Nokia Customer Care
6015/6015i/6016i/6019i (RH-55), 6012 (RM-20) Series Transceivers

Troubleshooting - RF

Contents

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RF Troubleshooting

When troubleshooting the receiver, first check the RX_AGC PDM value. The AGC value should be close to the typical values (see "RF AGC Status" on page 26). The RX AGC tries to keep a constant amplitude at the output of the receiver chain; if the AGC value indicates an AGC gain that is substantially higher than normal, the AGC is compensating for extra loss in another component. If the AGC PDM values are normal and there is still a problem, check the actual AGC voltages. RF probing at specific locations in the chain can then help to pinpoint the source of the problem.

Likewise, when troubleshooting the transmitter, first check the measured output power and AGC values, which give an indication of where to start probing. Although probing points and signal-level information are given for each point in the receiver and transmitter chains, the troubleshooter is not expected to probe each point on every phone — only the suspected trouble spots.

Absolute power measurements were made with an Agilent (HP) 85024A active high-impedance probe. Other probes can be used (but should be high-impedance so that the measurement does not load the circuit) but may very well have a different gain; therefore, adjust the absolute measurements accordingly. Also, adjust if using a probe attenuator.

Where a range is given for loss, typically the higher loss occurs at the band edges. Probing is not a very accurate method to measure absolute power; therefore, you cannot expect measured results to exactly match the numbers listed here.

Power depends on the impedance of the circuit. For example, if a filter has a nominal loss of 5 dB, then straightforward probing on the input and output, then subtracting, might not result in 5 dB because the input impedance might be different from the output impedance. Most components in the RF section have the same input and output impedance (50 ohms), but where this is not the case, absolute power is noted in the tables in dBm, rather than loss or gain in dB.

When testing the CDMA receiver, it is easier to inject a CW tone into the receiver. The gains and losses are the same for a CW signal as for CDMA.

Note: After opening the shield lids, always replace them with new lids.

Phone Components

Figures 1 and 2 illustrate the main components of the 6015/6015i/6016i/6019i, and 6012.

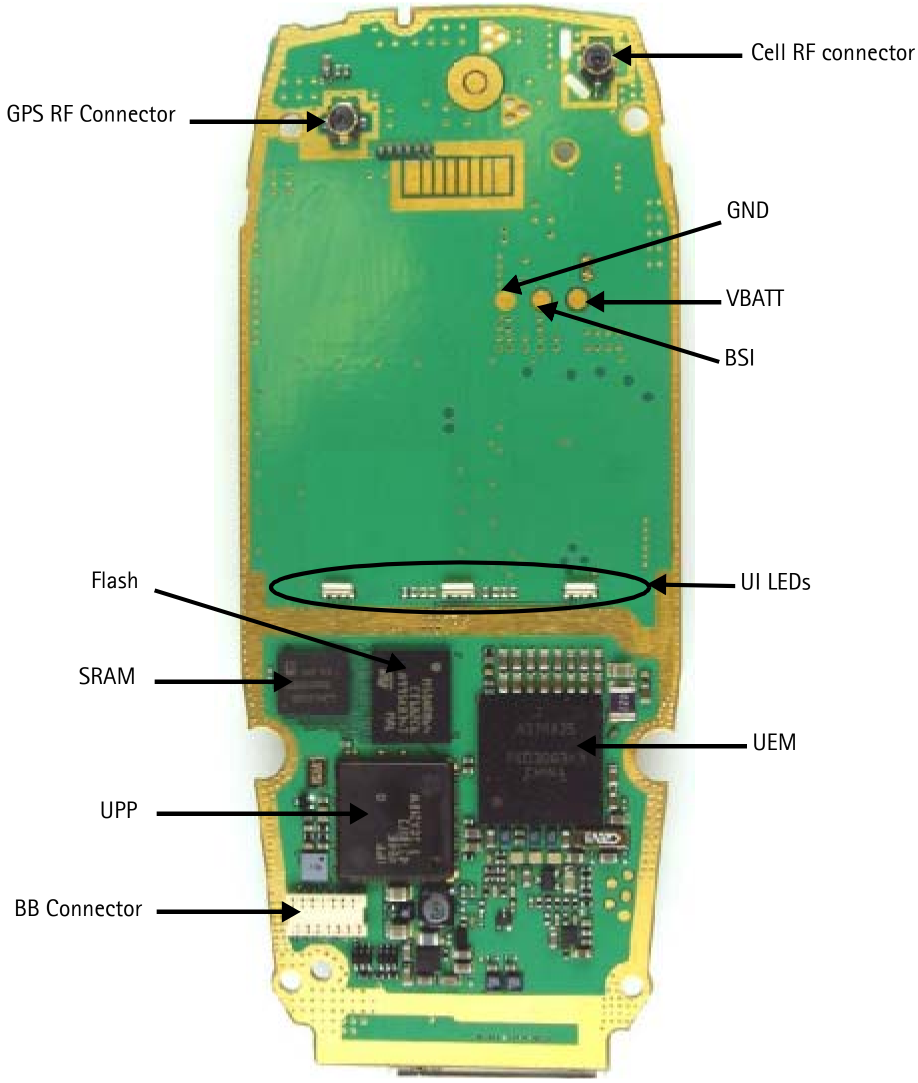

Figure 1: Component layout (bottom)

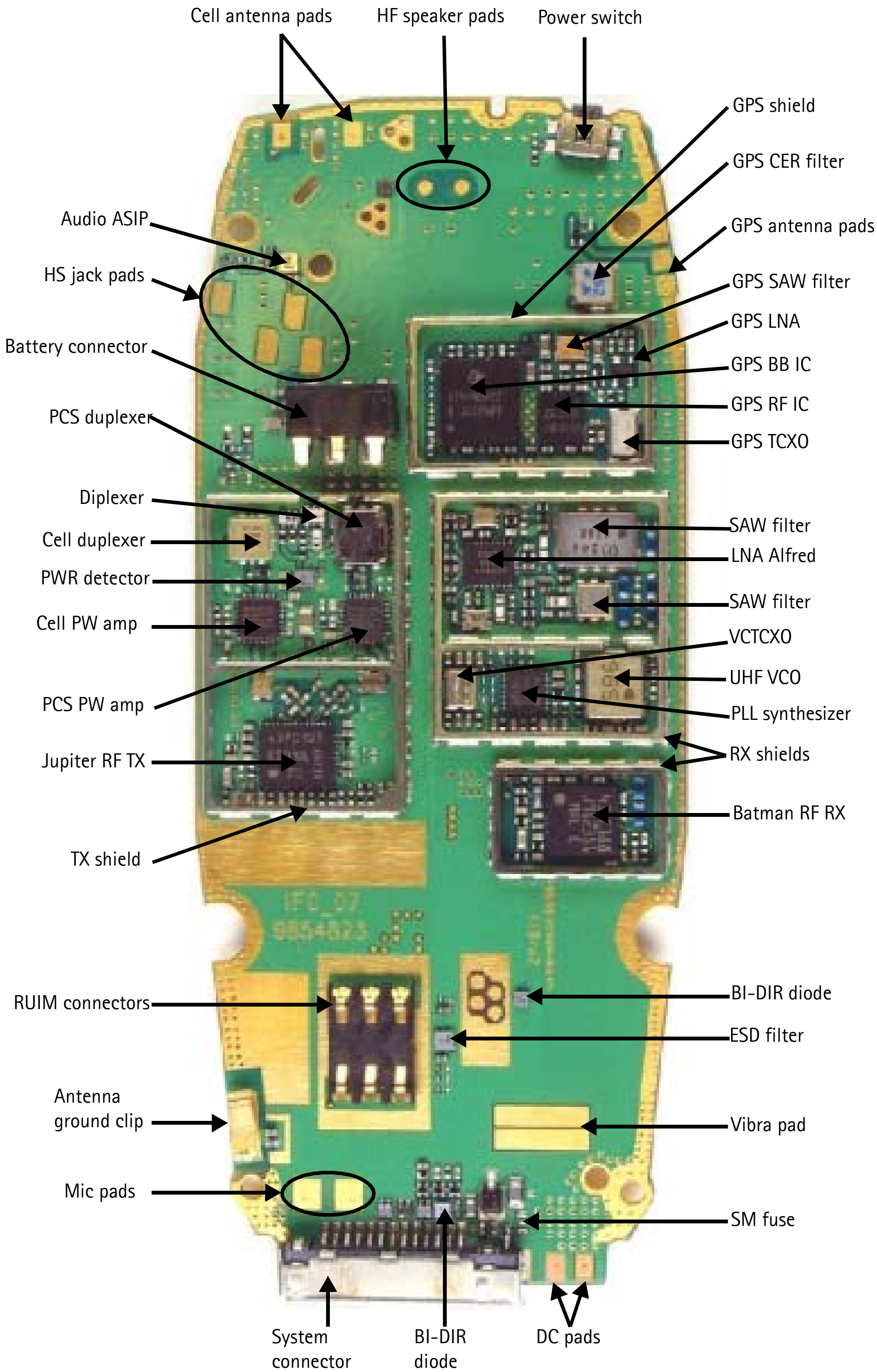

Figure 2: Component layout (top)

General Troubleshooting

Use the following steps to troubleshoot some common issues, such as low transmitter power, a faulty receiver, or a phone that cannot make a call.

TX Power Low

If TX power is low, use Phoenix to turn on the transmitter in Local Mode and check the following:

1. Perform a visual inspection of the PWB under a microscope to check for the proper placement, rotation, and soldering of components.
2. Look for the presence of a CDMA modulated signal on a spectrum analyzer at the correct frequency.
   - If a signal is present but off-frequency or distorted, check the synthesizer. Most likely, one of the synthesizers is not locked or the VCO has no output signal.
   - If a signal is not present, or present but low in amplitude, use check the probing diagrams to determine where in the chain the fault occurs.
3. Check that the AGC PDMs are set for the desired TX power and ensure the AGC voltages are correct.
4. Check the synthesizers for proper frequency and amplitude.
5. Ensure that the power supplies to the transmitter have the correct voltage.

Receiver Not Working Properly

If the receiver is not working properly, turn it on in Local Mode and check the following:

1. Turn on receiver with Phoenix and inject a signal.
2. Check the AGC PDM.
3. Perform a visual inspection of the PWB under a microscope to check for the proper placement, rotation, and soldering of components.
4. Measure signal levels at various points in the chain and determine where in the chain the fault lies.
5. Check the LOs for proper frequency and amplitude.
6. Ensure power supplies to receiver have correct voltage.

Phone Cannot Make a Call

Verify the following if the phone cannot make a call:

1. The phone is in Normal Mode (i.e., the phone is searching for a signal, net server is on).
2. The Preferred Roaming List (PRL) is loaded into the phone.
3. The phone is tuned and has passed tuning. (Read the tuning parameters using the batch tune component in Phoenix; an untuned phone has all zeros in the tuning file.)

4. The call box channel is set for a channel in PRL.
5. The SID is correct and entered into the phone.
6. The VCTCXO is centered as described in the VCTCXO tuning description on page 49.
7. The transmitter and receiver are working properly in Local Mode.

Transmitter Parts

Following are the transmitter RF parts.

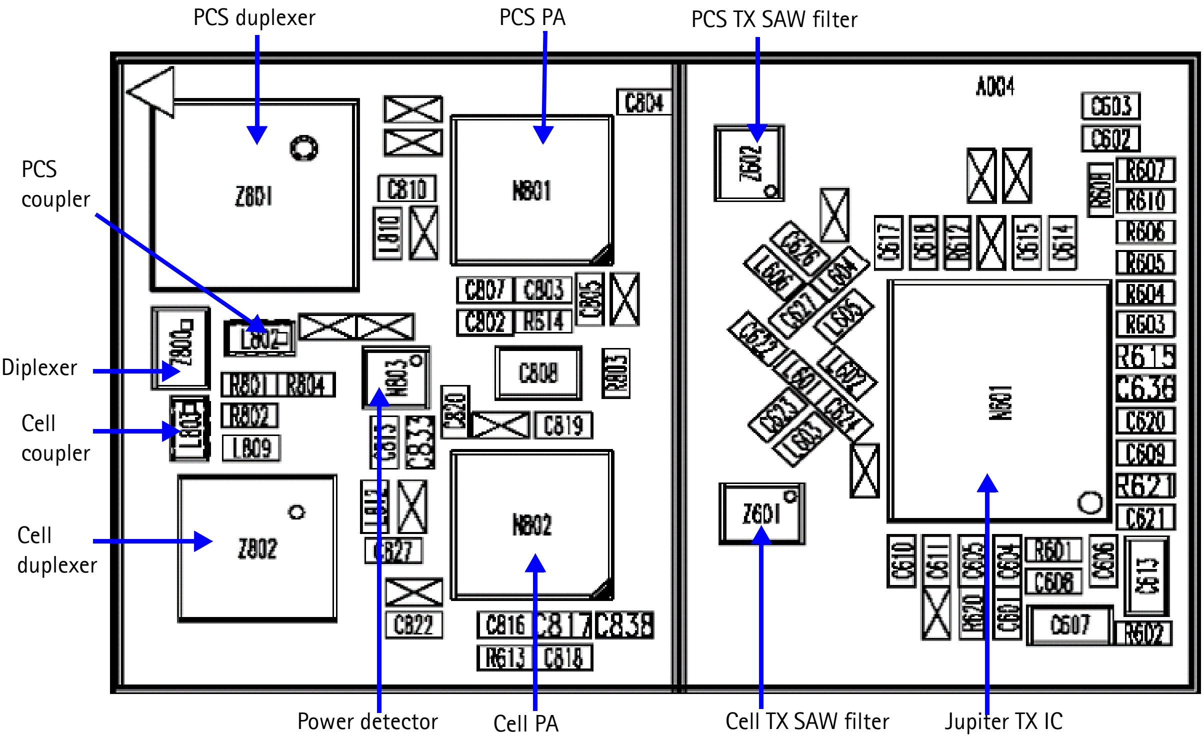

Figure 3: Transmitter parts

Cell Transmitter Block Diagram

Following is the block diagram for the TX system.

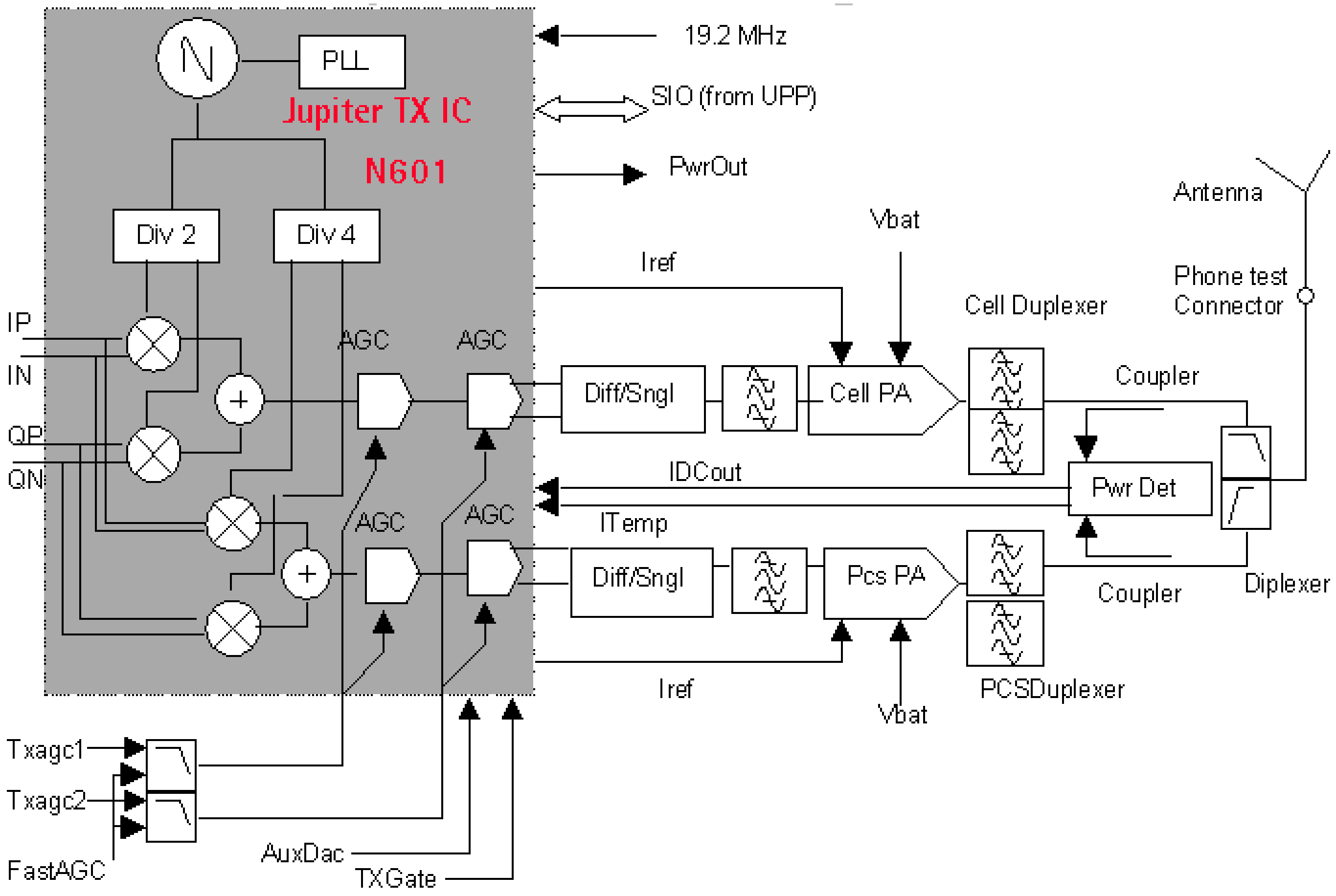

Figure 4: TX system block diagram

Transmitter Schematics

The following schematics are for general reference only. See the *Schematics* chapter for detailed versions.

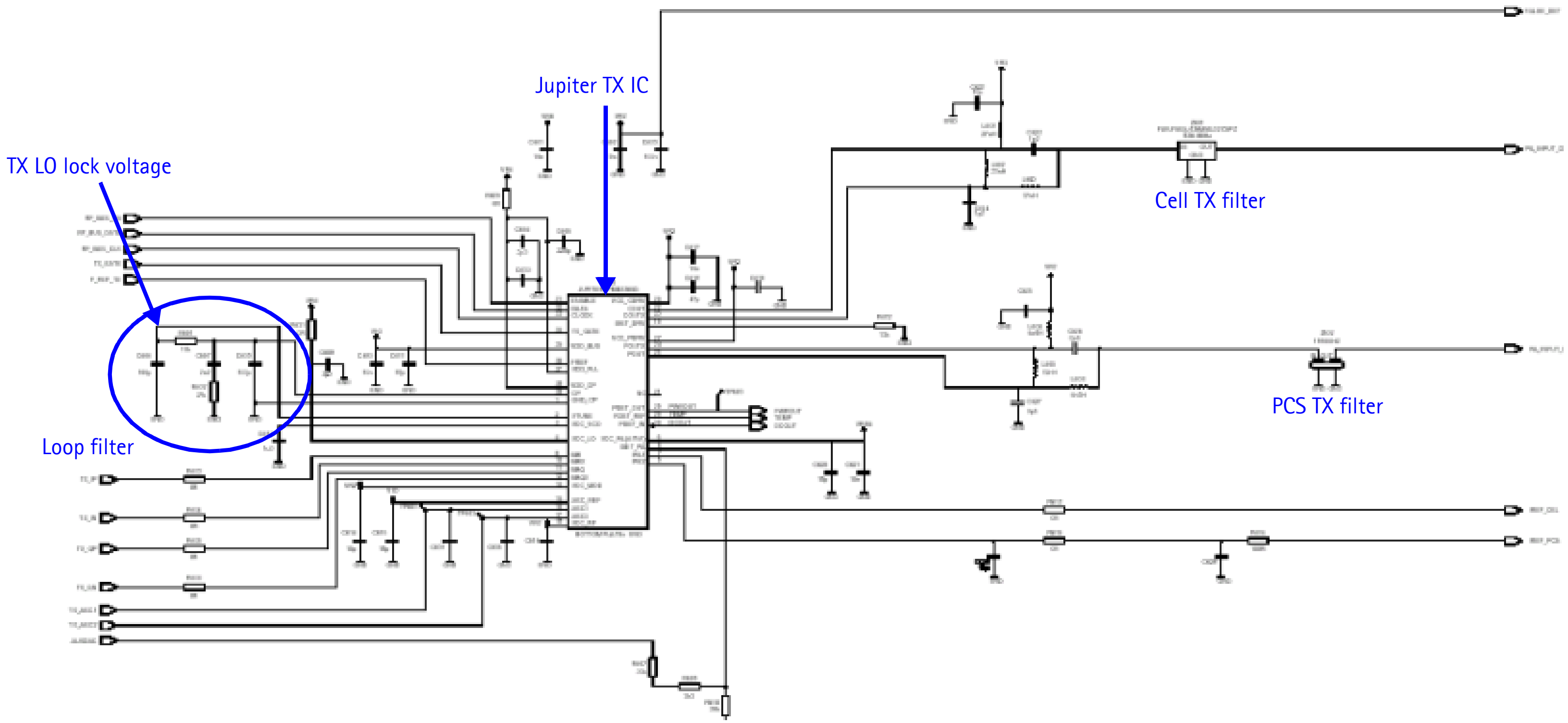

Figure 5: Transmitter schematic 1

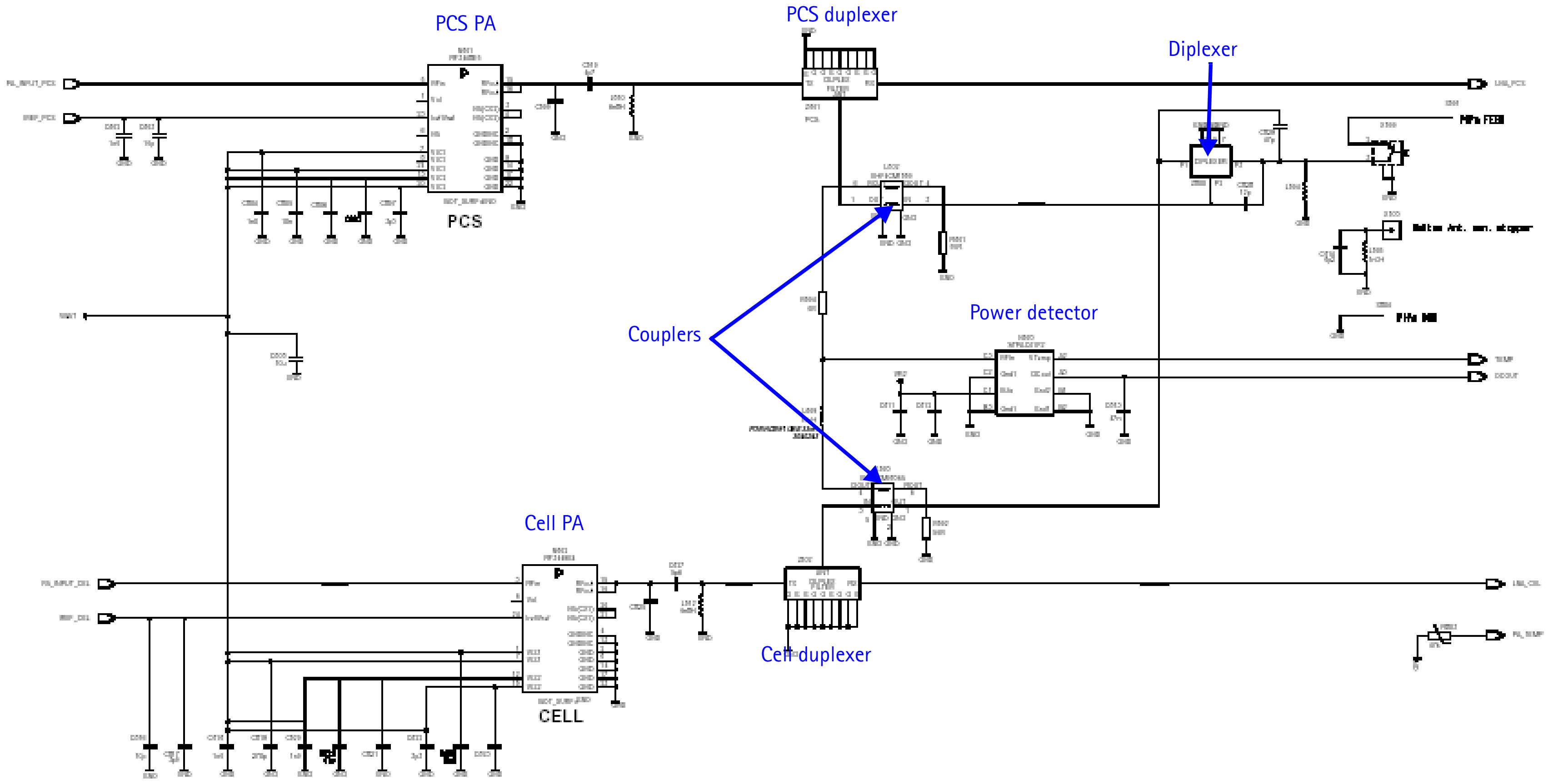

Figure 6: Transmitter schematic 2

Transmitter Troubleshooting Setup

Use the following sections to set up troubleshooting in Phoenix according to the band you are using:

- "AMPS TX Setup"
- "Cell TX Setup"
- "PCS TX Setup"

AMPS TX Setup

Use the following procedures to prepare for AMPS TX troubleshooting using Phoenix.

1. Connect RF test connector to a call box.
2. Connect the phone to a PC via the bottom connector, and connect a power supply.
3. Open the **Troubleshooting** menu, and click **Phone Control**.

   The **Phone Control** dialog box appears.
4. On the **Phone Control** dialog box, click the **LOCAL** button in the **Phone State** area to put the phone into Local Mode.

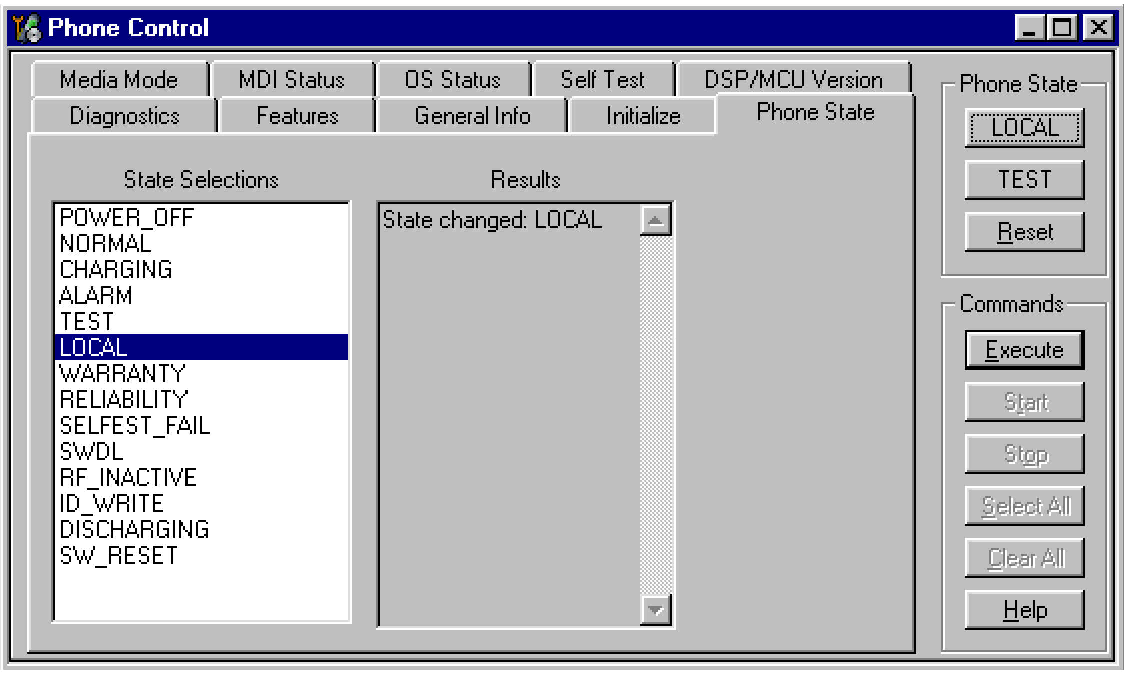

Figure 7: Phone Control dialog box

5. Open the **Troubleshooting** menu, point to **AMPS**, and click **AMPS Control**.

The **AMPS Control** dialog box appears.

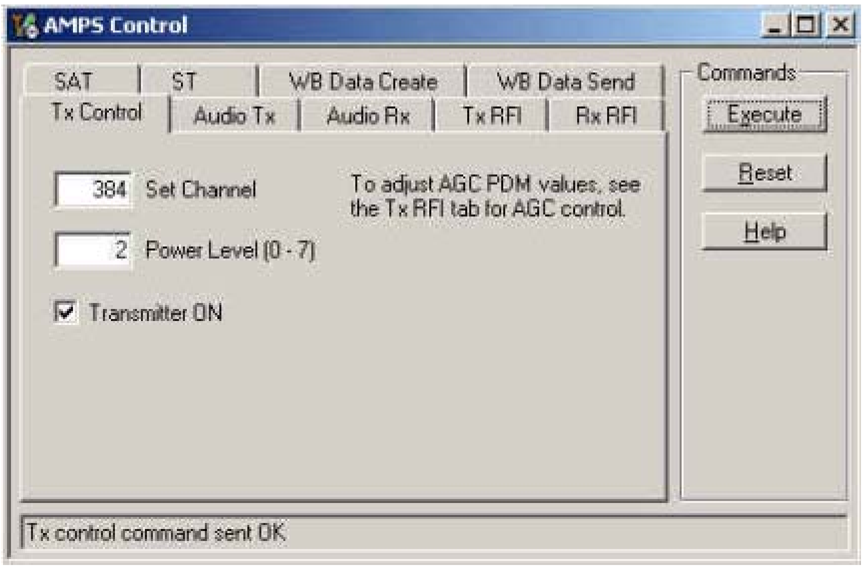

Figure 8: AMPS Control dialog box

6. Click the **Tx Control** tab.
7. In the **Set Channel** field, type 384.
8. In the **Power Level** field, type 2.
9. Select the **Transmitter ON** option, and click **Execute**.
10. Configure the spectrum analyzer using the following values:
    - Center Frequency = 836.52 MHz
    - Span = 100 MHz
    - Amplitude = 20 dBm
    - Attenuation = Auto
    - BW = Auto

Cell TX Setup

Use the following procedures to prepare for Cell TX troubleshooting using Phoenix.

1. On the **Phone Control** dialog box, click the **LOCAL** button in the **Phone State** area to put the phone into Local Mode. (See Figure 7 on page 13.)
2. Open the **Troubleshooting** menu, point to **RF**, and click **RF Main Mode**.

   The **RF Main Mode** dialog box appears.

3. Select the following values on the **RF Main Mode** dialog box:
    - **Band** = Cell (CDMA)
    - **Channel** = 384
    - **Mode** = Rx/Tx

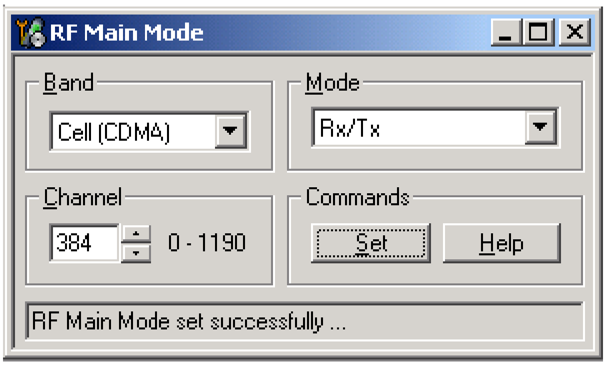

Figure 9: RF Main Mode dialog box

4. Click **Set**.

Note: Be sure that the "RF Main Mode set successfully" message appears in the status bar.

5. Open the **Troubleshooting** menu, point to **RF**, and click **CDMA Control**.

   The **CDMA Control** dialog box appears.

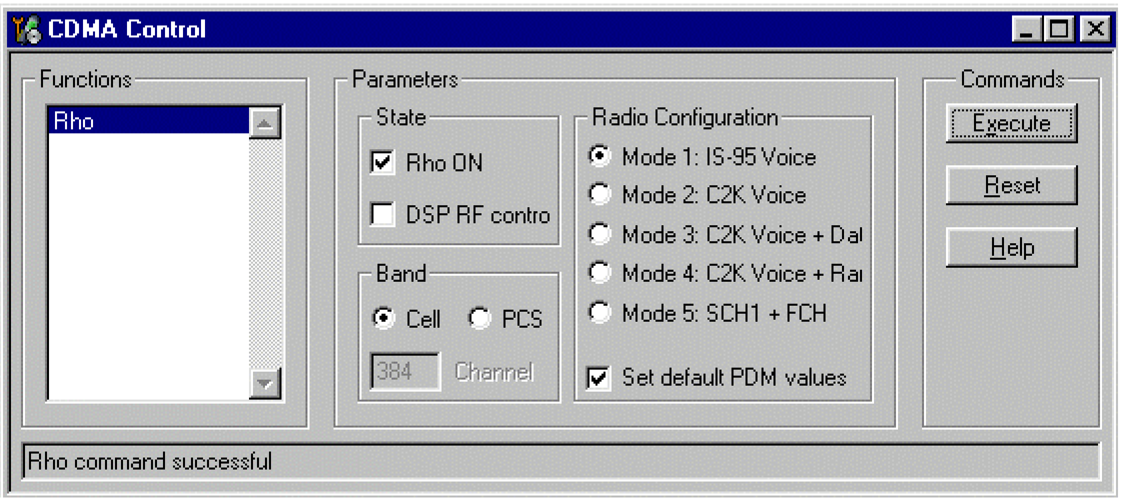

Figure 10: CDMA Control dialog box for Cell TX troubleshooting

6. Select the following values on the **CDMA Control** dialog box.
    - **State** = Rho ON
    - **Band** = Cell
    - **Radio Configuration** = Mode 1: IS-95 Voice
    - Select the **Set default PDM values** check box.
7. Click **Execute**.
8. Open the **Troubleshooting** menu, point to **RF**, and click **PDM Control**.

The **RF PDM Control** dialog box appears.

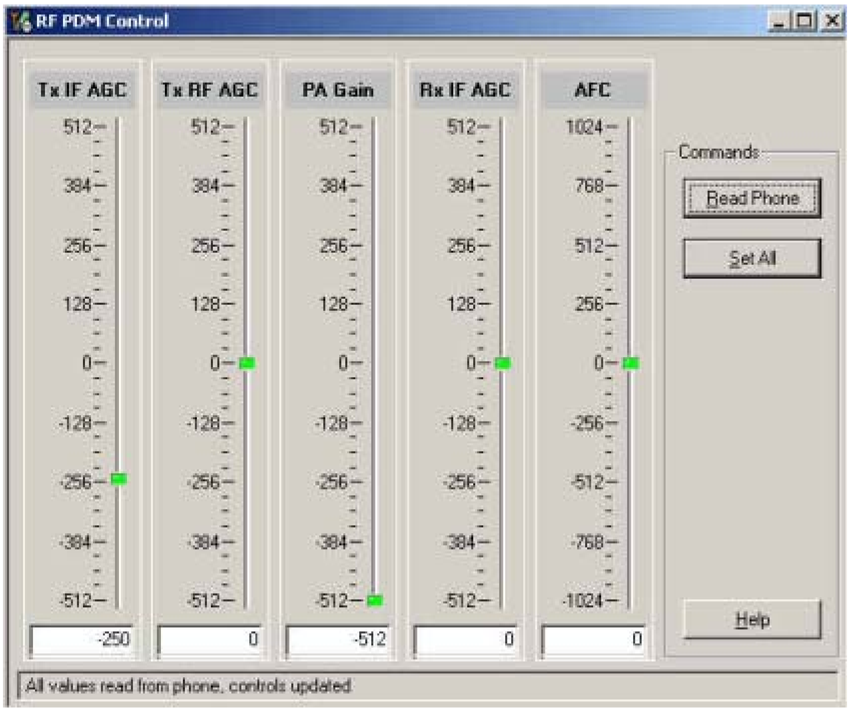

Figure 11: RF PDM Control dialog box for Cell troubleshooting

9. Click **Read Phone** to update the values.
10. Configure the spectrum analyzer using the following values:
    - Center Frequency = 836.52 MHz
    - Span = 100 MHz
    - Amplitude = 20 dBm
    - Attenuation = Auto
    - BW = Auto

PCS TX Setup

Use the following procedures to prepare for PCS TX troubleshooting using Phoenix.

1. Open the **Troubleshooting** menu, and point to **Phone Control.**

   The **Phone Control** dialog box appears.

2. Click the **LOCAL** button in the **Phone State** area to put the phone into Local Mode. (See Figure 7 on page 13.)
3. Open the **Troubleshooting** menu, point to **RF**, and click **RF Main Mode**.

   The **RF Main Mode** dialog box appears. (See Figure 9 on page 15.)

4. Select the following values on the **RF Main Mode** dialog box:
   - **Band** = PCS (CDMA)
   - **Channel** = 600
   - **Mode** = Rx/Tx
5. Click **Set**.

Note: Be sure that the "RF Main Mode set successfully" message appears in the status bar.

6. Open the **Troubleshooting** menu, point to **RF**, and click **CDMA Control**.

   The **CDMA Control** dialog box appears. (See Figure 10 on page 15.)
7. Select the following values on the **CDMA Control** dialog box.
   - **State** = Rho ON
   - **Band** = PCS
   - **Radio Configuration** = Mode 1: IS-95 Voice
   - Select the **Set default PDM values** check box.
8. Click **Execute**.
9. Open the **Troubleshooting** menu, point to **RF**, and click **PDM Control**.

   The **RF PDM Control** dialog box appears. (See Figure 11 on page 16.)
10. Click **Read Phone** to update the values.
11. Configure the spectrum analyzer using the following values:
    - Center Frequency = 1880 MHz
    - Span = 100 MHz
    - Amplitude = 20 dBm
    - Attenuation = Auto
    - BW = Auto

Transmitter Troubleshooting

After Phoenix is set up using either the AMPS, Cell, or PCS setup procedures, use the following steps to troubleshoot the transmitter.

1. Use a voltmeter to verify that the VR2, VR6, and VR1B are on the transmit system. (See Figure 13 on page 19 and Figure 14 on page 20).
   - If any are missing, look for SMD problems around Jupiter and the UEM.
   - If the SMD is good, replace the UEM.

2. If all DC voltages are present, check the AGC control voltages. (See Figure 13 on page 19).
   - If the voltages are incorrect, check the SMDs around the TX_AGC1 and TX_AGC2 lines.
   - If SMDs are all good, replace the UPP.
3. Using an oscilloscope, look at the input modulation waveforms on R603, R604, R605, and R606. They should all be present with an AC swing of about 500 mVpp and a +1.2 V offset.
   - If one or more waveforms are missing, look for SMD problems around these resistors.
   - If the SMD is good, replace the UEM.
4. Probe the Cell TX output of Jupiter using AAS-10 type RF probe.
5. Use the spectrum analyzer to probe the RF center frequency (see the "AMPS TX Setup", "Cell TX Setup", or "PCS TX Setup" section for the correct spectrum analyzer settings).
   - If there is no RF or low RF, look for faulty SMD around the Jupiter chip.
   - If the SMD is good, replace the Jupiter chip.
6. Probe the PA input. If level is low, look for an SMD issue on the TX filter. Reflow or replace the filter as necessary.
7. Probe the PA output. If the RF is missing or low, look for Vbatt voltages and SMD issues on and around the PA. If these voltages are good, replace the PA.
8. Probe the duplexer output. If the RF is missing or low, reflow or replace the duplexer.
9. Probe the coupler output. If the RF is missing or low, reflow or replace the coupler.
10. Probe the diplexer output. If the RF is missing or low, reflow or replace the diplexer.

Failed Test: TX PA Detector

1. Use Phoenix to set the phone in Local Mode, and activate the TX with default output power. The output power at the RF test connector should read 9 dBm +/- 4 dB.
2. Use a voltmeter on DC, and probe the detector output at C813. The voltmeter should read approximately 1.4 V. If not, replace the detector (N803).

See Figure 13 on page 19 for test point location and common power and voltage variations.

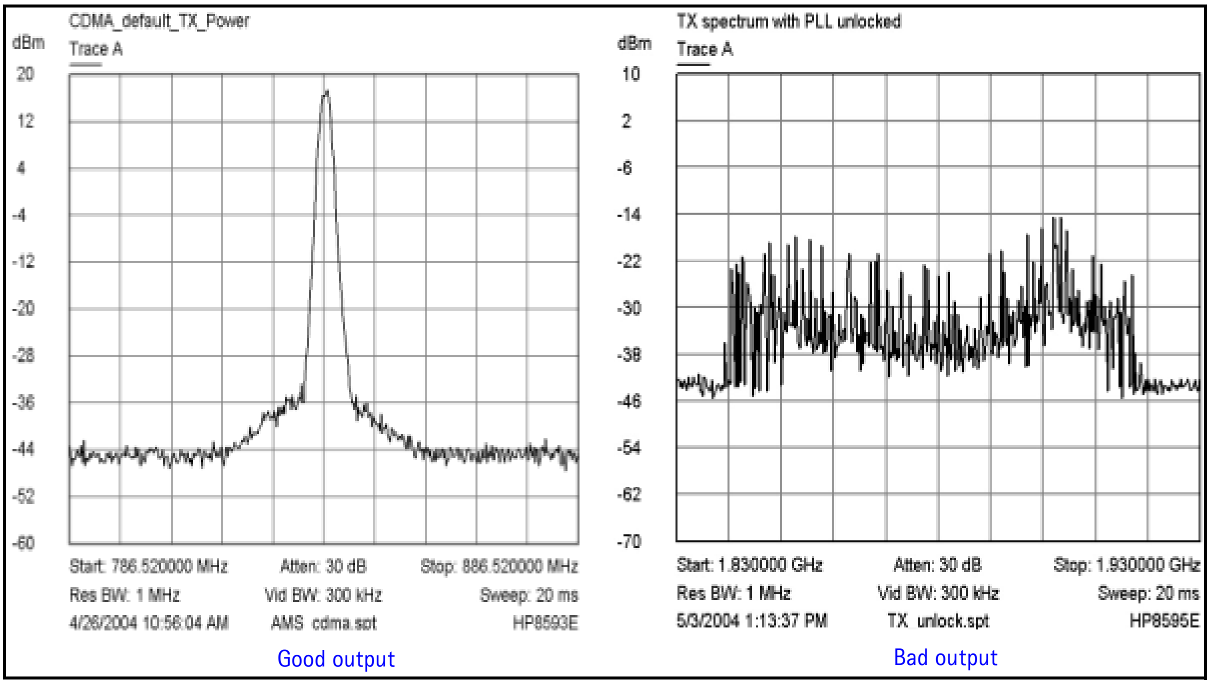

Figure 12: The output of the phone on a spectrum analyzer should look like the figure on the left

If using the AAS-10 probe with the phone connected to the call box, the amplitude should be approximately -7 dBm at the antenna test point on the top of the PWB.

TX DC Probe Points

Following are the transmitter DC probe points on the top side of the PWB. See Table 1 on page 20 for test point descriptions and values.

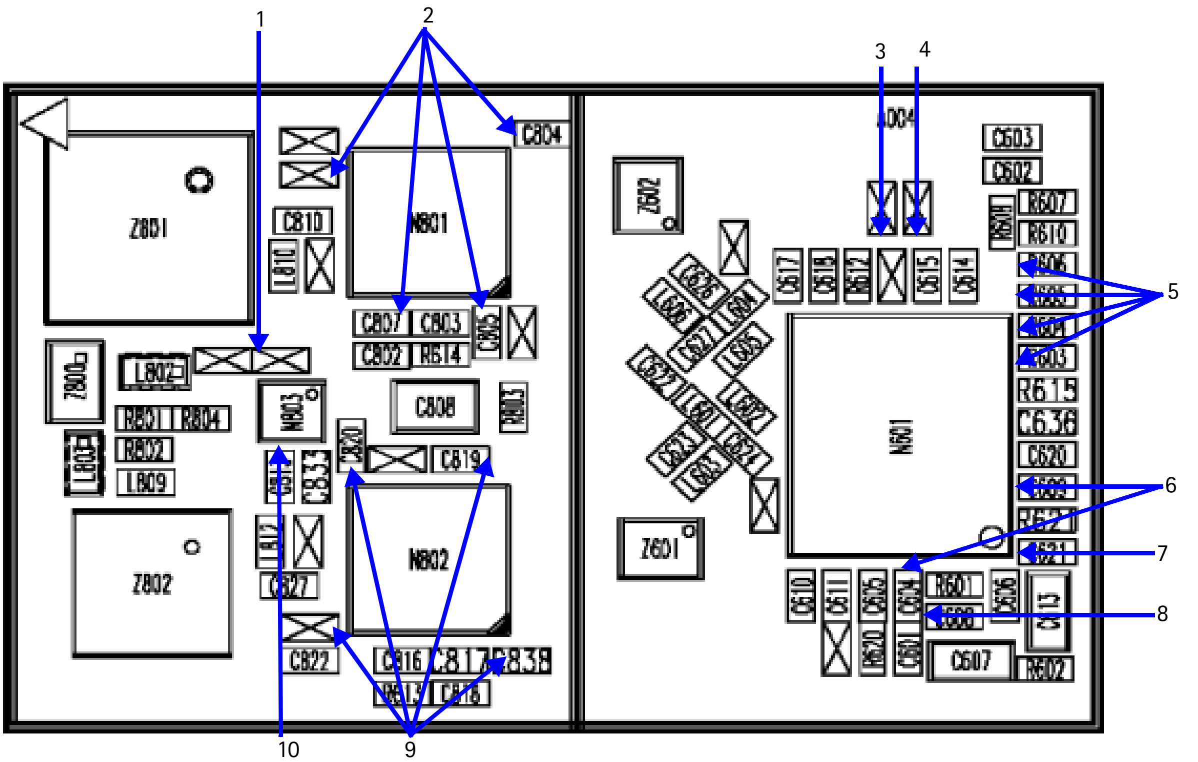

Figure 13: Top side TX DC test points

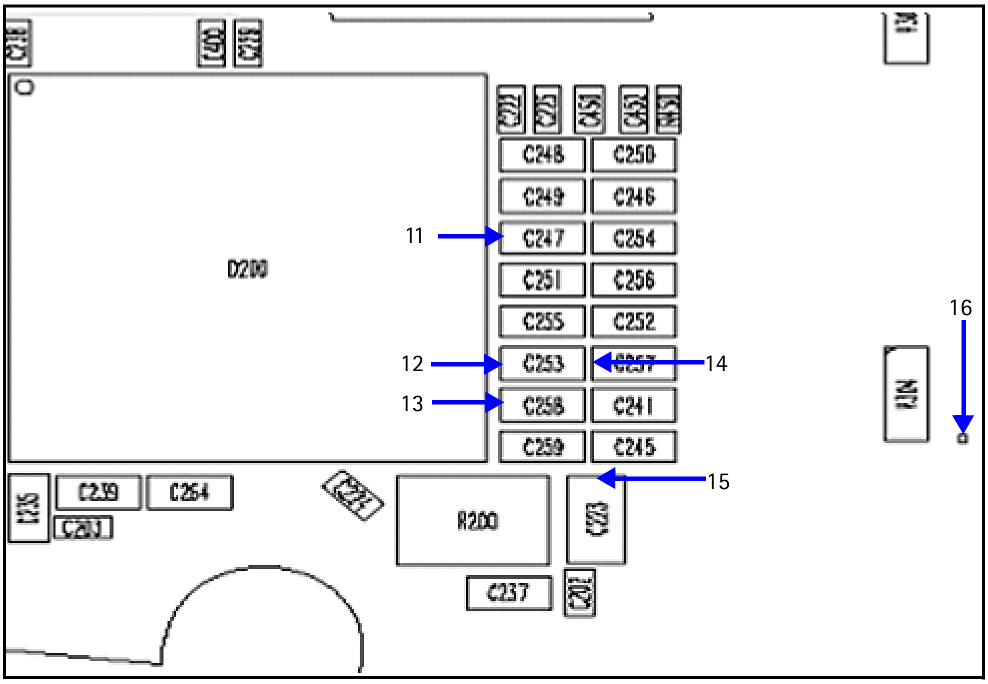

Figure 14: Bottom side TX DC probe points

Table 1 shows the TX DC probe points for the bottom and top sides of the PWB.

Table 1: TX DC Probe Points

Test Point	Description	Value
1	Power detector VR2	2.76V
2	Vbatt PCS*	
3	AGC 2	0.1 to 1.8V
4	AGC 1	0.1 to 1.8V
5	TX IQ IN TX IQ IN with oscilloscope	Approximately 1. 2V Approximately 500 mV p-p
6	VR6	2.8V
7	VR1B	4.8V
8	TX UHF LO lock voltage	1.2V
9	Vbatt Cell*	
10	Power detector output	PCS: 1.9V at <5dBm 1.6V at 15dBm 0.8V at 25dBm Cell: 1.9V at <5dBm 1.7V at 15dBm 1.3V at 25dBm
11	VrefRF1	1.45V

Table 1: TX DC Probe Points (Continued)

Test Point	Description	Value
12	VR6	2.78V
13	VR1B	4.7V
14	VR2	2.78V
15	Vbatt*	3.2 to 4.7V
16	TX detector out	Approximately 1.5V

Note: Vbatt also appears at the outputs of the PAs.

TX RF Probe Points

Following are the TX RF probe points.

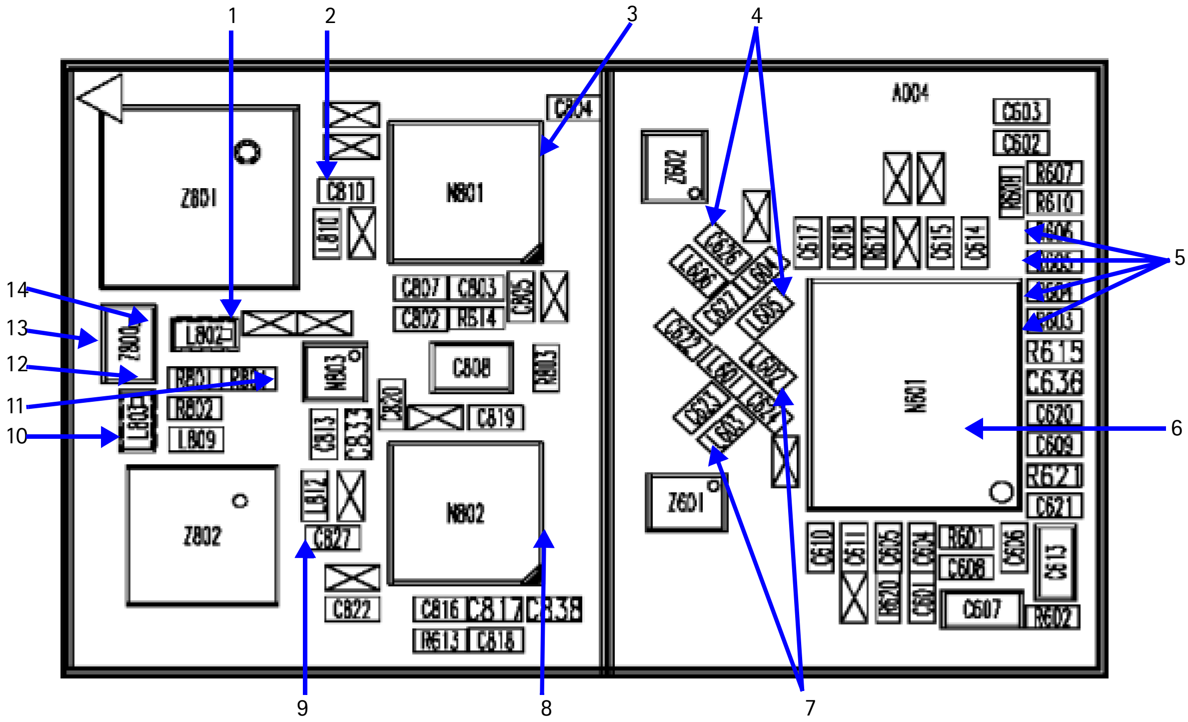

Figure 15: TX RF test points

Table 2 includes the values from the test points in Figure 15. The PCS frequency is at 1880 MHz, and the Cell/AMPS frequency is at 836.25 MHz.

Table 2: TX RF Probe Points

Test Point	Description	Value
1	PCS duplexer out	-2 dBm
2	PCS PA out	-2 dBm
3	PCS PA in	-23 dBm
4	PCS Jupiter out	-22 dBm

Table 2: TX RF Probe Points (Continued)

Test Point	Description	Value
5	TX IQ in with oscilloscope	Approximately 500 mV p-p with +1.2 V offset
6	TX UHF LO	PCS: 3760 MHz, -54 dBm Cell: 3346.08 MHz, -57 dBm
7	Jupiter out	Cell: -15 dBm AMPS: -6 dBm
8	PA in	Cell: -15 dBm AMPS: -7 dBm
9	PA out	Cell: +11 dBm AMPS: +22 dBm
10	Duplexer out	Cell: +10 dBm AMPS: +20 dBm
11	Power detector in	PCS: -17 dBm Cell: -8 dBm AMPS: +3 dBm
12	Coupler out	Cell: +8 dBm AMPS: +18 dBm
13	Diplexer out	PCS: -2 dBm Cell: +10 dBm AMPS: +19 dBm
14	PCS coupler out	-1 dBm

Receiver Troubleshooting

The primary component of the receiver is the Alfred Rx IC. This Rx IC contains two LNAs and mixers. The other components are passive. There are two RF SAW filters for the Cell and PCS bands. In addition, there are two IF filters, an IF SAW for CDMA and an IC Crystal for AMPS. The back-end of the receiver consists of the Batman IC. The VGA and IQ demodulator are the main functions.

Following is the RX system block diagram.

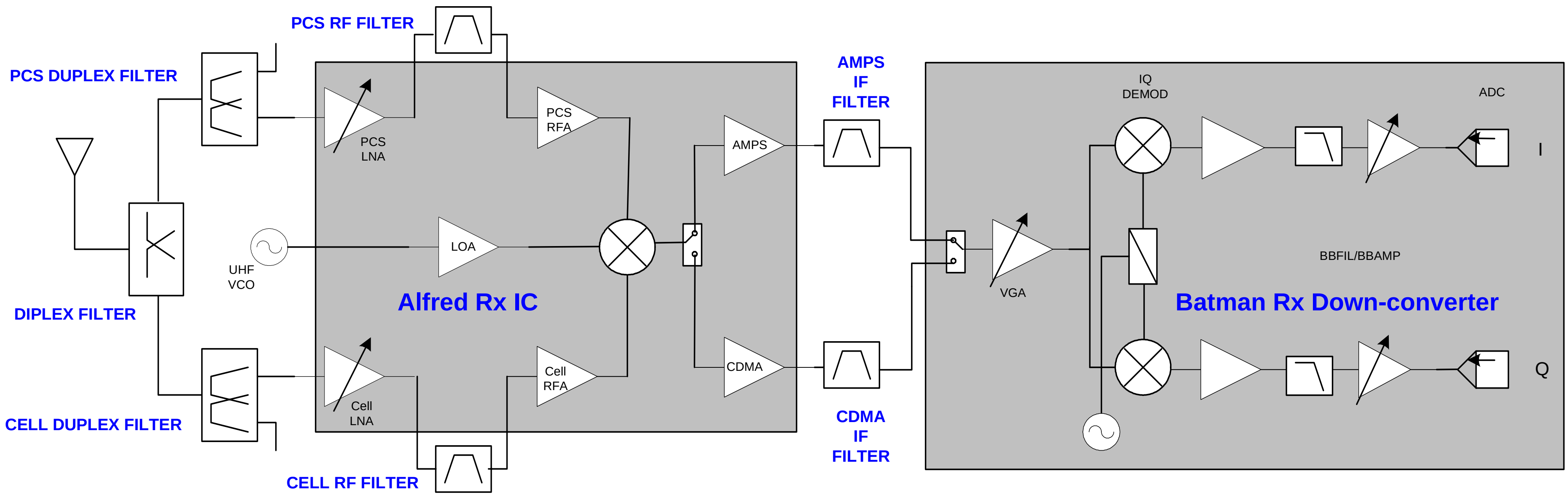

Figure 16: Receiver system block diagram

Receiver Schematics

The following schematics are for general reference only. See the *Schematics* chapter for detailed versions.

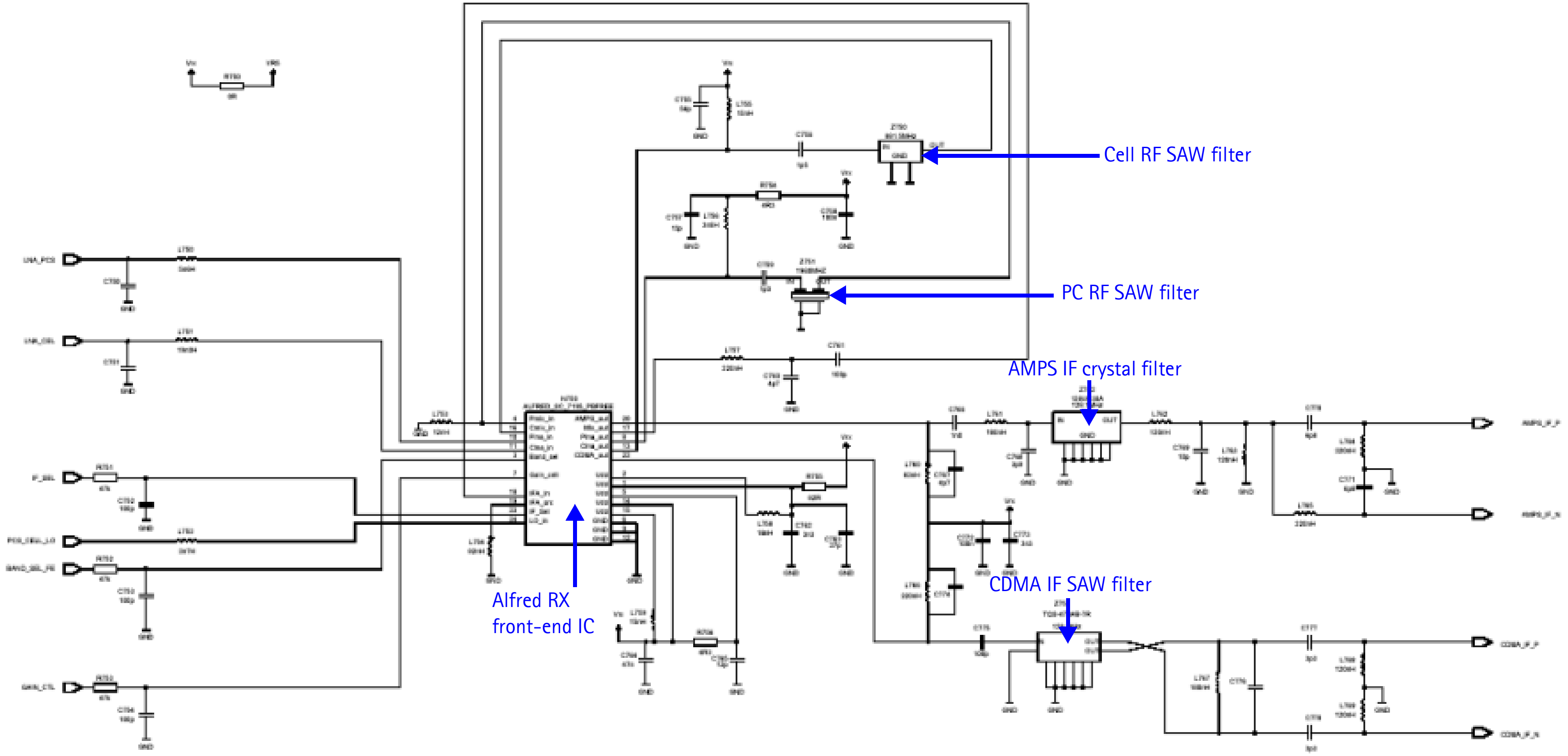

Figure 17: Receiver schematic 1

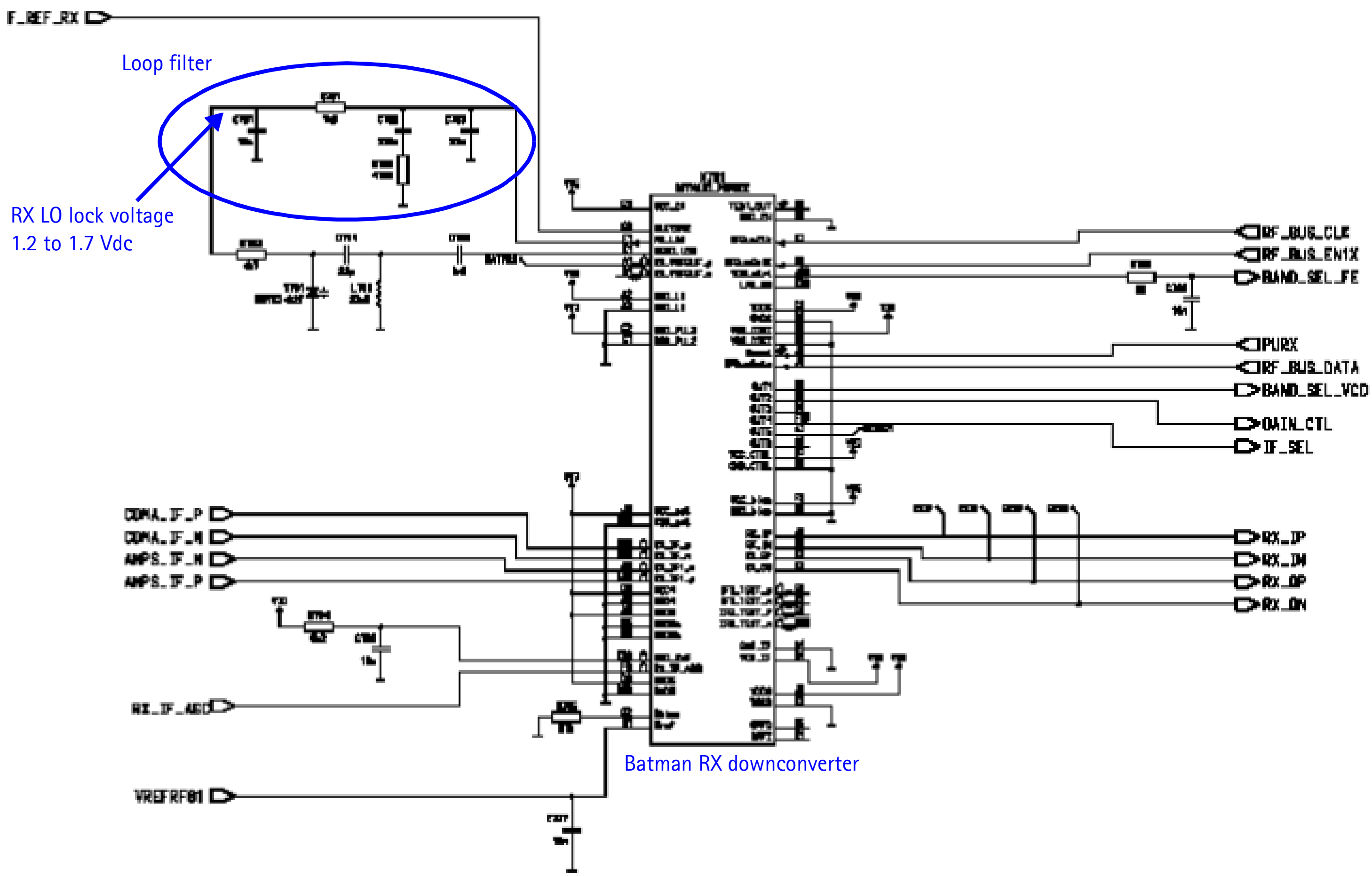

Figure 18: Receiver schematic 2

RF AGC Status

Figure 19 shows the **RF AGC Status** dialog box. When configuring the values on this dialog box, note the following:

- The RF AGC status functionality only works in Call Mode.
- In the **PLL Lock Status** area, bright green indicates a locked PLL and dark green indicates an unlocked PLL.
- In the **Baseband Type** field, ensure that the correct baseband is selected (BB 4.0).
- Clicking the **Update Once Per Second** button allows you to toggle between the **Update Once Per Second** and **Stop Updating** functions.

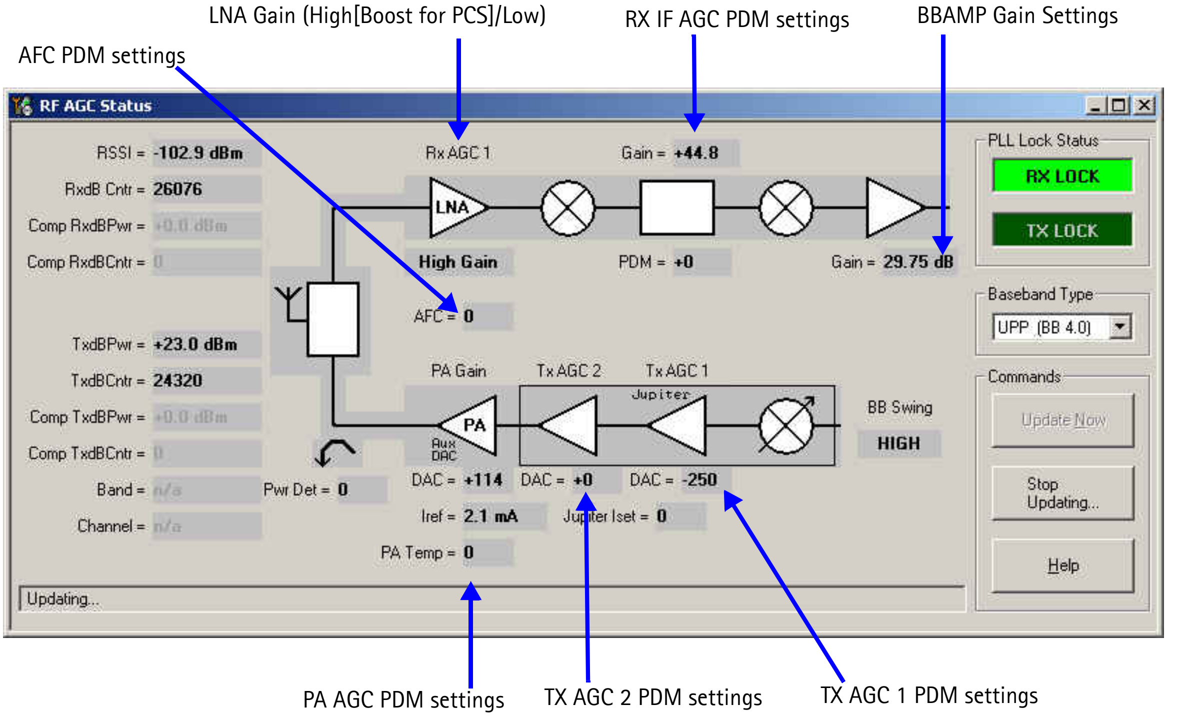

Figure 19: RF AGC Status dialog box

Turning on the RX Path

Use the following steps to turn on the RX path using Phoenix.

1. Turn on Receiver Only in CDMA mode.
2. On the **Phone Control** dialog box, click the **LOCAL** button in the **Phone State** area to put the phone into Local Mode.

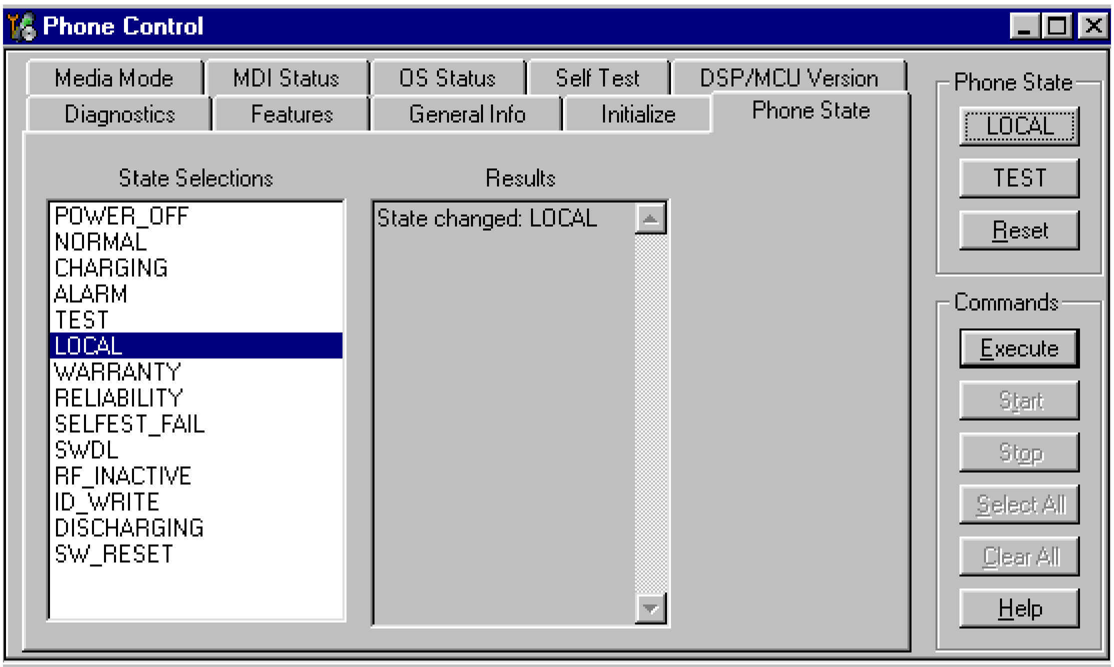

Figure 20: Phone Control dialog box

3. Click **Execute**.
4. Depending on the mode of phone you have, use the settings from Table 3 on the **RF Main Mode** dialog box.

Table 3: RF Main Mode Dialog Box Settings

Band	Mode	Channel
Cell	RX = 881.52 MHz	384
AMPS	RX = 881.52 MHz	384
PCS	RX = 1960 MHz	600

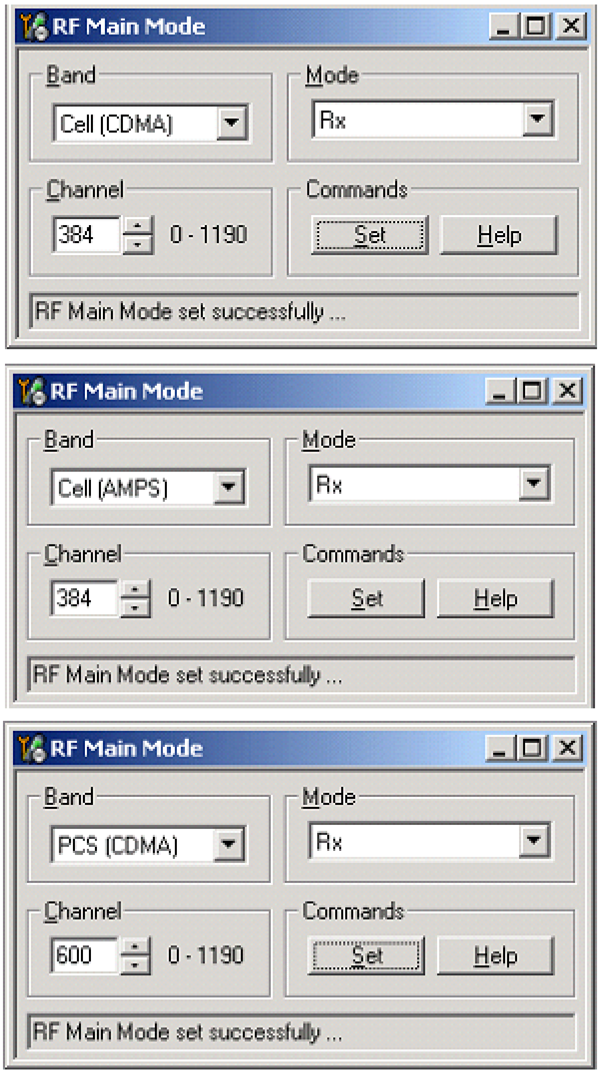

Figure 21: RF Main Mode dialog box for Cell (top), AMPS (middle), and PCS (bottom)

Switching the RX Gain States

Use the **RF Gen I/O** dialog box to switch the gain state (Hi and Lo) for CDMA and AMPS modes. Select the desired state, and click **Refresh**.

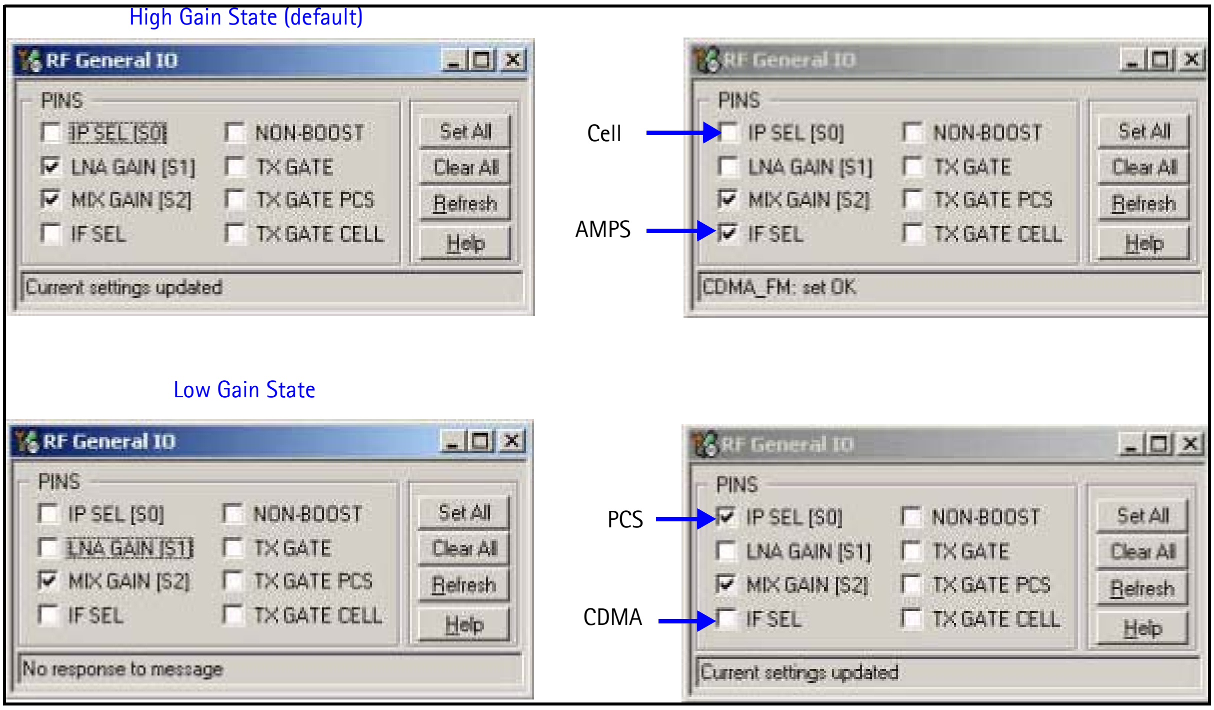

Figure 22: RF Gen I/O dialog box

Cell Receiver Check from RF to IQ

Use the following values to check the CDMA Cell RX functionality from RF to IQ output.

1. Start Phoenix in Local Mode with only the RX path turned on.
2. Inject a –75dBm CW signal of 881.82MHz (i.e. 300kHz offset from 881.52MHz or 10 channels away).
3. Measure a 300kHz tuning on the analyzer. You should see a typical -21dBm IQ tuning for CDMA Cell.

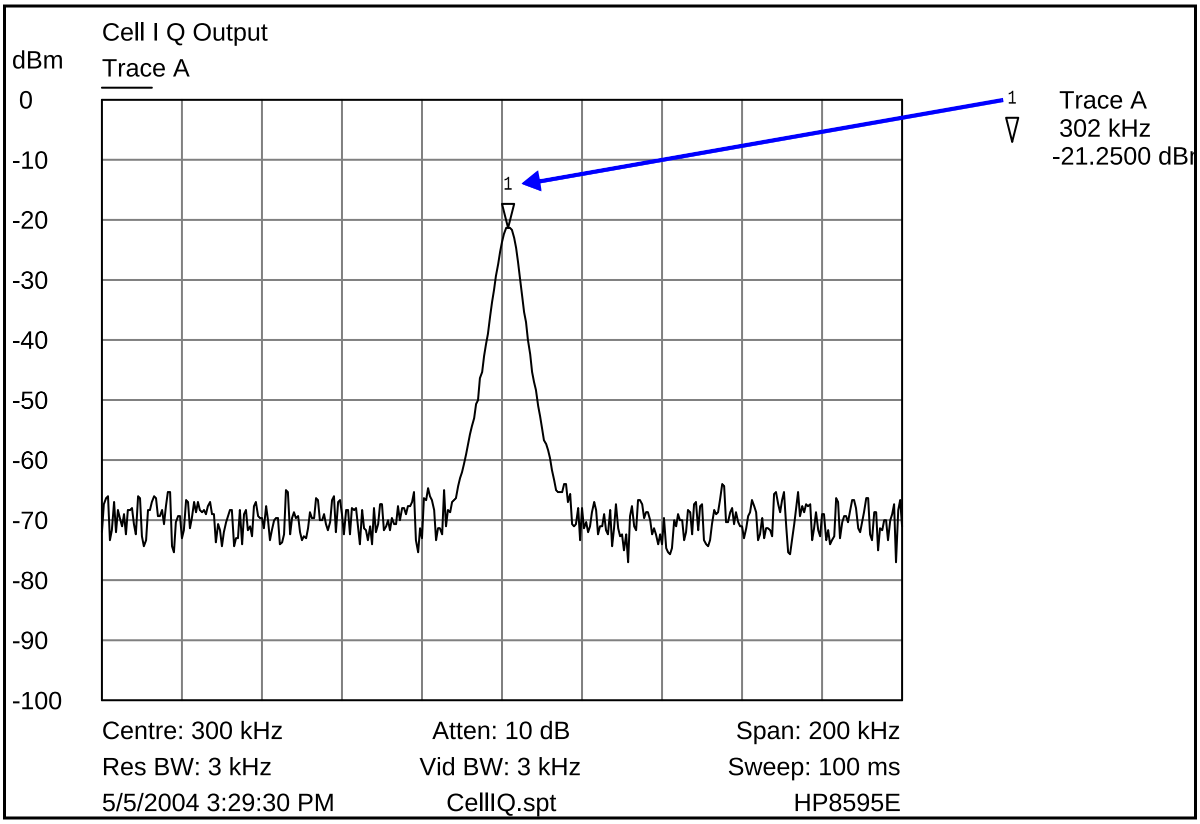

Figure 23: Receiver IQ level on CDMA Cell band

Figure 24 shows the Cell spectrum with an inject tone at -75dBm, as well as the IQ output test points. Note that DC is present on the IQ output test points, and all test points should be approximately equal.

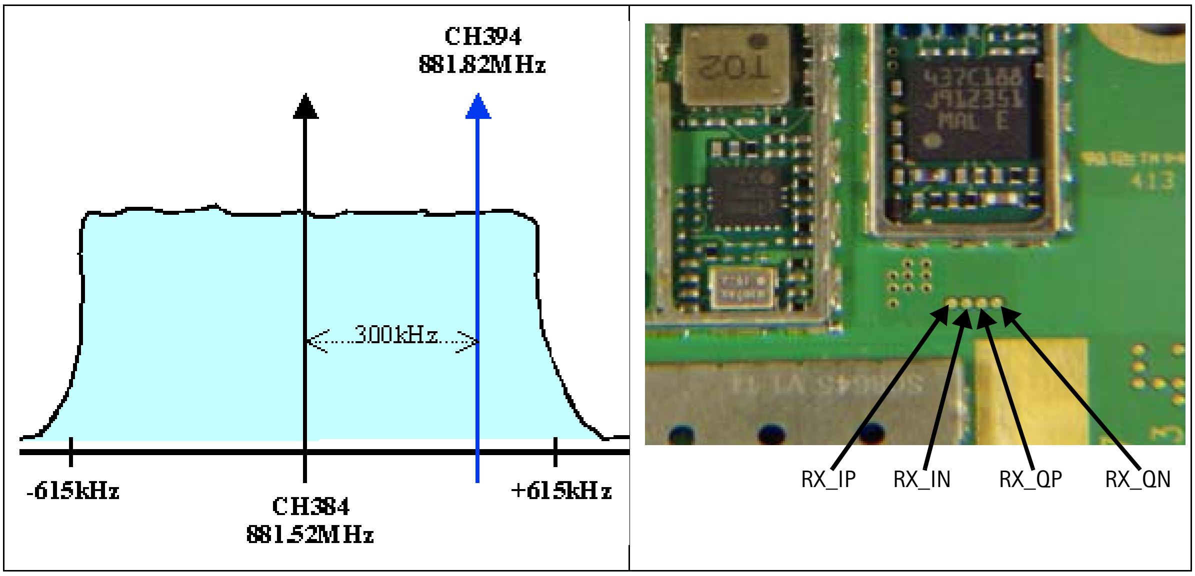

Figure 24: Cell spectrum (left) and IQ output test points (right)

PCS Receiver Check from RF to IQ

Use the following values to check the PCS receiver functionality from RF to IQ output.

1. Start Phoenix in Local Mode with only the RX path turned on.
2. Inject a –75dBm CW signal of 1960.5MHz (i.e. 500kHz offset from 1960MHz or 10 channels away).
3. Measure a 500kHz tuning on the analyzer. You should see a typical -22dBm IQ tuning. If the 300kHz tone works but the 500kHz tone does not, it is possible that the BB filter was not set by Phoenix.

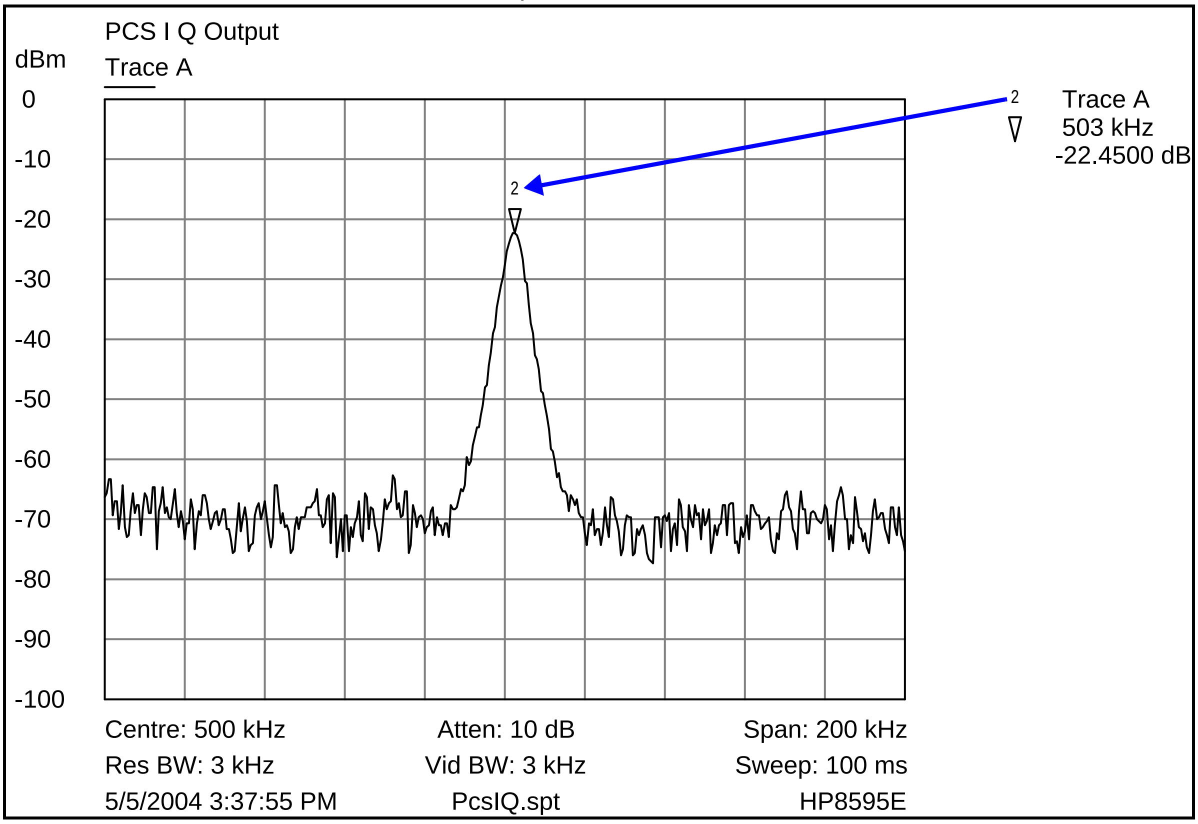

Figure 25: Receiver IQ Level on PCS Band

Figure 25 shows the PCS spectrum with an inject tone at -75dBm, as well as the IQ output test points. Note that DC is present on the IQ output test points, and all test points should be approximately equal.

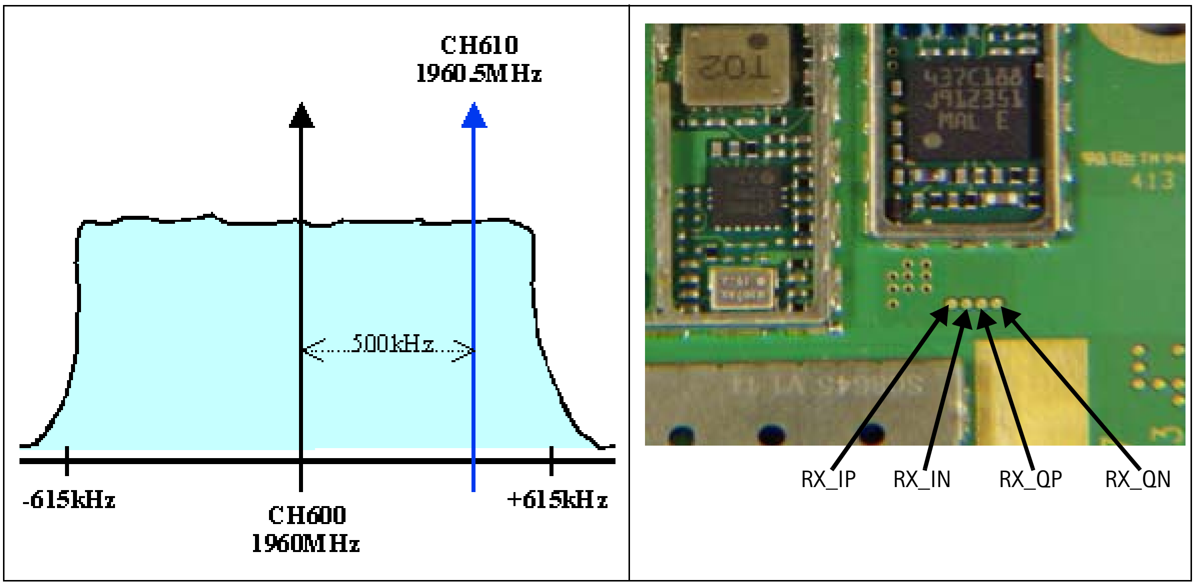

Figure 26: Cell spectrum (left) and IQ output test points (right)

AMPS Receiver Check from RF to IQ

Use the following steps to check the AMPS receiver functionality from RF to IQ output.

1. Start Phoenix in Local Mode with only the RX path turned on.
2. Inject a –75dBm CW signal of 881.53MHz (i.e., 10kHz offset from 881.52MHz) into the RF.
3. Measure a 10kHz tone on the analyzer. You should see a typical -20Bm IQ tuning for AMPS.

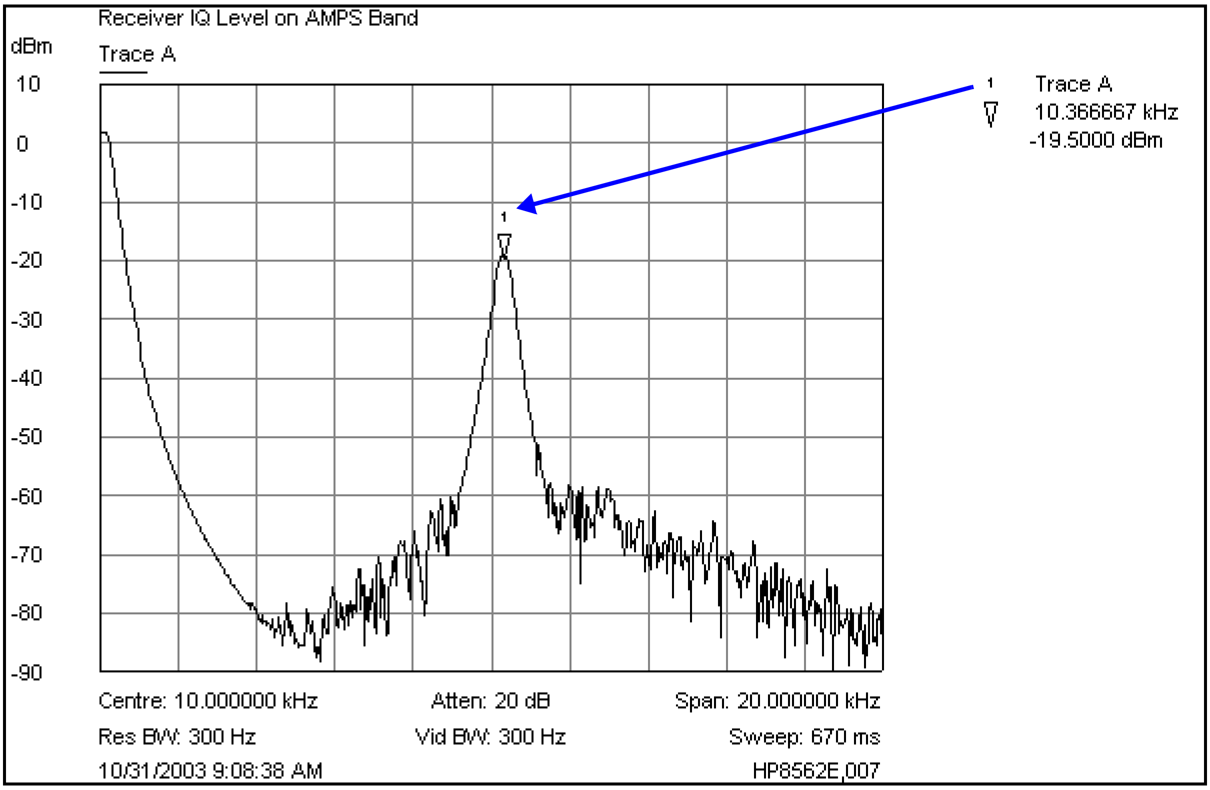

Figure 27: Receiver IQ Level on AMPS band

Figure 28 shows the AMPS spectrum with an inject tone at -75dBm, as well as the IQ output test points. Note that DC is present on the IQ output test points, and all test points should be approximately equal.

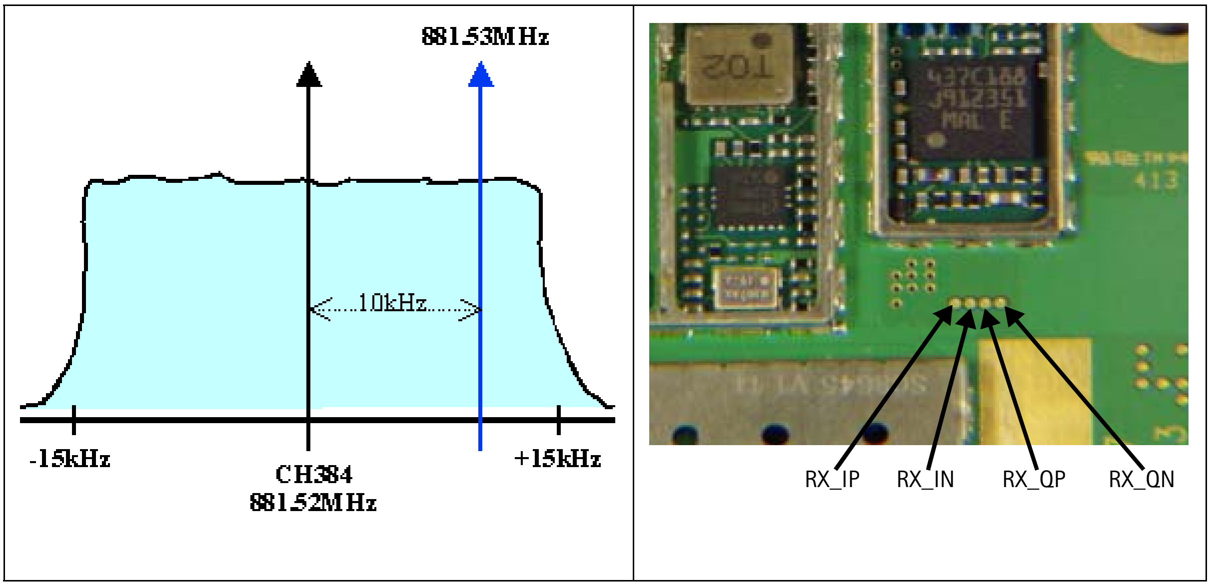

Figure 28: AMPS spectrum (left) and IQ output test points (right)

Receiver Diagnostic Signal Tracing

Use the following steps to trace a receiver signal.

1. Inject an external signal source of −25dBm into the RF input. An Agilent call box 8960 is recommended.
2. Press the Call Setup button, press the Active Cell soft button, and select CW.
3. Inject a CW signal for PCS (1960MHz) or Cell/AMPS (881.52MHz) at a fixed −25dBm power level.

Receiver IF RF

The test point measurements were taken using an AAS-10 probe. Signal levels are approximate, and accuracy may be +/- 2dB or more, depending on the position of the grounding probe.

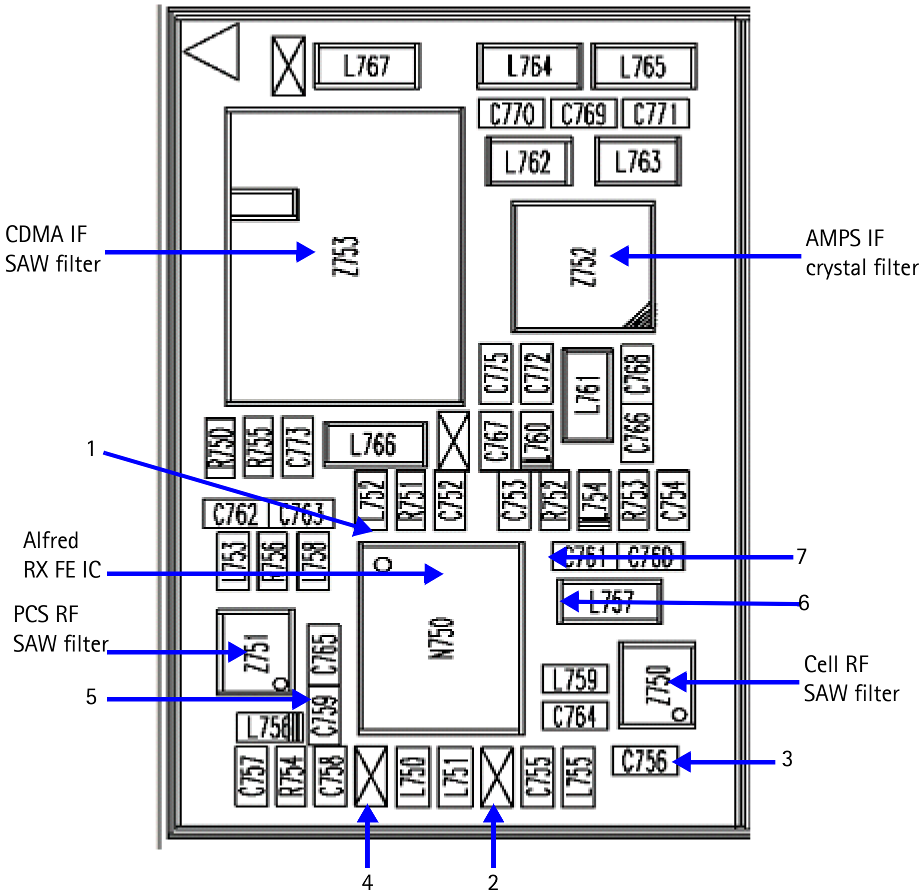

Figure 29: Receiver RF troubleshooting test points

Table 4 includes the descriptions and values for the RX RF troubleshooting test points shown in Figure 29.

Table 4: Receiver RF Troubleshooting Values

Test Point	Description	Value
1	RX LO (from VCO)	1009.62MHz at -8 dBm 2088.1MHz at -14 dBm
2	Cell Channel 384 (from duplexer)	881.52MHz at -31 dBm
3	Cell Channel 384 (to RF SAW)	881.52MHz at -20 dBm (HG) 881.52MHz at -36 dBm (LG)
4	PCS Channel 600 (from duplexer)	1960MHz at -40 dBm
5	PCS Channel 600 (to RF SAW)	1960MHz at -30 dBm (HG) 1960MHz at -45 dBm (LG)
6	IF MIX OUT (from Alfred)	128.1MHz at -20 dBm (HG) 128.1MHz at -37 dBm (LG)
7	IFA IN (to Alfred)	128.1MHz at -15 dBm (HG) 128.1MHz at -30 dBm (LG)

Receiver IF

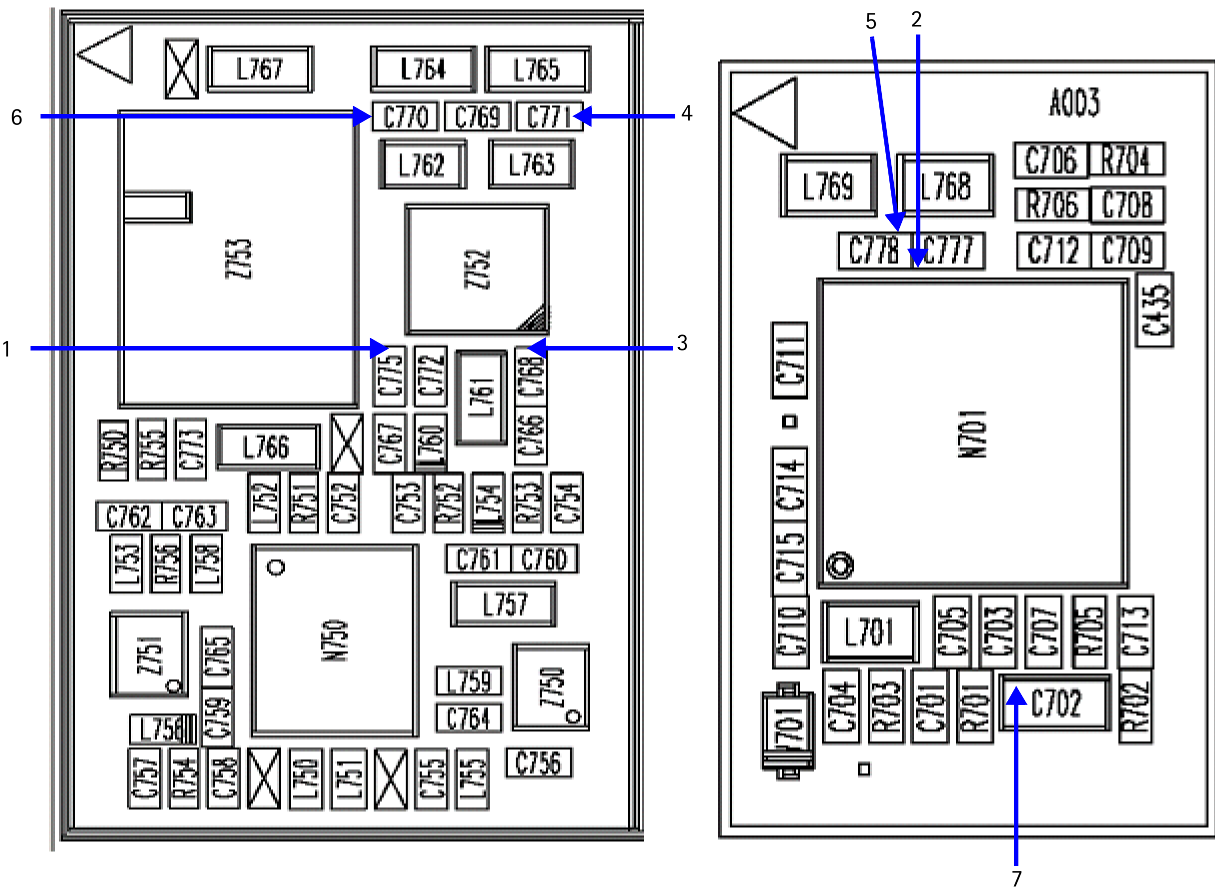

Figure 30: Receiver IF troubleshooting test points

Table 5 includes the descriptions and values for RX IF troubleshooting test points shown in Figure 30.

Table 5: Receiver IF Troubleshooting Values

Test Point	Description	Value
1	CDMA IF (to SAW) 128.1 MHz	Cell Channel 384 at -6 dBm (HG) Cell Channel 384 at -23 dBm (LG) PCS Channel 600 at -6 dBm (HG) PCS Channel 600 at -20 dBm (LG)
2	CDMA_IF_P (to Batman) 128.1 MHz	Cell -18 dBm (HG) Cell -35 dBm (LG) PCS -18 dBm (HG) PCS -32 dBm (LG)
3	AMPS IF (to MCF) 128.1MHz	Cell Channel 384 at -17 dBm (HG) Cell Channel 384 at -34 dBm (LG)
4	AMPS_IF_N (to Batman) 128.1MHz	Cell -23 dBm (HG) Cell -41 dBm (LG)
5	CDMA_IF_N (to Batman) 128.1 MHz	Cell -18 dBm (HG) Cell -35 dBm (LG) PCS -18 dBm (HG) PCS -32 dBm (LG)
6	AMPS_IF_P (to Batman) 128.1MHz	Cell -23 dBm (HG) Cell -41 dBm (LG)
7	RX LO	256.2 MHz; -60 dBm

Receiver DC

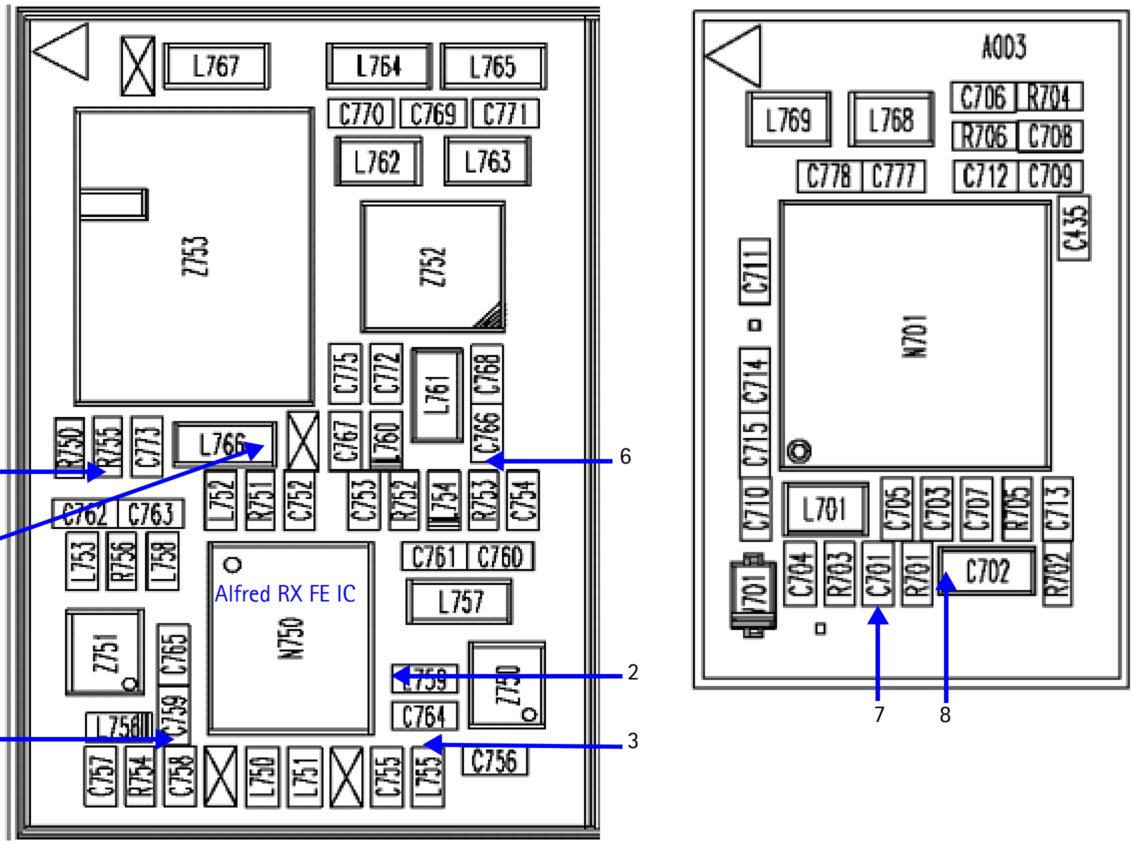

Figure 31: Receiver DC troubleshooting test points and RX front-end logic levels

Table 6 includes the descriptions and values for RX DC troubleshooting test points shown in Figure 31.

Table 6: Receiver DC Troubleshooting Values

Test Point	Description	Value
1	LO Vdd	2.59 VDC LO Amp Vdd supply lines for Cell and PCS
2	RFA Vdd	2.76 VDC RF Amp Vdd supply line for Cell band
3	C_LNA Vdd	2.76 VDC External Vdd supply line for Cell LNA
4	P_LNA Vdd	2.76 VDC External Vdd supply line for PCS LNA
5	IFA Vdd	2.76 VDC IF Amp Vdd supply line for CDMA and AMPS IFs
6	IFA Vdd	2.76 VDC IF Amp Vdd supply line for CDMA and AMPS IFs
7	RX LO Lock Voltage	1.2 to 1.7 VDC
8	RX LO 256.2 MHz	-60 dBm

Receiver Logic Input Voltages

Following are the measure logic levels for the RX front end (N750). See Figure 22 on page 29 for the manual selection of logic states using Phoenix.

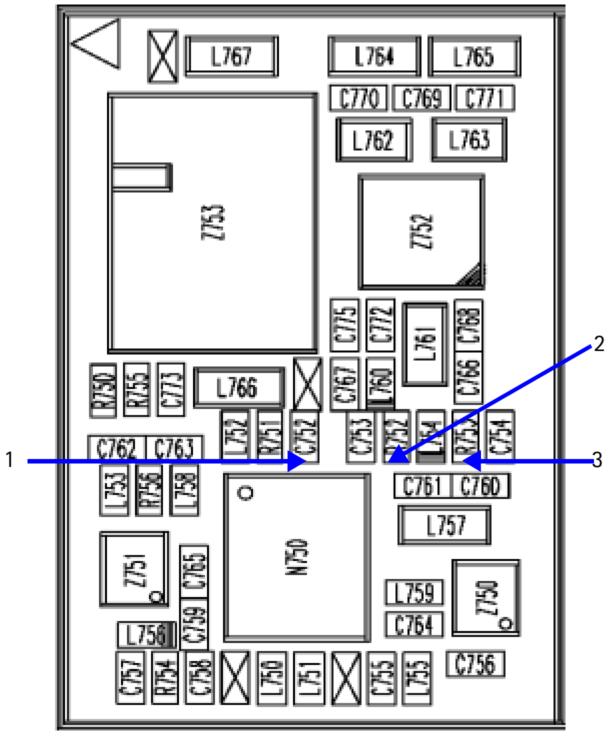

Table 7 includes the logic level values for the RX front end.

Table 7: RX Front-end (N750) Logic Levels

Mode	Logic Input Voltages		
	IF_SEL	BAND	GAIN_CTL
Cell CDMA High Gain	0 V	0.1 V	2.75 V
Cell CDMA Low Gain	0 V	0.1 V	0 V
PCS CDMA High Gain	0 V	2.68 V	2.75 V
PCS CDMA Low Gain	0 V	2.68 V	0 V
AMPS High Gain	2.76 V	0.1 V	2.76 V
AMPS Low Gain	2.76 V	0.1 V	0 V

If the logic levels are significantly off (+/- 0.2 V), replace Alfred (N750) and re-measure. If the voltages are still out of specifications, refer to the *Baseband Troubleshooting* chapter.

Alfred (N750) Receiver Troubleshooting

Keep the following under consideration when troubleshooting the Alfred (N750) receiver:

- There is a separate LNA for 800MHz (Cell and AMPS) and 1900MHz (PCS).
- There is a separate RFA (inside Alfred) for 800MHz (Cell and AMPS) and 1900MHz (PCS).
- After the RFA, there is a mixer and then the signals are separated by CDMA (Cell and PCS) and AMPS.

  For example, if there is no IF frequency (128.1MHz) check both Cell and PCS. If there is only one at 128.1MHz (L753), ensure that IF_SEL is working. If it is, then replace Alfred because of a bad RFA.

  If Cell and AMPS are working but PCS is not, look at the band select line and the PCS RF filter before replacing Alfred.

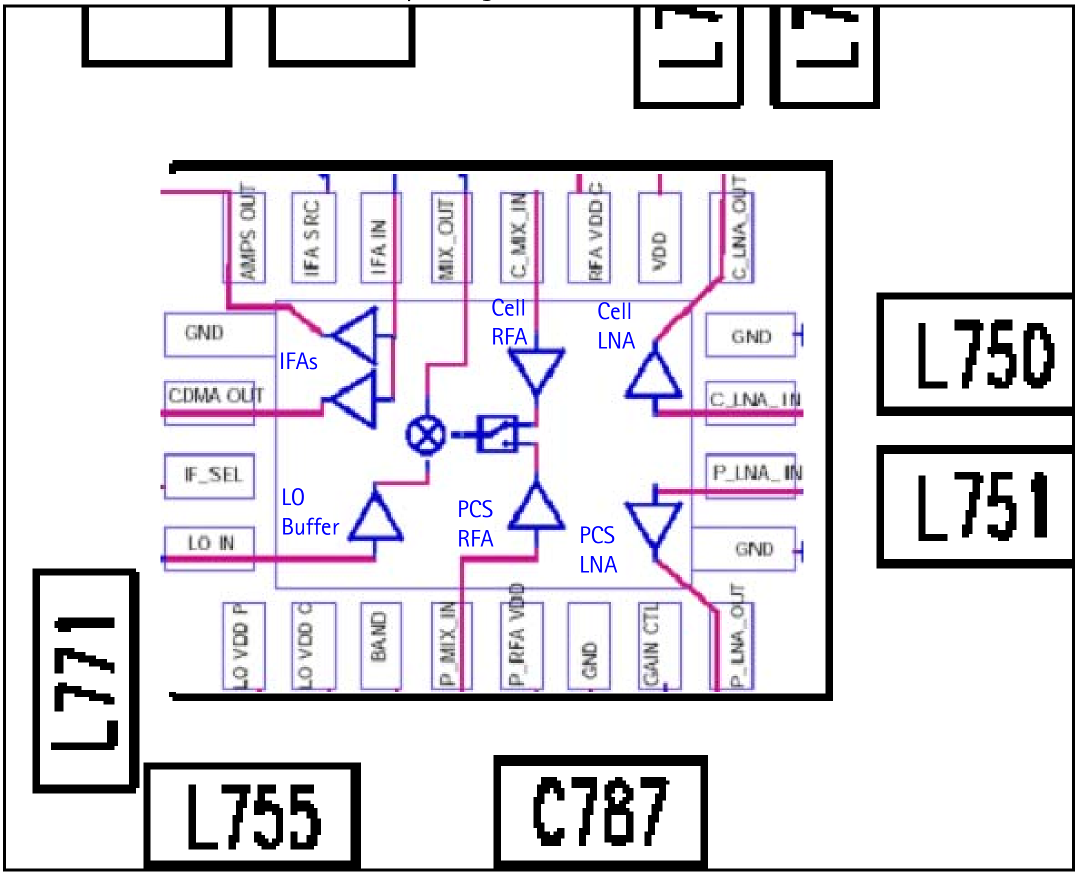

Figure 32: N750 (Alfred) receiver

Alfred DC Troubleshooting

There are two common explanations for an Alfred failure consisting of high current in Local Mode with just the RX turned on:

- No presence of an LO signal
- Input impedance drop is shorting out one of the DC supply pins to the chip

IMPORTANT: You must check for both conditions before replacing Alfred. If you have no LO signal, refer to "UHF Synthesizer Troubleshooting" on page 50. If you have a significant supply voltage drop on one of the supply pins, then replace Alfred.

Table 8: Alfred Conditions and Supply Currents

Condition: Local Mode, Set RX Only in RF Main Mode	Supply Current (From Power Supply)
Good phone	100mA
No UHF LO signal present	254mA
Pin 13 shorted	255mA

Synthesizer Troubleshooting

Faulty synthesizers can cause both RX and TX failures during tuning, in addition to the VCTCXO tuning. However, it is recommended first to check for the presence of various LO signals and their proper levels. The 19.2MHz reference clock is needed for the phone to power up. Therefore, if everything fails, check for the presence of 19.2MHz. The level of 19.2MHz is also important because the UPP is very sensitive and can still pick up a very weak 19.2MHz clock, which can result in the phone constantly resetting. See "19.2 MHZ VCTCXO Reference Clock" on page 44 for more information.

The following synthesizers are used in the phone:

- Dual-band UHF:
  - 1009.62 MHz for channel 384 in Cell and AMPS with separate LMX2310 PLL IC
  - 2088.1MHz for channel 600 in PCS with separate LMX2310 PLL IC
- TX UHF
  - 3296.16 MHz ~ 3395.88 MHz for Cell and AMPS with PLL inside Jupiter IC
  - 3700 MHz ~ 3819.9 MHz for PCS with PLL inside Jupiter IC
- RX VHF (256.2 MHz for Cell, AMPS, and PCS with PLL inside Batman IC

Incorrect PLL Frequencies

Following are possible causes for incorrect PLL frequencies:

- Incorrect power supplies to the PLL portion
- Control line to the VCO
- Loop filter or resonator components missing or incorrectly installed
- 19.2 MHz reference clock is missing or low
- Component failure (PLL IC, Batman, Jupiter, VCO, or VCTCXO)

Synthesizer Block Diagram

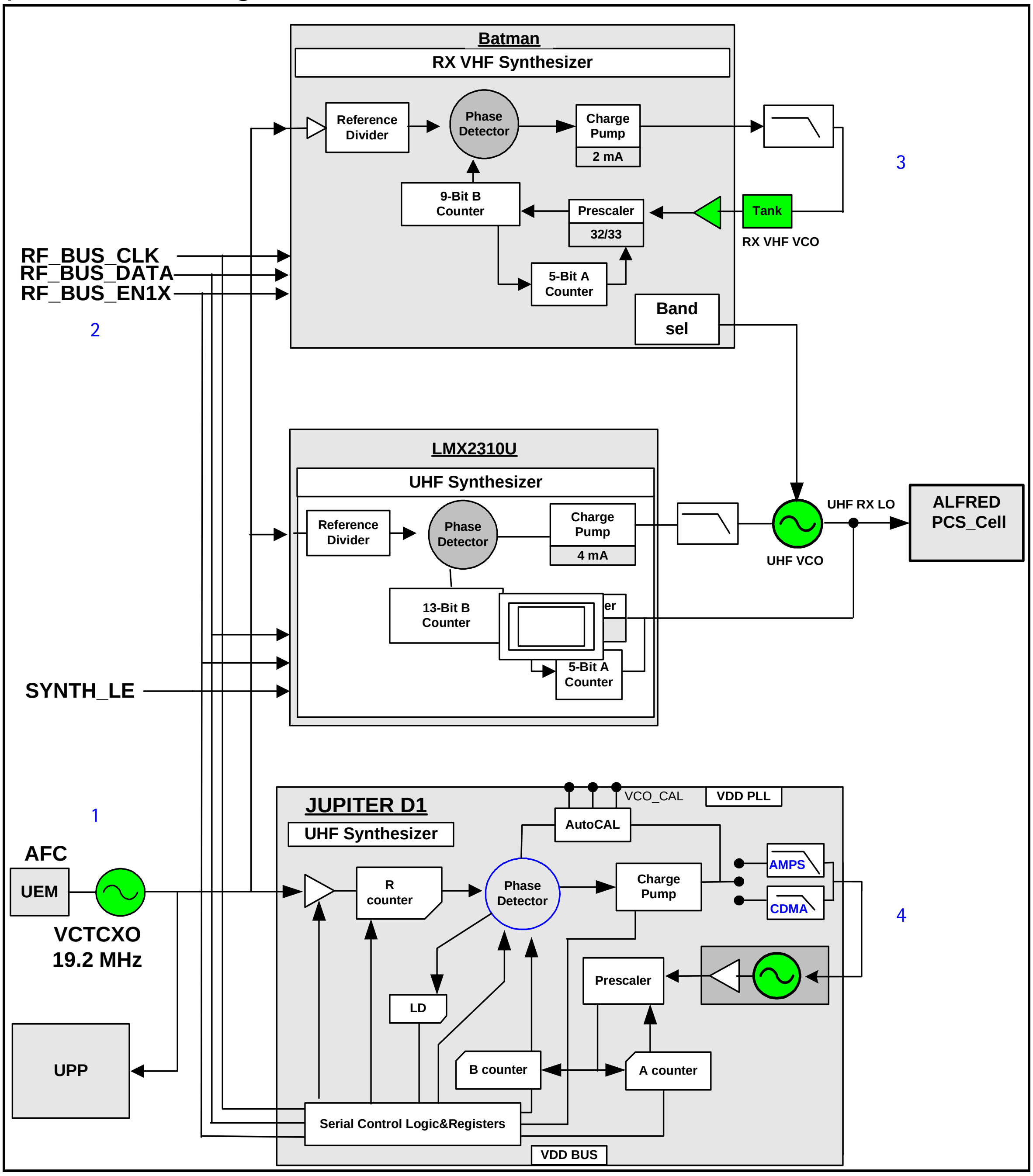

Figure 33: Synthesizer block diagram

Table 9 includes the component values shown in Figure 33.

Table 9: Synthesizer Block Diagram Component Values

Item	Description	Value
1	VCTCXO	19.2MHz
2	UHF LO	1009.62MHz (Cell channel 384) 2088.1MHz (PCS channel 600)

Table 9: Synthesizer Block Diagram Component Values (Continued)

Item	Description	Value
3	RX VHF LO	256.2MHz
4	TX UHF LO	3395.88MHz 3819.90MHz

Synthesizer Schematic

The following schematic is for general reference only. See the *Schematics* chapter for detailed versions.

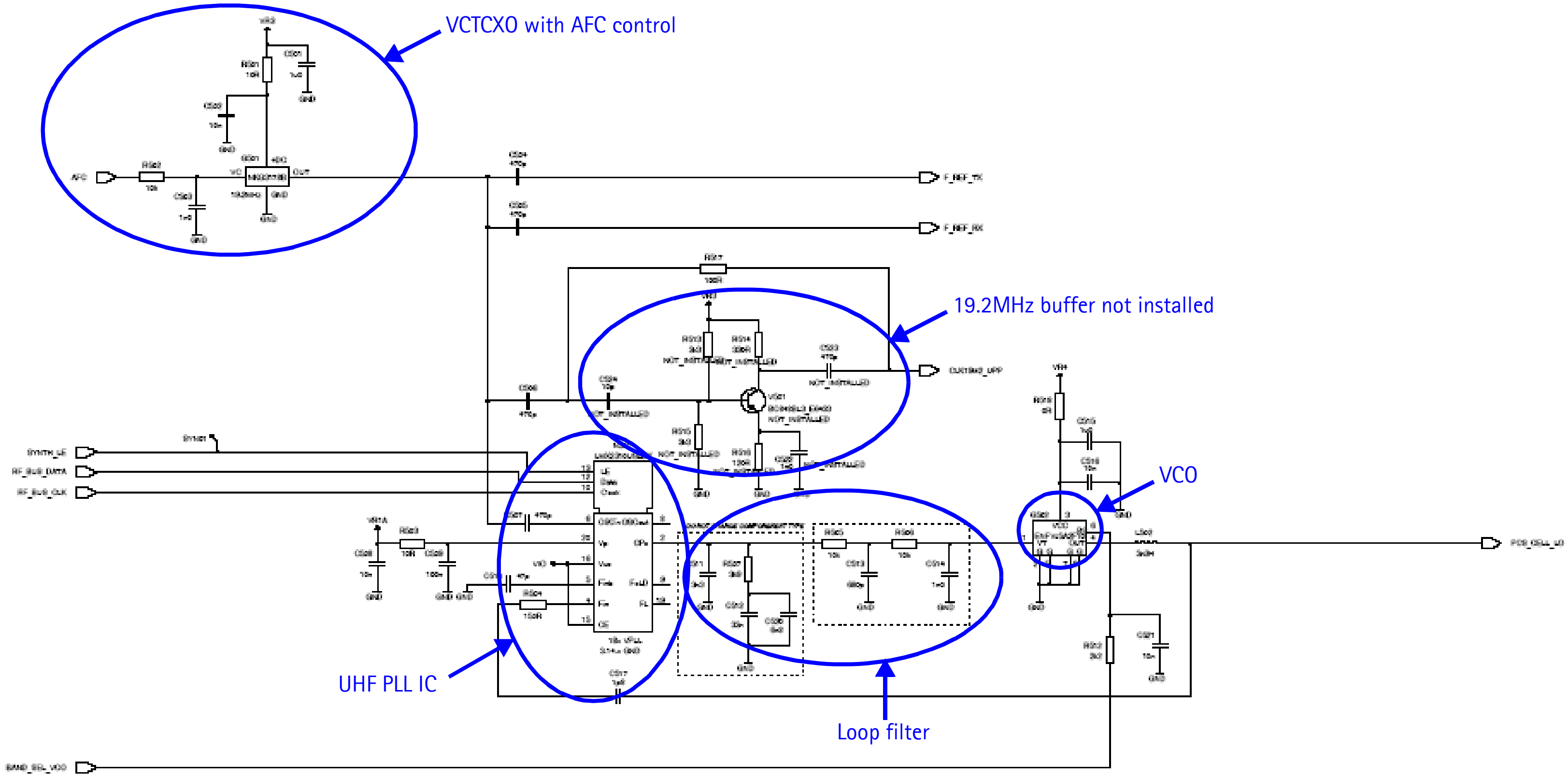

Figure 34: Synthesizer schematic

Use the following steps to troubleshoot the synthesizer using Phoenix:

1. On the **Phone Control** dialog box, click the **LOCAL** button in the **Phone State** area to put the phone into Local Mode.

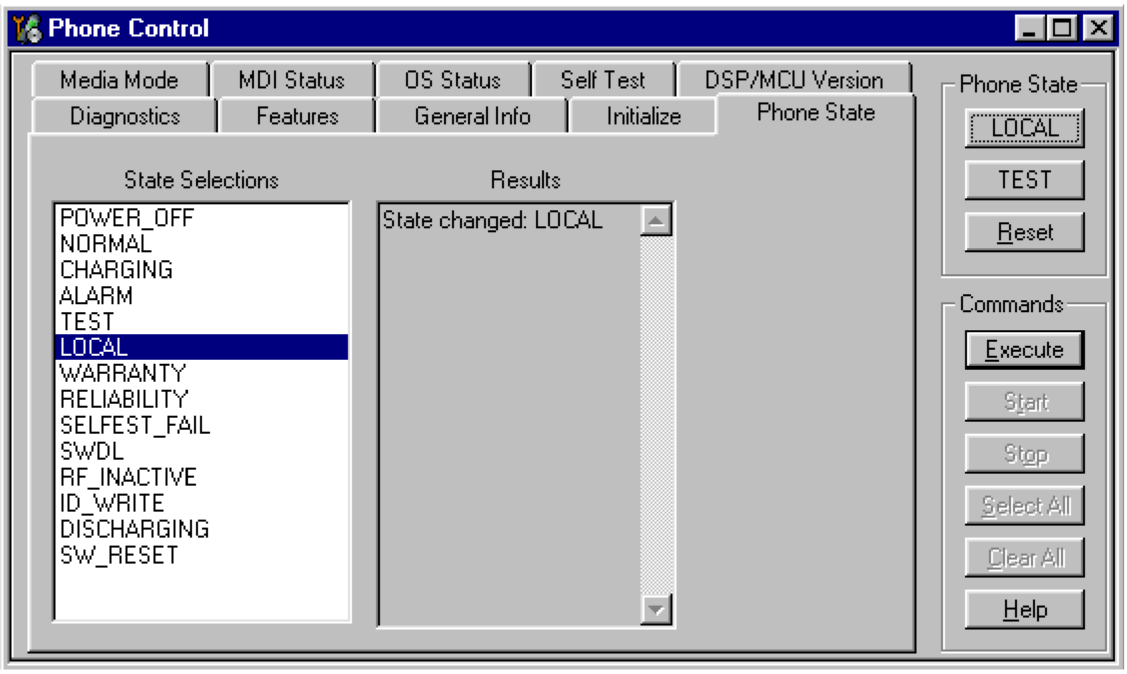

Figure 35: Phone Control dialog box

2. Select the following values on the **RF Main Mode** dialog box:.

Table 10: RF Main Mode Dialog Box Settings

Synthesizer	Band	Mode	Channel	Notes
UHF	Cell	RX/TX	384	Allows for checking power to both RX and TX circuits.
	PCS	RX/TX	600	
RX VHF		RX		One band is enough.
TX VHF	Cell PCS	RX/TX	384 600	

19.2 MHZ VCTCXO Reference Clock

The VCTCXO frequency is a 19.2MHz reference signal. Without 19.2MHz, the phone does not power up. This signal goes to Batman, Jupiter, the UHF PLL, and also to the UPP. Use a high impedance probe to check for the presence of the signal at the following points:

- F_REF_TX, clock reference to Jupiter, should be ~ -9 dBm
- F_REF_RX, clock reference to Batman, should be ~ -9 dBm
- CLK10M2_UPP, clock reference to UPP, should be ~ -9 dBm and ~2 dB less in the other side on R517

If you do not see the VCTCXO signal at any of these points, check to see if there is voltage at the following points:

- VR3, main supply line for VCTCXO circuitry, should be 2.78VDC
- AFC voltage, should be between 1 and 3 V, and should be adjustable with the FC slider on the **RF PDM Control** dialog box in Phoenix. If the AFC voltage is missing, check the UEM.

Measuring the AFC Voltage

1. Measure the DC voltage at R502.

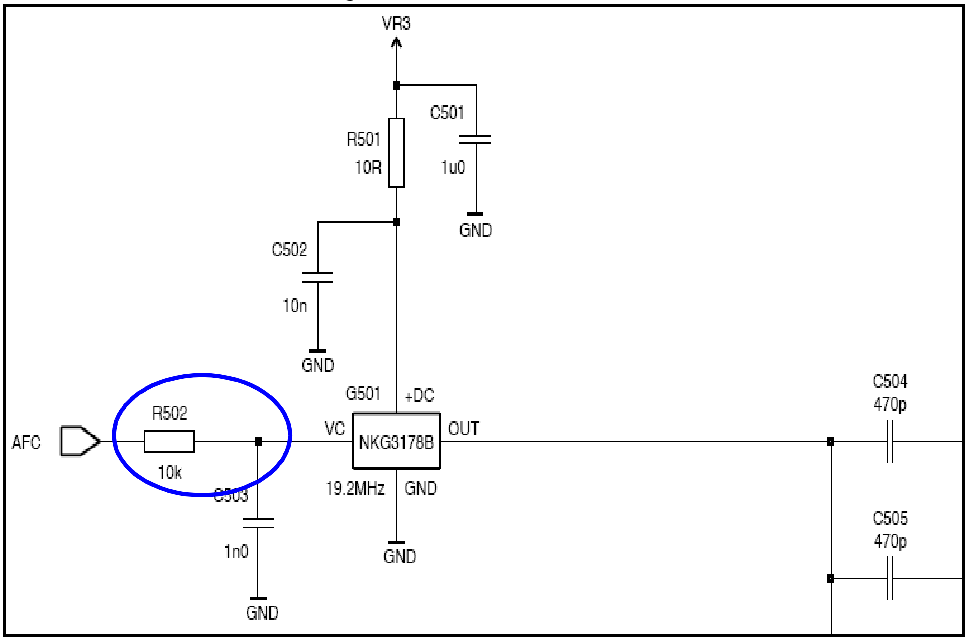

Figure 36: AFC voltage measurement location at R502

2. Open the **RF PDM** dialog box component in RF.

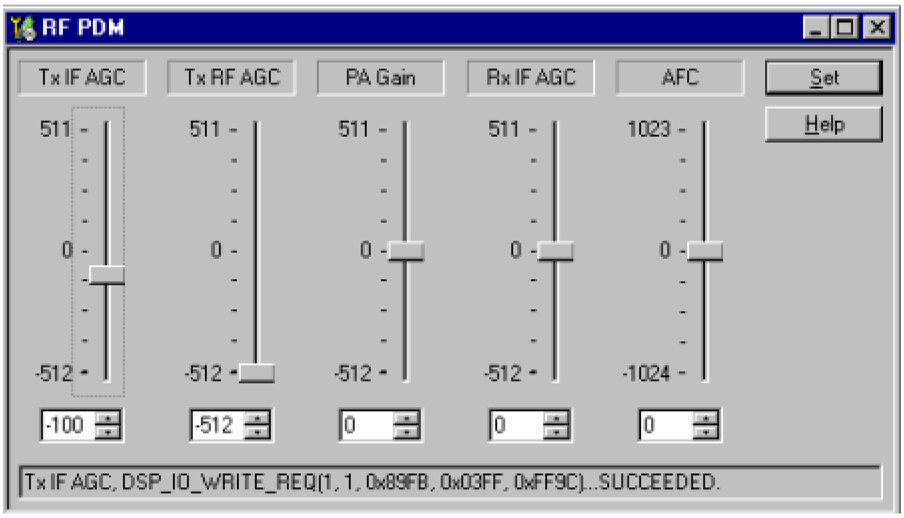

Figure 37: RF PDM dialog box for AFC measurement

Typical voltages observed are as follows:

- AFC PDM[0] = 1.3V
- AFC PDM[-1024] = 0.8V
- AFC PDM[1023] = 2.5V

VCTCXO Manual Tuning

The VCTCXO can be manually tuned to verify when a phone is tuned incorrectly or if the phone cannot make a call. To verify, monitor the RF signal at the output of the phone.

Use the following steps to set up a CW signal:

1. On the **Phone Control** dialog box, click the **LOCAL** button in the **Phone State** area to put the phone into Local Mode.

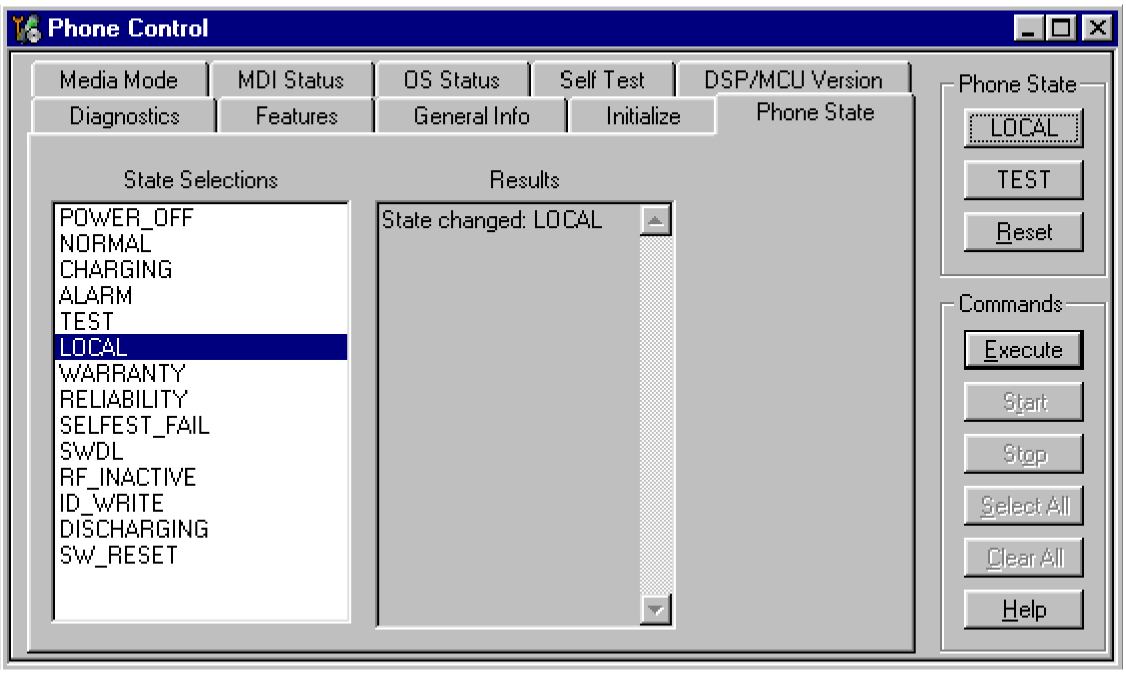

Figure 38: Phone Control dialog box

2. Click the **Execute** button.
3. Open the **Troubleshooting** menu, point to **AMPS**, and click **AMPS Control**.

   The **AMPS Control** dialog box appears.
4. Click the **Tx Control** tab, and type the following values:
   - **Channel** = 384
   - **Power Level** = 5
   - Select the **Transmitter On** option.
5. Select the **Rx RFI** tab, make sure the **AFC Control** box is unchecked, and click **Execute**.

6. The next step depends on the type of measurement equipment you are using:
   - Spectrum analyzer: Set the center frequency to 836.52MHz, set the span to 2MHz, and establish a marker at 836.52MHz.
   - HP8960: Set the callbox System Type to AMPS, set the ACC channel to 384, and use the Frequency Accuracy measurement to center the VCTCXO (minimum Frequency Error).
7. Use the RF PDM value to adjust the AFC to center the VCTCXO. The tuning range is approximately +/- 10kHz.
8. Adjust the AFC so that the output signal is within +/- 150Hz. If using the spectrum analyzer, narrow the span to 1kHz or less.

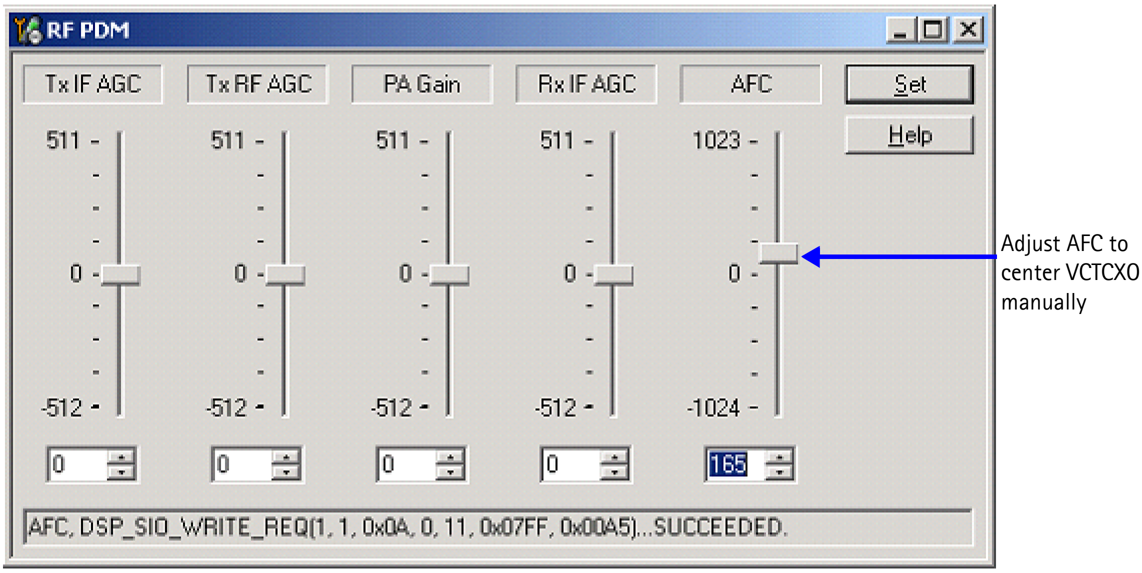

Figure 39: RF PDM dialog box

9. If the VCTCXO does not tune, replace the UEM.

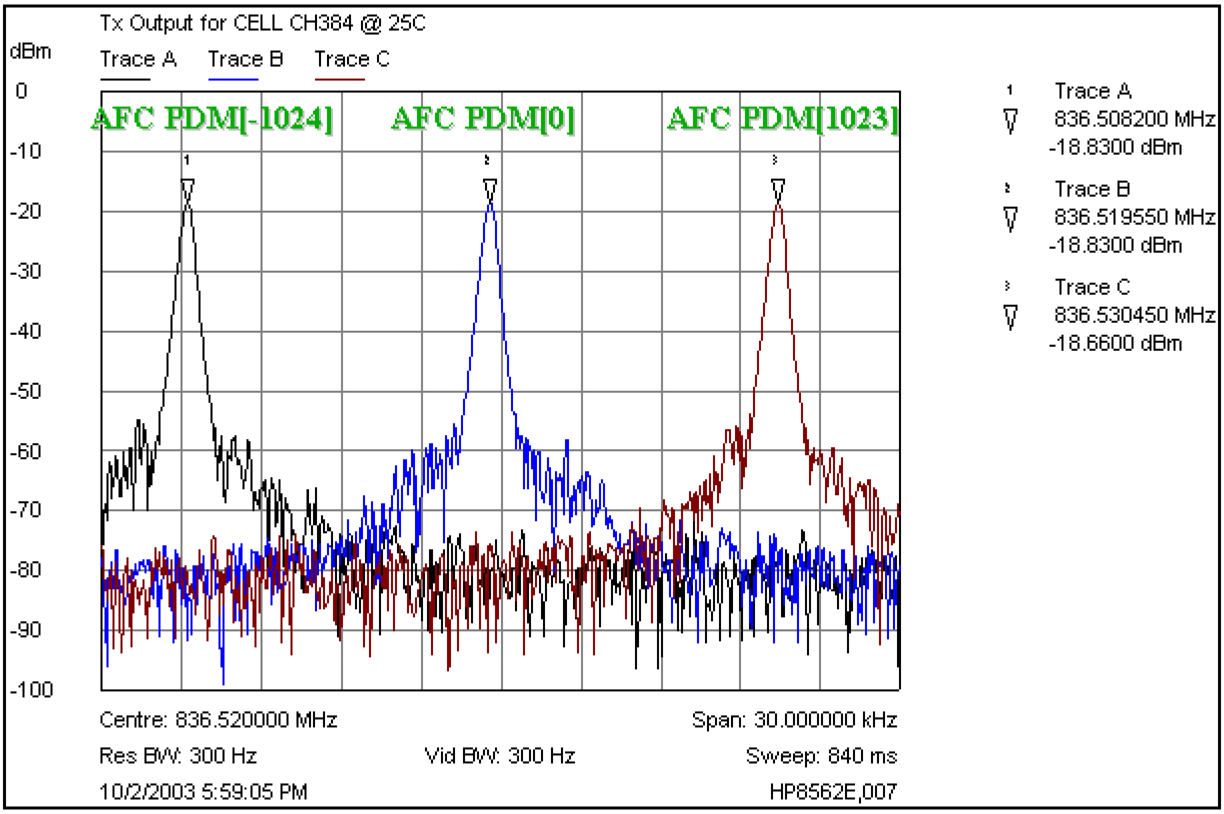

Figure 40: TX output for Cell channel 384 at 25C

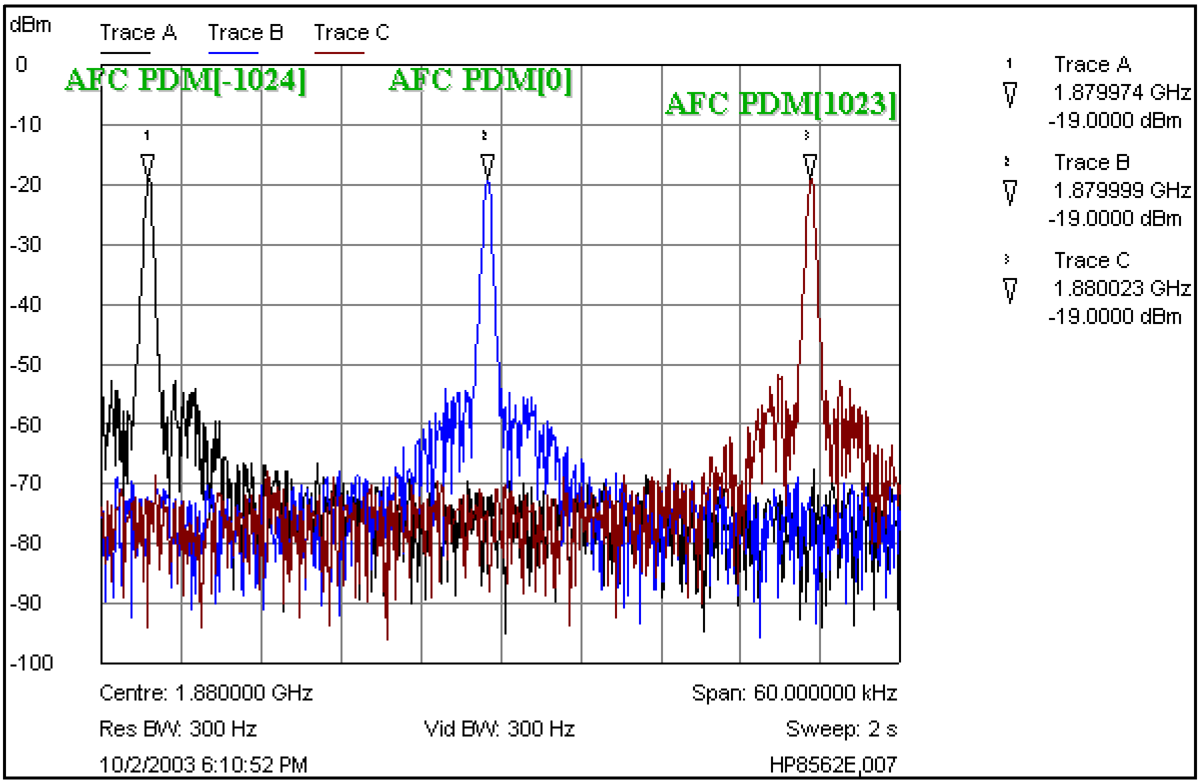

Figure 41: TX output for PCS channel 600 at 25C

VCTCXO and UHF Synthesizer Probe Points

Figure 42 shows the VCTCXO probe points (alphabetic) and the UHF synthesizer probe points (numeric).

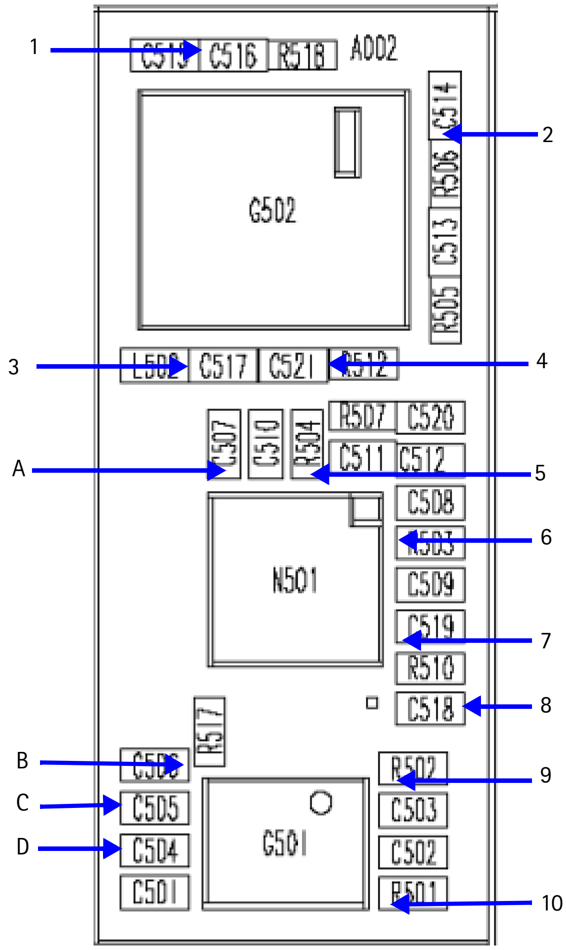

Figure 42: VCTCXO and UHF synthesizer probe points

Table 12 shows the values and description for the VCTCXO probe points in Figure 42.

Table 11: VCTCXO Probe Point Values and Descriptions

Probe Point	Description
A	19.2 MHz clocks: -9 dBm to UHF PLL
B	CLK19M2_UPP to UPP
C	F_REF_RX to Batman
D	F_REF_TX to Jupiter

Table 11 shows the values and description for the UHF synthesizer probe points in Figure 42.

Table 12: UHF Synthesizer Probe Point Values and Descriptions

Probe Point	Description	Values
1	VR3	2.8V
2	Lock voltage	DC between 0.8 and 3.4V, S/B 1.2V at the center frequency
3	UHF LO PCS_CEL_LO input to Alfred	Cell channel 384: 1009.62MHz > -9dBm PCS channel 600: 2088.1MHz > -16dBm
4	BAND_SEL_VCO	Cell = 0 VDC PCS = 2.8 VDC
5	PCS_SEL_LO return to UHF PLL	Cell = -11 dBm PCS = -18 dBm
6	VR1A	4.8V
7	VPLL	2.8V
8	VR4	2.8V
9	AFC voltage	DC between 1 and 3V 1.3V for PDM 0 0.8V for PDM -1024 2.5 for PDM 1023
10	VR3	2.8V

UHF Synthesizer Troubleshooting

The UHF LO frequency varies with the channel. Use the following steps to troubleshoot the UHF synthesizer using Phoenix.

1. Open the **RF** menu, and click **Frequency Calculator.**

The **Frequency Calculator** dialog box appears.

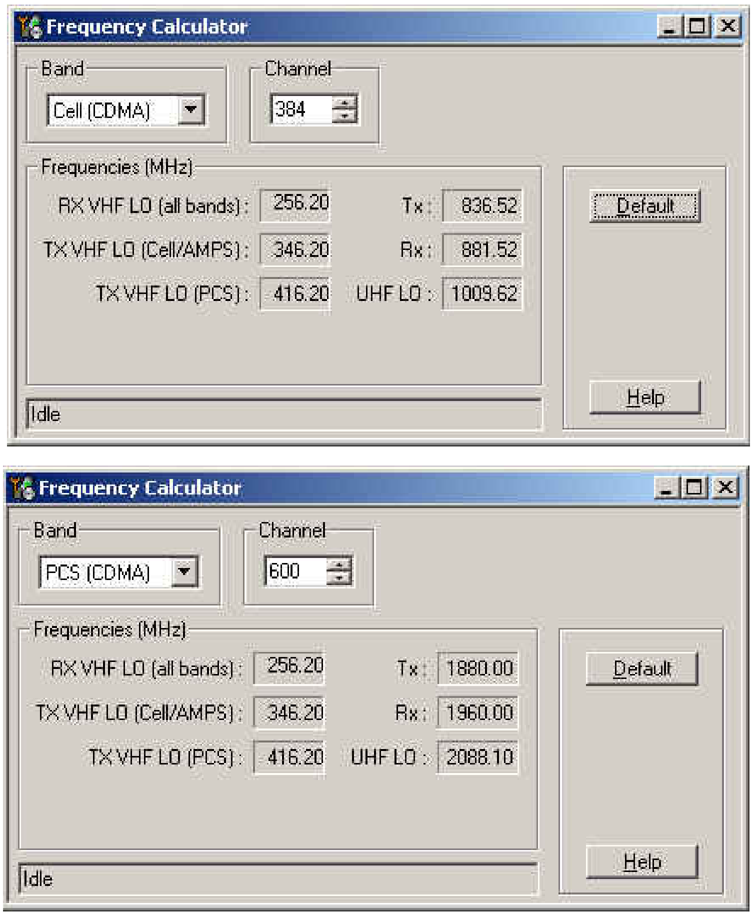

Figure 43: Frequency Calculator dialog box for Cell (top) and PCS (bottom)

2. Check to see if the LO is locked. Set a channel and check the output of the UHF LO at L502 within a very narrow span of 100KHz. The LO should be virtually immobile.
3. Measure for nominal UHF LO signal levels using and RF probe. (See Figure 42 on page 49 and Table 12, “UHF Synthesizer Probe Point Values and Descriptions,” on page 50.)
4. If you do not see the presence of any LOs, check the DC voltages at the following locations:
   - VR1A (R503), the supply line for UHF_PLL_IC, should be 4.76 VDC
   - VR4 (R510), supply line for VCO_IC, should be 2.76 VDC
5. Check lock voltage at C514, which should be between 1 and 3 V.
6. Check the RF return at R504.

UHF Synthesizer Schematic

The following schematic is for general reference only. See the *Schematics* chapter for a detailed version.

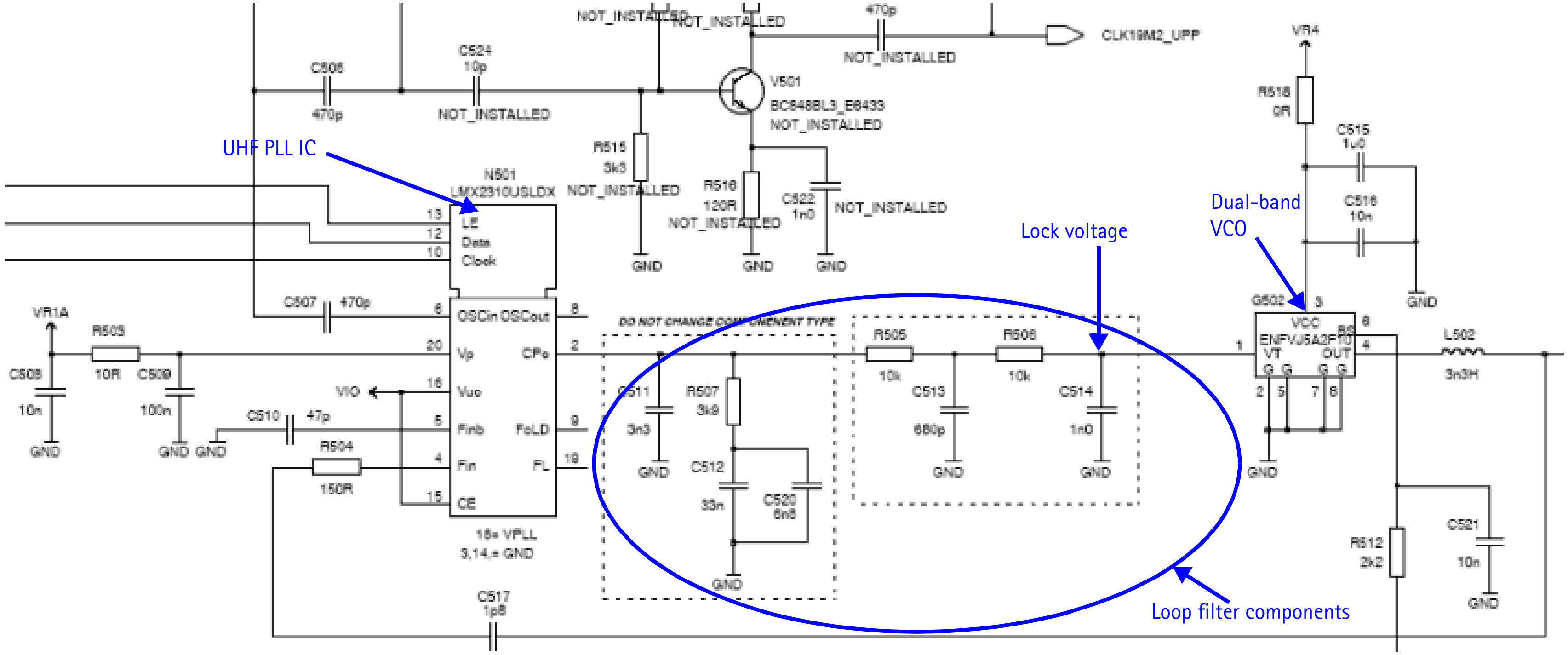

Figure 44: UHF synthesizer schematic

PCS UHF LO Channel 600 Spectrum

Measure the signal purity of the UHF LO and check the spur level offset from the carrier. Also, check the VCO, PLL IC, loop filter, and power supply decoupling.

Key observations:

- Clean and spur-free signal
- 30kHz offset -84dBc
- 50kHz offset -87dBc
- 60kHz offset -85dBc
- 90kHz offset -88dBc

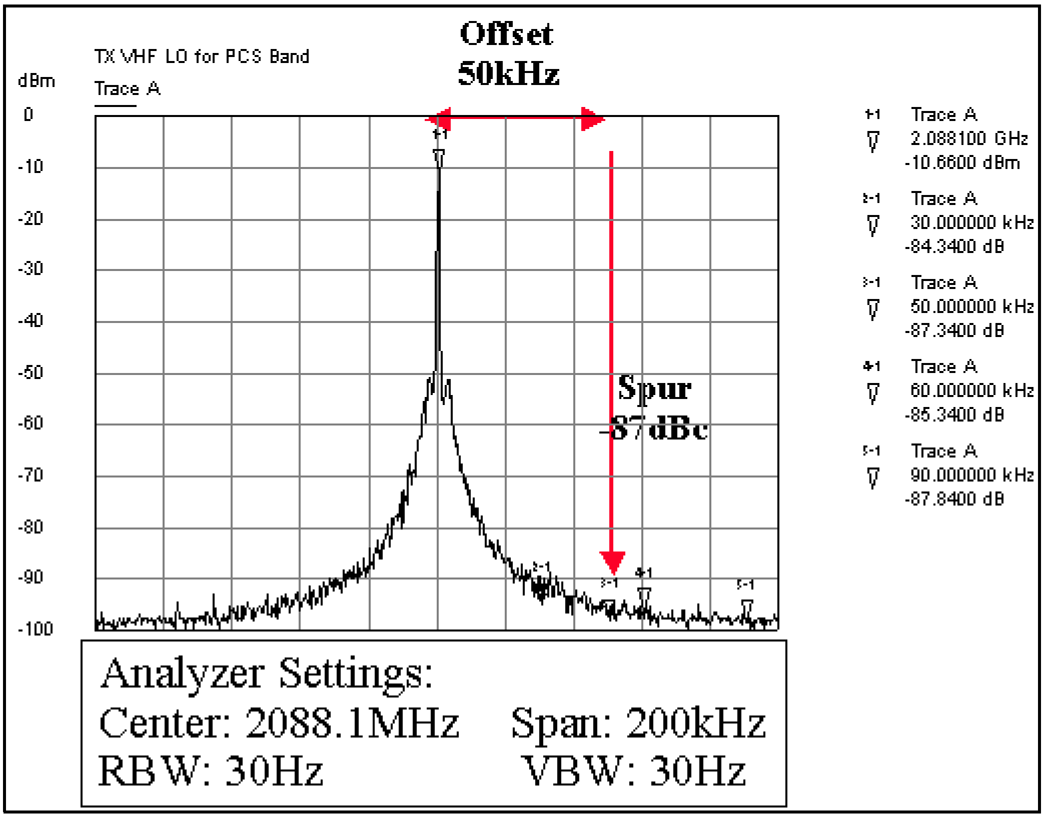

Figure 45: PCS UHF LO channel 600 typical spectrum

Note: The view in Figure 45 maybe difficult to accomplish without a high impedance probe and a high dynamic range spectrum analyzer.

Cell UHF LO Channel 384 Spectrum

Measure the signal purity of the UHF LO and check the spur level offset from the carrier. Also, check the VCO, PLL IC, loop filter, and power supply decoupling.

Key observations:

- Clean and spur-free signal
- 30kHz offset -83dBc
- 50kHz offset -92dBc

- 60kHz offset -91dBc
- 90kHz offset -91dBc

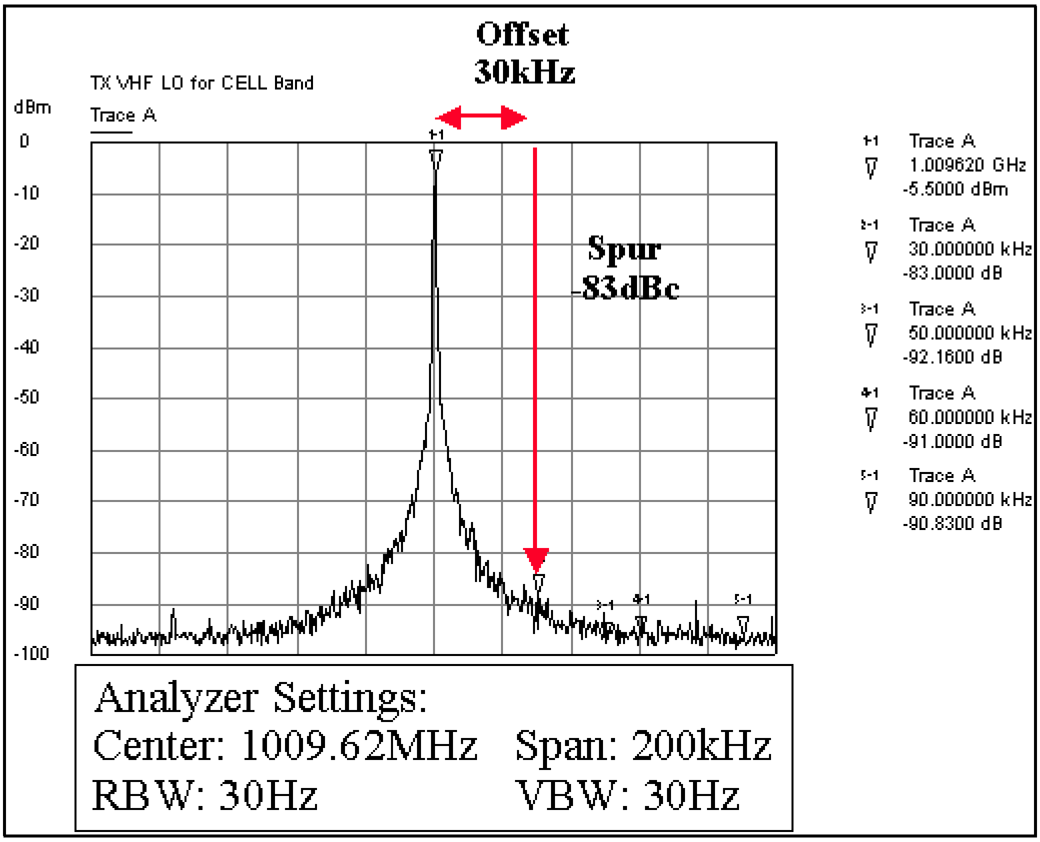

Figure 46: Cell UHF LO channel 384 typical spectrum

Following ar possible causes for an incorrect UHF frequency:

RX VHF LO

The RX VHF LO operates at a fixed frequency of 256.2MHz. It is the second LO for down-conversion to I and Q for baseband processing. Use the following guidelines when troubleshooting:

- Monitor the probing point at C702 for the Batman LO. A locked and stable 256.2MHz with an amplitude of ~ –60dBm should be observed on the spectrum analyzer (~ -2 dBm at C705 if using a high impedance probe).
- Monitor the control voltage at C715. The control voltage in a locked state should be between 1.2 and 1.7 VDV for the proper operation of the Batman LO.

RX VHF LO (Batman) Schematic

The following partial schematic is for general reference only. See the *Schematics* chapter for a detailed version.

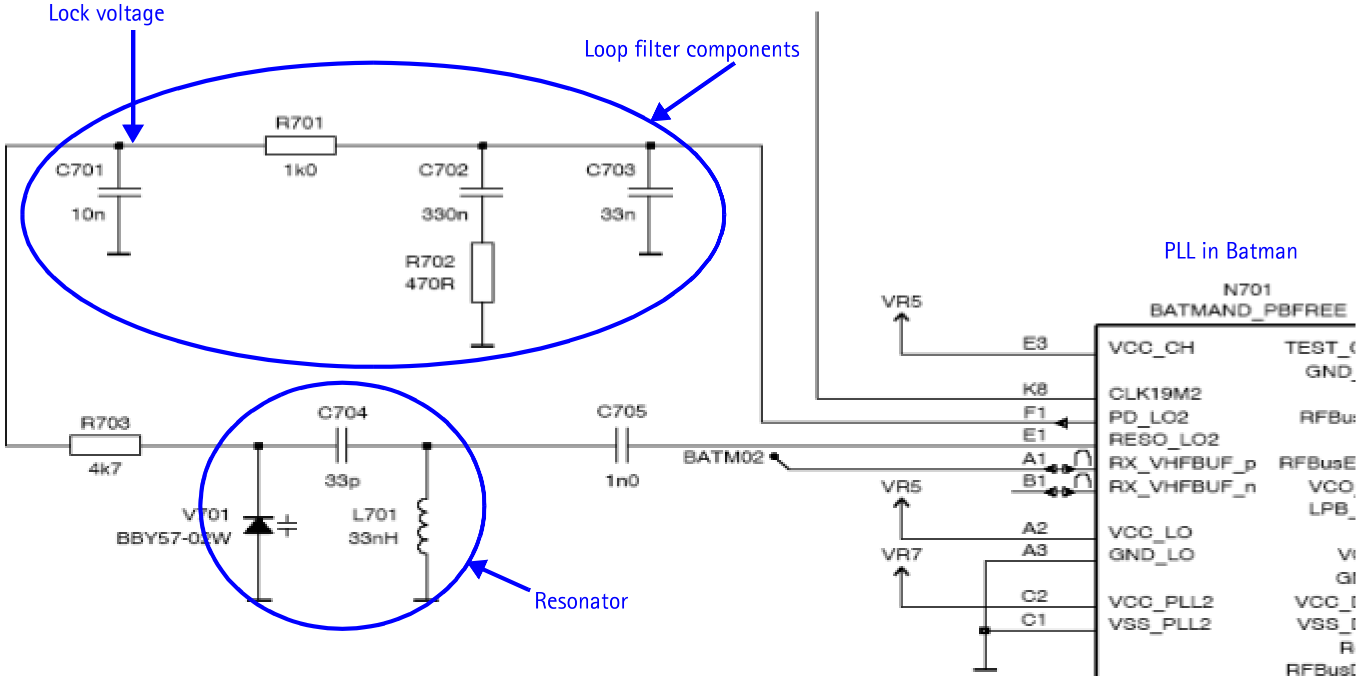

Figure 47: RX VHF LO (Batman) schematic (partial view)

Figure 48 shows the RX VHF LO probe points.

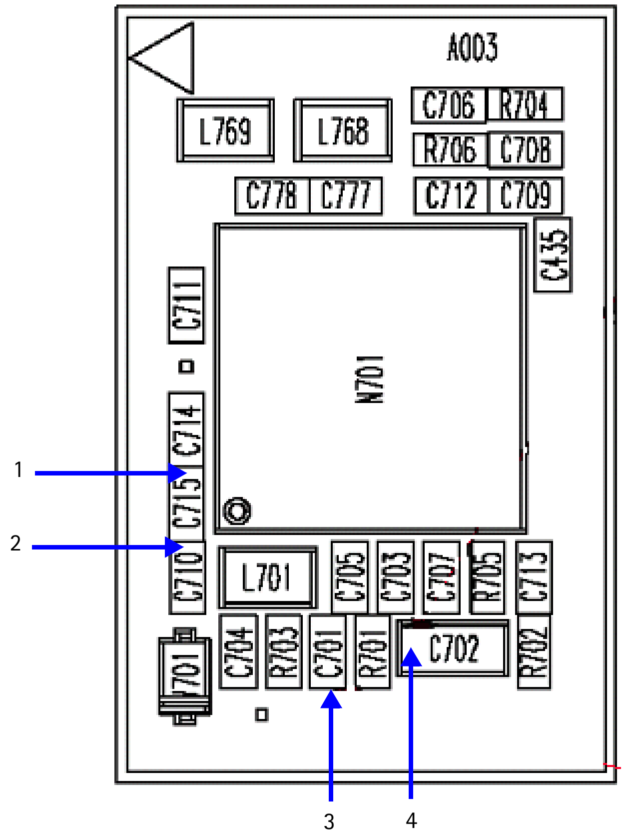

Figure 48: RX VHF LO probe points

Table 13 gives the description and values for the probe points as shown in Figure 48.

Table 13: RX VHF LO Probe Points

Probe Point	Description	Value
1	VR5	2.8V
2	VR7	2.8V
3	RX LO lock voltage	1.2 to 1.7 VDC
4	RX LO	256.2 MHz, -60 dBm

TX UHF LO

There are two fixed LOs: 3296.16~3395.88MHz for Cell band and 3700~3819.90MHz for PCS band. This is the first LO for up-conversion. Monitor the control voltage at R601. At this control voltage, the Jupiter LO is locked and should be between 1.2 and 1.8VDC.

TX UHF LO Schematic

The following partial schematic is for general reference only. See the *Schematics* chapter for a detailed version.

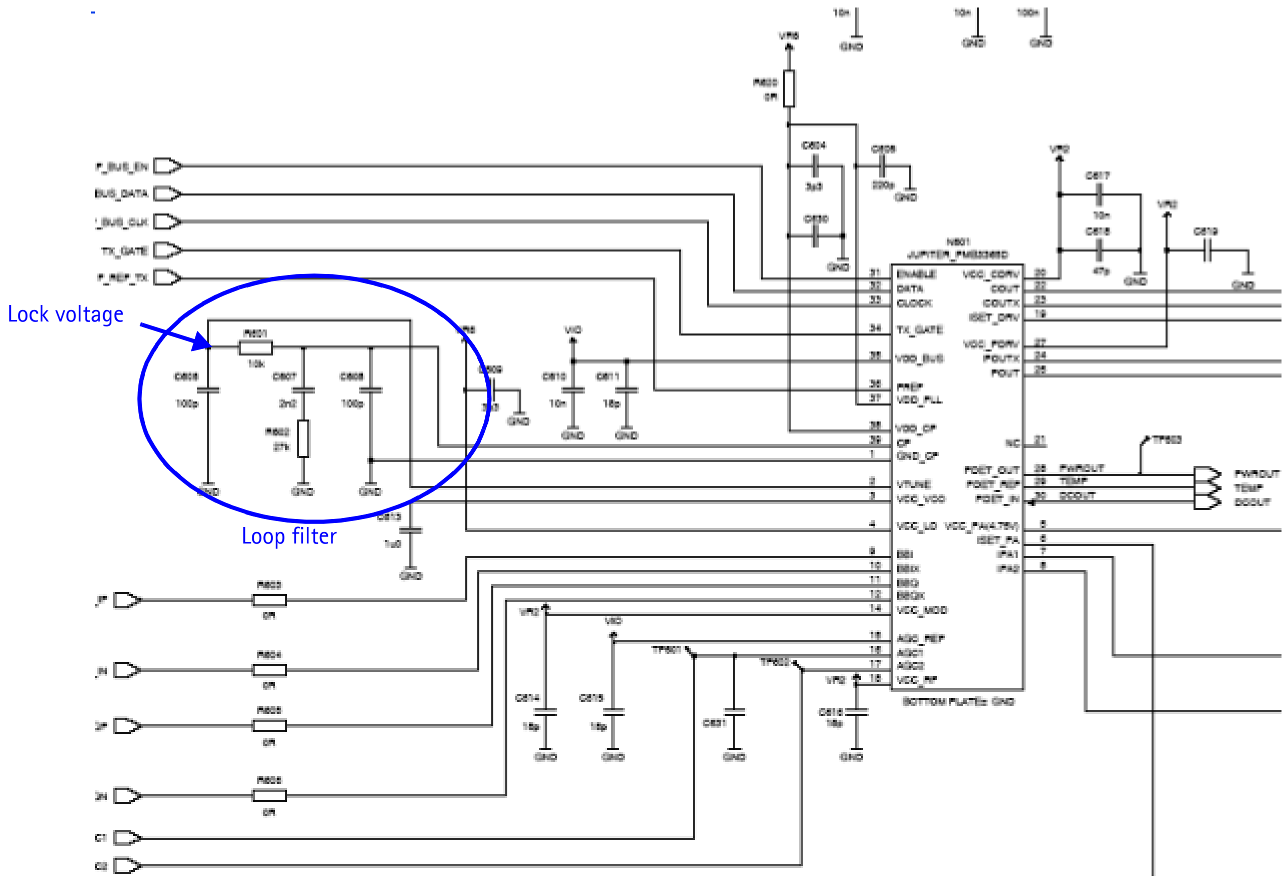

Figure 49: TX UHF LO schematic (partial view)

Figure 50 shows the TX UHF LO probe points.

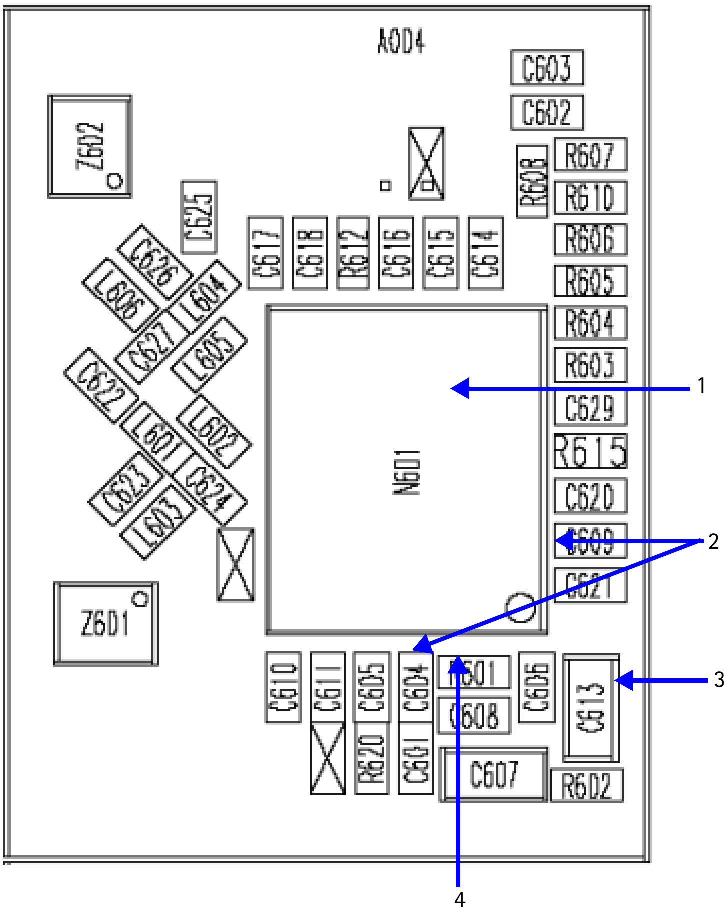

Figure 50: TX UHF LO (Jupiter) probe points

Table 14 gives the description and values for the probe points as shown in Figure 50.

Table 14: TX UHF LO Probe Points

Probe Point	Description	Value
1	Measure frequency by probing the top of the chip	PCS: 3760 MHz (channel 600) -54dBm Cell: 3346.08 MHz (channel 384) -57dBm
2	VR6	2.8V
3	VCC_VCO	2.3 V
4	Lock voltage	DC between 1.2 and 1.8 V

UHF PCS TX LO Spectrum

Following is the UHF PCS TX LO (3700 ~3819.90)/2 MHz spectrum.

Key observations:

- The following reference spurs
- 50kHz offset -59dBc

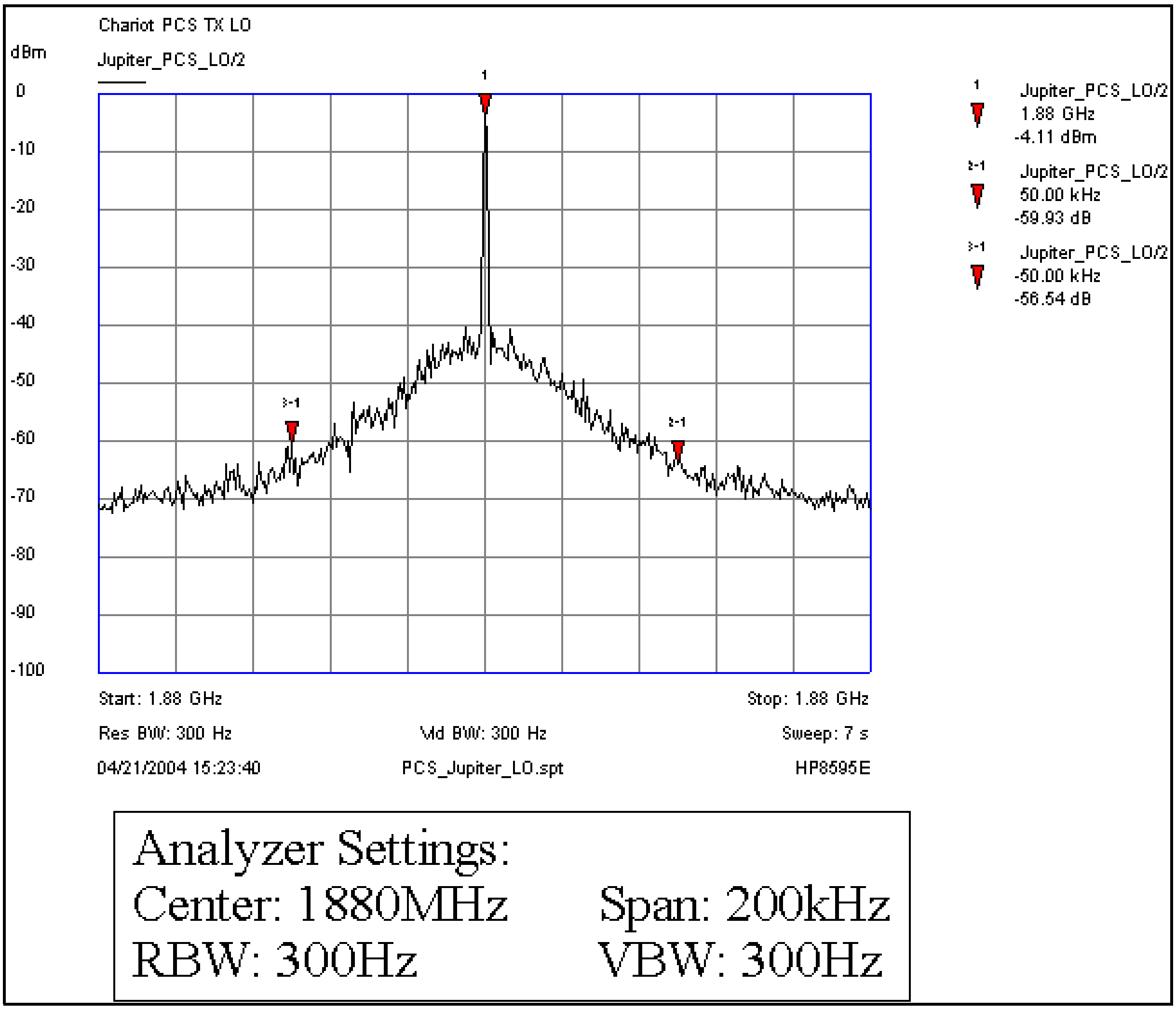

Figure 51: UHF PCS TX LO (3700 ~3819.90)/2 MHz typical spectrum

UHF Cell TX LO Spectrum

Following is the UHF Cell TX LO (3296 ~3395.88)/4 MHz Cell spectrum.

Key observations:

- The following reference spurs
- 30kHz offset -65dBc

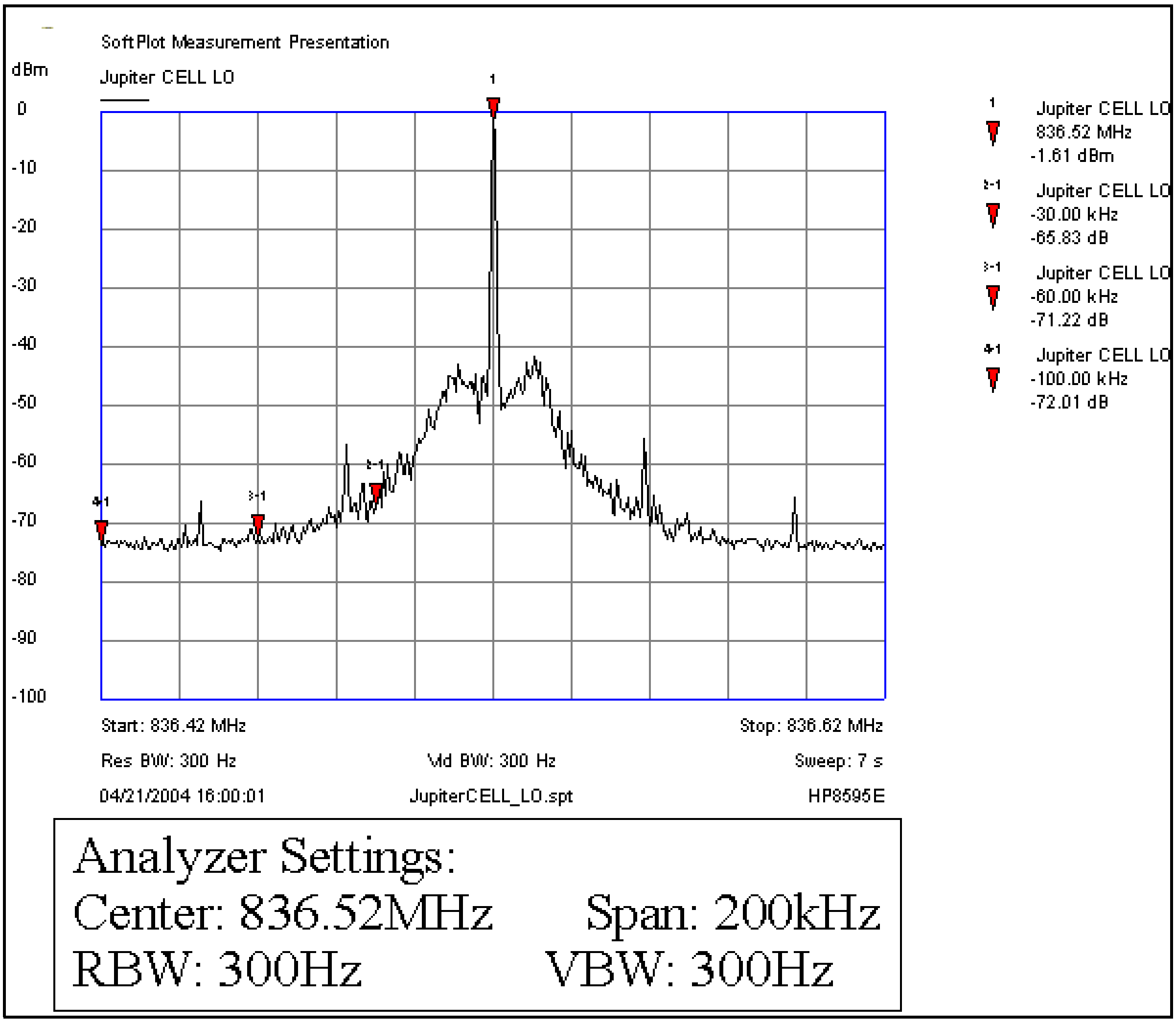

Figure 52: UHF Cell TX LO (3296.16 ~3395.88)/4 MHz Cell typical spectrum

GPS RF Troubleshooting

Following is the GPS RF block diagram.

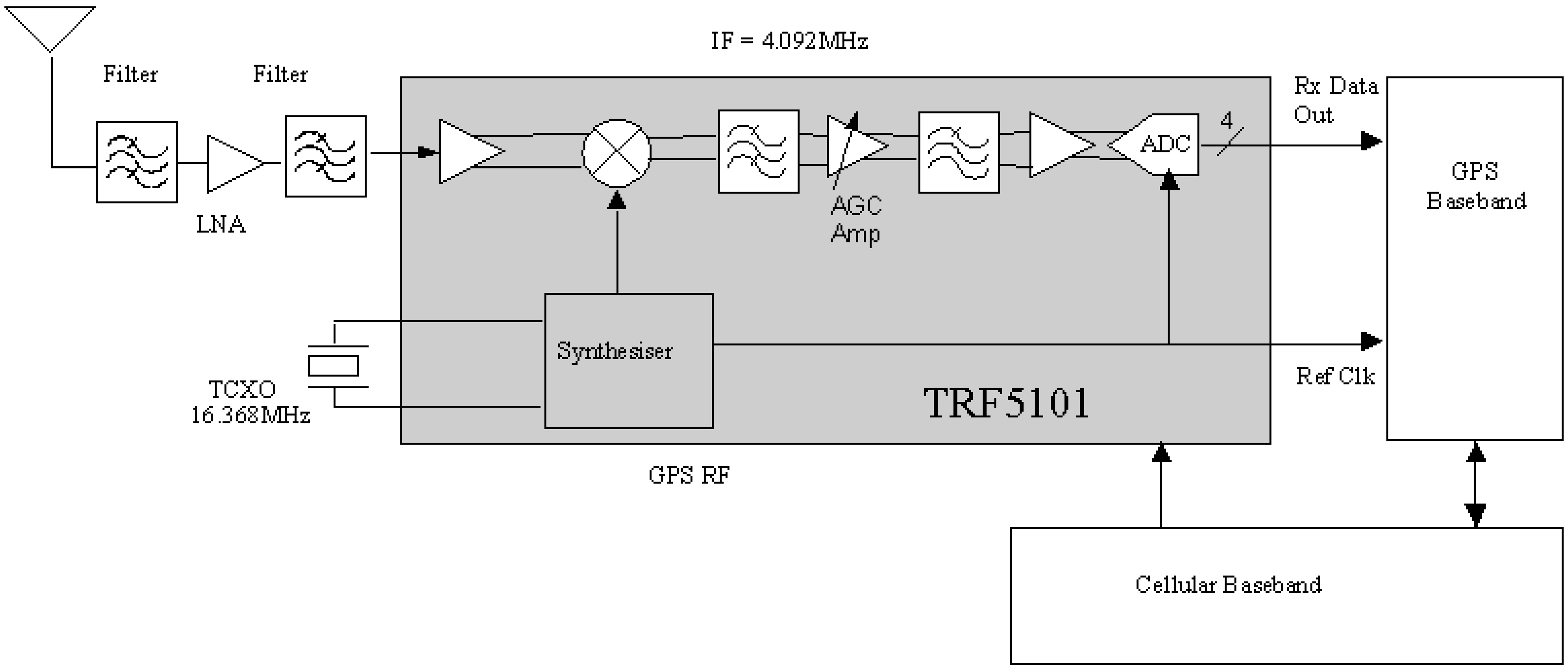

Figure 53: GPS RF block diagram

GPS Schematic

The following schematic is for general reference only. See the *Schematics* chapter for a detailed version.

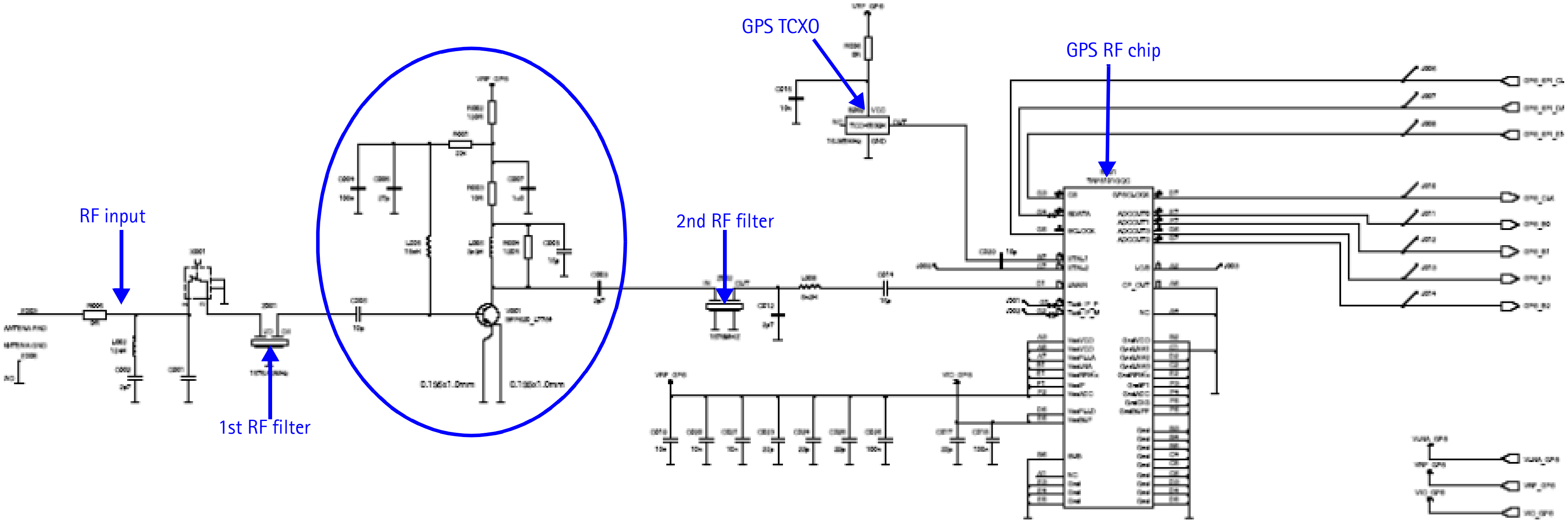

Figure 54: GPS RF schematic

GPS RF General Testing

In radiated testing the CW level has to be higher because of the attenuation in pad + cable + coupler. With a -20 dB pad, the signal level in the signal generator is ~ -110 dBm + cable attenuation + 20 dB + 18 dB. The CW analysis allows end-to-end spectral purity to be assessed during manufacturing and development.

1. On the **Phone Control** dialog box, click the **LOCAL** button in the **Phone State** area to put the phone into Local Mode.

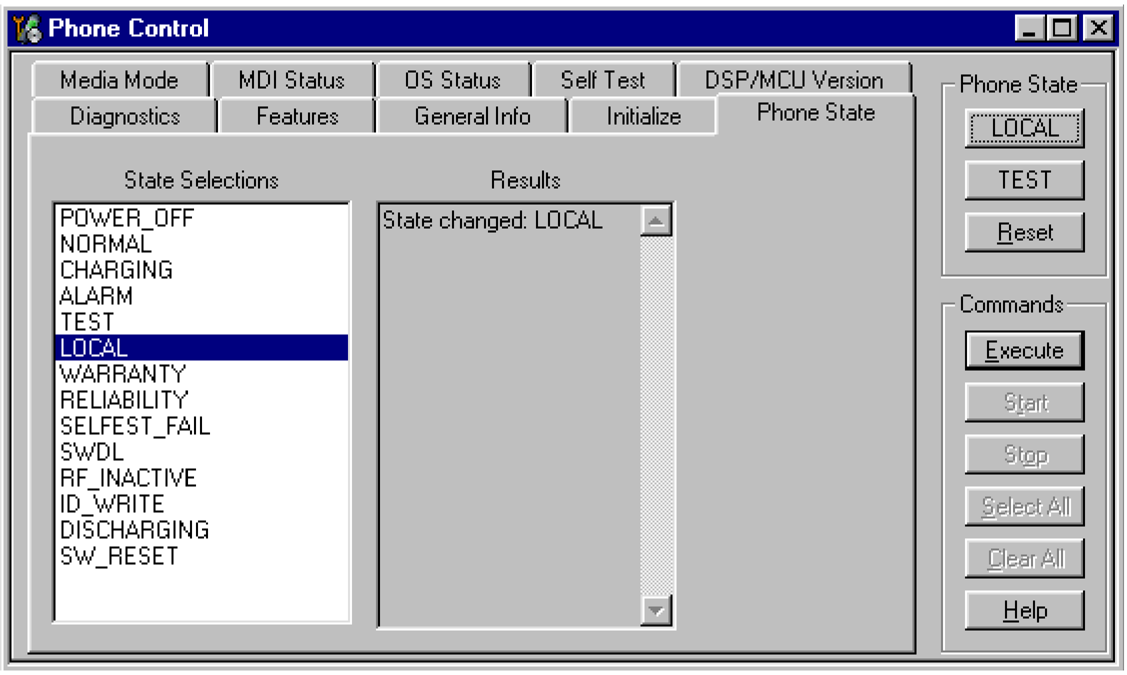

Figure 55: Phone Control dialog box

2. Inject -110dBm tone at 1575.52 MHz at the GPS connector (X001) with a signal generator or a call box.

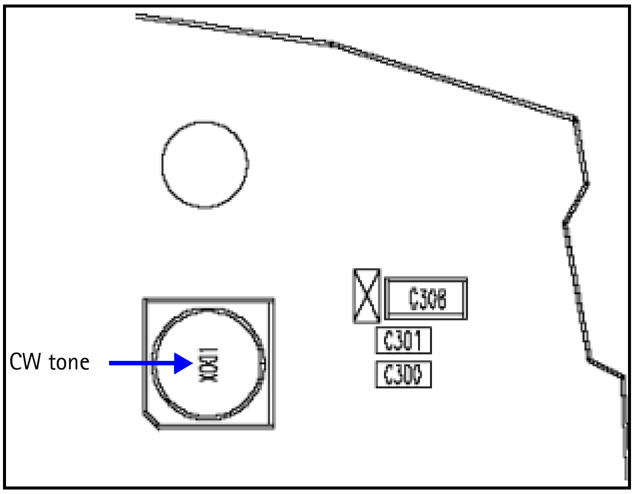

Figure 56: GPS antenna port

3. Open the **Troubleshooting** menu, and click **GPS Control**.

   The **GPS Control** dialog box appears.

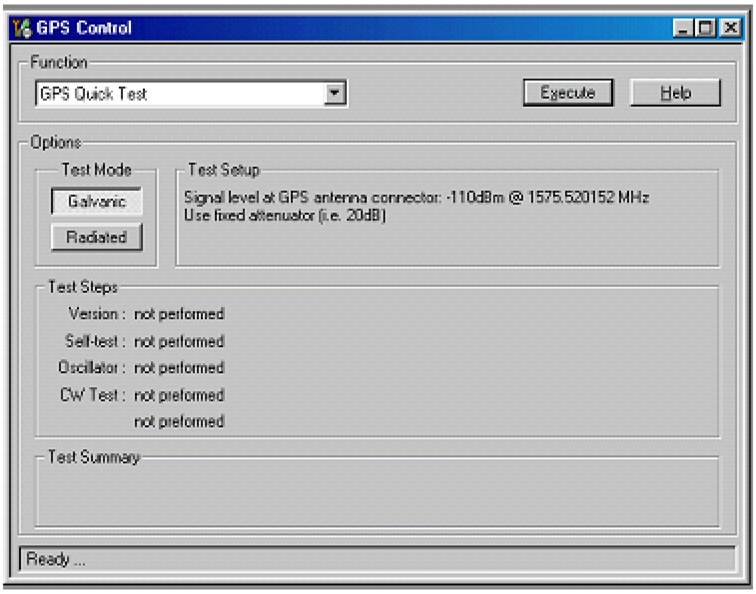

Figure 57: GPS Control dialog box

4. Select **GPS Quick Test** in the **Function** area, and ensure that the **Test Mode** area shows a value of **Galvanic**.
5. Click **Execute**.

Self Test Failure

If the test fails, repeat steps 1—5. If the test fails again, continue with the following self-test failure troubleshooting:

1. Verify the DC voltages at VRF_GPS and VIO_GPS.
2. Inspect all GPS circuit elements around D051.
3. If the elements pass a visual inspection, replace the D051.

Oscillator Failure

1. Inspect all GPS circuit elements around N001.
2. If the elements around N001 are okay, replace B002.

CW Test Failure

1. Check that the signal generator is on and sourcing a signal to the GPS RF input port (X001).
2. Inspect all GPS RF circuit elements.
3. Inspect all GPS circuit elements around D051. If the elements are okay, replace the GPS RF IC (N001).

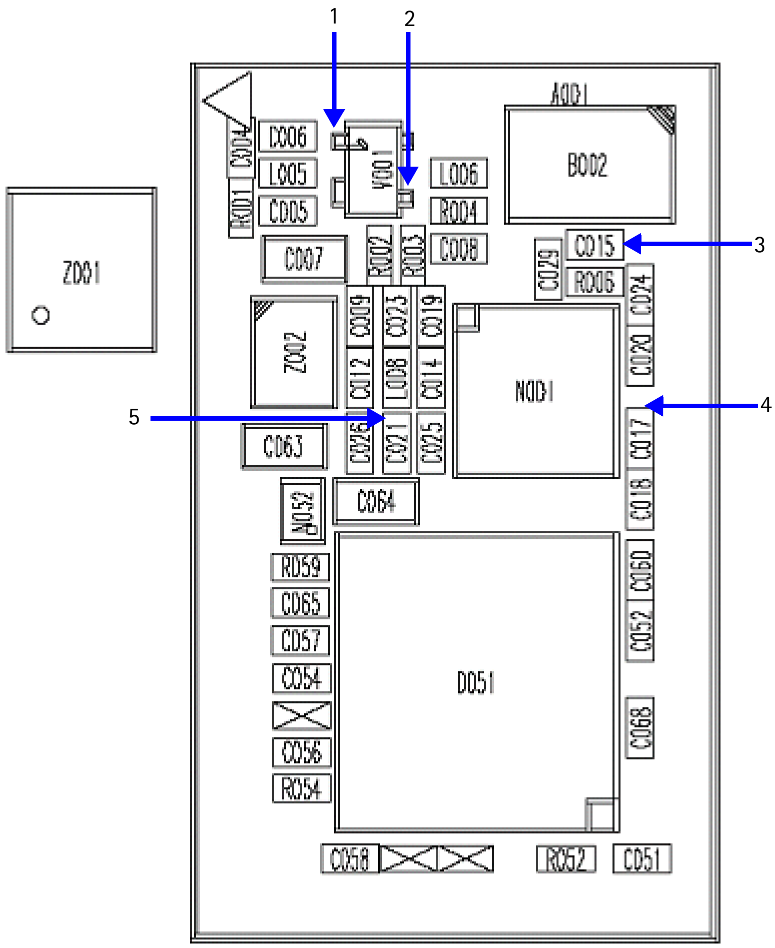

Figure 58: GPS testing area

Table 15 gives the description and values for the probe points as shown in Figure 58.

Table 15: GPS Test and DC Probe Point Values

Probe Point	Description	Value
1	LNS_Base	0.8V
2	LNA Vcc	1.5V
3	TCXO Vcc	2.8V
4	VIO_GPS	1.8V
5	VRF_GPS	2.8V

GPS RF Probing

Use the following steps for RF probing:

1. Open the **Troubleshooting** menu, and click **GPS Control**.

   The **GPS Control** dialog box appears.

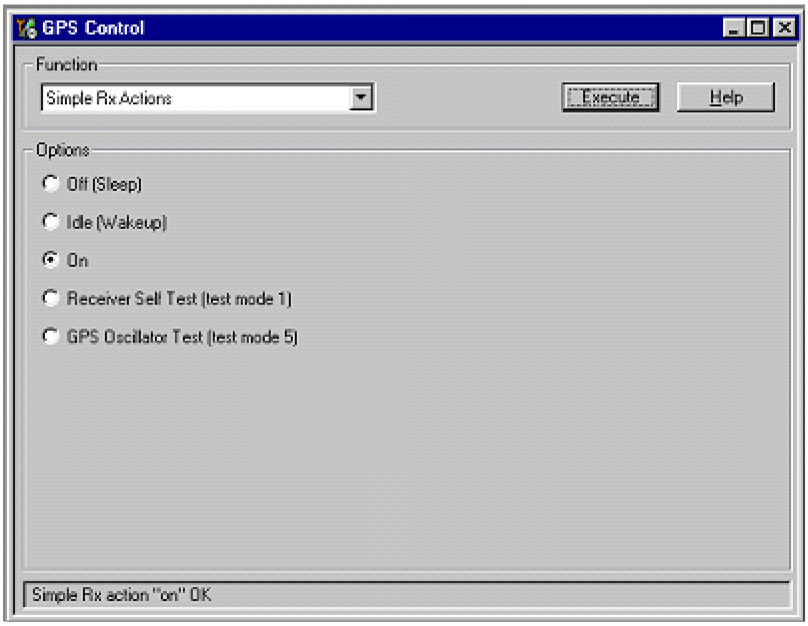

Figure 59: GPS Control dialog box

2. Select **Simple Rx Actions** in the **Function** area.
3. Select **On** in the **Options** area.
4. Click **Execute**.
5. Inject a -50 dBm tone at 1575.52 MHz into the GPS connector (X001) with a signal generator or call box. (See Figure 56 on page 63.)

6. Measure the probe points with either a voltmeter or an AAS_10B probe with a spectrum analyzer set at a center frequency of 1575.25MHz and a span of 500kHz. (All points are 1575.52MHz, except for TCXO, which is at 16.368MHz.)

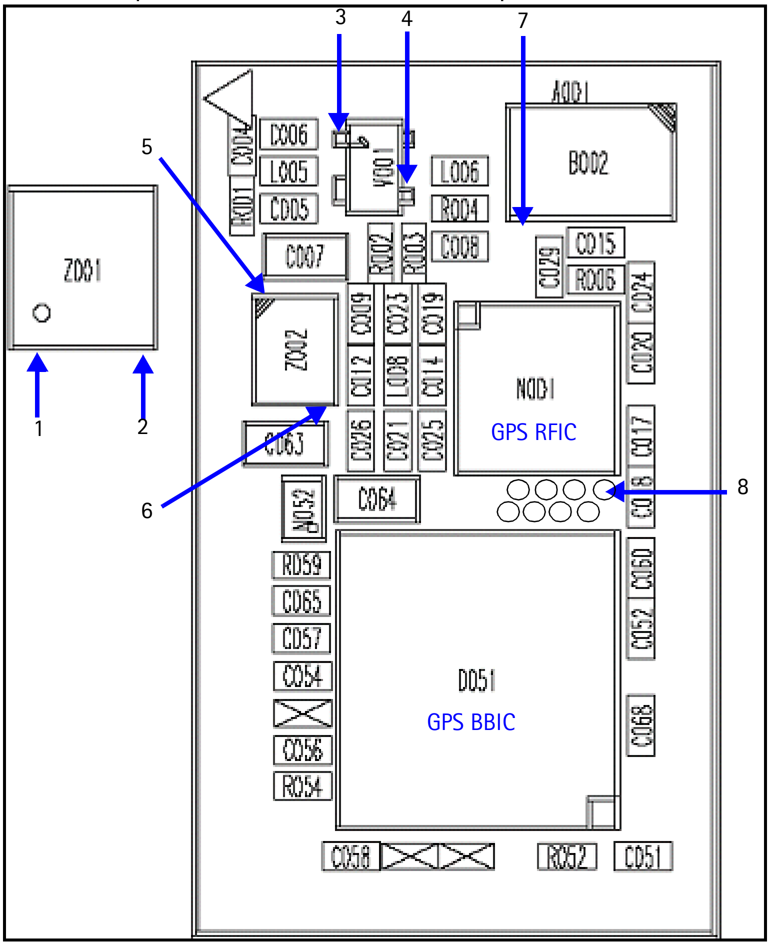

Figure 60: GPS RF probing points

Table 16 includes the values for the probing points in Figure 60.

Table 16: GPS RF Probing Point Values

Test Point	Description	Values
1	1st RF filter in	-62 dBm
2	1st RF filter out	-65 dBm
3	GPS LNA in	-63 dBm
4	GPS LNA out	-45 dBm
5	2nd RF filter in	-46 dBm
6	2nd RF filter out	-46 dBm
7	GPS TCXO out (16.368MHz)	-3 dBm
8	GPS TCXO (16.368MHz)	-8 dBm

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