**Qualification Report**

**OpenCellular - Connect1**

**Radio Frequency module with Software Defined Radio (RF-SDR)**

Revision: 1.1

[13-FEB-2017]

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# Purpose

The purpose of this document is to capture test data for Radio-Frequency module with Software-Defined-Radio (RF-SDR) as part of OpenCellular Base Transceiver Station (BTS). The document is intended to provide a formal report of measured and validated parameters to qualify RF-SDR module as part of design validation testing to ensure consistent and reliable operation across all supported operating and environmental conditions.

# Scope

Scope of this document is to qualify different sections as mentioned below:

1. **Power Source section** which includes Volatge regualators, FPGA PMIC
2. **Clock section** which includes VCTCXO, PLL
3. **FPGA and FX3 section**
4. **Transceiver** **Section** (AD9361)
5. **Transmitter and Receiver Sections**

# Device-Under-Test (DUT) Details

1. System : OpenCellular Connect -1
2. Sub-system : RF-SDR
3. Hardware version : Life – 1 & Life -2
4. Software version : The git versions as follows
   1. Openbsc :   5085e0b
   2. Osmo-trx :   2e5e2c5
   3. Uhd :    f70dd85
5. Sample Count : 01

# Qualification Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

# Qualification Result Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Sub-system** | **Function** | **Test cases/specification** | **Priority** | **Status** |
| **Test ID** |
| **Pwr1.1** | Power | 1. Conversion from 12V input from GBC board to 5.7, 3.7, 1.8, 1.2, 3.3,1 and 5.1V output using switching regulators. | Voltage Accuracy | P0 | Pass |
| **Pwr1.2** | Load regulation | P0 | Pass |
| **Pwr1.3** | Line regulation | P0 | Pass |
| **Pwr1.4** | Ripple Noise | P1 | Pass |
| **Pwr1.5** | Voltage Control | P0 | Pass |
| **Pwr1.6** | 2. Converting and regulating from switching regulators out to voltages required by various devices on RF\_SDR section using LDO’s. | Voltage Accuracy | P0 | Pass |
| **Pwr1.7** | Voltage Control | P0 | Pass |
| **Pwr1.8** | 3. Read current flow via current sensor circuit. | Current consumption | P0 | Pass |
| **Clk 1.1** | Clock | To synchronize with the GBC system clock and generate clock frequency required for transceiver IC | Clock output level |  | Pass |
| **Clk 1.2** | Frequency |  | Pass |
| **Clk 1.3** | Frequency accuracy |  | Pass |
| **Clk 1.4** | Phase noise |  | Fail |
| **Clk 1.5** | Lock time |  | Pass |
| **Clk 1.6** | To synchronize with the GBC system clock and generate clock frequency required for codec FPGA | Clock Duty Cycle | P1 | Pass |
|
| **Clk 1.7** | Jitter | P1 | Pass |
| **Clk 1.8** | Clock from AD9361 out to FPGA and other digital clocks | Clock Duty Cycle | P4 | Pass |
|
| **Clk 1.9** | Jitter | P4 | Pass |
| **FPGA 1.1.1** | FPGA | Artix-7 | Boot configuration | P0 | Pass |
| **FPGA 1.1.2** | Power sequence | P0 | Pass |
| **FPGA 1.2.1** | FX3 - SPI | Electrical validation | P0 | Pass |
| **FPGA 1.2.2** | Functional validation | P1 | Pass |
| **FPGA 1.3.1** | AD9361 - SPI | Electrical validation | P0 | Fail |
| **FPGA 1.3.2** | Functional validation | P1 | Pass |
| **FPGA 1.4.1** | FX3 - GPIF:Control | Electrical validation | P0 | Pass |
| **FPGA 1.4.2** | Functional validation | P1 | Pass |
| **FPGA 1.5.1** | FX3 - GPIF:Data | Electrical validation | P0 | Pass |
| **FPGA 1.5.2** | Functional validation | P1 | Pass |
| **FPGA 1.6.1** | AD9361 - Control | Electrical validation | P0 | Pass |
| **FPGA 1.6.2** | Functional validation | P1 | Pass |
| **FPGA 1.7.1** | AD9361 - Data | Electrical validation | P0 | Fail |
| **FPGA 1.7.2** | Functional validation | P1 | Pass |
| **FX3 1.1** | FX3 | FX3 | Configuration | P0 | Pass |
| **FX3 1.2.1** | EEPROM-I2C | Electrical validation | P0 | Pass |
| **FX3 1.2.2** | Functional validation | P0 | Pass |
| **FX3 1.3.1** | Debug USB Switch - USB2.0 | Functional validation | P0 | Pass |
| **FX3 1.4.1** | Debug USB Switch - USB 3.0 | Functional validation | P0 | Pass |
| **TRX 1.1** | RF/Transceiver (AD9361) - Pipe1 | AD9361(Transceiver IC)is used to convert base band data to RF on transmit side and RF to base band on receive side. | Maximum Output Power |  | Pass |
| **TRX 1.2** | Transmit power control-ATTENUATION RANGE |  | Pass |
| **TRX 1.3** | Modulation Accuracy | P2 | Pass |
| **TRX 1.4** | Carrier Leakage | P2 | Pass |
| **TRX 1.5** | LO Lock Detect |  | Pass |
| **TRX 1.6** | Output RF spectrum i). Adjacent channel power ii). Spectrum due to switching | P2 | Fail |
| **TRX 1.7** | Receiver sensitivity | P1 | Open |
| **TRX 1.8** | Maximum Input signal | P1 | Open |
| **TRX 2.1** | RF/Transceiver (AD9361) - Pipe2 | Maximum Output Power |  | Pass |
| **TRX 2.2** | Transmit power control-ATTENUATION RANGE |  | Pass |
| **TRX 2.3** | Modulation Accuracy | P2 | Pass |
| **TRX 2.4** | Carrier Leakage | P2 | Pass |
| **TRX 2.5** | LO Lock Detect |  | Pass |
| **TRX 2.6** | Output RF spectrum i). Adjacent channel power ii). Spectrum due to switching | P2 | Fail |
| **TRX 2.7** | Receiver sensitivity | P1 | Open |
| **TRX 2.8** | Maximum Input signal | P1 | Open |
| **TX\_P 1.1** | TX pipe - 1 | TX pipe is used to amplify and control TX signal | Gain |  | Pass |
| **TX\_P 1.2** | Attenuation (part of TIVA I2C testing) |  | Pass |
| **TX\_P 1.3** | Attenuation step (part of TIVA I2C testing) |  | Pass |
| **TX\_P 1.4** | Output Power |  | Pass |
| **TX\_P 1.5** | RF power detection | P0 | Pass |
| **TX\_P 2.1** | TX pipe - 2 | Gain |  | Pass |
| **TX\_P 2.2** | Attenuation (part of TIVA I2C testing) |  | Pass |
| **TX\_P 2.3** | Attenuation step (part of TIVA I2C testing) |  | Pass |
| **TX\_P 2.4** | Output Power |  | Pass |
| **TX\_P 2.5** | RF power detection | P0 | Pass |
| **RX\_P 1.1** | RX pipe - 1 | RX pipe is used to amplify and control RX signal | Noise Figure | P0 | Fail |
| **RX\_P 1.2** | Gain |  | Fail |
| **RX\_P 1.3** | Attenuation (part of TIVA I2C testing) |  | Pass |
| **RX\_P 1.4** | Attenuation step (part of TIVA I2C testing) |  | Pass |
| **RX\_P 2.1** | RX pipe -2 | Noise Figure | P0 | Fail |
| **RX\_P 2.2** | Gain |  | Fail |
| **RX\_P 2.3** | Attenuation (part of TIVA I2C testing) |  | Pass |
| **RX\_P 2.4** | Attenuation step (part of TIVA I2C testing) |  | Pass |
|  | Transmitter \_Chain 1 | To transmit and receive GSM signals with baseband data from Linux PC. | TX Subsystem along with AD9361 with GBC |  |  |
| **TX\_C 1.2** | i) Output Power and Tolerance ii) RF carrier power versus time | P0 | Pass |
| **TX\_C 1.3** | Static Power Control | P0 | Pass |
| **TX\_C 1.4** | Modulation accuracy | P2 | Pass |
| **TX\_C 1.5** | Output RF spectrum i). Adjacent channel power ii). Spectrum due to switching | P2 | Fail |
| **TX\_C 1.6** | Spurious Emissions i). Tx and Rx band spurious ii). Cross-band spurious iii). Out-of-band spurious | P0 | Fail |
|  | Transmitter \_Chain 2 | TX Subsystem along with AD9361 with GBC |  |  |
| **TX\_C 2.2** | i) Output Power and Tolerance ii) RF carrier power versus time | P0 | Pass |
| **TX\_C 2.3** | Static Power Control | P0 | Pass |
| **TX\_C 2.4** | Modulation accuracy | P2 | Pass |
| **TX\_C 2.5** | Output RF spectrum i). Adjacent channel power ii). Spectrum due to switching | P2 | Fail |
| **TX\_C 2.6** | Spurious Emissions i). Tx and Rx band spurious ii). Cross-band spurious iii). Out-of-band spurious | P0 | Fail |
| **RX\_C 1.1** | Receiver Chain 1 | Reference Sensitivity Level | P1 | Open |
| **RX\_C 2.1** | Receiver Chain 2 | Reference Sensitivity Level | P1 | Open |

# Tools and Test Equipment

|  |  |  |
| --- | --- | --- |
| Test (Sub-System) | Tools and Test Equipment | Model and Version Information |
| Power | DC Power Supply | RIGOL DP832 |
| Electronic Load | KMO64 |
| Oscilloscope | MSO9404A |
| Clock | DC Power Supply | RIGOL DP832 |
| PXIe chassis | M9381A |
| RF Cables | SMA Male to SMA Male |
| Pig tail SMA Cables | One end SMA Female connector and another end open cable |
| Linux PC | TBD |
| Oscilloscope | MSO9404A |
| FPGA | DC Power Supply | RIGOL DP832 |
| Oscilloscope | MSO9404A |
| Linux PC | TBD |
| FX3 | DC Power Supply | RIGOL DP832 |
| Oscilloscope | MSO9404A |
| Linux PC | TBD |
| RF/Transceiver      (AD9361) – Pipe1 | DC Power Supply | RIGOL DP832 |
| PXIe chassis | M9381A |
| RF Cables | SMA Male to SMA Male |
| Pig tail SMA Cables | One end SMA Female connector and another end open cable |
| Linux PC | TBD |
| Oscilloscope | MSO9404A |
| RF/Transceiver      (AD9361) – Pipe2 | DC Power Supply | RIGOL DP832 |
| PXIe chassis | M9381A |
| RF Cables | SMA Male to SMA Male |
| Pig tail SMA Cables | One end SMA Female connector and another end open cable |
| Oscilloscope | MSO9404A |
| Linux PC | TBD |
| TX pipe – 1 | DC Power Supply | RIGOL DP832 |
| PXIe chassis | M9381A |
| RF Cables | SMA Male to SMA Male |
| Pig tail SMA Cables | One end SMA Female connector and another end open cable |
| TX pipe – 2 | DC Power Supply | RIGOL DP832 |
| PXIe chassis | M9381A |
| RF Cables | SMA Male to SMA Male |
| Pig tail SMA Cables | One end SMA Female connector and another end open cable |
| RX pipe – 1 | Noise Source | HP – 346B |
| Signal Analyzer | Keysight N9020A |
| RF Cables | SMA(F) to Switch type cable |
|  | BNC to BNC cable |
| RX pipe -2 | Noise Source | HP – 346B |
| Signal Analyzer | Keysight N9020A |
| RF Cables | SMA(F) to Switch type cable |
|  | BNC to BNC cable |
| Transmitter \_Chain 1 | DC Power Supply | RIGOL DP832 |
| PXIe chassis | M9381A |
| RF Cables | SMA Male to SMA Male |
| Attenuator | 30dB |
| Transmitter \_Chain 2 | DC Power Supply | RIGOL DP832 |
| PXIe chassis | M9381A |
| RF Cables | SMA Male to SMA Male |
| Attenuator | 30dB |
| Receiver Chain 1 |  |  |
| Receiver Chain 2 |  |  |

# Power

# Voltage accuracy

# Test ID

Pwr1.1

# Purpose

The purpose of the test case is to measure the output voltage of switching regulators and to ensure that these voltages are in specified limits.

# Test and Measurement Method

Refer to section 3.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Full

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

# Test Results

The measured output voltage accuracy of switching regulators are within 2% of expected voltage

**U3500 (12V to 5.7V):**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Voltage Accuracy for U3500** | | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply  Voltage (V)** | **Load  Current (A)** | **Output  Current (A)** | **Output  Voltage (V)** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.1 | 11.4 | 4 | 2.184 | 5.795 | 5.586 | 5.814 | -0.326797386 | PASS |
| 2 | Pwr1.1 | 12 | 4 | 2.072 | 5.796 | 5.586 | 5.814 | -0.309597523 | PASS |
| 3 | Pwr1.1 | 12.6 | 4 | 1.969 | 5.792 | 5.586 | 5.814 | -0.378396973 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Voltage Accuracy for U3501** | | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply  Voltage (V)** | **Load  Current (A)** | **Output  Current (A)** | **Output  Voltage (V)** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.1 | 11.4 | 4 | 2.153 | 5.713 | 5.586 | 5.814 | -1.737186103 | PASS |
| 2 | Pwr1.1 | 12 | 4 | 2.043 | 5.717 | 5.586 | 5.814 | -1.668386653 | PASS |
| 3 | Pwr1.1 | 12.6 | 4 | 1.942 | 5.714 | 5.586 | 5.814 | -1.71998624 | PASS |

**U3501 (12V to 5.7V):**

**U4000 (12V to 3.7V):**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Voltage Accuracy for U4000** | | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply  Voltage (V)** | **Load  Current (A)** | **Output  Current (A)** | **Output  Voltage (V)** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.1 | 11.4 | 4 | 1.402 | 3.741 | 3.626 | 3.774 | -0.874403816 | PASS |
| 2 | Pwr1.1 | 12 | 4 | 1.338 | 3.741 | 3.626 | 3.774 | -0.874403816 | PASS |
| 3 | Pwr1.1 | 12.6 | 4 | 1.274 | 3.739 | 3.626 | 3.774 | -0.927397986 | PASS |

**U3400 (3.7V to 1.8V):**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Voltage Accuracy for U3400** | | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply  Voltage (V)** | **Load  Current (A)** | **Output  Current (A)** | **Output  Voltage (V)** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.1 | 3.6 | 500 | 0.261 | 1.81 | 1.773 | 1.827 | -0.930487137 | PASS |
| 2 | Pwr1.1 | 3.7 | 500 | 0.25 | 1.815 | 1.773 | 1.827 | -0.65681445 | PASS |
| 3 | Pwr1.1 | 3.8 | 500 | 0.248 | 1.817 | 1.773 | 1.827 | -0.547345375 | PASS |

NOTE: Refer to section 8.4.7 for measurement logs of switching regulators for voltage accuracy.

# Load Regulation

# Test ID

Pwr1.2

# Purpose

The purpose of this test case is to check the capability of switching regulators to maintain a constant output voltage over changes in the load.

# Test and Measurement Method

Refer to section 3.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage -12V DC

System/Test Load: Min-Typical-Max

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

# Test Results

The output voltage accuracy of regulators are within 2% of expected voltage under various load conditions.

**U3500 (12V to 5.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load Regulation ( Input Voltage – 12V) for U3500** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Load  Current (A)** | **Output  Current (A)** | **Output  Voltage (V) (avg)** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.2 | 1 | 0.494 | 5.788 | 5.586 | 5.814 | -0.447196422 | PASS |
| 2 | Pwr1.2 | 2 | 0.998 | 5.791 | 5.586 | 5.814 | -0.395596835 | PASS |
| 3 | Pwr1.2 | 3 | 1.524 | 5.794 | 5.586 | 5.814 | -0.343997248 | PASS |
| 4 | Pwr1.2 | 4 | 2.072 | 5.796 | 5.586 | 5.814 | -0.309597523 | PASS |

**U3501 (12V to 5.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load Regulation ( Input Voltage – 12V) for U3501** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Load  Current (A)** | **Output  Current (A)** | **Output  Voltage (V) (avg)** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.2 | 1 | 0.486 | 5.76 | 5.586 | 5.814 | -0.92879257 | PASS |
| 2 | Pwr1.2 | 2 | 0.983 | 5.758 | 5.586 | 5.814 | -0.963192294 | PASS |
| 3 | Pwr1.2 | 3 | 1.501 | 5.743 | 5.586 | 5.814 | -1.22119023 | PASS |
| 4 | Pwr1.2 | 4 | 2.043 | 5.717 | 5.586 | 5.814 | -1.668386653 | PASS |

**U4000 (12V to 3.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load Regulation ( Input Voltage – 12V) for U4000** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Load  Current (A)** | **Output  Current (A)** | **Output  Voltage (V) (avg)** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.2 | 1 | 0.325 | 3.737 | 3.626 | 3.774 | -0.980392157 | PASS |
| 2 | Pwr1.2 | 2 | 0.646 | 3.741 | 3.626 | 3.774 | -0.874403816 | PASS |
| 3 | Pwr1.2 | 3 | 0.983 | 3.739 | 3.626 | 3.774 | -0.927397986 | PASS |
| 4 | Pwr1.2 | 4 | 1.338 | 3.741 | 3.626 | 3.774 | -0.874403816 | PASS |

**U3400 (3.7V to 1.8V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load Regulation ( Input Voltage – 3.7V) for U3400** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Load  Current (A)** | **Output  Current (A)** | **Output  Voltage (V) (avg)** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.2 | 300 | 0.15 | 1.82 | 1.773 | 1.827 | -0.383141762 | PASS |
| 2 | Pwr1.2 | 400 | 0.202 | 1.816 | 1.773 | 1.827 | -0.602079912 | PASS |
| 3 | Pwr1.2 | 500 | 0.25 | 1.815 | 1.773 | 1.827 | -0.65681445 | PASS |

NOTE: Refer to section 8.4.7 for measurement logs of switching regulators for Load regulation.

# Line Regulation

# Test ID

Pwr1.3

# Purpose

The purpose of this test case is to check the ability of the switching regulators to maintain its specified output voltage over changes in the input line voltage.

# Test and Measurement Method

Refer to section 3.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +11.4V DC to 12.6V DC

System/Test Load: Min-Typical-Max

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

# Test Results

The output voltage accuracy of switching regulators are within 2% of expected voltage under various supply input and load conditions.

**U3500 (12V to 5.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Line regulation without electronic load for U3500** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply** | **Output** | **Output** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Voltage (V)** | **Current (A)** | **Voltage (V)** | **Min** | **Max** |
| 1 | Pwr1.3 | 11.4 | 0.01 | 5.79 | 5.586 | 5.814 | -0.4128 | PASS |
| 2 | Pwr1.3 | 12 | 0.01 | 5.789 | 5.586 | 5.814 | -0.43 | PASS |
| 3 | Pwr1.3 | 12.6 | 0.01 | 5.793 | 5.586 | 5.814 | -0.3612 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Line regulation with electronic load for U3500** | | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply** | **Load** | **Output** | **Output** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Voltage (V)** | **Current (A)** | **Current (A)** | **Voltage (V)** | **Min** | **Max** |
| 1 | Pwr1.3 | 11.4 | 1 | 0.519 | 5.791 | 5.586 | 5.814 | -0.3956 | PASS |
| 2 | Pwr1.3 | 11.4 | 2 | 1.047 | 5.79 | 5.586 | 5.814 | -0.4128 | PASS |
| 3 | Pwr1.3 | 11.4 | 3 | 1.6 | 5.795 | 5.586 | 5.814 | -0.3268 | PASS |
| 4 | Pwr1.3 | 11.4 | 4 | 2.184 | 5.795 | 5.586 | 5.814 | -0.3268 | PASS |
| 5 | Pwr1.3 | 12 | 1 | 0.494 | 5.788 | 5.586 | 5.814 | -0.4472 | PASS |
| 6 | Pwr1.3 | 12 | 2 | 0.998 | 5.791 | 5.586 | 5.814 | -0.3956 | PASS |
| 7 | Pwr1.3 | 12 | 3 | 1.524 | 5.794 | 5.586 | 5.814 | -0.344 | PASS |
| 8 | Pwr1.3 | 12 | 4 | 2.072 | 5.796 | 5.586 | 5.814 | -0.3096 | PASS |
| 9 | Pwr1.3 | 12.6 | 1 | 0.473 | 5.791 | 5.586 | 5.814 | -0.3956 | PASS |
| 10 | Pwr1.3 | 12.6 | 2 | 0.949 | 5.786 | 5.586 | 5.814 | -0.4816 | PASS |
| 11 | Pwr1.3 | 12.6 | 3 | 1.45 | 5.798 | 5.586 | 5.814 | -0.2752 | PASS |
| 12 | Pwr1.3 | 12.6 | 4 | 1.969 | 5.792 | 5.586 | 5.814 | -0.3784 | PASS |

**U3501 (12V to 5.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Line regulation without electronic load for U3501** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply** | **Output** | **Output** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Voltage (V)** | **Current (A)** | **Voltage (V)** | **Min** | **Max** |
| 1 | Pwr1.3 | 11.4 | 0.009 | 5.781 | 5.586 | 5.814 | -0.5676 | PASS |
| 2 | Pwr1.3 | 12 | 0.009 | 5.764 | 5.586 | 5.814 | -0.85999 | PASS |
| 3 | Pwr1.3 | 12.6 | 0.009 | 5.779 | 5.586 | 5.814 | -0.602 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Line regulation with electronic load for U3501** | | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply** | **Load** | **Output** | **Output** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Voltage (V)** | **Current (A)** | **Current (A)** | **Voltage (V)** | **Min** | **Max** |
| 1 | Pwr1.3 | 11.4 | 1 | 0.512 | 5.76 | 5.586 | 5.814 | -0.92879 | PASS |
| 2 | Pwr1.3 | 11.4 | 2 | 1.038 | 5.756 | 5.586 | 5.814 | -0.99759 | PASS |
| 3 | Pwr1.3 | 11.4 | 3 | 1.585 | 5.738 | 5.586 | 5.814 | -1.30719 | PASS |
| 4 | Pwr1.3 | 11.4 | 4 | 2.153 | 5.713 | 5.586 | 5.814 | -1.73719 | PASS |
| 5 | Pwr1.3 | 12 | 1 | 0.486 | 5.76 | 5.586 | 5.814 | -0.92879 | PASS |
| 6 | Pwr1.3 | 12 | 2 | 0.983 | 5.758 | 5.586 | 5.814 | -0.96319 | PASS |
| 7 | Pwr1.3 | 12 | 3 | 1.501 | 5.743 | 5.586 | 5.814 | -1.22119 | PASS |
| 8 | Pwr1.3 | 12 | 4 | 2.043 | 5.717 | 5.586 | 5.814 | -1.66839 | PASS |
| 9 | Pwr1.3 | 12.6 | 1 | 0.465 | 5.759 | 5.586 | 5.814 | -0.94599 | PASS |
| 10 | Pwr1.3 | 12.6 | 2 | 0.935 | 5.756 | 5.586 | 5.814 | -0.99759 | PASS |
| 11 | Pwr1.3 | 12.6 | 3 | 1.43 | 5.735 | 5.586 | 5.814 | -1.35879 | PASS |
| 12 | Pwr1.3 | 12.6 | 4 | 1.942 | 5.714 | 5.586 | 5.814 | -1.71999 | PASS |

**U4000 (12V to 3.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Line regulation without electronic load for U4000** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply** | **Output** | **Output** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Voltage (V)** | **Current (A)** | **Voltage (V)** | **Min** | **Max** |
| 1 | Pwr1.3 | 11.4 | 0.008 | 3.734 | 3.626 | 3.774 | -1.05988 | PASS |
| 2 | Pwr1.3 | 12 | 0.008 | 3.739 | 3.626 | 3.774 | -0.9274 | PASS |
| 3 | Pwr1.3 | 12.6 | 0.008 | 3.742 | 3.626 | 3.774 | -0.84791 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Line regulation with electronic load for U4000** | | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply** | **Load** | **Output** | **Output** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Voltage (V)** | **Current (A)** | **Current (A)** | **Voltage (V)** | **Min** | **Max** |
| 1 | Pwr1.3 | 11.4 | 1 | 0.339 | 3.737 | 3.626 | 3.774 | -0.98039 | PASS |
| 2 | Pwr1.3 | 11.4 | 2 | 0.681 | 3.739 | 3.626 | 3.774 | -0.9274 | PASS |
| 3 | Pwr1.3 | 11.4 | 3 | 1.035 | 3.738 | 3.626 | 3.774 | -0.9539 | PASS |
| 4 | Pwr1.3 | 11.4 | 4 | 1.402 | 3.741 | 3.626 | 3.774 | -0.8744 | PASS |
| 5 | Pwr1.3 | 12 | 1 | 0.325 | 3.737 | 3.626 | 3.774 | -0.98039 | PASS |
| 6 | Pwr1.3 | 12 | 2 | 0.646 | 3.741 | 3.626 | 3.774 | -0.8744 | PASS |
| 7 | Pwr1.3 | 12 | 3 | 0.983 | 3.739 | 3.626 | 3.774 | -0.9274 | PASS |
| 8 | Pwr1.3 | 12 | 4 | 1.338 | 3.741 | 3.626 | 3.774 | -0.8744 | PASS |
| 9 | Pwr1.3 | 12.6 | 1 | 0.309 | 3.741 | 3.626 | 3.774 | -0.8744 | PASS |
| 10 | Pwr1.3 | 12.6 | 2 | 0.618 | 3.737 | 3.626 | 3.774 | -0.98039 | PASS |
| 11 | Pwr1.3 | 12.6 | 3 | 0.936 | 3.737 | 3.626 | 3.774 | -0.98039 | PASS |
| 12 | Pwr1.3 | 12.6 | 4 | 1.274 | 3.739 | 3.626 | 3.774 | -0.9274 | PASS |

**U3400 (3.7V to 1.8V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Line regulation without electronic load for U3400** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply** | **Output** | **Output** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Voltage (V)** | **Current (A)** | **Voltage (V)** | **Min** | **Max** |
| 1 | Pwr1.3 | 3.6 | 0.04 | 1.82 | 1.773 | 1.827 | -0.38314 | PASS |
| 2 | Pwr1.3 | 3.7 | 0.04 | 1.82 | 1.773 | 1.827 | -0.38314 | PASS |
| 3 | Pwr1.3 | 3.8 | 0.04 | 1.82 | 1.773 | 1.827 | -0.38314 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Line regulation with electronic load for U3400** | | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply** | **Load** | **Output** | **Output** | **Specification(V)** | | **Design margin (%)** | **Result** |
| **Voltage (V)** | **Current (A)** | **Current (A)** | **Voltage (V)** | **Min** | **Max** |
| 1 | Pwr1.3 | 3.6 | 300 | 0.153 | 1.82 | 1.773 | 1.827 | -0.38314 | PASS |
| 2 | Pwr1.3 | 3.6 | 400 | 0.207 | 1.817 | 1.773 | 1.827 | -0.54735 | PASS |
| 3 | Pwr1.3 | 3.6 | 500 | 0.261 | 1.81 | 1.773 | 1.827 | -0.93049 | PASS |
| 4 | Pwr1.3 | 3.7 | 300 | 0.15 | 1.82 | 1.773 | 1.827 | -0.38314 | PASS |
| 5 | Pwr1.3 | 3.7 | 400 | 0.202 | 1.816 | 1.773 | 1.827 | -0.60208 | PASS |
| 6 | Pwr1.3 | 3.7 | 500 | 0.25 | 1.815 | 1.773 | 1.827 | -0.65681 | PASS |
| 7 | Pwr1.3 | 3.8 | 300 | 0.147 | 1.82 | 1.773 | 1.827 | -0.38314 | PASS |
| 8 | Pwr1.3 | 3.8 | 400 | 0.198 | 1.818 | 1.773 | 1.827 | -0.49261 | PASS |
| 9 | Pwr1.3 | 3.8 | 500 | 0.248 | 1.817 | 1.773 | 1.827 | -0.54735 | PASS |

NOTE: Refer to section 8.4.7 for measurement logs of switching regulators for line regulation.

# Ripple Noise

# Test ID

Pwr1.4

# Purpose

The purpose of this test case is to check the maximum peak-to-peak ripple voltage of switching regulators output under full load condition and typical input voltage.

# Test and Measurement Method

Refer to section 3.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage -12V DC

System/Test Load: Full

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

# Test Results

The maximum peak-to-peak ripple voltage measured is found to be less than 10% (as per the LT8640IUDC specification) of the output voltage.

**U3500 (12V to 5.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ripple Measurement for U3500** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply  Voltage (V)** | **Load  Current (A)** | **Ripple  Voltage (mV)** | **Specification(mV)** | | **Design Margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.4 | 12 | 4 | 8.8 | 0 | 10 | -12 | PASS |

**U3501 (12V to 5.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ripple Measurement for U3501** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply  Voltage (V)** | **Load  Current (A)** | **Ripple  Voltage (mV)** | **Specification(mV)** | | **Design Margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.4 | 12 | 4 | 2.4 | 0 | 10 | -76 | PASS |

**U4000 (12V to 3.7V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ripple Measurement for U4000** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply  Voltage (V)** | **Load  Current (A)** | **Ripple  Voltage (mV)** | **Specification(mV)** | | **Design Margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.4 | 12 | 4 | 9.6 | 0 | 10 | -4 | PASS |

**U3400 (3.7V to 1.8V):**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ripple Measurement for U3400** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **Supply  Voltage (V)** | **Load  Current (A)** | **Ripple  Voltage (mV)** | **Specification(mV)** | | **Design Margin (%)** | **Result** |
| **Min** | **Max** |
| 1 | Pwr1.4 | 3.7 | 500 | 8.12 | 0 | 10 | -18.8 | PASS |

# Measurement logs

The detailed analysis report with waveform captured for each of the Switching regulators function test cases executed is embed in the excel document attached herewith



# Voltage Control

# Test ID

Pwr1.5

# Purpose

The purpose of this test case is to check the Voltage Output with respect to Enable on Switching Regulators.

# Test and Measurement Method

Refer to section 3.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage -12V DC

System/Test Load: Full

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

# Test Results

PASS - Test case is replica of Voltage accuracy,refer to section 8.1.

# Voltage accuracy

# Test ID

Pwr1.6

# Purpose

The purpose of the test case is to measure the Output voltage of all LDO’s and to ensure that these voltages are in specified limits.

# Test and Measurement Method

Refer to section 3.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Full

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Voltage Accuracy for LDO’s** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **LDO** | **Supply Voltage (V)** | **Output Voltage (V)** | **Expected Voltage (V)** | **Deviation (%)** | **Output voltage accuracy (%)** | **Pass/Fail** |
| 1 | Pwr1.6 | U3700 (TPS7A8300) | 5.7 | 5.04 | 5 | 0.8 | 1 | PASS |
| 2 | U3701 (TPS7A8300) | 5.7 | 5.066 | 5 | 1.32 | 1 | FAIL |
| 3 | U3600 (TPS7A8300) | 5.7 | 5.077 | 5 | 1.54 | 1 | FAIL |
| 4 | U3601 (TPS7A8300) | 5.7 | 5.03 | 5 | 0.6 | 1 | PASS |
| 5 | U3900 (TPS7A8300) | 5.7 | 5.059 | 5 | 1.18 | 1 | FAIL |
| 6 | U3901 (TPS7A8300) | 5.7 | 5.04 | 5 | 0.8 | 1 | PASS |
| 7 | U3800 (TPS7A8300) | 5.7 | 5.082 | 5 | 1.64 | 1 | FAIL |
| 8 | U4100 (TPS7A8300) | 3.7 | 3.295 | 3.3 | 0.151515 | 1 | PASS |
| 9 | U3801 (TPS7A8300) | 5.7 | 5.076 | 5 | 1.52 | 1 | FAIL |
| 10 | U3401 (ADP1755ACPZ-R7) | 1.8 | 1.303 | 1.3 | 0.230769 | 2 | PASS |
| 11 | U3402 (ADP1755ACPZ-R7) | 1.8 | 1.301 | 1.3 | 0.076923 | 2 | PASS |
| 12 | U4001 (TPS7A8001) | 5.7 | 5.01 | 5 | 0.2 | 3 | PASS |

**Resolution for failure:**

Change the tolerance of feed back resistors of LDO’s to 1%.

Results table after changing feedback resistors tolerance of LDO’s to 1%

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Voltage Accuracy for LDO’s** | | | | | | | | |
| **Sl. No.** | **Test case No.** | **LDO** | **Supply Voltage (V)** | **Output Voltage (V)** | **Expected Voltage (V)** | **Deviation (%)** | **Output voltage accuracy (%)** | **Result** |
| 1 | Pwr1.6 | U3700 (TPS7A8300) | 5.7 | 5.04 | 5 | 0.8 | 1 | PASS |
| 2 | U3701 (TPS7A8300) | 5.7 | 4.97 | 5 | 0.87 | 1 | PASS |
| 3 | U3600 (TPS7A8300) | 5.7 | 4.97 | 5 | 0.87 | 1 | PASS |
| 4 | U3601 (TPS7A8300) | 5.7 | 5.03 | 5 | 0.6 | 1 | PASS |
| 5 | U3900 (TPS7A8300) | 5.7 | 4.96 | 5 | 0.87 | 1 | PASS |
| 6 | U3901 (TPS7A8300) | 5.7 | 5.04 | 5 | 0.8 | 1 | PASS |
| 7 | U3800 (TPS7A8300) | 5.7 | 4.99 | 5 | 0.87 | 1 | PASS |
| 8 | U4100 (TPS7A8300) | 3.7 | 3.295 | 3.3 | 0.151515 | 1 | PASS |
| 9 | U3801 (TPS7A8300) | 5.7 | 4.96 | 5 | 0.87 | 1 | PASS |
| 10 | U3401 (ADP1755ACPZ-R7) | 1.8 | 1.303 | 1.3 | 0.230769 | 2 | PASS |
| 11 | U3402 (ADP1755ACPZ-R7) | 1.8 | 1.301 | 1.3 | 0.076923 | 2 | PASS |
| 12 | U4001 (TPS7A8001) | 5.7 | 5.01 | 5 | 0.2 | 3 | PASS |

# Voltage Control

# Test ID

Pwr1.7

# Purpose

The purpose of this test case is to check the Voltage Output with respect to Enable on LDO’s.

# Test and Measurement Method

Refer to section 3.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage -12V DC

System/Test Load: Full

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

# Test Results

PASS - Test case is replica of Voltage accuracy ,refer to section 8.6.

# Current consumption

# Test ID

Pwr1.8

# Purpose

The purpose of the test case is to measure the board current consumption through current sensing IC.

# Test and Measurement Method

Refer to section 3.1.6 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Full

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0011

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **RF INA226 SENSORS** | | | | | | | | | | | | |
| **FPGA** | | | | **CH1** | | | | **CH2** | | | |  |
|  |
| **SPEC** | **BUS\_VOLT** | **MARGIN** | **CURRENT** | **SPEC** | **VOLT** | **MARGIN** | **CURRENT** | **SPEC** | **VOLT** | **MARGIN** | **CURRENT** | **RESULT** |
| **(mA)** | **(mV)** | **(mA)** | **(mA)** | **(mA  )** | **(mV)** | **(mA)** | **(mA)** | **(mA)** | **(mV)** | **(mA)** | **(mA)** |  |
| <100 | 12006 | 15 | 85 | <2000 | 5666 | 372 | 1628 | <1800 | 5660 | 79 | 1721 | PASS |
| <100 | 12008 | 15 | 85 | <2000 | 5667 | 373 | 1627 | <1800 | 5660 | 84 | 1716 | PASS |
| <100 | 12006 | 15 | 85 | <2000 | 5667 | 369 | 1631 | <1800 | 5662 | 92 | 1708 | PASS |
| <100 | 12007 | 15 | 85 | <2000 | 5667 | 374 | 1626 | <1800 | 5662 | 97 | 1703 | PASS |
| <100 | 12010 | 14 | 86 | <2000 | 5667 | 180 | 1820 | <1800 | 5662 | 102 | 1698 | PASS |
| <100 | 12007 | 12 | 88 | <2000 | 5668 | 382 | 1618 | <1800 | 5662 | 108 | 1692 | PASS |
| <100 | 12010 | 10 | 90 | <2000 | 5667 | 355 | 1645 | <1800 | 5663 | 110 | 1690 | PASS |
| <100 | 12003 | 13 | 87 | <2000 | 5667 | 388 | 1612 | <1800 | 5662 | 99 | 1701 | PASS |
| <100 | 12011 | 12 | 88 | <2000 | 5668 | 389 | 1611 | <1800 | 5665 | 120 | 1680 | PASS |
| <100 | 12011 | 12 | 88 | <2000 | 5667 | 389 | 1611 | <1800 | 5665 | 125 | 1675 | PASS |
| <100 | 12012 | 10 | 90 | <2000 | 5668 | 397 | 1603 | <1800 | 5665 | 124 | 1676 | PASS |
| <100 | 12015 | 12 | 88 | <2000 | 5668 | 200 | 1800 | <1800 | 5666 | 128 | 1672 | PASS |
| <100 | 12015 | 10 | 90 | <2000 | 5670 | 394 | 1606 | <1800 | 5666 | 134 | 1666 | PASS |
| <100 | 12013 | 12 | 88 | <2000 | 5670 | 395 | 1605 | <1800 | 5666 | 134 | 1666 | PASS |
| <100 | 12012 | 10 | 90 | <2000 | 5670 | 398 | 1602 | <1800 | 5666 | 140 | 1660 | PASS |
| <100 | 12013 | 10 | 90 | <2000 | 5670 | 397 | 1603 | <1800 | 5666 | 139 | 1661 | PASS |
| <100 | 12012 | 10 | 90 | <2000 | 5671 | 399 | 1601 | <1800 | 5667 | 142 | 1658 | PASS |
| <100 | 12015 | 12 | 88 | <2000 | 5670 | 404 | 1596 | <1800 | 5665 | 143 | 1657 | PASS |
| <100 | 12015 | 13 | 87 | <2000 | 5671 | 278 | 1722 | <1800 | 5666 | 148 | 1652 | PASS |

# Clock

# Clock output level

# Test ID

CLK 1.1

# Purpose

The purpose of this test case is to verify if the PLL is locked and to check the Clock output level.

# Test and Measurement Method

Refer to section 4.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Reference input-From signal generator (For system measurements reference input will be from GBC/Sync board)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

# Test Results

|  |  |  |  |
| --- | --- | --- | --- |
| **Clock Amplitude** | | | |
| **Specification** | **Result** | **Margin** | **Pass/Fail** |
| <1.3V(p-p) | 1V(p-p) | 0.3V | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Frequency and Frequency accuracy

# Test ID

CLK 1.2 & 1.3

# Purpose

The purpose of this test case is to verify if the frequency is within acceptable accuracy.

# Test and Measurement Method

Refer to section 4.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

All measurements are done with reference from signal generator, loop filter values are updated on the board.

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

# Test Results

GSM system specification is <±0.05ppm (±2Hz), since the measurement is only for RF\_SDR Board without Sync board, We have a tighter spec of <±0.025ppm (±1Hz),

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Accuracy** | | | |
| **Specification** | **Output Result(Hz)** | **Margin** | **Pass/Fail** |
| <±0.025ppm(±1Hz) | -0.084 | 0.916 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Phase noise

# Test ID

CLK 1.4

# Purpose

The purpose of this test case is to verify that the phase noise of the clock is within acceptable limits

# Test and Measurement Method

Refer to section 4.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

All measurements are done with reference from signal generator, loop filter values are updated on the board.

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

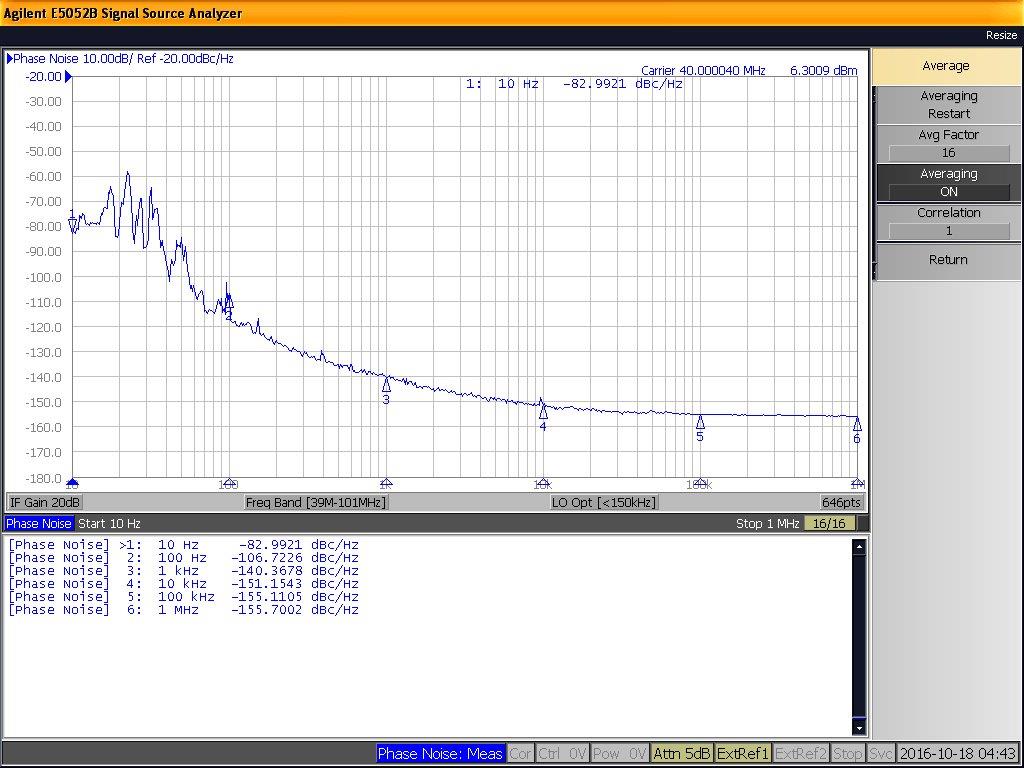
# Test Results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Phase Noise Measurement** | | | | | |
| **Frequency Offset** | **Phase Noise dBc/Hz** | | **margin** | **Pass/Fail** | **Phase noise measurement dBc/Hz** |
| **Specification** | **Result** |
| 10Hz | <-88 | -73.08 | -14.92 | FAIL | -82.9921 |
| 100Hz | <-115 | -93.28 | -21.72 | PASS | -115.5(Marker is on spurious) |
| 1kHz | <-138 | -104.89 | -33.11 | PASS | -140.3678 |
| 10kHz | <-145 | -109.49 | -35.51 | PASS | -151.1543 |
| 100kHz | <-150 | -118.03 | -31.97 | PASS | -155.1105 |
| 1MHz | <-152 | -138.62 | -13.38 | PASS | -155.7002 |

**Resolution for failure:**

Measurements were taken with reference input from signal generator having accuracy of 5Hz. In actual scenario input reference is from SYNC board which is in lock with 1PPS GPS signal,with this input as per design we will meet requirements at 10Hz.

# Test and Measurement Logs



# Lock time

# Test ID

CLK 1.5

# Purpose

The purpose of the test is to verify the maximum time taken for the PLL to settle to certain frequency and accuracy.

# Test and Measurement Method

Refer to section 4.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

# Test Results

|  |  |  |  |
| --- | --- | --- | --- |
| **Lock Time** | | | |
| **Specification** | **Measured** | **Margin** | **Result** |
| 2 ms | 900.9 us | 1099.1 us | PASS |

NOTE: specification is from GSM frequency hoping parameter

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Clock Duty Cycle

# Test ID

CLK 1.6

# Purpose

The purpose of this test case is to verify whether the duty cycle of the clock signal satisfies the minimum required specifications

# Test and Measurement Method

Refer to section 4.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Reference input-From signal generator (For system measurements reference input will be from GBC/Sync board)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **Clock Duty Cycle** | | | | | | | |
| SIN\_CLK\_BUFF\_OUT3 | R22.2 | Duty Cycle (%) | 47.73 | 25 | NA | -90.92 | PASS |
|

NOTE:The Max value of clock duty cycle is not mentioned in the FPGA datasheet. Hence, mentioned as NA.

# Test and Measurement Logs

****

# Jitter

# Test ID

CLK 1.7

# Purpose

The purpose of this test case is to verify if the period jitter of the clock signal is within the expected limit.

# Test and Measurement Method

Refer to section 4.1.6 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Reference input-From signal generator (For system measurements reference input will be from GBC/Sync board)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **Clock Period Jitter** | | | | | | | |
| SIN\_CLK\_BUFF\_OUT3 | R22.2 | Period Jitter (ns) | 0.075 | NA | 5 | -98.50 | PASS |
|

NOTE: The Min. value of clock period jitter is not mentioned in FPGA datasheet. Hence, mentioned as NA.

# Test and Measurement Logs

****

# Clock Duty Cycle

# Test ID

CLK 1.8

# Purpose

The purpose of this test case is to verify whether the duty cycle of the clock signal satisfies the minimum required specifications

# Test and Measurement Method

Refer to section 4.1.7 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Reference input-From signal generator (For system measurements reference input will be from GBC/Sync board)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **Clock Duty Cycle** | | | | | | | |
| CAT\_CLKOUT\_FPGA | U9.B2 | Duty Cycle (%) | 48.47 | 25 | NA | -93.88 | PASS |
|

NOTE:The Max value of clock duty cycle is not mentioned in the FPGA datasheet. Hence, mentioned as NA.

# Test and Measurement Logs



# Jitter

# Test ID

CLK 1.9

# Purpose

The purpose of this test case is to verify if the period jitter of the clock signal is within the expected limit.

# Test and Measurement Method

Refer to section 4.1.8 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Reference input-From signal generator (For system measurements reference input will be from GBC/Sync board)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **Clock Period Jitter** | | | | | | | |
| CAT\_CLKOUT\_FPGA | U9.B2 | Period Jitter (ns) | 0.175 | NA | 5 | -96.50 | PASS |
|

NOTE: The Min. value of clock period jitter is not mentioned in FPGA datasheet. Hence, mentioned as NA.

# Test and Measurement Logs

****

# FPGA

# Artix – 7 –Boot configuration

# Test ID

FPGA 1.1.1

# Purpose

The purpose of the test case is to verify the boot configuration of Artix – 7 FPGA.

# Test and Measurement Method

Refer to section 5.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

Artix – 7 FPGA booted up successfully and was functioning as required.

# Test and Measurement Logs

The snapshot of boot configuration of Artix – 7 FPGA is attached below.



NOTE: This test case is a functional test. Hence, no specification table.

# Artix – 7 –Power sequence

# Test ID

FPGA 1.1.2

# Purpose

The purpose of this test case is to verify the power sequence of Artix – 7 FPGA.

# Test and Measurement Method

Refer to section 5.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Artix\_7\_Power\_On\_Sequence** | | | | | |
| **Sl.No** | **Specification (Expected sequence)** | **Logic analyzer bits** | **Measurement Points** | **Measured sequence** | **Design Margin** | **Pass/Fail** |
| 1 | 1P8V \_FX3 | D0 | C276 | 1P8V \_FX3 | NA | PASS |
| 2 | 1P2V \_FX3 | D6 | C272 | 1P2V \_FX3 |
| 3 | VCCINT+VCCBRAM | D4 | C245 | VCCINT+VCCBRAM |
| 4 | VCCAUX18 | D1 | C256 | VCCAUX18 |
| 5 | 1.8VD\_FPGA | D2 | C251 | 1.8VD\_FPGA |
| 6 | 3.3VD\_FPGA | D3 | C255 | 3.3VD\_FPGA |

# Test and Measurement Logs



# FX3 – SPI –Electrical validation

# Test ID

FPGA 1.2.1

# Purpose

The purpose of the test case is to verify the electrical characteristics of SPI interface of FX3.

# Test and Measurement Method

Refer to section 5.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | | **Test result** |
| **Min** | **Max** |
| **FX3 – SPI** | | | | | | | | |
| FX3\_SCLK | U9.V19 | VIL (max) (V) | 0.3 | -0.3 | 0.63 | 200.00 | PASS | |
| VIH (min) (V) | 1.5 | 1.17 | 2.1 | -28.21 | PASS | |
| Minimum High time (ns) | 22.6 | 2.5 | NA | -804.00 | PASS | |
| Minimum Low time (ns) | 23.1 | 2.5 | NA | -824.00 | PASS | |
| Frequency (MHz) | 20.16 | 0 | 100 | -79.84 | PASS | |
| FX3\_MOSI | U9.R22 | VIL (max) (V) | 0 | -0.3 | 0.63 | 100.00 | PASS | |
| VIH (min) (V) | 1.8 | 1.17 | 2.1 | -14.29 | PASS | |
| Minimum High time (ns) | 47.8 | 2.5 | NA | -1812.00 | PASS | |
| Minimum Low time (ns) | 97.2 | 2.5 | NA | -3788.00 | PASS | |

NOTE:The Max. value of Minimum High time and Minimum Low time is not mentioned in FPGA datasheet. Hence, mentioned as NA.

# Test and Measurement Logs



# FX3 – SPI –Functional validation

# Test ID

FPGA 1.2.2

# Purpose

The purpose of the test case is to validate the functioning of the SPI interface of FX3.

# Test and Measurement Method

Refer to section 5.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

FX3 is able to read and write registers of FPGA and the functioning of the SPI interface is validated.

# Test and Measurement Logs

The snapshot for the functional validation of FX3 – SPI signals is attached below.



NOTE: This test case is a functional test. Hence, no specification table.

# AD9361 – SPI-Electrical validation/Signal integrity

# Test ID

FPGA 1.3.1

# Purpose

The purpose of the test case is to verify the electrical characteristics of SPI interface of AD9361 transceiver

# Test and Measurement Method

Refer to section 5.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **AD9361 – SPI (EV)** | | | | | | | |
| CAT\_SCLK | U9.C2 | VIL (max) (V) | -0.02 | 0 | 0.36 | -105.56 | FAIL |
| VIH (min) (V) | 1.82 | 1.44 | 1.8 | 1.11 | FAIL |
| Frequency (MHz) | 1 | 0 | 50 | -98.00 | PASS |
| CAT\_MOSI | U9.A1 | VIL (max) (V) | 0.02 | 0 | 0.36 | -94.44 | PASS |
| VIH (min) (V) | 1.78 | 1.44 | 1.8 | -1.11 | PASS |
| CAT\_MISO | U9.B1 | VIL (max) (V) | -0.02 | -0.3 | 0.63 | 93.33 | PASS |
| VIH (min) (V) | 1.9 | 1.17 | 2.10 | -9.52 | PASS |

**Resolution for failure:**

The voltage levels of CAT\_SCLK clock signal exceeds beyond the specified Min. and Max. values. A series resistor has been included in the path of the signal in Rev. C to resolve this issue.

# Test and Measurement Logs



**Signal Integrity**

# Purpose

The purpose of the test case is to verify the signal integrity characteristics of SPI interface of AD9361 transceiver.

# Test and Measurement Method

Refer to section 5.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document.

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| CAT\_SCLK | U9.C2 | Positive Overshoot (V) | 0.645 | 0 | 0.18 | 258.33 | FAIL |
| Negative Overshoot (V) | 0.528 | 0 | 0.18 | 193.33 | FAIL |
| CAT\_MOSI | U9.A1 | Positive Overshoot (V) | 0.388 | 0 | 0.18 | 115.56 | FAIL |
| Negative Overshoot (V) | 0.511 | 0 | 0.18 | 183.89 | FAIL |
| Data Setup time (ns) | 10 | 2 | NA | -400.00 | PASS |
| Data Hold time (ns) | 2000 | 1 | 1000 | 100.00 | PASS |
| CAT\_MISO | U9.B1 | Positive Overshoot (V) | 0.36 | 0 | 0.18 | 100 | FAIL |
| Negative Overshoot (V) | 0.26 | 0 | 0.18 | 44.44 | FAIL |
| Data Setup time (ns) | 984 | 2.44 | NA | -40227.87 | PASS |
| Data Hold time (ns) | 4 | 0.62 | 1000 | -99.60 | PASS |

NOTE:The Max. value of Data Setup time and Data Hold time is not mentioned in the FPGA datasheet. Hence, mentioned as NA.

**Resolution for failure:**

The positive and negative overshoot of the signals, namely, CAT\_SCLK, CAT\_MOSI, and CAT\_MISO exceed beyond the specified Max. value of overshoot. A series resistor has been included in the path of the signal in Rev. C to resolve this issue.

# Test and Measurement Logs



# AD9361 – SPI-Functional validation

# Test ID

FPGA 1.3.2

# Purpose

The purpose of the test case is to validate the functioning of the SPI interface of AD9361 transceiver.

# Test and Measurement Method

Refer to section 5.1.6 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document.

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

The functioning of the SPI interface between AD9361 transceiver and Artix – 7 FPGA has been validated.

# Test and Measurement Logs

The snapshot for the functional validation of AD9361 – SPI signals is attached below.

** **

NOTE: This test case is a functional test. Hence, no specification table.

# FX3 – GPIF Control – Electrical validation

# Test ID

FPGA 1.4.1

# Purpose

The purpose of the test case is to verify the electrical characteristics of control signals of FX3 – GPIF.

# Test and Measurement Method

Refer to section 5.1.7 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **FX3 – GPIF (Control)** | | | | | | | |
| GPIF\_CTL3 | U9.G15 | VIL (max) (V) | 0 | -0.3 | 0.63 | 100.00 | PASS |
| VIH (min) (V) | 1.8 | 1.17 | 2.1 | -14.29 | PASS |
| Minimum High Time (ns) | 18000 | 2.5 | 19750 | -8.86 | PASS |
| Minimum Low Time (ns) | 1750 | 2.5 | 19750 | -91.14 | PASS |
| GPIF\_CTL12 | U9.G13 | VIL (max) (V) | 0 | -0.3 | 0.63 | 100.00 | PASS |
| VIH (min) (V) | 1.8 | 1.17 | 2.1 | -14.29 | PASS |
| Minimum High Time (ns) | 200 | 2.5 | 1200 | -83.33 | PASS |
| Minimum Low Time (ns) | 1000 | 2.5 | 1200 | -16.67 | PASS |

# Test and Measurement Logs



# FX3 – GPIF Control – Functional validation

# Test ID

FPGA 1.4.2

# Purpose

The purpose of the test case is to validate the functioning of the control signals of FX3-GPIF.

# Test and Measurement Method

Refer to section 5.1.8 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

The functioning of the control signals from FX3 to Artix – 7 FPGA has been validated.

# Test and Measurement Logs

The snapshot for the functional validation of FX3 – GPIF control signals is attached below.



NOTE: This test case is a functional test. Hence, no specification table.

# FX3 – GPIF Data – Electrical validation

# Test ID

FPGA 1.5.1

# Purpose

The purpose of the test case is to verify the electrical characteristics of data signals of FX3 – GPIF.

# Test and Measurement Method

Refer to section 5.1.9 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **FX3 – GPIF (Data)** | | | | | | | |
| GPIF\_D04 | U9.K21 | VIL (max) (V) | 0 | -0.3 | 0.63 | 100.00 | PASS |
| VIH (min) (V) | 1.88 | 1.17 | 2.1 | -10.48 | PASS |
| Minimum High Time (ns) | 10 | 2.5 | NA | -300.00 | PASS |
| Minimum Low Time (ns) | 10 | 2.5 | NA | -300.00 | PASS |
| GPIF\_D19 | U9.L18 | VIL (max) (V) | 0 | -0.3 | 0.63 | 100.00 | PASS |
| VIH (min) (V) | 1.8 | 1.17 | 2.1 | -14.29 | PASS |
| Minimum High Time (ns) | 210 | 2.5 | NA | -8300.00 | PASS |
| Minimum Low Time (ns) | 45 | 2.5 | NA | -1700.00 | PASS |
| GPIF\_D29 | U9.J17 | VIL (max) (V) | 0 | -0.3 | 0.63 | 100.00 | PASS |
| VIH (min) (V) | 1.84 | 1.17 | 2.1 | -12.38 | PASS |
| Minimum High Time (ns) | 145 | 2.5 | NA | -5700.00 | PASS |
| Minimum Low Time (ns) | 95 | 2.5 | NA | -3700.00 | PASS |
| GPIF\_D31 | U9.L15 | VIL (max) (V) | 0 | -0.3 | 0.63 | 100.00 | PASS |
| VIH (min) (V) | 1.8 | 1.17 | 2.1 | -14.29 | PASS |
| Minimum High Time (ns) | 44 | 2.5 | NA | -1660.00 | PASS |
| Minimum Low Time (ns) | 44 | 2.5 | NA | -1660.00 | PASS |

NOTE: The Max. value of Min. High time and Min. Low time is not mentioned in the FPGA datasheet. Hence, mentioned as NA.

# Test and Measurement Logs



# FX3 – GPIF Data – Functional validation

# Test ID

FPGA 1.5.2

# Purpose

The purpose of the test case is to validate the functioning of the data signals of FX3 – GPIF.

# Test and Measurement Method

Refer to section 5.1.10 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

FX3 is able to send data to FPGA and the functioning of the data signals has been validated.

# Test and Measurement Logs

The snapshot for the functional validation of FX3 – GPIF data signals is attached below.



NOTE: This test case is a functional test. Hence, no specification table.

# AD9361 – Control- Electrical validation

# Test ID

FPGA 1.6.1

# Purpose

The purpose of the test case is to validate the electrical characteristics of the control signals of AD9361 transceiver.

# Test and Measurement Method

Refer to section 5.1.11 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document.

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **AD9361 (Control)** | | | | | | | |
| CODEC\_CTRL\_OUT2 | U9.U21 | VIL (max) (V) | -0.04 | -0.3 | 0.63 | 86.67 | PASS |
| VIH (min) (V) | 1.8 | 1.17 | 2.1 | -14.29 | PASS |
| CODEC\_CTRL\_OUT3 | U9.P19 | VIL (max) (V) | -0.04 | -0.3 | 0.63 | 86.67 | PASS |
| VIH (min) (V) | 1.8 | 1.17 | 2.1 | -14.29 | PASS |

# Test and Measurement Logs

****

# AD9361 – Control- Functional validation

# Test ID

FPGA 1.6.2

# Purpose

The purpose of the test case is to validate the functioning of AD9361 control signals.

# Test and Measurement Method

Refer to section 5.1.12 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

The functioning of the control signals from AD9361 Transceiver to Artix – 7 FPGA has been validated.

# Test and Measurement Logs

The snapshot for the functional validation of AD9361 control signals is attached below.



NOTE: This test case is a functional test. Hence, no specification table.

# AD9361 – Data- Electrical validation

# Test ID

FPGA 1.7.1

# Purpose

The purpose of the test case is to verify the electrical characteristics of data signals of AD9361 transceiver.

# Test and Measurement Method

Refer to section 5.1.13 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** |  | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **AD9361 (Data)** | | | | | | | |
| CODEC\_D1 | U9.AB12 | VIL (max) (V) | 0.01 | 0 | 0.36 | -97.22 | PASS |
| VIH (min) (V) | 1.73 | 1.44 | 1.8 | -3.89 | PASS |
| Rx Data Delay (DATA\_CLK to Data Outputs) (ns) | 10.4 | 0 | 1.5 | 593.33 | FAIL |
| Rx Data Delay (DATA\_CLK to Rx\_FRAME) (ns) | 7.6 | 0 | 1 | 660.00 | FAIL |
| CODEC\_D10 | U9.W12 | VIL (max) (V) | 0 | 0 | 0.36 | -100.00 | PASS |
| VIH (min) (V) | 1.74 | 1.44 | 1.8 | -3.33 | PASS |
| Rx Data Delay (DATA\_CLK to Data Outputs) (ns) | 11 | 0 | 1.5 | 633.33 | FAIL |
| Rx Data Delay (DATA\_CLK to Rx\_FRAME) (ns) | 6.8 | 0 | 1 | 580.00 | FAIL |
| CODEC\_D18 | U9.AA15 | VIL (max) (V) | -0.01 | 0 | 0.36 | -102.78 | PASS |
| VIH (min) (V) | 1.79 | 1.44 | 1.8 | -0.56 | PASS |
| Tx Data Setup Time (ns) | 5.9 | 0 | 1.5 | 293.33 | FAIL |
| Tx Data Hold Time (ns) | 9.3 | 0 | 1 | 830.00 | FAIL |
| CODEC\_D20 | U9.Y13 | VIL (max) (V) | -0.02 | 0 | 0.36 | -105.56 | PASS |
| VIH (min) (V) | 1.8 | 1.44 | 1.8 | 0.00 | PASS |
| Tx Data Setup Time (ns) | 7.8 | 0 | 1.5 | 420.00 | FAIL |
| Tx Data Hold Time (ns) | 8 | 0 | 1 | 700.00 | FAIL |

**Resolution for failure:**

The Rx data delay (DATA\_CLK to Data Outputs), Rx Data delay (DATA\_CLK to Rx Frame), Tx Data Setup time, and Tx Data Hold time exceed beyond the specified Max. value.

Series resistors are included in the path of the signal and all the data lines are length matched in Rev. C.

# Test and Measurement Logs



# AD9361 – Data- Functional validation

# Test ID

FPGA 1.7.2

# Purpose

The purpose of the test case is to validate the functioning of AD9361 data signals.

# Test and Measurement Method

Refer to section 5.1.14 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

AD9361 was able to send and receive data from FPGA and the functioning of the data signals has been validated.

# Test and Measurement Logs

The snapshot for the functional validation of AD9361 data signals is attached below.

****

NOTE: This test case is a functional test. Hence, no specification table.

# FX3

# FX3 (CYUSB3014)-Configuration

# Test ID

FX3 1.1

# Purpose

The purpose of this test case is to verify the configuration of FX3.

# Test and Measurement Method

Refer to section 6.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

The snapshot for FX3 configuration is attached below.



# EEPROM (24LC256) – I2C –Electrical validation

# Test ID

FX3 1.2.1

# Purpose

The purpose of the test case is to verify the electrical characteristics of I2C interface of the serial EEPROM.

# Test and Measurement Method

Refer to section 6.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Measuring Point** | **Measuring Criteria** | **Observation** | **Specification** | | **Design Margin (%)** | **Test result** |
|  |  |  |  | **Min** | **Max** |  |
| **EEPROM – I2C** | | | | | | | |
| FX3\_SCL | R61.2 | VIL (max) (V) | -0.06 | -0.5 | 0.36 | 88.00 | PASS |
| VIH (min) (V) | 1.8 | 1.26 | 2.3 | -21.74 | PASS |
| Rise time (ns) | 132 | 20 | 1000 | -86.80 | PASS |
| Fall time (ns) | 32 | 6.54 | 300 | -89.33 | PASS |
| Frequency (KHz) | 371.7 | 0 | 400 | -7.08 | PASS |
| FX3\_SDA | R60.2 | VIL (max) (V) | -0.06 | -0.5 | 0.36 | 88.00 | PASS |
| VIH (min) (V) | 1.8 | 1.26 | 2.3 | -21.74 | PASS |
| Rise time (ns) | 100 | 20 | 1000 | -90.00 | PASS |
| Fall time (ns) | 33 | 6.54 | 300 | -89.00 | PASS |

# Test and Measurement Logs



# EEPROM (24LC256) – I2C –Functional validation

# Test ID

FX3 1.2.2

# Purpose

The purpose of the test case is to validate the functioning of I2C interface of the serial EEPROM.

# Test and Measurement Method

Refer to section 6.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

# Test Results

FX3 was able to read /write data from EEPROM and the functioning of the I2C interface has been validated.

# Test and Measurement Logs

The snapshot for the functional validation of EEPROM – I2C signals is attached below.



NOTE: This test case is a functional test. Hence, no specification table.

# Functional validation of Debug USB Switch – USB2.0 from FX3

# Test ID

FX3 1.3.1

# Purpose

The purpose of the test case is to validate USB 2.0 through Debug USB Switch.

# Test and Measurement Method

Refer to section 6.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

The functional validation of USB 2.0 through Debug USB Switch is verified.

# Test and Measurement Logs

The snapshot of functional validation of USB 2.0 in Debug USB Switch are attached.



NOTE: This test case is a functional test. Hence, no specification table.

# Functional validation of Debug USB Switch – USB3.0 from FX3

# Test ID

FX3 1.4.1

# Purpose

The purpose of the test case is to validate USB 3.0 through Debug USB Switch.

# Test and Measurement Method

Refer to section 6.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

The functional validation of USB 3.0 through Debug USB Switch is verified.

# Test and Measurement Logs

The snapshot of functional validation of USB 3.0 in Debug USB Switch are attached here.



NOTE: This test case is a functional test. Hence, no specification table.

# RF/Transceiver (AD9361) – Pipe1

# Maximum Output Power from AD9361- Pipe 1

# Test ID

TRX 1.1

# Purpose

The purpose of this test case is to check maximum power that is possible from AD9361 transceiver.

# Test and Measurement Method

Refer to section 7.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Attenuation setting from UHD code for AD9361 (dB)** |  | **CH1 Maximum Output Power at Balun (dBm)** | | | **Min(dBm)** |  |  | **Result** |
| **Specification** | **GSM-900** | | | **Max(dBm)** | **Margin** **(dBm)** |
|  | **B** | **M** | **T** |  |  |
| 0 | >-5dBm | -1.7 | -1.7 | -1.8 | -1.8 | -1.7 | 3.2 | PASS |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Attenuation setting from UHD code for AD9361 (dB)** |  | **CH1 Maximum Output Power at Balun (dBm)** | | | **Min(dBm)** |  |  | **Result** |
| **Specification** | **DCS-1800** | | | **Max (dBm)** | **Margin** **in(dBm)** |
|  | **B** | **M** | **T** |  |  |
| 0 | >-5dBm | -3.1 | -3.1 | -3.2 | -3.2 | -3.1 | 1.8 | PASS |

NOTE: Pig tail cable losses are taken into account during setup calibration.

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Transmit Power Control from AD9361-Pipe1

# Test ID

TRX 1.2

# Purpose

The purpose of this test case is to control Transmit power from AD9361 transceiver.

# Test and Measurement Method

Refer to section 7.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ATTENUATION SETTING FROM UHD CODE FOR AD9361** | **CH1 OUTPUT POWER CONTROL** | | | | **MIN** |  | **MARGIN**  **IN (dBm)** | **RESULT** |
| **SPECIFICATION** | **GSM-900** | | | **MAX** |
| **B** | **M** | **T** |  |
| Output power level in dBm with 0dB attenuation | >-5dBm | -1.7 | -1.7 | -1.8 | -1.8 | -1.7 | 3.2 | PASS |
| Output power level in dBm with 10dB attenuation | >-15dBm | -11.5 | -11 | -11.5 | -11.5 | -11 | 3.5 | PASS |
| Attenuation in dB with 10dB atten setting in AD9361 | 10dB(+/- 2dB) | 9.8 | 9.3 | 9.7 | 9.3 | 9.8 | 1.3 | PASS |
| Output power level in dBm with 20dB attenuation | >-25dBm | -21.4 | -21 | -21.3 | -21.4 | -21 | 3.6 | PASS |
| Attenuation in dB with 20dB atten setting in AD9361 | 20dB(+/- 2dB) | 19.7 | 19.3 | 19.5 | 19.3 | 19.7 | 0.8 | PASS |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ATTENUATION SETTING FROM UHD CODE FOR AD9361** | **CH1 OUTPUT POWER CONTROL** | | | | **MIN** |  | **MARGIN**  **IN (dBm)** | **RESULT** |
| **SPECIFICATION** | **DCS-1800** | | | **MAX** |
| **B** | **M** | **T** |  |
| Output power level in dBm with 0dB attenuation | >-5dBm | -3.1 | -3.1 | -3.2 | -3.2 | -3.1 | 1.8 | PASS |
| Output power level in dBm with 10dB attenuation | >-15dBm | -12.4 | -12.5 | -12.7 | -12.7 | -12.4 | 2.6 | PASS |
| Attenuation in dB with 10dB atten setting in AD9361 | 10dB(+/- 2dB)  12dB< Atten>8dB | 9.3 | 9.4 | 9.5 | 9.3 | 9.5 | 1.3 | PASS |
| Output power level in dBm with 20dB attenuation | >-25dBm | -21.9 | -22.1 | -22.2 | -22.2 | -21.9 | 2.8 | PASS |
| Attenuation in dB with 20dB atten setting in AD9361 | 20dB(+/- 2dB)  22dB< Atten>18dB | 18.8 | 19 | 19 | 18.8 | 19 | 0.8 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Modulation Accuracy –TRx – Pipe 1

# Test ID

TRX\_1.3

# Purpose

The purpose of this test case is, Phase error and EVM are fundamental parameters used in GSM to characterize modulation accuracy. These measurements reveal much about a transmitter’s performance. Poor phase error or EVM indicates a problem with the I/Q baseband generator, filters, modulator or amplifier in the transmitter circuitry.

# Test and Measurement Method

Refer to section 7.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document.

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **GSM 900** | | | | | |
| **RMS(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin (deg)** |
| **RMS(deg)** | **RMS(deg)** | **B** | **M** | **T** |
| GMSK | <3.6 | <5 | 0.39 | 0.4 | 0.44 | 0.39 | 0.44 | 3.16 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **GSM 900** | | | | | |
| **PEAK(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin (deg)** |
| **< PEAK(deg)** | **< PEAK(deg)** | **B** | **M** | **T** |
| GMSK | <14.2 | <20 | 1.02 | 0.98 | 1.23 | 0.98 | 1.23 | 12.97 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Mean Frequency Error** | | | | | | **Min (Hz)** | **Max (Hz)** | **Margin**  **(Hz)** | **Result** |
| **Modulation** | **Specification(R&D)** | **Specification(normal)** | **GSM 900** | | |
| **ppm / Hz** | **ppm / Hz** | **B(Hz)** | **M(Hz)** | **T(Hz)** |
| GMSK | < 0.03/±27Hz | < 0.05/±45Hz | 0.12 | -0.48 | -0.45 | -0.48 | 0.12 | 26.52 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **DCS 1800** | | | | | |
| **RMS(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin** **(deg)** |
| **< RMS(deg)** | **< RMS(deg)** | **B** | **M** | **T** |
| GMSK | <3.6 | <5 | 0.4 | 0.47 | 0.44 | 0.4 | 0.47 | 3.13 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **DCS 1800** | | | | | |
| **PEAK(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin** **(deg)** |
| **< PEAK(deg)** | **< PEAK(deg)** | **B** | **M** | **T** |
| GMSK | <14.2 | <20 | 1.08 | 1.38 | 1.44 | 1.08 | 1.44 | 12.76 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Mean Frequency Error** | | | | | | **Min (Hz)** | **Max (Hz)** | **Margin**  **(Hz)** | **Result** |
| **Modulation** | **Specification(R&D)** | **Specification(normal)** | **DCS 1800** | | |
| **ppm / Hz** | **ppm / Hz** | **B(Hz)** | **M(Hz)** | **T(Hz)** |
| GMSK | < 0.03/±54Hz | < 0.05/±90Hz | -0.44 | -0.43 | -0.18 | -0.44 | -0.18 | 53.56 | PASS |

# Test and Measurement Logs



# Output RF Spectrum- i) Adjacent channel power-TRx Pipe 1

# Test ID

TRX 1.6

# Purpose

The purpose of this test case is measure adjacent channel power, the modulation process in a transmitter causes the continuous wave (CW) Carrier to spread spectrally. The “spectrum due to modulation and wideband noise” measurement is used to ensure that modulation process does not cause excessive spectral spread. If it did, other users who are operating on different frequencies would experience interference. The measurement of spectrum due to modulation and wideband noise can be thought of as an adjacent channel power (ACP).

# Test and Measurement Method

Refer to section 7.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Signal output level: 0dBm

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_spectrum due to modulation** | | | | | | | | | | | | **Result** |
| **Specification** | | | **GSM 900 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin in (dB)** |
| **offset frequency** | **< dBc** | **RBW KHz** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 100KHz | 0.5 | 30 | -9.15 | -9.67 | -8.61 | -9.06 | -9.14 | -9.66 | -9.67 | -8.61 | 8.11 | PASS |
| 200KHz | -30 | 30 | -38.66 | -37.65 | -38.08 | -37.04 | -38.58 | -37.59 | -38.66 | -37.04 | 7.04 | PASS |
| 250KHz | -33 | 30 | -40.28 | -41.5 | -40.68 | -42.1 | -40.72 | -41.7 | -42.1 | -40.28 | 7.28 | PASS |
| 400KHz | -60 | 30 | -63.69 | -63.18 | -62.71 | -63.11 | -62.85 | -62.31 | -63.69 | -62.31 | 2.31 | PASS |
| 600KHz to 1200KHz | -60 | 30 | -70.97 | -71.06 | -69.82 | -69.89 | -69.61 | -69.69 | -71.06 | -69.61 | 9.61 | PASS |
| 1200KHz to 1800KHz | -63 | 30 | -75.15 | -75.66 | -74.35 | -74.28 | -74.15 | -75.11 | -75.66 | -74.15 | 11.15 | PASS |
| 1800KHz to 6000KHz | -65 | 100 | -74.52 | -74.08 | -71.13 | -73.91 | -74.05 | -74.49 | -74.52 | -71.13 | 6.13 | PASS |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_spectrum due to modulation** | | | | | | | | | | | | **Result** |
| **Specification** | | | **DCS 1800 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin** **in (dB)** |
| **offset frequency** | **< dBc** | **RBW KHz** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 100KHz | 0.5 | 30 | -11.61 | -4.54 | -9.12 | -9.62 | -9.13 | -9.63 | -11.61 | -4.54 | 4.04 | PASS |
| 200KHz | -30 | 30 | -35 | -36.31 | -38.49 | -37.6 | -38.57 | -37.5 | -38.57 | -35 | 5 | PASS |
| 250KHz | -33 | 30 | -38.88 | -40.6 | -40.66 | -42.34 | -39.72 | -41.54 | -42.34 | -38.88 | 5.88 | PASS |
| 400KHz | -60 | 30 | -55.98 | -56.19 | -59.67 | -59.56 | -58.75 | -59.81 | -59.81 | -55.98 | -4.02 | FAIL |
| 600KHz to 1200KHz | -60 | 30 | -60.32 | -60.78 | -64.26 | -64.6 | -64.39 | -63.6 | -64.6 | -60.32 | 4.32 | PASS |
| 1200KHz to 1800KHz | -63 | 30 | -65.73 | -66.77 | -69.97 | -69.75 | -69.8 | -70.19 | -70.19 | -65.73 | 2.73 | PASS |
| 1800KHz to 6000KHz | -65 | 100 | -67.46 | -67.61 | -71.65 | -71.49 | -72.48 | -72.23 | -72.48 | -67.46 | 2.46 | PASS |

**Resolution for failure:**

We are meeting spectrum due to modulation requirements with only one chain at AD9361 active. When two chains of AD9361 are active the output of one chain is not stable (not all time slots are ON only burst broadcast channel is seen).

# Test and Measurement Logs



# ii) Spectrum due to switching- TRx Pipe 1

# Test ID

TRX 1.6

# Purpose

The purpose of this test case is the GSM/EDGE transmitter’s ramp RF power rapidly. The “transmitted RF carrier power versus time” measurement is used to ensure that this process happens at the correct times and happens fast enough. However, if RF power is ramped too quickly, undesirable spectral components exist in the transmission. This measurement is used to ensure that these components are below the acceptable level.

# Test and Measurement Method

Refer to section 7.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_spectrum due to switching** | | | | | | | | | | | **Result** |
| **Specification** | | **GSM 900 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin** **in (dB)** |  |
| **offset frequency** | **< dBc** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 400 KHz | -57 | -57.48 | -58.23 | -57.77 | -57.99 | -57.2 | -59.51 | -59.51 | -57.2 | 0.2 | PASS |
| 600 KHz | -67 | -64.65 | -64.87 | -64.99 | -65.32 | -64.89 | -63.72 | -65.32 | -63.72 | 3.28 | PASS |
| 1200 KHz | -74 | -67.98 | -68.43 | -66.45 | -67.34 | -67.77 | -67.3 | -68.43 | -66.45 | -7.55 | FAIL |
| 1800 KHz | -74 | -73.11 | -74.64 | -70.86 | -73.6 | -74.31 | -73.71 | -74.64 | -70.86 | -3.14 | FAIL |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_spectrum due to switching** | | | | | | | | | | | **Result** |
| **Specification** | | **DCS 1800 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin** **(dB)** |  |
| **offset frequency** | **< dBc** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 400 KHz | -50 | -54.16 | -55.6 | -53.11 | -52.7 | -54.78 | -54.16 | -55.6 | -52.7 | 2.7 | PASS |
| 600 KHz | -58 | -58.53 | -58.74 | -58.35 | -58.71 | -57.92 | -57.85 | -58.74 | -57.85 | -0.15 | FAIL |
| 1200 KHz | -66 | -64.02 | -63.74 | -63.7 | -62.66 | -62.9 | -62.3 | -64.02 | -62.3 | -3.7 | FAIL |
| 1800 KHz | -66 | -72.21 | -71.88 | -72.02 | -71.54 | -72.86 | -70.69 | -72.86 | -70.69 | 4.69 | PASS |

**Resolution for failure:**

We are meeting spectrum due to switching requirements with only one chain at AD9361 active. When two chains of AD9361 are active the output of one chain is not stable (not all time slots are ON only burst broadcast channel is seen).

# Test and Measurement Logs



# Carrier leakage - Pipe1

# Test ID

TRX 1.4

# Purpose

The purpose of this test case is to check carrier leakage that is possible from AD9361 transceiver LO.

# Test and Measurement Method

Refer to section 7.1.6 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Carrier Leakage at 0dB attenuation** | **Spec in dBc** | **Carrier leakage in dBc** | | | **Margin from Spec in dB** | **Result** |
| **B** | **M** | **T** | PASS |
| **Chain1** | -50 | -55.7 | -55.1 | -55.8 | 5.1 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Chain1** | | | | | | |
|  | **Wanted signal power in dBm** | | | **Carrier leakage including 2dB cable loss in dBm** | | |
| **Band** | **B** | **M** | **T** | **B** | **M** | **T** |
| 900 | -1.7 | -1.7 | -1.8 | -57.4 | -56.8 | -57.6 |
| 1800 | -3.1 | -3.1 | -3.2 | -54.7 | -53.78 | -55.3 |

# Test and Measurement Logs



# RF/Transceiver (AD9361) – Pipe2

# Maximum Output Power from AD9361-Pipe2

# Test ID

TRX 2.1

# Purpose

The purpose of this test case is to check maximum power that is possible from AD9361 transceiver.

# Test and Measurement Method

Refer to section 8.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Attenuation setting from UHD code for AD9361 (dB)** |  | **CH2 Maximum Output Power at Balun (dBm)** | | | **Min(dBm)** |  |  | **Result** |
| **Specification** | **GSM-900** | | | **Max(dBm)** | **Margin in (dBm)** |
|  | **B** | **M** | **T** |  |  |
| 0 | >-5dBm | -1.5 | -1.4 | -1.6 | -1.6 | -1.4 | 3.4 | PASS |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Attenuation setting from UHD code for AD9361 (dB)** |  | **CH2 Maximum Output Power at Balun (dBm)** | | | **Min(dBm)** |  |  | **Result** |
| **Specification** | **DCS-1800** | | | **Max(dBm)** | **Margin in (dBm)** |
|  | **B** | **M** | **T** |  |  |
| 0 | >-5dBm | -2.7 | -3.1 | -3.1 | -3.1 | -2.7 | 1.9 | PASS |

NOTE: Pig tail cable losses are taken into account during setup calibration.

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Transmit Power Control from AD9361-Pipe2

# Test ID

TRX 2.2

# Purpose

The purpose of this test case is to control Transmit power from AD9361 transceiver.

# Test and Measurement Method

Refer to section 8.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ATTENUATION SETTING FROM UHD CODE FOR AD9361** | **CH2 OUTPUT POWER CONTROL** | | | | **MIN** |  | **MARGIN**  **IN (dBm)** | **RESULT** |
| **SPECIFICATION** | **GSM-900** | | | **MAX** |
| **B** | **M** | **T** |  |
| Output power level in dBm with 0dB attenuation | >-5dBm | -1.5 | -1.4 | -1.6 | -1.6 | -1.4 | 3.4 | PASS |
| Output power level in dBm with 10dB attenuation | >-15dBm | -11.4 | -11 | -11.5 | -11.5 | -11 | 3.5 | PASS |
| Attenuation in dB with 10dB atten setting in AD9361 | 10dB(+/- 2dB)  12dB< Atten>8dB | 9.9 | 9.6 | 9.9 | 9.6 | 9.9 | 1.4 | PASS |
| Output power level in dBm with 20dB attenuation | >-25dBm | -20.5 | -21 | -21.1 | -21.1 | -20.5 | 3.9 | PASS |
| Attenuation in dB with 20dB atten setting in AD9361 | 20dB(+/- 2dB)  12dB< Atten>8dB | 19 | 19.6 | 19.5 | 19 | 19.6 | 0.8 | PASS |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Attenuation setting from UHD code for AD9361** | **CH2 Output Power Control** | | | | **MIN** |  | **MARGIN**  **IN (dBm)** | **RESULT** |
| **Specification** | **DCS-1800** | | | **MAX** |
| **B** | **M** | **T** |  |
| Output power level in dBm with 0dB attenuation | >-5dBm | -2.7 | -3.1 | -3.1 | -3.1 | -2.7 | 1.9 | PASS |
| Output power level in dBm with 10dB attenuation | >-15dBm | -12.2 | -12.5 | -12.5 | -12.5 | -12.2 | 2.5 | PASS |
| Attenuation in dB with 10dB atten setting in AD9361 | 10dB(+/- 2dB) | 9.5 | 9.4 | 9.4 | 9.4 | 9.5 | 1.4 | PASS |
| Output power level in dBm with 20dB attenuation | >-25dBm | -21.7 | -21.9 | -22.1 | -22.1 | -21.7 | 2.9 | PASS |
| Attenuation in dB with 20dB atten setting in AD9361 | 20dB(+/- 2dB) | 19 | 18.8 | 19 | 18.8 | 19 | 0.8 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Modulation Accuracy –TRx – Pipe 2

# Test ID

TRX 2.3

# Purpose

The purpose of this test case is, Phase error and EVM are fundamental parameters used in GSM to characterize modulation accuracy. These measurements reveal much about a transmitter’s performance. Poor phase error or EVM indicates a problem with the I/Q baseband generator, filters, modulator or amplifier in the transmitter circuitry.

# Test and Measurement Method

Refer to section 8.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **GSM 900** | | | | | |
| **RMS(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin in (deg)** |
| **< RMS(deg)** | **< RMS(deg)** | **B** | **M** | **T** |
| GMSK | 3.6 | 5 | 0.41 | 0.42 | 0.4 | 0.4 | 0.42 | 3.18 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **GSM 900** | | | | | |
| **PEAK(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin in (deg)** |
| **< PEAK(deg)** | **< PEAK(deg)** | **B** | **M** | **T** |
| GMSK | 14.2 | 20 | 1.01 | 1.12 | 0.96 | 0.96 | 1.12 | 13.08 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Mean Frequency Error** | | | | | | **Min (Hz)** | **Max (Hz)** | **Margin** **in (Hz)** | **Result** |
| **Modulation** | **Specification(R&D)** | **Specification(normal)** | **GSM 900** | | |
| **ppm / Hz** | **ppm / Hz** | **B(Hz)** | **M(Hz)** | **T(Hz)** |
| GMSK | < 0.03/±27Hz | < 0.05/±45Hz | -0.31 | -0.49 | 0.31 | -0.49 | 0.31 | 26.51 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **DCS 1800** | | | | | |
| **RMS(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin** **in (deg)** |
| **< RMS(deg)** | **< RMS(deg)** | **B** | **M** | **T** |
| GMSK | 3.6 | 5 | 0.4 | 0.44 | 0.47 | 0.4 | 0.47 | 3.13 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **DCS 1800** | | | | | |
| **PEAK(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin** **in (deg)** |
| **< PEAK(deg)** | **< PEAK(deg)** | **B** | **M** | **T** |
| GMSK | 14.2 | 20 | 0.97 | 1.17 | 1.24 | 0.97 | 1.24 | 12.96 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Mean Frequency Error** | | | | | | **Min (Hz)** | **Max (Hz)** | **Margin** **in (Hz)** | **Result** |
| **Modulation** | **Specification(R&D)** | **Specification(normal)** | **DCS 1800** | | |
| **ppm / Hz** | **ppm / Hz** | **B(Hz)** | **M(Hz)** | **T(Hz)** |
| GMSK | < 0.03/±54Hz | < 0.05/±90Hz | 0.01 | -0.35 | -0.9 | -0.9 | 0.01 | 53.1 | PASS |

# Test and Measurement Logs



# AD9361 Local Oscillator lock detect- Pipe 1&2

# Test ID

TRX 1.5 and TRX 2.5.

# Purpose

The purpose of this test case is to verify whether AD9361 Local oscillator is locked or not.

# Test and Measurement Method

Refer to section 8.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

# Test Results

Pass, All lock detects from AD9361 GPIO out pins are high. (>1.8V)

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Output RF Spectrum- i) Adjacent channel power-TRx Pipe 2

# Test ID

TRX 2.6

# Purpose

The purpose of this test case is the modulation process in a transmitter causes the continuous wave (CW) Carrier to spread spectrally. The “spectrum due to modulation and wideband noise” measurement is used to ensure that modulation process does not cause excessive spectral spread. If it did, other users who are operating on different frequencies would experience interference. The measurement of spectrum due to modulation and wideband noise can be thought of as an adjacent channel power (ACP).

# Test and Measurement Method

Refer to section 8.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Signal output level: 0dBm

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_spectrum due to modulation** | | | | | | | | | | | | **Result** |
| **Specification** | | | **GSM 900 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin** **in (dB)** |
| **offset frequency** | **< dBc** | **RBW KHz** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 100KHz | 0.5 | 30 | -10.11 | -8.02 | -9.87 | -7.77 | -9.13 | -9.64 | -10.11 | -7.77 | 7.27 | PASS |
| 200KHz | -30 | 30 | -37.79 | -37.52 | -37.37 | -37.24 | -38.58 | -37.59 | -38.58 | -37.24 | 7.24 | PASS |
| 250KHz | -33 | 30 | -40.37 | -41.74 | -40.31 | -41.62 | -40.68 | -41.72 | -41.74 | -40.31 | 7.31 | PASS |
| 400KHz | -60 | 30 | -61.45 | -62.07 | -61.78 | -61.51 | -63.74 | -63.83 | -63.83 | -61.45 | 1.45 | PASS |
| 600KHz to 1200KHz | -60 | 30 | -69.26 | -68.86 | -69.07 | -68.46 | -70.02 | -69.7 | -70.02 | -68.46 | 8.46 | PASS |
| 1200KHz to 1800KHz | -63 | 30 | -73.06 | -73.15 | -72.71 | -72.72 | -73.99 | -74.2 | -74.2 | -72.71 | 9.71 | PASS |
| 1800KHz to 6000KHz | -65 | 100 | -73 | -72.7 | -72.74 | -72.67 | -73.92 | -73.9 | -73.92 | -72.67 | 7.67 | PASS |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_spectrum due to modulation** | | | | | | | | | | | | **Result** |
| **Specification** | | | **DCS 1800 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin** **in (dB)** |
| **offset frequency** | **< dBc** | **RBW KHz** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 100KHz | 0.5 | 30 | -8.9 | -9.19 | -8.81 | -9.35 | -8.88 | -9.42 | -9.42 | -8.81 | 8.31 | PASS |
| 200KHz | -30 | 30 | -38.17 | -37.32 | -38.03 | -37.43 | -38.26 | -37.44 | -38.26 | -37.32 | 7.32 | PASS |
| 250KHz | -33 | 30 | -40.32 | -41.28 | -40.11 | -41.41 | -40.17 | -41.65 | -41.65 | -40.11 | 7.11 | PASS |
| 400KHz | -60 | 30 | -62.39 | -62.7 | -59.63 | -60.08 | -59.74 | -60.56 | -62.7 | -59.63 | -0.37 | FAIL |
| 600KHz to 1200KHz | -60 | 30 | -69.3 | -68.79 | -64.37 | -64.66 | -64.6 | -64.27 | -69.3 | -64.27 | 8.27 | PASS |
| 1200KHz to 1800KHz | -63 | 30 | -73.7 | -73.86 | -69.99 | -69.62 | -69.79 | -70.33 | -73.86 | -69.62 | 6.62 | PASS |
| 1800KHz to 6000KHz | -65 | 100 | -73.2 | -74 | -71.2 | -71.27 | -71.8 | -71.88 | -74 | -71.2 | 6.2 | PASS |

**Resolution for failure:**

We are meeting spectrum due to modulation requirements with only one chain at AD9361 active. When two chains of AD9361 are active the output of one chain is not stable (not all time slots are ON only burst broadcast channel is seen).

# Test and Measurement Logs



# ii) Spectrum due to switching- TRx Pipe 2

# Test ID

TRX 2.6

# Purpose

The purpose of this test case is the GSM/EDGE transmitter’s ramp RF power rapidly. The “transmitted RF carrier power versus time” measurement is used to ensure that this process happens at the correct times and happens fast enough. However, if RF power is ramped too quickly, undesirable spectral components exist in the transmission. This measurement is used to ensure that these components are below the acceptable level.

# Test and Measurement Method

Refer to section 8.1.6 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_spectrum due to switching** | | | | | | | | | | | **Result** |
| **Specification** | | **GSM 900 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin** **in (dB)** |  |
| **offset frequency** | **< dBc** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 400 KHz | -57 | -58.24 | -59.04 | -56.22 | -58.85 | -57.55 | -58.91 | -59.04 | -56.22 | -0.78 | FAIL |
| 600 KHz | -67 | -64.35 | -64.37 | -64.43 | -64.76 | -64.27 | -63.8 | -64.76 | -63.8 | -3.2 | FAIL |
| 1200 KHz | -74 | -68.15 | -67.14 | -68 | -65.92 | -68.31 | -66.22 | -68.31 | -65.92 | -8.08 | FAIL |
| 1800 KHz | -74 | -74.46 | -74.66 | -73.96 | -74.75 | -74.24 | -74.22 | -74.75 | -73.96 | -0.04 | FAIL |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_spectrum due to switching** | | | | | | | | | | | **Result** |
| **Specification** | | **DCS 1800 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin** **in (dB)** |  |
| **offset frequency** | **< dBc** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 400 KHz | -50 | -58.29 | -58.52 | -53.43 | -55.64 | -54.44 | -54.8 | -58.52 | -53.43 | 3.43 | PASS |
| 600 KHz | -58 | -63.57 | -62.41 | -59.54 | -57.52 | -59.44 | -59.61 | -63.57 | -57.52 | -0.48 | FAIL |
| 1200 KHz | -66 | -67.84 | -66.74 | -63.55 | -62.83 | -63.37 | -62.63 | -67.84 | -62.63 | -3.37 | FAIL |
| 1800 KHz | -66 | -73.34 | -74.05 | -71.72 | -70.45 | -71.39 | -71.88 | -74.05 | -70.45 | 4.45 | PASS |

**Resolution for failure:**

We are meeting spectrum due to switching requirements with only one chain at AD9361 active. When two chains of AD9361 are active the output of one chain is not stable (not all time slots are ON only burst broadcast channel is seen).

# Test and Measurement Logs



# Carrier leakage – Pipe2

# Test ID

TRX 2.4

# Purpose

The purpose of this test case is to check carrier leakage that is possible from AD9361 transceiver LO.

# Test and Measurement Method

Refer to section 8.1.7 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Carrier Leakage at 0dB attenuation** | **Spec in dBc** | **Carrier leakage in dBc** | | | **Margin from Spec in dB** | **Result** |
| **B** | **M** | **T** | PASS |
| **Chain2** | -50 | -51.6 | -50.68 | -52.1 | 0.68 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Chain2** | | | | | | |
|  | **Wanted signal power in dBm** | | | **Carrier leakage including 2dB cable loss in dBm** | | |
| **Band** | **B** | **M** | **T** | **B** | **M** | **T** |
| 900 | -1.5 | -1.4 | -1.6 | -56.15 | -56 | -55.67 |
| 1800 | -2.7 | -3.1 | -3.1 | -57.32 | -52.7 | -53.4 |

# Test and Measurement Logs



Test Result for TRX 1.7, 1.8, 2.7 and 2.8 are missing

# TX pipe – 1

# Gain-Pipe1

# Test ID

TX\_P 1.1

# Purpose

The purpose of this test case is to verify and validate TX – Pipe1 gain (excluding AD9361 transceiver).

# Test and Measurement Method

Refer to section 9.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results (Rev-A)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Gain Specification (dB)** | **Input Signal (dBm)** | **Measured Output Power (dBm)** | | | **Overall Gain (dB)** | | | **Margin** **in (dB)** | **RESULT** |
| **B** | **M** | **T** | **B** | **M** | **T** |
| E-GSM-900 | 43 | -24 | 29.1 | 30.8 | 30.6 | 49.1 | 50.8 | 50.6 | 6.1 | PASS |
| GSM-850 | 43 | -24 | 30.6 | 31.2 | 30.1 | 50.6 | 51.2 | 50.1 | 7.1 | PASS |
| DCS-1800 | 43 | -16 | 26 | 27.9 | 29 | 46 | 47.9 | 49 | 3 | PASS |
| DCS-1900 | 43 | -16 | 24.5 | 25.4 | 26 | 44.5 | 45.4 | 46 | 1.5 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Attenuation and Attenuation step- TX Pipe1

# Test ID

TX\_P 1.2 and TX\_P 1.3

# Purpose

The purpose of this test case is to verify TX – Pipe1 digital attenuator attenuation and attenuation step (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 9.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **I/P Power (dBm)** | **Attenuation (dB)** | **Overall power after attenuation (dBm)** | **Gain (dB)** | **Spec (dB)** | **Margin (dB)** | **Result** |
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| E-GSM-900 | -22 | 0 | 29.5 | 51.5 | ≥ 43 | 8.5 | PASS |
| 0.5 | 28.9 | 50.9 | ≥ 42.5 | 8.4 |
| 1 | 28.4 | 50.4 | ≥ 42 | 8.4 |
| 2 | 27.5 | 49.5 | ≥ 41 | 8.5 |
| 4 | 25.5 | 47.5 | ≥ 39 | 8.5 |
| 8 | 21.6 | 43.6 | ≥ 35 | 8.6 |
| 15.5 | 14.3 | 36.3 | ≥ 27.5 | 8.8 |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| **Band** | **I/P Power (dBm)** | **Attenuation (dB)** | **Overall power after attenuation (dBm)** | **Gain (dB)** | **Spec (dB)** | **Margin (dB)** | **Result** |
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| DCS-1800 | -14 | 0 | 31.7 | 45.7 | ≥ 43 | 2.7 | PASS |
| 0.5 | 31.3 | 45.3 | ≥ 42.5 | 2.8 |
| 1 | 30.8 | 44.8 | ≥ 42 | 2.8 |
| 2 | 29.7 | 43.7 | ≥ 41 | 2.7 |
| 4 | 27.8 | 41.8 | ≥ 39 | 2.8 |
| 8 | 24 | 38 | ≥ 35 | 3 |
| 15.5 | 16.6 | 30.6 | ≥ 27.5 | 3.1 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| E-GSM  -900 | 0 | 51.5 | 0 | NA | NA | PASS |
| 0.5 | 50.9 | 0.6 | 0.35-0.65 | 0.05 | PASS |
| 1 | 50.4 | 1.1 | 0.85-1.15 | 0.05 | PASS |
| 2 | 49.5 | 2 | 1.75-2.25 | 0.25 | PASS |
| 4 | 47.5 | 4 | 3.75-4.25 | 0.25 | PASS |
| 8 | 43.6 | 7.9 | 7.5-8.5 | 0.4 | PASS |
| 15.5 | 36.3 | 15.2 | 15-16 | 0.2 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| DCS-1800 | 0 | 45.7 | 0 | NA | NA | PASS |
| 0.5 | 45.3 | 0.4 | 0.35-0.65 | 0.05 | PASS |
| 1 | 44.8 | 0.9 | 0.85-1.15 | 0.05 | PASS |
| 2 | 43.7 | 2 | 1.75-2.25 | 0.25 | PASS |
| 4 | 41.8 | 3.9 | 3.75-4.25 | 0.15 | PASS |
| 8 | 38 | 7.7 | 7.5-8.5 | 0.2 | PASS |
| 15.5 | 30.6 | 15.1 | 15-16 | 0.1 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Output Power- TX Pipe 1

# Test ID

TX\_P 1.4

# Purpose

The purpose of this test case is to verify TX – Pipe1 output power at antenna port (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 9.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Output power Specification (dB)** | **Input Signal (dBm)** | **Measured Output Power (dBm)** | | | **Output power Margin**  **(dB)** | **RESULT** |
| **B** | **M** | **T** |
| E-GSM-900 | 33 ± 2 | -24 | 31.1 | 31.8 | 31.6 | 0.1 | PASS |
| DCS-1800 | 33 ± 2 | -16 | 31.8 | 32.2 | 32.1 | 0.8 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# RF power detection – TX Pipe1

# Test ID

TX\_P 1.5

# Purpose

The purpose of this test case is to verify TX – Pipe1 RF Power detection at antenna port (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 9.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power at Antenna Port (dBm)** | **Power at Input of Power Detector (dBm)** | **ADC Decimal Value** | **ADC Binary Value** | **RESULT** |
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| 29.5 | -7.5 | 24 | 00011000 | PASS |
| 28.9 | -8.1 | 23 | 00010111 | PASS |
| 28.4 | -8.6 | 21 | 00010101 | PASS |
| 27.5 | -9.5 | 19 | 00010011 | PASS |
| 25.5 | -11.5 | 14 | 00001110 | PASS |
| 21.6 | -15.4 | 9 | 00001001 | PASS |
| 14.3 | -22.7 | 5 | 00000101 | PASS |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| **Power at Antenna Port (dBm)** | **Power at Input of Power Detector (dBm)** | **ADC Decimal Value** | **ADC Binary Value** | **RESULT** |
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| 31.7 | -5.3 | 30 | 00011110 | PASS |
| 31.3 | -5.7 | 28 | 00011100 | PASS |
| 30.8 | -6.2 | 28 | 00011100 | PASS |
| 29.7 | -7.3 | 23 | 00010111 | PASS |
| 27.8 | -9.2 | 19 | 00010011 | PASS |
| 24 | -13 | 11 | 00001011 | PASS |
| 16.6 | -20.4 | 4 | 00000100 | PASS |

# TX pipe – 2

# Gain-Pipe2

# Test ID

TX\_P 2.1

# Purpose

The purpose of this test case is to verify TX – Pipe2 gain (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 10.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

# Test Results (Rev-A)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Gain Specification (dB)** | **Input Signal (dBm)** | **Measured Output Power (dBm)** | | | **Overall Gain (dB)** | | | **Min Gain Margin in (dB)** | **RESULT** |
| **B** | **M** | **T** | **B** | **M** | **T** |
| E-GSM-900 | 43 | -24 | 30.1 | 31.8 | 31.6 | 50.1 | 51.8 | 51.6 | 7.1 | PASS |
| GSM-850 | 43 | -24 | 31.6 | 32.2 | 31.2 | 51.6 | 52.2 | 51.2 | 8.2 | PASS |
| DCS-1800 | 43 | -16 | 26.8 | 28.4 | 31.2 | 46.8 | 48.4 | 51.2 | 3.8 | PASS |
| PCS-1900 | 43 | -16 | 24.5 | 25.8 | 26.1 | 44.5 | 45.8 | 46.1 | 1.5 | PASS |
|  |  |  |  |  |  |  |  |  |  |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Attenuation and Attenuation step- TX Pipe2

# Test ID

TX\_P 2.2 and TX\_P 2.3

# Purpose

The purpose of this test case is to verify TX – Pipe2 digital attenuator attenuation and attenuation step (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 10.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **I/P Power (dBm)** | **Attenuation (dB)** | **Overall power after attenuation (dBm)** | **Gain(dB)** | **Spec (dB)** | **Margin(dB)** | **Result** |
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| E-GSM-900 | -22 | 0 | 29.7 | 51.7 | ≥ 43 | 8.7 | PASS |
| 0.5 | 29.1 | 51.1 | ≥ 42.5 | 8.6 |
| 1 | 28.6 | 50.6 | ≥ 42 | 8.6 |
| 2 | 27.6 | 49.6 | ≥ 41 | 8.6 |
| 4 | 25.6 | 47.6 | ≥ 39 | 8.6 |
| 8 | 21.6 | 43.6 | ≥ 35 | 8.6 |
| 15.5 | 14.3 | 36.3 | ≥ 27.5 | 8.8 |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| **Band** | **I/P Power (dBm)** | **Attenuation (dB)** | **Overall power after attenuation (dBm)** | **Gain(dB)** | **Spec (dB)** | **Margin(dB)** | **Result** |
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| DCS-1800 | -14 | 0 | 32.7 | 46.7 | ≥ 43 | 3.7 | PASS |
| 0.5 | 32.3 | 46.3 | ≥ 42.5 | 3.8 |
| 1 | 31.9 | 45.9 | ≥ 42 | 3.9 |
| 2 | 30.9 | 44.9 | ≥ 41 | 3.9 |
| 4 | 28.9 | 42.9 | ≥ 39 | 3.9 |
| 8 | 25.1 | 39.1 | ≥ 35 | 4.1 |
| 15.5 | 17.9 | 31.6 | ≥ 27.5 | 4.4 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| E-GSM  -900 | 0 | 51.7 | 0 | NA | NA | PASS |
| 0.5 | 51.1 | 0.6 | 0.35-0.65 | 0.05 | PASS |
| 1 | 50.6 | 1.1 | 0.85-1.15 | 0.15 | PASS |
| 2 | 49.6 | 2.1 | 1.75-2.25 | 0.15 | PASS |
| 4 | 47.6 | 4.1 | 3.75-4.25 | 0.15 | PASS |
| 8 | 43.6 | 8.1 | 7.5-8.5 | 0.4 | PASS |
| 15.5 | 36.3 | 15.4 | 15-16 | 0.4 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| DCS-1800 | 0 | 46.7 | 0 | NA | NA | PASS |
| 0.5 | 46.3 | 0.4 | 0.35-0.65 | 0.05 | PASS |
| 1 | 45.9 | 0.8 | 0.85-1.15 | 0.05 | PASS |
| 2 | 44.9 | 1.8 | 1.75-2.25 | 0.05 | PASS |
| 4 | 42.9 | 3.8 | 3.75-4.25 | 0.05 | PASS |
| 8 | 39.1 | 7.6 | 7.5-8.5 | 0.1 | PASS |
| 15.5 | 31.6 | 15.1 | 15-16 | 0.1 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Output Power- TX Pipe 2

# Test ID

TX\_P 2.4

# Purpose

The purpose of this test case is to verify TX – Pipe2 output power at antenna port (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 10.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Output power Specification (dB)** | **Input Signal (dBm)** | **Measured Output Power (dBm)** | | | **Output power Margin** **in**  **(dBm)** | **RESULT** |
| **B** | **M** | **T** |
| E-GSM-900 | 33 ± 2 | -24 | 31 | 31.329 | 31.2 | 0 | PASS |
| DCS-1800 | 33 ± 2 | -16 | 31.560 | 32.690 | 32.393 | 0.5 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# RF power detection – Tx Pipe 2

# Test ID

TX\_P 2.5

# Purpose

The purpose of this test case is to verify TX – Pipe 2 RF Power detection at antenna port (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 10.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power at Antenna port (dBm)** | **Power at Input of Power Detector (dBm)** | **ADC Decimal Value** | **ADC Binary Value** | **RESULT** |
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| 29.7 | -7.3 | 24 | 00011000 | PASS |
| 29.1 | -7.9 | 23 | 00010111 | PASS |
| 28.6 | -8.4 | 22 | 00010110 | PASS |
| 27.6 | -9.4 | 19 | 00010011 | PASS |
| 25.6 | -11.4 | 15 | 00001111 | PASS |
| 21.6 | -15.4 | 9 | 00001001 | PASS |
| 14.3 | -22.7 | 2 | 00000010 | PASS |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| **Power at Antenna port (dBm)** | **Power at Input of Power Detector (dBm)** | **ADC Decimal Value** | **ADC Binary Value** | **RESULT** |
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| 32.7 | -4.3 | 33 | 00100001 | PASS |
| 32.3 | -4.7 | 33 | 00100001 | PASS |
| 31.9 | -5.1 | 30 | 00011110 | PASS |
| 30.9 | -6.1 | 27 | 00011011 | PASS |
| 28.9 | -8.1 | 22 | 00010110 | PASS |
| 25.1 | -11.9 | 14 | 00001110 | PASS |
| 17.9 | -19.1 | 5 | 00000101 | PASS |

# RX pipe – 1

# Noise Figure and Gain – Rx Pipe-1

# Test ID

RX\_P 1.1 and RX\_P 1.2

# Purpose

The purpose of this test case is to verify Rx Pipe -1 Noise Figure and Gain for all four bands at antenna port (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 11.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

# Test Results for Noise Figure

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Noise Figure specification**  **(dB)** | **I/P Signal from Noise Source**  **ENR in dB** | **Measured Noise Figure (dB)** | | | **Margin(dB)** | **Result** |
| **B** | **M** | **T** |  |
| E-GSM-900 | < 7 | 15.20 | 6.9942 | 4.6031 | 9.7379 | 2.7379 | FAIL |
| GSM-850 | < 7 | 15.20 | 5.6602 | 6.8264 | 8.6216 | 1.6216 | FAIL |
| DCS-1800 | < 7 | 15.20 | 5.0506 | 4.8100 | 7.0427 | 1.0427 | FAIL |
| PCS-1900 | < 7 | 15.20 | 6.4666 | 5.074 | 8.0144 | 1.0144 | FAIL |
|  |  |  |  |  |  |  |

# Test Results for Gain

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Gain specification**  **(dB)** | **I/P Signal from Noise Source**  **ENR in dB** | **Measured Gain (dB)** | | | **Margin** **in (dB)** | **RESULT** |
| **B** | **M** | **T** |
| E-GSM-900 | ≥ 5 | 15.20 | 8.924 | 10.736 | 7.130 | 2.130 | PASS |
| GSM-850 | ≥ 5 | 15.20 | 11.117 | 10.621 | 7.787 | 2.787 | PASS |
| DCS-1800 | ≥ 5 | 15.20 | 6.542 | 6.124 | 3.995 | -1.005 | FAIL |
| PCS-1900 | ≥ 5 | 15.20 | 5.563 | 4.770 | 1.582 | -3.418 | FAIL |
|  |  |  |  |  |  |  |

**Resolution for failure:**

We have removed switches and changed low noise amplifier part which is having high gain in REV\_C design,through which we can improve noise figure and gain at band edges for 1800 and 1900 bands.

# Test and Measurement Logs



# Attenuation and Attenuation step- Rx Pipe1

# Test ID

RX\_P 1.3 and RX\_P 1.4

# Purpose

The purpose of this test case is to verify RX – Pipe1 digital attenuator attenuation and attenuation step (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 11.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Input Power (dBm)** | **Attenuation (dB)** | **Overall Power after Attenuation (dBm)** | **Gain(dB)** | **Spec (dB)** | **Margin(dB)** | **Result** |
| **902(MHz)** | **902(MHz)** | **902(MHz)** | **902(MHz)** | **902(MHz)** |
| E-GSM-900 | -30 | 0 | -21.2 | 8.8 | ≥ 5 | 3.8 | PASS |
| 0.5 | -21.7 | 8.3 | ≥ 4.5 | 3.8 | PASS |
| 1 | -22.2 | 7.8 | ≥ 4 | 3.8 | PASS |
| 2 | -23.2 | 6.8 | ≥ 3 | 3.8 | PASS |
| 4 | -25.2 | 4.8 | ≥1 | 3.8 | PASS |
| 8 | -29.2 | 0.8 | ≥ -3 | 3.8 | PASS |
| 15.5 | -36.6 | -6.6 | ≥ -10.5 | 3.9 | PASS |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Input Power (dBm)** | **Attenuation (dB)** | **Overall Power after Attenuation (dBm)** | **Gain(dB)** | **Spec (dB)** | **Margin(dB)** | **Result** |
| **1747(MHz)** | **1747(MHz)** | **1747(MHz)** | **1747(MHz)** | **1747(MHz)** |
| DCS-1800 | -30 | 0 | -24.4 | 5.6 | ≥ 5 | 1.6 | PASS |
| 0.5 | -25 | 5 | ≥ 4.5 | 0.5 | PASS |
| 1 | -25.5 | 4.5 | ≥ 4 | 0.5 | PASS |
| 2 | -26.6 | 3.4 | ≥ 3 | 0.4 | PASS |
| 4 | -28.6 | 1.4 | ≥1 | 0.4 | PASS |
| 8 | -32.8 | -2.8 | ≥ -3 | 0.2 | PASS |
| 15.5 | -40.4 | -10.4 | ≥ -10.5 | 0.1 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| E-GSM  -900 | 0 | 8.8 | 0 | NA | NA | PASS |
| 0.5 | 8.3 | 0.5 | 0.35-0.65 | 0.15 | PASS |
| 1 | 7.8 | 1 | 0.85-1.15 | 0.15 | PASS |
| 2 | 6.8 | 2 | 1.75-2.25 | 0.25 | PASS |
| 4 | 4.8 | 4 | 3.75-4.25 | 0.25 | PASS |
| 8 | 0.8 | 8 | 7.5-8.5 | 0.5 | PASS |
| 15.5 | -6.6 | 15.4 | 15-16 | 0.4 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| DCS-1800 | 0 | 5.6 | 0 | NA | NA | PASS |
| 0.5 | 5 | 0.6 | 0.35-0.65 | 0.05 | PASS |
| 1 | 4.5 | 1.1 | 0.85-1.15 | 0.05 | PASS |
| 2 | 3.4 | 2.2 | 1.75-2.25 | 0.05 | PASS |
| 4 | 1.4 | 4.2 | 3.75-4.25 | 0.05 | PASS |
| 8 | -2.8 | 8.4 | 7.5-8.5 | 0.1 | PASS |
| 15.5 | -10.4 | 16 | 15-16 | 0 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# RX pipe -2

# Noise Figure and Gain – Rx Pipe-2

# Test ID

RX\_P 2.1 and RX\_P 2.2

# Purpose

The purpose of this test case is to verify Rx Pipe -2 Noise Figure and Gain for all four bands at antenna port (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 12.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

# Test Results for Noise Figure

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Noise Figure specification**  **(dB)** | **I/P Signal from Noise Source**  **ENR in dB** | **Measured Noise Figure (dB)** | | |  | **RESULT** |
| **B** | **M** | **T** | **Margin(dB)** |
| E-GSM-900 | < 7 | 15.20 | 6.2058 | 4.4882 | 8.6773 | 1.6773 | FAIL |
| GSM-850 | < 7 | 15.20 | 6.1122 | 10.3793 | 8.1498 | 1.1498 | FAIL |
| DCS-1800 | < 7 | 15.20 | 4.7813 | 4.6170 | 11.4487 | 4.4487 | FAIL |
| PCS-1900 | < 7 | 15.20 | 5.7172 | 5.1511 | 7.8780 | 0.878 | FAIL |
|  |  |  |  |  |  |  |

# Test Results for Gain

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Gain specification**  **(dB)** | **I/P Signal from Noise Source**  **ENR in dB** | **Measured Gain (dB)** | | | **Margin in (dB)** | **RESULT** |
| **B** | **M** | **T** |
| E-GSM-900 | ≥ 5 | 15.20 | 9.784 | 11.113 | 7.367 | 2.367 | PASS |
| GSM-850 | ≥ 5 | 15.20 | 11.044 | 11.338 | 8.588 | 3.588 | PASS |
| DCS-1800 | ≥ 5 | 15.20 | 6.981 | 6.187 | -2.27 | -7.27 | FAIL |
| PCS-1900 | ≥ 5 | 15.20 | 6.086 | 4.946 | 1.695 | -3.305 | FAIL |
|  |  |  |  |  |  |  |

**Resolution for failure:**

We have removed switches and changed low noise amplifier part which is having high gain in REV\_C design,through which we can improve noise figure and gain at band edges for 1800 and 1900 bands.

# Test and Measurement Logs



# Attenuation and Attenuation step- Rx Pipe2

# Test ID

RX\_P 2.3 and RX\_P 2.4

# Purpose

The purpose of this test case is to verify RX – Pipe2 digital attenuator attenuation and attenuation step (excluding Transceiver AD9361).

# Test and Measurement Method

Refer to section 12.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Input Power (dBm)** | **Attenuation (dB)** | **Overall Power after Attenuation (dBm)** | **Gain(dB)** | **Spec (dB)** | **Margin(dB)** | **Result** |
| **902(MHz)** | **902(MHz)** | **902(MHz)** | **902(MHz)** | **902(MHz)** |
| E-GSM-900 | -30 | 0 | -21.2 | 8.8 | ≥ 5 | 3.8 | PASS |
| 0.5 | -21.7 | 8.3 | ≥ 4.5 | 3.8 | PASS |
| 1 | -22.2 | 7.8 | ≥ 4 | 3.8 | PASS |
| 2 | -23.1 | 6.9 | ≥ 3 | 3.9 | PASS |
| 4 | -25.2 | 4.8 | ≥1 | 3.8 | PASS |
| 8 | -29.1 | 0.9 | ≥ -3 | 3.9 | PASS |
| 15.5 | -36.5 | -6.5 | ≥ -10.5 | 4 | PASS |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Input Power (dBm)** | **Attenuation (dB)** | **Overall Power after Attenuation (dBm)** | **Gain(dB)** | **Spec (dB)** | **Margin(dB)** | **Result** |
| **1747(MHz)** | **1747(MHz)** | **1747(MHz)** | **1747(MHz)** | **1747(MHz)** |
| DCS-1800 | -30 | 0 | -24 | 6 | ≥ 5 | 1.6 | PASS |
| 0.5 | -24.7 | 5.3 | ≥ 4.5 | 0.8 | PASS |
| 1 | -25.3 | 4.7 | ≥ 4 | 0.7 | PASS |
| 2 | -26.4 | 3.6 | ≥ 3 | 0.6 | PASS |
| 4 | -28.5 | 1.5 | ≥1 | 0.5 | PASS |
| 8 | -32.6 | -2.6 | ≥ -3 | 0.4 | PASS |
| 15.5 | -40.3 | -10.3 | ≥ -10.5 | 0.2 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| E-GSM  -900 | 0 | 8.8 | 0 | NA | NA | PASS |
| 0.5 | 8.3 | 0.5 | 0.35-0.65 | 0.15 | PASS |
| 1 | 7.8 | 1 | 0.85-1.15 | 0.15 | PASS |
| 2 | 6.9 | 1.9 | 1.75-2.25 | 0.15 | PASS |
| 4 | 4.8 | 4 | 3.75-4.25 | 0.25 | PASS |
| 8 | 0.9 | 7.9 | 7.5-8.5 | 0.4 | PASS |
| 15.5 | -6.5 | 15.3 | 15-16 | 0.3 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| DCS-1800 | 0 | 6 | -0.4 | NA | NA | PASS |
| 0.5 | 5.3 | 0.3 | 0.35-0.65 | 0.05 | PASS |
| 1 | 4.7 | 0.9 | 0.85-1.15 | 0.05 | PASS |
| 2 | 3.6 | 2 | 1.75-2.25 | 0.25 | PASS |
| 4 | 1.5 | 4.1 | 3.75-4.25 | 0.15 | PASS |
| 8 | -2.6 | 8.2 | 7.5-8.5 | 0.3 | PASS |
| 15.5 | -10.3 | 15.9 | 15-16 | 0.1 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Transmitter \_Chain 1

# i) Output Power- TX Chain 1

# Test ID

TX\_C 1.2

# Purpose

The purpose of this test case is to verify TX – Chain 1 output power at antenna port.

# Test and Measurement Method

Refer to section 13.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Output power Specification (dB)** | **Input Signal (dBm)** | **Measured Output Power (dBm)** | | | **Output power Margin** **in**  **(dBm)** | **RESULT** |
| **B** | **M** | **T** |
| E-GSM-900 | 33 ± 2 | -22 | 32.1 | 32.6 | 32.4 | 1.1 | PASS |
| DCS-1800 | 33 ± 2 | -14 | 31.5 | 32 | 31.6 | 0.5 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Power Vs Time – TX Chain 1

# Test ID

TX\_C 1.2

# Purpose

The purpose of this test case is to verify TX – Chain 1 Power Vs Time at antenna port.

# Test and Measurement Method

Refer to section 13.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

PASS

# Test and Measurement Logs



# Static power control – TX chain1

# Test ID

TX\_C 1.3

# Purpose

The purpose of this test case is to verify static power control for chain1.

# Test and Measurement Method

Refer to section 13.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Input Power (dBm)** | **Attenuation (dB)** | **Overall Power after Attenuation (dBm)** | **Gain(dB)** | **Spec (≥ dB)** | **Margin(dB)** | **Result** |
| **902(MHz)** | **902(MHz)** | **902(MHz)** | **902(MHz)** | **902(MHz)** |
| E-GSM-900 | -22 | 0 | 29.5 | 51.5 | 43 | 8.5 | PASS |
| 0.5 | 28.9 | 50.9 | 42.5 | 8.4 | PASS |
| 1 | 28.4 | 50.4 | 42 | 8.4 | PASS |
| 2 | 27.5 | 49.5 | 41 | 8.5 | PASS |
| 4 | 25.5 | 47.5 | 39 | 8.5 | PASS |
| 8 | 21.6 | 43.6 | 35 | 8.6 | PASS |
| 15.5 | 14.3 | 36.3 | 27.5 | 8.8 | PASS |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Input Power (dBm)** | **Attenuation (dB)** | **Overall Power after Attenuation (dBm)** | **Gain(dB)** | **Spec (≥ dB)** | **Margin(dB)** | **Result** |
| **1747(MHz)** | **1747(MHz)** | **1747(MHz)** | **1747(MHz)** | **1747(MHz)** |
| DCS-1800 | -14 | 0 | 31.7 | 45.7 | 43 | 2.7 | PASS |
| 0.5 | 31.3 | 45.3 | 42.5 | 2.8 | PASS |
| 1 | 30.8 | 44.8 | 42 | 2.8 | PASS |
| 2 | 29.7 | 43.7 | 41 | 2.7 | PASS |
| 4 | 27.8 | 41.8 | 39 | 2.8 | PASS |
| 8 | 24 | 38 | 35 | 3 | PASS |
| 15.5 | 16.6 | 30.6 | 27.5 | 3.1 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| E-GSM  -900 | 0 | 51.5 | 0 | NA | NA | PASS |
| 0.5 | 50.9 | 0.6 | 0.35-0.65 | 0.05 | PASS |
| 1 | 50.4 | 1.1 | 0.85-1.15 | 0.05 | PASS |
| 2 | 49.5 | 2 | 1.75-2.25 | 0.25 | PASS |
| 4 | 47.5 | 4 | 3.75-4.25 | 0.25 | PASS |
| 8 | 43.6 | 7.9 | 7.5-8.5 | 0.4 | PASS |
| 15.5 | 36.3 | 15.2 | 15-16 | 0.2 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| DCS-1800 | 0 | 45.7 | 0 | NA | NA | PASS |
| 0.5 | 45.3 | 0.4 | 0.35-0.65 | 0.05 | PASS |
| 1 | 44.8 | 0.9 | 0.85-1.15 | 0.05 | PASS |
| 2 | 43.7 | 2 | 1.75-2.25 | 0.25 | PASS |
| 4 | 41.8 | 3.9 | 3.75-4.25 | 0.15 | PASS |
| 8 | 38 | 7.7 | 7.5-8.5 | 0.2 | PASS |
| 15.5 | 30.6 | 15.1 | 15-16 | 0.1 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Modulation Accuracy for TX – Chain 1

# Test ID

TX\_C\_1.4

# Purpose

The purpose of this test case is, Phase error and EVM are fundamental parameters used in GSM to characterize modulation accuracy. These measurements reveal much about a transmitter’s performance. Poor phase error or EVM indicates a problem with the I/Q baseband generator, filters, modulator or amplifier in the transmitter circuitry.

# Test and Measurement Method

Refer to section 13.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document.

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **GSM 900** | | | | | |
| **RMS(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin (deg)** |
| **RMS(deg)** | **RMS(deg)** | **B** | **M** | **T** |
| GMSK | <3.6 | <5 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 2.96 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **GSM 900** | | | | | |
| **PEAK(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin** **in (deg)** |
| **< PEAK(deg)** | **< PEAK(deg)** | **B** | **M** | **T** |
| GMSK | <14.2 | <20 | 1.55 | 1.72 | 1.71 | 1.55 | 1.72 | 12.48 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Mean Frequency Error** | | | | | | **Min (Hz)** | **Max (Hz)** | **Margin** **in (Hz)** | **Result** |
| **Modulation** | **Specification(R&D)** | **Specification(normal)** | **GSM 900** | | |
| **ppm / Hz** | **ppm / Hz** | **B(Hz)** | **M(Hz)** | **T(Hz)** |
| GMSK | < 0.03/±27Hz | < 0.05/±45Hz | -1.8 | -2.1 | -5.85 | -5.85 | -1.8 | 21.15 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **DCS 1800** | | | | | |
| **RMS(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin** **in (deg)** |
| **< RMS(deg)** | **< RMS(deg)** | **B** | **M** | **T** |
| GMSK | <3.6 | <5 | 0.53 | 0.56 | 0.62 | 0.53 | 0.62 | 2.98 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **DCS 1800** | | | | | |
| **PEAK(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin** **in (deg)** |
| **< PEAK(deg)** | **< PEAK(deg)** | **B** | **M** | **T** |
| GMSK | <14.2 | <20 | 1.33 | 1.84 | 1.68 | 1.33 | 1.84 | 12.36 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_Mean Frequency Error** | | | | | | **Min (Hz)** | **Max (Hz)** | **Margin (Hz)** | **Result** |
| **Modulation** | **Specification(R&D)** | **Specification(normal)** | **DCS 1800** | | |
| **ppm / Hz** | **ppm / Hz** | **B(Hz)** | **M(Hz)** | **T(Hz)** |
| GMSK | < 0.03/±54Hz | < 0.05/±90Hz | -1.22 | 0.38 | -1.95 | -1.95 | 0.38 | 52.05 | PASS |

# Test and Measurement Logs



# Output RF Spectrum- i) Adjacent channel power-TX Chain 1

# Test ID

TX\_C 1.5

# Purpose

The purpose of this test case is measure adjacent channel power, the modulation process in a transmitter causes the continuous wave (CW) Carrier to spread spectrally. The “spectrum due to modulation and wideband noise” measurement is used to ensure that modulation process does not cause excessive spectral spread. If it did, other users who are operating on different frequencies would experience interference. The measurement of spectrum due to modulation and wideband noise can be thought of as an adjacent channel power (ACP).

# Test and Measurement Method

Refer to section 13.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_spectrum due to modulation** | | | | | | | | | | | | **Result** |
| **Specification** | | | **GSM 900 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin(dB)** |
| **offset frequency** | **< dBc** | **RBW KHz** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 100KHz | 0.5 | 30 | -8.94 | -9.25 | -10.39 | -6.23 | -8.89 | -8.7 | -10.39 | -6.23 | 6.73 | PASS |
| 200KHz | -30 | 30 | -38.26 | -37.31 | -36.55 | -36.35 | -37.8 | -37.11 | -38.26 | -36.35 | 6.35 | PASS |
| 250KHz | -33 | 30 | -40.37 | -41.43 | -39.51 | -40.27 | -40.42 | -41.38 | -41.43 | -39.51 | 6.51 | PASS |
| 400KHz | -60 | 30 | -57.79 | -57.48 | -54.77 | -54.88 | -57.55 | -58.41 | -58.41 | -54.77 | -5.23 | FAIL |
| 600KHz to 1200KHz | -60 | 30 | -61.96 | -62.15 | -59.46 | -59.14 | -62.2 | -62.21 | -62.21 | -59.14 | -0.86 | FAIL |
| 1200KHz to 1800KHz | -63 | 30 | -72.28 | -72.24 | -69.32 | -69.39 | -72.02 | -71.79 | -72.28 | -69.32 | 6.32 | PASS |
| 1800KHz to 6000KHz | -65 | 100 | -71.97 | -72.21 | -68.79 | -69.37 | -71.43 | -71.44 | -72.21 | -68.79 | 3.79 | PASS |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_spectrum due to modulation** | | | | | | | | | | | | **Result** |
| **Specification** | | | **DCS 1800 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin(dB)** |
| **offset frequency** | **< dBc** | **RBW KHz** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 100KHz | 0.5 | 30 | -9.01 | -9.25 | -8.75 | -9.34 | -8.78 | -9.23 | -9.34 | -8.75 | 9.25 | PASS |
| 200KHz | -30 | 30 | -38.32 | -37.57 | -38.31 | -37.13 | -37.85 | -37.06 | -38.32 | -37.13 | 7.13 | PASS |
| 250KHz | -33 | 30 | -40.36 | -41.42 | -40.2 | -41.7 | -40.79 | -42.09 | -42.09 | -40.2 | 7.2 | PASS |
| 400KHz | -60 | 30 | -57.82 | -57.48 | -57.47 | -58.28 | -57.88 | -56.97 | -58.28 | -57.47 | -2.53 | FAIL |
| 600KHz to 1200KHz | -60 | 30 | -63 | -63.09 | -62.61 | -63.44 | -62 | -62.58 | -63.44 | -62 | 2 | PASS |
| 1200KHz to 1800KHz | -63 | 30 | -71.69 | -71.21 | -69.17 | -68.03 | -72.33 | -70.31 | -72.33 | -68.03 | 5.03 | PASS |
| 1800KHz to 6000KHz | -65 | 100 | -72.58 | -71.82 | -71.28 | -71.76 | -71.41 | -71.73 | -72.58 | -71.28 | 6.28 | PASS |

**Resolution for failure:**

We have seen improvement in spectrum due to modulation by changing charge pump current value in AD9361 transceiver.

# Test and Measurement Logs



# ii) Spectrum due to switching- TX Chain 1

# Test ID

TX\_C 1.5

# Purpose

The purpose of this test case is the GSM/EDGE transmitter’s ramp RF power rapidly. The “transmitted RF carrier power versus time” measurement is used to ensure that this process happens at the correct times and happens fast enough. However, if RF power is ramped too quickly, undesirable spectral components exist in the transmission. This measurement is used to ensure that these components are below the acceptable level.

# Test and Measurement Method

Refer to section 13.1.6 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_spectrum due to switching** | | | | | | | | | | | **Result** |
| **Specification** | | **GSM 900 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin(dB)** |  |
| **offset frequency** | **< dBc** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 400 KHz | -57 | -53.19 | -53.79 | -53.63 | -52.89 | -54.56 | -53.65 | -54.56 | -52.89 | -4.11 | FAIL |
| 600 KHz | -67 | -55.75 | -58.02 | -57.94 | -56.34 | -57.11 | -57.66 | -58.02 | -55.75 | -11.25 | FAIL |
| 1200 KHz | -74 | -66.55 | -66.29 | -67.42 | -67.43 | -66.14 | -66.93 | -67.43 | -66.14 | -7.86 | FAIL |
| 1800 KHz | -74 | -72.32 | -72.52 | -73.24 | -73.17 | -73.44 | -72.68 | -73.44 | -72.32 | -1.68 | FAIL |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_spectrum due to switching** | | | | | | | | | | | **Result** |
| **Specification** | | **DCS 1800 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin**  **(dB)** |  |
| **offset frequency** | **< dBc** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 400 KHz | -50 | -54.88 | -54.33 | -54.56 | -53.23 | -53.09 | -52.56 | -54.88 | -53.09 | 3.09 | PASS |
| 600 KHz | -58 | -58.79 | -58.53 | -58.51 | -54.96 | -58.36 | -56.38 | -58.79 | -54.96 | -3.04 | FAIL |
| 1200 KHz | -66 | -67.14 | -65.35 | -66.51 | -64.9 | -65.24 | -66.35 | -67.14 | -64.9 | -1.1 | FAIL |
| 1800 KHz | -66 | -74.49 | -71.99 | -73.47 | -72.76 | -72.5 | -73.01 | -74.49 | -71.99 | 5.99 | PASS |

**Resolution for failure:**

Need software support to change raise time/fall time of each time slot.

# Test and Measurement Logs



# Spurious Emissions – TX chain1

# Test ID

TX\_C 1.6

# Purpose

The purpose of this test case is to ensure GSM transmitters do not put energy into the wrong parts of the spectrum, as this would cause interference to other users of the spectrum.

# Test and Measurement Method

Refer to section 13.1.7 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_900MHZ** | | | | | | | | | | |
| **Start Frequency (MHz)** | **Start Frequency (MHz)** | **Spec (dBm)** | **RBW (KHz)** | **VBW (KHz)** | **Amplitude(dBm)** | | | **Max  (dBm)** | **Margin (dB)** | **Result** |
| **B** | **M** | **T** |
| 0.1 | 50 | -36 | 10 | 30 | no spur | no spur | no spur | 0 | 36 | PASS |
| 50 | 880 | -36 | 3000 | 9000 | -65.14 | -64.25 | -64.21 | -64.21 | 28.21 | PASS |
| 880 | 915 | -98 | 100 | 100 | -80.89 | -80.18 | -79.93 | -79.93 | -18.07 | FAIL |
| 915 | 920 | -36 | 100 | 300 | -81.44 | -80.2 | -82.25 | -80.2 | 44.2 | PASS |
| 920 | 923 | -36 | 30 | 90 | -74.5 | -77.5 | -83.02 | -74.5 | 38.5 | PASS |
| **925** | **960** |  |  |  |  |  |  |  |  |  |
| 962 | 965 | -36 | 30 | 90 | -77.86 | -71.84 | -67.02 | -67.02 | 31.02 | PASS |
| 965 | 970 | -36 | 100 | 300 | -76.35 | -70.3 | -67.58 | -67.58 | 31.58 | PASS |
| 970 | 980 | -36 | 300 | 900 | -73.31 | -72.32 | -66.38 | -66.38 | 30.38 | PASS |
| 989 | 990 | -36 | 1000 | 3000 | -71.22 | -68.24 | -69.14 | -68.24 | 32.24 | PASS |
| 990 | 1000 | -36 | 3000 | 9000 | -65.22 | -64.11 | -64.17 | -64.11 | 28.11 | PASS |
| 1000 | 12750 | -30 | 3000 | 9000 | -45.99 | -45 | -53 | -45 | 15 | PASS |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH1\_1800MHZ** | | | | | | | | | | |
| **Start Frequency (MHz)** | **Start Frequency (MHz)** | **Spec (dBm)** | **RBW (KHz)** | **VBW (KHz)** | **Amplitude(dBm)** | | | **Max  (dBm)** | **Margin (dB)** | **Result** |
| **B** | **M** | **T** |
| 0.1 | 50 | -36 | 10 | 30 | no spur | no spur | no spur | 0 | 36 | PASS |
| 50 | 1000 | -36 | 3000 | 9000 | -66.3 | -66.4 | -65.99 | -65.99 | 29.99 | PASS |
| 1000 | 1710 | -30 | 3000 | 9000 | -65 | -64.8 | -63 | -63 | 33 | PASS |
| 1710 | 1785 | -98 | 100 | 100 | -80.14 | -79.95 | -80.2 | -79.95 | -18.05 | FAIL |
| 1785 |  | -30 | 300 | 900 | -75.9 | -76.25 | -76 | -75.9 | 45.9 | PASS |
| 1795 |  | -30 | 100 | 300 | -74 | -79 | -78 | -74 | 44 | PASS |
| 1800 | 1803 | -30 | 30 | 90 | -69 | -80 | -82 | -69 | 39 | PASS |
| 1805 | 1880 |  |  |  |  |  |  |  |  |  |
| 1882 | 1885 | -30 | 30 | 90 | -82 | -73.42 | -63.51 | -63.51 | 33.51 | PASS |
| 1887 | 1890 | -30 | 100 | 300 | -76.8 | -77.3 | -65.2 | -65.2 | 35.2 | PASS |
| 1890 | 1900 | -30 | 300 | 900 | -74 | -73.63 | -60 | -60 | 30 | PASS |
| 1900 | 1910 | -30 | 1000 | 3000 | -68 | -68.28 | -62 | -62 | 32 | PASS |
| 1910 | 12750 | -30 | 3000 | 9000 | -56.76 | -65 | -61 | -56.76 | 26.76 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

**Resolution for failure:**

We have added band pass filter in REV\_C design on TX side for better rejections in self RX band.

# Transmitter \_Chain 2

# i) Output Power- TX Chain 2

# Test ID

TX\_C 2.2

# Purpose

The purpose of this test case is to verify TX – Chain 2 output power at antenna port.

# Test and Measurement Method

Refer to section 14.1.1 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Output power Specification (dB)** | **Input Signal (dBm)** | **Measured Output Power (dBm)** | | | **Output power Margin**  **(dBm)** | **RESULT** |
| **B** | **M** | **T** |
| E-GSM-900 | 33 ± 2 | -22 | 32.7 | 33.5 | 33.4 | 1.7 | PASS |
| DCS-1800 | 33 ± 2 | -14 | 31.5 | 32.6 | 32.3 | 0.5 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Power Vs Time – TX Chain 2

# Test ID

TX\_C 2.2

# Purpose

The purpose of this test case is to verify TX – Chain 2 Power Vs Time at antenna port.

# Test and Measurement Method

Refer to section 14.1.2 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

PASS

# Test and Measurement Logs



# Static power control – TX chain2

# Test ID

TX\_C 2.3

# Purpose

The purpose of this test case is to verify static power control for chain2.

# Test and Measurement Method

Refer to section 14.1.3 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

# Test Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Input Power (dBm)** | **Attenuation (dB)** | **Overall Power after Attenuation (dBm)** | **Gain(dB)** | **Spec (≥ dB)** | **Margin(dB)** | **Result** |
| **902(MHz)** | **902(MHz)** | **902(MHz)** | **902(MHz)** | **902(MHz)** |
| E-GSM-900 | -22 | 0 | 29.7 | 51.7 | 43 | 8.7 | PASS |
| 0.5 | 29.1 | 51.1 | 42.5 | 8.6 | PASS |
| 1 | 28.6 | 50.6 | 42 | 8.6 | PASS |
| 2 | 27.6 | 49.6 | 41 | 8.6 | PASS |
| 4 | 25.6 | 47.6 | 39 | 8.6 | PASS |
| 8 | 21.6 | 43.6 | 35 | 8.6 | PASS |
| 15.5 | 14.3 | 36.3 | 27.5 | 8.8 | PASS |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Input Power (dBm)** | **Attenuation (dB)** | **Overall Power after Attenuation (dBm)** | **Gain(dB)** | **Spec (≥ dB)** | **Margin(dB)** | **Result** |
| **1747(MHz)** | **1747(MHz)** | **1747(MHz)** | **1747(MHz)** | **1747(MHz)** |
| DCS-1800 | -14 | 0 | 32.7 | 46.7 | 43 | 3.7 | PASS |
| 0.5 | 32.3 | 46.3 | 42.5 | 3.8 | PASS |
| 1 | 31.9 | 45.9 | 42 | 3.9 | PASS |
| 2 | 30.9 | 44.9 | 41 | 3.9 | PASS |
| 4 | 28.9 | 42.9 | 39 | 3.9 | PASS |
| 8 | 25.1 | 39.1 | 35 | 4.1 | PASS |
| 15.5 | 17.7 | 31.7 | 27.5 | 4.2 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** | **945.2(MHz)** |
| E-GSM  -900 | 0 | 51.7 | 0 | NA | NA | PASS |
| 0.5 | 51.1 | 0.6 | 0.35-0.65 | 0.05 | PASS |
| 1 | 50.6 | 1.1 | 0.85-1.15 | 0.05 | PASS |
| 2 | 49.6 | 2.1 | 1.75-2.25 | 0.05 | PASS |
| 4 | 47.6 | 4.1 | 3.75-4.25 | 0.15 | PASS |
| 8 | 43.6 | 8.1 | 7.5-8.5 | 0.4 | PASS |
| 15.5 | 36.3 | 15.4 | 15-16 | 0.4 | PASS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band** | **Attenuation Step (dB)** | **Gain measured (dB)** | **Measured Attenuation Step (dB)** | **Spec from datasheet (dB)** | **Margin (dB)** | **Result** |
|
|
| **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** | **1842.4(MHz)** |
| DCS-1800 | 0 | 46.7 | 0 | NA | NA | PASS |
| 0.5 | 46.3 | 0.4 | 0.35-0.65 | 0.05 | PASS |
| 1 | 45.9 | 0.8 | 0.85-1.15 | 0.05 | PASS |
| 2 | 44.9 | 1.8 | 1.75-2.25 | 0.05 | PASS |
| 4 | 42.9 | 3.8 | 3.75-4.25 | 0.05 | PASS |
| 8 | 39.1 | 7.6 | 7.5-8.5 | 0.4 | PASS |
| 15.5 | 31.7 | 15 | 15-16 | 0 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

# Modulation Accuracy for TX – Chain 2

# Test ID

TX\_C\_2.4

# Purpose

The purpose of this test case is, Phase error and EVM are fundamental parameters used in GSM to characterize modulation accuracy. These measurements reveal much about a transmitter’s performance. Poor phase error or EVM indicates a problem with the I/Q baseband generator, filters, modulator or amplifier in the transmitter circuitry.

# Test and Measurement Method

Refer to section 14.1.4 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **GSM 900** | | | | | |
| **RMS(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin (deg)** |
| **< RMS(deg)** | **< RMS(deg)** | **B** | **M** | **T** |
| GMSK | 3.6 | 5 | 0.64 | 0.64 | 0.65 | 0.64 | 0.65 | 2.95 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **GSM 900** | | | | | |
| **PEAK(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin (deg)** |
| **< PEAK(deg)** | **< PEAK(deg)** | **B** | **M** | **T** |
| GMSK | 14.2 | 20 | 1.67 | 1.51 | 1.67 | 1.51 | 1.67 | 12.53 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Mean Frequency Error** | | | | | | **Min (Hz)** | **Max (Hz)** | **Margin (Hz)** | **Result** |
| **Modulation** | **Specification(R&D)** | **Specification(normal)** | **GSM 900** | | |
| **ppm / Hz** | **ppm / Hz** | **B(Hz)** | **M(Hz)** | **T(Hz)** |
| GMSK | < 0.03/±27Hz | < 0.05/±45Hz | 2.66 | -0.74 | -0.41 | -0.74 | 2.66 | 24.34 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **DCS 1800** | | | | | |
| **RMS(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin (deg)** |
| **< RMS(deg)** | **< RMS(deg)** | **B** | **M** | **T** |
| GMSK | 3.6 | 5 | 0.51 | 0.54 | 0.54 | 0.51 | 0.54 | 3.06 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Phase Error** | | | | | | | | | **Result** |
| **Modulation** | **Specification (R&D)** | **Specification (Normal)** | **DCS 1800** | | | | | |
| **PEAK(deg)** | | | **Min (deg)** | **Max (deg)** | **Margin (deg)** |
| **< PEAK(deg)** | **< PEAK(deg)** | **B** | **M** | **T** |
| GMSK | 14.2 | 20 | 1.32 | 1.46 | 1.65 | 1.32 | 1.65 | 12.55 | PASS |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_Mean Frequency Error** | | | | | | **Min (Hz)** | **Max (Hz)** | **Margin (Hz)** | **Result** |
| **Modulation** | **Specification(R&D)** | **Specification(normal)** | **DCS 1800** | | |
| **ppm / Hz** | **ppm / Hz** | **B(Hz)** | **M(Hz)** | **T(Hz)** |
| GMSK | < 0.03/±54Hz | < 0.05/±90Hz | -0.12 | -0.92 | 0.22 | -0.92 | 0.22 | 53.08 | PASS |

# Test and Measurement Logs



# Output RF Spectrum- i) Adjacent channel power-Tx Chain 2

# Test ID

TX\_C 2.5

# Purpose

The purpose of this test case is the modulation process in a transmitter causes the continuous wave (CW) Carrier to spread spectrally. The “spectrum due to modulation and wideband noise” measurement is used to ensure that modulation process does not cause excessive spectral spread. If it did, other users who are operating on different frequencies would experience interference. The measurement of spectrum due to modulation and wideband noise can be thought of as an adjacent channel power (ACP).

# Test and Measurement Method

Refer to section 14.1.5 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_spectrum due to modulation** | | | | | | | | | | | | **Result** |
| **Specification** | | | **GSM 900 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin(dB)** |
| **offset frequency** | **< dBc** | **RBW KHz** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 100KHz | 0.5 | 30 | -9.88 | -7.5 | -9.1 | -9.45 | -9.1 | -9.33 | -9.88 | -7.5 | 8 | PASS |
| 200KHz | -30 | 30 | -37.48 | -36.83 | -38.47 | -37.43 | -38.32 | -37.34 | -38.47 | -36.83 | 6.83 | PASS |
| 250KHz | -33 | 30 | -39.95 | -40.77 | -40.38 | -41.53 | -40.64 | -41.33 | -41.53 | -39.95 | 6.95 | PASS |
| 400KHz | -60 | 30 | -56.79 | -56.16 | -57.79 | -58.33 | -57.11 | -57.03 | -58.33 | -56.16 | -3.84 | FAIL |
| 600KHz to 1200KHz | -60 | 30 | -59.84 | -60.85 | -61.86 | -63.03 | -61.64 | -62.42 | -63.03 | -59.84 | -0.16 | FAIL |
| 1200KHz to 1800KHz | -63 | 30 | -70.83 | -70.51 | -72.94 | -73.19 | -72.1 | -71.64 | -73.19 | -70.51 | 7.51 | PASS |
| 1800KHz to 6000KHz | -65 | 100 | -70.38 | -70.34 | -72.25 | -72.17 | -71.11 | -71.35 | -72.25 | -70.34 | 5.34 | PASS |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_spectrum due to modulation** | | | | | | | | | | | | **Result** |
| **Specification** | | | **DCS 1800 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin(dB)** |
| **offset frequency** | **< dBc** | **RBW KHz** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 100KHz | 0.5 | 30 | -8.84 | -9.07 | -9.94 | -7.9 | -9.19 | -9.53 | -9.94 | -7.9 | 8.4 | PASS |
| 200KHz | -30 | 30 | -38.18 | -37.07 | -37.61 | -37.23 | -38.36 | -36.86 | -38.36 | -37.07 | 7.07 | PASS |
| 250KHz | -33 | 30 | -40.53 | -41.69 | -39.93 | -41.28 | -40.22 | -41.62 | -41.69 | -39.93 | 6.93 | PASS |
| 400KHz | -60 | 30 | -58.2 | -57.68 | -57.84 | -57.53 | -58.15 | -57.86 | -58.2 | -57.53 | -2.47 | FAIL |
| 600KHz to 1200KHz | -60 | 30 | -63.22 | -63.21 | -62.06 | -62.14 | -63.02 | -63.62 | -63.62 | -62.06 | 2.06 | PASS |
| 1200KHz to 1800KHz | -63 | 30 | -73 | -72.15 | -71.81 | -71.12 | -72.7 | -72.44 | -73 | -71.12 | 8.12 | PASS |
| 1800KHz to 6000KHz | -65 | 100 | -72.53 | -71.36 | -70.96 | -70.79 | -71.59 | -71.97 | -72.53 | -70.79 | 5.79 | PASS |

**Resolution for failure:**

We have seen improvement in spectrum due to modulation by changing charge pump current value in AD9361 transceiver.

# Test and Measurement Logs



# ii) Spectrum due to switching- TX Chain 2

# Test ID

TX\_C 2.5

# Purpose

The purpose of this test case is the GSM/EDGE transmitter’s ramp RF power rapidly. The “transmitted RF carrier power versus time” measurement is used to ensure that this process happens at the correct times and happens fast enough. However, if RF power is ramped too quickly, undesirable spectral components exist in the transmission. This measurement is used to ensure that these components are below the acceptable level.

# Test and Measurement Method

Refer to section 14.1.6 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_spectrum due to switching** | | | | | | | | | | | **Result** |
| **Specification** | | **GSM 900 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin**  **(dB)** |  |
| **offset frequency** | **< dBc** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 400 KHz | -57 | -53.56 | -52.57 | -52.52 | -53.17 | -53.37 | -51.34 | -53.56 | -52.52 | -4.48 | FAIL |
| 600 KHz | -67 | -56.65 | -58.21 | -56.82 | -56.69 | -57.26 | -56.43 | -58.21 | -56.65 | -10.35 | FAIL |
| 1200 KHz | -74 | -66.25 | -67.5 | -68.89 | -68.5 | -67.17 | -66.97 | -68.89 | -66.25 | -7.75 | FAIL |
| 1800 KHz | -74 | -73.34 | -73.77 | -72.28 | -72.1 | -72.81 | -72.37 | -73.77 | -72.1 | -1.9 | FAIL |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_spectrum due to switching** | | | | | | | | | | | **Result** |
| **Specification** | | **DCS 1800 Result** | | | | | | | | |
| **B(dBc)** | | **M(dBc)** | | **T(dBc)** | | **Min**  **(dBc)** | **Max**  **(dBc)** | **Margin**  **(dB)** |  |
| **offset frequency** | **< dBc** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** |
| 400 KHz | -50 | -55.79 | -54.2 | -55.35 | -55.44 | -53.76 | -54.47 | -55.79 | -53.76 | 3.76 | PASS |
| 600 KHz | -58 | -58.92 | -57.96 | -58.23 | -59.22 | -59.4 | -58.06 | -59.4 | -57.96 | -0.04 | FAIL |
| 1200 KHz | -66 | -69.7 | -68.22 | -68.84 | -68.98 | -67.95 | -67.36 | -69.7 | -67.95 | 1.95 | PASS |
| 1800 KHz | -66 | -73.79 | -72.92 | -73.6 | -74.11 | -72.52 | -73.49 | -74.11 | -72.52 | 6.52 | PASS |

**Resolution for failure:**

Need software support to change raise time/fall time of each time slot.

# Test and Measurement Logs



# Spurious Emissions – TX chain2

# Test ID

TX\_C 2.6

# Purpose

The purpose of this test case is to ensure GSM transmitters do not put energy into the wrong parts of the spectrum, as this would cause interference to other users of the spectrum.

# Test and Measurement Method

Refer to section 14.1.7 of OpenCellular – Connect1 Radio Frequency module with Software Defined Radio Test Specification document

# Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

# DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

# Test Results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_900MHZ** | | | | | | | | | | |
| **Start Frequency (MHz)** | **Start Frequency (MHz)** | **Spec (dBm)** | **RBW (KHz)** | **VBW (KHz)** | **Amplitude(dBm)** | | | **Max  (dBm)** | **Margin (dB)** | **Result** |
| **B** | **M** | **T** |
| 0.1 | 50 | -36 | 10 | 30 | no spur | no spur | no spur | 0 | 36 | PASS |
| 50 | 880 | -36 | 3000 | 9000 | -66 | -64.5 | -65 | -64.5 | 28.5 | PASS |
| 880 | 915 | -98 | 100 | 100 | -80.98 | -80.4 | -79.12 | -79.12 | -18.88 | FAIL |
| 915 | 920 | -36 | 100 | 300 | -78.6 | -79.8 | -80.28 | -78.6 | 42.6 | PASS |
| 920 | 923 | -36 | 30 | 90 | -73.4 | -78.6 | no spur | -73.4 | 37.4 | PASS |
| **925** | **960** |  |  |  |  |  |  |  |  |  |
| 962 | 965 | -36 | 30 | 90 | -80.46 | -70 | -66.25 | -66.25 | 30.25 | PASS |
| 965 | 970 | -36 | 100 | 300 | -74.41 | -67.27 | -66.6 | -66.6 | 30.6 | PASS |
| 970 | 980 | -36 | 300 | 900 | -75.7 | -72.6 | -67.63 | -67.63 | 31.63 | PASS |
| 989 | 990 | -36 | 1000 | 3000 | -71.3 | -68.99 | -69.25 | -68.99 | 32.99 | PASS |
| 990 | 1000 | -36 | 3000 | 9000 | -64.85 | -64.5 | -63.22 | -63.22 | 27.22 | PASS |
| 1000 | 12750 | -30 | 3000 | 9000 | -47.13 | -45.02 | -53.2 | -45.02 | 15.02 | PASS |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CH2\_1800MHZ** | | | | | | | | | | |
| **Start Frequency (MHz)** | **Start Frequency (MHz)** | **Spec (dBm)** | **RBW (KHz)** | **VBW (KHz)** | **Amplitude(dBm)** | | | **Max  (dBm)** | **Margin (dB)** | **Result** |
| **B** | **M** | **T** |
| 0.1 | 50 | -36 | 10 | 30 | no spur | no spur | no spur | 0 | 36 | PASS |
| 50 | 1000 | -36 | 3000 | 9000 | -66.6 | -65 | -65.14 | -65 | 29 | PASS |
| 1000 | 1710 | -30 | 3000 | 9000 | -65.2 | -63 | -63.44 | -63 | 33 | PASS |
| 1710 | 1785 | -98 | 100 | 100 | -79.93 | -79.5 | -78.87 | -78.87 | -19.13 | FAIL |
| 1785 |  | -30 | 300 | 900 | -74.4 | -74.33 | -73.9 | -73.9 | 43.9 | PASS |
| 1795 |  | -30 | 100 | 300 | -73 | -78 | -77 | -73 | 43 | PASS |
| 1800 | 1803 | -30 | 30 | 90 | -69.35 | -77.95 | -83 | -69.35 | 39.35 | PASS |
| 1805 | 1880 |  |  |  |  |  |  |  |  |  |
| 1882 | 1885 | -30 | 30 | 90 | -82 | -73 | -64 | -64 | 34 | PASS |
| 1887 | 1890 | -30 | 100 | 300 | -76.8 | -76 | -62.22 | -62.22 | 32.22 | PASS |
| 1890 | 1900 | -30 | 300 | 900 | -73 | -70 | -56 | -56 | 26 | PASS |
| 1900 | 1910 | -30 | 1000 | 3000 | -69.47 | -67 | -60 | -60 | 30 | PASS |
| 1910 | 12750 | -30 | 3000 | 9000 | -57.45 | -60 | -57 | -57 | 27 | PASS |

NOTE: Screen shots were not captured, if required we make sure that we are capturing screen shots for REV\_C boards.

**Resolution for failure:**

We have added band pass filter in REV\_C design on TX side for better rejections in self RX band.

# Revision History

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SL.no | Date | Version | Author | Comments |
| 1 | February 9th, 2017 | 1.0 | OpenCellular Team | First Release |
| 2 | February 13th 2017 | 1.1 | OpenCellular Team | Incorporated comments on the 1st and 2nd Page |