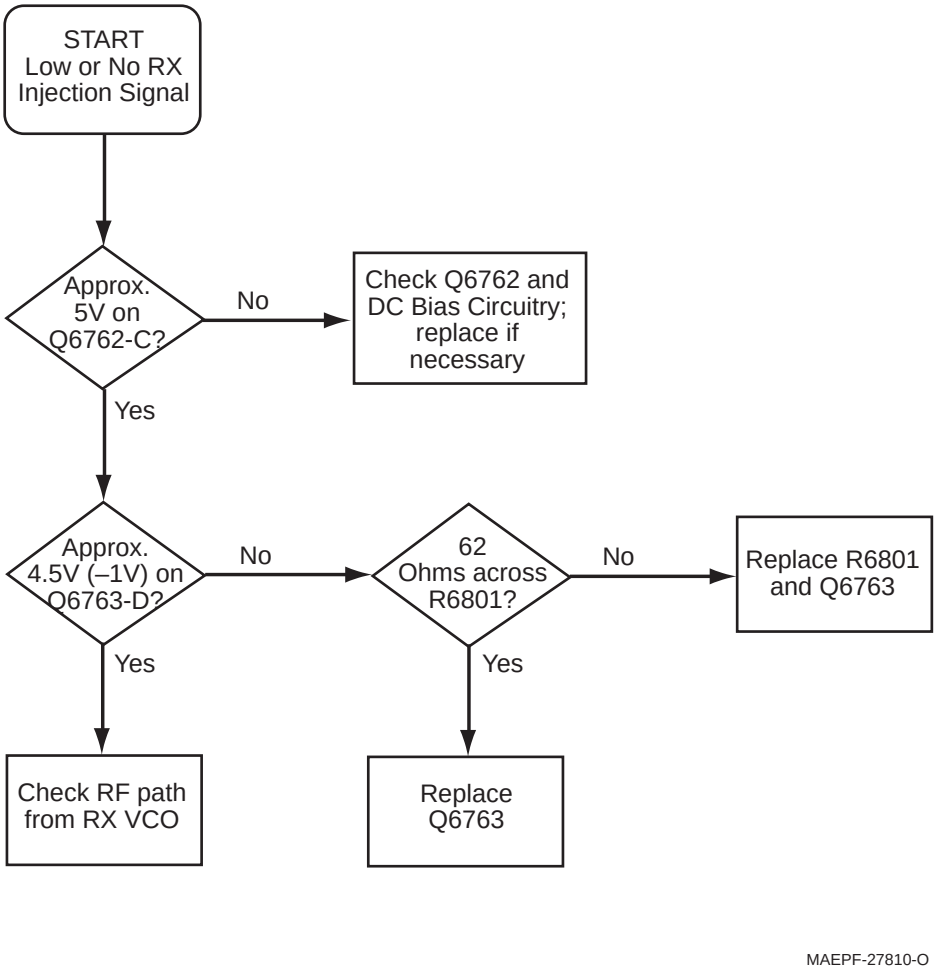


Figure 5-41. Low or No RX Injection Signal (700–800 MHz)

5.6.40 Low or No TX Injection Signal (700–800 MHz)

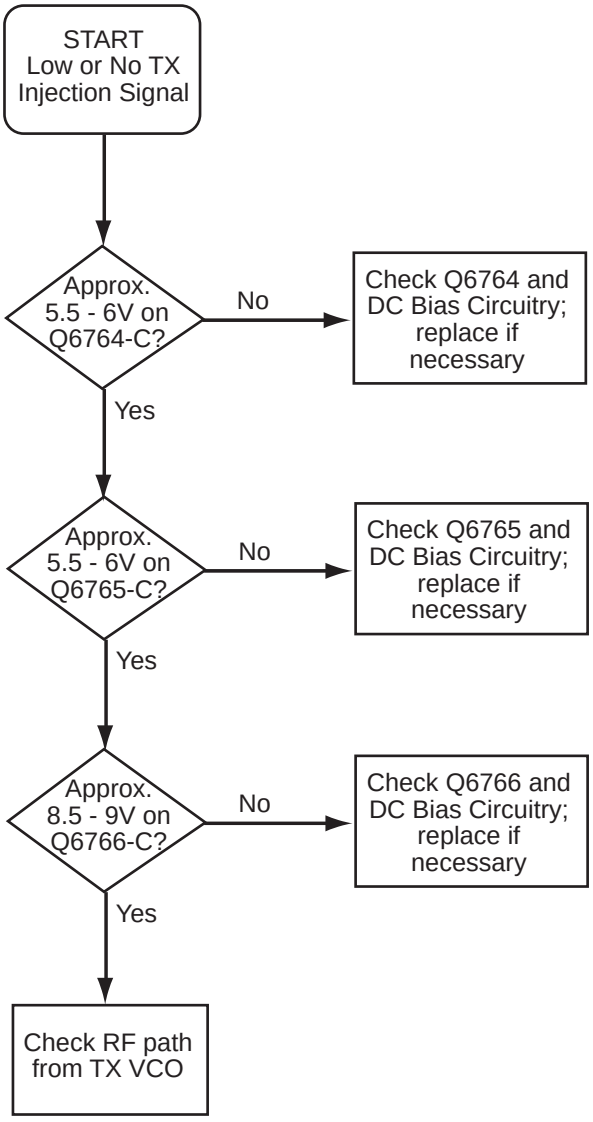


Figure 5-42. Low or No TX Injection Signal (700–800 MHz)

5.6.41 No TX Audio (700–800 MHz)

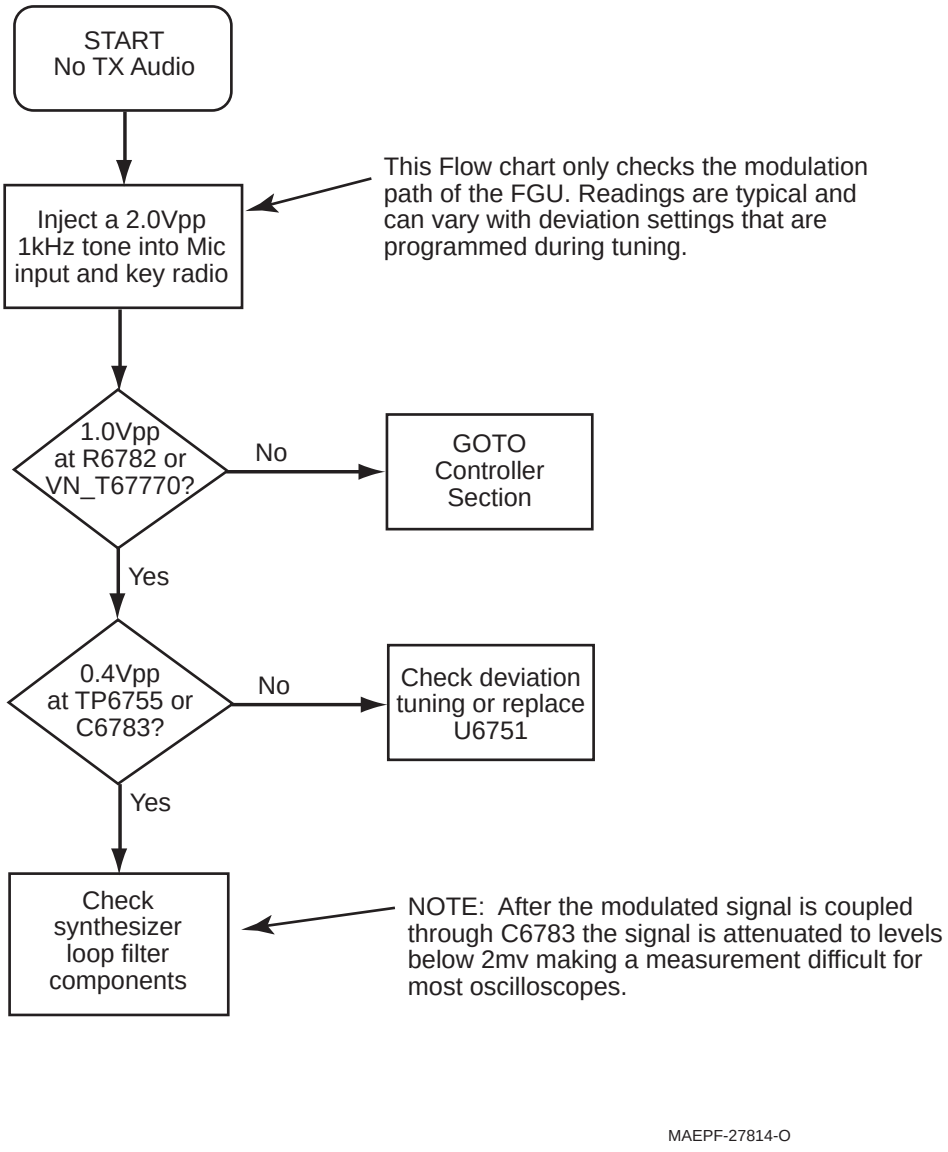


Figure 5-43. No TX Audio (700–800 MHz)

5.6.42 TX or RX VCO Unlock (Fail 001) (700–800 MHz)—Part 1 of 2

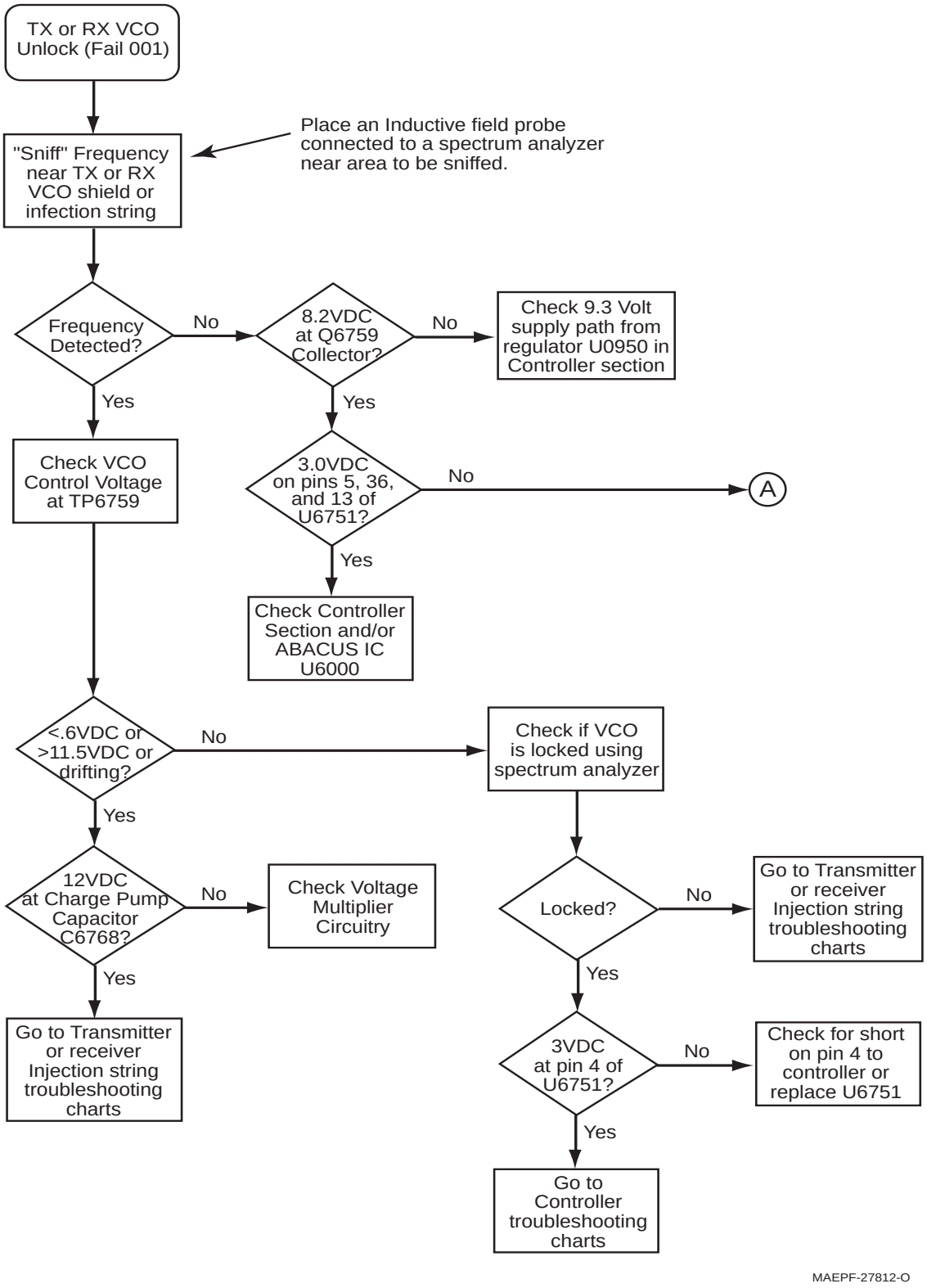


Figure 5-44. TX or RX VCO Unlock (Fail 001) (700–800 MHz)—Part 1 of 2

5.6.43 TX or RX VCO Unlock (Fail 001) (700–800 MHz)—Part 2 of 2

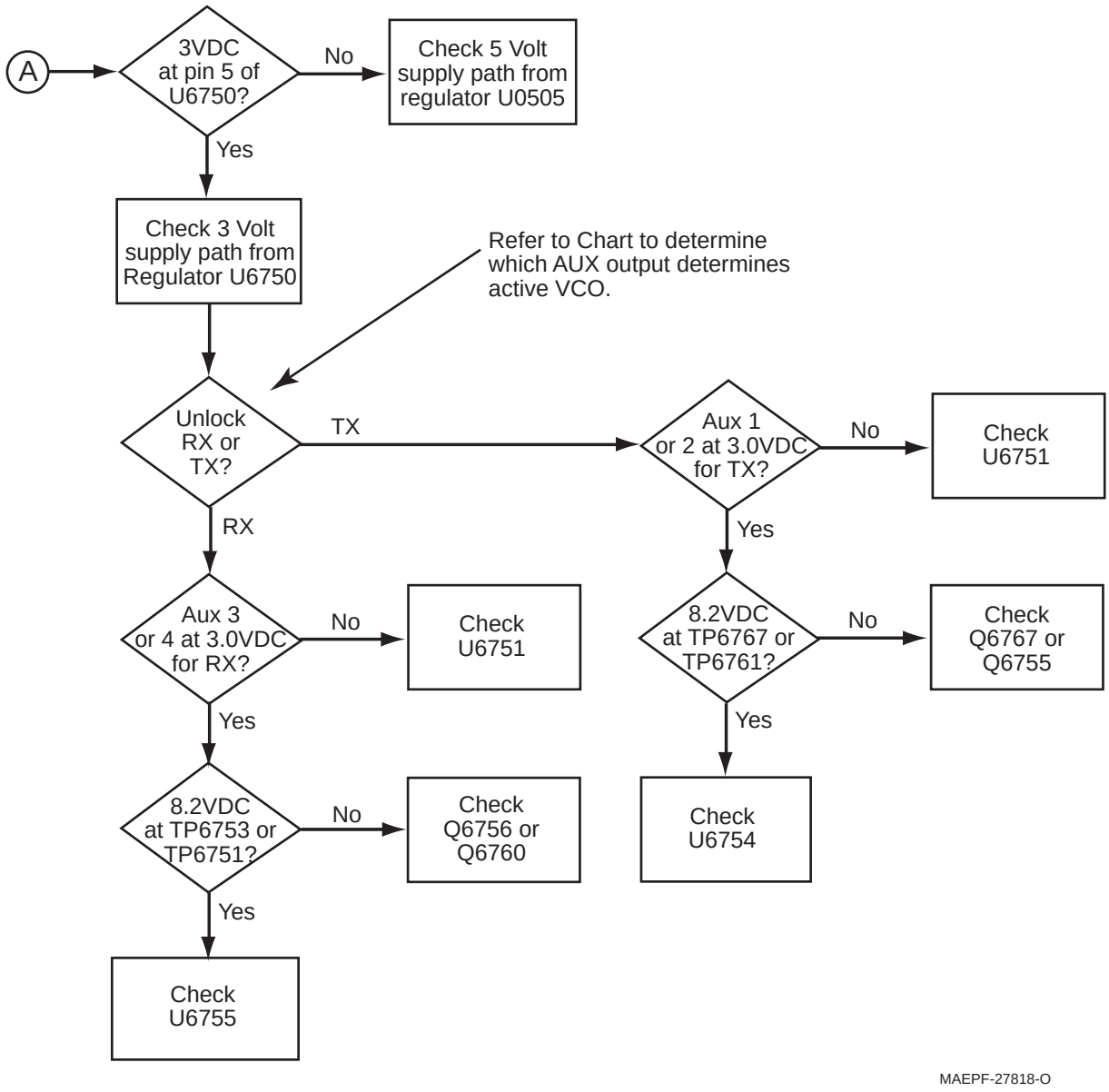


Figure 5-45. TX or RX VCO Unlock (Fail 001) (700–800 MHz)—Part 2 of 2

5.6.44 RF Power Amplifier (RFPA)—No or Low TX Power Output (700–800 MHz)—Part 1 of 5

NOTE: For each flowchart step in which reference is made to a note, be sure to refer to that specific note (located on page 61 of this flowchart) for guidance in performing the actual troubleshooting procedure. Also, RFPA DC voltages are shown in Table 5-7 on page 5-62.

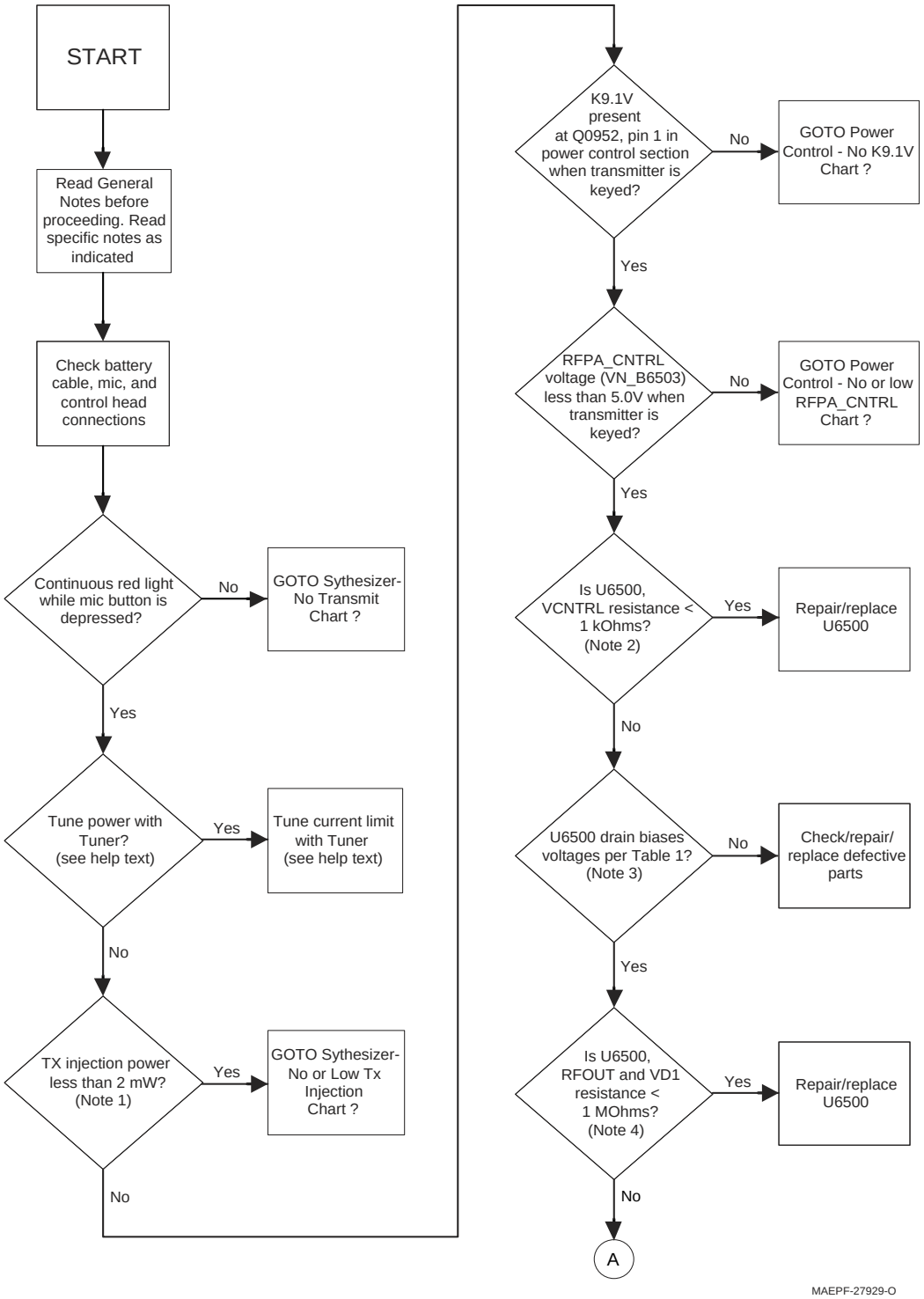


Figure 5-46. RF Power Amplifier (RFPA)—No or Low TX Power Output (700–800 MHz)—Part 1 of 5

5.6.45 RF Power Amplifier (RFPA)—No or Low TX Power Output (700–800 MHz)—Part 2 of 5

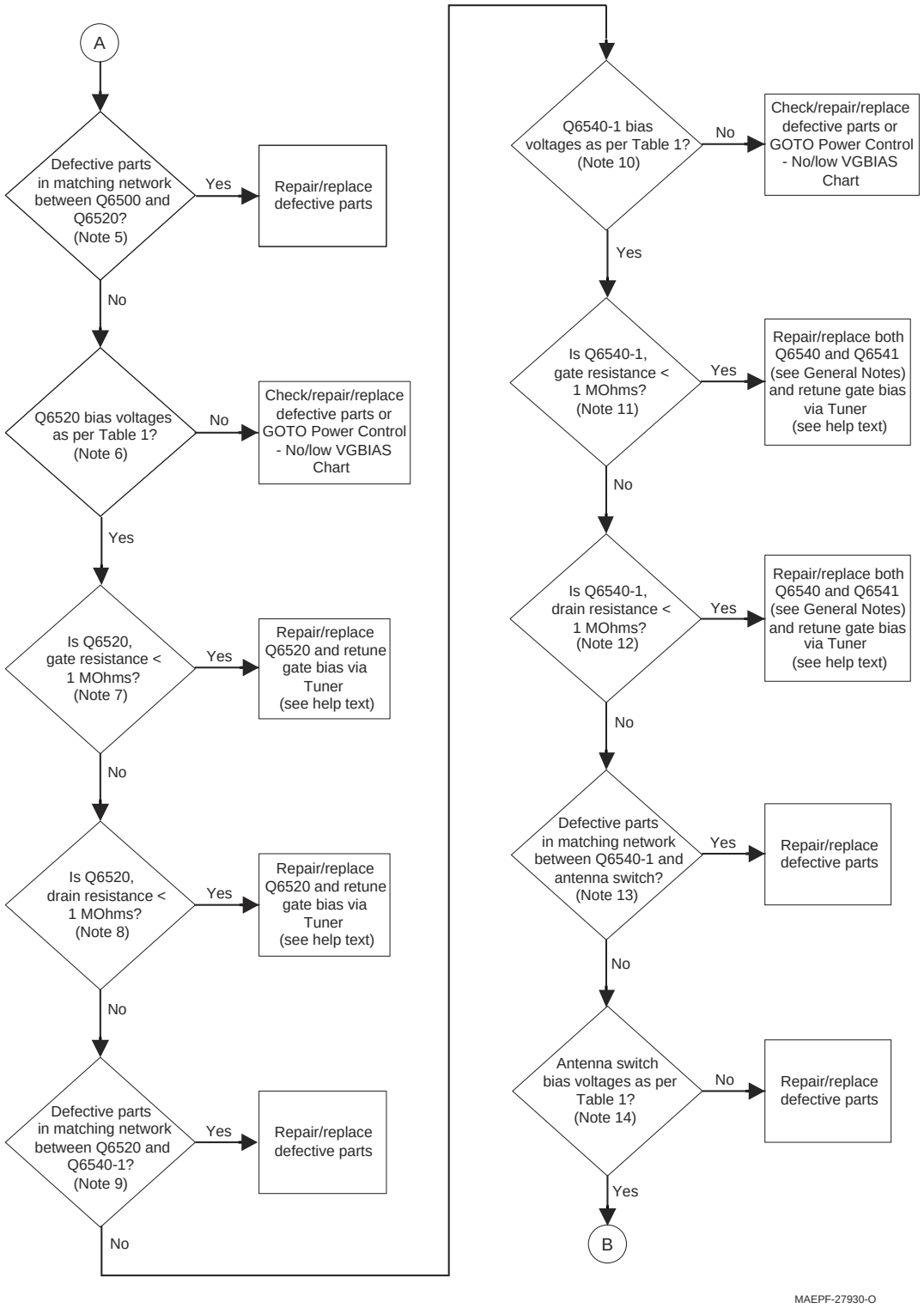


Figure 5-47. RF Power Amplifier (RFPA)—No or Low TX Power Output (700–800 MHz)—Part 2 of 5

5.6.46 RF Power Amplifier (RFPA)—No or Low TX Power Output (700–800 MHz)—Part 3 of 5

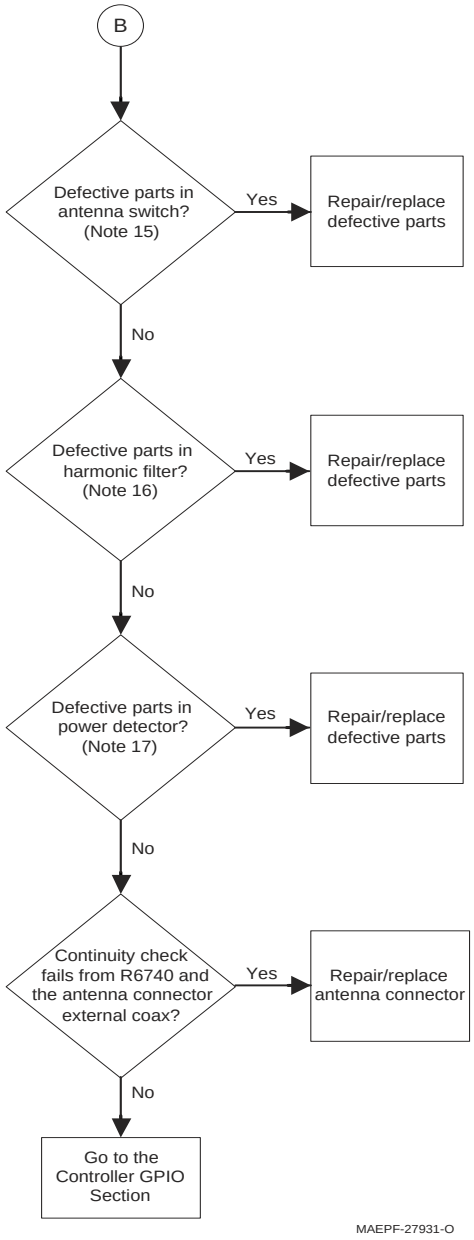


Figure 5-48. RF Power Amplifier (RFPA)—No or Low TX Power Output (700–800 MHz)—Part 3 of 5

5.6.47 RF Power Amplifier (RFPA)—No or Low TX Power Output (700–800 MHz)—Part 4 of 5

Specific Notes:

1. Remove C6501 and solder the center conductor of a small 50-ohm, coaxial cable to VN_B6500. Solder ground to the gold shield track adjacent to VN_B6500. Attach an RF milliwatt meter, key the transmitter, and measure TX_INJ power. Then, remove the coaxial cable and replace C6501. Remove the solder added to shield track.
2. Remove R0977 in the power control section, and measure the resistance between VCNTRL (VN_B6503) and ground. Replace R0977.
3. If U6500, VD1, is incorrect, inspect the bias feed circuitry (L6501 and C6504) and interstage match components (L6502, C6506, and C6503). If U6500, RFOUT, is incorrect, inspect the bias feed circuitry (L6500 and C6500).
4. Remove L6501 and measure the resistance between VD1 (VN_B6501) and ground. Replace L6501. Remove L6500 and measure the resistance between RFOUT (VN_B6504) and ground. Replace L6500.
5. Inspect C6502, C6509-11, and R6521-5.
6. If the Q6520 gate bias is incorrect, inspect the bias feed circuitry (R6520 and C6520). If the bias feed circuitry is functional, then go to the Power Control—No or low VGBIAS flowchart. If the Q6520 drain bias is incorrect, inspect the bias feed circuitry (L6521, C6521-2, R6526-7, and L6521-5).
7. Remove R6520 and measure the resistance between Q6520 gate and ground. Replace R6520.
8. Remove L6521 and measure the resistance between Q6520 drain and ground. Replace L6521.
9. Inspect C6541-2, C6544-5, C6547-8, C6565-6, R6550-7, and R6559.
10. If the Q6540 gate bias is incorrect, inspect the bias feed circuitry (R6540 and C6540). If the gate bias feed circuitry is functional, then go to the Power Control—No or low VGBIAS flowchart. If the Q6541gate bias is incorrect, inspect the bias feed circuitry (R6543 and C6558). If the bias feed circuitry is functional, then go to the Power Control—No or low VGBIAS flowchart. If the Q6540-1 common drain bias is incorrect, inspect the bias feed circuitry (L6542-3, C6559-60, R6544-5, and L6521-5).
11. Remove R6540 and measure the resistance between Q6540 gate and ground. Replace R6540. Remove R6543 and measure the resistance between Q6541 gate and ground. Replace R6541.
12. Remove L6542 and measure the resistance between Q6540-1 drain and ground. Replace L6542.
13. Inspect R6560 and C6549-57.
14. If the antenna switch bias voltages are incorrect, inspect R6547-8, L6700, and L6702-3, as well as perform diode checks on D6701-2.
15. Inspect the remaining antenna switch parts (C6700-5).
16. Inspect L6720-2 and C6720-1.
17. Inspect D6730, R6730-2, R6735-6, L6730, and C6730-1.

5.6.48 RF Power Amplifier (RFPA)—No or Low TX Power Output (700–800 MHz)—Part 5 of 5

Table 5-7. RFPA DC Voltages

Description	Location	Voltage (Vdc)
A+ = 13.6 Vdc		
U5501, VD1	VN_B6503	9.0–9.3
U5501, RFOUT	VN_B6504	9.0–9.3
Q6520 Gate Bias	VN_B6520	2.0–2.2
Q6520 Drain Bias	L6521/R6526 Node	13.0–13.6
Q6540 Gate Bias	VN_B6540	3.5–3.7
Q6541 Gate Bias	VN_B6541	3.5–3.7
Q6540/Q6541 Drain Bias	L6542/R6544 Node	13.0–13.6
Antenna Switch Bias Voltage 1	VN_B6563	~5.3
Antenna Switch Bias Voltage 2	VN_T6701	~1.6
Antenna Switch Bias Voltage 3	D6701/D6702 Node	~0.8

5.6.49 RFPA Power Control—No K9.1V (700–800 MHz)

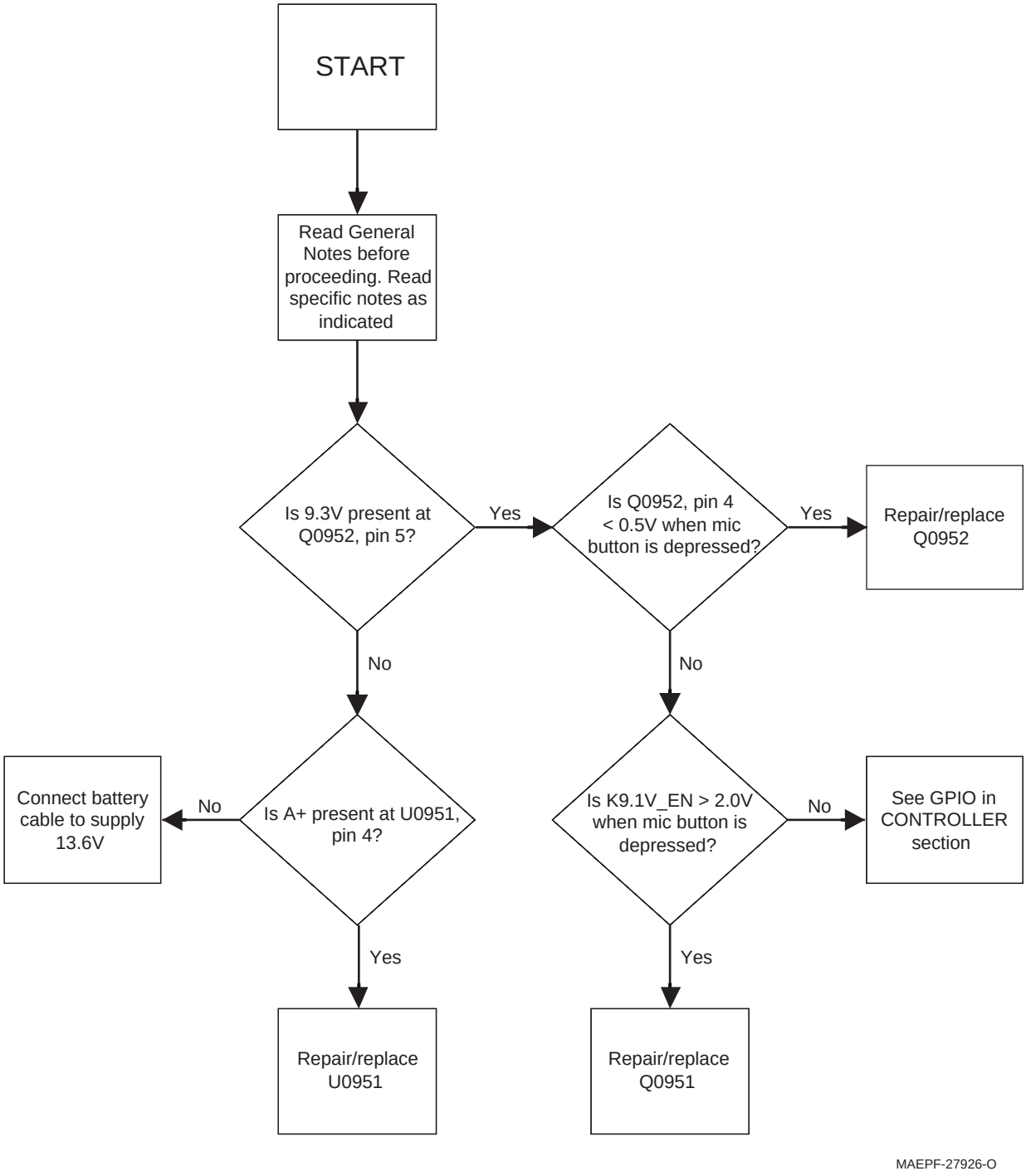


Figure 5-49. RFPA Power Control—No K9.1V (700–800 MHz)

5.6.50 RFPA Power Control—No VGBIAS (700–800 MHz)

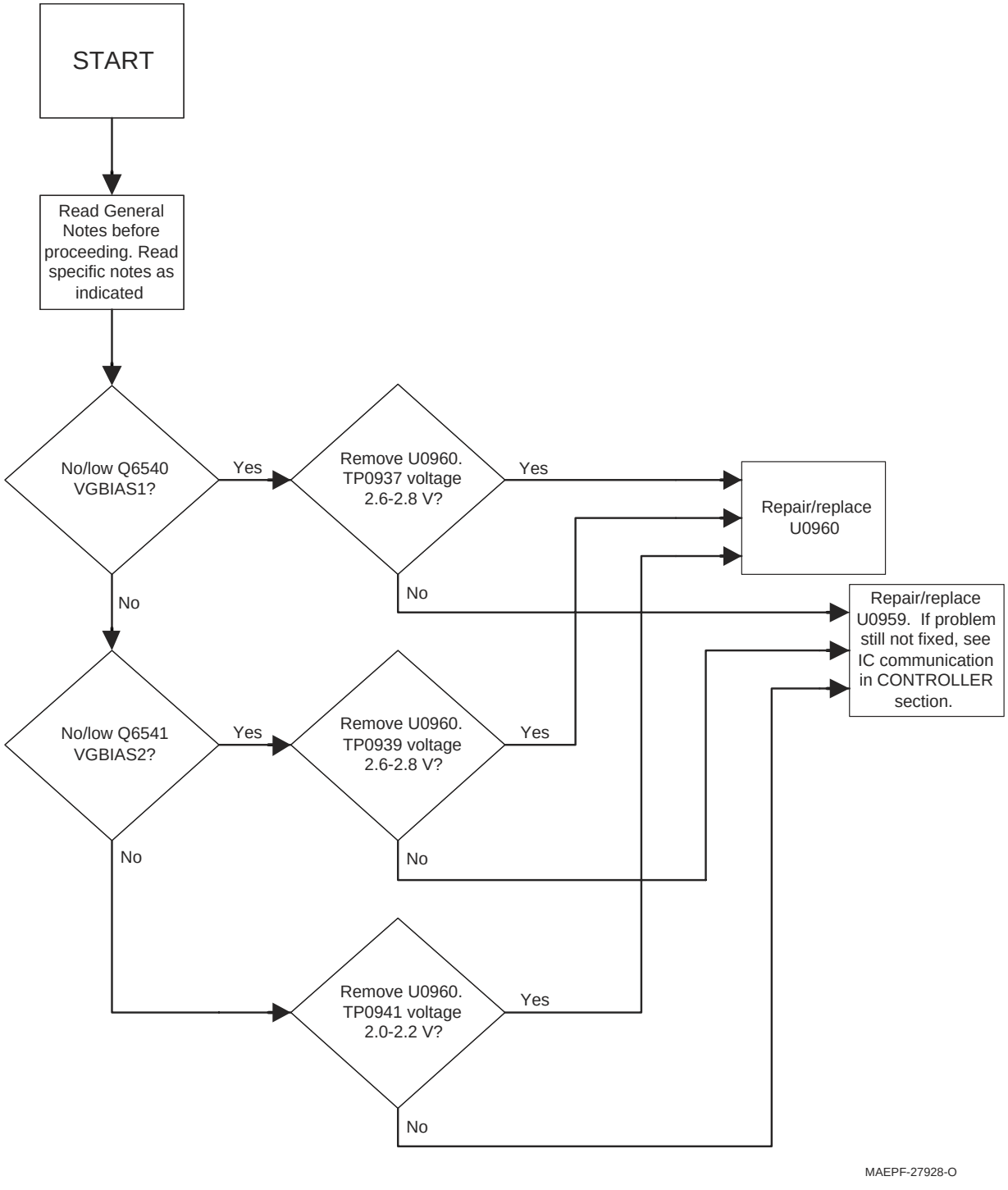


Figure 5-50. RFPA Power Control—No VGBIAS (700–800 MHz)

5.6.51 RFPA Power Control—No or Low TX RFPA_CNTRL (700–800 MHz)—Part 1 of 2

For each flowchart step in which reference is made to a note, be sure to refer to that specific note (located on page 66 of this flowchart) for guidance in performing the actual troubleshooting procedure.

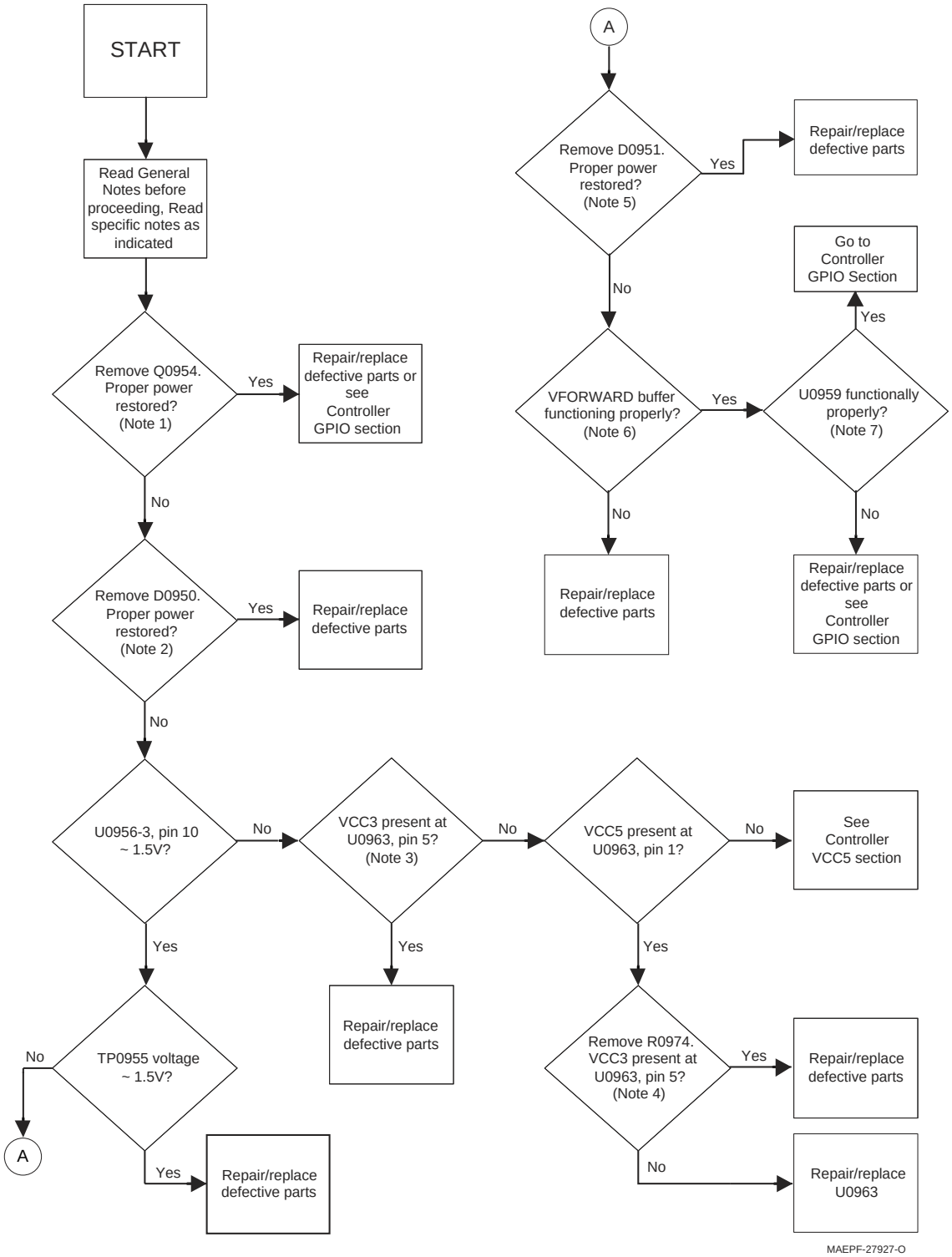


Figure 5-51. RFPA Power Control—No or Low TX RFPA_CNTRL (700–800 MHz)—Part 1 of 2

5.6.52 RFPA Power Control—No or Low TX RFPA_CNTRL (700–800 MHz)—Part 2 of 2

Specific Notes:

1. Remove Q0954. If proper power is restored, repair/replace Q0954. If the problem still persists, check for proper operation of U0958-1, and replace U0958 if not functioning properly. If U0958-1 operation is correct, refer the controller section in the theory of operation chapter.
2. Remove D0950. If proper power is restored, inspect R0942-5, R0991, and U0956-4. Replace D0958.
3. Inspect R0974-5.
4. Remove R0974. Measure U0963, pin 5 voltage. Replace R0974.
5. Inspect the current limit and temperature cutback circuitry (refer to the power control section in the theory of operation chapter).
6. Adjust the Power Detector Calibration via the Tuner software (see the tuner Help text) and monitor the output power while the transmitter is keyed. If the circuit is functioning properly, output power will decrease if the softpot is increased, and output power will increase if the softpot is decreased. If the circuitry is not functioning properly, then inspect U0952, U0956-2, R0971-3. If the problem persists, refer to the controller section in the theory of operation chapter.
7. Retune the Power Detector Calibration if any circuitry is repaired/replaced.
8. Adjust the power via CPS (see the Help text) and monitor output power. If the softpot is decreased, power will increase; if the softpot is increased, power will decrease. If the circuitry is not functioning properly, replace U0959 and retune the power via CPS (see the Help text for complete procedures). If the problem persists, refer to the controller section in the theory of operation chapter.

Chapter 6 Troubleshooting Waveforms

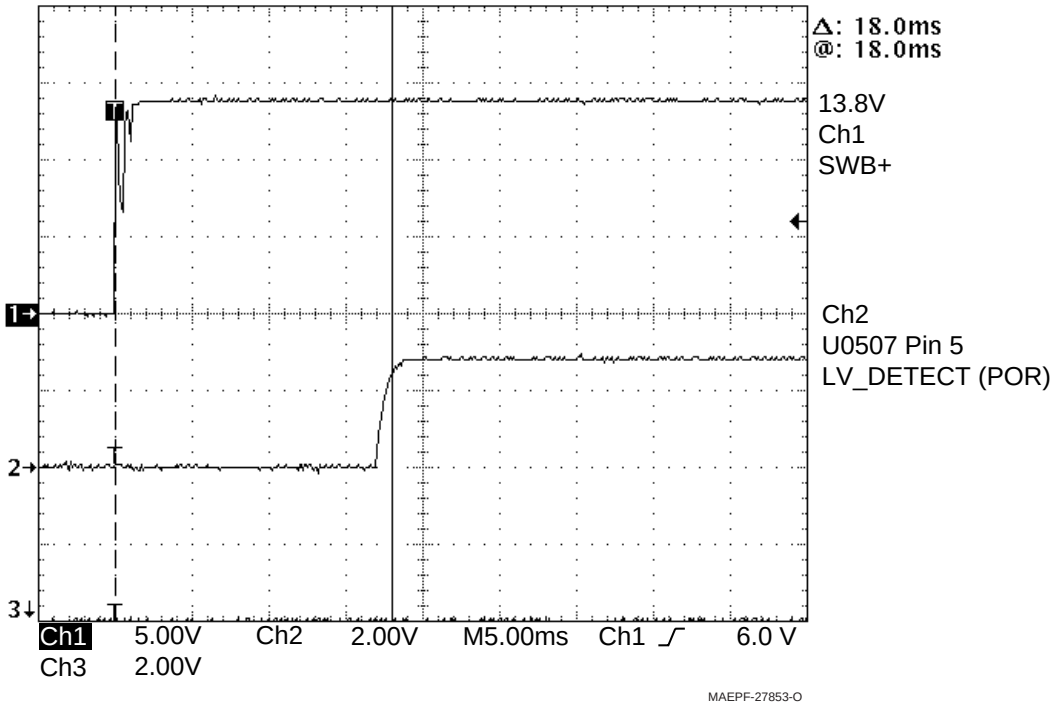
6.1 Introduction

This chapter 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 the operating conditions.

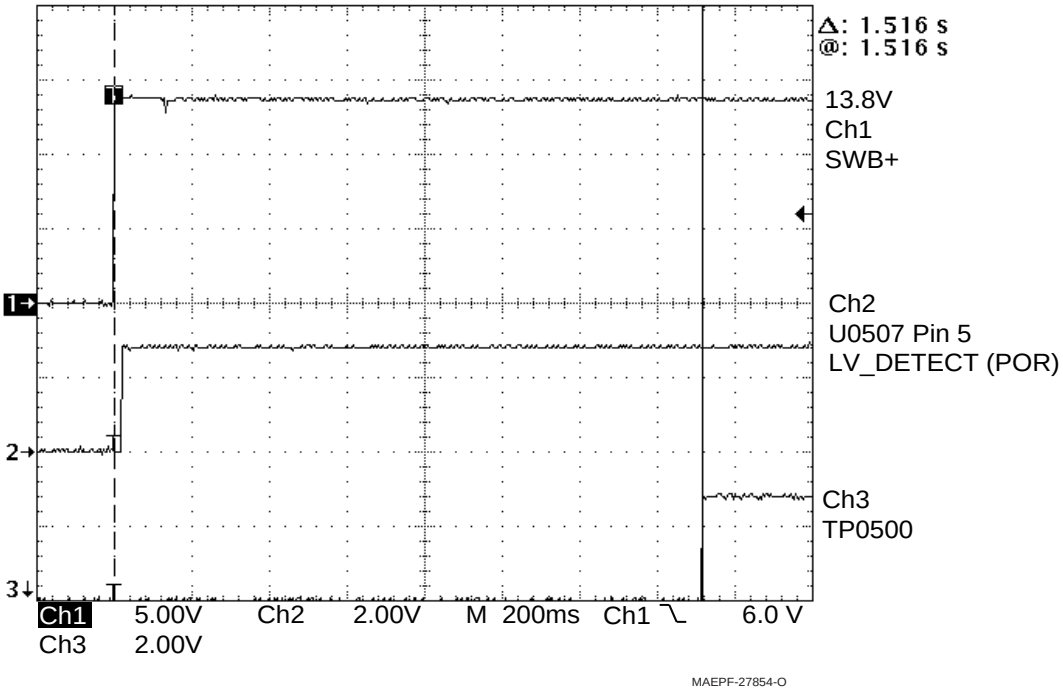
Table 6-1. List of Troubleshooting Waveforms

6.2 XTL 5000 Waveforms

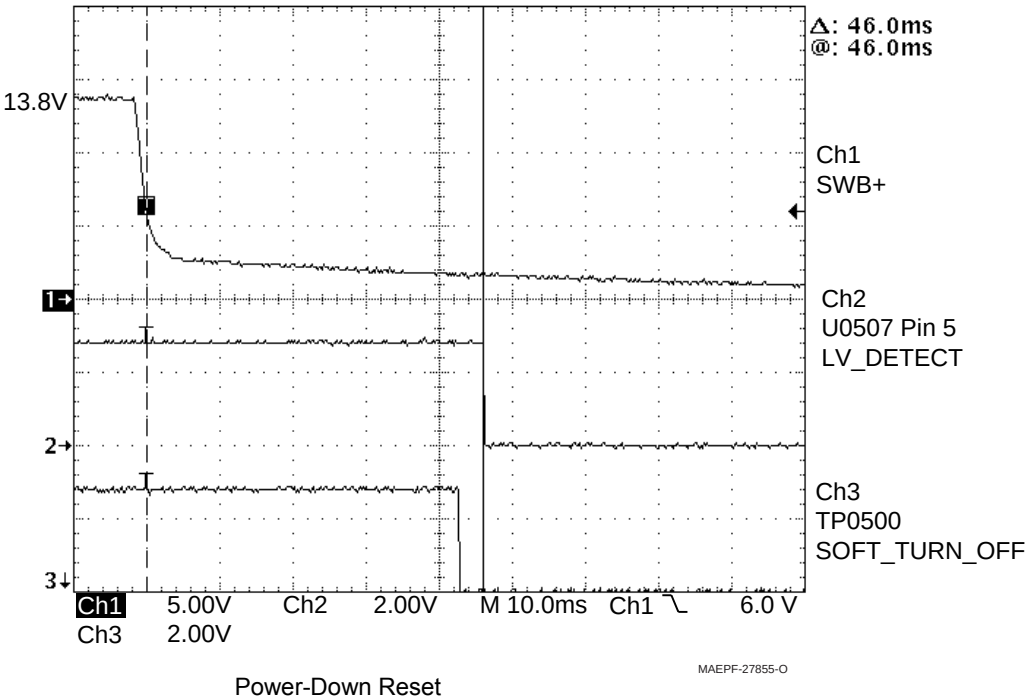
6.2.1 Power-On Reset Timing



6.2.2 Power-On to Soft Turn-On Timing

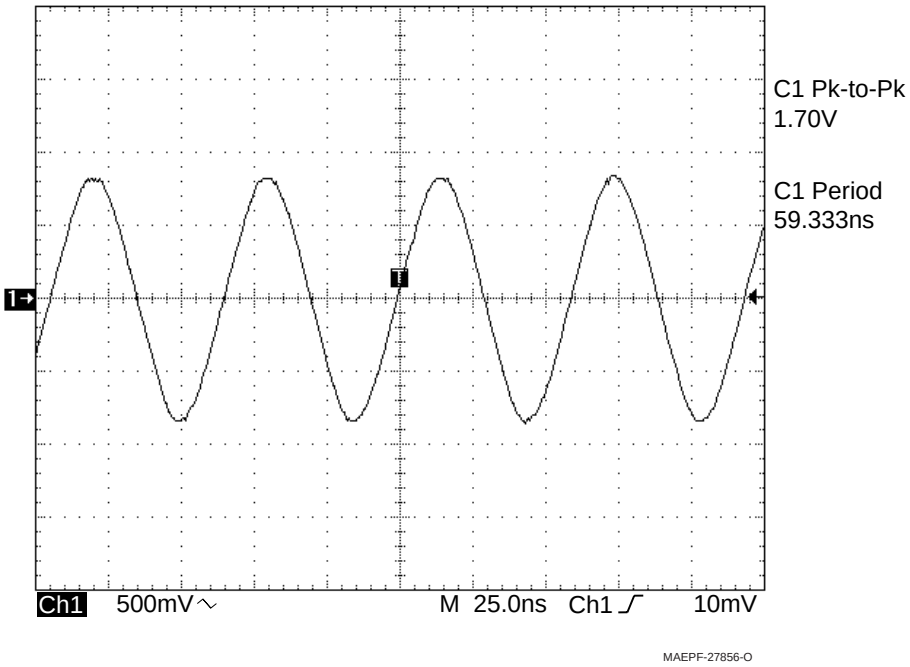


6.2.3 Power-Down Reset



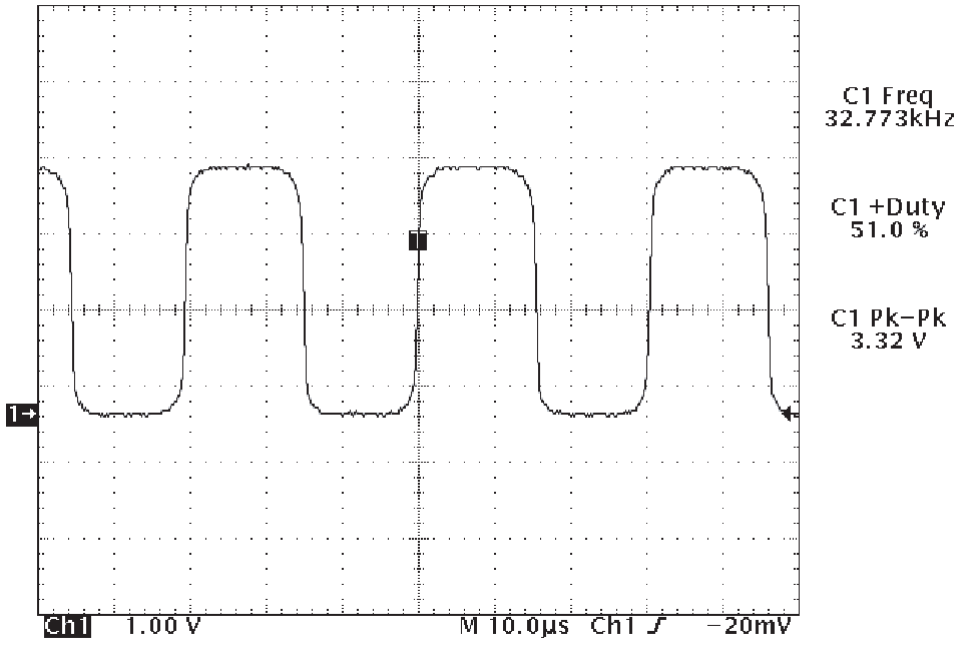
Power-Down Reset
Trace 1 — SWB+
Trace 2 — LV_DETECT — U0507 Pin 5
Trace 3 — SOFT_TURN_OFF — TP0500

6.2.4 16.8 MHz Clock Waveform



Trace 1 — U0903 Pin 3 — 16.8 MHz Clock

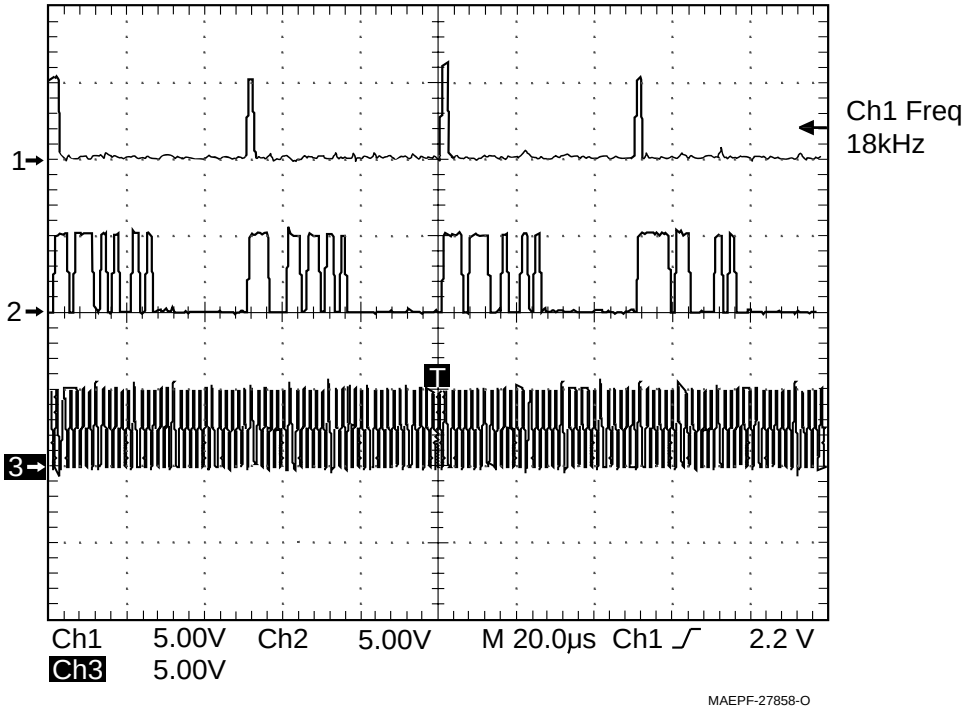
6.2.5 32 kHz Clock Waveform



Trace 1 — R428 — 32 kHz Clock

MAEPF-27857-O

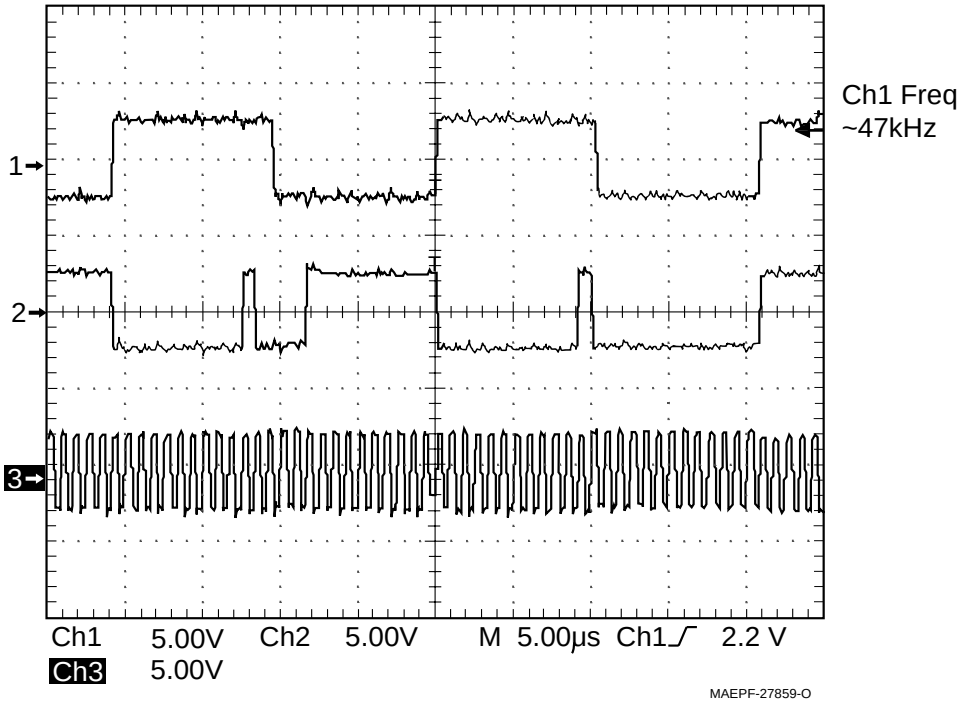
6.2.6 DSP SSI Port RX Mode



MAEPF-27858-O

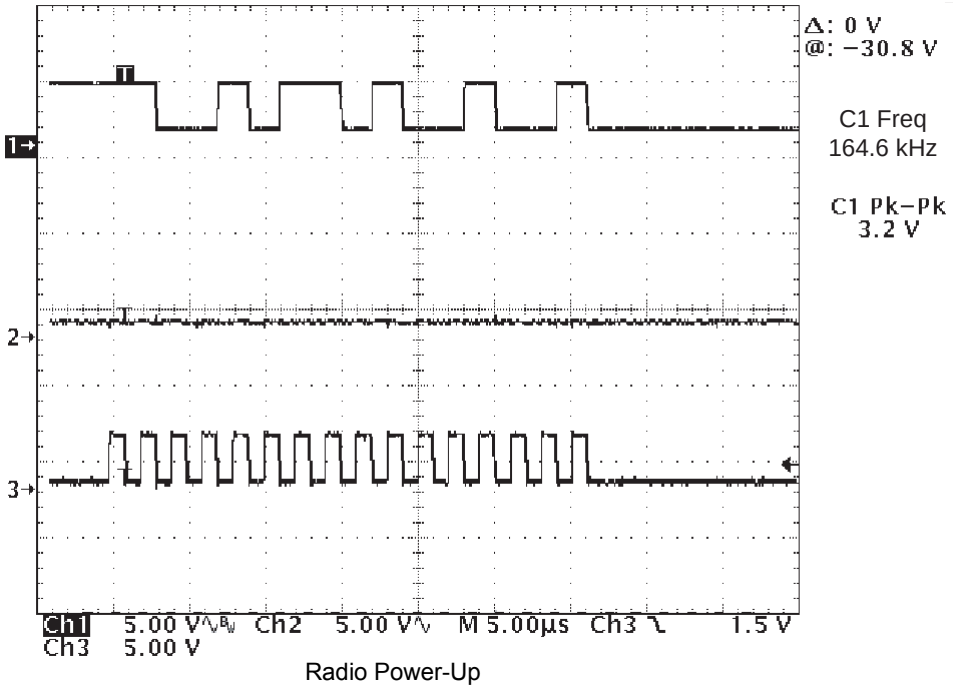
DSP SSI Port RX Mode CSQ
Trace 1 — ABACUS_SSI_FSYNC
Trace 2 — ABACUS_SSI_RXD
Trace 3 — ABACUS_SSI_CLK (1.2 MHz)

6.2.7 DSP SSI Port TX Mode CSQ



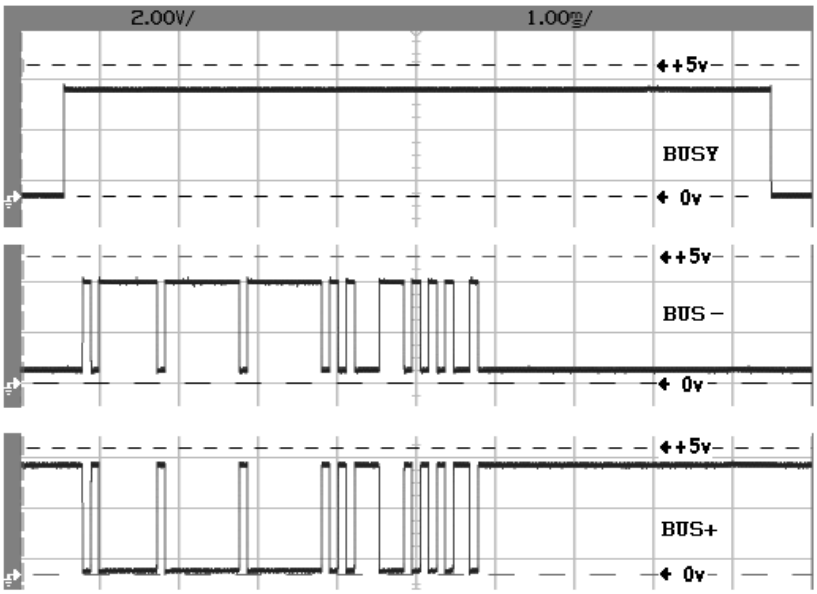
DSP SSI Port TX Mode CSQ
Trace 1 — DAC_SSI_FSYNC
Trace 2 — DAC_SSI_TXD
Trace 3 — DAC_SSI_CLK (2.4 MHz)

6.2.8 SPI Bus Waveform



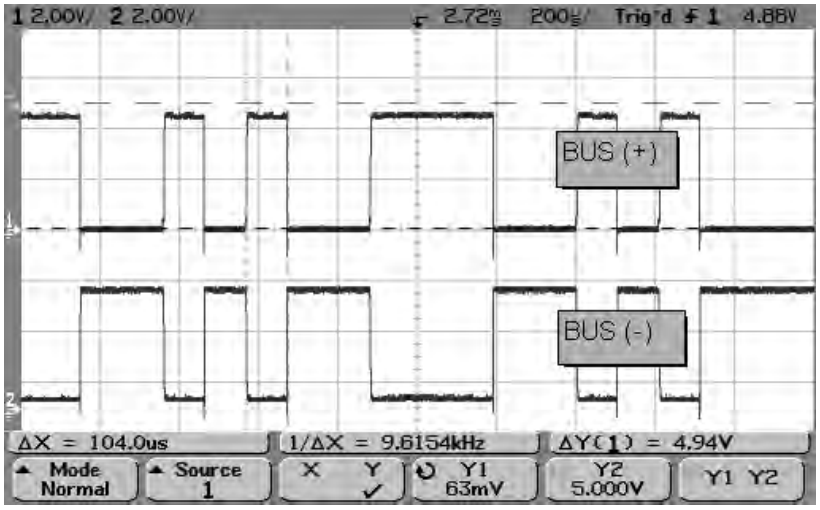
Radio Power-Up
Trace 1 — Data
Trace 2 — Chip Select
Trace 3 — Clock

6.2.9 SB9600 Waveforms



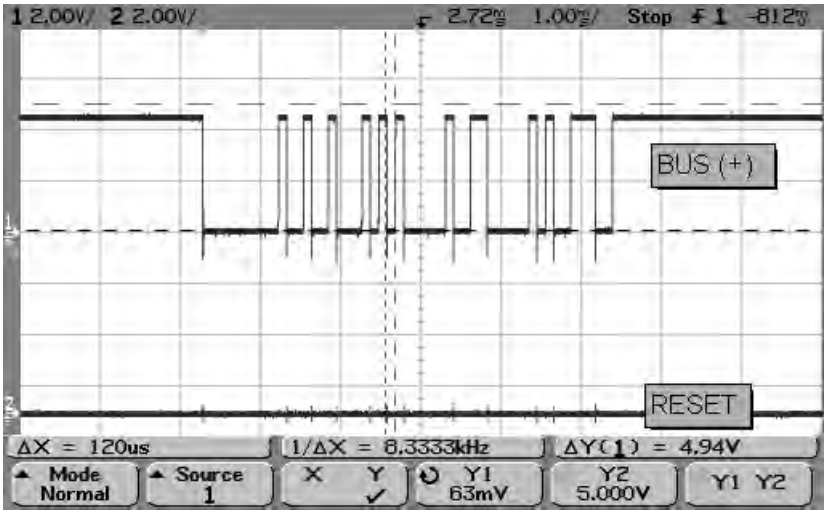
MAEPF-27781-O

6.2.10 SB9600 BUS+ and BUS- Waveforms



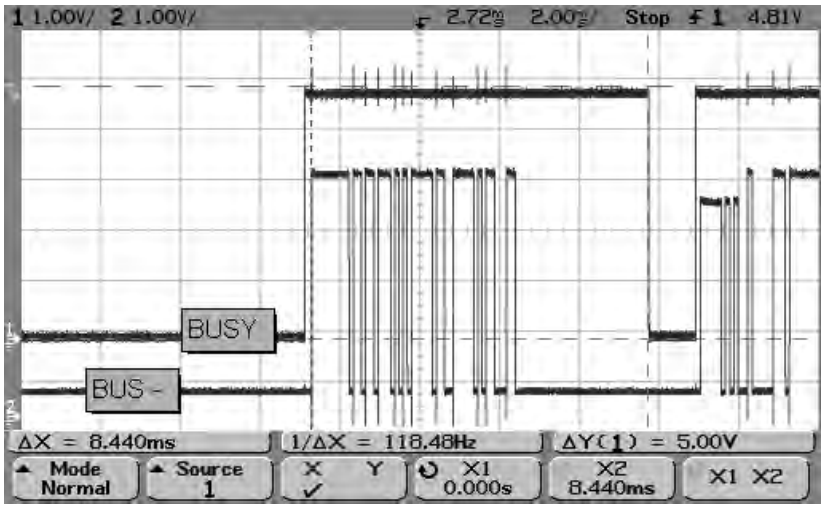
MAEPF-27871-O

6.2.11 SB9600 BUS+ and RESET Waveforms



MAEPF-27872-O

6.2.12 SB9600 BUSY and BUS- Waveforms



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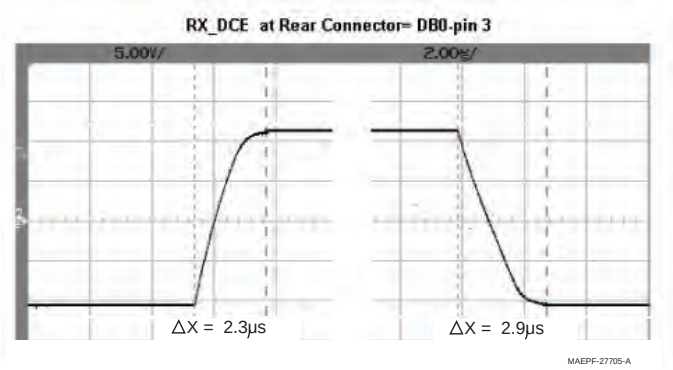
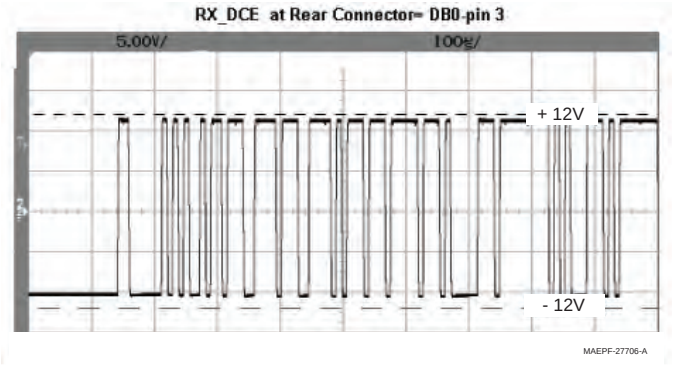
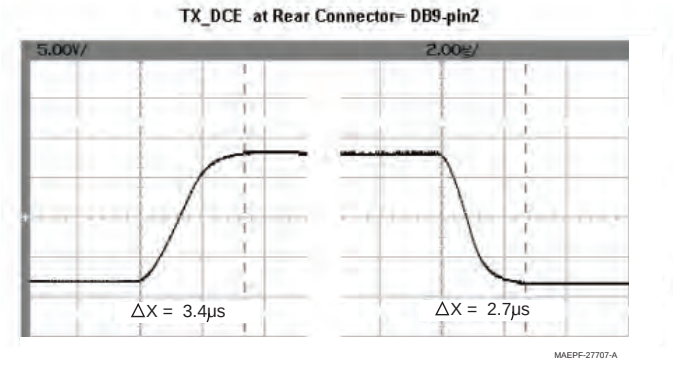
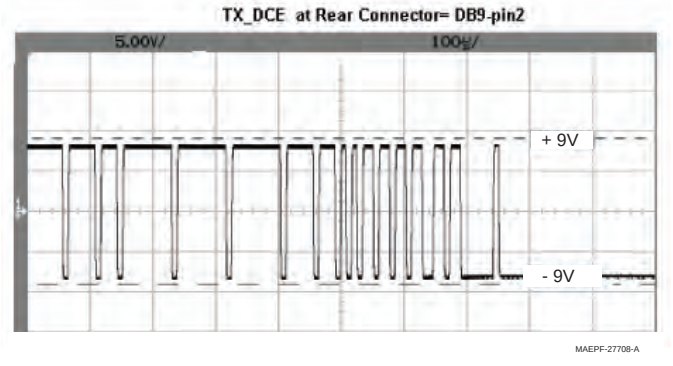
6.2.13 RS-232 RX Waveforms



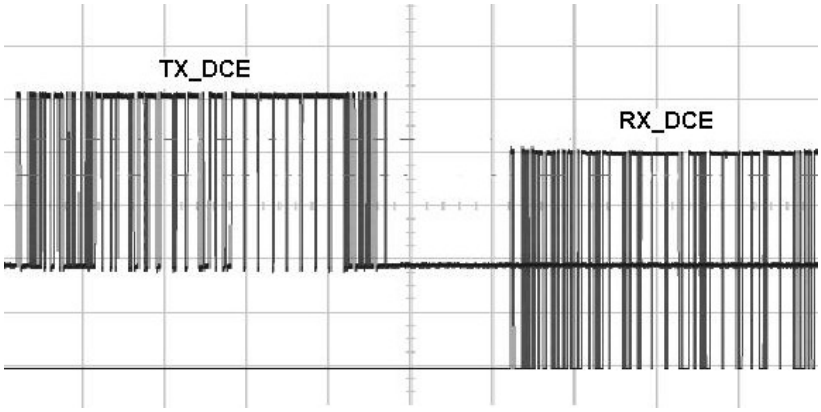


6.2.14 RS-232 TX Waveforms

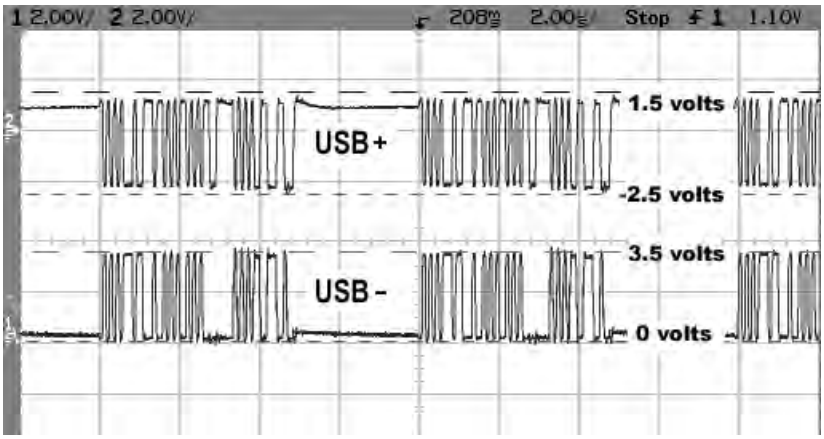




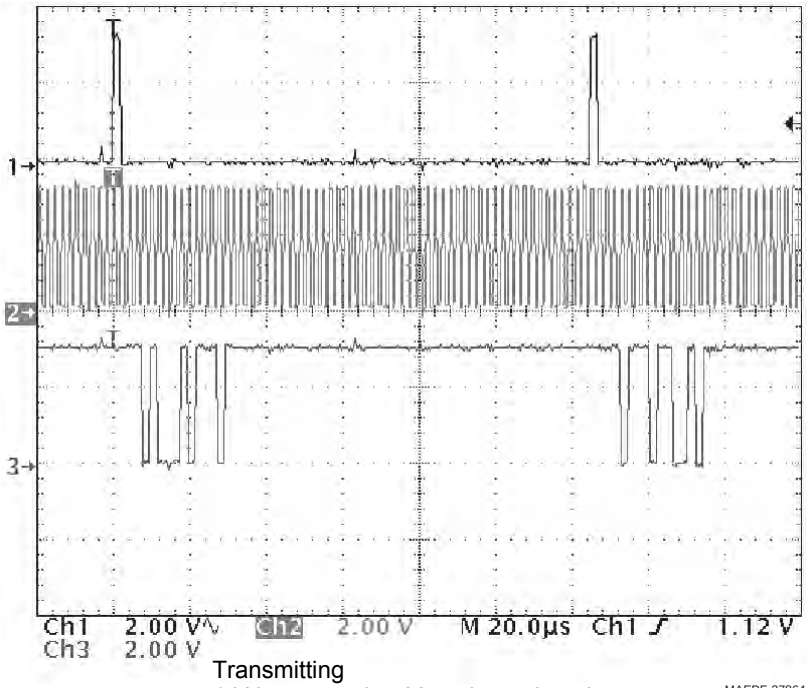
6.2.15 RS-232 RX/TX Waveforms



6.2.16 USB Waveforms

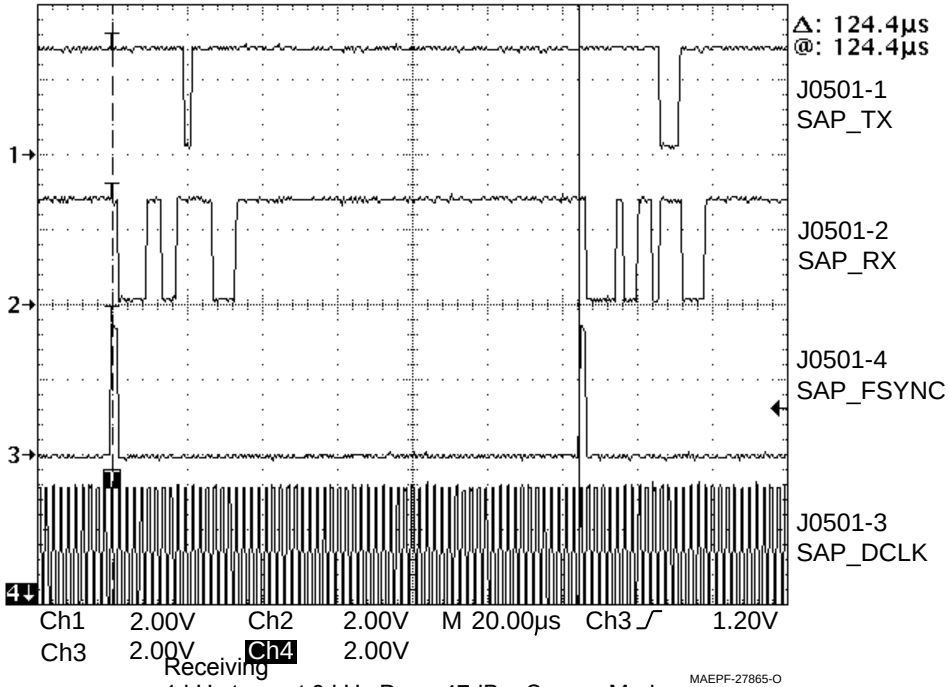


6.2.17 Serial Audio Port Waveforms



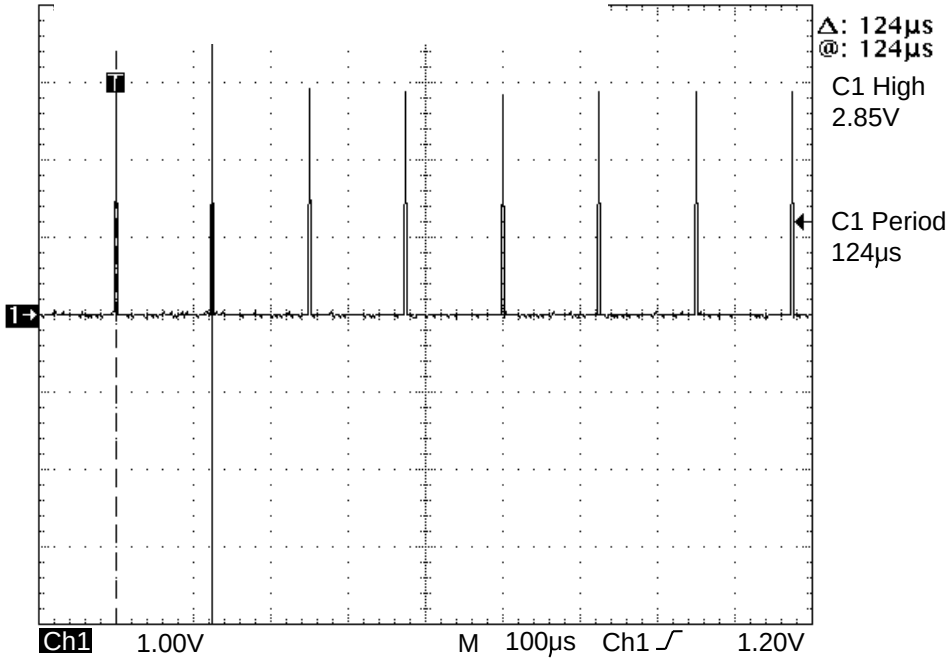
Transmitting
1 kHz tone at 85mVrms into microphone
Trace 1 — Frame Sync — SAP_FSYNC
Trace 2 — Clock — SAP_DCLK
Trace 3 — Data — SAP_TX

6.2.18 Secure Interface Waveforms



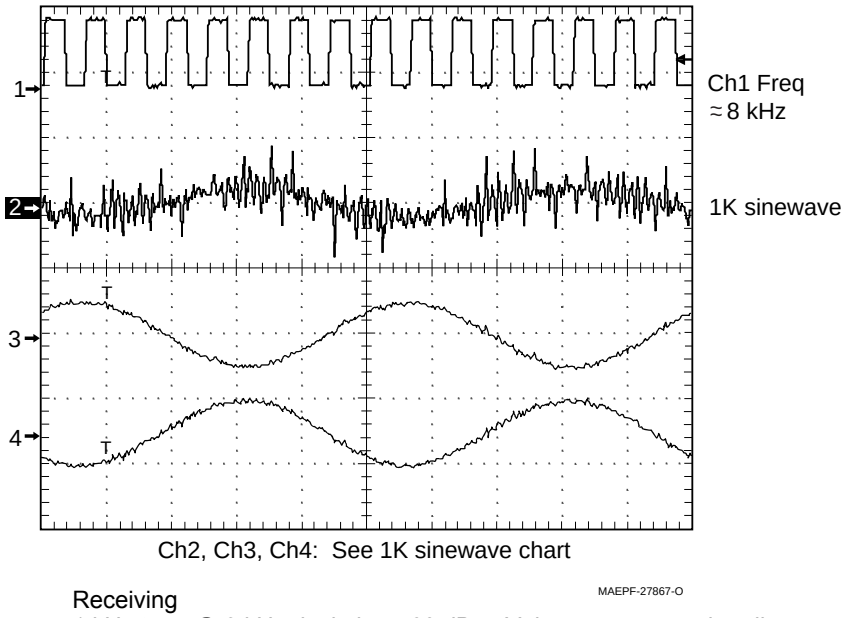
Receiving
1 kHz tone at 3 kHz Dev, -47dBm Secure Mode
Trace 1 — J0501 — 1 - SAP TX
Trace 2 — J0501 — 2 - SAP RX
Trace 3 — J0501 — 3 - SAP DCLK

6.2.19 8 kHz Frame Sync Waveform



Receiving
1 kHz tone at 3 kHz Dev, -47dBm Secure Mode
Trace 1 — J0501 — 4

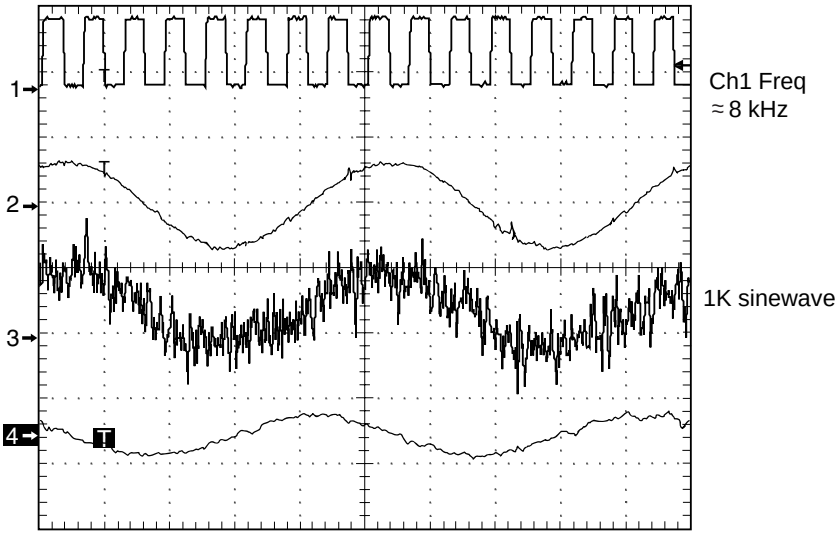
6.2.20 RX Audio Waveforms



Ch2, Ch3, Ch4: See 1K sinewave chart

Receiving
1 kHz tone @ 3 kHz deviation, -60 dBm. Volume set to rated audio.
Trace 1 — SAP_DCLK (8 kHz)
Trace 2 — TP0205
Trace 3 — SPKR_LOW out of U0204
Trace 4 — SPKR_HI out of U0204
Note 3: Actual level is dependent upon volume setting.

6.2.21 TX Audio Waveforms



Ch2, Ch3, Ch4: See 1K sinewave chart

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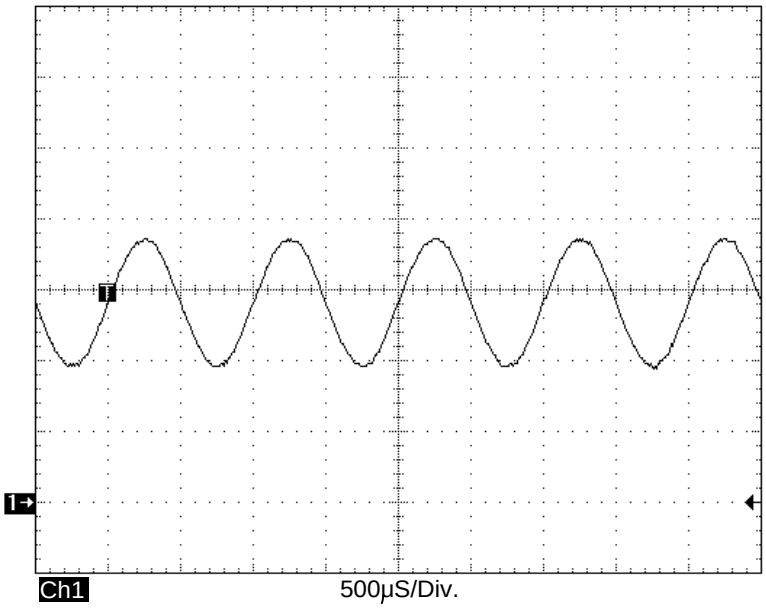
Transmit Audio
1 kHz tone which provides 3 kHz deviation
Trace 1 — SAP_DCLK (8 kHz)
Trace 2 — MODIN R6782
Trace 3 — MIC TP0200
Trace 4 — TP0203
Note 3: Actual level is dependent upon volume setting.

6.2.22 TX and RX 1 kHz Audio Path Sinewave and Chart



Refer to Table 6-2 **for test point data**

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Table 6-2. TX and RX Audio Path Test Points for 1 kHz Sine Wave (for Mid Power VHF, UHF R1 and 700/800 MHz)

		Typical	O-Scope	Measured mV p-p		Volts
Test Point	**Description**	**mV RMS**	**mV/div**	**LL [1]**	**UL [2]**	**DC Bias**
TX Audio Path						
MIC_HI	80 mV RMS input	80 mV	20	226	227	3 to 9
TP0200	MIC_PREAMP_IN	80 mV	20	220	227	1.42
TP0201	Preamp in, attn.-out	43 mV	10	100	122	1.42
U0201-1	1st op amp out [3]	42 mV	10	97	121	1.42
TP0202	2nd op amp in [3]	41 mV	10	97	121	1.42
U0201-7	2nd op amp out	41 mV	10	94	120	1.42
U0201-8	3rd op amp and filter out	40 mV	10	91	119	1.42
U0201-14	4th op amp and filter out	39 mV	10	88	118	1.42
TP0203	CODEC op amp in	38 mV	10	85	117	1.42
U0200-17	Buffered CODEC in	36 mV	10	82	116	1.42
C0904	5 CF Out	150 mV	50	400	700	1.42
R6782	MOD_IN at 3 kHz dev. [3]	150 mV	50	400	700	1.5
RX Audio Path [4]						
TP0204	RX_FILT_AUDIO	318	500	849	953	1.42
TP0205	RX_AUDIO_IN	318	500	849	953	1.42
TP0206	AUDIO_PA_IN	39	10	92	130	1/2 A+
SPKR+	NON INVERTED PA out	7.74 Vbtl [5]	2 V	9.5 Vpp	12.4 Vpp	1/2 A+
SPKR-	INVERTED PA out	7.74 Vbtl [5]	2 V	9.5 Vpp	12.4 Vpp	1/2 A+

[1] LL = lower limit

[2] UL = upper limit

[3] Measurement depends on tuning parameters

[4] 1 kHz tone at 3 kHz deviation, -47 dBm

[5] “btl” = bridge to load

Table 6-3. TX and RX Audio Path Test Points for 1 kHz Sine Wave (for all High Power and Mid Power R2)

		Typical	O-Scope	Measured mV p-p		Volts
Test Point	**Description**	**mV RMS**	**mV/div**	**LL [1]**	**UL [2]**	**DC Bias**
TX Audio Path						
MIC_HI	80 mV RMS input	80 mV	20	226	227	3 to 9
TP0200	MIC_PREAMP_IN	80 mV	20	220	227	2.5
U0201-8	1st op amp out [3]	0 mV	10	0	10	2.5
U0201-7	2nd op amp out	80 mV	10	210	227	2.5
U0201-1	3rd op amp and filter out	80 mV	10	210	227	2.5
U0201-14	4th op amp and filter out	80 mV	10	210	227	2.5
TP0203	CODEC op amp in	36 mV	10	85	117	1.42
U0200-17	Buffered CODEC in	36 mV	10	82	116	1.42
C0904	5 CF Out	150 mV	50	400	700	1.42
R6782	MOD_IN at 3 kHz dev. [3]	150 mV	50	400	700	1.5
RX Audio Path [4]						
TP0204	RX_FILT_AUDIO	318	500	849	953	1.42
TP0205	RX_AUDIO_IN	318	500	849	953	1.42
TP0206	AUDIO_PA_IN	39	10	92	130	1/2 A+
SPKR+	NON INVERTED PA out	7.74 Vbtl [5]	2 V	9.5 Vpp	12.4 Vpp	1/2 A+
SPKR-	INVERTED PA out	7.74 Vbtl [5]	2 V	9.5 Vpp	12.4 Vpp	1/2 A+

[1] LL = lower limit

[2] UL = upper limit

[3] Measurement depends on tuning parameters

[4] 1 kHz tone at 3 kHz deviation, -47 dBm

[5] “btl” = bridge to load