OpenCellular - Connect1

RF-SDR Test Specifications

Version 1.0

History.

SL.no	Date	Version	Author	Comments
1	February 9th, 2017	1.0	OpenCellular Team	First Release

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1. Purpose and Scope.

The purpose of this document is to capture design validation and verification requirements for Radio-Frequency module with Software-Defined-Radio (RF-SDR) as part of OpenCellular Base Transceiver Station (BTS). The document is intended to provide fundamental set of test specifications required to ensure consistent and reliable operation of RF-SDR in a BTS system under all supported operating and environmental conditions.

These test specification covers following sub-systems of RF-SDR:

- Power Sub-system
- FPGA Sub-System
- FX3 Sub-system
- Clock Sub-system
- Transceiver AD9361 Sub-system
- TX Pipe Sub-system
- Rx Pipe Sub-system
- Transmitter chain
- Receiver chain

2. Abbreviation

ADC	Analog to Digital Converter
ANT	Antenna
BTS	Base Transceiver Station
DAC	Digital to Analog Converter
GMSK	Gaussian Minimum Shift Keying
LNA	Low Noise Amplifier
NF	Noise Figure
PA	Power Amplifier
PAR	Peak to Average Ratio
PSK	Phase Shift keying
RF	Radio Frequency
RX	Receiver
SDR	Software-Defined-Radio
TX	Transmitter
VGA	Variable Gain Attenuator
EV	Electrical Validation
FV	Functional Validation

3. POWER

The power management of RF front end is handled by 3 switching regulators (LT8640IUDC), 1 step down regulator (ADP2164ACPZ-R7), 13 LDO’s provides all the required power rails for the system operation, to reduce the power consumption the LDO’s enables can be controlled by TIVA controller to disable the LDO when not in use.FPGA and FX3 has their own power management IC’s which will generate required voltage from 12V supply.

3.1 Test Purpose and Description

The purpose of this test is to verify and validate Switching regulators and LDO’s.

Verification and validation of the Switching regulators and LDO’s cover following functions and features:

1. Voltage accuracy
2. Line regulation
3. Load regulation
4. Ripple noise

3.1.1 Test Case: Voltage accuracy and voltage control (Pwr 1.1 & Pwr 1.5) of LT8640IUDC

3.1.1.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the output voltage is not within the tolerance limit then the end devices will not power up or will get damage.
Performance	NA	NA
Compliance	NA	NA

Table 1. Impact of Failure - Voltage Accuracy and Voltage control

3.1.1.2 Test Equipment List

- Power supply(E3633A or Equivalent)
- Oscilloscope (MSO9404A)
- Electronic load

3.1.1.3 Test Setup

i. Setup Block diagram

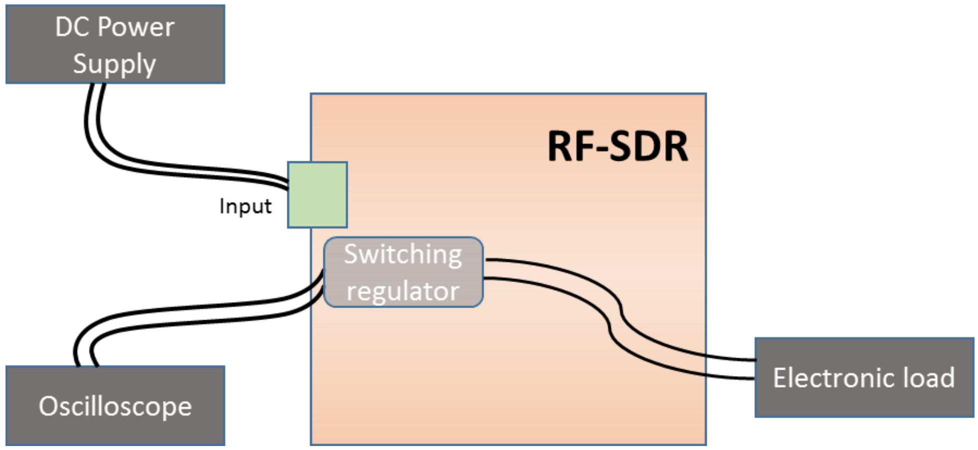

Figure 1. Voltage accuracy Test Setup Block Diagram

ii. Measurement Locations

- C3505 (5P7V_REG_1), C3518 (5P7V_REG_2) and C4005 (3P7V), C3408 (V1P8).

iii. Equipment Settings

For U3500, U3501 and U4000:

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 11.4V-12V-12.6V
  Current Limit: 4A
  OVP: 13V
  OCP: 5A
- Electronic load
  Current set: 4A

For U3400:

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 3.6V-3.7V-3.8V
  Current Limit: 500mA
  OVP: 4V
  OCP: 500mA
- Electronic load
  Current set: 500mA

iv. Software settings

NA

3.1.1.4 Requirements

Switching regulator	Input Voltage(V)	Expected Output Voltage	Accuracy/Pass criteria
U3500,U3501 (LT8640IUDC)	11.76 – 12.24	5.7	±2%
U4000 (LT8640IUDC)	11.75 – 12.24	3.7	±2%
U3400 (ADP2164ACPZ-R7)	3.626 – 3.774	1.8	±1.5%

Table 2. Voltage Accuracy

3.1.1.5 Test Condition

Test condition	Value	Remarks
System/Test Load	Full	Maximum load
Voltage	As per the requirement table	Varying voltage
Temperature	+25 C	Normal Room temperature

Table 3. Test Condition

3.1.1.6 Test Procedure

For U3500, U3501 and U4000:

1. This test is conducted by configuring power supply to give a voltage in the range of 11.76V to 12.24V.
2. Isolate regulators input from rest other circuitry by removing D10127. Give input power supply from external source.

3. Since we are giving supply through P12V to all three switching regulators, disable other two when you are measuring one.
    - To measure voltage accuracy of U3500, disable U3501 and U4000.
    - To measure voltage accuracy of U3501, disable U3500 and U4000.
    - To measure voltage accuracy of U4000, disable U3500 and U3501.
    - To disable U3500 remove R3500 (To make enable pin low) and R10881 (To remove software control)
    - To disable U3501 remove R3510 (To make enable pin low) and R10882(To remove software control)
    - To disable U4000 remove R4000 (To make enable pin low) and R10883 (To remove software control).
4. Isolate output of U3500 by removing R2170 and R2168, and connect electronic load to 5P7V_REG_1.
5. Isolate output of U3501 by removing R2157 and R2155, and connect electronic load to 5P7V_REG_2.
6. Isolate output of U4000 by removing L3400, R3400, FB6312 and FB6314, and connect electronic load to 3P7V.
7. Vary the voltage in step of ±2% tolerance of nominal 12V.
8. Set Full load (4A) in electronic load.
9. Measure the output voltage at C3505 (5P7V_REG_1), C3518 (5P7V_REG_2) and C4005 (3P7V) for various input voltages using scope.
10. Measured voltage should be with in ±2% tolerance of expected output voltage as mentioned in the above requirement table.

For U3400:

1. This test is conducted by configuring power supply to give a voltage in the range of 3.626V to 3.774V.
2. Isolate regulator input from rest other circuitry by removing L3400, R3400, FB6314 and FB6312. Give input power supply from external source.
3. Isolate output of U3400 by removing FB6313, FB6315 and FB1701, and connect electronic load to V1P8.
4. Vary the voltage in step of ±2% tolerance of nominal 3.7V.
5. Set Full load (500mA) in electronic load.
6. Measure the output voltage at C3408 (V1P8) for various input voltages using scope.
7. Measured voltage should be with in ±2% tolerance of expected output voltage as mentioned in the above requirement table.

3.1.1.7 Reference

1. Section 8 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://github.com/markhor/OpenCellular

3.1.2 Test Case: Load regulation (Pwr 1.2) of LT8640IUDC

3.1.2.1 Description

I. 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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the output voltage is not as expected with the varying output load, then the end devices will not power up or will get damage.
Performance	NA	NA
Compliance	NA	NA

Table 4. Impact of Failure – Load regulation

3.1.2.2 Test Equipment List

- Power supply(E3633A or Equivalent)
- Oscilloscope (MSO9404A)
- Electronic load

3.1.2.3 Test Setup

i. Setup Block diagram

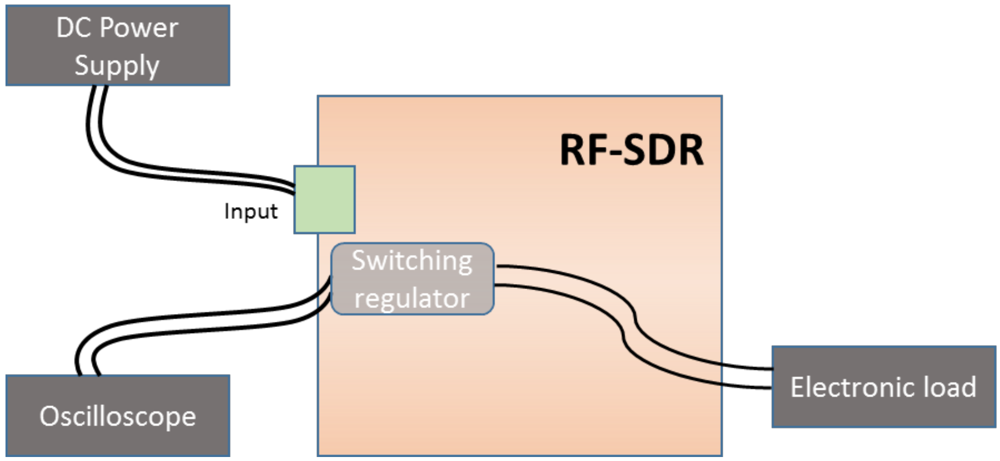

Figure 2. Load regulation Test Setup Block Diagram

ii. Measurement Locations

- C3505 (5P7V_REG_1), C3518 (5P7V_REG_2) and C4005 (3P7V), C3408 (V1P8).

iii. Equipment Settings

For U3500, U3501 and U4000:

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 12V
  Current Limit: 4A
  OVP: 13V
  OCP: 5A
- Electronic load
  Current set: Min-Typical -Max

For U3400:

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 3.7V
  Current Limit: 500mA
  OVP: 4V
  OCP: 500mA
- Electronic load
  Current set: Min-Typical -Max

iv. Software settings

NA

3.1.2.4 Requirements

Switching regulator	Input Voltage(V)	Load current(A)	Expected Output Voltage	Accuracy/Pass criteria
U3500,U3501 (LT8640IUDC)	11.76 – 12.24	1 - 4	5.7	±2%
U4000 (LT8640IUDC)	11.76 – 12.24	1 - 4	3.7	±2%
U3400 (ADP2164ACPZ-R7)	3.626 - 3.774	0.3 - 0.5	1.8	±1.5%

Table 5. Load regulation

3.1.2.5 Test Condition

Test condition	Value	Remarks
System/Test Load	Min-Typical-Max	Varying load
Voltage	As per the requirement table	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 6. Test Condition

3.1.2.6 Test Procedure

For U3500, U3501 and U4000:

1. This test is conducted by configuring power supply to give a voltage 12V.
2. Isolate regulators input from rest other circuitry by removing D10127. Give input power supply from external source.
3. Since we are giving supply through P12V to all three switching regulators, disable other two when you are measuring one.
    - To measure voltage accuracy of U3500, disable U3501 and U4000.
    - To measure voltage accuracy of U3501, disable U3500 and U4000.
    - To measure voltage accuracy of U4000, disable U3500 and U3501.
    - To disable U3500 remove R3500 (To make enable pin low) and R10881 (To remove software control)

- To disable U3501 remove R3510 (To make enable pin low) and R10882(To remove software control)
- To disable U4000 remove R4000 (To make enable pin low) and R10883 (To remove software control).

4. Isolate output of U3500 by removing R2170 and R2168, and connect electronic load to 5P7V_REG_1.
5. Isolate output of U3501 by removing R2157 and R2155, and connect electronic load to 5P7V_REG_2.
6. Isolate output of U4000 by removing L3400, R3400, FB6312 and FB6314, and connect electronic load to 3P7V.
7. Set the input to nominal 12V.
8. Vary the load from 1A (min) to 4A (Max) in step of 1A.
9. Using scope measure the output voltages at C3505 (5P7V_REG_1), C3518 (5P7V_REG_2) and C4005 (3P7V) for various loads.
10. Measured voltage should be with in ±2% tolerance of expected output voltage as mentioned in the above requirement table

For U3400:

1. This test is conducted by configuring power supply to give a voltage of 3.7V.
2. Isolate regulator input from rest other circuitry by removing L3400, R3400, FB6314 and FB6312. Give input power supply from external source.
3. Isolate output of U3400 by removing FB6313, FB6315 and FB1701, and connect electronic load to V1P8.
4. Vary the load from 0.3A (min) to 0.5A (Max) in step of 0.1A.
5. Measure the output voltage at C3408 (V1P8) for various load condition using scope.

3.1.2.7 Reference

1. Section 8 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

3.1.3 Test Case: Line regulation (Pwr 1.3) of LT8640IUDC

3.1.3.1 Description

I. 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.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the output voltage is not as expected with the varying input voltage, then the end devices will not power up or will get damage.
Performance	NA	NA
Compliance	NA	NA

Table 7. Impact of Failure – Line regulation

3.1.3.2 Test Equipment List

- Power supply(E3633A or Equivalent)
- Oscilloscope (MSO9404A)
- Electronic load

3.1.3.3 Test Setup

i. Setup Block diagram

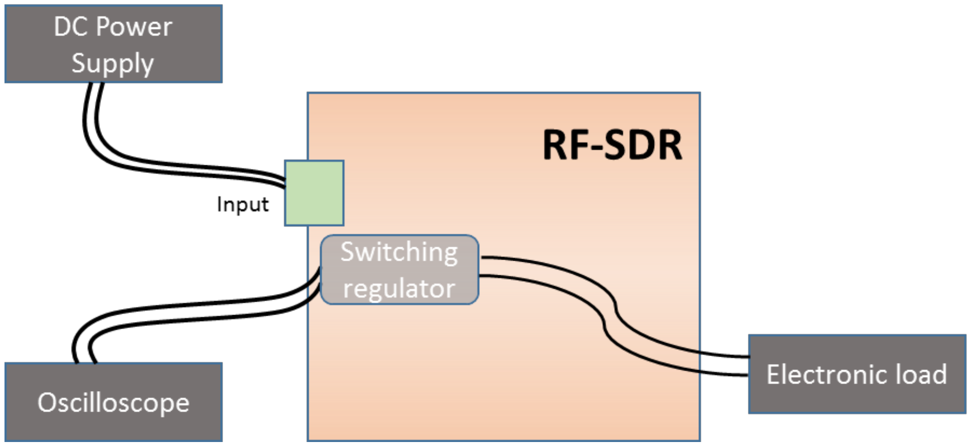

Figure 3. Line regulation Test Setup Block Diagram

ii. Measurement Locations

- C3505 (5P7V_REG_1), C3518 (5P7V_REG_2) and C4005 (3P7V), C3408 (V1P8).

iii. Equipment Settings

For U3500, U3501 and U4000:

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 11.4V-12V-12.6V
  Current Limit: 4A
  OVP: 13V
  OCP: 5A
- Electronic load
  Current set: Min-Typical -Max

For U3400:

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 3.6V-3.7V-3.8V
  Current Limit: 500mA
  OVP: 4V
  OCP: 500mA
- Electronic load

Current set: Min-Typical -Max

iv. Software settings

NA

3.1.3.4 Requirements

Switching regulator	Input Voltage(V)	Load current(A)	Expected Output Voltage	Accuracy/Pass criteria
U3500,U3501 (LT8640IUDC)	11.76 – 12.24	1 - 4	5.7	±2%
U4000 (LT8640IUDC)	11.76 – 12.24	1 - 4	3.7	±2%
U3400 (ADP2164ACPZ-R7)	3.626 - 3.774	0.3 - 0.5	1.8	±1.5%

Table 8. Line regulation

3.1.3.5 Test Condition

Test condition	Value	Remarks
System/Test Load	Min-Typical-Max	Varying load
Voltage	As per the requirement table	Varying voltage
Temperature	+25 C	Normal Room temperature

Table 9. Test Condition

3.1.3.6 Test Procedure

For U3500, U3501 and U4000:

1. This test is conducted by configuring power supply to give a voltage in the range of 11.4V to 12.6V.
2. Isolate regulators input voltage rail TRXFE_IN_12V from rest others by removing D10127. Give input supply to cathode of D10127.
3. Since TRXFE_IN_12V is giving power supply to all three switching regulators, disable other two when you are measuring one.
    - To measure voltage accuracy of U3500, disable U3501 and U4000.

- To measure voltage accuracy of U3501, disable U3500 and U4000.
- To measure voltage accuracy of U4000, disable U3500 and U3501.
- To disable U3500 remove R3500 (To make enable pin low) and R10881 (To remove software control)
- To disable U3501 remove R3510 (To make enable pin low) and R10882(To remove software control)
- To disable U4000 remove R4000 (To make enable pin low) and R10883 (To remove software control).

4. Isolate output of U3500 by removing R2170 and R2168, and connect electronic load to 5P7V_REG_1.
5. Isolate output of U3501 by removing R2157 and R2155, and connect electronic load to 5P7V_REG_2.
6. Isolate output of U4000 by removing L3400, R3400, FB6312 and FB6314, and connect electronic load to 3P7V.
7. Vary the voltage settings for voltages in steps of ±2% tolerance of nominal 12V.
8. Vary the load from 1A (min) to 4A (Max) in step of 1A.
9. Using scope measure the output voltages at C3505 (5P7V_REG_1), C3518 (5P7V_REG_2) and C4005 (3P7V) for various input voltages and for various loads (with and without load).
10. Measured voltage should be with in ±2% tolerance of expected output voltage as mentioned in the above requirement table.

For U3400:

1. This test is conducted by configuring power supply to give a voltage in the range of 3.6V to 3.8V.
2. Isolate regulator input from rest other circuitry by removing L3400, R3400, FB6314 and FB6312. Give input power supply from external source.
3. Isolate output of U3400 by removing FB6313, FB6315 and FB1701, and connect electronic load to V1P8.
4. Vary the voltage in step of ±2% tolerance of nominal 3.7V.
5. Vary the load from 0.3A (min) to 0.5A (Max) in step of 0.1A.
6. Measure the output voltage at C3408 (V1P8) for various input voltages and various load conditions using scope.
7. Measured voltage should be with in ±2% tolerance of expected output voltage as mentioned in the above requirement table

3.1.3.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

3.1.4 Test Case: Ripple Noise (Pwr 1.4) of LT8640IUDC

3.1.4.1 Description

I. 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.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	If ripple voltage is more than expected, board noise will increase and leading to failure of capacitors.
Compliance	NA	NA

Table 10. Impact of Failure – Ripple Noise

3.1.4.2 Test Equipment List

- Power supply(E3633A or Equivalent)
- Oscilloscope (MSO9404A)
- Electronic load

3.1.4.3 Test Setup

i. Setup Block diagram

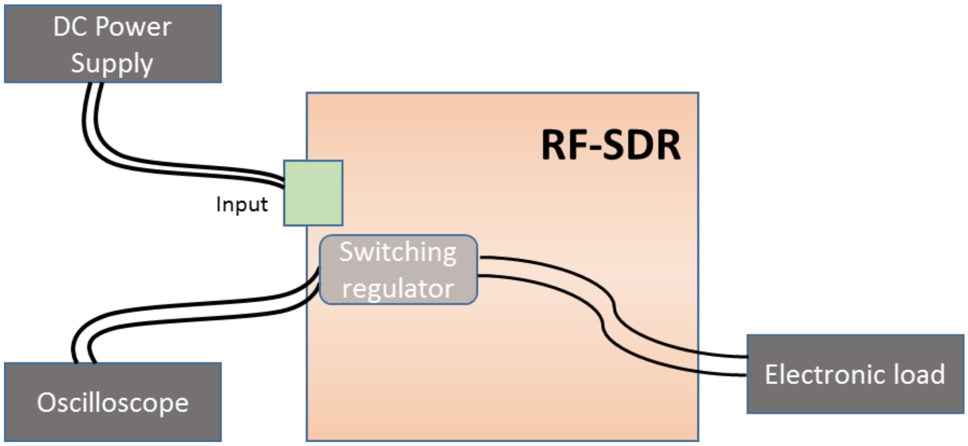

Figure 4. Ripple noise Test Setup Block Diagram

ii. Measurement Locations

- C3505 (5P7V_REG_1), C3518 (5P7V_REG_2) and C4005 (3P7V), C3408 (V1P8).

iii. Equipment Settings

For U3500, U3501 and U4000:

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 12V
  Current Limit: 4A
  OVP: 13V
  OCP: 5A
- Electronic load
  Current set: 4A (Max)

For U3400:

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 3.7V
  Current Limit: 500mA
  OVP: 4V
  OCP: 500mA
- Electronic load
  Current set: 500mA (Max)

iv. Software settings

NA

3.1.4.4 Requirements

Switching regulator	Input Voltage(V)	Load current(A)	Expected peak to peak ripple Voltage(mV)
U3500,U3501 (LT8640IUDC)	11.76 – 12.24	4	10
U4000 (LT8640IUDC)	11.76 – 12.24	4	10
U3400 (ADP2164ACPZ-R7)	3.626 - 3.774	0.5	10

Table 11. Ripple Noise

3.1.4.5 Test Condition

Test condition	Value	Remarks
System/Test Load	Full	Full load
Voltage	As per the requirement table	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 12. Test Condition

3.1.4.6 Test Procedure

For U3500, U3501 and U4000:

1. This test is conducted by configuring power supply to give a voltage in the range of 11.4V to 12.6V.
2. Isolate regulators input from rest other circuitry by removing D10127. Give input power supply from external source.
3. Since we are giving supply through P12V to all three switching regulators, disable other two when you are measuring one.
   - To measure voltage accuracy of U3500 disable U3501 and U4000.
   - To measure voltage accuracy of U3501 disable U3500 and U4000.
   - To measure voltage accuracy of U4000 disable U3500 and U3501.

- To disable U3500 remove R3500 (To make enable pin low) and R10881 (To remove software control)
- To disable U3501 remove R3510 (To make enable pin low) and R10882(To remove software control)
- To disable U4000 remove R4000 (To make enable pin low) and R10883 (To remove software control).

4. Isolate output of U3500 by removing R2170 and R2168, and connect electronic load to 5P7V_REG_1.
5. Isolate output of U3501 by removing R2157 and R2155, and connect electronic load to 5P7V_REG_2.
6. Isolate output of U4000 by removing L3400, R3400, FB6312 and FB6314, and connect electronic load to 3P7V.
7. Set the input to nominal 12V.
8. Set 4A (full load) current in electronic load.
9. Using scope measure the ripple voltage at C3505 (5P7V_REG_1), C3518 (5P7V_REG_2) and C4005 (3P7V).
10. Measured ripple voltage should be less than 10mV as per the LT8640IUDC specification.

For U3400:

1. This test is conducted by configuring power supply to give a voltage of 3.7V.
2. Isolate regulator input from rest other circuitry by removing L3400, R3400, FB6314 and FB6312. Give input power supply from external source.
3. Isolate output of U3400 by removing FB6313, FB6315 and FB1701, and connect electronic load to V1P8.
4. Set the input to nominal 3.7V.
5. Set Full load (500mA) in electronic load.
6. Measure the ripple voltage at C3408 (V1P8).
7. Measured ripple voltage should be less than 10mV as mentioned in the above requirement table.

3.1.4.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

3.1.5 Test Case: Voltage accuracy and voltage control (Pwr 1.6 & Pwr 1.7)

3.1.5.1 Description

I. Purpose

The purpose of the test case is to measure the output voltage of LDO's and to ensure that the voltages are in specified limits.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the output voltage is not within the tolerance limit then the end devices will not power up or will get damage.
Performance	NA	NA
Compliance	NA	NA

Table 13. Impact of Failure – Voltage accuracy and Voltage control

3.1.5.2 Test Equipment List

- Power supply(E3633A or Equivalent)
- Oscilloscope (MSO9404A)

3.1.5.3 Test Setup

i. Setup Block diagram

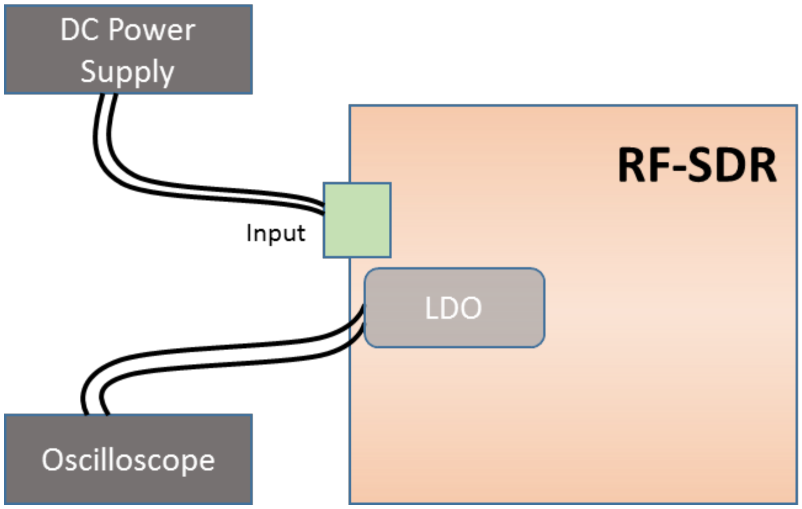

Figure 5. Voltage accuracy Test Setup Block Diagram

ii. Measurement Locations

- C3708, C3719, C3608, C3619, C4018, C3907, C3919, C3808, C3819, C3415, C3421 and C4108

iii. **Equipment Settings**

- Oscilloscope : MSO9404A
  Voltage scale: 1V
- DC power supply : E3633A
  Supply Voltage: 12V
  Current Limit: 4A
  OVP: 13V
  OCP: 5A

iv. **Software settings**

NA

3.1.5.4 Requirements

LDO's	Supply Voltage (V)	Expected Voltage (V)	Output voltage accuracy (in %)
U3700, U3701, U3600, U3601, U3900, U3901, U3800, U3801(TPS7A8300)	5.7	5	1
U4100 (TPS7A8300)	3.7	3.3	1
U3401, U3402(ADP1755ACPZ-R7)	1.8	1.3	2
U4001 (TPS7A8001)	5.7	5	3

Table 14. Voltage Accuracy

3.1.5.5 Test Condition

Test condition	Value	Remarks
System/Test Load	Operating load	Typical load
Voltage	As per the requirement table	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 15. Test Condition

3.1.5.6 Test Procedure

1. This test is conducted by configuring power supply to give a voltage of 12V.
2. Measure the output voltages at appropriate locations as mentioned in the above requirement table using scope.
3. Measured voltage should match expected voltage or should be within the tolerance limit as mentioned in the above requirement table.

3.1.5.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

3.1.6 Test Case: Current consumption (pwr1.8)

3.1.6.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	If we fail to read current sensing IC values, alert cannot be generated when board current consumption goes beyond threshold level which results in board damage.
Compliance	NA	NA

Table 16. Impact of Failure – Current consumption

3.1.6.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- Linux PC

3.1.6.3 Test Setup

i. Setup Block diagram

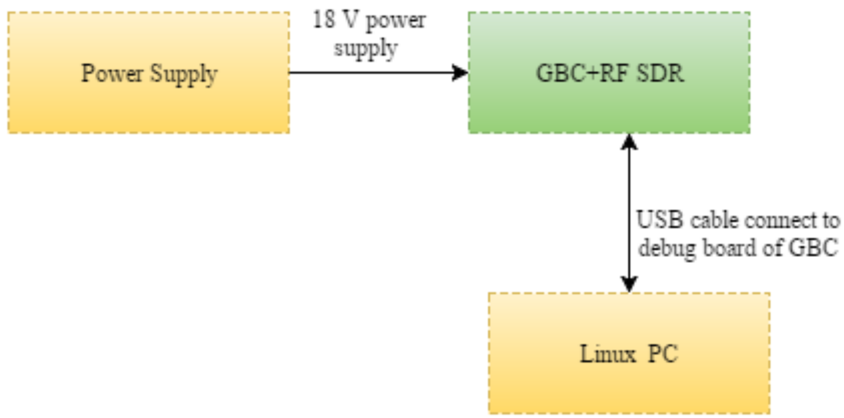

Figure 6.current consumption – TX-Pipe1 Test Setup Block Diagram

ii. Measurement Locations

- U2105, U2104 and U32.

iii. Equipment Setting

- RIGOL DP832 DC power supply

voltage	12 V
current	3 A

Table 17. DC power supply Settings

iv. Software settings

- All current sensing IC's are communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA code.

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:

  1. osmo-trx
  2. osmo-bts
  3. openbsc

- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 18. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)	ARFCN
	M	M
P-GSM-900	945.2	51
DCS-1800	1842.4	698

Table 19. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

3.1.6.4 Requirements

Current sensing	Current consumption (mA)
FPGA	<100
CH1	<2000
CH2	<1800

Table 20. Current consumption Test Specification

3.1.6.5 Test Condition

Test condition	Value	Remarks
Frequency	M	For each band test at Bottom, Middle and top frequencies.
Voltage	18V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 21. Test Condition

3.1.6.6 Test Procedure

1. For this test case make sure that board is on with full current consumption, that means activate any one band on both the chains in maximum power transmission.
2. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.
3. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.

4. Refer to below tables for switch controls on both the chains.

	REFERENCE DEISGNATOR	BAND			
		850	900	1800	1900
Chain 1 jumpers	J3305	short pins 1 and 2 ,4 and 5, 8 and 9	short pins 2 and 3 ,4 and 5, 8 and 9	short pins 1 and 2, 5 and 6, 8 and 9	short pins 2 and 3, 5 and 6, 8 and 9,
	J3307	short pins 1 and 2 ,4 and 5	short pins 2 and 3 ,4 and 5	short pins 1 and 2, 5 and 6	short pins 2 and 3, 5 and 6, 8 and 9,

Table 22. Chain one switch controls

	REFERENCE DEISGNATOR	BAND			
		850	900	1800	1900
Chain 2 jumpers	J3306	short pins 1 and 2 ,4 and 5, 8 and 9	short pins 2 and 3 ,4 and 5, 8 and 9	short pins 1 and 2, 5 and 6, 8 and 9	short pins 2 and 3, 5 and 6, 8 and 9,
	J3308	short pins 1 and 2 ,4 and 5	short pins 2 and 3 ,4 and 5	short pins 1 and 2, 5 and 6	short pins 2 and 3, 5 and 6, 8 and 9,

Table 23. Chain two switch controls

5. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
6. Once the powered up run the osmo stack and TIVA code on Linux PC. For this refer to software settings section.

3.1.6.7 Reference

1. Sections 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

4. CLOCK

The Phase lock loop (PLL) IC from Analog devices is a frequency synthesizer is used to implement local oscillator, it consists of a low noise digital phase frequency detector (PFD), a precision charge pump, a programmable reference divider, and programmable N divider. A complete phase-locked loop (PLL) can be implemented if the synthesizer is used with an external loop filter and voltage controlled oscillator (VCO).

4.1 Test Purpose and Description

The purpose of this test is to verify parameters like clock output power, frequency accuracy, lock time and phase noise after synchronizing board clock with the system clock.

Verification and validation of the Clock sub-system covers following functions and features:

1. Clock output power.
2. Frequency accuracy.
3. Phase noise.
4. Clock lock time

4.1.1 Test Case: Clock output level (Clk 1.1)

4.1.1.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If clock output is not of the required level, the devices (AD9361 and FPGA) to which the clock is the input will not function.
Performance	NA	
Compliance	NA	

Table 24. Impact of Failure of Clock Output Level

4.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Oscilloscope
- Linux PC

4.1.1.3 Test Setup

i. Setup Block diagram

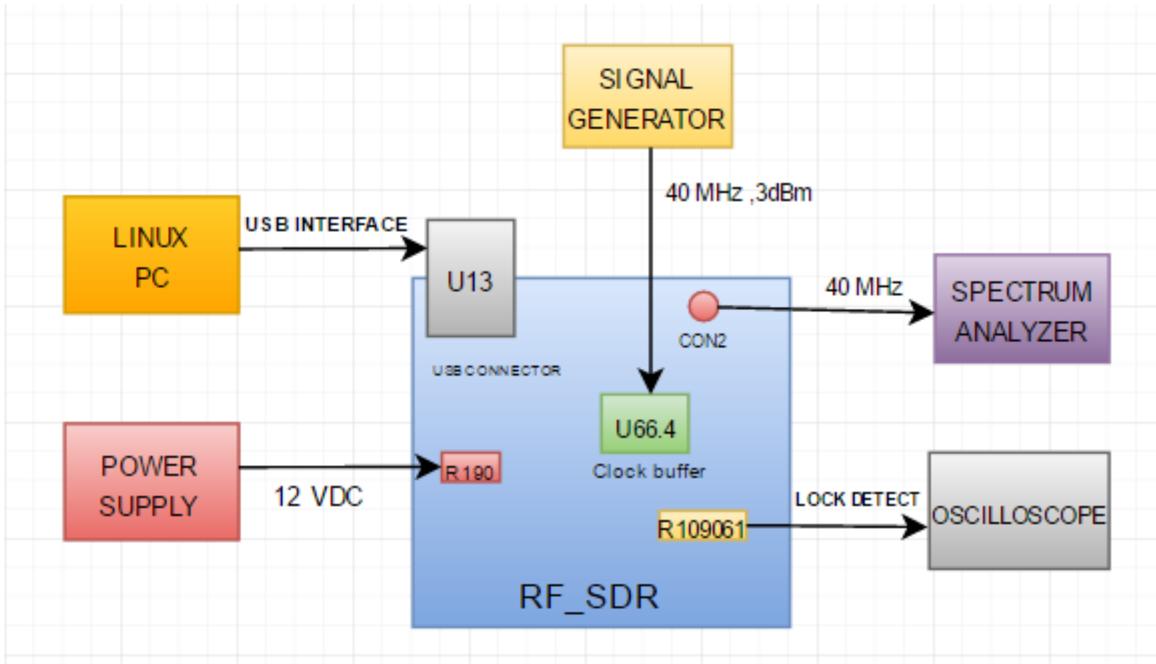

Figure 7. Clock Output Level Test Setup Block Diagram

ii. Measurement Locations

- Observe the clock output at connectors CON2 in spectrum analyser.
- Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope

iii. **Equipment Settings**

- **Keysight M9381A** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 25. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	40MHz
Span	<1KHz
RBW	1kHz

Table 26. Spectrum Analyser Settings

iv. **Software settings**

Settings that need to be changed based on Reference and VCXO frequencies are as follows.

- For 40MHz reference and 40MHz VCXO.
- Set R-divider value to 1.
- Set N-divider value to 1.
- Set Mux out-Lock detect.
- Set charge pump out in normal state.
- Set the 40MHz reference frequency in FPGA and TRANSCEIVER code.

4.1.1.4 Requirements

Frequency (MHz)	Lock detect level	Signal Level in V(p-p)
40MHz	>1.8V	<1.3V

Table 27. Frequency and Lock detect

4.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal Frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 28. Test Condition

4.1.1.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADF4002 section is from GBC board in actual scenario, during standalone testing programing will be done using on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, feed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
6. For the signal to be tapped at CON2 mount C4347 which is DNP by default on the board.
7. For code build go to this path “ $ cd connect/uhd/uhd/host/build “ and hit this command “$ sudo ./builduhd.sh “ in Linux terminal.
8. For running Transceiver go to this path” $ cd osmo-trx/Trasceiver52M “and hit this command “$ sudo osmo-trx -f 1” in Linux terminal.
9. Observe the clock output at connectors CON2 in spectrum analyser.
10. Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope, the output level should be greater than 1.8V.
11. Check if the clock is locked at the required frequency and measure its level in dBm.

4.1.1.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

4.1.2 Test Case: Frequency and Frequency accuracy (Clk 1.2 and Clk 1.3)

4.1.2.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	Will Impact timing of the system. Standalone system frequency reference will be based on signal generators accuracy.
Performance	NA	
Compliance	NA	

Table 29. Impact of Failure of Clock Frequency and Frequency accuracy

4.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Oscilloscope
- Linux PC

4.1.2.3 Test Setup

i. Setup Block diagram

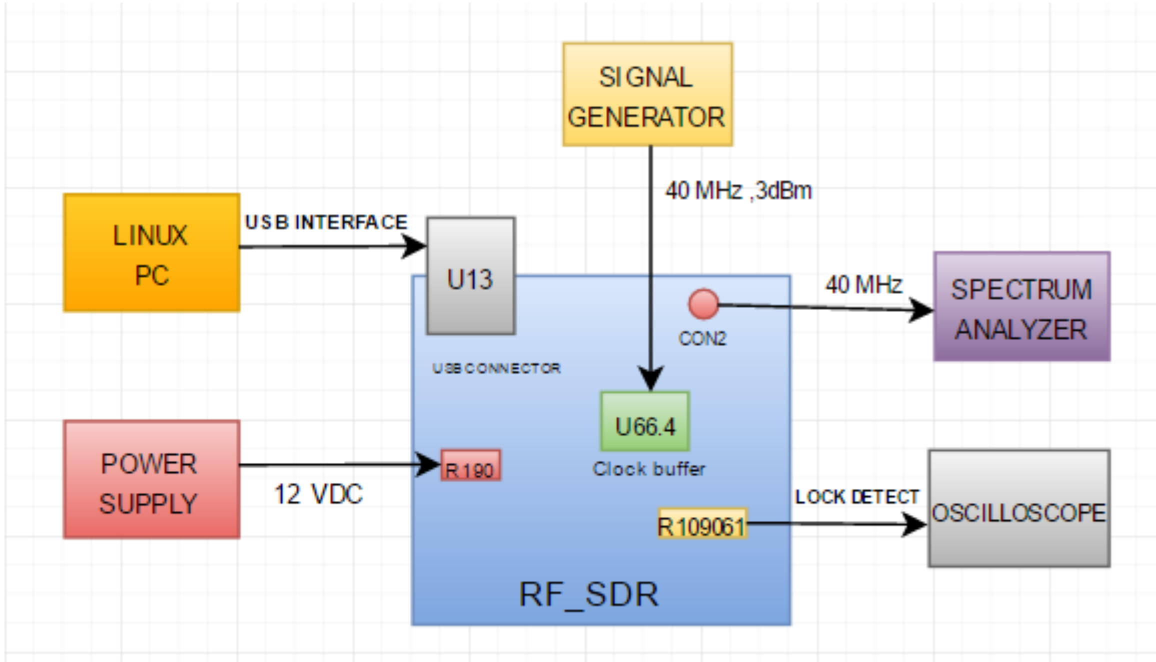

Figure 8. Frequency Accuracy Test Setup Block Diagram

ii. Measurement Locations

- Observe the clock output at connectors CON2 in spectrum analyser.
- Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope.

iii. Equipment Settings

- **Keysight M9381A** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 30. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	40MHz
Span	<1KHz
RBW	1kHz

Table 31. Spectrum Analyser Settings

iv. Software settings

Settings that need to be changed based on Reference and VCXO frequencies are as follows.

- For 40MHz reference and 40MHz VCXO.
- Set R-divider value to 1.
- Set N-divider value to 1.
- Set Mux out-Lock detect.
- Set charge pump out in normal state.
- Set the 40MHz reference frequency in FPGA and TRANSCEIVER code.

4.1.2.4 Requirements

Frequency (MHz)	Frequency drift
40MHz	<±0.05ppm(±2Hz)

Table 32. Clock frequency drift

4.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal Frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 33. Test Condition

4.1.2.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done using on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
6. For the signal to be tapped at CON2 mount C4347 which is DNP by default on the board.
7. For code build go to this path " $ cd connect/uhd/uhd/host/build " and hit this command "$ sudo ./builduhd.sh " in Linux terminal.
8. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -f 1" in Linux terminal.
9. Observe the clock output at connectors CON2 in spectrum analyser.
10. Check if the clock is at the required frequency and measure the frequency drift.
11. Set trace hold on the spectrum analyser to measure the frequency drift.

4.1.2.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

4.1.3 Test Case: Phase noise (Clk 1.4)

4.1.3.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the phase noise of the clock is not within the acceptable limits will degrade the system performance
Performance	NA	
Compliance	NA	

Table 34. Impact of Failure of Phase Noise

4.1.3.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no’s (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Oscilloscope
- Linux PC

4.1.3.3 Test Setup

i. Setup Block diagram

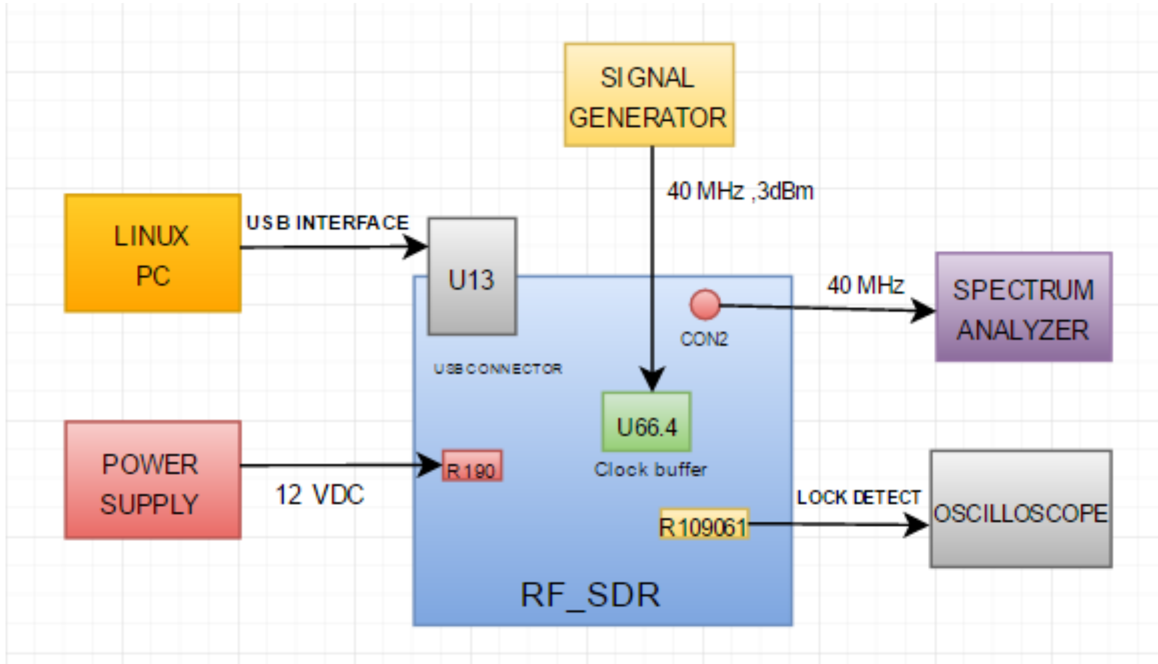

Figure 9. Phase Noise Test Setup Block Diagram

ii. **Measurement Locations**

- Observe the clock output at connectors CON2 in spectrum analyser.
- Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope

iii. **Equipment Settings**

- **Keysight M9381A** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 35. Signal Generator Settings

- **Keysight 89600 signal analyser**

Centre Frequency	40MHz
Span	3*offset
RBW	Minimum possible by the spectrum Analyser

Table 36. Spectrum Analyser Settings

iv. Software settings

Settings that need to be changed based on Reference and VCXO frequencies are as follows.

- For 40MHz reference and 40MHz VCXO.
- Set R-divider value to 1.
- Set N-divider value to 1.
- Set Mux out-Lock detect.
- Set charge pump out in normal state.
- Set the 40MHz reference frequency in FPGA and TRANSCEIVER code.

4.1.3.4 Requirements

Frequency Offset	Phase Noise dBc/Hz
10Hz	<-88
100Hz	<-115
1kHz	<-138
10kHz	<-145
100kHz	<-150
1MHz	<-152

Table 37. Requirement of Phase noise

4.1.3.5 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal Frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 38. Test Condition

4.1.3.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done using on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.

5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
6. For the signal to be tapped at CON2 mount C4347 which is DNP by default on the board.
7. For code build go to this path " $ cd connect/uhd/uhd/host/build " and hit this command "$ sudo ./builduhd.sh " in Linux terminal.
8. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -f 1" in Linux terminal.
9. Observe the clock output at connectors CON2 in spectrum analyser.
10. Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope, the output level should be greater than 1.8V.
11. Check if the clock is at the required frequency and measure its phase noise.
12. The spectrum Analyser settings will change based on the offset at which we are measuring the phase noise.
13. To measure phase noise at 1KHz offset need to change span based on the offset that is being measured. Span=3*offset.
14. Keep a marker on the carrier and a delta market at the offset, note down the delta marker readings and to that reading add 10*log (Resolution BW).

4.1.3.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

4.1.4 Test Case: Clock lock time (Clk 1.5)

4.1.4.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	Will impact timing of the system
Performance	NA	
Compliance	NA	

Table 39. Impact of Failure of Clock Lock Time

4.1.4.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no’s (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Oscilloscope
- Linux PC

4.1.4.3 Test Setup

i. Setup Block diagram

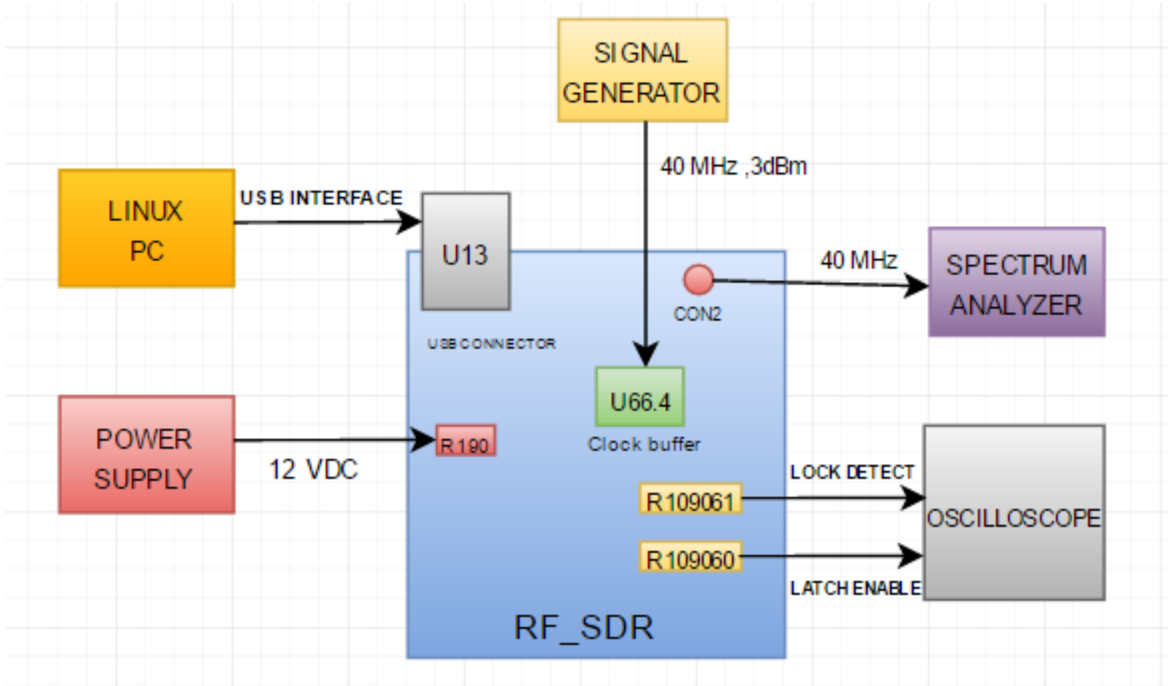

Figure 10. Clock lock time Test Setup Block Diagram

ii. Measurement Locations

- Observe the clock output at connectors CON2 in spectrum analyser.
- Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope.
- Monitor the latch enable pin and check if latch enable is high (monitor at R109060) in oscilloscope.

iii. Equipment Settings

- **Keysight M9381A** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 40. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	40MHz
Span	<1KHz
RBW	1KHz

Table 41. Spectrum Analyser Settings

- This test is performed in the Oscilloscope.
- If CRO is used the time period is set in such a way that both the last Latch enable signal and the Lock detect signal are visible on the screen.

iv. Software settings

Settings that need to be changed based on Reference and VCXO frequencies are as follows.

- For 40MHz reference and 40MHz VCXO.
- Set R-divider value to 1.
- Set N-divider value to 1.
- Set Mux out-Lock detect.
- Set charge pump out in normal state.
- Set the 40MHz reference frequency in FPGA and TRANSCEIVER code.

4.1.4.4 Requirements

Feature	Specification
Lock time	2 ms (specification is from GSM frequency hoping parameter)

Table 42. Lock time

4.1.4.5 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal Frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 43. Test Condition

4.1.4.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done using on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
6. For the signal to be tapped at CON2 mount C4347 which is DNP by default on the board.
7. For code build go to this path “ $ cd connect/uhd/uhd/host/build “ and hit this command “$ sudo ./builduhd.sh “ in Linux terminal.
8. For running Transceiver go to this path” $ cd osmo-trx/Trasceiver52M “and hit this command “$ sudo osmo-trx -f 1” in Linux terminal.
9. Observe the clock output at connectors CON2 in spectrum analyser.
10. Measure the lock time using oscilloscope. Probe Latch enable and lock detect using two CRO probes.
11. Probe CRO channel-1 at R10960 to measure LE and Probe CRO channel- 2 probe at R10961 to measure lock detect.
12. Time taken from the last latch enable to when the lock detect becomes high gives the lock time.

4.1.4.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

4.1.5 Test Case: Clock Duty Cycle (Clk 1.6)

4.1.5.1 Description

I. Purpose

The purpose of the test is to verify if the duty cycle of the clock signal at the input of FPGA is greater than the expected requirement.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in incorrect data reception at the input of FPGA
Compliance	NA	

Table 44. Impact of Failure of Clock Duty Cycle

4.1.5.2 Test Equipment List

- Power supply(Agilent N5182A or Equivalent)
- RF cables – 1 no's (SMA female to SMA female)
- Oscilloscope: MSO70404C Mixed Signal Oscilloscope
- Linux PC
- USB Cable

4.1.5.3 Test Setup

i. Setup Block diagram

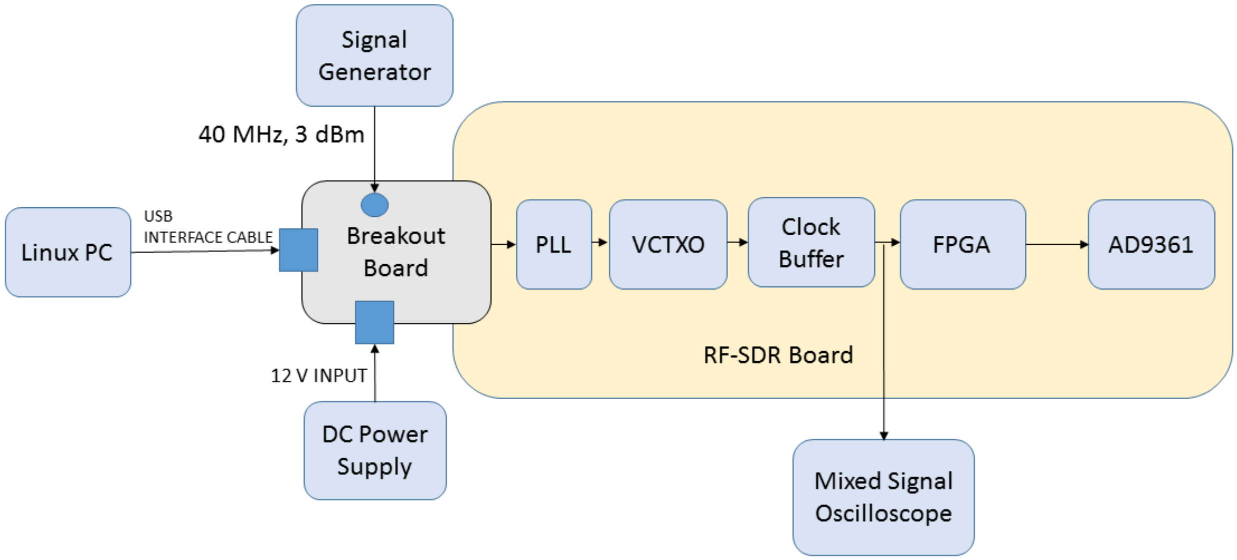

Figure 11. Clock Duty Cycle Test Setup Block Diagram

ii. Measurement Locations

- Observe the clock output at pin number 2 of resistor R22 on the Mixed Signal Oscilloscope
- Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope
- Monitor the latch enable pin and check if latch enable is high (monitor at R109060) in oscilloscope

v. Equipment Settings

- **Agilent N5182A MXG** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 21. Signal Generator Settings

- **Tektronix MS070404C** mixed signal oscilloscope

Amplitude	800 mV/div
Timescale	10 ns/div

Resolution	12.5 GS/s

Table 22. Mixed Signal Oscilloscope Settings

- This test is performed in the Mixed Signal Oscilloscope.
- Frequency, VIH, VIL, Vmax, Vmin, and Duty cycle are selected in the measurement setup option.

iii. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and run the command mentioned below

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and run this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation.

Settings that need to be changed based on Reference and VCXO frequencies are as follows.

- For 40MHz reference and 40MHz VCXO.
- Set R-divider value to 1.
- Set N-divider value to 1.
- Set Mux out-Lock detect.
- Set charge pump out in normal state.
- Set the 40MHz reference frequency in FPGA and TRANSCEIVER code.

4.1.5.4 Requirements

Feature	Specification
Clock Duty Cycle	>= 25 %

Table 23. Clock Duty Cycle Requirement

4.1.5.5 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal Frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 24. Test Condition

4.1.5.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programming of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -fc 1 -x" in Linux terminal.
7. Observe the clock output at R22 by probing at pin 2 of the resistor and check the clock waveform on the mixed signal oscilloscope
8. Measure the clock duty cycle using oscilloscope.

4.1.5.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

4.1.6 Test Case: Jitter (Clk 1.7)

4.1.6.1 Description

I. Purpose

The purpose of the test is to verify if the period jitter of the clock signal at the input of FPGA is well within the required limit.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in incorrect data reception at the input of FPGA
Compliance	NA	

Table 45. Impact of Failure of Clock Period Jitter

4.1.6.2 Test Equipment List

- Power supply (Agilent N5182A or Equivalent)
- RF cables – 1 no’s (SMA female to SMA female)
- Oscilloscope: MSO70404C Mixed Signal Oscilloscope
- Linux PC
- USB Cable

4.1.6.3 Test Setup

i. Setup Block diagram

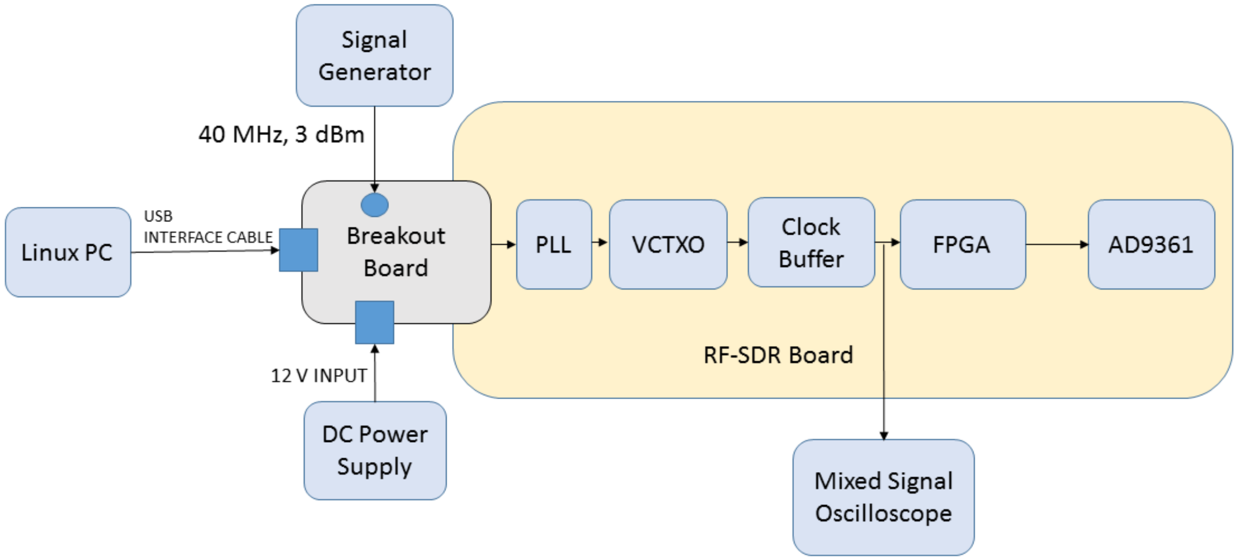

Figure 12. Clock Jitter Test Setup Block Diagram

ii. **Measurement Locations**

- Observe the clock output at pin number 2 of resistor R22 on the Mixed Signal Oscilloscope
- Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope
- Monitor the latch enable pin and check if latch enable is high (monitor at R109060) in oscilloscope

iii. **Equipment Settings**

- **Agilent N5182A MXG** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 25. Signal Generator Settings

- **Tektronix MS070404C** mixed signal oscilloscope

Amplitude	800 mV/div
Timescale	10 ns/div
Resolution	12.5 GS/s

Table 26. Mixed Signal Oscilloscope Settings

- This test is performed in the Mixed Signal Oscilloscope.
- DPOJET is selected and is configured to measure period jitter, frequency, and time period in the MSO.

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation.

Settings that need to be changed based on Reference and VCXO frequencies are as follows.

- For 40MHz reference and 40MHz VCXO.
- Set R-divider value to 1.
- Set N-divider value to 1.
- Set Mux out-Lock detect.
- Set charge pump out in normal state.
- Set the 40MHz reference frequency in FPGA and TRANSCEIVER code.

4.1.6.4 Requirements

Feature	Specification
Period Jitter	< 5 ns

Table 27. Period Jitter requirement

4.1.6.5 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal Frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 28. Test Condition

4.1.6.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and run this command "$ sudo osmo-trx -fc 1 -x" in Linux terminal.
7. Observe the clock output at R22 by probing at pin 2 of the resistor and check the clock waveform on the mixed signal oscilloscope
8. Measure the clock period jitter using oscilloscope.

4.1.6.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

4.1.7 Test Case: Clock Duty Cycle (Clk 1.8)

4.1.7.1 Description

I. Purpose

The purpose of the test is to verify if the duty cycle of the clock signal at the input of FPGA is greater than the expected requirement

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in incorrect data reception at the input of FPGA
Compliance	NA	

Table 46. Impact of Failure of Clock Duty Cycle

4.1.7.2 Test Equipment List

- Power supply(Agilent N5182A or Equivalent)
- RF cables – 1 no's (SMA female to SMA female)
- Oscilloscope: MSO70404C Mixed Signal Oscilloscope
- Linux PC
- USB Cable

4.1.7.3 Test Setup

i. Setup Block diagram

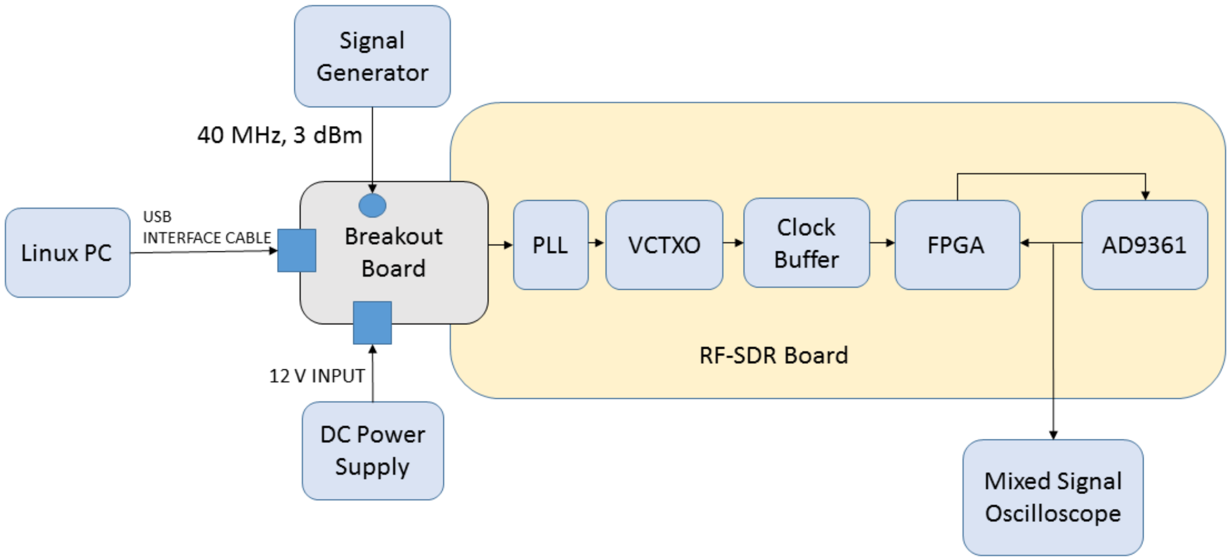

Figure 13. Clock Duty Cycle Test Setup Block Diagram

ii. Measurement Locations

- Observe the clock output at pin B2 of FPGA (U9.B2) with the help of Mixed Signal Oscilloscope
- Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope
- Monitor the latch enable pin and check if latch enable is high (monitor at R109060) in oscilloscope

iii. Equipment Settings

- **Agilent N5182A MXG** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 29. Signal Generator Settings

- **Tektronix MS070404C** mixed signal oscilloscope

Amplitude	300 mV/div

Timescale	10 ns/div
Resolution	12.5 GS/s

Table 30. Mixed Signal Oscilloscope Settings

- This test is performed in the Mixed Signal Oscilloscope.
- Frequency, VIH, VIL, Vmax, Vmin, and Duty cycle is selected in the measurement setup option.

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and run the command mentioned below

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and run this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation.

Settings that need to be changed based on Reference and VCXO frequencies are as follows.

- For 40MHz reference and 40MHz VCXO.
- Set R-divider value to 1.
- Set N-divider value to 1.
- Set Mux out-Lock detect.
- Set charge pump out in normal state.
- Set the 40MHz reference frequency in FPGA and TRANSCEIVER code.

4.1.7.4 Requirements

Feature	Specification
Clock Duty Cycle	>= 25 %

Table 31. Clock Duty Cycle requirement

4.1.7.5 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal Frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 32. Test Condition

4.1.7.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -fc 1 -x" in Linux terminal.
7. Observe the clock output by probing at pin B2 of FPGA and check the clock waveform on the mixed signal oscilloscope
8. Measure the clock duty cycle using oscilloscope.

4.1.7.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

4.1.8 Test Case: Jitter (Clk 1.9)

4.1.8.1 Description

I. Purpose

The purpose of the test is to verify if the period jitter of the clock signal at the input of FPGA is well within the required limit.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in incorrect data reception at the input of FPGA
Compliance	NA	

Table 47. Impact of Failure of Clock Period Jitter

4.1.8.2 Test Equipment List

- Power supply (Agilent N5182A or Equivalent)
- RF cables – 1 no's (SMA female to SMA female)
- Oscilloscope: MSO70404C Mixed Signal Oscilloscope
- Linux PC
- USB Cable

4.1.8.3 Test Setup

i. Setup Block diagram

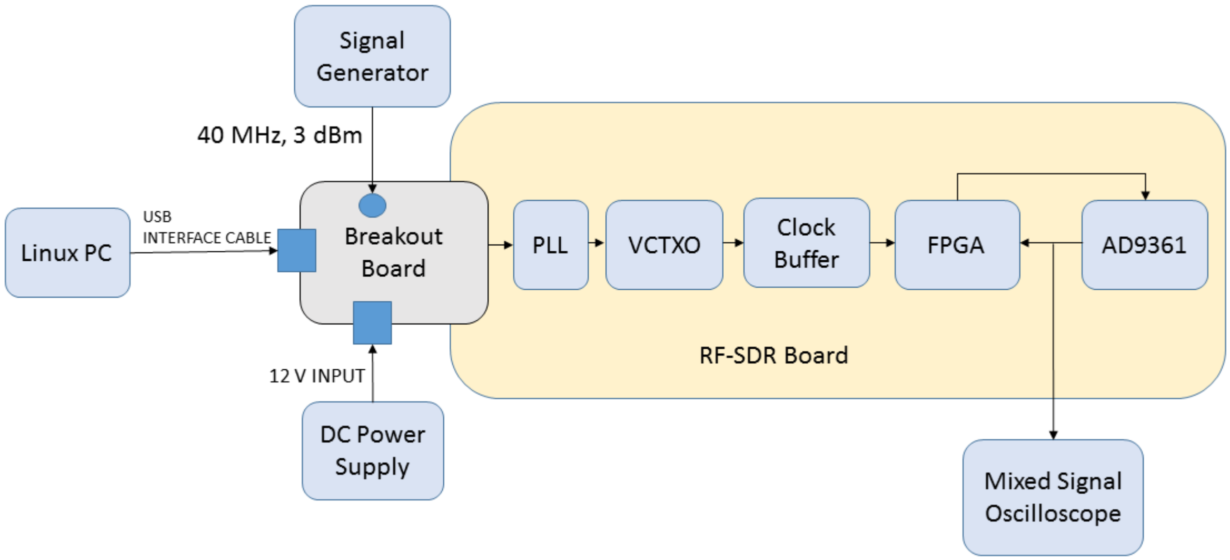

Figure 14. Clock Jitter Test Setup Block Diagram

ii. Measurement Locations

- Observe the clock output at pin B2 of FPGA (U9.B2) with the help of Mixed Signal Oscilloscope
- Monitor the lock detect pin and check if lock detect is high (monitor at R10961) in oscilloscope
- Monitor the latch enable pin and check if latch enable is high (monitor at R109060) in oscilloscope

iii. Equipment Settings

- **Agilent N5182A MXG** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 33. Signal Generator Settings

- **Tektronix MS070404C** mixed signal oscilloscope

Amplitude	300 mV/div
Timescale	10 ns/div

Resolution	12.5 GS/s

Table 34. Mixed Signal Oscilloscope Settings

- This test is performed in the Mixed Signal Oscilloscope.
- DPOJET is selected and is configured to measure period jitter, frequency, and time period in the MSO.

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation.

Settings that need to be changed based on Reference and VCXO frequencies are as follows.

- For 40MHz reference and 40MHz VCXO.
- Set R-divider value to 1.
- Set N-divider value to 1.
- Set Mux out-Lock detect.
- Set charge pump out in normal state.
- Set the 40MHz reference frequency in FPGA and TRANSCEIVER code.

4.1.8.4 Requirements

Feature	Specification
Period Jitter	< 5 ns

Table 35. Period Jitter requirement

4.1.8.5 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal Frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 36. Test Condition

4.1.8.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -fc 1 -x" in Linux terminal.
7. Observe the clock output by probing at pin B2 of FPGA and check the clock waveform on the mixed signal oscilloscope .
8. Measure the clock period jitter using oscilloscope.

4.1.8.7 Reference

1. Section 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

5. FPGA

The FPGA used for base band data transfer is Artix-7 XA7A100T from Xilinx. These 28nm Artix-7 FPGAs are optimized for the lowest cost and power with small form-factor packaging.

5.1 Test Purpose and Description

The purpose of this test case is to verify and validate the boot configuration of the FPGA and its power sequence.

Verification and validation of the FPGA sub-system covers the following functions and features:

1. SPI signals coming from FX3
2. SPI interface between Artix – 7 and AD9361 Transceiver
3. Control and Data signals from FX3
4. Control and Data signals from AD9361 Transceiver

5.1.1 Test Case: Artix – 7 – Boot Configuration (FPGA 1.1.1)

5.1.1.1 Description

I. Purpose

The purpose of this test case is to validate the Boot configuration of Artix – 7 FPGA.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	If this test case fails, then there will not be any communication between FPGA and AD9361 Transceiver.
Compliance	NA	

Table 48. Impact of Failure of Artix – 7 Boot configuration

5.1.1.2 Test Equipment List

- DC power supply: E3633A
- RF Cables – 1 no’s (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.1.3 Test Setup

i. Setup Block diagram

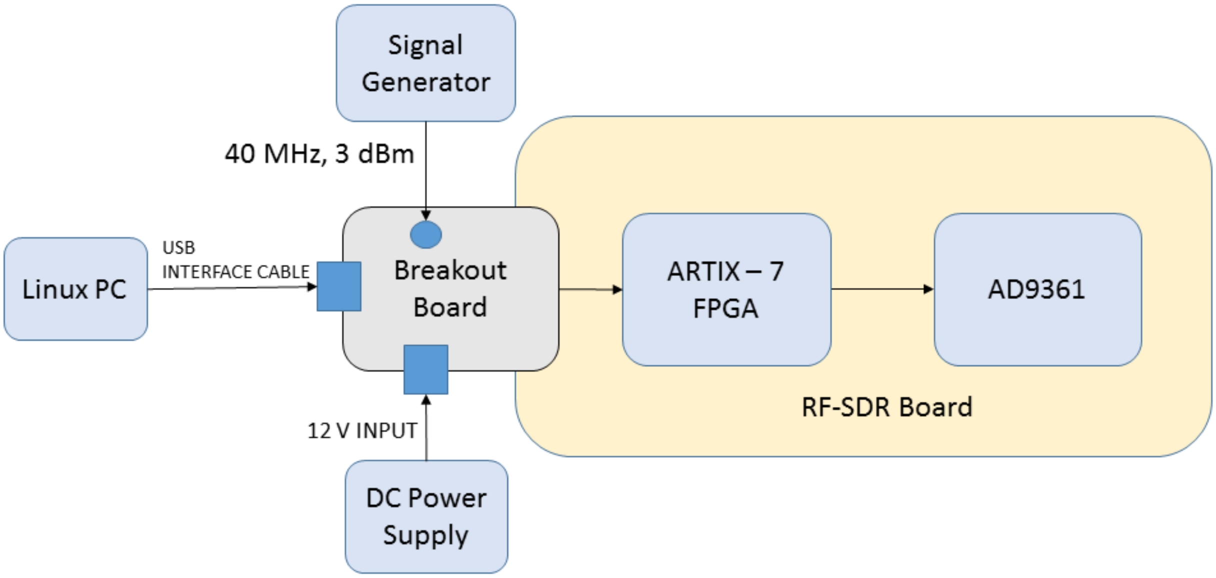

Figure 15. Artix – 7 – Boot Configuration Test Setup Block Diagram

ii. Equipment Settings

- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iii. Test Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and run this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation

5.1.1.4 Requirements

Test	Measuring Parameter	Result
Artix – 7 Boot	Binary file load completion	The binary file was loaded into the EEPROM and the FPGA booted up successfully

Table 49. Artix – 7 Boot Configuration Requirement

5.1.1.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 50. Test Condition

5.1.1.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1” in Linux terminal
7. The FPGA booted up successfully as per requirement.

5.1.1.7 Reference

1. Section 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

5.1.2 Test Case: Artix – 7 – Power Sequence (FPGA 1.1.2)

5.1.2.1 Description

I. Purpose

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

II. Impact of failure on the system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in abnormal functionality of the system
Compliance	NA	

Table 51. Impact of Failure of Artix – 7 Power Sequence

5.1.2.2 Test Equipment List

- Oscilloscope: MSO9404A
- DC power supply: E3633A

5.1.2.3 Test Setup

i. Setup Block diagram

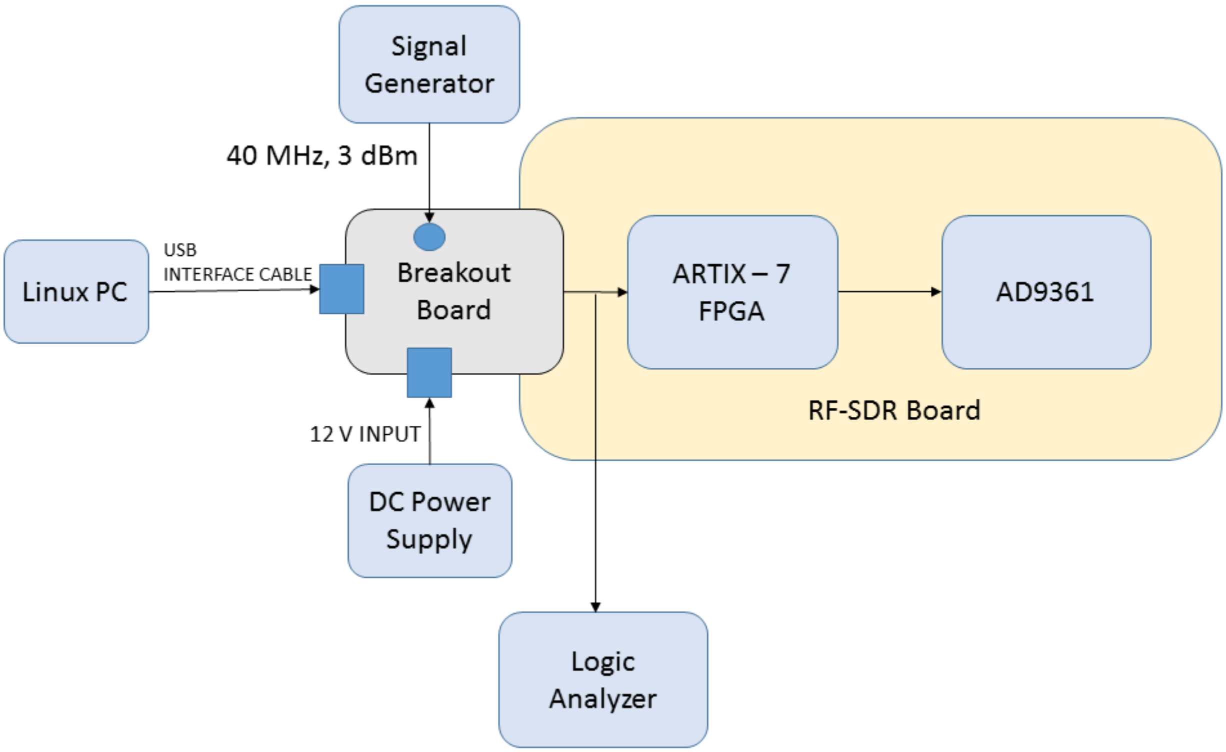

Figure 16. Artix – 7 – Power Sequence Test Setup Block Diagram

ii. **Measurement Locations**

- C245 (VCCINT+VCCBRAM), C256 (VCCAUX18), C251 (1.8VD_FPGA), C255 (3.3VD_FPGA), C276 (1P8V_FX3), C272(1P2V_FX3)

iii. **Equipment Settings**

- Oscilloscope: MSO9404A
  Voltage per division: 1V
  Time scale: 2 ms
- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iv. **Test Software settings**

- None

5.1.2.4 Requirements

Sl. No.	Measurement Points	Expected sequence
1	C276	1P8V_FX3
2	C272	1P2V_FX3
3	C245	VCCINT+VCCBRAM
4	C256	VCCAUX18
5	C251	1.8VD_FPGA
6	C255	3.3VD_FPGA

Table 52. Artix – 7 Power on Sequence Test Requirement

5.1.2.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 53. Test Condition

5.1.2.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. Select Logic Analyser (LA) in the oscilloscope, and select the logic analyser bits from D0 to D6.
7. The power rails 1P8V_FX3, 1P2V_FX3, VCCINT+VCCBRAM, VCCAUX18, 1.8VD_FPGA, and 3.3VD_FPGA are set to bits D0, D6, D4, D1, D2, D3 respectively in the logic analyzer.
8. The power rails 1P8V_FX3, 1P2V_FX3, VCCINT+VCCBRAM, VCCAUX18, 1.8VD_FPGA, and 3.3VD_FPGA are probed at C276, C272, C245, C256, C251, C255 respectively using the logic analyzer probe
9. The measured and expected power sequence is tabulated and the test is validated

5.1.2.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

5.1.3 Test Case: FX3 – SPI – Electrical Validation (FPGA 1.2.1)

5.1.3.1 Description

I. Purpose

The purpose of this test case is to validate the electrical characteristics of SPI interface of FX3

II. Impact of failure on the system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in improper read and write instructions
Compliance	NA	

Table 54. Impact of Failure of FX3 – SPI- EV

5.1.3.2 Test Equipment List

- Oscilloscope: MSO9404A
- DC power supply: E3633A
- RF Cables – 1 no's (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.3.3 Test Setup

i. Setup Block diagram

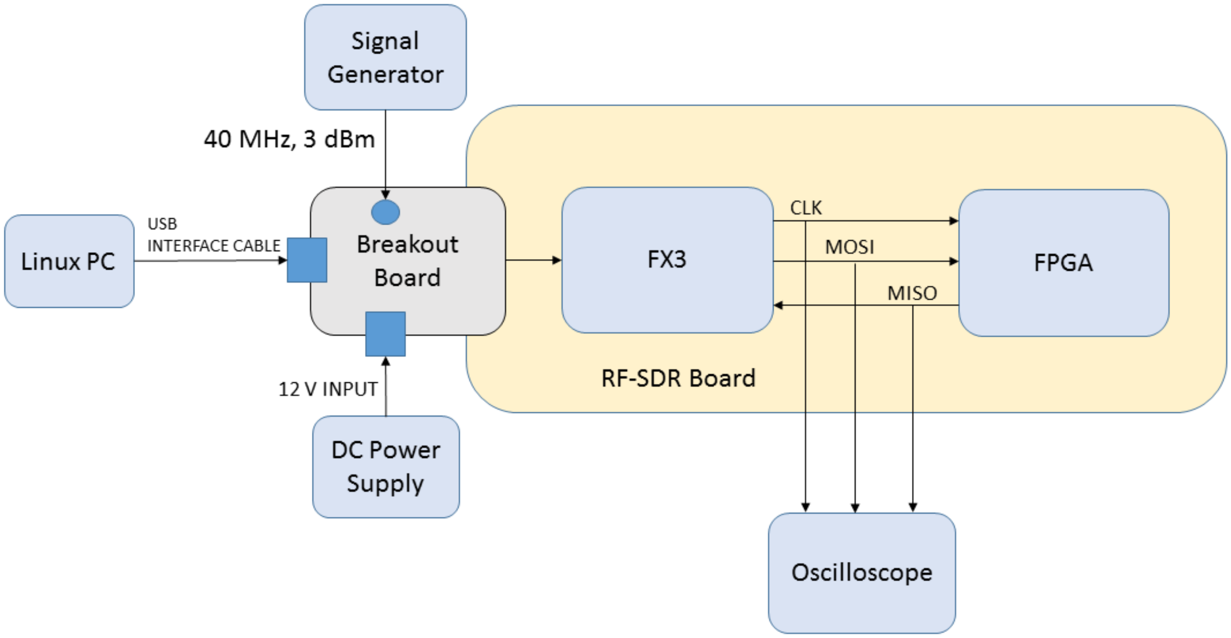

Figure 17. FX3 - SPI – EV Test Setup Block Diagram

ii. **Measurement Locations**

- U9.V19 (FX3_SCLK), U9.R22 (FX3_MOSI)

iii. **Equipment Settings**

- Oscilloscope: MSO9404A
  Voltage per division: 1V
  Time scale: 20 ns
- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iv. **Test Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation

5.1.3.4 Requirements

Test	Measuring Point	Measuring Parameters	Pass Criteria
FX3_SCLK	U9.V19	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
		Rise time (ns)	≥2.5
		Fall time (ns)	≥2.5
		Frequency (MHz)	< 100
FX3_MOSI	U9.R22	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
		Rise time (ns)	≥2.5
		Fall time (ns)	≥2.5

Table 55. FX3 - SPI – EV Test Requirement

5.1.3.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 56. Test Condition

5.1.3.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.

5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. Measure the voltage levels, minimum high time, and minimum low time for Clock and MOSI signals at U9.V19 and U9.R22 respectively. Measure the frequency of clock signal.

5.1.3.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

5.1.4 Test Case: FX3 – SPI – Functional Validation (FPGA 1.2.2)

5.1.4.1 Description

I. Purpose

The purpose of this test case is to validate the function of the SPI interface of FX3 – GPIF.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	Registers of Artix – 7 FPGA become inaccessible on failure of this test case
Performance	NA	
Compliance	NA	

Table 57. Impact of Failure of FX3 – SPI- FV

5.1.4.2 Test Equipment List

- DC power supply: E3633A
- RF Cables – 1 no's (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.4.3 Test Setup

i. Setup Block diagram

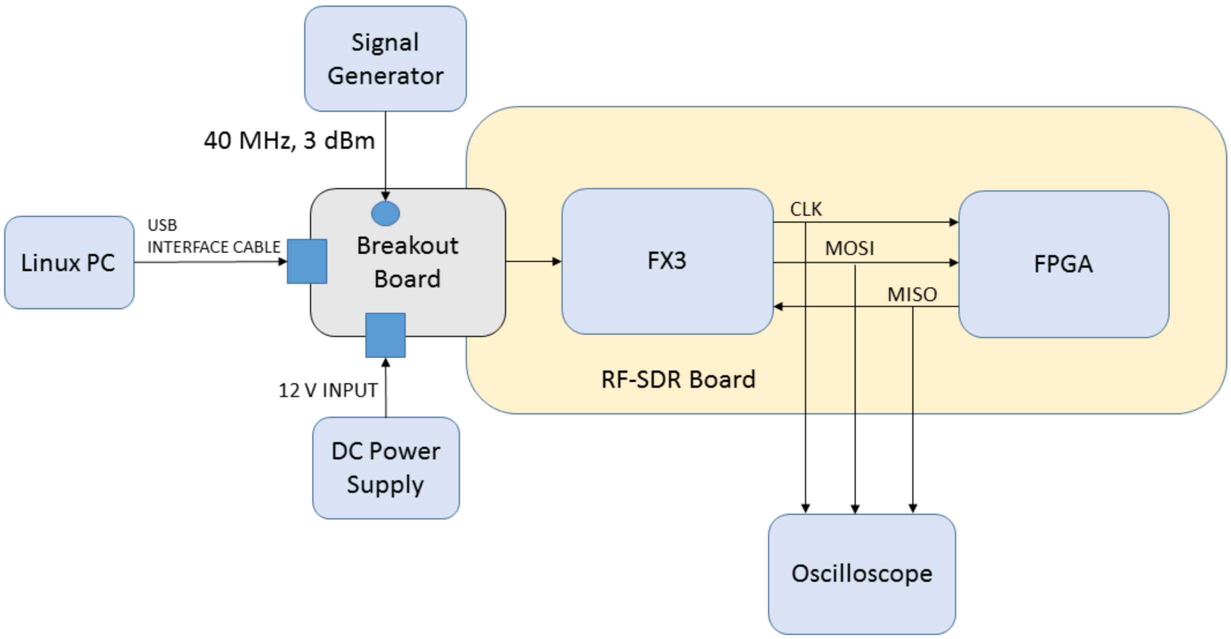

Figure 18. FX3 – SPI - FV Test Setup Block Diagram

ii. Equipment Settings

- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iii. Test Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation

5.1.4.4 Requirements

Test	Measuring Parameter	Result
SPI Interface	Data Transaction	Able to write data into the FPGA

Table 58. FX3 – SPI - FV Test Requirement

5.1.4.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 59. Test Condition

5.1.4.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. The probed SPI signals were found to function as per requirement

5.1.4.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

5.1.5 Test Case: AD9361 – SPI – Electrical Validation/Signal Integrity (FPGA 1.3.1)

5.1.5.1 Description

I. Purpose

The purpose of this test case is to validate the electrical characteristics of SPI interface of AD9361 Transceiver.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in improper read and write instructions
Compliance	NA	

Table 60. Impact of Failure of AD9361 – SPI - EV

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in improper read and write instructions
Compliance	NA	

Table 61. Impact of Failure of AD9361 – SPI - SI

5.1.5.2 Test Equipment List

- Oscilloscope: DPO7354C
- DC power supply: E3633A
- RF cables – 1 no’s (SMA female to SMA female)
- Linux PC
- USB Cable

5.1.5.3 Test Setup

i. Setup Block diagram

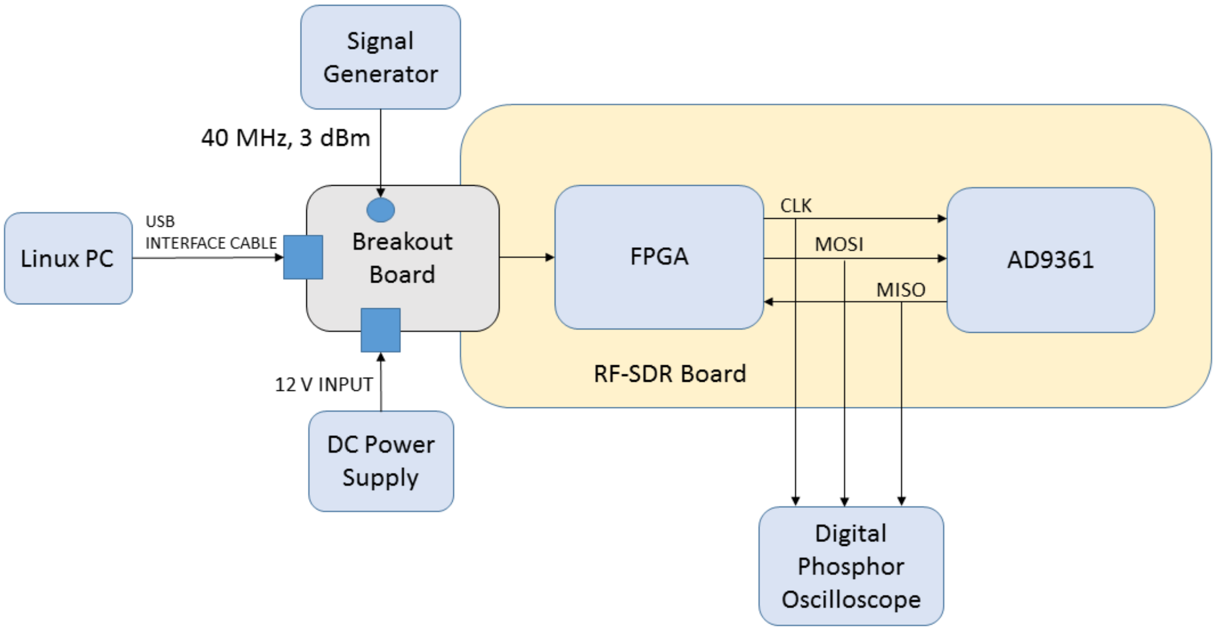

Figure 19. AD9361 – SPI - EV Test Setup Block Diagram

ii. **Measurement Locations**

- U9.C2 (CAT_SCLK), U9.A1 (CAT_MOSI), U9.B1 (CAT_MISO)

iii. **Equipment Settings**

- Oscilloscope: DPO7354C
  Voltage per division: 1V
  Time scale: 2 ns
- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation.

5.1.5.4 Requirements

Test	Measuring Point	Measuring Parameters	Pass Criteria
CAT_SCLK	U9.C2	VIL (max) (V)	0 - 0.36
		VIH (min) (V)	1.44 - 1.8
		Frequency (MHz)	<= 50
CAT_MOSI	U9.A1	VIL (max) (V)	0 - 0.36
		VIH (min) (V)	1.44 - 1.8
CAT_MISO	U9.B1	VIL (max) (V)	-0.3 – 0.63
		VIH (min) (V)	1.17 – 2.1

Table 62. AD9361 - SPI - EV Test Requirement

Test	Measuring Point	Measuring Parameters	Pass Criteria
CAT_SCLK	U9.C2	Positive Overshoot (V)	<= 0.18
		Negative Overshoot (V)	<= 0.18
CAT_MOSI	U9.A1	Positive Overshoot (V)	<= 0.18
		Negative Overshoot (V)	<= 0.18
		Data Setup time (ns)	>= 2
		Data Hold time (ns)	>= 1

CAT_MISO	U9.B1	Positive Overshoot (V)	<= 0.18
		Negative Overshoot (V)	<= 0.18
		Data Setup time (ns)	>= 2.44
		Data Hold time (ns)	>= 0.62

Table 63. AD9361 - SPI - SI Test Requirement

5.1.5.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 64. Test Condition

5.1.5.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing, programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.

6. Change the value in the register 0x035 to 0x09 in AD9361_device.cpp file for receiving data from the transceiver.
7. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
8. Probe for the Clock (CAT_SCLK), MOSI (CAT_MOSI) signal and MISO (CAT_MISO) at U9.C2 U9.A1, and U9.B1 respectively
9. Measure the voltage levels of the signals. Measure the frequency of the clock signal.
10. Measure the Positive and negative overshoot of CAT_MOSI and CAT_MISO signals. Measure the Data Setup time and Data Hold time of CAT_MOSI and CAT_MISO with respect to CAT_SCLK.

5.1.5.7 Reference

1. Section 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

5.1.6 Test Case: AD9361 – SPI – Functional Validation (FPGA 1.3.2)

5.1.6.1 Description

I. Purpose

The purpose of this test case is to validate the function of SPI interface of AD9361 Transceiver.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	Registers of Artix – 7 FPGA become inaccessible on failure of this test case
Performance	NA	
Compliance	NA	

Table 65. Impact of Failure of AD9361 – SPI- FV

5.1.6.2 Test Equipment List

- DC power supply: E3633A
- RF Cables – 1 no’s (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.6.3 Test Setup

i. Setup Block diagram

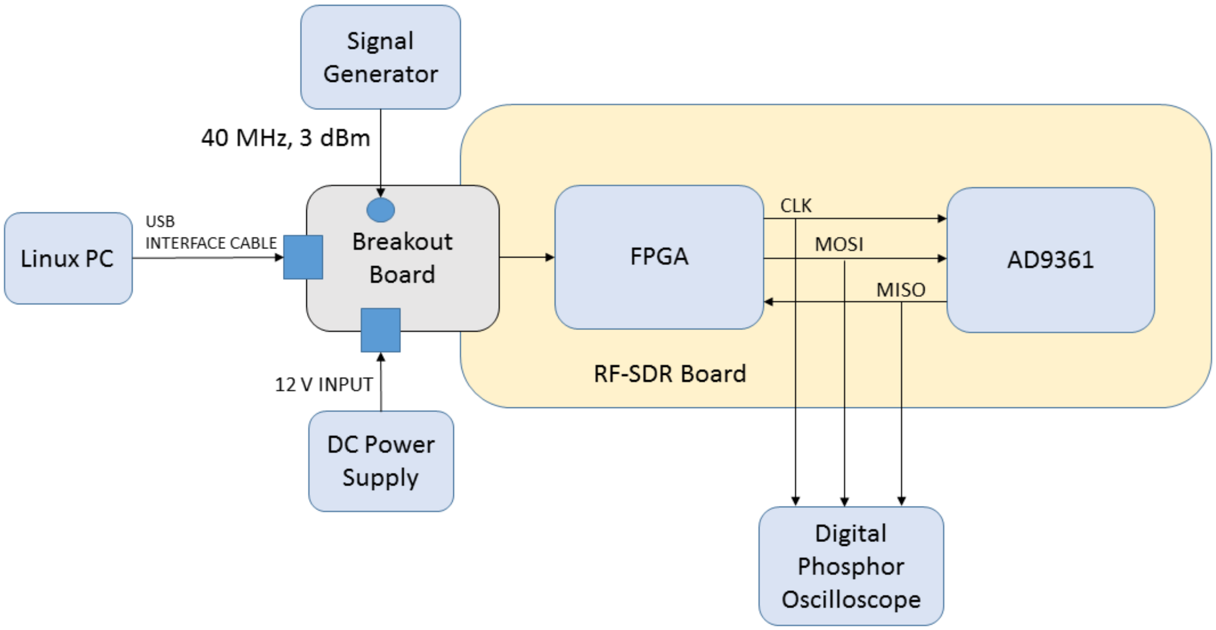

Figure 20. AD9361 - SPI – FV Test Setup Block Diagram

ii. Equipment Settings

- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iii. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and run this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation.

5.1.6.4 Requirements

Test	Measuring Parameter	Result
SPI Interface	Control Output Pointer	Able to read Control Output Pointer with register address, 0x035, which has a value of 0x09

Table 66. AD9361 – SPI – FV Test Requirement

5.1.6.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 67. Test Condition

5.1.6.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. Change the value in the register 0x035 to 0x09 in AD9361_device.cpp file for receiving data from the transceiver.
7. For running Transceiver, go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx –fc 1 -x" in Linux terminal
8. The SPI Interface was found to function as per requirement

5.1.6.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

5.1.7 Test Case: FX3 – GPIF: Control – Electrical Validation (FPGA 1.4.1)

5.1.7.1 Description

I. Purpose

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

II. Impact of failure on the system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	There will be no transfer of data from FX3 if this test case fails
Compliance	NA	

Table 68. Impact of Failure of FX3 – GPIF: Control – EV

5.1.7.2 Test Equipment List

- Oscilloscope: DPO7354C
- DC power supply: E3633A
- RF Cables – 1 no’s (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.7.3 Test Setup

i. Setup Block diagram

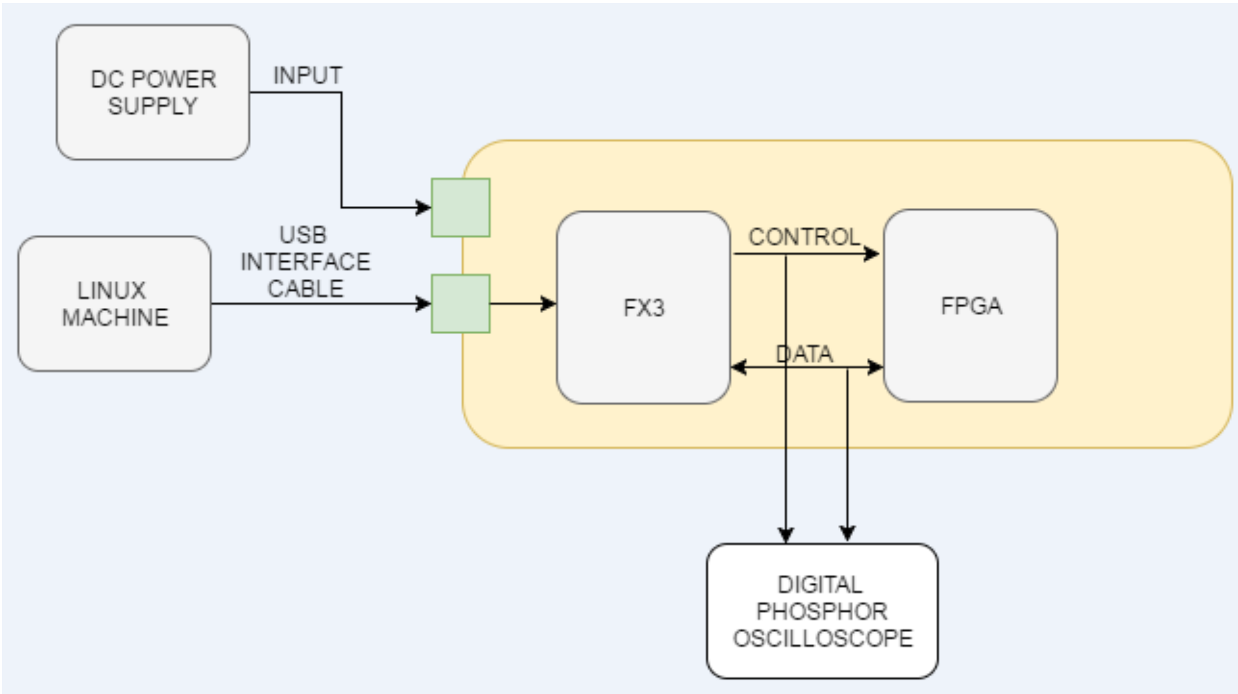

Figure 21. FX3 – GPIF Control - EV Test Setup Block Diagram

ii. **Measurement Locations**

- U9.G15 (GPIF_CTL3), U9.G13 (GPIF_CTL12)

iii. **Equipment Settings**

- Oscilloscope: DPO7354C
  Voltage per division: 1V
  Time scale: 10 us
- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and

this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation

5.1.7.4 Requirements

Test	Measuring Point	Measuring Parameters	Pass Criteria
GPIF_CTL3	U9.G15	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
		Minimum High time (ns)	≥2.5
		Minimum Low time (ns)	≥2.5
GPIF_CTL12	U9.G13	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
		Minimum High time (ns)	≥2.5
		Minimum Low time (ns)	≥2.5

Table 49. FX3 – GPIF: Control Test Requirement

5.1.7.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 50. Test Condition

5.1.7.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.

4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. Probe for the control signals, namely, GPIF_CTL3, GPIF_CTL12 at U9.G15 and U9.G13 respectively
8. Measure the voltage levels of the control signals along with minimum high time and minimum low time.

5.1.7.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

5.1.8 Test Case: FX3 – GPIF: Control – Functional Validation (FPGA 1.4.2)

5.1.8.1 Description

I. Purpose

The purpose of this test case is to validate the function of the control signals of FX3 – GPIF.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	No data will be written into the FPGA if this test case fails
Performance	NA	
Compliance	NA	

Table 69. Impact of Failure of FX3 – GPIF: Control- FV

5.1.8.2 Test Equipment List

- DC power supply: E3633A
- RF Cables – 1 no's (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.8.3 Test Setup

i. Setup Block diagram

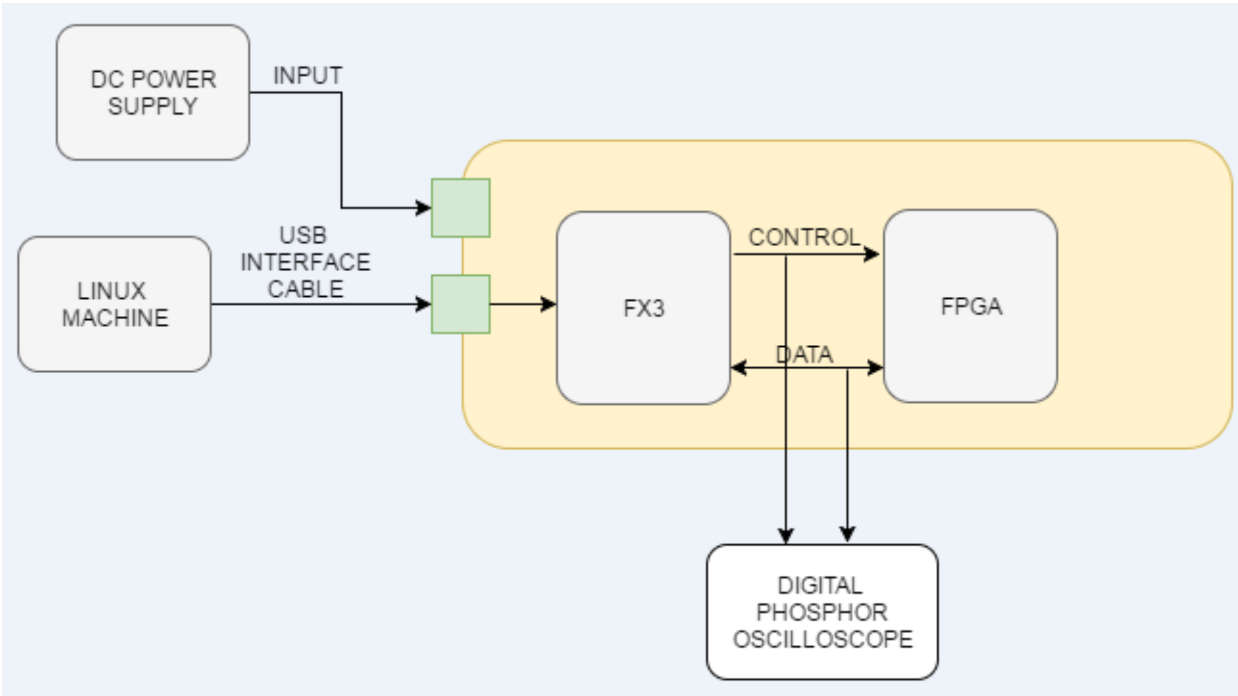

Figure 22. FX3 – GPIF Control – FV Test Setup Block Diagram

ii. Equipment Settings

- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iii. Test Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation

5.1.8.4 Requirements

Test	Measuring Parameter	Result
Control Signals	Control Output Pointer	Able to read Control Output Pointer with register address 0x035, which has a value 0x01

Table 70. FX3 – GPIF: Control Test Requirement

5.1.8.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 71. Test Condition

5.1.8.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together

and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.

6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. Probe for the control signals, namely, GPIF_CTL3 and GPIF_CTL12 at U9.G15 and U9.G13 respectively.
8. The control signals were found to function as per requirement.

5.1.8.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

5.1.9 Test Case: FX3 – GPIF: Data – Electrical Validation (FPGA 1.5.1)

5.1.9.1 Description

I. Purpose

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

II. Impact of failure on the system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	There will be no transfer of data from FX3 if this test case fails
Compliance	NA	

Table 72. Impact of Failure of FX3 – GPIF: Data – EV

5.1.9.2 Test Equipment List

- Oscilloscope: DPO7354C
- DC power supply: E3633A
- RF Cables – 1 no's (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.9.3 Test Setup

i. **Setup Block diagram**

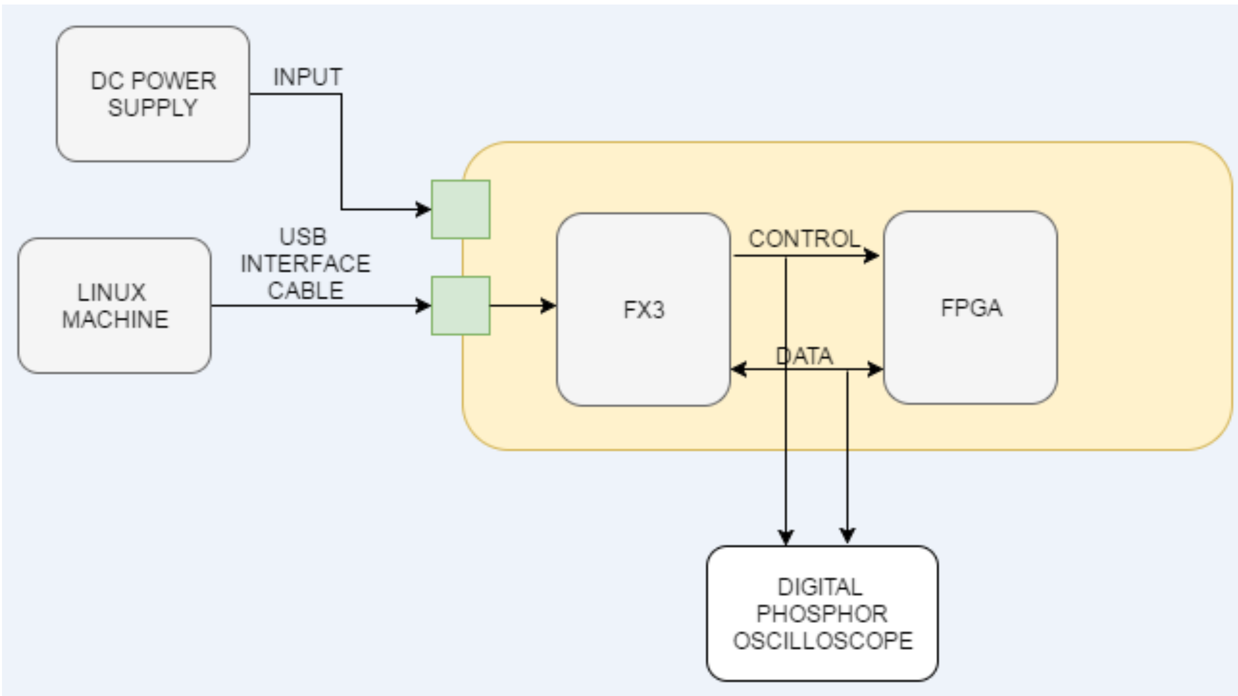

Figure 23. FX3 – GPIF Data – EV Test Setup Block Diagram

ii. **Measurement Locations**

- U9.K21 (GPIF_D04), U9.L18 (GPIF_D19), U9.J17 (GPIF_D29), U9.L15 (GPIF_D31)

iii. **Equipment Settings**

- Oscilloscope: DPO7354C

  Voltage per division: 1V

  Time scale: 20 ns

- DC power supply : E3633A

  Supply Voltage: 12 V

  Current Limit: 1 A

  OVP: 13V

  OCP: 1.5 A

iv. Test Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation

5.1.9.4 Requirements

Test	Measuring Point	Measuring Parameters	Pass Criteria
GPIF_D04	U9.K21	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
		Minimum High Time (ns)	>=2.5
		Minimum Low Time (ns)	>=2.5
GPIF_D19	U9.L18	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
		Minimum High Time (ns)	>=2.5
		Minimum Low Time (ns)	>=2.5
GPIF_D29	U9.J17	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
		Minimum High Time (ns)	>=2.5
		Minimum Low Time (ns)	>=2.5
GPIF_D31	U9.L15	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
		Minimum High Time (ns)	>=2.5
		Minimum Low Time (ns)	>=2.5

Table 73. FX3 – GPIF: Data Test Requirement

5.1.9.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 74. Test Condition

5.1.9.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. Probe for the data signals, namely, GPIF_D04, GPIF_D19, GPIF_D29, GPIF_D31 at U9.K21, U9.L18, U9.J17, and U9.L15 respectively

4 Measure the voltage levels, minimum high time, and minimum low time of all the data signals

5.1.9.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

5.1.10 Test Case: FX3 – GPIF: Data – Functional Validation (FPGA 1.5.2)

5.1.10.1 Description

I. Purpose

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

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	No data will be written into the FPGA if this test case fails
Performance	NA	
Compliance	NA	

Table 75. Impact of Failure of FX3 – GPIF: Data- FV

5.1.10.2 Test Equipment List

- DC power supply: E3633A
- RF Cables – 1 no’s (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.10.3 Test Setup

i. Setup Block diagram

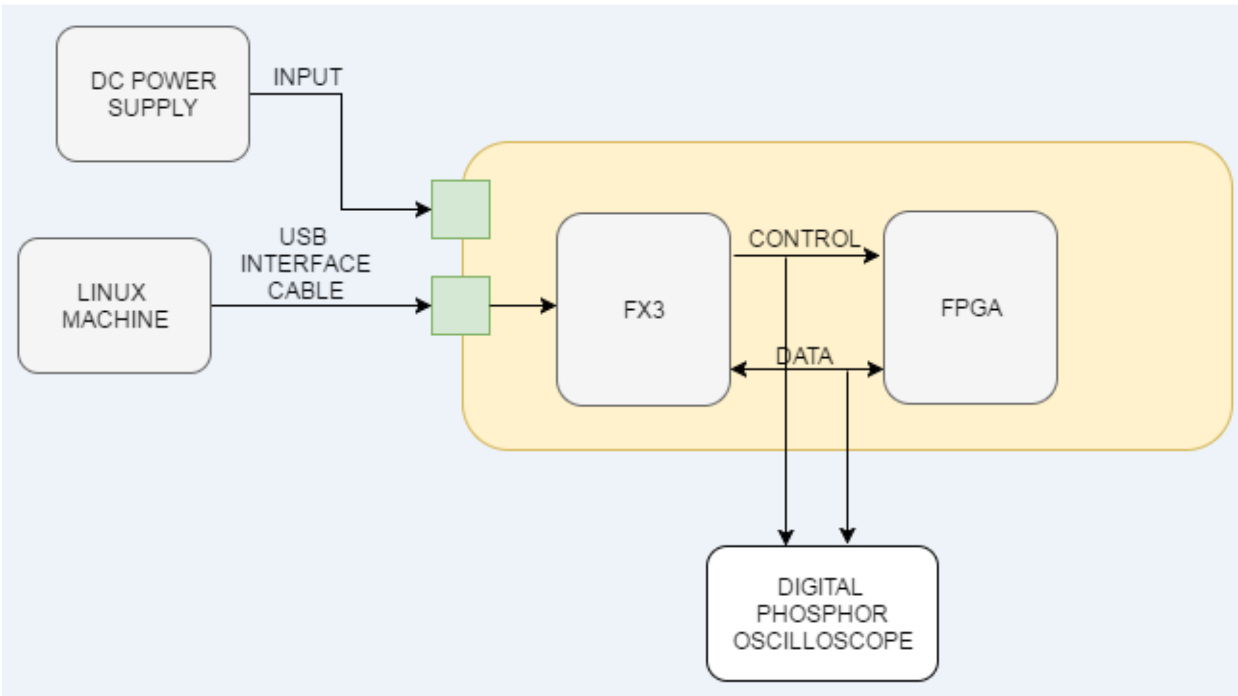

Figure 24. FX3 – GPIF Data - FV Test Setup Block Diagram

ii. Equipment Settings

- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iii. Test Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and run this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

  Step3. Running osmo-trx
- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation

5.1.10.4 Requirements

Test	Measuring Parameter	Result
Data Signals	Control Output Pointer	Able to read Control Output Pointer with register address 0x035, which has a value 0x01

Table 76. FX3 – GPIF: Data Test Requirement

5.1.10.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 77. Test Condition

5.1.10.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.

3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. The data signals were found to function as per requirement

5.1.10.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

5.1.11 Test Case: AD9361 – Control – Electrical Validation (FPGA 1.6.1)

5.1.11.1 Description

I. Purpose

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

II. Impact of failure on the system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	There will be no data transaction between AD9361 and FPGA if this test case fails
Compliance	NA	

Table 78. Impact of Failure of AD9361 - Control- EV

5.1.11.2 Test Equipment List

- Oscilloscope: MSO9404A
- DC power supply: E3633A
- RF Cables – 1 no's (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.11.3 Test Setup

i. Setup Block diagram

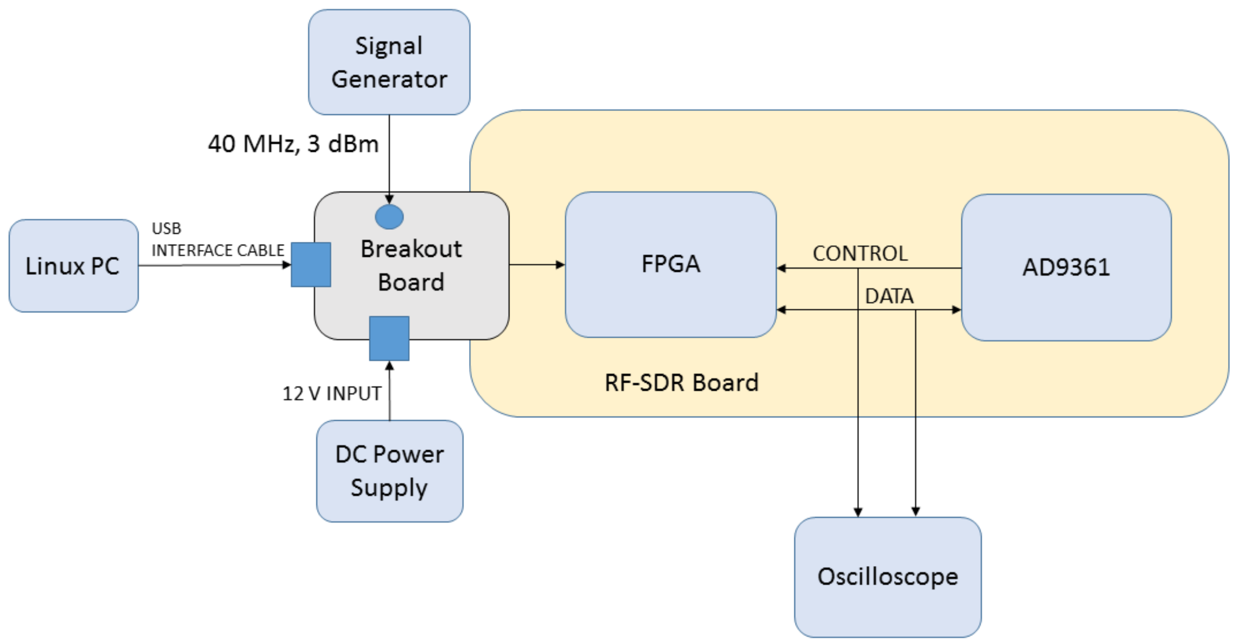

Figure 25. AD9361 – Control – EV Test Setup Block Diagram

ii. **Measurement Locations**

- U9.U21 (CODEC_CTRL_OUT2), U9.P19 (CODEC_CTRL_OUT3)

iii. **Equipment Settings**

- Oscilloscope: MSO9404A
  Voltage per division: 1V
  Time scale: 5 ms
- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iv. **Test Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command
- "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation.

5.1.11.4 Requirements

Test	Measuring Point	Measuring Parameters	Pass Criteria
CODEC_CTRL_OUT2	U9.U21	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1
CODEC_CTRL_OUT3	U9.P19	VIL (max) (V)	-0.3 - 0.63
		VIH (min) (V)	1.17 - 2.1

Table 79. AD9361 – Control - EV Test Requirement

5.1.11.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 80. Test Condition

5.1.11.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. Change the value in the register 0x035 to 0x06 in AD9361_device.cpp file for receiving data from the transceiver.

7. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
8. Probe for the control signals, namely, CODEC_CTRL_OUT2 (Shortest trace length) and CODEC_CTRL_OUT3 (Longest trace length) at U9.U21 and U9.P19 respectively
9. Measure the voltage levels of both the signals.

5.1.11.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

5.1.12 Test Case: AD9361 – Control – Functional Validation (FPGA 1.6.2)

5.1.12.1 Description

I. Purpose

The purpose of this test case is to validate the function of the control signals of AD9361 Transceiver.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	No data will be written into the FPGA if this test case fails
Performance	NA	
Compliance	NA	

Table 81. Impact of Failure of AD9361 – Control - FV

5.1.12.2 Test Equipment List

- DC power supply: E3633A
- RF Cables – 1 no's (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.12.3 Test Setup

i. Setup Block diagram

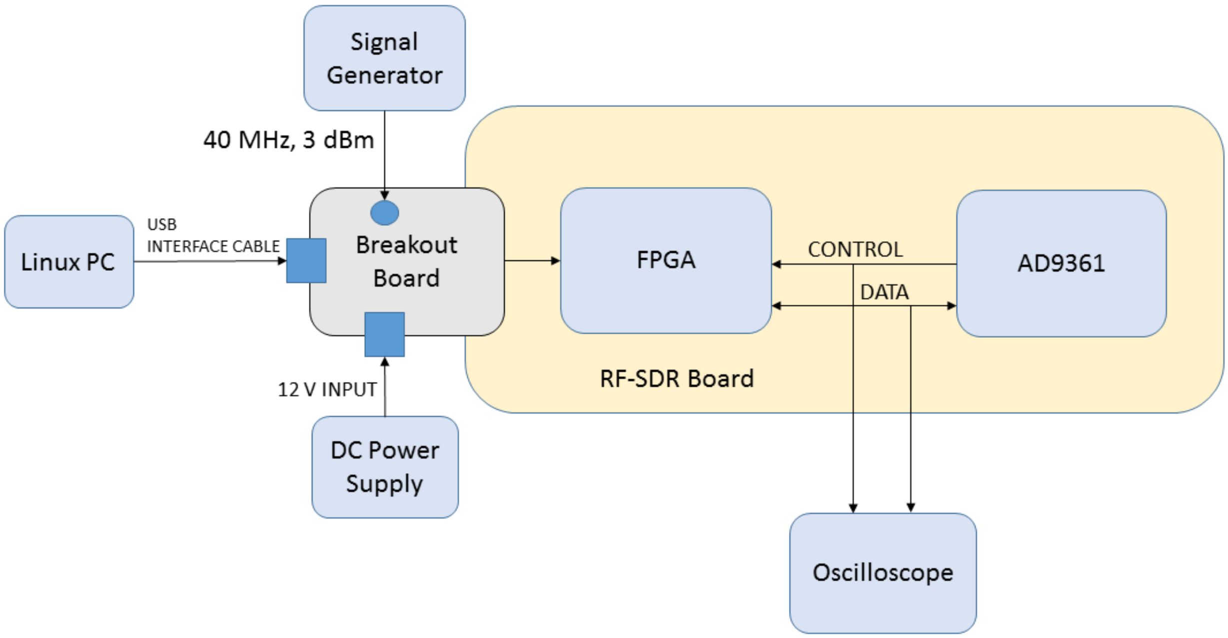

Figure 26. AD9361 - Control – FV Test Setup Block Diagram

ii. Equipment Settings

- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iii. Test Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and

this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command
- “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation.

5.1.12.4 Requirements

Test	Measuring Parameter	Result
Control Signals	Control Output Pointer	Able to read Control Output Pointer with register address 0x035, which has a value of 0x06

Table 82. AD9361 – Control - FV Test Requirement

5.1.12.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 83. Test Condition

5.1.12.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.

4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. Change the value in the register 0x035 to 0x06 in AD9361_device.cpp file for receiving data from the transceiver.
7. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
8. The control output signals were found to function as per requirement.

5.1.12.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

5.1.13 Test Case: AD9361 – Data – Electrical Validation (FPGA 1.7.1)

5.1.13.1 Description

I. Purpose

The purpose of this test case is to validate the electrical characteristics of the data signals of AD9361 Transceiver.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	Failure of this test case will result in reception of incorrect data at the input of FPGA.
Performance	NA	
Compliance	NA	

Table 84. Impact of Failure of AD9361 – Data - EV

5.1.13.2 Test Equipment List

- Oscilloscope: MSO9404A, DPO7354C
- DC power supply: E3633A
- RF Cables – 1 no's (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.13.3 Test Setup

i. **Setup Block diagram**

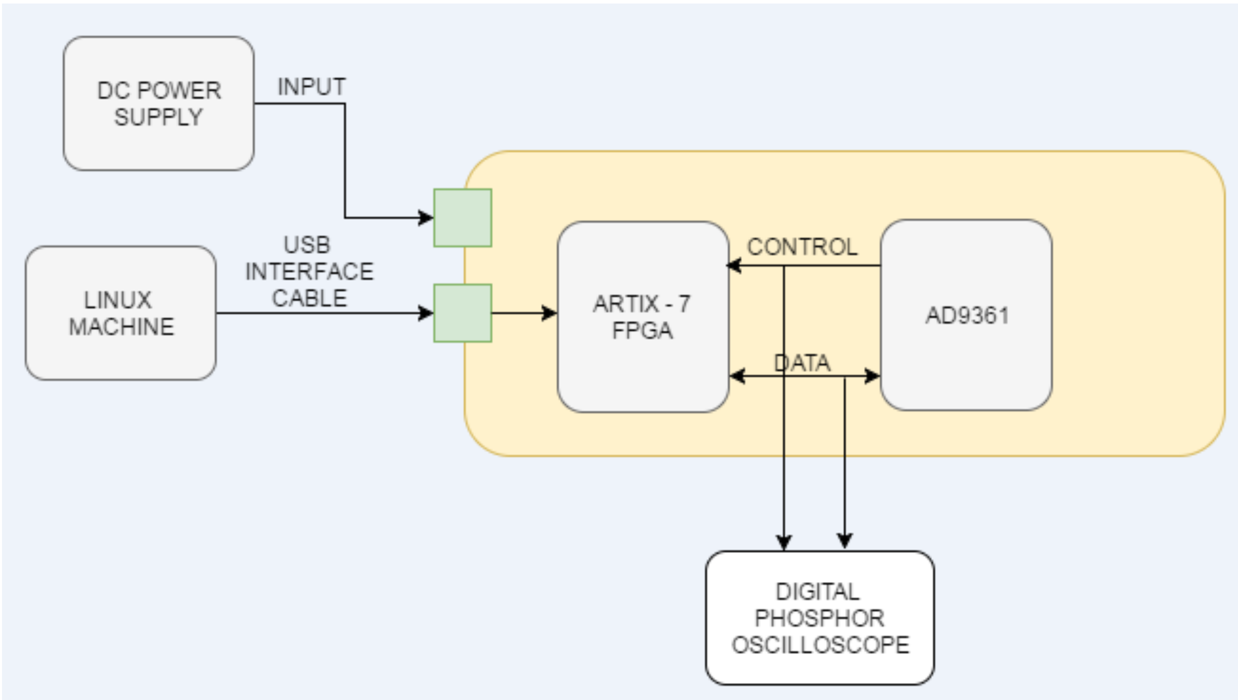

Figure 27. AD9361 – Data - EV Test Setup Block Diagram

ii. Measurement Locations

- U9.AB12 (CODEC_D1), U9.W12 (CODEC_D10), U9.AA15 (CODEC_D18), U9.Y13 (CODEC_D20)

iii. Equipment Settings

- Oscilloscope: MSO9404A
  Voltage per division: 1V
  Time scale: 10 ns
- Oscilloscope: DPO7354C
  Voltage per division: 1V
  Time scale: 20 ns
- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iv. Test Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command
- "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation.

5.1.13.4 Requirements

Test	Measuring Point	Measuring Parameters	Pass Criteria
CODEC_D1	U9.AB12	VIL (max) (V)	0 - 0.36
		VIH (min) (V)	1.44 – 1.8
		Rx Data Delay (DATA_CLK to Data Outputs) (ns)	0 - 1.5
		Rx Data Delay (DATA_CLK to Rx_FRAME) (ns)	0 - 1
CODEC_D10	U9.W12	VIL (max) (V)	0 - 0.36
		VIH (min) (V)	1.44 – 1.8
		Rx Data Delay (DATA_CLK to Data Outputs) (ns)	0 - 1.5
		Rx Data Delay (DATA_CLK to Rx_FRAME) (ns)	0 - 1
CODEC_D18	U9.AA15	VIL (max) (V)	0 - 0.36
		VIH (min) (V)	1.44 – 1.8
		Tx Data Setup Time (ns)	0 - 1.5
		Tx Data Hold Time (ns)	0 - 1
CODEC_D20	U9.Y13	VIL (max) (V)	0 - 0.36
		VIH (min) (V)	1.44 – 1.8
		Tx Data Setup Time (ns)	0 - 1.5
		Tx Data Hold Time (ns)	0 - 1

Table 85. AD9361 – Data - EV Test Requirement

5.1.13.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 86. Test Condition

5.1.13.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. Change the value in the register 0x035 to 0x06 in AD9361_device.cpp file for receiving data from the transceiver
7. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
8. Probe for the data signals, namely, CODEC_D1, CODEC_D10, CODEC_D18, CODEC_D20 at U9.AB12, U9.W12, U9.AA15, and U9.Y13 respectively
9. Measure the voltage levels of all the data signals.
10. For CODEC_D1 and CODEC_D10 signals, measure the Rx Data Delay of the data output with respect to DATA_CLK and Rx_FRAME.
11. For CODEC_D18 and CODEC_D20 signals, measure the Tx Data Setup Time and Tx Data Hold Time with respect to FB_CLK and Tx_FRAME.

5.1.13.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

5.1.14 Test Case: AD9361 – Data – Functional Validation (FPGA 1.7.2)

5.1.14.1 Description

I. Purpose

The purpose of this test case is to validate the function of the data signals of AD9361 Transceiver.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	Failure of this test case will result in reception of incorrect data at the input of FPGA
Performance	NA	
Compliance	NA	

5.1.14.2 Test Equipment List

- DC power supply: E3633A
- RF Cables – 1 no's (SMA Female to SMA Female)
- Linux PC
- USB Cable

5.1.14.3 Test Setup

i. Setup Block diagram

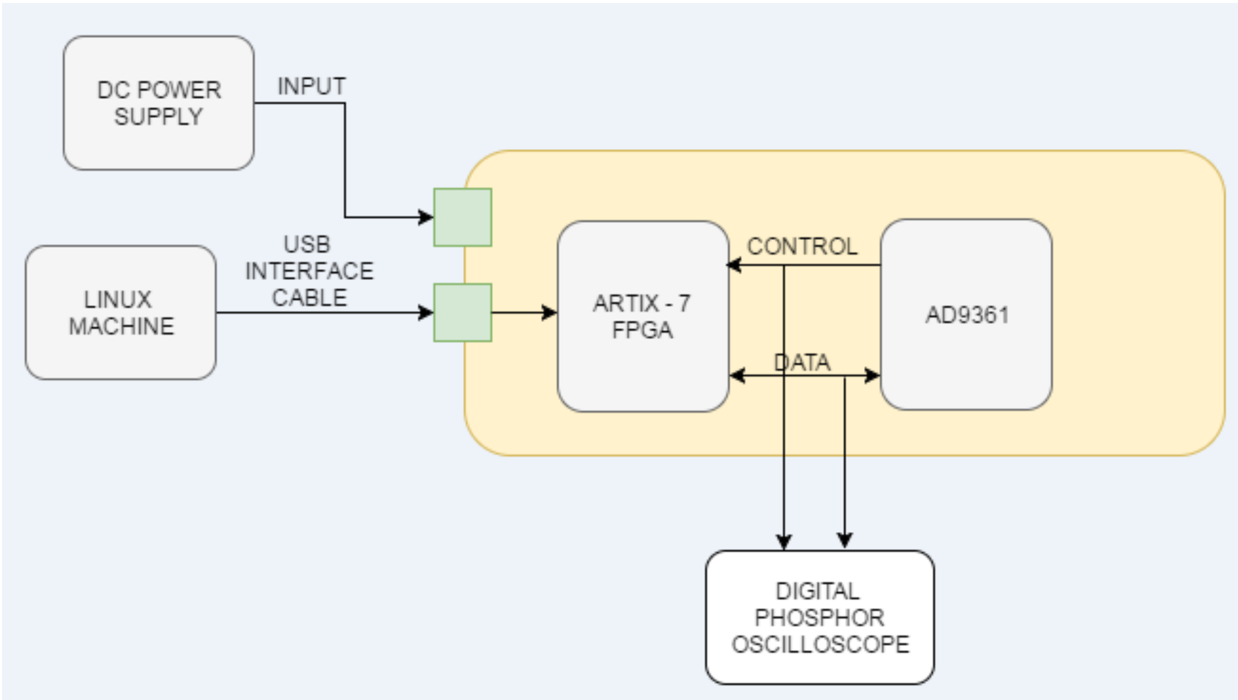

Figure 28. AD9361 - Data – FV Test Setup Block Diagram

ii. **Equipment Settings**

- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13V
  OCP: 1.5 A

iii. **Test Software settings**

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and run this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation

5.1.14.4 Requirements

Test	Measuring Parameter	Result
Data Signals	Control Output Pointer	Able to read Control Output Pointer with register address 0x035, which has a value of 0x06

Table 87. AD9361 – Data - FV Test Requirement

5.1.14.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 88. Test Condition

5.1.14.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. Change the value in the register 0x035 to 0x06 in AD9361_device.cpp file for receiving data from the transceiver.
7. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
8. The data signals were found to function as per requirement

5.1.14.7 Reference

1. Sections 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
   Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

6. FX3

The Baseband data is transferred from GBC board via Board-to-Board connector to FX3: SuperSpeed USB Controller from Cypress. This High-speed On-The-Go (HS-OTG) host and peripheral compliant Controller will convert the USB signals which is coming from B2B connector into 32bit parallel interface to FPGA.

6.1 Test Purpose and Description

The purpose of this test case is to verify if FX3 is configured properly and validate the data transactions.

Verification and validation of the FX3 sub system covers following functions and features:

1. Configuration of FX3.
2. I2C interface of EEPROM
3. Debug USB 2.0 Switch
4. Debug USB 3.0 Switch

6.1.1 Test Case: FX3 – Configuration (FX3 1.1)

6.1.1.1 Description

I. Purpose

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

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	If this test case fails, then FX3 will not be configured and FPGA will not boot up
Performance	NA	NA
Compliance	NA	NA

Table 89. Impact of Failure – FX3 configuration

6.1.1.2 Test Equipment List

- DC power supply : E3633A
- RF Cables – 1 no’s (SMA Female to SMA Female)
- Linux PC
- USB Cable

6.1.1.3 Test Setup

i. Setup Block diagram

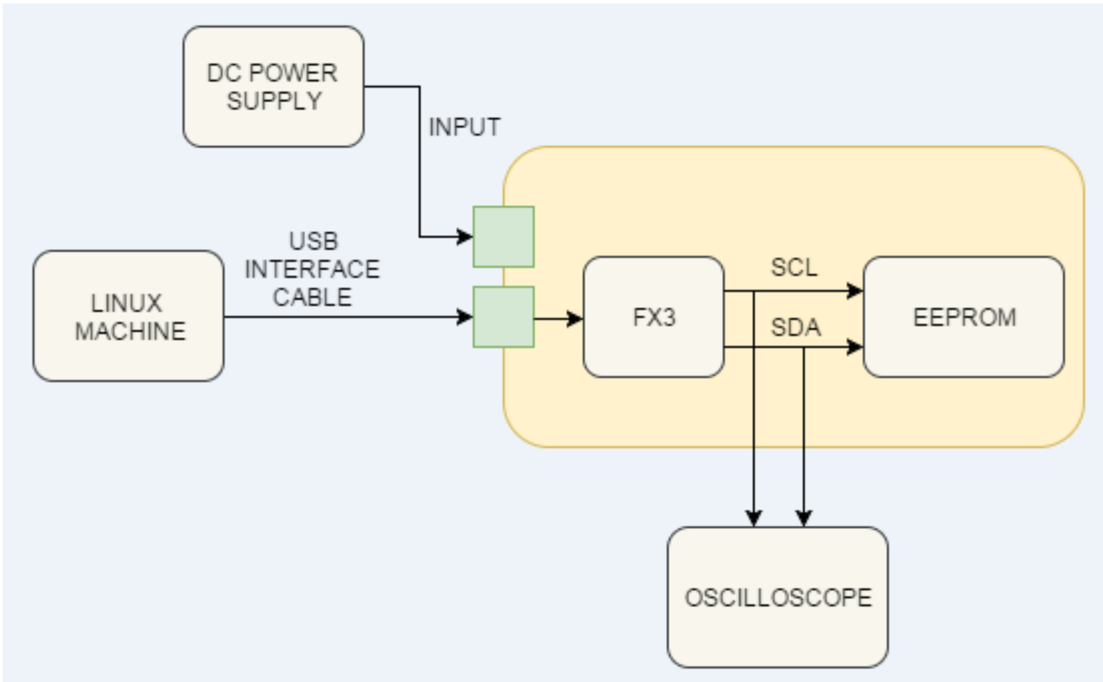

Figure 29. FX3 - Configuration Test Setup Block Diagram

ii. Equipment Settings

- DC power supply : E3633A

  Supply Voltage: 12 V

  Current Limit: 1 A

  OVP: 13 V

  OCP: 1.5 A

iii. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and run the command mentioned below

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and run this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg “for single chain activation and

this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation

6.1.1.4 Requirements

Test	Measuring Parameter	Result
FX3 Configuration	Signal Transmission	There is signal transmission from Linux PC to FX3 and from FX3 to FPGA

Table 90. FX3 – Configuration Test Requirement

6.1.1.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 91. Test Condition

6.1.1.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.

5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. . For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. There is signal transmission from the Linux PC to FX3 and from FX3 to FPGA.
8. FX3 is successfully configured.

6.1.1.7 Reference

1. Section 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

6.1.2 Test Case: EEPROM – I2C – Electrical Validation (FX3 1.2.1)

6.1.2.1 Description

I. Purpose

The purpose of this test case is to validate the electrical characteristics of the I2C interface of EEPROM.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	NA	
Performance	Yes	Failure of this test case will result in improper read and write operations
Compliance	NA	NA

Table 92. Impact of Failure – EEPROM I2C Electrical validation

6.1.2.2 Test Equipment List

- Oscilloscope : MSO9404A
- DC power supply : E3633A
- Linux PC

6.1.2.3 Test Setup

i. Setup Block diagram

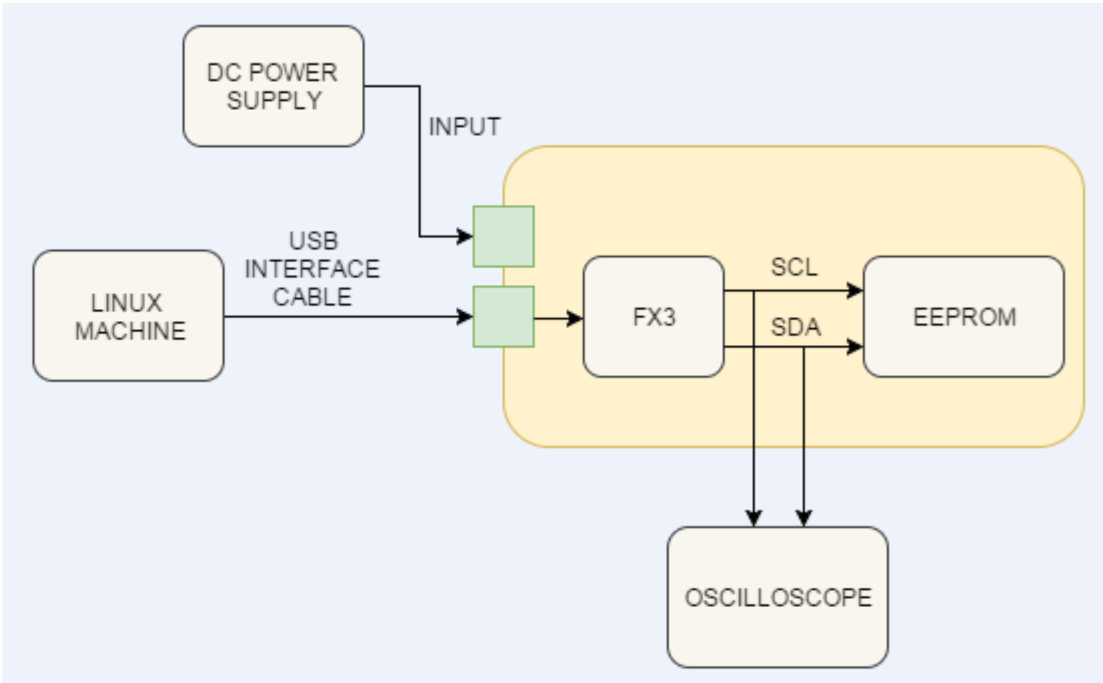

Figure 30. EEPROM – I2C – EV Test Setup Block Diagram

ii. **Measurement Locations**

- R61.2 (FX3_SCL), R60.2 (FX3_SDA)

iii. **Equipment Settings**

- Oscilloscope : MSO9404A
  Voltage per division: 1V
  Time scale: 500 ns
- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13 V
  OCP: 1.5 A

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 "for two chains activation.

  Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and run this command "$ sudo osmo-trx -fc 1 -x" for single chain activation and this for "$ sudo osmo-trx -fc 2 -x" for two chains activation

6.1.2.4 Requirements

Test	Measuring Point	Measuring Parameters	Pass Criteria
FX3_SCL	R61.2	VIL (max) (V)	-0.5 - 0.36
		VIH (min) (V)	1.26 – 2.3
		Rise time (ns)	20 - 1000
		Fall time (ns)	6.54 - 300
		Frequency (KHz)	400
FX3_SDA	R60.2	VIL (max) (V)	-0.5 - 0.36
		VIH (min) (V)	1.26 – 2.3
		Rise time (ns)	20 - 1000
		Fall time (ns)	6.54 - 300

Table 93. EEPROM – I2C Test Requirements

6.1.2.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 94. Test Condition

6.1.2.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done using on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.

4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.
5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply to RF_SDR (Connect breakout board)
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. Probe for the Clock and Data signals at R61.2 and R60.2 respectively
8. Measure the voltage levels and measure the rise time, and fall time of both the signals
9. Measure the frequency of clock signal

6.1.2.7 Reference

1. Section 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

6.1.3 Test Case: EEPROM – I2C – Functional Validation (FX3 1.2.1)

6.1.3.1 Description

I. Purpose

The purpose of this test case is to validate the function of the I2C interface of EEPROM.

II. Impact of failure on the system

Impact	Applicable	Description
Functional	Yes	Failure of this test case will result in improper read and write operations
Performance	NA	NA
Compliance	NA	NA

Table 95. Impact of Failure – EEPROM I2C Functional validation

6.1.3.2 Test Equipment List

- DC power supply : E3633A
- Linux PC
- USB Cable

6.1.3.3 Test Setup

i. Setup Block diagram

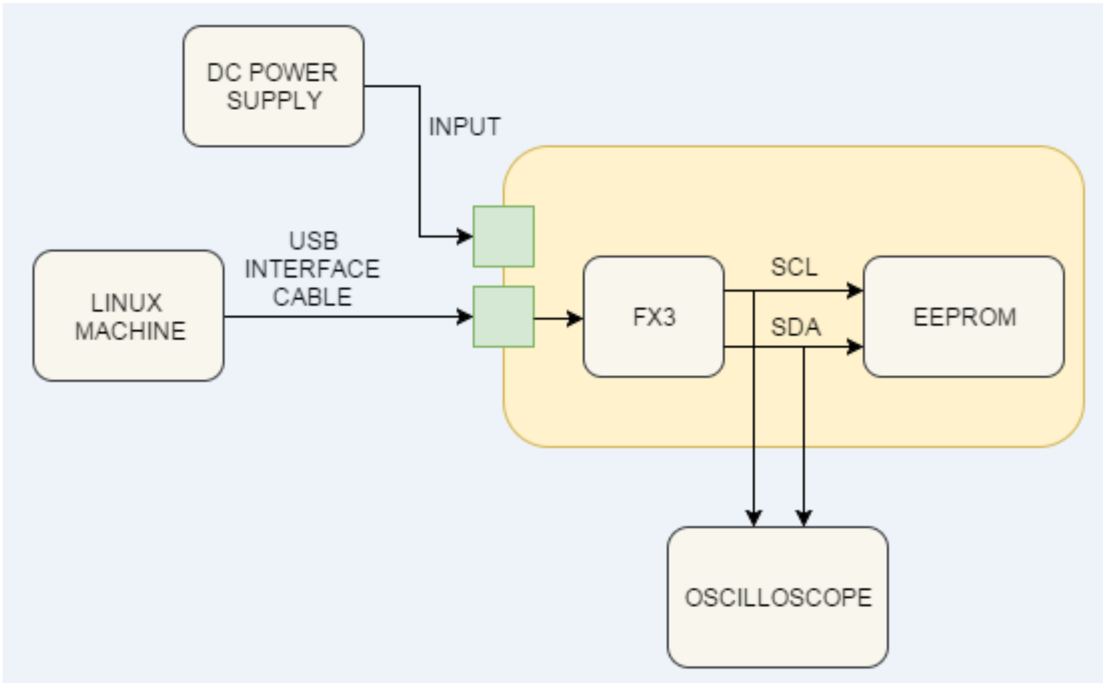

Figure 31. EEPROM – I2C – FV Test Setup Block Diagram

ii. Equipment Settings

- Oscilloscope : MSO9404A
  Voltage per division: 1V
  Time scale: 500 ns
- DC power supply : E3633A
  Supply Voltage: 12 V
  Current Limit: 1 A
  OVP: 13 V
  OCP: 1.5 A

iii. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and run the command mentioned below
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc-2trx-2CCH.cfg to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and run this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg "for single chain activation and

this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts-2trx.cfg -t 2 “for two chains activation.

Note: All the configuration files (openbsc-2trx-2CCH.cfg, osmobts-2trx.cfg) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx -fc 1 -x” for single chain activation and this for “$ sudo osmo-trx -fc 2 -x” for two chains activation

6.1.3.4 Requirements

Test	Measuring Parameter	Result
I2C Interface	Data Transaction	The EEPROM is able to read and write registers into FX3

Table 96. EEPROM – I2C Test Requirements

6.1.3.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 97. Test Condition

6.1.3.6 Test Procedure

1. The ADF4002 40MHz clock in actual scenario will synchronise with the GBC system clock, to test this section on a standalone RF_SDR board, the reference is given from a Signal generator.
2. The programing of the ADFR002 section is from GBC board in actual scenario, during standalone testing programing will be done using on board using a USB connector from Linux PC.
3. Software settings need to be changed based on Reference and VCXO frequencies as mentioned above.
4. Remove U66 IC and connect cable at IC pad (U66.4) for external clock reference, fed 40 MHz reference clock (3dBm) from signal generator to the cable.

5. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply to RF_SDR (Connect breakout board)
6. For running Transceiver, go to this path “$ cd osmo-trx/Transceiver52M” and run this command “$ sudo osmo-trx –fc 1 -x” in Linux terminal
7. The I2C interface was found to function as per requirement

6.1.3.7 Reference

1. Section 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

6.1.4 Test Case: Functional validation of Debug USB Switch – USB2.0 (FX3 1.3.1)

6.1.4.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	The Failure of this test case results in communication failure between FX3 and USB2.0 device connected to debug USB Switch.
Performance	NA	NA
Compliance	NA	NA

Table 98. Impact of Failure – Functional validation of Debug USB switch USB2.0

6.1.4.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- Linux PC with uhd drivers installed.

6.1.4.3 Test Setup

i. Setup Block diagram

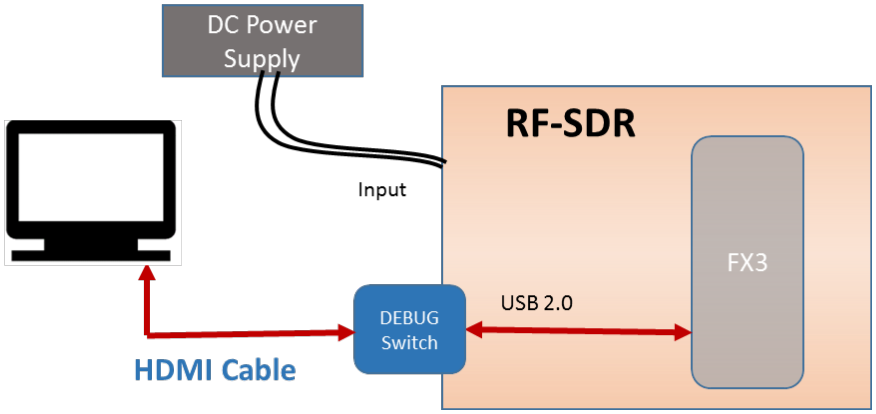

Figure 32. USB 2.0 Functional validation Test Setup Block Diagram

ii. Measurement Locations

NA

iii. Equipment Settings

- DC power supply : E3633A
  Supply Voltage: 12V
  Current Limit: 2A
  OVP: 13V
  OCP: 2.1A

iv. Software settings

Install uhd drivers to a Linux PC

6.1.4.4 Requirements

Test	Measuring criteria
USB 2.0 Interface	USB2.0 device connected to debug switch should communicate with FX3 when “sudo uhd_usrp_probe” command has given.

Table 99. USB 2.0 Functional validation

6.1.4.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 100. Test Condition

6.1.4.6 Test Procedure

1. This test is conducted by configuring power supply to give a voltage of 12V.
2. Connect a Linux PC (USB2.0 device) to debug USB switch which is present on RF-SDR board.
3. Install uhd drivers into Linux PC.
4. Run command “sudo uhd_usrp_probe” in Linux PC terminal, to start communication between FX3 and Linux PC (USB2.0 device).
5. Make sure the communication is happening through USB2.0 interface.

6.1.4.7 Reference

1. Section 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

6.1.5 Test Case: Functional validation of Debug USB Switch – USB3.0 (FX3 1.4.1)

6.1.5.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	The Failure of this test case results in communication failure between FX3 and USB3.0 device connected to debug USB Switch.
Performance	NA	NA
Compliance	NA	NA

Table 101. Impact of Failure – Functional validation of Debug USB switch USB3.0

6.1.5.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- Linux PC with uhd drivers installed.

6.1.5.3 Test Setup

i. Setup Block diagram

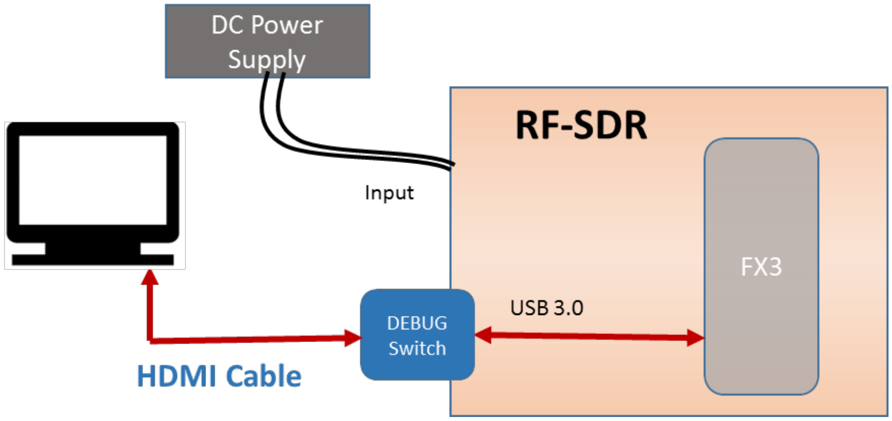

Figure 33. USB 3.0 Functional validation Test Setup Block Diagram

ii. Measurement Locations

NA

iii. Equipment Settings

- DC power supply : E3633A
  Supply Voltage: 12V
  Current Limit: 2A
  OVP: 13V
  OCP: 2.1A

iv. Software settings

Install uhd drivers to a Linux PC

6.1.5.4 Requirements

Test	Measuring criteria
USB 3.0 Interface	USB3.0 device connected to debug switch should communicate with FX3 when "sudo uhd_usrp_probe" command has given.

Table 102. USB 3.0 Functional validation

6.1.5.5 Test Condition

Test condition	Value	Remarks
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 103. Test Condition

6.1.5.6 Test Procedure

1. This test is conducted by configuring power supply to give a voltage of 12V.
2. Connect a Linux PC (USB3.0 device) to debug USB switch which is present on RF-SDR board.
3. Install uhd drivers into Linux PC.
4. Run command "sudo uhd_usrp_probe" in Linux PC terminal, to start communication between FX3 and Linux PC (USB3.0 device).
5. Make sure the communication is happening through USB3.0 interface.

6.1.5.7 Reference

1. Section 4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

7. RF Transceiver (AD9361) – pipe1

This RF Agile transceiver, AD9361 from ADI integrates all RF, mixed signal, and digital blocks necessary to provide all transceiver functions in a single device.

7.1 Test Purpose and Description

The purpose of this test is to verify parameters like maximum output power and attenuation and also system level parameters in Transceiver AD9361.

Verification of system level parameters in Transceiver AD9361 covers following functions and features:

1. Maximum Output Power
2. Transmit power control- Attenuation Range
3. Modulation Accuracy
4. Carrier Leakage
5. LO Lock Detect
6. Output RF Spectrum
    a. Adjacent channel power
    b. Spectrum due to switching
7. Receiver sensitivity
8. Maximum Input signal

7.1.1 Test Case: Maximum Output Power from AD9361– Pipe1 (TRX 1.1)

7.1.1.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with Maximum Output Power– Pipe1 requirements will impact the maximum output power range of transceiver AD9361
Compliance	NA	NA

Table 104. Impact of Failure – Maximum Output Power from AD9361 - Pipe1

7.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

7.1.1.3 Test Setup

i. Setup Block diagram

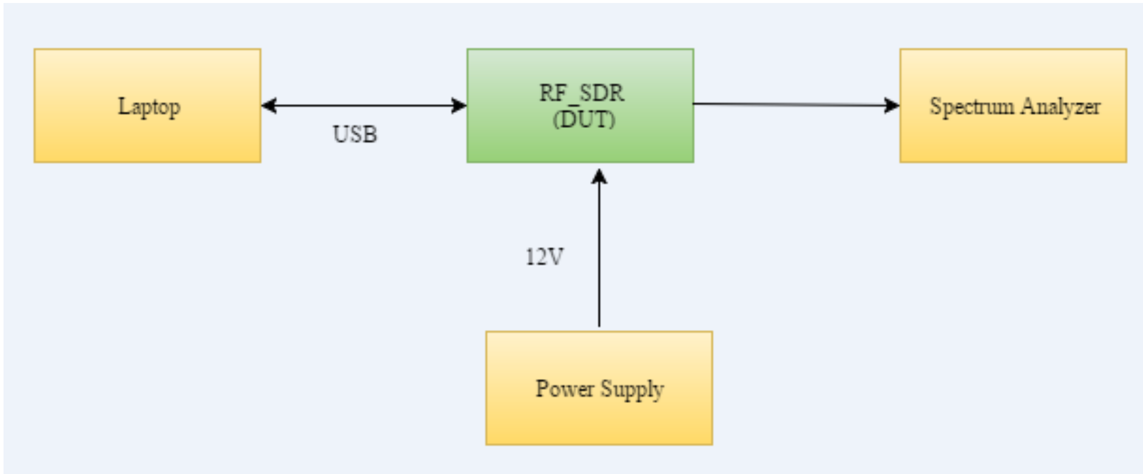

Figure 34. Maximum Output Power– Pipe - 1 Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1511 pad for TX pipe1.

iii. **Equipment Settings**

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz

Table 105. Spectrum Analyser Settings

iv. **Software settings**

1. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -f 1" in Linux terminal.
2. For running openbts go to this path" $ cd dev/openbts/apps "and hit this command "$ sudo<space>./OpenBTSCLI" in another Linux terminal. Run this openbts after starting of Transceiver.
3. Once openbts started running, now here you can change power dynamically from transceiver AD9361 with this command "Power <space><value>". Set this power value to zero for this test case.
4. In order to change band enter the command "config<space>GSM.Radio.Band<space> <value>"in openbts. Refer to below table for band and its corresponding value.

Band	Value
E-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 106. Band and corresponding Value

5. Band will not change dynamically, enter this command CTRL+C to come out of command line interface and run the openbts again by entering commands listed below one after other.
6. $ sudo<space>stop<space>openbts
7. $ sudo<space>start<space>openbts
8. $ sudo<space>./OpenBTSCLI
9. In order to change ARFCN number enter the command "config<space>GSM.Radio.C0<space><value>"in openbts. Refer to below table for band and its corresponding ARFCN value for centre frequencies.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
GSM-850	869.2	881.6	893.8	128	190	251
DCS-1800	1805.2	1842.4	1879.8	512	698	885
PCS-1900	1930.2	1960	1989.8	512	661	810

Table 107. ARFCN value and corresponding centre frequency

10. ARFCN will not change dynamically, enter this command CTRL+C to come out of command line interface and run the openbts again by entering commands listed below one after other.
11. $ sudo<space>stop<space>openbts
12. $ sudo<space>start<space>openbts
13. $ sudo<space>./OpenBTSCLI

7.1.1.4 Requirements

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Output Power(dBm)
P-GSM-900	935.2	947.6	959.8	>-5
GSM-850	869.2	881.6	893.8	>-5
DCS-1800	1805.2	1842.4	1879.8	>-5
PCS-1900	1930.2	1960	1989.8	>-5

Table 108. Pipe - 1 Maximum Output Power of AD9361 Test Specification

7.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	centre	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 109. Test Condition

7.1.1.6 Test Procedure

1. Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
4. Once the board is powered up run the software in Linux PC, for this refer to fourth point, software settings of test setup 7.1.1.3 section.
5. Collect output at pigtail which is connected at C1511 pad for TX pipe1 and feed it to Spectrum analyser.

7.1.1.7 Reference

1. Sections 5.1-5.3 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

7.1.2 Test Case: Transmit Power Control from AD9361 – Pipe1 (TRX 1.2)

7.1.2.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	Failure to conform with Transmit power control from AD9361-Pipe1 requirement will impact the further devices in chain which will get damage due to high power input from AD9361.
Performance	NA	NA
Compliance	NA	NA

Table 110. Impact of Failure – Transmit power Control from AD9361 - Pipe1

7.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

7.1.2.3 Test Setup

i. Setup Block diagram

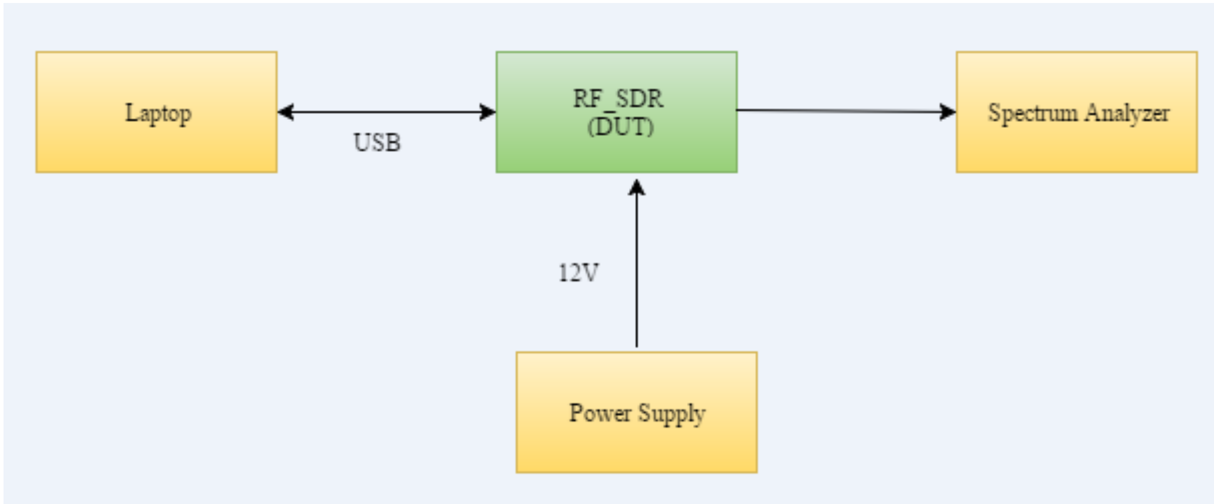

Figure 35. Transmit Power control – Pipe - 1 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1511 pad for TX pipe1.

iii. Equipment Settings

- **Keysight M9381A** vector signal generator

Band	**Centre Frequency (MHz)**
E-GSM-900	945.2
GSM-850	881.6
DCS-1800	1842.4
PCS-1900	1961

Table 111. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz

Table 112. Spectrum Analyser Settings

iv. Software settings

1. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -f 1" in Linux terminal.
2. For running openbts go to this path" $ cd dev/openbts/apps "and hit this command "$ sudo<space>./OpenBTSCLI" in another Linux terminal. Run this openbts after starting of Transceiver.
3. Once openbts started running, now here you can change Attenuation dynamically from transceiver with this command "Power <space><value>".
4. In order to change band enter the command "config<space>GSM.Radio.Band<space> <value>"in openbts. Refer to below table for band and its corresponding value.

Band	Value
E-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 113. Band and corresponding Value

5. Band will not change dynamically, enter this command CTRL+C to come out of command line interface and run the openbts again by entering commands listed below one after other.
6. $ sudo<space>stop<space>openbts
7. $ sudo<space>start<space>openbts
8. $ sudo<space>./OpenBTSCLI
9. In order to change ARFCN number enter the command "config<space>GSM.Radio.C0<space><value>"in openbts. Refer to below table for band and its corresponding ARFCN value for centre frequencies.

Band	ARFCN	Centre Frequency
E-GSM-900	51	945.2
GSM-850	190	881.6
DCS-1800	698	1842.4
PCS-1900	661	1961

Table 114. ARFCN value and corresponding centre frequency

10. ARFCN will not change dynamically, enter this command CTRL+C to come out of command line interface and run the openbts again by entering commands listed below one after other.
11. $ sudo<space>stop<space>openbts
12. $ sudo<space>start<space>openbts
13. $ sudo<space>./OpenBTSCLI

7.1.2.4 Requirements

Band	Frequency (MHz)	Attenuation step	Specification
E-GSM-900	945.2	10±2dB,20±2dB	>-15dBm , >-25dBm
GSM-850	881.6	10±2dB,20±2dB	>-15dBm , >-25dBm
DCS-1800	1842.4	10±2dB,20±2dB	>-15dBm , >-25dBm
PCS-1900	1961	10±2dB,20±2dB	>-15dBm , >-25dBm

Table 115. TX pipe - 1 Maximum Output Power of AD9361 – Pipe1 Test Specification

7.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 116. Test Condition

7.1.2.6 Test Procedure

1. Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
4. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.3.3 section.
5. Collect output at pigtail which is connected at C1511 pad for TX pipe1 and feed it to Spectrum analyser.

7.1.2.7 Reference

1. Sections 5.1-5.3 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

7.1.3 Test Case: Modulation Accuracy– Pipe1 (TRX 1.3)

7.1.3.1 Description

I. 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.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with modulation accuracy – Pipe1, in a real system poor phase error or EVM will reduce the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.
Compliance	Yes	Failure to conform with modulation accuracy – Pipe1, in a real system poor phase error or EVM will reduce the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.

Table 117. Impact of Failure – Modulation Accuracy - Pipe1

III. Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- 20dB Attenuator
- Linux PC
- Pig tail SMA Cables – 2 no's (One end SMA Female connector and another end open cable)

7.1.3.2 Test Setup

i. **Setup Block diagram**

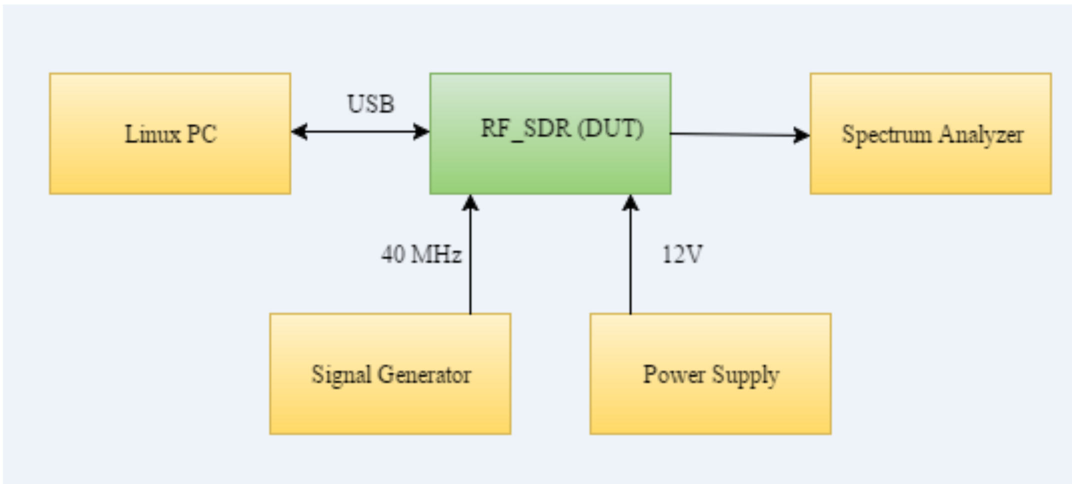

Figure 36. Modulation Accuracy – Pipe - 1 Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1511 pad for TX pipe1.

iii. **Equipment Settings**

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 118. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 119. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.

- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
GSM-850	869.2	881.6	893.8	128	190	251
DCS-1800	1805.2	1842.4	1879.8	512	698	885
PCS-1900	1930.2	1960	1989.8	512	661	810

Table 120. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

7.1.3.3 Requirements

Modulation	Specification (R&D)	Specification (Normal)
	RMS(deg)	RMS(deg)
GMSK(900 & 1800MHz)	<3.6	<5

Table 121. Phase error RMS – Pipe - 1 Test Specification

Modulation	Specification (R&D)	Specification (Normal)
	< PEAK(deg)	< PEAK(deg)
GMSK(900 & 1800MHz)	<14.2	<20

Table 122. Phase error PEAK – Pipe - 1 Test Specification

Modulation	Specification(R&D)	Specification(normal)
	ppm / Hz	ppm / Hz
GMSK(900MHz)	< 0.03/±27Hz	< 0.05/±45Hz

Table 123. Frequency error – Pipe - 1 Test Specification

Modulation	Specification(R&D)	Specification(normal)
	ppm / Hz	ppm / Hz
GMSK(1800MHz)	< 0.03/±54Hz	< 0.05/±90Hz

Table 124. Frequency error – Pipe - 1 Test Specification

7.1.3.4 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 125. Test Condition

7.1.3.5 Test Procedure

1. Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
4. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.9.3 section.
7. Collect output at pigtail which is connected at C1511 pad for TX pipe1 and feed it to Spectrum analyser.

7.1.3.6 Reference

1. Sections 5 and 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

7.1.4 Test Case: Output RF Spectrum – Adjacent channel power – Pipe1 (TRX 1.6)

7.1.4.1 Description

I. 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).

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with adjacent channel power – Pipe1 requirement will impact other users who are operating on different frequencies would experience interference.
Compliance	Yes	Failure to conform with adjacent channel power – Pipe1 requirement will impact other users who are operating on different frequencies would experience interference.

Table 126. Impact of Failure – Output RF Spectrum_Adjacent channel power - Pipe1

7.1.4.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no’s (SMA male to SMA male)
- 20dB Attenuator
- Linux PC
- Pig tail SMA Cables – 2 no’s (One end SMA Female connector and another end open cable)

7.1.4.3 Test Setup

i. **Setup Block diagram**

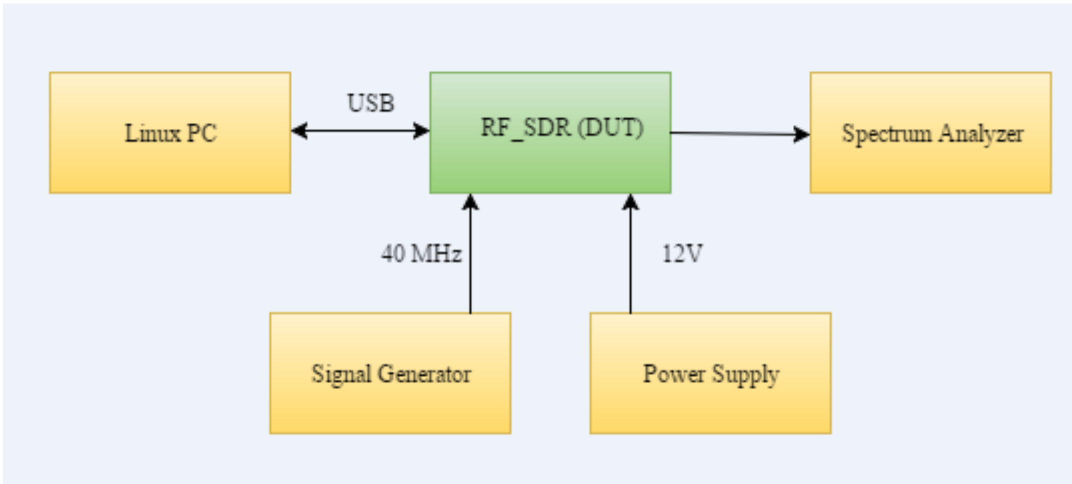

Figure 37. Adjacent channel power – Pipe - 1 Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1511 pad for TX pipe1.

iii. **Equipment Settings**

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 127. Spectrum Analyser Setting

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 128. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.

- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
GSM-850	869.2	881.6	893.8	128	190	251
DCS-1800	1805.2	1842.4	1879.8	512	698	885
PCS-1900	1930.2	1960	1989.8	512	661	810

Table 129. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

7.1.4.4 Requirements

Specification for 900MHz		
offset frequency	**< dBc**	**RBW KHz**
100KHz	0.5	30
200KHz	-30	30
250KHz	-33	30
400KHz	-60	30
600KHz to 1200KHz	-60	30
1200KHz to 1800KHz	-63	30
1800KHz to 6000KHz	-65	100

Table 130. Adjacent channel power – Pipe - 1 Test Specification

Specification for 1800Mhz		
offset frequency	**< dBc**	**RBW KHz**
100KHz	0.5	30
200KHz	-30	30
250KHz	-33	30
400KHz	-60	30
600KHz to 1200KHz	-56	30
1200KHz to 1800KHz	-63	30
1800KHz to 6000KHz	-65	100

Table 131. Adjacent channel power – Pipe - 1 Test Specification

7.1.4.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 132. Test Condition

7.1.4.6 Test Procedure

1. Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
4. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.5.3 section.
7. Collect output at pigtail which is connected at C1511 pad for TX pipe1 and feed it to Spectrum analyser.

7.1.4.7 Reference

1. Sections 5 and 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

7.1.5 Test Case: Output RF Spectrum – Spectrum due to switching – Pipe1 (TRX 1.6)

7.1.5.1 Description

I. 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.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with Spectrum due to switching – Pipe1, If a transmitter ramps power too quickly, users operating on different frequencies, especially those close to the channel of interest, will experience significant interference. Failures with this measurement often point to faults in a transmitter's output power amplifier or levelling loop.
Compliance	Yes	Failure to conform with Spectrum due to switching – Pipe1, If a transmitter ramps power too quickly, users operating on different frequencies, especially those close to the channel of interest, will experience significant interference. Failures with this measurement often point to faults in a transmitter's output power amplifier or levelling loop.

Table 133. Impact of Failure – Output RF Spectrum_Spectrum due to switching - Pipe1

7.1.5.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- 20dB Attenuator
- Linux PC

- Pig tail SMA Cables – 2 no’s (One end SMA Female connector and another end open cable)

7.1.5.3 Test Setup

i. **Setup Block diagram**

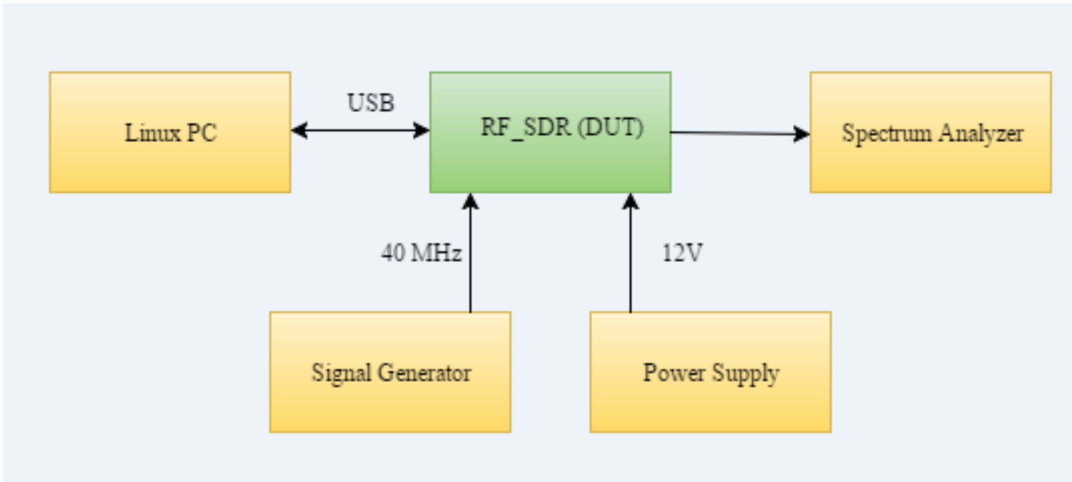

Figure 38. Spectrum due to switching – Pipe - 1 Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1511 pad for TX pipe1.

iii. **Equipment Settings**

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 134. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 135. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.

- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
GSM-850	869.2	881.6	893.8	128	190	251
DCS-1800	1805.2	1842.4	1879.8	512	698	885
PCS-1900	1930.2	1960	1989.8	512	661	810

Table 136. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

7.1.5.4 Requirements

Specification for 900MHz	
offset frequency	**< dBc**
400 KHz	-57
600 KHz	-67
1200 KHz	-74
1800 KHz	-74

Table 137. Spectrum due to switching – Pipe - 1 Test Specification

Specification for 1800MHz	
offset frequency	< dBc
400 KHz	-50
600 KHz	-58
1200 KHz	-66
1800 KHz	-66

Table 138. Spectrum due to switching – Pipe - 1 Test Specification

7.1.5.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 139. Test Condition

7.1.5.6 Test Procedure

1. Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
4. After completion of all rework instructions connect to power supply of 12V DC from external power supply.

5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.6.3 section.
7. Collect output at pigtail which is connected at C1511 pad for TX pipe1 and feed it to Spectrum analyser.

7.1.5.7 Reference

1. Sections 5 and 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

7.1.6 Test Case: Carrier leakage – Pipe1 (TRX 1.4)

7.1.6.1 Description

I. Purpose

The purpose of this test case is to check carrier leakage.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform carrier leakage affects EVM
Compliance	Yes	Failure to conform carrier leakage affects EVM

Table 140. Impact of Failure – Carrier leakage - Pipe1

7.1.6.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no’s (SMA male to SMA male)`
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

7.1.6.3 Test Setup

i. Setup Block diagram

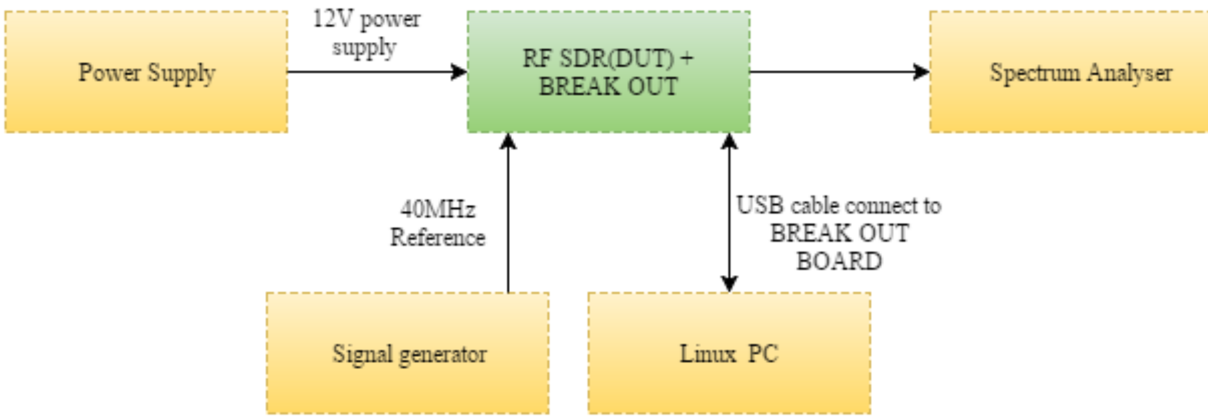

Figure 39. Carrier leakage – Pipe - 1 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1501, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1511 pad for TX pipe1.

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz

Table 141. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

  Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

  Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:

  1. osmo-trx
  2. osmo-bts
  3. openbsc

- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 142. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 143. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in "openbsc_config_file". In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

7.1.6.4 Requirements

Band	Carrier leakage level(dBc)
P-GSM-900	-50
DCS-1800	-50

Table 144. Carrier leakage Pipe - 1Test Specification

7.1.6.5 Test Condition

Test condition	Value	Remarks
Frequency	M	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 145. Test Condition

7.1.6.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
5. Short pins 2 and 3 of jumper J3304.
6. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
7. Collect output at pig tail which is connected capacitor pad (C1511) for TX pipe1 and feed it to Spectrum analyser.

7.1.6.7 Reference

1. Sections 5 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

8. RF Transceiver (AD9361) – pipe2

This RF Agile transceiver, AD9361 from ADI integrates all RF, mixed signal, and digital blocks necessary to provide all transceiver functions in a single device.

8.1 Test Purpose and Description

The purpose of this test is to verify parameters like maximum output power and attenuation and also system level parameters in Transceiver AD9361.

Verification of system level parameters in Transceiver AD9361 covers following functions and features:

1. Maximum Output Power
2. Transmit power control- Attenuation Range
3. Modulation Accuracy
4. Carrier Leakage
5. LO Lock Detect
6. Output RF Spectrum
    a. Adjacent channel power
    b. Spectrum due to switching
7. Receiver sensitivity
8. Maximum Input signal

8.1.1 Test Case: Maximum Output Power from AD9361– Pipe2 (TRX 2.1)

8.1.1.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with Maximum Output Power– Pipe2 requirements will impact the maximum output power range of transceiver AD9361.
Compliance	NA	NA

Table 146. Impact of Failure – Maximum output power from AD9361 – Pipe2

8.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

8.1.1.3 Test Setup

i. Setup Block diagram

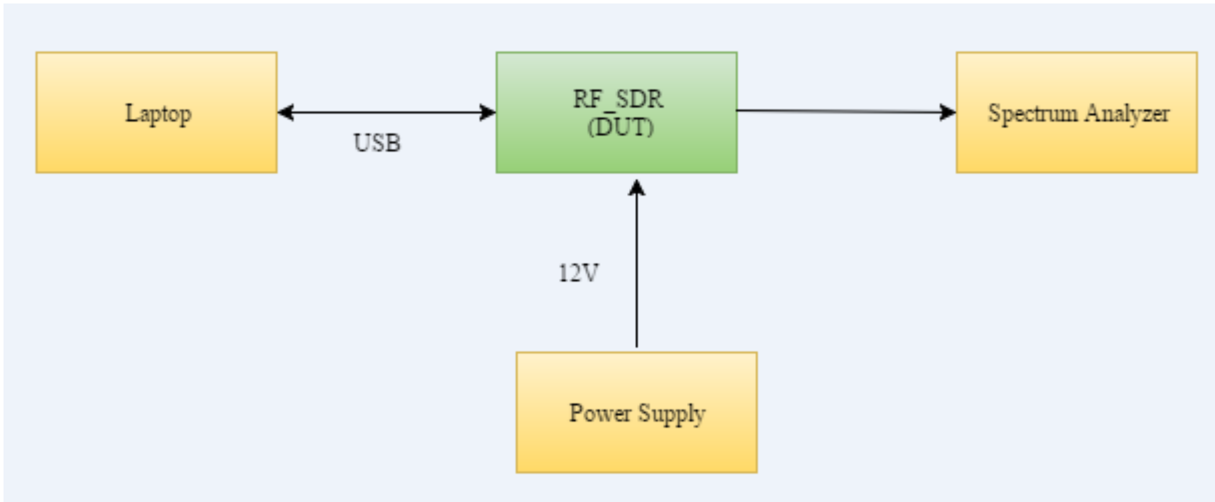

Figure 40. Maximum Output Power– Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1512 pad for TX pipe2.

iii. Equipment Settings

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)
P-GSM-900	935.2	947.6	959.8
GSM-850	869.2	881.6	893.8
DCS-1800	1805.2	1842.4	1879.8
PCS-1900	1930.2	1960	1989.8

Table 147. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz

Table 148. Spectrum Analyser Settings

iv. Software settings

1. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -f 1" in Linux terminal.
2. For running openbts go to this path" $ cd dev/openbts/apps "and hit this command "$ sudo<space>./OpenBTSCLI" in another Linux terminal. Run this openbts after starting of Transceiver.
3. Once openbts started running, now here you can change power dynamically from transceiver AD9361 with this command "Power <space><value>". Set this power value to zero for this test case.
4. In order to change band enter the command "config<space>GSM.Radio.Band<space> <value>"in openbts. Refer to below table for band and its corresponding value.

Band	**Value**
E-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 149. Band and corresponding Value

5. Band will not change dynamically, enter this command CTRL+C to come out of command line interface and run the openbts again by entering commands listed below one after other.
6. $ sudo<space>stop<space>openbts
7. $ sudo<space>start<space>openbts
8. $ sudo<space>./OpenBTSCLI
9. In order to change ARFCN number enter the command "config<space>GSM.Radio.C0<space><value>"in openbts. Refer to below table for band and its corresponding ARFCN value for centre frequencies.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
GSM-850	869.2	881.6	893.8	128	190	251
DCS-1800	1805.2	1842.4	1879.8	512	698	885
PCS-1900	1930.2	1960	1989.8	512	661	810

Table 150. ARFCN value and corresponding centre frequency

10. ARFCN will not change dynamically, enter this command CTRL+C to come out of command line interface and run the openbts again by entering commands listed below one after other.
11. $ sudo<space>stop<space>openbts
12. $ sudo<space>start<space>openbts
13. $ sudo<space>./OpenBTSCLI

8.1.1.4 Requirements

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Output Power(dBm)
P-GSM-900	935.2	947.6	959.8	>-5
GSM-850	869.2	881.6	893.8	>-5
DCS-1800	1805.2	1842.4	1879.8	>-5
PCS-1900	1930.2	1960	1989.8	>-5

Table 151. TX pipe - 2 Maximum Output Power of AD9361 Test Specification

8.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	centre	For each band test at centre frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 152. Test Condition

8.1.1.6 Test Procedure

1. Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
4. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.2.3 section.
5. Collect output at pigtail which is connected at C1512 pad for TX pipe2 and feed it to Spectrum analyser

8.1.1.7 Reference

1. Sections 5.1-5.3 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZI1a?dl=0

8.1.2 Test Case: Transmit Power Control from AD9361 – Pipe2 (TRX 2.2)

8.1.2.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	Failure to conform with Transmit power control from AD9361-Pipe2 requirement will impact the further devices in chain which will get damage due to high power input from AD9361.
Performance	NA	NA
Compliance	NA	NA

Table 153. Impact of Failure – Transmit power control from AD9361 – Pipe2

8.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

8.1.2.3 Test Setup

i. Setup Block diagram

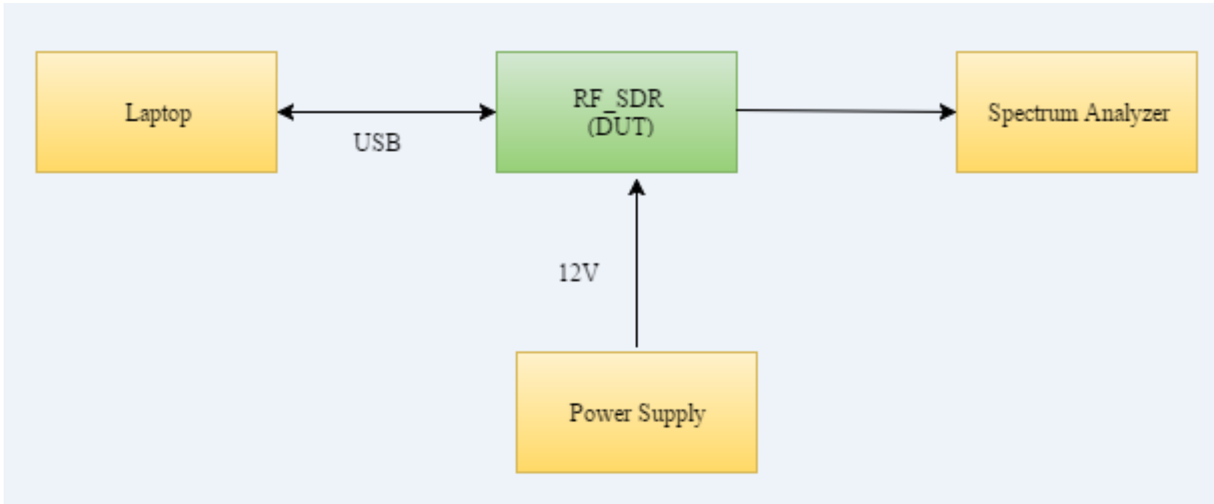

Figure 41. Transmit Power control – Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1512 pad for TX pipe2.

iii. Equipment Settings

- **Keysight M9381A** vector signal generator

Band	Centre Frequency (MHz)
E-GSM-900	945.2
GSM-850	881.6
DCS-1800	1842.4
PCS-1900	1961

Table 154. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz

Table 155. Spectrum Analyser Settings

iv. Software settings

1. For running Transceiver go to this path” $ cd osmo-trx/Trasceiver52M “and hit this command “$ sudo osmo-trx -f 1” in Linux terminal.
2. For running openbts go to this path” $ cd dev/openbts/apps “and hit this command “$ sudo<space>./OpenBTSCLI” in another Linux terminal. Run this openbts after starting of Transceiver.
3. Once openbts started running, now here you can change Attenuation dynamically from transceiver with this command “Power <space><value>”.
4. In order to change band enter the command “config<space>GSM.Radio.Band<space> <value>“in openbts. Refer to below table for band and its corresponding value.

Band	Value
E-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 156. Band and corresponding Value

5. Band will not change dynamically, enter this command CTRL+C to come out of command line interface and run the openbts again by entering commands listed below one after other.
6. $ sudo<space>stop<space>openbts
7. $ sudo<space>start<space>openbts
8. $ sudo<space>./OpenBTSCLI
9. In order to change ARFCN number enter the command "config<space>GSM.Radio.C0<space><value>"in openbts. Refer to below table for band and its corresponding ARFCN value for centre frequencies.

Band	ARFCN	Centre Frequency
E-GSM-900	51	945.2
GSM-850	190	881.6
DCS-1800	698	1842.4
PCS-1900	661	1961

Table 157. ARFCN value and corresponding centre frequency

10. ARFCN will not change dynamically, enter this command CTRL+C to come out of command line interface and run the openbts again by entering commands listed below one after other.
11. $ sudo<space>stop<space>openbts
12. $ sudo<space>start<space>openbts
13. $ sudo<space>./OpenBTSCL

8.1.2.4 Requirements

Band	Frequency (MHz)	Power (dBm) Attenuation (dB)	Specification
E-GSM-900	945.2	10±2dB,20±2dB	>-15dBm , >-25dBm
GSM-850	881.6	10±2dB,20±2dB	>-15dBm , >-25dBm
DCS-1800	1842.4	10±2dB,20±2dB	>-15dBm , >-25dBm
PCS-1900	1961	10±2dB,20±2dB	>-15dBm , >-25dBm

Table 158. TX pipe 2 Maximum Output Power of AD9361 – Pipe2 Test Specification

8.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	centre	For each band test at centre frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 159. Test Condition

8.1.2.6 Test Procedure

1. Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
4. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.4.3 section.
5. Collect output at pigtail which is connected at C1512 pad for TX pipe2 and feed it to Spectrum analyser.

8.1.2.7 Reference

1. Sections 5.1-5.3 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

8.1.3 Test Case: Modulation Accuracy– Pipe2 (TRX 2.3)

8.1.3.1 Description

I. 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.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with modulation accuracy – Pipe2, in a real system poor phase error or EVM will reduce the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.
Compliance	Yes	Failure to conform with modulation accuracy – Pipe2, in a real system poor phase error or EVM will reduce the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.

Table 160. Impact of Failure – Modulation Accuracy – Pipe2

III. Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no’s (SMA male to SMA male)
- 20dB Attenuator
- Linux PC
- Pig tail SMA Cables – 2 no’s (One end SMA Female connector and another end open cable)

8.1.3.2 Test Setup

i. Setup Block diagram

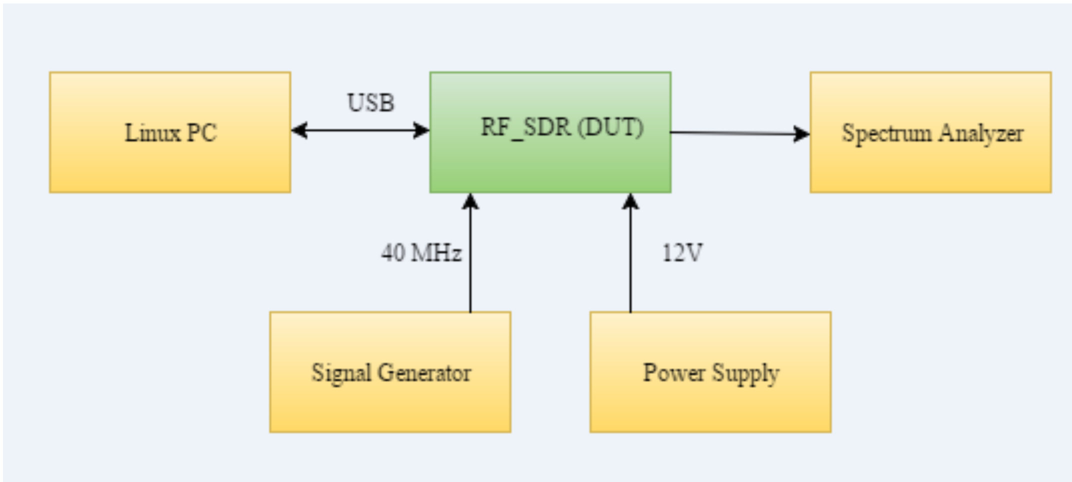

Figure 42. Modulation Accuracy – Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1512 pad for TX pipe2

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 161. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 162. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
GSM-850	869.2	881.6	893.8	128	190	251
DCS-1800	1805.2	1842.4	1879.8	512	698	885
PCS-1900	1930.2	1960	1989.8	512	661	810

Table 163. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

8.1.3.3 Requirements

Modulation	Specification (R&D)	Specification (Normal)
	RMS(deg)	RMS(deg)
GMSK(900 & 1800MHz)	<3.6	<5

Table 164. Phase error RMS – Pipe - 2 Test Specification

Modulation	Specification (R&D)	Specification (Normal)
	< PEAK(deg)	< PEAK(deg)
GMSK(900 & 1800MHz)	<14.2	<20

Table 165. Phase error PEAK – Pipe - 2 Test Specification

Modulation	Specification(R&D)	Specification(normal)
	ppm / Hz	ppm / Hz
GMSK(900MHz)	< 0.03/±27Hz	< 0.05/±45Hz

Table 166. Frequency error – Pipe - 2 Test Specification

Modulation	Specification(R&D)	Specification(normal)
	ppm / Hz	ppm / Hz
GMSK(1800MHz)	< 0.03/±54Hz	< 0.05/±90Hz

Table 167. Frequency error – Pipe - 2 Test Specification

8.1.3.4 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 168. Test Condition

8.1.3.5 Test Procedure

1. Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
4. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.10.3 section.
2. Collect output at pigtail which is connected at C1512 pad for TX pipe2 and feed it to Spectrum analyser.

8.1.3.6 Reference

1. Sections 5 and 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

8.1.4 Test Case: LO lock detect (TRX 1.5 and TRX 2.5)

8.1.4.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with local oscillator lock detect will degrade the AD9361 performance.
Compliance	NA	NA

Table 169. Impact of Failure – LO lock detect

III. Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no’s (SMA male to SMA male)
- 20dB Attenuator
- Linux PC
- Pig tail SMA Cables – 2 no’s (One end SMA Female connector and another end open cable)
- Digital Oscilloscope

8.1.4.2 Test Setup

i. **Setup Block diagram**

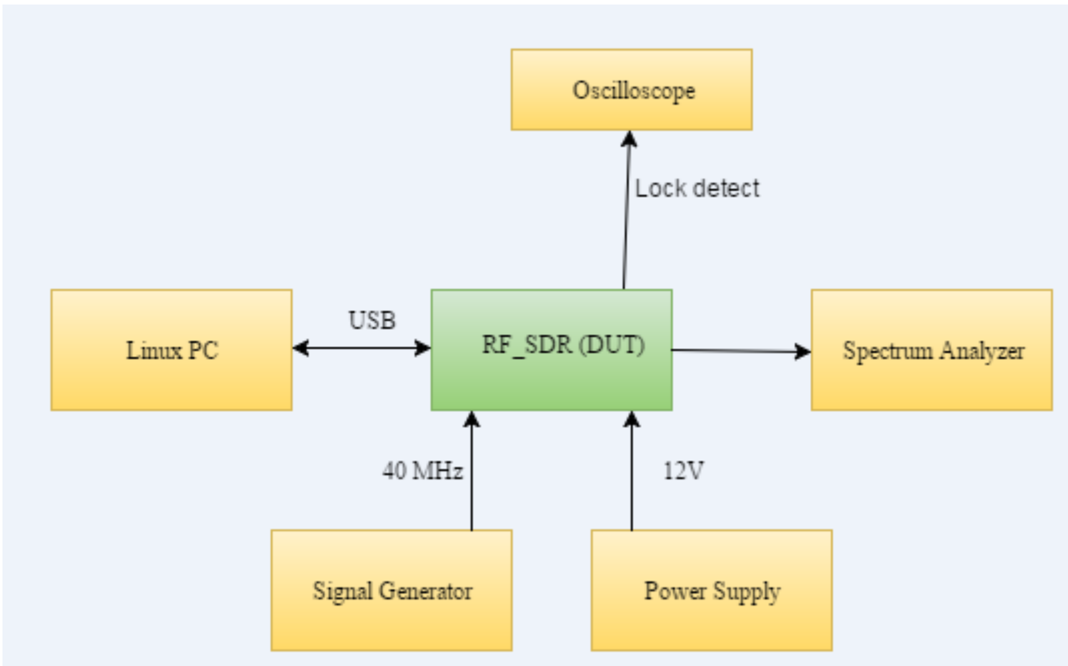

Figure 43. AD9361 LO Lock Detect Test Setup Block Diagram

ii. **Measurement Locations**

- Measure at pin number W21, W22 and T19 of FPGA (U9).
- Monitor the lock detect status and check if lock detect is high (>1.8V) in oscilloscope.

iii. **Equipment Settings**

- **Keysight M9391A** vector signal generator

Frequency (MHz)	Amplitude
40	3 dBm

Table 170. Signal Generator Settings

iv. **Software settings**

1. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -f 1" in Linux terminal.

8.1.4.3 Requirements

Frequency (MHz)	Lock detect level	Signal Level in V(p-p)
40MHz	>1.8V	3.3V

Table 171. AD9361 LO Lock Detect Test Specification

8.1.4.4 Test Condition

Test condition	Value	Remarks
Frequency	40MHz	Nominal frequency.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 172. Test Condition

8.1.4.5 Test Procedure

1. After completion of all rework instructions connect to power supply of 12V DC from external power supply. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
2. After powering up 40MHz clock is given to AD9361 from clock buffer IC.
3. For running Transceiver go to this path" $ cd osmo-trx/Trasceiver52M "and hit this command "$ sudo osmo-trx -f 1" in Linux terminal.
4. Measure the lock detect status of AD9361 at FPGA pin number W21, W22 and T19.
5. Check if lock detect is high (>1.8V) in oscilloscope.

8.1.4.6 Reference

1. Sections 5.3 and 9 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZI1a?dl=0

8.1.5 Test Case: Output RF Spectrum – Adjacent channel power – Pipe 2 (TRX 2.6)

8.1.5.1 Description

I. 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).

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with adjacent channel power – Pipe2 requirement will impact other users who are operating on different frequencies would experience interference.
Compliance	Yes	Failure to conform with adjacent channel power – Pipe2 requirement will impact other users who are operating on different frequencies would experience interference.

Table 173. Impact of Failure –Output RF spectrum_Adjacent channel power – Pipe2

8.1.5.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no’s (SMA male to SMA male)
- 20dB Attenuator
- Linux PC
- Pig tail SMA Cables – 2 no’s (One end SMA Female connector and another end open cable)

8.1.5.3 Test Setup

i. Setup Block diagram

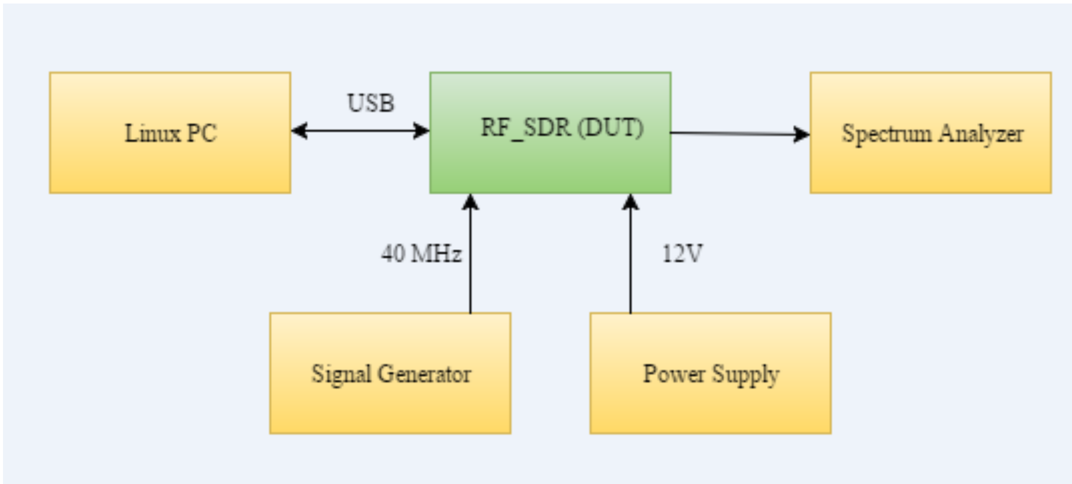

Figure 44. Adjacent channel power – Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1512 pad for TX pipe2.

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 174. Spectrum Analyser Setting

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 175. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.

- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
GSM-850	869.2	881.6	893.8	128	190	251
DCS-1800	1805.2	1842.4	1879.8	512	698	885
PCS-1900	1930.2	1960	1989.8	512	661	810

Table 176. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

8.1.5.4 Requirements

Specification for 900MHz		
offset frequency	**< dBc**	**RBW KHz**
100KHz	0.5	30
200KHz	-30	30
250KHz	-33	30
400KHz	-60	30
600KHz to 1200KHz	-60	30
1200KHz to 1800KHz	-63	30
1800KHz to 6000KHz	-65	100

Table 177. Adjacent channel power – Pipe - 2 Test Specification

Specification for 1800Mhz		
offset frequency	**< dBc**	**RBW KHz**
100KHz	0.5	30
200KHz	-30	30
250KHz	-33	30
400KHz	-60	30
600KHz to 1200KHz	-56	30
1200KHz to 1800KHz	-63	30
1800KHz to 6000KHz	-65	100

Table 178. Adjacent channel power – Pipe - 2 Test Specification

8.1.5.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 179. Test Condition

8.1.5.6 Test Procedure

1. Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
4. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.7.3 section.
7. Collect output at pigtail which is connected at C1512 pad for TX pipe2 and feed it to Spectrum analyser.

8.1.5.7 Reference

1. Sections 5 and 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

8.1.6 Test Case: Output RF Spectrum – Spectrum due to switching – Pipe2 (TRX 2.6)

8.1.6.1 Description

I. 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.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with Spectrum due to switching – Pipe2, If a transmitter ramps power too quickly, users operating on different frequencies, especially those close to the channel of interest, will experience significant interference. Failures with this measurement often point to faults in a transmitter's output power amplifier or levelling loop
Compliance	Yes	Failure to conform with Spectrum due to switching – Pipe2, If a transmitter ramps power too quickly, users operating on different frequencies, especially those close to the channel of interest, will experience significant interference. Failures with this measurement often point to faults in a transmitter's output power amplifier or levelling loop

Table 180. Impact of Failure – Output RF spectrum_spectrum due to switching – Pipe2

8.1.6.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- 20dB Attenuator
- Linux PC

- Pig tail SMA Cables – 2 no’s (One end SMA Female connector and another end open cable)

8.1.6.3 Test Setup

i. **Setup Block diagram**

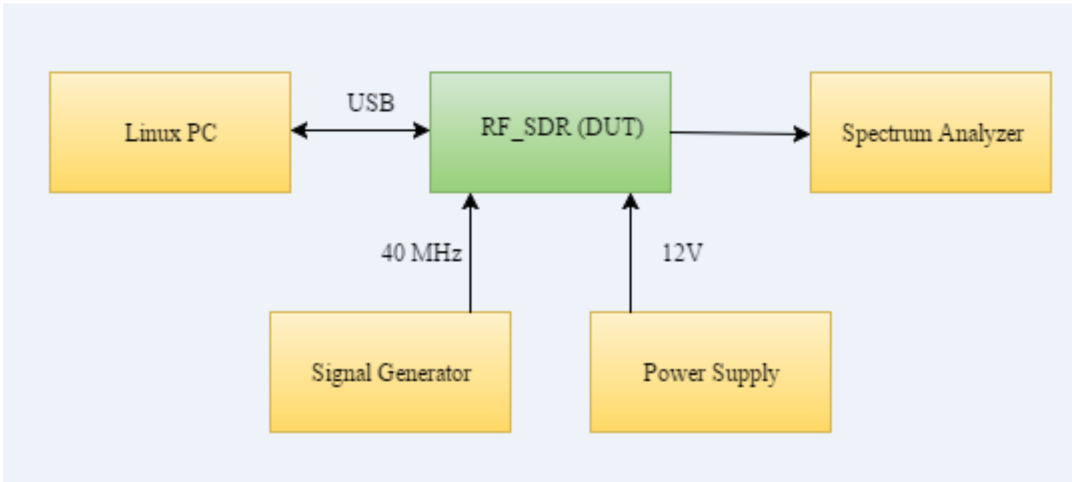

Figure 45. Spectrum due to switching – Pipe - 2 Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1512 pad for TX pipe2.

iii. **Equipment Settings**

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 181. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
GSM-850	850
DCS-1800	1800
PCS-1900	1900

Table 182. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.

- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

• Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
GSM-850	869.2	881.6	893.8	128	190	251
DCS-1800	1805.2	1842.4	1879.8	512	698	885
PCS-1900	1930.2	1960	1989.8	512	661	810

Table 183. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

8.1.6.4 Requirements

Specification for 900MHz	
offset frequency	**< dBc**
400 KHz	-57
600 KHz	-67
1200 KHz	-74
1800 KHz	-74
Specification for 1800MHz	
offset frequency	**< dBc**
400 KHz	-50
600 KHz	-58
1200 KHz	-66
1800 KHz	-66

Table 184. Spectrum due to switching – Pipe - 2 Test Specification

8.1.6.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 185. Test Condition

8.1.6.6 Test Procedure

1. Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503 so that we will isolate transceiver and chain.
2. For power supply to RF_SDR board alone connect positive cable to R190 resistor and ground to second pin of connector with reference designator J3.
3. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
4. After completion of all rework instructions connect to power supply of 12V DC from external power supply.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Once the board is powered up run the software in Linux PC, for this refer to fourth point software settings of test setup 7.1.8.3 section.
7. Collect output at pigtail which is connected at C1512 pad for TX pipe2 and feed it to Spectrum analyser.

8.1.6.7 Reference

1. Sections 5 and 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

8.1.7 Test Case: Carrier leakage – Pipe2 (TRX 2.4)

8.1.7.1 Description

I. Purpose

The purpose of this test case is to check carrier leakage.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform carrier leakage affects EVM
Compliance	Yes	Failure to conform carrier leakage affects EVM

Table 186. Impact of Failure –Carrier leakage – Pipe2

8.1.7.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no’s (SMA male to SMA male)`
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

8.1.7.3 Test Setup

i. Setup Block diagram

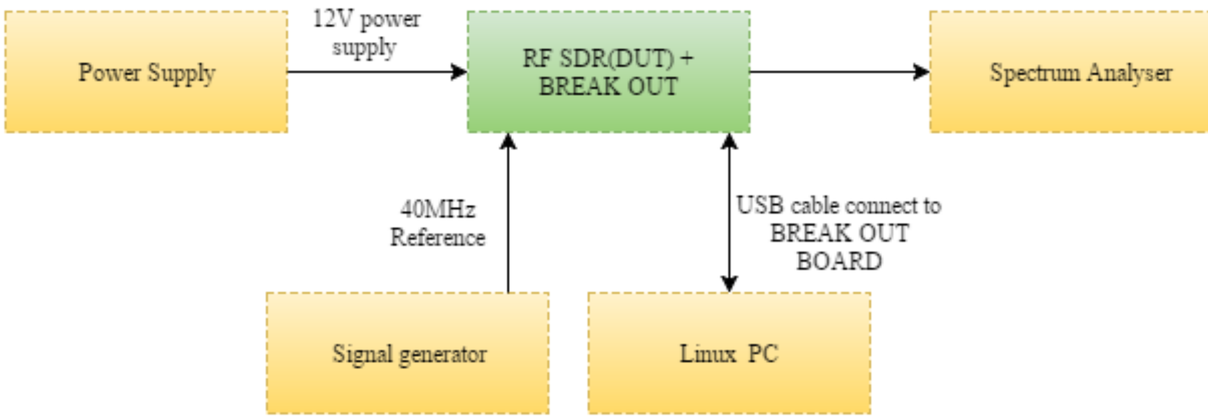

Figure 46. Carrier leakage – Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1503, so that we will isolate transceiver and chain. Collect output at pigtail which is connected at C1512 pad for TX pipe2.

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz

Table 187. Spectrum Analyser Settings

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 188. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.

- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 189. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

8.1.7.4 Requirements

Band	Carrier leakage level(dBc)
P-GSM-900	-50
DCS-1800	-50

Table 190. Carrier leakage Pipe - 2Test Specification

8.1.7.5 Test Condition

Test condition	Value	Remarks
Frequency	M	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 191. Test Condition

8.1.7.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
3. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
4. Short pins 2 and 3 of jumper J3304.
5. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
6. Collect output at pig tail which is connected capacitor pad (C1512) for TX pipe 2 and feed it to Spectrum analyser.

8.1.7.7 Reference

1. Sections 5 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

9. TX – Pipe-1 Sub-System

TX-Pipe consists of gain blocks, Digital Attenuator, Driver Amplifier, Power Amplifier, Power Combiner, Switches and Duplexer.

Output of the transceiver section is fed to gain block for further signal amplification and passed to Digital Attenuator to control variable gain and fed to Power Amplifiers which amplifies signal to +33dBm (2W)

Band/Switch selection operates based on the frequency selection

9.1 Test Purpose and Description

The purpose of this test is to verify and validate TX chain gain from output of the transceiver to Antenna port while controlling attenuation, PA selection and Switch selection controls.

Verification and validation of the TX - Pipe sub-system covers following functions and features:

1. Gain
2. Attenuation
3. Attenuation Step
4. Output Power
5. RF Power Detection

9.1.1 Test Case: Gain – Pipe1 (TX_P 1.1)

9.1.1.1 Description

I. Purpose

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

II. Impact of failure

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with TX – Pipe1 gain requirements will impact system output power target of 2W.
Compliance	Yes	Failure to conform with TX – Pipe1 gain requirements will impact system output power target of 2W.

Table 192. Impact of Failure – Gain – Pipe1

9.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- 20dB Attenuator

9.1.1.3 Test Setup

i. Setup Block diagram

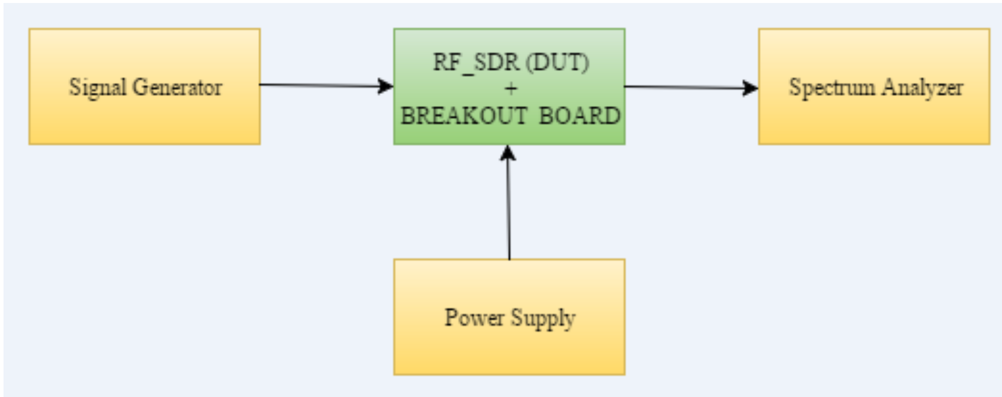

Figure 47. TX pipe - 1 GainTest Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1500 so that we will isolate chain and transceiver. From Signal generator feed signal at C1511 through pig tail and collect output at antenna port J2701 for TX pipe1.

iii. **Equipment Settings**

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Amplitude(dBm)
E-GSM-900	925	942	960	-24
GSM-850	870	881	892	-24
DCS-1800	1806	1842	1879	-16
PCS-1900	1931	1959	1989	-16

Table 193. Signal Generator Settings

- **Keysight 89600** vector signal analyser.

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 194. Spectrum Analyser Settings

iv. **Test Software settings**

- None

9.1.1.4 Requirements

Band	Gain (dB)	Remarks
E-GSM-900	≥43	
GSM-850	≥43	
DCS-1800	≥43	
PCS-1900	≥43	

Table 195. TX pipe 1 Gain Test Specification

9.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state

Table 196. Test Condition

9.1.1.6 Test Procedure

1. Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1500 so that we will isolate chain and transceiver.
2. TX pipe1 side all switches are controlled with three controls named CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS and CH1_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band
   (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
   (ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. After completion of all rework instructions connect to power supply of 12V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
6. From Signal generator feed signal at C1511 through pig tail and collect output at antenna port J2701 for TX pipe1 and feed it to Spectrum analyser.

9.1.1.7 Reference

1. Sections 6.1-6.8 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

9.1.2 Test Case: Attenuation and Attenuation step – Pipe1 (TX_P 1.2 and TX_P 1.3)

9.1.2.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the TX – Pipe1 digital attenuator attenuation is not working, further devices in line up may get damage due to high power input.
Performance	NA	NA
Compliance	NA	NA

Table 197. Impact of Failure – Attenuation and Attenuation step – Pipe1

9.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- 20dB Attenuator
- Linux PC

9.1.2.3 Test Setup

i. Setup Block diagram

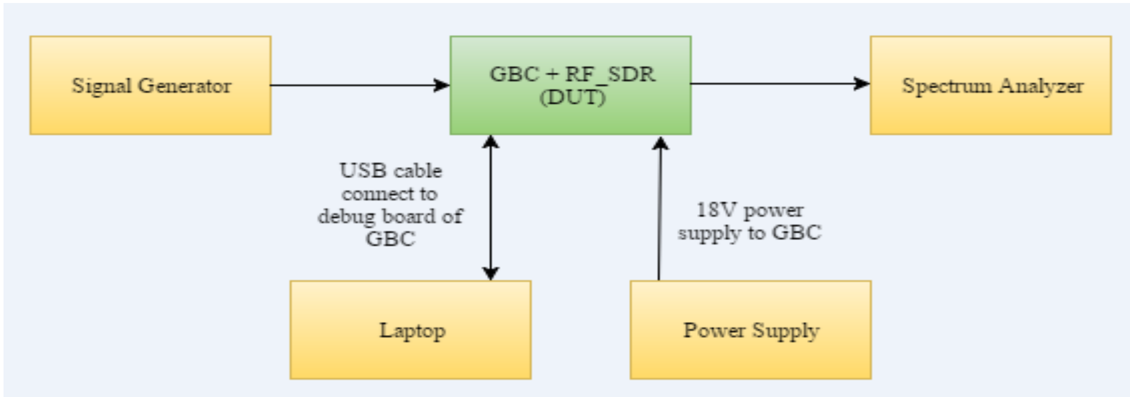

Figure 48. Attenuation and Attenuation step – TX-Pipe1 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1500 so that we will isolate chain and transceiver. From Signal generator feed signal at C1511 through pig tail and collect output at antenna port J2701 for TX pipe1.

iii. Equipment Settings

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Amplitude (dBm)
E-GSM-900	925	942	960	-24
DCS-1800	1806	1842	1879	-16

Table 198. Signal Generator Settings

- **Keysight 89600** vector signal analyser.

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 199. Spectrum Analyser Settings

iv. Software settings

- To digital attenuator all attenuation controls are coming from IO Expander which is communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA attenuator code.

9.1.2.4 Requirements

Attenuation (dB)	Chain Gain (dB)
0	≥ 43
0.5	≥ 42.5
1	≥ 42
2	≥ 41
4	≥ 39
8	≥ 35

Table 200. Attenuation – TX-Pipe1 Test Specification

Attenuation (dB)	Chain Gain (dB)
0	≥ 43
0.5	≥ 42.5
1.0	≥ 42
1.5	≥ 41.5
2	≥ 41
2.5	≥ 40.5
3	≥ 40

Table 201. Attenuation step – TX-Pipe1 Test Specification

9.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	M	For each band test at Bottom, Middle and top frequencies.
Voltage	18V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 202. Test Condition

9.1.2.6 Test Procedure

1. Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1500 so that we will isolate chain and transceiver.
2. TX pipe1 side all switches are controlled with three controls named CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS and CH1_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground
      (ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.
4. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.

5. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.
6. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
7. From Signal generator feed signal at C1511 through pig tail and collect output at antenna port J2701 for TX pipe1 and feed it to Spectrum analyser.
8. Now through coding change the attenuation value, for e.g. If you want attenuate signal by an amount 4dB then make that IO Expander(U2205) I/O line to one and rest all I/O lines to zero.
9. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4dB comparing to previous displayed value.
10. Digital attenuator supports 0.5dB step attenuation, to check that make that IO Expander (U2205) I/O line to one and rest all I/O lines with same values as mentioned above.
11. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4.5 dB comparing to previous displayed value.

9.1.2.7 Reference

1. Sections 7.4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

9.1.3 Test Case: Output Power – Pipe1 (TX_P 1.4)

9.1.3.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	If the TX – Pipe1 output power is not met, overall system design for 2W power will get affected.
Compliance	Yes	If the TX – Pipe1 output power is not met, overall system design for 2W power will get affected.

Table 203. Impact of Failure – Output power – Pipe1

9.1.3.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- 20dB Attenuator

9.1.3.3 Test Setup

i. Setup Block diagram

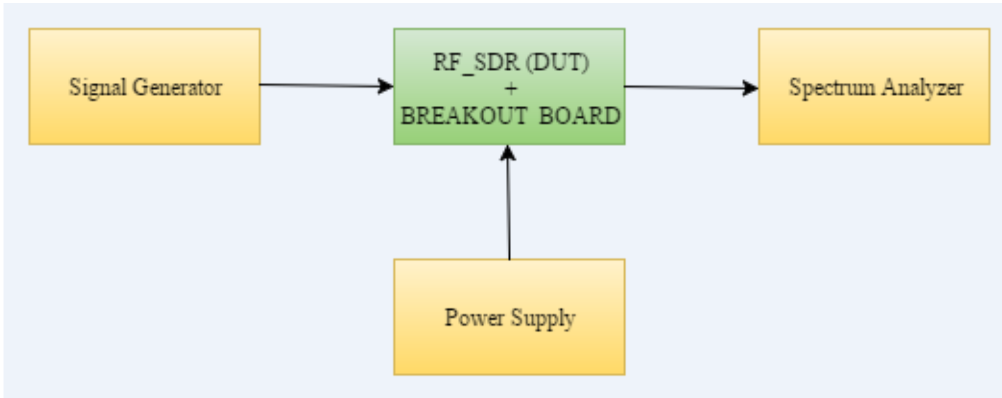

Figure 49. Output power TX pipe - 1 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1500 so that we will isolate chain and transceiver. From Signal generator feed signal at C1511 through pig tail and collect output at antenna port J2701 for TX pipe1.

iii. Equipment Settings

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Amplitude (dBm)
P-GSM-900	935	942	960	-24
DCS-1800	1806	1842	1879	-16

Table 204. Signal Generator Settings

- **Keysight 89600** vector signal analyser.

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 205. Spectrum Analyser Settings

iv. Test Software settings

- None

9.1.3.4 Requirements

Band	Output power (dBm)	Remarks
P-GSM-900	33 ± 1	
DCS-1800	33 ± 1	

Table 206. TX pipe - 1 Output Power Test Specification

9.1.3.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state

Table 207. Test Condition

9.1.3.6 Test Procedure

1. Remove series capacitor C1511 and connect RF cable at capacitor pad C1511 which is near to U1500 so that we will isolate chain and transceiver.
2. TX pipe1 side all switches are controlled with three controls named CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS and CH1_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3305.
    a. Low Band
        (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
        (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band

(i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. After completion of all rework instructions connect to power supply of 12V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
6. From Signal generator feed signal at C1511 through pig tail and collect output at antenna port J2701 for TX pipe1 and feed it to Spectrum analyser.

9.1.3.7 Reference

1. Sections 6.1-6.8 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

9.1.4 Test Case: RF power detection – Pipe1 (TX_P 1.5)

9.1.4.1 Description

I. Purpose

The purpose of this test case is to verify power detection of TX – Pipe1 (excluding Transceiver AD9361).

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	RF power monitoring get impacted if we are not able to read power detector values.
Compliance	NA	NA

Table 208. Impact of Failure – RF power detection – Pipe1

9.1.4.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Linux PC

9.1.4.3 Test Setup

i. Setup Block diagram

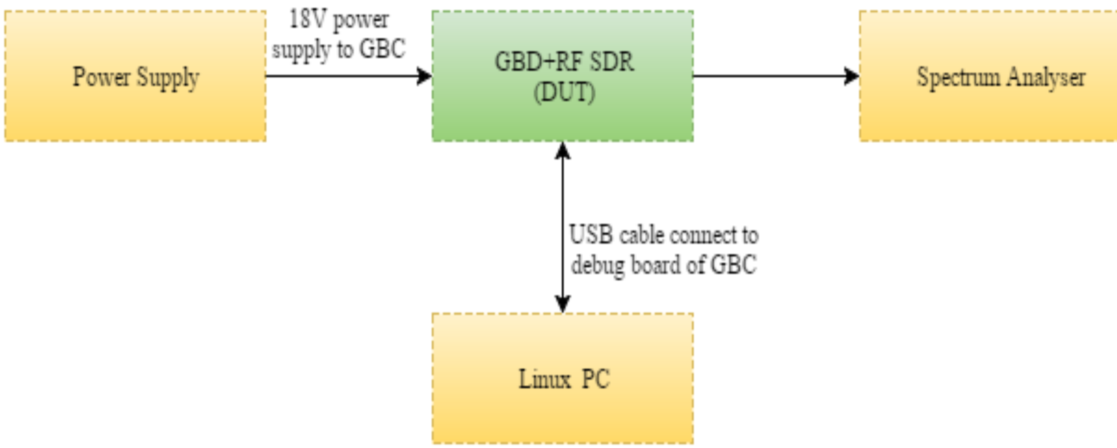

Figure 50. Power detection – TX-Pipe1 Test Setup Block Diagram

ii. **Measurement Locations**

- Collect output at antenna port J2701 for TX pipe1.

iii. **Equipment Settings**

- **Keysight 89600** vector signal analyser.

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 209. Spectrum Analyser Settings

iv. **Software settings**

- RF power monitoring binary values can be read through ADC (U1802) which is communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA code.

  Step1. Running openbsc
- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

  Step2. Running osmo-bts
- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

  Step3. Running osmo-trx
- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

  Changing the config file parameters
- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:

  1. osmo-trx
  2. osmo-bts
  3. openbsc

- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 210. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter"arfcn<space><value>", for arfcn value refer to below table.

Band	Frequency (MHz)	ARFCN
	M	M
P-GSM-900	945.2	51
DCS-1800	1842.4	698

Table 211. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in "openbsc_config_file". In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

9.1.4.4 Requirements

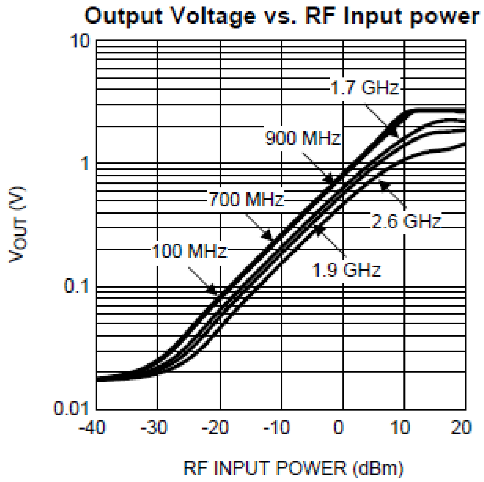

Figure 15.

- Power Vs ADC Value read is updated for each board at Middle frequency and over temperature during calibration.
- Power read for that board should be within the table limits within an accuracy of +/-1dB.

Power at Antenna port in dBm	Power at input of power detector in dBm	Power detector output in mV	ADC Value in digital
33	8	2500	5mV to 217mV values in digital in steps of 12.89mV
32	7		
31	6		
30	5		
29	4		
28	3		
27	2		
26	1		
25	0	800	
24	-1		
23	-2		
22	-3		
21	-4		
20	-5		
19	-6		
18	-7		
17	-8		
16	-9		
15	-10	180	
14	-11		
13	-12		
12	-13		
11	-14		
10	-15		
9	-16		
8	-17		
7	-18		
6	-19		
5	-20	80	
4	-21		
3	-22		

Table 212. RF power detection spec table-pipe1

9.1.4.5 Test Condition

Test condition	Value	Remarks
Frequency	M	For each band test at Middle frequency
Voltage	18V	Nominal voltage
Temperature	+25 C	Normal Room temperature
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 213. Test Condition

9.1.4.6 Test Procedure

1. TX pipe1 side all switches are controlled with three controls named CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS and CH1_RF_BYPASS_CNTL_LVL.
2. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper

J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground

(ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

4. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.
5. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.
6. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
7. Short pin’s 1and 2 of jumpers JP1, JP2 and J3304.
8. Once the board is powered up run the osmostack on Linux pc, for this refer to software settings.
9. Collect output at antenna port J2701 for TX pipe1 and feed it to Spectrum analyser.
10. Now run the TIVA code to read the power detection values.

9.1.4.7 Reference

1. Sections 6.5 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

10. TX – Pipe-2 Sub-System

TX-Pipe consists of gain blocks, Digital Attenuator, Driver Amplifier, Power Amplifier, Power Combiner, Switches and Duplexer.

Output of the transceiver section is fed to gain block for further signal amplification and passed to Digital Attenuator to control variable gain and fed to Power Amplifiers which amplifies signal to +33dBm (2W)

Band/Switch selection operates based on the frequency selection

10.1 Test Purpose and Description

The purpose of this test is to verify and validate TX chain gain from output of the transceiver to Antenna port while controlling attenuation, PA selection and Switch selection controls.

Verification and validation of the TX - Pipe sub-system covers following functions and features:

1. Gain
2. Attenuation
3. Attenuation Step
4. Output Power
5. RF Power Detection

10.1.1 Test Case: Gain – Pipe2 (TX_P 2.1)

10.1.1.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with TX – Pipe2 gain requirements will impact system output power target of 2W.
Compliance	Yes	Failure to conform with TX – Pipe2 gain requirements will impact system output power target of 2W.

Table 214. Impact of Failure – Gain – Pipe2

10.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- 20dB Attenuator

10.1.1.3 Test Setup

i. Setup Block diagram

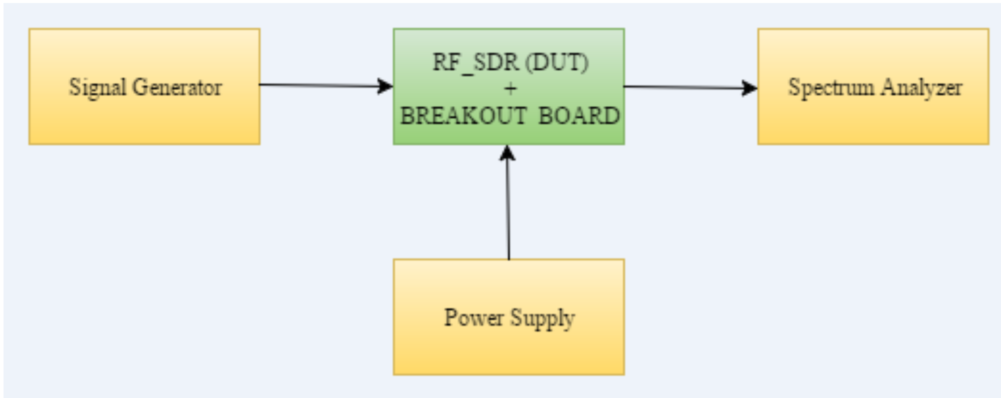

Figure 51. TX pipe - 2 GainTest Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1504 so that we will isolate chain and transceiver. From Signal generator feed signal at C1512 through pig tail and collect output at antenna port J3302 for TX pipe2.

iii. **Equipment Settings**

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Amplitude
E-GSM-900	925	942	960	-24
GSM-850	870	881	892	-24
DCS-1800	1806	1842	1879	-16
PCS-1900	1931	1959	1989	-16

Table 215. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 216. Spectrum Analyser Settings

iv. **Test Software settings**

- None

10.1.1.4 Requirements

Band	Gain (dB)	Remarks
E-GSM-900	≥43	
GSM-850	≥43	
DCS-1800	≥43	
PCS-1900	≥43	

Table 217. TX pipe 2 Gain Test Specification

10.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state

Table 218. Test Condition

10.1.1.6 Test Procedure

1. Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1504 so that we will isolate chain and transceiver.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper

J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

(ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band

(i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. After completion of all rework instructions connect to power supply of 12V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
6. From Signal generator feed signal at C1512 through pig tail and collect output at antenna port J3302 for TX pipe2 and feed it to Spectrum analyser.

10.1.1.7 Reference

1. Sections 6.1-6.8 of OpenCellular – Connect1 RF-SDR Design Document (v0.1). https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

10.1.2 Test Case: Attenuation and Attenuation step – Pipe2 (TX_P 2.2 and TX_P 2.3)

10.1.2.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the TX – Pipe2 digital attenuator attenuation is not working, further devices in line up may get damage due to high power input.
Performance	NA	NA
Compliance	NA	NA

Table 219. Impact of Failure – Attenuation and Attenuation step – Pipe2

10.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- 20dB Attenuator
- Linux PC

10.1.2.3 Test Setup

i. Setup Block diagram

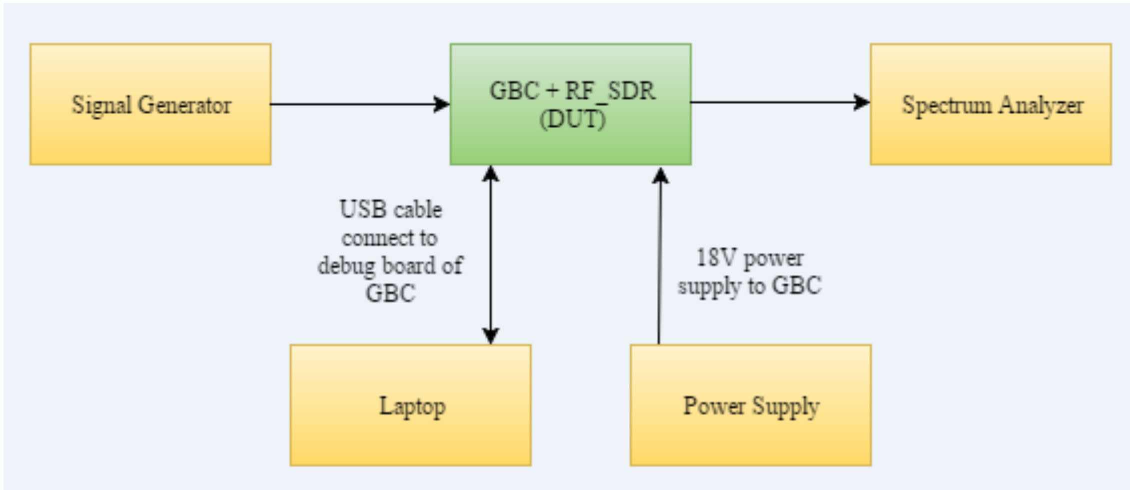

Figure 52. Attenuation and Attenuation step – TX-Pipe2 Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1504 so that we will isolate chain and transceiver. From Signal generator feed signal at C1512 through pig tail and collect output at antenna port J3302 for TX pipe2.

iii. **Equipment Settings**

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Amplitude
E-GSM-900	925	942	960	-24
DCS-1800	1806	1842	1879	-16

Table 220. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 221. Spectrum Analyser Settings

iv. **Software settings**

- To digital attenuator all attenuation controls are coming from IO Expander which is communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA attenuator code

10.1.2.4 Requirements

Attenuation (dB)	Chain Gain (dB)
0	≥ 43
0.5	≥ 42.5
1	≥ 42
2	≥ 41
4	≥ 39
8	≥ 35

Table 222. Attenuation – TX-Pipe2 Test Specification

Attenuation (dB)	Chain Gain (dB)
0	≥ 43
0.5	≥ 42.5
1.0	≥ 42
1.5	≥ 41.5
2	≥ 41
2.5	≥ 40.5
3	≥ 40

Table 223. Attenuation step – TX-Pipe2 Test Specification

10.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 224. Test Condition

10.1.2.6 Test Procedure

1. Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1504 so that we will isolate chain and transceiver.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground
      (ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.
4. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.

5. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.
6. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
7. From Signal generator feed signal at C1512 through pig tail and collect output at antenna port J3302 for TX pipe2 and feed it to Spectrum analyser.
8. Now through coding change the attenuation value, for e.g. If you want attenuate signal by an amount 4dB then make that IO Expander(U2805) I/O line to one and rest all I/O lines to zero.
9. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4dB comparing to previous displayed value.
10. Digital attenuator supports 0.5dB step attenuation, to check that make that IO Expander (U2805) I/O line to one and rest all I/O lines with same values as mentioned above.
11. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4.5 dB comparing to previous displayed value.

10.1.2.7 Reference

1. Sections 7.4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

10.1.3 Test Case: Output Power – Pipe2 (TX_P 2.4)

10.1.3.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	If the TX – Pipe2 output power is not met, overall system design for 2W power will get affected.
Compliance	Yes	If the TX – Pipe2 output power is not met, overall system design for 2W power will get affected.

Table 225. Impact of Failure – Output power – Pipe2

10.1.3.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- 20dB Attenuator

10.1.3.3 Test Setup

i. Setup Block diagram

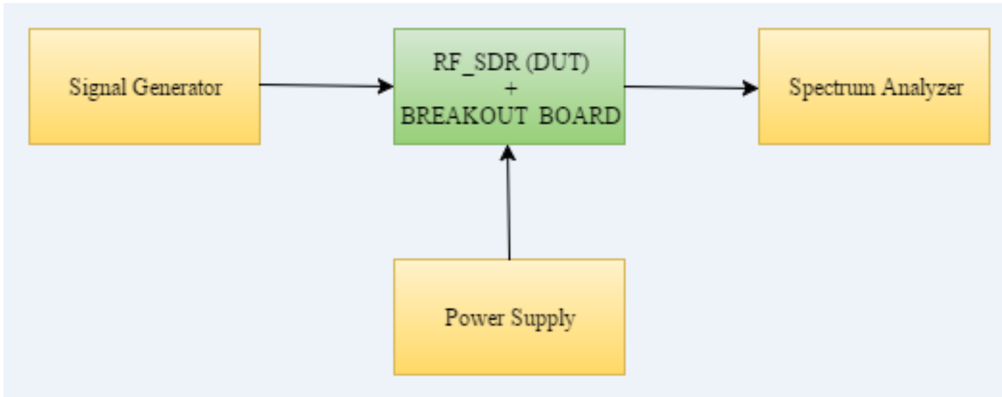

Figure 53. TX pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1504 so that we will isolate chain and transceiver. From Signal generator feed signal at C1512 through pig tail and collect output at antenna port J3302 for TX pipe2.

iii. Equipment Settings

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Amplitude
P-GSM-900	935	942	960	-24
DCS-1800	1806	1842	1879	-16

Table 226. Signal Generator Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 227. Spectrum Analyser Settings

iv. Test Software settings

- None

10.1.3.4 Requirements

Band	Output power (dBm)	Remarks
P-GSM-900	33 ± 1	
DCS-1800	33 ± 1	

Table 228. TX pipe 2 Output Power Test Specification

10.1.3.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state

Table 229. Test Condition

10.1.3.6 Test Procedure

1. Remove series capacitor C1512 and connect RF cable at capacitor pad C1512 which is near to U1504 so that we will isolate chain and transceiver.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
    a. Low Band
        (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
        (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band
   (i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
   (ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. After completion of all rework instructions connect to power supply of 12V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
6. From Signal generator feed signal at C1512 through pig tail and collect output at antenna port J3302 for TX pipe2 and feed it to Spectrum analyser.

10.1.3.7 Reference

1. Sections 6.1-6.8 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZI1a?dl=0

10.1.4 Test Case: RF power detection – Pipe2 (TX_P 2.5)

10.1.4.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	RF power monitoring get impacted if we are not able to read power detector values.
Compliance	NA	NA

Table 230. Impact of Failure – RF power detection – Pipe2

10.1.4.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Linux PC

10.1.4.3 Test Setup

i. Setup Block diagram

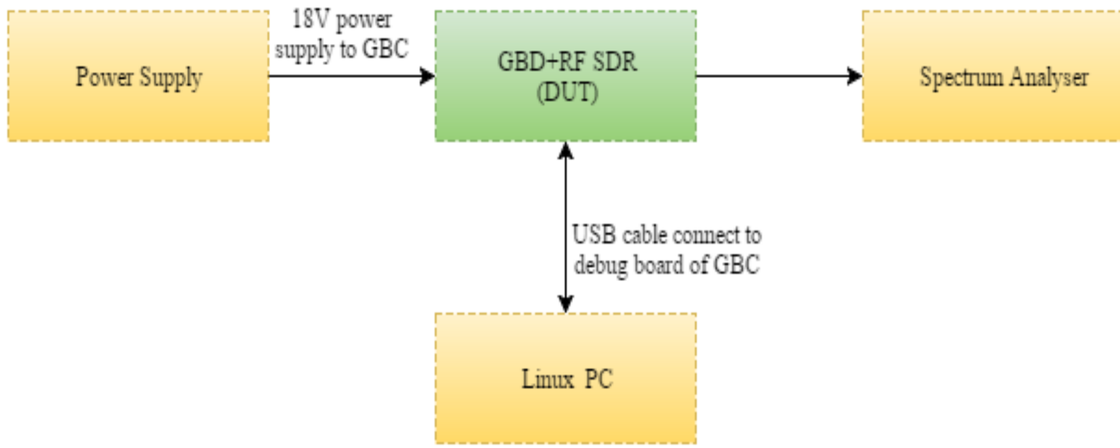

Figure 54. Power detection – TX-Pipe2 Test Setup Block Diagram

ii. **Measurement Locations**

- Collect output at antenna port J3302 for TX pipe2.

iii. **Equipment Settings**

- **Keysight M9381A** vector signal generator

Band	Middle(MHz)	Amplitude
E-GSM-900	942	-20
DCS-1800	1842	-20

Table 231. Signal Generator Settings

- **Keysight 89600** vector signal analyser.

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 232. Spectrum Analyser Settings

iv. **Software settings**

- RF power monitoring binary values can be read through ADC (U2002) which is communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA code.

  Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

  Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:

1. osmo-trx
2. osmo-bts
3. openbsc

- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 233. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)	ARFCN
	M	M
P-GSM-900	945.2	51
DCS-1800	1842.4	698

Table 234. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.

- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

10.1.4.4 Requirements

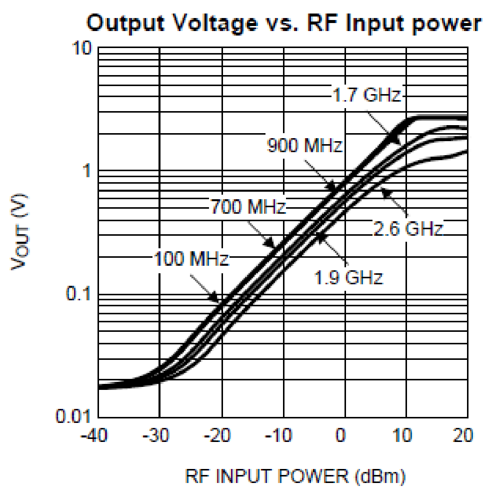

Figure 15.

- Power Vs ADC Value read is updated for each board at Middle frequency and over temperature during calibration.
- Power read for that board should be within the table limits within an accuracy of +/- 1dB.

Power at Antenna port in dBm	Power at input of power detector in dBm	Power detector output in mV	ADC Value in digital
33	8	2500	5mV to 217mV values in digital in steps of 12.89mV
32	7		
31	6		
30	5		
29	4		
28	3		
27	2		
26	1		
25	0	800	
24	-1		
23	-2		
22	-3		
21	-4		
20	-5		
19	-6		
18	-7		
17	-8		
16	-9		
15	-10	180	
14	-11		
13	-12		
12	-13		
11	-14		
10	-15		
9	-16		
8	-17		
7	-18		
6	-19		
5	-20	80	
4	-21		
3	-22		

Table 235. RF power detection spec table-pipe2

10.1.4.5 Test Condition

Test condition	Value	Remarks
Frequency	M	For each band test at Middle frequency.
Voltage	18V	Nominal voltage
Temperature	+25 C	Normal Room temperature
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 236. Test Condition

10.1.4.6 Test Procedure

1. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
2. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

3. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.
4. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.
5. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
6. Short pin's 1and 2 of jumpers JP1, JP2 and J3304.
7. Once the board is powered up run the osmostack on Linux pc, for this refer to software settings
8. From Signal generator feed signal at C1512 through pig tail and collect output at antenna port J3302 for TX pipe2 and feed it to Spectrum analyser.
9. Now run the TIVA code to read the power detection values.

10.1.4.7 Reference

1. Sections 6.5 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

11. RX – Pipe-1 Sub-System

RX-Pipe consists of Low noise Amplifier, Digital Attenuator, SAW filters, Switches and Duplexer.

Signal received by antenna will be fed to low noise amplifier for amplification and then to SAW filters for further filtering, finally this filtered will be fed to transceiver.

Band/Switch selection operates based on the frequency selection

11.1 Test Purpose and Description

The purpose of this test is to verify and validate RX chain and Switch selection controls.

Verification and validation of the RX - Pipe sub-system covers following functions and features:

1. Gain
2. Attenuation
3. Attenuation Step
4. Noise figure

11.1.1 Test Case: Noise Figure and Gain – Pipe1 (RX_P 1.1 & P 1.2)

11.1.1.1 Description

I. Purpose

The purpose of this test case is to verify and validate RX – Pipe1 Noise figure and Gain for all four bands (excluding AD9361 transceiver).

II. Impact of failure

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	RX – Pipe1 Noise Figure deviations will impact on System's Rx Sensitivity.
Compliance	Yes	RX – Pipe1 Noise Figure deviations will impact on System's Rx Sensitivity.

Table 237. Impact of Failure – Noise Figure and Gain – Pipe1

11.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- Signal Analyzer (N9020A or Equivalent)
- Noise Source (HP-346B)
- RF cables – 2 no's (SMA male to SMA male)
- BNC to BNC cable
- SMA Cables – 1no (SMA Female connector and another end Switch type Connector)

11.1.1.3 Test Setup

i. Setup Block diagram

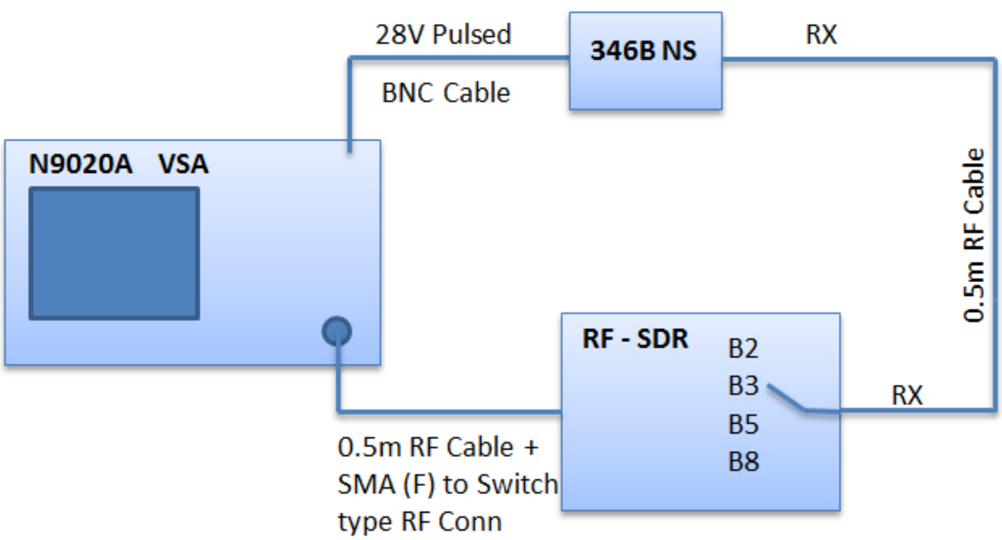

Figure 55. RX pipe - 1 Noise Figure & Gain Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C4409 and connect on capacitor pad C4390 which is near U7117 so that we will isolate Rx chain and transceiver. From Noise Source, feed signal at Rx Pipe-1 through RF Connector J2701 and collect output at U7117.

iii. **Equipment Settings**

- **Keysight N9020A** vector signal analyser

Band	Bottom(MHz)	Top(MHz)
GSM 850	824	850
E-GSM-900	880	915
DCS-1800	1710	1785
PCS-1900	1850	1910

Table 238. Signal Analyser Frequency Settings

Centre Frequency	Signal Analyser
RBW	4MHz

Table 239. Signal Analyser Settings

iv. **Test Software settings**

- None

11.1.1.4 Requirements

Band	Noise Figure (dB)	Gain (dB)	Remarks
GSM-850	< 7	>5dB	
E-GSM-900	< 7	>5dB	
DCS-1800	< 7	>5dB	
PCS-1900	< 7	>5dB	

Table 240. RX pipe 1 Noise Figure & Gain Test Specification

11.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state

Table 241. Test Condition

11.1.1.6 Test Procedure

1. Remove series capacitor C4409 and connect on capacitor pad C4390 which is near U7117 so that we will isolate Rx chain and transceiver.
2. RX pipe1 side all switches are controlled with five controls named CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS, CH1_RF_BYPASS_CNTL_LVL, CH1_RX_BAND_CTNL2_CPU_LVL_TRNS and CH1_RX_BAND_CTNL1_CPU_LVL_TRNS.

	REFERENCE DEISGNATOR	BAND			
		850	900	1800	1900
Chain 1 jumpers	J3305	short pins 1 and 2 ,4 and 5, 8 and 9	short pins 2 and 3 ,4 and 5, 8 and 9	short pins 1 and 2, 5 and 6, 8 and 9	short pins 2 and 3, 5 and 6, 8 and 9,
	J3307	short pins 1 and 2 ,4 and 5	short pins 2 and 3 ,4 and 5	short pins 1 and 2, 5 and 6	short pins 2 and 3, 5 and 6, 8 and 9,

Table 242. Chain 1 jumper settings for switch controls

3. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. After completion of all rework instructions based on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
5. Calibrate Noise source as per Band selection. Ensure GSM phones are OFF during tests.
6. Ensure Signal analyser should be in Noise Figure mode and RF 50Ω AC Coupled at Input.
7. From Noise Source, feed signal at Rx Pipe-1 through RF Connector J2701 and collect output at U7117.

11.1.1.7 Reference

1. Sections 7.1-7.7 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

11.1.2 Test Case: Attenuation and Attenuation step – Pipe1 (RX_P 1.3 and RX_P 1.4)

11.1.2.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the RX – Pipe1 digital attenuator attenuation is not working, further devices in line up may get damage due to high power input.
Performance	NA	NA
Compliance	NA	NA

Table 243. Impact of Failure – Attenuation and Attenuation step – Pipe1

11.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

11.1.2.3 Test Setup

i. Setup Block diagram

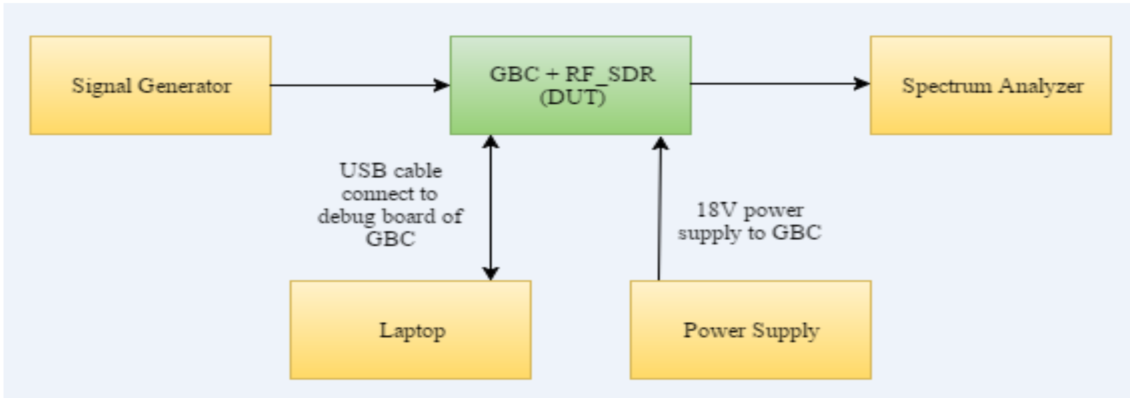

Figure 56. Attenuation and Attenuation step – RX-Pipe1 Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C4409 and connect RF cable at capacitor pad C4409 which is near to IC U2504, so that we will isolate chain and transceiver. From Signal generator feed signal at antenna port J2701 for RX pipe1 and collect output through pig tail connected at C4409.

iii. **Equipment Settings**

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Amplitude (dBm)
P-GSM-900	935	942	960	-30
DCS-1800	1806	1842	1879	-30

Table 244. Signal Generator Settings

- **Keysight 89600** vector signal analyser.

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 245. Spectrum Analyser Settings

iv. **Software settings**

- To digital attenuator all attenuation controls are coming from IO Expander which is communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA attenuator code.

11.1.2.4 Requirements

Attenuation (dB)	Chain Gain (dB)
0	>5dB
0.5	Gain at 0dB-0.5dB
1	Gain at 0dB-1dB
2	Gain at 0dB-2dB
4	Gain at 0dB-4dB
8	Gain at 0dB-8dB

Table 246. Attenuation – RX-Pipe1 Test Specification

Attenuation (dB)	Chain Gain (dB)
0	>5dB
0.5	Gain at 0dB-0.5dB
1.0	Gain at 0dB-1dB
1.5	Gain at 0dB-1.5B
2	Gain at 0dB-2dB
2.5	Gain at 0dB-2.5dB
3	Gain at 0dB-3dB

Table 247. Attenuation step – RX-Pipe1 Test Specification

11.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	M	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 248. Test Condition

11.1.2.6 Test Procedure

1. Remove series capacitor C4409 and connect RF cable at capacitor pad C4409 which is near to U2504 so that we will isolate chain and transceiver.
2. RX pipe1 side all switches are controlled with five controls named CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS, CH1_RF_BYPASS_CNTL_LVL, CH1_RX_BAND_CTNL2_CPU_LVL_TRNS and CH1_RX_BAND_CTNL1_CPU_LVL_TRNS.

3. Refer to below table for jumper settings of switch controls.

	REFERENCE DEISGNATOR	BAND			
		850	900	1800	1900
Chain 1 jumpers	J3305	short pins 1 and 2 ,4 and 5, 8 and 9	short pins 2 and 3 ,4 and 5, 8 and 9	short pins 1 and 2, 5 and 6, 8 and 9	short pins 2 and 3, 5 and 6, 8 and 9,
	J3307	short pins 1 and 2 ,4 and 5	short pins 2 and 3 ,4 and 5	short pins 1 and 2, 5 and 6	short pins 2 and 3, 5 and 6, 8 and 9,

Table 249. Chain 1 jumper settings for switch controls

6. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.
7. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.
8. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
9. From Signal generator feed signal at antenna port J2701 for RX pipe1 and collect output through pig tail connected at C4409.

11.1.2.7 Reference

1. Sections 7.4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

12. RX – Pipe-2 Sub-System

RX-Pipe consists of Low noise Amplifier, Digital Attenuator, SAW filters, Switches and Duplexer.

Signal received by antenna will be fed to low noise amplifier for amplification and then to SAW filters for further filtering, finally this filtered will be fed to transceiver.

Band/Switch selection operates based on the frequency selection

12.1 Test Purpose and Description

The purpose of this test is to verify and validate RX chain and Switch selection controls.

Verification and validation of the RX - Pipe sub-system covers following functions and features:

1. Gain
2. Attenuation
3. Attenuation Step
4. Noise figure

12.1.1 Test Case: Noise Figure and Gain – Pipe 2 (RX_P 2.1 & P 2.2)

12.1.1.1 Description

I. Purpose

The purpose of this test case is to verify and validate RX – Pipe 2 Noise figure and Gain for all four bands (excluding AD9361 transceiver).

II. Impact of failure

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	RX – Pipe 2 Noise Figure deviations will impact on System's Rx Sensitivity.
Compliance	Yes	RX – Pipe 2 Noise Figure deviations will impact on System's Rx Sensitivity.

Table 250. Impact of Failure – Noise Figure and Gain – Pipe2

12.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- Signal Analyzer (N9020A or Equivalent)
- Noise Source (HP-346B)
- RF cables – 2 no's (SMA male to SMA male)
- BNC to BNC cable
- SMA Cables – 1no (SMA Female connector and another end Switch type Connector)

12.1.1.3 Test Setup

i. Setup Block diagram

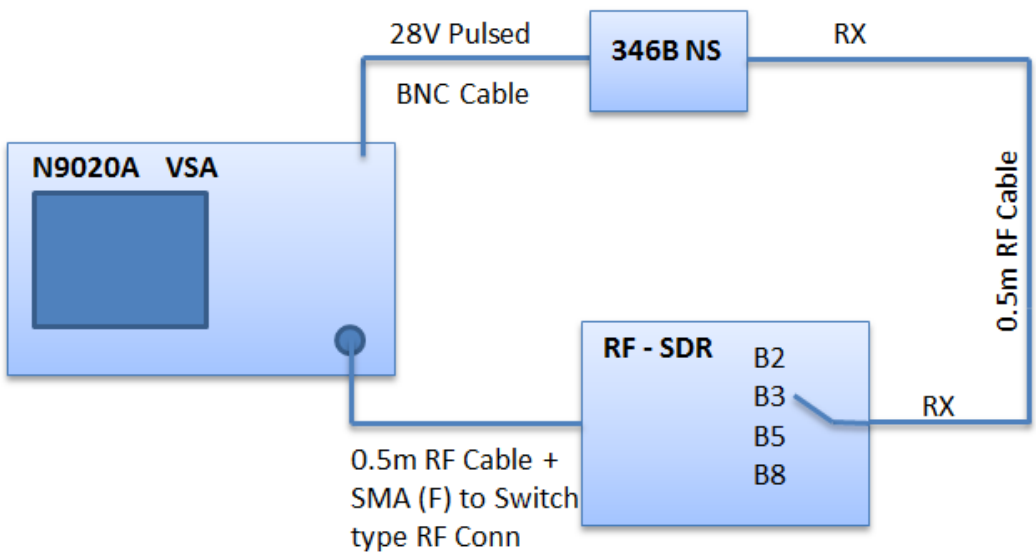

Figure 57. RX pipe - 2 Noise Figure & Gain Test Setup Block Diagram

ii. Measurement Locations

- Remove series capacitor C4410 and connect on capacitor pad C4389 which is near U7116 so that we will isolate Rx chain and transceiver. From Noise Source, feed signal at Rx Pipe-2 through RF Connector J3302 and collect output at U7116.

iii. Equipment Settings

- **Keysight N9020A** vector signal analyser

Band	Bottom(MHz)	Top(MHz)
GSM 850	824	850
E-GSM-900	880	915
DCS-1800	1710	1785
PCS-1900	1850	1910

Table 251. Signal Analyser Frequency Settings

Centre Frequency	Signal Analyser
RBW	4MHz

Table 252. Signal Analyser Settings

iv. Test Software settings

- None

12.1.1.4 Requirements

Band	Noise Figure (dB)	Gain (dB)	Remarks
GSM-850	< 7	>5dB	
E-GSM-900	< 7	>5dB	
DCS-1800	< 7	>5dB	
PCS-1900	< 7	>5dB	

Table 253. RX pipe 2 Noise Figure & Gain Test Specification

12.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state

Table 254. Test Condition

12.1.1.6 Test Procedure

1. Remove series capacitor C4410 and connect on capacitor pad C4389 which is near U7116 so that we will isolate Rx chain and transceiver.
2. RX pipe2 side all switches are controlled with five controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS, CH2_RF_BYPASS_CNTL_LVL, CH2_RX_BAND_CTNL2_CPU_LVL_TRNS and CH2_RX_BAND_CTNL1_CPU_LVL_TRNS.

	REFERENCE DEISGNATOR	BAND			
		850	900	1800	1900
Chain 2 jumpers	J3306	short pins 1 and 2 ,4 and 5, 8 and 9	short pins 2 and 3 ,4 and 5, 8 and 9	short pins 1 and 2, 5 and 6, 8 and 9	short pins 2 and 3, 5 and 6, 8 and 9,
	J3308	short pins 1 and 2 ,4 and 5	short pins 2 and 3 ,4 and 5	short pins 1 and 2, 5 and 6	short pins 2 and 3, 5 and 6, 8 and 9,

Table 255. Chain 2 jumper settings for switch controls

3. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. After completion of all rework instructions based on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
5. Calibrate Noise source as per Band selection. Ensure GSM phones are OFF during tests.
6. Ensure Signal analyser should be in Noise Figure mode and RF 50Ω AC Coupled at Input.
7. From Noise Source, feed signal at Rx Pipe-2 through RF Connector J3302 and collect output at U7116.

12.1.1.7 Reference

1. Sections 7.1-7.7 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

12.1.2 Test Case: Attenuation and Attenuation step – Pipe1 (RX_P 2.3 and RX_P 2.4)

12.1.2.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	If the RX – Pipe2 digital attenuator attenuation is not working, further devices in line up may get damage due to high power input.
Performance	NA	NA
Compliance	NA	NA

Table 256. Impact of Failure – Attenuation and Attenuation step – Pipe1

12.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 2 no's (SMA male to SMA male)
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

12.1.2.3 Test Setup

i. Setup Block diagram

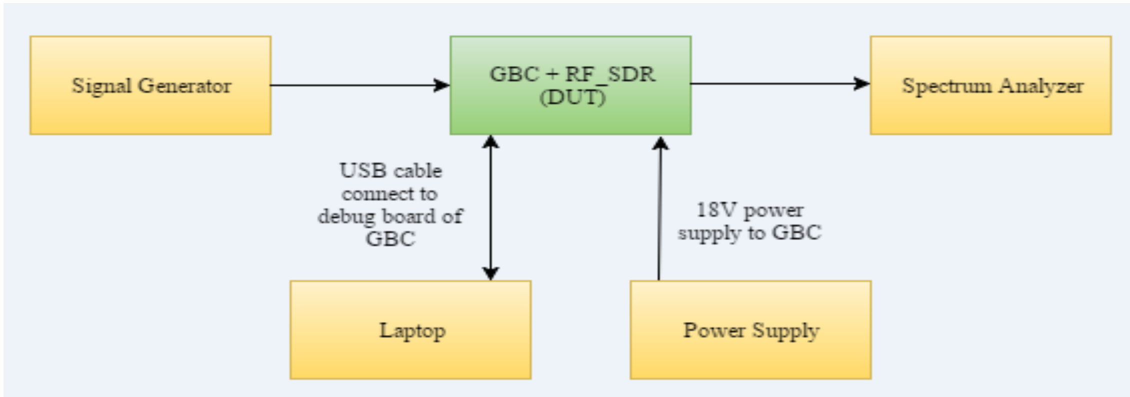

Figure 58. Attenuation and Attenuation step – RX-Pipe2 Test Setup Block Diagram

ii. **Measurement Locations**

- Remove series capacitor C4410 and connect RF cable at capacitor pad C4410 which is near to IC U3103, so that we will isolate chain and transceiver. From Signal generator feed signal at antenna port J3302 for RX pipe2 and collect output through pig tail connected at C4410.

iii. **Equipment Settings**

- **Keysight M9381A** vector signal generator

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Amplitude
P-GSM-900	935	942	960	-30
DCS-1800	1806	1842	1879	-30

Table 257. Signal Generator Settings

- **Keysight 89600** vector signal analyser.

Centre Frequency	Same as Signal Generator input frequency
Span	10MHz
RBW	3KHz

Table 258. Spectrum Analyser Settings

iv. **Software settings**

- To digital attenuator all attenuation controls are coming from IO Expander which is communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA attenuator code.

12.1.2.4 Requirements

Attenuation (dB)	Chain Gain (dB)
0	>5dB
0.5	Gain at 0dB-0.5dB
1	Gain at 0dB-1dB
2	Gain at 0dB-2dB
4	Gain at 0dB-4dB
8	Gain at 0dB-8dB

Table 259. Attenuation – RX-Pipe2 Test Specification

Attenuation (dB)	Chain Gain (dB)
0	>5dB
0.5	Gain at 0dB-0.5dB
1.0	Gain at 0dB-1dB
1.5	Gain at 0dB-1.5B
2	Gain at 0dB-2dB
2.5	Gain at 0dB-2.5dB
3	Gain at 0dB-3dB

Table 260. Attenuation step – RX-Pipe2 Test Specification

12.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	M	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature

Table 261. Test Condition

12.1.2.6 Test Procedure

1. Remove series capacitor C4409 and connect RF cable at capacitor pad C4409 which is near to U2504 so that we will isolate chain and transceiver.
2. RX pipe2 side all switches are controlled with five controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS, CH2_RF_BYPASS_CNTL_LVL, CH2_RX_BAND_CTNL2_CPU_LVL_TRNS and CH2_RX_BAND_CTNL1_CPU_LVL_TRNS.
3. Refer to below table for jumper settings of switch controls.

	REFERENCE DEISGNATOR	**BAND**			
		850	**900**	**1800**	**1900**
Chain 2 jumpers	J3306	short pins 1 and 2 ,4 and 5, 8 and 9	short pins 2 and 3 ,4 and 5, 8 and 9	short pins 1 and 2, 5 and 6, 8 and 9	short pins 2 and 3, 5 and 6, 8 and 9,
	J3308	short pins 1 and 2 ,4 and 5	short pins 2 and 3 ,4 and 5	short pins 1 and 2, 5 and 6	short pins 2 and 3, 5 and 6, 8 and 9,

Table 262. Chain 2 jumper settings for switch controls

4. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.
5. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.
6. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.
7. From Signal generator feed signal at antenna port J3302 for RX pipe2 and collect output through pig tail connected at C4410.

12.1.2.7 Reference

1. Sections 7.4 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

13. Transmitter chain – Pipe-1 Sub-System

Transmitter chain consists of Transceiver, gain blocks, Digital Attenuator, Driver Amplifier, Power Amplifier, Power Combiner, Switches and Duplexer.

Output of the transceiver section is fed to gain block for further signal amplification and passed to Digital Attenuator to control variable gain and fed to Power Amplifiers which amplifies signal to +33dBm (2W)

Band/Switch selection operates based on the frequency selection

13.1 Test Purpose and Description

The purpose of this test is to verify and validate Transmitter chain gain and system level parameters from output of the transceiver to Antenna port while controlling attenuation, PA selection and Switch selection controls.

Verification and validation of the TX - Pipe sub-system covers following functions and features:

1. Maximum Output Power
    a. Output power
    b. RF carrier power vs time
2. Static power control
3. Modulation Accuracy
4. Output RF Spectrum
    a. Adjacent channel power
    b. Spectrum due to switching
5. Spurious Emission

13.1.1 Test Case: Maximum Output Power – Pipe1 (TX_C 1.2)

13.1.1.1 Description

I. Purpose

The purpose of this test case is to check maximum power that is possible from antenna port.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform Maximum Output Power–Pipe1 requirements will impact the overall system design of 2W.
Compliance	NA	NA

Table 263. Impact of Failure – Maximum output power – Pipe1

13.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

13.1.1.3 Test Setup

i. Setup Block diagram

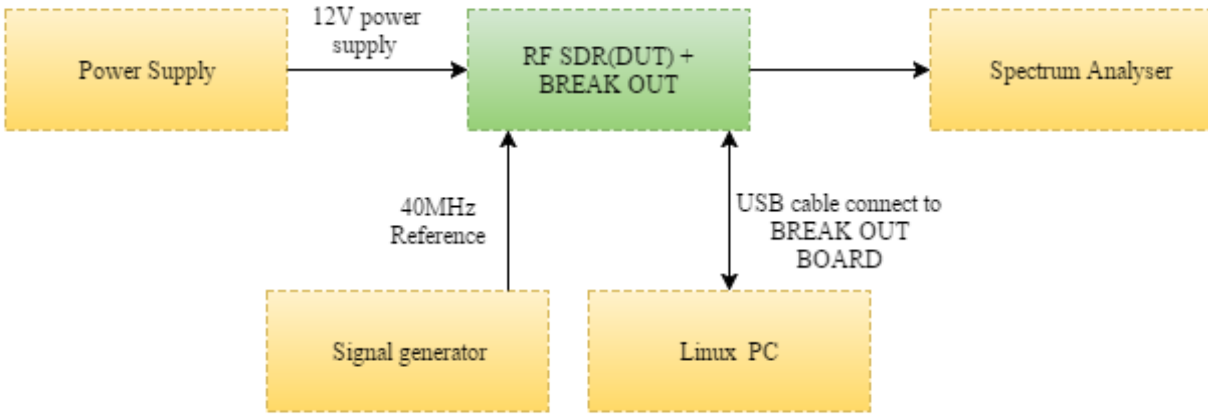

Figure 59. Maximum Output Power– Pipe - 1 Test Setup Block Diagram

ii. **Measurement Locations**

- Measure the output at antenna port connector-J2701

iii. **Equipment Settings**

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 264. Spectrum Analyser Settings

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:

1. osmo-trx
2. osmo-bts
3. openbsc

- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 265. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 266. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

13.1.1.4 Requirements

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Output Power(dBm)
P-GSM-900	935.2	947.6	959.8	33 ± 2
DCS-1800	1805.2	1842.4	1879.8	33 ± 2

Table 267. Pipe - 1 Maximum Output Power at Antenna Port Test Specification

13.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 268. Test Condition

13.1.1.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.

(ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high

b. High Band

(i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

3. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
5. Short pins 2 and 3 of jumper J3304.
6. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
7. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser.

13.1.1.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

13.1.2 Test Case: RF Carrier Power vs Time – Pipe1 (TX_C 1.2)

13.1.2.1 Description

I. Purpose

Power vs. Time measures the mean transmit power during the "useful part" of GSM bursts and verifies that the power ramp fits the within the defined mask. Power vs. Time also lets you view the rise, fall, and "useful part" of the GSM burst.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	GSM is a Time Division Multiple Access (TDMA) scheme with eight time slots, or bursts, per RF channel. If the burst does not occur at exactly the right time, or if the burst is irregular, then other adjacent timeslots can experience interference. Because of this, the industry standards specify a tight mask for the fit of the TDMA burst
Compliance	Yes	GSM is a Time Division Multiple Access (TDMA) scheme with eight time slots, or bursts, per RF channel. If the burst does not occur at exactly the right time, or if the burst is irregular, then other adjacent timeslots can experience interference. Because of this, the industry standards specify a tight mask for the fit of the TDMA burst

Table 269. Impact of Failure – RF carrier power vs Time – Pipe1

13.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no’s (SMA male to SMA male)
- 20dB Attenuator

- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

13.1.2.3 Test Setup

i. **Setup Block diagram**

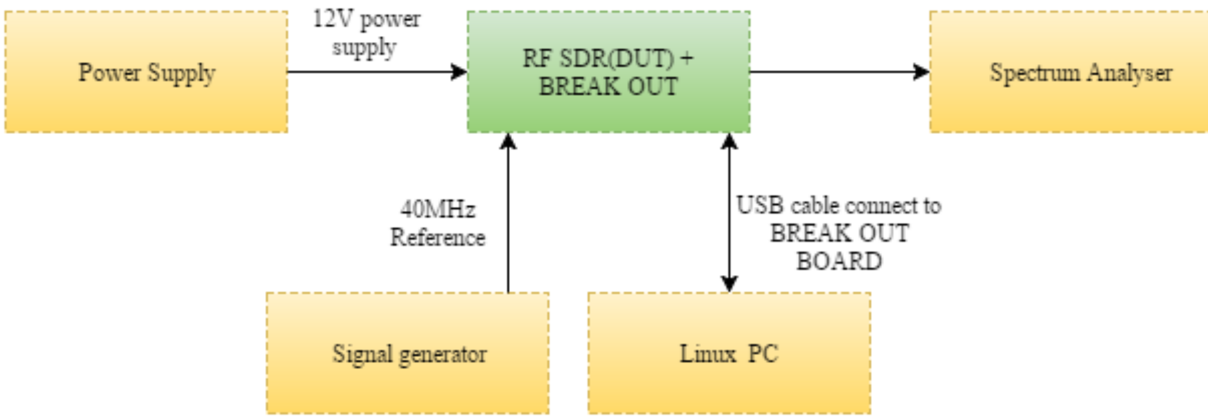

Figure 60. Power Vs Time– Pipe - 1 Test Setup Block Diagram

ii. **Measurement Locations**

- Measure the output at antenna port connector-J2701

iii. **Equipment Settings**

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 270. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in "openbsc_config_file"
  In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 271. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in "openbsc_config_file"
  In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.

- Now change the parameter"arfcn<space><value>", for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 272. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in "openbsc_config_file". In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

13.1.2.4 Requirements

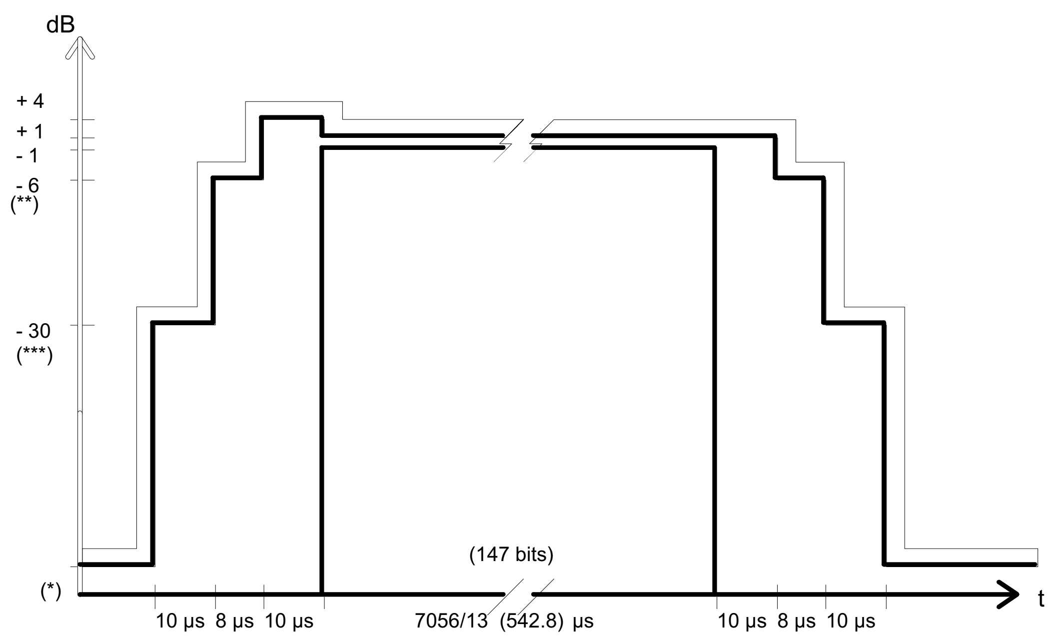

Figure 61. Power Vs Time– Pipe - 1 test specification

13.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 273. Test Condition

13.1.2.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. All the switches can be controlled with jumper having reference designator J3305.
    a. Low Band
        (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
        (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band
   (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
   (ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

3. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
5. Short pins 2 and 3 of jumper J3304.
6. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
7. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser

13.1.2.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

13.1.3 Test Case: Static Power Control – Pipe1 (TX_C 1.3)

13.1.3.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	Failure to conform with Transmit power control Pipe1 requirement will impact the further devices in chain which will get damage due to high power input.
Performance	NA	NA
Compliance	NA	NA

Table 274. Impact of Failure – Static power control – Pipe1

13.1.3.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Linux PC

13.1.3.3 Test Setup

i. Setup Block diagram

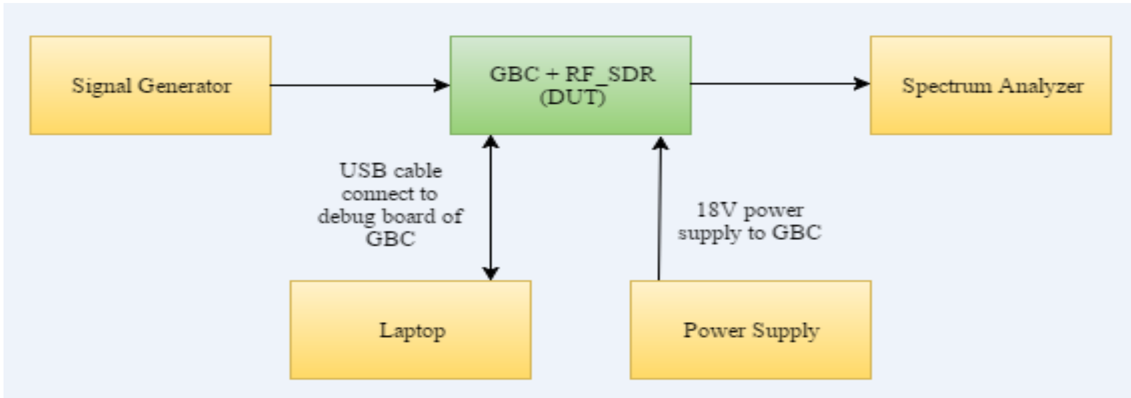

Figure 62. Static Power Control– Pipe - 1 Test Setup Block Diagram

ii. Measurement Locations

- Measure the output at antenna port connector-J2701

iii. Equipment Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz

Table 275. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in “openbsc_config_file”
  In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.

- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 276. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in "openbsc_config_file"
  In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter"arfcn<space><value>", for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 277. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in "openbsc_config_file". In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.
  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)
- To digital attenuator all attenuation controls are coming from IO Expander which is communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA attenuator code

13.1.3.4 Requirements

Attenuation (dB)	Chain Gain (dB)
0	≥ 43
0.5	≥ 42.5
1	≥ 42
2	≥ 41
4	≥ 39
8	≥ 35

Table 278. Pipe - 1 Static Power Control Test Specification

13.1.3.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	18V	Nominal voltage
Temperature	+25 C	Normal Room temperature
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 279. Test Condition

13.1.3.6 Test Procedure

1. TX pipe1 side all switches are controlled with three controls named CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS and CH1_RF_BYPASS_CNTL_LVL.
2. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground
      (ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.
4. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.
5. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.

6. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above
7. Now through coding change the attenuation value, for e.g. If you want attenuate signal by an amount 4dB then make that IO Expander(U2205) I/O line to one and rest all I/O lines to zero.
8. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4dB comparing to previous displayed value.
9. Digital attenuator supports 0.5dB step attenuation, to check that make that IO Expander (U2205) I/O line to one and rest all I/O lines with same values as mentioned above.
10. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4.5 dB comparing to previous displayed value.
11. Measure the output at antenna port connector-J2701 feed it to Spectrum analyser.

13.1.3.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

13.1.4 Test Case: Modulation accuracy– Pipe1 (TX_C 1.4)

13.1.4.1 Description

I. 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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with modulation accuracy – Pipe1, in a real system poor phase error or EVM will reduce the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.
Compliance	Yes	Failure to conform with modulation accuracy – Pipe1, in a real system poor phase error or EVM will reduce the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.

Table 280. Impact of Failure – Modulation accuracy – Pipe1

13.1.4.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

13.1.4.3 Test Setup

i. Setup Block diagram

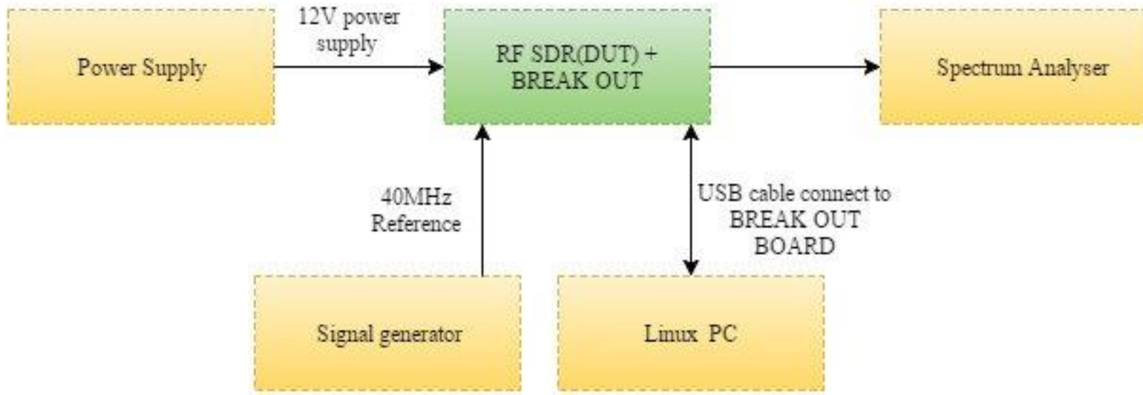

Figure 63. Modulation Accuracy – Pipe - 1 Test Setup Block Diagram

ii. Measurement Locations

- Measure the output at antenna port connector-J2701

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 281. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 282. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.

- Now change the parameter"arfcn<space><value>", for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 283. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in "openbsc_config_file". In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

13.1.4.4 Requirements

Modulation	Specification (R&D)	Specification (Normal)
	RMS(deg)	RMS(deg)
GMSK(900 & 1800MHz)	<3.6	<5

Table 284. Phase error RMS – Pipe - 1 Test Specification

Modulation	Specification (R&D)	Specification (Normal)
	< PEAK(deg)	< PEAK(deg)
GMSK(900 & 1800MHz)	<14.2	<20

Table 285. Phase error PEAK – Pipe - 1 Test Specification

Modulation	Specification(R&D)	Specification(normal)
	ppm / Hz	ppm / Hz
GMSK(900MHz)	< 0.03/±27Hz	< 0.05/±45Hz

Table 286. Frequency error – Pipe - 1 Test Specification

Modulation	Specification(R&D)	Specification(normal)
	ppm / Hz	ppm / Hz
GMSK(1800MHz)	< 0.03/±54Hz	< 0.05/±90Hz

Table 287. Frequency error – Pipe - 1 Test Specification

13.1.4.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 288. Test Condition

13.1.4.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull

CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

3. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
5. Short pins 2 and 3 of jumper J3304.
6. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
7. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser

13.1.4.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

13.1.5 Test Case: Adjacent Channel Power– Pipe1 (TX_C 1.5)

13.1.5.1 Description

I. 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).

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with adjacent channel power – Pipe1 requirement will impact other users who are operating on different frequencies would experience interference.
Compliance	Yes	Failure to conform with adjacent channel power – Pipe1 requirement will impact other users who are operating on different frequencies would experience interference.

Table 289. Impact of Failure – Adjacent Channel power – Pipe1

13.1.5.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no’s (SMA male to SMA male)
- 20dB Attenuator
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

13.1.5.3 Test Setup

i. Setup Block diagram

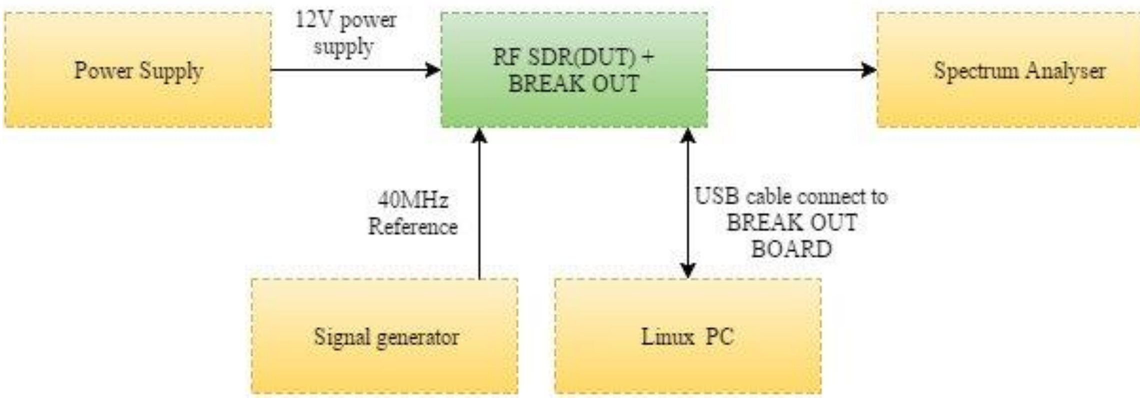

Figure 64. Adjacent Channel Power – Pipe - 1 Test Setup Block Diagram

ii. Measurement Locations

- Measure the output at antenna port connector-J2701

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 290. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

  Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

  Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:

  1. osmo-trx
  2. osmo-bts
  3. openbsc

- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 291. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 292. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

13.1.5.4 Requirements

Specification for 900MHz		
offset frequency	**< dBc**	**RBW KHz**
100KHz	0.5	30
200KHz	-30	30
250KHz	-33	30
400KHz	-60	30
600KHz to 1200KHz	-60	30
1200KHz to 1800KHz	-63	30
1800KHz to 6000KHz	-65	100

Table 293. Adjacent channel power – Pipe - 1 Test Specification

Specification for 1800Mhz		
offset frequency	**< dBc**	**RBW KHz**
100KHz	0.5	30
200KHz	-30	30
250KHz	-33	30
400KHz	-60	30
600KHz to 1200KHz	-56	30
1200KHz to 1800KHz	-63	30
1800KHz to 6000KHz	-65	100

Table 294. Adjacent channel power – Pipe - 1 Test Specification

13.1.5.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 295. Test Condition

13.1.5.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band

   (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.

   (ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

3. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
5. Short pins 2 and 3 of jumper J3304.
6. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
7. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser

13.1.5.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

13.1.6 Test Case: Spectrum Due To Switching– Pipe1 (TX_C 1.5)

13.1.6.1 Description

I. 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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with Spectrum due to switching – Pipe1, If a transmitter ramps power too quickly, users operating on different frequencies, especially those close to the channel of interest, will experience significant interference. Failures with this measurement often point to faults in a transmitter's output power amplifier or levelling loop
Compliance	Yes	Failure to conform with Spectrum due to switching – Pipe1, If a transmitter ramps power too quickly, users operating on different frequencies, especially those close to the channel of interest, will experience significant interference. Failures with this measurement often point to faults in a transmitter's output power amplifier or levelling loop

Table 296. Impact of Failure – Spectrum Due To switching – Pipe1

13.1.6.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator

- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

13.1.6.3 Test Setup

i. Setup Block diagram

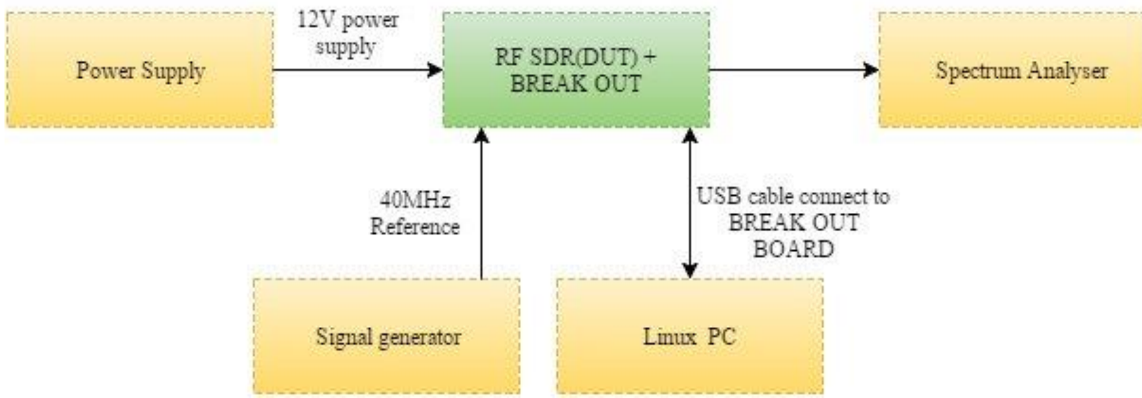

Figure 65. Spectrum Due To Switching – Pipe - 1 Test Setup Block Diagram

ii. Measurement Locations

- Measure the output at antenna port connector-J2701

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 297. Spectrum Analyser Setting

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:

  1. osmo-trx
  2. osmo-bts
  3. openbsc

- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 298. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.

- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	**Frequency (MHz)**			**ARFCN**		
	B	**M**	**T**	**B**	**M**	**T**
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 299. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc)

13.1.6.4 Requirements

Specification for 900MHz	
offset frequency	**< dBc**
400 KHz	-57
600 KHz	-67
1200 KHz	-74
1800 KHz	-74

Table 300. Spectrum due to switching – Pipe - 1 Test Specification

Specification for 1800MHz	
offset frequency	**< dBc**
400 KHz	-50
600 KHz	-58
1200 KHz	-66
1800 KHz	-66

Table 301. Spectrum due to switching – Pipe - 1 Test Specification

13.1.6.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 302. Test Condition

13.1.6.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

3. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
5. Short pins 2 and 3 of jumper J3304.
6. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
7. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser

13.1.6.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

13.1.7 Test Case: Spurious Emissions – Pipe1 (TX_C 1.6)

13.1.7.1 Description

I. 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.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with spurious emissions-pipe 1 requirement, will cause interference to other users of the spectrum.
Compliance	Yes	Failure to conform with spurious emissions-pipe 1 requirement, will cause interference to other users of the spectrum.

Table 303. Impact of Failure – Spurious Emissions – Pipe1

III. Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

13.1.7.2 Test Setup

i. Setup Block diagram

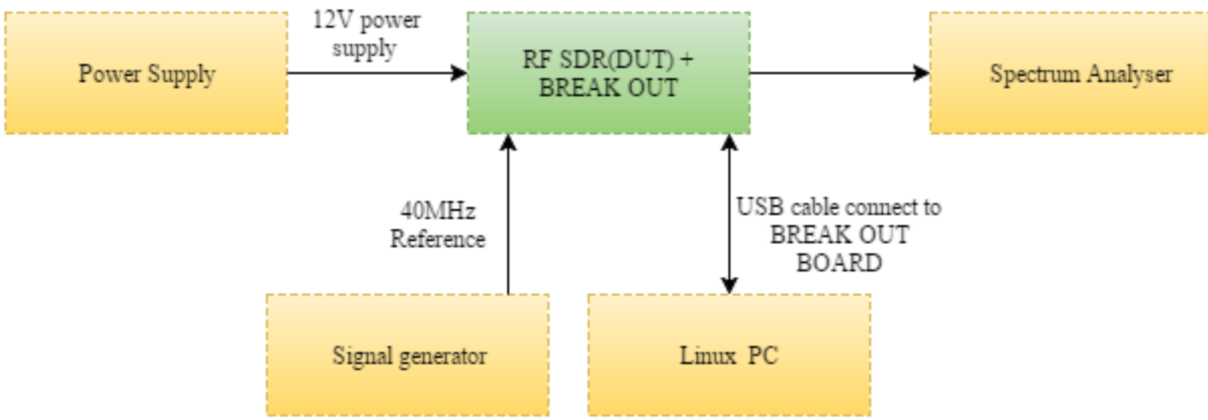

Figure 66. Spurious Emissions – Pipe - 1 Test Setup Block Diagram

ii. **Measurement Locations**

- Antenna port (J2701).

iii. **Equipment Settings**

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 304. Spectrum Analyser Settings

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command

$ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:

1. osmo-trx
2. osmo-bts
3. openbsc

- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 305. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T

P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 306. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in "openbsc_config_file". In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

13.1.7.3 Requirements

CH1_900MHZ				
Start Frequency (MHz)	**Start Frequency (MHz)**	**Spec (dBm)**	**RBW (KHz)**	**VBW (KHz)**
0.1	50	-36	10	30
50	880	-36	3000	9000
880	915	-98	100	100
915	920	-36	100	300
920	923	-36	30	90
925	**960**			
962	965	-36	30	90
965	970	-36	100	300
970	980	-36	300	900
989	990	-36	1000	3000
990	1000	-36	3000	9000
1000	12750	-30	3000	9000

Table 307. Spurious emissions – Pipe - 1 Test Specification

CH1_1800MHZ				
Start Frequency (MHz)	**Start Frequency (MHz)**	**Spec (dBm)**	**RBW (KHz)**	**VBW (KHz)**
0.1	50	-36	10	30
50	1000	-36	3000	9000
1000	1710	-30	3000	9000
1710	1785	-98	100	100
1785	1795	-30	300	900
1795	1800	-30	100	300
1800	1803	-30	30	90
1805	1880			
1882	1885	-30	30	90
1887	1890	-30	100	300
1890	1900	-30	300	900
1900	1910	-30	1000	3000
1910	12750	-30	3000	9000

Table 308. Spurious emissions – Pipe - 1 Test Specification

13.1.7.4 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 309. Test Condition

13.1.7.5 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. All the switches can be controlled with jumper having reference designator J3305.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH1_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH1_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3305 and other two controls should be pulled high. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3305.Short pins 4 and 5 of jumper J3305 to pull the control CH1_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH1_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3305 and other two controls should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper

J3305.Short pins 8 and 9 of jumper J3305 to pull the control CH1_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH1_RF_PASW_CTNL1_LVL_TRNS, CH1_RF_PASW_CTNL2_LVL_TRNS CH1_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH1_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3305. In order to pull CH1_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3305. In order to pull CH1_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3305.

3. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
4. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
5. Short pins 2 and 3 of jumper J3304.
6. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
7. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser.

13.1.7.6 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

14. Transmitter chain – Pipe-2 Sub-System

Transmitter chain consists of Transceiver, gain blocks, Digital Attenuator, Driver Amplifier, Power Amplifier, Power Combiner, Switches and Duplexer.

Output of the transceiver section is fed to gain block for further signal amplification and passed to Digital Attenuator to control variable gain and fed to Power Amplifiers which amplifies signal to +33dBm (2W)

Band/Switch selection operates based on the frequency selection

14.1 Test Purpose and Description

The purpose of this test is to verify and validate Transmitter chain gain and system level parameters from output of the transceiver to Antenna port while controlling attenuation, PA selection and Switch selection controls.

Verification and validation of the TX - Pipe sub-system covers following functions and features:

1. Maximum Output Power
    a. Output power
    b. RF carrier power vs time
2. Static power control
3. Modulation Accuracy
4. Output RF Spectrum
    a. Adjacent channel power
    b. Spectrum due to switching
5. Spurious Emission

14.1.1 Test Case: Maximum Output– Pipe2 (TX_C 2.2)

14.1.1.1 Description

I. Purpose

The purpose of this test case is to check maximum power that is possible from antenna port.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform Maximum Output Power– Pipe1 requirements will impact the overall system design of 2W.
Compliance	NA	NA

Table 310. Impact of Failure – Maximum Output – Pipe2

14.1.1.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

14.1.1.3 Test Setup

i. Setup Block diagram

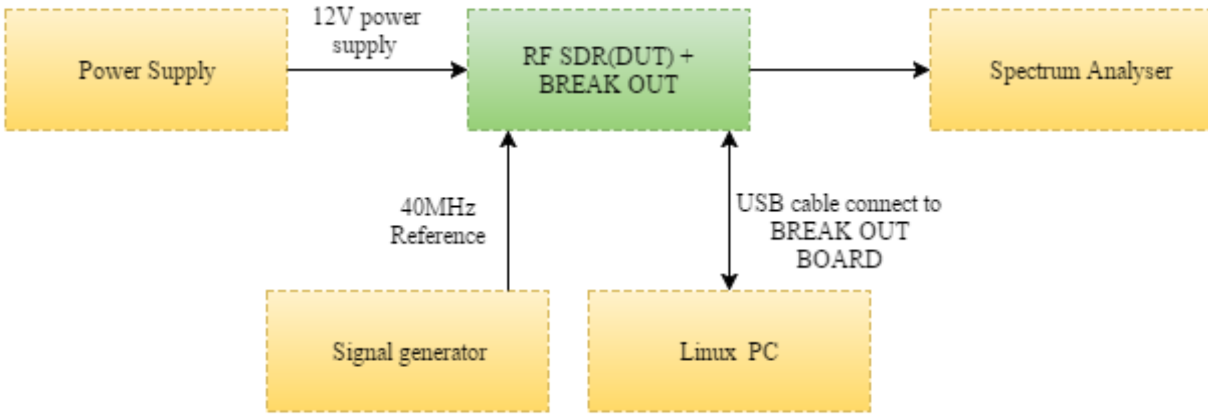

Figure 67. Maximum Output Power– Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Antenna port (J3302).

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 311. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc

- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 312. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 313. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

14.1.1.4 Requirements

Band	Bottom(MHz)	Middle(MHz)	Top(MHz)	Output Power(dBm)
P-GSM-900	935.2	947.6	959.8	33 ± 2
DCS-1800	1805.2	1842.4	1879.8	33 ± 2

Table 314. Pipe - 2 Maximum Output Power at Antenna Port Test Specification

14.1.1.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 315. Test Condition

14.1.1.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper

J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

(ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band

(i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Short pins 2 and 3 of jumper J3304.
7. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
8. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser.

14.1.1.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

14.1.2 Test Case: RF Carrier Power Vs Time (TX_C 2.2)

14.1.2.1 Description

I. Purpose

Power vs. Time measures the mean transmit power during the "useful part" of GSM bursts and verifies that the power ramp fits the within the defined mask. Power vs. Time also lets you view the rise, fall, and "useful part" of the GSM burst

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	GSM is a Time Division Multiple Access (TDMA) scheme with eight time slots, or bursts, per RF channel. If the burst does not occur at exactly the right time, or if the burst is irregular, then other adjacent timeslots can experience interference. Because of this, the industry standards specify a tight mask for the fit of the TDMA burst.
Compliance	Yes	GSM is a Time Division Multiple Access (TDMA) scheme with eight time slots, or bursts, per RF channel. If the burst does not occur at exactly the right time, or if the burst is irregular, then other adjacent timeslots can experience interference. Because of this, the industry standards specify a tight mask for the fit of the TDMA burst.

Table 316. Impact of Failure – RF Carrier Power vs Time

14.1.2.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator

- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

14.1.2.3 Test Setup

i. Setup Block diagram

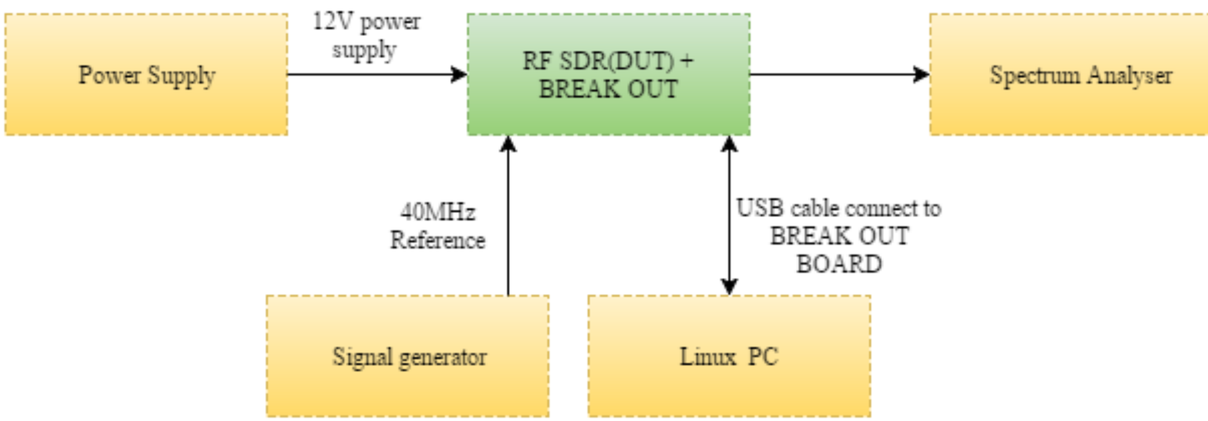

Figure 68. Power Vs Time– Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Antenna port (J3302).

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 317. Spectrum Analyser Settings

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command

  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:

  1. osmo-trx
  2. osmo-bts
  3. openbsc

- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 318. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.

- Now change the parameter"arfcn<space><value>", for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 319. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in "openbsc_config_file". In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

14.1.2.4 Requirements

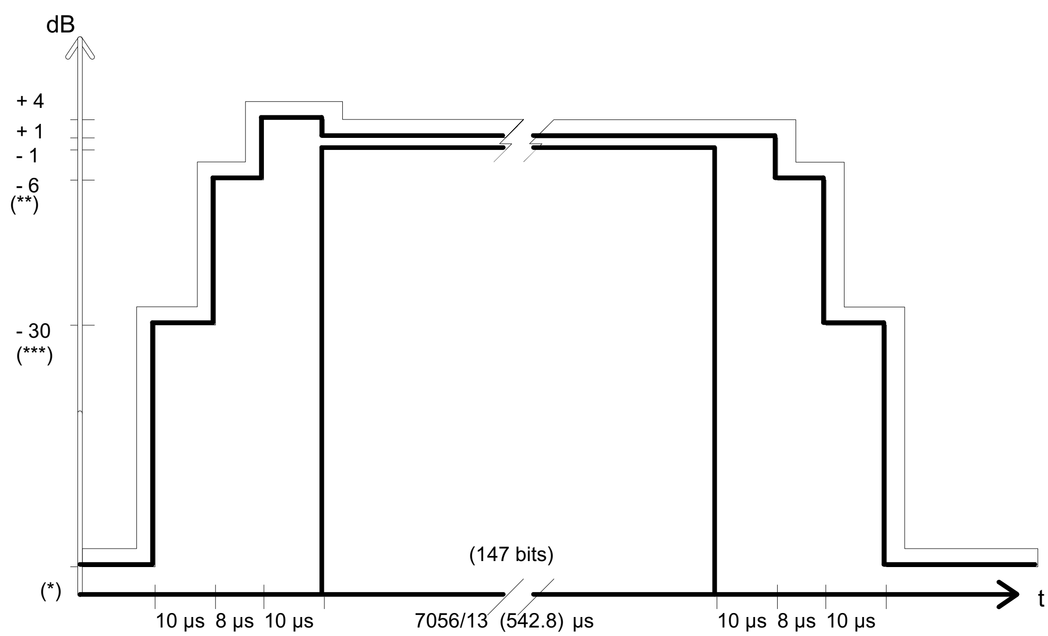

Figure 69. Power Vs Time– Pipe - 2 test specification

14.1.2.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 320. Test Condition

14.1.2.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band

(i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Short pins 2 and 3 of jumper J3304.
7. Once the board is powered up run the software in Linux PC, for this refer to software settings section.

   Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser

14.1.2.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

14.1.3 Test Case: Static Power Control – Pipe2 (TX_C 2.3)

14.1.3.1 Description

I. Purpose

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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	Yes	Failure to conform with Transmit power control from Pipe2 requirement will impact the further devices in chain which will get damage due to high power input.
Performance	NA	NA
Compliance	NA	NA

Table 321. Impact of Failure – Static Power Control – Pipe2

14.1.3.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Linux PC

14.1.3.3 Test Setup

i. Setup Block diagram

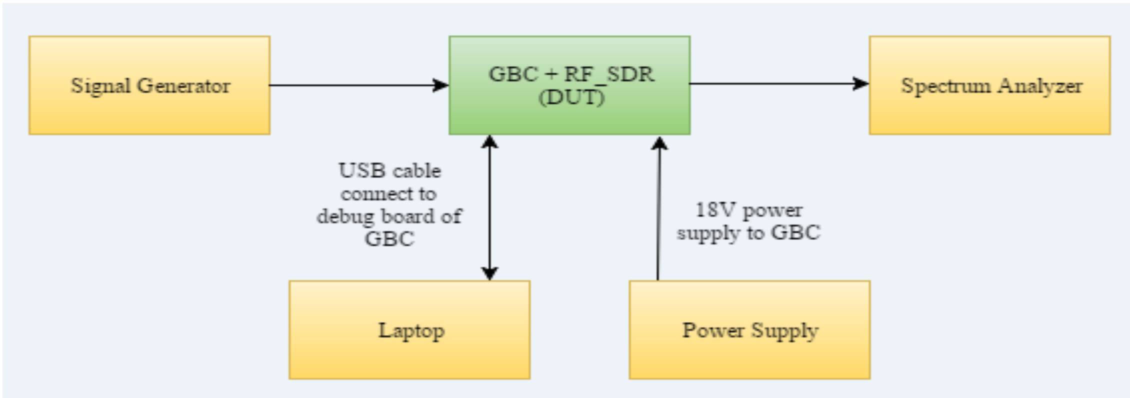

Figure 70. Static Power Control– Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Antenna port (J3302).

iii. Equipment Settings

- **Keysight 89600** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz

Table 322. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in "openbsc_config_file"
  In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.

- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 323. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 324. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)
- To digital attenuator all attenuation controls are coming from IO Expander which is communicating with TIVA on GBC board through I2C interface.
- Connect the USB cable from debug board of GBC to laptop and run the TIVA attenuator code

14.1.3.4 Requirements

Attenuation (dB)	Chain Gain (dB)
0	≥ 43
0.5	≥ 42.5
1	≥ 42
2	≥ 41
4	≥ 39
8	≥ 35

Table 325. Pipe - 2 Static Power Control Test Specification

14.1.3.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	18V	Nominal voltage
Temperature	+25 C	Normal Room temperature
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 326. Test Condition

14.1.3.6 Test Procedure

1. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.

2. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground
      (ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.
3. For this test case GBC and RF_SDR board should connect together, so to supply power to GBC board connect positive cable to first pin of connector with reference designator (JTB10) and ground to second pin.
4. For this test case power supply to RF_SDR board come from GBC board through board to board connector as we connect two boards together.
5. After completion of all rework instructions connect to power supply of 18V DC and based up on your band selection connect those corresponding controls to high or low with the help of jumper settings as mentioned above.

6. Now through coding change the attenuation value, for e.g. If you want attenuate signal by an amount 4dB then make that IO Expander(U2805) I/O line to one and rest all I/O lines to zero.
7. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4dB comparing to previous displayed value.
8. Digital attenuator supports 0.5dB step attenuation, to check that make that IO Expander (U2805) I/O line to one and rest all I/O lines with same values as mentioned above.
9. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4.5 dB comparing to previous displayed value.
10. Measure output at Antenna port (J3302) feed it to Spectrum analyser.

14.1.3.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents
   https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZI1a?dl=0

14.1.4 Test Case: Modulation accuracy – Pipe2 (TX_C 2.4)

14.1.4.1 Description

I. 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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with modulation accuracy – Pipe2, in a real system poor phase error or EVM will reduce the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.
Compliance	Yes	Failure to conform with modulation accuracy – Pipe2, in a real system poor phase error or EVM will reduce the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.

Table 327. Impact of Failure – Modulation accuracy – Pipe2

14.1.4.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

14.1.4.3 Test Setup

i. Setup Block diagram

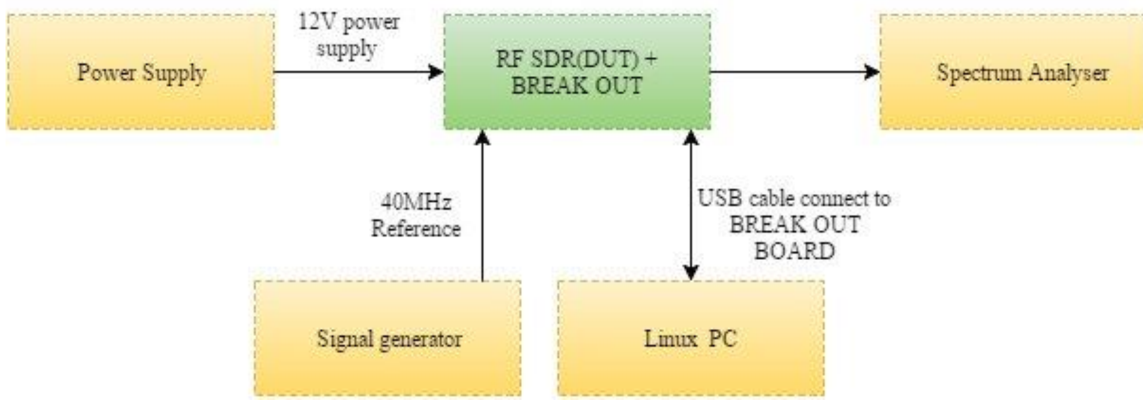

Figure 71. Modulation Accuracy – Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Antenna port (J3302).

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 328. Spectrum Analyser Setting

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 329. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in "openbsc_config_file"

In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.

- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 330. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

14.1.4.4 Requirements

Modulation	Specification (R&D)	Specification (Normal)
	RMS(deg)	RMS(deg)
GMSK(900 & 1800MHz)	<3.6	<5

Table 331. Phase error RMS – Pipe - 2 Test Specification

Modulation	Specification (R&D)	Specification (Normal)
	< PEAK(deg)	< PEAK(deg)
GMSK(900 & 1800MHz)	<14.2	<20

Table 332. Phase error PEAK – Pipe - 2 Test Specification

Modulation	Specification(R&D)	Specification(normal)
	ppm / Hz	ppm / Hz
GMSK(900MHz)	< 0.03/±27Hz	< 0.05/±45Hz

Table 333. Frequency error – Pipe - 2 Test Specification

Modulation	Specification(R&D)	Specification(normal)
	ppm / Hz	ppm / Hz
GMSK(1800MHz)	< 0.03/±54Hz	< 0.05/±90Hz

Table 334. Frequency error – Pipe - 2 Test Specification

14.1.4.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 335. Test Condition

14.1.4.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
    a. Low Band
        (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
        (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band
   (i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
   (ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Short pins 2 and 3 of jumper J3304.
7. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
8. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser

14.1.4.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZI1a?dl=0

14.1.5 Test Case: Adjacent Channel Power – Pipe2 (TX_C 2.5)

14.1.5.1 Description

I. 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).

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with adjacent channel power – Pipe2 requirement will impact other users who are operating on different frequencies would experience interference.
Compliance	Yes	Failure to conform with adjacent channel power – Pipe2 requirement will impact other users who are operating on different frequencies would experience interference.

Table 336. Impact of Failure – Adjacent Channel Power – Pipe2

14.1.5.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

14.1.5.3 Test Setup

i. Setup Block diagram

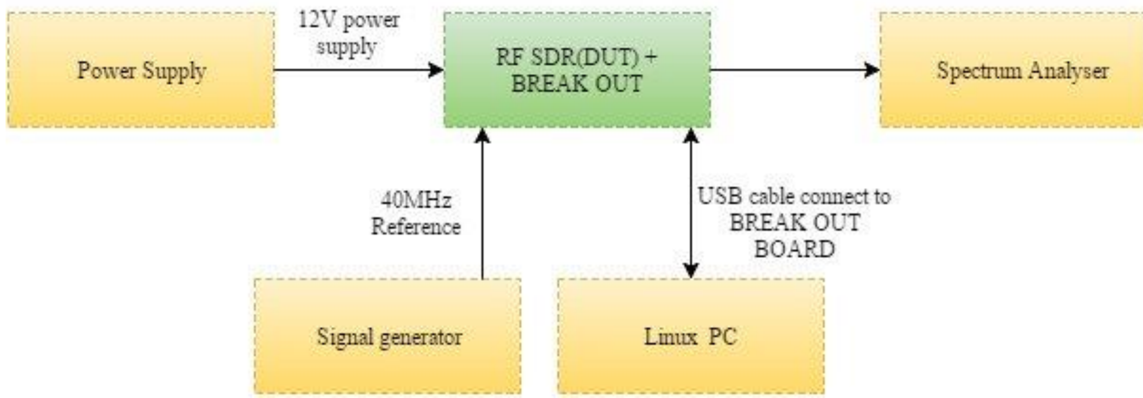

Figure 72. Adjacent Channel Power – Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Antenna port (J3302).

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 337. Spectrum Analyser Setting

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path “$ cd osmo-bts/src/osmo-bts-trx “and hit this command “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file “for single chain activation and this for “$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 “for two chains activation.

Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path “$ cd osmo-trx/Transceiver52M” and hit this command “$ sudo osmo-trx -f 1” for single chain activation and this for “$ sudo osmo-trx -fc 2” for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software’s by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter” band GSM<value>”, for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 338. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file”

In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.

- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 339. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

14.1.5.4 Requirements

Specification for 900MHz		
offset frequency	**< dBc**	**RBW KHz**
100KHz	0.5	30
200KHz	-30	30
250KHz	-33	30
400KHz	-60	30
600KHz to 1200KHz	-60	30
1200KHz to 1800KHz	-63	30
1800KHz to 6000KHz	-65	100

Table 340. Adjacent channel power – Pipe - 2 Test Specification

Specification for 1800Mhz		
offset frequency	**< dBc**	**RBW KHz**
100KHz	0.5	30
200KHz	-30	30
250KHz	-33	30
400KHz	-60	30
600KHz to 1200KHz	-56	30
1200KHz to 1800KHz	-63	30
1800KHz to 6000KHz	-65	100

Table 341. Adjacent channel power – Pipe - 2 Test Specification

14.1.5.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 342. Test Condition

14.1.5.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band

(i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Short pins 2 and 3 of jumper J3304.
7. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
8. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser

14.1.5.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0

14.1.6 Test Case: Spectrum Due To Switching– Pipe2 (TX_C 2.5)

14.1.6.1 Description

I. 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

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with Spectrum due to switching – Pipe2, If a transmitter ramps power too quickly, users operating on different frequencies, especially those close to the channel of interest, will experience significant interference. Failures with this measurement often point to faults in a transmitter’s output power amplifier or levelling loop.
Compliance	Yes	Failure to conform with Spectrum due to switching – Pipe2, If a transmitter ramps power too quickly, users operating on different frequencies, especially those close to the channel of interest, will experience significant interference. Failures with this measurement often point to faults in a transmitter’s output power amplifier or levelling loop.

Table 343. Impact of Failure – Spectrum Due to Switching – Pipe2

14.1.6.2 Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no’s (SMA male to SMA male)
- 20dB Attenuator

- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

14.1.6.3 Test Setup

i. Setup Block diagram

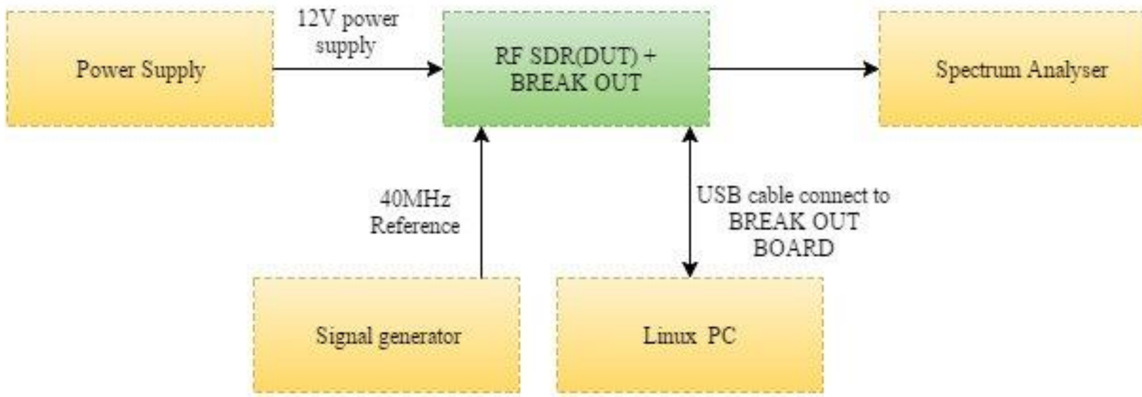

Figure 73. Spectrum Due To Switching – Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Antenna port (J3302).

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 344. Spectrum Analyser Setting

iv. **Software settings**

Step1. Running openbsc

- In new terminal go to this path "$ cd openbsc/openbsc/src/osmo-nitb "and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:
  1. osmo-trx
  2. osmo-bts
  3. openbsc
- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 345. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.

- For changing the transmit arfcn ,change the arfcn parameter in “openbsc_config_file” In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter”arfcn<space><value>”, for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124
DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 346. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

14.1.6.4 Requirements

Specification for 900MHz	
offset frequency	**< dBc**
400 KHz	-57
600 KHz	-67
1200 KHz	-74
1800 KHz	-74

Table 347. Spectrum due to switching – Pipe - 2 Test Specification

Specification for 1800MHz	
offset frequency	**< dBc**
400 KHz	-50
600 KHz	-58
1200 KHz	-66
1800 KHz	-66

Table 348. Spectrum due to switching – Pipe - 2 Test Specification

14.1.6.5 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 349. Test Condition

14.1.6.6 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.

b. High Band

   (i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

   (ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Short pins 2 and 3 of jumper J3304.
7. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
8. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser

14.1.6.7 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1IZl1a?dl=0

14.1.7 Test Case: Spurious Emissions – Pipe2 (TX_C 2.6)

14.1.7.1 Description

I. 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.

II. Impact of failure of test case on system

Impact	Applicable	Description
Functional	NA	NA
Performance	Yes	Failure to conform with spurious emissions-pipe2 requirement, will cause interference to other users of the spectrum.
Compliance	Yes	Failure to conform with spurious emissions-pipe2 requirement, will cause interference to other users of the spectrum.

Table 350. Impact of Failure – Spurious Emission – Pipe2

III. Test Equipment List

- Power supply(RIGOL DP832 or Equivalent)
- PXIe chassis (M9381A or Equivalent)
- RF cables – 1 no's (SMA male to SMA male)
- 20dB Attenuator
- Pig tail SMA Cables – 1no (One end SMA Female connector and another end open cable)
- Linux PC

14.1.7.2 Test Setup

i. Setup Block diagram

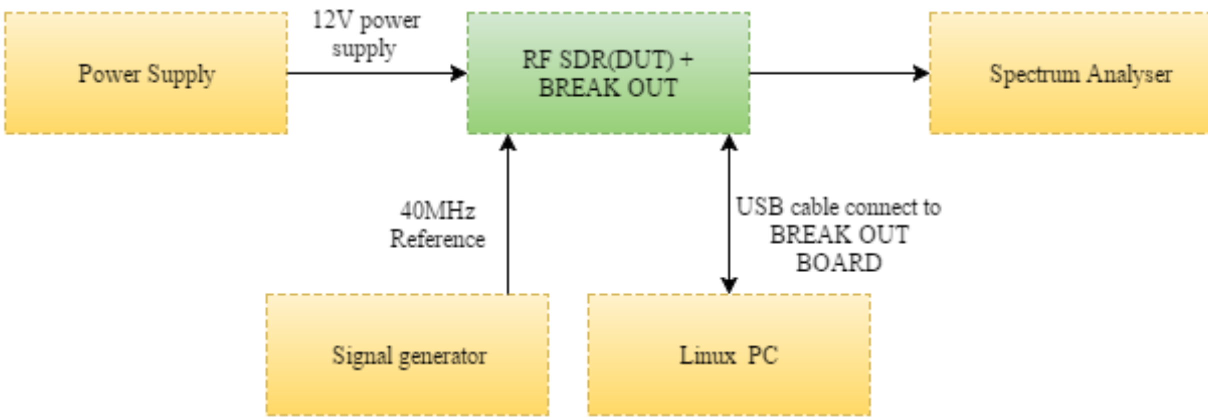

Figure 74. Spurious Emissions – Pipe - 2 Test Setup Block Diagram

ii. Measurement Locations

- Antenna port (J3302).

iii. Equipment Settings

- **Keysight M90XA** series **M9391A** vector signal analyser

Centre Frequency	Same as frequency set in coding.
Span	10MHz
RBW	3KHz
Mode	GSM/EDGE
Timeslot	ON
Burst Sync	RF Amplitude

Table 351. Spectrum Analyser Settings

iv. Software settings

Step1. Running openbsc

- In new terminal go to this path “$ cd openbsc/openbsc/src/osmo-nitb “and hit below command
  $ sudo ./osmo-nitb -c ~/.osmocom/openbsc_config_file -l ~/.osmocom/hlr.sqlite3 -P -C --debug=DRLL:DCC:DMM:DRR:DRSL:DNM to run openbsc.

Step2. Running osmo-bts

- In new terminal go to this path "$ cd osmo-bts/src/osmo-bts-trx "and hit this command "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file "for single chain activation and this for "$ sudo. /osmo-bts-trx -c ~/.osmocom/osmobts_config_file -t 2 "for two chains activation.

  Note: All the configuration files (openbsc_config_file, osmobts_config_file) will be saved in the folder .osmocom

Step3. Running osmo-trx

- In new terminal go to this path "$ cd osmo-trx/Transceiver52M" and hit this command "$ sudo osmo-trx -f 1" for single chain activation and this for "$ sudo osmo-trx -fc 2" for two chains activation.

Changing the config file parameters

- In order to change any parameter stop all the running software's by pressing CTRL+C in the following order:

  1. osmo-trx
  2. osmo-bts
  3. openbsc

- For changing the transmit band, change the band parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter" band GSM<value>", for band value refer to below table.

Band	Value
P-GSM-900	900
DCS-1800	1800

Table 352. Band and corresponding Value

- After changing band parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- For changing the transmit arfcn ,change the arfcn parameter in "openbsc_config_file" In new terminal go to this path "$ cd ~/.osmocom" and enter this command" $ gedit openbsc_config_file" to open config file.
- Now change the parameter"arfcn<space><value>", for arfcn value refer to below table.

Band	Frequency (MHz)			ARFCN		
	B	M	T	B	M	T
P-GSM-900	935.2	947.6	959.8	1	63	124

DCS-1800	1805.2	1842.4	1879.8	512	698	885

Table 353. ARFCN value and corresponding centre frequency

- After changing arfcn parameter save the config file and repeat steps 1, 2 and 3 in the same order.
- Similarly for changing the transmit power change the parameter max_power_red to the desired value in “openbsc_config_file”. In new terminal go to this path “$ cd ~/.osmocom” and enter this command” $ gedit openbsc_config_file” to open config file.
- Now change the parameter max_power_red<space><value>.
- After changing max_power_red parameter save the config file and repeat steps 1, 2 and 3 in the same order.

  Note: for multi trx, arfcn and max_power_red should be modified in multiple places (for each trx 0, trx 1 etc.)

14.1.7.3 Requirements

CH2_900MHZ				
Start Frequency (MHz)	Start Frequency (MHz)	Spec (dBm)	RBW (KHz)	VBW (KHz)
0.1	50	-36	10	30
50	880	-36	3000	9000
880	915	-98	100	100
915	920	-36	100	300
920	923	-36	30	90
925	**960**			
962	965	-36	30	90
965	970	-36	100	300
970	980	-36	300	900
989	990	-36	1000	3000
990	1000	-36	3000	9000
1000	12750	-30	3000	9000

Table 354. Spurious emissions – Pipe - 2 Test Specification

CH2_1800MHZ				
Start Frequency (MHz)	**Start Frequency (MHz)**	**Spec (dBm)**	**RBW (KHz)**	**VBW (KHz)**
0.1	50	-36	10	30
50	1000	-36	3000	9000
1000	1710	-30	3000	9000
1710	1785	-98	100	100
1785	1795	-30	300	900
1795	1800	-30	100	300
1800	1803	-30	30	90
1805	1880			
1882	1885	-30	30	90
1887	1890	-30	100	300
1890	1900	-30	300	900
1900	1910	-30	1000	3000
1910	12750	-30	3000	9000

Table 355. Spurious emissions – Pipe - 2 Test Specification

14.1.7.4 Test Condition

Test condition	Value	Remarks
Frequency	B,M,T	For each band test at Bottom, Middle and top frequencies.
Voltage	12V	Nominal voltage
Temperature	+25 C	Normal Room temperature
Digital attenuator	0dB	Minimum attenuation state
E-GSM-900	-24 dBm	To achieve maximum power at antenna
DCS-1800	-16 dBm	To achieve maximum power at antenna

Table 356. Test Condition

14.1.7.5 Test Procedure

1. Remove IC with reference designator U66 and connect pigtail at fourth pin of IC pad for reference clock input of 40MHz with 3dBm power from signal generator.
2. TX pipe2 side all switches are controlled with three controls named CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS and CH2_RF_BYPASS_CNTL_LVL.
3. All the switches can be controlled with jumper having reference designator J3306.
   a. Low Band
      (i) E-GSM-900: For selecting this band8 pull this control CH2_RF_PASW_CTNL2_LVL_TRNS to high by closing pins 4 and 5 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.
      (ii) GSM-850**:** For selecting this band5 pull this control CH2_RF_BYPASS_CNTL_LVL low to ground by closing pins 8 and 9 of jumper J3306 and other two controls should be pulled high. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to high, short pins 1 and 2 of jumper J3306.Short pins 4 and 5 of jumper J3306 to pull the control CH2_RF_PASW_CTNL2_LVL_TRNS low to high.
   b. High Band
      (i) DCS-1800: For selecting this band3 pull this control CH2_RF_PASW_CTNL1_LVL_TRNS to high by closing pins 1 and 2 of jumper J3306 and other two controls should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306.Short pins 8 and 9 of jumper J3306 to pull the control CH2_RF_BYPASS_CNTL_LVL low to ground.

(ii) PCS-1900: For selecting this band2, all the three controls CH2_RF_PASW_CTNL1_LVL_TRNS, CH2_RF_PASW_CTNL2_LVL_TRNS CH2_RF_BYPASS_CNTL_LVL should be pulled low to ground. In order to pull CH2_RF_PASW_CTNL2_LVL_TRNS to ground, short pins 5 and 6 of jumper J3306. In order to pull CH2_RF_PASW_CTNL1_LVL_TRNS to ground, short pins 2 and 3 of jumper J3306. In order to pull CH2_RF_BYPASS_CNTL_LVL to ground, short pins 8 and 9 of jumper J3306.

4. For power supply, connect BREAKOUT_BOARD and RF_SDR board together and connect positive cable to first pin and ground to second pin of connector with reference designator JP3 on breakout board.
5. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
6. Short pins 2 and 3 of jumper J3304.
7. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
8. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser.

14.1.7.6 Reference

1. Sections 6 of OpenCellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

https://www.dropbox.com/sh/u6cqi0diwnbksgd/AADG-VHbcHhy2uvBMPM1lZl1a?dl=0