Qualification Report

OpenCellular - Connect1
Radio Frequency module with Software Defined Radio (RF-SDR)

Revision: 1.1

[13-FEB-2017]

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1. 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.

2. 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**

3. Device-Under-Test (DUT) Details

a. System : OpenCellular Connect -1

b. Sub-system : RF-SDR

c. Hardware version : Life – 1 & Life -2

d. Software version : The git versions as follows

   a. Openbsc : 5085e0b
   b. Osmo-trx : 2e5e2c5
   c. Uhd : f70dd85

e. Sample Count : 01

4. Qualification Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

5. Qualification Result Summary

Test ID	Sub-system	Function	Test cases/specification	Priority	Status
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

6. 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		

8 Power

8.1 Voltage accuracy

8.1.1 Test ID

Pwr1.1

8.1.2 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.

8.1.3 Test and Measurement Method

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

8.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Full

8.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

8.1.6 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

U3501 (12V to 5.7V):

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

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.

8.2 Load Regulation

8.2.1 Test ID

Pwr1.2

8.2.2 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.

8.2.3 Test and Measurement Method

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

8.2.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage -12V DC

System/Test Load: Min-Typical-Max

8.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

8.2.6 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.

8.3 Line Regulation

8.3.1 Test ID

Pwr1.3

8.3.2 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.

8.3.3 Test and Measurement Method

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

8.3.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +11.4V DC to 12.6V DC

System/Test Load: Min-Typical-Max

8.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

8.3.6 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 Voltage (V)	Output Current (A)	Output Voltage (V)	Specification(V) Min	Specification(V) Max	Design margin (%)	Result
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 Voltage (V)	Load Current (A)	Output Current (A)	Output Voltage (V)	Specification(V) Min	Specification(V) Max	Design margin (%)	Result
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 Voltage (V)	Output Current (A)	Output Voltage (V)	Specification(V) Min	Specification(V) Max	Design margin (%)	Result
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 Voltage (V)	Load Current (A)	Output Current (A)	Output Voltage (V)	Specification(V) Min	Specification(V) Max	Design margin (%)	Result
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.

8.4 Ripple Noise

8.4.1 Test ID

Pwr1.4

8.4.2 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.

8.4.3 Test and Measurement Method

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

8.4.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage -12V DC

System/Test Load: Full

8.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

8.4.6 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

8.4.7 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

switch_regulators.xlsx

8.5 Voltage Control

8.5.1 Test ID

Pwr1.5

8.5.2 Purpose

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

8.5.3 Test and Measurement Method

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

8.5.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage -12V DC

System/Test Load: Full

8.5.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

8.5.6 Test Results

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

8.6 Voltage accuracy

8.6.1 Test ID

Pwr1.6

8.6.2 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.

8.6.3 Test and Measurement Method

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

8.6.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Full

8.6.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

8.6.6 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

8.7 Voltage Control

8.7.1 Test ID

Pwr1.7

8.7.2 Purpose

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

8.7.3 Test and Measurement Method

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

8.7.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage -12V DC

System/Test Load: Full

8.7.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0004

8.7.6 Test Results

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

8.8 Current consumption

8.8.1 Test ID

Pwr1.8

8.8.2 Purpose

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

8.8.3 Test and Measurement Method

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

8.8.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Full

8.8.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0011

8.8.6 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

9 Clock

9.1 Clock output level

9.1.1 Test ID

CLK 1.1

9.1.2 Purpose

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

9.1.3 Test and Measurement Method

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

9.1.4 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)

9.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

9.1.6 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.

9.2 Frequency and Frequency accuracy

9.2.1 Test ID

CLK 1.2 & 1.3

9.2.2 Purpose

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

9.2.3 Test and Measurement Method

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

9.2.4 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.

9.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

9.2.6 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.

9.3 Phase noise

9.3.1 Test ID

CLK 1.4

9.3.2 Purpose

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

9.3.3 Test and Measurement Method

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

9.3.4 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.

9.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

9.3.6 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.

9.3.7 Test and Measurement Logs

9.4 Lock time

9.4.1 Test ID

CLK 1.5

9.4.2 Purpose

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

9.4.3 Test and Measurement Method

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

9.4.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

9.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

9.4.6 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.

9.5 Clock Duty Cycle

9.5.1 Test ID

CLK 1.6

9.5.2 Purpose

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

9.5.3 Test and Measurement Method

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

9.5.4 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)

9.5.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

9.5.6 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.

9.5.7 Test and Measurement Logs

Clk.1.6_Test_Measur
ement_Logs_with_W

9.6 Jitter

9.6.1 Test ID

CLK 1.7

9.6.2 Purpose

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

9.6.3 Test and Measurement Method

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

9.6.4 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)

9.6.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

9.6.6 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.

9.6.7 Test and Measurement Logs

Clk.1.7_Test_Measur
ement_Logs_with_W

9.7 Clock Duty Cycle

9.7.1 Test ID

CLK 1.8

9.7.2 Purpose

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

9.7.3 Test and Measurement Method

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

9.7.4 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)

9.7.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

9.7.6 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.

9.7.7 Test and Measurement Logs

Clk.1.8_Test_Measur
ement_Logs_with_W

9.8 Jitter

9.8.1 Test ID

CLK 1.9

9.8.2 Purpose

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

9.8.3 Test and Measurement Method

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

9.8.4 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)

9.8.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

9.8.6 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.

9.8.7 Test and Measurement Logs

Clk.1.9_Test_Measur
ement_Logs_with_W

10 FPGA

10.1 Artix – 7 –Boot configuration

10.1.1 Test ID

FPGA 1.1.1

10.1.2 Purpose

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

10.1.3 Test and Measurement Method

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

10.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

10.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.1.6 Test Results

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

10.1.7 Test and Measurement Logs

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

Artix_7_Boot_Configuration.PNG

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

10.2 Artix – 7 –Power sequence

10.2.1 Test ID

FPGA 1.1.2

10.2.2 Purpose

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

10.2.3 Test and Measurement Method

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

10.2.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

10.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.2.6 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		

10.2.7 Test and Measurement Logs

ARTIX_7_POWER_ON_SEQUENCE.xlsx

10.3 FX3 – SPI –Electrical validation

10.3.1 Test ID

FPGA 1.2.1

10.3.2 Purpose

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

10.3.3 Test and Measurement Method

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

10.3.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

10.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.3.6 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.

10.3.7 Test and Measurement Logs

FPGA_FX3_SPI_Measurement_Logs_with_

10.4 FX3 – SPI –Functional validation

10.4.1 Test ID

FPGA 1.2.2

10.4.2 Purpose

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

10.4.3 Test and Measurement Method

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

10.4.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

10.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.4.6 Test Results

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

10.4.7 Test and Measurement Logs

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

FX3_SPI_Functional_Snapshot.PNG

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

10.5 AD9361 – SPI-Electrical validation/Signal integrity

10.5.1 Test ID

FPGA 1.3.1

10.5.2 Purpose

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

10.5.3 Test and Measurement Method

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

10.5.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

10.5.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.5.6 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.

10.5.7 Test and Measurement Logs

FPGA_AD9361_SPI_ Measurement_Logs_

Signal Integrity

10.5.8 Purpose

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

10.5.9 Test and Measurement Method

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

10.5.10 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

10.5.11 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.5.12 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.

10.5.13 Test and Measurement Logs

FPGA_AD9361_SPI_SI_Measurement_Log

10.6 AD9361 – SPI-Functional validation

10.6.1 Test ID

FPGA 1.3.2

10.6.2 Purpose

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

10.6.3 Test and Measurement Method

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

10.6.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

10.6.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.6.6 Test Results

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

10.6.7 Test and Measurement Logs

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


AD9361_SPI_Functional_Validation_sna


AD9361_SPI_Functional_Snapshot.png

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

10.7 FX3 – GPIF Control – Electrical validation

10.7.1 Test ID

FPGA 1.4.1

10.7.2 Purpose

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

10.7.3 Test and Measurement Method

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

10.7.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

10.7.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.7.6 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

10.7.7 Test and Measurement Logs

FPGA_FX3_GPIF_Control_Measurement_

10.8 FX3 – GPIF Control – Functional validation

10.8.1 Test ID

FPGA 1.4.2

10.8.2 Purpose

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

10.8.3 Test and Measurement Method

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

10.8.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

10.8.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.8.6 Test Results

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

10.8.7 Test and Measurement Logs

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


FX3_GPIF_Control_F unctional_Snapshot


FX3_GPIF_Function al_Snapshot_0x01.p

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

10.9 FX3 – GPIF Data – Electrical validation

10.9.1 Test ID

FPGA 1.5.1

10.9.2 Purpose

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

10.9.3 Test and Measurement Method

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

10.9.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

10.9.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.9.6 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.

10.9.7 Test and Measurement Logs

FPGA_FX3_GPIF_Dat
a_Measurement_Log

10.10 FX3 – GPIF Data – Functional validation

10.10.1 Test ID

FPGA 1.5.2

10.10.2 Purpose

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

10.10.3 Test and Measurement Method

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

10.10.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

10.10.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.10.6 Test Results

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

10.10.7 Test and Measurement Logs

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


FX3_GPIF_Data_Functional_Snapshot.PNG


FX3_GPIF_Functional_Snapshot_0x01.pn

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

10.11 AD9361 – Control- Electrical validation

10.11.1 Test ID

FPGA 1.6.1

10.11.2 Purpose

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

10.11.3 Test and Measurement Method

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

10.11.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

10.11.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.11.6 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

10.11.7 Test and Measurement Logs

FPGA_AD9361_Cont
rol_Measurement_Lc

10.12 AD9361 – Control- Functional validation

10.12.1 Test ID

FPGA 1.6.2

10.12.2 Purpose

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

10.12.3 Test and Measurement Method

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

10.12.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

10.12.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.12.6 Test Results

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

10.12.7 Test and Measurement Logs

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

AD9361_Control_Fu
nctional_Snapshot.p

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

10.13 AD9361 – Data- Electrical validation

10.13.1 Test ID

FPGA 1.7.1

10.13.2 Purpose

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

10.13.3 Test and Measurement Method

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

10.13.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

10.13.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.13.6 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.

10.13.7 Test and Measurement Logs

FPGA_AD9361_Data
_Measurement_Logs

10.14 AD9361 – Data- Functional validation

10.14.1 Test ID

FPGA 1.7.2

10.14.2 Purpose

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

10.14.3 Test and Measurement Method

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

10.14.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

10.14.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

10.14.6 Test Results

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

10.14.7 Test and Measurement Logs

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

AD9361_Data_Functional_Snapshot.png

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

11 FX3

11.1 FX3 (CYUSB3014)-Configuration

11.1.1 Test ID

FX3 1.1

11.1.2 Purpose

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

11.1.3 Test and Measurement Method

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

11.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

11.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

11.1.6 Test Results

The snapshot for FX3 configuration is attached below.

FX3_Configuration_Snapshot.PNG

Operating_over_USB_3.0.png

11.2 EEPROM (24LC256) – I2C –Electrical validation

11.2.1 Test ID

FX3 1.2.1

11.2.2 Purpose

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

11.2.3 Test and Measurement Method

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

11.2.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

11.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

11.2.6 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

11.2.7 Test and Measurement Logs

FX3_EEPROM_I2C_
Measurement_Logs_

11.3 EEPROM (24LC256) – I2C –Functional validation

11.3.1 Test ID

FX3 1.2.2

11.3.2 Purpose

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

11.3.3 Test and Measurement Method

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

11.3.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage – 18V

System load – Typical

11.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0022

11.3.6 Test Results

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

11.3.7 Test and Measurement Logs

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

EEPROM_I2C_Functional_Snapshot.PNG

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

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

11.4.1 Test ID

FX3 1.3.1

11.4.2 Purpose

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

11.4.3 Test and Measurement Method

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

11.4.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

11.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

11.4.6 Test Results

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

11.4.7 Test and Measurement Logs

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

USB2.0_FV.png

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

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

11.5.1 Test ID

FX3 1.4.1

11.5.2 Purpose

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

11.5.3 Test and Measurement Method

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

11.5.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

11.5.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

11.5.6 Test Results

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

11.5.7 Test and Measurement Logs

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

usb3.0_FV.png

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

12 RF/Transceiver (AD9361) – Pipe1

12.1 Maximum Output Power from AD9361- Pipe 1

12.1.1 Test ID

TRX 1.1

12.1.2 Purpose

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

12.1.3 Test and Measurement Method

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

12.1.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

12.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

12.1.6 Test Results

Attenuation setting from UHD code for AD9361 (dB)	Specification	CH1 Maximum Output Power at Balun (dBm)			Min(dBm)	Max(dBm)	Margin (dBm)	Result
		GSM-900						
		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)	Specification	CH1 Maximum Output Power at Balun (dBm)			Min(dBm)	Max (dBm)	Margin in(dBm)	Result
		DCS-1800						
		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.

12.2 Transmit Power Control from AD9361-Pipe1

12.2.1 Test ID

TRX 1.2

12.2.2 Purpose

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

12.2.3 Test and Measurement Method

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

12.2.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

12.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

12.2.6 Test Results

ATTENUATION SETTING FROM UHD CODE FOR AD9361	CH1 OUTPUT POWER CONTROL				MIN	MAX	MARGIN IN (dBm)	RESULT
	SPECIFICATION	GSM-900						
		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	MAX	MARGIN IN (dBm)	RESULT
	SPECIFICATION	DCS-1800						
		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.

12.3 Modulation Accuracy –TRx – Pipe 1

12.3.1 Test ID

TRX_1.3

12.3.2 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.

12.3.3 Test and Measurement Method

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

12.3.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

12.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

12.3.6 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									
Modulation	Specification(R&D)	Specification(normal)	GSM 900			Min (Hz)	Max (Hz)	Margin (Hz)	Result
	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

12.3.7 Test and Measurement Logs

CH1_RF_SDR_EVM.zip

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

12.4.1 Test ID

TRX 1.6

12.4.2 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).

12.4.3 Test and Measurement Method

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

12.4.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical
Signal output level: 0dBm

12.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

12.4.6 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).

12.4.7 Test and Measurement Logs

CH1_RF_SDR_modulation.zip

ii) Spectrum due to switching- TRx Pipe 1

12.4.8 Test ID

TRX 1.6

12.4.9 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.

12.4.10 Test and Measurement Method

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

12.4.11 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

12.4.12 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

12.4.13 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).

12.4.14 Test and Measurement Logs

CH1_RF_SDR_switching.zip

12.5 Carrier leakage - Pipe1

12.5.1 Test ID

TRX 1.4

12.5.2 Purpose

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

12.5.3 Test and Measurement Method

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

12.5.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

12.5.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

12.5.6 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

12.5.7 Test and Measurement Logs

CH1_LO_Leakage.zip

13 RF/Transceiver (AD9361) – Pipe2

13.1 Maximum Output Power from AD9361-Pipe2

13.1.1 Test ID

TRX 2.1

13.1.2 Purpose

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

13.1.3 Test and Measurement Method

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

13.1.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

13.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

13.1.6 Test Results

Attenuation setting from UHD code for AD9361 (dB)	Specification	CH2 Maximum Output Power at Balun (dBm)			Min(dBm)	Max(dBm)	Margin in (dBm)	Result
		GSM-900						
		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)	Specification	CH2 Maximum Output Power at Balun (dBm)			Min(dBm)	Max(dBm)	Margin in (dBm)	Result
		DCS-1800						
		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.

13.2 Transmit Power Control from AD9361-Pipe2

13.2.1 Test ID

TRX 2.2

13.2.2 Purpose

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

13.2.3 Test and Measurement Method

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

13.2.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

13.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

13.2.6 Test Results

ATTENUATION SETTING FROM UHD CODE FOR AD9361	CH2 OUTPUT POWER CONTROL				MIN	MAX	MARGIN IN (dBm)	RESULT
	SPECIFICATION	GSM-900						
		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	MAX	MARGIN IN (dBm)	RESULT
	Specification	DCS-1800						
		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.

13.3 Modulation Accuracy –TRx – Pipe 2

13.3.1 Test ID

TRX 2.3

13.3.2 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.

13.3.3 Test and Measurement Method

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

13.3.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

13.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

13.3.6 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

13.3.7 Test and Measurement Logs

CH2_RF_SDR_EVM.zip

13.4 AD9361 Local Oscillator lock detect- Pipe 1&2

13.4.1 Test ID

TRX 1.5 and TRX 2.5.

13.4.2 Purpose

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

13.4.3 Test and Measurement Method

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

13.4.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

13.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0013

13.4.6 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.

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

13.5.1 Test ID

TRX 2.6

13.5.2 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).

13.5.3 Test and Measurement Method

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

13.5.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Signal output level: 0dBm

13.5.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

13.5.6 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).

13.5.7 Test and Measurement Logs

CH2_RF_SDR_modulation.zip

ii) Spectrum due to switching- TRx Pipe 2

13.5.8 Test ID

TRX 2.6

13.5.9 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.

13.5.10 Test and Measurement Method

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

13.5.11 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

13.5.12 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

13.5.13 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).

13.5.14 Test and Measurement Logs

CH2_RF_SDR_switching.zip

13.6 Carrier leakage – Pipe2

13.6.1 Test ID

TRX 2.4

13.6.2 Purpose

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

13.6.3 Test and Measurement Method

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

13.6.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

13.6.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

13.6.6 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

13.6.7 Test and Measurement Logs

CH2_LO_Leakage.zip

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

14 TX pipe – 1

14.1 Gain-Pipe1

14.1.1 Test ID

TX_P 1.1

14.1.2 Purpose

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

14.1.3 Test and Measurement Method

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

14.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

14.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

14.1.6 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.

14.2 Attenuation and Attenuation step- TX Pipe1

14.2.1 Test ID

TX_P 1.2 and TX_P 1.3

14.2.2 Purpose

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

14.2.3 Test and Measurement Method

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

14.2.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

14.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

14.2.6 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.

14.3 Output Power- TX Pipe 1

14.3.1 Test ID

TX_P 1.4

14.3.2 Purpose

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

14.3.3 Test and Measurement Method

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

14.3.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

14.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

14.3.6 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.

14.4 RF power detection – TX Pipe1

14.4.1 Test ID

TX_P 1.5

14.4.2 Purpose

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

14.4.3 Test and Measurement Method

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

14.4.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

14.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

14.4.6 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

15 TX pipe – 2

15.1 Gain-Pipe2

15.1.1 Test ID

TX_P 2.1

15.1.2 Purpose

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

15.1.3 Test and Measurement Method

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

15.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

15.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1622LIFE1SDR0003

15.1.6 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.

15.2 Attenuation and Attenuation step- TX Pipe2

15.2.1 Test ID

TX_P 2.2 and TX_P 2.3

15.2.2 Purpose

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

15.2.3 Test and Measurement Method

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

15.2.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

15.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

15.2.6 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.

15.3 Output Power- TX Pipe 2

15.3.1 Test ID

TX_P 2.4

15.3.2 Purpose

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

15.3.3 Test and Measurement Method

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

15.3.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

15.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

15.3.6 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.

15.4 RF power detection – Tx Pipe 2

15.4.1 Test ID

TX_P 2.5

15.4.2 Purpose

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

15.4.3 Test and Measurement Method

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

15.4.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

15.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

15.4.6 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

16 RX pipe – 1

16.1 Noise Figure and Gain – Rx Pipe-1

16.1.1 Test ID

RX_P 1.1 and RX_P 1.2

16.1.2 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).

16.1.3 Test and Measurement Method

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

16.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

16.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

16.1.6 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

16.1.7 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.

16.1.8 Test and Measurement Logs

RX Pipe -1_NF_Gain.zip

16.2 Attenuation and Attenuation step- Rx Pipe1

16.2.1 Test ID

RX_P 1.3 and RX_P 1.4

16.2.2 Purpose

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

16.2.3 Test and Measurement Method

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

16.2.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

16.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

16.2.6 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.

17 RX pipe -2

17.1 Noise Figure and Gain – Rx Pipe-2

17.1.1 Test ID

RX_P 2.1 and RX_P 2.2

17.1.2 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).

17.1.3 Test and Measurement Method

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

17.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

17.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0020

17.1.6 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	6.2058	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

17.1.7 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.

17.1.8 Test and Measurement Logs

RX Pipe
-2_NF_Gain.zip

17.2 Attenuation and Attenuation step- Rx Pipe2

17.2.1 Test ID

RX_P 2.3 and RX_P 2.4

17.2.2 Purpose

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

17.2.3 Test and Measurement Method

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

17.2.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

17.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

17.2.6 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.

18 Transmitter _Chain 1

18.1 i) Output Power- TX Chain 1

18.1.1 Test ID

TX_C 1.2

18.1.2 Purpose

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

18.1.3 Test and Measurement Method

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

18.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

18.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

18.1.6 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.

ii) Power Vs Time – TX Chain 1

18.1.7 Test ID

TX_C 1.2

18.1.8 Purpose

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

18.1.9 Test and Measurement Method

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

18.1.10 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

18.1.11 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

18.1.12 Test Results

PASS

18.1.13 Test and Measurement Logs

CH1_Power vs Time.zip

18.2 Static power control – TX chain1

18.2.1 Test ID

TX_C 1.3

18.2.2 Purpose

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

18.2.3 Test and Measurement Method

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

18.2.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

18.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

18.2.6 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.

18.3 Modulation Accuracy for TX – Chain 1

18.3.1 Test ID

TX_C_1.4

18.3.2 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.

18.3.3 Test and Measurement Method

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

18.3.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical
Digital Attenuator: Minimum attenuation (0dB)

18.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

18.3.6 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

18.3.7 Test and Measurement Logs

CH1_RF_SDR_TX_PORT_EVM.zip

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

18.4.1 Test ID

TX_C 1.5

18.4.2 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).

18.4.3 Test and Measurement Method

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

18.4.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

18.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

18.4.6 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.

18.4.7 Test and Measurement Logs

CH1_RF_SDR_TX_PORT_modulation.zip

ii) Spectrum due to switching- TX Chain 1

18.4.8 Test ID

TX_C 1.5

18.4.9 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.

18.4.10 Test and Measurement Method

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

18.4.11 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

18.4.12 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

18.4.13 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.

18.4.14 Test and Measurement Logs

CH1_RF_SDR_TX_PORT_switching.zip

18.5 Spurious Emissions – TX chain1

18.5.1 Test ID

TX_C 1.6

18.5.2 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.

18.5.3 Test and Measurement Method

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

18.5.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

18.5.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

18.5.6 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	1795	-30	300	900	-75.9	-76.25	-76	-75.9	45.9	PASS
1795	1800	-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.

19 Transmitter _Chain 2

19.1 i) Output Power- TX Chain 2

19.1.1 Test ID

TX_C 2.2

19.1.2 Purpose

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

19.1.3 Test and Measurement Method

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

19.1.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

19.1.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

19.1.6 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.

ii) Power Vs Time – TX Chain 2

19.1.7 Test ID

TX_C 2.2

19.1.8 Purpose

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

19.1.9 Test and Measurement Method

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

19.1.10 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

Digital Attenuator: Minimum attenuation (0dB)

19.1.11 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

19.1.12 Test Results

PASS

19.1.13 Test and Measurement Logs

CH2_Power vs Time.zip

19.2 Static power control – TX chain2

19.2.1 Test ID

TX_C 2.3

19.2.2 Purpose

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

19.2.3 Test and Measurement Method

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

19.2.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

19.2.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0008

19.2.6 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.

19.3 Modulation Accuracy for TX – Chain 2

19.3.1 Test ID

TX_C_2.4

19.3.2 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.

19.3.3 Test and Measurement Method

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

19.3.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical
Digital Attenuator: Minimum attenuation (0dB)

19.3.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

19.3.6 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									
Modulation	Specification(R&D)	Specification(normal)	DCS 1800			Min (Hz)	Max (Hz)	Margin (Hz)	Result
	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

19.3.7 Test and Measurement Logs

CH2_RF_SDR_TX_PORT_EVM.zip

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

19.4.1 Test ID

TX_C 2.5

19.4.2 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).

19.4.3 Test and Measurement Method

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

19.4.4 Test Condition

Ambient Temperature – 25˚C

Operating Voltage - +12V DC

System/Test Load: Typical

19.4.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

19.4.6 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.

19.4.7 Test and Measurement Logs

CH2_RF_SDR_TX_PORT_modulation.zip

ii) Spectrum due to switching- TX Chain 2

19.4.8 Test ID

TX_C 2.5

19.4.9 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.

19.4.10 Test and Measurement Method

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

19.4.11 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

19.4.12 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

19.4.13 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.

19.4.14 Test and Measurement Logs

CH2_RF_SDR_TX_PORT_switching.zip

19.5 Spurious Emissions – TX chain2

19.5.1 Test ID

TX_C 2.6

19.5.2 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.

19.5.3 Test and Measurement Method

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

19.5.4 Test Condition

Ambient Temperature – 25˚C
Operating Voltage - +12V DC
System/Test Load: Typical

19.5.5 DUT Sample Information

RF-SDR Board Serial Number – WZ1630LIFE2SDR0010

19.5.6 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	1795	-30	300	900	-74.4	-74.33	-73.9	-73.9	43.9	PASS
1795	1800	-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.

20 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