LTE-A Base Station Transmitter Tests
According to TS 36.141 Rel. 14

Application Note

Products:

- R&S®FSW
- R&S®FSV
- R&S®FSVA
- R&S®FPS
- R&S®VSE
- R&S®SMW200A
- R&S®SMBV100A

3GPP TS36.141 defines conformance tests for E-UTRA base stations (eNodeB). Release 14 added several tests, especially for enhanced License Assisted Accsess (eLAA).

This application note describes how all required transmitter (Tx) tests (TS36.141 Chapter 6) can be performed quickly and easily by using signal and spectrum analyzers from Rohde & Schwarz. A few tests additionally require signal generators from Rohde & Schwarz.

Examples illustrate the manual operation. A free software program enables and demonstrates remote operation.

The LTE base station receiver (Rx) tests (TS36.141 Chapter 7) are described in Application Note 1MA195.

The LTE base station performance (Px) tests (TS36.141 Chapter 8) are described in Application Note 1MA162.

Application Note

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ROHDE&SCHWARZ

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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®SMBV100A vector signal generator is referred to as the SMBV.
- The R&S®FSV spectrum analyzer is referred to as the FSV.
- The R&S®FSVA spectrum analyzer is referred to as the FSVA.
- The R&S®FPS spectrum analyzer is referred to as the FPS.
- The R&S®FSW spectrum analyzer is referred to as the FSW.
- The SMW and SMBV are referred to as the SMx.
- The FSW, FSV, FSVA and FPS are referred to as the FSx.
- The software R&S®TSrun is referred to as the TSrun.

Note:

Please find the most up-to-date document on our homepage

http://www.rohde-schwarz.com/appnote/1MA154.

This document is complemented by software. The software may be updated even if the version of the document remains unchanged

1 Introduction

Long Term Evolution (LTE) networks or Evolved Universal Terrestrial Radio Access (E-UTRA) (from Releases 8, 9 and 10) have long since been introduced into daily usage. As a next step, 3GPP has added several extensions in Releases 11 and 12, known as LTE- Advanced (LTE-A). These include a contiguous and non-contiguous multicarrier and/or carrier aggregation (CA) option, changes to MIMO (up to 8x8 in the downlink and introduction of MIMO in the uplink). Release 13 (now called LTE advanced pro) introduces a 3GPP solution for the Internet of Things, called NB-IoT as a new physical layer. In Release 14, the new innovations are the enhanced Licensed Assisted Access (eLAA) in Unlicensed Spectrum, the support for Vehicle-to-Everything (V2x) services as well as 4-band and inter-band Carrier Aggregation (CA).

An overview of the technology behind LTE and LTE-Advanced is provided in Application Note 1MA111, 1MA232 and 1MA252. The white papers 1MA166 and the application note 1MA296 handle NB-IoT.

The LTE-A conformance tests for base stations (eNodeB) are defined in 3GPP TS 36.141 Release 13 [1] and include transmitter (Tx), receiver (Rx) and performance (Px) tests. T&M instruments from Rohde & Schwarz can be used to perform all tests easily and conveniently.

This application note describes the transmitter (Tx) tests in line with TS36.141 Chapter 6. It explains the necessary steps in manual operation for signal and spectrum analyzers and signal generators. A free remote-operation software program is additionally provided. With this software, users can remotely control and demo tests on base stations quickly and easily. It also provides the SCPI commands required to implement each test in user-defined test programs.

The receiver (Rx) tests (TS36.141 Chapter 7) are described in Application Note 1MA195 and the performance (Px) tests (TS36.141 Chapter 8) are covered in Application Note 1MA162.

The following abbreviations are used in this application note:

Abbreviations for 3GPP standards	
TS 36.141	Application Note
E-UTRA FDD or TDD	LTE (FDD or TDD)
UTRA-FDD	W-CDMA
UTRA-TDD	TD-SCDMA
GSM, GSM/EDGE	GSM

Table 1-1: Abbreviations for 3GPP standards

Table 1-2 gives an overview of the Transmitter tests defined in line with Chapter 6 of TS36.141. All can be carried out using instruments from Rohde & Schwarz. These tests are individually described in this application note.

Covered TX tests	
Chapter (TS36.141)	**Test**
Base station output power	
6.2	Base station output power
6.2.6	Home BS output power for adjacent channel WCDMA protection
6.2.7	Home BS output power for adjacent channel LTE protection
6.2.8	Home BS output power for co-channel LTE protection
Output power dynamics	
6.3.1	RE power control dynamic range – no dedicated test, covered by 6.5.2
6.3.2	Total dynamic range
6.3.3	NB-IoT RB power dynamic range for in-band or guard band operation
Transmit ON/OFF power	
6.4	Transmit ON/OFF power
Transmitter signal quality	
6.5.1	Frequency error
6.5.2	Error vector magnitude
6.5.3	Time alignment error
6.5.4	DL RS power
Unwanted emissions	
6.6.1	Occupied bandwidth
6.6.2	Adjacent channel leakage power ratio
6.6.3	Operating band unwanted emissions
6.6.4	Transmitter spurious emissions
Transmitter intermodulation	
6.7	Transmitter intermodulation

Table 1-2: Covered TX tests

Ready for RED?

The new radio equipment directive RED 2014/53/EU adopted by the European Union replaces the previous directive RTTED 1999/5/EC, better known as R&TTE. With RED, not only radio transmitters, but also radio receivers have to meet minimum regulatory performance requirements and need to be tested. Article 3.2 contains fundamental technical requirements.

The Harmonised European Standard **ETSI EN 301 908 Part 14** covers essential requirements of article 3.2 for E-UTRA Base Stations. The tests refer to **ETSI TS 136 141**, which is the same as **3GPP TS36.141**.

The Harmonised European Standard **ETSI EN 301 908** covers essential requirements of article 3.2 for Mobile Communication On Board Aircraft (MCOBA) systems. Chapter 4.2. defines tests for E-UTRA-OBTS (Onboard Base Transceiver Station), which refer to **ETSI TS 136 141**, which is the same as **3GPP TS36.141**.

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 NB-IoT Modes of Operation

NB-IoT has a channel bandwidth of 200 kHz but occupies 180 kHz only. This is equal to one resource block in LTE (1RB). This bandwidth enables three modes of operation:

- **Standalone operation**: NB-IoT operates independently, for example on channels previously used for GSM.
- **Guard band operation**: NB-IoT utilizes resource blocks in the guard bands of an LTE channel.
- **In-band operation**: NB-IoT re-uses frequencies that are not used by LTE inside the LTE channel bandwidth.

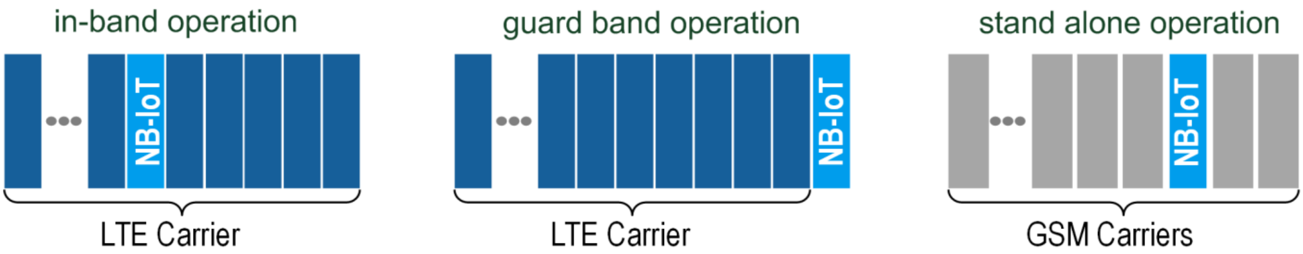


Fig. 2-1: The three NB-IoT modes of operation. (NB-IoT operates independently in standalone mode (right). The GSM channels are shown only to illustrate coexistence.)

2.3 Multicarrier Test Scenarios

Multicarrier configurations are a significant portion of LTE-A according to Rel. 12. These allow multiple carriers (even those using a different radio access technology) to be transmitted simultaneously, but independently of one another, from a single base station (multicarrier, MC). Another special attribute of LTE-A is the ability to link multiple carriers using carrier aggregation (CA). This allows an increase in the data rate to an individual subscriber (user equipment, UE). Overlapping of adjacent carriers is also possible, making more effective use of the bandwidth.

A distinction is made between the following CA scenarios:

- Intra-band contiguous
- Inter-band non-contiguous

2.3.1 Intra-band Contiguous Carrier Aggregation

In this scenario, multiple carriers are transmitted in parallel within a single bandwidth of an LTE operating band (bands 1 to 32 and 65 to 68 for FDD and 33 to 46 for TDD; see [1]). Fig. 2-2 defines carrier aggregation. For a complete list see Table 5.5-2 in [1]. The notation is CA_x where x defines the used band (example CA_1).

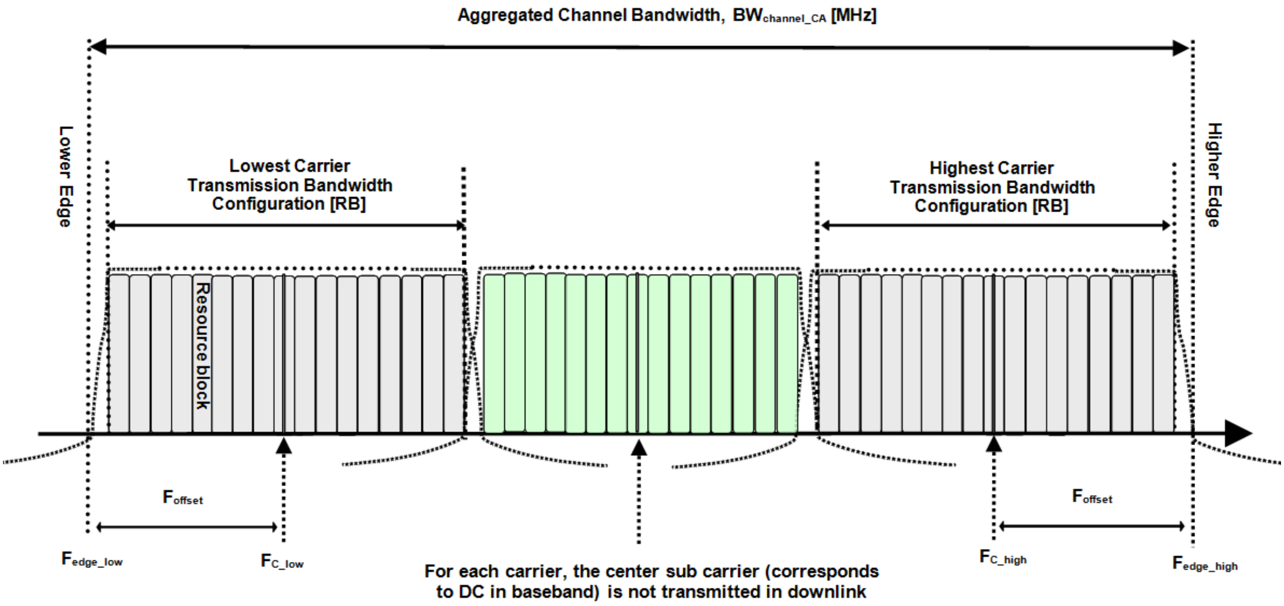


Fig. 2-2: Definition of intra-band carrier aggregation [1].

The distance between the individual carriers is calculated as follows:

$$\left\lfloor \frac{BW_{Channel\_1} + BW_{Channel\_2} - 0.1\left|BW_{Channel\_1} - BW_{Channel\_2}\right|}{0.6} \right\rfloor 0.3$$

Fig. 2-3: Possible offset between two carriers.

2.3.2 Intra-band Non-contiguous Carrier Aggregation

In this scenario, multiple non-contiguous carriers are transmitted in parallel within a single bandwidth of an LTE operating band. Fig. 2-4 defines the sub-block bandwidth for a base station operating in non-contiguous spectrum. For a complete list with two sub-blocks see Table 5.5-4 in [1]. The notation is CA_x_x where x defines the used band (example CA_2_2).

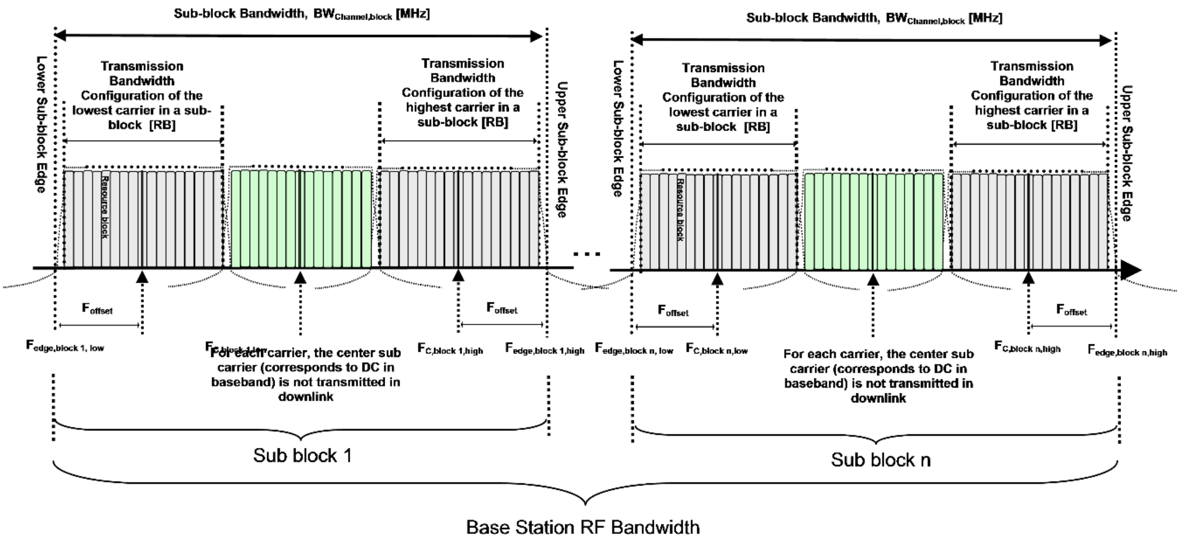


Fig. 2-4: Definition of intra-band non-contiguous carrier aggregation [1].

2.3.3 Inter-band Non-contiguous Carrier Aggregation

Carrier aggregation is also possible across multiple frequency bands. The notation is the same as for intra-band CA. For example, CA_1-3 refers to band 1 and band 3, CA_2-2-5 to band 2 (with two sub-blocks) and band 5. For three or four bands, the notation is analog. For a complete list see tables 5.5-3 for two bands, 5.5-3A for three bands and 5.5-3B for four bands in [1].

2.3.4 Test Scenarios for Multicarrier and/or CA Tests

The various test configurations ETC1 to ETC5 for multicarrier and/or CA tests can be found in TS36.141 Chapter 4.10 [1]. Table 2-1 gives an overview of the test configurations.

Overview of Test Configurations		
Section	**Test Configuration**	**Description**
2.3.4.1	ETC1	Contiguous spectrum operation
-	ETC2	Contiguous CA occupied bandwidth
2.3.4.2	ETC3	Non-contiguous spectrum operation
2.3.4.3	ETC4	Multi-band test configuration for full carrier aggregation
2.3.4.4	ETC5	Multi-band test configuration with high PSD per carrier
2.3.4.5	ETC6	NB-IoT standalone
2.3.4.6	ETC7	E-UTRA and NB-IoT standalone
2.3.4.7	ETC8	E-UTRA and NB-IoT in-band
2.3.4.8	ETC9	E-UTRA and NB-IoT guard band

Table 2-1: Overview of test configurations for multicarrier and/or CA tests

ETC2 is not described in this application note, as the test configuration only explains all carrier combinations that are possible for CA tests.

2.3.4.1 Contiguous spectrum operation (ETC1)

To make transmitter tests easy and comparable, the ETC1 test configuration in TS36.141 Chapter 4.10 [1] defines multicarrier and/or CA test scenarios. All Tx tests, with the exception of the occupied bandwidth test, follow these basic steps:

- Within the maximum available bandwidth, the narrowest supported LTE carrier is placed at the lower edge.
- A 5 MHz carrier is placed at the upper edge.
- The remaining free spectrum, starting from the right, is filled with 5 MHz carriers until no more carriers fit into the remaining bandwidth.
- If the base station does not support 5 MHz carriers, then the narrowest supported carrier is used instead.

The offset to the edges is as shown in Table **2-2**. There are no precise specifications for the bandwidths 1.4 MHz and 3 MHz.

Definition of F_{offset}	
Channel bandwidth [MHz]	**F_{offset} [MHz]**
1.4, 3.0	Not defined
5, 10, 15, 20	$BW_{Channel}/2$

Table 2-2: Calculation of F_{offset}

Example

The process for multicarrier configuration is explained based on an example (fictitious) base station using the following parameters:

- Aggregated channel bandwidth ($BW_{Channel\_CA}$) = 20 MHz
- Support for 1.4 MHz and 5 MHz

1. The 1.4 MHz carrier is placed at the lower edge; the offset is not defined. F_{offset} = 0.7 MHz is used.
2. The first 5 MHz carrier is placed at the upper edge at an offset of 2.5 MHz.
3. The remaining two 5 MHz carriers are placed following the above formula at an offset of 4.8 MHz from the adjacent carrier to the right (carrier aggregation, CA). No additional carriers fit in the spectrum, leaving a free area of 4 MHz (Fig. 2-5).

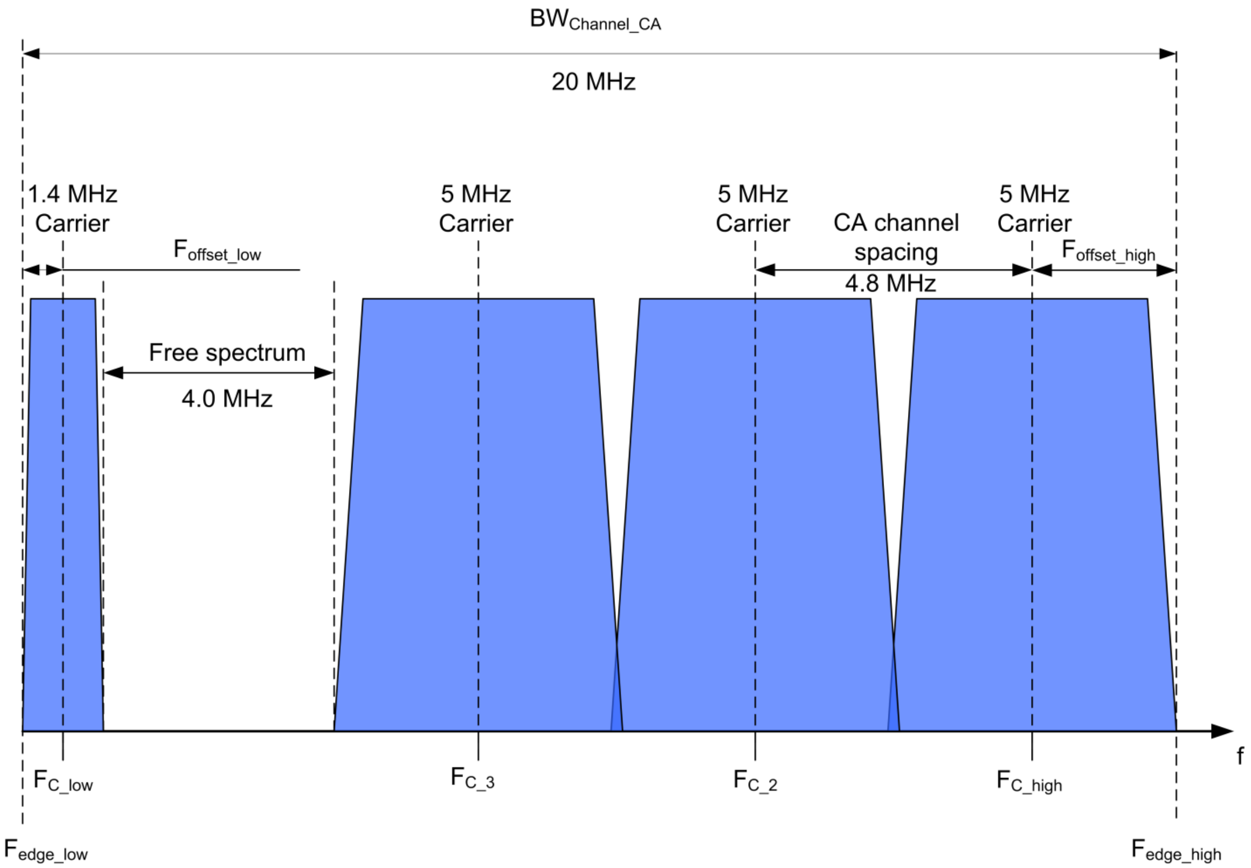


Fig. 2-5: Example MC scenario. $BW_{Channel\_CA}$ is 20 MHz. One 1.4 MHz carrier and three 5 MHz carriers fit into the 20 MHz bandwidth.

2.3.4.2 Non-contiguous spectrum operation (ETC3)

The ETC3 test configuration in TS36.141 Chapter 4.10 [1] describes test scenarios that are constructed on a per band basis. All Tx tests, with the exception of the occupied bandwidth test, follow these basic steps:

- Within the maximum available bandwidth for non-contiguous spectrum operation, locate two sub-blocks at the edges of the bandwidth with one sub-block gap in between.
- A 5 MHz carrier is placed at the upper edge of the bandwidth.
- A 5 MHz carrier is placed at the lower edge of the bandwidth.

- If the base station does not support 5 MHz carriers, then the narrowest supported carrier is used instead.
- The offset to the edges and to the sub-block gap is as shown in Table 2-2.

Example

The process for non-contiguous spectrum operation is explained based on an example (fictitious) base station using the following parameters:

- RF channel bandwidth ($BW_{Channel\_RF}$) = 20 MHz
- Support for two 5 MHz carriers

4. One 5 MHz carrier is placed at the upper edge. The offset is defined according to Table 2-2. F_{offset} = 2.5 MHz.
5. Another 5 MHz carrier is placed at the lower edge at an offset of 2.5 MHz.
6. Sub-block 1 and 2 consist of one carrier each, with a sub-block gap of 10 MHz in between (Fig. 2-6).

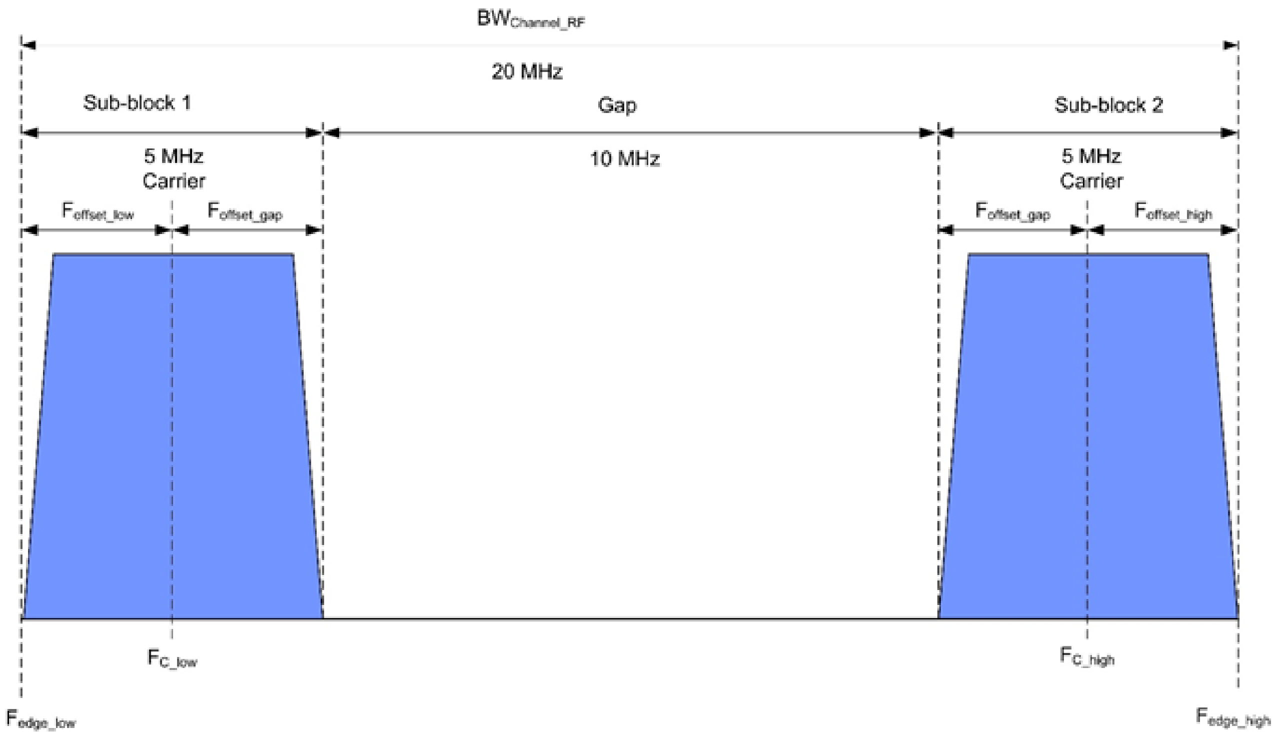


Fig. 2-6: Example for non-contiguous spectrum operation. $BW_{Channel\_RF}$ is 20 MHz. Two 5 MHz carriers are located in the 20 MHz bandwidth with one sub-block gap of 10 MHz in between.

2.3.4.3 Multiband test configuration for full carrier allocation (ETC4)

The purpose of the ETC4 test configuration in TS36.141 Chapter 4.10 [1] is to test multiband operation aspects considering maximum supported number of carriers. It is constructed using the following method:

- The supported operation bands for Tx tests with the available bandwidths are chosen according to TS36.141 Chapter 5.5 [1].
- The declared maximum number of supported carriers in multiband operation is equal to the number of carriers each supported operation band.
- Carriers are first placed at the upper and lower edges of the declared maximum radio bandwidth. Additional carriers shall next be placed at the edges of the RF bandwidths, if possible.
- The allocated RF bandwidths of the outermost bands shall be located at the upper and lower edges of the declared maximum radio bandwidth.
- Each band is independent and the carriers within the bands are located according to the tests for contiguous spectrum operation.

Example

The process for multiband test configuration for full carrier allocation is explained based on an example (fictitious) base station using the following parameters:

- Radio channel bandwidth (BW_{Radio}) = 365 MHz
- Support for bands 1 and 3. Band 1: 2110 MHz – 2170 MHz;
  Band 3: 1805 MHz – 1880 MHz

1. $F_{C\_low\_B3}$ = 1805 MHz, $F_{C\_high\_B3}$ = 1880 MHz; $F_{C\_low\_B1}$ = 2110 MHz, $F_{C\_high\_B1}$ = 2170 MHz.
2. BW_{RF_lower} = 75 MHz according to band 3; BW_{RF_upper} = 60 MHz according to band 1.
3. In total, two 1.4 MHz carriers and two 5 MHz carriers are located in band 1 and band 3 according to the example for contiguous spectrum operation. Theoretically, more carriers can be used.
4. Each band consists of two sub-blocks and one gap in between (Fig. 2-7).

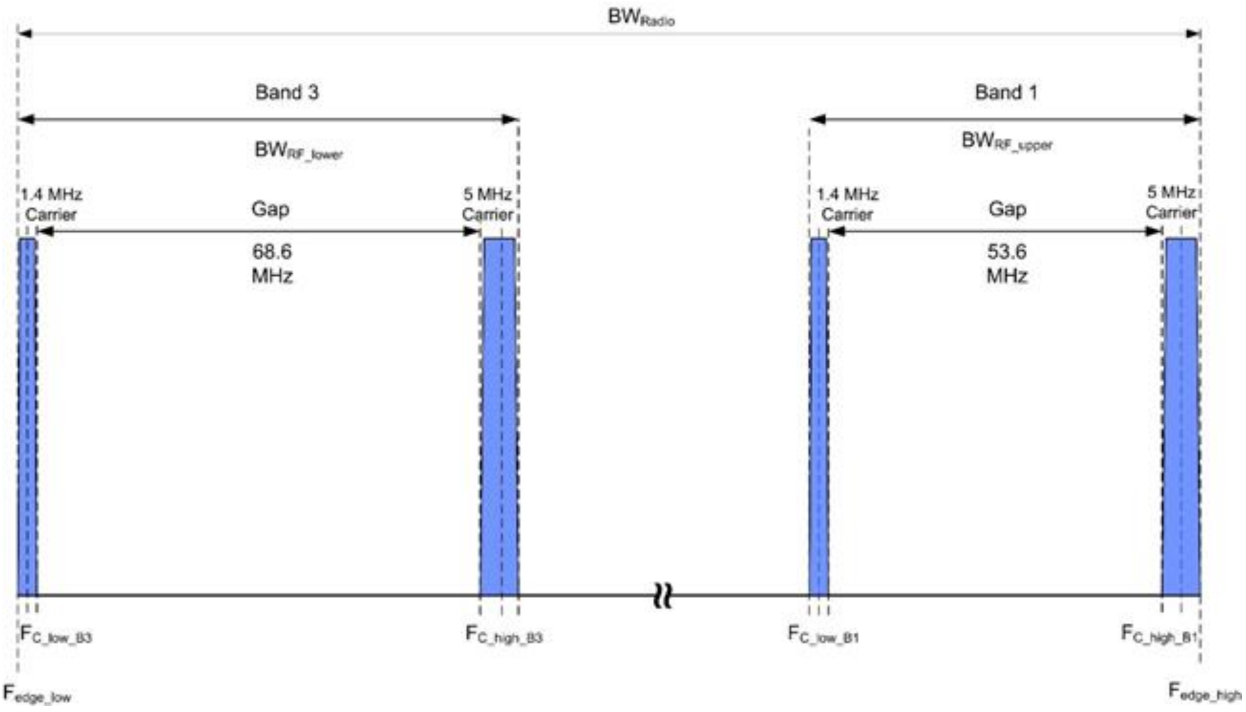


Fig. 2-7: Example multiband test configuration for full carrier allocation. BW_{Radio} is 365 MHz. In total, two 1.4 MHz and two 5 MHz carriers are located in band 1 and band 3.

2.3.4.4 Multiband test configuration with high PSD per carrier (ETC5)

The purpose of the ETC5 test configuration in TS36.141 Chapter 4.10 [1] is to test multiband operation aspects considering higher power spectrum density (PSD) cases with reduced number of carriers. It is constructed using the following method:

- The supported operation bands for Tx tests with the available bandwidths are chosen according to TS36.141 Chapter 5.5 [1].
- The maximum number of carriers is limited to two per band.
- Carriers are first placed at the upper and lower edges of the declared maximum radio bandwidth. Additional carriers shall next be placed at the edges of the RF bandwidths, if possible.
- The allocated RF bandwidths of the outermost bands shall be located at the upper and lower edges of the declared maximum radio bandwidth.
- Each band is independent and the carriers within the bands are located according to the tests for non-contiguous spectrum operation.

Example

The process for multiband test configuration with high PSD per carrier is explained based on an example (fictitious) base station using the following parameters:

- Radio channel bandwidth (BW_{Radio}) = 365 MHz

- Support for bands 1 and 3. Band 1: 2110 MHz – 2170 MHz; Band 3: 1805 MHz – 1880 MHz

5. $F_{C\_low\_B3}$ = 1805 MHz, $F_{C\_high\_B3}$ = 1880 MHz; $F_{C\_low\_B1}$ = 2110 MHz, $F_{C\_high\_B1}$ = 2170 MHz.
6. BW_{RF_lower} = 75 MHz according to band 3; BW_{RF_upper} = 60 MHz according to band 1.
7. In total, four 5 MHz carriers are located in band 1 and band 3 according to the example for contiguous spectrum operation.
8. Each band consists of two sub-blocks and one gap in between

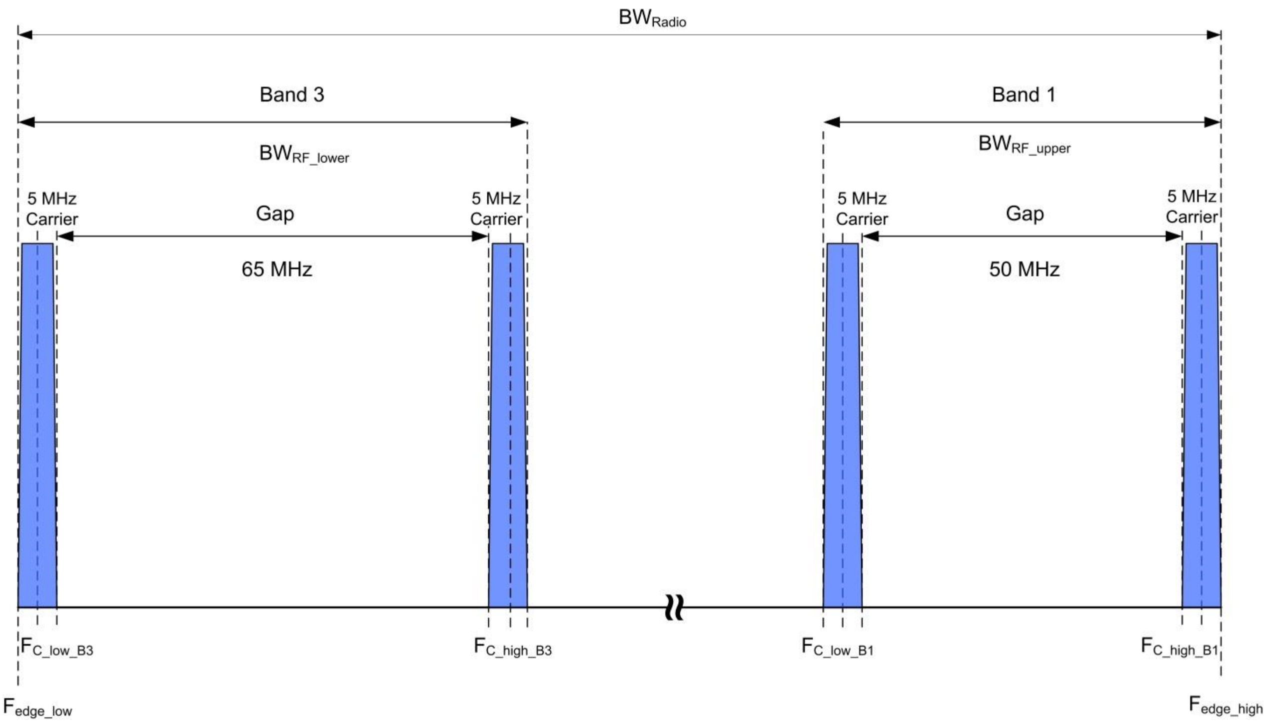


Fig. 2-8: Example multiband test configuration with high PSD per carrier. BWRadio is 365 MHz. In total, four 5 MHz carriers are located in band 1 and band 3.

2.3.4.5 NB-IoT standalone multi-carrier operation (ETC6)

- Place a NB-IoT carrier at the upper edge and a NB-IoT carrier at the lower Base Station RF Bandwidth edge.
- For transmitter tests, add NB-IoT carriers at the edges using 600 kHz spacing until no more NB-IoT carriers are supported or no more NB-IoT carriers fit.
- Set the power of each carrier to the same level

Example

The process for multiband test configuration for NB-IoT standalone is explained based on an example (fictitious) base station using the following parameters:

1. Aggregated channel bandwidth ($BW_{Channel\_RF}$) = 10 MHz

2. The basestation supports 8 carriers
3. A NB-IoT carrier is placed at the upper edge; the offset is not defined. F_{offset} = 0.1 MHz is used.
4. A NB-IoT carrier is placed at the lower edge at an offset of 0.1 MHz.
5. The remaining six NB-IoT carriers are placed with an offset of 600 kHz. (Fig. 2-9).

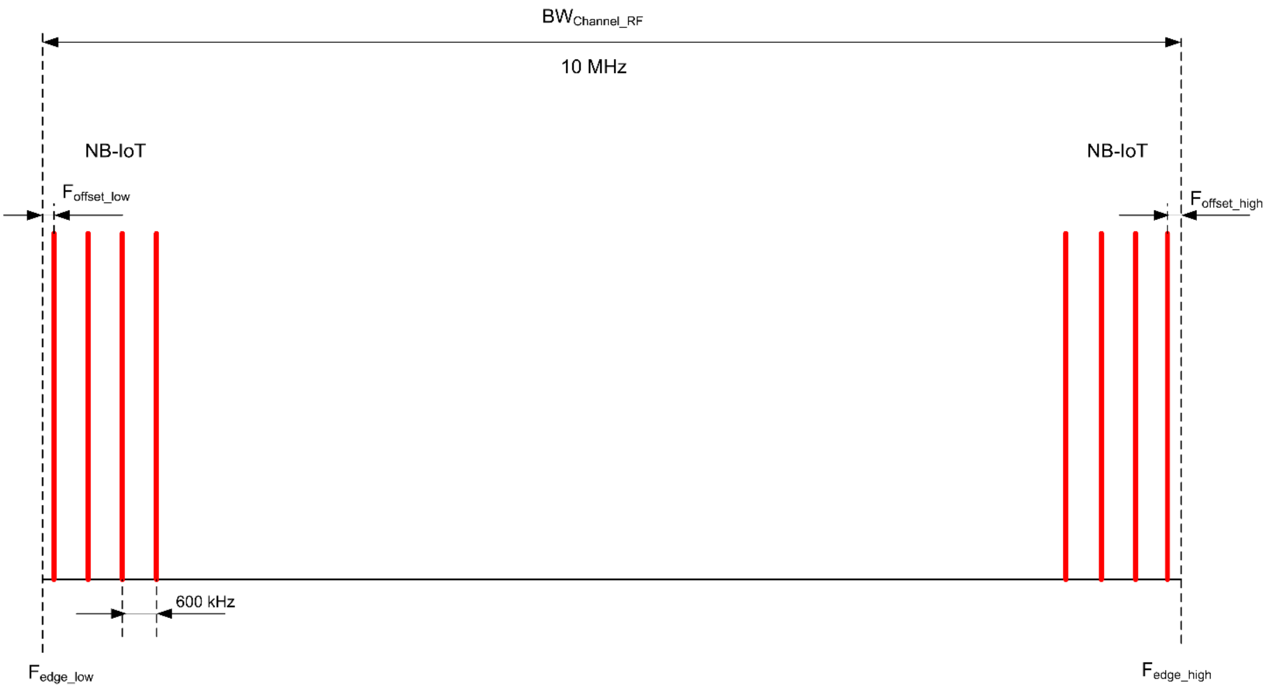


Fig. 2-9: Example for NB-IoT standalone multi-carrier

2.3.4.6 E-UTRA and NB-IoT standalone multi-carrier operation (ETC7)

- Receiver Tests
  - Place a NB-IoT carrier at the lower edge and a 5 MHz carrier at the upper Base Station RF Bandwidth edge. If the BS does not support 5 MHz channel BW use the narrowest supported BW.
- Transmitter Tests, if BS supports only one NB-IoT carrier
  - Add additional E-UTRA carriers of the same bandwidth as the already allocated E-UTRA carriers in the middle if possible. Set the power of each carrier to the same level
- Transmitter Tests, if BS supports more than one NB-IoT carrier
  - Place a NB-IoT carrier at the upper edge and a NB-IoT carrier at the lower Base Station RF Bandwidth edge.
  - Place two 5 MHz E-UTRA carriers in the middle of the Base Station RF Bandwidth. If the BS does not support 5 MHz channel BW use the narrowest supported BW, if only one carrier is supported or two carriers do not fit place only one carrier.
  - Add NB-IoT carriers at the edges using 600 kHz spacing until no more NB-IoT carriers are supported or no more NB-IoT carriers fit.

- Add additional E-UTRA carriers of the same bandwidth as the already allocated E-UTRA carriers in the middle if possible.

Example

The process for LTE and NB-IoT multi-carrier test configuration is explained based on an example (fictitious) base station using the following parameters:

1. Aggregated channel bandwidth ($BW_{Channel\_RF}$) = 25 MHz
2. The basestation supports 8 NB-IoT carriers
3. A NB-IoT carrier is placed at the upper edge; the offset is not defined. F_{offset} = 0.1 MHz is used.
4. A NB-IoT carrier is placed at the lower edge at an offset of 0.1 MHz.
5. Two LTE carriers of 5 MHz are placed in the middle.
6. The remaining six NB-IoT carriers are placed with an offset of 600 kHz. (Fig. 2-10).

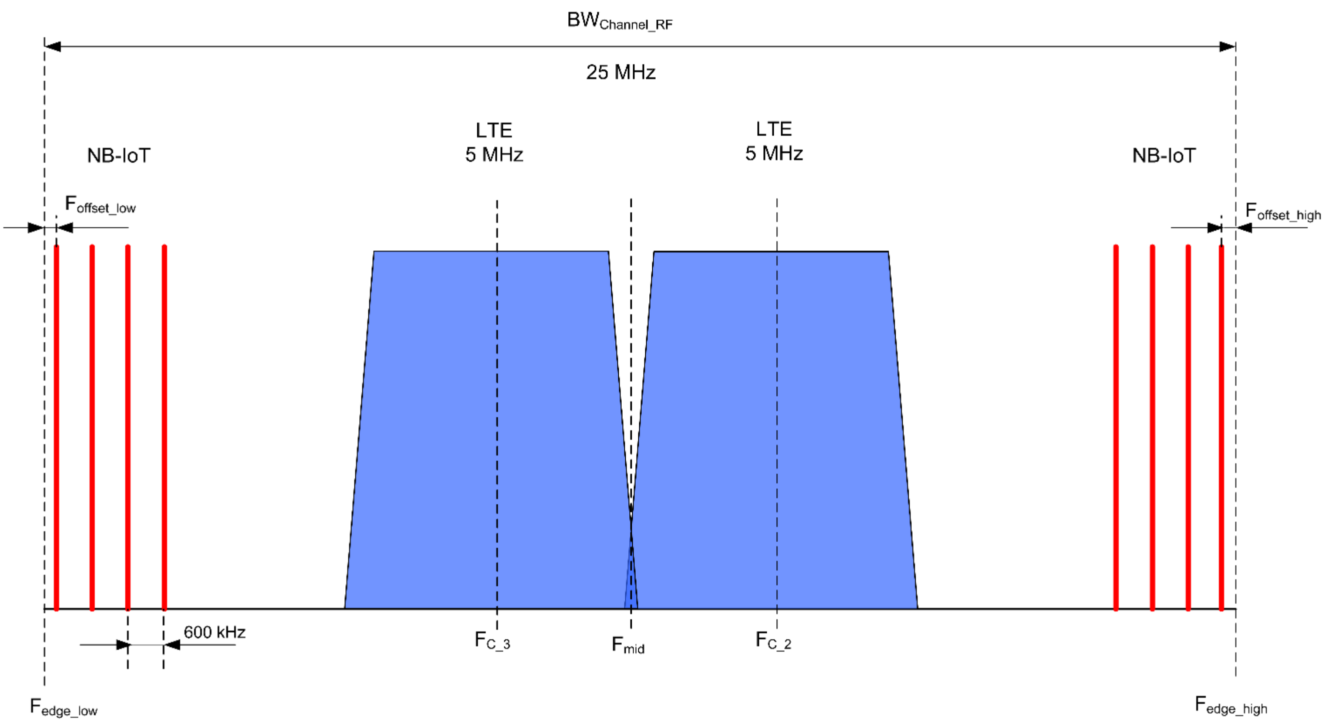


Fig. 2-10: Example for LTE and NB-IoT standalone multi-carrier operation

2.3.4.7 E-UTRA and NB-IoT in-band multi-carrier operation (ETC8)

- Place a 5 MHz carrier at the lower Base Station RF Bandwidth edge and a NB-IoT PRB at the outermost in-band position at the lower edge 5 MHz carrier.

- Place a 5 MHz carrier at the upper Base Station RF Bandwidth edge. If the basestation supports more than one NB-IoT carrier, place a NB-IoT PRB at the outermost in-band position of the upper 5 MHz carrier.
- For transmitter tests, select as many 5 MHz E-UTRA carriers that the BS supports and that fit in the rest of the Base Station RF Bandwidth. Place the carriers adjacent to each other starting from the high Base Station RF Bandwidth edge. The nominal carrier spacing defined in the formula of Fig. 2-3 shall apply
- If 5 MHz E-UTRA carriers are not supported by the BS the narrowest supported channel BW shall be selected instead.
- Set the power of each carrier to the same level

Example

The process for in-band E-UTRA and NB-IoT in-band multi carrier test configuration is explained based on an example (fictitious) base station using the following parameters:

1. Aggregated channel bandwidth ($BW_{Channel\_RF}$) = 25 MHz
2. The basestation supports 2 NB-IoT carriers
3. One 5 MHz LTE carrier with in-band NB-IoT carrier is placed at the upper edge and one is placed at the lower edge.
4. The remaining two 5 MHz carriers are placed following the above formula at an offset of 4.8 MHz from the adjacent carrier to the right (carrier aggregation, CA). No additional carriers fit in the spectrum (Fig. 2-11).

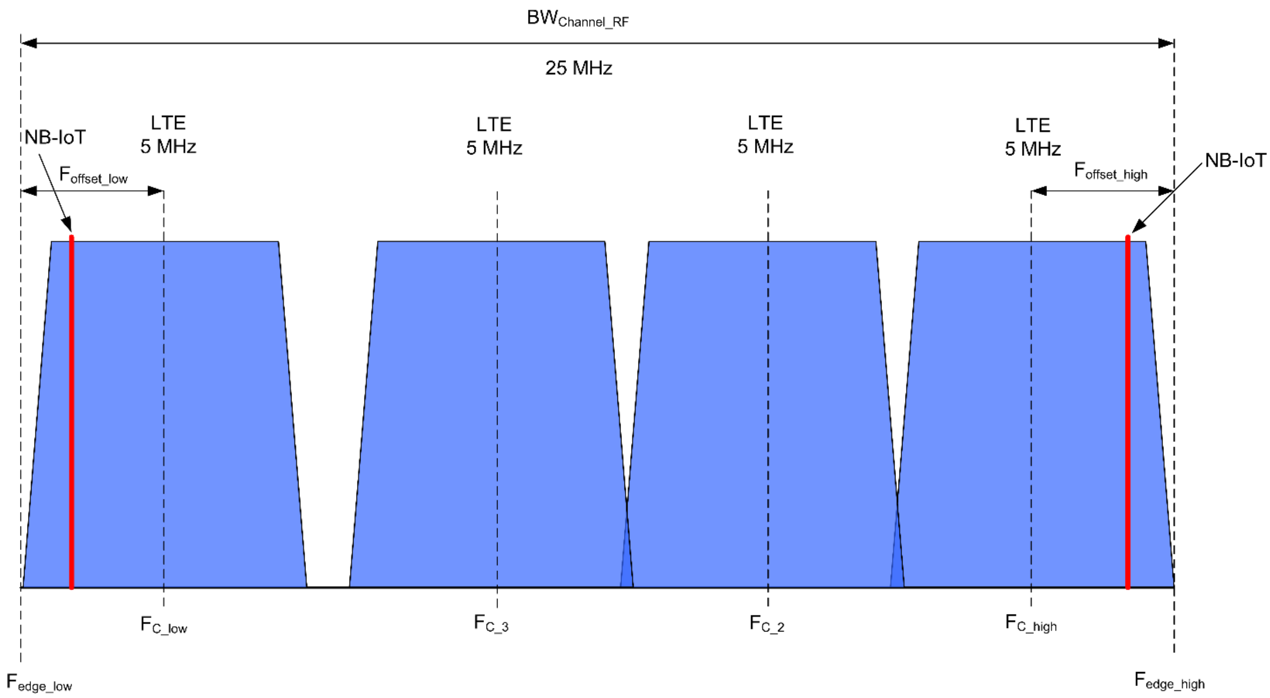


Fig. 2-11: Example for NB-IoT in-band multi-carrier

2.3.4.8 E-UTRA and NB-IoT guard-band multi-carrier operation (ETC9)

- Place a 10 MHz carrier at the lower Base Station RF Bandwidth edge and a NB-IoT PRB at the outermost guard-band position at the lower edge 10 MHz carrier.
- Place a 10 MHz carrier at the upper Base Station RF Bandwidth edge. If the basestation supports more than one NB-IoT carrier, place a NB-IoT PRB at the outermost guard-band position of the upper 10 MHz carrier.
- For transmitter tests, select as many 10 MHz E-UTRA carriers that the BS supports and that fit in the rest of the Base Station RF Bandwidth. Place the carriers adjacent to each other starting from the high Base Station RF Bandwidth edge. The nominal carrier spacing defined in the formula of Fig. 2-3 shall apply
- If 10 MHz E-UTRA carriers are not supported by the BS the narrowest supported channel BW shall be selected instead.
- Set the power of each carrier to the same level

Example

The process for in-band E-UTRA and NB-IoT guard-band multi carrier test configuration is explained based on an example (fictitious) base station using the following parameters:

1. Aggregated channel bandwidth ($BW_{Channel\_RF}$) = 50 MHz
2. The basestation supports 2 NB-IoT carriers
3. One 10 MHz LTE carrier with guard-band NB-IoT carrier is placed at the upper edge and one is placed at the lower edge.
4. The remaining two 10 MHz carriers are placed following the above formula at an offset of 9.6 MHz from the adjacent carrier to the right (carrier aggregation, CA). No additional carriers fit in the spectrum (Fig. 2-11).

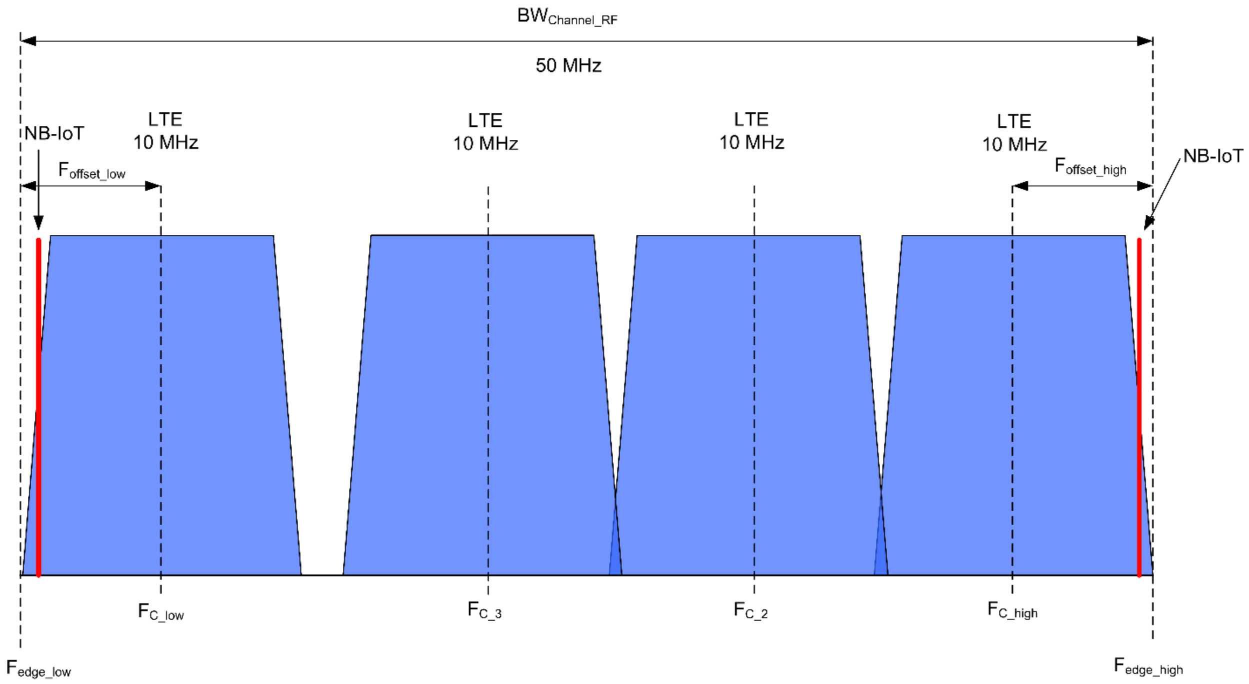


Fig. 2-12: Example for NB-IoT guard-band multi-carrier

2.4 Tx Test Setup

Fig. 2-13 shows the basic setup for the Tx test. An FSx is used to perform the test. An attenuator connects the FXs to the DUT. An external trigger is additionally required for some tests (such as TDD tests). In several tests, the SMx feeds an additional signal via a circulator. A few tests (on/off power and time alignment) require special setups; these are described in the respective sections.

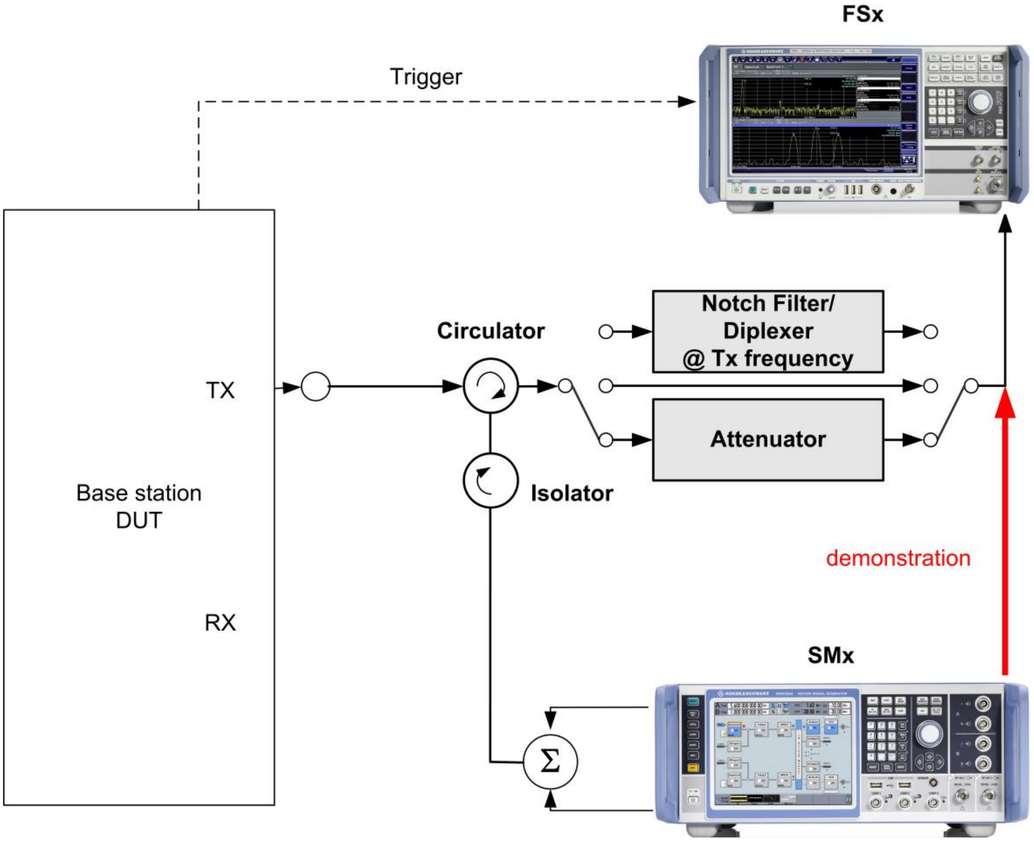


Fig. 2-13: Basic Tx test setup; some tests require a special setup.

2.5 Instruments and Options

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

- FSW
- FSV(A)
- FPS

The **E-UTRA/LTE measurements** software option is available for each of the listed analyzers. The following are needed for the Tx tests:

- FSx-K100 E-UTRA/LTE FDD downlink measurements
- FSx-K102 E-UTRA/LTE downlink MIMO measurements
- FSx-K104 E-UTRA/LTE TDD downlink measurements

The **E-UTRA/LTE NB-IoT downlink measurements** software option is available for the FSW and for the other analyzers in the VSE.

- FSW-K106 E-UTRA/LTE NB-IoT downlink measurements
- VSE-K106 E-UTRA/LTE NB-IoT measurements

A few tests require additional signals; for example, to simulate adjacent carriers. These are provided via vector signal generators. The following are suitable:

- SMW
- SMBV

One of the tests (Home BS output power with co-channel LTE and option 2) requires two LTE signals. These signals can be generated by using a two-path generator or by adding a generator. The following software options are required:

- SMx-K55 LTE
- SMx-K115 Cellular IoT (here NB-IoT)
- SMx-K42 W-CDMA
- SMx-K62 AWGN

Table 2-3 gives an overview of the required instruments and options.

Number	Measurement	Instruments and options							
		LTE				NB-IoT	Interferer		Simulation
		LTE	FS K100 FDD	FS K104 TDD	FS K104 MIMO	FS K106	SMx	SMx Option	SMx
6	Transmitter Tests								
6.2	Basestation output power	☑	⚙	⚙		☑			👓
6.2.6	Home BS with adjacent W-CDMA	☑	⚙	⚙			⚙	K-42, K-62	👓
6.2.6	Home BS with adjacent LTE	☑	⚙	⚙			⚙	K-55, K-62	👓
6.2.6	Home BS with co-channel LTE	☑	⚙	⚙			⚙	K-55 (two paths) K-62	
6.3	Output power dynamics								
6.3.2	Total power dynamic range	☑	⚙	⚙					👓
6.3.3.	NB-IoT RB dynamic range					☑			
6.4	Transmit ON/OFF	☑	⚙	⚙					👓
6.5	Transmitted signal quality								
6.5.1	Frequency error	☑	⚙	⚙		☑			👓
6.5.2	Error vector magnitude	☑	⚙	⚙		☑			👓
6.5.3	Time alignment	☑	⚙	⚙	⚙	☑			👓
6.5.4	DL RS power	☑	⚙	⚙		☑			👓
6.6	Unwanted emissions								
6.6.1	Occupied bandwidth	B				B			👓
6.6.2	ACLR	☑	⚙	⚙		☑			👓
6.6.3	Operating band unwanted emissions	☑	⚙	⚙		☑			👓
6.6.4	Transmitter spurious emissions	B				B			👓
6.7	Transmitter intermodulation	C				C	⚙	K-55, K-115	👓

⚙ needed for the measurement

☑ can do the measurement

👓 needed for demonstration program

B uses basic function of Spectrum Analyzer

C Combined measurements: ACLR, SEM and Spurious emissions

Table 2-3: Overview of required instruments and software options

Notes:

- 6.2.6 Home BS co-channel LTE: Simulation requires 3 LTE signals
- 6.3.3 not implemented yet

2.6 Multistandard Radios and TS 37.141

TS 37.141 applies when more than one radio access technology (RAT) is supported on a signal base station (multi-RAT). The conformance specifications overlap for some Tx tests, which can alternatively be performed in line with 37.141. See TS37.141 [5] and Chapter 4.9 from TS36.141 [1]. Refer also to the application note **Measuring Multistandard Radio Base Stations according to TS 37.141** [6].

TS36.141 and TS37.141		
RF requirement	**Clause in TS36.141**	**Clause in TS 37.141**
Base station output power	6.2.5	6.2.1.5
Transmit ON/OFF power	6.4	6.4
Transmitter spurious emissions	6.6.4.5	6.6.1.5
Operating band unwanted emissions	6.6.3.5.1, 6.6.3.5.2	6.6.2.5
Transmitter intermodulation	6.7.5	6.7.5.1

Table 2-4: Overlaps between TS36.141 and TS37.141

3 Transmitter Tests (Chapter 6)

Specification TS36.141 defines the tests required in the various frequency ranges (bottom, middle, top, **B M T**) of the operating band. The same applies for multicarrier scenarios. In instruments from Rohde & Schwarz, the frequency range can be set to any frequency within the supported range independently of the operating bands.

In order to allow comparisons between tests, test models (TMs) standardize the resource block (RB) allocations. For LTE, these are called enhanced TMs (E-TM) to differentiate them from the TMs for W-CDMA. The E-TMs are stored as predefined settings in instruments from Rohde & Schwarz.

Table 3-1 and Table 3-2 provide an overview of the basic parameters for the individual tests. The chapter in TS36.141 and the corresponding chapter in the application note are both listed. Both the required E-TMs and the frequencies to be measured (B M T) are included. There is also a column listing the single carriers (SC) and multicarriers (MC) to be used for the test. The following terms are used:

- Any: Any supported channel BW
- Max: The maximum supported channel BW
- EVM: Error Vector Magnitude
- C Spectrum: The base station is capable of multi-carrier and/or CA operation in contiguous spectrum for single band. ETC2 is only applicable when contiguous CA is supported.
- C and NC Multi-carrier/CA: The base station is capable of multi-carrier and/or CA operation in contiguous (C) and non-contiguous (NC) spectrum for single band. It is distinguished between same parameters and different parameters when regarding contiguous and non-contiguous operations. The test configurations are for both cases, if not pointed out differently. ETC2 is only applicable when contiguous CA is supported.
- Multi-band: For multi-band operations, multiple bands are either mapped on common antenna connectors or mapped on separate antenna connectors. If not pointed out differently, the test configurations are for both cases. ETC1 and/or ETC 3 shall be applied in each supported operating band. ETC2 is only applicable when contiguous CA is supported.
- SC: For C Spectrum, C and NC Multicarrier/CA and multi-band operations, single carrier (SC) means that every carrier is regarded individually for measurement.
- The occupied bandwidth shall be measured using several different MC combinations.

Basic parameter overview, part 1

Chapter TS36.141	Chapter AppNote	Name	Test models	Channels	Single-Carrier	Multi-Carrier: C Spectrum C and NC Multi-carrier/CA Multi-band	Comment
6.2	3.2	BS Max Output Power	E-TM1.1	B M T	Max SC	ETC1 ETC1, ETC3* ETC1/3***,ETC4	
6.2.6	3.2.1	Home BS Output Power adjacent W-CDMA	E-TM1.1 (TM1)	M	Any SC	-	
6.2.7		Home BS Output Power adjacent LTE	E-TM1.1 (E-TM1.1)	M	Any SC	-	
6.2.8		Home BS Output Power co-channel LTE	E-TM1.1 (any)	M	Any SC	-	
6.3.2	3.3.1	Total Power Dynamic Range	E-TM3.1 E-TM2	B M T	Any SC	SC SC SC	
6.4	3.4	Transmit ON/OFF Power	E-TM1.1	M	Max SC	ETC1 ETC1, ETC3* ETC4	TDD only
6.5.1	3.5.1	Frequency Error	E-TM3.1 E-TM3.2 E-TM3.3 E-TM2	B M T	Any SC	Tested with EVM Tested with EVM Tested with EVM	
6.5.2		Error Vector Magnitude (EVM)			Any SC	ETC1 ETC1, ETC3* ETC1/3,ETC4	
6.5.3	3.5.2	Time Alignment Error	E-TM1.1	M	Max SC	ETC1 ETC1, ETC3* ETC1/3,ETC5***	TX, MIMO CA
6.5.4	3.5.3	Reference Symbol Power	E-TM1.1	B M T	Any SC	SC SC SC	
6.6.1	3.6.1	Occupied Bandwidth	E-TM1.1	B M T	Any SC	SC,ETC2 SC,ETC2 SC,ETC2	Different MCs
6.6.2	3.6.2	Adjacent Channel Leakage Power (ACLR)	E-TM1.1 E-TM1.2	B M T	Any SC	ETC1 ETC1*,ETC3 ETC1/3,ETC5	
6.6.2.6	3.6.2	Cumulative ACLR requirement in non-contiguous spectrum			Any SC	- ETC3 ETC3,ETC5**	

*Note: Applicable only for different parameters
**Note: Applicable only for common antenna connector
***Note: ETC5 is only applicable when inter-band CA is supported

Table 3-1: Basic parameter overview, part 1

Basic parameter overview, part 2							
Chapter TS36.141	**Chapter AppNote**	**Name**	**Test models**	**Channels**	**Single-Carrier**	**Multi-Carrier:** C Spectrum C and NC Multi-carrier/CA Multi-band	**Comment**
6.6.3	3.6.3	Operating Band Unwanted Emissions (SEM)	E-TM1.1 E-TM1.2	B M T	Any SC	ETC1 ETC1,ETC3 ETC1/3,ETC5	
6.6.4	3.6.4	Transmitter Spurious Emissions	E-TM1.1	B M T	Any SC	ETC1 ETC1*, ETC3 ETC1/3,ETC5	
6.7	3.7	Transmitter Intermodulation	E-TM1.1	B M T	Max SC	ETC1 Analog to 6.6 ETC1/3	
*Note: Applicable only for different parameters **Note: Applicable only for common antenna connector							

Table 3-2: Basic parameter overview, part 2

When measuring unwanted transmission according to chapter 3.6 or transmitter intermodulation according to chapter 3.7 for multi-band with separate antenna connectors, single-band requirements apply to each antenna connector for both multi-band operation test and single band operation test. Other antenna connectors are terminated for single-band operation tests.

For ACLR and CACLR measurement, it is possible that ETC5 is only applicable for Inter RF bandwidth gap.

Basestations with NB-IoT support

Overview Test with NB-IoT							
Chapter TS36.141	**Chapter AppNote**	**Name**	**Single Carrier NB-IoT Standalone**	**Muli-carrier NB-IoT Standalone**	**Muli-carrier NB-IoT / LTE Standalone**	**Muli-carrier NB-IoT / LTE In-band**	**Muli-carrier NB-IoT / LTE In-band and / or guard-band**
6.2	3.2	Base station output power	N-TM	ETC6	ETC7	ETC8	ETC9
6.3		Output power dynamics					
6.3.1	3.3.1	RE Power control dynamic range	N/A	N/A	With EVM	With EVM	With EVM
6.3.2	3.3.2	Total power dynamic range	N/A	N/A	SC	SC	SC
6.3.3	3.3.3	NB-IoT RB power dynamic range	N/A	N/A	N/A	SC	SC
6.4	3.4	Transmit ON/OFF power	N/A	N/A	N/A	N/A	N/A
6.5		Transmitted signal quality					
6.5.1		Frequency error	With EVM	With EVM	With EVM	With EVM	With EVM
6.5.2	3.5.1	Error Vector Magnitude	N-TM	ETC6	ETC7	ETC1	ETC1
6.5.3	3.5.2	Time alignment error	N-TM TxDiversity	ETC6	ETC7	ETC1	ETC1
6.5.4	3.5.3	DL RS power	N-TM	SC	SC	SC	SC
6.6		Unwanted emissions					
6.6.1	3.6.1	Occupied bandwidth	N-TM	SC	SC	SC	SC
6.6.2	3.6.2	ACLR	N-TM	ETC6	SC	ETC8, ETC1	ETC9, ETC1
6.6.3	3.6.3	SEM	N-TM	ETC6	ETC7	ETC8, ETC1	ETC9, ETC1
6.6.4	3.6.4	Transmitter spurious emissions	N-TM	ETC6	ETC7	ETC8	ETC9
6.7	3.7	Transmitter intermodulation	N-TM	ETC6	ETC7	ETC8	ETC9

Table 3-3: NB-IoT

3.1 Basic Operation

3.1.1 FSx Spectrum and Signal Analyzer

LTE

Most of the tests described here follow the same initial steps. They are explained here once:

1. Launch the LTE test application: Press the MODE hardkey. Select **LTE**.

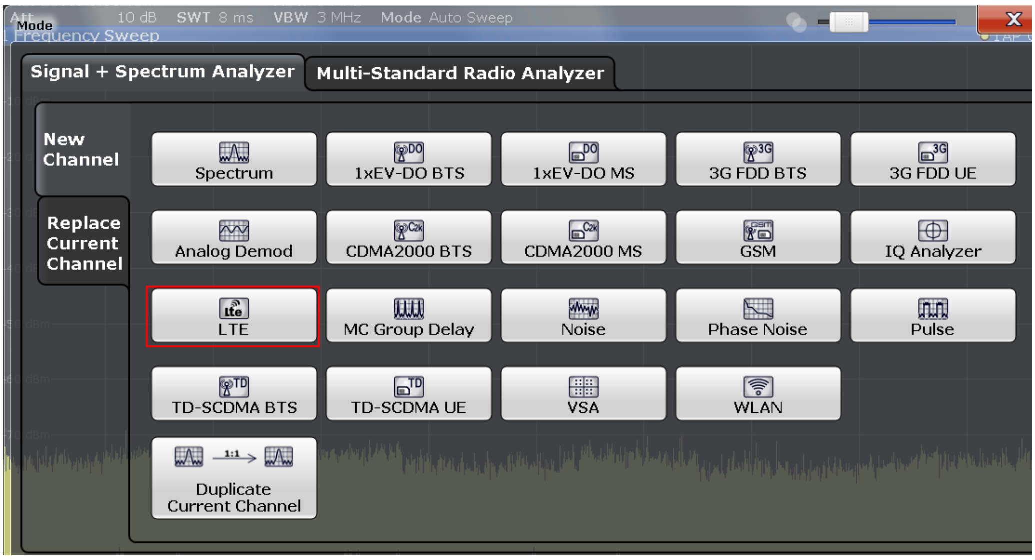


Fig. 3-1: FSW: launching the LTE option.

2. Choose **Downlink** as the direction
3. Set the duplex mode (**FDD** or **TDD**)
4. Select the wanted test model (E-TM) (example: 10 MHz with E-TM1.1)

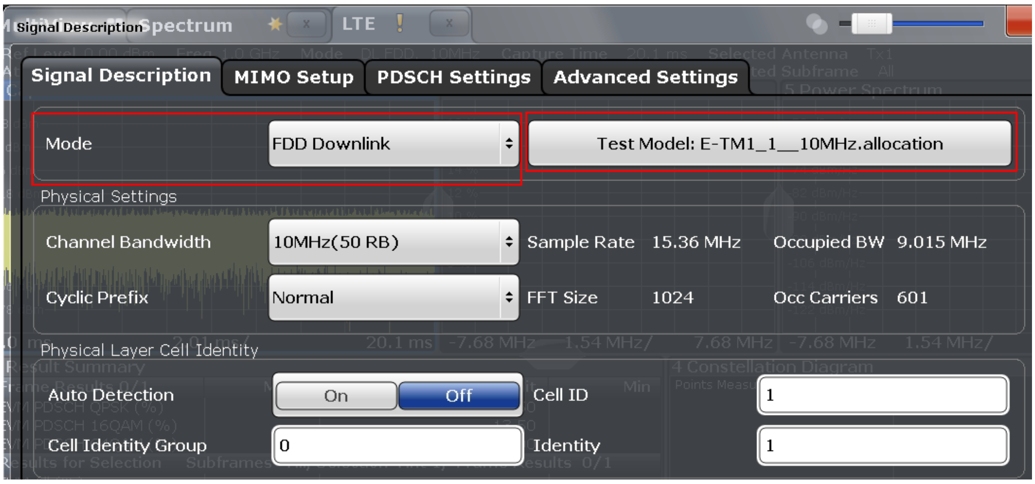


Fig. 3-2: FSW: setting duplex mode, direction, and test model.

Tx tests can be fundamentally divided into demodulation tests and spectrum measurements. In demodulation tests, the LTE signal is acquired and then various test results are calculated based on the I/Q data. Spectrum measurements determine the level versus frequency of a selected signal. Fig. 3-3 shows the available selection in the FSW.

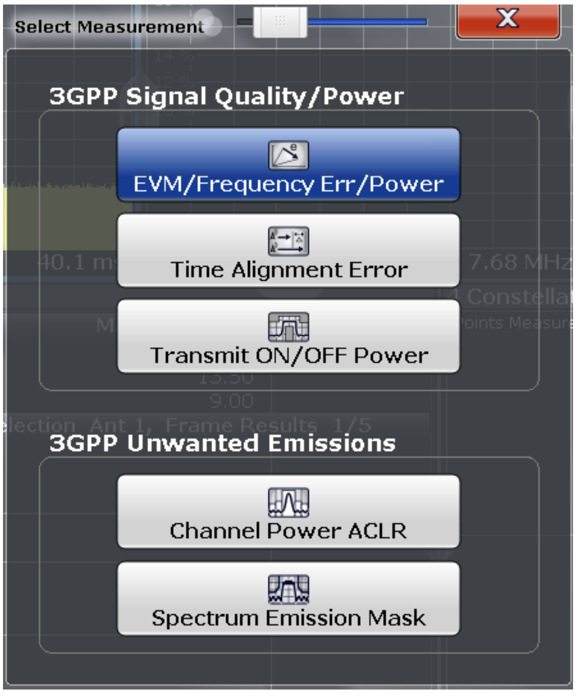


Fig. 3-3: FSW: selecting the LTE tests (On/Off power is available only for TDD).

For MC scenarios a special MC filter is available for the demodulation tests. It can be set under DEMOD. The filter minimizes influences from adjacent carriers:

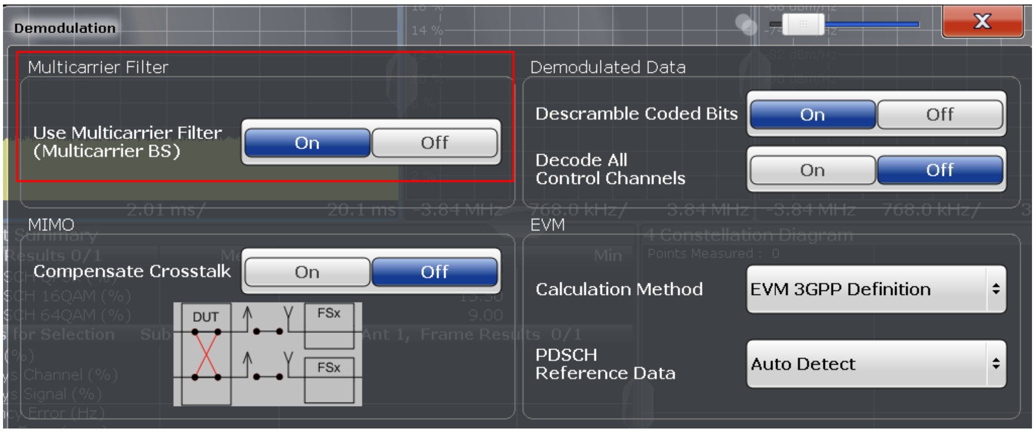


Fig. 3-4: Enabling the MC filter.

An FSW is used whenever possible in the sections below to illustrate the test examples. Special settings such as external triggers for TDD signals are discussed in the individual sections.

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

Fig. 3-5 shows the LTE demodulation measurement in the FSW.

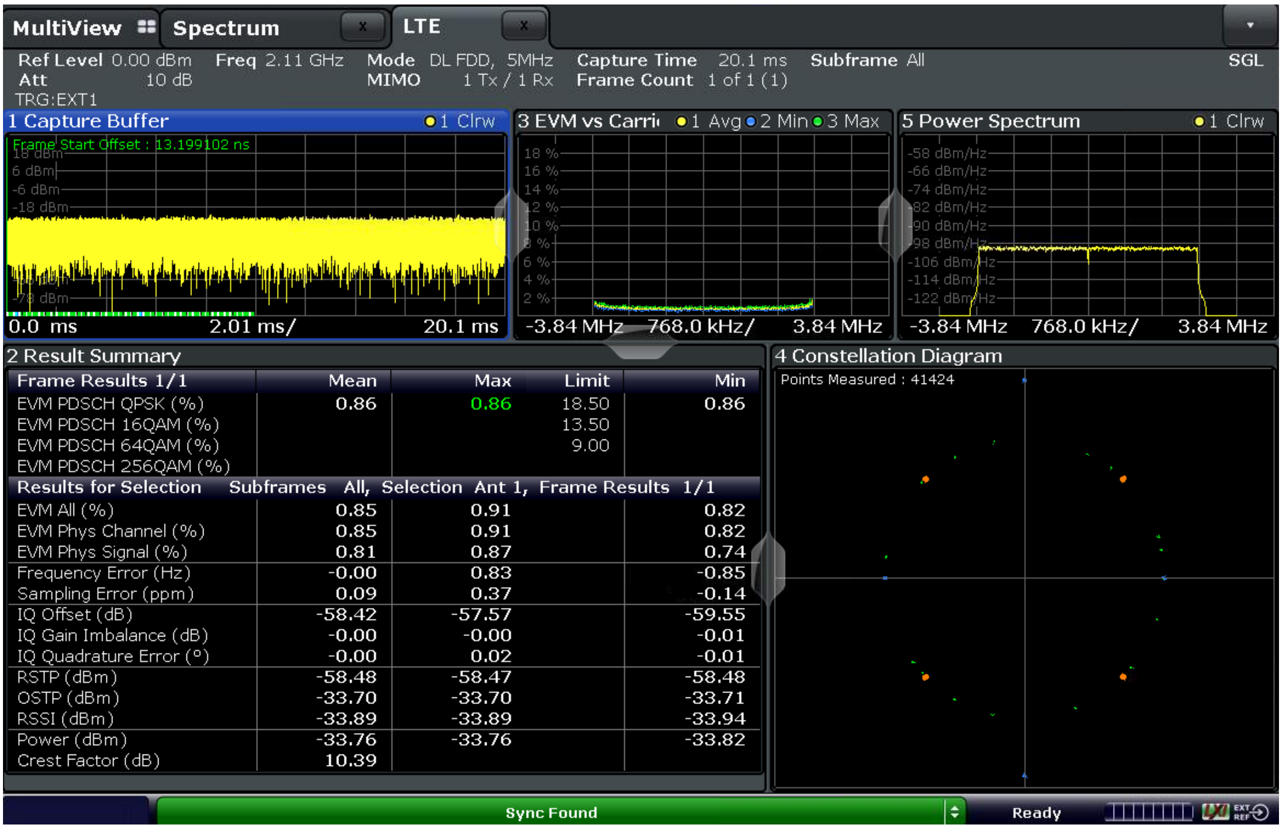


Fig. 3-5: LTE overview in the FSW: Under Result Summary (bottom left), the test values are summarized in scalar form.

NB-IoT

Measurements on basestations capable of NB-IoT require an additional firmware option on the FSW (FSW-K106: NB-IoT Downlink) or the VSE with option VSE-K106.

Most of the tests described here follow the same initial steps. They are explained here once:

1. Launch the NB-IoT test application

   Press the MODE hardkey. Select **NB-IoT**.

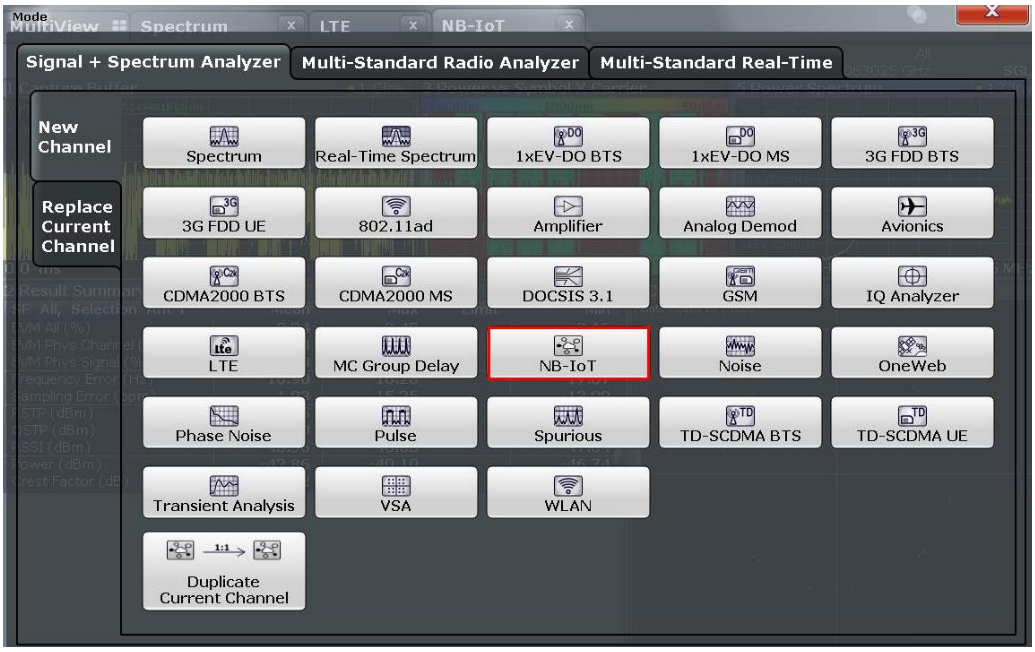


Fig. 3-6: FSW: launching the LTE option.

2. **FDD Downlink** is the only possible direction
3. Select the wanted Deployment: Stand-alone, inband or guard band

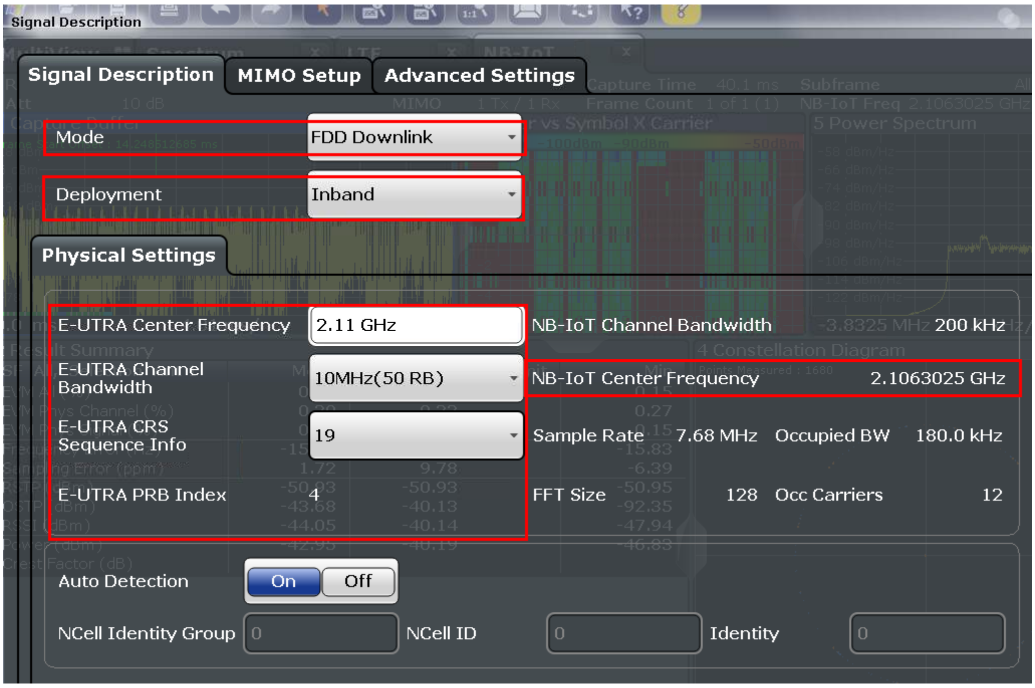


Fig. 3-7: FSW: setting deployment, channel bandwidth and frequency.

4. Set the frequency and for inband or guard band deployments the E-UTRA channel bandwidth and the CRS Sequence Info. Alternatively, just set the wanted PRB index. The firmware calculates and sets the NB-IoT frequency automatically.
5. For Demodulation measurements the firmware automatically detects the used N-TM.

Tx tests can be fundamentally divided into demodulation tests and spectrum measurements. In demodulation tests, the NB-IoT signal is acquired and then various test results are calculated based on the I/Q data. Spectrum measurements determine the level versus frequency of a selected signal. Fig. 3-3 shows the available selection in the FSW.

Fig. 3-8: FSW: selecting the NB-IoT tests.

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

Fig. 3-9 shows the NB-IoT demodulation measurement in the FSW.

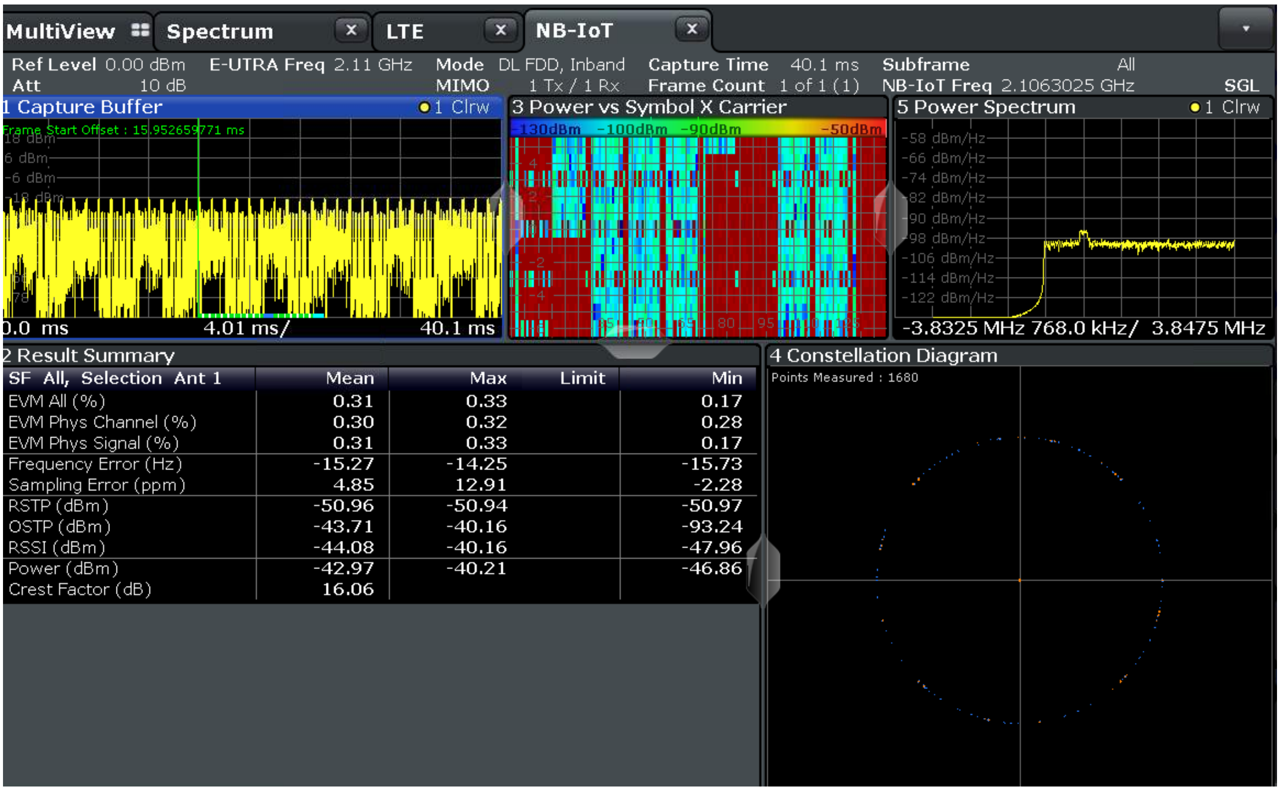


Fig. 3-9: NB-IoT overview in the FSW: Under Result Summary (bottom left), the test values are summarized in scalar form.

3.1.2 SMx Vector Signal Generator

The SMx is used here to generate additional LTE or W-CDMA signals, such as interferers or adjacent channel signals. Only the basic steps for LTE are provided here. Several special settings are needed for the individual tests. Significantly different settings, such as those for W-CDMA, are discussed directly in the corresponding chapters.

1. Set the center frequency and the levels (**Freq** and **Lev**)(Fig. 3-10)
2. Select the LTE standard in baseband block A (**E-UTRA/LTE)** (Fig. 3-11)

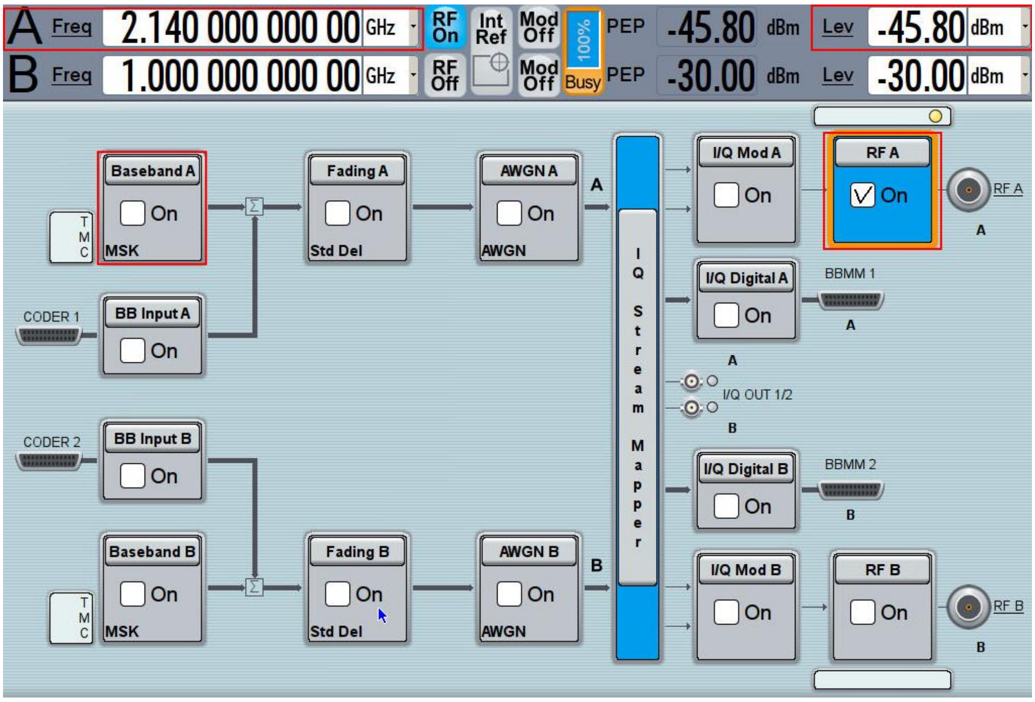


Fig. 3-10: SMW: Setting the frequency and level. Digital standards such as LTE are set in the baseband block.

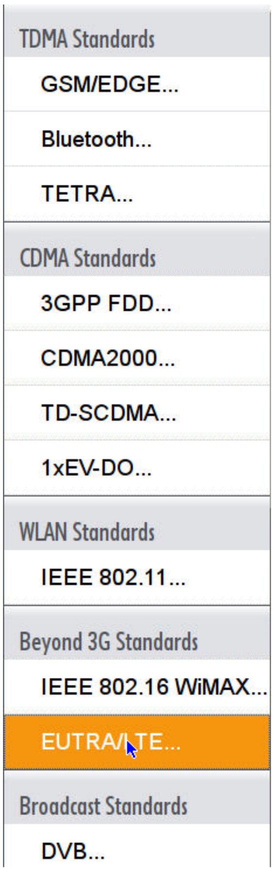


Fig. 3-11: SMW: selecting LTE in the baseband block.

3. Make the basic settings such as **Duplexing** (FDD or TDD) and the **Link Direction** (normally **Downlink (OFDMA)**; one test requires **Uplink**) (Fig. 3-12)

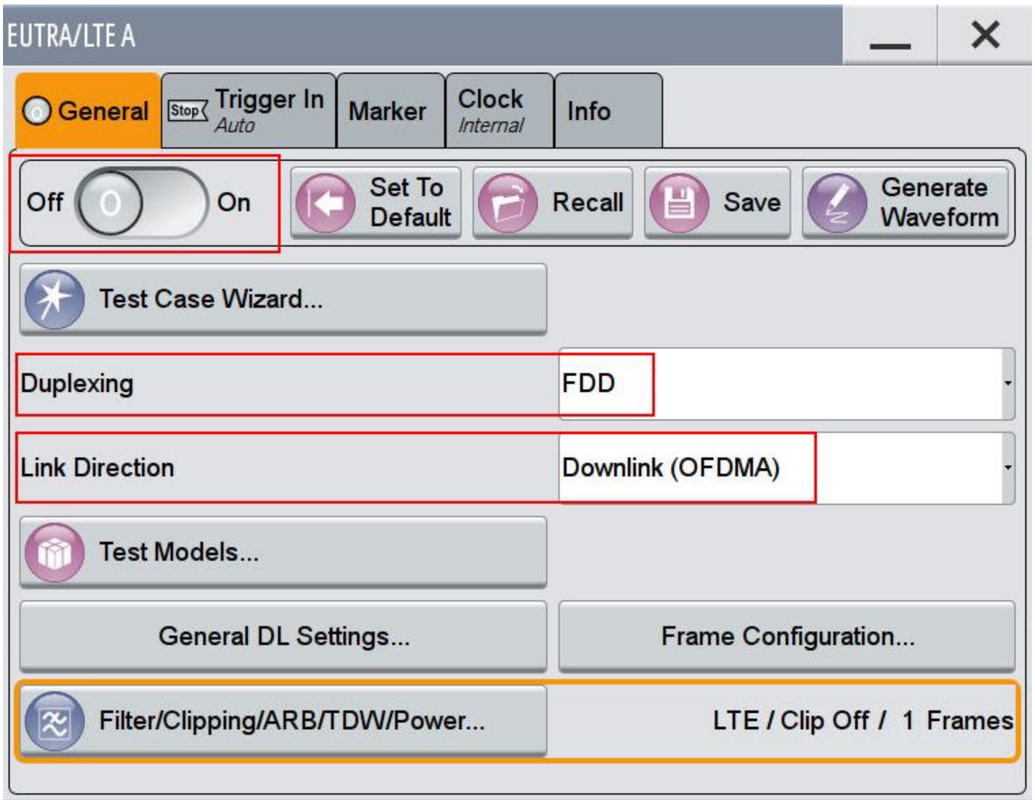


Fig. 3-12: SMW: general LTE settings: duplexing, link direction.

4. Select a filter. No filters are defined in the LTE. The SMx therefore offers several optimizations (Fig. 3-13).

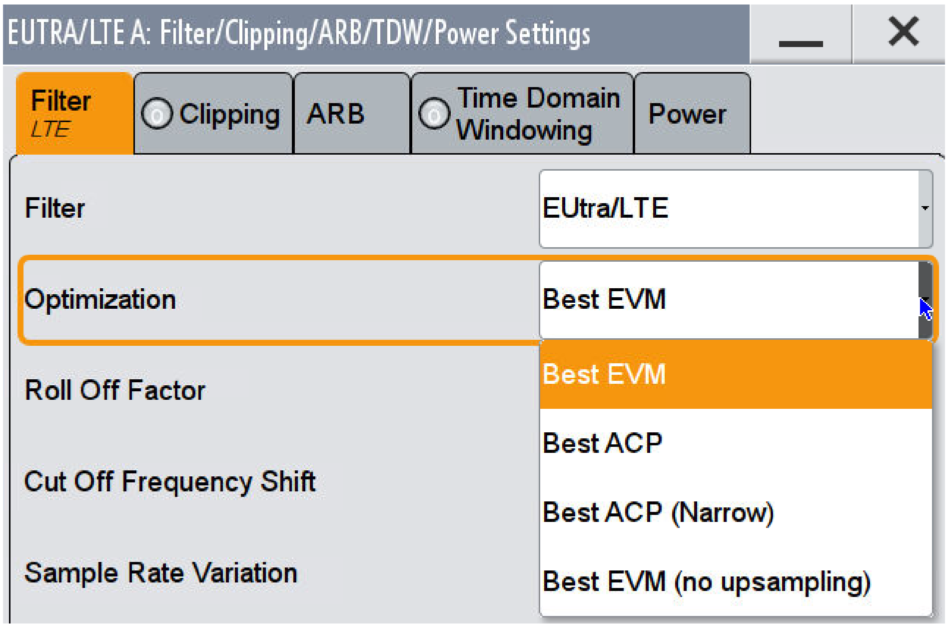


Fig. 3-13: SMW: selecting the LTE filter settings.

3.1.3 R&S TSrun Demo Program

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

The **LTE BS Tx Test** module represents a so called test for the TSrun software. See Section 4.1 for some important points on the basic operation of TSrun.

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 will be 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

Please note that the module allows the control of the internal LTE FW options on the FSW only (Fig. 3-14).

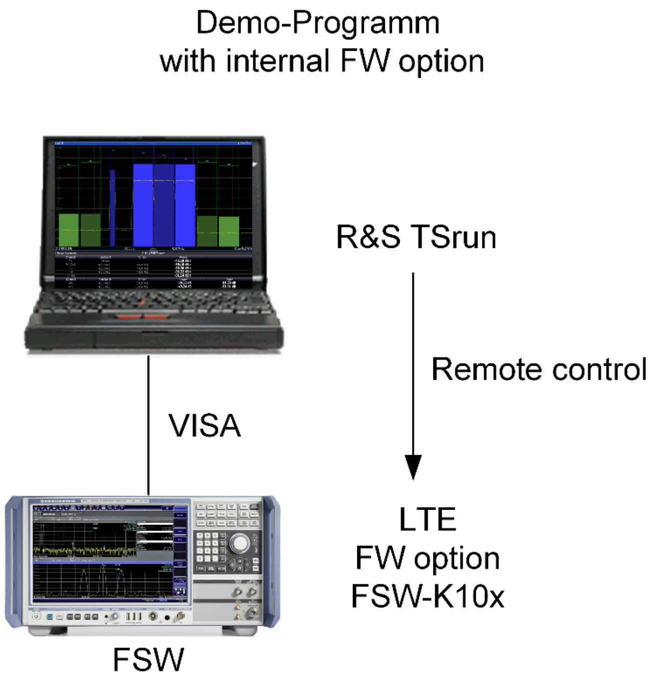


Fig. 3-14: TSrun directly controls the LTE FW option on the FSx via VISA.

		FSW	
Chapter	**Name**	**SC**	**MC**
6.2	BS Max Output Power	☑	☑
6.2.6	Home BS Output Power adjacent W-CDMA	☑	—
6.2.7	Home BS Output Power adjacent LTE	☑	—
6.2.6	Home BS Output Power co-channel LTE	☑	—
6.3.2	Total Power Dynamic Range	☑	—
6.3.3	NB-IoT RB power Dynamic Range	☑	
6.4	Transmit ON/OFF Power	☑	☑
6.5.1	Frequency Error	☑	—
6.5.2	Error Vector Magnitude (EVM)		
6.5.3	Time Alignment Error	☑	☑
6.5.4	Reference Symbol Power	☑	—
6.6.1	Occupied Bandwidth	☑[1]	☑[1]
6.6.2	Adjacent Channel Leakage Power (ACLR)	☑	☑
6.6.3	Operating Band Unwanted Emissions (SEM)	☑	☑
6.6.4	Transmitter Spurious Emissions	☑[1]	☑[1]
6.7	Transmitter Intermodulation	☑	☒

☑ Supported by the demo program

1: Uses a basic function on FSx

— not stipulated (but can be done carrier by carrier)

☒Not supported.

Getting started

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

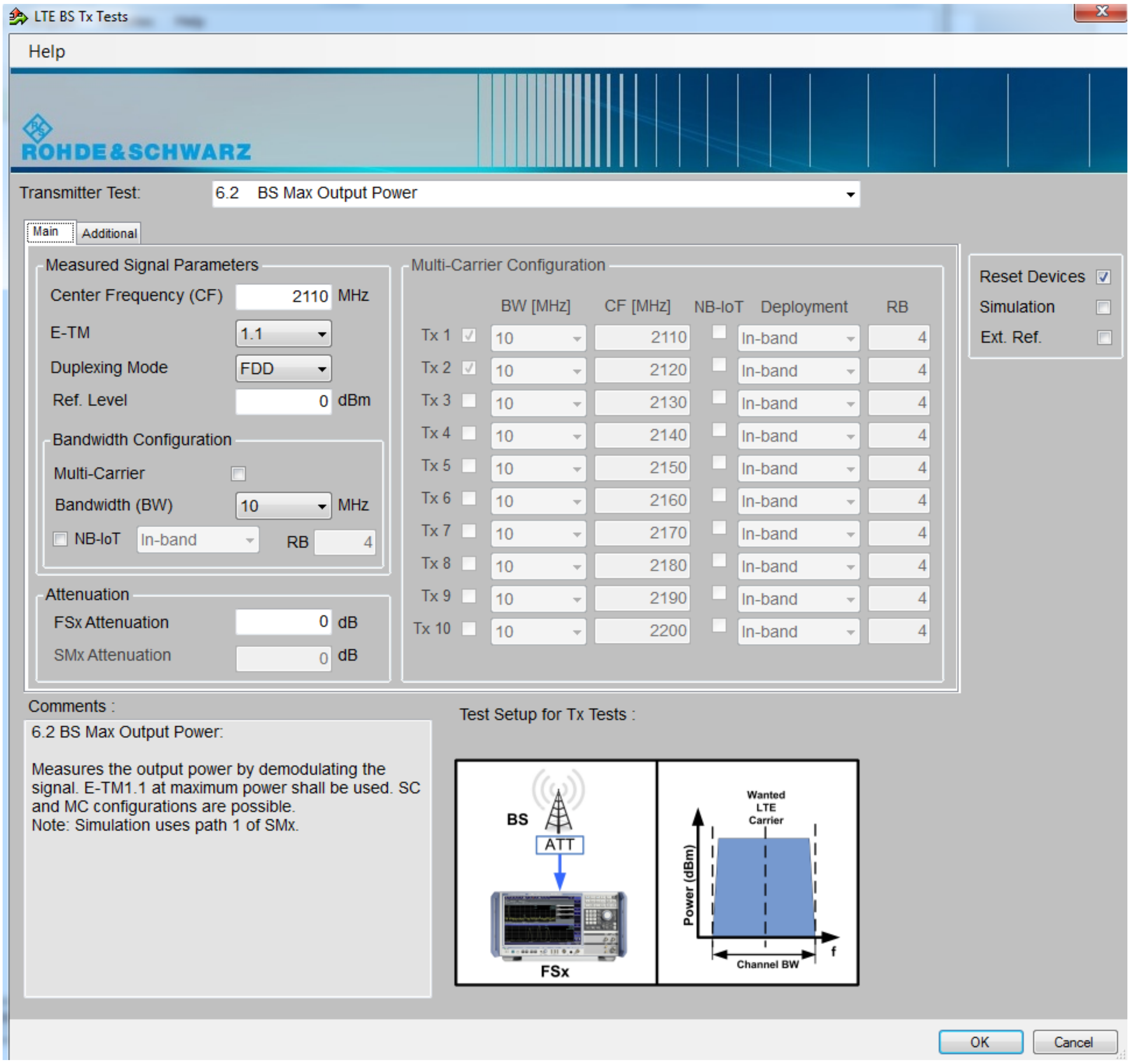


Fig. 3-15: Full overview: setting parameters for the LTE BS Tx test.

General settings

The basic parameters are set at the top right:

- **Reset Devices**: Sends a reset command to all connected instruments
- **Simulation**: Generates a signal using the SMx for demonstration purposes.
- **External ref**: Switches the FSx over to an external reference source (typ. 10 MHz).

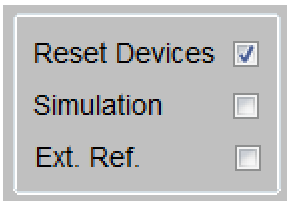


Fig. 3-16: General settings.

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

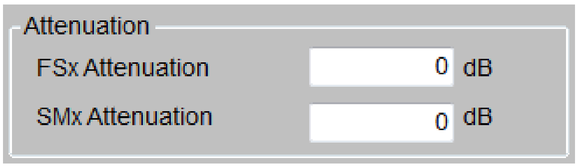


Fig. 3-17: Attenuation settings.

Test cases

This is the main parameter. Select the wanted test case here. All 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.

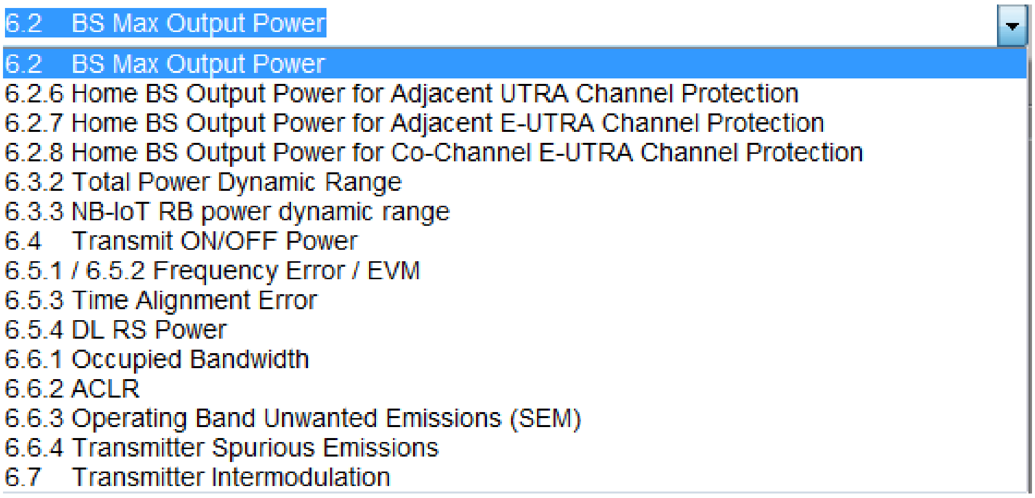


Fig. 3-18: Available test cases.

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

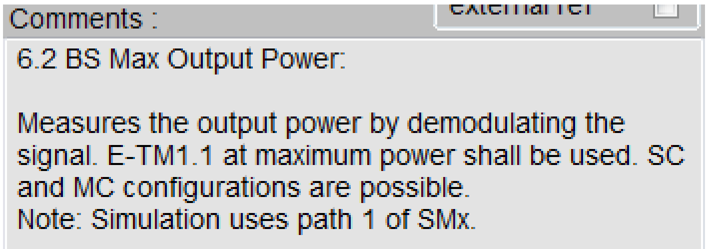


Fig. 3-19: Brief notes are provided in the Comments **section (top right) based on the selected test case.**

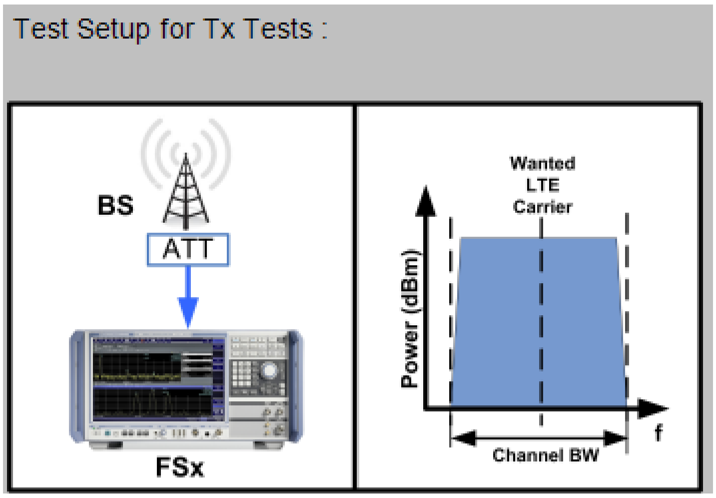


Fig. 3-20: The Test Setup **section (bottom right) displays a basic setup for the selected test case along with the location of the signals in the spectrum.**

The settings are split in two main tabs:

- **Main**: for main parameters of the wanted signal
- **Additional**: for test specific parameters

Settings for measured signal

Use this section to define the basic parameters for the LTE signal to be measured:

- **Center Frequency** for SC
- The test model **E-TM** (E-TM1.1 is required for most test cases)
- **Duplexing Mode**
- **Ref. Level**: Set here the expected reference level.
- **Bandwidth**
  - **0.2 MHz**: Standalone NB-IoT
  - **Others**: Mark **NB-IoT** do deploy a NB-IoT RB with the LTE signal. The RB has to be set separately.

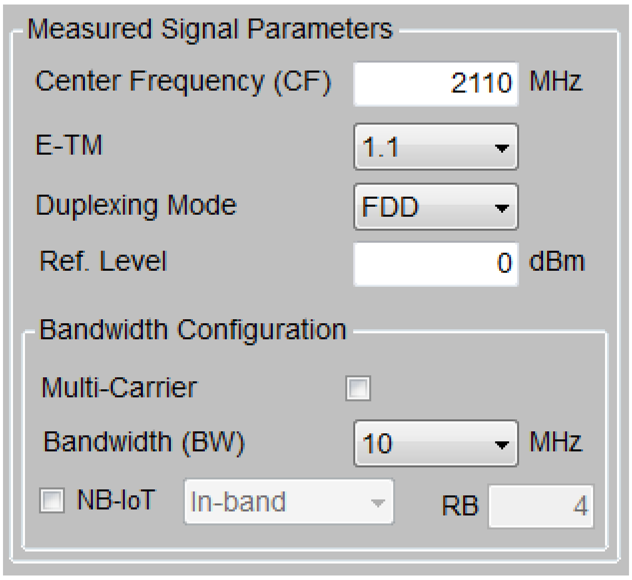


Fig. 3-21: Main settings for measured signal.

Multi-Carrier

Several tests can be carried out with MC. Selecting the **Multi-Carrier** option grays out the center frequency and bandwidth parameters and allows you to enter up to ten carriers along with their frequency and bandwidth. Again, mark **NB-IoT** in the individual carrier to deploy a NB-IoT RB.

Note: No logical checks of the MC settings are made. The frequencies must be entered in rising sequence. In other words, start with TX1 for the lowest frequency and then enter each subsequent frequency, ending with the highest frequency.

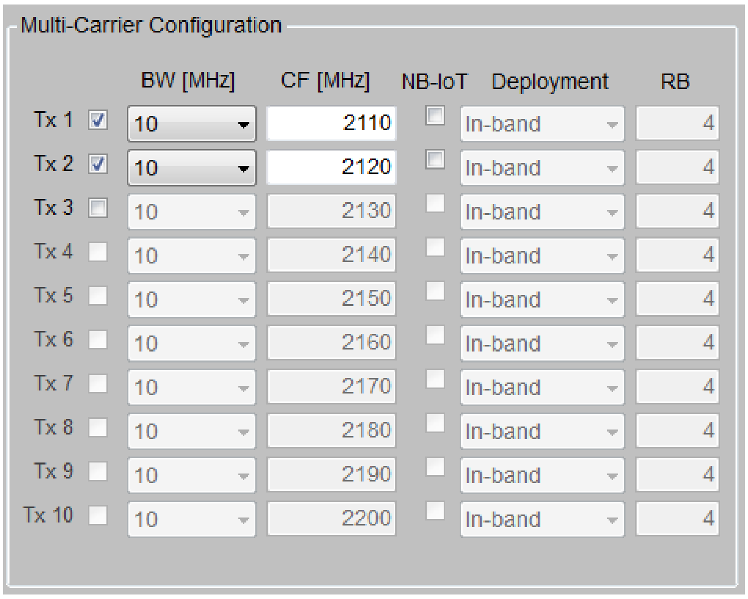


Fig. 3-22: Multicarrier settings.

More advanced settings for specific tests cases are described in the corresponding sections below (see Fig. 3-23).

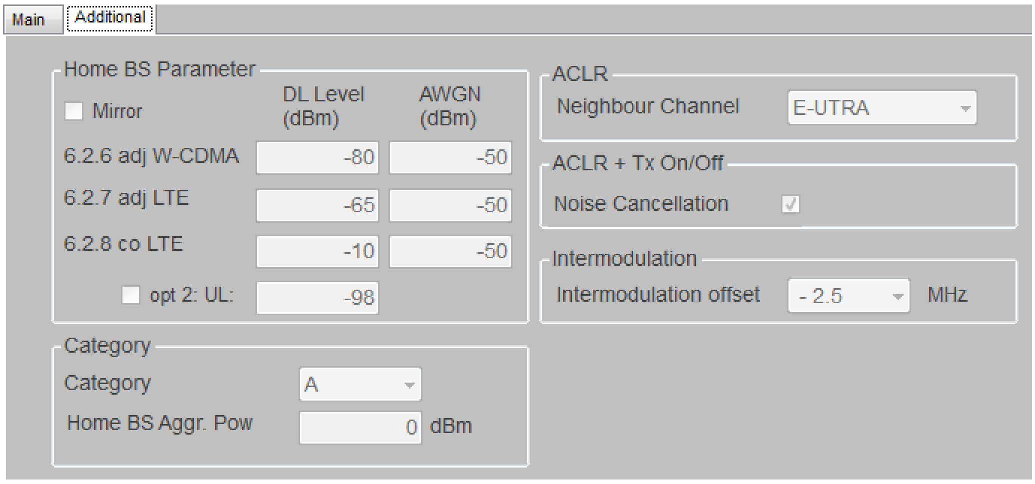


Fig. 3-23: The tab Additional

3.2 Base Station Output Power (Clause 6.2)

The rated output power (PRAT) of the base station is the mean power level per carrier for BS operating in single carrier, multicarrier, or carrier aggregation configurations that the manufacturer has declared to be available at the antenna connector during the transmitter ON period [1].

The test is performed for SC as well as MC.

The power declared by the manufacturer must not exceed the values specified in Table 3-4. Table 3-5 shows the allowed tolerances.

Maximum rated output power for different BS classes	
BS class	PRAT
Wide Area BS	No upper limit
Medium Range BS	≤ ±38 dBm
Local Area BS	≤ ±24 dBm
Home BS	≤ ±20 dBm
The limit is lower by 3 dB for two ports, by 6 dB for four ports and 9 dB for eight ports for Home BS	

Table 3-4: Maximum rated output power

Requirements for BS output power	
Frequency range	**Limit**
f ≤ 3.0 GHz	±2.7 dB
3.0 GHz < f ≤ 4.2 GHz	±3.0 dB
Relaxed limits apply for extreme conditions	

Table 3-5: Limits for BS output power

Test setup

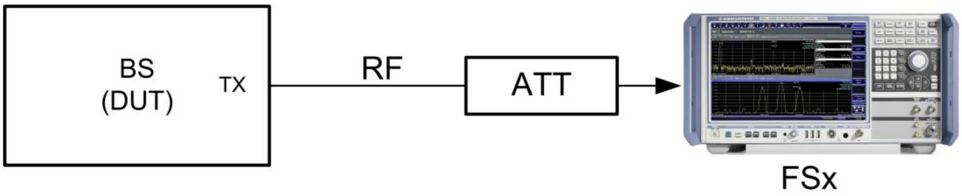


Fig. 3-24: Test setup for BS output power.

The DUT (base station) transmits at the declared maximum PRAT. E-TM1.1 is required.

Procedure

The test can be performed in one of two different ways:

- 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 Section 3.1.1. The calculated power is displayed under **Power** (see Fig. 3-25).
- Channel Power / ACLR: This method can be used to determine the output power and the adjacent channel power simultaneously. Use as channel filter 'Rect'.

2 Result Summary

Frame Results 1/1	Mean	Max	Limit	Min
EVM PDSCH QPSK (%)	0.86	0.86	18.50	0.86
EVM PDSCH 16QAM (%)			13.50	
EVM PDSCH 64QAM (%)			9.00	
EVM PDSCH 256QAM (%)				
Results for Selection Subframes All, Selection Ant 1, Frame Results 1/1				
EVM All (%)	0.85	0.88		0.80
EVM Phys Channel (%)	0.85	0.88		0.80
EVM Phys Signal (%)	0.80	0.84		0.75
Frequency Error (Hz)	0.19	0.67		-0.38
Sampling Error (ppm)	0.00	0.33		-0.28
IQ Offset (dB)	-57.91	-56.56		-58.81
IQ Gain Imbalance (dB)	-0.00	-0.00		-0.01
IQ Quadrature Error (°)	0.00	0.01		-0.02
RSTP (dBm)	-58.50	-58.49		-58.50
OSTP (dBm)	-33.72	-33.72		-33.73
RSSI (dBm)	-33.91	-33.91		-33.96
Power (dBm)	-33.78	-33.78		-33.83
Crest Factor (dB)	10.80			

Fig. 3-25: Output power in the result summary.

For MC scenarios, each carrier must be tested individually.

NB-IoT stand-alone Procedure

The DUT (base station) transmits at the declared maximum PRAT. N-TM is required.

The test can be performed in one of two different ways:

- 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 Section 3.1.1. The calculated power is displayed under **Power** (see Fig. 3-26).

- Channel Power / ACLR: This method can be used to determine the output power and the adjacent channel power simultaneously. Use as channel filter 'Rect'.

2 Result Summary

SF All, Selection Ant 1	Mean	Max	Limit	Min
EVM All (%)	0.31	0.33		0.17
EVM Phys Channel (%)	0.30	0.32		0.28
EVM Phys Signal (%)	0.31	0.33		0.17
Frequency Error (Hz)	-15.27	-14.25		-15.73
Sampling Error (ppm)	4.85	12.91		-2.28
RSTP (dBm)	-50.96	-50.94		-50.97
OSTP (dBm)	-43.71	-40.16		-93.24
RSSI (dBm)	-44.08	-40.16		-47.96
Power (dBm)	-42.97	-40.21		-46.86
Crest Factor (dB)	16.06			

Fig. 3-26: NB-IoT Output power in the result summary.

The limits for NB-IoT standalone are ± 3 dB. Relaxed limits apply for extreme conditions.

NB-IoT inband and guard band Procedure

For NB-IoT inband and guard band, the signal shall be seen as a combination between LTE carriers and NB-IoT carriers. The DUT (base station) transmits at the declared maximum PRAT. E-TM1.1 for the LTE part and N-TM for NB-IoT part are required.

Use the Channel Power / ACLR to determine the output power and the adjacent channel power simultaneously. Use as channel filter 'Rect'.

The limits are the same as in Table 3-5.

Demo program

No further special settings are needed for this test. The test is carried out as a demodulation. The output power and other measurements are reported. In the case of MC tests, each individual carrier is tested in sequence.

********* 6.2 Basestation Output Power ************

Duplex mode: FDD

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	Power (dBm)	Status
6.2 Basetstaion Output Power					
Output Power	2110	10	E-TM1.1	-10.49	Ignored
Test Item	**Carrier Frequency (MHz)**	**Carrier BW (MHz)**	**Test Model**		**Status**
Additional Measurements					
Frequency Error *Hz*	2110	10	E-TM1.1	0.00	Ignored
EVM *%*	2110	10	E-TM1.1	0.20	Ignored
OSTP *dBm*	2110	10	E-TM1.1	-10.49	Ignored

FSx: 0,"No error"

Fig. 3-27: Example report for test case 6.2.

3.2.1 Home BS Output Power Measurements (Clause 6.2.6…6.2.8)

In addition to the general output power requirements, Release 12 also introduced special tests for home BS. There is no conventional network planning for home BS. Instead, they are installed as a supplement to the various existing provider networks. This increases the risk of interference because the home BS can transmit on adjacent channels as well as on the same channels as an existing network. As a result, a home BS must adapt (reduce) its output power to the specific conditions. These scenarios are covered by the following requirements.

All three tests are required only for SC.

3.2.1.1 Home BS Output Power for Adjacent UTRA Channel Protection (Clause 6.2.6)

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 optimizing the Home BS coverage. These requirements are only applicable to Home BS. The requirements in this clause are applicable for AWGN radio propagation conditions [1].

A W-CDMA signal is provided for the test on the adjacent channel. In addition, AWGN is simulated in the same 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. P_{out} must not exceed the values in Table 3-6 for the four different input parameter sets.

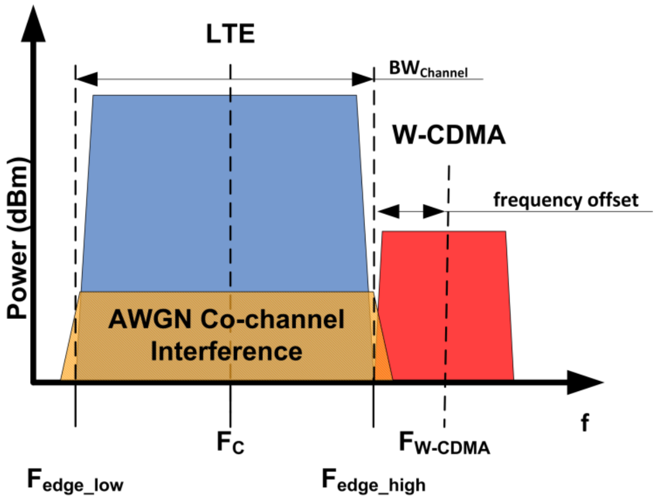


Fig. 3-28: Home BS with adjacent W-CDMA signal.

Requirements based on input conditions						
Testcase	**P_{CPICH} (dBm)**	**P_{Total} (dBm)**	**P_{AWGN} (dBm)**	**Carrier/Noise (dB)**	**P_{out} (dBm)**	**Limits (normal conditions)**
1	-80	-70	-50	- 20	**≤ 20**	+ 2.7 dB (f ≤ 3 GHz) + 3.0 dB (3 GHz ≤ f ≤ 4.2 GHz)
2	-90	-80	-60		**≤ 10**	
3	-100	-90	-70		**≤ 8**	
4	-100	-90	-50		**≤ 10**	

Table 3-6: Requirements for home BS with adjacent W-CDMA signal

Test setup

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

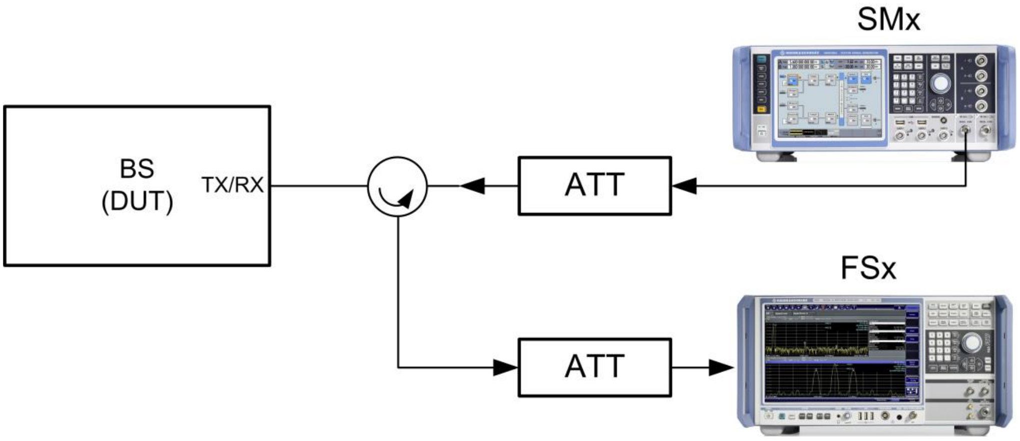


Fig. 3-29: Test setup for a home BS with adjacent W-CDMA signal. The SMW generates both the W-CDMA signal and the AWGN. The analyzer measures the Tx power.

Overview of settings:

- The DUT (base station) generates the wanted signal at F_C with $BW_{Channel}$ and E-TM1.1.
- The SMx generates the W-CDMA signal as adjacent channel with TM1, offset $F_C \pm BW_{Channel}/2 \pm 2.5$ MHz (to the right or left of the wanted signal)
- The SMx generates AWGN on the same channel as the wanted LTE signal of the DUT. The bandwidth corresponds to $BW_{Channel}$.

Procedure

The procedure is shown with an example of $BW_{Channel}$ = 20 MHz and Testcase 1.

1. Set the frequency of the SMx to the center frequency of the wanted signal

Generating the W-CDMA signal in the adjacent channel

2. Select W-CDMA (**3GPP FDD**) in baseband block A (Fig. 3-30)

Fig. 3-30: SMW: selecting the 3GPP FDD (W-CDMA) signal in the baseband block.

3. Go to the **Basestations** tab (Fig. 3-31)

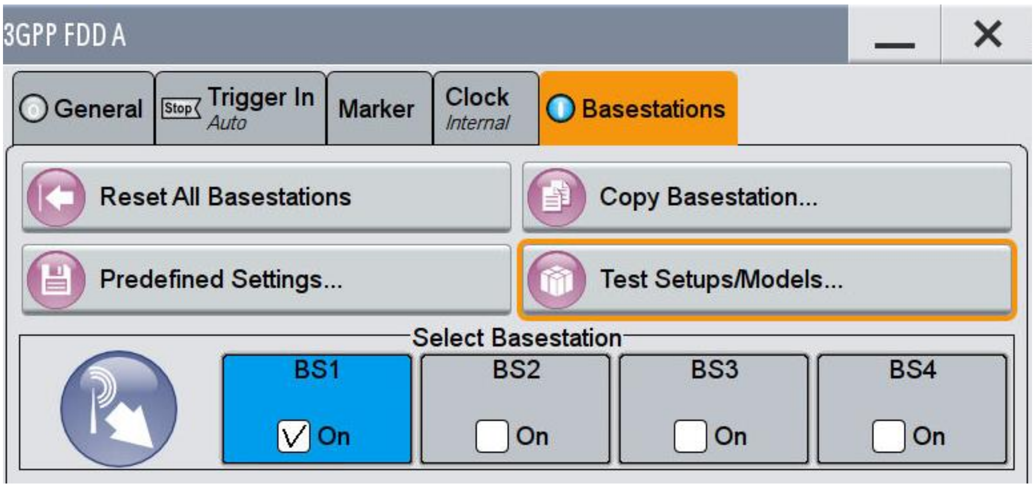


Fig. 3-31: SMW: W-CDMA base stations.

4. Click **Test Setups/Models**
5. Select a TM1 (any number of channels) (Fig. 3-32)

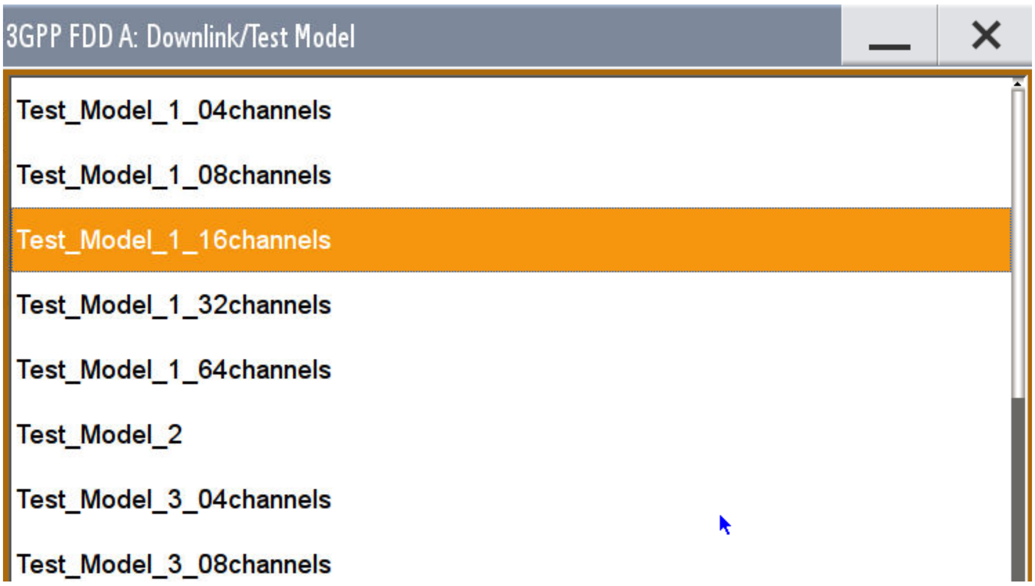


Fig. 3-32: SMW: selecting TM1 for W-CDMA.

6. Switch on the baseband and set the frequency offset of the wanted LTE carrier in order to set the W-CDMA carrier in the adjacent channel: F_{off} = BW_{LTE} / 2 + 2.5 MHz (example: F_{off} = 20 MHz / 2 + 2.5 MHz = 12.5 MHz) (Fig. 3-33 and Fig. 3-34)

Fig. 3-33: SMW: offsets in the baseband.

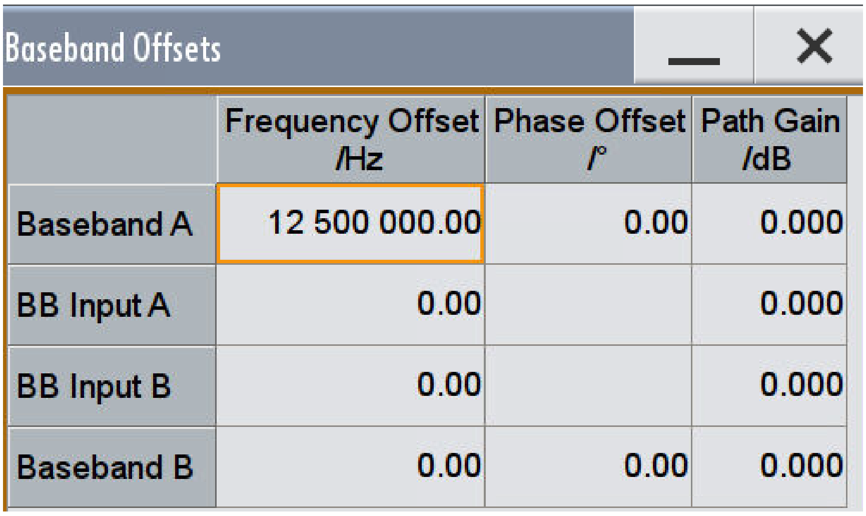


Fig. 3-34: Setting the frequency offset for the W-CDMA carrier (e.g. 12.5 MHz).

7. 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)

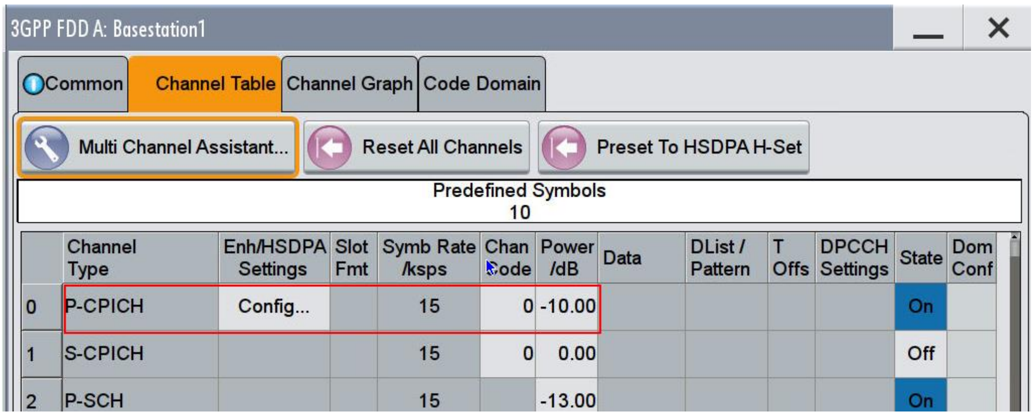


Fig. 3-35: SMW: CPICH level in W-CDMA.

AWGN

8. Click the AWGN block and set the bandwidths (Fig. 3-36).(example: System BW = 18 MHz)

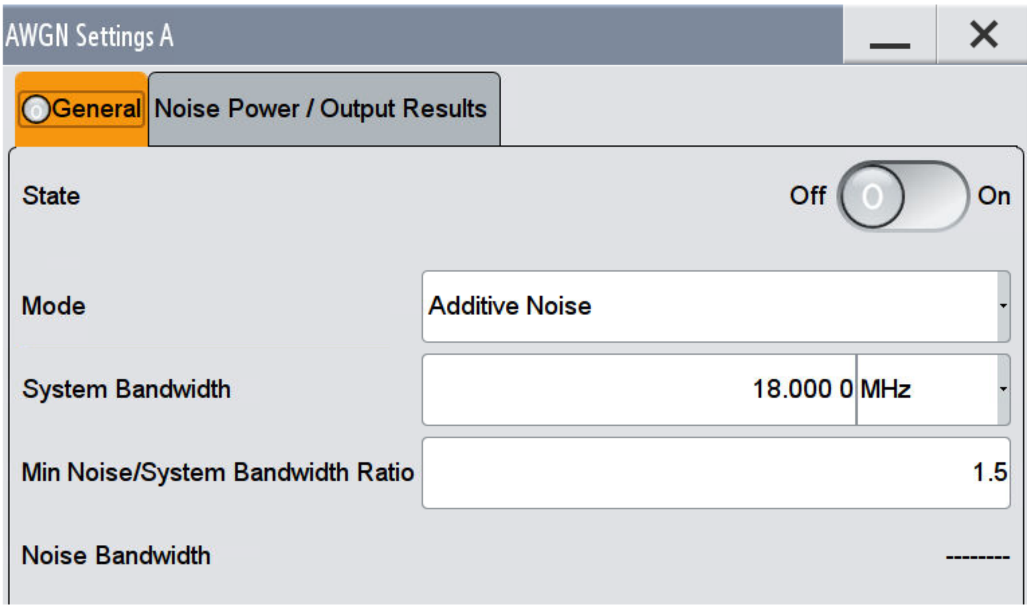


Fig. 3-36: AWGN: setting the bandwidth (e.g. BW_{LTE} = 20 MHz – System BW: 18 MHz).

9. Go to the Noise Power / Output Results tab and enter the appropriate carrier/noise ratio from Table 3-6 (Fig. 3-37). (example: C/N = - 20 dB, Noise Power = -50 dBm)

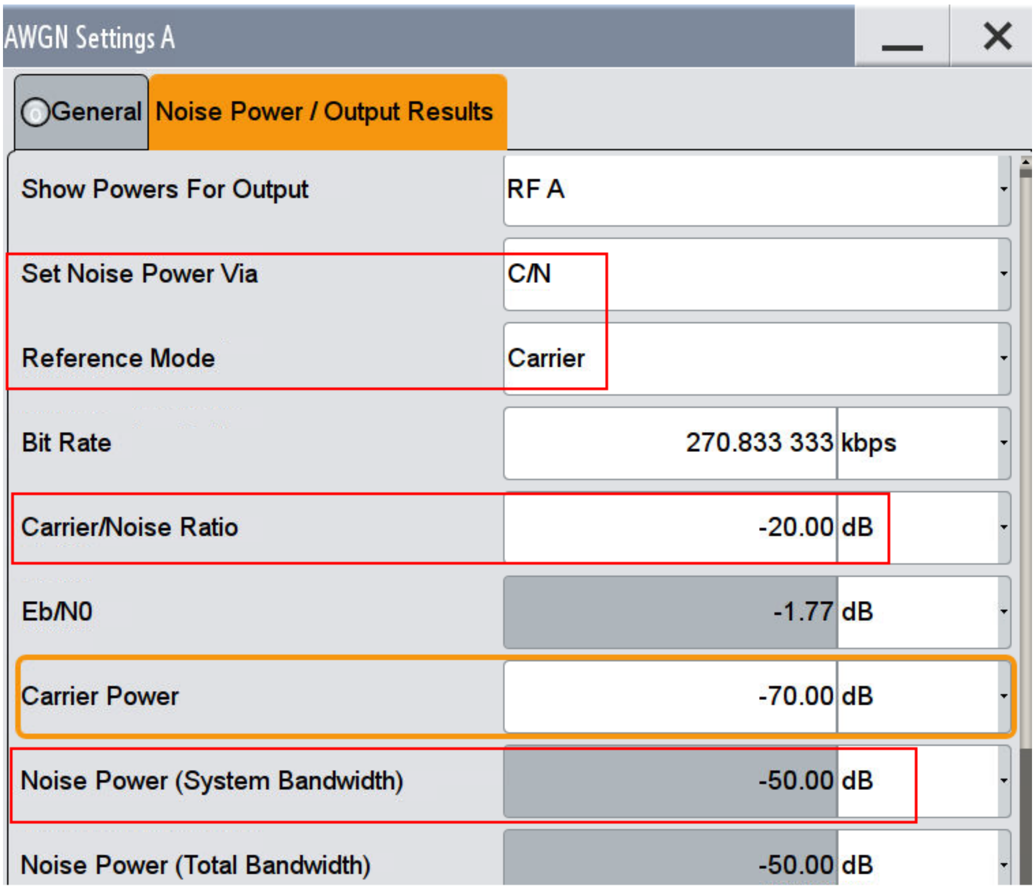


Fig. 3-37: AWGN: Setting the noise power relative to the carrier power via the carrier/noise ratio (e.g. the carrier power is –70 dBm, so the noise power in test case 1 should be –50 dBm: –70 dB – (–50 dB) = –20 dB).

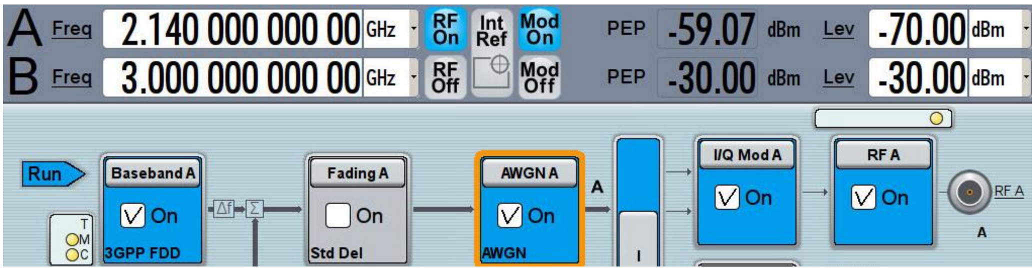


Fig. 3-38: Overview of the SMW for W-CDMA with AWGN. The W-CDMA signal is offset to the adjacent channel in the baseband.

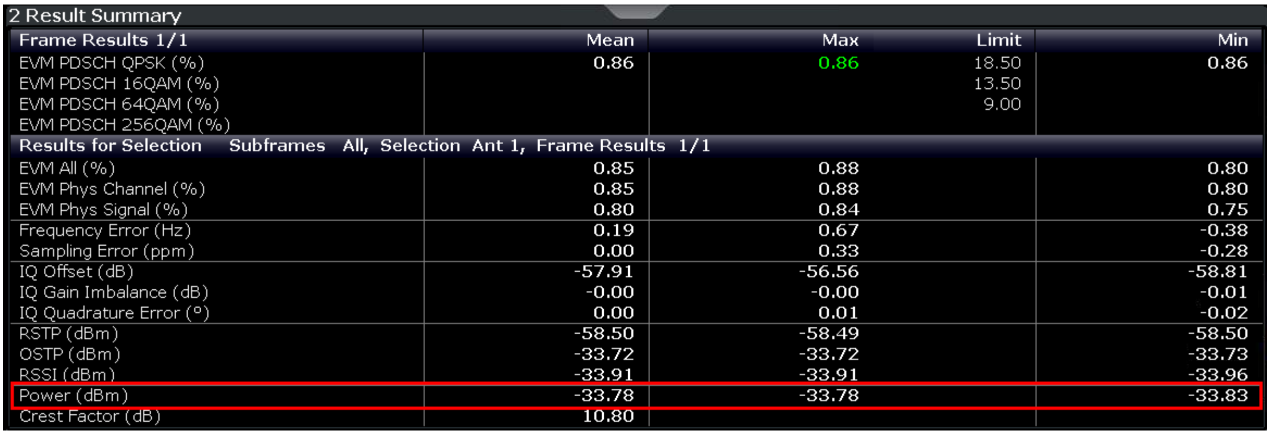
Measurement with FSx

Measure the P_{out} of the home BS for all test cases (Table 3-6) and both offsets.

The test can be performed in one of two different ways:

- 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 Section 3.1.1. The calculated power is displayed under **Power** (see Fig. 3-39).

- Channel Power / ACLR: This method can be used to determine the output power and the adjacent channel power simultaneously. Use as channel filter ‘Rect’.



2 Result Summary

Frame Results 1/1	Mean	Max	Limit	Min
EVM PDSCH QPSK (%)	0.86	0.86	18.50	0.86
EVM PDSCH 16QAM (%)			13.50	
EVM PDSCH 64QAM (%)			9.00	
EVM PDSCH 256QAM (%)				
Results for Selection Subframes All, Selection Ant 1, Frame Results 1/1				
EVM All (%)	0.85	0.88		0.80
EVM Phys Channel (%)	0.85	0.88		0.80
EVM Phys Signal (%)	0.80	0.84		0.75
Frequency Error (Hz)	0.19	0.67		-0.38
Sampling Error (ppm)	0.00	0.33		-0.28
IQ Offset (dB)	-57.91	-56.56		-58.81
IQ Gain Imbalance (dB)	-0.00	-0.00		-0.01
IQ Quadrature Error (°)	0.00	0.01		-0.02
RSTP (dBm)	-58.50	-58.49		-58.50
OSTP (dBm)	-33.72	-33.72		-33.73
RSSI (dBm)	-33.91	-33.91		-33.96
Power (dBm)	-33.78	-33.78		-33.83
Crest Factor (dB)	10.80			

Fig. 3-39: Output power in der result summary.

Demo program

For this test, additional parameters must be defined. The test is carried out as a demodulation measurement. The output power and other measurements are reported.

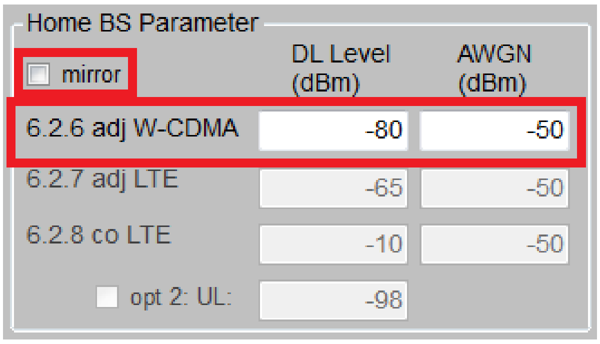


Fig. 3-40: Special settings for output power with adjacent W-CDMA.

The level for the adjacent W-CDMA carrier and AWGN can be entered directly. Please note the settings from the specification listed in Table 3-6.

By default, the W-CDMA carrier is set to the right of the wanted signal. Checking **mirror** sets it to the left.

*********** 6.2.6 Home BS Output Power with adjacent WCDMA*************

Duplex mode: FDD
W-CDMA carrier with TM1.1 at offset: 7.5 MHz
W-CDMA carrier level: -80 dBm
AWGN level: -50 dBm

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	Power (dBm)	Status
6.2.6 Home BS Output Power with adjacent WCDMA					
Output Power	2110	10	E-TM1.1	-10.54	Ignored
Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model		Status
Additional Measurements					
Frequency Error Hz	2110	10	E-TM1.1	0.01	Ignored
EVM %	2110	10	E-TM1.1	0.19	Ignored
OSTP dBm	2110	10	E-TM1.1	-10.53	Ignored

FSx: 0,"No error"

Fig. 3-41: Example report for test case 6.2.6.

3.2.1.2 Home BS Output Power for Adjacent E-UTRA Channel Protection (Clause 6.2.7)

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 optimizing the Home BS coverage. These requirements are only applicable to Home BS. The requirements in this clause are applicable for AWGN radio propagation conditions [1].

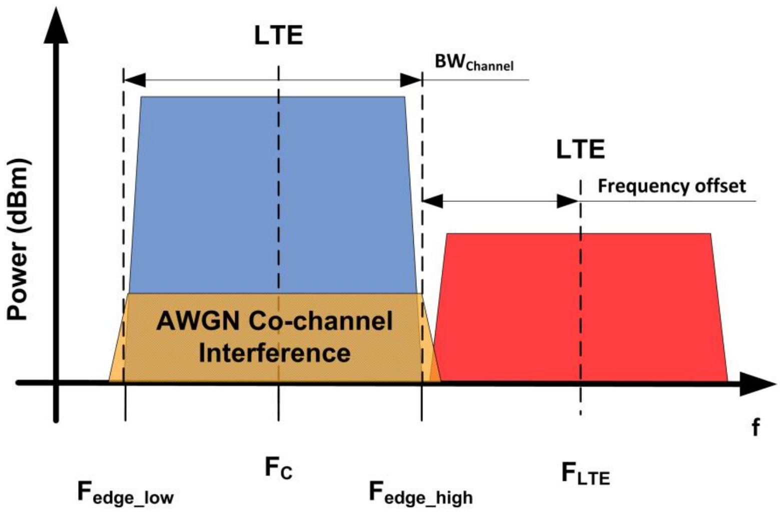


Fig. 3-42: Home BS with adjacent LTE signal.

An LTE signal is provided for the test on the adjacent channel. AWGN is also simulated in the same channel of the wanted signal. The output power measurements for the home BS is to be measured at different levels of the LTE signal and the AWGN. P_{out} must not exceed the values in Table 3-7 for the four different input parameter sets. In the specification, the level of the adjacent LTE signal is set via the reference symbol power using the formula $10 \cdot \log_{10}\left(N_{RB}^{DL} \cdot N_{sc}^{RB}\right)$. Because the required test model E-TM1.1 assigns all RBs, the total level (P_{total}) can be entered directly and set on the SMx.

Requirements based on input conditions for adjacent LTE					
Test case	**P_{total} (dBm)**	**P_{AWGN} (dBm)**	**Carrier/Noise (dB)**	**P_{out} (dBm)**	**Limits (normal conditions)**
1	–65	–50	-15	**≤ 20**	+2.7 dB (f ≤ 3 GHz) +3.0 dB (3 GHz ≤ f ≤ 4.2 GHz)
2	–75	–60	-15	**≤ 10**	
3	–90	–70	-20	**≤ 8**	
4	–90	–50	-40	**≤ 10**	

Table 3-7: Requirements for home BS with adjacent LTE signal

Test setup

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

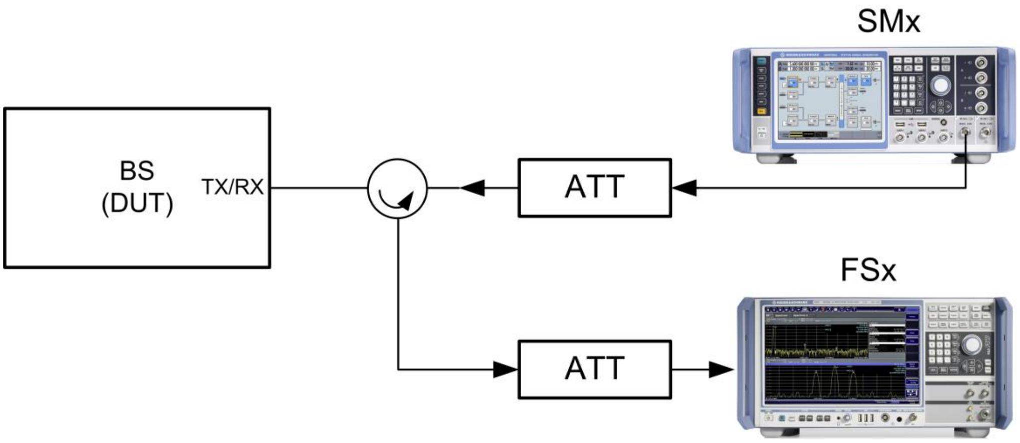


Fig. 3-43: Test setup for a home BS with adjacent LTE signal. The SMW generates both the LTE signal and the AWGN.

Overview of settings:

- The DUT (base station) generates the wanted signal at F_C with $BW_{Channel}$ and E-TM1.1.
- The SMx generates the LTE signal as an adjacent channel with the same $BW_{Channel}$ and E-TM1.1, offset $F_c \pm BW_{Channel}$ (to the right or left of the wanted signal)
- The SMx generates AWGN on the same channel as the wanted LTE signal of the DUT. The bandwidth corresponds to $BW_{Channel}$.

Procedure

The procedure is shown with an example of $BW_{Channel}$ = 20 MHz and Testcase 1.

1. Set the frequency of the SMx to the center frequency of the wanted signal

Generating the adjacent LTE signal

2. Generate an LTE signal that is equivalent to the wanted signal (see 3.1.2)
3. Select test model E-TM1.1. (Fig. 3-44)(example E-TM1.1 with 20 MHz)

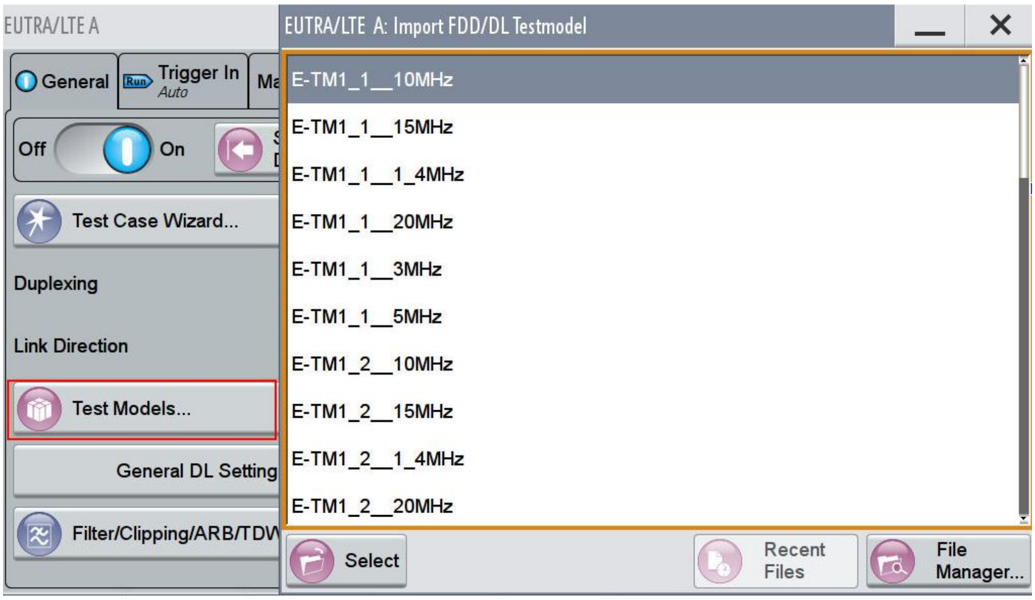


Fig. 3-44: Selecting the test model in LTE.

4. Switch on the baseband and set the frequency offset of the wanted LTE carrier in order to set the LTE carrier in the adjacent channel: $F_{off} = BW_{LTE}$ (example. 20 MHz) (Fig. 3-45 and Fig. 3-46)

Fig. 3-45: SMW: offsets in the baseband.

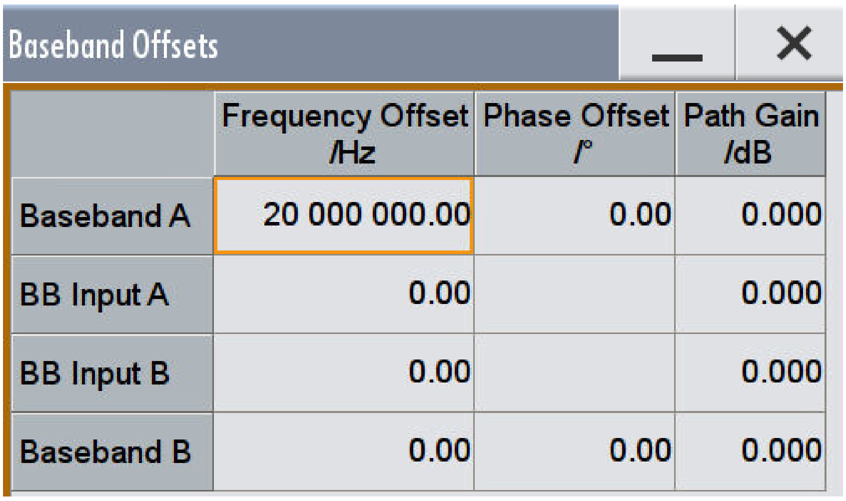


Fig. 3-46: Setting the frequency offset for the W-CDMA carrier (example: 20.0 MHz).

5. In the SMx, the total level is set over all RBs and the reference symbol power for each RE is entered relative to the total level (Fig. 3-47). Therefore, just set the total level based on Table 3-7.

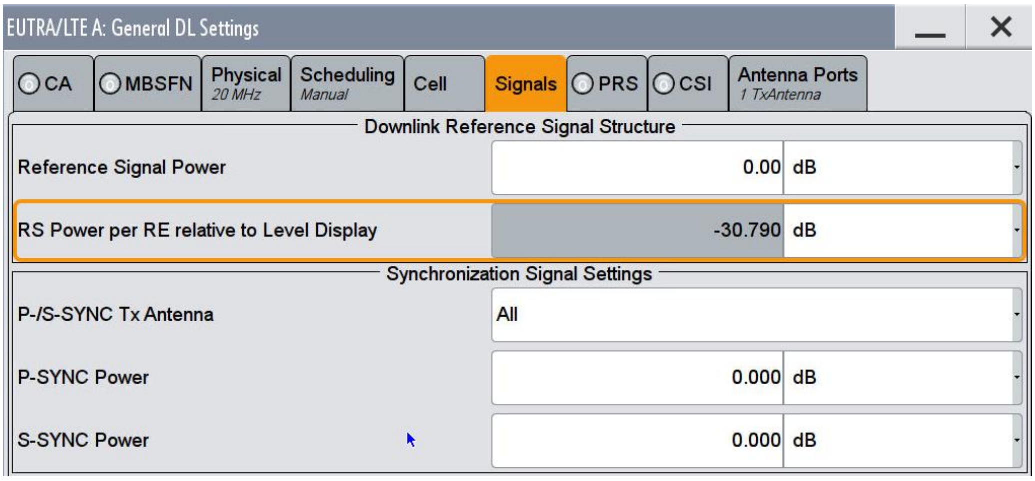


Fig. 3-47: LTE: displaying the RS power per RE.

AWGN

6. Click the AWGN block and set the bandwidths (Fig. 3-48). (example System Bandwidth = 18 MHz)

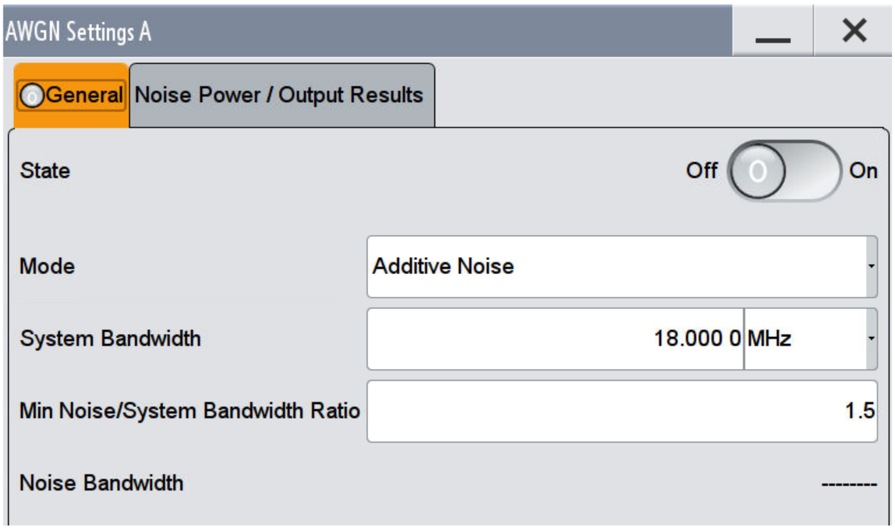


Fig. 3-48: AWGN: setting the bandwidth (example: BW_{LTE} = 20 MHz -> System BW: 18 MHz).

7. Go to the Noise Power / Output Results tab and enter the appropriate carrier/noise ratio from (Fig. 3-49).

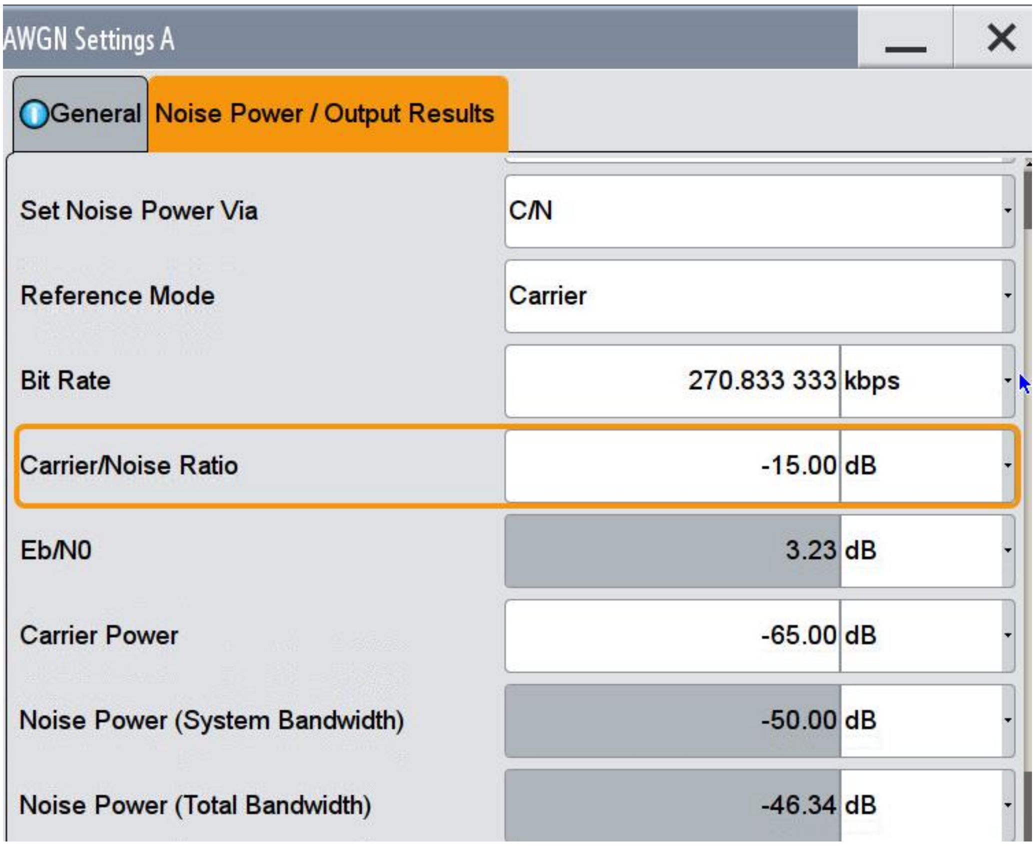


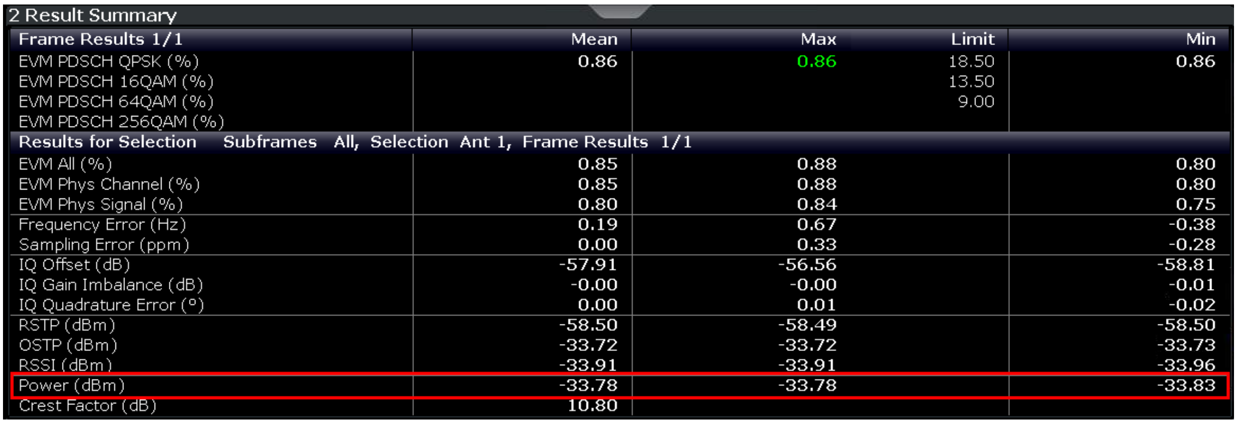
Fig. 3-49: AWGN: Setting the noise power relative to the carrier power via the carrier/noise ratio (example: the carrier power is –65 dBm, so the noise power in test case 1 should be –50 dBm: –65 dB – (–50 dB) = –15 dB).

Measurement with FSx

Measure the P_{out} of the home BS for all test cases (Table 3-7) and both offsets.

The test can be performed in one of two different ways:

- 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 Section 3.1.1. The calculated power is displayed under **Power** (see Fig. 3-50).
- Channel Power / ACLR: This method can be used to determine the output power and the adjacent channel power simultaneously. Use as channel filter ‘Rect’.



2 Result Summary

Frame Results 1/1	Mean	Max	Limit	Min
EVM PDSCH QPSK (%)	0.86	0.86	18.50	0.86
EVM PDSCH 16QAM (%)			13.50	
EVM PDSCH 64QAM (%)			9.00	
EVM PDSCH 256QAM (%)				
Results for Selection Subframes All, Selection Ant 1, Frame Results 1/1				
EVM All (%)	0.85	0.88		0.80
EVM Phys Channel (%)	0.85	0.88		0.80
EVM Phys Signal (%)	0.80	0.84		0.75
Frequency Error (Hz)	0.19	0.67		-0.38
Sampling Error (ppm)	0.00	0.33		-0.28
IQ Offset (dB)	-57.91	-56.56		-58.81
IQ Gain Imbalance (dB)	-0.00	-0.00		-0.01
IQ Quadrature Error (°)	0.00	0.01		-0.02
RSTP (dBm)	-58.50	-58.49		-58.50
OSTP (dBm)	-33.72	-33.72		-33.73
RSSI (dBm)	-33.91	-33.91		-33.96
Power (dBm)	-33.78	-33.78		-33.83
Crest Factor (dB)	10.80			

Fig. 3-50: Output power in the result summary.

Demo program

For this test, additional parameters must be defined. The test is carried out as a demodulation measurement. The output power and other measurements are reported.

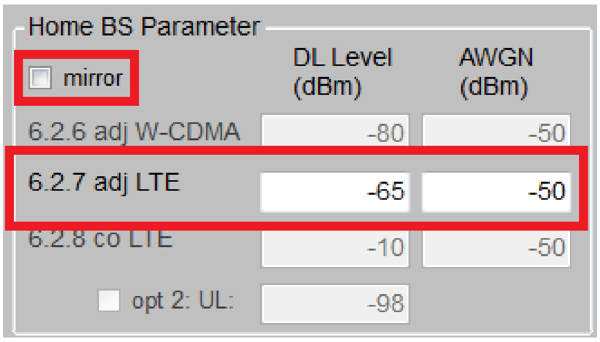


Fig. 3-51: Special settings for output power with adjacent LTE.

The level for the adjacent LTE carrier and AWGN can be entered directly. Please note the settings from the specification listed in Table 3-7.

By default, the LTE carrier is set to the right of the wanted signal. Checking **mirror** sets it to the left.

********** 6.2.7 Home BS Output Power with adjacent LTE**************

\---

Duplex mode: FDD
LTE carrier with E-TM1.1 at offset: 10 MHz
LTE carrier level: -65 dBm
AWGN level: -50 dBm

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	Power (dBm)	Status
6.2.7 Home BS Output Power with adjacent LTE					
Output Power	2110	10	E-TM1.1	-10.55	Ignored
Test Item	**Carrier Frequency (MHz)**	**Carrier BW (MHz)**	**Test Model**		**Status**
Additional Measurements					
Frequency Error *Hz*	2110	10	E-TM1.1	0.02	Ignored
EVM %	2110	10	E-TM1.1	0.20	Ignored
OSTP *dBm*	2110	10	E-TM1.1	-10.55	Ignored

FSx: 0,"No error"

Fig. 3-52: Example report for test case 6.2.7.

3.2.1.3 Home BS Output Power for Co-Channel E-UTRA Protection (Clause 6.2.8)

To minimize the co-channel DL interference to non-CSG macro UEs operating in close proximity while optimizing the CSG Home BS coverage, Home BS may adjust its output power according to the requirements set out in this clause. These requirements are only applicable to Home BS. The requirements in this clause are applicable for AWGN radio propagation conditions [1].

A downlink LTE signal with different levels is provided for the test on the same channel. AWGN is also simulated in the same channel. The output power for the home BS is to be measured. For so called option 2, an LTE signal is additionally generated for the uplink.

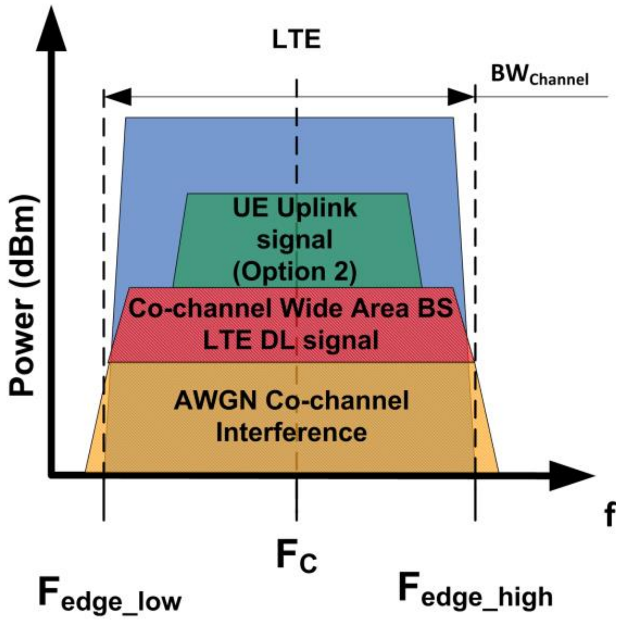


Fig. 3-53: Home BS with co-channel LTE signal.

Because no configurations are defined for the co-channel LTE signals, the test parameters can vary widely:

Home BS output power for co-channel LTE	
Input Conditions	Pout
Ioh (DL) > CRS Ês + 10log10(N_{RB}^{DL} N_{sc}^{RB}) + 30 dB	≤ 10 dBm
Ioh (DL) ≤ CRS Ês + 10log10(N_{RB}^{DL} N_{sc}^{RB}) + 30 dB	≤ max (- 10 dBm, min (Pmax, CRS Ês + 10log10(N_{RB}^{DL} N_{sc}^{RB}) + 30 dB))

Table 3-8: Home BS output power for co-channel E-UTRA channel protection [1]

Requirements based on input conditions for co-channel LTE					
Test case	**P_{total}DL (dBm)**	**P_{AWGN} (dBm)**	**P_{total}UL (dBm)**	**P_{out} (dBm)**	**Limits (normal conditions)**
1	–10 – 10log10(N_{RB}^{DL} N_{sc}^{RB})	–50	–98	See condition defined in table 3-6	+2.7 dB (f ≤ 3 GHz) +3.0 dB (3 GHz ≤ f ≤ 4.2 GHz)
2	–20 – 10log10(N_{RB}^{DL} N_{sc}^{RB})	–60			
3	–40 – 10log10(N_{RB}^{DL} N_{sc}^{RB})	–70			
4	–90 – 10log10(N_{RB}^{DL} N_{sc}^{RB})	–50			

Table 3-9: Requirements based on input conditions for co-channel LTE

The example below uses E-TM1.1 for the downlink signal and FRC1 for the uplink signal, which simplifies the settings (see Table 3-10).

Test setup

The following setup is used for this test. The FSx measures via circulator the output power (Tx) of the home BS. The SMx provides both the adjacent downlink LTE carrier and the AWGN and feeds the signal to the home BS via a circulator. For option 2, the SMx additionally provides the LTE uplink signal via the second path.

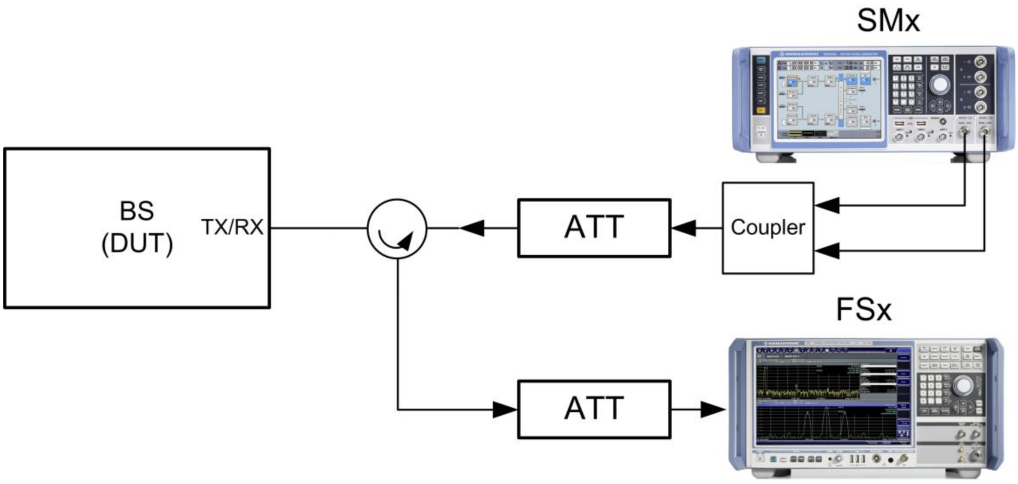


Fig. 3-54: Test setup for a home BS with co-channel LTE signal.The SMW generates both the LTE signal and the AWGN.

Overview of settings:

- The DUT (base station) generates the wanted signal at F_C with $BW_{Channel}$ and E-TM1.1.
- The SMx generates the co-channel LTE downlink signal with the same $BW_{Channel}$. There is no special configuration required.
- The SMx generates AWGN on the same channel as the wanted LTE signal of the DUT. The bandwidth corresponds to $BW_{Channel}$.
- For option 2, the SMx additionally generates an LTE uplink signal. There is no special configuration required.

Procedure

The procedure is shown with an example of $BW_{Channel}$ = 20 MHz and Testcase 1. To simplify the settings, E-TM1.1 is used (see Table 3-10).

1. Set the frequency of the SMx to the center frequency of the wanted signal

Generating the downlink LTE signal

2. Generate an LTE signal that is equivalent to the wanted signal (see 3.1.2)
3. Select test model E-TM1.1. (Fig. 3-55) (example with 20 MHz)

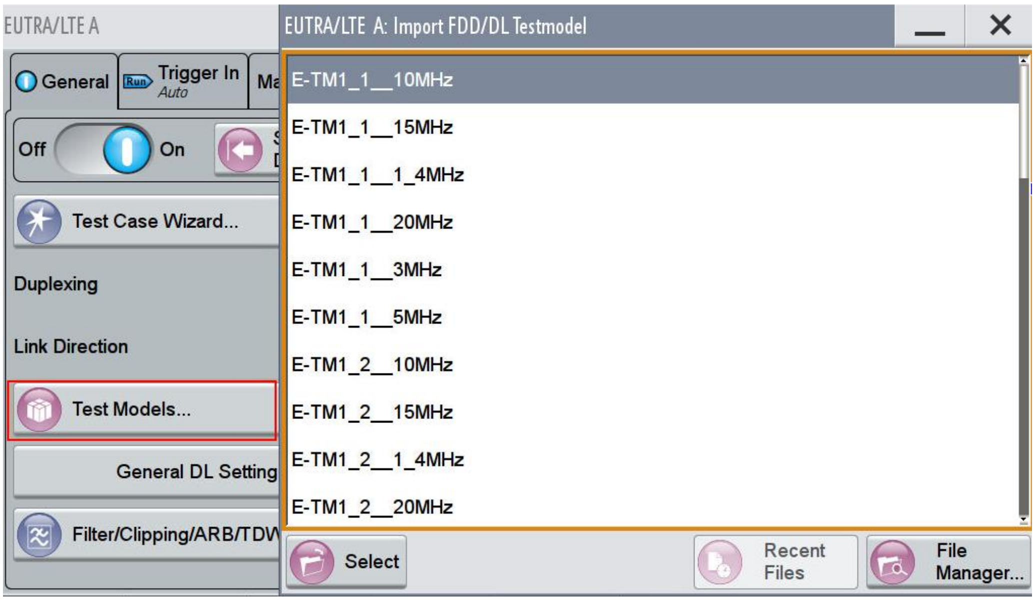


Fig. 3-55: Selecting the test model in LTE.

4. In the SMx, the total level is set over all RBs and the reference symbol power for each RE is entered relative to the total level (Fig. 3-56). Therefore, set the total level based on Table 3-10.

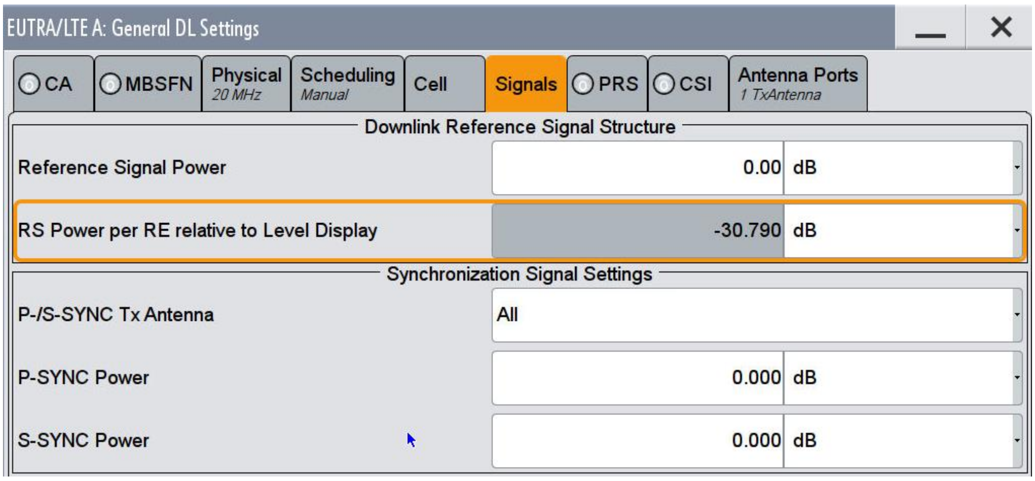


Fig. 3-56: LTE: displaying the RS power per RE.

AWGN

5. Click the AWGN block and set the bandwidths (Fig. 3-57). (example: System BW = 18 MHz)

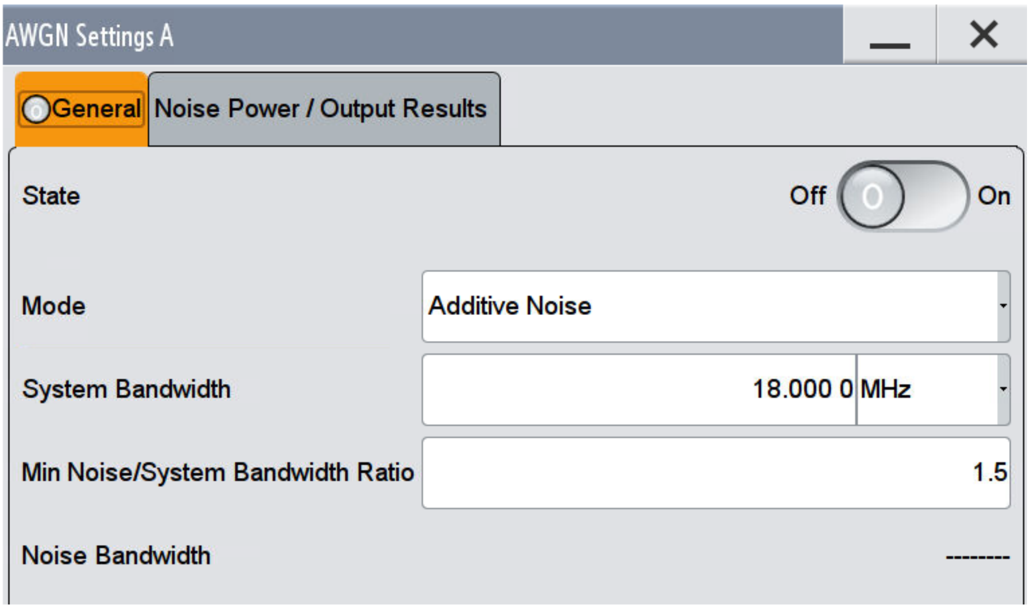


Fig. 3-57: AWGN: setting the bandwidth (example: BW_{LTE} = 20 MHz – System BW: 18 MHz).

6. Go to the Noise Power / Output Results tab and enter the appropriate carrier/noise ratio from (Fig. 3-58).

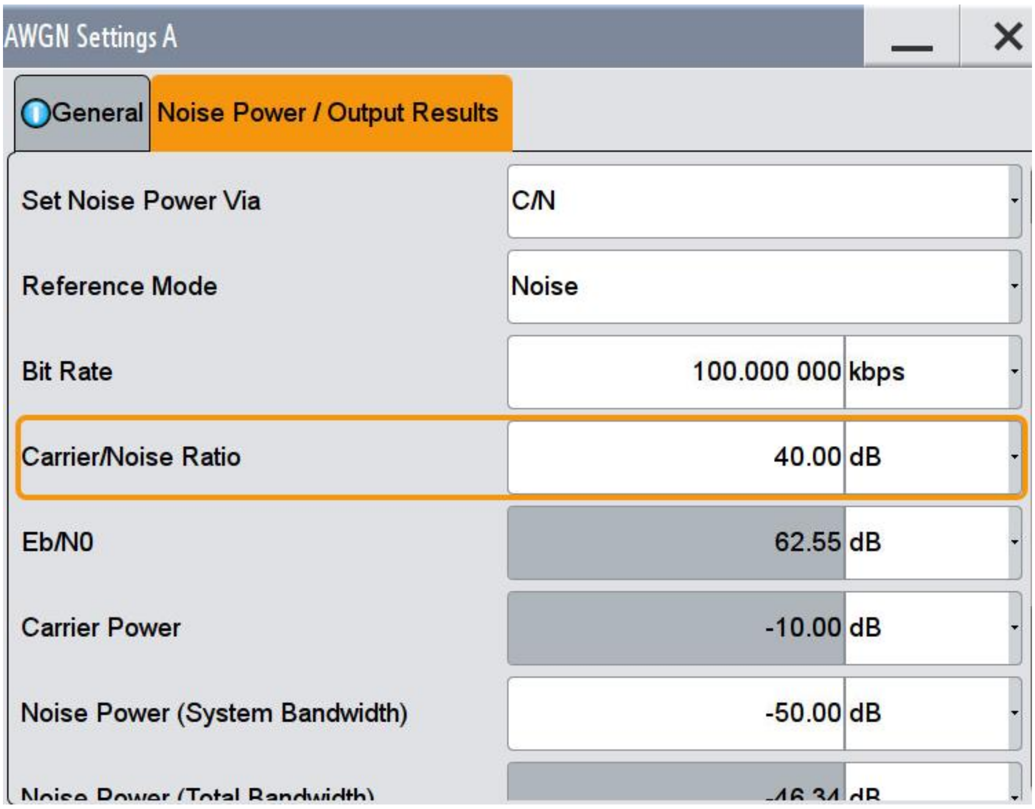


Fig. 3-58: AWGN: setting the noise power relative to the carrier power via the carrier/noise ratio (example: the carrier power is –10 dBm, so the noise power in test case 1 should be –50 dBm: –10 dB – (–50 dB) = + 40 dB).

Option 2 only: Generating the uplink LTE signal

7. Set the link direction to **Uplink (SC-FDMA)**.

8. Set the corresponding bandwidth.

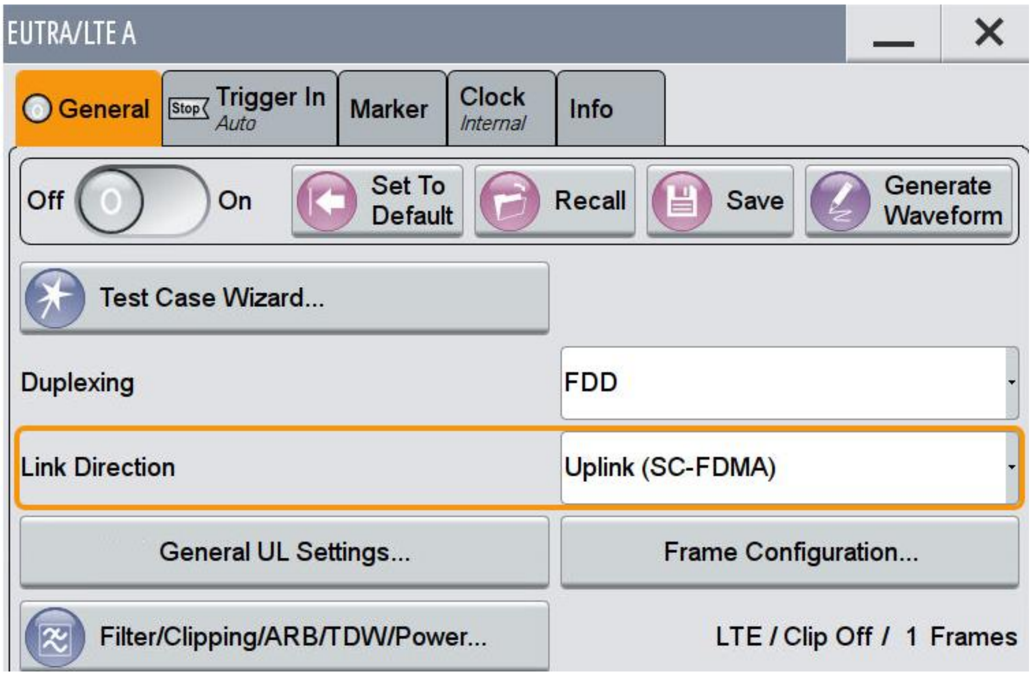


Fig. 3-59: Setting the uplink in the LTE.

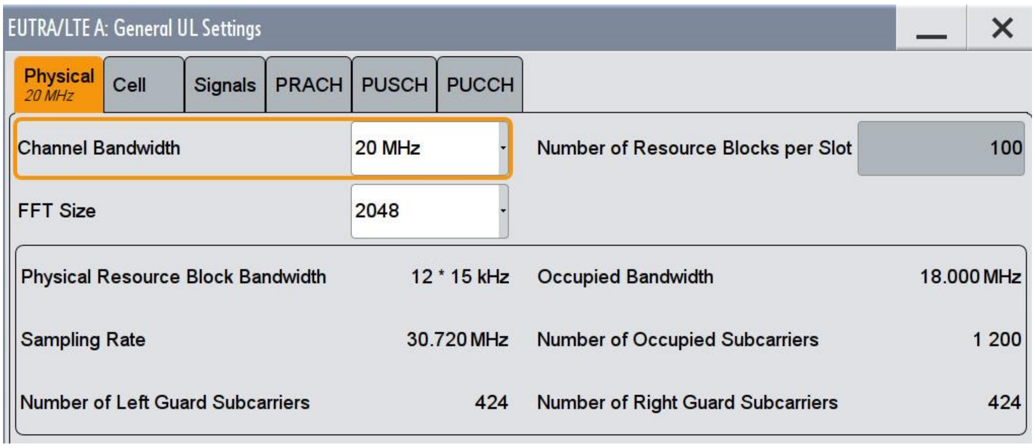


Fig. 3-60: Setting the bandwidth BW in the uplink.

9. Click **UE1**.

10. Select the corresponding **FRC** and switch **FRC state On**. (example: FRC A3-7)

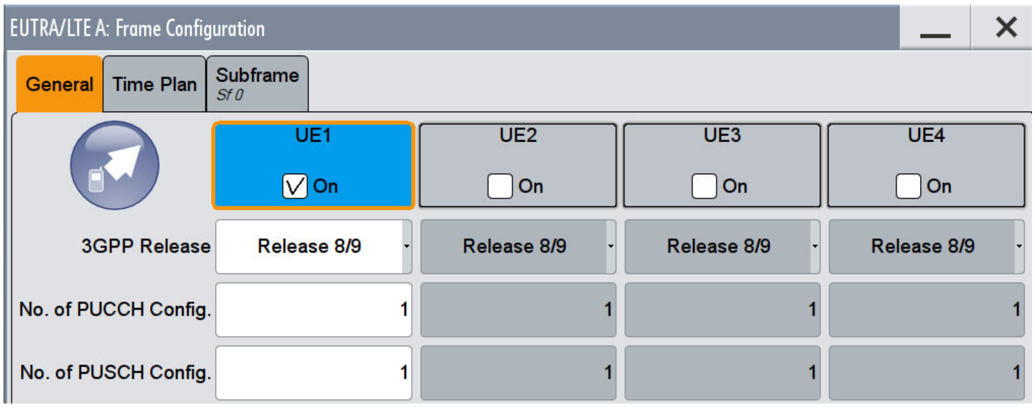


Fig. 3-61: Displaying the simulated UE1. The UE parameters can be entered with a mouse click.

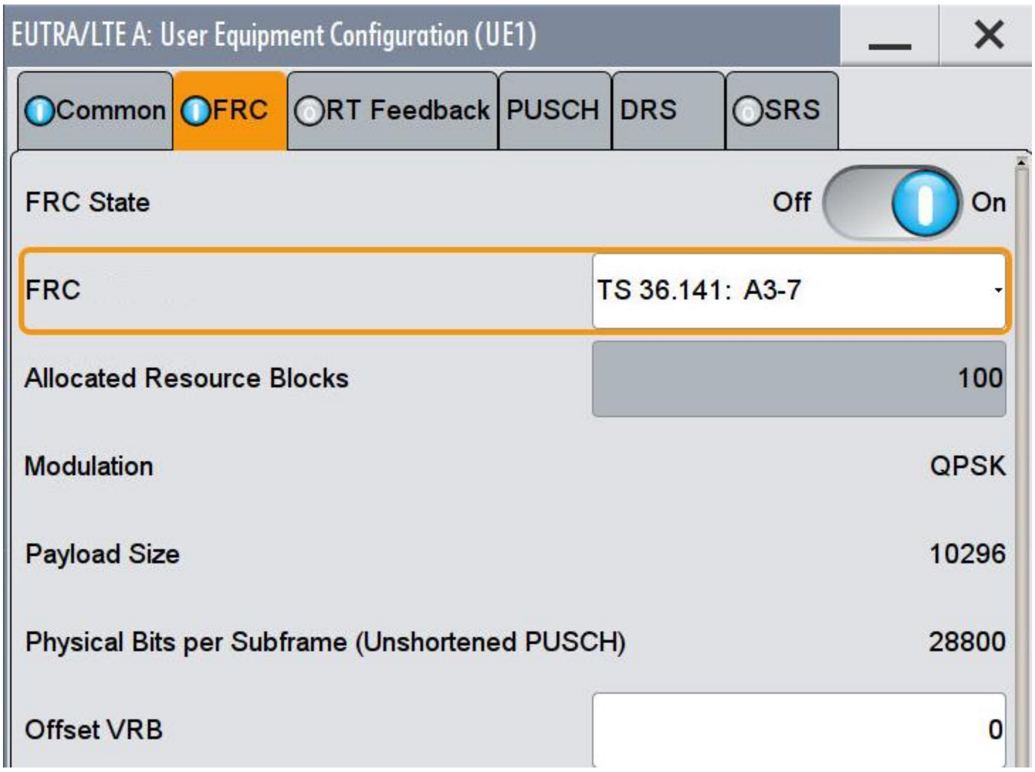


Fig. 3-62: Setting the FRC for the UE. (example: A3-7)

Measurement with FSx

If E-TM1.1 is used for the wanted signal, Table 3-9 is simplified as follows:

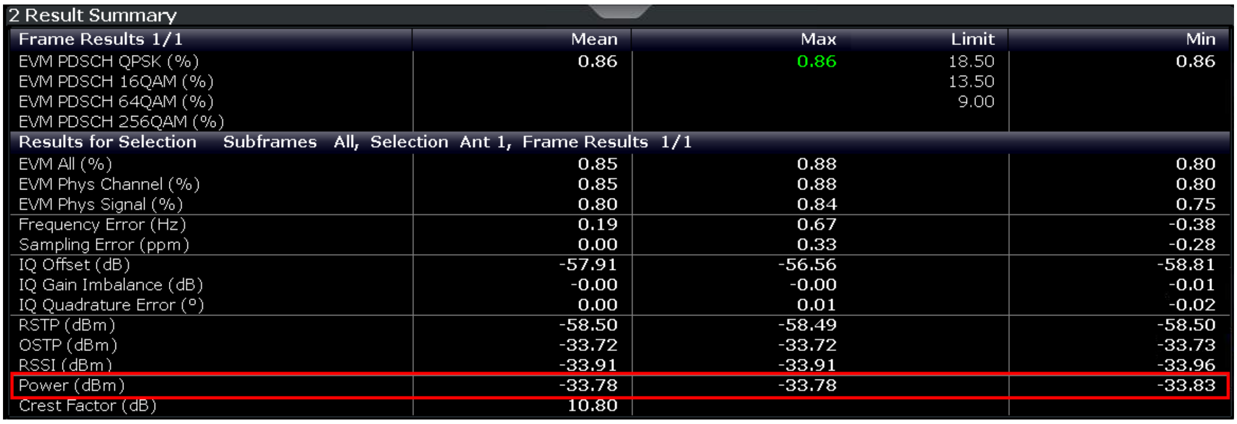
Requirements based on input conditions for adjacent LTE						
Test case	**P_{total}DL (dBm)**	**P_{AWGN} (dBm)**	**Carrier/Noise (dB)**	**P_{total}UL (dBm)**	**P_{out} (dBm)**	**Limits (normal conditions)**
1	–10	–50	+ 40	–98	**≤ 20**	+2.7 dB (f ≤ 3 GHz) +3.0 dB (3 GHz ≤ f ≤ 4.2 GHz)
2	–20	–60	+ 40		**≤ 10**	
3	–40	–70	+ 30		**≤ Pmax**	
4	–90	–50	- 40		**≤ 10**	

Table 3-10: Requirements for home BS with co-channel LTE signal for an example using E-TM1.1

Measure the P_{out} of the home BS for all test cases (Table 3-10) and both offsets.

The test can be performed in one of two different ways:

- 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 Section 3.1.1. The calculated power is displayed under **Power** (see Fig. 3-63).
- Channel Power / ACLR: This method can be used to determine the output power and the adjacent channel power simultaneously. Use as channel filter 'Rect'.



2 Result Summary

Frame Results 1/1	Mean	Max	Limit	Min
EVM PDSCH QPSK (%)	0.86	0.86	18.50	0.86
EVM PDSCH 16QAM (%)			13.50	
EVM PDSCH 64QAM (%)			9.00	
EVM PDSCH 256QAM (%)				
Results for Selection Subframes All, Selection Ant 1, Frame Results 1/1				
EVM All (%)	0.85	0.88		0.80
EVM Phys Channel (%)	0.85	0.88		0.80
EVM Phys Signal (%)	0.80	0.84		0.75
Frequency Error (Hz)	0.19	0.67		-0.38
Sampling Error (ppm)	0.00	0.33		-0.28
IQ Offset (dB)	-57.91	-56.56		-58.81
IQ Gain Imbalance (dB)	-0.00	-0.00		-0.01
IQ Quadrature Error (°)	0.00	0.01		-0.02
RSTP (dBm)	-58.50	-58.49		-58.50
OSTP (dBm)	-33.72	-33.72		-33.73
RSSI (dBm)	-33.91	-33.91		-33.96
Power (dBm)	-33.78	-33.78		-33.83
Crest Factor (dB)	10.80			

Fig. 3-63: Output power in the result summary.

Demo program

For this test, additional the parameters must be defined. The test is carried out as a demodulation measurement. The output power and other measurements are reported.

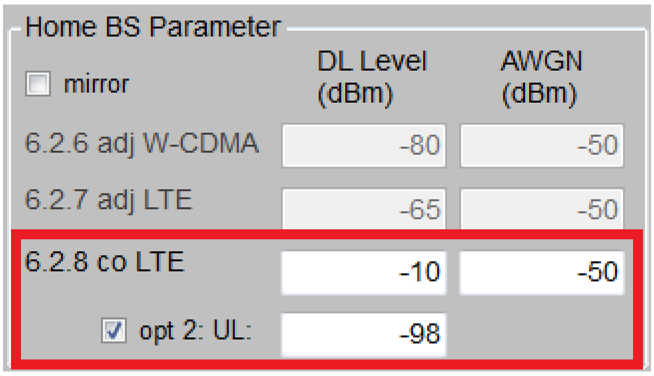


Fig. 3-64: Special settings for output power with co-channel LTE.

The level for the co-channel LTE carrier and AWGN can be entered directly. The uplink level is needed only for option 2. Please note the settings from the specification listed in Table 3-9.

********** 6.2.8 Home BS Output Power with co-channel LTE**************

Duplex mode: FDD
LTE carrier with E-TM1.1 at co-channel:
LTE carrier Downlink level: -10 dBm
AWGN level: -50 dBm
LTE carrier option 2: Uplink level: -98 dBm

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	Power (dBm)	Status
6.2.8 Home BS Output Power with co-channel LTE					
Output Power	2110	10	E-TM1.1	-10.93	Ignored
Test Item	**Carrier Frequency (MHz)**	**Carrier BW (MHz)**	**Test Model**		**Status**
Additional Measurements					
Frequency Error *Hz*	2110	10	E-TM1.1	0.07	Ignored
EVM %	2110	10	E-TM1.1	1.04	Ignored
OSTP *dBm*	2110	10	E-TM1.1	-10.92	Ignored

FSx: 0,"No error"

Fig. 3-65: Example report for test case 6.2.8.

3.3 Output Power Dynamics (Clause 6.3)

3.3.1 Total Power Dynamic Range (Clause 6.3.2)

The total power dynamic range is the difference between the maximum and the minimum transmit power of an OFDM symbol for a specified reference condition [1].

The measured OFDM symbols shall not contain RS, PBCH or synchronization signals. The test software includes this automatically in the calculation and displays the result as OSTP (OFDM symbol transmit power) in the Result Summary. The test is performed only for SC.

Dynamic range requirements	
Channel bandwidth (MHz)	Power dynamic range
1.4	7.3
3	11.3
5	13.5
10	16.5
15	18.3
20	19.6

Table 3-11: BS total power dynamic range, paired spectrum

Test setup

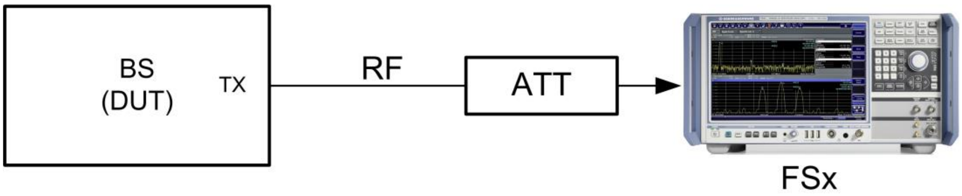


Fig. 3-66: Test setup for BS output power.

The DUT (base station) transmits at the declared maximum PRAT sequentially with two different configurations.

- E-TM3.1
- E-TM2

Procedure

The test can be performed in one of two different ways:

- 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 Section 3.1.1. The calculated power is displayed under **Power** (see Fig. 3-67).
- Channel Power / ACLR: This method can be used to determine the output power and the adjacent channel power simultaneously. Use as channel filter ‘Rect’.

2 Result Summary

Frame Results 1/1	Mean	Max	Limit	Min
EVM PDSCH QPSK (%)	0.86	0.86	18.50	0.86
EVM PDSCH 16QAM (%)			13.50	
EVM PDSCH 64QAM (%)			9.00	
EVM PDSCH 256QAM (%)				
Results for Selection Subframes All, Selection Ant 1, Frame Results 1/1				
EVM All (%)	0.85	0.88		0.80
EVM Phys Channel (%)	0.85	0.88		0.80
EVM Phys Signal (%)	0.80	0.84		0.75
Frequency Error (Hz)	0.19	0.67		-0.38
Sampling Error (ppm)	0.00	0.33		-0.28
IQ Offset (dB)	-57.91	-56.56		-58.81
IQ Gain Imbalance (dB)	-0.00	-0.00		-0.01
IQ Quadrature Error (°)	0.00	0.01		-0.02
RSTP (dBm)	-58.50	-58.49		-58.50
OSTP (dBm)	-33.72	-33.72		-33.73
RSSI (dBm)	-33.91	-33.91		-33.96
Power (dBm)	-33.78	-33.78		-33.83
Crest Factor (dB)	10.80			

Fig. 3-67: Result summary: OSTP (OFDM symbol transmit power).

Two measurements are taken. The total power dynamic range is the difference between the two measurements $OSTP_{E\text{-}TM3.1} – OSTP_{E\text{-}TM2}$.

Demo program

No further special settings are needed for this test. The test is carried out as a demodulation measurement. Two measurements for the different TMs are performed one after the other. The difference is reported as Dynamic range. A dialog box tells the user when to change to the next TM. Simulation is not supported.

********* 6.3.2 Total Power Dynamic Ranger ************

Duplex mode: FDD

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	Power	Status
6.3.2 Total power Dynamic Range					
OSTP *dBm*	2110	10	E-TM3.1	-10.73	Ignored
OSTP *dBm*	2110	10	E-TM2	-27.20	Ignored
Dymamic Range *dB*	2110	10	-	16.47	Ignored

Fig. 3-68: Example report for test case 6.3.2.

3.3.2 NB-IoT RB power dynamic range for in-band or guard band operation (6.3.3)

The NB-IoT RB power dynamic range (or NB-IoT power boosting) for guard band operation is the difference between the power of NB-IoT RB (which occupies 180kHz in guard band of an E-UTRA carrier) and the average power over all RBs (from both NB-IoT and the E-UTRA carrier containing the NB-IoT RB). [1]

The NB-IoT RB power dynamic range (or NB-IoT power boosting) for in-band operation is the difference between the average power of NB-IoT REs (which occupy certain REs in a RB of an E-UTRA carrier) and the average power over all REs (from both NB-IoT and the E-UTRA carrier containing the NB-IoT REs). [1]

NB-IoT power dynamic range shall be larger than or equal to +5.6 dB, except for guard band operation with E-UTRA 5 MHz channel bandwidth signal where BS manufacturer shall declare the NB-IoT dynamic range power it could support (in this version of the specification).

Test setup

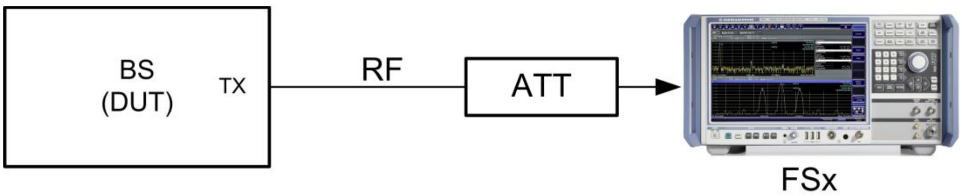


Fig. 3-69: Test setup for NB-IoT power dynamic range.

Procedure Inband

1. Measure with the FSx the **NB-IoT** part according to chapter 3.1.1.with the **Deployment** to *Inband* and the right E-UTRA PRB Index. Read and save the value **RB power excluding E-UTRA**.

2 Result Summary				
Subframes All, Selection Ant 1	Mean	Max	Limit	Min
EVM All (%)	0.32	0.48		0.17
EVM Phys Channel (%)	0.21	0.31		0.15
EVM Phys Signal (%)	0.44	0.48		0.23
Frequency Error (Hz)	3.76	4.67		2.43
Sampling Error (ppm)	-0.60	8.57		-12.75
RSTP (dBm)	-54.16	-54.15		-54.18
OSTP (dBm)	-37.70	-33.37		-92.79
RSSI (dBm)	-37.80	-34.08		-51.17
Power (dBm)	-38.89	-34.37		-50.08
RB power excluding E-UTRA (dBm)	-35.89	-33.63		-43.39
Crest Factor (dB)	13.66			

Fig. 3-70: NB-IoT dynamic range inband: RB power without E-UTRA

2. Measure with the option **LTE** the power of the whole signal according to chapter 3.1.1.

3. Calculate the average in Watt of the whole signal by

   $\text{Power Average}_{\text{whole signal}} = \text{Power}_{\text{LTE}}$ (in Watt) / (number of RBs + 1)

4. Calculate the Dynamic Range in dB by:

   $\text{Power}_{\text{NB-IoT dynamic range}} = \text{RB}_{\text{power excluding E-UTRA}}$ (in dBm) – $\text{Power Average}_{\text{whole signal}}$ (in dBm)

Procedure Guard-band

1. Measure with the FSx the NB-IoT part according to chapter 3.1.1.with the **Deployment** to *Guardband* and the right E-UTRA PRB Index. Read and save the value P**ower** $_{\textbf{NB}}$.

2. Measure with the option **LTE** the power according to chapter 3.1.1. Read and save the value **Power** $_{\textbf{LTE}}$.

3. Calculate the average in Watt of the whole signal by:

   $\text{Power Average}_{\text{whole signal}}$ = (Power_{NB} (in Watt) + $\text{Power}_{\text{LTE}}$ (in Watt)) / (number of RBs + 1)

4. Calculate the Dynamic Range in dB by:

   $\text{Power}_{\text{NB-IoT dynamic range}} = \text{Power}_{\text{NB}}$ (in dBm) – $\text{Power Average}_{\text{whole signal}}$ (in dBm)

Demo program

No further special settings are needed for this test. Just set the relevant NB-IoT parameter. The test is carried out as a demodulation measurement. Two measurements for the LTE and NB-IoT part are performed one after the other. The difference is reported as NB-IoT Dynamic range. Simulation is not supported.

****************** 6.3.3 NB-IoT RB Power Dynamic Range *****************

Duplex Mode: FDD

LTE Carrier + NB-IoT...
NB-IoT Deployment: In-Band
NB-IoT RB: 4
...

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	Power	Status
6.3.3 NB-IoT RB Power Dynamic Range					
NB-IoT Carrier excluding E-UTRA *dBm*	1000	10	E-TM1.1	-34.66	Ignored
Average Power over all Carriers *dBm*	1000	10	E-TM1.1	-30.38	Ignored
Power Dymamic Range *dB*	--	--	--	12.79	Ignored

FSx: 0,"No error"!

Fig. 3-71: Example report for test case 6.3.3.

3.4 Transmit ON/OFF Power (Clause 6.4)

Transmitter OFF power is defined as the mean power measured over 70 µs filtered with a square filter of bandwidth that is equal to the transmission bandwidth configuration of the base station (BW_{Config}) centered on the assigned channel frequency during the transmitter OFF period. [1]

For BS supporting intra-band contiguous CA, the transmitter OFF power is defined as the mean power measured over 70 µs filtered with a square filter of bandwidth equal to the aggregated channel bandwidth $BW_{Channel\_CA}$ centered on $(F_{edge\_high}+F_{edge\_low})/2$ during the transmitter OFF period. [1]

This test applies only for TDD and is defined for both SC and MC.

Fig. 3-72 shows the definition of the ranges and Table 3-12 lists the limits.

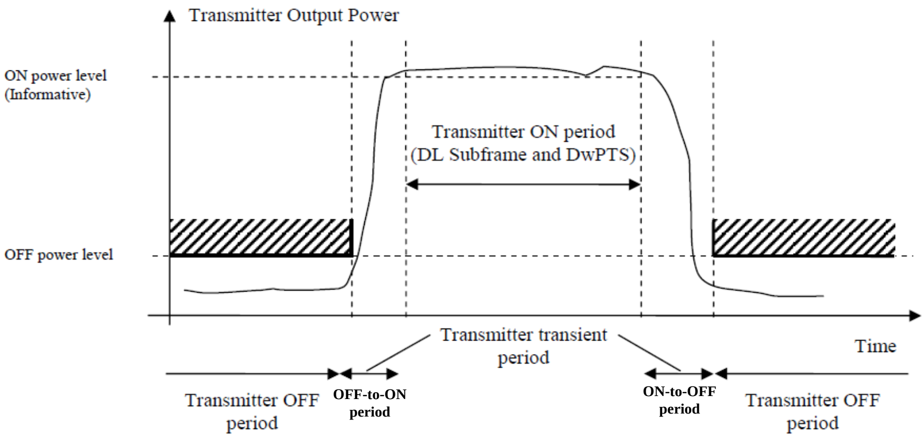


Fig. 3-72: Definition of transmitter ON and OFF periods [1].

Transmitter OFF power limit	
Frequency range	Limit
f ≤ 3 GHz	-83 dBm/MHz
3 GHz < f ≤ 4.2 GHz	-82.5 dBm/MHz

Table 3-12: Transmitter OFF limits

Multi-band test configuration for full carrier allocation

1. With separate antenna connector: The antenna connector not being under test shall be terminated.
2. Test requirement is only applicable during the transmitter OFF period in all supported operating bands. [1]

Test setup

Additional hardware is required for this test. An RF limiter is used to limit the power received at the analyzer during the transmitter ON periods. This enables the full dynamic range for the measurements in the OFF periods. In addition, an attenuator is used to absorb the reflected power for limiters without optimal VSWR.

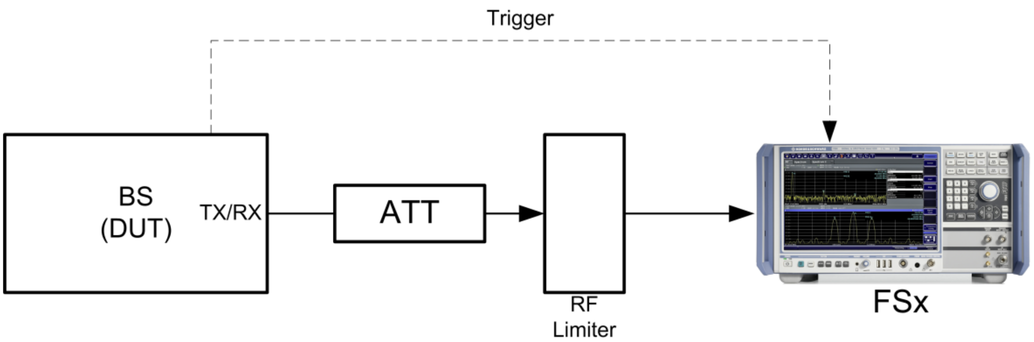


Fig. 3-73: Test setup: transmit ON/OFF.

The DUT (base station) generates the wanted signal at F_C with $BW_{Channel}$ and E-TM1.1.

The ON/OFF measurement for SC and MC is included in all options.

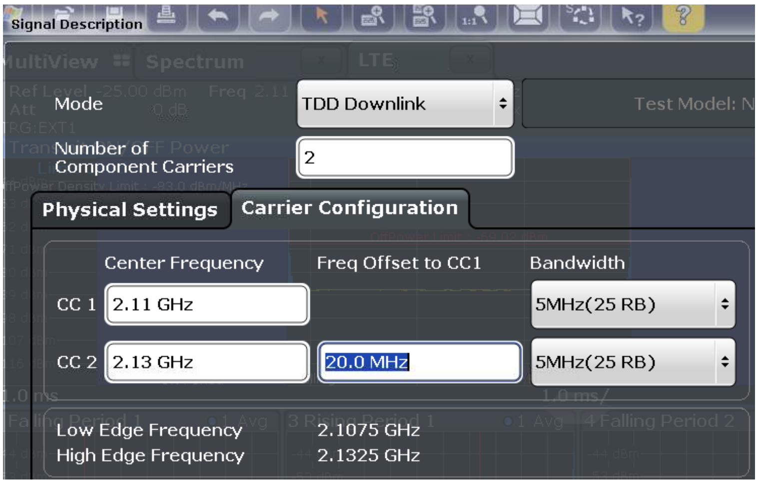
Single and Multi Carrier

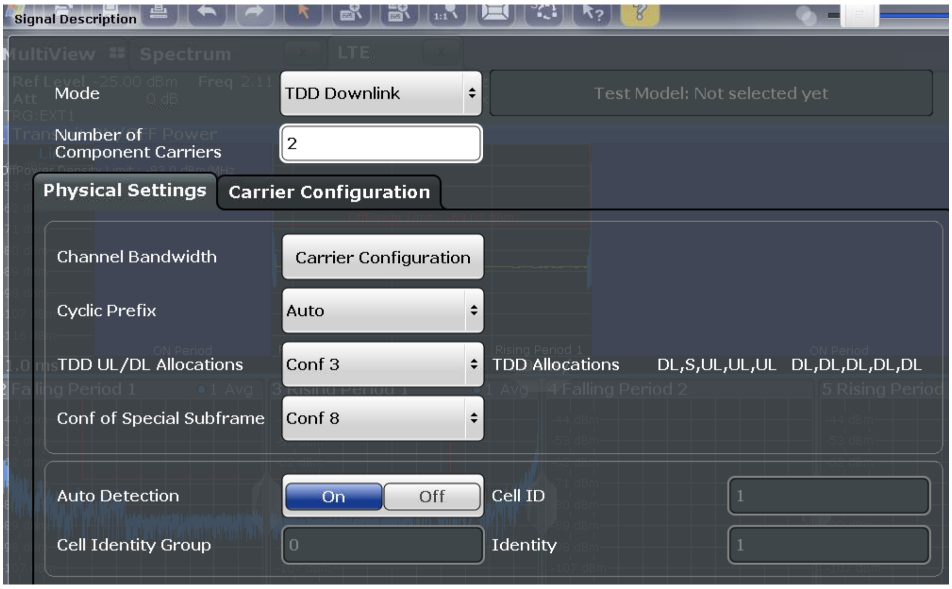
The procedure for single carrier is shown with the FSW.

Procedure

1. Select in **Duplexing Mode** “TDD Downlink”. After this, the measurement **Transmit ON/OFF Power** is available under Meas.
2. Set the **Number of Component Carriers**, the **center frequency** and the **bandwidth**.
3. Set the **UL/DL Configuration** and the **special subframe** (to measure in accordance with the specification UL/DL is 3 and Special subframe is 8)
4. Set the **number of frames** (specification: 50)

5. Press **ADJ Timing.**





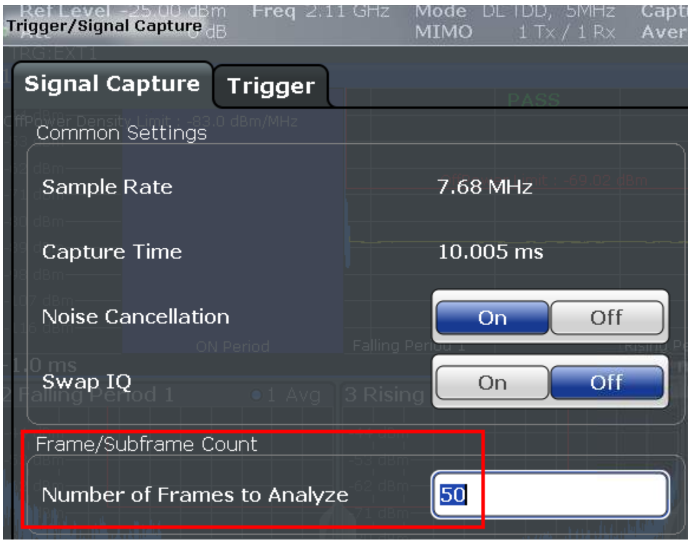


Fig. 3-74: Configuring the Tx ON/OFF Power measurement in the FSW

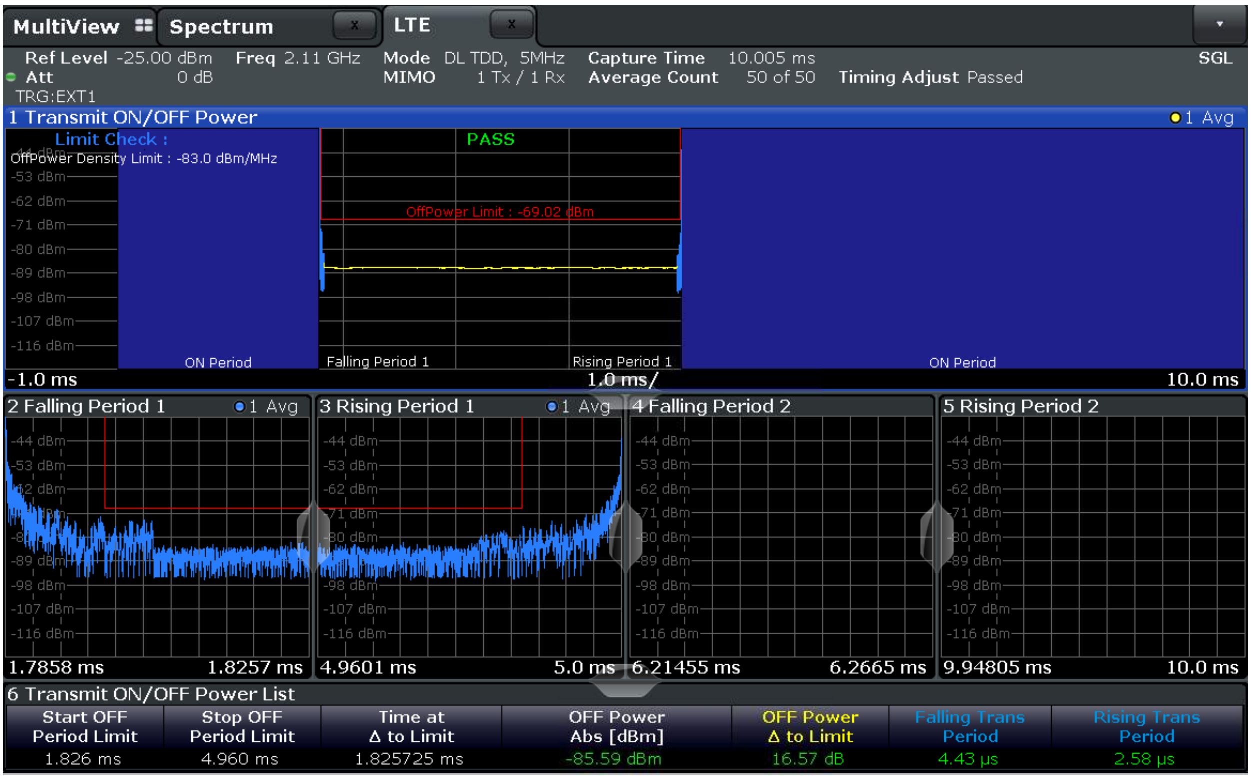


Fig. 3-75: The Tx ON/OFF measurement in the FSW

Demo program

This test is possible for TDD only. The measured OFF power is displayed. By default, the test uses **Noise Cancellation**. At present, the measurement with the PC SW uses one frame only, while the FSW option measurement uses 50 frames. The times for the **Rising and Falling Period** are also measured and reported.

Fig. 3-76: Noise cancellation at transmit On/Off.

********* 6.4 Transmit ON / OFF ************

\---

Duplex mode: TDD
Number of frames: 1

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	dBm	Status
6.4 Transmit ON / OFF					
Period 1:	2110	10	E-TM1.1	-15.13	Ignored

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	us	Status
Additional Measurements					
Period 1 Falling Period	2110	10	E-TM1.1	51.95313	Ignored
Period 1 Rising Period	2110	10	E-TM1.1	0.00000	Ignored

FSx: 0,"No error"

Fig. 3-77: Example report for test case 6.4.

3.5 Transmitted Signal Quality (Clause 6.5)

3.5.1 Frequency Error (Clause 6.5.1) and Error Vector Magnitude (Clause 6.5.2)

The two tests are defined only for SC.

Frequency error is the measure of the difference between the actual BS transmit frequency and the assigned frequency [1].

Table 3-13 shows the limits for the various base stations.

Frequency error requirements	
BS class	Accuracy
Wide Area BS	± (0.05 ppm + 12 Hz)
Medium Range BS	± (0.1 ppm + 12 Hz)
Local Area BS	± (0.1 ppm + 12 Hz)
Home BS	± (0.25 ppm + 12 Hz)

Table 3-13: Frequency error requirements [1]

For this measurement the FSx must be synchronized via **External Reference** to the basestation under test.

The error vector magnitude is a measure of the difference between the ideal symbols and the measured symbols after the equalization. This difference is called the error vector. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed in percent.

Table 3-14 shows the limits for the various modulation modes. The EVM requirement for 256QAM applies to Home BS, Local Area BS and Medium Range BS [1].

EVM requirements	
Modulation scheme PDSCH	EVM [%]
QPSK	18.5
16QAM	13.5
64QAM	9
256QAM	4.5

Table 3-14: EVM requirements [1]

Test setup

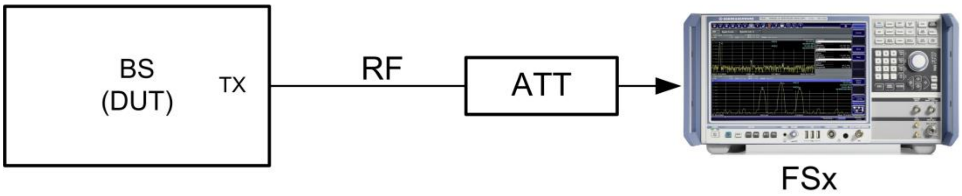


Fig. 3-78: Test setup for BS output power The DUT (base station) transmits with the declared maximum PRAT. The following configurations are specified:

- E-TM3.1
- E-TM3.2
- E-TM3.3
- E-TM2

Procedure

The signal is demodulated for the test. The test results are displayed in a scalar overview under RESULT SUMMARY. This method uses a single data record from the same test to obtain different values, such as power, crest factor, etc. The procedure follows the basic instructions provided in Section 3.1.1. The calculated power is displayed under **EVM PDSCH** and **Frequency Error** (see Fig. 3-79).

2 Result Summary

Frame Results 1/1	Mean	Max	Limit	Min
EVM PDSCH QPSK (%)	0.86	0.86	18.50	0.86
EVM PDSCH 16QAM (%)			13.50	
EVM PDSCH 64QAM (%)			9.00	
EVM PDSCH 256QAM (%)				
Results for Selection Subframes All, Selection Ant 1, Frame Results 1/1				
EVM All (%)	0.85	0.88		0.80
EVM Phys Channel (%)	0.85	0.88		0.80
EVM Phys Signal (%)	0.80	0.84		0.75
Frequency Error (Hz)	0.19	0.67		-0.38
Sampling Error (ppm)	0.00	0.33		-0.28
IQ Offset (dB)	-57.91	-56.56		-58.81
IQ Gain Imbalance (dB)	-0.00	-0.00		-0.01
IQ Quadrature Error (°)	0.00	0.01		-0.02
RSTP (dBm)	-58.50	-58.49		-58.50
OSTP (dBm)	-33.72	-33.72		-33.73
RSSI (dBm)	-33.91	-33.91		-33.96
Power (dBm)	-33.78	-33.78		-33.83
Crest Factor (dB)	10.80			

Fig. 3-79: Result summary: EVM and frequency error.

In addition to the required measured values for frequency errors and EVM, the summary also includes results such as sample error, I/Q imbalance, etc.

NB-IoT Procedure

The required EVM for QPSK modulation in NB-IoT is 18.5 %. The DUT (base station) transmits with the declared maximum PRAT with N-TM.

The signal is demodulated for the test. The test results are displayed in a scalar overview under RESULT SUMMARY. This method uses a single data record from the same test to obtain different values, such as power, crest factor, etc. The procedure follows the basic instructions provided in Section 3.1.1. The calculated power is displayed under **EVM PDSCH** and **Frequency Error** (see Fig. 3-80).

2 Result Summary

SF All, Selection Ant 1	Mean	Max	Limit	Min
EVM All (%)	0.31	0.33		0.17
EVM Phys Channel (%)	0.30	0.32		0.28
EVM Phys Signal (%)	0.31	0.33		0.17
Frequency Error (Hz)	-15.27	-14.25		-15.73
Sampling Error (ppm)	4.85	12.91		-2.28
RSTP (dBm)	-50.96	-50.94		-50.97
OSTP (dBm)	-43.71	-40.16		-93.24
RSSI (dBm)	-44.08	-40.16		-47.96
Power (dBm)	-42.97	-40.21		-46.86
Crest Factor (dB)	16.06			

Fig. 3-80: NB-IoT Result summary: EVM and frequency error.

In addition to the required measured values for frequency errors and EVM, the summary also includes results such as sample error, I/Q imbalance, etc.

Demo program

No further special settings are needed for this test. The test is carried out as a demodulation measurement. The frequency error and EVM are reported. In the case of MC tests, each individual carrier is measured in sequence.

********* 6.5.1 / 6.5.2 Frequency Error / EVM *************

Duplex mode: FDD

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model		Status
6.5.1 / 6.5.2 Frequency Error / EVM					
Frequency Error *Hz*	2110	10	E-TM1.1	0.06	Ignored
EVM %	2110	10	E-TM1.1	0.18	Ignored
Test Item	**Carrier Frequency (MHz)**	**Carrier BW (MHz)**	**Test Model**		**Status**
Additional Measurements					
Output Power	2110	10	E-TM1.1	-10.51	Ignored
OSTP *dBm*	2110	10	E-TM1.1	-10.51	Ignored

FSx: 0,"No error"

Fig. 3-81: Example report for test case 6.5.1.

3.5.2 Time Alignment Error (Clause 6.5.3)

Frames of the LTE signals present at the BS transmitter antenna ports are not perfectly aligned in time. In relation to each other, the RF signals present at the BS transmitter antenna ports experience certain timing differences. [1]

Time alignment error (TAE) is defined as the largest timing difference between any two signals. This test is only applicable for base stations supporting TX diversity, MIMO transmission, carrier aggregation and their combinations.

The test is performed for SC as well as MC.

Table 3-15 lists the limits for various combinations.

Time alignment error limits	
Transmission combination	Limit
MIMO/TX diversity single carrier	90 ns
Intra-band CA with or without MIMO or TX diversity	155 ns
Intra-band non-contiguous CA with or without MIMO or TX diversity	285 ns
Inter-band CA with or without MIMO or TX diversity	285 ns

Table 3-15: Time alignment error limits [1]

The DUT (basestation) transmits typically with E-TM1.1.

NB-IoT

NB-IoT support Tx Diversity, so the limit of 90 ns applies here, too. The procedures mentioned below are valid for NB-IoT as well (see section 3.5.2.1). The DUT (basestation) transmits with N-TM.

Demo program

No further special settings are needed for this test. Take note of the special test setup. The difference is output in ns. Please note that the simulation with the SMW allows two possibilities:

- NB-IoT: Tx Diversity signal
- LTE: Multicarrier with 2 CCs and 2 Tx Antennas each

*********** 6.5.3 Time Alignment Error ************

Duplex mode: FDD

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	ns	Status
6.5.3 Time Alignment Error					
Time delay Tx2:	2110	10	E-TM1.1	1.24051	Ignored

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	dBm	Status
Additional Measurements					
Output Power	2110	10	E-TM1.1	-12.17	Ignored

FSx: 0,"No error"

Fig. 3-82: Example report for test case 6.5.3.

3.5.2.1 Single Carrier (MIMO, Tx Diversity)

Test setup

The following 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 being used should be equal in electrical length.

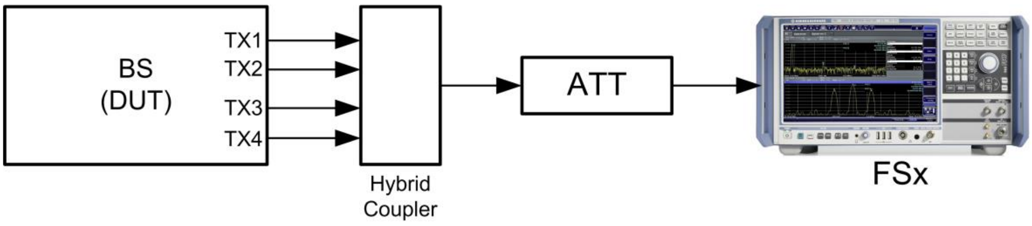


Fig. 3-83: Test setup: time alignment for SC.

Procedure

Up to 4 antennas can be measured in parallel. The measurement is taken on the reference signals (RS) of the individual antennas, and PDSCHs are ignored.

1. Start the test using MEAS and "Time Alignment"
2. The measurement is always relative to one reference antenna. The antenna can be changed under "Reference Antenna".

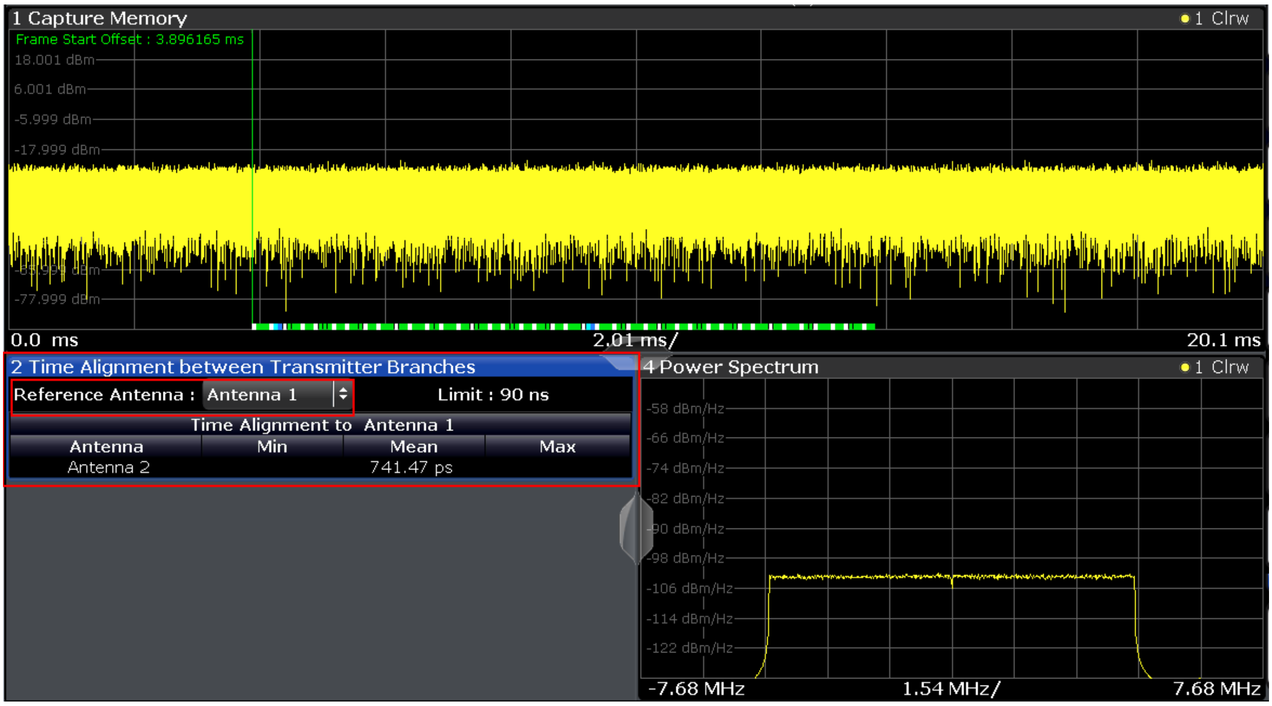


Fig. 3-84: Time alignment: Up to 4 antennas can be measured. The measurement is displayed relative to one selectable reference antenna.

3.5.2.2 Multicarrier (CA)

The CA measurement (including intra-band) can be performed with one FSx : Simple, precise measurement, in parallel with MIMO. For configurations with very high bandwidth needed, two FSx may needed.

Test setup

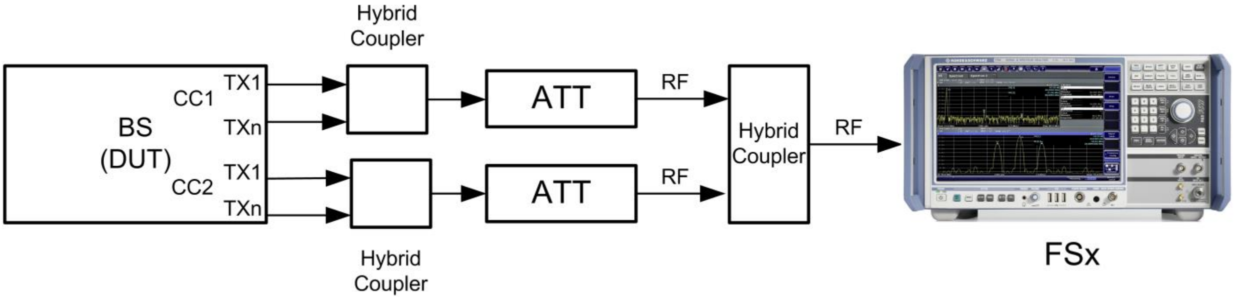
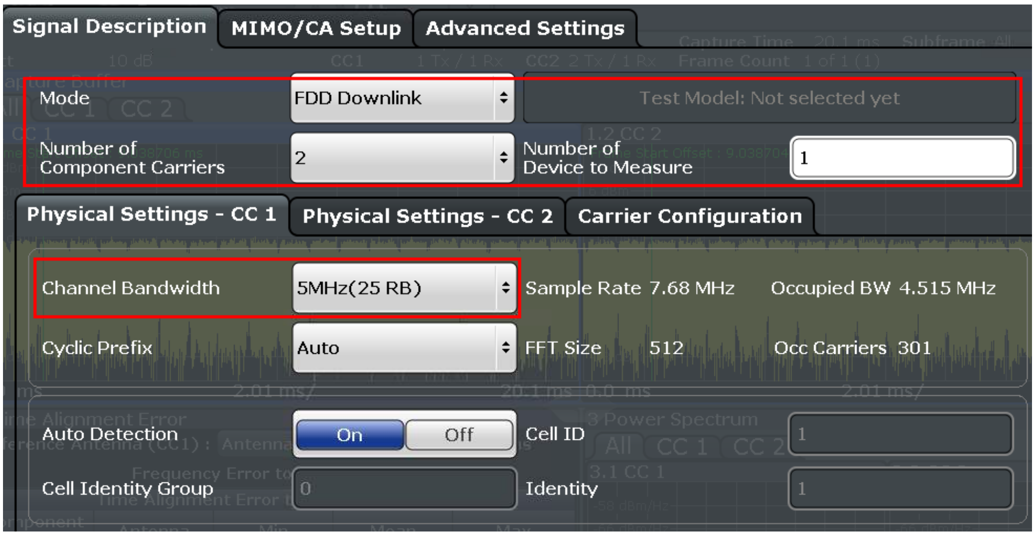


Fig. 3-85: Test setup for the time alignment error measurement for CA with FSx.

Procedure

1. Select the **Time Alignment** measurement
2. Set the relevant settings.



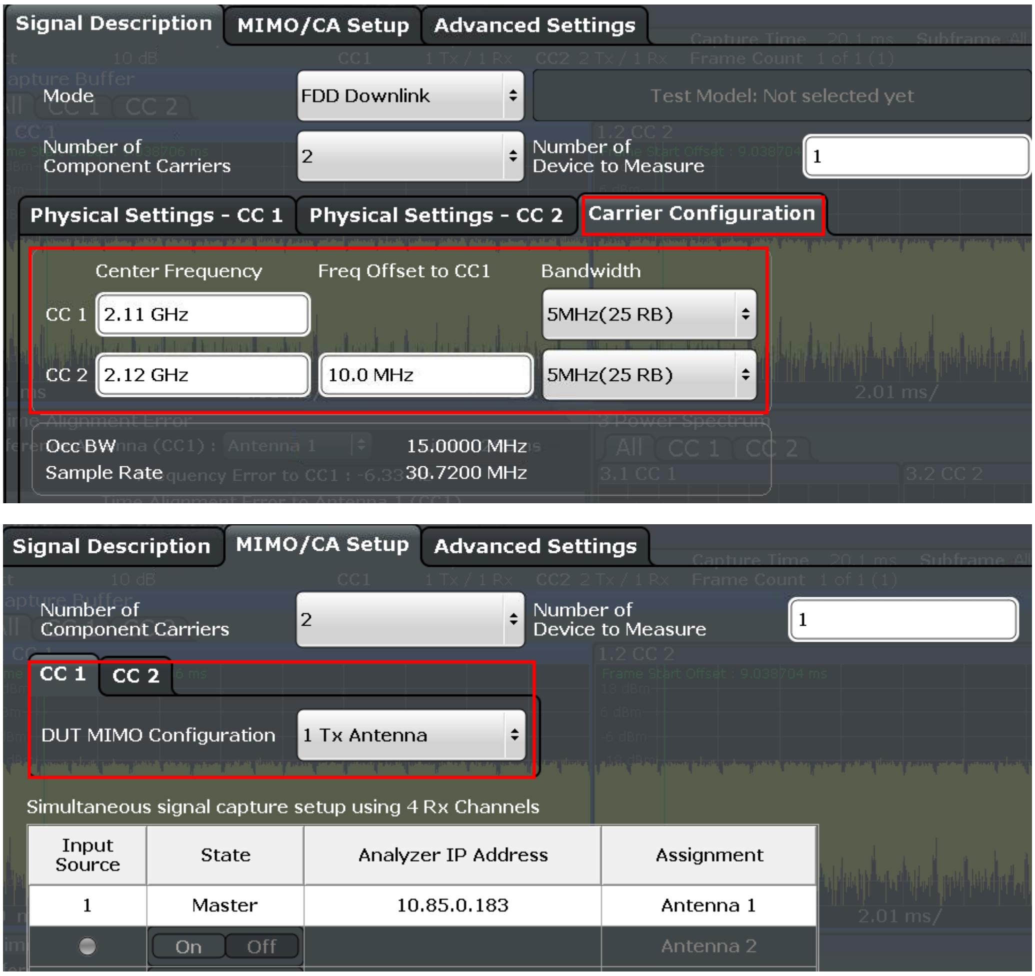


Fig. 3-86: Configuring the time alignment measurement in the FSW

3. The timing of the start of the frame relative to the external trigger is displayed in the Capture Buffer (Fig. 3-87).

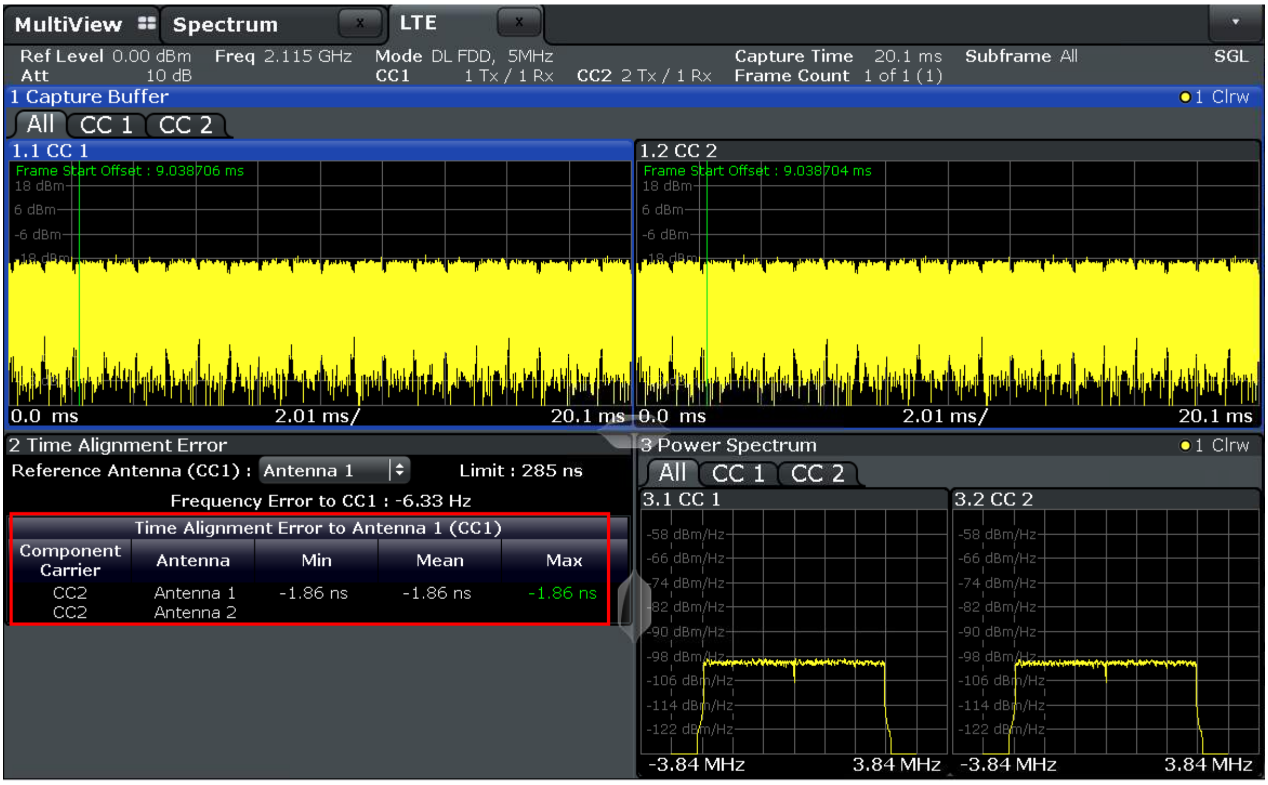


Fig. 3-87: Time alignment error measurement.

3.5.3 DL RS Power (Clause 6.5.4)

DL RS power is the resource element power of downlink reference symbol. The absolute DL RS power is indicated on the downlink shared channel (DL-SCH) in Layer 2.

The test is defined only for SC.

Table 3-16 lists the tolerances dependent on the frequency range.

DL RS power	
Frequency range	Deviation to indicated power
≤ 3 GHz	± 2.9 dB
3 GHz ≤ f ≤ 4.2 GHz	± 3.2 dB

Table 3-16: DL RS power requirements

Test setup

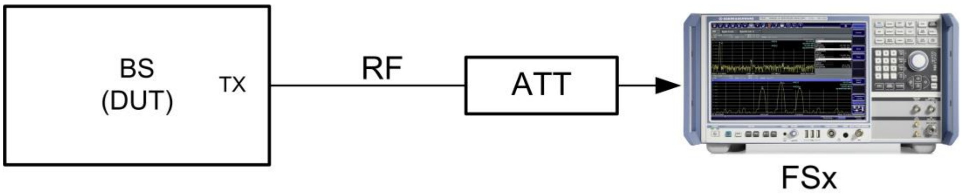


Fig. 3-88: Test setup for BS output power.

The DUT (base station) transmits with the declared maximum PRAT. E-TM1.1 is required.

Procedure

The signal is demodulated for the test. The test results are displayed in a scalar overview under RESULT SUMMARY. This method uses a single data record from the same test to obtain different values, such as power, crest factor, etc. The procedure follows the basic instructions provided in Section 3.1.1. The calculated power is displayed under **RSTP** (see Fig. 3-89).

2 Result Summary

Frame Results 1/1	Mean	Max	Limit	Min
EVM PDSCH QPSK (%)	0.86	0.86	18.50	0.86
EVM PDSCH 16QAM (%)			13.50	
EVM PDSCH 64QAM (%)			9.00	
EVM PDSCH 256QAM (%)				
Results for Selection Subframes All, Selection Ant 1, Frame Results 1/1				
EVM All (%)	0.85	0.88		0.80
EVM Phys Channel (%)	0.85	0.88		0.80
EVM Phys Signal (%)	0.80	0.84		0.75
Frequency Error (Hz)	0.19	0.67		-0.38
Sampling Error (ppm)	0.00	0.33		-0.28
IQ Offset (dB)	-57.91	-56.56		-58.81
IQ Gain Imbalance (dB)	-0.00	-0.00		-0.01
IQ Quadrature Error (°)	0.00	0.01		-0.02
RSTP (dBm)	-58.50	-58.49		-58.50
OSTP (dBm)	-33.72	-33.72		-33.73
RSSI (dBm)	-33.91	-33.91		-33.96
Power (dBm)	-33.78	-33.78		-33.83
Crest Factor (dB)	10.80			

Fig. 3-89: Result summary: display of the DL RS power (RSTP).

NB-IoT

DL NRS power is the resource element power of downlink reference symbol. The absolute DL RS power is indicated on the downlink shared channel (DL-SCH) in Layer 2.

The DUT (base station) transmits with the declared maximum PRAT. N-TM is required.

The limit is ± 2.9 dB of the indicated power.

The signal is demodulated for the test. The test results are displayed in a scalar overview under RESULT SUMMARY. This method uses a single data record from the same test to obtain different values, such as power, crest factor, etc. The procedure follows the basic instructions provided in Section 3.1.1. The calculated power is displayed under **RSTP** (see Fig. 3-89).

2 Result Summary

SF All, Selection Ant 1	Mean	Max	Limit	Min
EVM All (%)	0.31	0.33		0.17
EVM Phys Channel (%)	0.30	0.32		0.28
EVM Phys Signal (%)	0.31	0.33		0.17
Frequency Error (Hz)	-15.27	-14.25		-15.73
Sampling Error (ppm)	4.85	12.91		-2.28
RSTP (dBm)	-50.96	-50.94		-50.97
OSTP (dBm)	-43.71	-40.16		-93.24
RSSI (dBm)	-44.08	-40.16		-47.96
Power (dBm)	-42.97	-40.21		-46.86
Crest Factor (dB)	16.06			

Fig. 3-90: NB-IoT Result summary: display of the DL RS power (RSTP).

Demo program

No further special settings are needed for this test. The test is carried out as a demodulation measurement. The reference symbol power is reported.

********** 6.5.4 Reference Symbol Power **************

Duplex mode: FDD

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model		Status
6.5.4 Reference Symbol Power					
RS Power *dBm*	2110	10	E-TM1.1	-38.28	Ignored
Test Item	**Carrier Frequency (MHz)**	**Carrier BW (MHz)**	**Test Model**		**Status**
Additional Measurements					
Output Power	2110	10	E-TM1.1	-10.51	Ignored
OSTP *dBm*	2110	10	E-TM1.1	-10.50	Ignored
Frequency Error *Hz*	2110	10	E-TM1.1	0.11	Ignored
EVM %	2110	10	E-TM1.1	0.20	Ignored

FSx: 0,"No error"

Fig. 3-91: Example report for test case 6.5.4.

3.6 Unwanted Emissions (Clause 6.6)

Unwanted emissions consist of out-of-band emissions and spurious emissions. Out-of-band emissions are unwanted emissions immediately outside the channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. 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 [1].

3.6.1 Occupied Bandwidth (Clause 6.6.1)

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 a specified percentage β/2 of the total mean transmitted power. It defines the spectral properties of emission in a simple manner.

The value of β/2 shall be taken as 0.5%. This results in a power bandwidth of 99%.

The measurement of the spectrum is carried out with resolution bandwidth (RBW) of 30 kHz or less and the measurement points mentioned in Table 3-17.

Span and measurement points for OBW measurement								
Channel bandwidth [MHz]	0.2	1.4	3	5	10	15	20	>20
Span [MHz]	0.4	10	10	10	20	30	40	$2 * BW_{Channel\_CA}$
Minimum number of measurement points	400	1429	667	400	400	400	400	$\left\lceil \frac{2 * BW_{Channel\_CA}}{100kHz} \right\rceil$

Table 3-17: OBW: span and measurement points

The measured bandwidth (OBW) shall be smaller than the nominal bandwidth (see Table 3-17, top row). For multicarrier scenarios, the OBW should be smaller than the aggregated bandwidth. Multiple combinations shall be tested as described in Section 4.10.2 [1].

Test setup

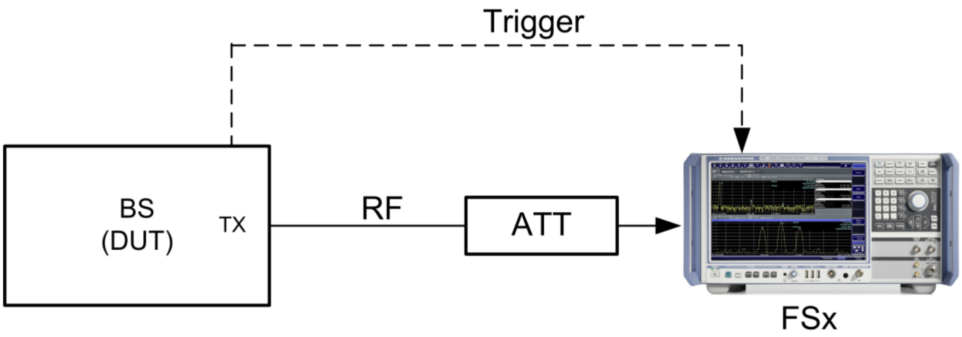


Fig. 3-92: Test setup for BS output power.

The DUT (base station) transmits with the declared maximum PRAT. E-TM1.1 is required.

The general base unit function "OBW" is used for the test. For TDD signals, the trigger must be set to external.

Procedure (example: 10 MHz bandwidth)

1. Press MODE and then select Spectrum
2. Press MEAS and select OBW
3. Verify the **%Power Bandwidth** default setting of 99%
4. Set the **Channel Bandwidth** (example: 10 MHz)
5. Press **Overview** and select "Bandwidth"

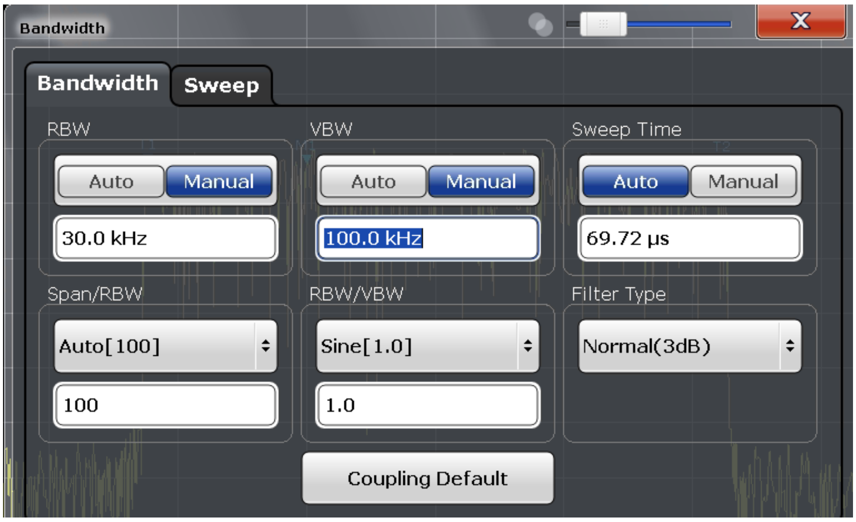


Fig. 3-93: OBW: set the bandwidth and sweep.

6. On the SWEEP tab, set the **sweep points** and **Optimization** to "speed"
7. Set the **Span** per Table 3-17 (example: 20 MHz)
8. The spectrum and the calculated OBW are displayed.

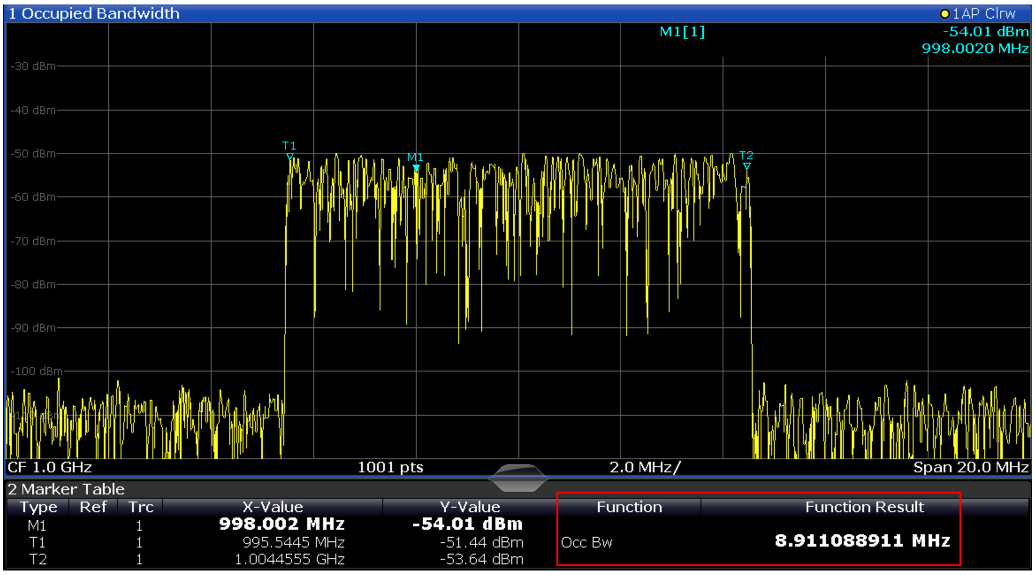


Fig. 3-94: OBW measurements (in the example, an OBW of 8.91 MHz is calculated for a 10 MHz channel).

The measurement is performed in the same way for multicarrier scenarios. In this case, the aggregated bandwidth is entered manually as the bandwidth (see step 4).

NB-IoT stand-alone Procedure

The DUT (base station) transmits at the declared maximum PRAT. N-TM is required.

1. Press MODE and then select Spectrum
2. Press MEAS and select OBW
3. Verify the **%Power Bandwidth** default setting of 99%

4. Set the **Channel Bandwidth** to 200 kHz
5. Press **Overview** and select "Bandwidth"

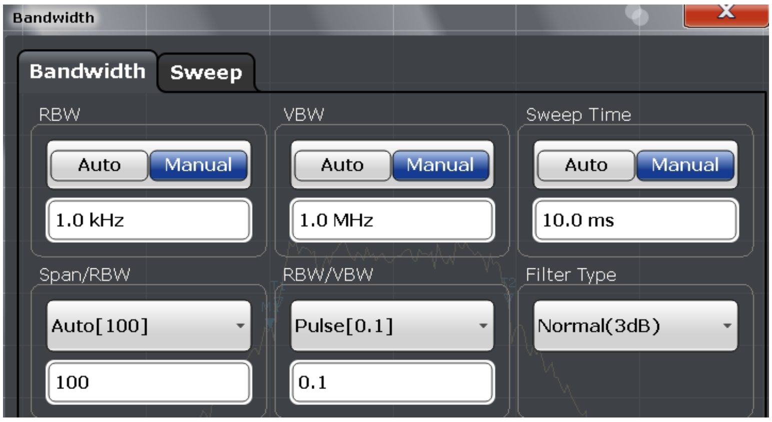


Fig. 3-95: OBW: set the bandwidth and sweep.

6. On the SWEEP tab, set the **sweep points** and **Optimization** to "speed"
7. Set the **Span** to 400 kHz
8. The spectrum and the calculated OBW are displayed.

Fig. 3-96: NB-IoT OBW measurements.

The limit is the NB-IoT channel bandwidth of 200 kHz.

NB-IoT inband and guard band Procedure

For NB-IoT inband and guard band, the signal shall be seen as a combination between LTE carriers and NB-IoT carriers. The DUT (base station) transmits at the declared maximum PRAT. E-TM1.1 for the LTE part and N-TM for NB-IoT part are required.

The limits are the same as in Table 3-5.

Demo program

No further special settings are needed for this test. It is performed in the base unit as a general spectrum measurement, which means that it cannot be performed directly using the PC SW. The measured bandwidth OBW is reported.

********* 6.6.1 Occupied Bandwidth ************

Duplex mode: FDD

Test Item	Carrier Frequency (MHz)	Carrier BW (MHz)	Test Model	MHz	Status
6.6.1 Occupied Bandwidth					
OBW	2110	10	E-TM1.1	8.93	Ignored

FSx: 0,"No error"

Fig. 3-97: Example report for test case 6.6.1.

3.6.2 Adjacent Channel Leakage Power (ACLR) (Clause 6.6.2)

The requirements for Adjacent channel leakage power ratio (ACLR) applies outside the used RF bandwidth for single or multi-carrier configurations. In multi-carrier scenarios with certain gap sizes (spectrum between two wanted channels) the requirements also apply inside the unused gap. In addition, for multi-carrier special gap sizes the Cumulative Adjacent channel Leakage power ratio (CACLR) applies.

ACLR

Scenario		ACLR		CACLR
Carrier	**Gap**	**Inside gap**	**Outside RF bandwidth**	
Single Carrier	-	-	✓	✗
Multi-Carrier / CA	5 MHz ≤ Gap ≤ 15 MHz	✗		✓
	15 MHz ≤ Gap < 20 MHz	✓		✓
	Gap ≥ 20 MHz	✓		✗

Table 3-18: Overview ACLR measurements

Adjacent Channel Leakage Power (ACLR)

Adjacent channel leakage power ratio (ACLR) is the ratio of the filtered mean power centered on the assigned channel frequency to the filtered mean power centered on an adjacent channel frequency. The requirements shall apply outside the base station RF bandwidth or maximum radio bandwidth edges regardless of the type of transmitter (single carrier, multicarrier and/or CA). [1]

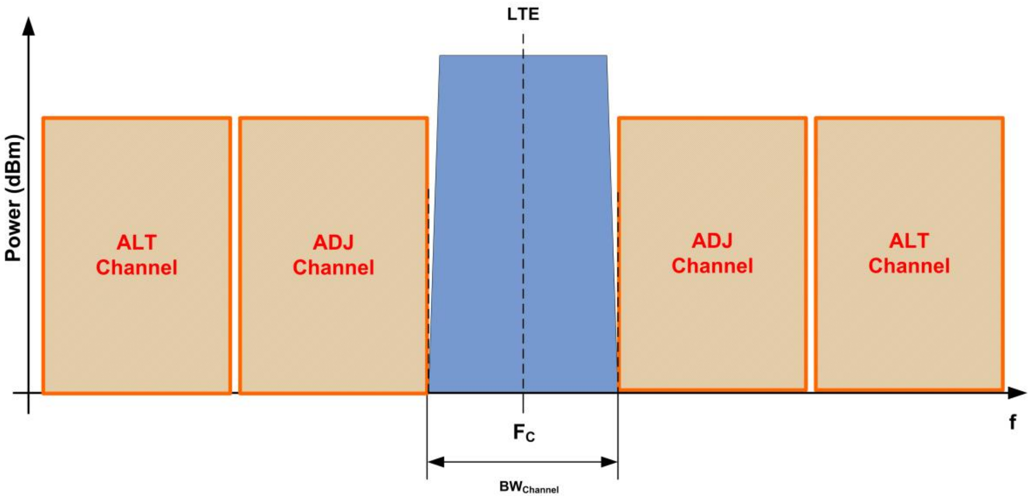


Fig. 3-98: ACLR for single carrier; red marks the measurement regions.

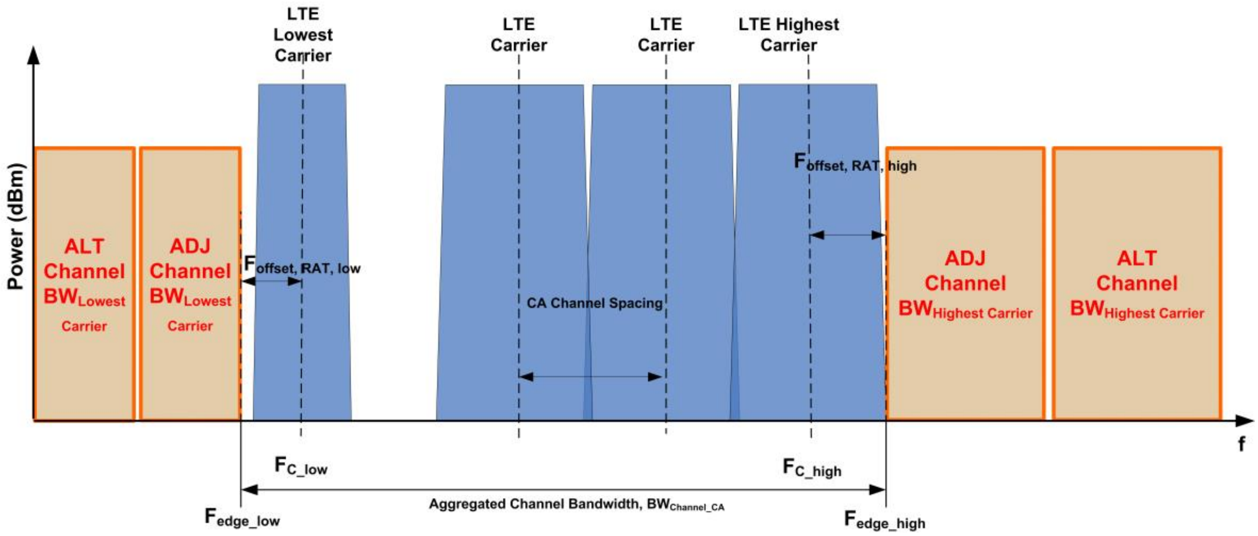


Fig. 3-99: ACLR for multicarrier; red marks the measurement regions.

Table 3-20 through Table 3-19 list the relative and absolute limits.

Test requirements for ACLR		
	BS Type	Minimum Absolute Value
Category A	Wide Area	-13 dBm/MHz
	Medium Range BS	-25 dBm/MHz
	Local Area	-32 dBm/MHz
	Home BS	-50 dBm/MHz
Category B	Wide Area	-15 dBm/MHz

Table 3-19: ACLR: absolute minimum requirements

Base station ACLR in paired spectrum				
Channel bandwidth of LTE lowest (highest) carrier transmitted BWChannel [MHz]	BS adjacent channel center frequency offset below the lowest or the above the highest carrier center frequency transmitted	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit [dB]
1.4, 3.0, 5, 10, 15, 20	BWChannel	LTE of same BW	Square (BWConfig)	44.2
	2 x BWChannel	LTE of same BW	Square (BWConfig)	44.2
	BWChannel/2 + 2.5 MHz	3.84 Mcps WCDMA	RRC (3.84 Mcps)	44.2
	BWChannel/2 + 7.5 MHz	3.84 Mcps WCDMA	RRC (3.84 Mcps)	44.2

Table 3-20: ACLR paired spectrum (FDD)

Base station ACLR in unpaired spectrum				
Channel bandwidth of LTE lowest (highest) carrier transmitted BWChannel [MHz]	BS adjacent channel center frequency offset below the lowest or the above the highest carrier center frequency transmitted	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit [dB]
1.4, 3.0	BWChannel	LTE of same BW	Square (BWConfig)	44.2
	2 x BWChannel	LTE of same BW	Square (BWConfig)	44.2
	BWChannel/2 + 0.8 MHz	1.28 Mcps WCDMA	RRC (1.28 Mcps)	44.2
	BWChannel/2 + 2.4 MHz	1.28 Mcps WCDMA	RRC (1.28 Mcps)	44.2
5, 10, 15, 20	BWChannel	LTE of same BW	Square (BWConfig)	44.2
	2 x BWChannel	LTE of same BW	Square (BWConfig)	44.2
	BWChannel/2 + 0.8 MHz	1.28 Mcps WCDMA	RRC (1.28 Mcps)	44.2
	BWChannel/2 + 2.4 MHz	1.28 Mcps WCDMA	RRC (1.28Mcps)	44.2
	BWChannel/2 + 2.5 MHz	3.84 Mcps WCDMA	RRC (3.84 Mcps)	44.2
	BWChannel/2 + 7.5 MHz	3.84 Mcps WCDMA	RRC (3.84 Mcps)	44.2

Table 3-21: ACLR unpaired spectrum (TDD)

Non-contiguous Spectrum

For a base station in non-contiguous spectrum, the ACLR applies additionally for the first adjacent channel inside any sub-block gap with a gap size $W_{gab} \geq$ 15MHz. The ACLR requirement for the second adjacent channel applies inside any sub-block gap with a gap size $W_{gap} \geq$ 20MHz (see Table 3-22). [1]

ACLR measurement channels inside gap		
Gap	**Channel Offset 2.5 MHz**	**Channel Offset 7.5 MHz**
15 MHz ≤ Gap < 20 MHz	☑	☒
Gap ≥ 20 MHz	☑	☑

Table 3-22: Measurements channels inside the gap

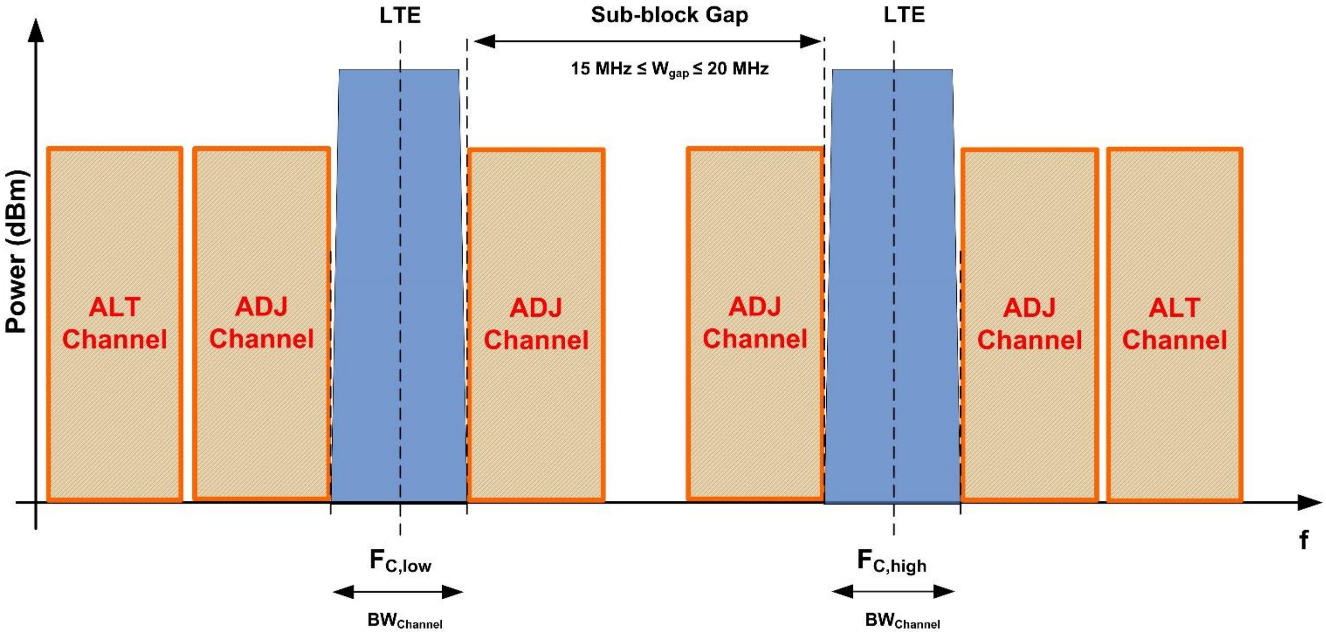


Fig. 3-100: Example for ACLR for multicarrier and sub-block gap; red marks the measurement regions. As W_{gap} ≤ 20 MHz, only the adjacent channels are measured in the gap.

Base station ACLR in non-contiguous paired spectrum or multiple bands				
Sub-block or inter RF bandwidth gap size (W_{gap}) where the limit applies	BS adjacent channel center frequency offset below or above the sub-block edge or the RF bandwidth edge (inside the gap)	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit [dB]
W_{gap} ≥ 15 MHz	2.5 MHz	3.84 Mcps WCDMA	RRC (3.84 Mcps)	44.2
W_{gap} ≥ 20 MHz	7.5 MHz	3.84 Mcps WCDMA	RRC (3.84 Mcps)	44.2

Table 3-23: ACLR in non-contiguous paired spectrum (FDD) or multiple bands

Base station ACLR in non-contiguous unpaired spectrum or multiple bands				
Sub-block or inter RF bandwidth gap size (W_{gap}) where the limit applies	BS adjacent channel center frequency offset below or above the sub-block edge or the RF bandwidth edge (inside the gap)	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit [dB]
W_{gap} ≥ 15 MHz	2.5 MHz	5 MHz LTE	Square (BWConfig)	44.2
W_{gap} ≥ 20 MHz	7.5 MHz	5 MHz LTE	Square (BWConfig)	44.2

Table 3-24: ACLR in non-contiguous unpaired spectrum (TDD) or multiple bands

Multi-band Operations

For a base station operating in multiple bands, where multiple bands are mapped onto the same antenna connector, the ACLR applies additionally for the first adjacent channel inside any inter RF bandwidth gap with a gap size W_{gab} ≥ 15MHz. The ACLR requirement for the second adjacent channel applies inside any inter RF bandwidth gap with a gap size $W_{gap} \geq$ 20MHz. [1]

For multi-bands, measure ACLR independently for every available band.

The setting is similar to Fig. 3-100, except the gap between the operating bands is regarded instead of the sub-block gap.

Test setup

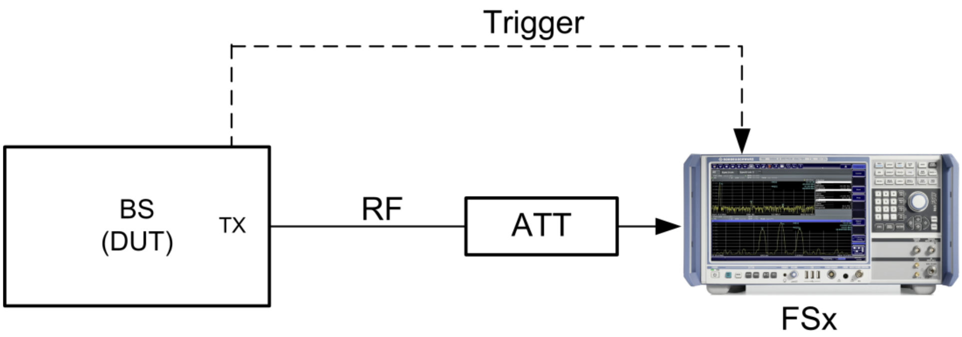


Fig. 3-101: Test setup for BS output power.

The DUT (base station) transmits with the declared maximum PRAT. E-TM1.1 and E-TM1.2 are required.

For TDD signals, the trigger must be set to external.

Both cases -- LTE and WCDMA as adjacent channels-- are handled (see tables). Both relative and absolute limits apply, although the easier to fulfill have to be met (see Table 3-19 for absolute values). "Paired spectrum" applies to FDD and "unpaired spectrum" to TDD configurations.

Single carrier

1. In the LTE option, start the measurement using MEAS and "Channel Power ACLR"
2. Under CP/ACLR CONFIG, set the corresponding parameters. The measurement for single carrier scenarios automatically takes data such as the bandwidth and spacing from the signal description. Set the base station to transmit according to E-TM 1.1. Use the applicable test configuration and corresponding power setting.

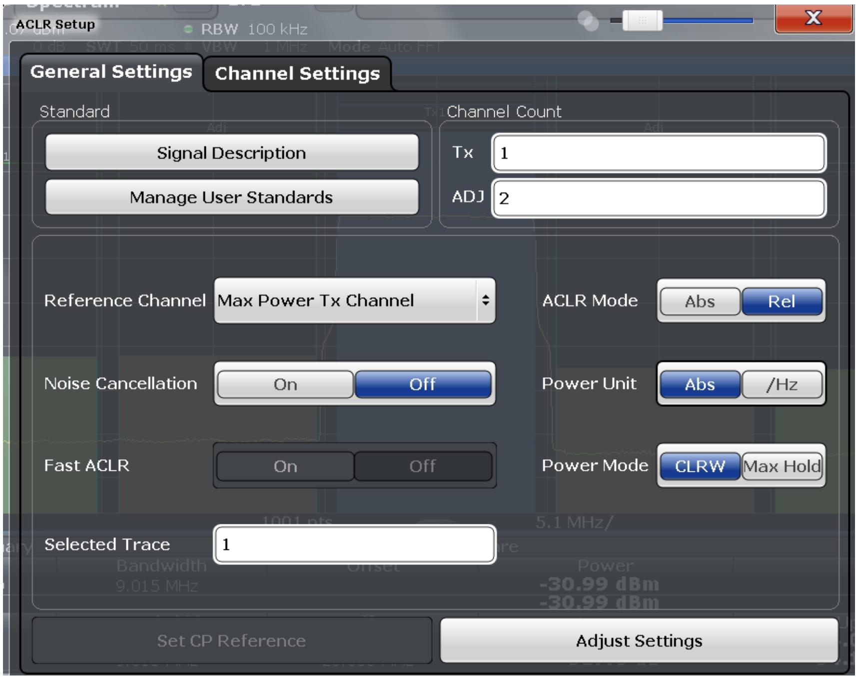


Fig. 3-102: ACLR: general settings.

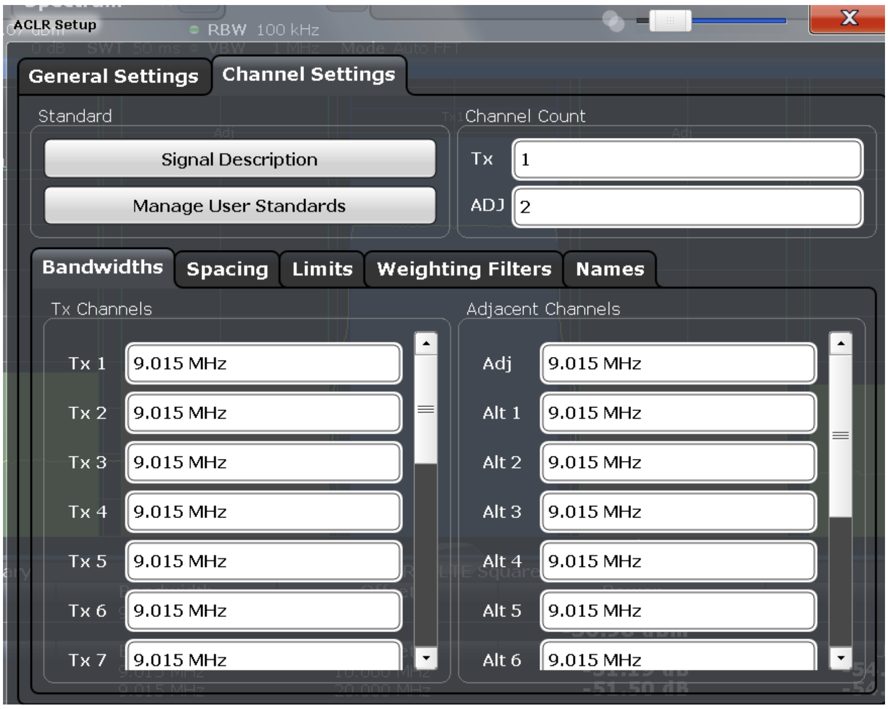


Fig. 3-103: ACLR: channel settings: bandwidth for Tx and adjacent channels.

Fig. 3-104: ACLR relative and absolute limits are based on the BS category (see also Table 3-19).

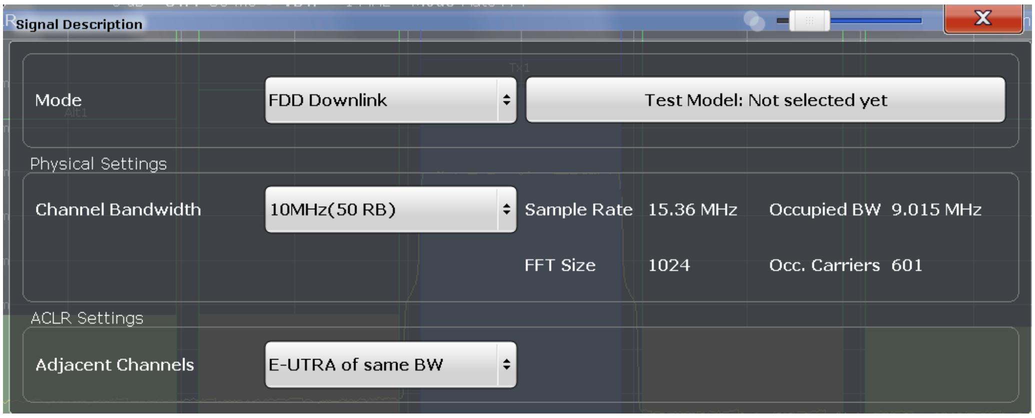


Fig. 3-105: ACLR: signal description with switch for adjacent channels (LTE or WCDMA).

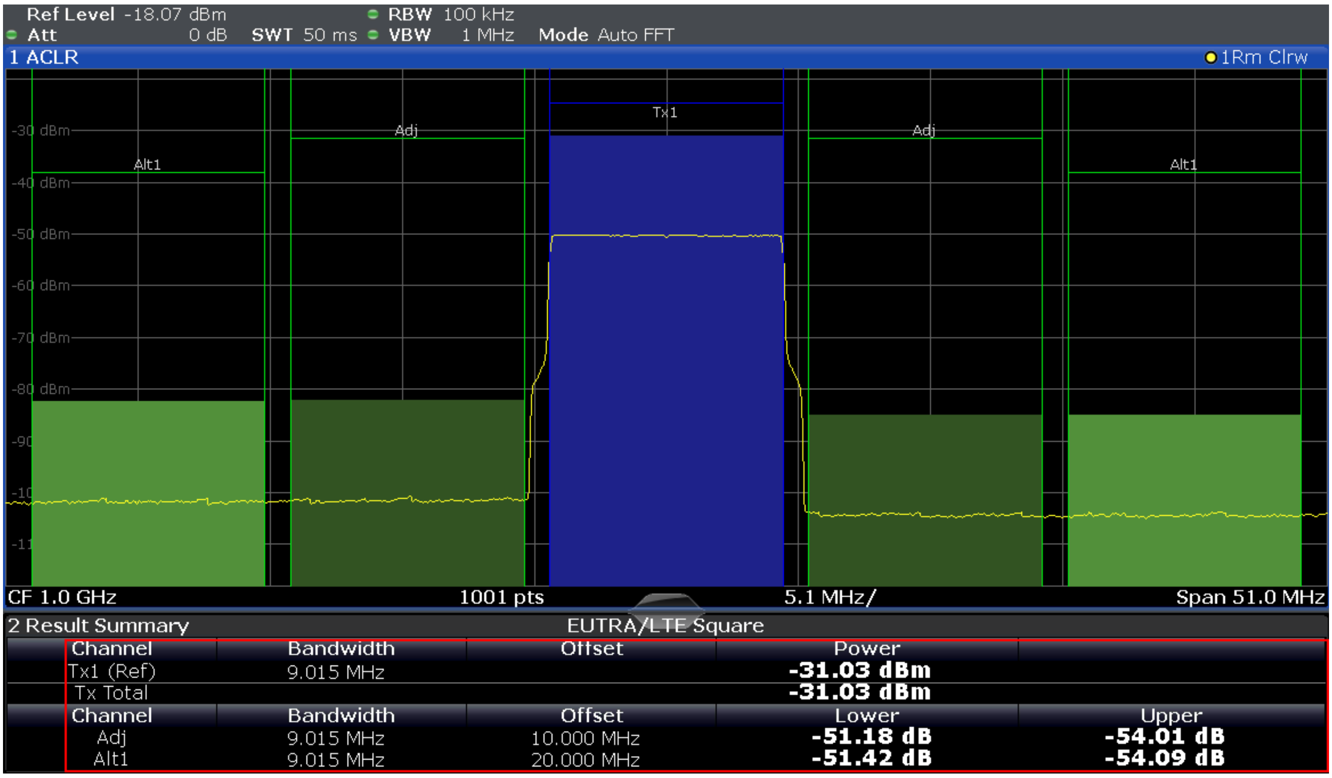


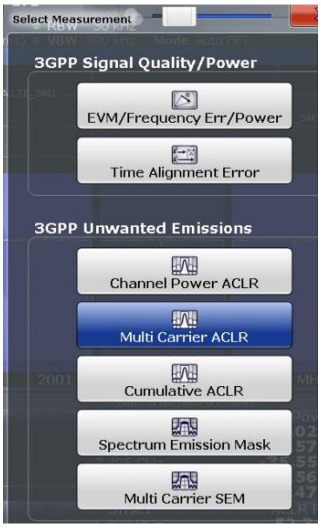
Fig. 3-106: ACLR for single carrier.

Multicarrier

For multicarrier and/or CA operation, set the base station to transmit according to E-TM 1.1 on all carriers.

The procedure is illustrated here using the multicarriers example from chapter 2.3 (see Fig. 2-5):

1. In the LTE option, start the measurement using MEAS and "Multi Carrier ACLR"



2. Under SIGNAL DESCRIPTION, set the corresponding parameters. Set the Number of Component Carriers (example: 4) and the frequencies and bandwidths.

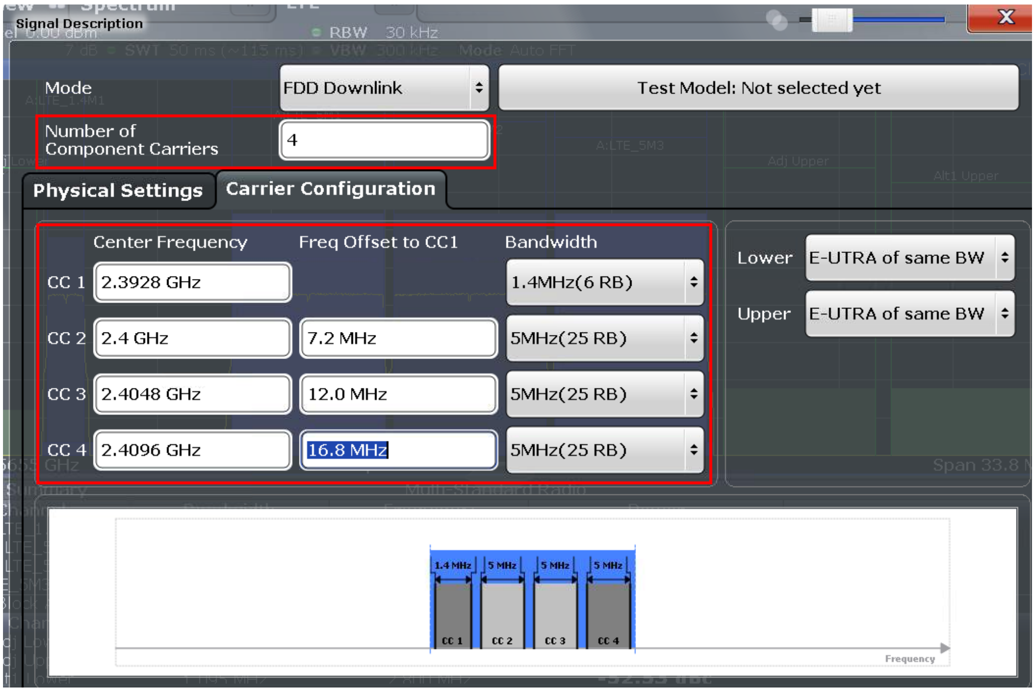


Fig. 3-107: Setting the 4 carriers and bandwidths. You can enter the center frequencies or the offsets.

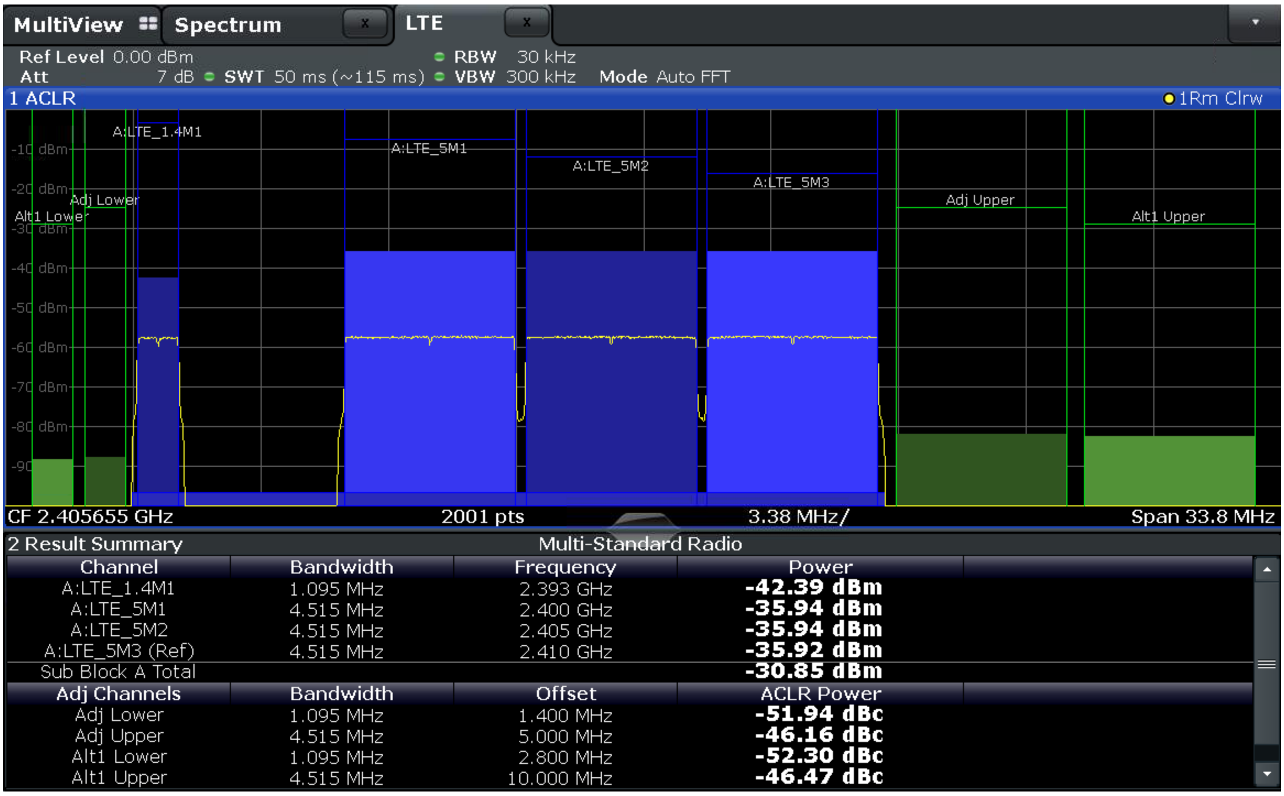


Fig. 3-108: ACLR with multicarriers.

The LTE option automatically sets the right measurement channels and bandwidths, even for the measurements in the gap.

Measurements inside the gap and Cumulative ALCR (CALCR)

In non-contiguous spectrum for certain gap sizes the ACLR applies also inside the gap. In addition also the CALCR applies.

CACLR in a sub-block gap or inter RF bandwidth gap is the ratio of:

a) the sum of the filtered mean power centered on the assigned channel frequencies for the two carriers adjacent to each side of the sub-block gap or inter RF bandwidth gap, and

b) the filtered mean power centered on a frequency channel adjacent to one of the respective sub-block edges or RF bandwidth edges.

Test requirements for CACLR		
Category A	BS Type	Minimum Absolute Value
	Wide Area	-13 dBm/MHz
	Medium Range BS	-25 dBm/MHz
	Local Area	-32 dBm/MHz
Category B	Wide Area	-15 dBm/MHz

Table 3-25: CACLR: absolute minimum requirements

Base station CACLR in non-contiguous paired spectrum or multiple bands				
Sub-block or inter RF bandwidth gap size (W_{gap}) where the limit applies	BS adjacent channel center frequency offset below or above the sub-block edge or the RF bandwidth edge (inside the gap)	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	CACLR limit [dB]
5 MHz ≤ W_{gap} < 15 MHz	2.5 MHz	3.84 Mcps WCDMA	RRC (3.84 Mcps)	44.2
10 MHz < W_{gap} < 20 MHz	7.5 MHz	3.84 Mcps WCDMA	RRC (3.84 Mcps)	44.2

Table 3-26: CACLR in non-contiguous paired spectrum (FDD) or multiple bands

Base station CACLR in non-contiguous unpaired spectrum or multiple bands				
Sub-block or inter RF bandwidth gap size (W_{gap}) where the limit applies	BS adjacent channel center frequency offset below or above the sub-block edge or the RF bandwidth edge (inside the gap)	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	CACLR limit [dB]
5 MHz ≤ W_{gap} < 15 MHz	2.5 MHz	5 MHz LTE	Square (BWConfig)	44.2
10 MHz < W_{gap} < 20 MHz	7.5 MHz	5 MHz LTE	Square (BWConfig)	44.2

Table 3-27: CACLR in non-contiguous unpaired spectrum (TDD) or multiple bands

Filter parameters for the assigned channel	
RAT of the carrier adjacent to the sub-block or inter RF bandwidth gap	Filter on the assigned channel frequency and corresponding filter bandwidth
LTE	LTE of same bandwidth

Table 3-28: CACLR: Filter parameters for the assigned channel

The CALCR is automatically measured in the multi-carrier ACLR, if applicable. In addition it can be measured separately with the function **Cumulative ACLR** under **MEAS**.

The following screenshots show an example with a measurement inside the gap. As the gap is 17.5 MHz, only the cannels with 2.5 MHz offsets are measured (see Table 3-22).

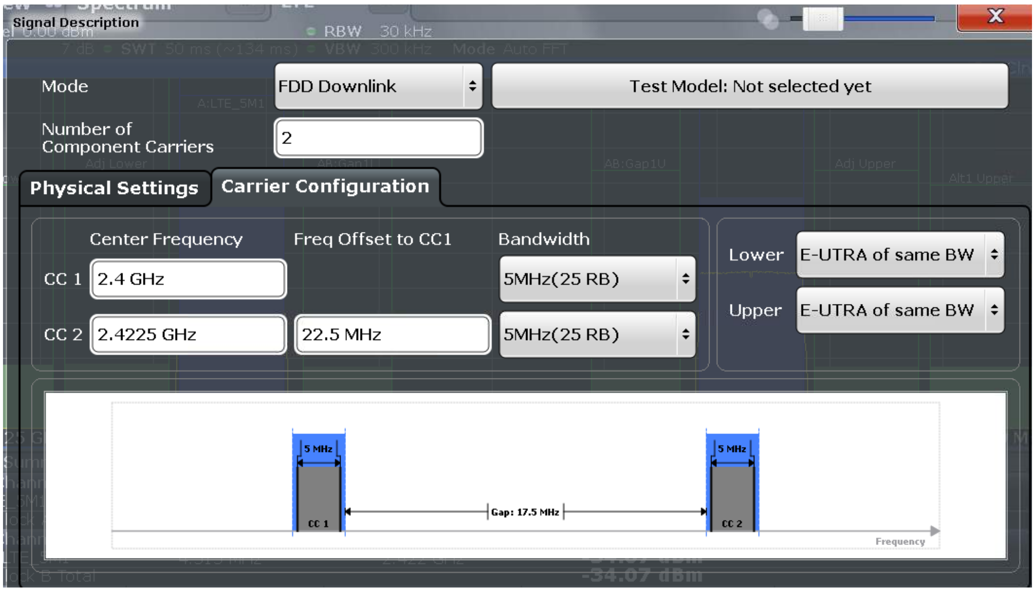


Fig. 3-109: Signal description for an example with measurements inside the gap

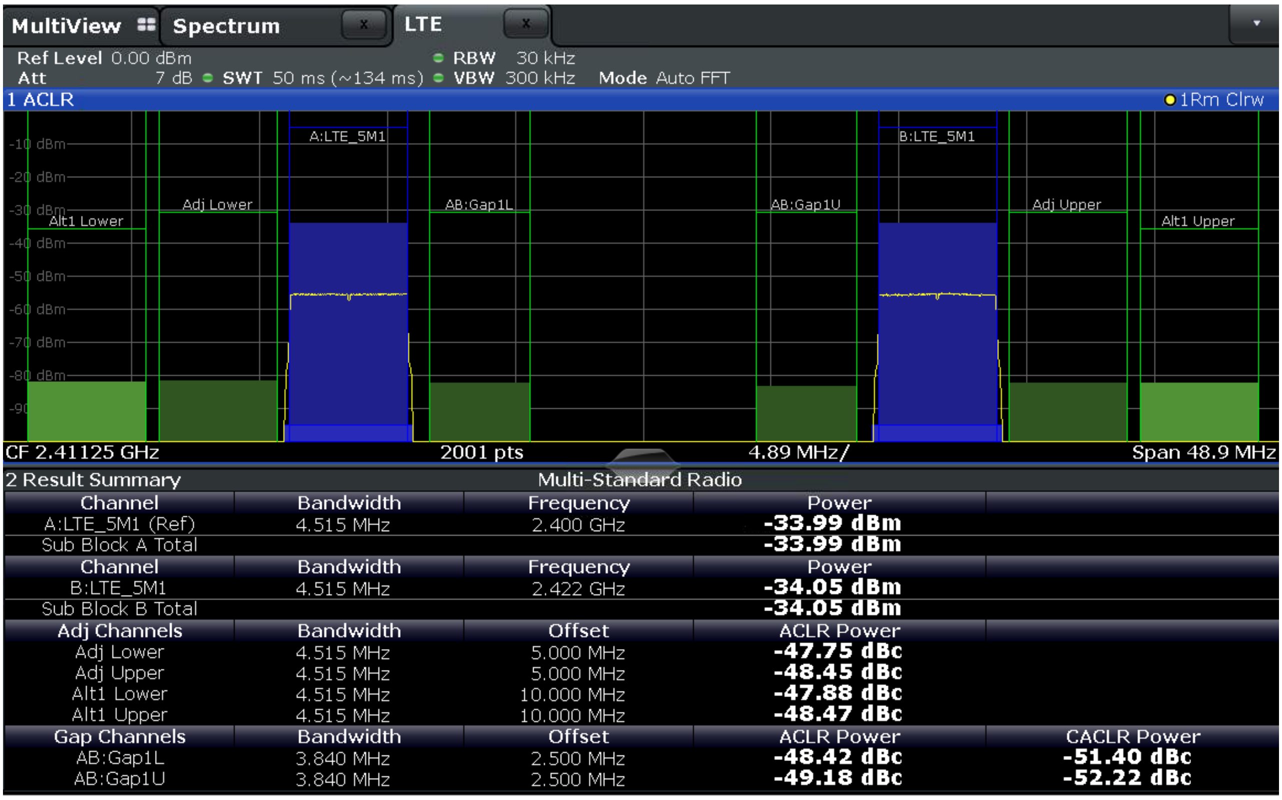


Fig. 3-110: ACLR with a measurement inside the gap. The FSW automatically measure the in-gap channels if necessary.

LTE-Band 46

LTE band 46 is the unlicensed band for Licensed Assisted Access (LAA).

Please note that for band 46 different gap settings and different limits apply:

Base station ACLR band 46				
Channel bandwidth of LTE lowest (highest) carrier transmitted BWChannel [MHz]	BS adjacent channel center frequency offset below the lowest or the above the highest carrier center frequency transmitted	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit [dB]
10	BWChannel	LTE of same BW	Square (BWConfig)	34.2
	2 x BWChannel	LTE of same BW	Square (BWConfig)	39.2
20	BWChannel	LTE of same BW	Square (BWConfig)	35
	2 x BWChannel	LTE of same BW	Square (BWConfig)	40

Table 3-29: ACLR band 46

Base station ACLR in non-contiguous spectrum band 46				
Sub-block or inter RF bandwidth gap size (W_{gap}) where the limit applies	BS adjacent channel center frequency offset below or above the sub-block edge or the RF bandwidth edge (inside the gap)	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit [dB]
$W_{gap} \geq$ 60 MHz	10 MHz	20 MHz LTE	Square (BWConfig)	35
$W_{gap} \geq$ 80 MHz	30 MHz	20 MHz LTE	Square (BWConfig)	40

Table 3-30: ACLR in non-contiguous spectrum band 46

Base station CACLR in non-contiguous band 46				
Sub-block or inter RF bandwidth gap size (W_{gap}) where the limit applies	BS adjacent channel center frequency offset below or above the sub-block edge or the RF bandwidth edge (inside the gap)	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	CACLR limit [dB]
20 MHz $\leq W_{gap} <$ 60 MHz	10 MHz	20 MHz LTE	Square (BWConfig)	34.2
40 MHz $< W_{gap} <$ 80 MHz	30 MHz	20 MHz LTE	Square (BWConfig)	34.2

Table 3-31: CACLR in non-contiguous paired spectrum (FDD) or multiple bands

NB-IoT stand-alone Procedure

Base station ACLR NB-IoT stand alone				
Channel bandwidth of LTE lowest (highest) carrier transmitted BWChannel [MHz]	BS adjacent channel center frequency offset below the lowest or the above the highest carrier center frequency transmitted	Assumed adjacent channel carrier	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit [dB]
0.2	300 kHz	Stand alone NB-IoT	Square (180 kHz)	39.2
	500 kHz	Stand alone NB-IoT	Square (180 kHz)	49.2

Table 3-32: NB-IoT ACLR

The DUT (base station) transmits at the declared maximum PRAT. N-TM is required.

1. In the NB-IoT option, start the measurement using MEAS and "Channel Power ACLR"
2. Under CP/ACLR CONFIG, set the corresponding parameters. The measurement for single carrier scenarios automatically takes data such as the bandwidth and spacing from the signal description.

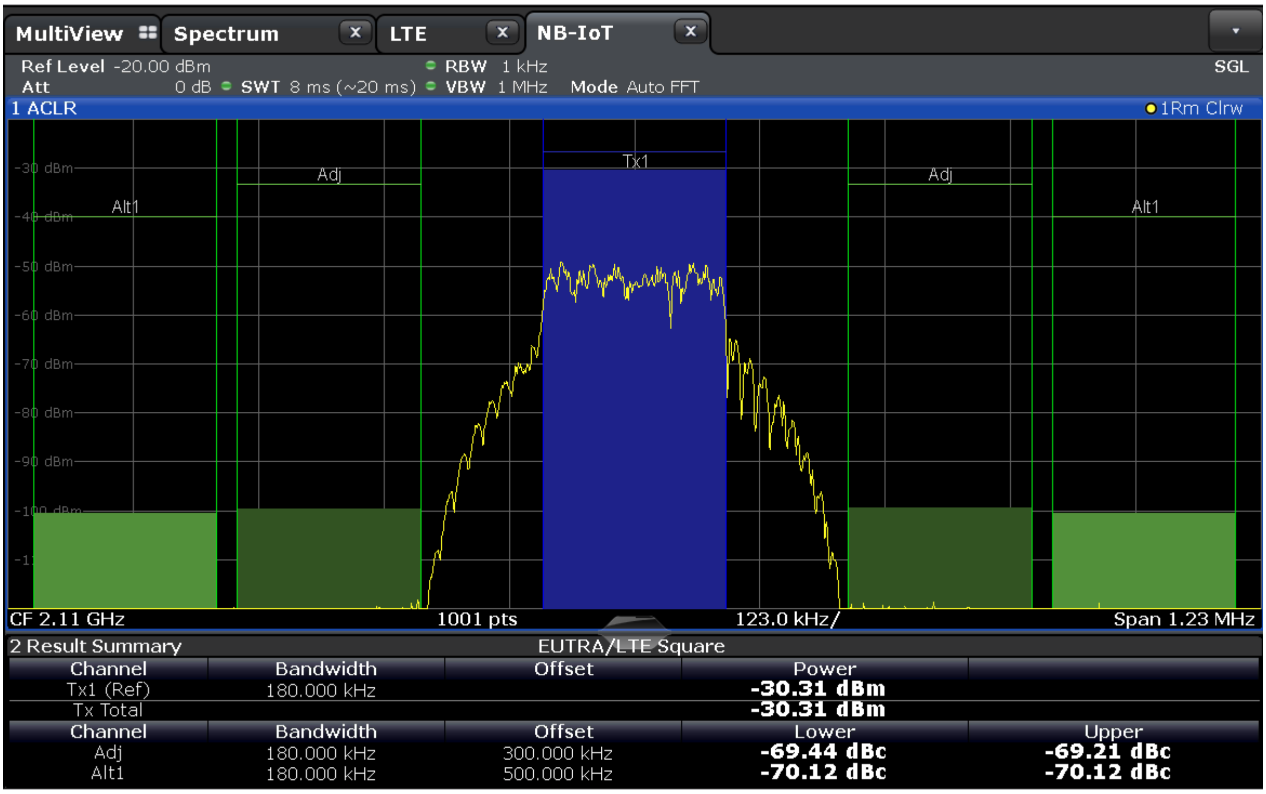


Fig. 3-111: Nb-IoT ACLR for single carrier.

NB-IoT inband and guard band Procedure

For NB-IoT inband and guard band, the signal shall be seen as combination between LTE carriers and NB-IoT carriers. The DUT (base station) transmits at the declared maximum PRAT. E-TM1.1 for the LTE part and N-TM for NB-IoT part are required.

The procedure is the same as for LTE.

Demo program

This test requires additional settings. The BS category affects the limit settings. The adjacent channel to be measured must also be specified. **Noise Cancellation** is enabled by default.

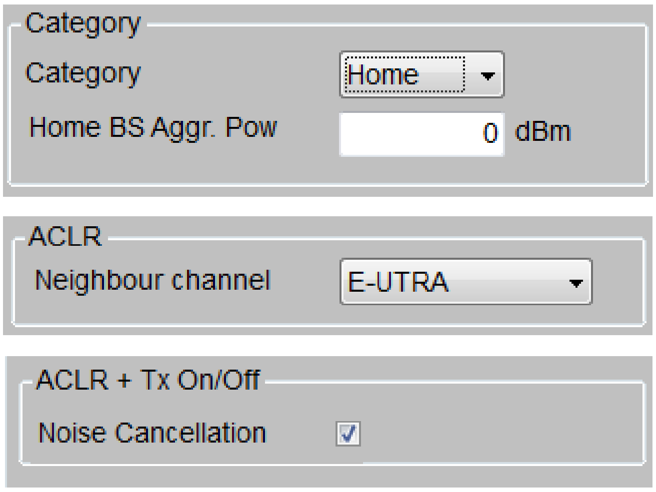


Fig. 3-112: Special settings for ACLR.

The measured power values for the individual channels are output together with a global limit check. MC tests are not supported by the PC SW.

********** 6.6.2 ACLR ***

Duplex mode: FDD
Multi carrier configuration
Carrier 0: BW 10 MHz, @ 2110 MHz
Carrier 1: BW 10 MHz, @ 2150 MHz

Power (Range)				Level (dBm)	Status
6.6.2 ACLR					
Power Tx Channel 0				-12.82	Ignored
Power Tx Channel 1				-13.12	Ignored
Power Adjacent Channel lower				-63.29	Ignored
Power Adjacent Channel higher				-63.54	Ignored
Power Alternate Channel lower				-63.74	Ignored
Power Alternate Channel higher				-64.06	Ignored
CACLR (Gap0): Lower Adjacent			-68.91	dBc	Ignored
CACLR (Gap0): Higher Adjacent			-69.12	dBc	Ignored
CACLR (Gap0): Lower Alternate			-69.43	dBc	Ignored
CACLR (Gap0): Higher Alternate			-69.39	dBc	Ignored
ACLR (Gap0): Lower Adjacent			-66.04	dBc	Ignored
ACLR (Gap0): Higher Adjacent			-65.96	dBc	Ignored
ACLR (Gap0): Lower Alternate			-66.57	dBc	Ignored
ACLR (Gap0): Higher Alternate			-66.23	dBc	Ignored
Over all	-	-	-	True	Ignored

Fig. 3-113: Example report for test case 6.6.2 with a two-carrier MC configuration and measurements inside the gap.

3.6.3 Operating Band Unwanted Emissions (SEM) (Clause 6.6.3)

The operating band unwanted emission limits are defined from 10 MHz below the lowest frequency of the downlink operating band up to 10 MHz above the highest frequency of the downlink operating band.

For a base station operating in non-contiguous spectrum, the requirements apply inside any sub-block gap. In addition, for multiband operation, the requirements apply inside any inter RF bandwidth gap.

For base station capable of multi-band operation where multiple bands are mapped on separate antenna connectors, the single-band requirements apply and the cumulative evaluation of the emission limit in the inter RF bandwidth gap are not applicable [1].

In multicarrier or intra-band contiguous or non-contiguous carrier aggregation, the test measurement is applicable below the lower edge of the lowest carrier and above the upper edge of the highest carrier in the aggregated channel bandwidth present in an operating band.

The test requirements shall apply as per categories either A or B. The minimum mandatory requirement is mentioned in subclause 6.6.3.5.1 or subclause 6.6.3.5.2 [1], whichever is applicable to the different type of base stations.

There are other optional requirements applicable regionally in subclause 6.6.3.5[2-3] [1].

Test setup

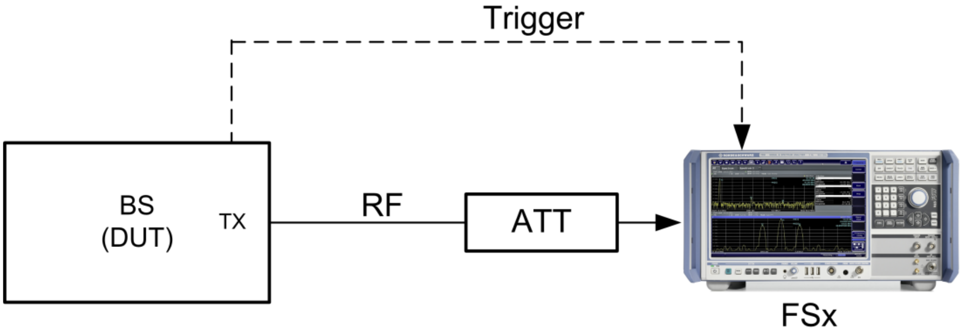


Fig. 3-114: Test setup for BS output power.

The DUT (base station) transmits with the declared maximum PRAT. E-TM1.1 and E-TM1.2 are required.

For TDD signals, the trigger must be set to external.MC is not supported at this time. It will follow later in the internal FSW.

Procedure

The test is implemented in the LTE as a spectrum emission mask (SEM).

1. Under MEAS, select "Spectrum Emission Mask" in LTE.
2. The parameters defined under Signal Description (see Fig. 3-115) cause the correct settings for the SEM test to be entered automatically. The BS category is also important in that it determines the limits.

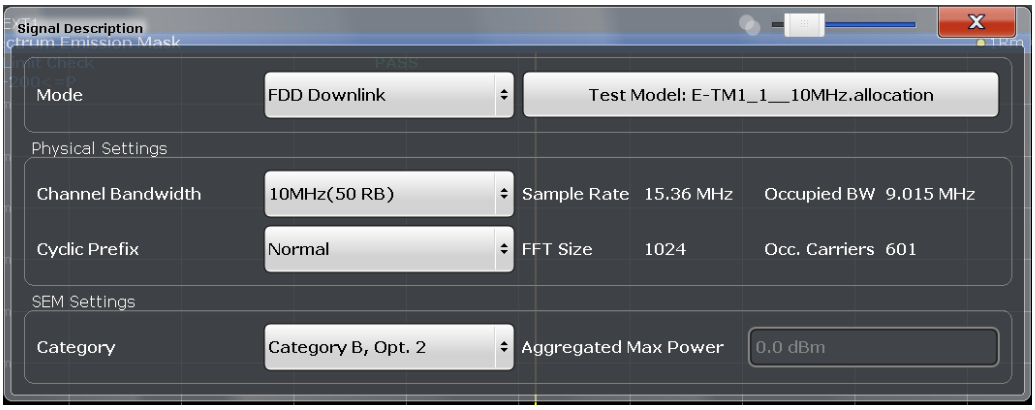


Fig. 3-115: SEM: selecting the predefined settings in LTE.

Fig. 3-116 shows a SEM test. The Result Summary displays the results of the individual ranges. The global limit check is displayed along the top.

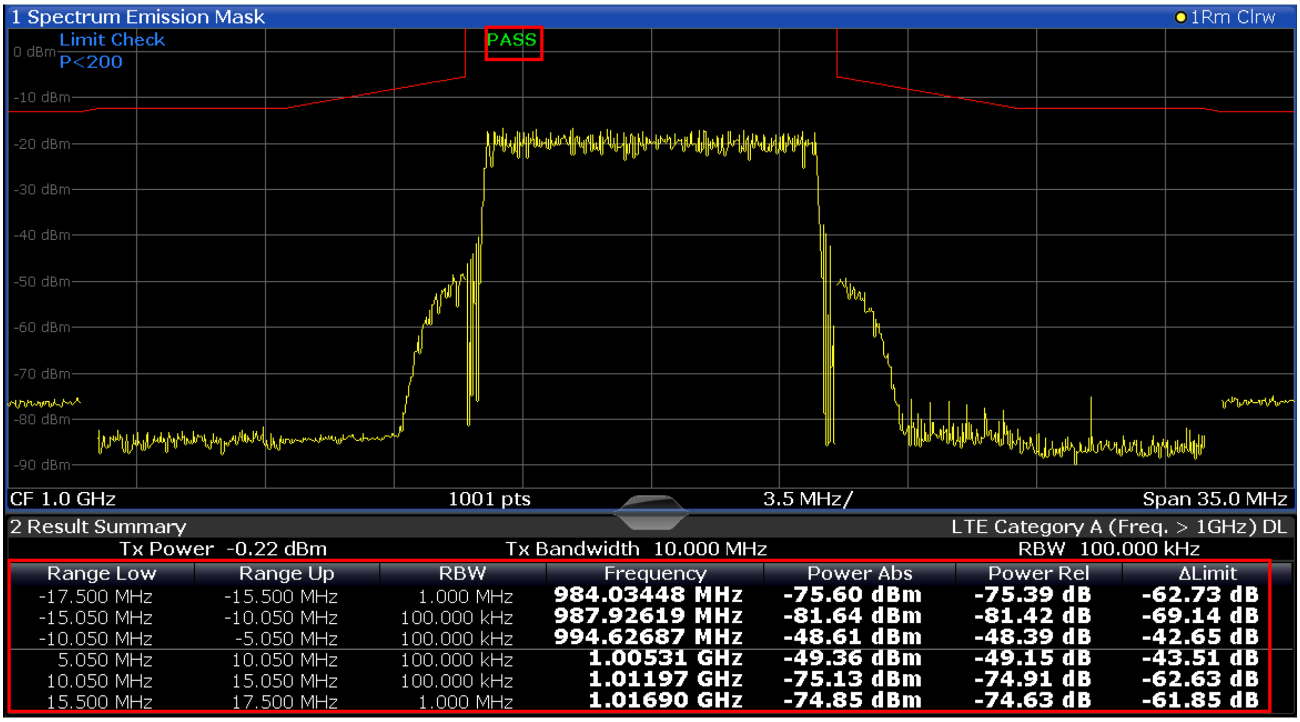


Fig. 3-116: Operating band unwanted emission (SEM).

Multi-Carrier SEM

The test is implemented in the LTE as a spectrum emission mask (SEM).

1. Under MEAS, select "Multi Carrier SEM" in LTE.
2. The parameters defined under Signal Description (see Fig. 3-117 and Fig. 3-118) cause the correct settings for the SEM test to be entered automatically. The BS category is also important in that it determines the limits.

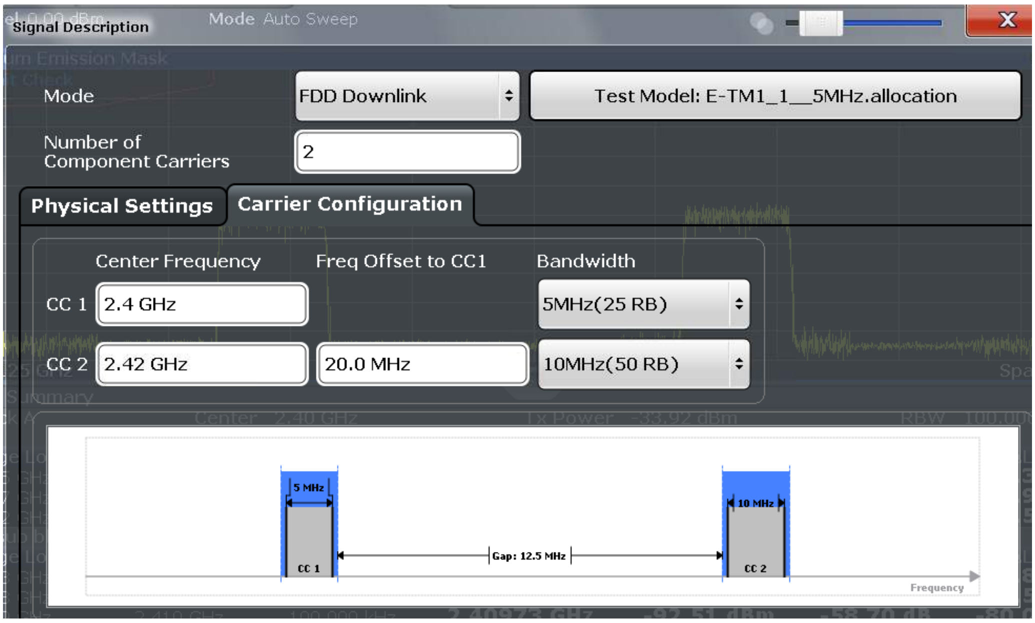


Fig. 3-117: Multi Carrier SEM: selecting the predefined settings in LTE.

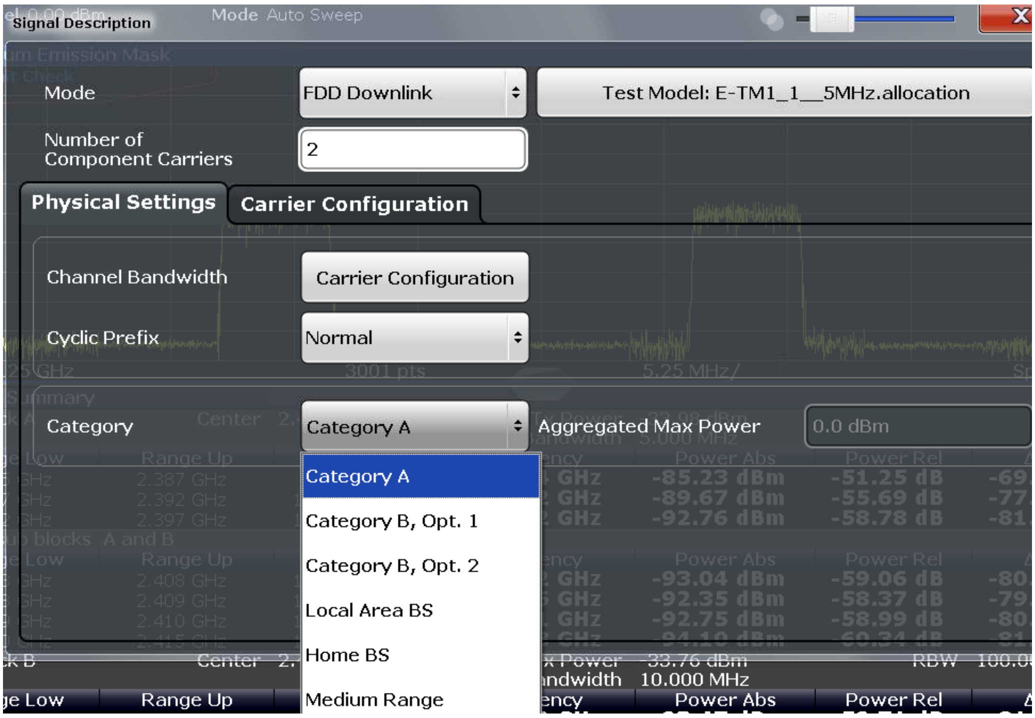


Fig. 3-118: Multi Carrier SEM: BS category.

Fig. 3-119 shows a Multi Carrier SEM test. The Result Summary displays the results of the individual ranges. The global limit check is displayed along the top.

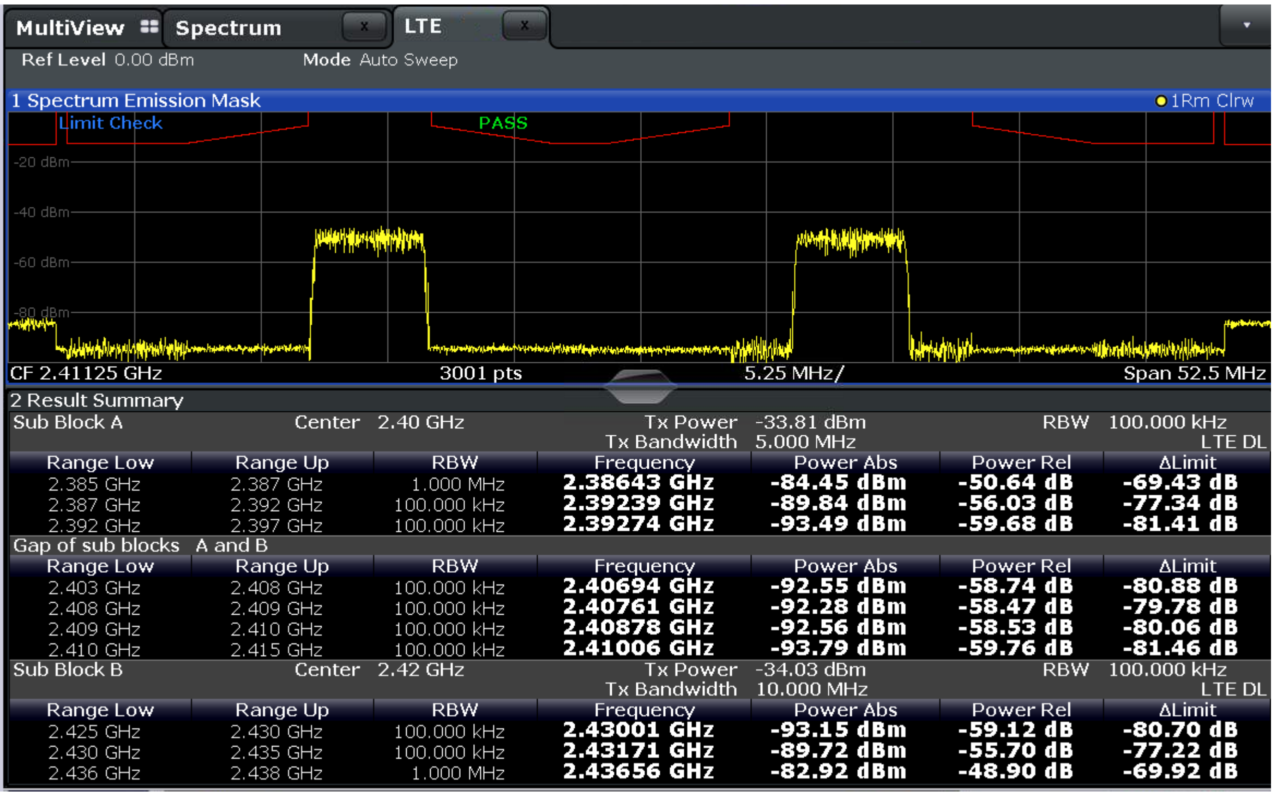


Fig. 3-119: Operating band unwanted emission (SEM).

Band 46

LTE band 46 is the unlicensed band for Licensed Assisted Access (LAA).

Please note that for band 46 different gap settings and different limits apply.

NB-IoT

The DUT (base station) transmits with the declared maximum PRAT with N-TM.

The test is implemented in the NB-IoT as a spectrum emission mask (SEM).

1. Under MEAS, select "Spectrum Emission Mask" in NB-IoT.
2. The parameters defined under Signal Description (see Fig. 3-115) cause the correct settings for the SEM test to be entered automatically.

Fig. 3-120 shows a SEM test. The Result Summary displays the results of the individual ranges. The global limit check is displayed along the top.

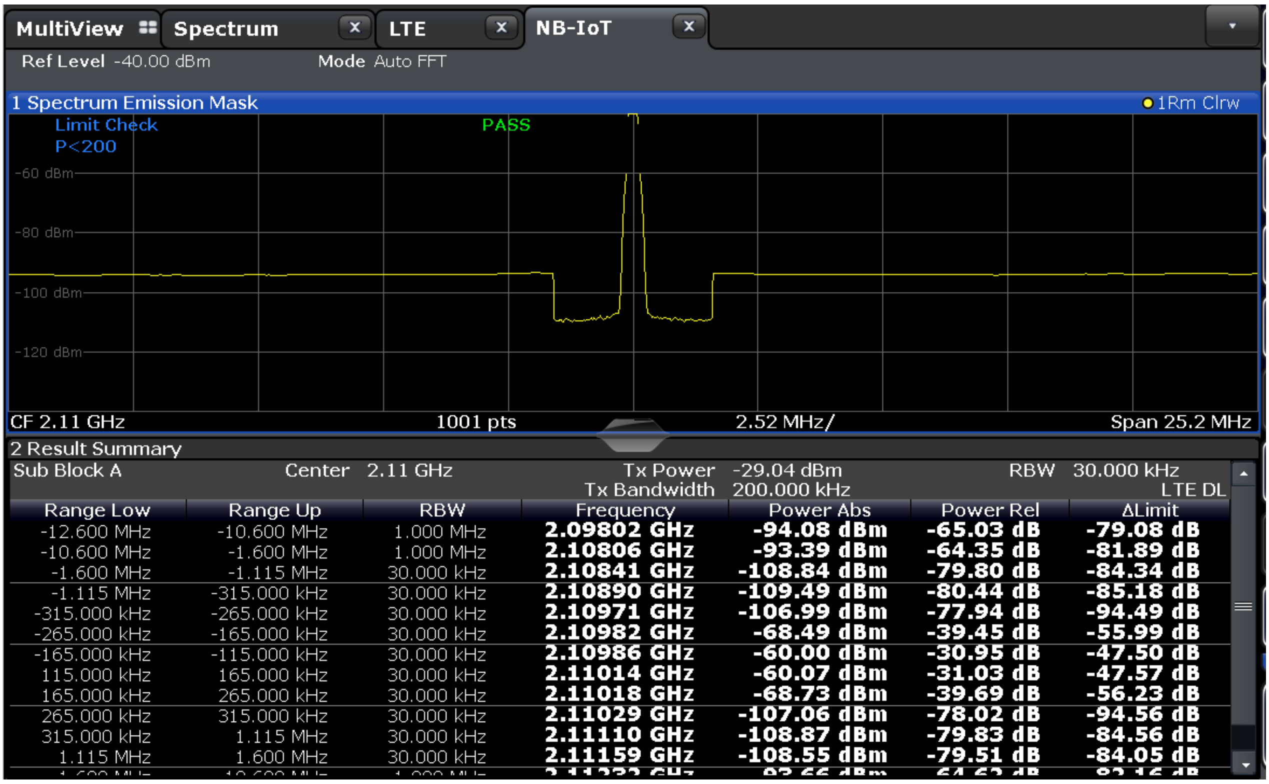


Fig. 3-120: NB-IoT Operating band unwanted emission (SEM).

For NB-IoT in-band and guard band, the signal shall be seen as a combination between LTE carriers and NB-IoT carriers. The DUT (base station) transmits at the declared maximum PRAT. E-TM1.1 for the LTE part and N-TM for NB-IoT part are required.

The procedure is the same as for LTE.

Demo program

No further special settings are needed for this test. The test is carried out as a spectrum measurement. The measured power values for the individual ranges are output together with a global limit check. MC tests are not yet supported.

********** 6.6.3 Operating Band Spurious Emissions (SEM) *************

Duplex mode: FDD

SEM (Range)	Start (MHz)	Stop (MHz)	RBW (MHz)	Level (dBm)	Status
6.6.3 Operating Band Spurious Emissions (SEM)					
Power 0	-17.5	-15.5	1.0	-81.02	Ignored
Power 1	-15.1	-10.1	0.1	-87.98	Ignored
Power 2	-10.1	-5.1	0.1	-56.91	Ignored
Power 3	5.1	10.1	0.1	-57.34	Ignored
Power 4	10.1	15.1	0.1	-88.07	Ignored
Power 5	15.5	17.5	1.0	-80.65	Ignored
Over all	-	-	-	True	Ignored

FSx: 0,"No error"

Fig. 3-121: Example report for test case 6.6.3.

3.6.4 Transmitter Spurious Emissions (Clause 6.6.4)

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 [1].

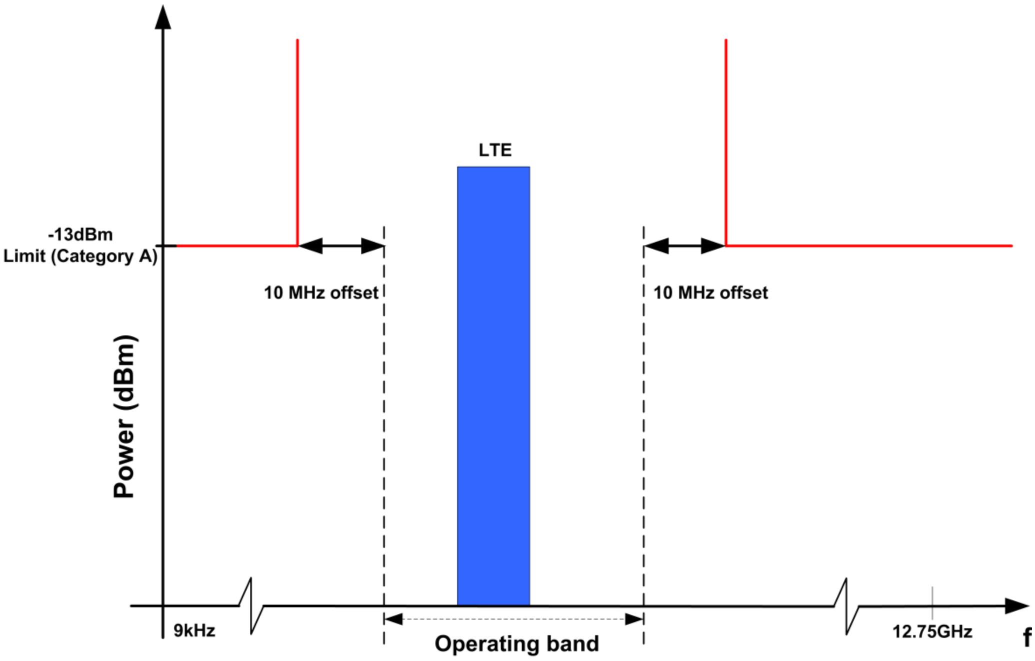


Fig. 3-122: Spurious emissions.

The transmitter spurious emission limits apply from 9 kHz to 12.75 GHz, excluding the frequency range from 10 MHz below the lowest frequency of the downlink operating band up to 10 MHz above the highest frequency of the downlink operating band. For BS capable of multi-band operation where multiple bands are mapped on the same antenna connector, this exclusion applies for each supported operating band. For BS capable of multi-band operation where multiple bands are mapped on separate antenna connectors, the single-band requirements apply and the multi-band exclusions and provisions are not applicable. For some operating bands, the upper frequency limit is higher than 12.75 GHz [1].

The test is performed for SC as well as MC and/or CA.

Spurious emissions (Category A)		
Frequency range	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 – 12.75 GHz		1 MHz
12.75 GHz – 5th harmonic of the upper frequency edge of the DL operating band in GHz. Applies only for bands 22, 42 and 43.		1 MHz Applies only for bands 22, 42 and 43.

Table 3-33: Spurious emissions requirement for Cat A

Spurious emissions (Category B)		
Frequency range	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 – 12.75 GHz	- 30 dBm	1 MHz
12.75 GHz – 5th harmonic of the upper frequency edge of the DL operating band in GHz. Applies only for bands 22, 42 and 43.	- 30 dBm	1 MHz Applies only for bands 22, 42 and 43.

Table 3-34: Spurious emissions requirement for Cat B

The following parameters additionally apply for the protection of the base station receiver:

Protection of the BS receiver			
BS	**Frequency range**	Maximum level	Measurement bandwidth
Wide Area BS	$F_{UL\_low} - F_{UL\_high}$	-96 dBm	100 kHz
Medium Range BS	$F_{UL\_low} - F_{UL\_high}$	-91 dBm	100 kHz
Local Area BS	$F_{UL\_low} - F_{UL\_high}$	-88 dBm	100 kHz
Home BS	$F_{UL\_low} - F_{UL\_high}$	-88 dBm	100 kHz

Table 3-35: BS spurious emissions limits for protection of the BS receiver

Note:

Additional limits apply for regional coexistence scenarios. These are dependent on the operating band in accordance with Tables 6.6.4.5.4-1 through 6.6.4.5.5-3 [1].

Test setup

The test requires a notch (or a diplexer) filter that suppresses the frequency range of the LTE carrier on the base station. This makes it possible to meet high dynamic requirements (e.g. DUT transmits with 24 dBm, Limit in Protection receiver test –96 dBm -> dynamic is 120 dB).

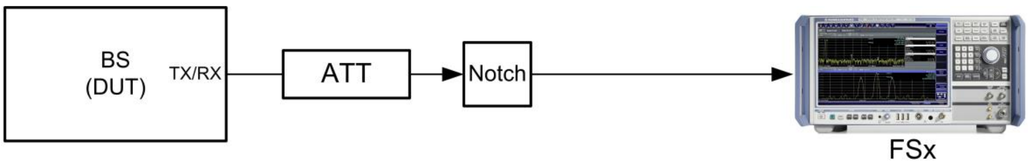
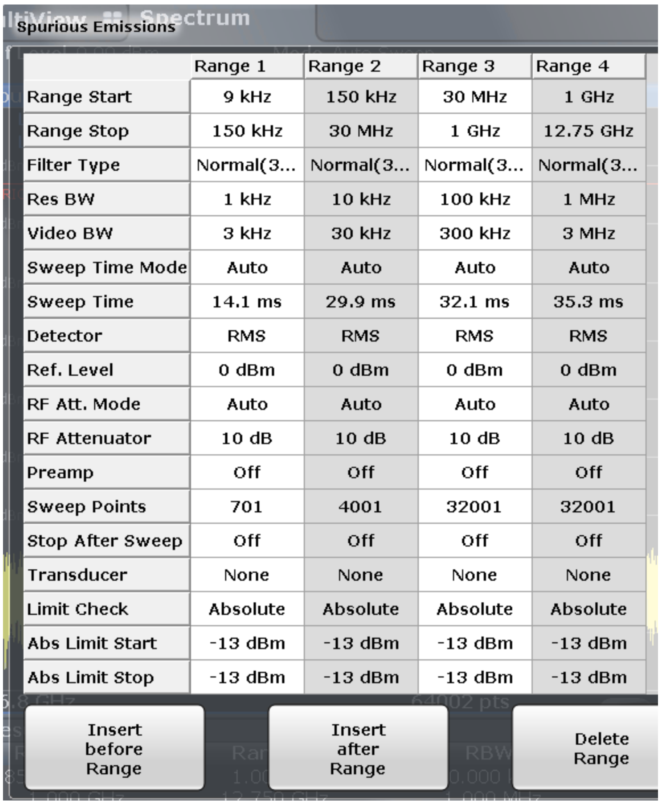


Fig. 3-123: Test setup: spurious emissions.

The DUT (base station) transmits with the declared maximum PRAT. E-TM1.1 is required.

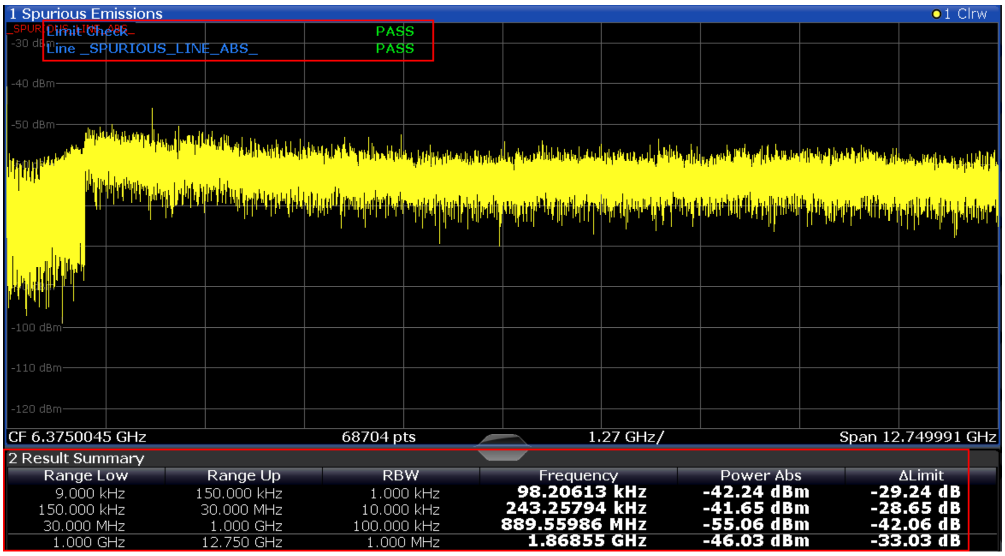
Procedure

1. In spectrum mode, select MEAS and then "Spurious Emissions".
2. Under **Sweep List** check the settings and adapt them as necessary. The predefined level values apply for Category A.
3. Press Adjust X-Axis. The settings are prefilled.



Spurious Emissions	Range 1	Range 2	Range 3	Range 4
Range Start	9 kHz	150 kHz	30 MHz	1 GHz
Range Stop	150 kHz	30 MHz	1 GHz	12.75 GHz
Filter Type	Normal(3...	Normal(3...	Normal(3...	Normal(3...
Res BW	1 kHz	10 kHz	100 kHz	1 MHz
Video BW	3 kHz	30 kHz	300 kHz	3 MHz
Sweep Time Mode	Auto	Auto	Auto	Auto
Sweep Time	14.1 ms	29.9 ms	32.1 ms	35.3 ms
Detector	RMS	RMS	RMS	RMS
Ref. Level	0 dBm	0 dBm	0 dBm	0 dBm
RF Att. Mode	Auto	Auto	Auto	Auto
RF Attenuator	10 dB	10 dB	10 dB	10 dB
Preamp	Off	Off	Off	Off
Sweep Points	701	4001	32001	32001
Stop After Sweep	Off	Off	Off	Off
Transducer	None	None	None	None
Limit Check	Absolute	Absolute	Absolute	Absolute
Abs Limit Start	-13 dBm	-13 dBm	-13 dBm	-13 dBm
Abs Limit Stop	-13 dBm	-13 dBm	-13 dBm	-13 dBm

Fig. 3-124: Spurious emissions: predefined sweep list.



Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	98.20613 kHz	-42.24 dBm	-29.24 dB
150.000 kHz	30.000 MHz	10.000 kHz	243.25794 kHz	-41.65 dBm	-28.65 dB
30.000 MHz	1.000 GHz	100.000 kHz	889.55986 MHz	-55.06 dBm	-42.06 dB
1.000 GHz	12.750 GHz	1.000 MHz	1.86855 GHz	-46.03 dBm	-33.03 dB

Fig. 3-125: Spurious emissions up to 12.75 GHz. The carrier is suppressed using filters. The results for the individual ranges are displayed at the bottom, and at the top is the limit check.

NB-IoT

The DUT (base station) transmits with the declared maximum PRAT with N-TM.

For NB-IoT inband and guard band, the signal shall be seen as combination between LTE carriers and NB-IoT carriers. The DUT (base station) transmits at the declared maximum PRAT. E-TM1.1 for the LTE part and N-TM for NB-IoT part are required.

The limits in Table 3-33 and Table 3-34 apply.

Demo program

This test requires additional settings. The BS category affects the limit settings. The test is performed in the base unit as a spectrum measurement, which means that it cannot be performed directly using the PC SW. The measured ranges and a limit check are reported.

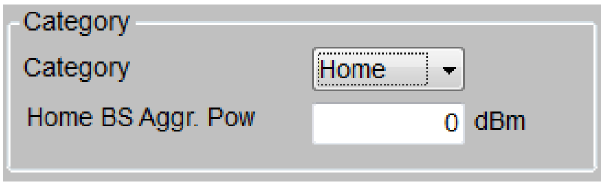


Fig. 3-126: Special settings for spurious emissions.

********** 6.6.4 Tx Spurious Emissions **************

Duplex mode: FDD

Test Item	Start (MHz)	Stop BW (MHz)	RBW (MHz)	dBm	Status
6.6.4 Tx Spurious Emissions					
Power 0	0.0	0.2	0.001	-97.26	Ignored
Power 1	0.2	30.0	0.010	-88.53	Ignored
Power 2	30.0	1000.0	0.100	-78.80	Ignored
Power 3	1000.0	12750.0	1.000	-14.81	Ignored
Over all	-	-	-	True	Ignored

FSx: 0,"No error"

Fig. 3-127: Example report for test case 6.6.4.

3.7 Transmitter Intermodulation (Clause 6.7)

The transmitter intermodulation requirement is a measure of the capability of the transmitter to inhibit the generation of signals in its nonlinear elements caused by presence of the own transmit signal and an interfering signal reaching the transmitter via the antenna. The requirement applies during the transmitter ON period and the transmitter transient period.

The transmit intermodulation level is the power of the intermodulation products when an E-UTRA signal of channel bandwidth 5 MHz as an interfering 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. The interfering signal offset is defined relative to the channel edges. [1]

The test is performed for SC as well as MC and/or CA, for both contiguous and non-contiguous spectrum operation.

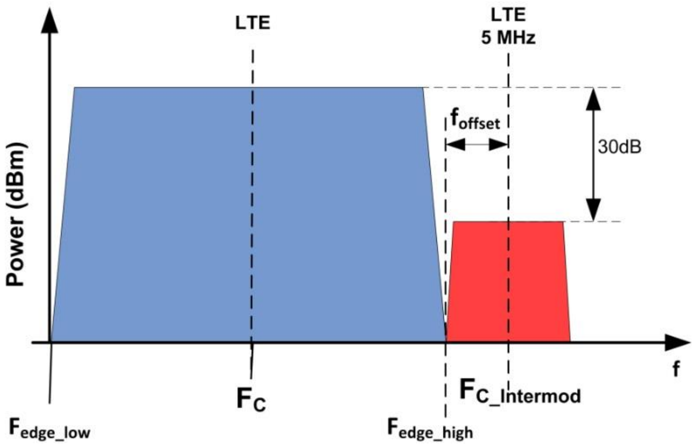


Fig. 3-128: Transmit intermodulation.

Transmit intermodulation			
Wanted signal	Interfering signal	Parameter	Frequency offset
LTE signal with maximum bandwidth with E-TM1.1	5 MHz LTE signal with E-TM1.1 - 30 dBc	Interfering signal center frequency offset from the lower (upper) edge of the wanted signal or edge of sub-block inside a sub-block gap	±2.5 MHz ±7.5 MHz ±12.5 MHz

Table 3-36: Transmit intermodulation parameters

Non-contiguous Spectrum

For a base station operating in non-contiguous spectrum, the interfering signal falls completely within the sub-block gap. The interfering signal is linked to the gap edge relative to the signal offset (see Fig. 3-129).

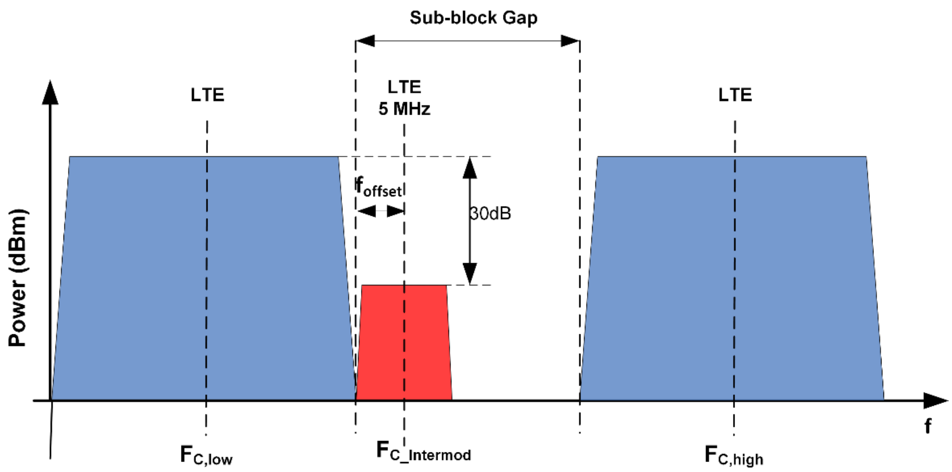


Fig. 3-129: Transmit intermodulation for non-contiguous spectrum. The interfering signal falls in the sub-block gap.

Multi-band Operation

When multiple bands are mapped on separate antenna connectors, the single-band requirements apply regardless of the interfering signals position. The interfering signals are located relative to the inter RF bandwidth gap and shall fall completely within the inter RF bandwidth gap.

Test setup

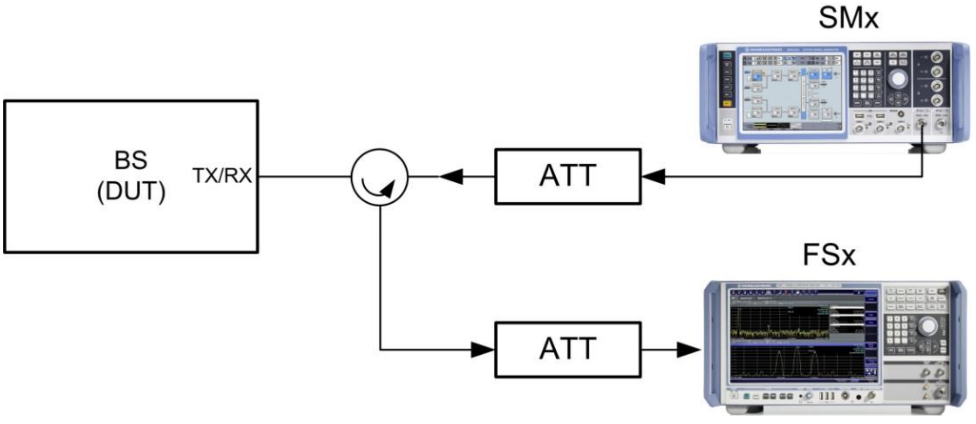


Fig. 3-130: Test setup: transmitter intermodulation.

Overview of settings:

- The DUT (base station) generates the wanted signal at F_C with $BW_{Channel}$ and E-TM1.1.
- The SMx generates a 5 MHz LTE signal with E-TM1.1 and the offsets in accordance with Table 3-36, without interfering frequencies that are outside of the allocated downlink operation band or interfering frequencies that are not completely within the sub-block gap or within the inter RF bandwidth gap.

Procedure

Use the SMx to generate a 5 MHz LTE signal with E-TM1.1 as described in Section 3.1.2. The frequency offset is entered directly under Frequency as described in Table 3-36. Set the level so that it is 30 dB under the level of the wanted signal.

The measurements shall be limited to the frequency ranges of all third and fifth order intermodulation products, considering the width of these products and excluding the channel bandwidths of the wanted and interfering signals.

The measurement regions are then calculated according to the table:

Measurement regions calculation		
Order of intermodulation products	Center frequency	Intermodulation width
3rd order	$2F_1 \pm F_2$	$2*BW_{Channel}$ + 1*5 MHz
	$2F_2 \pm F_1$	2*5 MHz + $1*BW_{Channel}$
5th order	$3F_1 \pm 2F_2$	$3*BW_{Channel}$ + 2*5 MHz
	$3F_2 \pm 2F_1$	3*5 MHz + $2*BW_{Channel}$
	$4F_1 \pm F_2$	$4*BW_{Channel}$ + 1*5 MHz
	$4F_2 \pm F_1$	4*5 MHz + $1*BW_{Channel}$
Note: F_1: Wanted signal, F_2: Interferer		

Table 3-37: Calculating the 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. 3-131). The ranges must be adjusted accordingly. In principle, the following intermodulation products (ranges) can be affected:

- $2F_1 + F_2$
- $2F_1 - F_2$
- $2F_2 + F_1$
- $2F_2 - F_1$

The settings are explained in this example:

- Wanted signal: F_1 = 2140 MHz with $BW_{Channel}$ = 20 MHz
- Interferer offset: + 2.5 MHz: F_2 = 2140 MHz + $BW_{Channel}$/2 + 2.5 MHz = 2152.5 MHz
- 3rd order
  - $2F_1 + F_2$ = 6432.5 MHz, Intermodulation BW = 45 MHz
  - $2F_1 - F_2$ = 2127.5 MHz, Intermodulation BW = 45 MHz
  - $2F_2 + F_1$ = 6445 MHz, Intermodulation BW = 30 MHz
  - $2F_2 - F_1$ = 2165 MHz, Intermodulation BW = 30 MHz

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

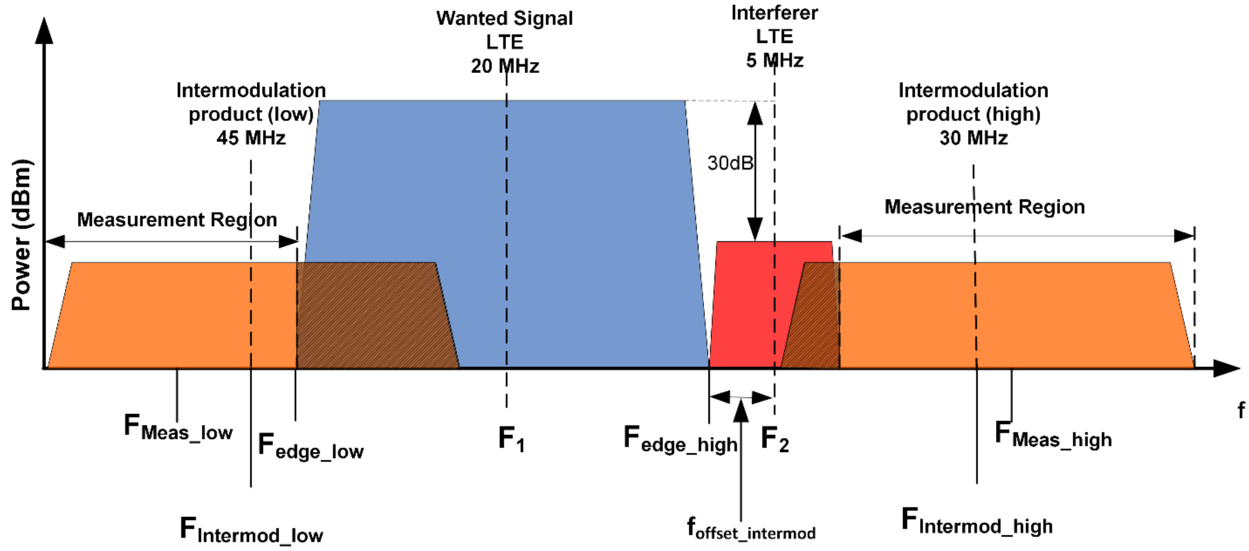


Fig. 3-131: Measurement regions for the intermodulation test. Regions that overlap with the wanted signal or the interferer must be excluded (example: with a wanted signal of 20 MHz and an offset of 2.5 MHz for the interferer).

The regions to be measured can be calculated as follows:

$BW_{Meas\_low} = F_1 – BW_{RFBW} / 2 – (F_{Intermod\_low} – BW_{Intermod\_width\_low} / 2)$

$BW_{Meas\_high} = F_{Intermod\_high} + BW_{Intermod\_width\_high} / 2 – (F_2 + BW_{Interferer} / 2)$

with the corresponding middle frequencies F_{Meas_low} and F_{Meas_high}

$F_{Meas\_low} = F_1 – BW_{Channel\_wanted} / 2 – BW_{Meas\_low} / 2$

$F_{Meas\_high} = F_2 + BW_{Channel\_Interferer} / 2 + BW_{Meas\_high} / 2$

The following regions result for the example:

BW_{Meas_low} = 2140 MHz – 2127.5 MHz – 20 MHz / 2 + 45 MHz / 2 = 25 MHz

BW_{Meas_high} = 2165 MHz – 2140 MHz – 20 MHz / 2 – 5 MHz + 30 MHz / 2 = 25 MHz

F_{Meas_low} = 2140 MHz – 10 MHz – 12.5 MHz = 2117.5 MHz

F_{Meas_high} = 2152.5 MHz + 2.5 MHz + 12.5 MHz = 2167.5 MHz

Summary Example		
Wanted Signal	F_1 = 2140 MHz	$BW_{Channel}$ = 20 MHz
Interferer (Offset: + 2.5 MHz)	F_2 = 2152.5 MHz	$BW_{nterferer}$ = 5 MHz
$F_{Intermod\_low}$	$2F_1 - F_2$ = 2127.5 MHz	$BW_{ntermod\_low}$ = 45 MHz
$F_{Intermod\_high}$	$2F_2 - F_1$ = 2165 MHz	$BW_{ntermod\_high}$ = 30 MHz
Measurement Region low	F_{Meas_low} = 2117.5 MHz	BW_{Meas_low} = 25 MHz
Measurement Region high	F_{Meas_high} = 2167.5 MHz	BW_{Meas_high} = 25 MHz

Table 3-38: Summary example for Tx intermodulation (3rd order products)

NB-IoT

For NB-IoT standalone the same rules apply, the channel bandwidth is 200 kHz.

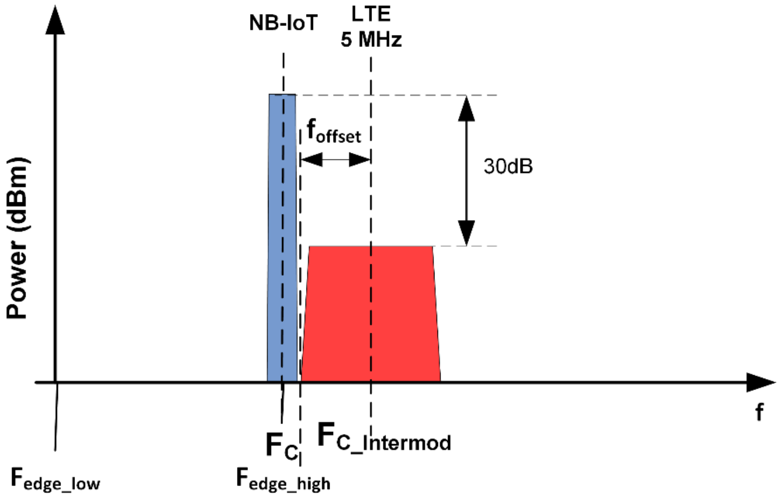


Fig. 3-132: NB-IoT Transmit Intermodulation

Measurements

The same conditions apply for these measurements as for:

- ACLR
- Operating band unwanted emissions (SEM)
- Spurious emissions

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

ACLR

The procedure for the ACLR measurement is the same as described for ACLR in Section 3.6.2, except that the measurement regions must be adapted:

1. Start the ACLR test
2. Set the bandwidth for TX1 (example: 18 MHz) and for the ADJ channel on the intermodulation bandwidth (e.g. 25 MHz)

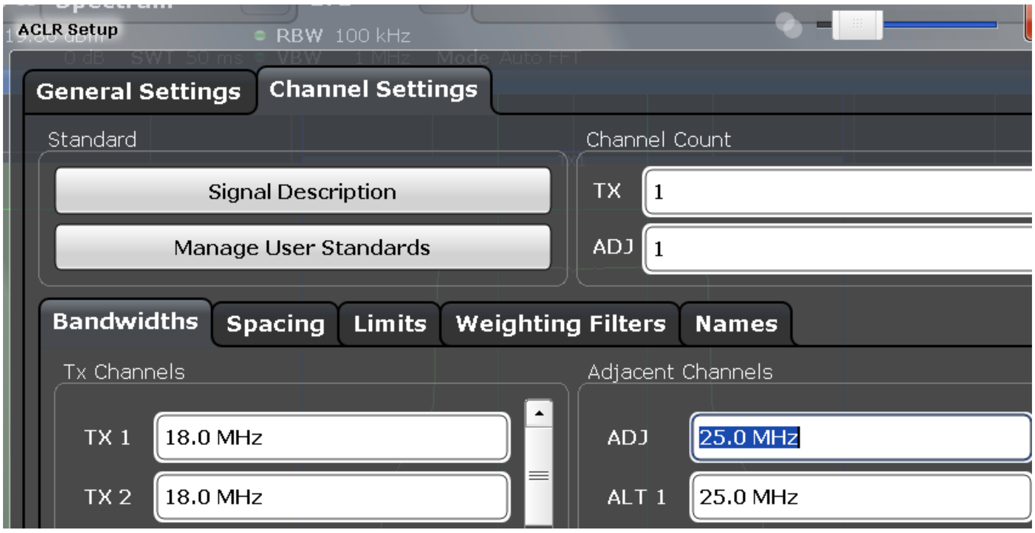


Fig. 3-133: Transmit intermodulation: Setting the bandwidths (18 MHz for the wanted signal and 25 MHz for the intermodulation bandwidth in the example).

3. Set the offset of the lower intermodulation product (e.g. $F_C - F_{C\_meas\_low}$ = 22.5 MHz).

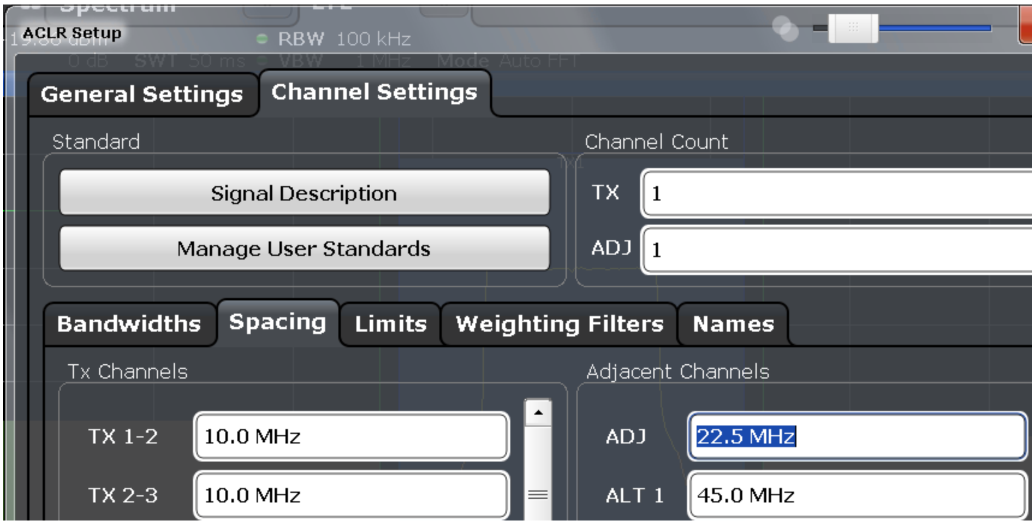


Fig. 3-134: Transmit intermodulation: set the intermodulation product spacing ($F_C - F_{C\_meas\_low}$ = 22.5 MHz in the example).

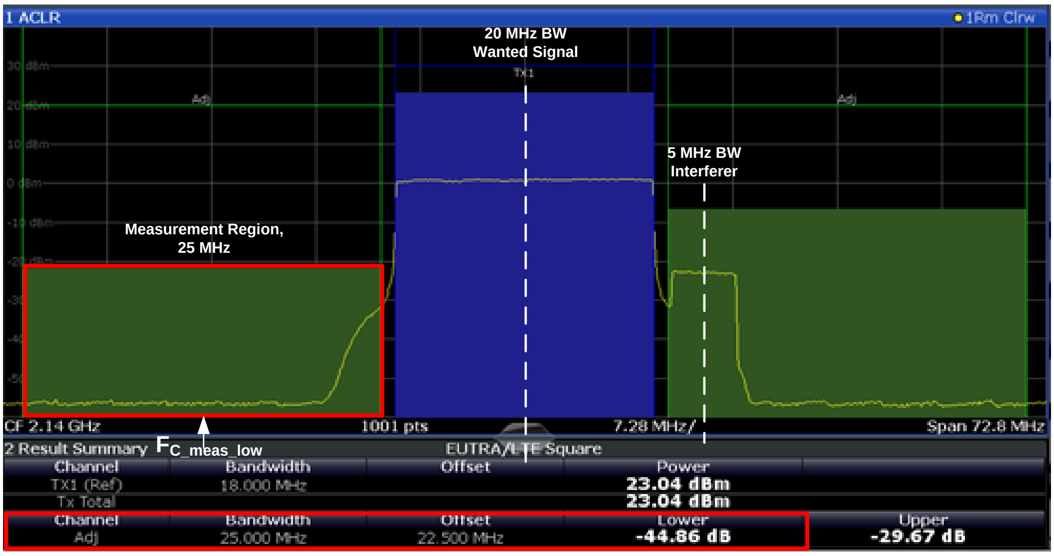


Fig. 3-135: Transmit intermodulation: measuring the lower intermodulation product.

4. Set the spacing of the upper intermodulation product (example: $F_{C\_meas\_high} - F_C = BW_{Meas\_region\_low} / 2 + BW_{Channel} / 2 + BW_{Interferer} = 27.5$ MHz).

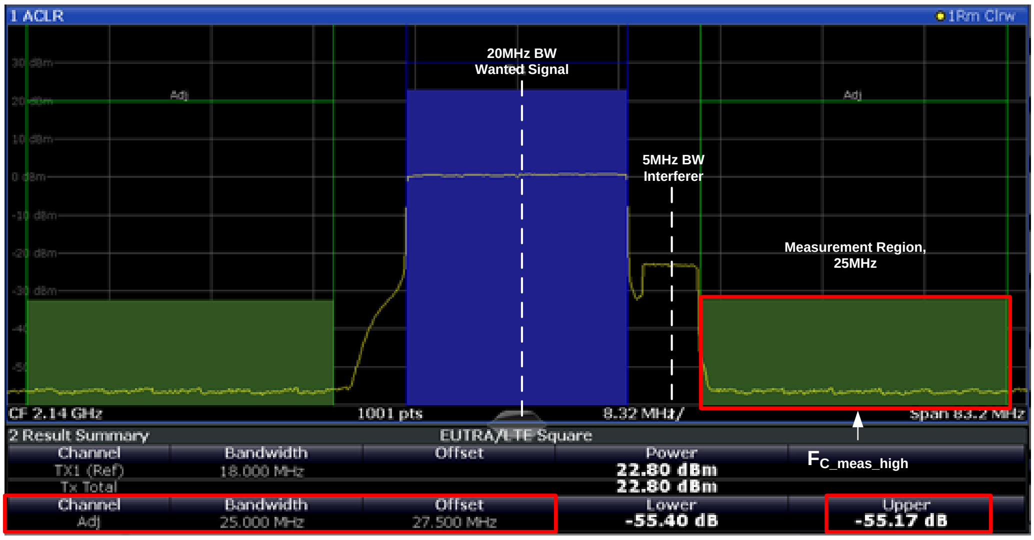


Fig. 3-136: Transmit intermodulation: Measuring the upper intermodulation product. The interferer is excluded from the test.

5. Repeat the procedure for the other tests (3rd + 5th order, each with different offsets)

Operating band unwanted emission (SEM)

The procedure for the SEM measurement is the same as described for SEM in Section 3.6.3, except that the measurement regions must be adjusted:

1. Adjust the measurement region to the intermodulation products. This is done via SPAN (example: intermodulation regions to be measured = 25 MHz on both sides, SPAN = 2 * 25 MHz + 20 MHz ($BW_{wanted\ signal}$) = 70 MHz)

2. Adjust the SWEEP times for the modified regions in the SWEEP LIST, e.g. by setting to AUTO (Fig. 3-137).


Spectrum Emission Mask

Sweep List | Reference Range | Power Classes | Standard Files

	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7
Range Start	-17.5 MHz	-15.05 MHz	-10.05 MHz	-5 MHz	5.05 MHz	10.05 MHz	15.5 MHz
Range Stop	-15.5 MHz	-10.05 MHz	-5.05 MHz	5 MHz	10.05 MHz	15.05 MHz	17.5 MHz
Fast SEM	Off	Off	Off	Off	Off	Off	Off
Filter Type	Channel	Normal(3...	Channel	Normal(3...	Channel	Normal(3...	Channel
RBW	1 MHz	100 kHz	100 kHz	100 kHz	100 kHz	100 kHz	1 MHz
VBW	3 MHz	300 kHz	300 kHz	300 kHz	300 kHz	300 kHz	3 MHz
Sweep Time Mode	Auto	Manual	Manual	Manual	Manual	Manual	Auto
Sweep Time	1 ms	10 ms	100 ms	10 ms	100 ms	10 ms	1 ms
Ref Level	0 dBm	0 dBm	0 dBm	0 dBm	0 dBm	0 dBm	0 dBm
RF Att Mode	Auto	Auto	Auto	Auto	Auto	Auto	Auto
RF Attenuation	10 dB	10 dB	10 dB	10 dB	10 dB	10 dB	10 dB
Preamp	Off	Off	Off	Off	Off	Off	Off
Transducer	None	None	None	None	None	None	None
Limit Check 1	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute
Abs Limit Start 1	-13 dBm	-12.5 dBm	-12.5 dBm	300 dBm	-5.5 dBm	-12.5 dBm	-13 dBm
Abs Limit Stop 1	-13 dBm	-12.5 dBm	-5.5 dBm	300 dBm	-12.5 dBm	-12.5 dBm	-13 dBm

Fig. 3-137: Setting the sweep time.

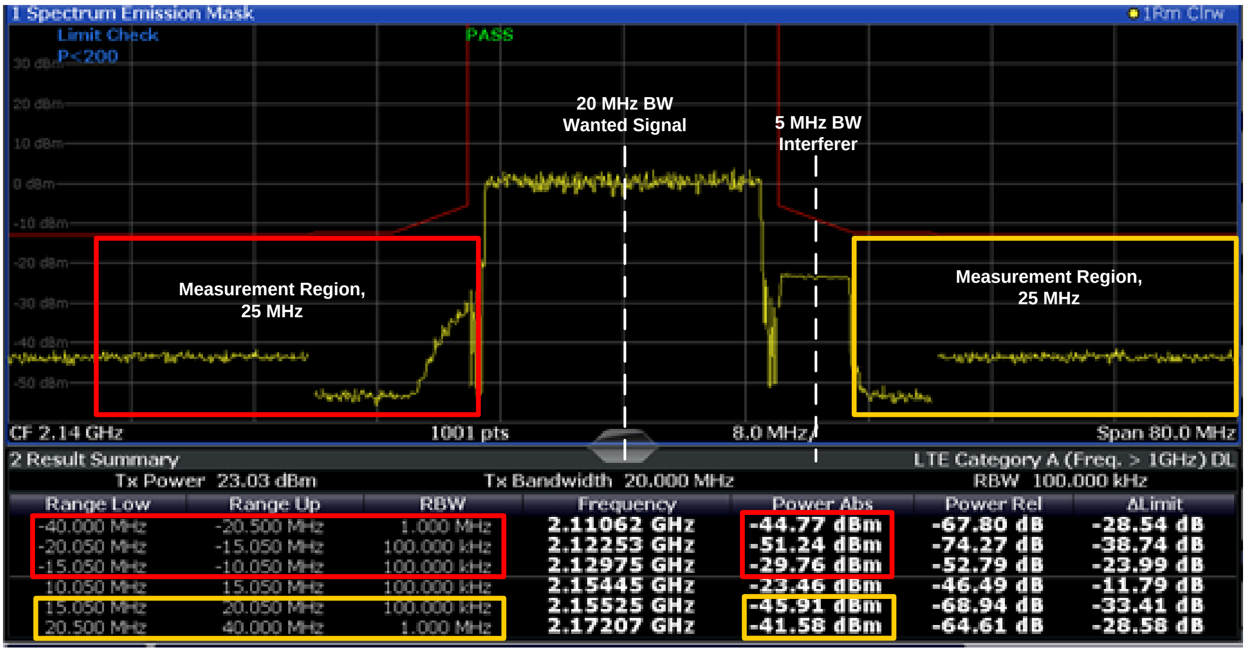


Fig. 3-138: Transmit intermodulation: adjusted SEM test.

Spurious emissions

The procedure for the spurious emissions test is the same as described for Spurious Emissions in Section 3.6.4.

Demo program

This test requires additional settings. The BS category affects the limit settings. The offset must be selected under Intermodulation. The test is a combination of ACLR, SEM and Spurious Emission. The measured regions are reported. The level of the intermodulation signal is set at 30 dB under the reference level.

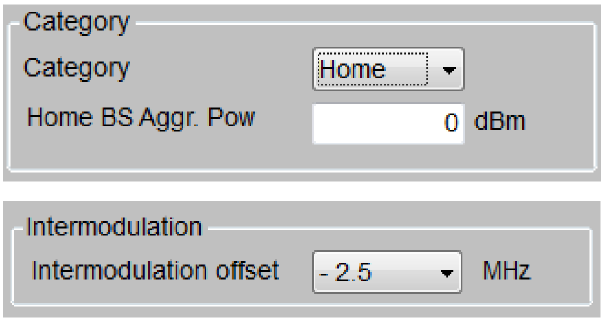


Fig. 3-139: Special settings for transmitter intermodulation.

********* 6.7 Transmitter Intermodulation ************

Duplex mode: FDD

Power (Range)	Meas Freq (MHz)	Channel BW (MHz)		Level (dBm)	Status
6.7 TX Intermodulation ACLR @ 2f1 - f2					
Power Tx Channel				-77.14	Ignored
Power Meas Range higher	2122.5	15.00		-74.94	Ignored

Power (Range)	Meas Freq (MHz)	Channel BW (MHz)		Level (dBm)	Status
6.7 TX Intermodulation ACLR @ 2f2 - f1					
Power Tx Channel				-77.08	Ignored
Power Meas Range lower	2092.5	15.00		-74.88	Ignored

Power (Range)	Meas Freq (MHz)	Channel BW (MHz)		Level (dBm)	Status
6.7 TX Intermodulation ACLR @ 3f1 - 2f2					
Power Tx Channel				-77.08	Ignored
Power Meas Range higher	2130	30.00		-72.00	Ignored

Power (Range)	Meas Freq (MHz)	Channel BW (MHz)		Level (dBm)	Status
6.7 TX Intermodulation ACLR @ 3f2 - 2f1					
Power Tx Channel				-77.10	Ignored
Power Meas Range lower	2085	30.00		-71.96	Ignored

SEM (Range)	Start (MHz)	Stop (MHz)	RBW (MHz)	Level (dBm)	Status
6.7 TX Intermodulation SEM					
Power 0	-50.0	-15.5	1.0	-80.37	Ignored
Power 1	-15.1	-10.1	0.1	-87.36	Ignored
Power 2	-10.1	-5.1	0.1	-92.66	Ignored
Power 3	5.1	10.1	0.1	-92.50	Ignored
Power 4	10.1	15.1	0.1	-86.98	Ignored
Power 5	15.5	50.0	1.0	-80.61	Ignored
Over all	-	-	-	True	Ignored

FSx: 0,"No error"

Test Item	Start (MHz)	Stop (MHz)	Test Model	MHz	Status
6.7 Tx Intermodulation Spurious Emissions					
Power 0	0.0	0.2	0.001	-99.68	Ignored
Power 1	0.2	30.0	0.010	-92.97	Ignored
Power 2	30.0	1000.0	0.100	-80.45	Ignored
Power 3	1000.0	12750.0	1.000	-72.51	Ignored
Over all	-	-	-	True	Ignored

FSx: 0,"No error"

Fig. 3-140: Example report for test case 6.7. The measurement is taken on the intermodulation products.

4 Appendix

4.1 R&S TSrun Program

The TSrun 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 / Windows 10
- .NET framework V4.0 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 TSrun is launched, the following splash screen appears:

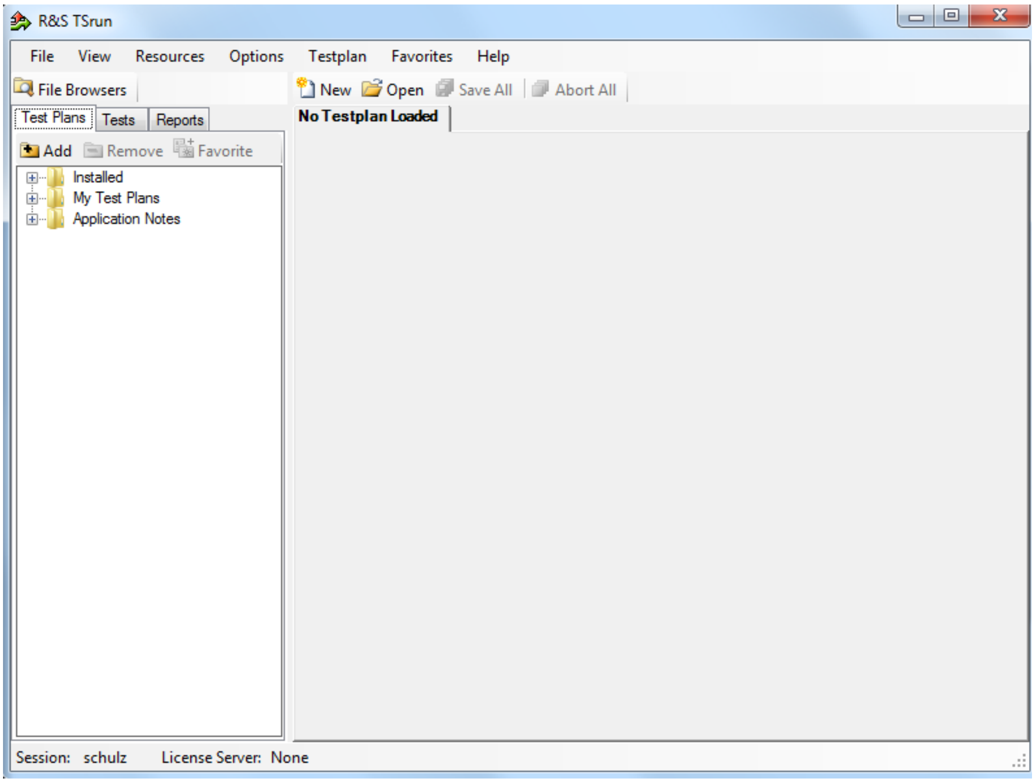


Fig. 4-1: Overview TSrun

Tests and test plans

Tests are separate, closed modules for TSrun. A test plan can consist of one or more tests.

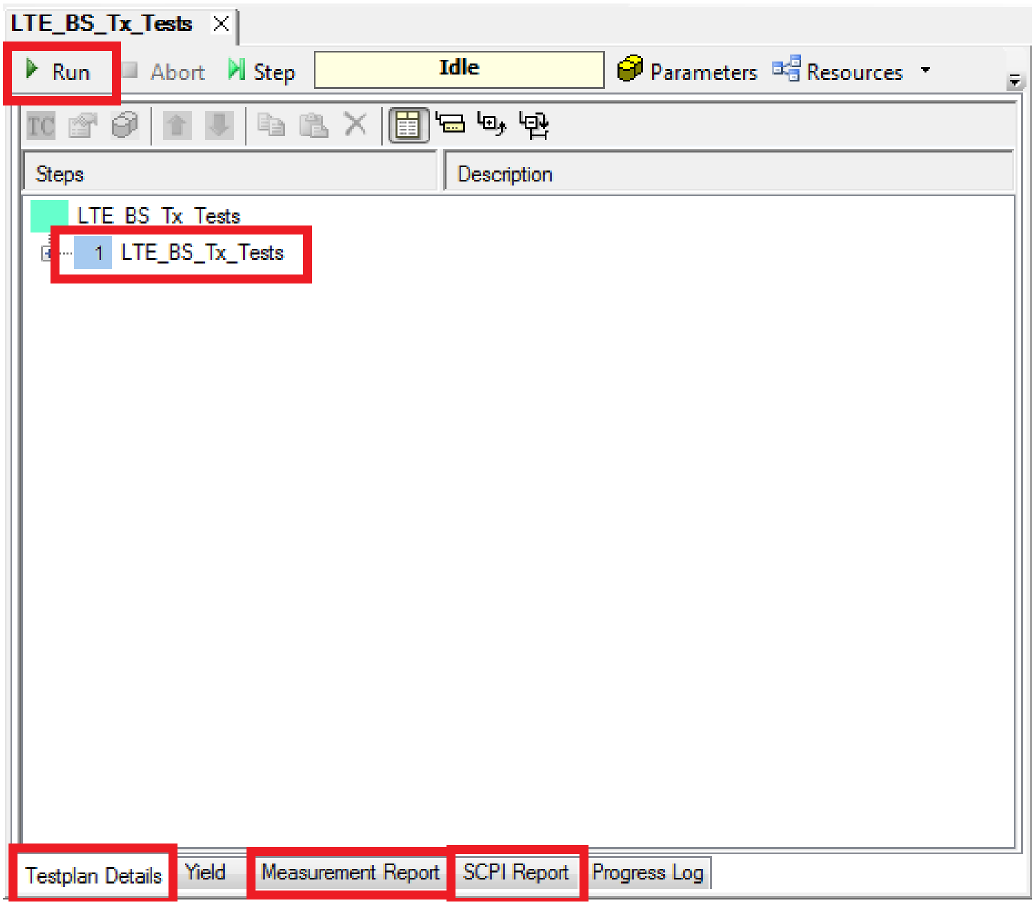


Fig. 4-2: Overview of a test plan in TSrun. The test plan in the example contains only one test (LTE_BS_Tx_Tests). After the test is completed, the bar along the bottom can be used to display the measurement and SCPI reports.

The LTE 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.

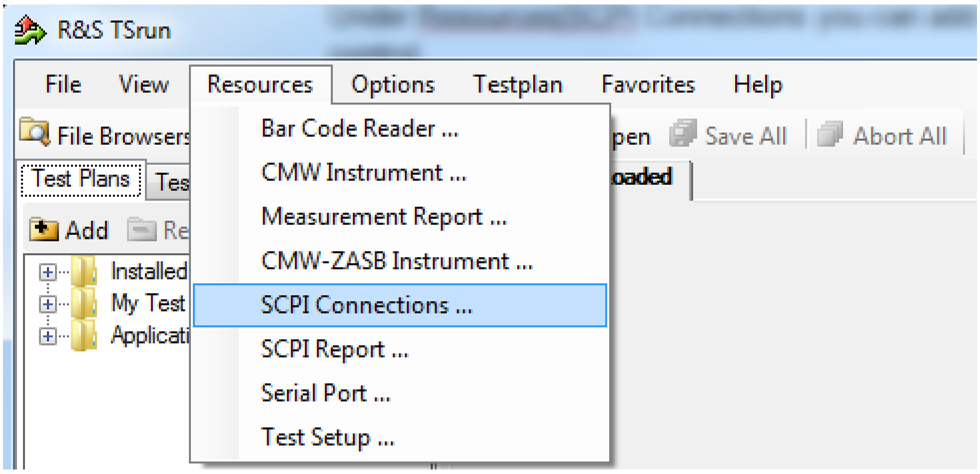


Fig. 4-3: Setting the SCPI connections.

Use **Configure…** to open a wizard for entering the VISA parameters (Fig. 4-5). Enter "localhost" for the external PC SW. 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 TSrun will run in demo mode and output a fictitious test report.

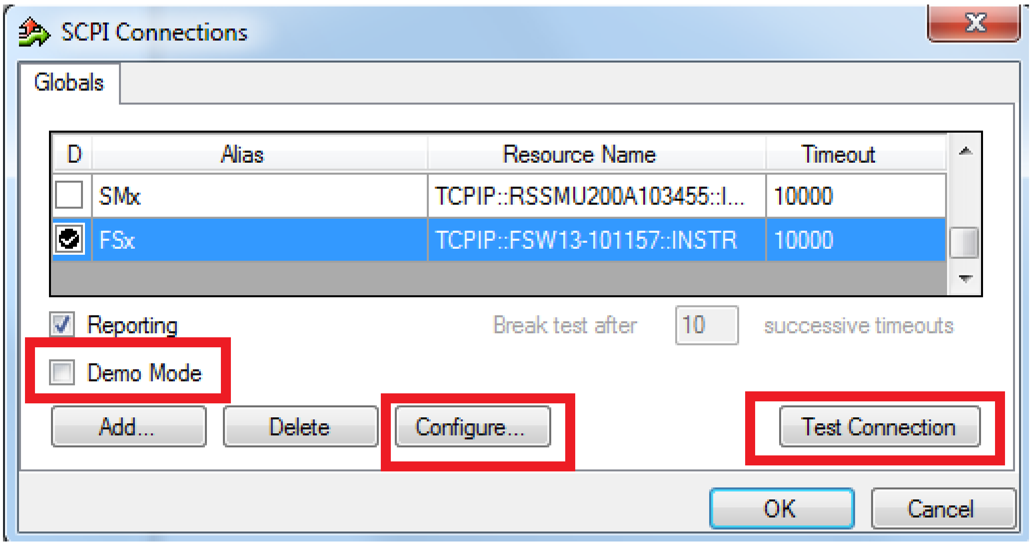


Fig. 4-4: SCPI connections.

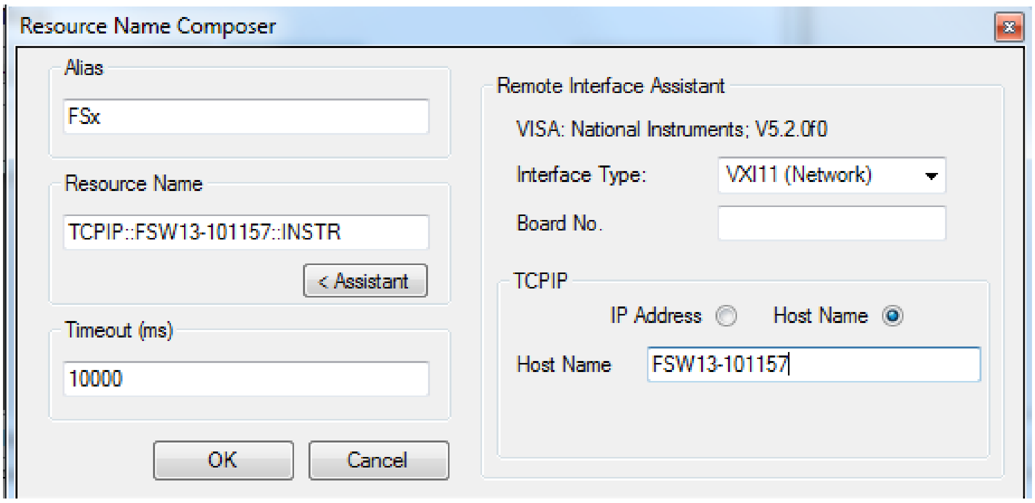


Fig. 4-5: Wizard for entering VISA parameters. Both the IP address and a host name can be entered directly.

Reports: Measurement and SCPI

After the test is completed, TSrun automatically generates both a measurement 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.

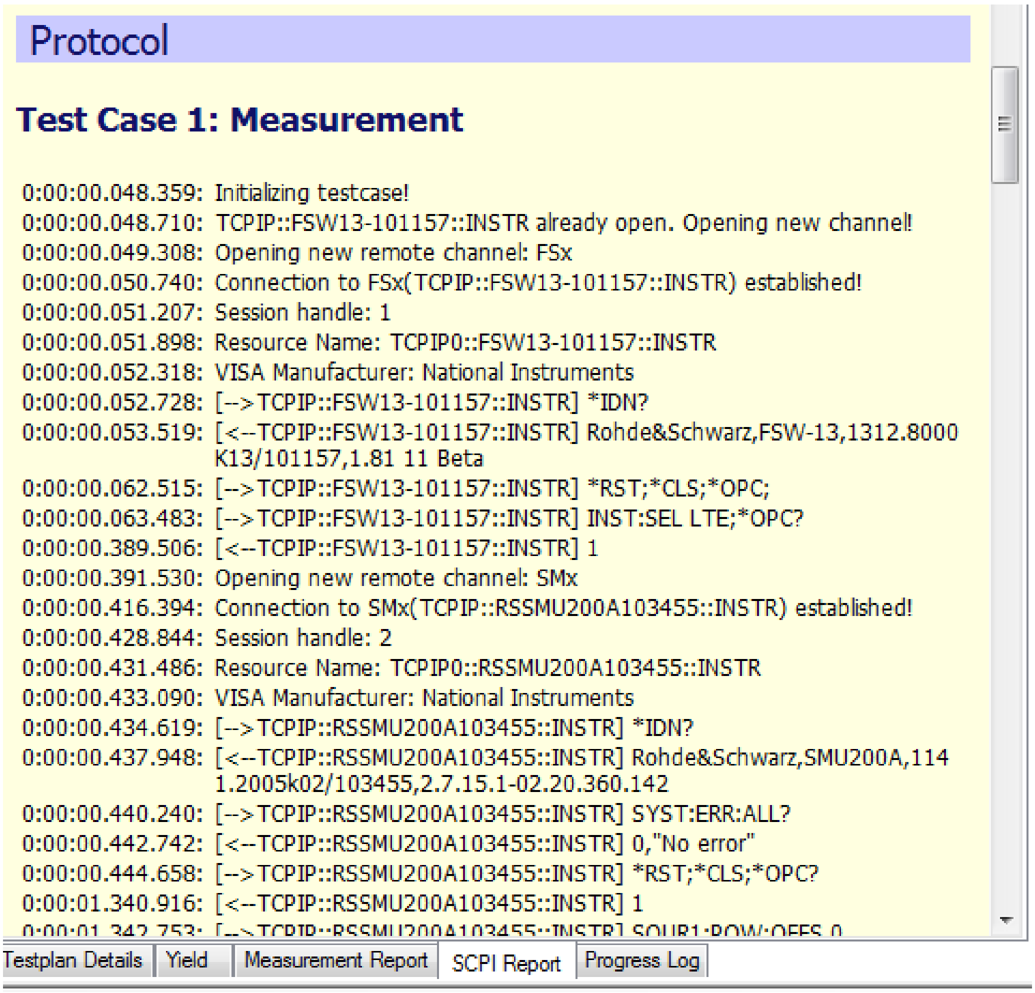


Fig. 4-6: SCPI report.

4.2 References

[1] Technical Specification Group Radio Access Network**; E-UTRA Base station conformance testing**, **Release 14; 3GPP TS 36.141,** V 14.9.0, March 2019

[2] Rohde & Schwarz: **UMTS Long Term Evolution (LTE) Technology Introduction,** Application Note 1MA111, October 2012

[3] Rohde & Schwarz: **LTE-A Base Station Receiver Tests according to TS 36.141 Rel. 14,** Application Note 1MA195, May 2019

[4] Rohde & Schwarz: **LTE-A Base Station Performance Tests according to TS 36.141 Rel. 14,** Application Note 1MA162, May 2019

[5] Technical Specification Group Radio Access Network**; E-UTRA, UTRA and GSM/EDGE; Multistandard Radio (MSR) Base Station (BS) conformance testing**, **Release 10; 3GPP TS 37.141,** V 10.10.0, July 2013

[6] Rohde & Schwarz: **Measuring Multistandard Radio Base Stations according to TS 37.141,** Application Note 1MA198, July 2012

[7] Rohde & Schwarz: **LTE-Advanced (3GPP Rel.11) Technology Introduction,** White Paper 1MA232, July 2013

[8] Rohde & Schwarz: **LTE-Advanced (3GPP Rel.12) Technology Introduction,** White Paper 1MA252, June 2014

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 analyzers		
Signal and spectrum analyzers		
Up to 8, 13, 26, 43, 67 or 85 GHz	**FSW**	**1312.8000Kxx**
E-UTRA/LTE FDD Downlink	FSW-K100	1313.1545.02
E-UTRA/LTE DL/MIMO Measurements (Requires FSW-K100 and/or FSW-K104)	FSW-K102	1313.1568.02
E-UTRA/LTE TDD Downlink	FSW-K104	1313.1574.02
EUTRA/LTE NB-IoT Downlink Measurements	FSW-K106	1331.6351.02
Up to 3, 7, 13, 30, or 40 GHz	**FSV**	**1307.9002Kxx**
Up to 4, 7, 13, 30, or 40 GHz	**FSVA**	**1321.3008.xx**
E-UTRA/LTE FDD-Downlink	FSV-K100	1310.9051.02
E-UTRA/LTE DL/MIMO Measurements (Requires FSV-K100)	FSV-K102	1310.9151.02
E-UTRA/LTE TDD Downlink	FSV-K104	1309.9774.02

Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, radiomonitoring and radiolocation. Founded more than 80 years ago, this independent company has an extensive sales and service network and is present in more than 70 countries.

The electronics group is among the world market leaders in its established business fields. The company is headquartered in Munich, Germany. It also has regional headquarters in Singapore and Columbia, Maryland, USA, to manage its operations in these regions.

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Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management ISO 9001

Certified Environmental Management ISO 14001