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| **OpenCellular - Connect1**  **RF-SDR Test Specifications** | Version 1.0 |
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# 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 Open Cellular 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

# 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

# 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.

## 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

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

#### Description

1. **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.

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

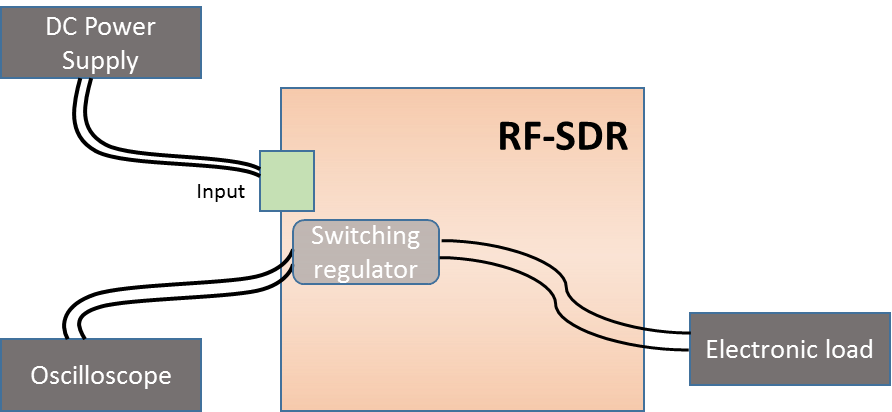
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Figure 1. Voltage accuracy Test Setup Block Diagram

1. **Measurement Locations**

* C3505 (5P7V\_REG\_1), C3518 (5P7V\_REG\_2) and C4005 (3P7V), C3408 (V1P8).

1. **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

1. **Software settings**

NA

#### 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**

#### 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**

#### 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).

1. Isolate output of U3500 by removing R2170 and R2168, and connect electronic load to 5P7V\_REG\_1.
2. Isolate output of U3501 by removing R2157 and R2155, and connect electronic load to 5P7V\_REG\_2.
3. Isolate output of U4000 by removing L3400, R3400, FB6312 and FB6314, and connect electronic load to 3P7V.
4. Vary the voltage in step of ±2% tolerance of nominal 12V.
5. Set Full load (4A) in electronic load.
6. Measure the output voltage at C3505 (5P7V\_REG\_1), C3518 (5P7V\_REG\_2) and C4005 (3P7V) 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.

**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.

#### Reference

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

https://github.com/markhor/OpenCellular

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

#### Description

1. **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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

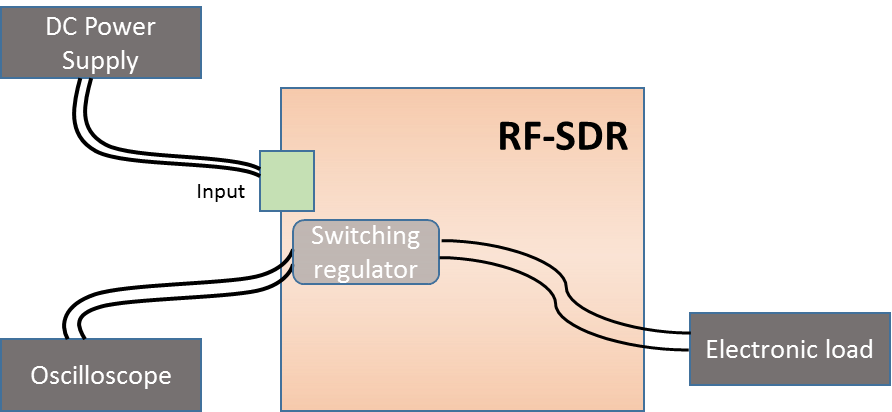
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Figure 2. Load regulation Test Setup Block Diagram

1. **Measurement Locations**

* C3505 (5P7V\_REG\_1), C3518 (5P7V\_REG\_2) and C4005 (3P7V), C3408 (V1P8).

1. **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

1. **Software settings**

NA

#### 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**

#### 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**

#### 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).

1. Isolate output of U3500 by removing R2170 and R2168, and connect electronic load to 5P7V\_REG\_1.
2. Isolate output of U3501 by removing R2157 and R2155, and connect electronic load to 5P7V\_REG\_2.
3. Isolate output of U4000 by removing L3400, R3400, FB6312 and FB6314, and connect electronic load to 3P7V.
4. Set the input to nominal 12V.
5. Vary the load from 1A (min) to 4A (Max) in step of 1A.
6. Using scope measure the output voltages at C3505 (5P7V\_REG\_1), C3518 (5P7V\_REG\_2) and C4005 (3P7V) for various loads.
7. 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.

#### Reference

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

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

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

#### Description

1. **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.

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

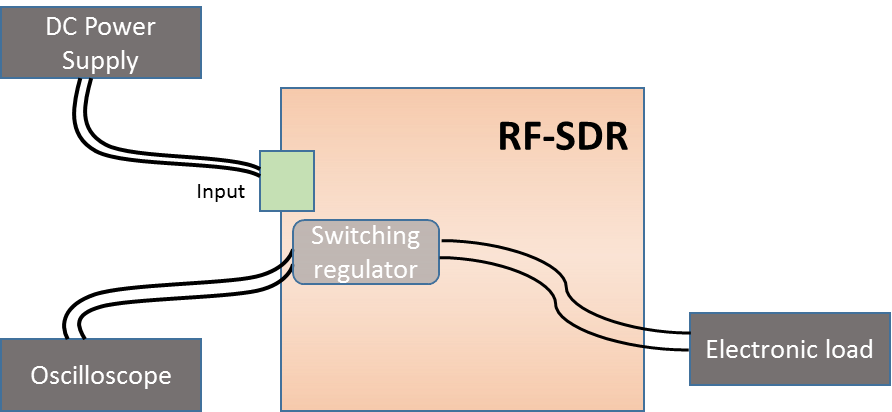
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Figure 3. Line regulation Test Setup Block Diagram

1. **Measurement Locations**

* C3505 (5P7V\_REG\_1), C3518 (5P7V\_REG\_2) and C4005 (3P7V), C3408 (V1P8).

1. **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

1. **Software settings**

NA

#### 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**

#### 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**

#### 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).

1. Isolate output of U3500 by removing R2170 and R2168, and connect electronic load to 5P7V\_REG\_1.
2. Isolate output of U3501 by removing R2157 and R2155, and connect electronic load to 5P7V\_REG\_2.
3. Isolate output of U4000 by removing L3400, R3400, FB6312 and FB6314, and connect electronic load to 3P7V.
4. Vary the voltage settings for voltages in steps of ±2% tolerance of nominal 12V.
5. Vary the load from 1A (min) to 4A (Max) in step of 1A.
6. 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).
7. 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

#### Reference

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

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

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

#### Description

1. **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.

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

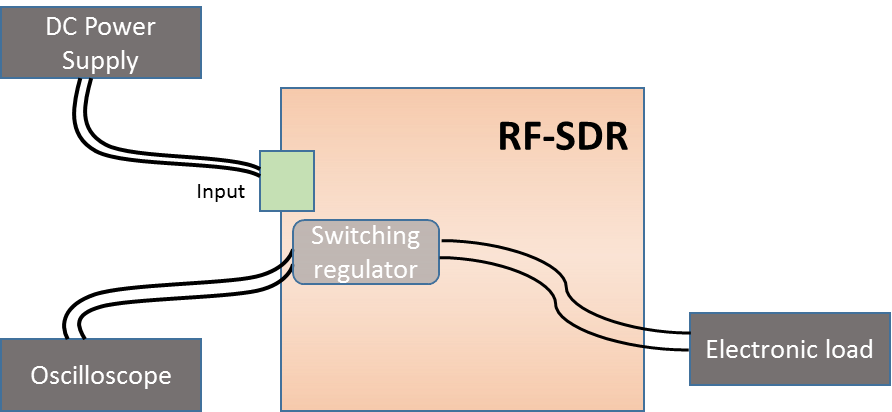
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Figure 4. Ripple noise Test Setup Block Diagram

1. **Measurement Locations**

* C3505 (5P7V\_REG\_1), C3518 (5P7V\_REG\_2) and C4005 (3P7V), C3408 (V1P8).

1. **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)

1. **Software settings**

NA

#### 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**

#### 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**

#### 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).

1. Isolate output of U3500 by removing R2170 and R2168, and connect electronic load to 5P7V\_REG\_1.
2. Isolate output of U3501 by removing R2157 and R2155, and connect electronic load to 5P7V\_REG\_2.
3. Isolate output of U4000 by removing L3400, R3400, FB6312 and FB6314, and connect electronic load to 3P7V.
4. Set the input to nominal 12V.
5. Set 4A (full load) current in electronic load.
6. Using scope measure the ripple voltage at C3505 (5P7V\_REG\_1), C3518 (5P7V\_REG\_2) and C4005 (3P7V).
7. 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.

#### Reference

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

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

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

#### Description

1. **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.

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

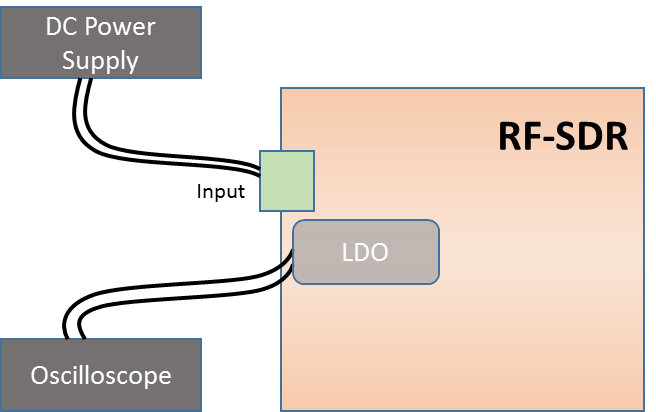
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Figure 5. Voltage accuracy Test Setup Block Diagram

1. **Measurement Locations**

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

1. **Equipment Settings**

* Oscilloscope : MSO9404A

Voltage scale: 1V

* DC power supply : E3633A

Supply Voltage: 12V

Current Limit: 4A

OVP: 13V

OCP: 5A

1. **Software settings**

NA

#### 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**

#### 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**

#### 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.

#### Reference

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

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

### Test Case: Current consumption (pwr1.8)

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (12).png**

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

1. **Measurement Locations**

* U2105, U2104 and U32.

1. **Equipment Setting**

* RIGOL DP832 DC power supply

|  |  |
| --- | --- |
| voltage | 12 V |
| current | 3 A |

**Table 17. DC power supply Settings**

1. **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.)

#### Requirements

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

**Table 20. Current consumption Test Specification**

#### 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**

#### 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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **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, |

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

**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**

1. 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.
2. Once the powered up run the osmo stack and TIVA code on Linux PC. For this refer to software settings section.

#### Reference

1. Sections 9 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

# 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).

## 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

### Test Case: Clock output level (Clk 1.1)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

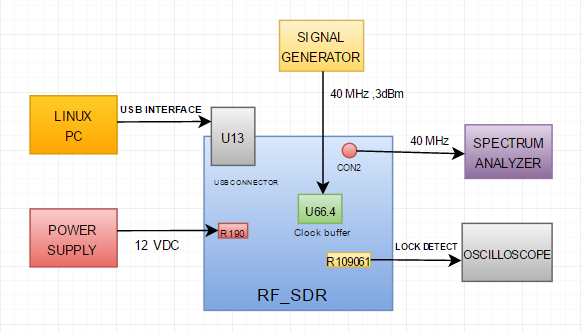


Figure 7. Clock Output Level Test Setup Block Diagram

1. **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

1. **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**

1. **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.

#### Requirements

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

**Table 27. Frequency and Lock detect**

#### Test Condition

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

**Table 28. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

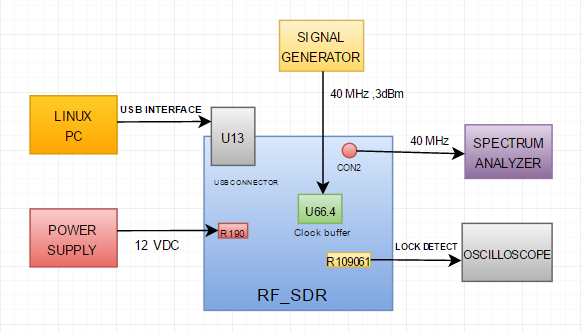


Figure 8. Frequency Accuracy Test Setup Block Diagram

1. **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.

1. **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**

1. **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.

#### Requirements

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

**Table 32. Clock frequency drift**

#### Test Condition

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

**Table 33. Test Condition**

#### 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.

#### Reference

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

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

### Test Case: Phase noise (Clk 1.4)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

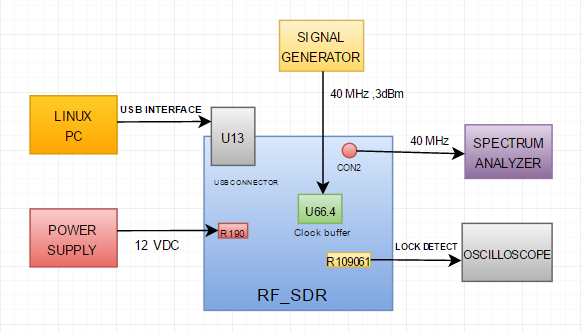


Figure 9. Phase Noise Test Setup Block Diagram

1. **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

1. **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**

1. **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.

#### 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**

#### Test Condition

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

**Table 38. Test Condition**

#### 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).

#### Reference

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

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

### Test Case: Clock lock time (Clk 1.5)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

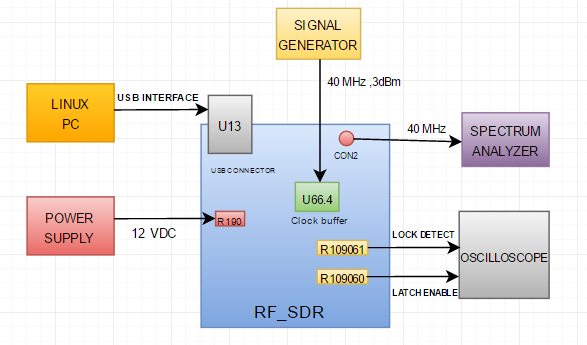


Figure 10. Clock lock time Test Setup Block Diagram

1. **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.

1. **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.

1. **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.

#### Requirements

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

**Table 42. Lock time**

#### Test Condition

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

**Table 43. Test Condition**

#### 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.

#### Reference

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

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

### Test Case: Clock Duty Cycle (Clk 1.6)

#### Description

1. **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.

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

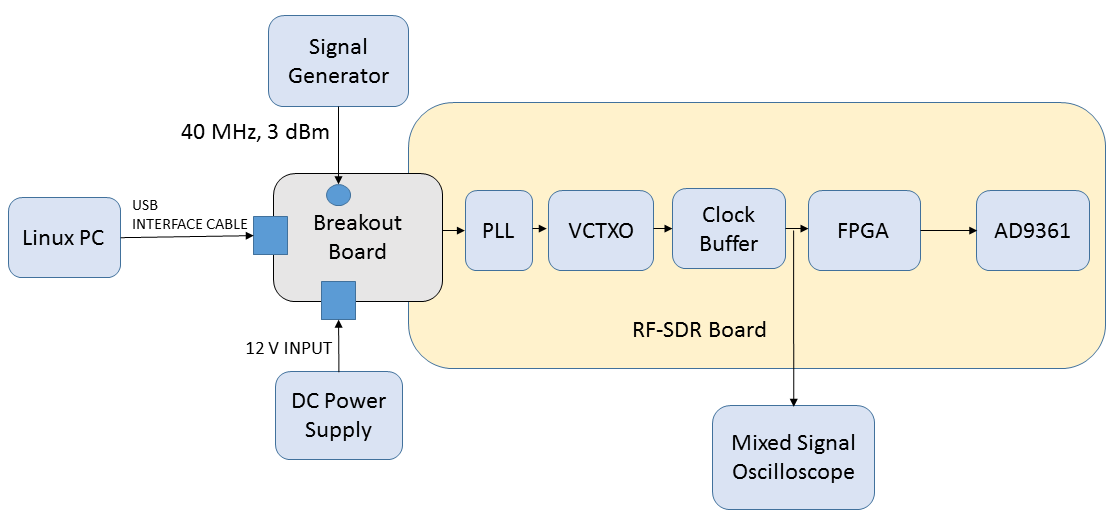


Figure 11. Clock Duty Cycle Test Setup Block Diagram

1. **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

1. **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.

1. **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.

#### Requirements

|  |  |
| --- | --- |
| **Feature** | **Specification** |
| Clock Duty Cycle | >= 25 % |

**Table 23. Clock Duty Cycle Requirement**

#### Test Condition

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

**Table 24. Test Condition**

#### 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.

#### Reference

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

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

### Test Case: Jitter (Clk 1.7)

#### Description

1. **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.

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

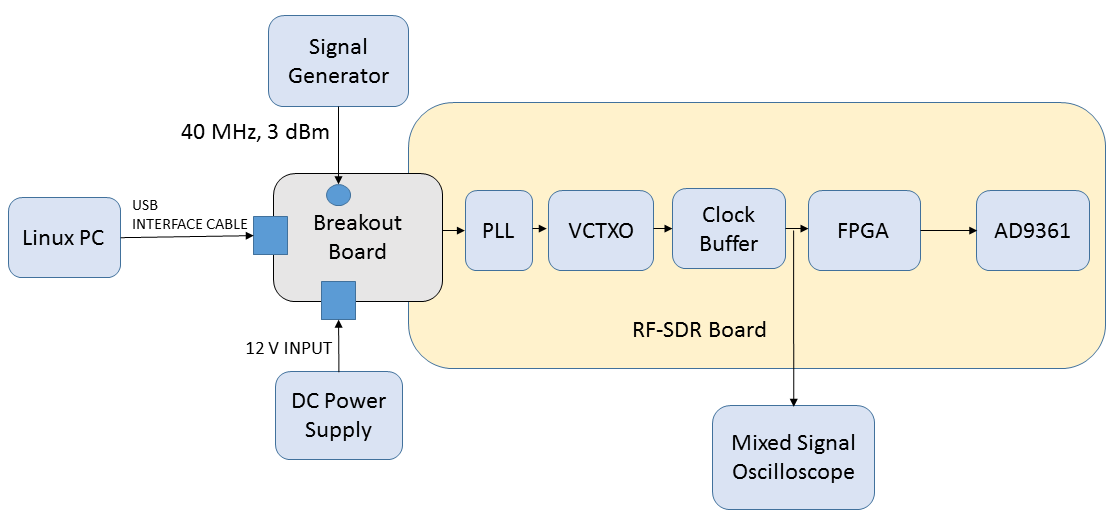


Figure 12. Clock Jitter Test Setup Block Diagram

1. **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

1. **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.

1. **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.

#### Requirements

|  |  |
| --- | --- |
| **Feature** | **Specification** |
| Period Jitter | < 5 ns |

**Table 27. Period Jitter requirement**

#### Test Condition

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

**Table 28. Test Condition**

#### 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.

#### Reference

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

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

### Test Case: Clock Duty Cycle (Clk 1.8)

#### Description

1. **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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

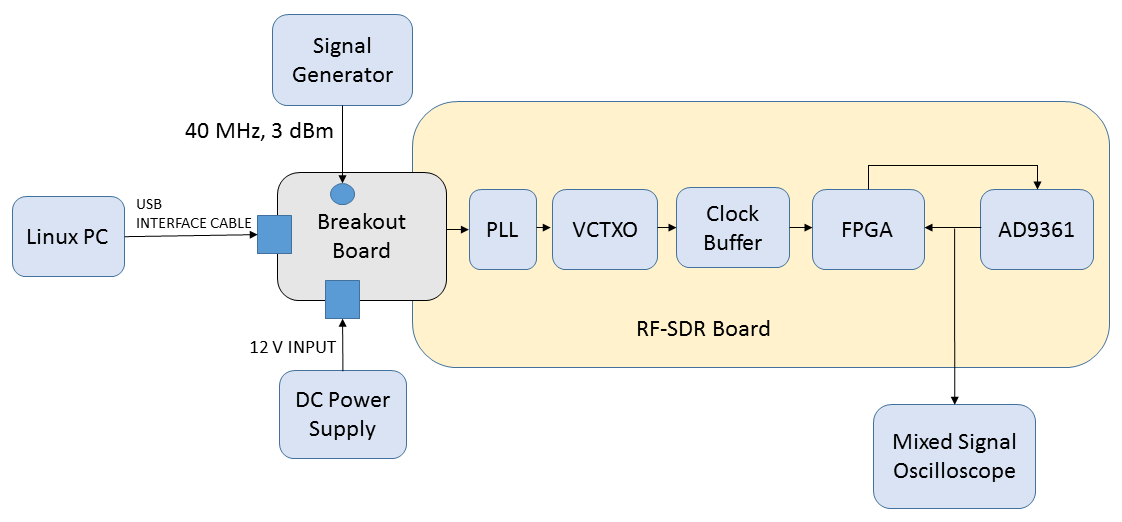
****

Figure 13. Clock Duty Cycle Test Setup Block Diagram

1. **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

1. **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.

1. **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.

#### Requirements

|  |  |
| --- | --- |
| **Feature** | **Specification** |
| Clock Duty Cycle | >= 25 % |

**Table 31. Clock Duty Cycle requirement**

#### Test Condition

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

**Table 32. Test Condition**

#### 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.

#### Reference

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

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

### Test Case: Jitter (Clk 1.9)

#### Description

1. **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.

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

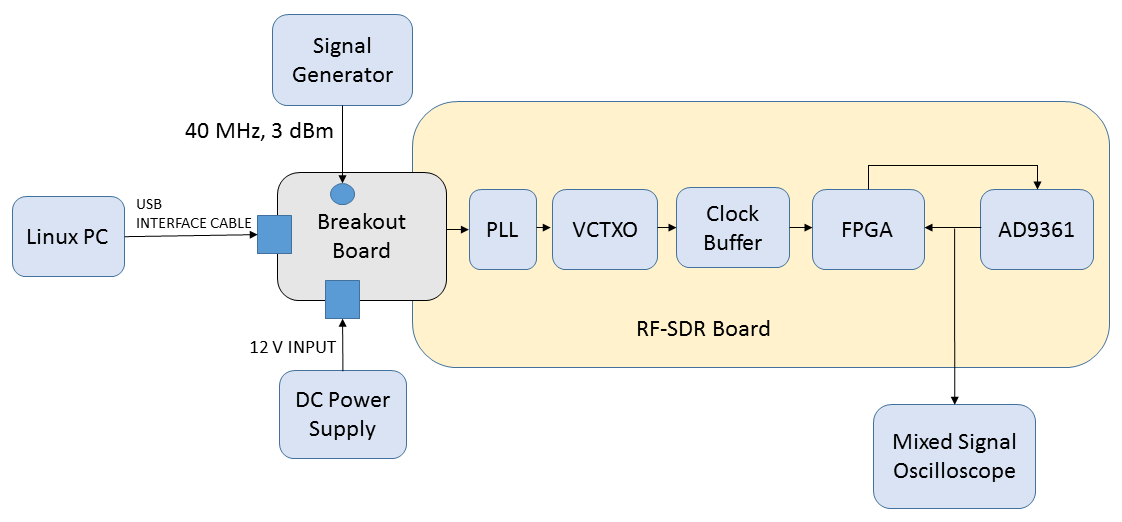
****

Figure 14. Clock Jitter Test Setup Block Diagram

1. **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

1. **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.

1. **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.

#### Requirements

|  |  |
| --- | --- |
| **Feature** | **Specification** |
| Period Jitter | < 5 ns |

**Table 35. Period Jitter requirement**

#### Test Condition

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

**Table 36. Test Condition**

#### 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.

#### Reference

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

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

# 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.

## 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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

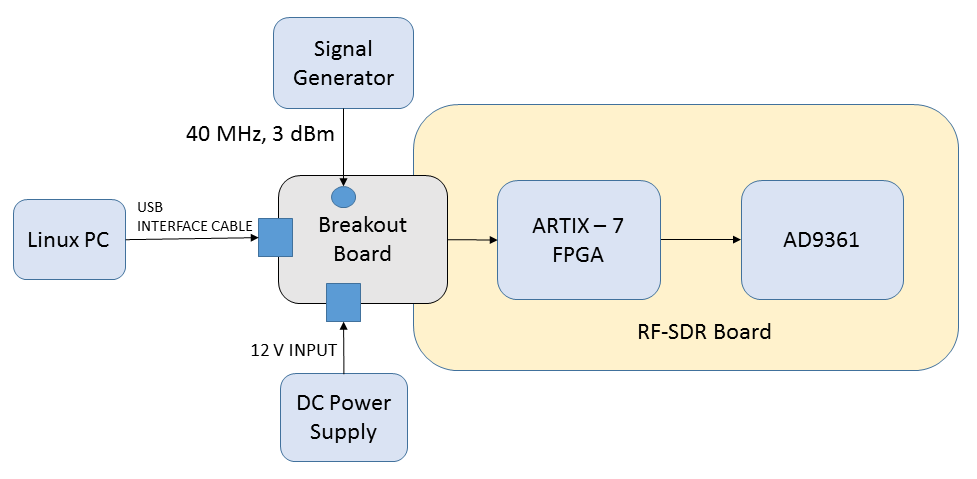
****

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

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12 V

Current Limit: 1 A

OVP: 13V

OCP: 1.5 A

1. **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

#### 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**

#### Test Condition

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

**Table 50. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

* Oscilloscope: MSO9404A
* DC power supply: E3633A

#### Test Setup

1. **Setup Block diagram**

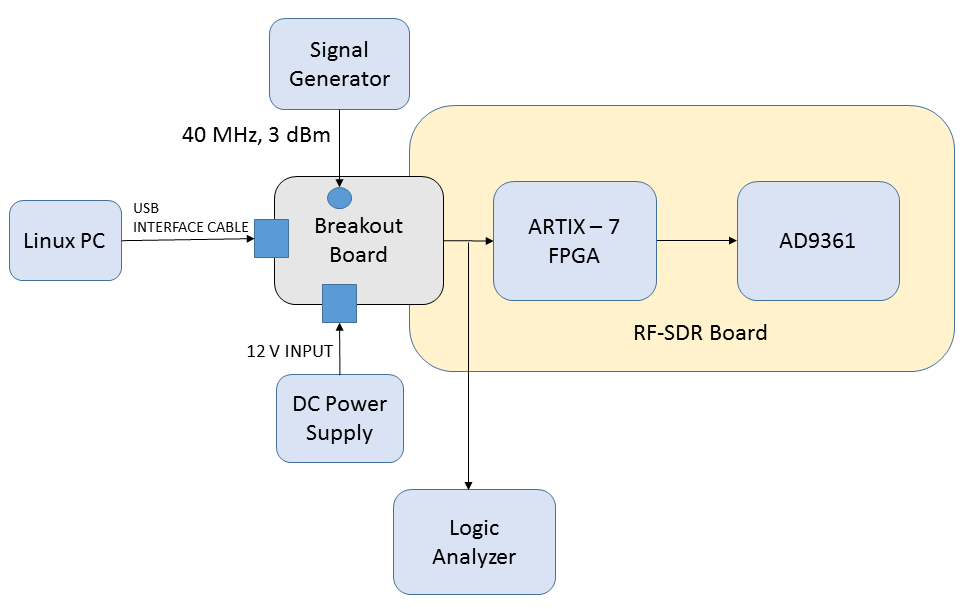


Figure 16*.* Artix – 7 – Power Sequence Test Setup Block Diagram

1. **Measurement Locations**

* C245 (VCCINT+VCCBRAM), C256 (VCCAUX18), C251 (1.8VD\_FPGA), C255 (3.3VD\_FPGA), C276 (1P8V\_FX3), C272(1P2V\_FX3)

1. **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

1. **Test Software settings**

* None

#### 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**

#### Test Condition

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

**Table 53. Test Condition**

#### 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

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

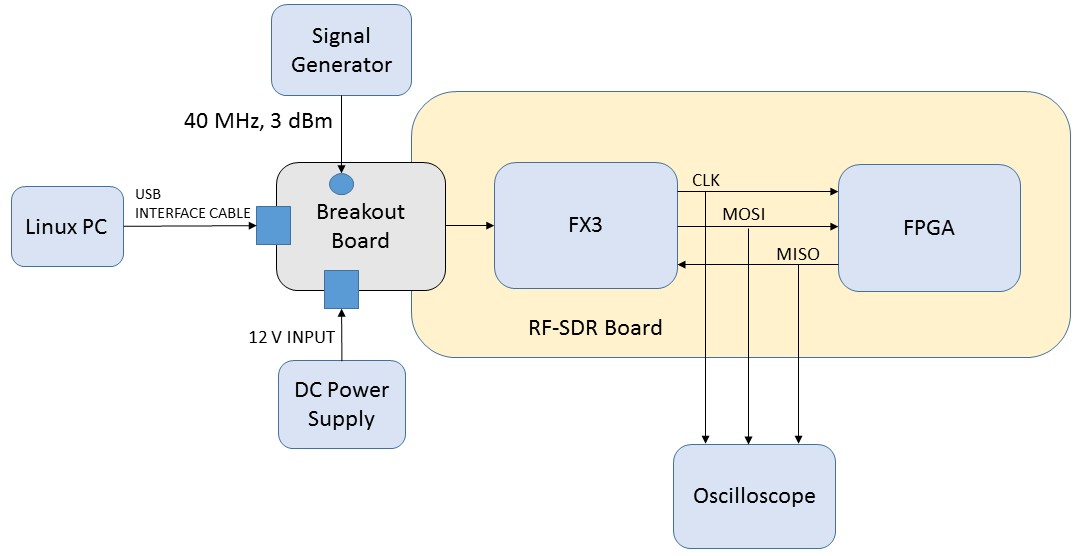
****

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

1. **Measurement Locations**

* U9.V19 (FX3\_SCLK), U9.R22 (FX3\_MOSI)

1. **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

1. **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

#### 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**

#### Test Condition

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

**Table 56. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

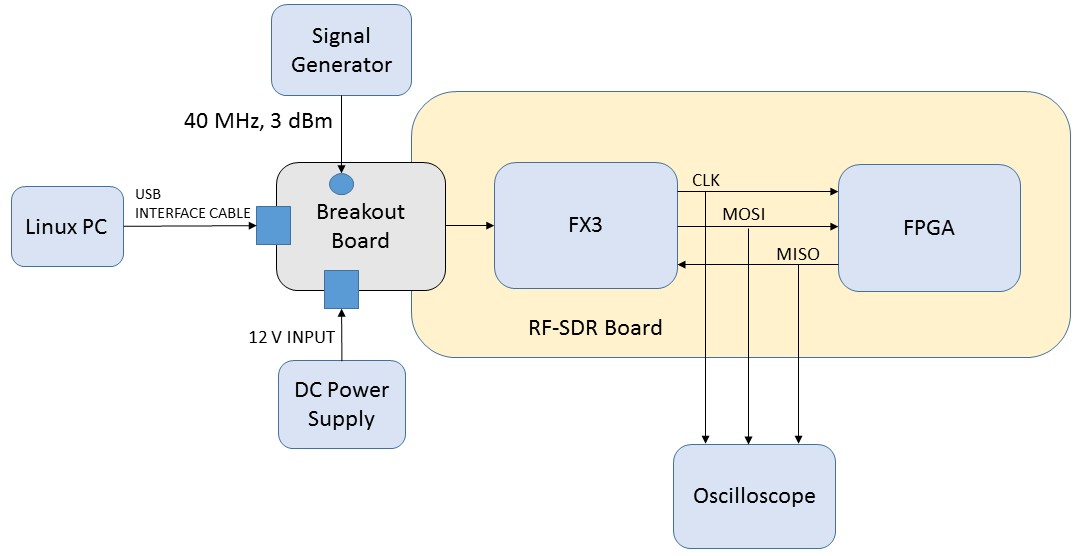
****

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

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12 V

Current Limit: 1 A

OVP: 13V

OCP: 1.5 A

1. **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

#### Requirements

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

**Table 58. FX3 – SPI - FV Test Requirement**

#### Test Condition

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

**Table 59. Test Condition**

#### 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

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

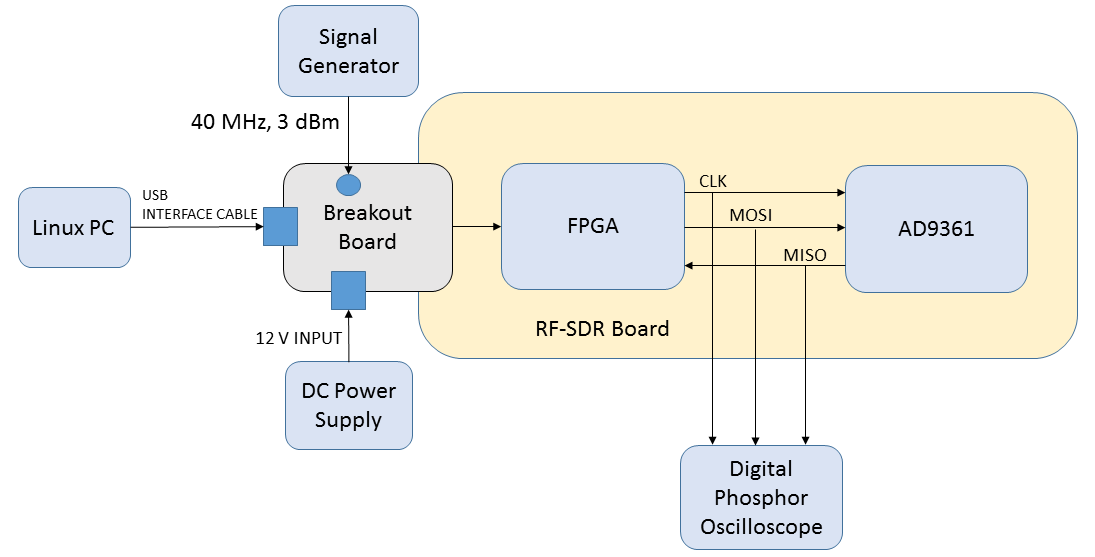
****

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

1. **Measurement Locations**

* U9.C2 (CAT\_SCLK), U9.A1 (CAT\_MOSI), U9.B1 (CAT\_MISO)

1. **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

1. **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.

#### 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**

#### Test Condition

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

**Table 64. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

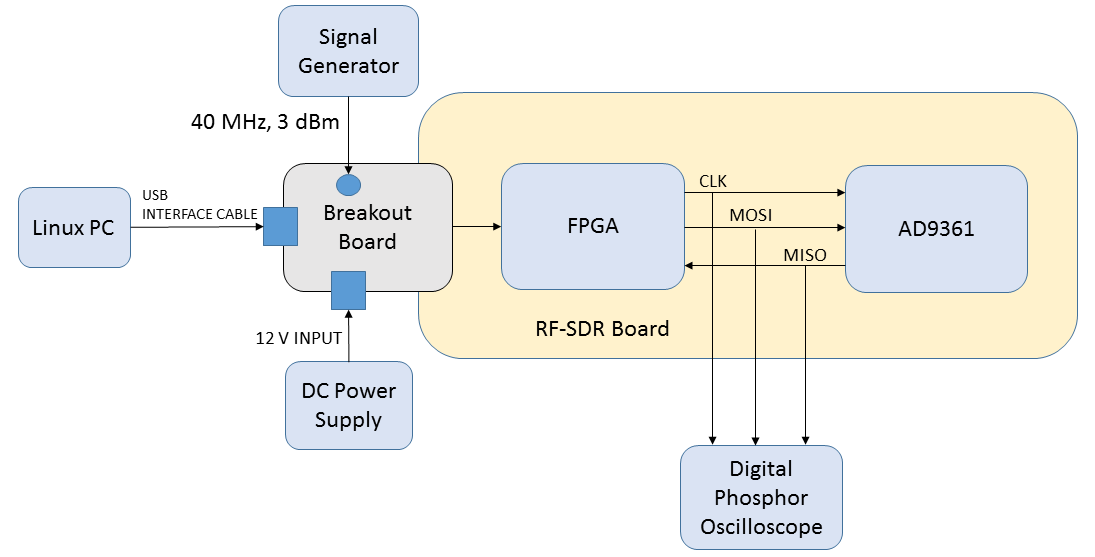
****

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

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12 V

Current Limit: 1 A

OVP: 13V

OCP: 1.5 A

1. **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.

#### 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**

#### Test Condition

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

**Table 67. Test Condition**

#### 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

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

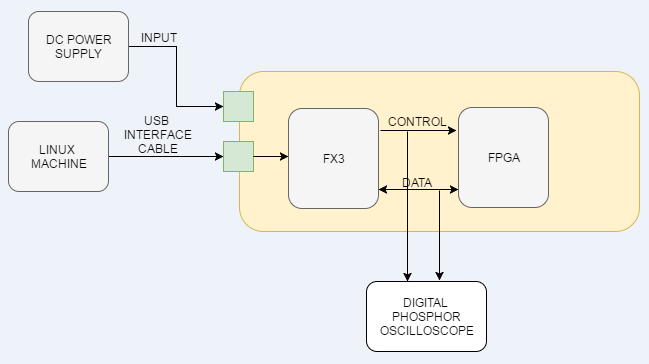
****

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

1. **Measurement Locations**

* U9.G15 (GPIF\_CTL3), U9.G13 (GPIF\_CTL12)

1. **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

1. **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

#### 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**

#### Test Condition

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

**Table 50. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

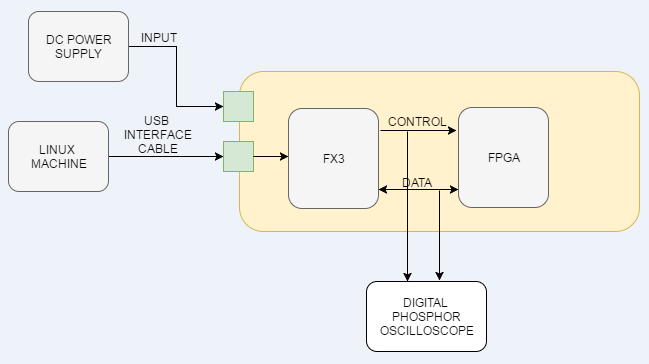
****

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

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12 V

Current Limit: 1 A

OVP: 13V

OCP: 1.5 A

1. **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

#### 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**

#### Test Condition

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

**Table 71. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

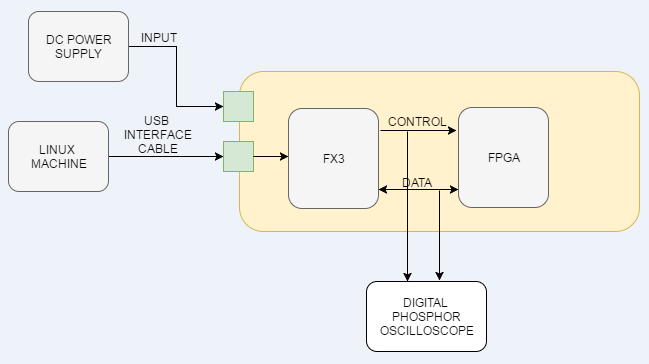
****

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

1. **Measurement Locations**

* U9.K21 (GPIF\_D04), U9.L18 (GPIF\_D19), U9.J17 (GPIF\_D29), U9.L15 (GPIF\_D31)

1. **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

1. **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

#### 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**

#### Test Condition

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

**Table 74. Test Condition**

#### 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
8. Measure the voltage levels, minimum high time, and minimum low time of all the data signals

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

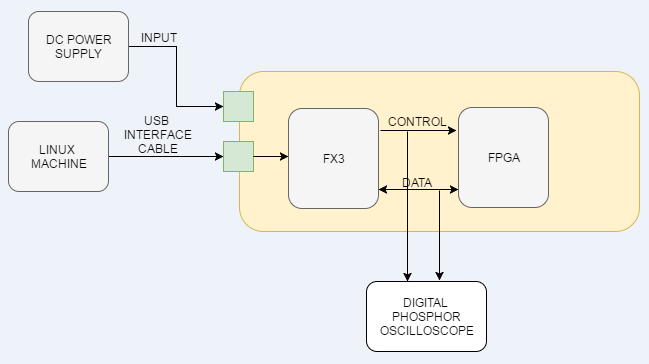
****

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

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12 V

Current Limit: 1 A

OVP: 13V

OCP: 1.5 A

1. **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

#### 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**

#### Test Condition

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

**Table 77. Test Condition**

#### 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

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

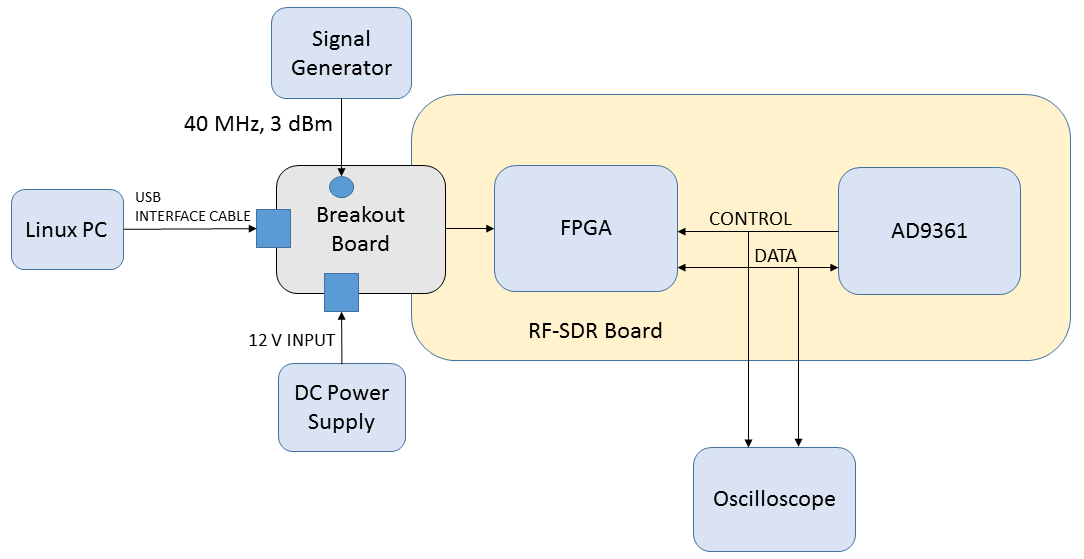
****

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

1. **Measurement Locations**

* U9.U21 (CODEC\_CTRL\_OUT2), U9.P19 (CODEC\_CTRL\_OUT3)

1. **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

1. **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.

#### 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**

#### Test Condition

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

**Table 80. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

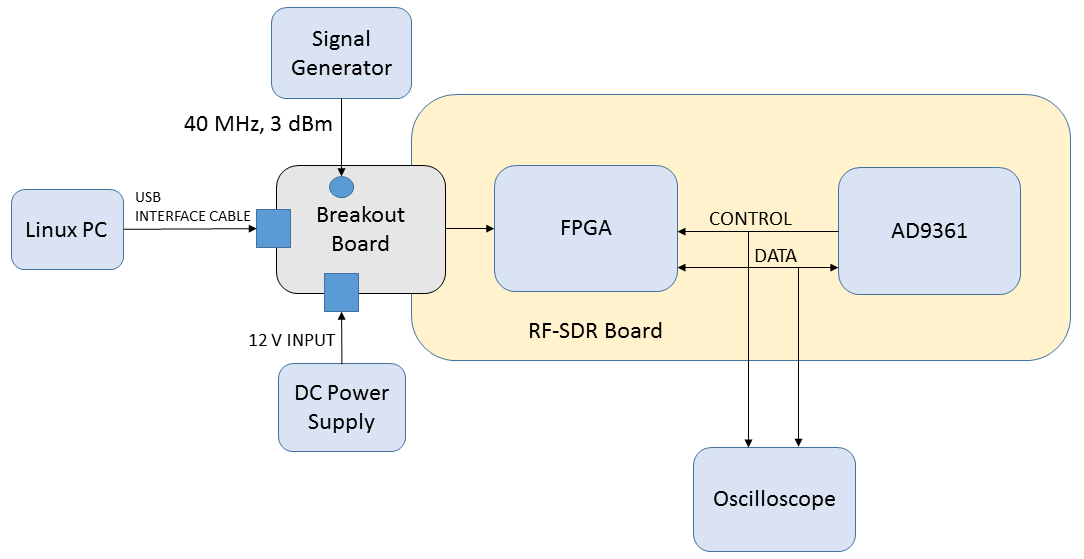
****

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

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12 V

Current Limit: 1 A

OVP: 13V

OCP: 1.5 A

1. **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.

#### 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**

#### Test Condition

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

**Table 83. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

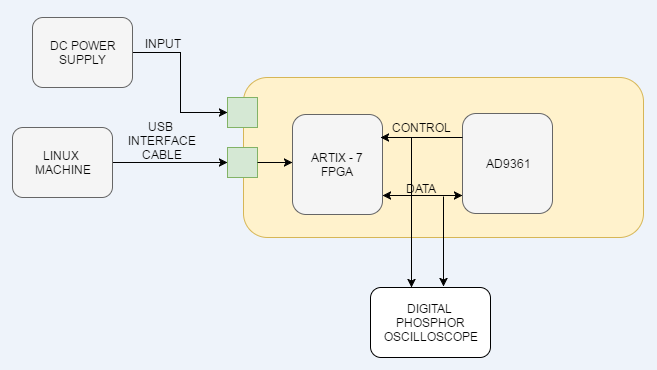
****

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

1. **Measurement Locations**

* U9.AB12 (CODEC\_D1), U9.W12 (CODEC\_D10), U9.AA15 (CODEC\_D18), U9.Y13 (CODEC\_D20)

1. **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

1. **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.

#### 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**

#### Test Condition

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

**Table 86. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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 |  |

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

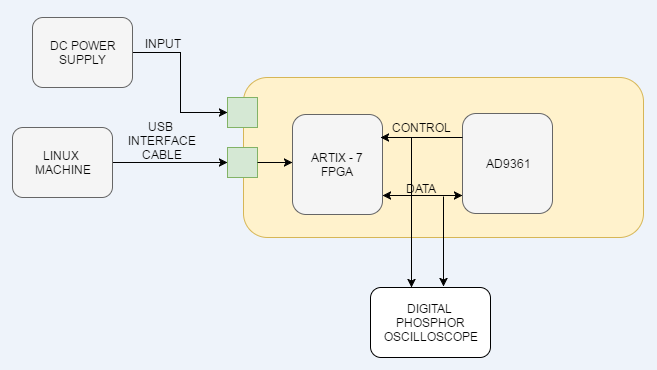
****

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

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12 V

Current Limit: 1 A

OVP: 13V

OCP: 1.5 A

1. **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

#### 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**

#### Test Condition

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

**Table 88. Test Condition**

#### 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

#### Reference

1. Sections 4 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).

Board design documents

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

# 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.

## 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

### Test Case: FX3 – Configuration (FX3 1.1)

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

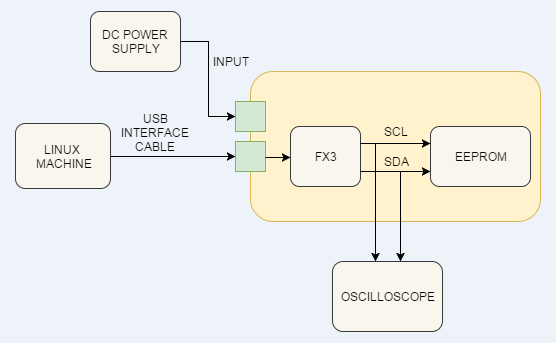


Figure 29. FX3 - Configuration Test Setup Block Diagram

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12 V

Current Limit: 1 A

OVP: 13 V

OCP: 1.5 A

1. **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

#### 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**

#### Test Condition

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

**Table 91. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

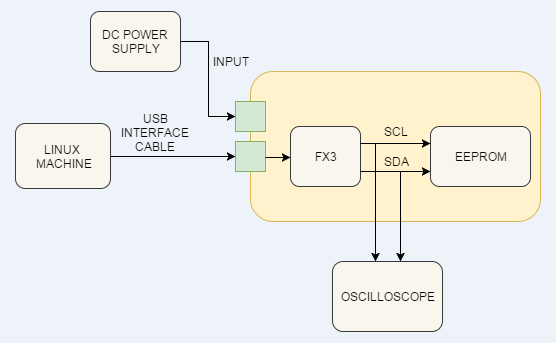


Figure 30. EEPROM – I2C – EV Test Setup Block Diagram

1. **Measurement Locations**

* R61.2 (FX3\_SCL), R60.2 (FX3\_SDA)

1. **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

1. **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

#### 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**

#### Test Condition

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

**Table 94. Test Condition**

#### 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

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

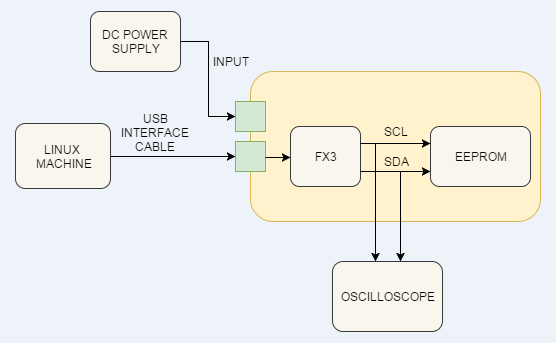


Figure 31. EEPROM – I2C – FV Test Setup Block Diagram

1. **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

1. **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

#### 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**

#### Test Condition

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

**Table 97. Test Condition**

#### 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

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

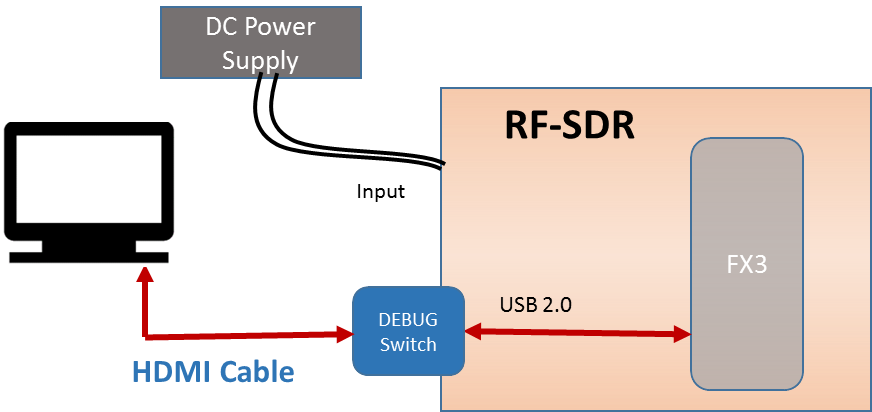
****

Figure 32. USB 2.0 Functional validation Test Setup Block Diagram

1. **Measurement Locations**

NA

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12V

Current Limit: 2A

OVP: 13V

OCP: 2.1A

1. **Software settings**

Install uhd drivers to a Linux PC

#### 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**

#### Test Condition

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

**Table 100. Test Condition**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### Test Equipment List

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

#### Test Setup

1. **Setup Block diagram**

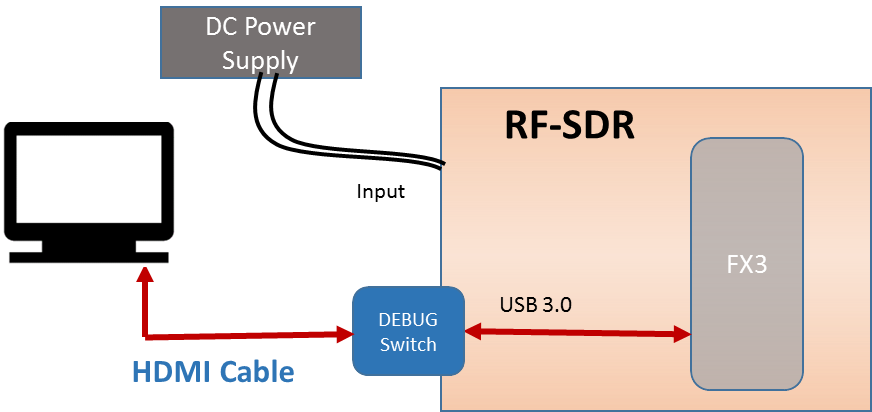
****

Figure 33. USB 3.0 Functional validation Test Setup Block Diagram

1. **Measurement Locations**

NA

1. **Equipment Settings**

* DC power supply : E3633A

Supply Voltage: 12V

Current Limit: 2A

OVP: 13V

OCP: 2.1A

1. **Software settings**

Install uhd drivers to a Linux PC

#### 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**

#### Test Condition

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

**Table 103. Test Condition**

#### 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.

#### Reference

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

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

# 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.

## 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
   1. Adjacent channel power
   2. Spectrum due to switching
7. Receiver sensitivity
8. Maximum Input signal

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

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

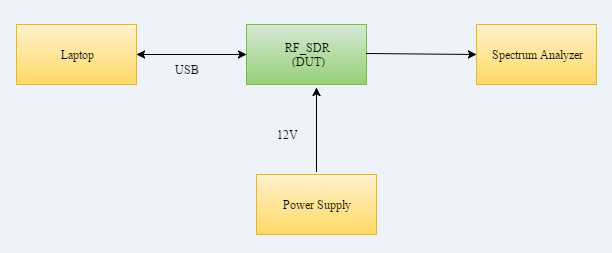


Figure 34. Maximum Output Power– Pipe - 1 Test Setup Block Diagram

1. **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.

1. **Equipment Settings**

* **Keysight 89600** vector signal analyser

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

**Table 105. Spectrum Analyser Settings**

1. **Software settings**
2. For running Transceiver go to this path” $ cd osmo-trx/Trasceiver52M “and hit this command “$ sudo osmo-trx -f 1” in Linux terminal.
3. 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.
4. 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.
5. 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**

1. 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.
2. $ sudo<space>stop<space>openbts
3. $ sudo<space>start<space>openbts
4. $ sudo<space>./OpenBTSCLI
5. 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**

1. 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.
2. $ sudo<space>stop<space>openbts
3. $ sudo<space>start<space>openbts
4. $ sudo<space>./OpenBTSCLI

#### 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**

#### 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**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

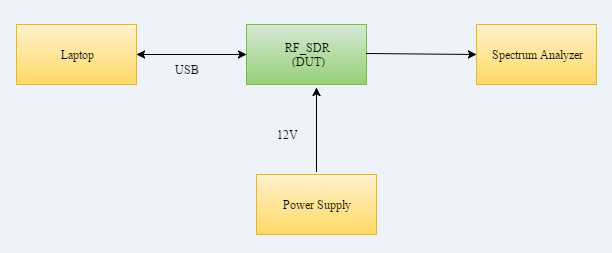


Figure 35. Transmit Power control – Pipe - 1 Test Setup Block Diagram

1. **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.

1. **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**

1. **Software settings**
2. For running Transceiver go to this path” $ cd osmo-trx/Trasceiver52M “and hit this command “$ sudo osmo-trx -f 1” in Linux terminal.
3. 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.
4. Once openbts started running, now here you can change Attenuation dynamically from transceiver with this command “Power <space><value>”.
5. 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**

1. 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.
2. $ sudo<space>stop<space>openbts
3. $ sudo<space>start<space>openbts
4. $ sudo<space>./OpenBTSCLI
5. 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**

1. 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.
2. $ sudo<space>stop<space>openbts
3. $ sudo<space>start<space>openbts
4. $ sudo<space>./OpenBTSCLI

#### 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**

#### 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**

#### 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.

#### Reference

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

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

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

#### Description

1. **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.

1. **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**

1. **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)

#### Test Setup

1. **Setup Block diagram**

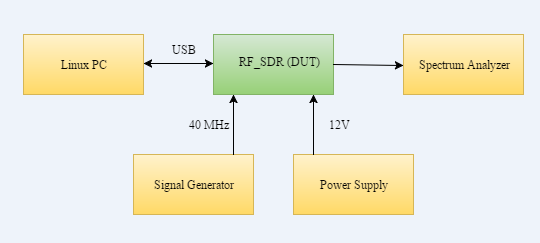


Figure 36. Modulation Accuracy – Pipe - 1 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.

#### Reference

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

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

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

#### Description

1. **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).

1. **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**

#### 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)

#### Test Setup

1. **Setup Block diagram**

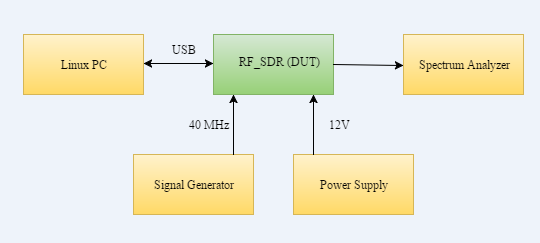


Figure 37. Adjacent channel power – Pipe - 1 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.

#### Reference

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

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

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

#### Description

1. **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.

1. **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**

#### 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)

#### Test Setup

1. **Setup Block diagram**

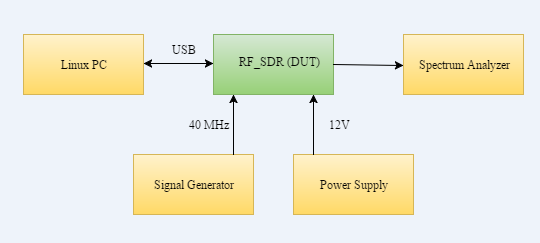


Figure 38. Spectrum due to switching – Pipe - 1 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (11).png**

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

1. **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.

1. **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**

1. **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.)

#### Requirements

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

**Table 144. Carrier leakage** **Pipe - 1Test Specification**

#### 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**

#### 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 (C1511) for TX pipe1 and feed it to Spectrum analyser.

#### Reference

1. Sections 5 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

# 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.

## 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
   1. Adjacent channel power
   2. Spectrum due to switching
7. Receiver sensitivity
8. Maximum Input signal

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

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

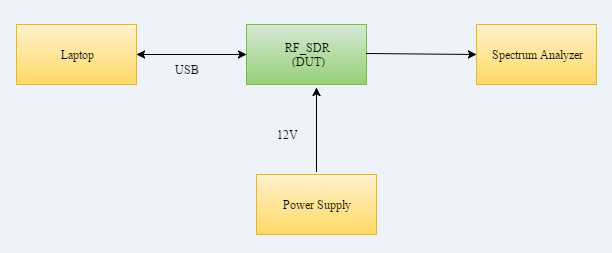


Figure 40. Maximum Output Power– Pipe - 2 Test Setup Block Diagram

1. **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.

1. **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**

1. **Software settings**
2. For running Transceiver go to this path” $ cd osmo-trx/Trasceiver52M “and hit this command “$ sudo osmo-trx -f 1” in Linux terminal.
3. 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.
4. 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.
5. 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**

1. 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.
2. $ sudo<space>stop<space>openbts
3. $ sudo<space>start<space>openbts
4. $ sudo<space>./OpenBTSCLI
5. 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**

1. 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.
2. $ sudo<space>stop<space>openbts
3. $ sudo<space>start<space>openbts
4. $ sudo<space>./OpenBTSCLI

#### 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**

#### 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**

#### 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

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

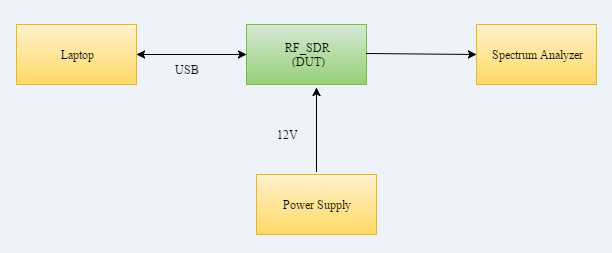


Figure 41. Transmit Power control – Pipe - 2 Test Setup Block Diagram

1. **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.

1. **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**

1. **Software settings**
2. For running Transceiver go to this path” $ cd osmo-trx/Trasceiver52M “and hit this command “$ sudo osmo-trx -f 1” in Linux terminal.
3. 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.
4. Once openbts started running, now here you can change Attenuation dynamically from transceiver with this command “Power <space><value>”.
5. 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**

1. 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.
2. $ sudo<space>stop<space>openbts
3. $ sudo<space>start<space>openbts
4. $ sudo<space>./OpenBTSCLI
5. 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**

1. 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.
2. $ sudo<space>stop<space>openbts
3. $ sudo<space>start<space>openbts
4. $ sudo<space>./OpenBTSCL

#### 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**

#### 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**

#### 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.

#### Reference

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

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

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

#### Description

1. **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.

1. **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**

1. **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)

#### Test Setup

1. **Setup Block diagram**

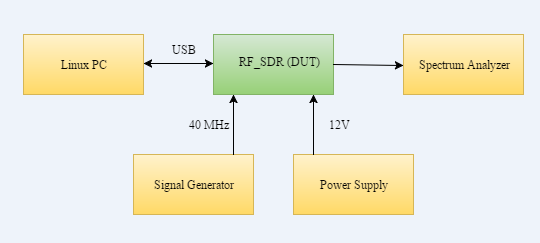


Figure 42. Modulation Accuracy – Pipe - 2 Test Setup Block Diagram

1. **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

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.
7. Collect output at pigtail which is connected at C1512 pad for TX pipe2 and feed it to Spectrum analyser.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

1. **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

#### Test Setup

1. **Setup Block diagram**

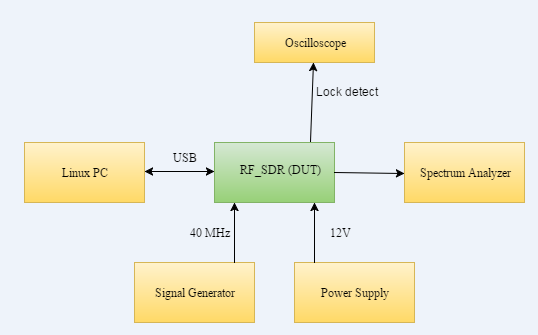


Figure 43. AD9361 LO Lock Detect Test Setup Block Diagram

1. **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.

1. **Equipment Settings**

* **Keysight M9391A** vector signal generator

|  |  |
| --- | --- |
| **Frequency (MHz)** | **Amplitude** |
| 40 | 3 dBm |

**Table 170. Signal Generator Settings**

1. **Software settings**
2. For running Transceiver go to this path” $ cd osmo-trx/Trasceiver52M “and hit this command “$ sudo osmo-trx -f 1” in Linux terminal.

#### 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**

#### Test Condition

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

**Table 172. Test Condition**

#### 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.

#### Reference

1. Sections 5.3 and 9 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

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

#### Description

1. **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).

1. **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**

#### 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)

#### Test Setup

1. **Setup Block diagram**

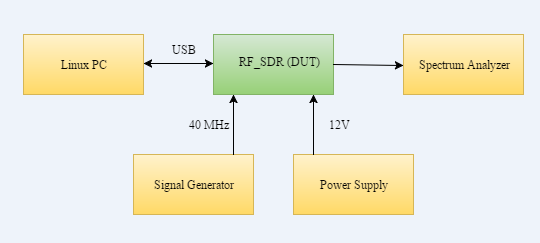


Figure 44. Adjacent channel power – Pipe - 2 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.

#### Reference

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

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

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

#### Description

1. **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.

1. **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**

#### 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)

#### Test Setup

1. **Setup Block diagram**

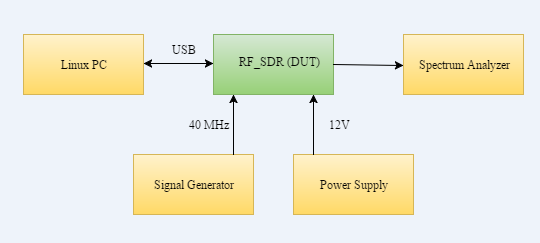


Figure 45. Spectrum due to switching – Pipe - 2 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.

#### Reference

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

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

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

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (11).png**

Figure 46. Carrier leakage – Pipe - 2 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.)

#### Requirements

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

**Table 190. Carrier leakage** **Pipe - 2Test Specification**

#### 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**

#### 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.

#### Reference

1. Sections 5 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

# 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

## 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

### Test Case: Gain – Pipe1 (TX\_P 1.1)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

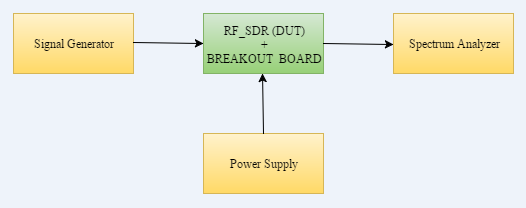


Figure 47*.* TX pipe - 1 GainTest Setup Block Diagram

1. **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.

1. **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**

1. **Test Software settings**

* None

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. 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.
3. 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.

#### Reference

1. Sections 6.1-6.8 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Attenuation and Attenuation step – Pipe1 (TX\_P 1.2 and TX\_P 1.3)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

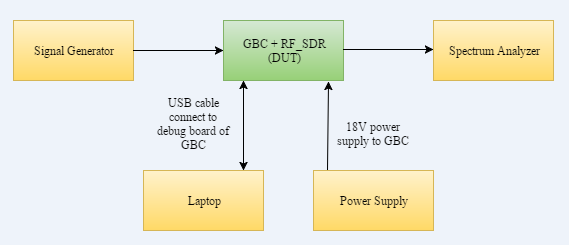


Figure 48*.* Attenuation and Attenuation step – TX-Pipe1 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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

PCS-1900:Forselecting 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.

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4dB comparing to previous displayed value.
7. 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.
8. 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.

#### Reference

1. Sections 7.4 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Output Power – Pipe1 (TX\_P 1.4)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

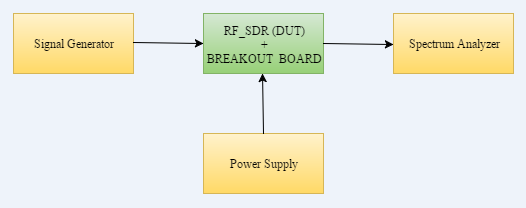


Figure 49. Output power TX pipe - 1 Test Setup Block Diagram

1. **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.

1. **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**

1. **Test Software settings**

* None

#### Requirements

|  |  |  |
| --- | --- | --- |
| **Band** | **Output power (dBm)** | **Remarks** |
| P-GSM-900 | 33 ± 1 |  |
| DCS-1800 | 33 ± 1 |  |

**Table 206. TX pipe - 1 Output Power Test Specification**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. 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.
3. 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.

#### Reference

1. Sections 6.1-6.8 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: RF power detection – Pipe1 (TX\_P 1.5)

#### Description

1. **Purpose**

The purpose of this test case is to verify power detection of TX – Pipe1 (excluding Transceiver AD9361).

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (10).png**

Figure 50*.* Power detection – TX-Pipe1 Test Setup Block Diagram

1. **Measurement Locations**

* Collect output at antenna port J2701 for TX pipe1.

1. **Equipment Settings**

* **Keysight 89600** vector signal analyser.

|  |  |
| --- | --- |
| Centre Frequency | Same as Signal Generator input frequency |
| Span | 10MHz |
| RBW | 3KHz |

**Table 209. Spectrum Analyser Settings**

1. **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.)

#### Requirements



* 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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

PCS-1900:Forselecting 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.

1. 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.
2. 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.
3. 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.
4. Short pin’s 1and 2 of jumpers JP1, JP2 and J3304.
5. Once the board is powered up run the osmostack on Linux pc, for this refer to software settings.
6. Collect output at antenna port J2701 for TX pipe1 and feed it to Spectrum analyser.
7. Now run the TIVA code to read the power detection values.

#### Reference

1. Sections 6.5 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

# 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

## 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

### Test Case: Gain – Pipe2 (TX\_P 2.1)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

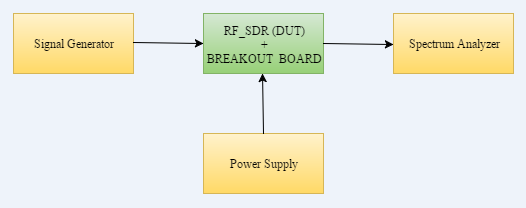


Figure 51. TX pipe - 2 GainTest Setup Block Diagram

1. **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.

1. **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**

1. **Test Software settings**

* None

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. 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.
3. 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.

#### Reference

1. Sections 6.1-6.8 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).

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

### Test Case: Attenuation and Attenuation step – Pipe2 (TX\_P 2.2 and TX\_P 2.3)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

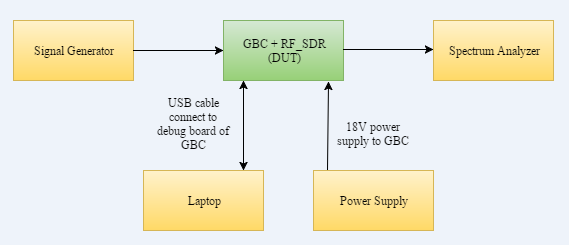


Figure 52*.* Attenuation and Attenuation step – TX-Pipe2 Test Setup Block Diagram

1. **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.

1. **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**

1. **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

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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

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.

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4dB comparing to previous displayed value.
7. 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.
8. 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.

#### Reference

1. Sections 7.4 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Output Power – Pipe2 (TX\_P 2.4)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

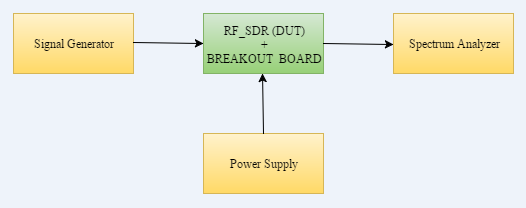


Figure 53. TX pipe - 2 Test Setup Block Diagram

1. **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.

1. **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**

1. **Test Software settings**

* None

#### Requirements

|  |  |  |
| --- | --- | --- |
| **Band** | **Output power (dBm)** | **Remarks** |
| P-GSM-900 | 33 ± 1 |  |
| DCS-1800 | 33 ± 1 |  |

**Table 228. TX pipe 2 Output Power Test Specification**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. 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.
3. 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.

#### Reference

1. Sections 6.1-6.8 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: RF power detection – Pipe2 (TX\_P 2.5)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (10).png**

Figure 54*.* Power detection – TX-Pipe2 Test Setup Block Diagram

1. **Measurement Locations**

* Collect output at antenna port J3302 for TX pipe2.

1. **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**

1. **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.)

#### Requirements



* 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. 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.
3. 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.
4. Short pin’s 1and 2 of jumpers JP1, JP2 and J3304.
5. Once the board is powered up run the osmostack on Linux pc, for this refer to software settings
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.
7. Now run the TIVA code to read the power detection values.

#### Reference

1. Sections 6.5 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

# 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

## 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

### Test Case: Noise Figure and Gain – Pipe1 (RX\_P 1.1 & P 1.2)

#### Description

1. **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).

1. **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**

#### 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)

#### Test Setup

1. **Setup Block diagram**

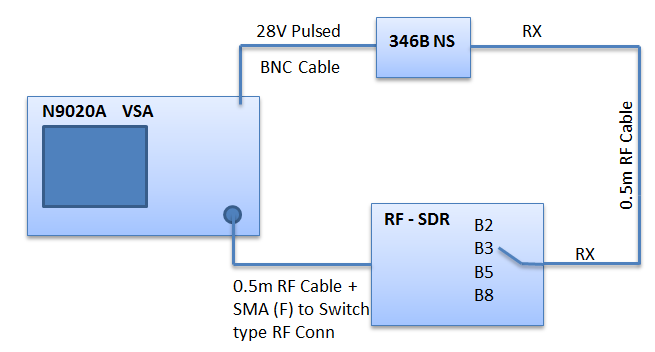
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Figure 55*.* RX pipe - 1 Noise Figure & Gain Test Setup Block Diagram

1. **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.

1. **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**

1. **Test Software settings**

* None

#### 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**

#### 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**

#### 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**

1. 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.
2. 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.
3. Calibrate Noise source as per Band selection. Ensure GSM phones are OFF during tests.
4. Ensure Signal analyser should be in Noise Figure mode and RF 50Ω AC Coupled at Input.
5. From Noise Source, feed signal at Rx Pipe-1 through RF Connector J2701 and collect output at U7117.

#### Reference

1. Sections 7.1-7.7 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Attenuation and Attenuation step – Pipe1 (RX\_P 1.3 and RX\_P 1.4)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

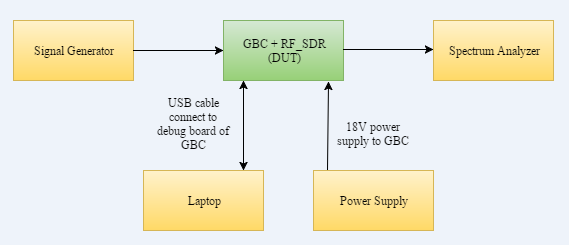


Figure 56*.* Attenuation and Attenuation step – RX-Pipe1 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.

#### 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**

#### 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**

#### 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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **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, |

1. Refer to below table for jumper settings of switch controls.

**Table 249. Chain 1 jumper settings for switch controls**

1. 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.
2. 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.
3. 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.
4. From Signal generator feed signal at antenna port J2701 for RX pipe1 and collect output through pig tail connected at C4409.

#### Reference

1. Sections 7.4 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

# 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

## 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

### Test Case: Noise Figure and Gain – Pipe 2 (RX\_P 2.1 & P 2.2)

#### Description

1. **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).

1. **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**

#### 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)

#### Test Setup

1. **Setup Block diagram**

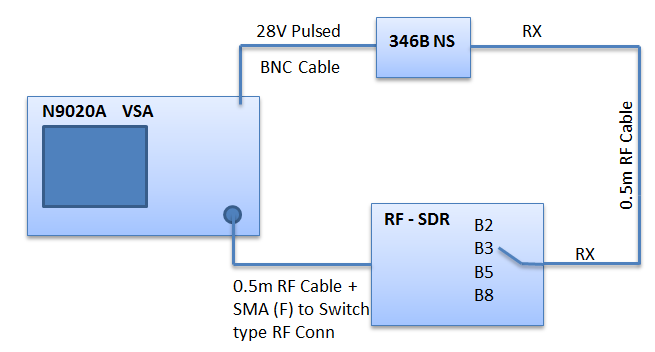
****

Figure 57*.* RX pipe - 2 Noise Figure & Gain Test Setup Block Diagram

1. **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.

1. **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**

1. **Test Software settings**

* None

#### 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**

#### 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**

#### 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**

1. 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.
2. 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.
3. Calibrate Noise source as per Band selection. Ensure GSM phones are OFF during tests.
4. Ensure Signal analyser should be in Noise Figure mode and RF 50Ω AC Coupled at Input.
5. From Noise Source, feed signal at Rx Pipe-2 through RF Connector J3302 and collect output at U7116.

#### Reference

1. Sections 7.1-7.7 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Attenuation and Attenuation step – Pipe1 (RX\_P 2.3 and RX\_P 2.4)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

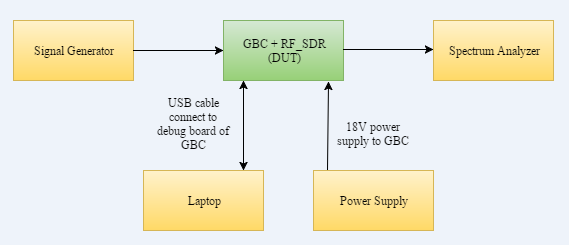


Figure 58*.* Attenuation and Attenuation step – RX-Pipe2 Test Setup Block Diagram

1. **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.

1. **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**

1. **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.

#### 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**

#### 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**

#### 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**

1. 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.
2. 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.
3. 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.
4. From Signal generator feed signal at antenna port J3302 for RX pipe2 and collect output through pig tail connected at C4410.

#### Reference

1. Sections 7.4 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

# 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

## 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
   1. Output power
   2. RF carrier power vs time
2. Static power control
3. Modulation Accuracy
4. Output RF Spectrum
   1. Adjacent channel power
   2. Spectrum due to switching
5. Spurious Emission

### Test Case: Maximum Output Power – Pipe1 (TX\_C 1.2)

#### Description

1. **Purpose**

The purpose of this test case is to check maximum power that is possible from antenna port.

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (11).png**

Figure 59. Maximum Output Power– Pipe - 1 Test Setup Block Diagram

1. **Measurement Locations**

* Measure the output at antenna port connector-J2701

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser.

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: RF Carrier Power vs Time – Pipe1 (TX\_C 1.2)

#### Description

1. **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.

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (11).png**

Figure 60. Power Vs Time– Pipe - 1 Test Setup Block Diagram

1. **Measurement Locations**

* Measure the output at antenna port connector-J2701

1. **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**

1. **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.)

#### Requirements



Figure 61. Power Vs Time– Pipe - 1 test specification

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Static Power Control – Pipe1 (TX\_C 1.3)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

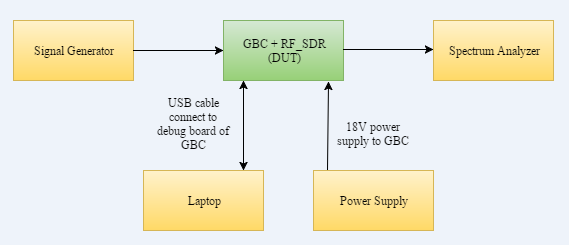


Figure 62. Static Power Control– Pipe - 1 Test Setup Block Diagram

1. **Measurement Locations**

* Measure the output at antenna port connector-J2701

1. **Equipment Settings**

* **Keysight 89600** vector signal analyser

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

**Table 275. Spectrum Analyser Settings**

1. **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

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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

* 1. High Band

DCS-1800: Forselecting 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

PCS-1900:Forselecting 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.

1. 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.
2. 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.
3. 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
4. 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.
5. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4dB comparing to previous displayed value.
6. 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.
7. 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.
8. Measure the output at antenna port connector-J2701 feed it to Spectrum analyser.

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Modulation accuracy– Pipe1 (TX\_C 1.4)

#### Description

1. **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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

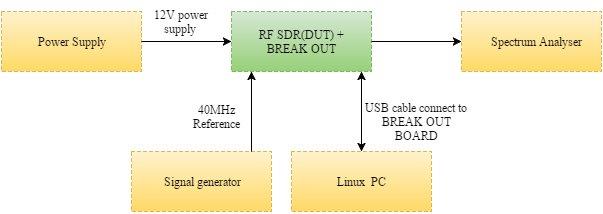
****

Figure 63. Modulation Accuracy – Pipe - 1 Test Setup Block Diagram

1. **Measurement Locations**

* Measure the output at antenna port connector-J2701

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Adjacent Channel Power– Pipe1 (TX\_C 1.5)

#### Description

1. **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).

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

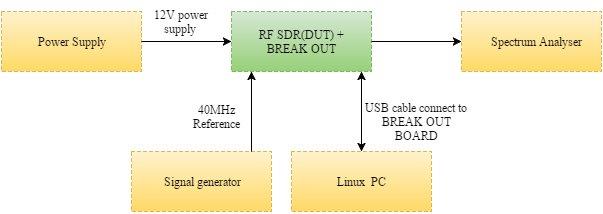
****

Figure 64. Adjacent Channel Power – Pipe - 1 Test Setup Block Diagram

1. **Measurement Locations**

* Measure the output at antenna port connector-J2701

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Spectrum Due To Switching– Pipe1 (TX\_C 1.5)

#### Description

1. **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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

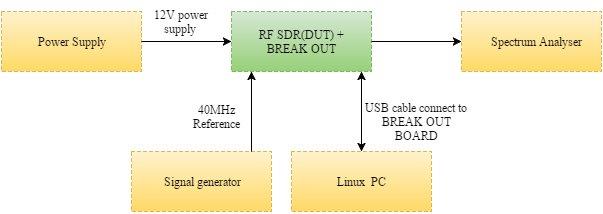
****

Figure 65. Spectrum Due To Switching – Pipe - 1 Test Setup Block Diagram

1. **Measurement Locations**

* Measure the output at antenna port connector-J2701

1. **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**

1. **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)

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Spurious Emissions – Pipe1 (TX\_C 1.6)

#### Description

1. **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.

1. **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**

1. **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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (11).png**

Figure 66. Spurious Emissions – Pipe - 1 Test Setup Block Diagram

1. **Measurement Locations**

* Antenna port (J2701).

1. **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**

1. **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.)

#### Requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CH1\_900MHZ** | | | | |
| **Start Frequency (MHz)** | **Start Frequency (MHz)** | **Spec** | **RBW** | **VBW** |
| **(dBm)** | **(KHz)** | **(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** | **RBW** | **VBW** |
| **(dBm)** | **(KHz)** | **(KHz)** |
| 0.1 | 50 | -36 | 10 | 30 |
| 50 | 1000 | -36 | 3000 | 9000 |
| 1000 | 1710 | -30 | 3000 | 9000 |
| 1710 | 1785 | -98 | 100 | 100 |
| 1785 |  | -30 | 300 | 900 |
| 1795 |  | -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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J2701) for TX pipe1 and feed it to Spectrum analyser.

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

# 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

## 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
   1. Output power
   2. RF carrier power vs time
2. Static power control
3. Modulation Accuracy
4. Output RF Spectrum
   1. Adjacent channel power
   2. Spectrum due to switching
5. Spurious Emission

### Test Case: Maximum Output– Pipe2 (TX\_C 2.2)

#### Description

1. **Purpose**

The purpose of this test case is to check maximum power that is possible from antenna port.

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (11).png**

Figure 67. Maximum Output Power– Pipe - 2 Test Setup Block Diagram

1. **Measurement Locations**

* Antenna port (J3302).

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser.

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: RF Carrier Power Vs Time (TX\_C 2.2)

#### Description

1. **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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (11).png**

Figure 68. Power Vs Time– Pipe - 2 Test Setup Block Diagram

1. **Measurement Locations**

* Antenna port (J3302).

1. **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**

1. **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.)

#### Requirements



Figure 69. Power Vs Time– Pipe - 2 test specification

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. 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

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Static Power Control – Pipe2 (TX\_C 2.3)

#### Description

1. **Purpose**

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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

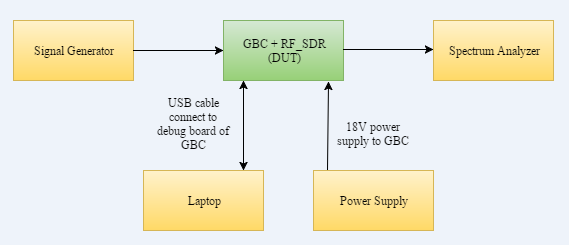


Figure 70. Static Power Control– Pipe - 2 Test Setup Block Diagram

1. **Measurement Locations**

* Antenna port (J3302).

1. **Equipment Settings**

* **Keysight 89600** vector signal analyser

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

**Table 322. Spectrum Analyser Settings**

1. **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

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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

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.

1. 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.
2. 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.
3. 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.
4. 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.
5. After doing above mentioned code changes, now check in spectrum analyser whether power got reduced by an amount 4dB comparing to previous displayed value.
6. 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.
7. 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.
8. Measure output at Antenna port (J3302) feed it to Spectrum analyser.

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Modulation accuracy – Pipe2 (TX\_C 2.4)

#### Description

1. **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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

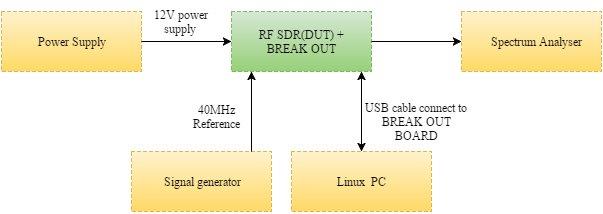
****

Figure 71. Modulation Accuracy – Pipe - 2 Test Setup Block Diagram

1. **Measurement Locations**

* Antenna port (J3302).

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Adjacent Channel Power – Pipe2 (TX\_C 2.5)

#### Description

1. **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).

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

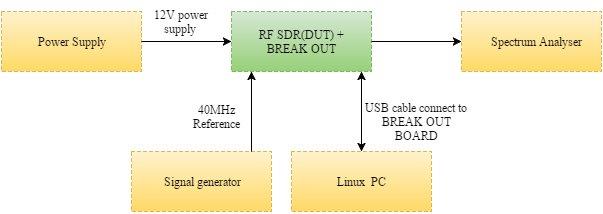
****

Figure 72. Adjacent Channel Power – Pipe - 2 Test Setup Block Diagram

1. **Measurement Locations**

* Antenna port (J3302).

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Spectrum Due To Switching– Pipe2 (TX\_C 2.5)

#### Description

1. **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

1. **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**

#### 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

#### Test Setup

1. **Setup Block diagram**

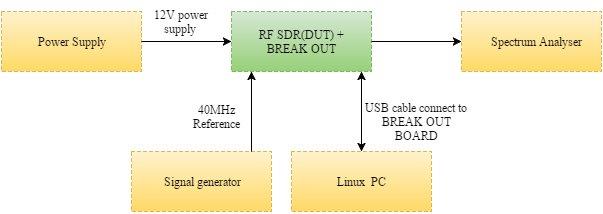
****

Figure 73. Spectrum Due To Switching – Pipe - 2 Test Setup Block Diagram

1. **Measurement Locations**

* Antenna port (J3302).

1. **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**

1. **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.)

#### 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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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

### Test Case: Spurious Emissions – Pipe2 (TX\_C 2.6)

#### Description

1. **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.

1. **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**

1. **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

#### Test Setup

1. **Setup Block diagram**

**C:\Users\gur39558\Desktop\Untitled Diagram (11).png**

Figure 74. Spurious Emissions – Pipe - 2 Test Setup Block Diagram

1. **Measurement Locations**

* Antenna port (J3302).

1. **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**

1. **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.)

#### Requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CH2\_900MHZ** | | | | |
| **Start Frequency (MHz)** | **Start Frequency (MHz)** | **Spec** | **RBW** | **VBW** |
| **(dBm)** | **(KHz)** | **(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** | **RBW** | **VBW** |
| **(dBm)** | **(KHz)** | **(KHz)** |
| 0.1 | 50 | -36 | 10 | 30 |
| 50 | 1000 | -36 | 3000 | 9000 |
| 1000 | 1710 | -30 | 3000 | 9000 |
| 1710 | 1785 | -98 | 100 | 100 |
| 1785 |  | -30 | 300 | 900 |
| 1795 |  | -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**

#### 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**

#### 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.
   1. Low Band

E-GSM-900: Forselecting 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.

GSM-850**:** Forselecting 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.

* 1. High Band

DCS-1800: Forselecting 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.

PCS-1900:Forselecting 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.

1. 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.
2. From signal generator generate clock of 40MHz with 3dBm power and feed it to pigtail, which we connected at IC pad of U66.
3. Short pins 2 and 3 of jumper J3304.
4. Once the board is powered up run the software in Linux PC, for this refer to software settings section.
5. Collect output at antenna port (J3302) for TX pipe2 and feed it to Spectrum analyser.

#### Reference

1. Sections 6 of Open Cellular – Connect1 RF-SDR Design Document (v0.1).
2. Board design documents

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