W-CDMA Base Station Transmitter Tests

According to TS25.141 Rel. 10

Application Note

Products:

- R&S®FSW
- R&S®FSQ
- R&S®FSV
- R&S®FPS
- R&S®SMW200A
- R&S®SMU200A
- R&S®SMJ100A

3GPP TS25.141 [1] defines conformance tests for W-CDMA base stations (including HSPA+ features).

This application note describes how transmitter (Tx) tests (TS25.141 Chapter 6) can be performed quickly and easily by using signal and spectrum analyzers from Rohde & Schwarz. A few tests additionally require vector signal generators from Rohde & Schwarz.

Example illustrates manual operation. A free software program enables and demonstrates remote operation.

The W-CDMA base station receiver (Rx) tests (TS25.141 Chapter 7) are described in Application Note 1MA114.

ROHDE&SCHWARZ

Application Note

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10.2014 – 1MA67_6e

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The following abbreviations are used in this Application Note for Rohde & Schwarz test equipment:

- The R&S®SMW200A vector signal generator is referred to as the SMW.
- The R&S®SMATE200A vector signal generator is referred to as the SMATE
- The R&S®SMU200A vector signal generator is referred to as the SMU.
- The R&S®SMBV100A vector signal generator is referred to as the SMBV.
- The R&S®FSQ signal analyzer is referred to as the FSQ.
- The R&S®FSV spectrum analyzer is referred to as the FSV.
- The R&S®FSW spectrum analyzer is referred to as the FSW.
- The R&S®FPS spectrum analyzer is referred to as the FPS.
- The SMW, SMATE, SMBV and SMU are referred to as the SMx.
- The FSQ, FSV, FSW and FPS are referred to as the FSx.

1 Introduction

The Wide band code division multiple access (W-CDMA) was first introduced in 3GPP Release 99/4 considering the growing demand for higher capacity and improved data rate. Since then, it has gone through a long process of evolution to ensure high quality experience for customers and maintain market competition.

Table 1-1 gives a brief overview of the evolution of W-CDMA with 3GPP releases.

Evolution of W-CDMA	
3GPP Release	**Main Features**
Rel-99/4	W-CDMA
Rel-5	HSDPA
Rel-6	HSUPA
Rel-7	▪ Downlink MIMO ▪ 16 QAM for Uplink and 64 QAM for Downlink
Rel-8	▪ Combination of MIMO and 64 QAM ▪ Dual cell HSDPA
Rel-9	▪ Dual cell HSUPA ▪ Dual band HSDPA ▪ Dual Cell HSDPA + MIMO
Rel-10	Four carrier HSDPA

Table 1-1: Evolution of W-CDMA from 3GPP release 99/4 to release 10

3GPP specification TS 25.141 describes the conformance tests for W-CDMA base stations operating in FDD mode. It includes transmitter (Tx), receiver (Rx) and performance (Px) tests.

This application note describes the transmitter tests for W-CDMA base station in according to TS25.141 Release 10. All of these tests can be performed using Rohde & Schwarz test and measurement instruments. Table 1-2 gives an overview of the transmitter tests defined according to Release 10 of TS25.141.

Covered Tx tests	
Chapter (TS25.141)	**Test name**
6.2 Base station output power	
6.2.1	Base station maximum output power
6.2.2	Primary CPICH power accuracy
6.2.3	Secondary CPICH power offset accuracy
6.3 Frequency Error	
6.4 Output Power Dynamics	
6.4.1	Inner loop power control
6.4.2	Power control steps
6.4.3	Power control dynamic range
6.4.4	Total power dynamic range
6.4.6	Home base station output power for adjacent channel protection
6.5 Output RF Spectrum emissions	
6.5.1	Occupied bandwidth
6.5.2	Out of band emission
6.5.3	Spurious emissions
6.6 Transmit Intermodulation	
6.7 Transmit modulation	
6.7.1	Error vector magnitude
6.7.2	Peak code domain error
6.7.3	Time alignment Error
6.7.4	Relative code domain error

Table 1-2: Covered Tx tests

2 General Transmitter Test Information

2.1 Note

Very high power occurs on base stations! Be sure to use suitable attenuators in order to prevent damage to the test equipment.

2.2 Transmitter Test Setup

Basic setup for Tx test

Fig. 2-1 shows the basic setup for the Tx tests. An FSx is used to perform the tests. An attenuator connects the FSx to the DUT. In several tests, the SMx feeds an additional signal via a circulator. One test (Time alignment error (Clause 6.7.3)) requires a special setup which is described in the respective section.

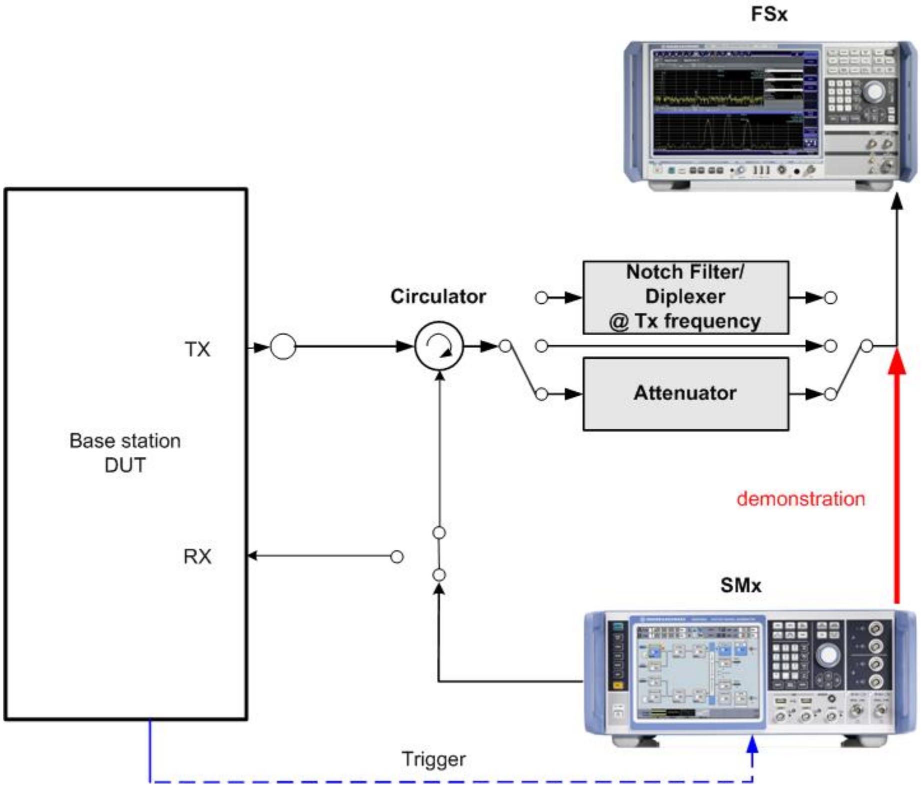


Fig. 2-1: Basic Measuring system Set-up for Tx test; some tests require special setups

An external trigger is additionally required for some tests (such as Power control steps (Clause 6.4.2)) to synchronize the frame timing of the base station and the SMx. The base station shall provide a frame trigger that starts the generator. The Trigger can be the start of a frame number (SFN) or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

2.3 Instrument and Options

Several different spectrum analyzers can be used for the tests described here:

- FSW
- FSQ
- FSV
- FPS

The **W-CDMA measurements** software option is available for each of the listed analyzers. **FSx-K72/** is needed for 3GPP FDD transmitter tests.

Several tests require additional signals, for example to generate an adjacent carrier. These are provided via a vector signal generator. The followings are suitable:

- SMW
- SMU
- SMJ
- SMATE

SMx-K42/-K83 software is required for the 3GPP FDD signal generation.

Please note that the SMBV is able to generate W-CDMA signals but does not support the test case wizard described in this application note.

3 Transmitter Tests (Chapter 6)

TS25.141 specifies various frequency channels (bottom (B), Middle (M) and Top (T)) of the operation bands for the BS test. Most of the tests shall be performed in all of B, M and T frequencies unless mentioned otherwise in the test. All the tests shall be performed with maximum power unless otherwise stated.

The center frequency can be set to any frequency within the supported range using Rohde & Schwarz instruments.

Different test models represent 3GPP specified channel settings and resource allocation in order to allow comparisons among tests. Table 3-1 shows the frequency channels and the test models used for individual tests.

Basic Parameter Overview						
Chapter (TS25.141)	**Chapter AppNote**	**Name**	**Test models**	**Channels**	**Instruments**	**Comment**
6.2	**3.2**	**Base station output power**				
6.2.1	3.2.1	Base station maximum output power	TM1	B,M,T	FSx	
6.2.2	3.2.2	Primary CPICH power accuracy	TM2	B,M,T	FSx	
6.2.3	3.2.3	Secondary CPICH power offset accuracy	TM2	B,M,T	FSx	MIMO only
6.3	**3.3**	**Frequency Error**	Tested with 6.7.1 (clause 3.7.1)			
6.4	**3.4**	**Output Power Dynamics**				
6.4.2	3.4.2	Power control steps	TM2	B,M,T	FSx, SMx	
6.4.3	3.4.3	Power control dynamic range	TM1, TM2	B,M,T	FSx	
6.4.4	3.4.4	Total power dynamic range	Tested with 6.7.1 (clause 3.7.1)			
6.4.6	3.4.6	Home base station output power for adjacent channel protection	TM1	M	FSx, SMx	
6.5	**3.5**	**Output RF Spectrum emissions**				
6.5.1	3.5.1	Occupied bandwidth	TM1	B,M,T	FSx	
6.5.2	3.5.2	Out of band emission			FSx	
6.5.2.1	3.5.2.1	Spectrum emission mask	TM1	B, M, T	FSx	
6.5.2.2	3.5.2.2	Adjacent Channel Leakage power Ratio (ACLR)	TM1	B, M, T	FSx	
6.5.3	3.5.3	Spurious emissions	TM1	B,M,T	FSx	
6.6	**3.6**	**Transmit Intermodulation**	TM1	B,M,T	FSx, SMx	
6.7	**3.7**	**Transmit modulation**				
6.7.1	3.7.1	Error vector magnitude	TM1, TM4, TM5	B,M,T	FSx	TM5 for 16 QAM only
6.7.2	3.7.2	Peak code domain error	TM3	B,M,T	FSx	
6.7.3	3.7.3	Time alignment Error	TM1	M	FSx	Tx diversity, MIMO, DC-HSDPA, DB-DC-HSDPA, or 4C-HSDPA and their combinations only
6.7.4	3.7.4	Relative code domain error	TM6	B,M,T	FSx	64 QAM only

Table 3-1: Overview of the basic parameters

3.1 Basic Operation

3.1.1 FSx Spectrum and Signal Analyzer

Most of the tests follow the initial steps described below. Please refer to [2] for further details.

1. Launch the W-CDMA test application:

   a) FSW, FSV: Press the hardkey **Mode** and select the **3G FDD BTS** for downlink /forward transmission

   b) FSQ: Navigate through the lower hardkey **menu bar**. Select **3G FDD BTS**

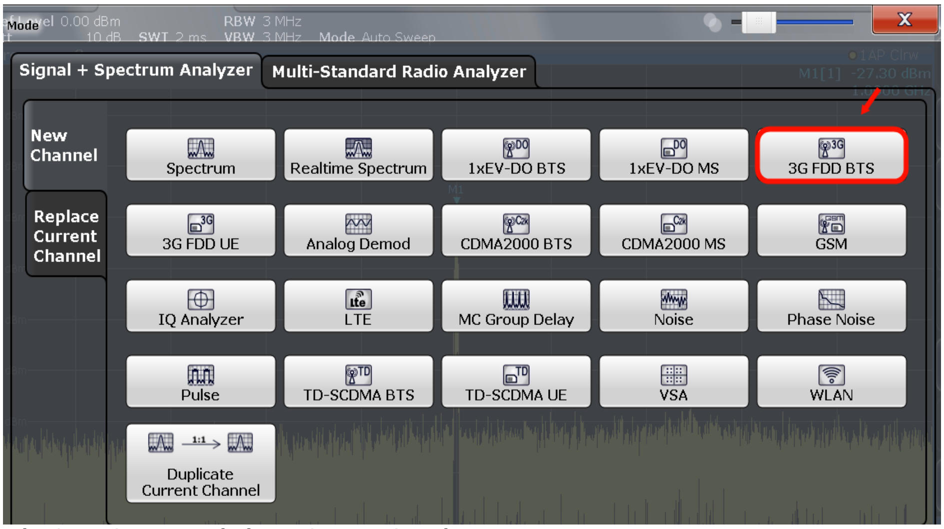


Fig. 3-1: FSW: Launch the W-CDMA BS option

Tx tests can be fundamentally divided into two types:

a) **Demodulation measurement**- the WCDMA signal is acquired and then various test results are calculated based on the I/Q data.

b) **Spectrum measurement**- determines the level versus frequency of a selected signal.

2. Set the analyzer frequency (via hardkey **FREQ)**

3. Set the attenuation and reference level (these settings are available via hardkey **AMPT**)

FSx automatically detects the test model used by the BS and displays results. The **Code Domain Power** evaluation shows the power of all the code channels used by the BS.

Fig. 3-2 shows the W-CDMA demodulation measurement in the FSW as an example.

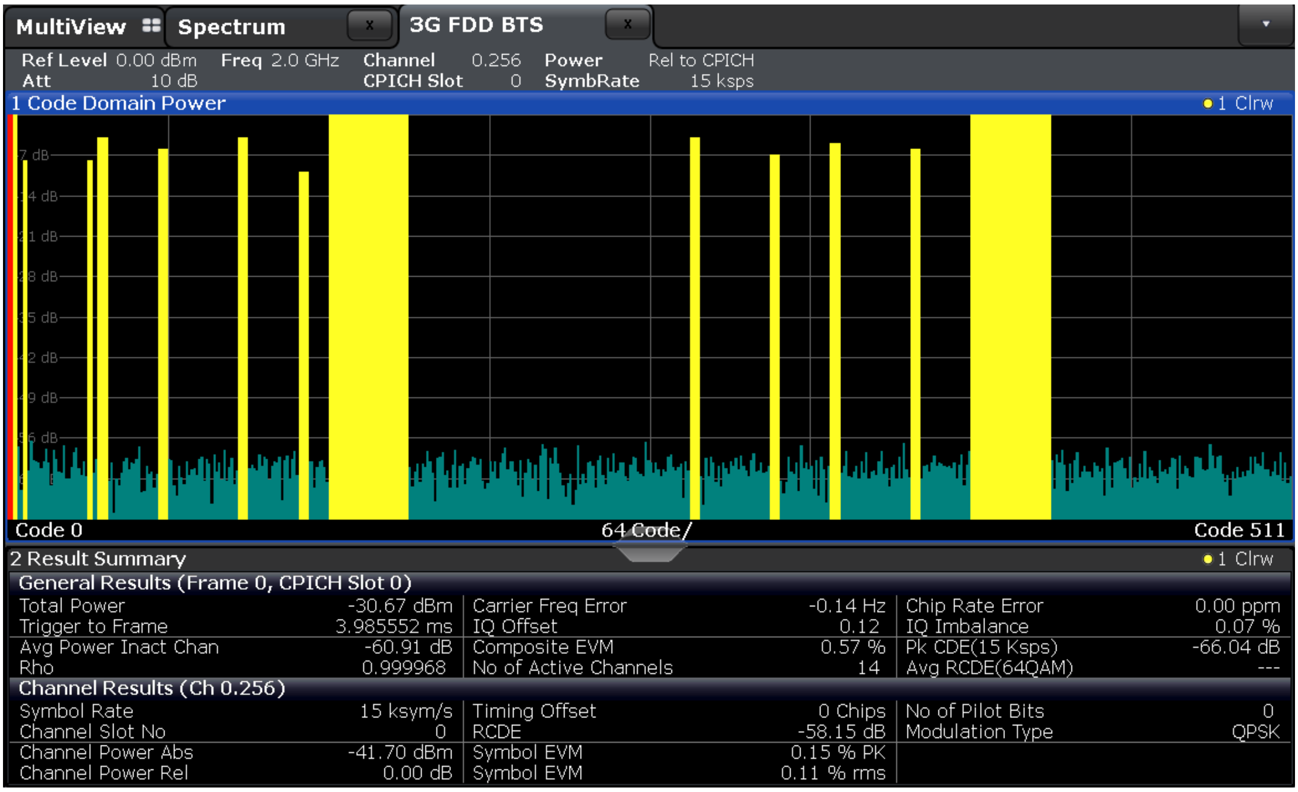


Fig. 3-2: W-CDMA overview in the FSW: Code Domain Power shows power for all transmitted code channels (upper half); the measurement results are summarized in scalar form under Result Summary

4. To show results for an individual code channel, click **Evaluation Range** and set the appropriate channel number (**Channel Ch.Sf**).

The analyzer automatically detects the spreading factor. Change the **Slot** number (0 to 14) to show results for that slot.

Fig. 3-3: FSW: Select Code Channel via evaluation range. Example: code channel 120. Spreading factor 128 is detected automatically by the analyzer. Slot number 0 is shown.

5. Press **Scrambling Code** and set the same code and format used by the BS.

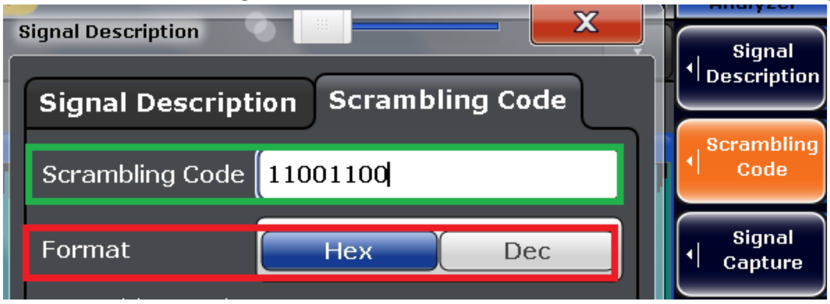


Fig. 3-4: FSW: set the Scrambling code and code format as the same as used by BS

3.1.2 SMx Vector Signal Generator

The SMx is used to generate additional signals, such as interferers, adjacent or co-channel signals for some of the tests. Only the basic steps for W-CDMA are discussed here. Please refer to [3] for further details.

1. Set the center frequency and level (via hardkey **FREQ** and **Lev**)

Fig. 3-5: SMW: set the frequency and level

2. Select the W-CDMA standard (**3GPP FDD**) in Baseband block A

Fig. 3-6: SMW: select W-CDMA in the baseband block

3. Set the **Link Direction** to Downlink/Forward.

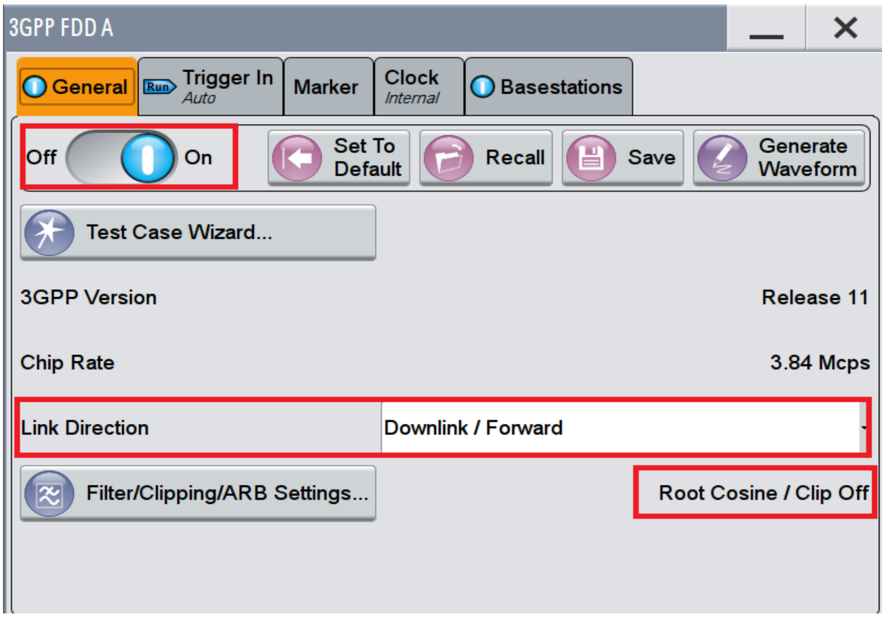


Fig. 3-7: SMW: general W-CDMA setting: link direction

4. Different test models with various numbers of channels can be selected from the **Test Setups/Models** section. Always use the largest number of channels that can be supported by the BS.

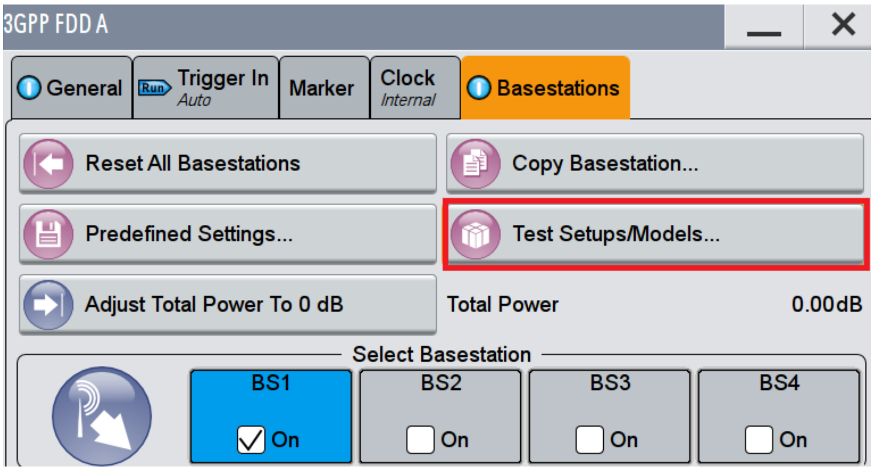


Fig. 3-8: SMW: select W-CDMA Test Setup/Models

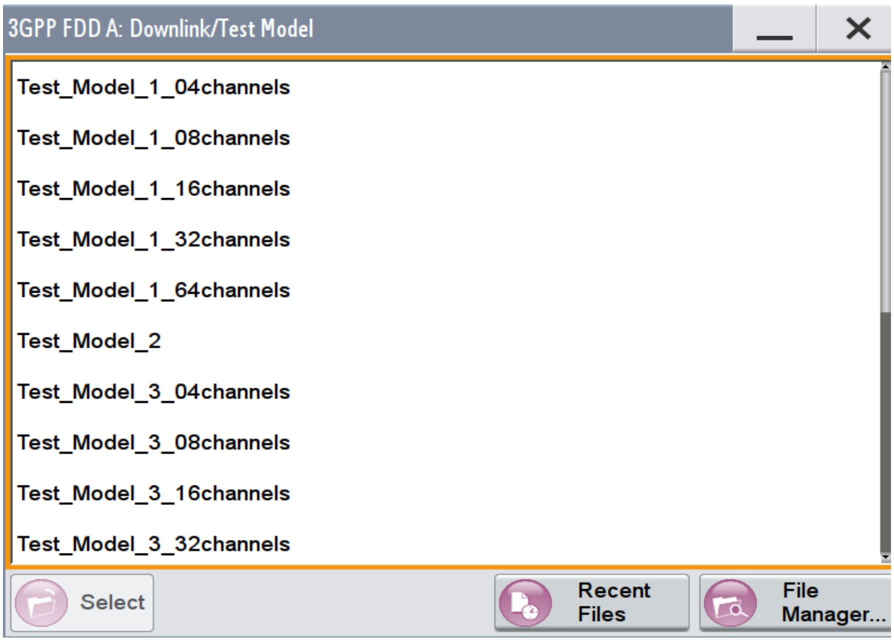


Fig. 3-9: SMW: select W-CDMA Test Model from the list.

5. Click on **BS1** (default)
6. Set the **Scrambling Code**

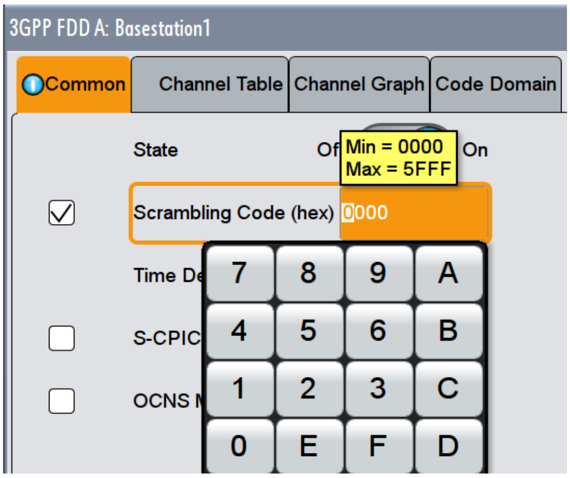


Fig. 3-10: SMW: set the Scrambling Code

7. Select the trigger **Mode** under “Trigger In” section. (Fig. 3-11)
   - Select **Auto** for continuous signal generation without any external trigger.
   - Select **Armed Auto** for continuous signal generation with the external trigger event.
8. Select the trigger **Source**. (Fig. 3-12)

   The SMW provides the option to configure the trigger connectors according to the user preference. Select **Global Connector Settings** and change the connector setting according to preference. Use the **find** function to display the location of the selected connector. Fig. 3-13 shows the default connector mapping.

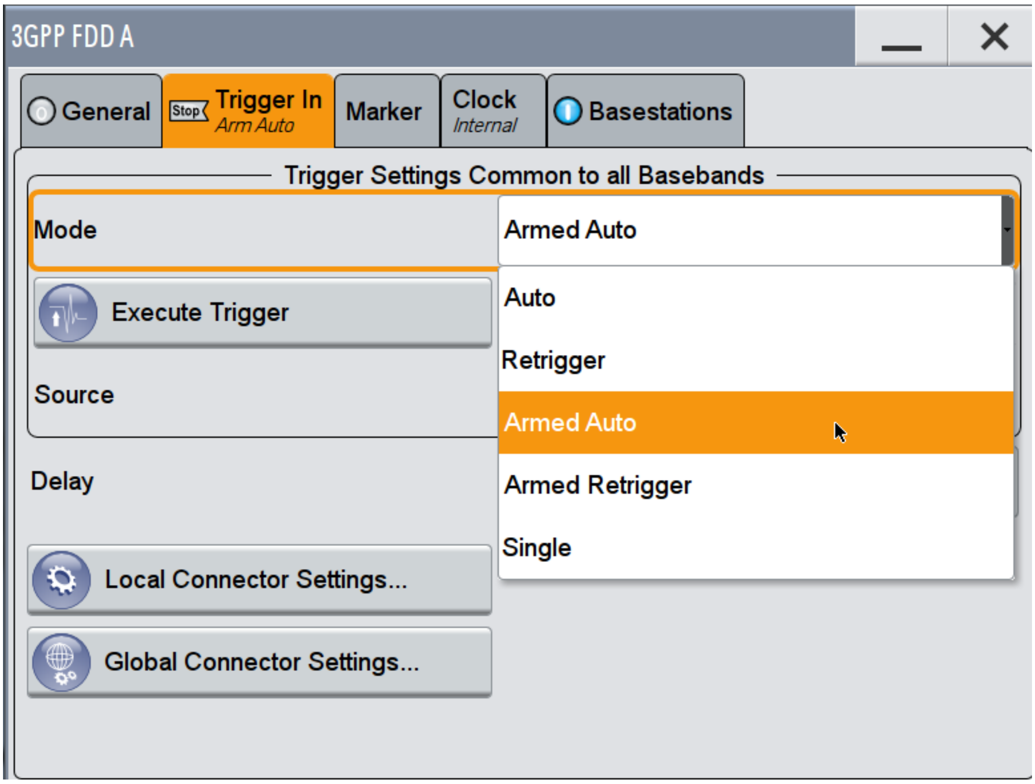


Fig. 3-11: SMW: select the trigger mode. Select armed auto in case of external trigger

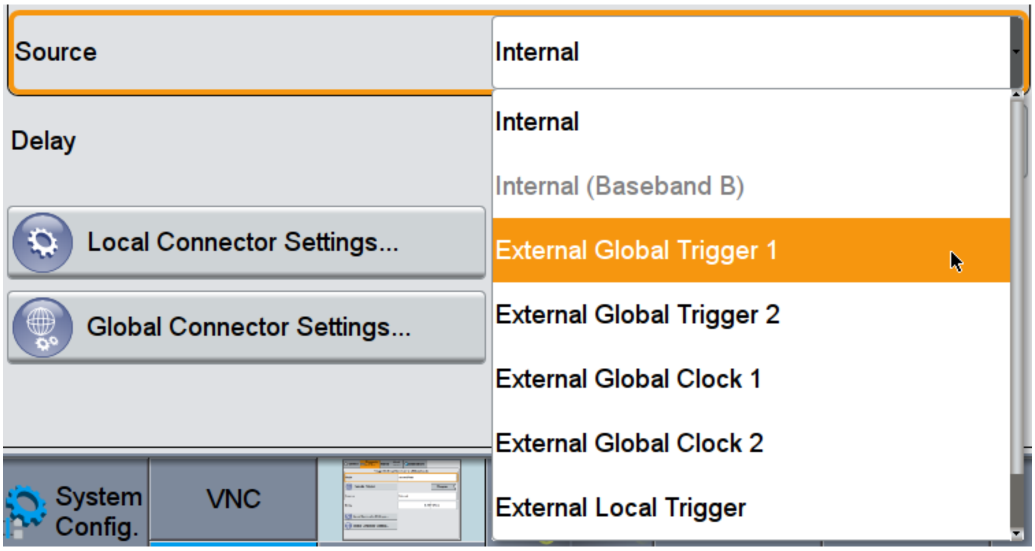


Fig. 3-12: SMW: select the trigger source. Example: "External Global Trigger 1" is selected here

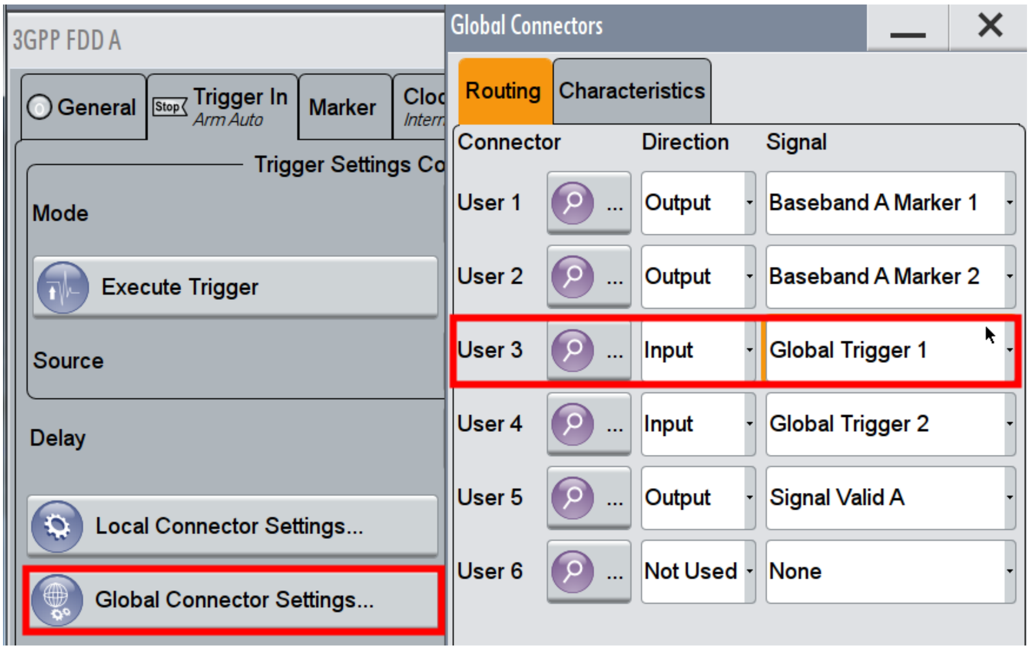


Fig. 3-13: SMW: configure the connector settings. Example: for the current configuration, Trigger 1 has to be supplied at the input connector USER 3.

3.1.3 R&S RUN Demo Program

This Application Note comes with a demonstration program module called **W-CDMA BS Tx Tests** for the software R&S RUN which is free of charge. The module covers all required tests (see table below).

The **W-CDMA BS Tx Tests** module represents a so called test for the R&S RUN software. See Section 4.1 for some important points on the basic operation of R&S RUN.

Each test described in this application note can be executed quickly and easily using the module. Additional individual settings can be applied.

The program offers a straightforward user interface, and SCPI remote command sequence export functions for integrating the necessary SCPI commands into any user-specific test environment. A measurement report is generated on each run. It can be saved to a file in different formats including PDF and HTML.

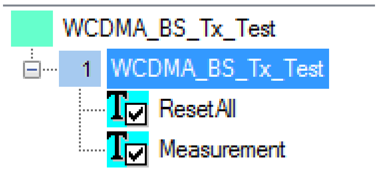
Following SCPI resources are needed:

- FSx
- SMx

Getting Started

This section describes only the module for the **W-CDMA BS Tx Test**. Double-click the test to open the window for entering parameters.

The test consists of two independent testcases:



- The testcase **ResetAll** resets all instruments (SMx and FSx). All instruments must be connected to use this feature.
- The testcase **Measurement** is the main part.

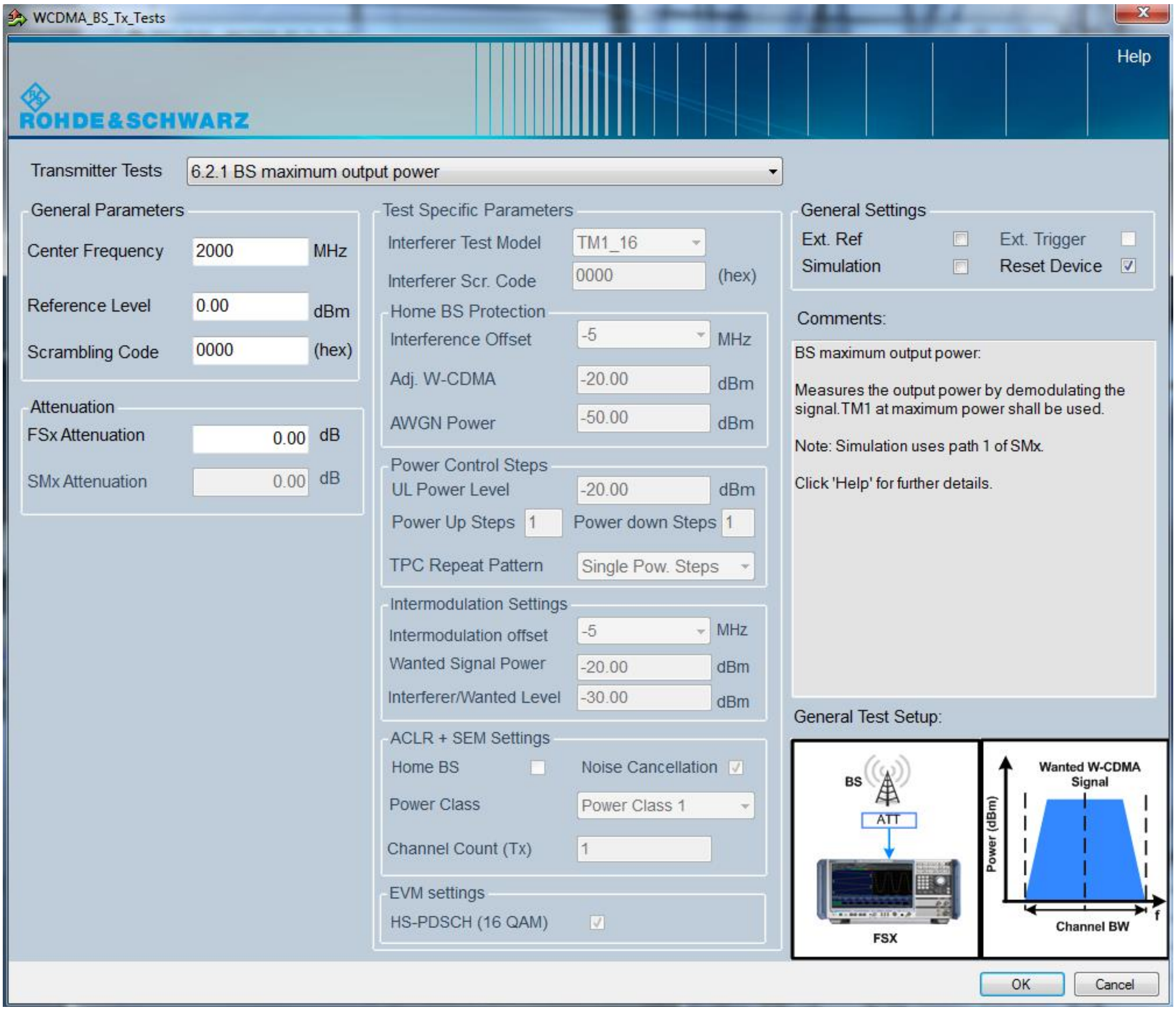


Fig. 3-14: **Full overview: setting parameters for the W-CDMA BS Rx test.**

General settings

The basic parameters are set at the top right:

- **Ext. Ref:** Switches the instruments to an external reference source (typ. 10 MHz).

- **Ext. trigger:** Check this to start the W-CDMA signal of the SMx with an external trigger.
- **Simulation:** Generates demo signal using the SMx and shows measurements using the FSx for demonstration purposes.
- **Reset Devices:** Sends a reset command to all the connected instruments

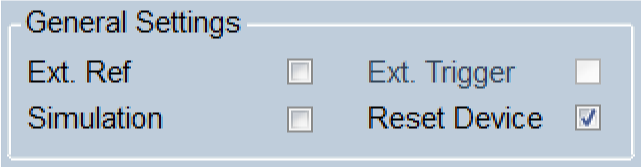


Fig. 3-15: General settings

The **Attenuation** section is used to enter compensations for external path attenuations.

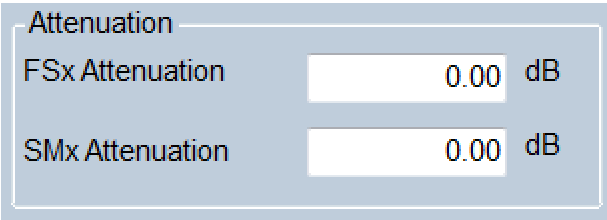


Fig. 3-16: Attenuation settings.

Test Cases

This is the main parameter. Select the wanted test case here. All the other remaining parameters in the window are grayed out or set active based on the requirements for the selected test case. These parameters are described in detail in the individual sections below.

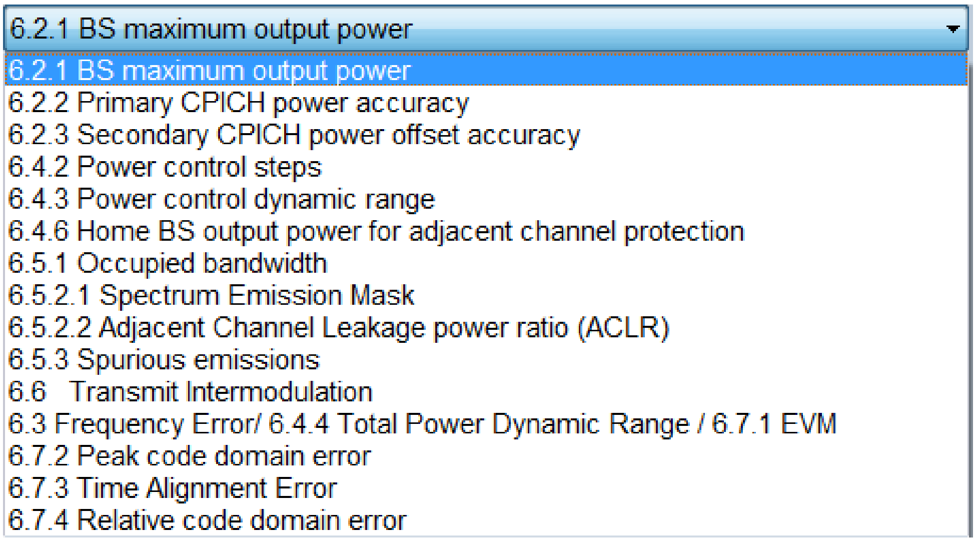


Fig. 3-17: Available test cases.

Based on the selected test case, helpful hints are provided in the **Comments** section and an illustration of the basic test setup is displayed.

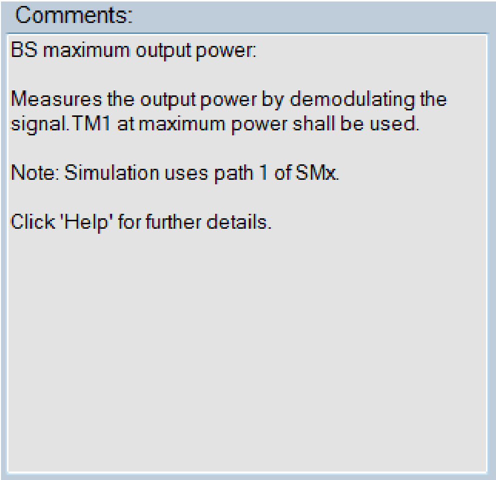


Fig. 3-18: Brief notes are provided in the Comments section (top right) based on the selected test case.

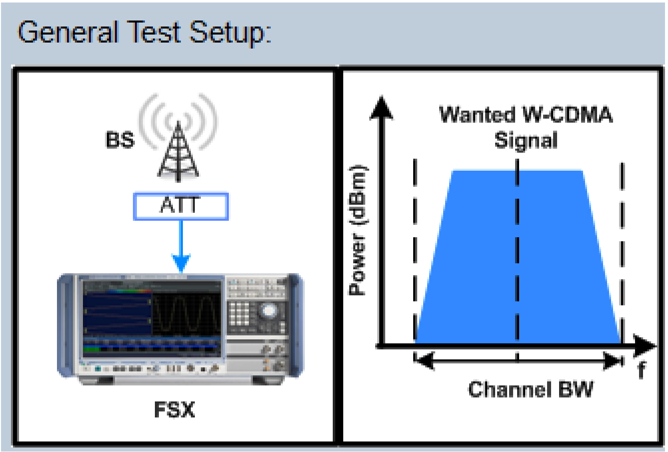


Fig. 3-19: The Test Setup section (bottom right) displays a basic setup for the selected test case along with the location of the signals in the spectrum.

Settings for measured signal

Use this section to define the basic parameters for the W-CDMA signal to be measured:

- **Center Frequency** of the signal to be measured
- **Reference Level:** Set here the expected reference level
- **Scrambling Code:** Set here the scrambling code of the signal to be measured

3.2 Base station output power (Clause 6.2)

3.2.1 Base station maximum output power (Clause 6.2.1)

Maximum output power of the base station is the mean power level per carrier measured at the antenna connector in specified reference condition.

This test verifies the accuracy of the maximum output power across the frequency range in different conditions. [1]

The power declared by the manufacturer for different BS classes shall not exceed the values mentioned in Table 3-2.

Maximum rated output power for different BS classes	
BS Classes	**PRAT**
Wide area BS	No upper limit
Medium Range BS	≤ +38 dBm
Local area BS	≤ +24 dBm
Home BS	≤ + 20 dBm (without transmit diversity or MIMO) ≤ + 17 dBm (with transmit diversity or MIMO)

Table 3-2: Maximum rated output power

Base station output power shall remain within following limits:

Requirements for BS output Power	
Frequency Range	**Limit (Normal Condition)**
f ≤ 3.0 GHz	≤± 2.7 dB
3.0 GHz < f ≤ 4.2 GHz	≤± 3 dB

Table 3-3: Limits for BS output Power

Test Setup

Set the DUT (base station) to transmit at the declared maximum PRAT using TM1 for channel setup.

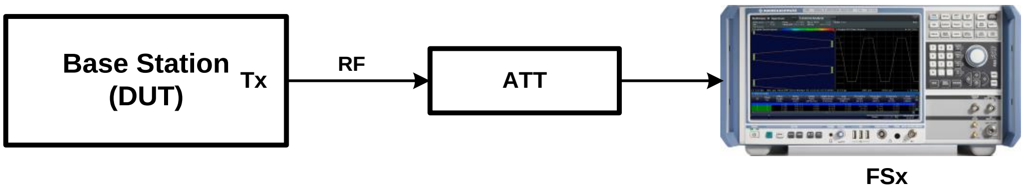


Fig. 3-20: Test setup for BS output power

Procedure

Measurement with the FSx

The test can be performed in two different ways:

a) **Demodulation> Result Summary:** This method uses a single data record from the same test to obtain different values, such as EVM, frequency error, etc.

The procedure follows the basic instructions provided in the section 3.1.1. The “Total Power” is shown in the result summary section at the lower half of the FSx window. (Fig. 3-21)

b) **Channel Power/ACLR:** This method can be used to determine the output power and adjacent channel power simultaneously.

Use the basic operation (see 3.1.1). Fig. 3-21 shows the code domain measurement. See **Total Power** under **General Results**.

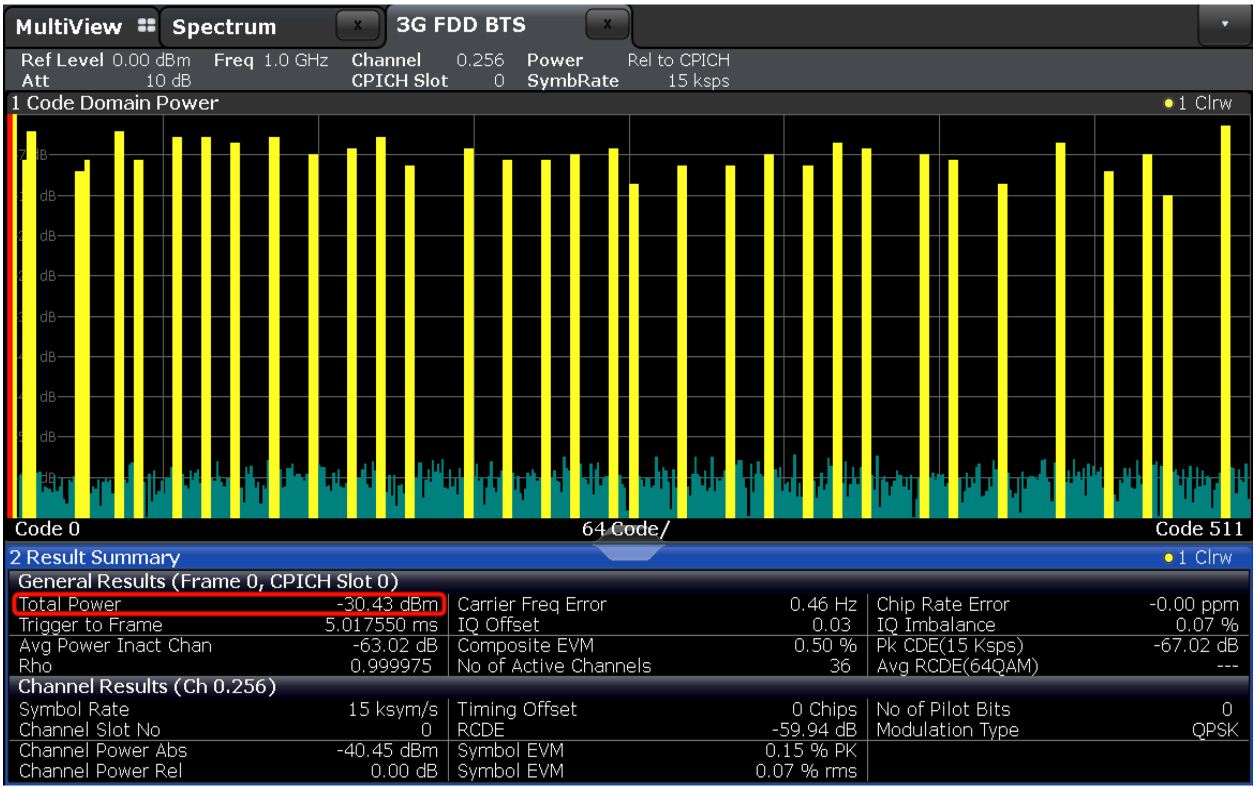


Fig. 3-21: Output Power in the result summary

Demo program

No further special setting is needed for this test. The test is carried out as a demodulation. The output power and other measurements are reported. Simulation is supported via path 1 of the SMx.

********** 6.2.1 Basestation Output Power **************

General Settings:
Scrambling Code:0000
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Total Power (dBm)			Status
6.2.1 Basestation Output Power					
Output Power	2000.00	-31.94			Ignored
Additional Measurements					
Frequency Error(Hz)	2000.00	-47.03			Ignored
Composite EVM(%)	2000.00	0.61			Ignored

FSx: 0,"No error"
Time: 9/19/2014 2:50:09 PM

Fig. 3-22: Example report for test case 6.2.1.

3.2.2 Primary CPICH power accuracy (Clause 6.2.2)

Primary CPICH (P-CPICH) power is the code domain power of the Primary Common Pilot Channel. P-CPICH power is indicated on the BCH. [1]

This test confirms that the BS delivers the Primary CPICH power within the allowed margins to ensure reliable cell planning and operation.

Table 3-4 shows the allowed tolerances.

Requirements for P-CPICH code domain power	
Frequency Range	**Limit**
f ≤ 3.0GHz	≤± 2.9 dB of the ordered absolute value
3.0 GHz < f ≤ 4.2 GHz	≤± 3.2 dB of the PRAT of the BS

Table 3-4: Limits for P-CPICH power

Test Setup

1. Set the DUT (base station) to transmit at the declared maximum PRAT using TM2 for the channel set up
2. Disable inner loop power control of the base station

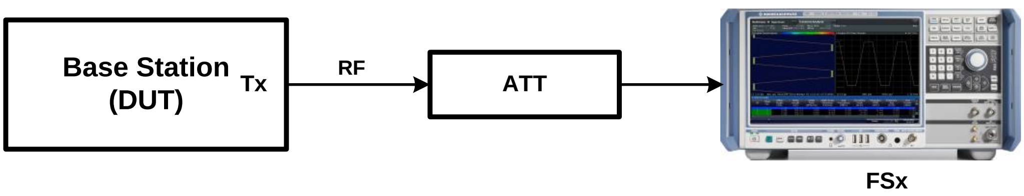


Fig. 3-23: Test setup for Primary CPICH power Accuracy

Procedure

Measurement with the FSx

Use the basic operation (see 3.1.1).

- P-CPICH is at the left-most position at the code channel “0” in the code domain power representation of the signal.

  Change the channel number in the **Evaluation range** section to find the appropriate code channel. Result for the channel “0” is shown by default.

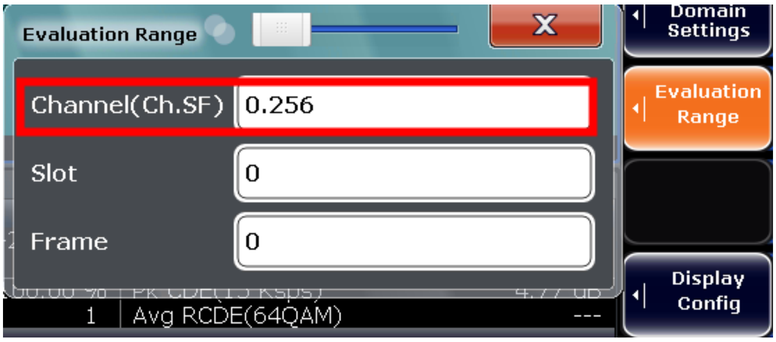


Fig. 3-24: Select the channel "0" using "Evaluation Range". The spreading factor is detected automatically.

- Check the **Channel Power Abs** in the result summary section (see Fig. 3-25)

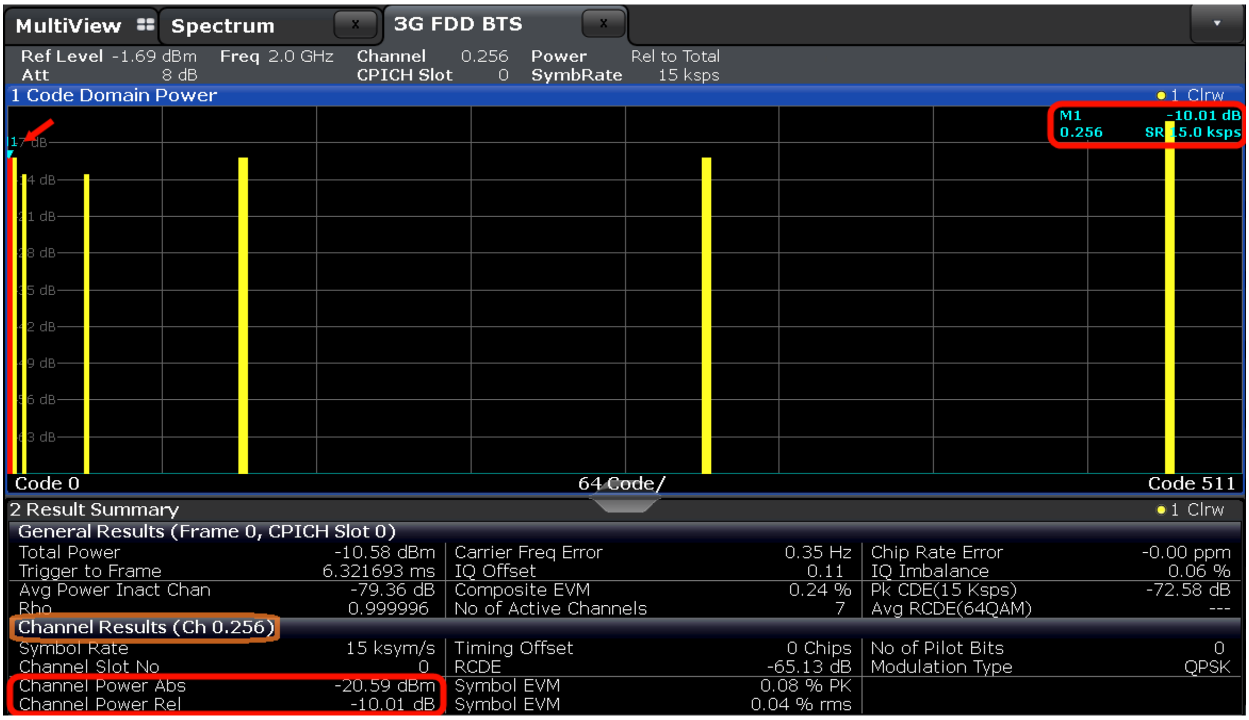


Fig. 3-25: P-CPICH power at code channel zero under the result summary section

Demo program

No further special setting is needed for this test. The channel power and the relative power of the channel and other measurements are reported. Simulation is supported via path 1 of the SMx.

*********** 6.2.2 Primary CPICH power accuracy ************

General Settings:
Scrambling Code:0000
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Total Power (dBm)	Abs. Power (dBm)	Rel. Power (dBm)	Status
6.2.2 Primary CPICH power accuracy					
P-CPICH Power	2000.00	-31.85	-41.86	-10.01	Ignored
Additional Measurements					
Frequency Error(Hz)	2000.00	-42.72			Ignored
Composite EVM(%)	2000.00	0.64			Ignored

FSx: 0,"No error"
Time: 9/22/2014 2:08:46 PM

Fig. 3-26: Example report for test case 6.2.2.

3.2.3 Secondary CPICH power offset accuracy (Clause 6.2.3)

Secondary CPICH power is the sum of code domain power of P-CPICH and the power offset, which are signaled to the UE. The power offset is signaled in the IE “Power Offset for S-CPICH for MIMO”.

This test ensures that the BS delivers the advertised power offset for S-CPICH power within margins which is necessary for reliable MIMO HS-DSCH demodulation and CQI reporting. [1]

This test is not necessary if the BS does not support MIMO or if the manufacturer implements Virtual Antenna Mapping (VAM).

Table 3-5 shows the allowed tolerances.

Requirements for S-CPICH power offset accuracy	
Frequency Range	**Limit**
f ≤ 3.0 GHz	≤± 2.7 dB
3.0 GHz < f ≤ 4.2 GHz	≤± 3.0 dB

Table 3-5: Limit for S-CPICH power

Test Setup

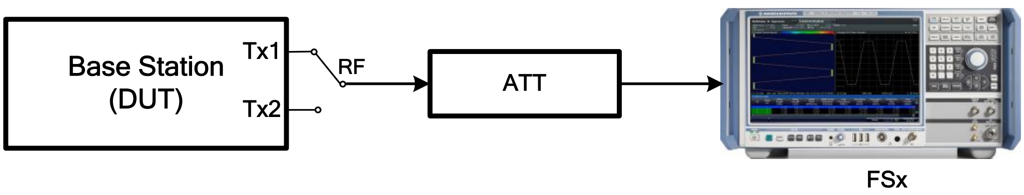


Fig. 3-27: Test setup for Secondary CPICH power offset accuracy

Procedure

Set the DUT (base station) to transmit at the declared maximum PRAT using TM2 for the channel set up via first antenna.

Measurement with the FSx

Use the basic operation (see 3.1.1). Connect the FSx to TX1.

1. In the FSx, P-CPICH is at the left-most position at the code channel “0” in the code domain power representation of the signal.

   Change the channel number in the **Evaluation range** section to find the appropriate code channel. Result for the channel “0” is shown by default.

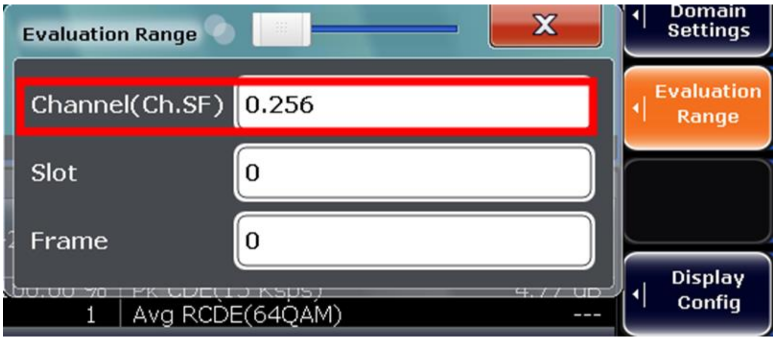


Fig. 3-28: Select channel 0 using “Evaluation Range”. The spreading factor is detected automatically.

2. Click on **Signal Description** and turn on **Antenna Diversity**. Select the **Antenna Number** to display measurement for that antenna

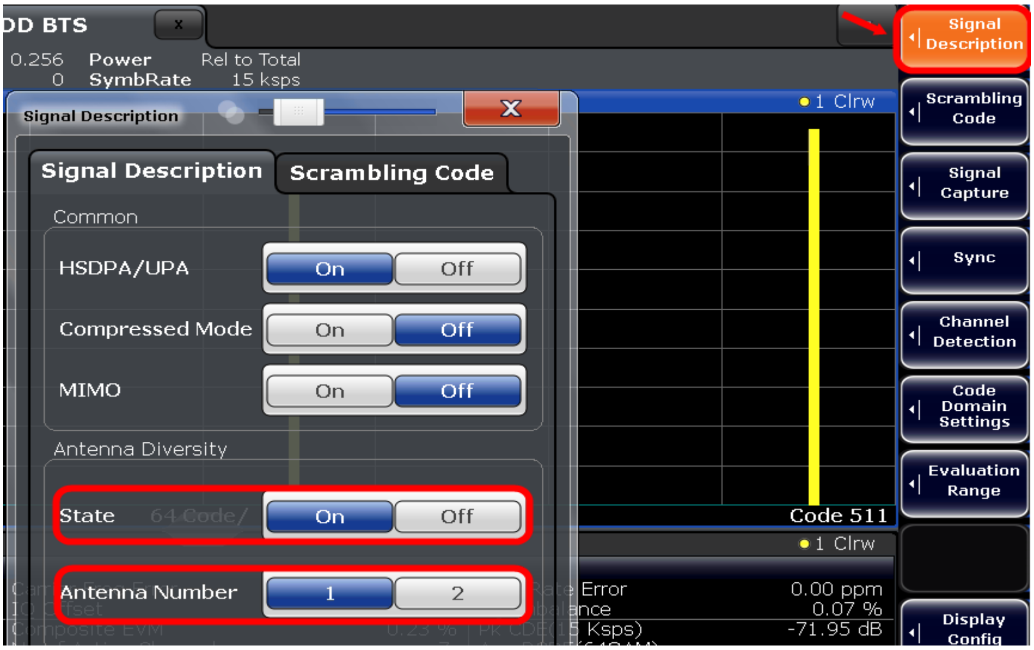


Fig. 3-29: Turn on antenna diversity and select desired antenna from “Signal Description” menu. Example: Antenna 1 is selected here

3. Check the **Channel Power Abs** in the result summary section for Antenna 1
4. Connect the FSx to TX1 and check the **Channel Power Abs** in the result summary section for Antenna 2
5. Calculate the difference between the results

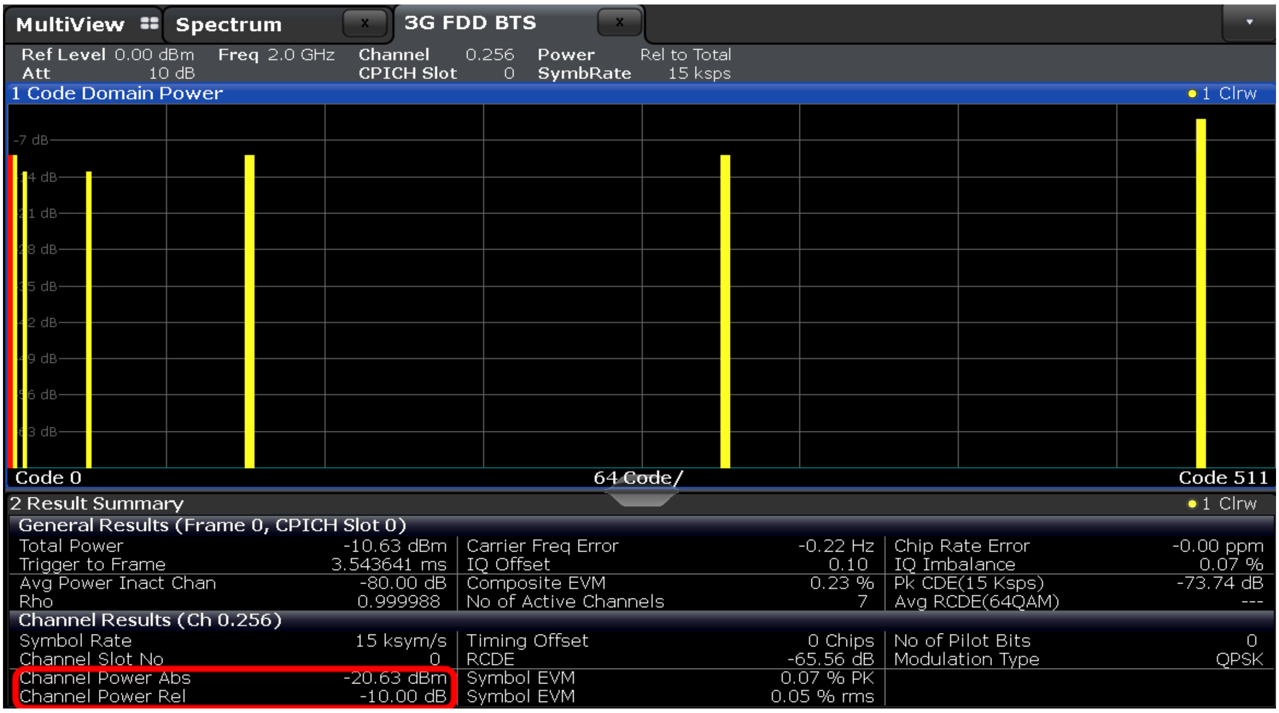


Fig. 3-30: Measure S-CPICH power offset accuracy from the power difference between two antennas

Demo program

No further special setting is needed for this test. The output power and other measurements are reported. Simulation is not supported.

********** 6.2.3 Secondary CPICH power offset accuracy **************

General Settings:
Scrambling Code:0000
FSx Attenuation:3 dB

Test Item	Carrier Frequency (MHz)	Total Power	Abs. Power (dBm)	Rel. Power (dBm)	Status
6.2.3 Secondary CPICH power offset accuracy					
First Antenna	2000.00	-30.03	-40.13	-10.10	Ignored
Second Antenna	2000.00	-30.15	-42.12	-10.10	Ignored
Power Offest (dB)	2000.00		1.99		Ignored
Additional Measurements					
Frequency Error(Hz)	2000.00	67.11			Ignored
Composite EVM(%)	2000.00	100.00			Ignored

FSx: 0,"No error"
Time: 9/19/2014 4:54:12 PM

Fig. 3-31: Example report for test case 6.2.3

3.3 Frequency error (Clause 6.3)

Frequency error is defined as the difference between transmitted BS frequency and the assigned frequency. [1]

This test ensures that the frequency error is within the tolerance margin specified in Table 3-6.

Requirements for Frequency error test		
BS class	**Minimum frequency error**	**Maximum frequency error**
Wide Area BS	-0.05 ppm - 12 Hz	+0.05 ppm + 12 Hz
Medium Range BS Local Area BS	-0.1 ppm - 12 Hz	+0.1 ppm + 12 Hz
Home BS	-0.25 ppm - 12 Hz	+0.25 ppm + 12 Hz

Table 3-6: Limits for Frequency error

This test is performed along with "Error Vector Magnitude (EVM) (Clause 6.7.1)" (test 3.7.1).

3.4 Output power dynamics (Clause 6.4)

3.4.1 Inner loop power control (Clause 6.4.1)

Inner loop power control in the downlink is the ability of the BS transmitter to adjust the code domain power of a code channel in accordance with the corresponding TPC symbols received in the uplink. [1]

Control of the output power is very important in W-CDMA to minimize the interference between different users. To make sure that the transmitted power of the code channel is at its minimum for a reliable connection, the mobile station sends power control message (TPC bits) to the base station using the uplink control channel (UL DPCCH) in each timeslot to request the base station to decrease or increase the transmit power and the base station immediately adjusts its downlink DPCCH/DPDCH power upwards or downwards by the indicated step size according to the TPC command.

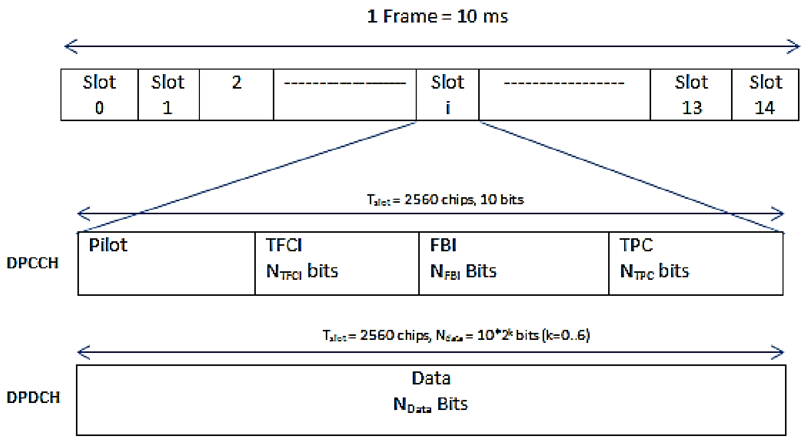


Fig. 3-32: W-CDMA uplink frame structure. Each frame is 10 ms and split into 15 slots, each of which corresponds to one power-control period.

N_{TPC} is the number of TPC bits sent per slot to represent one TPC command. This number is determined by the higher level parameter "Power control algorithm". Table 3-7 shows the transmitted power control command according to the TPC bit pattern.

TPC Bit pattern			Transmitted Power Control Command
N_{TPC} = 2	N_{TPC} = 4	N_{TPC} = 8	
11	1111	11111111	1
00	0000	00000000	0

Table 3-7: TPC Command according to TPC bits

The power control step size can be:

- 0.5 dB
- 1 dB
- 1.5 dB
- 2 dB

Support for the step size 1 dB is mandatory, while support for others is optional.

3.4.2 Power control steps (Clause 6.4.2)

The power control step is the required step change in the code domain power of a code channel in response to the corresponding power control command. The combined (or aggregated) output power change is the required total change in the DL transmitter output power of a code channel in response to multiple consecutive power control commands corresponding to that code channel.[1]

The TPC command is generated based on the estimated SIR (Signal to Interference ratio) on the downlink control channel (DL DPCCH) by the UE and carried by the uplink control channel (UL DPCCH) at each slot.

- If the estimated SIR is higher than the target SIR, then the transmitted TPC command is "0" and BS has to reduce the power by step size of 0.5, 1, 1.5 or 2 dB to decrease the SIR.
- If the estimated SIR is smaller than the target SIR, the TPC command to transmit is "1" and BS has to increase the power accordingly.

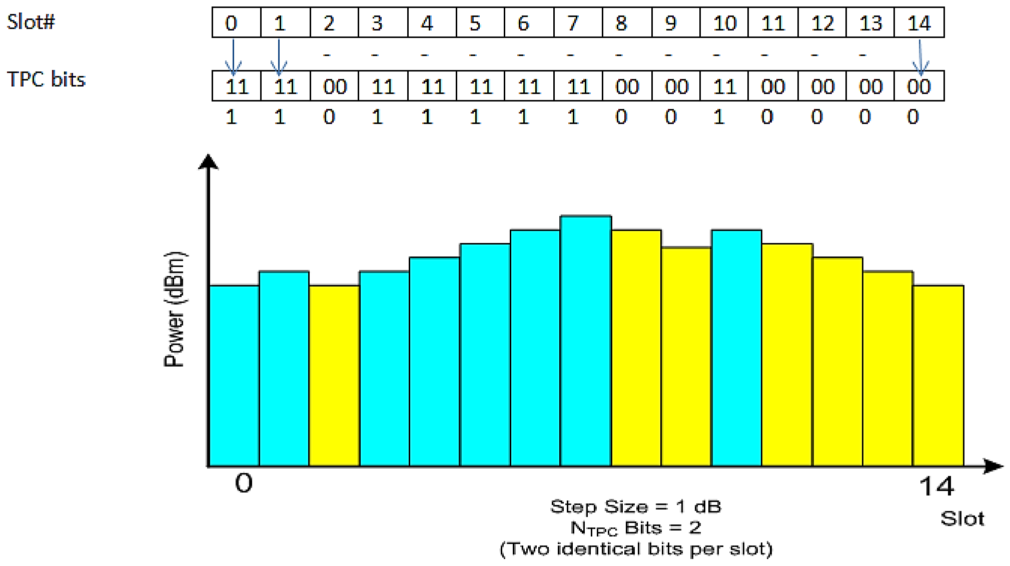


Fig. 3-33: Power control steps according to alternating TPC command. In this example, N_{TPC}= 2, so each slot includes two TPC bits. Two identical TPC bits represent one TPC command.

The purpose of this test is to verify that the power control step size and aggregated step range remain within the tolerance range.

Table 3-8 and Table 3-9 show the allowed tolerances:

Transmitter power control step tolerance

Power control commands in the downlink	**Transmitter power control step tolerance**							
	2 dB step size		**1.5 dB step size**		**1 dB step size**		**0.5 dB step size**	
	Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Up (TPC command "1")	+0.9 dB	+3.1 dB	+0.65 dB	+2.35 dB	+0.4 dB	+1.6 dB	+0.15 dB	+0.85 dB
Down (TPC command "0")	-0.9 dB	-3.1 dB	-0.65 dB	-2.35 dB	-0.4 dB	-1.6 dB	-0.15 dB	-0.85 dB

Table 3-8: Limits for Tx power control steps

Transmitter aggregated power control step range

Power control commands in the downlink	**Transmitter power control step tolerance**							
	2 dB step size		1.5 dB step size		1 dB step size		0.5 dB step size	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Up (TPC command "1")	+15.9 dB	+24.1 dB	+11.9 dB	+18.1 dB	+7.9 dB	+12.1 dB	+3.9 dB	+6.1 dB
Down (TPC command "0")	-15.9 dB	-24.1 dB	-11.9 dB	-18.1 dB	-7.9 dB	-12.1 dB	-3.9 dB	-6.1 dB

Table 3-9: Limits for Tx aggregated power control step

Test Setup

For this test, the SMx generates the necessary TPC bits in the uplink signal to the base station to control the power of the downlink signal. Establish the downlink power control with parameters as specified in Table 3-10. The FSx evaluates the power changes versus time on code channel 120.

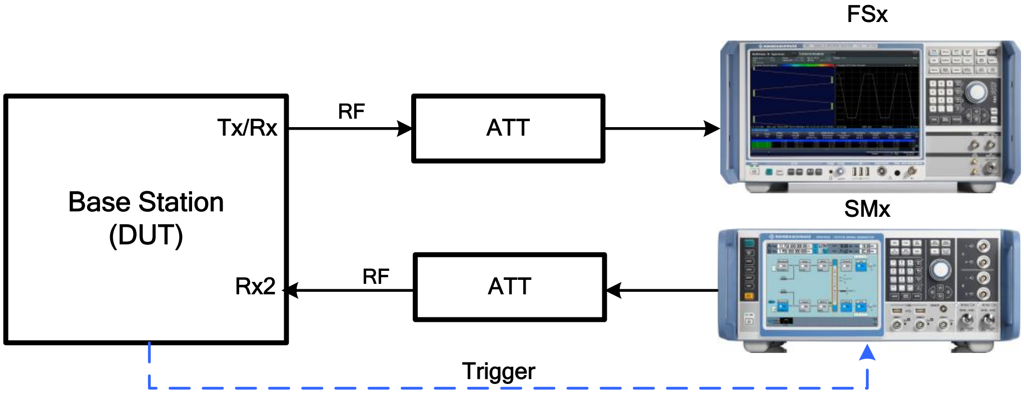


Fig. 3-34: Test setup for Power Control Steps Test. SMx generates the uplink TPC command. The analyzer measures the resulting power steps.

Overview of the Setting

- The DUT (Base station) generates the wanted W-CDMA signal using TM2. The measurement shall start on the maximum power – 3 dB. This can be controlled by the SMx with the **TPC Start Pattern** (see step 11).
- Set the BS to start the inner loop power control test
- Set the SMx to generate alternating uplink TPC bits.
- Send a trigger from the BS to the SMx to start the SMx.
- The UL signal shall be transmitted at the Reference Sensitivity Level + 10 dB. This results in levels in Table 3-10.

Signal source parameters				
Parameters	**Level/status**			**Unit**
UL signal level	**BS Class**	**f ≤ 3.0 GHz**	**3.0 GHz < f ≤ 4.2 GHz**	dBm/3.84 MHz
	Wide Area BS	-110.3 dBm	-110 dBm	
	Medium Range BS	-100.3 dBm	-100 dBm	
	Local Area BS / Home BS	-96.3 dBm	-96 dBm	
Data sequence	PN9 or longer			

Table 3-10: Uplink levels for power control

Procedure: Single power control step tolerance

Generation of Uplink Signal with SMx

1. Select W-CDMA **(3GPP FDD)** in the Baseband block A and choose **Link direction** *Uplink*.

Fig. 3-35: SMW: select 3GPP FDD to generate W-CDMA signal

2. Select **Armed Auto** as the trigger **Mode** under "Trigger In" section. Select the trigger **Source** as well.

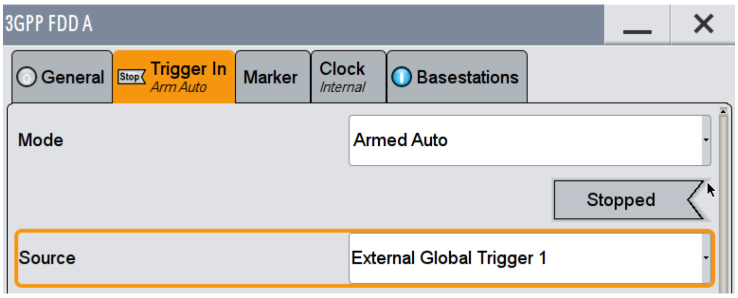


Fig. 3-36: Select Trigger Mode and Trigger Source

R&S signal generators offer "Test Case Wizard" for quick and easy generation of signal according to standard. It opens a configuration menu with a selection of predefined settings according to test Cases in TS 25.141. The default settings are set according to the standard. It is also possible to generate user defined signal by changing the "General Setting".

3. Go to the **Test Case Wizard** tab

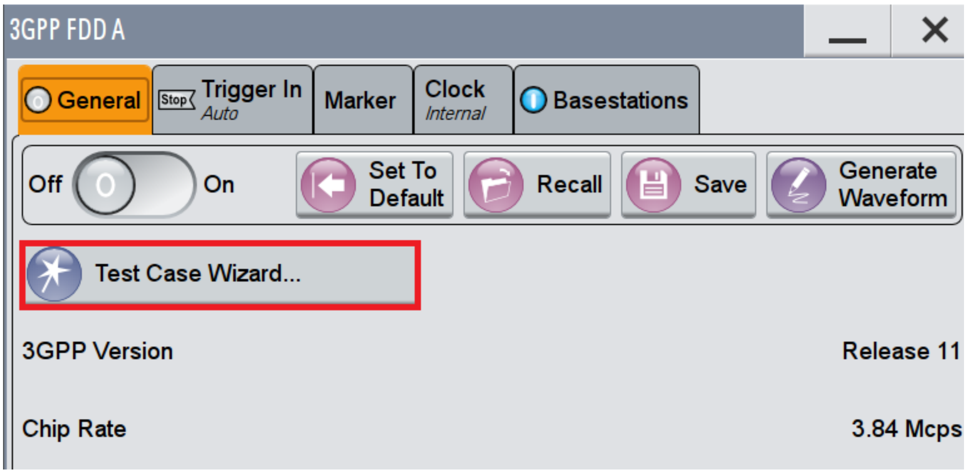


Fig. 3-37: SMW: Test Case Wizard for W-CDMA

4. Select **Test case 6.4.2 Power Control Steps.** (Fig. 3-38)
5. Select **According to Standard** in the **Edit Mode** under **General Settings** menu to generate a signal according to 3GPP standard. (Fig. 3-38)
6. Select **Unchanged** in the “Trigger Configuration” section

Fig. 3-38: Select “Unchanged” in the trigger configuration

7. Enter the uplink **Scrambling Code** and **Scrambling Mode** for the SMx

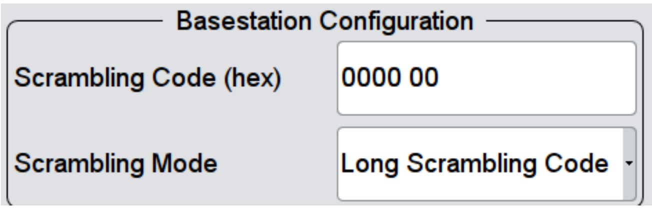


Fig. 3-39: Set Scrambling Code and Scrambling Mode

8. Select the **Power Class**. This sets the **Power Level** automatically according to the standard. (Fig. 3-40)
9. Set the **RF frequency** (Fig. 3-40)
10. Apply necessary changes (Slot format DPCCH#, Power ratio DPC/DPDCH, Symbol rate, Propagation delay, Step size) according the declaration of the manufacturer. (Fig. 3-40)
11. **Maximum Power Less n Steps** is fixed as the “TPC start pattern” in the edit mode “According to Standard”. This ensures reliable response of the BS to the TPC bits by sending a sequence of power up steps (TPC bits "1") followed by a number of power down steps (TPC bits "0"). (Fig. 3-40). Set the number of power up and down steps to reach the start level of Pmax – 3 dB.
12. Select **Single Power Steps** under “TPC Repeat Pattern” menu to measure power control steps for single steps. (Fig. 3-40)
13. Press **Apply Setting**

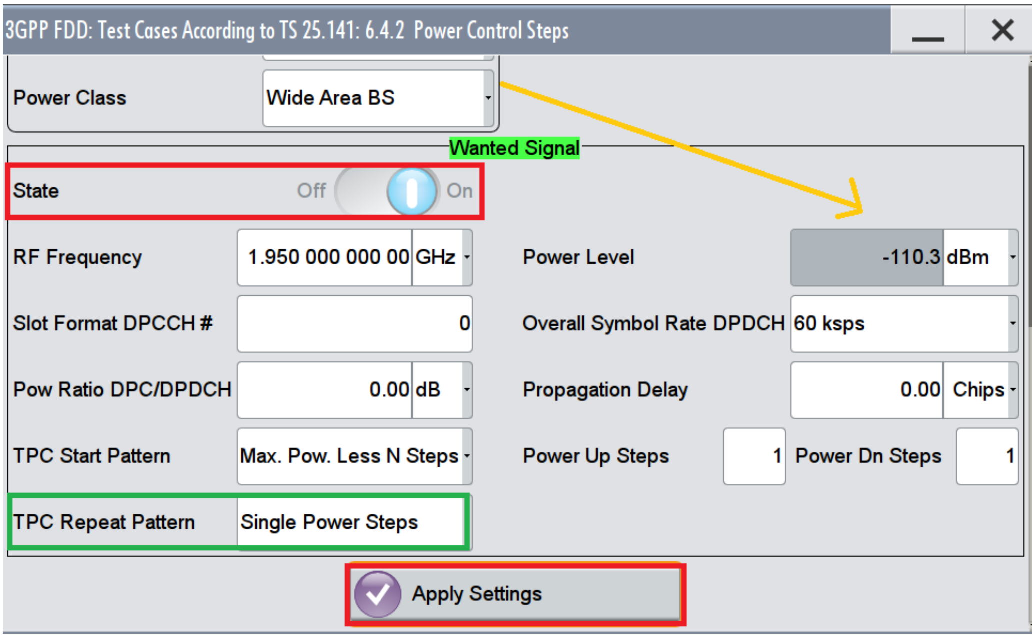


Fig. 3-40: SMW: The uplink power level is set based on the Power Class. Set the TPC Repeat Pattern.

Measurement with the FSx

1. Select **Evaluation Range** in the code domain display and set the **Channel (Ch. Sf)** to 120

Fig. 3-41: Set Channel to 120 to display result for code channel 120

2. Select **overview** at the bottom on right side of the window and select **display config**
3. Project **Power vs Slot** from the list of configuration at the right side of the screen to have an overview of the power on channel 120

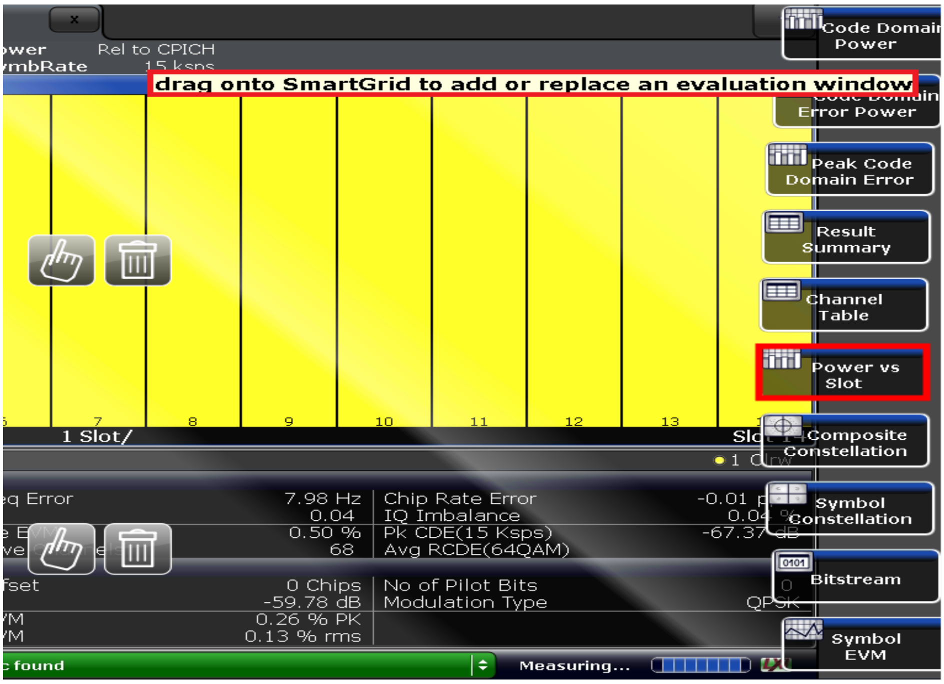


Fig. 3-42: Select Power vs Slot from display menu

4. The accuracy of each power step can be measured directly using the marker and delta marker function in the time domain display. Select the hardkey **MKR** on the front panel of the FSx and set **Mkr Type** to **Delta**.

Repeat the test for all steps within power control dynamic range declared by the manufacturer.

Fig. 3-43 shows example of **Power vs Slot** according to TPC command (01010101…) and step size 2 dB on Channel 120 using the FSW. Power per slot is reduced by 2 dB (step size) according for the TPC command “0” and increased by 2 dB for the TPC command “1” and so on.

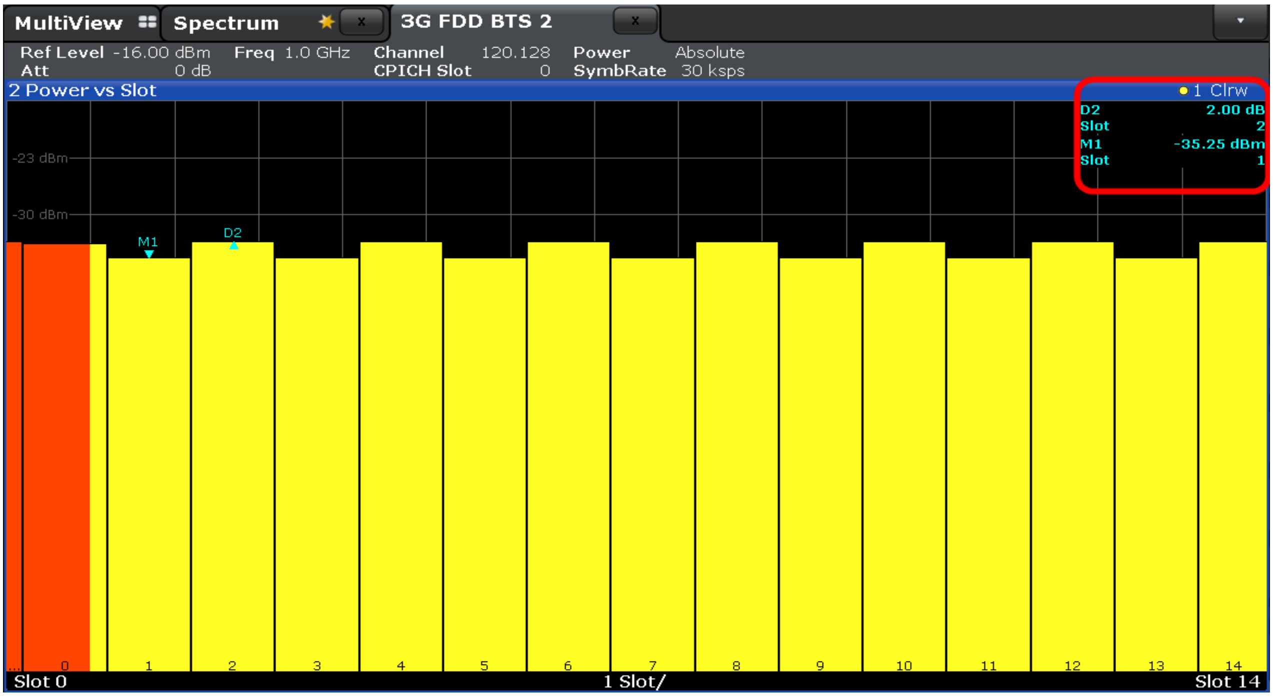


Fig. 3-43: FSW: Power control steps according to alternating TPC command (single steps). Example: 2 dB power control steps. Power increases 2 dB for each command "1" and decreases 2 dB for each command "0"

Aggregated power control step tolerance:

1. Follow steps 1 to 11 of **Generation of Uplink Signal with SMx** on page 30
2. In step 12, select **Aggregated Pow. Steps** under "TPC Repeat Pattern" menu to measure total change in the DL transmitter output power of the channel 120 in response to 10 consecutive power control commands

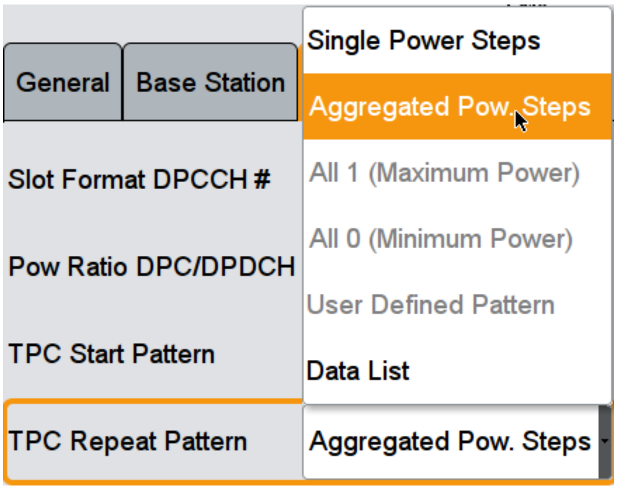


Fig. 3-44: Set Aggregated Pow. Steps as TPC repeat pattern

3. Press **Apply Settings**
4. The base station settings and the FSx settings shall remain the same.

Fig. 3-45 shows example of aggregated the power control steps tolerance for 10 consecutive identical commands. The power decreases 10 dB after ten consecutive TPC commands "0" of step size 1 dB.

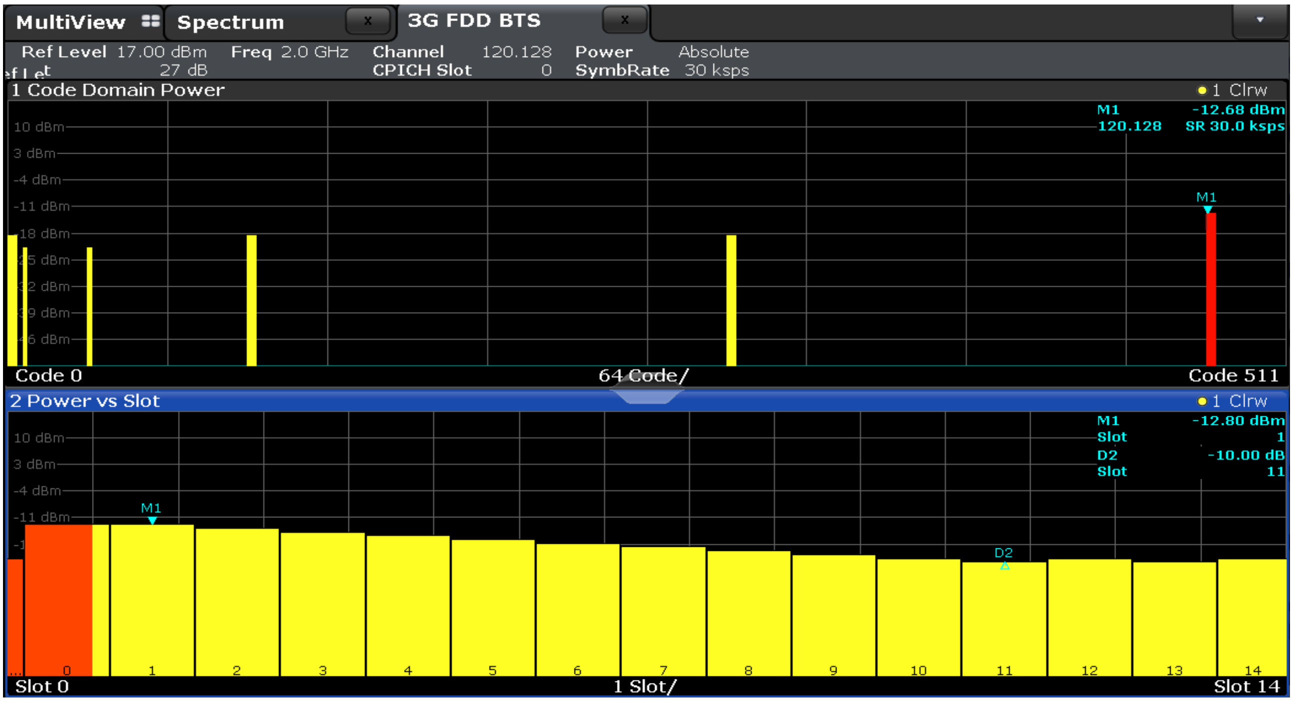


Fig. 3-45: SMW: Channel 120 is selected via evaluation range in the "Code Domain Power" overview (upper half). The power versus slot is represented in the lower half of the screen. The displayed result shows the power change on channel 120 for ten consecutive commands.

Demo program

For this test, additional parameters must be defined. The output power per slot and other measurements are reported.

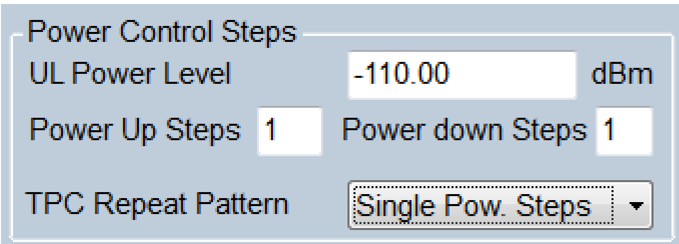


Fig. 3-46: Special settings for Power control steps

The Uplink power level and power steps can be entered directly. Perform the test for both single power steps and aggregated power steps (10 equal consecutive steps) by changing the TPC Repeat Pattern. Please note the settings from the specification listed in Table 3-8 and Table 3-9.

********* 6.4.2 Power control steps ************

General Settings:
Wanted Signa Scrambling Code:1111
Uplink Signa Scrambling Code:00000
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Power (dBm)	Frequency Error (Hz)	EVM (%rms)	Status
6.4.2 Power control steps					
TM2,Channel 120.128, Slot : 0	3500.00	-33.58	-56.66	0.13	Ignored
TM2,Channel 120.128, Slot : 1	3500.00	-35.58	-57.39	0.08	Ignored
TM2,Channel 120.128, Slot : 2	3500.00	-37.58	-58.17	0.09	Ignored
TM2,Channel 120.128, Slot : 3	3500.00	-35.58	-58.07	0.13	Ignored
TM2,Channel 120.128, Slot : 4	3500.00	-33.58	-57.20	0.08	Ignored
TM2,Channel 120.128, Slot : 5	3500.00	-33.58	-58.13	0.10	Ignored
TM2,Channel 120.128, Slot : 6	3500.00	-35.58	-58.19	0.09	Ignored
TM2,Channel 120.128, Slot : 7	3500.00	-37.58	-56.85	0.08	Ignored
TM2,Channel 120.128, Slot : 8	3500.00	-35.58	-57.25	0.08	Ignored
TM2,Channel 120.128, Slot : 9	3500.00	-33.58	-58.45	0.06	Ignored
TM2,Channel 120.128, Slot : 10	3500.00	-35.58	-56.90	0.13	Ignored
TM2,Channel 120.128, Slot : 11	3500.00	-37.58	-57.57	0.10	Ignored
TM2,Channel 120.128, Slot : 12	3500.00	-39.58	-56.85	0.16	Ignored
TM2,Channel 120.128, Slot : 13	3500.00	-37.58	-58.16	0.11	Ignored
TM2,Channel 120.128, Slot : 14	3500.00	-35.58	-57.74	0.08	Ignored

FSx: 0,"No error"
Time: 9/9/2014 2:33:38 PM

Fig. 3-47: Example report for test case 6.4.2.

3.4.3 Power control dynamic range (Clause 6.4.3)

The power control dynamic range is the difference between the maximum and the minimum code domain power of a code channel for a specified reference condition. [1]

This test verifies that the minimum power control dynamic range of the BS remains with the minimum specified range.

Table 3-11 shows the allowed tolerances.

Requirements for Power control Dynamic Range		
maximum code domain power	≥	BS maximum output power - 4.1 dB
minimum code domain power	≤	BS maximum output power - 26.9 dB

Table 3-11: limits for Power control dynamic range

Test Setup

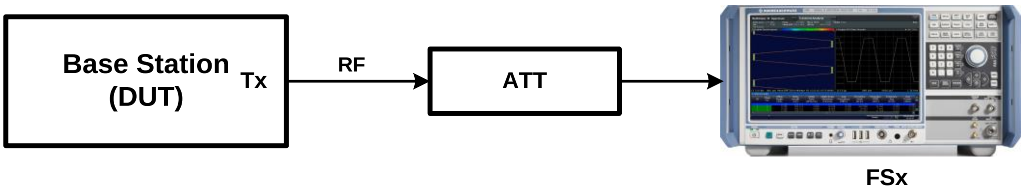


Fig. 3-48: Test setup for power control dynamic range

Procedure

The test consists of three steps:

1.

a) Set the BS to max. allowed output power (Pmax) and use TM1 for channel set up

b) At the FSx, measure the Channel Power under **result summary** section following the procedure mentioned in section 3.1.1

2.

a) At the BS, set the max. allowed output power and use TM2 for channel set up and set the power of the channel 120 to Pmax-3 dB (max. allowed code domain power)

b) At the FSx, select **Evaluation Range** in the code domain display of the analyzer and set the code **Channel (Ch. Sf)** to 120

Fig. 3-49: FSx: Set Channel to 120 to measure code domain power on channel 120

c) Measure the code domain power of DPCH on the channel 120 and compare with the BS maximum output power (result from step 1) in the FSx

3.

a) At the BS, set the power of the channel 120 to Pmax-28 dB (min. code domain power)

b) At the FSx, Select **Evaluation Range** in the code domain displays of the analyzer and set the code **Channel (Ch. Sf)** to 120

c) Measure the code domain power of DPCH on the channel 120 again and compare with the BS maximum output power (result from step 1) in the FSx

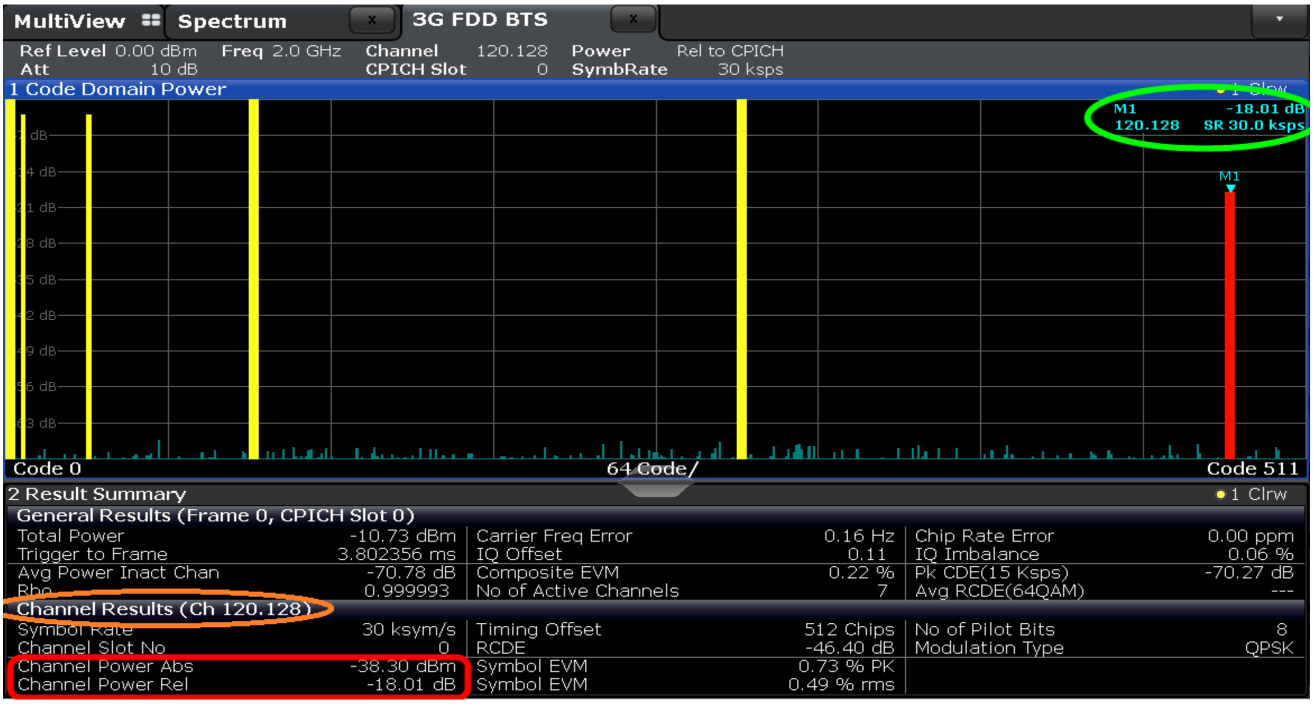


Fig. 3-50: FSx: Channel 120 is selected via evaluation range in the “Code Domain Power” overview (upper half). Code domain power in code channel 120 is shown in the result summary section for Channel 120

Demo program

No further special setting is needed for this test. The output power and other measurements are reported. Simulation is available via path 1 of the SMx.

*********** 6.4.3 Power control dynamic range *************

General Settings:
Scrambling Code:0000
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Power(dBm)	Difference (dB)		Status
6.4.3 Power control dynamic range					
BS Power	2000.00	-31.84			Ignored
Pmax-3 dB	2000.00	-34.84	-3.00		Ignored
Pmax-28 dB	2000.00	-56.85	-25.00		Ignored
Dynamic Range (dB)	2000.00	---	22.01		Ignored

FSx: 0,"No error"
Time: 9/22/2014 1:27:15 PM

Fig. 3-51: Example report for test case 6.4.3.

3.4.4 Total power dynamic range (Clause 6.4.4)

The total power dynamic range is the difference between the maximum and the minimum output power for a specified reference condition.

This test verifies that the total power dynamic range follows the allowed margins. It ensures that the interference to neighboring cells can be reduced by reducing the total output power during the transmission of a single code. [1]

Requirement for Total power dynamic range: The down link (DL) total power dynamic range shall be 17.7 dB or greater.

This test is performed along with "Error Vector Magnitude (EVM) (Clause 6.7.1)" (test 3.7.1)

3.4.5 Home base station output power for adjacent channel protection (Clause 6.4.6)

The Home BS shall be capable of adjusting the transmitter output power to minimize the interference level on the adjacent channels licensed to other operators in the same geographical area while optimize the Home BS coverage. These requirements are only applicable to Home BS. The requirements in this clause are applicable for AWGN radio propagation conditions. The requirements of this clause do not apply, in case the Home BS's operating channel and both adjacent channels are licensed to the same operator.

The test purpose is to verify the capability of the Home BS to adjust the transmitter output power according to the input conditions, as specified in Table 3-12, across the frequency range and under normal and extreme conditions for all transmitters in the BS. [1]

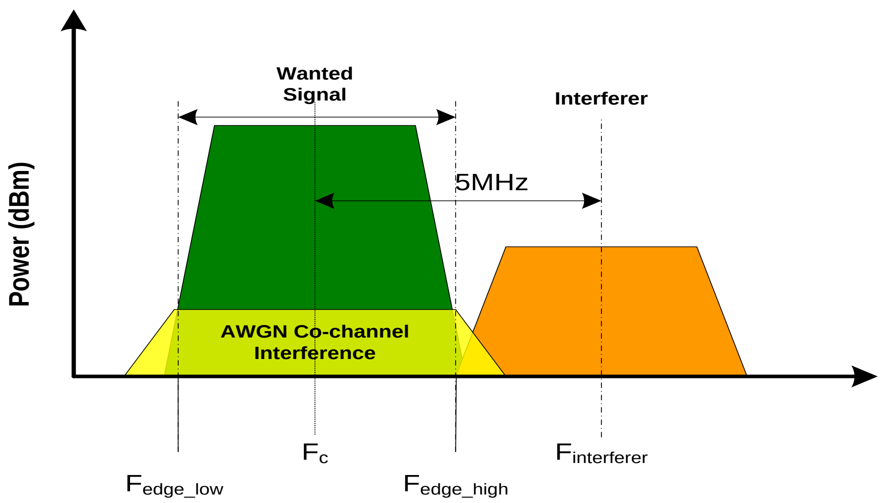


Fig. 3-52: Home BS with adjacent W-CDMA signal and co-channel interference

Requirements based on input conditions							
Test Case	P_{CPICH} (dBm)	P_{Total} (dBm)	P_{AWGN} (dBm)	Carrier/Noise (dB)	P_{out}(dBm) (without transmit diversity or MIMO)	P_{out}(dBm) (with transmit diversity or MIMO)	Limits
1	-80	-70	-50	-20	≤20	≤17	≤+ 2.7 dB (Normal Condition) ≤+ 3.2 dB (Extreme Condition)
2	-90	-80	-60		≤10	≤7	
3	-100	-90	-70		≤8	≤5	
3	-100	-90	-50	-40	≤10	≤7	

Table 3-12: Home BS output power for adjacent operator channel protection

A W-CDMA signal is provided for the test on the adjacent channel. In addition, an AWGN signal is simulated in the channel of the wanted signal. The output power of the Home BS is measured at different levels of the W-CDMA and the AWGN signals. Pout shall not exceed the values in mentioned in Table 3-12 for the four different input parameter sets.

Test Setup

The following setup is used for this test. The SMx generates both the adjacent W-CDMA carrier and the co-channel AWGN and feeds the signal to the home BS via a circulator. The FSx measures the output power (Tx) of the BS via a circulator.

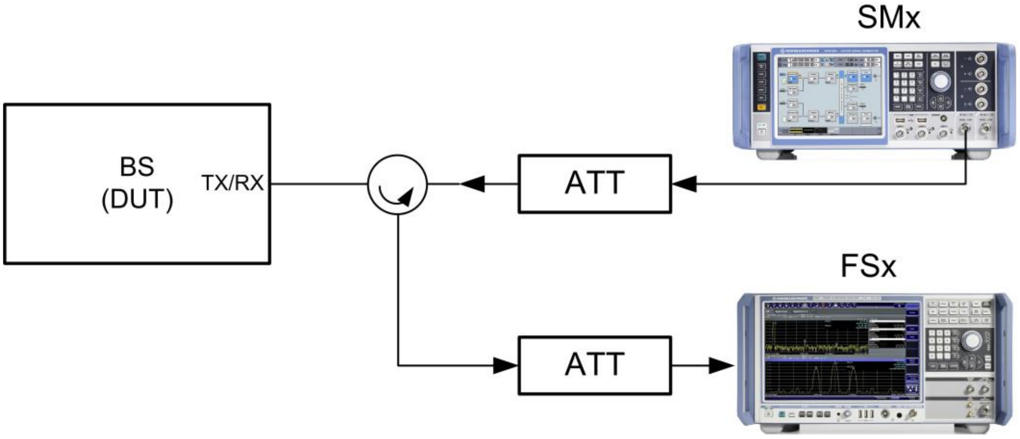


Fig. 3-53: Test setup for a home BS with adjacent W-CDMA signal. The SMx generates both the interfering W-CDMA signal and AWGN signal

RF channels to be tested: M

Overview of settings:

- The DUT (base station) generates the wanted W-CDMA signal at frequency M using TM1 channel setup and transmit at max. allowed output power
- The SMx generates the W-CDMA signal using TM1 as an adjacent channel interference at frequency M ± 5 MHz
- The SMx also generates AWGN on the same channel of the wanted W-CDMA signal of the DUT over 3.84 MHz bandwidth

Procedure

Generating Downlink Signal using the SMx:

Generating the W-CDMA signal in the adjacent signal

1. Use the standard procedure (see 3.1.2) to generate the wanted W-CDMA downlink signal
2. Switch on the baseband offset

Fig. 3-54: SMW: switch on the baseband offset

3. Set the **Frequency offset**

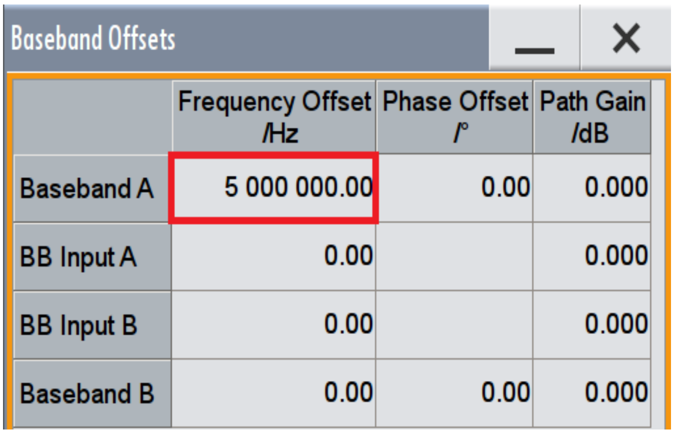


Fig. 3-55: SMW: set the frequency offset (example: 5 MHz frequency offset)

4. In the SMx, the default level for the P-CPICH is -10 dB relative to the total level of the SMx. Set the total level accordingly (example: Test case 1: P_{CPICH} = - 80 dBm: P_{total} = -80 dBm – (-10 dB) = -70 dBm)

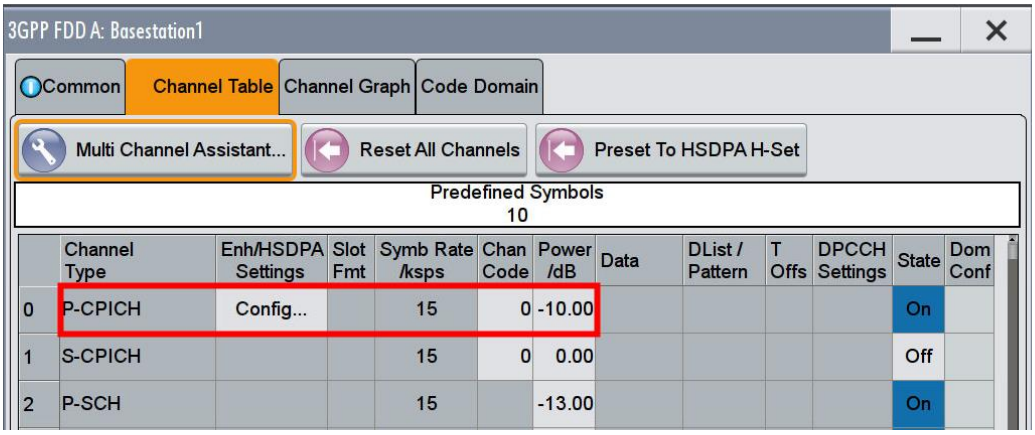


Fig. 3-56: SMW: example: P-CPICH level (-10 dB) in W-CDMA for test case 1

Generating AWGN Signal

1. Click the **AWGN** block

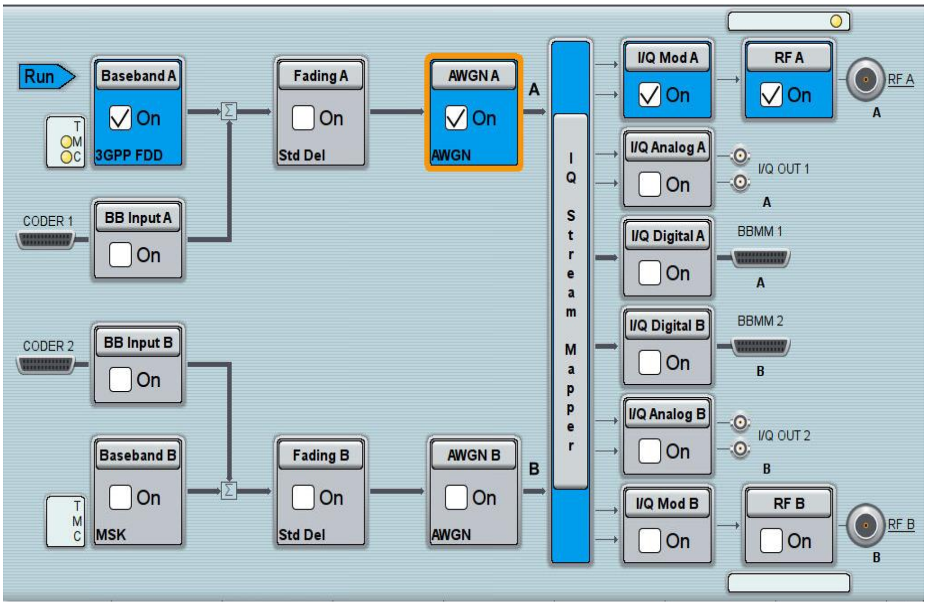


Fig. 3-57: SMW: select AWGN block

2. Set the **System Bandwidth** = 3.84 MHz

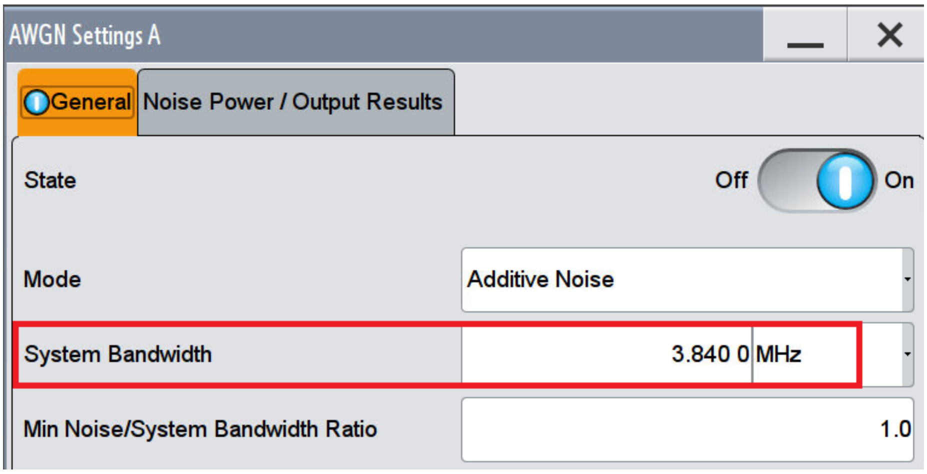


Fig. 3-58: SMW: set AWGN bandwidth to 3.84 MHz

3. Go to the **Noise Power/ Output Results** tab and enter the appropriate **Carrier/noise Ratio** from Table 3-12

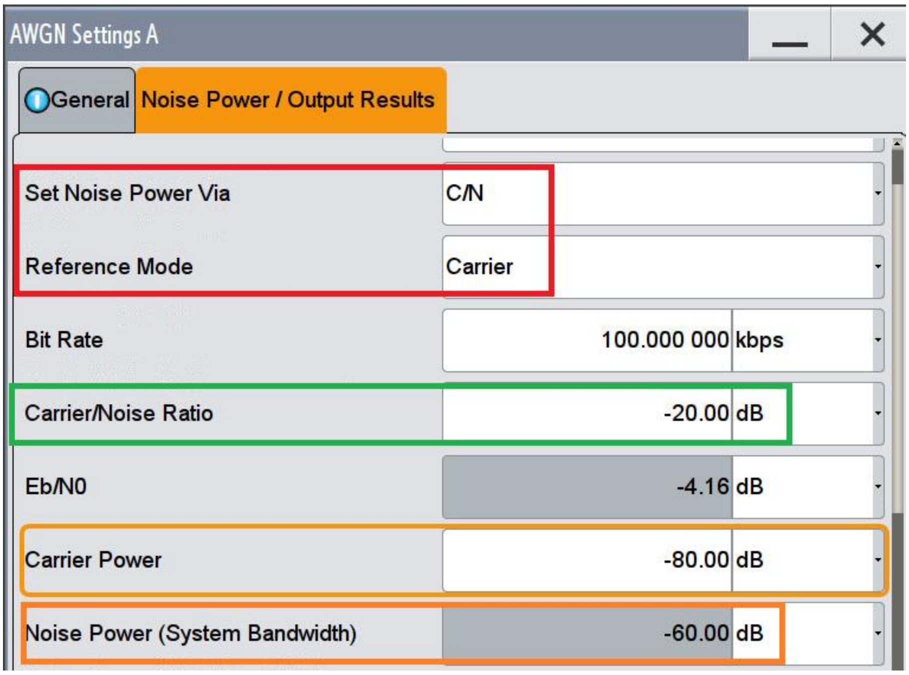


Fig. 3-59: SMW: set the noise power relative to the carrier power via Carrier/Noise Ratio. Example: The carrier power for test case 2 is -80 dB, the noise power is -60 dB. So C/N = -80 dB – (- 60 dB) = - 20 dB

Measurement with the FSx

Measure the Pout of the home BS for all test cases (Table 3-12) and both offsets following the basic instructions provided in the section 3.1.1.

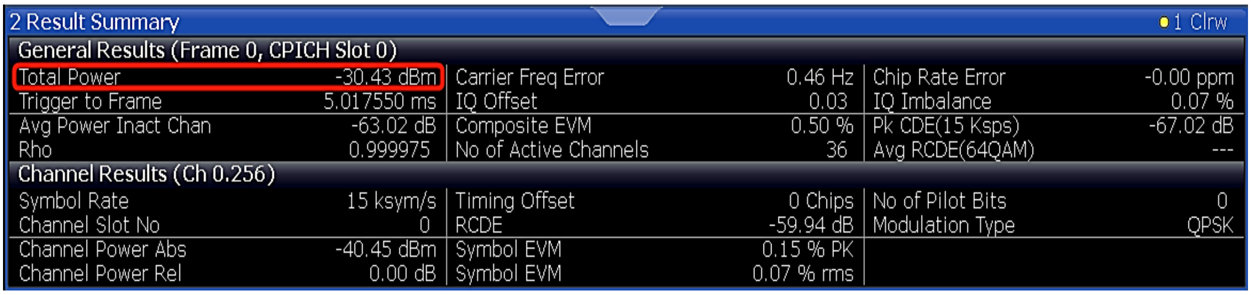


Fig. 3-60: Output Power in the result summary

Demo Program

For this test, additional parameters must be defined. Set the offset and the interferer levels. The output power and other measurements are reported. Simulation is not supported.

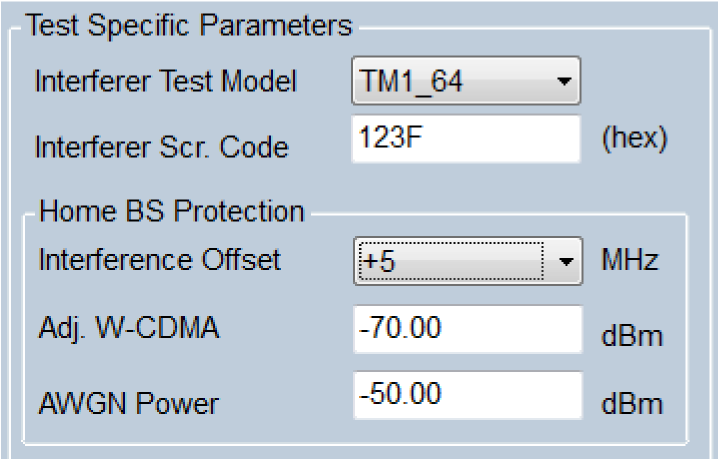


Fig. 3-61: Special settings for Home BS output power for the adjacent W-CDMA and the co-channel AWGN

The level for adjacent W-CDMA and co-channel AWGN can be entered directly. Please note the settings from the specifications listed in Table 3-12.

********** 6.4.6 Home BS output power for adjacent channel protection **************

General Settings:
Adj. W-CDMA Power:-70.00 dBm
Adj. W-CDMA Scrambling Code:2F134F
Adj. W-CDMA Center Frequency:2005
Adj. W-CDMA Test Model:TM1_64
AWGN Power:-50.00 dBm
Wanted Signal Scrambling Code:0000
FSx Attenuation:0.00 dB
SMx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Total Power (dBm)			Status
6.4.6 Home BS output power for adjacent channel protection					
Output Power	2000.00	-35.54			Ignored
Additional Measurements					
Frequency Error(Hz)	2000.00	-63.48			Ignored
Composite EVM(%)	2000.00	10.57			Ignored

FSx: 0,"No error"
Time: 9/15/2014 1:51:36 PM

Fig. 3-62: Example report for test case 6.4.6

3.5 Output RF spectrum emissions (Clause 6.5)

3.5.1 Occupied bandwidth (Clause 6.5.1)

The occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5% of the total mean transmitted power, which results in a power bandwidth of 99%.

This test verifies that the emission of the BS does not create interference to other users of the spectrum beyond certain margins due to occupying an excessive bandwidth. [1]

Test Requirement: The occupied bandwidth shall be less than 5 MHz based on a chip rate of 3.84 Mcps.

Test Setup

Set the DUT (base station) to transmit at the declared maximum PRAT using TM1 for channel set up.

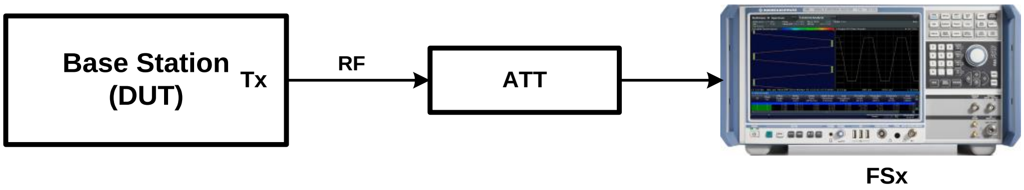


Fig. 3-63: Test setup for occupied bandwidth

Procedure

Measurement with the FSx

1. Follow step 1-3 of the basic instructions provided in the section 3.1.1
2. Press the hardkey **Meas** and select **OBW**

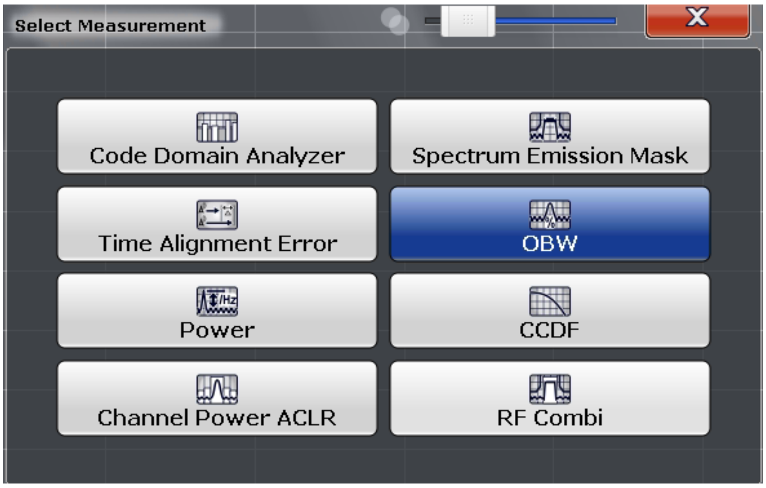


Fig. 3-64: FSx: select OBW

3. Press the hardkey **Span** and set it to 10 MHz
4. Verify the **%Power Bandwidth** default setting of 99% **(**Fig. 3-65**)**
5. Set the **Channel Bandwidth = 5 MHz**

Fig. 3-65: FSW: check % Power Bandwidth

6. Verify the Resolution Bandwidth (**RBW**) of 30 KHz

   The Spectrum and calculated OBW are displayed

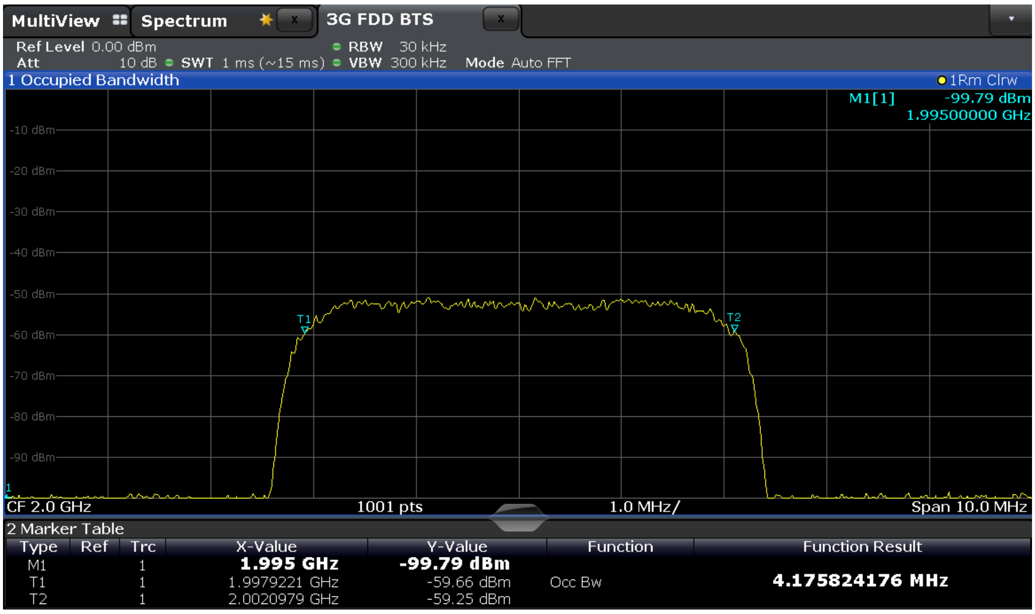


Fig. 3-66: FSW: result for Occupied Bandwidth

Demo program

No additional setting is required for this test. Measured occupied bandwidth is reported. Simulation is supported via path 1 of the SMx.

*********** 6.5.1 Occupied bandwidth *************

General Settings:
Scrambling Code:123F
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	MHz			Status
6.5.1 Occupied bandwidth					
OBW	2200.00	4.18			Ignored

FSx: 0,"No error"
Time: 9/15/2014 2:04:09 PM

Fig. 3-67: Example report for test case 6.5.1

3.5.2 Out of band emission (Clause 6.5.2)

Out of band emissions is defined as the unwanted emissions immediately outside the channel bandwidth due to the modulation process and non-linearity in the transmitter but excluding spurious emissions. It is specified in terms of a spectrum emission mask and adjacent channel leakage power ratio for the transmitter. [1]

3.5.2.1 Spectrum Emission Mask (Clause 6.5.2.1)

Spectrum Emission Mask measures the unwanted emissions close to the assigned channel when the BS is in operation.

This test is mandatory only for certain regions.

This test verifies that that emission of the BS transmitter in operation, close to the assigned channel bandwidth of the wanted signal is within the limit specified in TS25.104. [1]

Spectrum emission mask shall follow the requirements specified in 3GPP specification TS25.141 Table 6.18 to Table 6.21F according to the BS class and frequency band.

Minimum requirements are covered in tables 6.16 to 6.21A. Please note that additional requirements may apply for certain bands and Home BS.

Test Setup

Set the DUT (base station) to transmit at the declared maximum PRAT using TM1 for channel set up

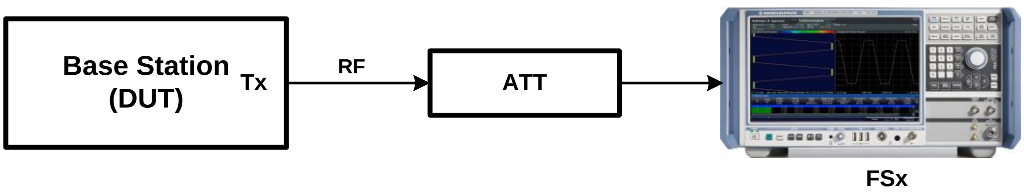


Fig. 3-68: Test setup for spectrum emission mask

Procedure

Measurement with the FSx

1. Press the hardkey **Meas** and select **Spectrum Emission Mask**

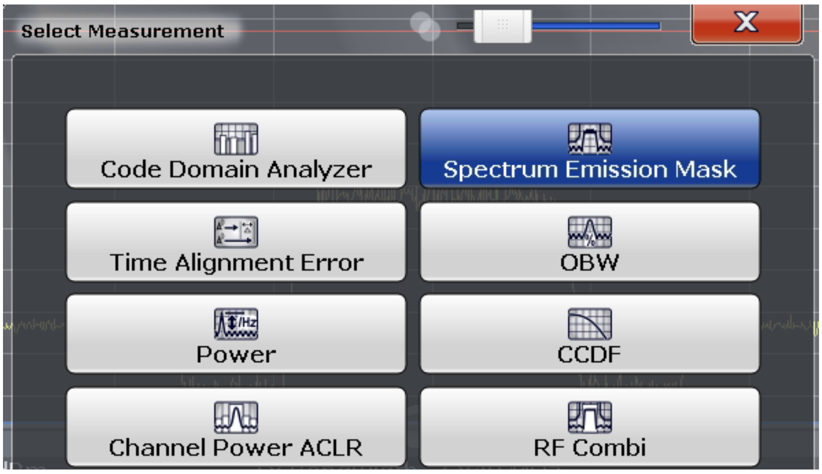


Fig. 3-69: FSW: select Spurious Emission from measurement section

2. Set **Standard** of the employed BS (Normal or Home BS) on the right softkey column.

3. Press **Power Class** and select the employed power class. Please refer to TS25.141, clause 6.5.2.1.5 for further details on power class.

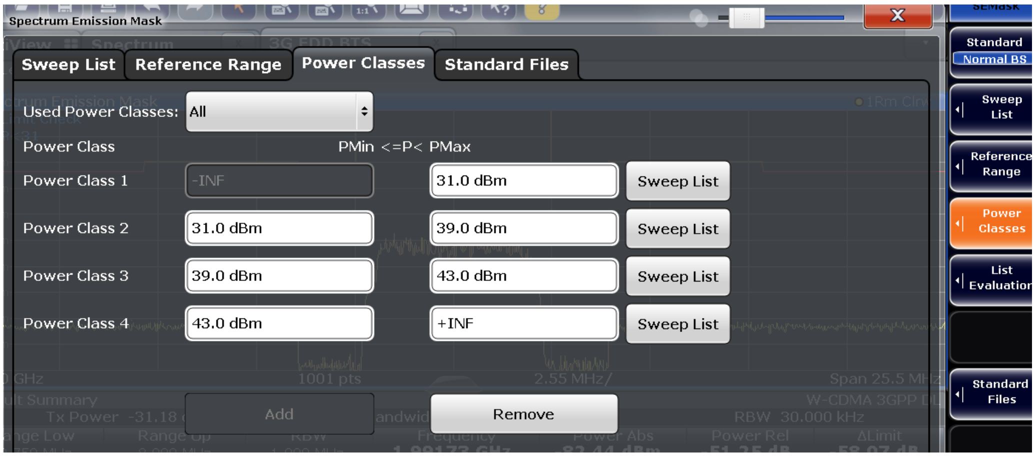
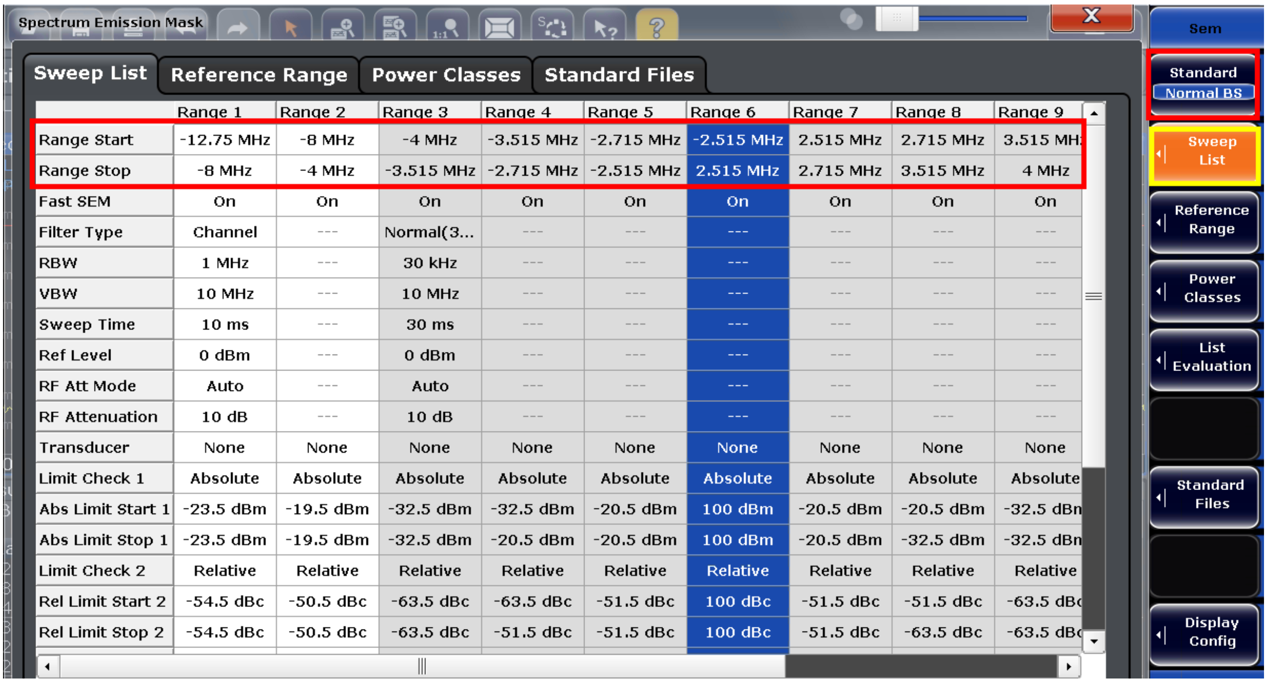


Fig. 3-70: Select the used power class of BS

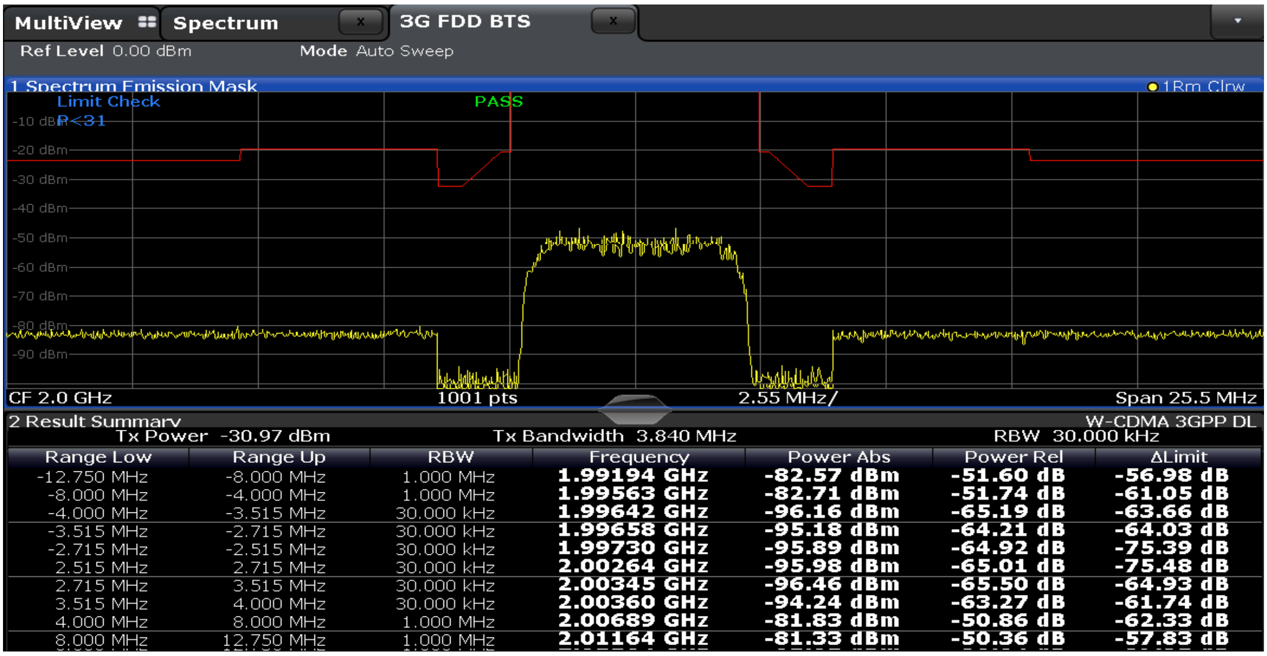
4. Press **Sweep list**. All the settings are predefined according to the selected BS Standard and Power class



	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8	Range 9
Range Start	-12.75 MHz	-8 MHz	-4 MHz	-3.515 MHz	-2.715 MHz	-2.515 MHz	2.515 MHz	2.715 MHz	3.515 MH
Range Stop	-8 MHz	-4 MHz	-3.515 MHz	-2.715 MHz	-2.515 MHz	2.515 MHz	2.715 MHz	3.515 MHz	4 MHz
Fast SEM	On	On	On	On	On	On	On	On	On
Filter Type	Channel	---	Normal(3...	---	---	---	---	---	---
RBW	1 MHz	---	30 kHz	---	---	---	---	---	---
VBW	10 MHz	---	10 MHz	---	---	---	---	---	---
Sweep Time	10 ms	---	30 ms	---	---	---	---	---	---
Ref Level	0 dBm	---	0 dBm	---	---	---	---	---	---
RF Att Mode	Auto	---	Auto	---	---	---	---	---	---
RF Attenuation	10 dB	---	10 dB	---	---	---	---	---	---
Transducer	None	None	None	None	None	None	None	None	None
Limit Check 1	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute
Abs Limit Start 1	-23.5 dBm	-19.5 dBm	-32.5 dBm	-32.5 dBm	-20.5 dBm	100 dBm	-20.5 dBm	-20.5 dBm	-32.5 dBn
Abs Limit Stop 1	-23.5 dBm	-19.5 dBm	-32.5 dBm	-20.5 dBm	-20.5 dBm	100 dBm	-20.5 dBm	-32.5 dBm	-32.5 dBn
Limit Check 2	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative
Rel Limit Start 2	-54.5 dBc	-50.5 dBc	-63.5 dBc	-63.5 dBc	-51.5 dBc	100 dBc	-51.5 dBc	-51.5 dBc	-63.5 dBc
Rel Limit Stop 2	-54.5 dBc	-50.5 dBc	-63.5 dBc	-51.5 dBc	-51.5 dBc	100 dBc	-51.5 dBc	-63.5 dBc	-63.5 dBc

Fig. 3-71: Sweep list for Spectrum emission mask. Example: ranges start from -12.75 and stop at 12.50 MHz for normal BS. RBW is also set accordingly.

The basic requirements tables 6.18 to 6.21 are automatically set by the FSx. A global **Limit Check is shown in the top line.**



Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	1.99194 GHz	-82.57 dBm	-51.60 dB	-56.98 dB
-8.000 MHz	-4.000 MHz	1.000 MHz	1.99563 GHz	-82.71 dBm	-51.74 dB	-61.05 dB
-4.000 MHz	-3.515 MHz	30.000 kHz	1.99642 GHz	-96.16 dBm	-65.19 dB	-63.66 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	1.99658 GHz	-95.18 dBm	-64.21 dB	-64.03 dB
-2.715 MHz	-2.515 MHz	30.000 kHz	1.99730 GHz	-95.89 dBm	-64.92 dB	-75.39 dB
2.515 MHz	2.715 MHz	30.000 kHz	2.00264 GHz	-95.98 dBm	-65.01 dB	-75.48 dB
2.715 MHz	3.515 MHz	30.000 kHz	2.00345 GHz	-96.46 dBm	-65.50 dB	-64.93 dB
3.515 MHz	4.000 MHz	30.000 kHz	2.00360 GHz	-94.24 dBm	-63.27 dB	-61.74 dB
4.000 MHz	8.000 MHz	1.000 MHz	2.00689 GHz	-81.83 dBm	-50.86 dB	-62.33 dB
8.000 MHz	12.750 MHz	1.000 MHz	2.01164 GHz	-81.33 dBm	-50.36 dB	-57.83 dB

Fig. 3-72: FSW: Example for a Spurious Measurment in the FSx.

Demo program

Special parameters must be defined for this test. The output power and other measurements are reported. The global limit check is reported in line **Over All**. Simulation is supported via path 1 of the SMx.

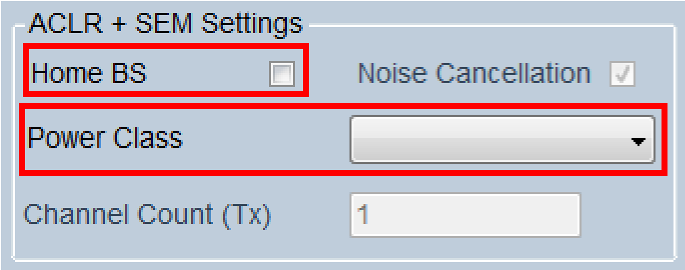


Fig. 3-73: special setting for SEM

*********** 6.5.2.1 Spectrum Emission Mask *************

General Settings:
Scrambling Code:0000
FSx Attenuation:0.00 dB
BS Standard: Normal BS, Power Class 1

SEM (Range)	Start (MHz)	Stop (MHz)	RBW (MHz)	Level (dBm)	Status
6.5.2.1 Spectrum Emission Mask					
Range 0	-12.750	-8.000	1.000	-76.57	Ignored
Range 1	-8.000	-4.000	1.000	-76.72	Ignored
Range 2	-4.000	-3.515	0.030	-90.53	Ignored
Range 3	-3.515	-2.715	0.030	-91.10	Ignored
Range 4	-2.715	-2.515	0.030	-90.77	Ignored
Range 5	2.515	2.715	0.030	-92.23	Ignored
Range 6	2.715	3.515	0.030	-90.29	Ignored
Range 7	3.515	4.000	0.030	-90.20	Ignored
Range 8	4.000	8.000	1.000	-76.71	Ignored
Range 9	8.000	12.750	1.000	-76.45	Ignored
Over all	-	-	-	True	Ignored

FSx: 0,"No error"
Time: 9/24/2014 11:54:14 AM

Fig. 3-74: Example report for test case 6.5.2.1

3.5.2.2 Adjacent Channel Leakage power Ratio (ACLR) (Clause 6.5.2.2)

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the RRC filtered mean power centered on the assigned channel frequency to the RRC filtered mean power centered on an adjacent channel frequency. [1]

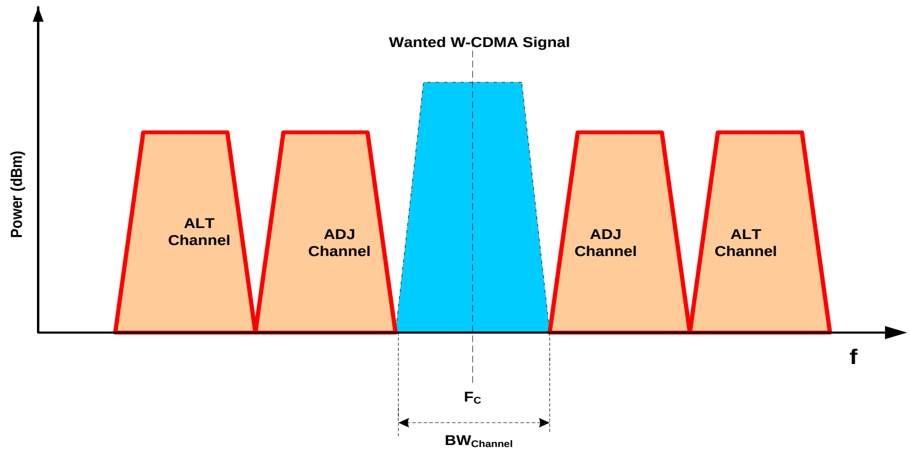


Fig. 3-75: ACLR for Single Carrier; red marks are the measurement regions

The aim is to verify that the adjacent channel leakage power ratio requirement meets the specified minimum requirement.

Requirements for ACLR	
BS channel offset below the first or above the last carrier frequency used	**ACLR limit**
5 MHz	≥ 44.2 dB
10 MHz	≥ 49.2 dB
Note* : Special rules apply for certain regions and for Home BS [1]	

Table 3-13: Limits for ACLR

Test Setup

1. The DUT (base station) transmits at the declared maximum PRAT using TM1 for channel set up

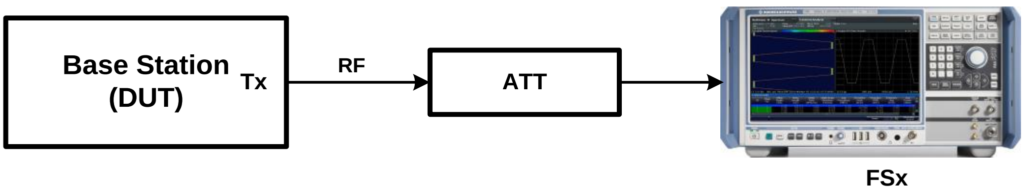


Fig. 3-76: Test setup for adjacent channel leakage power ratio

Procedure

Measurement with the FSx

Single Carrier

1. Start the measurement using hardkey **MEAS** and click **Channel Power ACLR**

2. Set **Standard** of the BS (Home or Normal) (Fig. 3-77)

3. Under **CP/ACLR Config** tab, set the corresponding parameters under "General Settings" and "Channel Settings" sections. The measurement for single carrier scenarios automatically takes data such as bandwidth and spacing from the signal description (Fig. 3-77, Fig. 3-78)

Fig. 3-77: ACLR: general settings

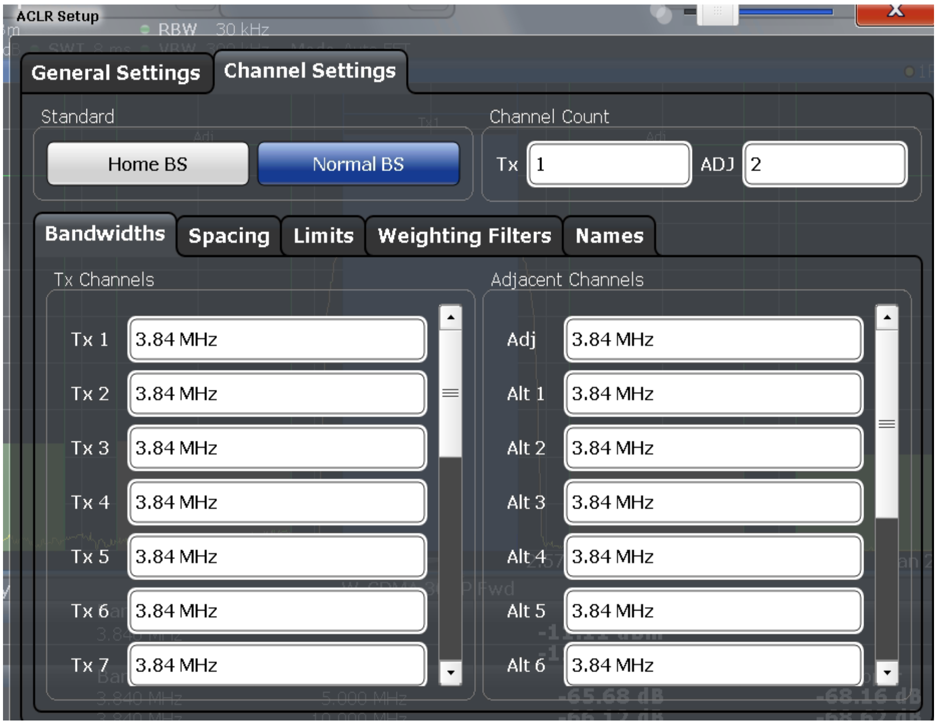


Fig. 3-78: ACLR: channel settings: bandwidth for Tx and adjacent channels

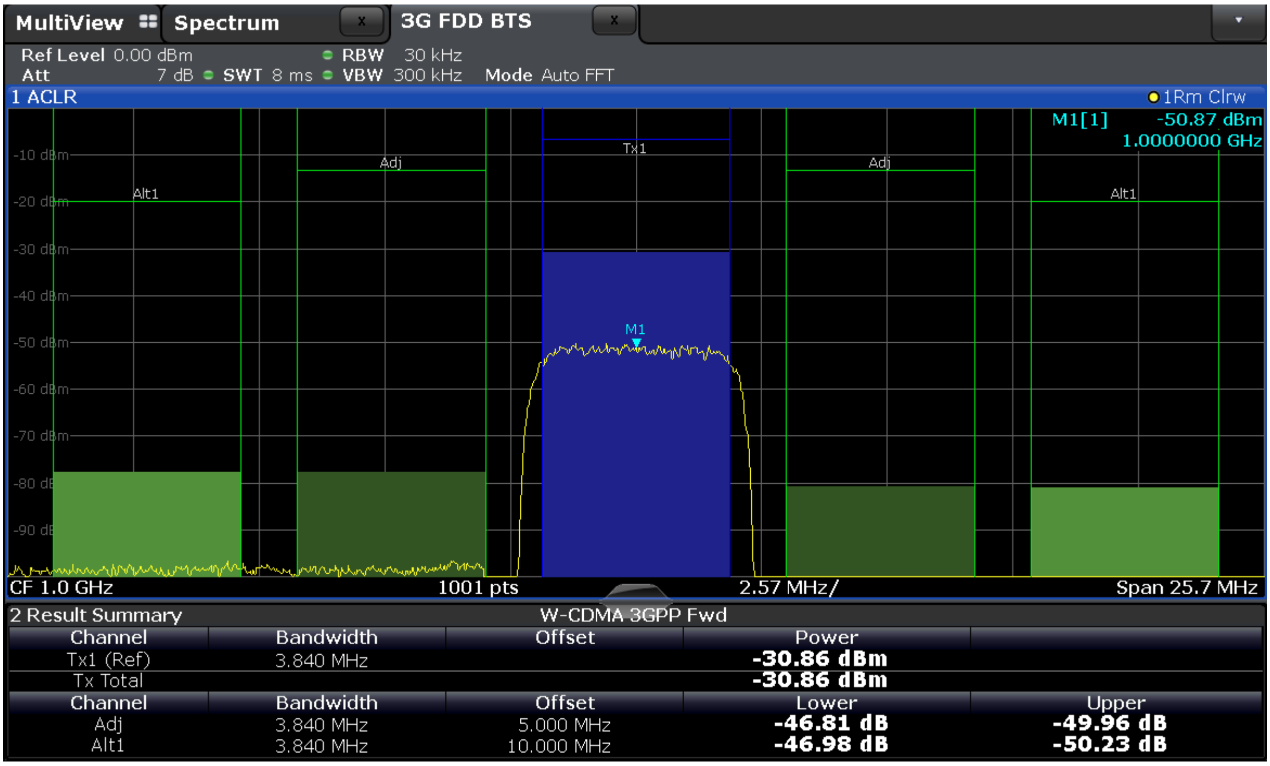


Fig. 3-79: ACLR for single carrier for 5 MHz and 10 MHz offsets

Multicarrier

The procedure used to measure signals with multiple carriers is the same in principle as for SC. Only the number of carriers needs to be set. (Fig. 3-80)

The overall center frequency is calculated automatically.

- **Odd number of Tx channels:** The middle Tx channel is centered to center frequency
- **Even number of Tx channels:** The two Tx channels in the middle are used to calculate the frequency between those two channels. The frequency is aligned to the center frequency.

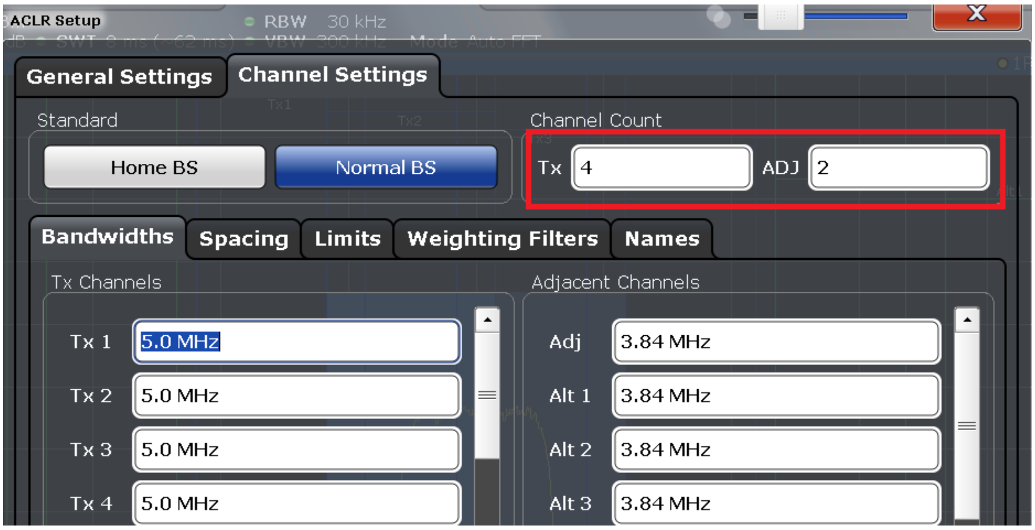


Fig. 3-80: Set the number of carriers in channel settings

Demo Program

For this test, additional settings are required. The output power and other measurements are reported. Simulation is supported via path 1 of the SMx.

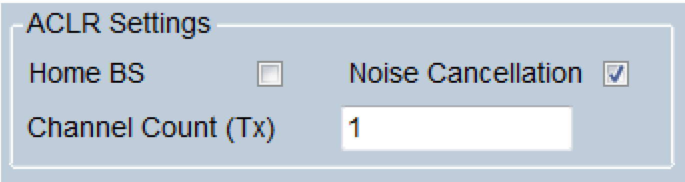


Fig. 3-81: Special setting for ACLR

Check **Noise Cancellation** to correct the result using the FSx's inherent noise. Check **Home BS** to switch between Home BS and Normal BS. The Number of Transmitted channel can be entered directly via **Channel Count (Tx).**

*********** 6.5.2.2 Adjacent Channel Leakage power ratio (ACLR) **************

General Settings:
Center Frequency:2200 MHz
Scrambling Code:123F
FSx Attenuation:0.00 dB
Noise Cancellation: ON

Power (Range)				Level (dBm)	Status
6.5.2.2 Adjacent Channel Leakage power ratio (ACLR)					
Power Tx Channel				-36.11	Ignored
Power Adjacent Channel lower				-56.12	Ignored
Power Adjacent Channel higher				-57.03	Ignored
Power Alternate Channel lower				-57.20	Ignored
Power Alternate Channel higher				-57.13	Ignored
Over all	-	-	-	True	Ignored

Time: 9/15/2014 2:05:23 PM

Fig. 3-82: Example report for test case 3.5.2.2

3.5.3 Spurious emissions (Clause 6.5.3)

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

The requirements (except 6.5.3.7.6 and 6.5.3.7.9 and specifically stated exceptions in Table 6.38 in TS25.141) apply at frequencies within the range from 9 KHz to 12.75 GHz, which are more than 12.5 MHz under the first carrier frequency used or more than 12.5 MHz above the last carrier frequency used.[1]

This test verifies that the spurious emission from the BS transmitter antenna connector is within the allowed margin.

Table 3-14, Table 3-15 and Table 3-16 show the requirements for spurious emission.

Spurious Emission (Category A)		
Band	**Maximum level**	**Measurement Bandwidth**
9 kHz ↔ 150 kHz	-13 dBm	1 kHz
150 kHz ↔ 30 MHz		10 kHz
30 MHz ↔ 1 GHz		100 kHz
1 GHz to 12,75 GHz		1 MHz

Table 3-14: BS Mandatory spurious emissions limits, Category A

Spurious Emission (operating band I, II, III, IV, VII, X, XXV (Category B))		
Band	**Maximum Level**	**Measurement Bandwidth**
9 kHz ↔ 150 kHz	-36 dBm	1 kHz
150 kHz ↔ 30 MHz		10 kHz
30 MHz ↔ 1 GHz		100 kHz
1 GHz ↔ F_{low} - 10 MHz	-30 dBm	1 MHz
F_{low} - 10 MHz ↔ F_{high} + 10 MHz	-15 dBm	
F_{high} + 10 MHz ↔ 12.75 GHz	-30 dBm	
Key: F_{low}: The lowest downlink frequency of the operating band F_{high}: The highest downlink frequency of the operating band		

Table 3-15: BS Mandatory spurious emissions limits, operating band I, II, III, IV, VII, X, XXV

Spurious Emission (operating band V, VIII, XII, XIII, XIV, XX (Category B))		
Band	**Maximum Level**	**Measurement Bandwidth**
9 kHz ↔ 150 kHz	-36 dBm	1 kHz
150 kHz ↔ 30 MHz		10 kHz
30 MHz ↔ Flow - 10 MHz		100 kHz
Flow - 10 MHz ↔ Fhigh + 10 MHz	-16 dBm	
Fhigh + 10 MHz ↔ 1 GHz	-36 dBm	
1GHz ↔ 12.75GHz	-30 dBm	1 MHz
Key: F_{low}: The lowest downlink frequency of the operating band. F_{high}: The highest downlink frequency of the operating band.		

Table 3-16: BS Mandatory spurious emissions limits, operating band V, VIII, XII, XIII, XIV, XX

The following parameters additionally apply for the protection of the base station receiver for band I to XXV:

Protection for the BS Receiver			
BS	**Frequency Range**	**Maximum level**	**Measurement bandwidth**
Wide Area BS	F_{low} – F_{high}	-96dBm	100 kHz
Medium Range BS		-86dBm	
Local Area BS/ Home BS		-82 dBm	

Table 3-17: Requirements for the protection of the receiver for band I to XXV

Note: Additional limits apply for regional coexistence scenarios. These are dependent on the operating band in accordance with Tables 6.38 through 6.47 in TS25.141

Test Setup

The DUT (base station) transmits at the declared maximum PRAT using TM1 for channel set up.

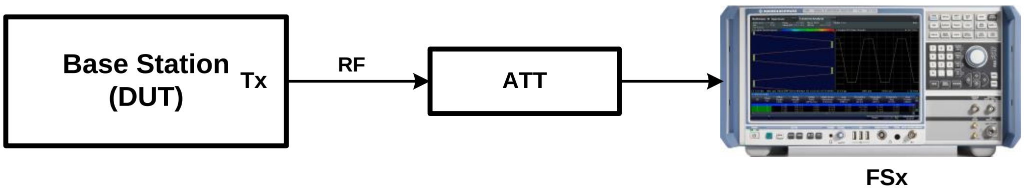


Fig. 3-83: Test setup for spurious emission

Procedure

Measurement with the FSx

1. In spectrum mode, select **MEAS** and then **Spurious Emissions**
2. Select frequency via harkey **FREQ**
3. Check **Sweep list** and adapt necessary settings. The predefined level values apply for Category A. Exclude frequencies between 12.5 MHz below the first

carrier frequency and 12.5 MHz above the last carrier frequency. Example: for operating band I (1920-1980 MHz), frequency range “1907.5 MHz to 1992.5” MHz is excluded.

4. Press **Adjust X-Axis**

Spurious Emissions

	Range 1	Range 2	Range 3	Range 4	Range 5
Range Start	9 kHz	150 kHz	30 MHz	1 GHz	1.9925 GHz
Range Stop	150 kHz	30 MHz	1 GHz	1.9075 GHz	12.75 GHz
Filter Type	Normal(3...	Normal(3...	Normal(3...	Normal(3...	Normal(3...
RBW	1 kHz	10 kHz	100 kHz	1 MHz	3 MHz
VBW	3 kHz	30 kHz	300 kHz	3 MHz	3 MHz
Sweep Time Mode	Auto	Auto	Auto	Auto	Auto
Sweep Time	14.1 ms	29.9 ms	32.1 ms	32.1 ms	64.6 ms
Detector	RMS	RMS	RMS	RMS	RMS
Ref Level	0 dBm	0 dBm	0 dBm	0 dBm	0 dBm
RF Att Mode	Auto	Auto	Auto	Auto	Auto
RF Attenuation	10 dB	10 dB	10 dB	10 dB	10 dB
Sweep Points	701	4001	32001	32001	101
Stop After Sweep	Off	Off	Off	Off	Off
Transducer	None	None	None	None	None
Limit Check	Absolute	Absolute	Absolute	Absolute	Absolute
Abs Limit Start	-13 dBm	-13 dBm	-13 dBm	-13 dBm	-13 dBm
Abs Limit Stop	-13 dBm	-13 dBm	-13 dBm	-13 dBm	-13 dBm

Fig. 3-84: Spurious emissions: Example for the predefined sweep list according to category A (Table 3-14). 1907.5 to 1992.5 MHz is excluded (example for Operating band I).

Fig. 3-85 shows the Spurious Emissions measurement. The top line shows a global limit check.

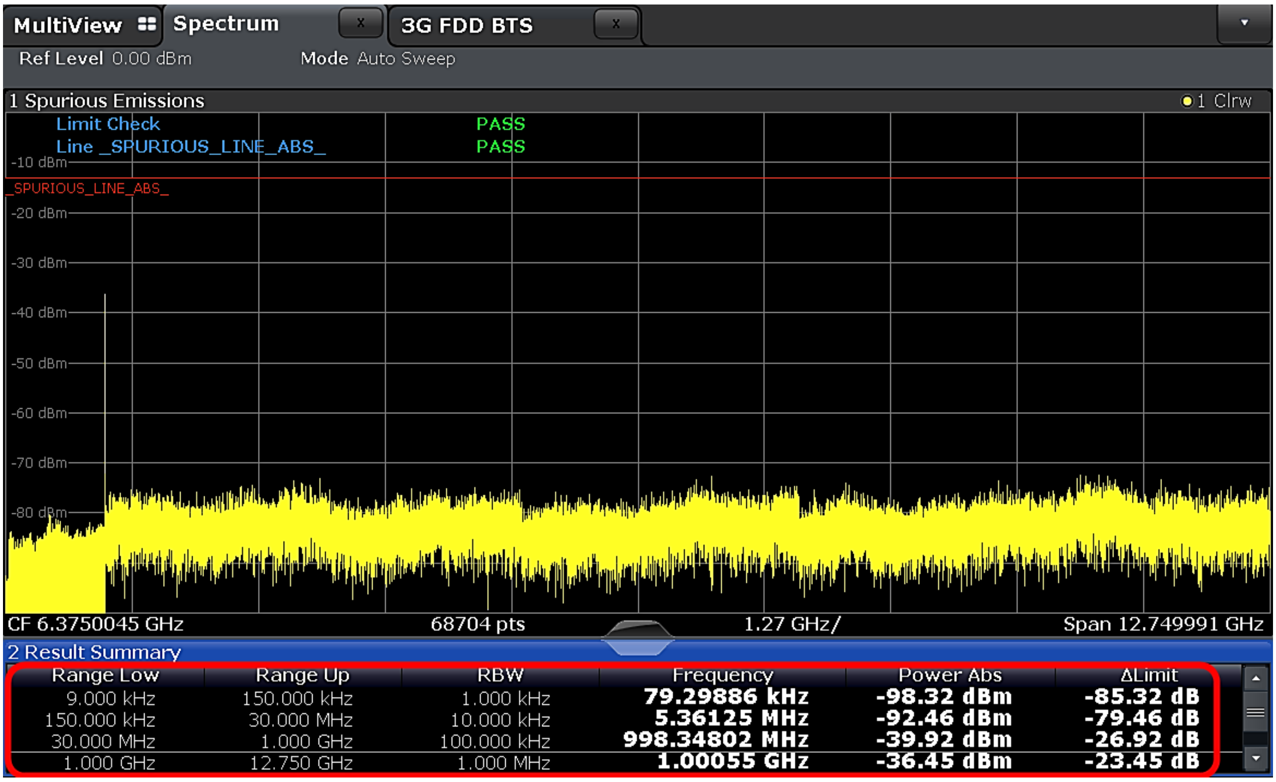


Fig. 3-85: Spurious emission from 9 kHz up to 12.75 GHz. Limit check is displayed at the top line. The results for individual ranges are displayed in the result summary section (at the bottom)

Demo Program

No further special setting is needed for this test. The output power and other measurements are reported. Simulation is supported via path 1 of the SMx.

********** 6.5.3 Spurious emissions **************

General Settings:
Scrambling Code:123F
FSx Attenuation:0.00 dB

Test Item	Start (MHz)	Stop BW (MHz)	RBW (MHz)	dBm	Status
6.5.3 Spurious emissions					
Power 0	0.009	0.15	0.001	-93.17	Ignored
Power 1	0.150	30.00	0.010	-91.23	Ignored
Power 2	30.000	1000.00	0.100	-83.99	Ignored
Power 3	1000.000	8000.00	1.000	-35.73	Ignored
Over all	-	-	-	True	Ignored

FSx: 0,"No error"
Time: 9/15/2014 2:05:54 PM

Fig. 3-86: Example report for test case 3.5.3

3.6 Transmit intermodulation (Clause 6.6)

The transmit intermodulation performance is a measure of the capability of the transmitter to inhibit the generation of signals in its nonlinear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna.

The transmit intermodulation level is the power of the intermodulation products when a WCDMA modulated interference signal is injected into an antenna connector at a mean power level of 30 dB lower than that of the mean power of the wanted signal.[1]

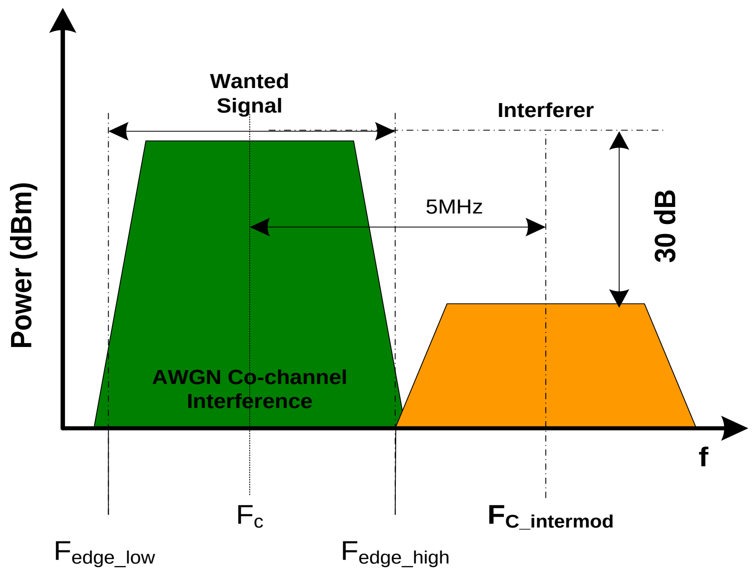


Fig. 3-87: Transmit Intermodulation

The interfering signal frequency offset from the subject signal carrier frequency shall be according to Table 3-18. The requirements are applicable only for single carrier.

Transmit intermodulation	
Parameter	**Value**
Interfering signal frequency offset from the subject signal carrier frequency	±5 MHz
	±10 MHz
	±15 MHz

Table 3-18: Interfering signal frequency offset

The test purpose is to verify the ability of the BS transmitter to restrict the generation of intermodulation products in its nonlinear elements caused by presence of the wanted signal and an interfering signal.

Transmit intermodulation level shall not exceed the out of band emission or the spurious emission requirements of sub-clauses 3.5.2 and 3.5.3 in the relevant frequency range in the presence of the interferer.

Test Setup

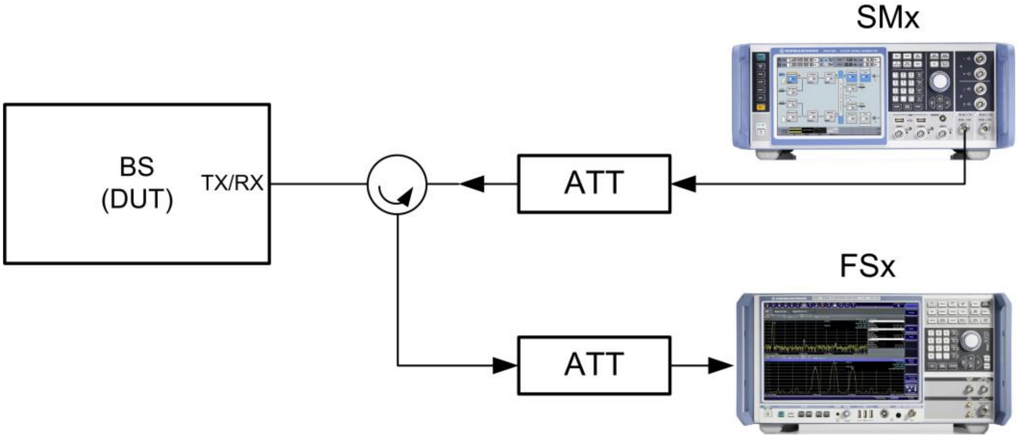


Fig. 3-88: Test setup for Transmit intermodulation

Overview of setting:

- The DUT (base station) generates the wanted W-CDMA signal and transmit at max. allowed output power using TM1
- The SMx generates the W-CDMA signal as adjacent channel using TM1 and frequency offsets according to Table 3-18

Procedure

Generating Downlink Signal with the SMx

1. Select W-CDMA **(3GPP FDD)** in the Baseband block A

Fig. 3-89: SMW: select 3GPP FDD to generate W-CDMA signal

2. Select the trigger **Mode** under "Trigger In" section. Select the trigger **Source** as well in case of external trigger.

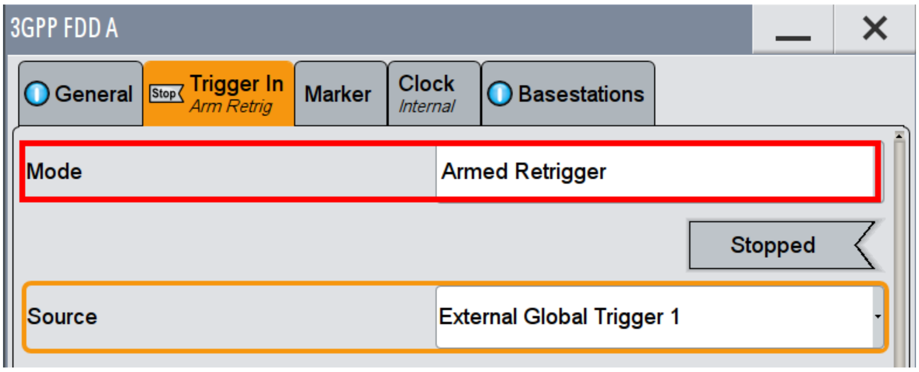


Fig. 3-90: Select Trigger Mode and Trigger Source

R&S signal generators offer “Test Case Wizard” for quick and easy generation of signal according to standard. It opens a configuration menu with a selection of predefined settings according to test cases in TS 25.141. The default settings are set according to the standard. It is also possible to generate user defined signal by changing the “General Setting”.

3. Go to the **Test Case Wizard** tab

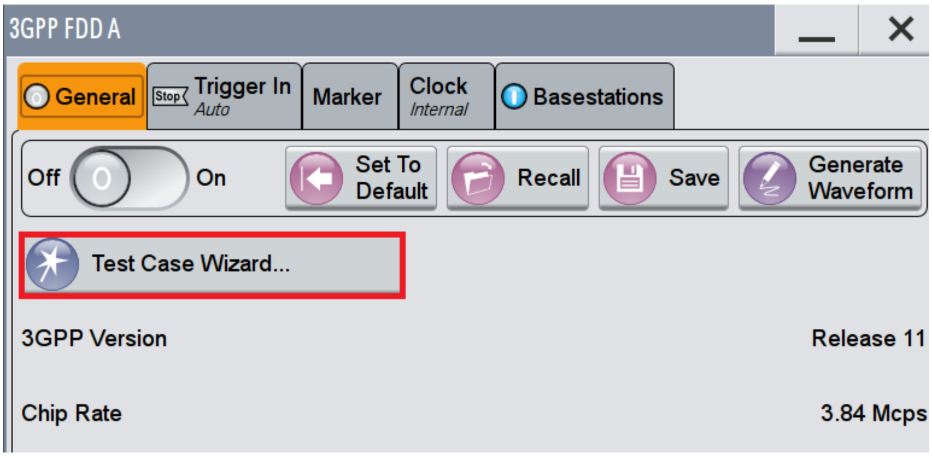


Fig. 3-91: SMW: Test Case Wizard for W-CDMA

4. Select Test case **6.6 Transmit Intermodulation**

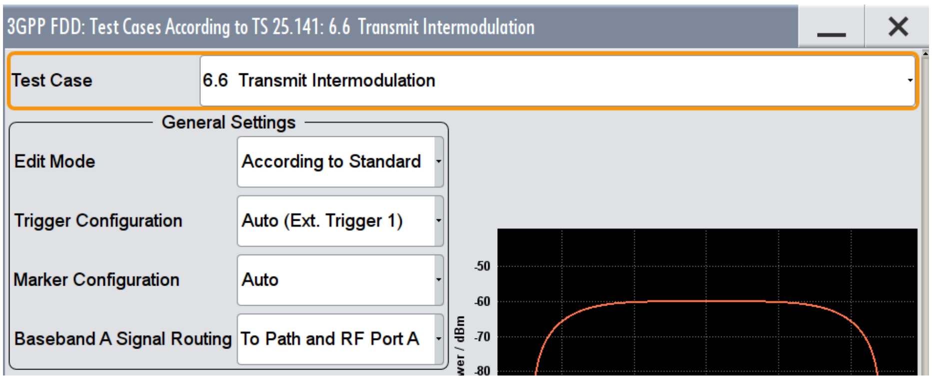


Fig. 3-92: Select Test Case 6.6

5. Select **According to Standard** in the **Edit Mode** under **General Settings** menu to generate a signal according to 3GPP standard.
6. Select **Unchanged** in the “Trigger Configuration” section
7. Enter the uplink **Scrambling Code** for the generator
8. Set the **RF frequency** and **Power Level** under the “Wanted Signal” section.

   (Fig. 3-93)
9. In the Interferer Configuration section**,** select **Interference Model** and **Frequency Offset. (**Fig. 3-93)
10. **Interferer Level/Wanted Signal Level** is be set as -30.00 dB according to standard

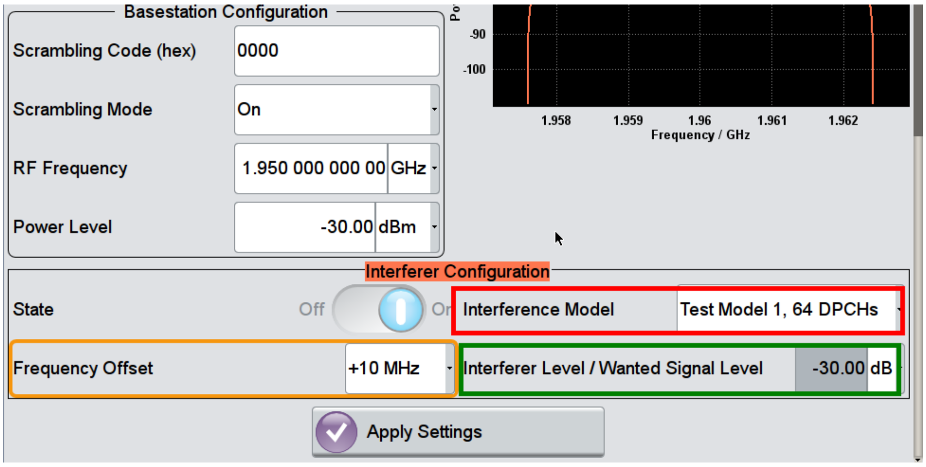


Fig. 3-93: Select the test model and the frequency offset of the interfering signal

11. Press **Apply Settings**

Measurement with the FSx

The measurements shall be limited to the frequency ranges of all third order and fifth order intermodulation products, excluding the channel bandwidths of the wanted and interferer signal.

The measurement regions are calculated according to the table:

Measurement regions calculation		
Order of intermodulation products	**Center frequency**	**Intermodulation width**
3rd order	F1 ± 2F2	15 MHz
	2F1 ± F2	
5th order	2F1 ± 3F2	25 MHz
	3F1 ± 2F2	
	4F1 ± F2	
	F1 ± 4F2	
Note: F1: Wanted Signal, F2: Interferer		

Table 3-19: Measurement regions for the intermodulation product

Ranges, which are calculated with subtraction and which have small distance to the wanted signal, may overlap with the wanted signal or the interferer (see example in Fig. 3-94). The ranges shall be adjusted accordingly. In principle, the following intermodulation products (ranges) can be affected:

- 2F1 - F2
- F1 - 2F2
- 3F1 - 2F2
- 2F1 – 3F2

The settings are explained in this example:

- Wanted signal, F1 = 2 GHz with BW = 5 MHz
- Interferer offset = 5 MHz
- Interfering Signal, F2 = 2 GHz+5 MHz = 2.005 GHz
- The third order intermodulation product at 2F1-F2 = 1.995 GHz with intermodulation BW 15 MHz
- 3rd order intermodulation products with intermodulation BW = 15 MHz
  - 2F1+F2 = 6.005 GHz
  - 2F1-F2 = 1.995 GHz
  - 2F2+F1 = 6010 GHz
  - 2F2-F1 = 2010 GHz

The ranges for the 5th order can be calculated using the same method.

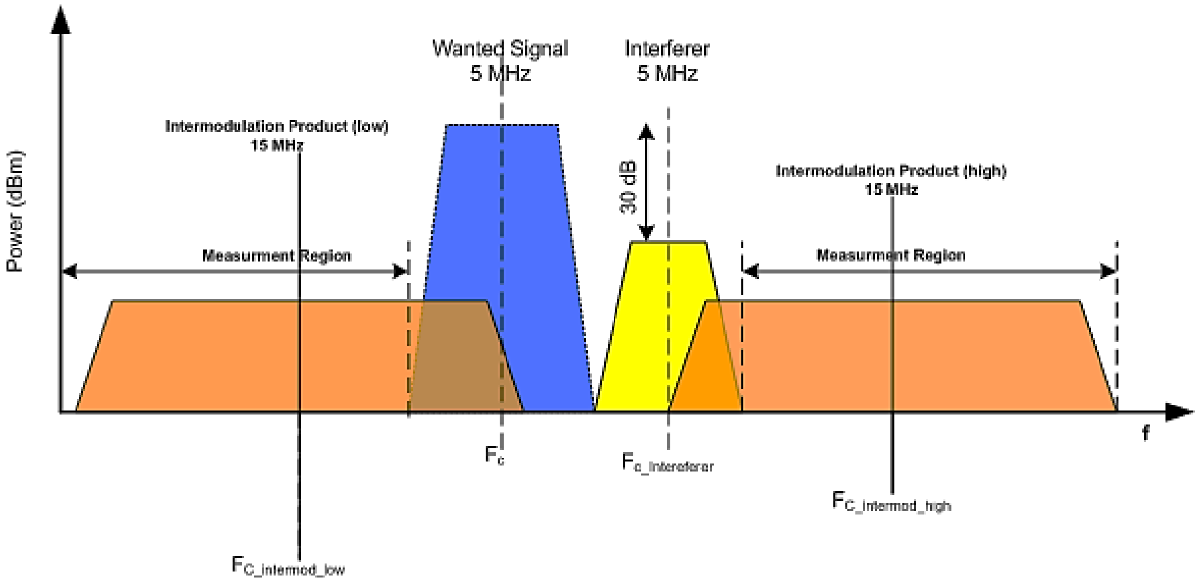


Fig. 3-94: Measurement regions for the intermodulation test. Regions that overlap with the wanted signal or the interferer shall not be included

The regions to be measured can be calculated as follows:

$\mathbf{BW}_{Meas\_region\_low} = \mathbf{F_C} - \mathbf{BW}/2 - (\mathbf{F}_{C\_Intermod\_low} - \mathbf{BW}_{Intermod\_width\_low}/2)$

$\mathbf{BW}_{Meas\_region\_high} = \mathbf{F}_{C\_Intermod\_high} + \mathbf{BW}_{Intermod\_width\_high}/2 - (\mathbf{F}_{C\_Intermod\_high} + \mathbf{BW}_{Interferer}/2)$

The same conditions apply for these measurements as for:

- Spectrum emission mask
- Adjacent Power leakage Power Ratio
- Spurious Emissions

The measurement regions can be limited to the regions containing intermodulation products.

Spectrum emission mask

The procedure for the spurious emission test is the same as described for Spurious emission mask in section 3.5.2.1

ACLR

The procedure for the ACLR measurement is the same as described for ACLR in section 3.5.2.2, except that the measurement regions shall be adopted:

1. Start the ACLR test
2. Set the intermodulation bandwidth as the bandwidth for the **ADJ** channel

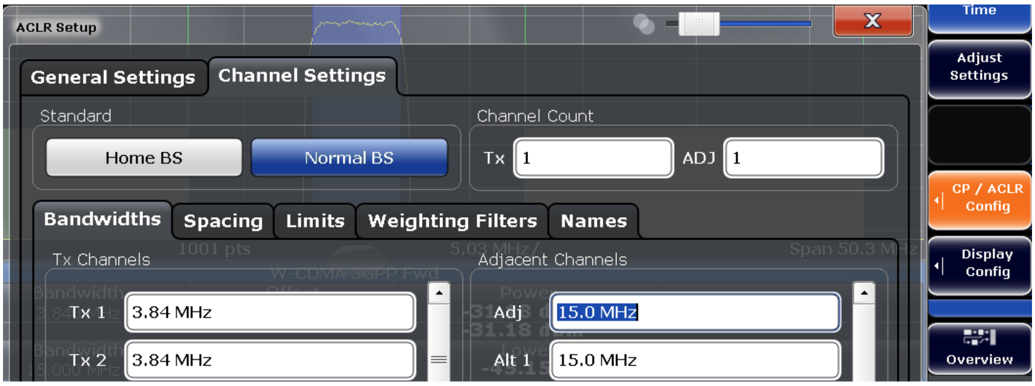


Fig. 3-95: Transmit intermodulation: set the bandwidths

5. Set the offset of the intermodulation product under “Spacing” menu

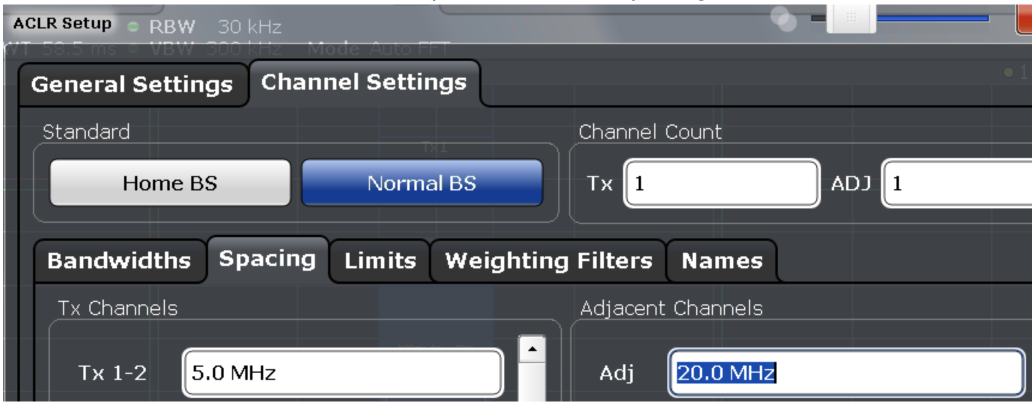


Fig. 3-96: Transmit intermodulation: set the intermodulation product spacing

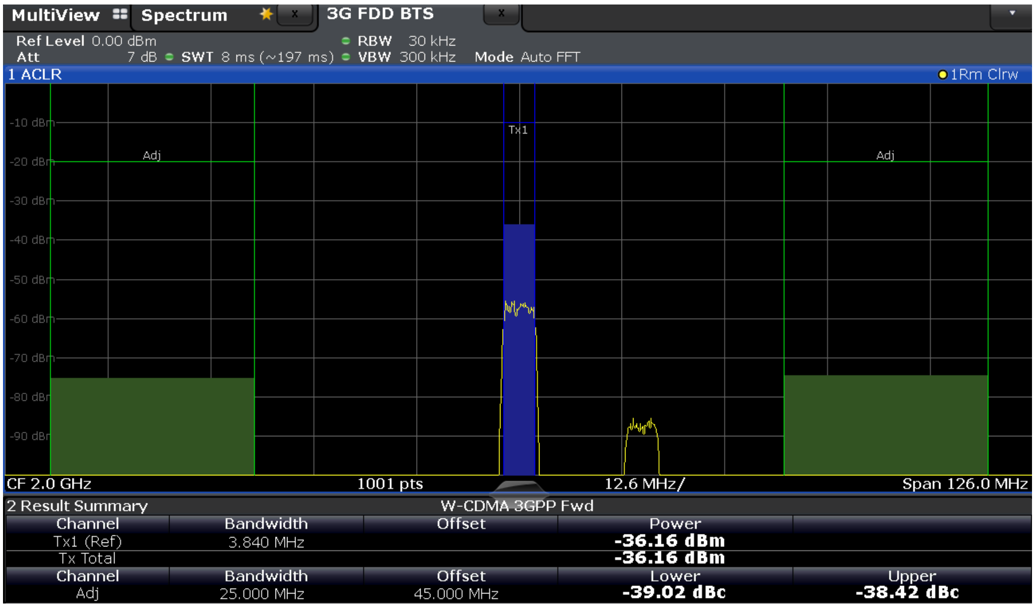


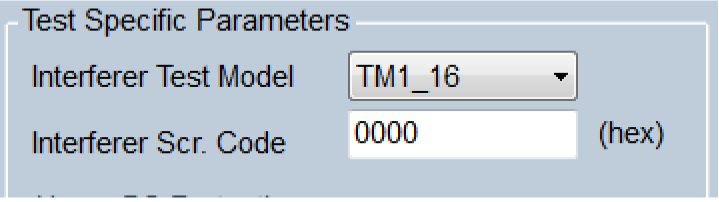
Fig. 3-97: Transmit intermodulation: measure the intermodulation product

Spurious Emissions

The procedure for the spurious emission test is the same as described for Spurious emissions in section 3.5.3.

Demo Program

This test requires additional settings. The level of the interfering signal is calculated from the Wanted Signal Power and Interferer/Wanted Level which can be entered directly. The test is a combination of ACLR, SEM and Spurious Emission. The measured regions are reported.



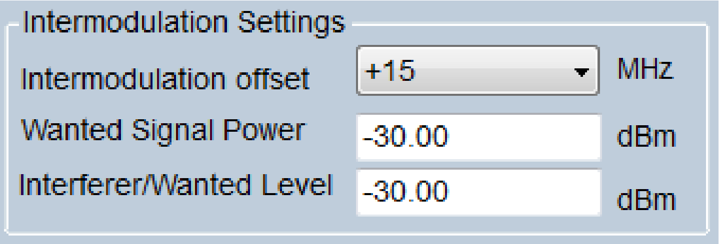


Fig. 3-98: Special settings for transmitter intermodulation.

********* 6.6 Transmit Intermodulation ************

General Settings:
Wanted Signal Power :-20.00 dBm
Interfeing Signal Power :-30.00-20.00 dBm
Wanted Signal Scrambling Code:0000
Adjacent Signal Scrambling Code:0000
FSx Attenuation:0.00 dB
SMx Attenuation:0.00 dB

Test Item	Start (MHz)	Stop (MHz)	RBW (MHz)	Level (dBm)	Status
6.6 Tx Intermodulation Spurious Emissions					
Power 0	0.0	0.2	0.001	-99.33	Ignored
Power 1	0.2	30.0	0.010	-90.64	Ignored
Power 2	30.0	1000.0	0.100	-83.34	Ignored
Power 3	1000.0	4000.0	1.000	-50.36	Ignored
Over all	-	-	-	True	Ignored

FSx: 0,"No error"

SEM (Range)	Start (MHz)	Stop (MHz)	RBW (MHz)	Level (dBm)	Status
6.6 Tx Intermodulation Spectrum Emission Mask					
Power 0	-12.750	-8.000	1.000	-83.06	Ignored
Power 1	-8.000	-4.000	1.000	-55.95	Ignored
Power 2	-4.000	-3.515	0.030	-68.41	Ignored
Power 3	-3.515	-2.715	0.030	-70.56	Ignored
Power 4	-2.715	-2.515	0.030	-91.66	Ignored
Power 5	2.515	2.715	0.030	-97.29	Ignored
Power 6	2.715	3.515	0.030	-99.87	Ignored
Power 7	3.515	4.000	0.030	-97.47	Ignored
Power 8	4.000	8.000	1.000	-83.08	Ignored
Power 9	8.000	12.750	1.000	-82.78	Ignored
Over all	-	-	-	True	Ignored

FSx: 0,"No error"

Power (Range)	Meas Freq (MHz)	Channel BW (MHz)		Level (dBm)	Status
6.7 TX Intermodulation ACLR @ 2f1 - f2					
Power Tx Channel				-83.05	Ignored
Power Meas Range higher	2007.5	10.00		4.15	Ignored

FSx: 0,"No error"

Power (Range)	Meas Freq (MHz)	Channel BW (MHz)		Level (dBm)	Status
6.7 TX Intermodulation ACLR @ 2f2 - f1					
Power Tx Channel				-83.17	Ignored
Power Meas Range lower	1987.5	10.00		11.16	Ignored

FSx: 0,"No error"

Power (Range)	Meas Freq (MHz)	Channel BW (MHz)		Level (dBm)	Status
6.7 TX Intermodulation ACLR @ 3f1 - 2f2					
Power Tx Channel				-82.96	Ignored
Power Meas Range higher	2012.5	20.00		7.03	Ignored

FSx: 0,"No error"

Power (Range)	Meas Freq (MHz)	Channel BW (MHz)		Level (dBm)	Status
6.7 TX Intermodulation ACLR @ 3f2 - 2f1					
Power Tx Channel				-83.16	Ignored
Power Meas Range lower	1982.5	20.00		17.37	Ignored

FSx: 0,"No error"
Time: 9/15/2014 3:08:19 PM

Fig. 3-99: Example report for test case 6.6. The measurement is taken on the intermodulation products.

3.7 Transmit modulation (Clause 6.7)

3.7.1 Error Vector Magnitude (EVM) (Clause 6.7.1)

The Error Vector Magnitude (EVM) is a measure of the difference between the reference waveform and the measured waveform. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. [1]

Frequency error (Clause 6.3) and Total power dynamic range (Clause 6.4.4) is also be performed together with EVM test.

This test ensures that the EVM, Frequency error and Total dynamic mean power are within the limit specified by the minimum requirement.

Table 3-20 shows the requirements for Frequency error test.

Requirements for EVM	
Modulation	**EVM limit**
QPSK	<17.5%
16 QAM	<12.5%

Table 3-20: Limits for EVM

Table 3-21 shows the requirements for Frequency error test.

Requirements for Frequency error test		
BS class	**Minimum frequency error**	**Maximum frequency error**
Wide Area BS	-0.05 ppm - 12 Hz	+0.05 ppm + 12 Hz
Medium Range BS Local Area BS	-0.1 ppm - 12 Hz	+0.1 ppm + 12 Hz
Home BS	-0.25 ppm - 12 Hz	+0.25 ppm + 12 Hz

Table 3-21: Limits for Frequency error

Requirement for Total power dynamic range: The down link (DL) total power dynamic range shall be 17.7 dB or greater.

Test Setup

The DUT (base station) transmits at the declared maximum PRAT.

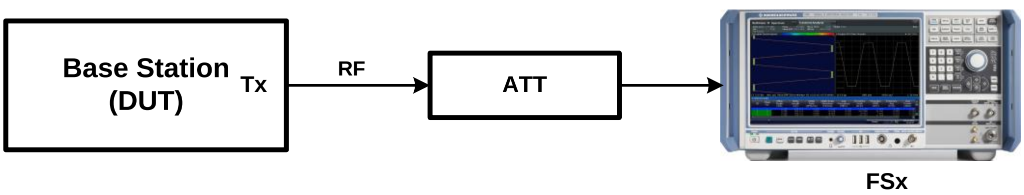


Fig. 3-100: Test setup for EVM

Procedure

This Test consists of two steps:

1. Set the base station to Pmax using TM1.

   At the FSx, the signal is demodulated for the test. The test results are displayed in a scalar overview under **Result Summary**. The procedure follows the basic instructions provided in section 3.1.1. Change the slot number using evaluation range and check result in all 15 slots.

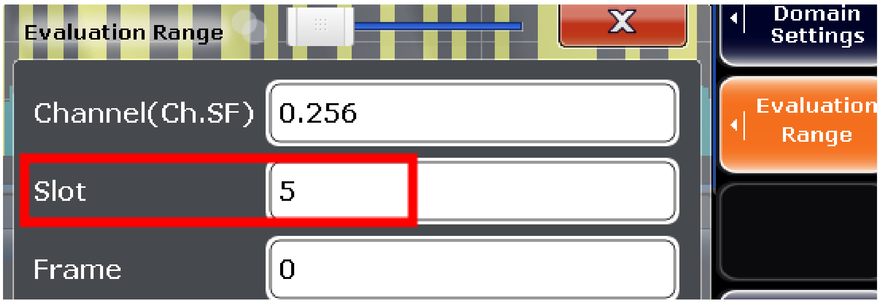


Fig. 3-101: Change slot number to display result for each slot.

The measured value of Error Vector Magnitude (**EVM**), **Frequency Error** and **Mean power** is shown at the bottom layer of in the **Result Summary** section.

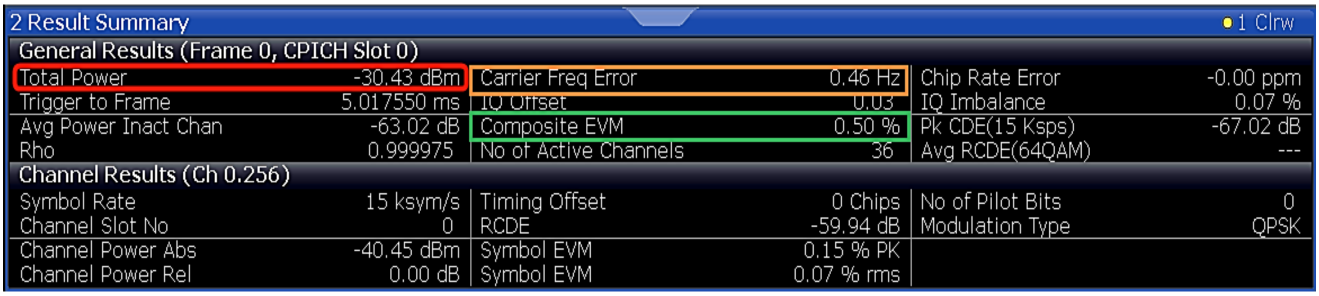


Fig. 3-102: Error Vector Magnitude, Frequency Error and Mean power for slot 0 in the Result Summary section

2.

   a) Set the base station to Pmax – **X** (**X**= 18) dB using TM4.

   b) Repeat step 1 (measure the total power)

   c) Calculate the BS total power dynamic from the difference between the measurement results of this test and the previous test using the Pmax.

   d) If the result does not fulfil the total power dynamic range requirement, set base station to lower power (set **X** greater than 18) and repeat the test.

3. Additional: If the BS supports HS-PDSCH transmission using 16QAM, repeat step 2 using TM5

Demo Program

This test requires special settings. The output power, EVM and frequency error measurements are reported for each slot. Simulation is supported via path 1 of the SMx.

Fig. 3-103: Special setting for EVM

If the BS supports HS-PDSCH transmission using 16QAM, check **HS-PDSCH (16 QAM).**

********** 6.3 Frequency Error/ 6.4.4 Total Power Dynamic Range / 6.7.1 EVM *************

General Settings:
Scrambling Code:123F
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Total Power (dBm)	Frequency Error (Hz)	EVM(%)	Status
6.3 Frequency Error/ 6.4.4 Total Power Dynamic Range / 6.7.1 EVM					
TM1 (Summary)	2200.00	-35.70	-62.65	0.72	Ignored
TM1, Slot 0	2200.00	-35.70	-62.65	0.18	Ignored
TM1, Slot 1	2200.00	-35.70	-62.92	0.13	Ignored
TM1, Slot 2	2200.00	-35.68	-62.81	0.14	Ignored
TM1, Slot 3	2200.00	-35.71	-62.86	0.13	Ignored
TM1, Slot 4	2200.00	-35.69	-62.48	0.13	Ignored
TM1, Slot 5	2200.00	-35.71	-62.23	0.18	Ignored
TM1, Slot 6	2200.00	-35.71	-62.81	0.15	Ignored
TM1, Slot 7	2200.00	-35.70	-62.42	0.17	Ignored
TM1, Slot 8	2200.00	-35.69	-63.29	0.14	Ignored
TM1, Slot 9	2200.00	-35.70	-62.64	0.17	Ignored
TM1, Slot 10	2200.00	-35.70	-62.72	0.16	Ignored
TM1, Slot 11	2200.00	-35.73	-62.42	0.17	Ignored
TM1, Slot 12	2200.00	-35.70	-63.55	0.18	Ignored
TM1, Slot 13	2200.00	-35.69	-62.44	0.15	Ignored
TM1, Slot 14	2200.00	-35.70	-63.35	0.14	Ignored
TM4 (Summary)	2200.00	-53.65	-62.90	5.51	Ignored
TM4, Slot 0	2200.00	-53.67	-62.59	0.30	Ignored
TM4, Slot 1	2200.00	-53.66	-61.03	0.53	Ignored
TM4, Slot 2	2200.00	-53.66	-62.24	0.47	Ignored
TM4, Slot 3	2200.00	-53.65	-63.02	0.41	Ignored
TM4, Slot 4	2200.00	-53.66	-62.07	0.43	Ignored
TM4, Slot 5	2200.00	-53.68	-62.35	0.44	Ignored
TM4, Slot 6	2200.00	-53.68	-62.29	0.58	Ignored
TM4, Slot 7	2200.00	-53.64	-63.11	0.47	Ignored
TM4, Slot 8	2200.00	-53.71	-63.32	0.49	Ignored
TM4, Slot 9	2200.00	-53.68	-63.41	0.49	Ignored
TM4, Slot 10	2200.00	-53.65	-63.65	0.40	Ignored
TM4, Slot 11	2200.00	-53.67	-61.43	0.44	Ignored
TM4, Slot 12	2200.00	-53.62	-62.35	0.49	Ignored
TM4, Slot 13	2200.00	-53.62	-62.68	0.46	Ignored
TM4, Slot 14	2200.00	-53.65	-62.90	0.47	Ignored
Dynamic Range (dB)	2200.00	17.96	---	---	Ignored

FSx: 0,"No error"
Time: 9/15/2014 2:07:08 PM

Fig. 3-104: Example report for test case 3.3

3.7.2 Peak Code Domain Error (PCDE) (Clause 6.7.2)

The Peak Code Domain Error (PCDE) is computed by projecting the error vector (as defined in clause 3.7.1) onto the code domain at a specific spreading factor. The Code Domain Error for every code in the domain is defined as the ratio of the mean power of the projection onto that code, to the mean power of the composite reference waveform. The Peak Code Domain Error is defined as the maximum value for the Code Domain Error for all codes. The measurement interval is one timeslot as defined by the C-PICH (when present); otherwise the measurement interval is one timeslot starting with the beginning of the SCH. [1]

The aim of this test is to detect inter-code cross-talk and limit them by keeping the code domain error within margin.

The peak code domain error for every measured slot shall not exceed -32 dB at spreading factor 256.

Test Setup

The DUT (base station) transmits at the declared maximum PRAT using TM3 for channel set up

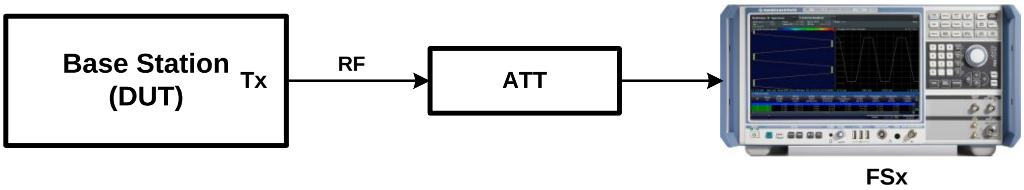


Fig. 3-105: Test setup for Peak Code Domain Error

Procedure

Measurement using the FSx

1. Select **Overview** at the bottom on right side of the window and select **Display Config**
2. Project **Peak Code Domain Error** from the list of configurations at the right side of the screen to have an overview of code domain error on all 15 slots of the frame defined by the test model.

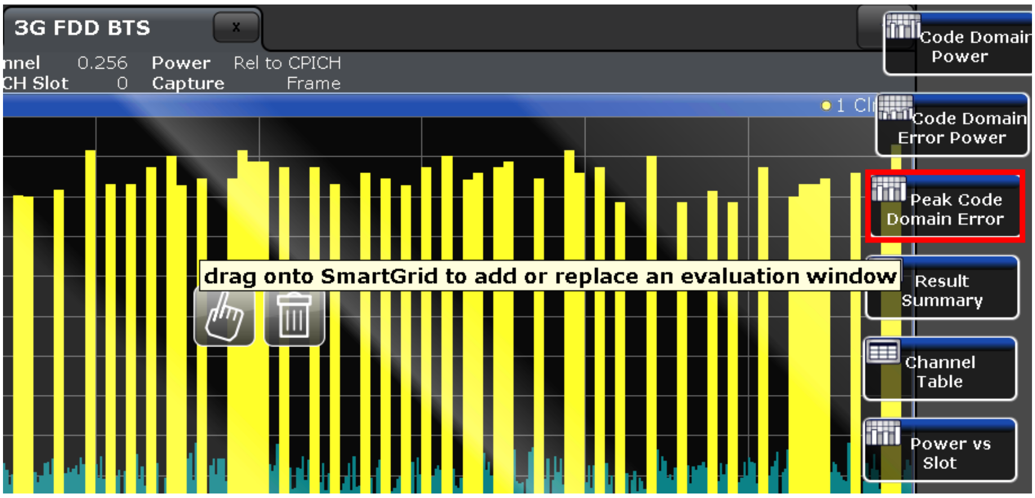


Fig. 3-106: Project Peak Code Domain Error from the list of configurations

3. Make sure that spreading factor 256 is selected using **Evaluation Range**. Change the **Slot** number and check result in all 15 slots (0 to 14).

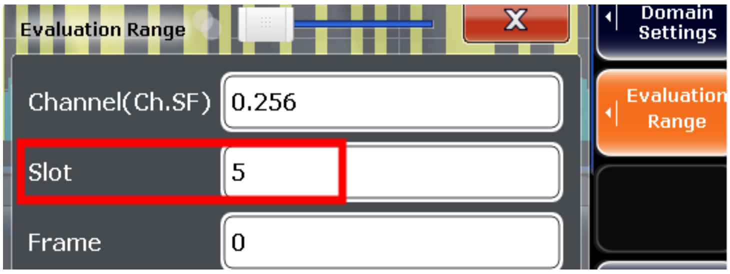


Fig. 3-107: Change slot number to display result for each slot in the result summary section

4. Press hardkey **PEAK SEARCH** to find the slot with peak error

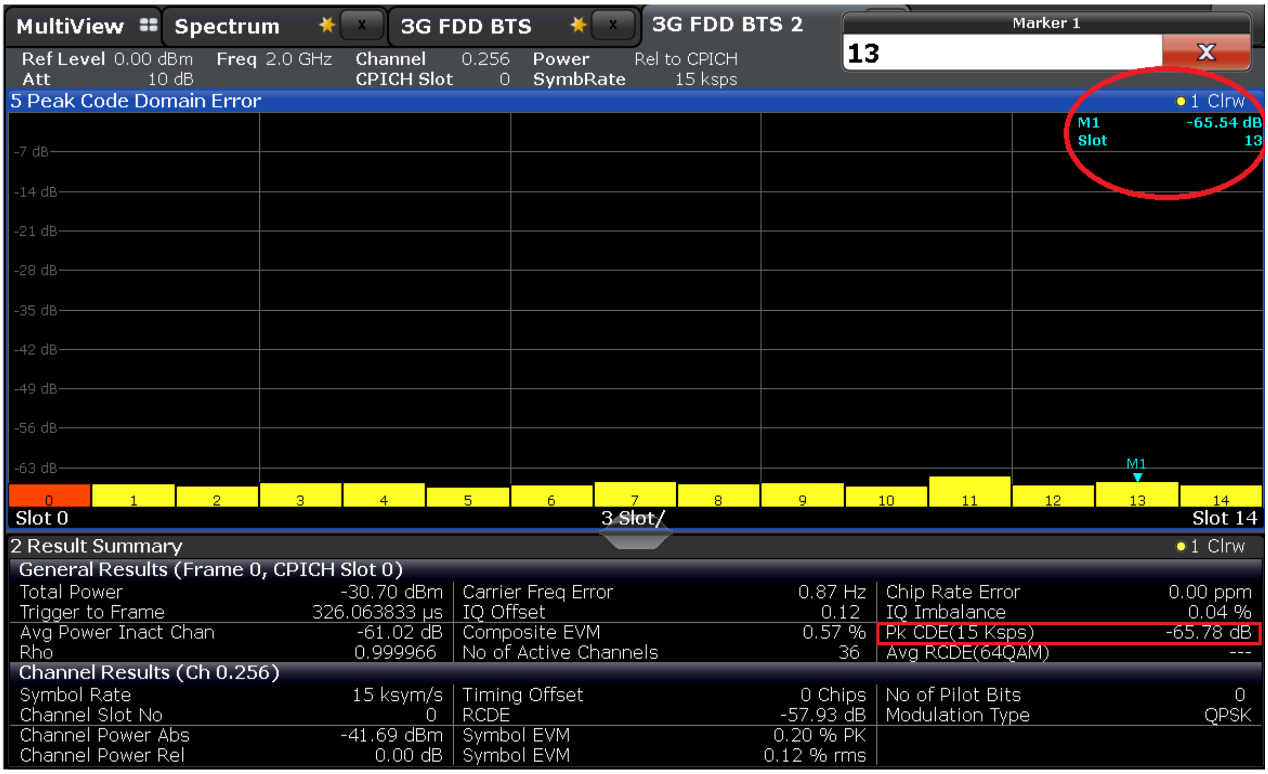


Fig. 3-108: Result for Peak Code Domain Error on each slot is displayed in the "Peak Code Domain Error "overview (upper half). Measurement value is shown in result summary (bottom)

Demo Program

No further special setting is needed for this test. The measured Peak Code Doman Error (PCDE) for all 15 slots is reported. Simulation is supported via path 1 of the SMx.

********** 6.7.2 Peak code domain error **************

General Settings:
Scrambling Code:123F
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Total Power (dBm)	PkCDE (dB)		Status
Slot 0	2200.00	-35.61	-63.85		Ignored
Slot 1	2200.00	-35.61	-63.26		Ignored
Slot 2	2200.00	-35.63	-63.87		Ignored
Slot 3	2200.00	-35.62	-64.21		Ignored
Slot 4	2200.00	-35.61	-63.48		Ignored
Slot 5	2200.00	-35.61	-63.08		Ignored
Slot 6	2200.00	-35.63	-63.84		Ignored
Slot 7	2200.00	-35.62	-64.27		Ignored
Slot 8	2200.00	-35.62	-63.96		Ignored
Slot 9	2200.00	-35.61	-63.45		Ignored
Slot 10	2200.00	-35.59	-63.66		Ignored
Slot 11	2200.00	-35.66	-63.07		Ignored
Slot 12	2200.00	-35.62	-64.05		Ignored
Slot 13	2200.00	-35.61	-63.22		Ignored
Slot 14	2200.00	-35.60	-63.67		Ignored

FSx: 0,"No error"
Time: 9/15/2014 2:08:21 PM

Fig. 3-109: Example report for test case 3.7.2

3.7.3 Time alignment error (Clause 6.7.3)

Frames of the WCDMA signals experience certain timing differences relation to each other at the BS transmitter antenna port. For a specific set of signals/transmitter configuration/transmission mode, Time Alignment Error (TAE) is defined as the largest timing difference between any two signals.

This test is only applicable for Node B supporting TX diversity transmission, MIMO, DC-HSDPA, DB-DC-HSDPA, or 4C-HSDPA, and their combinations. [1]

This test ensures that the frame timing alignment is within the specified limits.

Limits for Time alignment error	
Tx Case	**Limit**
Tx diversity and MIMO	≤ 0.35 T_C
Multiple cells within one frequency band	≤ 0.6 T_C
Multiple cells in different frequency band	≤ 5.1 T_C

Table 3-22: Requirements for Time alignment error

Test Setup

The following test setup is used for this test. The antennas to be measured are connected via a hybrid coupler. The FSx is connected via an attenuator. To achieve precise measurements, the RF cables used shall be equal in electrical length.

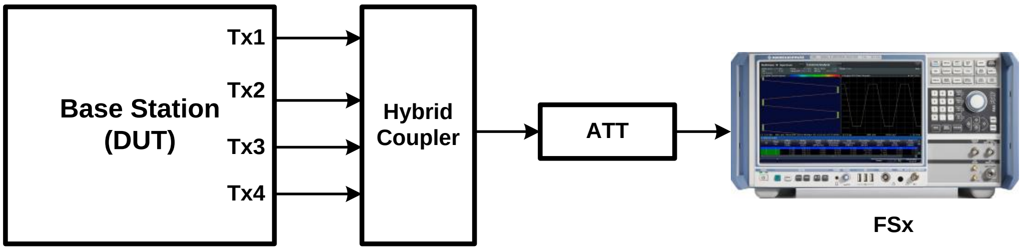


Fig. 3-110: Test setup for Time alignment error

The DUT (base station) transmits at the declared maximum PRAT using TM1 for channel set up

RF channels to be tested: M

Procedure

Measurement with the FSx

1. Launch the W-CDMA test application:
2. Press the hardkey **Meas** and select **Time Alignment Error**

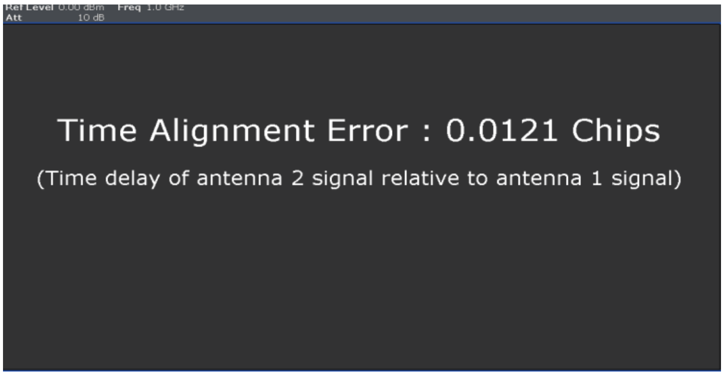


Fig. 3-111: Showing result for Time alignment error

Demo Program

No further special setting is needed for this test. The measured Time Alignment Error (TAE) is reported. Simulation is not supported.

********** 6.7.3 Time Alignment Error **************

General Settings:
Scrambling Code:0000
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Power	TAE(Tc)		Status
Avg RCDE	2000.00	-32.76	0.02		Ignored

FSx: 0,"No error"
Time: 9/15/2014 3:29:48 PM

Fig. 3-112: Example report for test case 6.7.3

3.7.4 Relative Code Domain Error (RCDE) (Clause 6.7.4)

The Relative Code Domain Error (RCDE) is computed by projecting the error vector of the code channels onto the code domain at a specific spreading factor. The Relative Code Domain Error for every active code is defined as the ratio of the mean power of the error projection onto that code, to the mean power of the active code in the composite reference waveform. [1]

This test is only applicable for 64QAM modulated codes.

This test ensures that the Relative Code Domain Error is within the specified limit.

Test Requirement

The average Relative Code Domain Error for 64QAM modulated codes shall not exceed -20 dB at the spreading factor 16.

Test Setup

The DUT (base station) transmits at the declared maximum PRAT using TM6 for channel set up

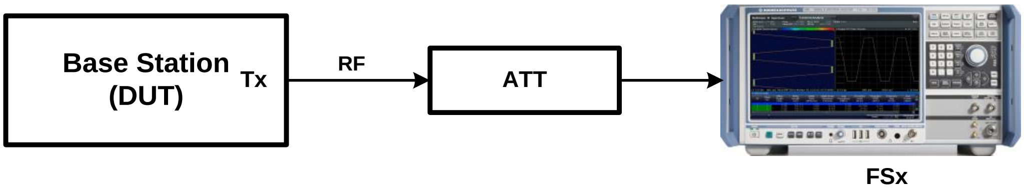


Fig. 3-113: Test setup for Relative code domain error

Procedure

Measurement with the FSx

The signal is demodulated for the test. The test results are displayed in a scalar overview in the **Result Summary** section. The calculated error can be found under **Avg RCDE (64 QAM)**

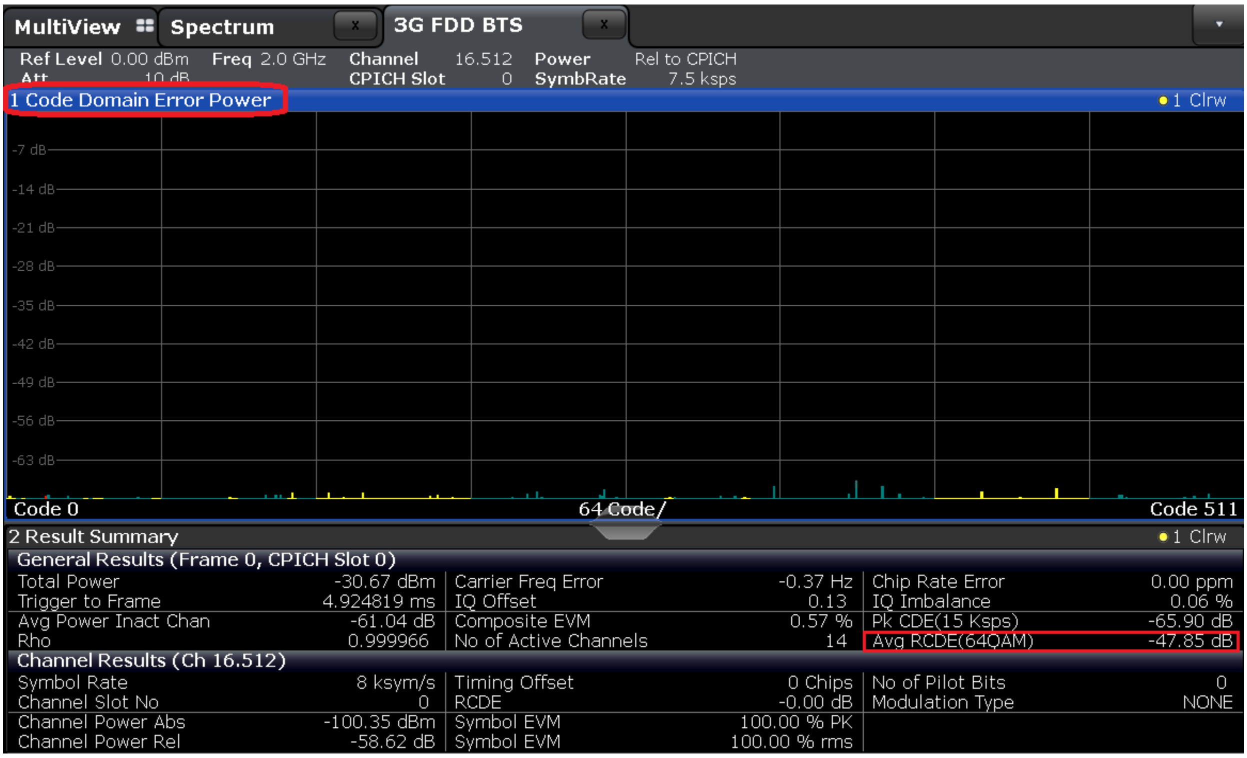


Fig. 3-114: “Code Domain Error Power” overview shows the error for all the Code channels (upper half). Measurements for average relative code domain Error is shown in the result summary

Demo Program

No further special setting is needed for this test. The calculated average Relative Code Domain Error (RCDE) is reported. Simulation is supported via path 1 of the SMx.

*********** 6.7.4 Relative code domain error *************

General Settings:
Scrambling Code:123F
FSx Attenuation:0.00 dB

Test Item	Carrier Frequency (MHz)	Power	Avg RCDE (64QAM) (dB)		Status
Avg RCDE	2200.00	-32.05	-46.08		Ignored

FSx: 0,"No error"
Time: 9/15/2014 2:10:58 PM

Fig. 3-115: Example report for test case 6.7.4

4 Appendix

4.1 R&S RUN Program

The R&S RUN software application makes it possible to combine tests (modules) provided by Rohde & Schwarz into test plans to allow rapid and easy remote control of test instruments. This program is available free of charge from our website.

Requirements

Operating system:

- Microsoft Windows XP / Vista / Windows 7 / Windows 8
- NET framework V2.0 or higher

General PC requirements:

- Pentium 1 GHz or faster
- 1 Gbyte RAM
- 100 Mbyte space harddisk
- XGA monitor (1024x768)

Remote control interface:

- National Instruments VISA
- GPIB card

Or

- LAN connection After R&S RUN is launched, the following splash screen appears:

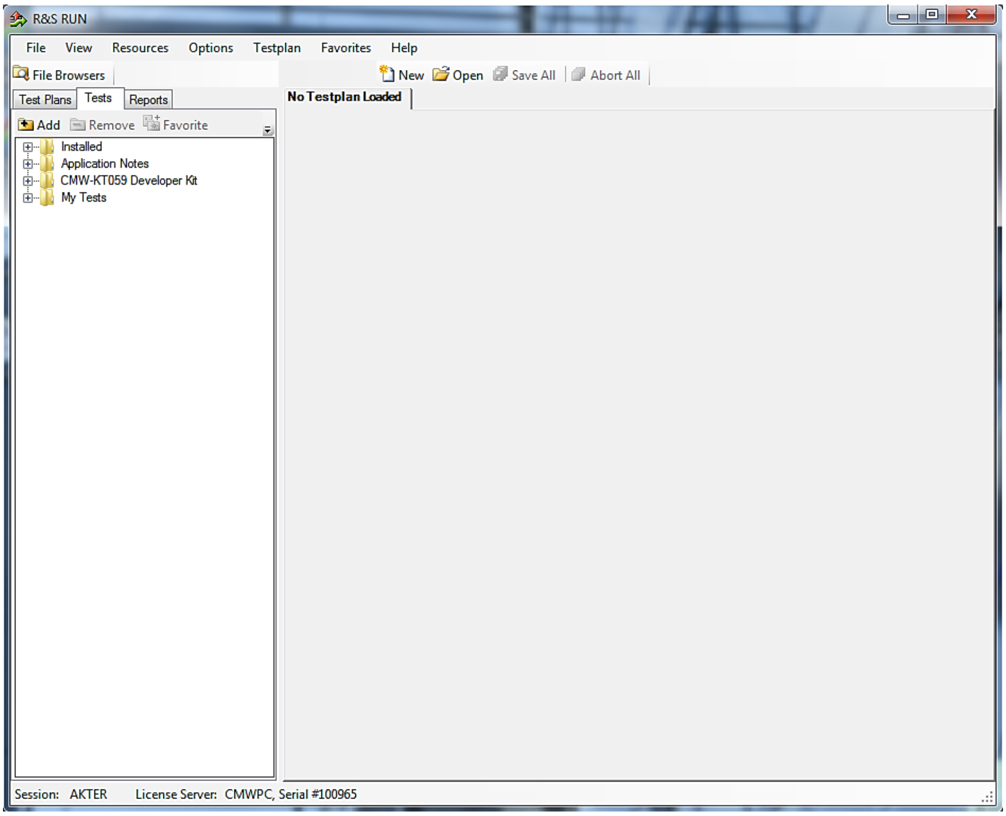


Fig. 4-1: Overview R&S RUN

Tests and test plans

Tests are separate, closed modules for R&S RUN. A test plan can consist of one or more tests.

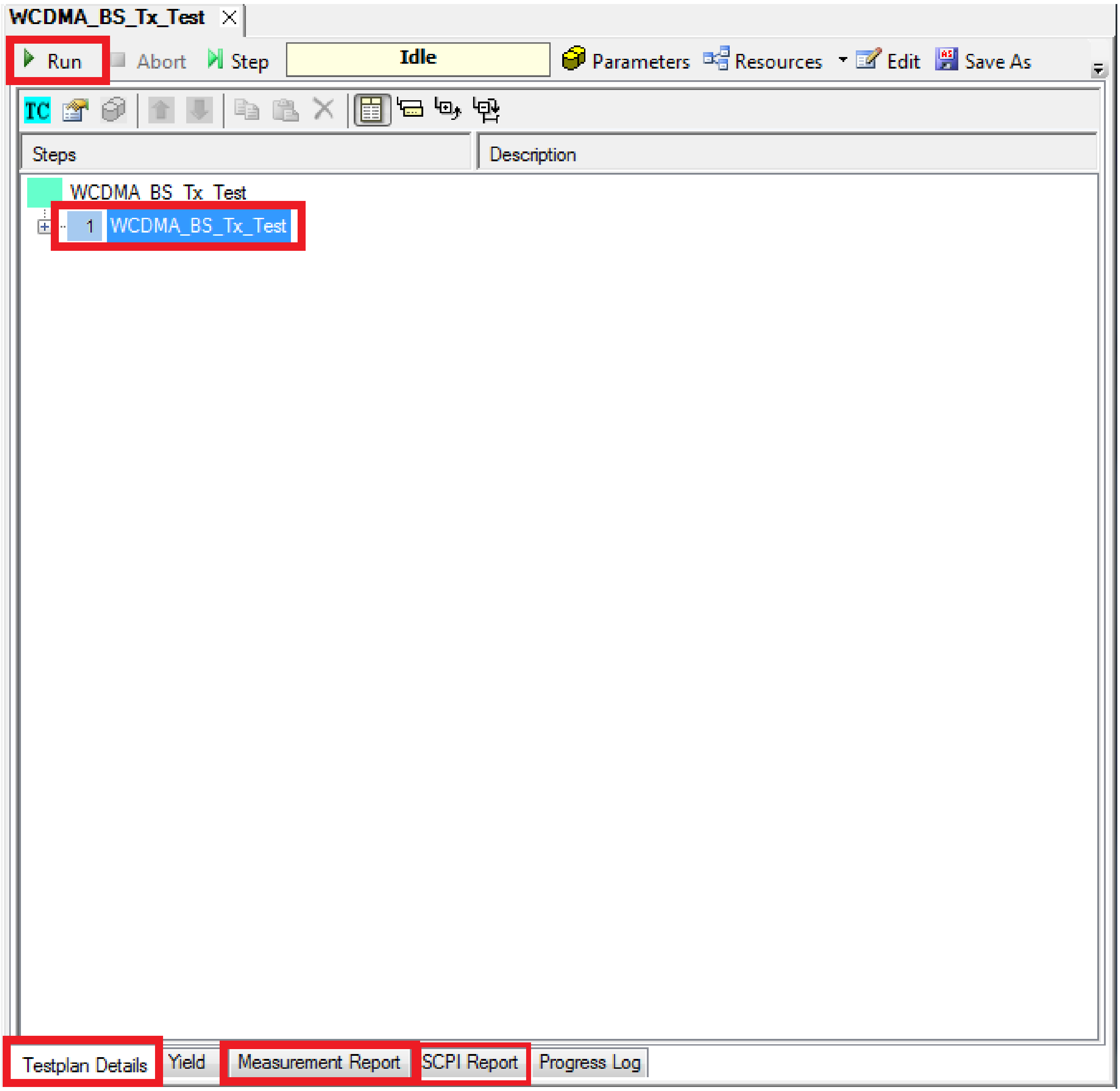


Fig. 4-2: Overview of a test plan in R&S RUN. The test plan in the example contains only one test (WCDMA BS Tx Test). After the test is completed, the bar along the bottom can be used to display the measurement and SCPI reports.

The WCDMA BS tests can be found under Tests/ApplicationNotes.

Click **RUN** to start the current test plan.

SCPI connections

Under **Resources|SCPI Connections**, you can add all required instruments for remote control.

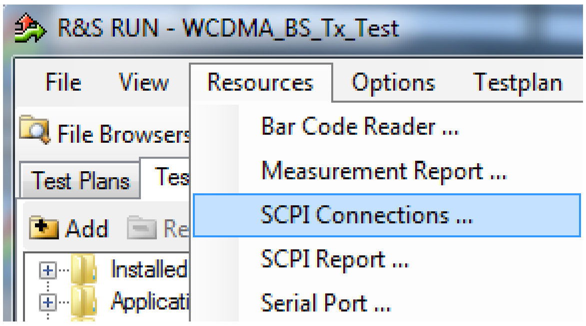


Fig. 4-3: Setting the SCPI connections.

Use **Configure…** to open a wizard for entering the VISA parameters (Fig. 4-4). Use the **Test Connection** button to test the connection to the instrument. When the **Demo Mode** button is enabled, no instruments need to be connected because R&S RUN run in demo mode and output a fictitious test report.

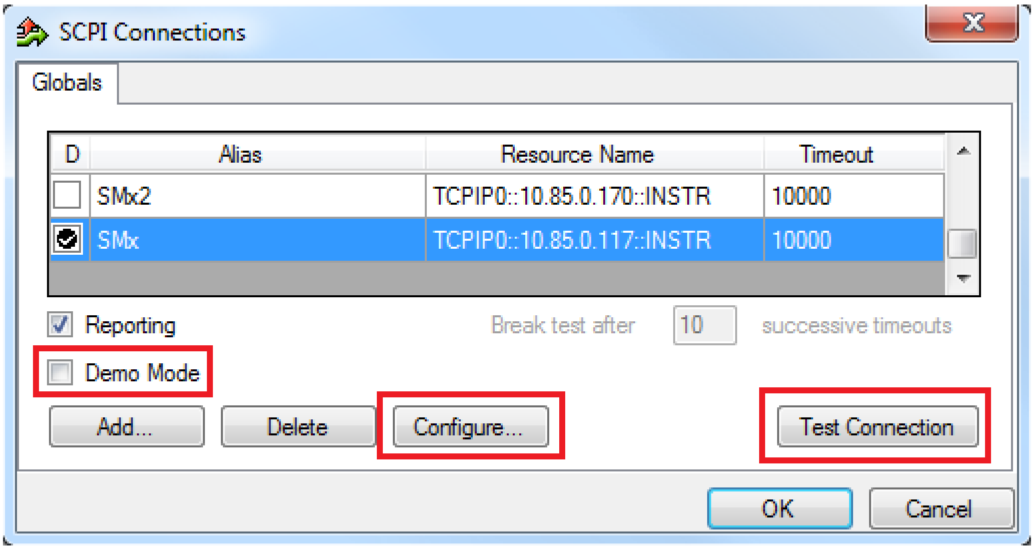


Fig. 4-4: SCPI connections.

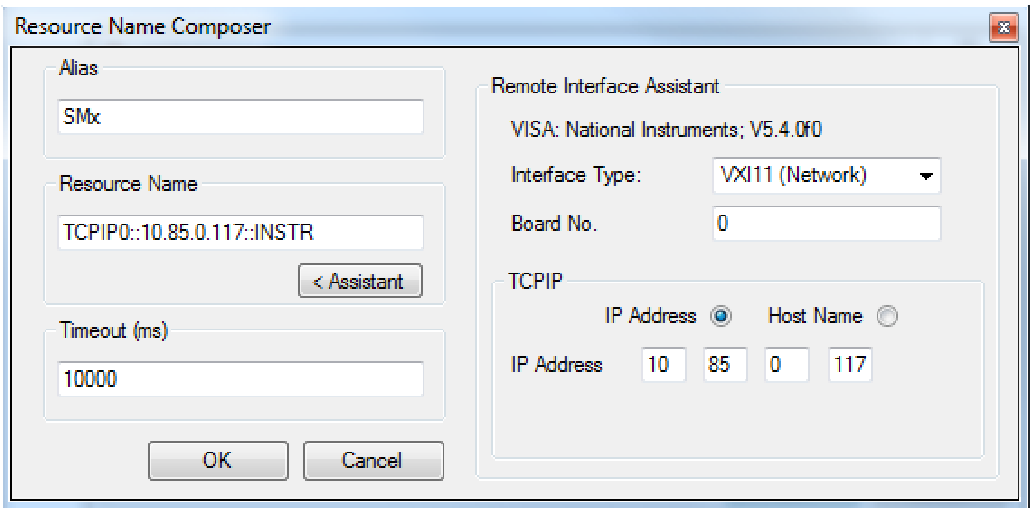


Fig. 4-5: Wizard for entering VISA parameters. Both the IP address and a host name can be entered directly.

Reports: Measurement and SCPI

After the test is completed, R&S RUN automatically generates both a **Measurement Report** and a **SCPI Report**.

The measurement report shows the actual results and the selected settings.

The SCPI report returns a LOG file of all transmitted SCPI commands. These can then be copied and easily used in separate applications.

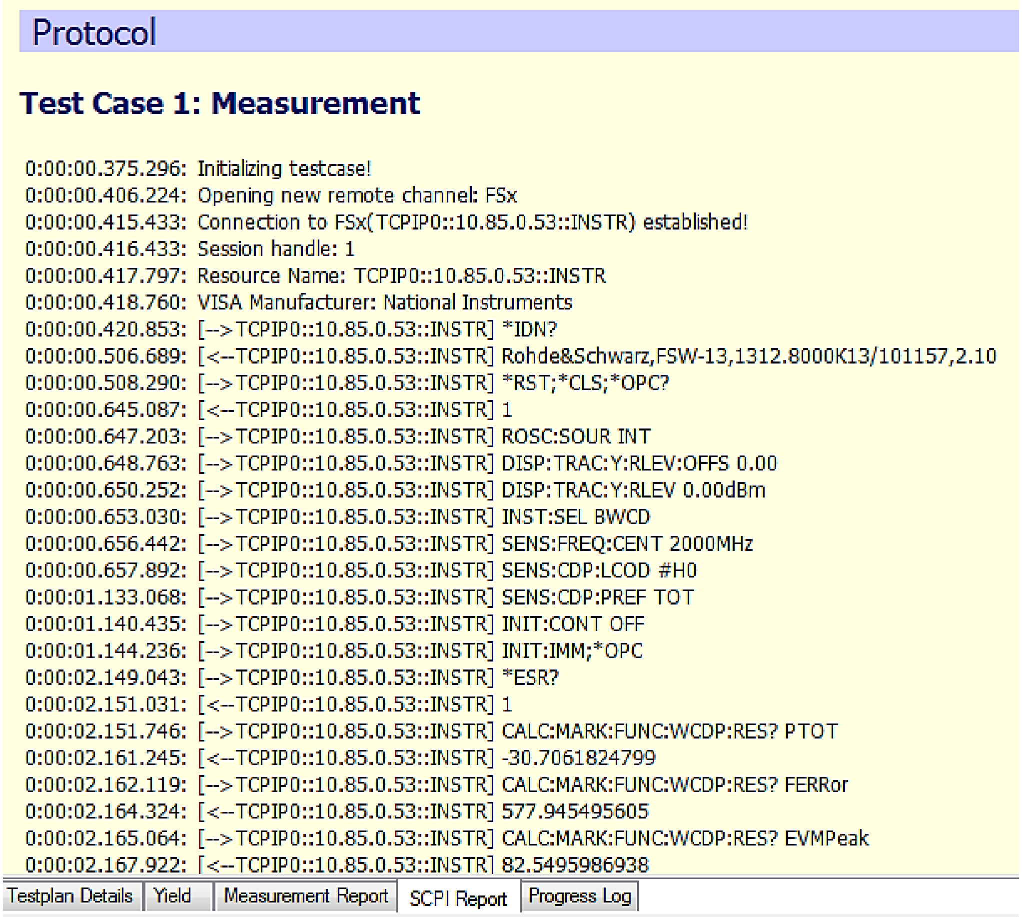


Fig. 4-6: SCPI report.

4.2 References

[1] Technical Specification Group Radio Access Network; Base Station (BS) conformance testing (FDD) (Release 10), 3GPP TS 25.141 V10.10.0 (2014-03)

[2] Rohde & Schwarz: **3GPP FDD Measurements Options**, User Manual FSW

[3] Rohde & Schwarz: **3GPP FDD incl. enh. MS/BS tests, HSDPA, HSUPA, HSPA+**

, User Manual SMx

4.3 Additional Information

Please send your comments and suggestions regarding this white paper to

TM-Applications@rohde-schwarz.com

4.4 Ordering Information

Ordering Information for Signal Generators		
Vector Signal Generator		
Product Description	**Type**	**Ordering No.**
Vector Signal Generator	**SMW200A**	**1412.0000.02**
Baseband Generator	SMW-B10	1413.1200.02
B11 Baseband Generator	SMW-B11	1159.8411.02
Baseband Main Module	SMW-B13	1141.8003.04
1st RF path	SMW-B10x	
2nd RF path	SMW-B20x	
AWGN	SMW-K-62	1413.3484.02
Digital Standard 3GPP FDD	SMW-K42	1413.3784.02

Ordering Information for Signal Generators		
Vector Signal Generator		
Product Description	**Type**	**Ordering No.**
Vector Signal Generator	**SMU200A**	**1141.2005.02**
Baseband Generator	SMU-B9	1161.0766.02
Baseband Generator	SMU-B10	1141.7007.02
B11 Baseband Generator	SMU-B11	1159.8411.02
Baseband Main Module	SMU-B13	1141.8003.04
1st RF path	SMU-B10x	
2nd RF path	SMU-B20x	
AWGN	SMU-K62	1159.8511.02
Digital Standard 3GPP FDD	SMU-K42	1160.7909.02
3GPP FDD Enhanced MS/BS Tests, incl. HSDPA	SMU-K43	1160.9660.02
Digital Standard 3GPP FDD HSUPA	SMU-K45	1161.0666.02
Digital Standard HSPA+	SMU-K59	1415.0001.02

Ordering Information for Signal Generators		
Vector Signal Generator		
Product Description	**Type**	**Ordering No.**
Vector Signal Generator	**SMBV100A**	**1407.6004.02**
RF 9 kHz – 6 GHz	SMBV-B106	1407.9703.02
Baseband Generator with Digital Modulation (Realtime) and ARB (32 Msample), 120-MHz RF BW	SMBV-B10	407.8907.02
AWGN	SMBV-K62	1415.8419.02
Digital Standard 3GPP FDD	SMBV-K42	1415.8048.02
3GPP FDD Enhanced MS/BS Tests, incl. HSDPA	SMBV-K43	1415.8054.02
Digital Standard HSPA+	SMBV-K59	1415.8219.02

Ordering Information for Analyzers		
Signal and Spectrum Analyzers		
Up to 8, 13, 26, or 43 GHz	**FSW**	**1312.8000Kxx**
3GPP (W-CDMA) BS (DL) Analysis, incl. HSDPA and HSPA+	FSW-K72	1313.1422.02
Up to 3, 8, 26, 31 or 40 GHz	**FSQ**	**1313.9000.xx**
3GPP BTS/Node B FDD Application Firmware	FS-K72	1154.7000.02
3GPP HSDPA BTS Application Firmware	FS-K74	1300.7156.02
3GPP HSPA+ BTS Application Firmware	FS-K74+	1309.9180.02
Up to 3, 7, 13, 30, or 40 GHz	**FSV**	**1307.9002Kxx**
3GPP FDD BS Analysis	FSV-K72	1310.8503.02
Up to 4, 7, 13, 30, or 40 GHz	**FPS**	**1319.2008.xx**
3GPP FDD (WCDMA) BS Measurements (incl. HSDPA and HSDPA+)	FPS-K72	1321.4133.02

About Rohde & Schwarz

Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

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ISO 9001

PAD-T-M: 3573.7380.02/02.00/CI/1/EN/

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