# Troubleshooting — GPS

## Contents

# Troubleshooting - Global Positioning System (GPS) Engine

The RH-44 handset supports 800 Amps and 800 CDMA / 1900 CDMA. The Model 3586i supports GPS functionality for E911 services.

GPS circuitry utilizes RF signals from satellites stationed in geosynchronous orbit to determine latitude and longitude of the handset. The GPS circuitry and the cellular engine (CE) circuitry are completely separate in the handset. The GPS circuitry is located almost exclusively on the secondary side of the PWB, underneath the display module.

See Figure 1 for the General Block Diagram.

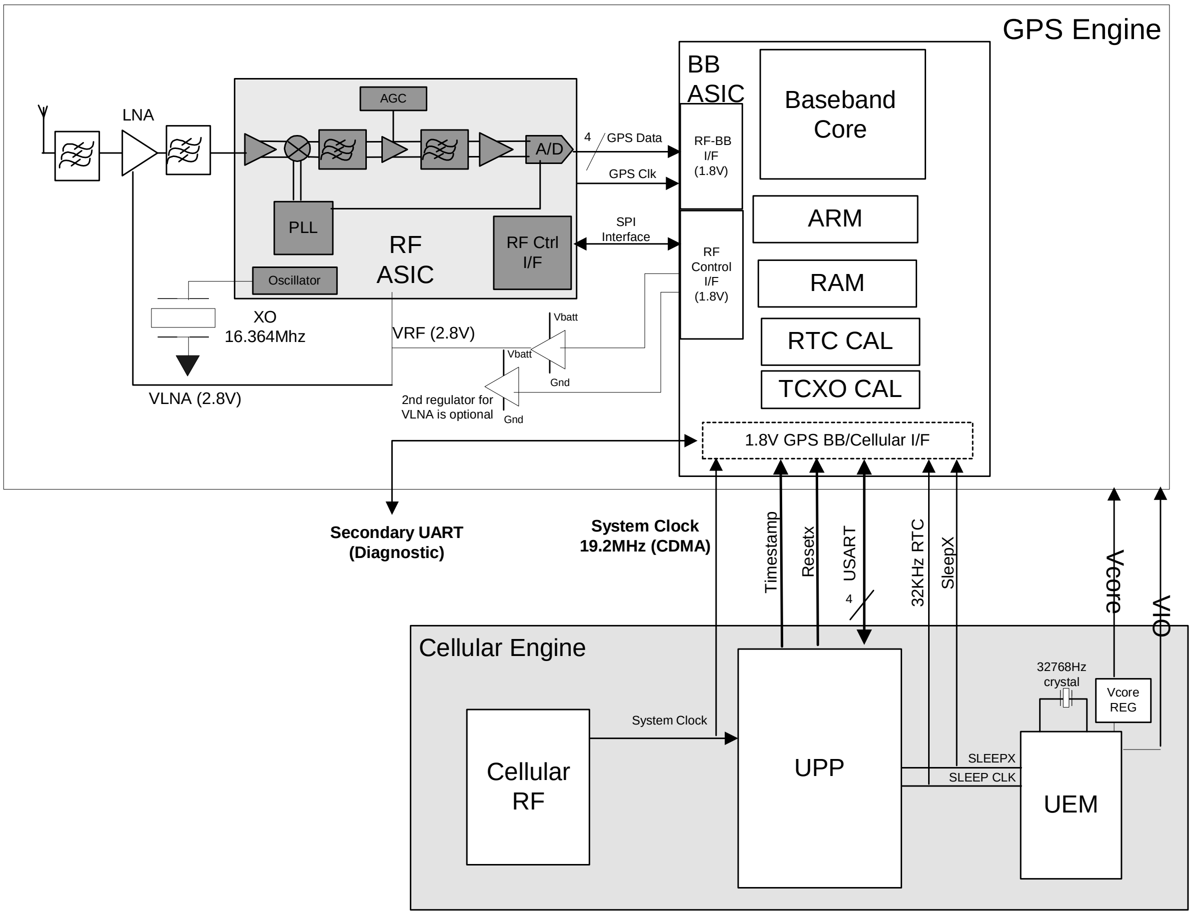



Figure 1: GPS Block Diagram

## Acronyms and Abbreviations

| | |
|---|---|
| AGPS | Assisted GPS |
| AMPS | Advanced Mobile Phone Service |
| ASIC | Application Specific Integrated Circuit |
| E911 | Enhanced 911 |
| FCC | Federal Communications Commission |
| BPSK | Binary Phase Shift Keying |
| BT | BlueTooth |
| C/A | Coarse Acquisition-Code |
| CE | Concurrent Engineering |
| CDMA | Code Division Multiple Access |
| C/No | Carrier to Noise ratio [dB-Hz] |
| DCT | Digital Core Technology |
| DSSS | Direct Sequence Spread Spectrum |
| FCC | Federal Communications Commission |
| GPS | Navstar Global Positioning System |
| HW | Hardware |
| IC | Integrated Circuit |
| L1 | Link 1 |
| LPRF | Low Power RF |
| NF | Noise Figure |
| PCS | Personal Communications Service |
| PRN | Pseudo Random Noise |
| PSAP | Public Safety Answering Point |
| PWB | Printed Wiring Board |

| | |
|---|---|
| RF | Radio Frequency |
| RHCP | Right Hand Circular Polarized |
| SA | Selective Availability |
| SPS | Standard Positioning Service |
| TTFF | Time To First Fix |
| UTC | Universal Time Coordinated |
| WB | Wideband |

## Troubleshooting the GPS BB

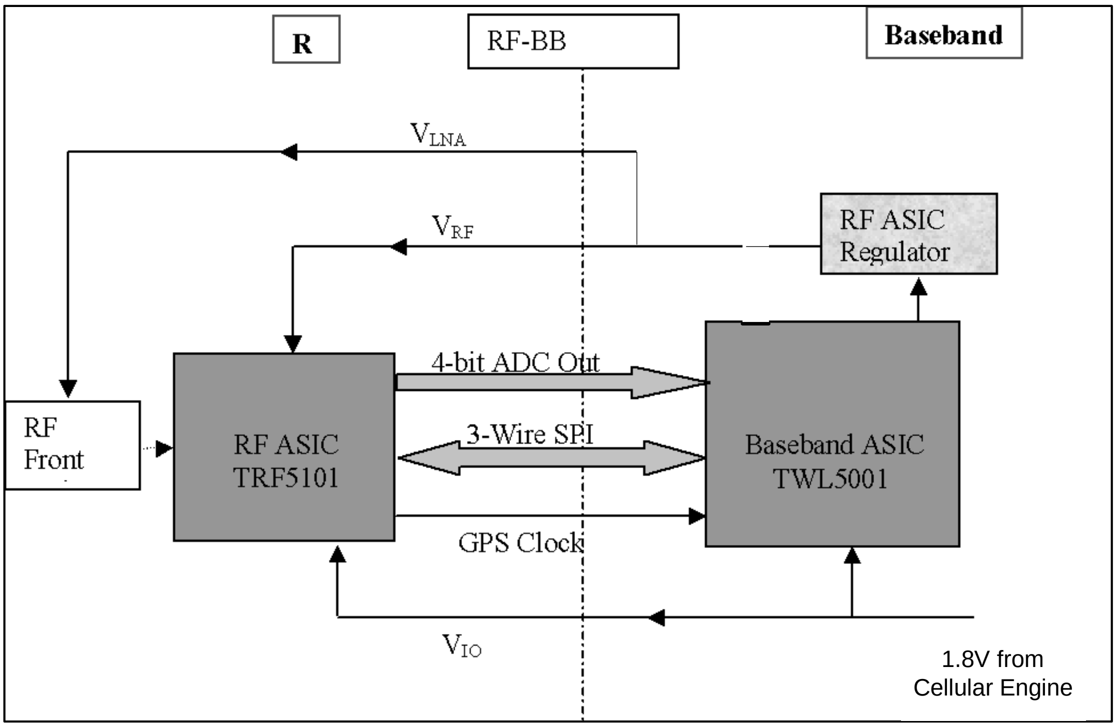



Figure 2: GPS RF-BB ASIC Interface

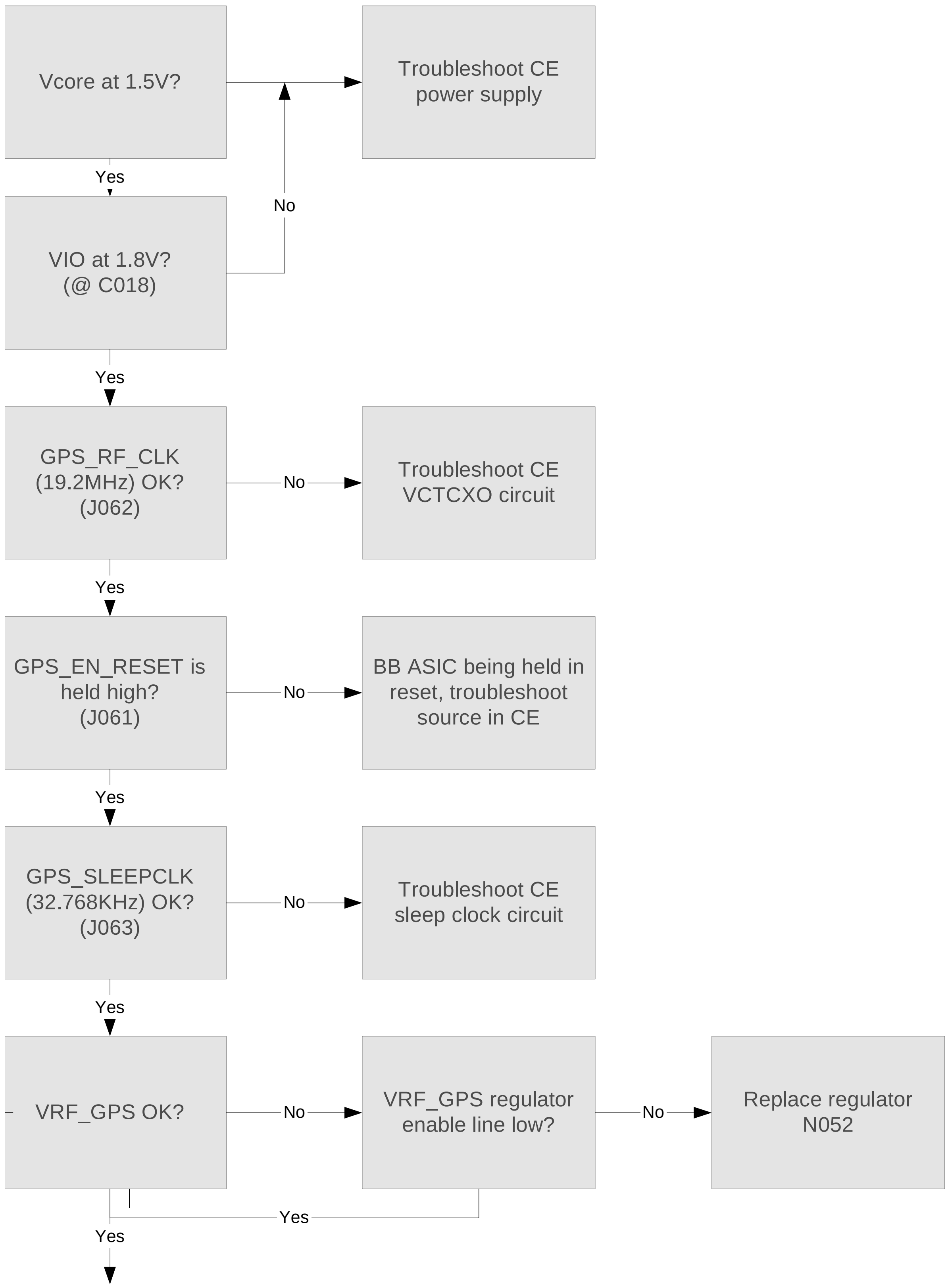
To troubleshoot the GPS BB, put the GPS engine (GE) and cellular engine (CE) in the proper mode by selecting the GPS Testing drop-down menu item from the “Troubleshooting” dialog box. Ensure that the necessary inputs from the CE are good (e.g., power, clock, and so on). Next, ensure that these inputs produce the proper outputs. Due to the large level of integration (most functionality is contained in the two ASIC chips), the diagnostics that may be performed are limited.

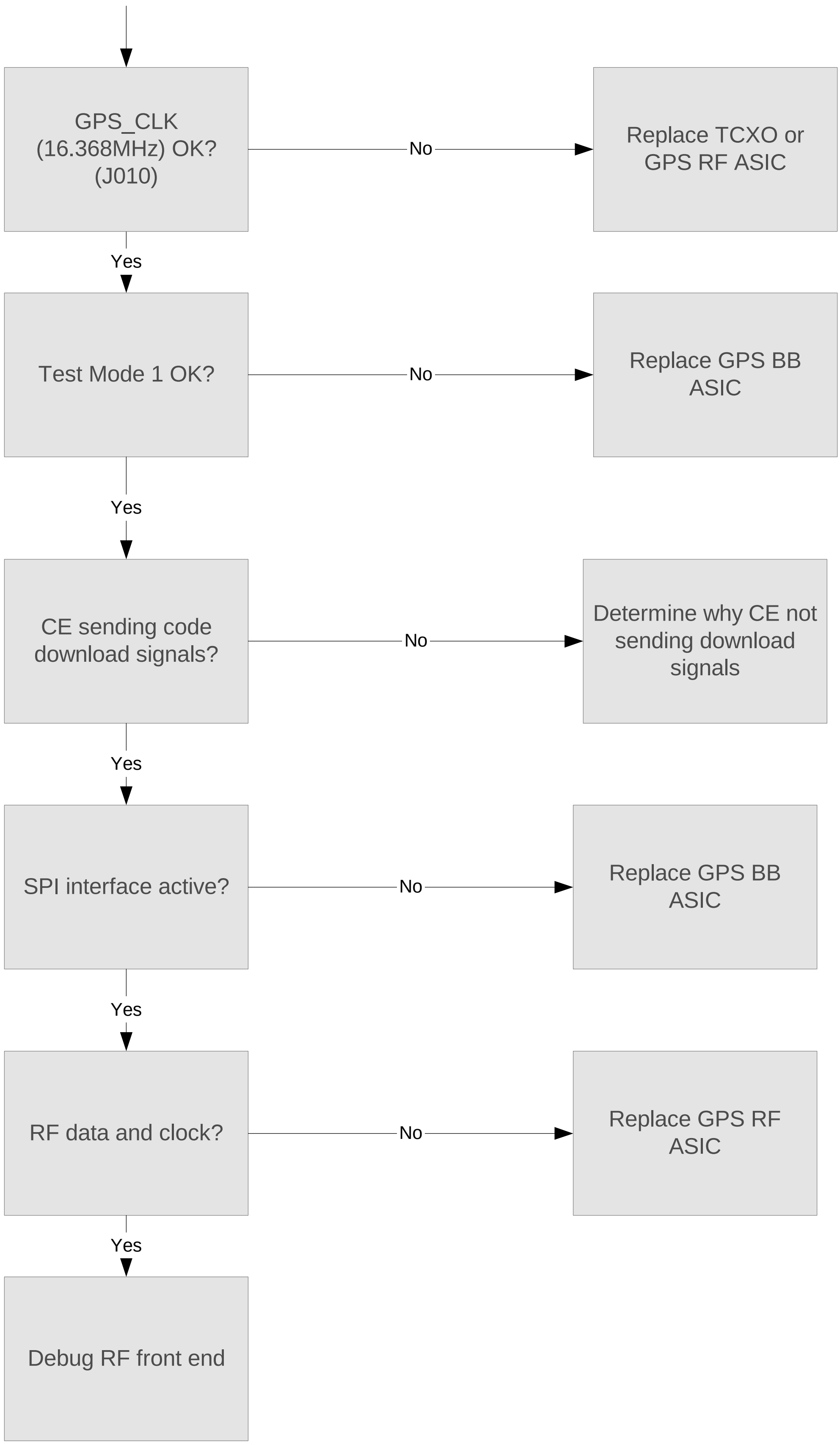
Visually inspect the GPS circuitry to determine if the problem is physical (dislodged parts, corrosion, poor solder joints, and so on) prior to performing any diagnostics.

### Troubleshooting Flowchart

Before implementing the flowchart, ensure that the CE is not in power-saving mode. This will allow the GE to run. Turn the GPS section ON in the "GPS Receiver Control (AMS)" tab of the GPS component in Phoenix.

Reference Table 1 for GPS Test Points assignment and Figure 10 for GPS Test Points locations.


Vcore at 1.5V?
Troubleshoot CE power supply
Yes
No
VIO at 1.8V? (@ C018)
Yes
GPS_RF_CLK (19.2MHz) OK? (J062)
No
Troubleshoot CE VCTCXO circuit
Yes
GPS_EN_RESET is held high? (J061)
No
BB ASIC being held in reset, troubleshoot source in CE
Yes
GPS_SLEEPCLK (32.768KHz) OK? (J063)
No
Troubleshoot CE sleep clock circuit
Yes
VRF_GPS OK?
No
VRF_GPS regulator enable line low?
No
Replace regulator N052
Yes
Yes


GPS_CLK (16.368MHz) OK? (J010)
No
Replace TCXO or GPS RF ASIC
Yes
Test Mode 1 OK?
No
Replace GPS BB ASIC
Yes
CE sending code download signals?
No
Determine why CE not sending download signals
Yes
SPI interface active?
No
Replace GPS BB ASIC
Yes
RF data and clock?
No
Replace GPS RF ASIC
Yes
Debug RF front end

## Flowchart Notes

Clocks and Power

The proper GPS_RF_CLK is a 19.2 MHz, approximately 800mV peak-to-peak sine wave (see Figure 3).

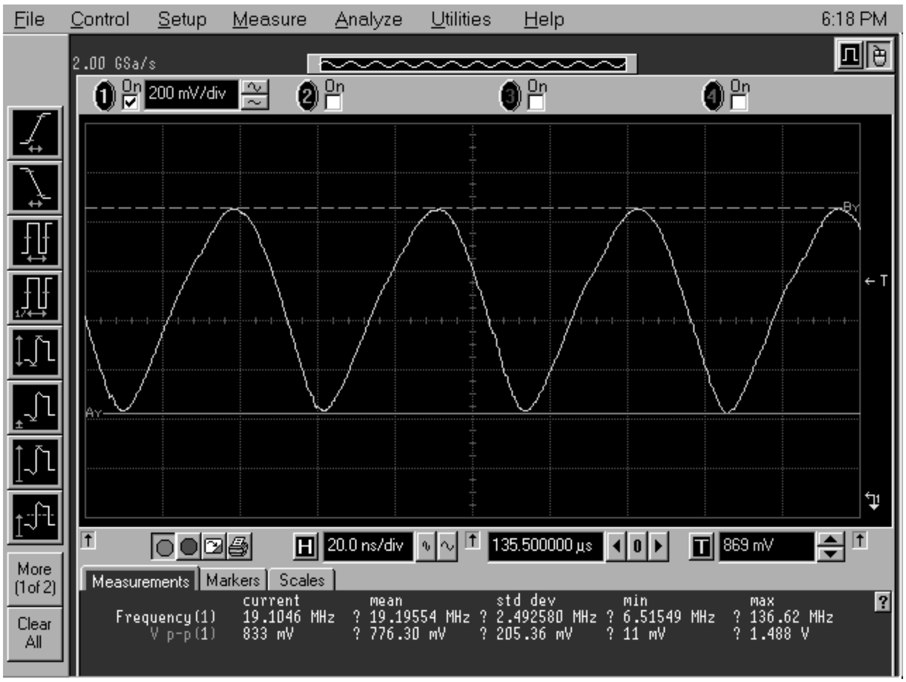



Figure 3: 19.2MHz System Clock

The GPS_CLK should be a 16.3MHz, 1.8V peak-to-peak square wave (see Figure 4).

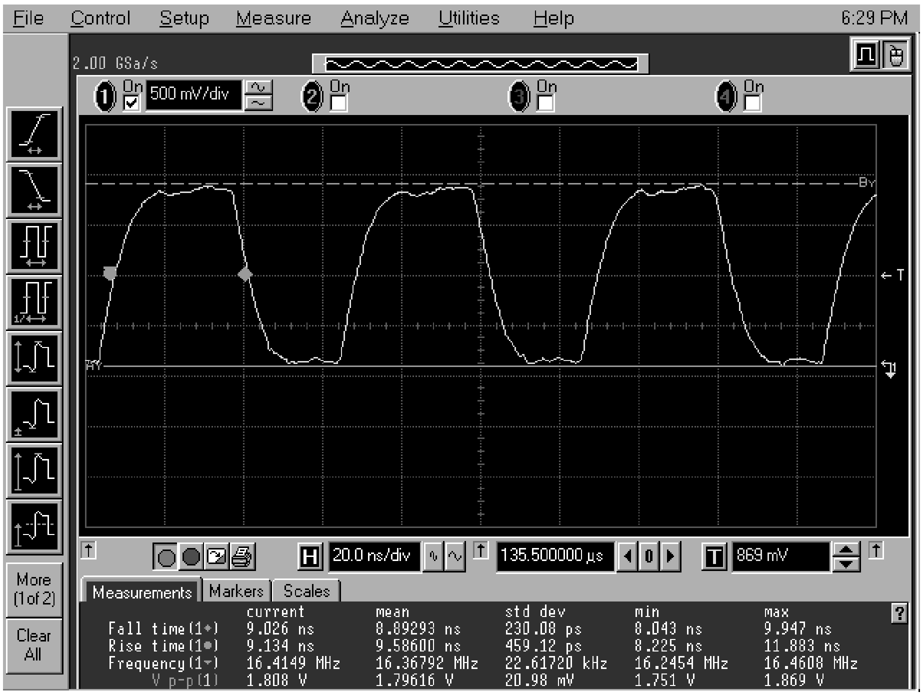



Figure 4: GPS_CLK

### Test Mode 1

Test Mode 1 is a built-in self-test (BIST) for the GPS BB ASIC that checks for internal faults. To implement Test Mode 1, select the test mode 1 radio button and then click the **Execute** button in the “Rx simple actions” tab of the GPS component in Phoenix.

### Code Download

The code store inside the GPS BB ASIC is volatile. As a result, each time power is applied to the ASIC, the code that runs there must be re-downloaded from the CE. If this process does not complete correctly, the GE will not work. The interface protocol utilized for this process is the Universal Synch/Asynch Receiver Transmitter (USART), and the pins on the GPS BB ASIC are labeled U1Tx, U1Rx, U1_DATA_RDY, and U1_CLK. To determine if this interface is active, check for activity on these lines at power up. Each of these lines should have a short burst of activity immediately after power is applied. To capture these signals, you will need to set the storage scope to single sweep or triggered mode (see Figure 5).

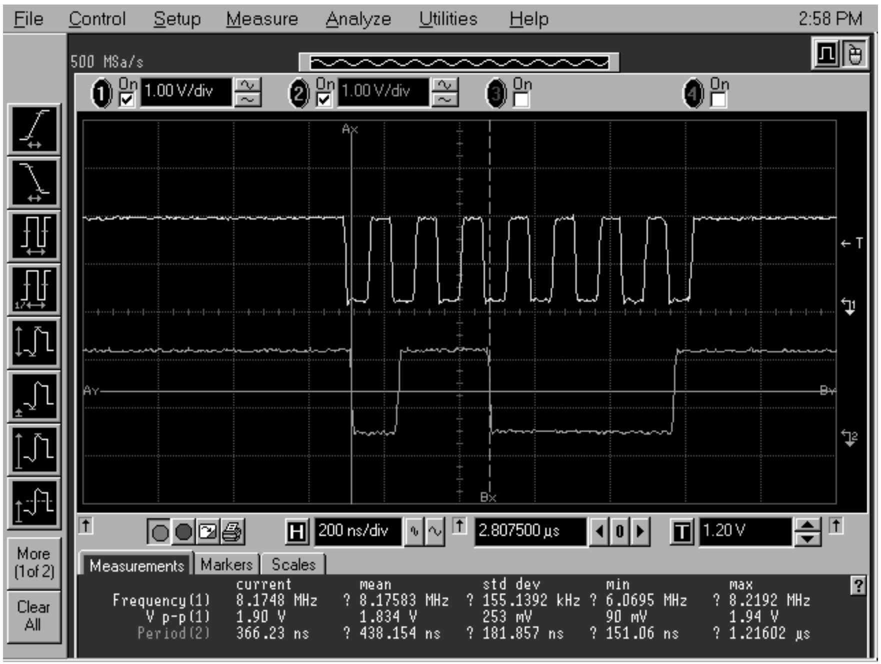



**Figure 5: GPS Code Download U1 CLK U1 RX**

### SPI Interface

The SPI interface is a three-line synchronous serial interface used by the GPS BB to communicate to the GPS RF. These lines are called SPI_CLK, SPI_DATA, and SPI_EN. Activity should be seen for a short period on these signals each time a mode switch is made (e.g., between idle and off mode in the “Rx simple actions” tab of the GPS component in Phoenix). See Figure 6.

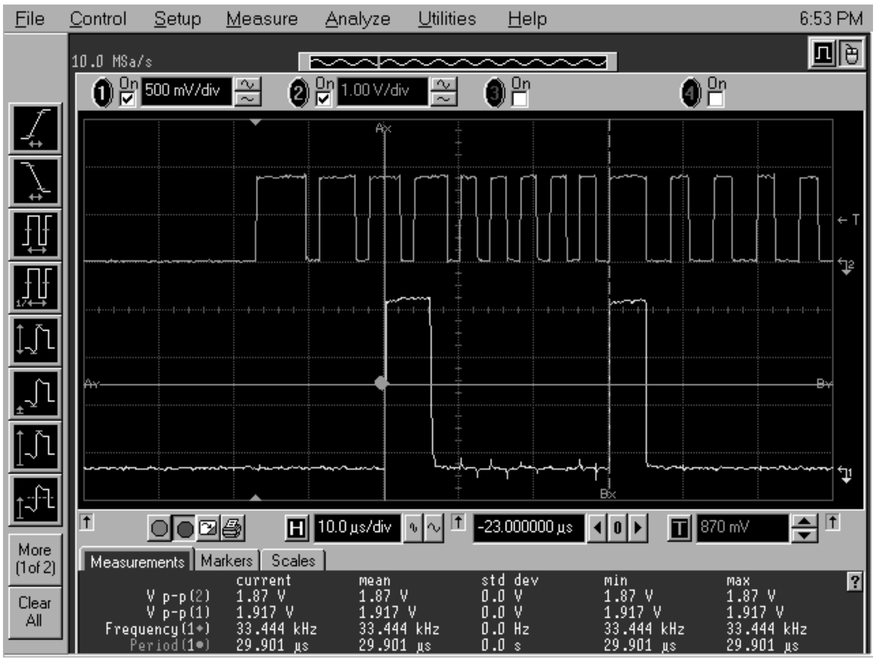



**Figure 6: Spi Data and Clock**

## RF Data and Clock

The GPS RF ASIC sends encoded raw GPS data to the GPS BB ASIC for further processing via a four-line synchronous parallel interface. These signals are data (labeled B0, B1, B2, and B3) and GPS_CLK. The GPS_CLK has been previously tested (see the flowchart). The four-data lines should show continuous activity almost immediately after power has been applied to the phone (see Figure 7).

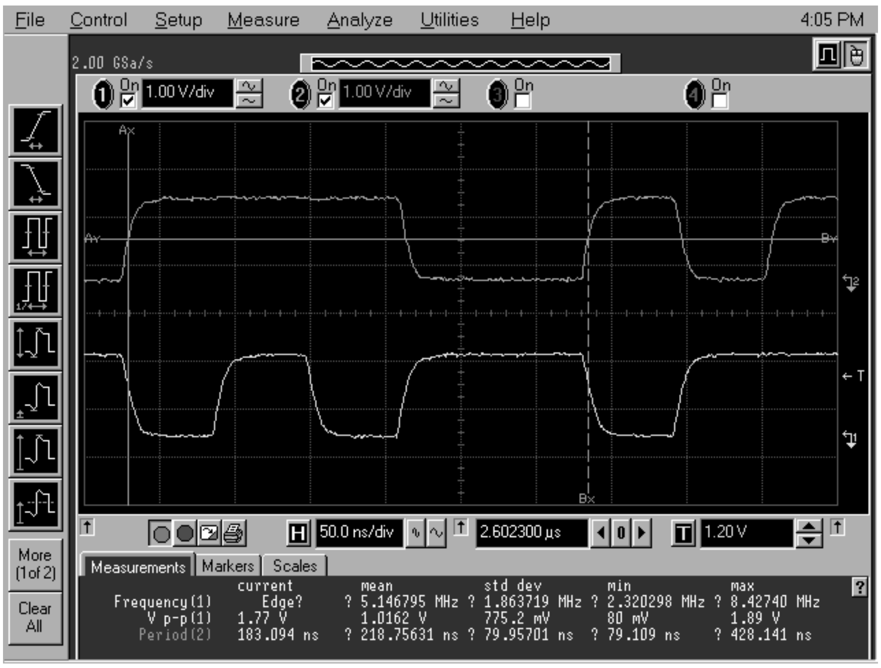



**Figure 7: RF Data and Clock**

## Troubleshooting the GPS RF

The purpose of this section is to define GPS test limits on the product line and to guide the GPS RF troubleshooting.

### Limitations

Measurements should be done using High-Frequency Probe with spectrum analyzer in order to measure local and reference frequencies and RF-power levels in intermediate stages of chain. Oscilloscope is used to measure DC-voltages and low frequency signals.

Digital multimeter is also useful measurement equipment in faultfinding. Also cellular tester is needed in order to perform tests mentioned in this section.

External RF connector is implemented for improving reliability of the measurements and should be used when reasonable.

GPS RF-section is mainly build around of TRF5101 PG2.1 IC (N001) ASIC. The GPS RF block has a separate front end filter, inter stage filter, LNA, TCXO, and down converter circuitry.

In this RF troubleshooting section, tolerances are specified for critical GPS RF signals and voltages.

Before changing a single ASIC or component, please check the following items:

1. The soldering and alignment marks of the GPS ASICs
2. Supply voltages and control signals are OK

*NOTE 1: The RF ASIC module is static discharge sensitive! It is recommended that EDS-protected clothes and shoes are worn and that grounded soldering irons are used.*

*NOTE 2:The shield lid must be always replaced with new one after it is opened. Check that there are no short circuits on PWB caused by plate ends.*

## GPS Receiver

### General Instructions

Receiver troubleshooting is divided into four sections:

1. GPS RF general checking
2. GPS reference clock checking
3. GPS RF and GPS BB interface checking
4. GPS RX chain checking

The fastest way to troubleshoot GPS RF is to follow the GPS RF Fault-finding chart Quick

Reference.

Please note that before changing ASICs or filters, soldering and missing components must be checked visually. There are no parameters in GPS RF, which should be tuned externally. Accurate signal levels are not shown in the flowcharts below because of the figures apply with specific measurement probes. It is useful to compare the results against reference phones.

## Test Equipment

1. Signal generator up to 2 GHz
2. Oscilloscope with 10:1 passive probe
3. High Frequency Probe for Spectrum Analyzer (Please note that the signal levels mentioned in the RX troubleshooting have been measured with an active probe.)
4. Spectrum analyzer up to 6.7 GHz
5. PC with Phoenix SW and GPS option

## Path of the Received Signal

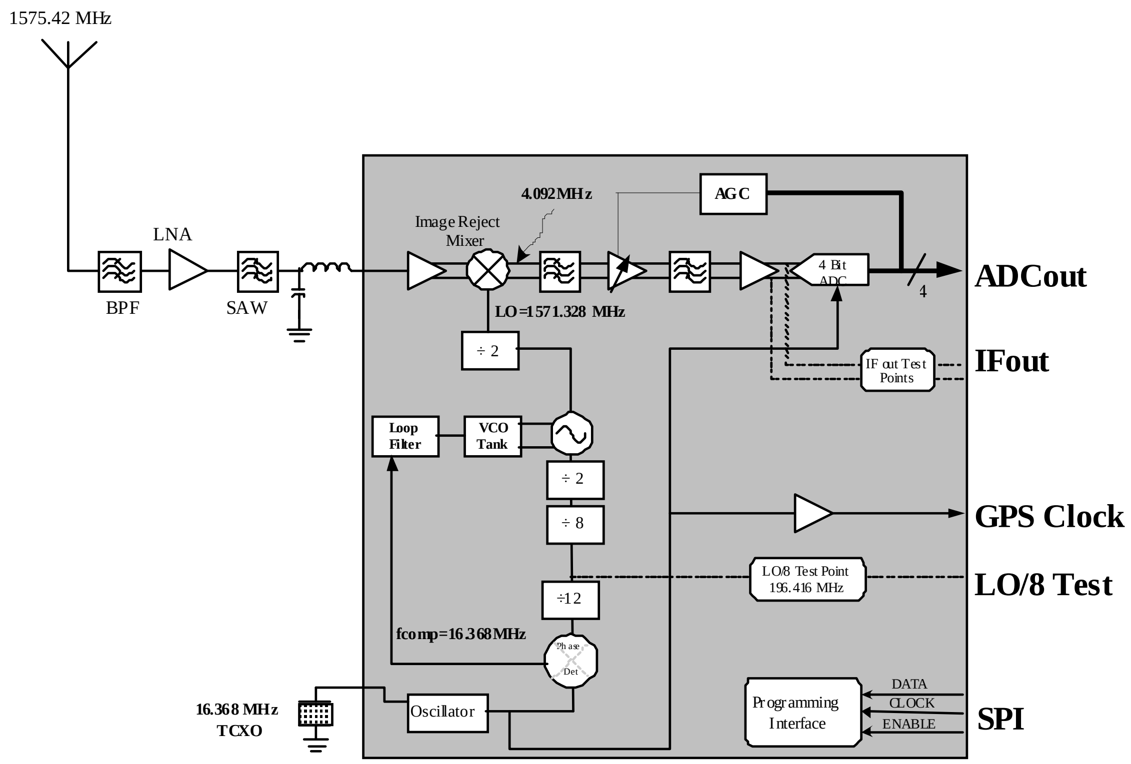



Figure 8: GPS RF Functional Diagram

## GPS RF Quick Fault-finding Chart

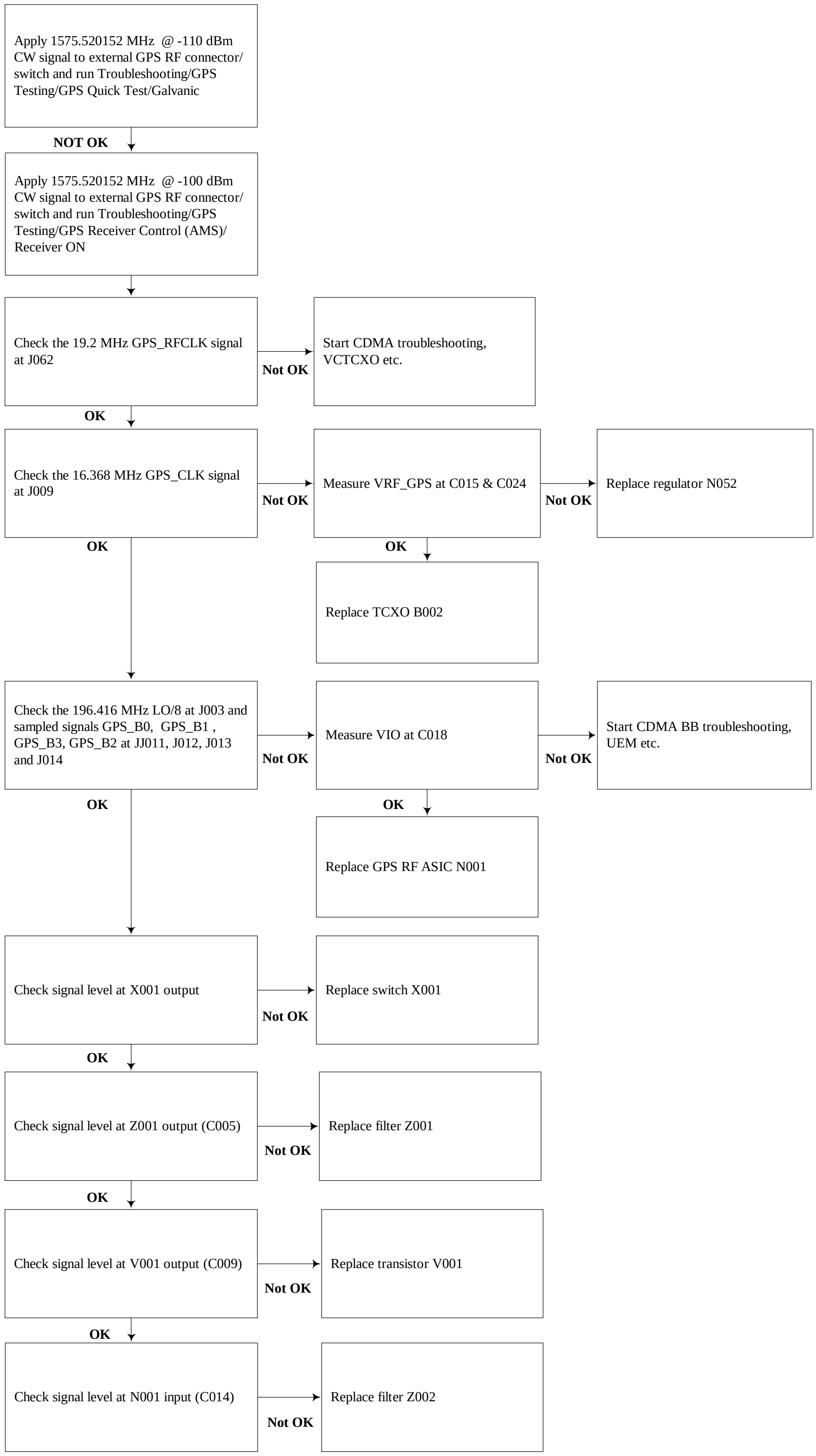



Figure 9: **GPS RF Fault-finding chart (Quick Reference)**

## GPS RF Circuitry and Component Placement

*Note: GPS RF Schematics are located in* Schematics *section of this Service Manual.*

**Table 1: GPS Engine Test Points Table**

| | |
|---|---|
| J001 | Test_IF_P |
| J002 | Test_IF_M |
| J003 | LO/8 |
| J006 | GPS_SPI_CLK |
| J007 | GPS_SPI_DATA |
| J008 | GPS_SPI_EN |
| J009 | XTAL 2 |
| J010 | GPS_CLK |
| J011 | GPS_B0 |
| J012 | GPS_B1 |
| J013 | GPS_B3 |
| J014 | GPS_B2 |
| J068 | GND |
| J052 | GPS_I2C_CLOCK |
| J051 | GPS_I2C_DATA |
| J065 | VDD_IO_GPS |
| J066 | GPS_U2TX |
| J067 | GPS_U2RX |
| J064 | GPS_PA_EN |
| J063 | GPS_SLEEPCLK |
| J060 | GPS_SLEEPX |
| J056 | GPS_U1_DATA_RDY-TIMESTAMP |
| J058 | GPS_U1_RX |
| J057 | GPS_U1_TX |
| J055 | GPS_INT_U1_CLK |
| J061 | GPS_EN_RESET |
| J062 | GPS_RFCLK (19.2 MHZ) |

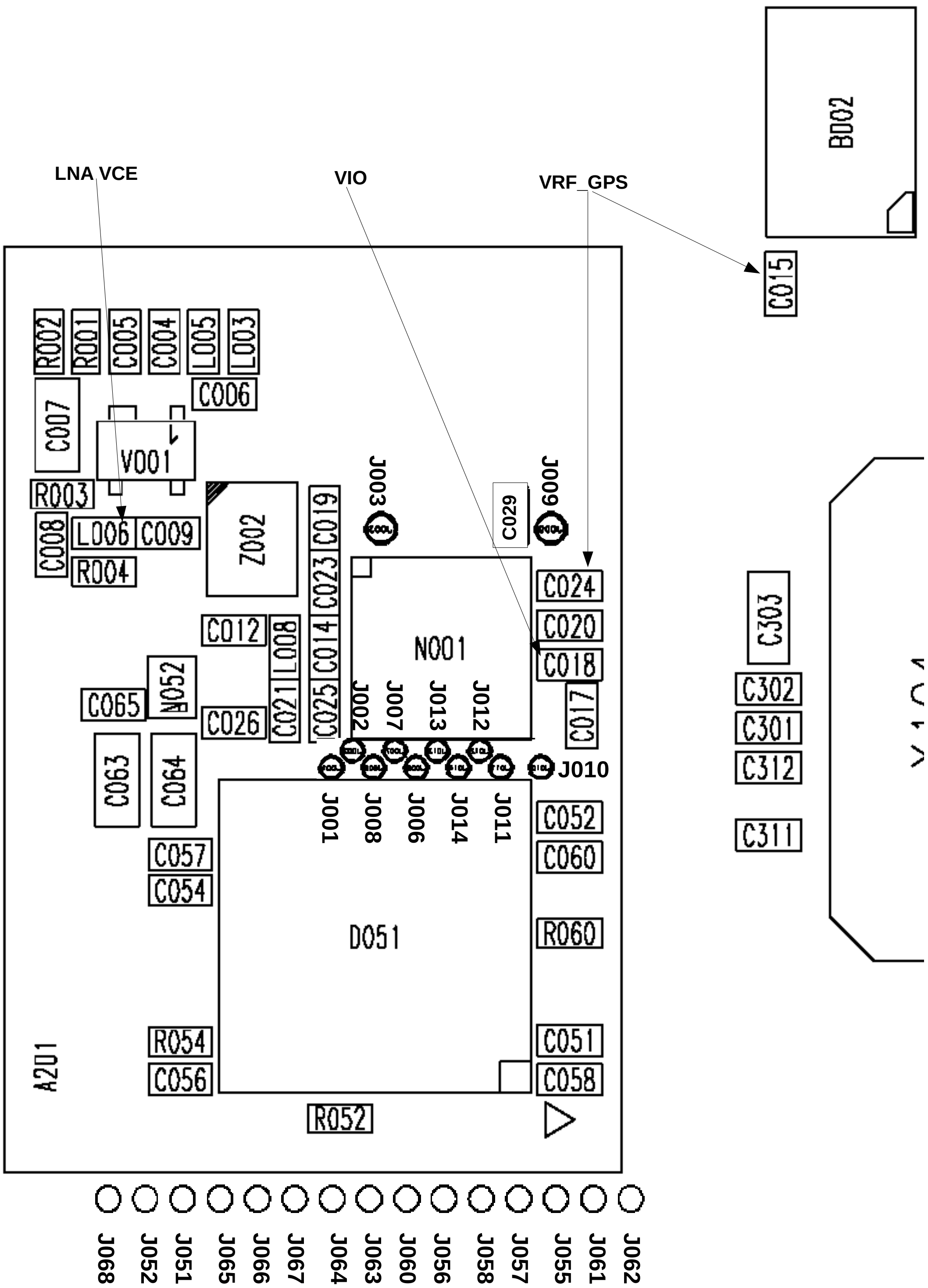



Figure 10: GPS Component Placement (PWB Bottom Side)

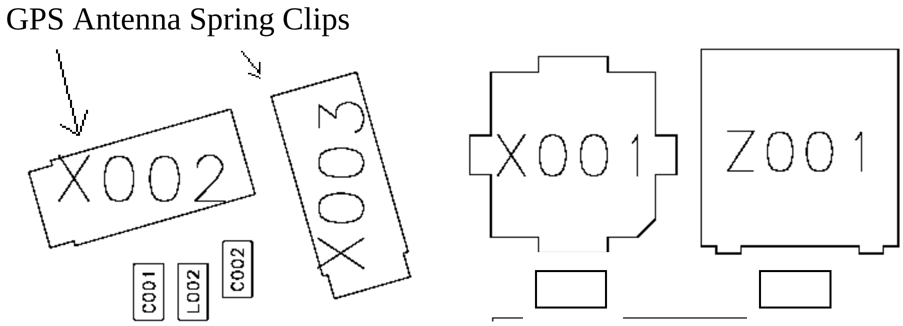



**Figure 11: GPS Component Placement (PWB top side)**

## GPS RF General Checking

The fastest way to get an overview of GPS RF status is to run GPS QUICK TEST. This can be done by using a CW signal generator and Phoenix. When running Galvanic testing, set signal generator frequency to 1575.520152 MHz and adjust level to -110 dBm at GPS antenna port. In radiated testing CW level has to be higher, because of the attenuation in pad + cable + coupler. With -20 dB pad signal level in signal generator is ~ -110 dBm + cable attenuation + 20 dB + 18 dB.

The CW analysis is functionality has been added to the GPS to allow end-to-end spectral purity to be assessed during manufacturing and development.

1 Power cycle transceiver under test

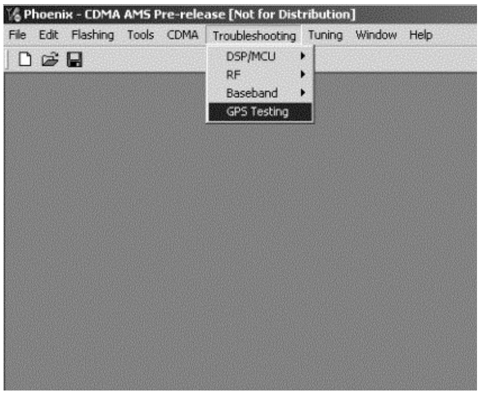
2 Connect CW signal as stated above via GPS RF connector

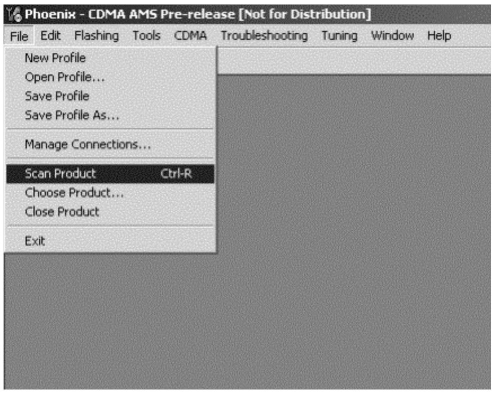
3 Connect DAU-9T cable to Tomahawk connector

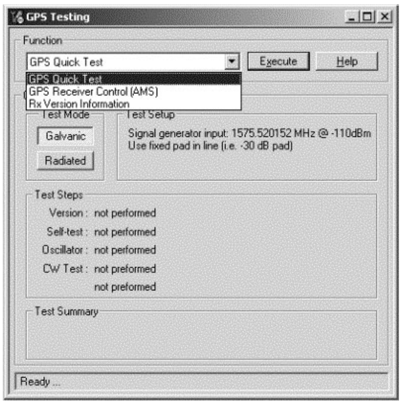
4 On Phoenix, choose connection as FBUS and select File/Scan Product

5 Select Troubleshooting/GPS Testing/GPS Quick Test/Test Mode Galvanic in Phoenix

6 Execute (see the following diagrams for reference)

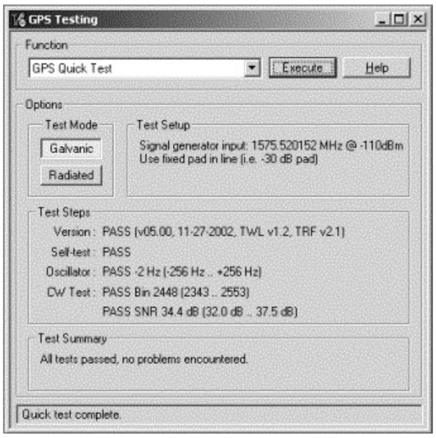


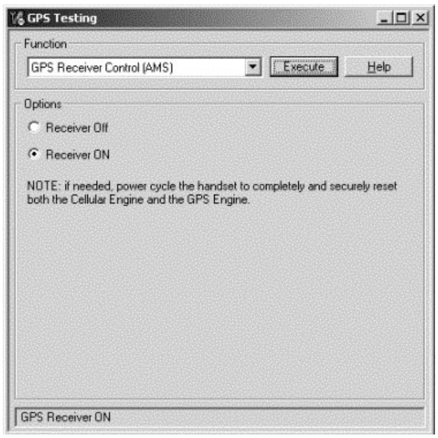

7 Check the version of the TWL5001 is v1.2 and TRF5101 is v2.1

8 Check SNR = 32 dB – 37.5 dB in Galvanic testing (or 31 – 38.5 dB in radiated testing) (or vary +/- 10 dB compared to galvanic SNR result)




9 Check Bin value is between 2448 +/- 105

10 If the test didn't pass, start to troubleshoot by selecting Troubleshooting/GPS Testing/GPS Receiver Control (AMS) / Receiver On in Phoenix




11 Execute

*Note: When turning the GPS "ON" for the first time via the Phoenix command, the CDMA engine will switch to "Local Mode". During this transition the GPS will perform an internal self-test and may turn the GPS "off" at the end of the self-test. If this is the case, execute the Receiver ON command again. Looking at the current consumption, you can easily monitor this state.*

12 Check operating voltages

DC voltages VRF_GPS at C024 and C015, LNA VCE at L006 and VIO at C018 should be as presented in the following picture:

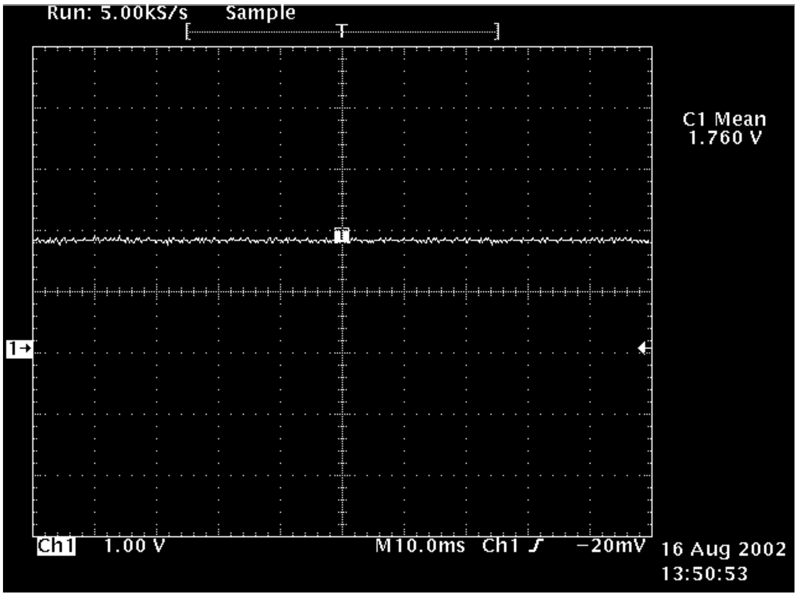



**Figure 12: DC level of LNA Collector Emitter Voltage Vce**

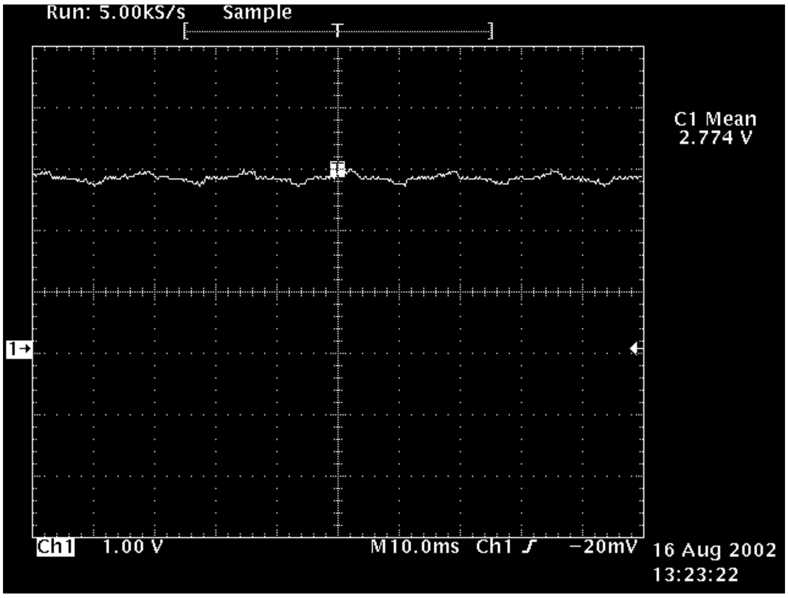



Figure 13: DC level of VRF_GPS and VLNA_GPS

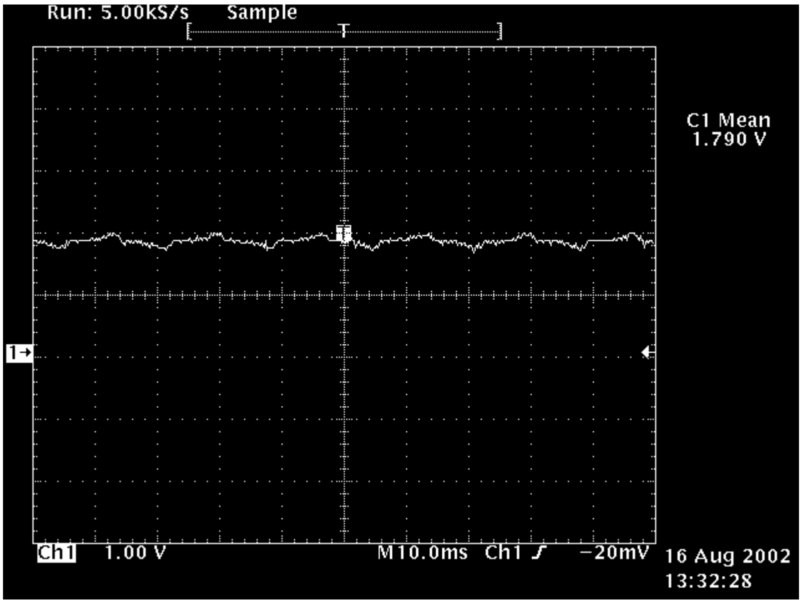



Figure 14: DC level of VIO

## GPS Reference Clock Checking

1 Cycle power

2 Choose connection as FBUS and select File/Scan Product

3 Select Troubleshoot/GPS Testing/GPS Receiver Control (AMS) / Receiver On in Phoenix

4 Execute

5 Connect oscilloscope 10:1 probe to test pad J062

6 CDMA 19.2 MHz system clock to GPS should look like the following picture:

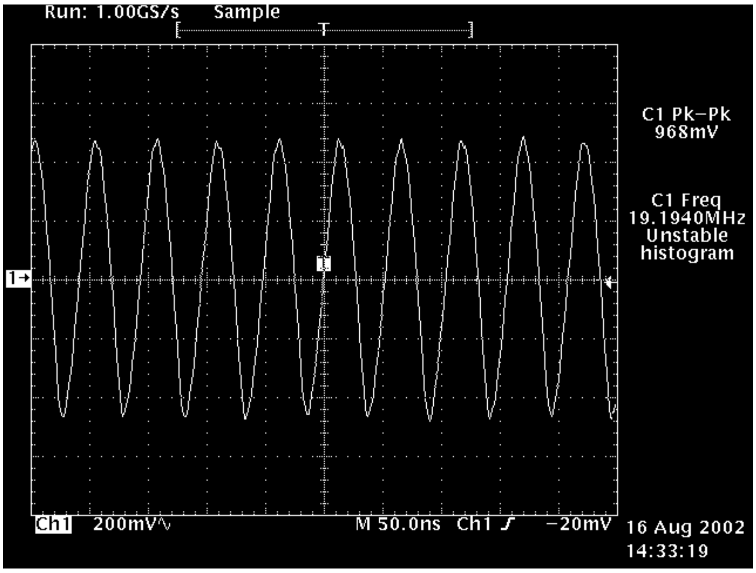



Figure 15: CDMA 19.2 MHz reference clock to GPS

7 Connect oscilloscope 10:1 probe to test pad J009

8 GPS 16.368 MHz system clock for GPS RF ASIC N001 should be within +/- 256 Hz limits if tested with MCU/GPS Control/GPS Quick Test. The 16.368 MHz signal looks like the following picture:

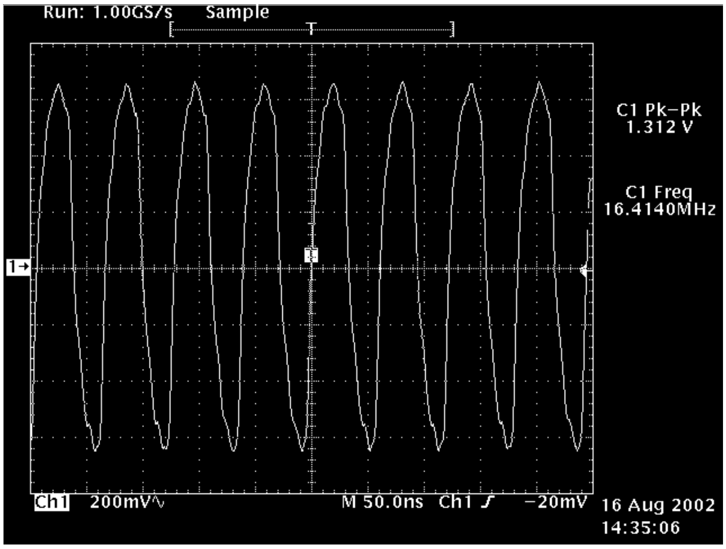



Figure 16: GPS 16.368 MHz reference clock from TCXO before C029

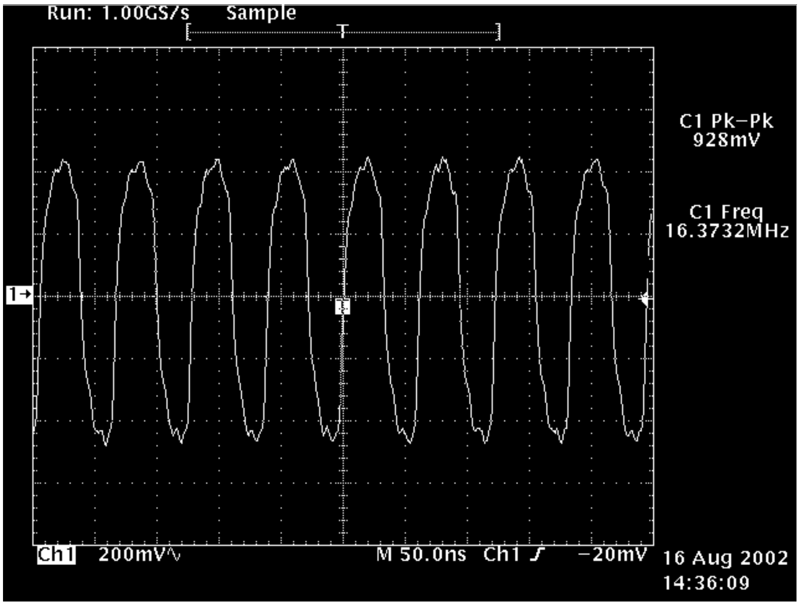



Figure 17: GPS 16.368 MHz reference clock from TCXO at J009

9 Connect spectrum analyzer probe on test pad J003

10 Check that LO is active by measuring LO/8 signal, which should be within 196.416 MHz +/- 2.946 kHz

## GPS RF and GPS BB Interface Checking

1 Next connect oscilloscope 10:1 probe into GPS_CLK output of the N001 between pin D7 and J010

2 GPS 16.368 MHz system clock to GPS BB should look like the following picture:

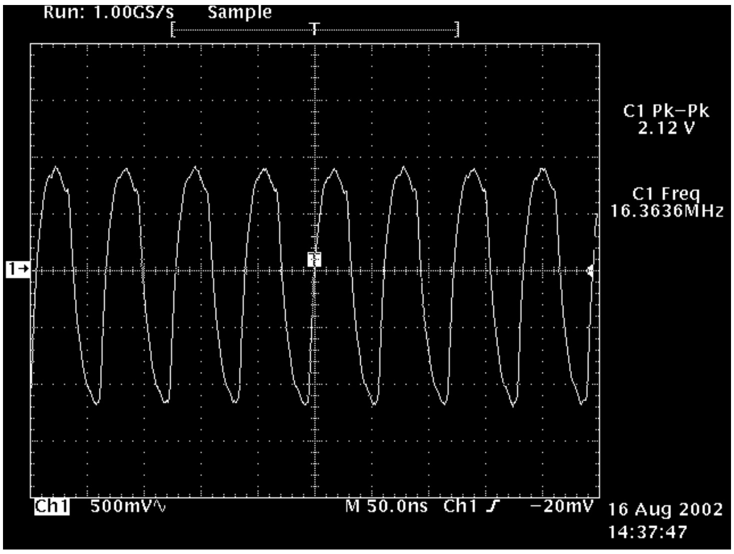



Figure 18: GPS 16.368 MHz reference clock to GPS BB

3 Next connect oscilloscope 10:1 probe into J011(GPS_B0), J012(GPS_B1), J013(GPS_B2) or J014(GPS_B3) outputs of the N001 (pins E7, F7, G7 and G6)

4 Sampled signal going to GPS BB should look like in the following picture:

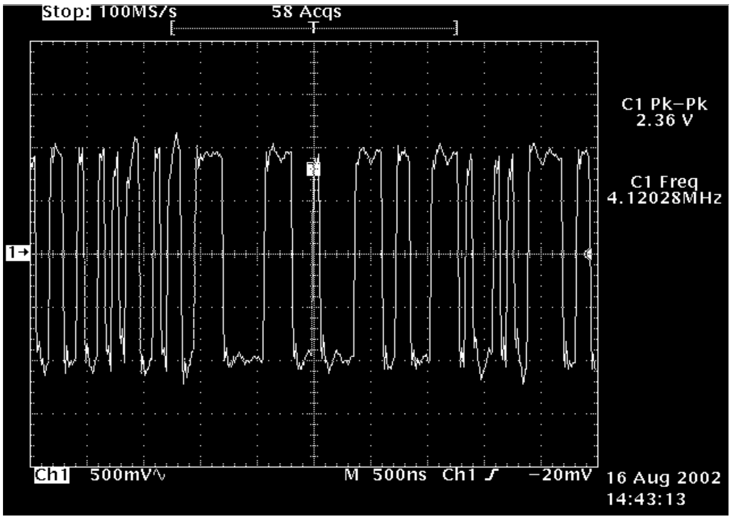



**Figure 19: Sampled signal going to GPS BB**

## GPS RX Chain Checking

1 Connect 1575.520152 MHz CW signal generator at the level of −100dBm to GSP antenna connector. *NOTE: Cable loss or attenuator loss has to be taken into account.*

2 Connect spectrum analyzer through active probe with attenuator into filter Z001 output

3 If connector/switch X001 and filter Z001 are OK, the signal level should be similar to the following picture:

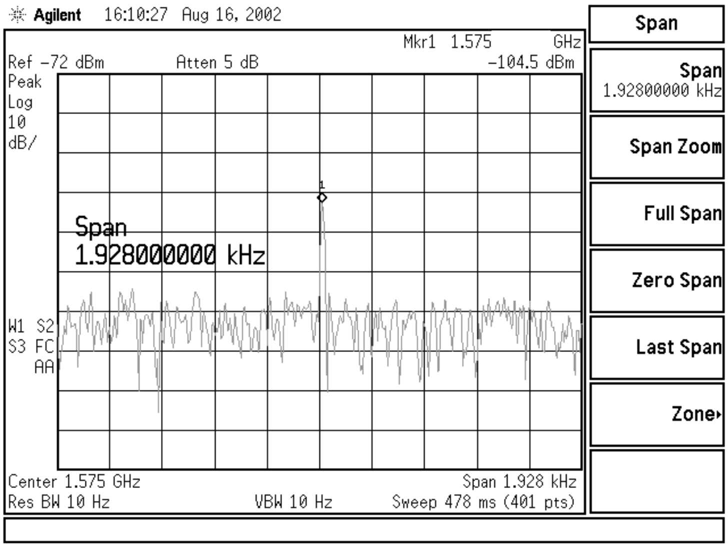



**Figure 20: Signal level at Z001 output**

4 Next connect spectrum analyzer through active probe with attenuator into filter Z002 input

5 If connector/switch X001, filter Z001 and LNA V001 are OK signal level should be similar to the following picture:

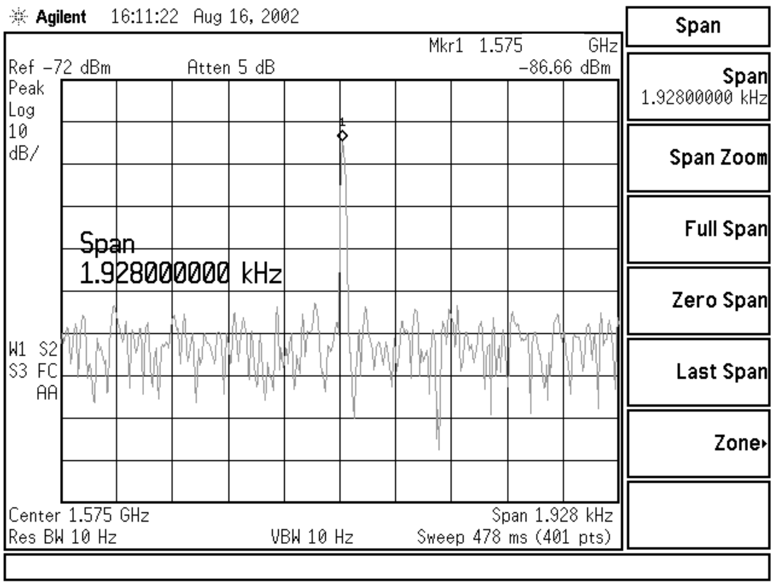



**Figure 21: Signal level at Z002 input**

6 Next connect spectrum analyzer through active probe with attenuator into filter Z002 Output

7 If connector/switch X001, filter Z001, LNA V001 and filter Z002 are OK , the signal level should be similar to the following picture:

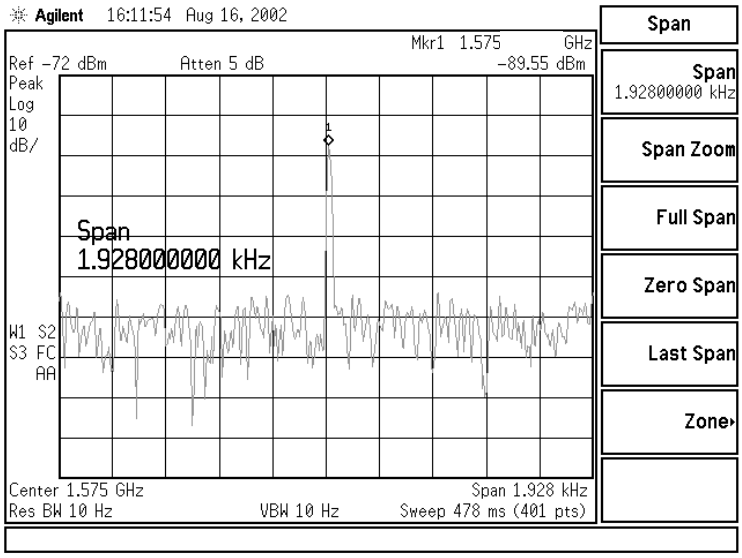



Figure 22: Signal level at Z002 output

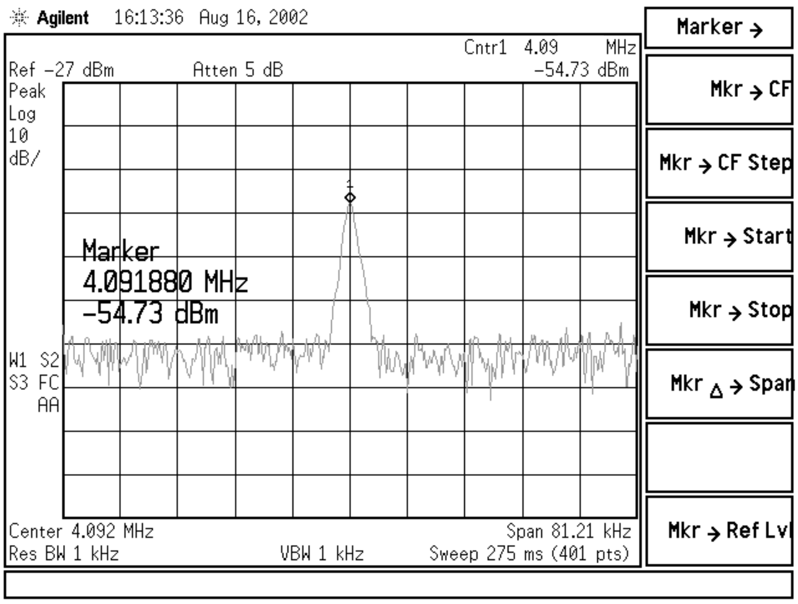



Figure 23: Signal level at IF output @-100dBm Input

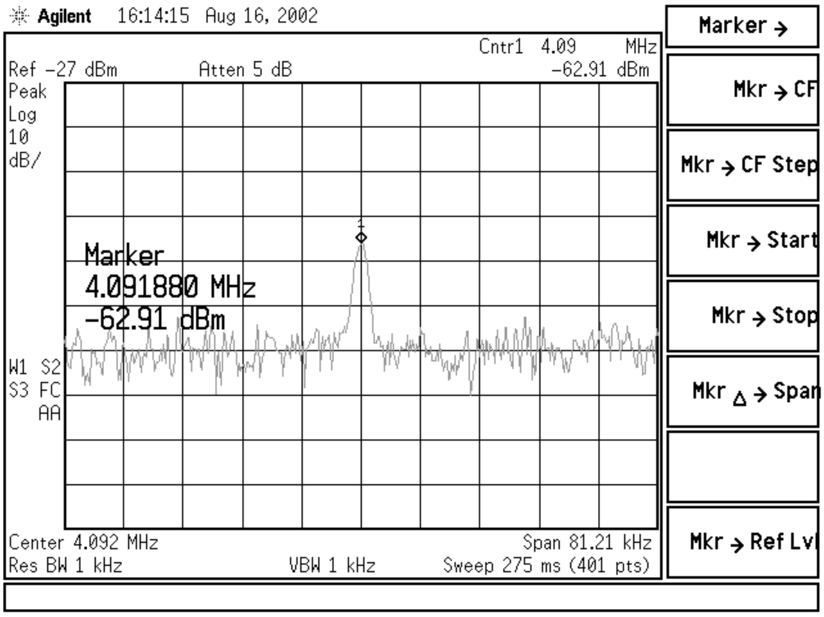



Figure 24: Signal level at IF output @-110dBm Input

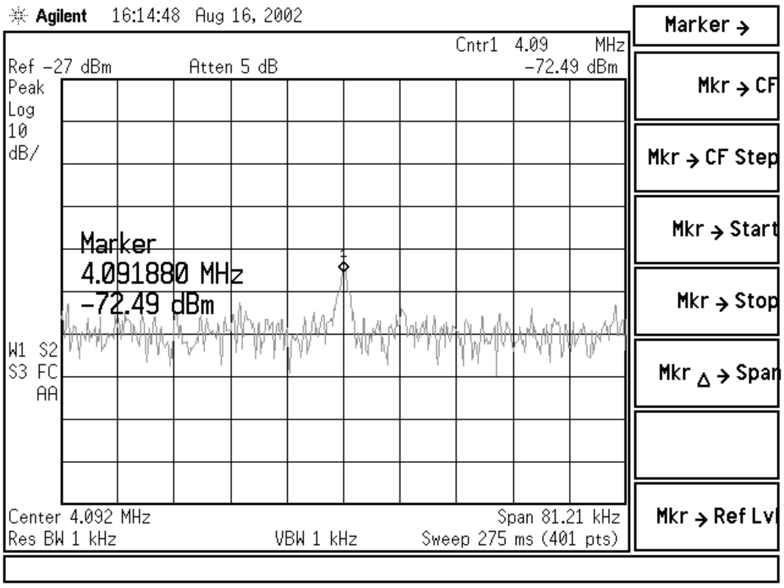



Figure 25: Signal level at IF output @-120dBm Input