LTE-A Base Station Receiver Tests
According to TS36.141 Rel. 14

Application Note

Products:

- R&S®SMW200A
- R&S®FSW
- R&S®FSV
- R&S®FSVA
- R&S®FPS
- R&S®SMF100A
- R&S®SMB100A
- R&S®SGS100A
- R&S®SGT100A

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

This application note describes how all required receiver (Rx) tests (TS36.141 Chapter 7) can be performed quickly and easily by using vector signal generators from Rohde & Schwarz. A few tests additionally require spectrum analyzers from Rohde & Schwarz.

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

The LTE base station transmitter (Tx) tests (TS36.141 Chapter 6) are described in Application Note 1MA154.

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

Application Note

Bernhard Schulz

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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®SMF100A signal generator is referred to as the SMF.
- The R&S®SMB100A signal generator is referred to as the SMB.
- The R&S®SGS100A signal generator is referred to as the SGS.
- The R&S®SGT100A signal generator is referred to as the SGT.
- 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 FSV, FSVA, FPS and FSW 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/1MA195

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 and 9) have long since been introduced into daily usage. As a next step, 3GPP has added several extensions in Release 12, known as LTE-Advanced (LTE-A). These include a contiguous and non-contiguous multicarrier and/or carrier aggregation (CA) option and 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 and enhanced Machine Type Communication (eMTC). Release 14 enables LTE support for V2x services, eLAA, 4 band Carrier Aggregation and inter-band Aggregation.

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 14 [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 receiver (Rx) tests in line with TS36.141 Chapter 7. It explains the necessary steps in manual operation for vector signal generators and spectrum analyzers. 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 transmitter (Tx) tests (TS36.141 Chapter 6) are described in Application Note 1MA154 and the performance (Px) tests (TS36.141 Chapter 8) are covered in Application Note 1MA162.

Abbrevations 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: Naming of standards

Table 1-2 gives an overview of the receiver tests defined in line with Chapter 7 of TS36.141. All can be carried out using instruments from Rohde & Schwarz. These tests are individually described in this application note.

Receiver Characteristics (Chapter 7)	
Chapter (TS36.141)	**Test**
7.2	Reference Sensitivity Level
7.3	Dynamic Range
7.4	In-channel Selectivity
7.5	Adjacent Channel Selectivity (ACS) and Narrow-band Blocking
7.6	Blocking
7.7	Receiver Spurious Emissions
7.8	Receiver Intermodulation

Table 1-2: Covered 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 Receiver Tests

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 only 180 kHz. 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.

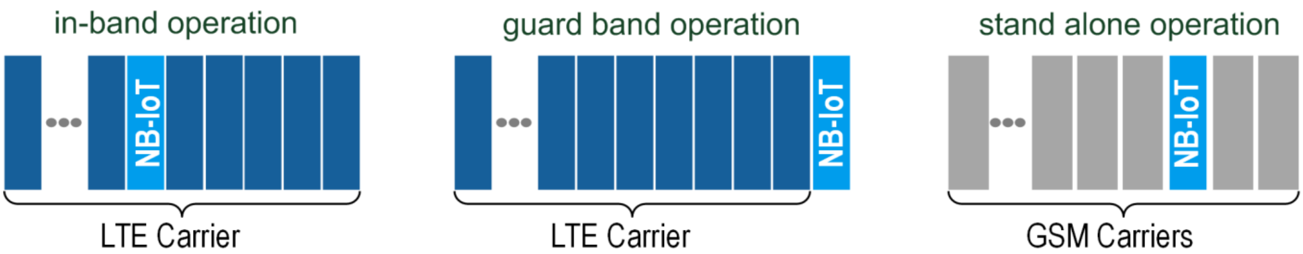


Fig. 2-1: The three NB-IoT modes of operation. (NB-IoT operates independently in standalone mode (right). The GSM channels are shown only to illustrate coexistence.)

2.3 Multi-Carrier 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). A 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).

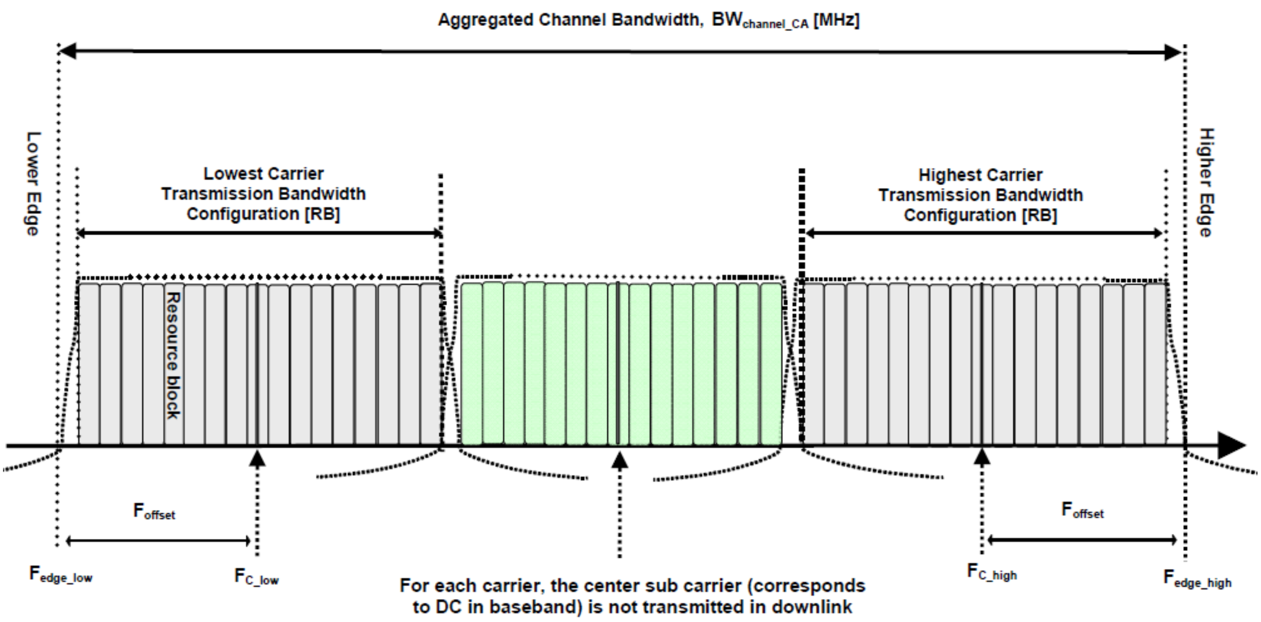


Fig. 2-2: Definition for intra-band contiguous aggregation [1].

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).

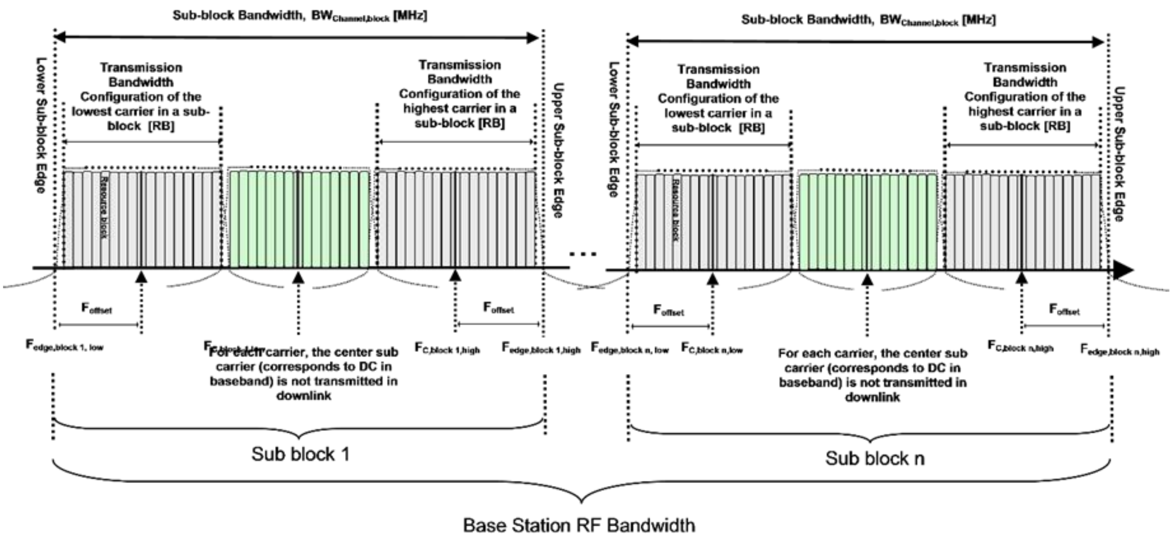


Fig. 2-4: Definition of intra-band non-contiguous carrier aggregation [1].

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 Configurations 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 receiver tests easy and comparable, the ETC1 test configuration in TS36.141 Chapter 4.10 [1] defines multicarrier test scenarios. All Rx tests 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.
- 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 5 MHz carrier is placed at the upper edge at an offset of 2.5 MHz (Fig. 2-5).

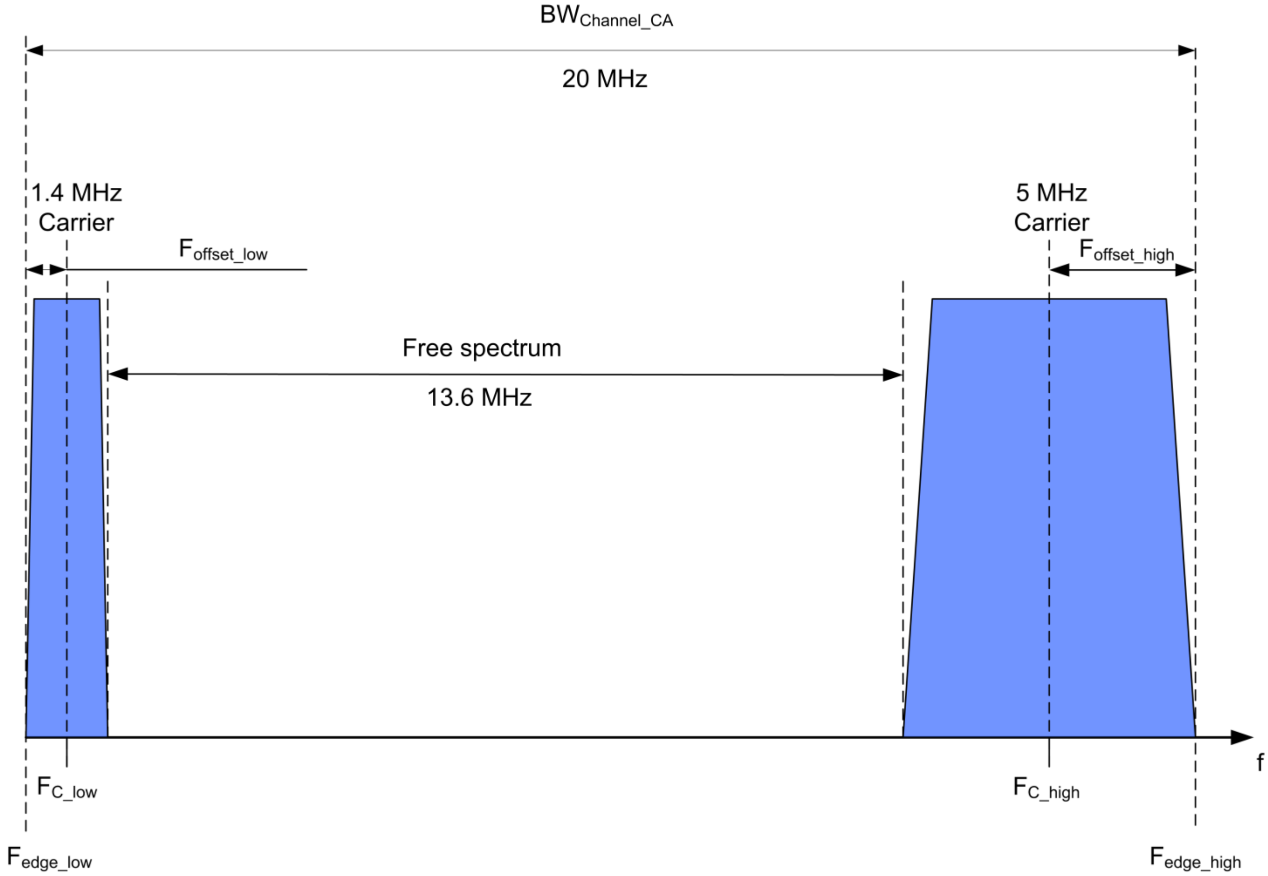


Fig. 2-5: Example MC scenario. $BW_{Channel\_CA}$ is 20 MHz. One 1.4 MHz carrier and one 5 MHz carrier are placed at the edges of the 20 MHz bandwidth.

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 Rx 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.

- For single-band operation: If the remaining gap is at least 15 MHz plus two times the channel bandwidth and the base station supports at least 4 carriers, place a carrier of the same bandwidth adjacent to each already placed carrier for each sub-block. For CA, 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. 2-6: For CA, possible offset between two carriers.

- 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 ($BW_{Channel\_RF}$) = 40 MHz
- Place four 5 MHz carriers, as for two carriers Gap > 15 MHz + 2*$BW_{Channel}$

3. One 5 MHz carrier is placed at the upper edge. The offset is defined according to Table 2-2. F_{offset} = 2.5 MHz.
4. Another 5 MHz carrier is placed at the lower edge at an offset of 2.5 MHz.
5. For CA, the third and fourth 5 MHz carrier are located adjacent to the lower and upper carrier with a nominal channel spacing of 4.8 MHz each, according to Fig. 2-6.
6. Sub-block 1 and 2 consist of two carriers each, with a sub-block gap of 20.4 MHz in between (Fig. 2-7).

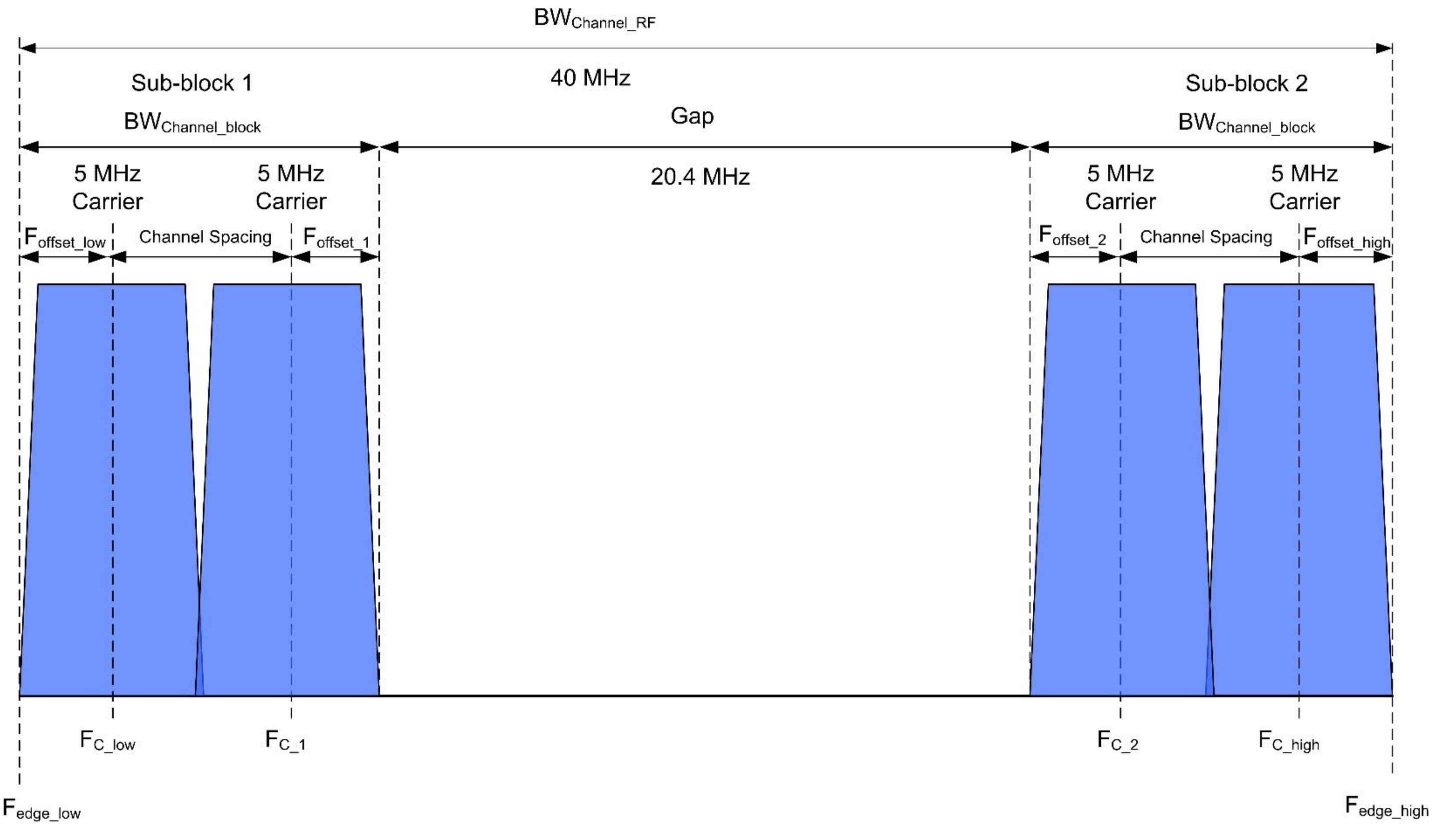


Fig. 2-7: Example for non-contiguous spectrum operation. $BW_{Channel\_RF}$ is 40 MHz. Four 5 MHz carriers are located in the 40 MHz bandwidth with one sub-block gap of 20.4 MHz in between.

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 Rx 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 (ETC1).

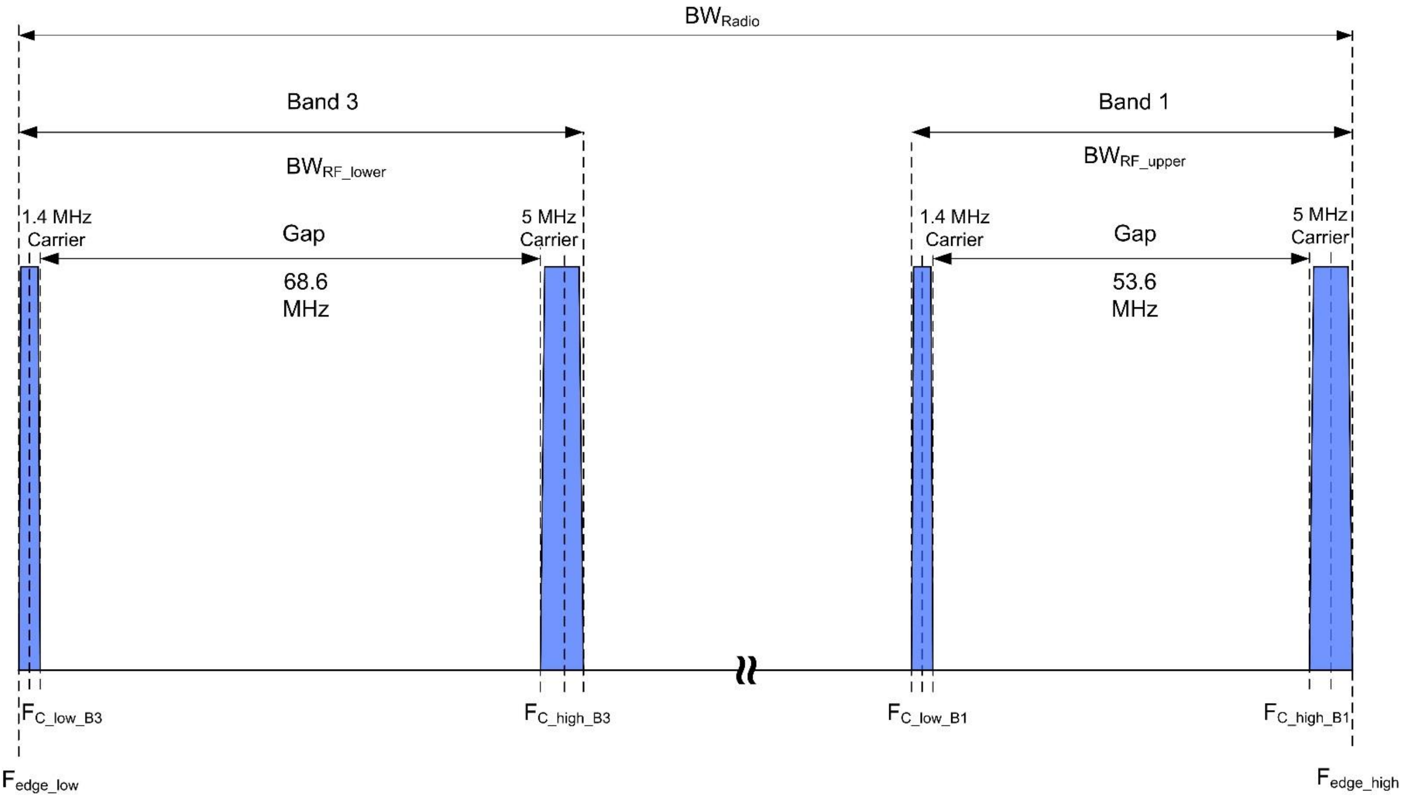
Example

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}) = 270 MHz
- Support for bands 1 and 3. Band 1: 1920 MHz – 1980 MHz;
  Band 3: 1710 MHz – 1785 MHz

1. $F_{C\_low\_B3}$ = 1710 MHz, $F_{C\_high\_B3}$ = 1785 MHz; $F_{C\_low\_B1}$ = 1920 MHz, $F_{C\_high\_B1}$ = 1980 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 (ETC1). Theoretically, more carriers can be used (Fig. 2-8).

Fig. 2-8: Example multiband test configuration for full carrier allocation. BW_{Radio} is 270 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 Rx 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 (ETC3).

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}) = 270 MHz
- Support for bands 1 and 3. Band 1: 1920 MHz – 1980 MHz;
  Band 3: 1710 MHz – 1785 MHz

4. $F_{C\_low\_B3}$ = 1710 MHz, $F_{C\_high\_B3}$ = 1785 MHz; $F_{C\_low\_B1}$ = 1920 MHz, $F_{C\_high\_B1}$ = 1980 MHz.
5. BW_{RF_lower} = 75 MHz according to band 3; BW_{RF_upper} = 60 MHz according to band 1.
6. In total, four 5 MHz carriers are located in band 1 and band 3 according to the example for non-contiguous spectrum operation (ETC3).
7. Each band consists of two sub-blocks and one gap in between (Fig. 2-9).

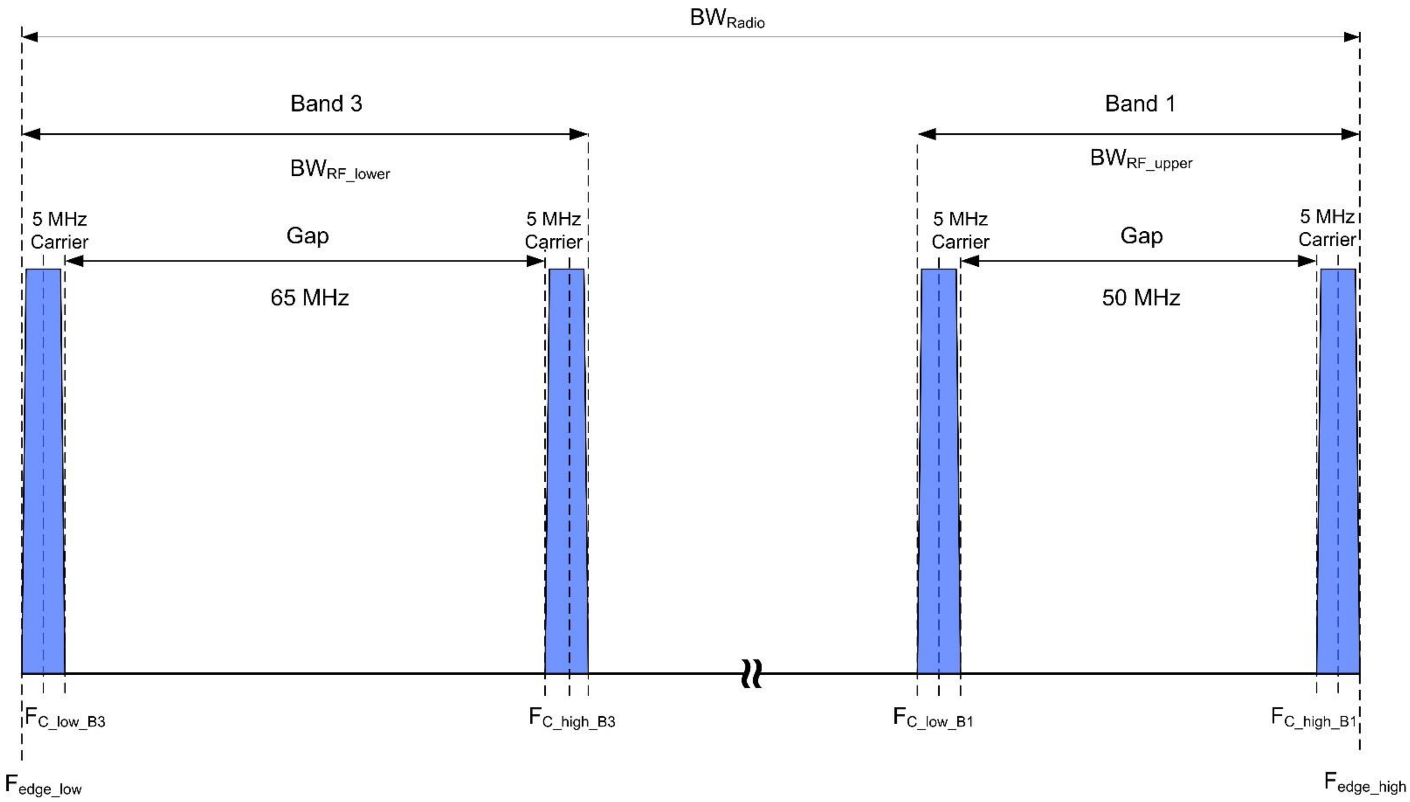


Fig. 2-9: Example multiband test configuration with high PSD per carrier. BW_{Radio} is 270 MHz. In total, four 5 MHz carriers are located in band 1 and band 3.

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.
- 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 (Fig. 2-10):

1. Aggregated channel bandwidth ($BW_{Channel\_RF}$) = 10 MHz
2. A NB-IoT carrier is placed at the upper edge; the offset is not defined. F_{offset} = 0.1 MHz is used.
3. A NB-IoT carrier is placed at the lower edge at an offset of 0.1 MHz.

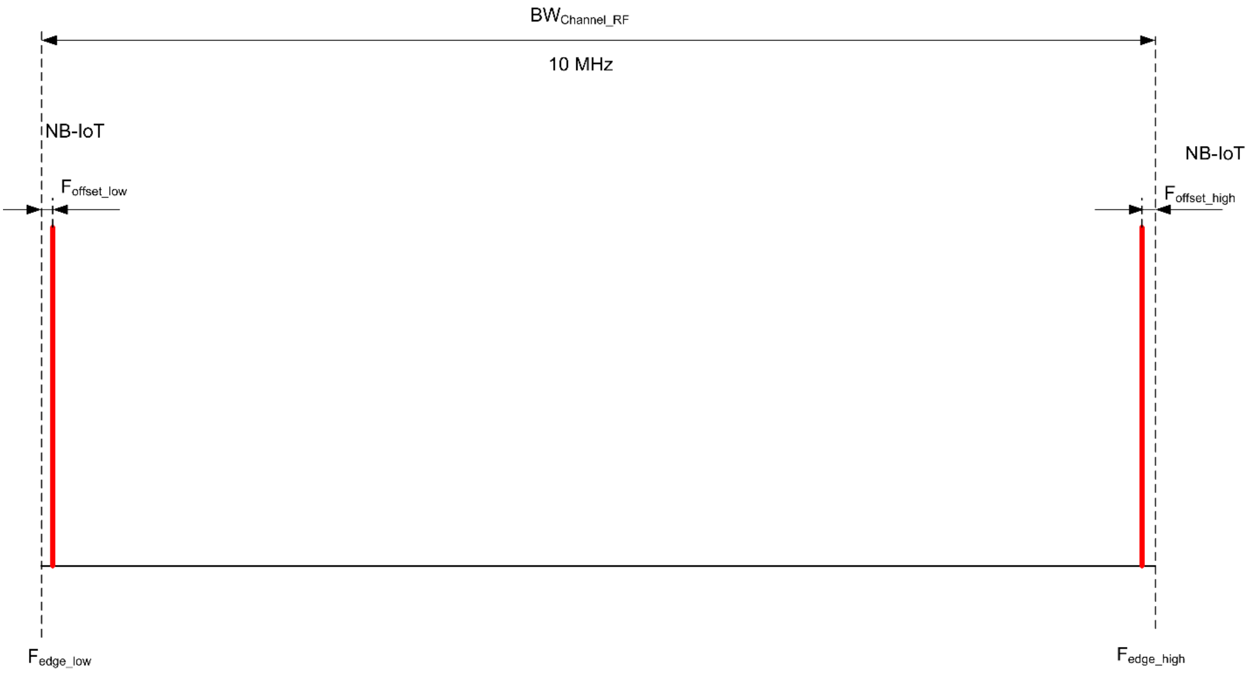


Fig. 2-10: Example for NB-IoT standalone multi-carrier

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

- 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.

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 (Fig. 2-11):

1. Aggregated channel bandwidth ($BW_{Channel\_RF}$) = 25 MHz
2. A LTE carrier with 5 MHz is placed at the upper edge at an the offset of 2.5 MHz.
3. A NB-IoT carrier is placed at the lower edge at an offset of 0.1 MHz.

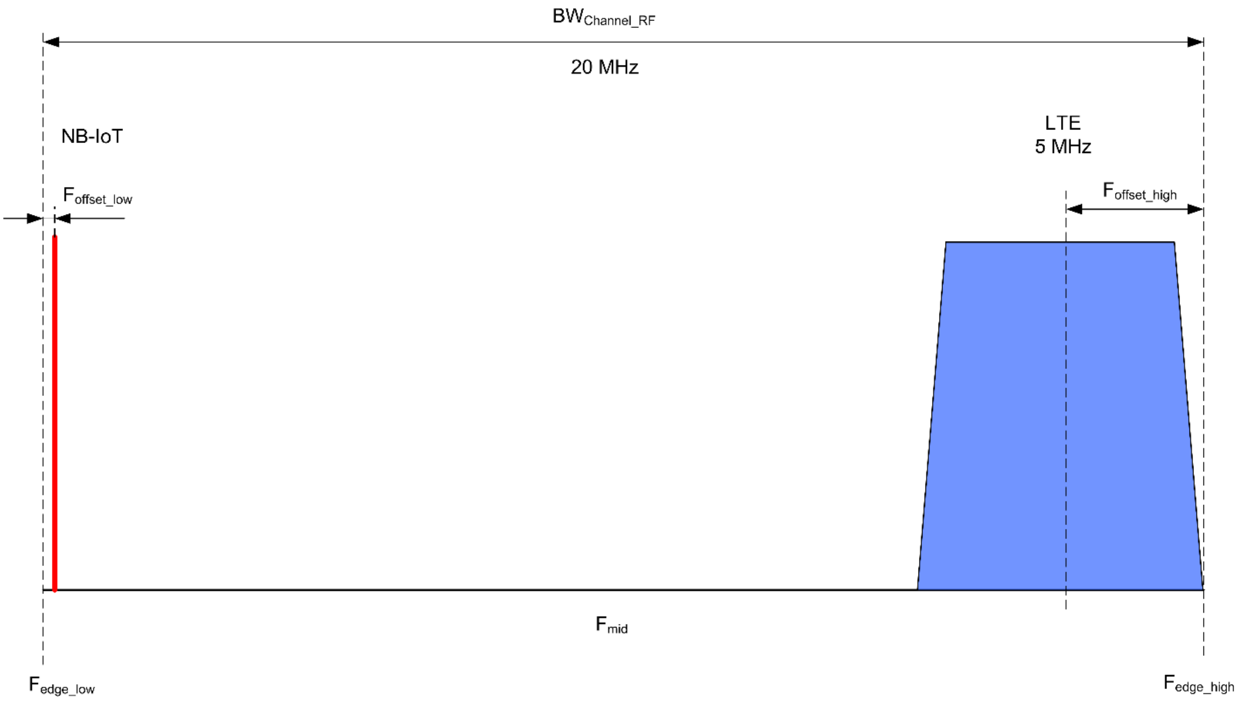


Fig. 2-11: Example for LTE and NB-IoT standalone multi-carrier operation

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.
- 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 (Fig. 2-12):

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.

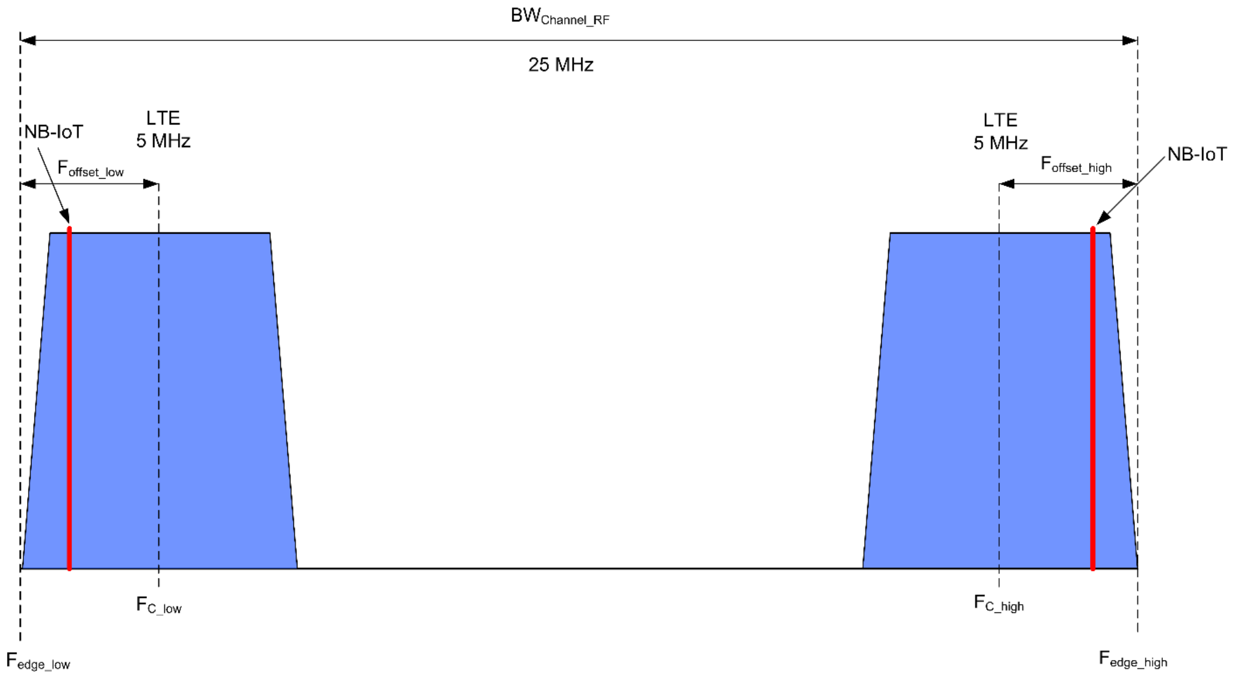


Fig. 2-12: Example for NB-IoT in-band multi-carrier

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.
- 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 (Fig. 2-12):

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.

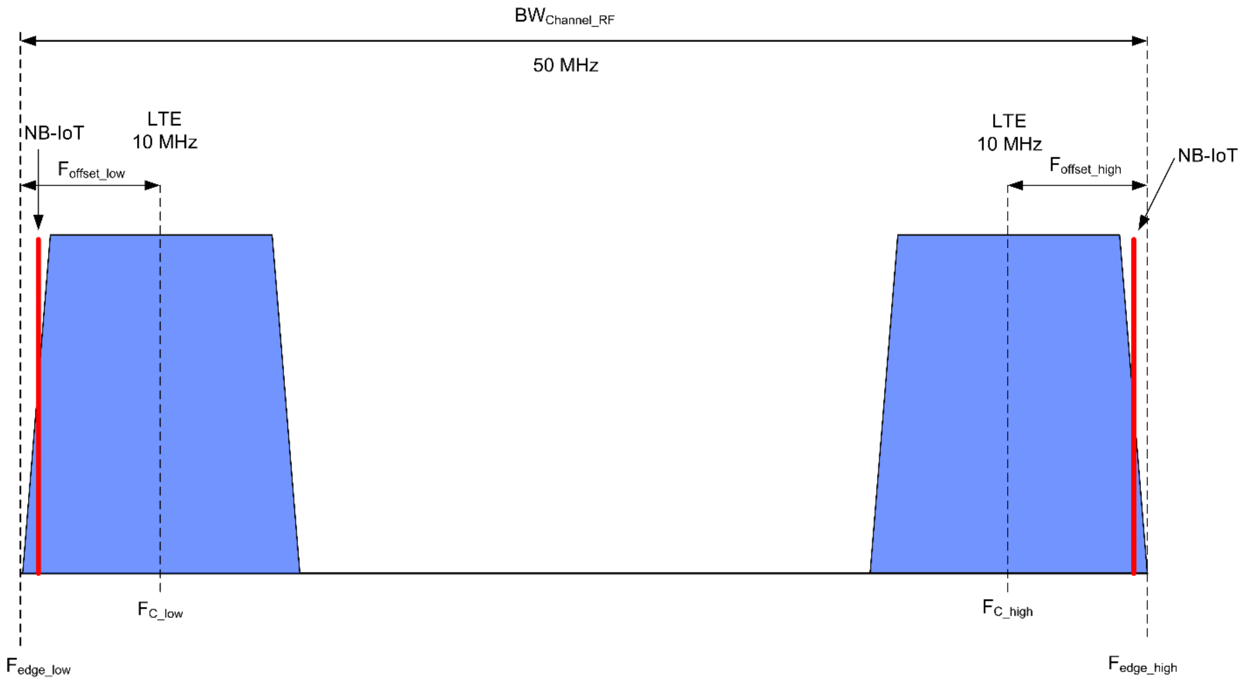


Fig. 2-13: Example for NB-IoT guard-band multi-carrier

2.4 RX Test setup

Fig. 2-14 shows the general test setup for receiver tests. A SMW is used to perform the test. For Multi-Carrier tests up to three LTE signals and paths are needed. One fully equipped SMW is needed. A few tests require special setups; these are described in the respective sections.

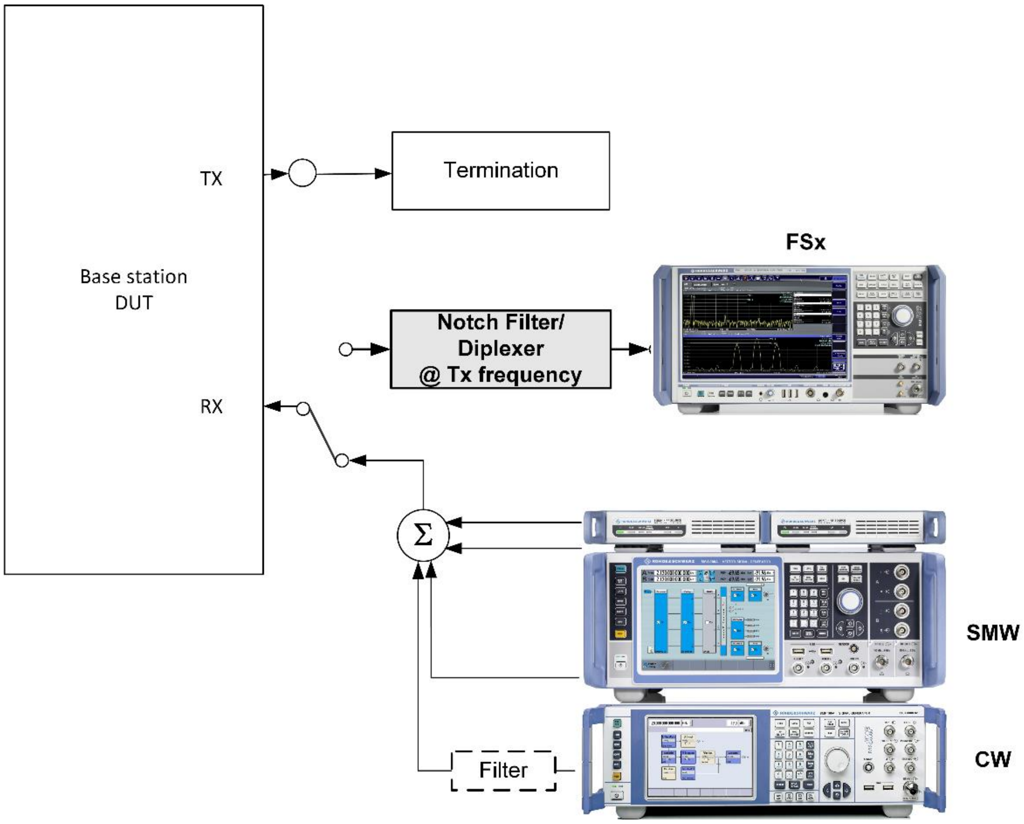


Fig. 2-14: Rx Test Setup; some tests require a special setup.

2.5 Instruments and Software options

A vector signal generators can be used for the tests described here:

- SMW

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

- SMW-K55 EUTRA/LTE (for three paths)
- SMW-K84 EUTRA/LTE Release 9 (for three paths)
- SMW-K85 EUTRA/LTE Release 10 (for three paths)
- SMW-K115 Cellular IoT (here NB-IoT) (for three paths)

A few tests require an additional CW signal. This is provided via a CW signal generator. The following are suitable:

- SMF
- SMB
- SGS
- SGT

One of the tests (receiver spurious emissions) requires a spectrum analyzer. The following instruments are available:

- FSW
- FSV(A)
- FPS

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

Number	Measurement	Instruments and options								
		Vector signal generator			LTE SW	Interferer				
						mandadory		optional		
		SMx	SMx-K62 (AWGN)	2nd LTE / NB-IoT for MC	SMx-K55 SMx-K85 SMx-K115	3rd BB + RF LTE / NB-IoT	CW	4th BB + RF LTE / NB-IoT	2nd CW	FSx
7	***Receiver characteristics***									
7.2	Reference sensitivity level	☑			☑	---				
7.3	Dynamic range	☑	☑		☑	---				
7.4	In-channel selectivity	☑			☑	---	---			
7.5	Adjacent channel selectivity and narrow-band blocking	☑		☑	☑	☑	---	☑	---	
7.6	Blocking									
a	In-band blocking	☑		☑	☑	☑	---			
b	Out-of-band blocking	☑		☑	☑	---	☑			
7.7	Receiver spurious emissions	---			---	---				☑
7.8	Receiver intermodulation	☑		☑	☑	☑	☑	☑	☑	

☑ needed for the measurement (exact this one)

--- not used

Note: For MC tests, all together 3 RF LTE paths are necessary (optional 4)

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

2.6 Multi-Standard Radio und TS 37.141

TS 37.141 applies when more than one radio access technology (RAT) is supported on a single base station (multi-RAT). The conformance specifications overlap for some Rx 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**
Narrow band blocking	7.5.5	7.4.5.2
Blocking	7.6.5.1	7.4.5.1
Out-of-band blocking	7.6.5.1	7.5.5.1
Co-location with other base stations	7.6.5.2	7.5.5.2
Receiver spurious emissions	7.7.5	7.6.5.1
Intermodulation	7.8.5	7.7.5.1
Narrowband intermodulation	7.8.5	7.7.5.2

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

2.7 LAA 5 GHz Band 46

With the 3GPP Release 14 the LTE standard made a jump to the unlicensed 5 GHz band, which is known as LTE-LAA (Licensed Assisted Access). The according band number is 46.

As this is a very special extension, special tests have to be applied, whereas the common tests do not have to be done for band 46. The special test extension for band 46 are marked at the appropriate places in the chapters and tables, so make sure to distinguish between these cases.

3 Receiver Tests (Chapter 7)

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 and/or CA 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, fixed reference channels (FRCs) standardize the resource block (RB) allocations. The FRC's are stored as predefined settings in instruments from Rohde & Schwarz.

Table 3-1 provides 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 FRCs 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
- C Spectrum: The base station is capable of multi-carrier and/or CA operation in contiguous spectrum for single band.
- 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.
- 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.
- 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.

<table>
<tr><th colspan="9">Basic parameter overview</th></tr>
<tr><th rowspan="4">Chapter TS36.141</th><th rowspan="4">Chapter AppNote</th><th rowspan="4">Name</th><th rowspan="4">FRC</th><th rowspan="4">Channels</th><th rowspan="4">Single-carrier</th><th>Multi-Carrier:</th><th rowspan="4" colspan="2">Comment</th></tr>
<tr><td>C Spectrum</td></tr>
<tr><td>C and NC Multi-carrier/CA</td></tr>
<tr><td>Multi-band</td></tr>
<tr><td rowspan="3">7.2</td><td rowspan="3">3.2</td><td rowspan="3">Reference sensitivity level</td><td rowspan="3">A1-1…3</td><td rowspan="3">B M T</td><td rowspan="3">Any SC</td><td>SC</td><td rowspan="3" colspan="2"></td></tr>
<tr><td>SC</td></tr>
<tr><td>SC</td></tr>
<tr><td rowspan="3">7.3</td><td rowspan="3">3.3</td><td rowspan="3">Dynamic range</td><td rowspan="3">A2-1…3</td><td rowspan="3">B M T</td><td rowspan="3">All SC</td><td>SC</td><td rowspan="3" colspan="2"></td></tr>
<tr><td>SC</td></tr>
<tr><td>SC</td></tr>
<tr><td rowspan="3">7.4</td><td rowspan="3">3.4</td><td rowspan="3">In-channel selectivity</td><td rowspan="3">A1-1…5</td><td rowspan="3">B M T</td><td rowspan="3">All SC</td><td>SC</td><td rowspan="3" colspan="2">Interferer
16QAM</td></tr>
<tr><td>SC</td></tr>
<tr><td>SC</td></tr>
<tr><td rowspan="3">7.5</td><td rowspan="3">3.5</td><td rowspan="2">Adjacent channel selectivity (ACS)</td><td rowspan="3">A1-1…3</td><td rowspan="3">B M T</td><td rowspan="3">Max SC
Any MC</td><td>ETC1</td><td rowspan="3" colspan="2">Interferer
QPSK</td></tr>
<tr><td>ETC1*,ETC3</td></tr>
<tr><td>Narrow band blocking</td><td>ETC1/3**,ETC5***</td></tr>
<tr><td rowspan="3">7.6</td><td rowspan="3">3.6</td><td rowspan="2">In-band blocking</td><td rowspan="3">A1-1…3</td><td rowspan="3">M</td><td rowspan="3">Max SC
Any MC</td><td>ETC1</td><td rowspan="2">Interferer
16QAM</td><td rowspan="3">Tx off</td></tr>
<tr><td>ETC1*,ETC3</td></tr>
<tr><td>Out-of-band blocking</td><td>ETC1/3**,ETC5***</td><td>Interferer
CW</td></tr>
<tr><td rowspan="3">7.7</td><td rowspan="3">3.7</td><td rowspan="3">Receiver Spurious Emissions</td><td rowspan="3">-</td><td rowspan="3">M</td><td rowspan="3">Max SC
Any MC</td><td>ETC1</td><td rowspan="3" colspan="2">Tx: SC and MC</td></tr>
<tr><td>ETC1*,ETC3</td></tr>
<tr><td>ETC1/3,ETC5</td></tr>
<tr><td rowspan="3">7.8</td><td rowspan="3">3.8</td><td rowspan="2">Receiver Intermodulation</td><td rowspan="3">A1-1…3</td><td rowspan="3">B M T</td><td rowspan="3">Max SC
Any MC</td><td>ETC1</td><td rowspan="2" colspan="2">Interferer
QPSK</td></tr>
<tr><td>ETC1*,ETC3</td></tr>
<tr><td>Receiver Narrowband Intermodulation</td><td>ETC1/3**,ETC5***</td><td colspan="2">Interferer
CW</td></tr>
<tr><td colspan="9">*Note: Applicable only for different parameters
**Note: Applicable only for separate antenna connectors
***Note: ETC5 is only applicable for multi-band receiver</td></tr>
</table>

Table 3-1: Basic parameter overview

NB-IoT overview						
Chapter TS36.141	Name	FRC	Deployment			Multi-Carrier
			Standalone	In-Band	Guard band	
7.2	Reference sensitivity level	A14-x	☑	☑	☒	-
7.3	Dynamic range	A15-x	☑		☑	-
7.4	In-channel selectivity	A14-x	☒		☒	-
7.5	Adjacent channel selectivity (ACS) And Narrow band blocking	A14-x	☑		☑	ETC8 ETC9
7.6	Blocking	A14-x	☑		☑	ETC8 ETC9
7.7	Receiver Spurious Emissions	-	☑		☑	ETC8 ETC9
7.8	Receiver Intermodulation	A14-x	☑		☑	ETC8 ETC9

Table 3-2: Overview NB-IoT tests

When measuring receiver spurious emissions 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.

3.1 Basic Operation

3.1.1 System Configuration SMW

The test setups require a routing of the UE signals to the Rx antennas of the base station under test.

The SMW is able to handle up to four independent basebands and (with additional RF generators) up to eight RF paths. Routing is done via **System configuration** (simple settings can be done via routing in the baseband block).

You can reach the **System Configuration** via the soft button in the lower left area or by a click on *Fading*.

1. Set **Mode** to **Advanced.**
2. Set the wanted configuration.

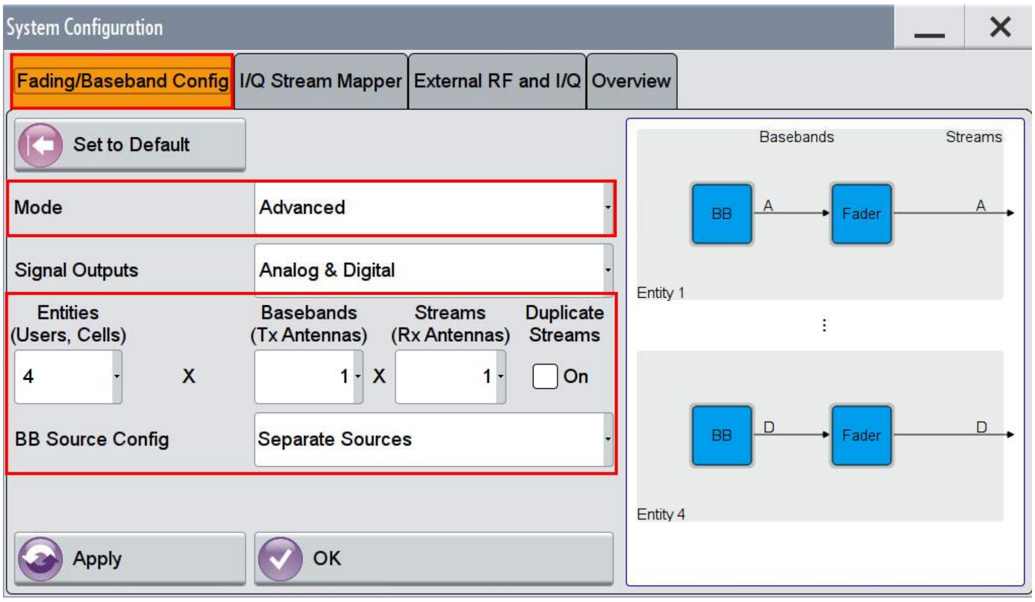


Fig. 3-1: System Configuration in the SMW

3.1.2 General Uplink LTE and NB-IoT settings at SMW

The SMW generates an uplink LTE and NB-IoT signal(s) for measurement of throughput at the Base Station receiver port. Here only the basic settings for the LTE uplink signal in SMW are detailed.

3. Set the Center Frequency and the Level (**Freq** und **Lev**)(Fig. 3-2)
4. Choose the digital standard LTE in the Baseband Block A (**EUTRA/LTE)** (Fig. 3-3)

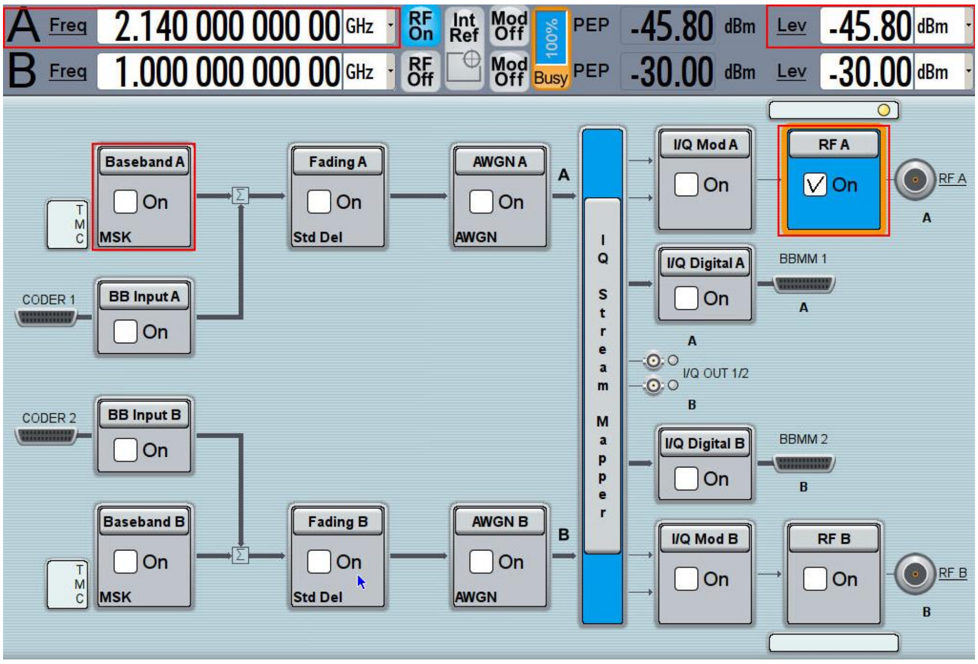


Fig. 3-2: SMW: Setting of frequency and level. Digital standards like LTE are enabled in baseband block.

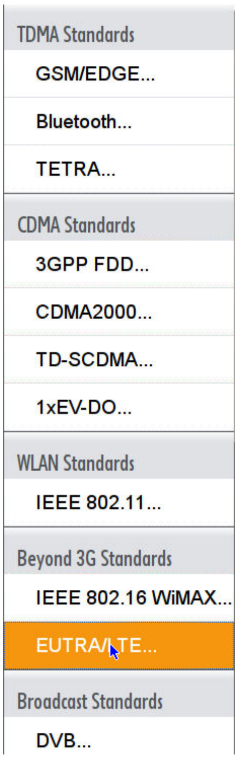


Fig. 3-3: SMW: Choosing of LTE in the baseband block

5. Choose under **Mode LTE/eMTC/NB-IoT** to enable mixed signals
6. Set the **Duplexing** mode to **FDD** or **TDD** (Fig. 3-4).
7. Select the **Channel Bandwidth** (Fig. 3-5).
8. For TDD mode set also the **UL/DL configuration** and the **special subframe configuration**. (Fig. 3-5).

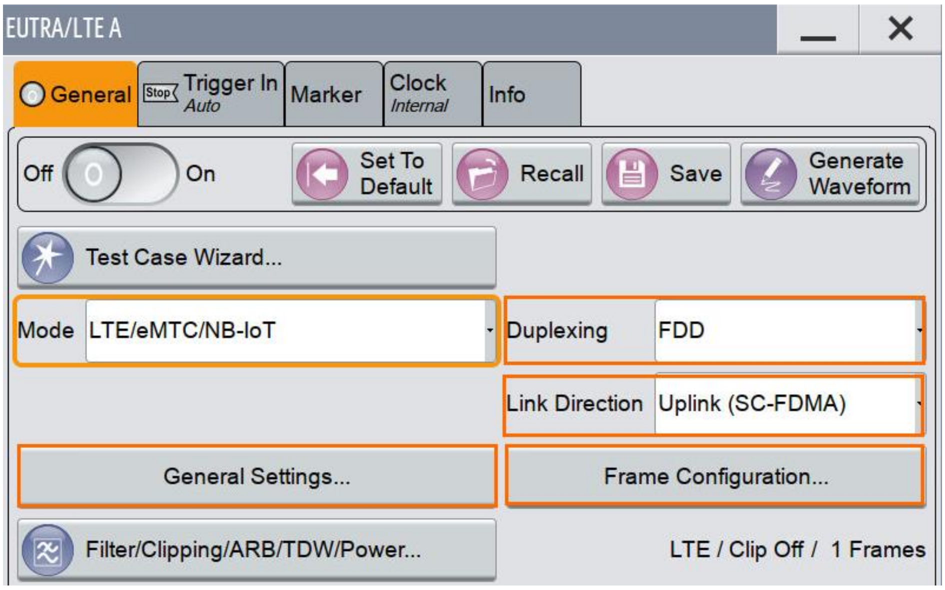


Fig. 3-4: LTE Settings: Uplink with duplexing mode.

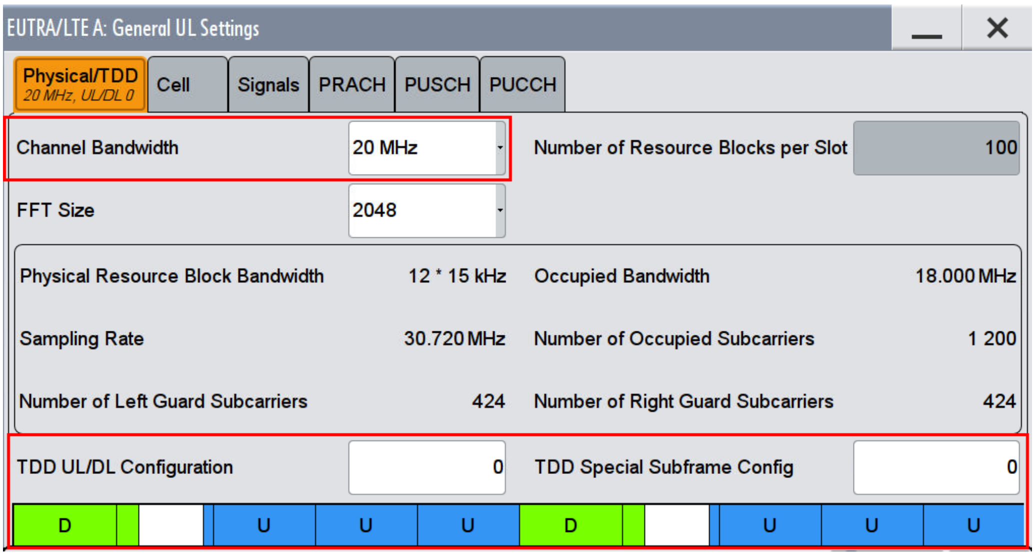


Fig. 3-5: Selection of Channel Bandwidth in General UL Setting. For TDD set the UL/DL configuration and the special subframe configuration. The SMW shows the configuration graphically.

9. Click on **UE1** to set details. Set **3GPP release** to **Release 8/9** or **10** (Fig. 3-6).
10. Switch in tab **FRC** the **FRC state On** and select required FRC (Fig. 3-7).

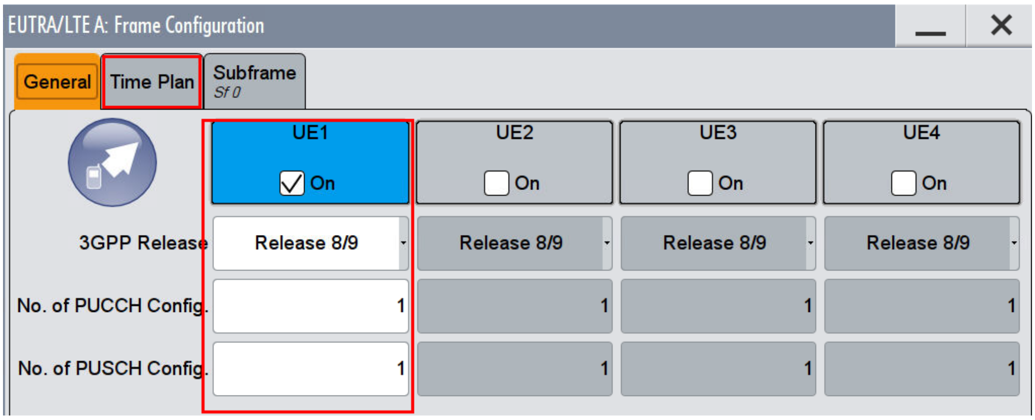


Fig. 3-6: LTE UL Frame Configuration. UE1 is switched on per default. Click on UE1 to set details. Time Plan shows the configuration graphically.

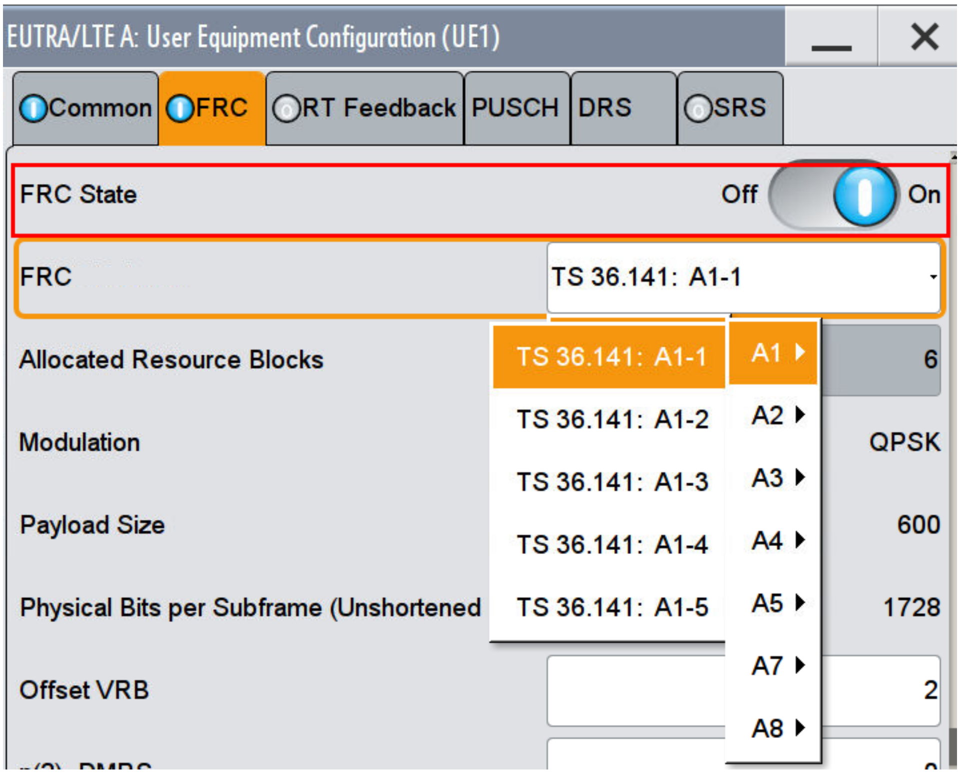


Fig. 3-7: LTE UL UE configuration. All FRCs defined in TS36.141 are available. With Offset VRB the allocated RBs can be shifted to "higher" RBs.

As mentioned earlier, each FRC sets the number of resource blocks for the UE according to the respective bandwidth. In certain combinations of channel bandwidth and FRC, not all possible resource blocks are allocated. The allocated resource blocks according to FRC can be shifted by using the **Offset VRB** (offset Virtual resource block) function of the SMW. It moves the blocks from "lower" resource blocks to "higher" resource blocks. Always consider the total number of resource blocks allocated and available.

MultiCarrier/CA

If multiple carriers are needed, use the following method for a certain baseband:

1. Choose the digital standard LTE in the Baseband Block A or B (**EUTRA/LTE) according to** Fig. 3-2 **and** Fig. 3-3. For example, choose Baseband Block A and set frequency to 2.14 GHz.
2. Go to "General Settings" and "CA" (see Fig. 3-8); switch ON "Activate Carrier Aggregation" (see Fig. 3-9).

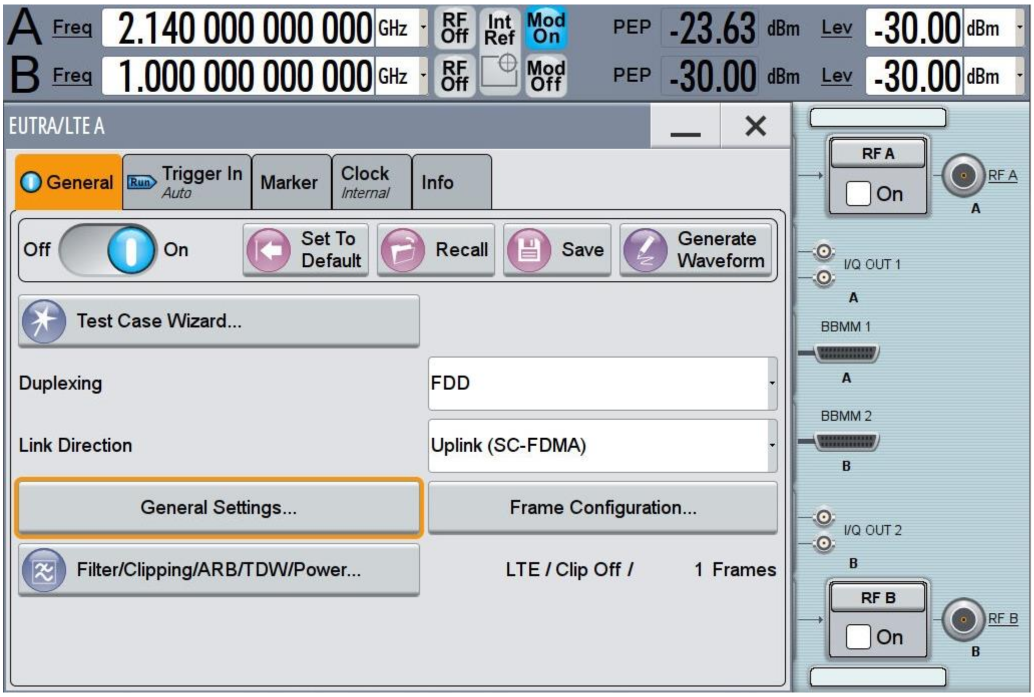


Fig. 3-8: Setting of multiple carriers. Open EUTRA/LTE for chosen Baseband Block and go to "General Settings…"

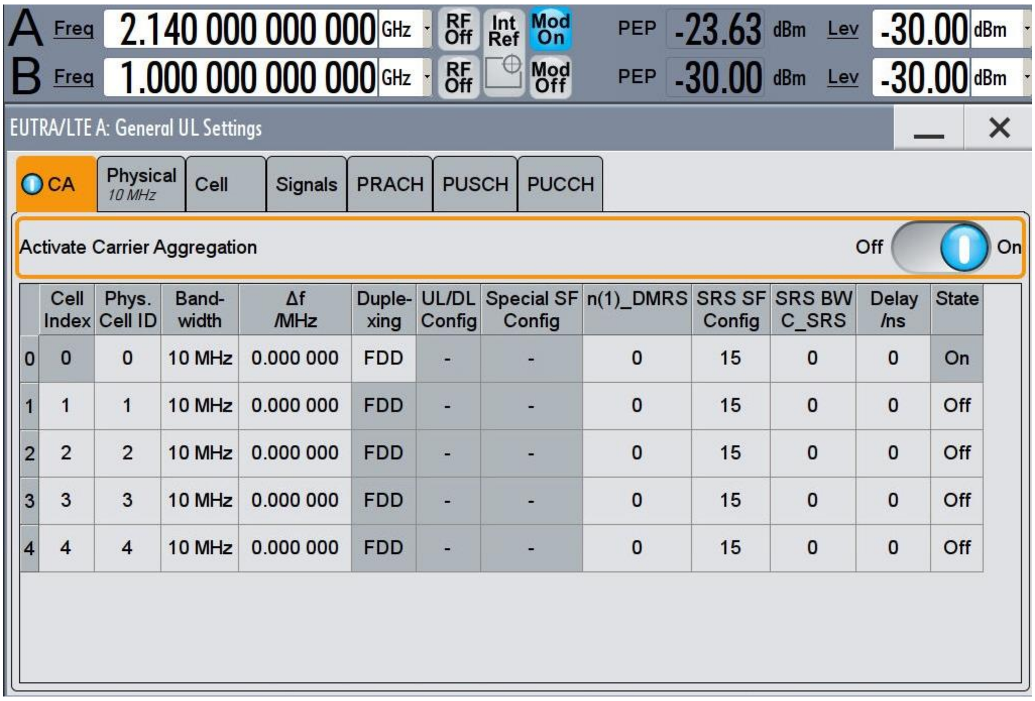
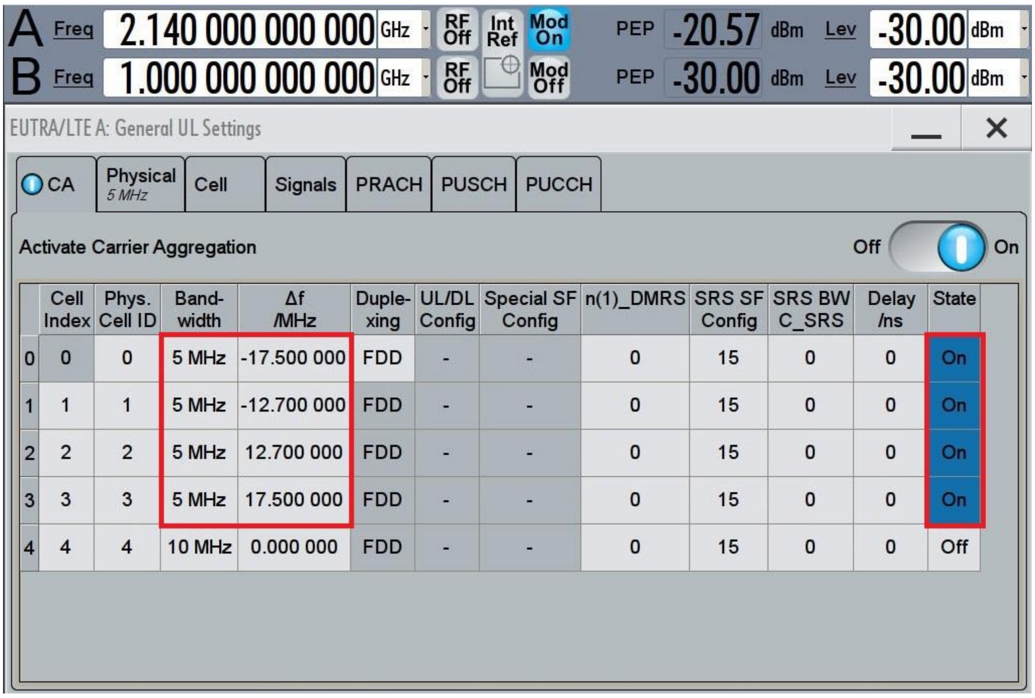


Fig. 3-9: Setting of multiple carriers. Select CA and activate carrier aggregation.

3. Switch ON the number of carriers that shall be regarded. Select the bandwidths of the carriers and the spacing between the center frequency (here for Baseband Block A Freq = 2.14 GHz) and the carrier. For example, switch ON four carriers

(State ON) with a bandwidth of 5 MHz each. The first carrier is located at 2.1225 GHz, therefore Δf = -17.5 MHz. The second carrier is located at 2.1273 GHz, therefore Δf = -12.7 MHz. Locate carrier three and four accordingly (see Fig. 3-10).



	Cell Index	Phys. Cell ID	Band-width	Δf /MHz	Duple-xing	UL/DL Config	Special SF Config	n(1)_DMRS	SRS SF Config	SRS BW C_SRS	Delay /ns	State
0	0	0	5 MHz	-17.500 000	FDD	-	-	0	15	0	0	On
1	1	1	5 MHz	-12.700 000	FDD	-	-	0	15	0	0	On
2	2	2	5 MHz	12.700 000	FDD	-	-	0	15	0	0	On
3	3	3	5 MHz	17.500 000	FDD	-	-	0	15	0	0	On
4	4	4	10 MHz	0.000 000	FDD	-	-	0	15	0	0	Off

Fig. 3-10: Setting of multiple carriers. Choose State ON for four carriers. Set the bandwidth and the spacing between carrier and center frequency.

You can set the FRC for the additional uplink carriers under Frame Configuration UE in the same way like for single carrier.

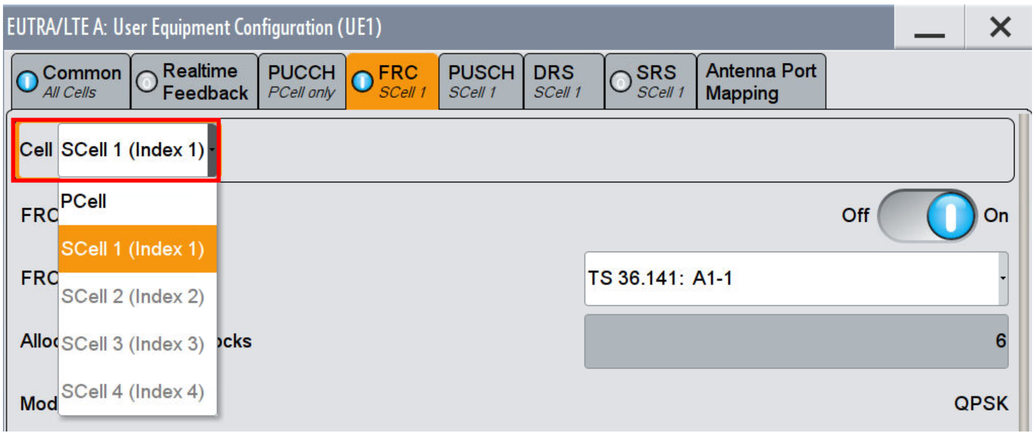


Fig. 3-11: FRC for additional uplink carriers.

In addition, for a multi-band capable BS, the following steps shall apply:

1. For multi-band capable BS and single band tests, repeat the steps above per involved band where single band test configurations and test models shall apply with no carrier activated in the other band.
2. For multi-band capable BS with separate antenna connector, the antenna connector not being under test in case of single-band or multi-band test shall be terminated. [1]

NB-IoT standalone

1. To generate standalone NB-IoT signals, set the Channel Bandwidth to 200 kHz. Thus, the SMW automatically uses standalone mode.

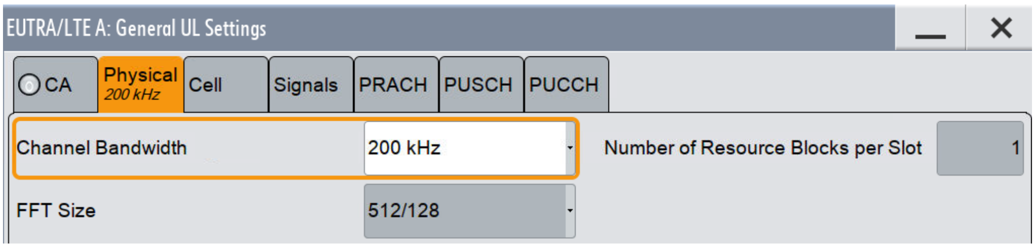


Fig. 3-12: NB-IoT standalone mode uses 200 kHz bandwidth

2. Click on UE1 to open further settings

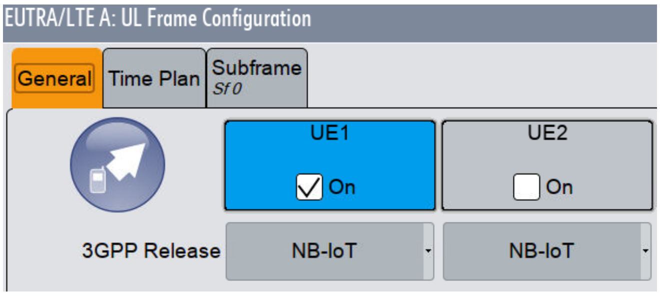


Fig. 3-13: UE1 transmits an NB-IoT signal

3. In the tab **FRC** choose the wanted **FRC** (A14….A15) and switch **on** the **FRC State**.

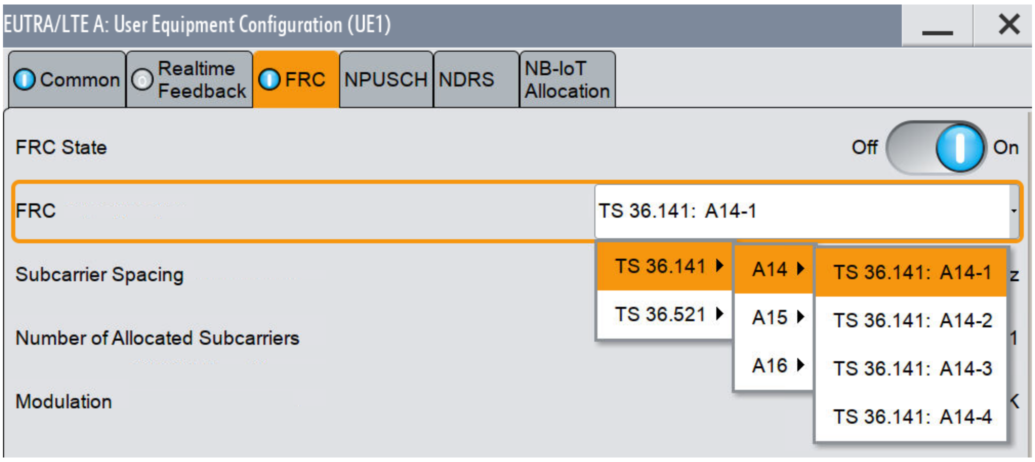


Fig. 3-14: FRCs for NB-IoT

4. The SMW automatically sets the parameters according to the wanted FRC. Click **Adjust Length** if the Current **ARB Sequence Length** differs from the Suggested length.

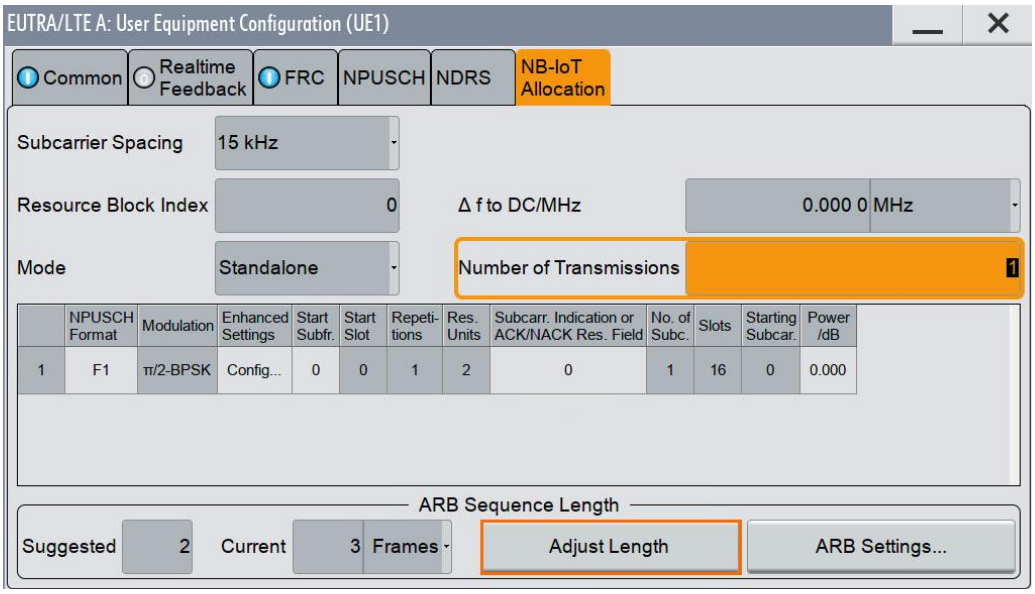


Fig. 3-15: Detailed FRC settings

NB-IoT in-band / guard band

For in-band / guard band deployment, the LTE settings are the same as in in Fig. 3-5 and Fig. 3-7.

1. In addition, set up another UE signal for NB-IoT.

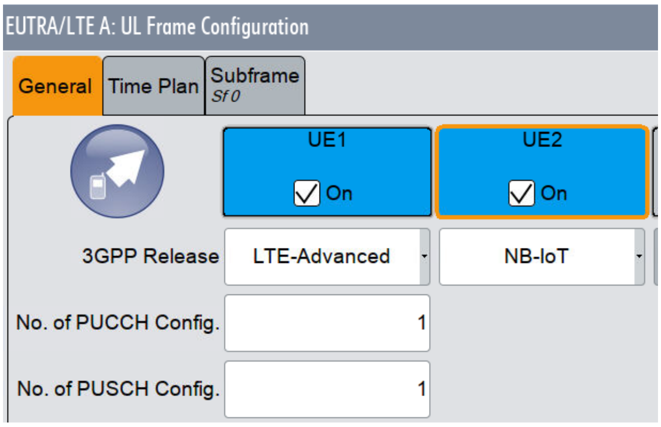


Fig. 3-16: For in-band and guard band deployment, the SMW generates two UE signals, one for the LTE part and one for the in-band/guardband part.

2. Click on UE2 to set the **FRC** (Fig. 3-14).
3. In the tab NB-IoT Allocation, set the Mode an the wanted Resource Block Index. Click Adjust Length, if suggested. The SMW shows the frequency offset of the NB-IoT signal relatively to the center frequency of the LTE signal. All other settings are according to the wanted FRC.

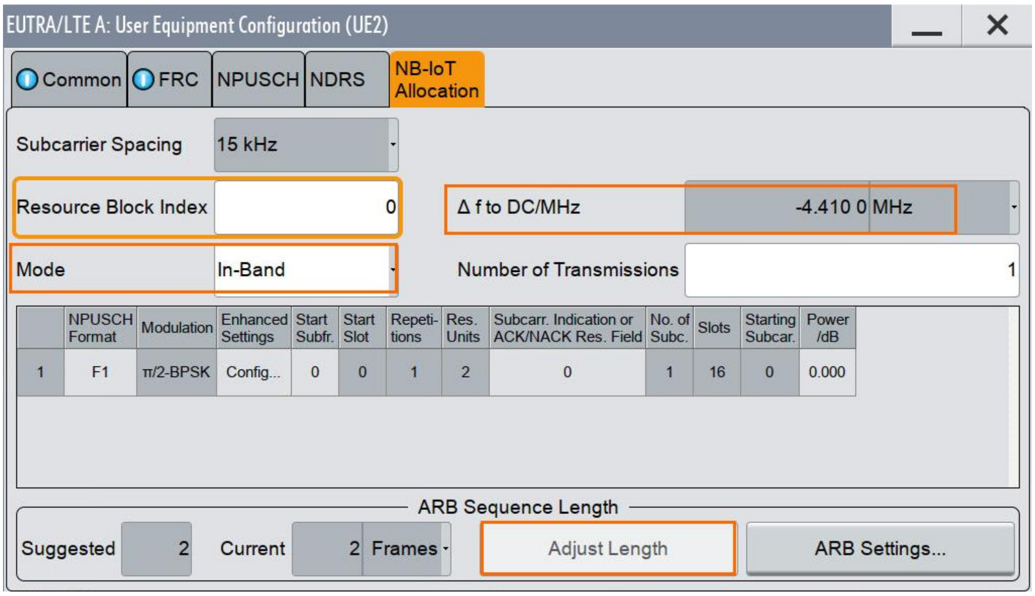


Fig. 3-17: An in-band deployment

4. Check the settings in the time plan

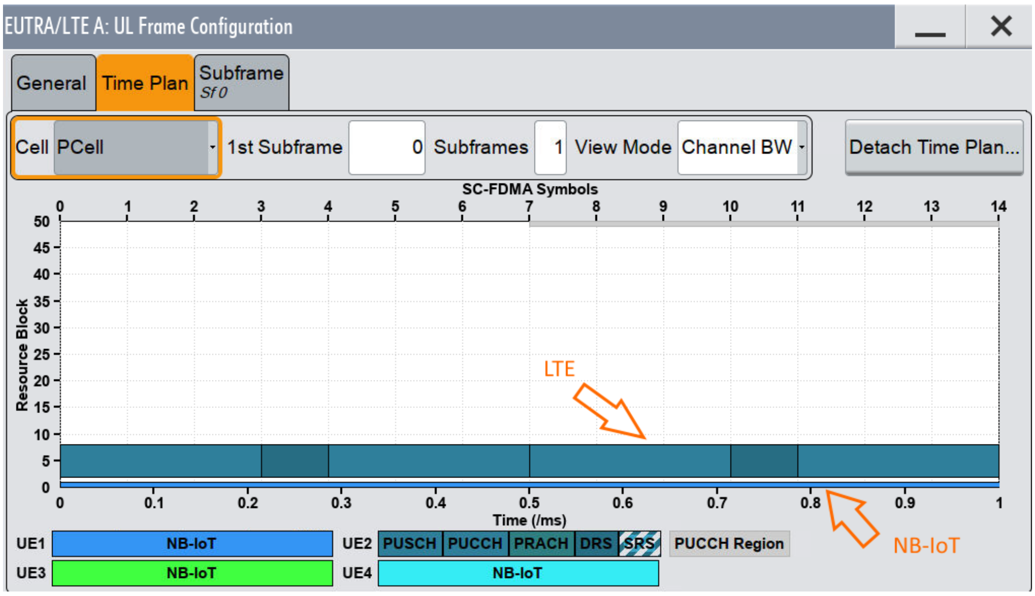


Fig. 3-18: Timeplan of an in-band deployment

5. To set different power levels between the LTE- and NB-IoT-signals, set a relative offset in the NB-IoT part.

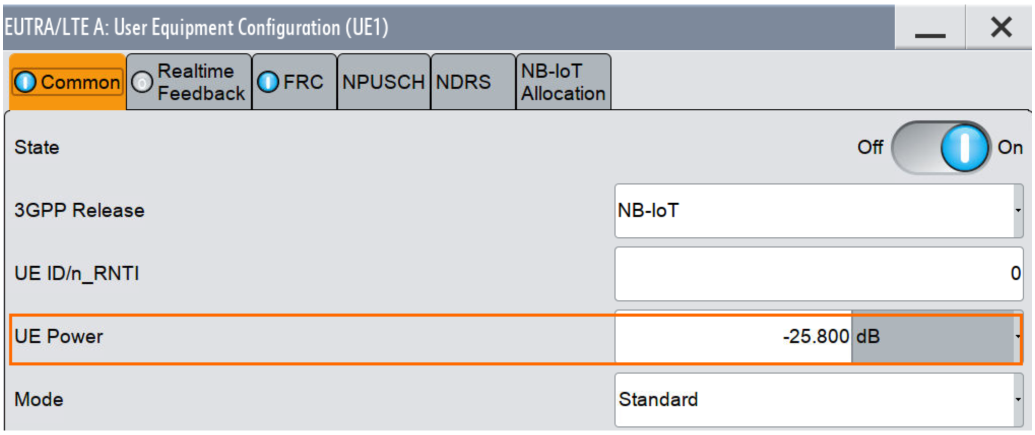


Fig. 3-19: Relative power offset

External Trigger

Per default, the SMW generates and starts the signal automatically. If needed, the signal can be aligned to an external trigger.

1. Set in tab **Trigger In** the **Mode** to **Armed Auto** (Fig. 3-20 and Fig. 3-21)
2. Check the **Source** and **Routing** (Fig. 3-21 and Fig. 3-22). In the SMW, you can route the trigger via different connectors. Default is USER 3 at the Front Panel.

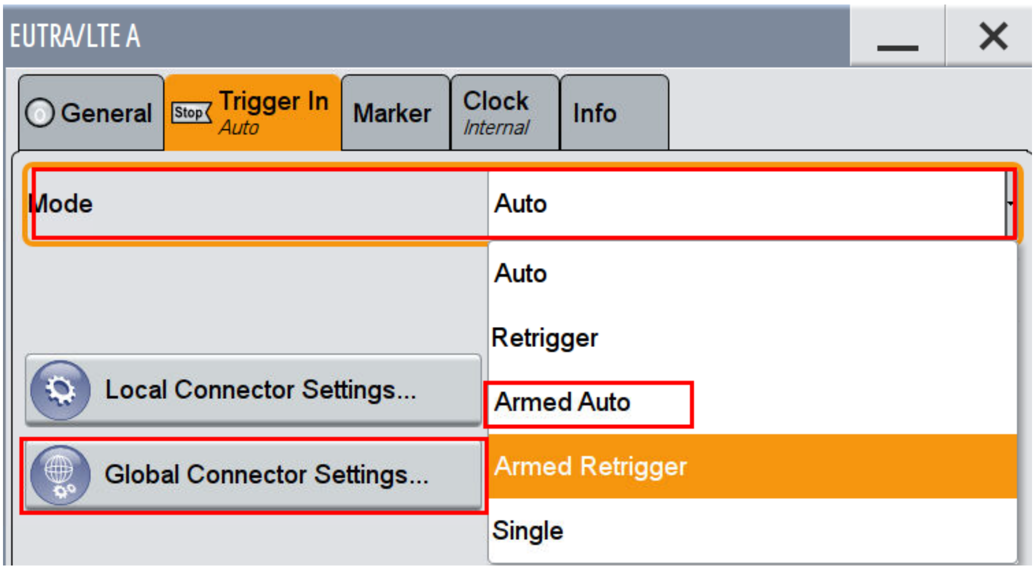


Fig. 3-20: Trigger options in the SMW

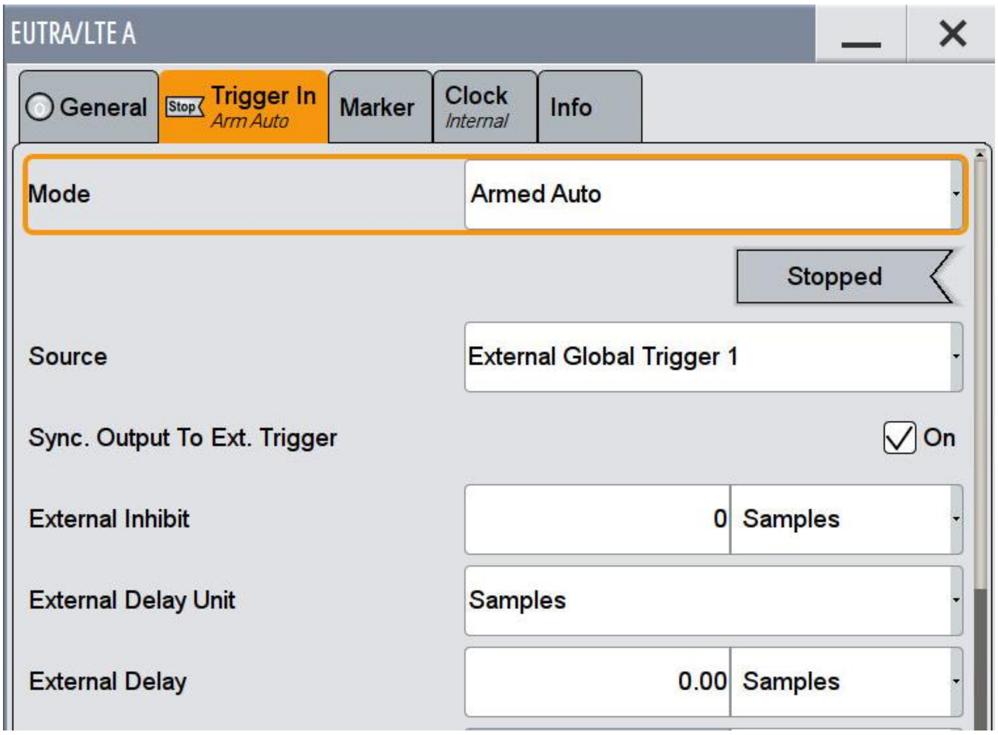


Fig. 3-21: Trigger Armed Auto in the SMW

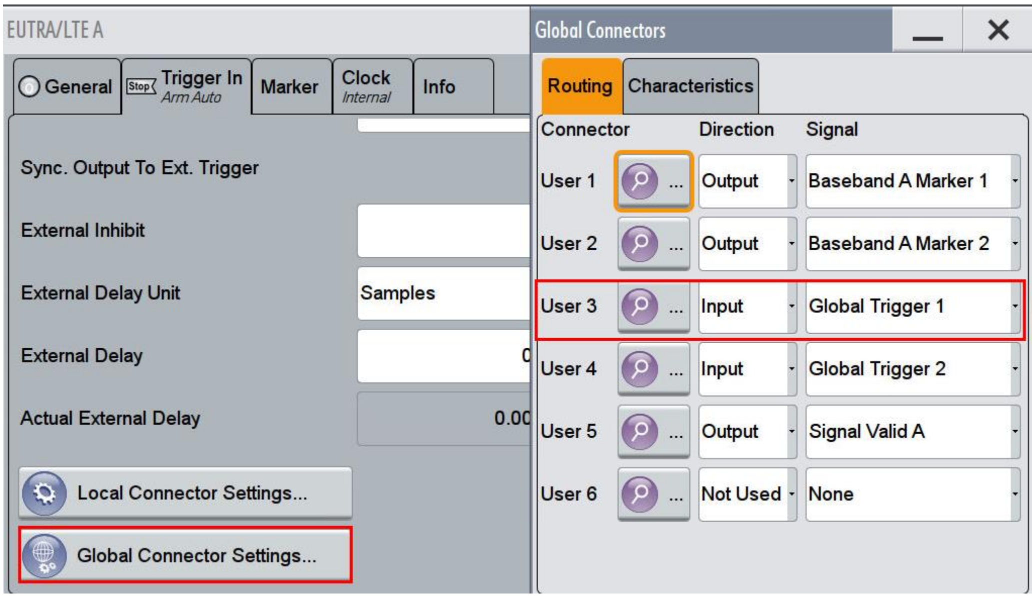


Fig. 3-22: Set the routing of the Trigger in the SMW

Time alignment for 2 Basebands

The SMW can generate two UEs in two different baseband blocks and paths. If the two UEs have to be time aligned (e.g. for Multi-carrier testing), the two baseband blocks have to be synchronized.

- If an external Trigger is used, provide it to both baseband blocks. For the settings see section External Trigger (above)
- If the SMW runs without external trigger, set the second baseband block (B) to Source Internal (Baseband A) (Fig. 3-23). Restart Baseband Block A.

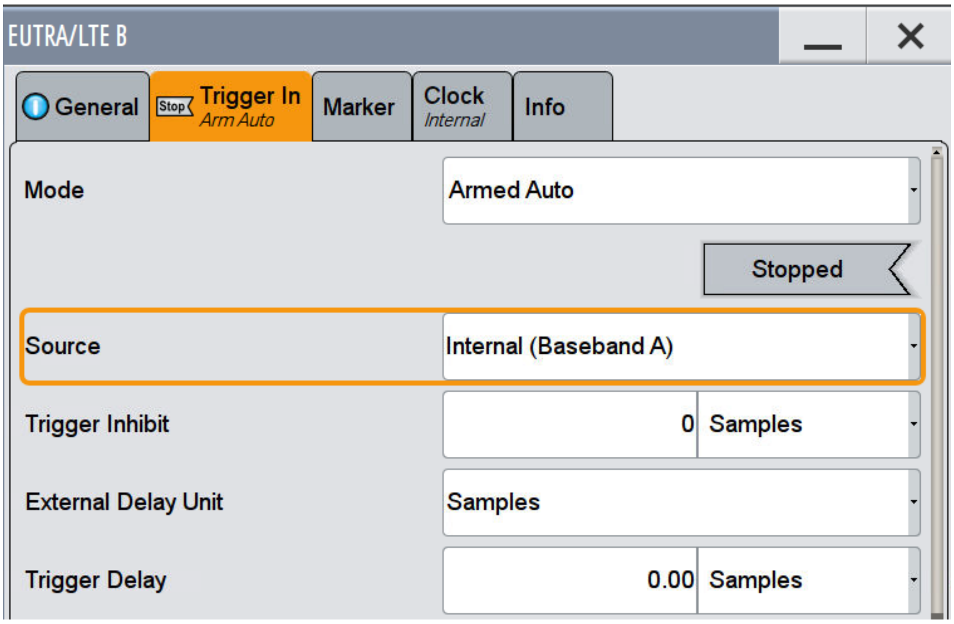


Fig. 3-23: Synchronizing Baseband Block B to Baseband Block A, if no external trigger is used.

Filter settings

The SMW supports different filters, see Fig. 3-24.

Best ACP focusses an excellent ACP performance. **Narrow** additionally features a smoother shape in the frequency domain. **Best EVM** focusses an excellent EVM performance. **No upsampling** additionally features a small output waveform file size.

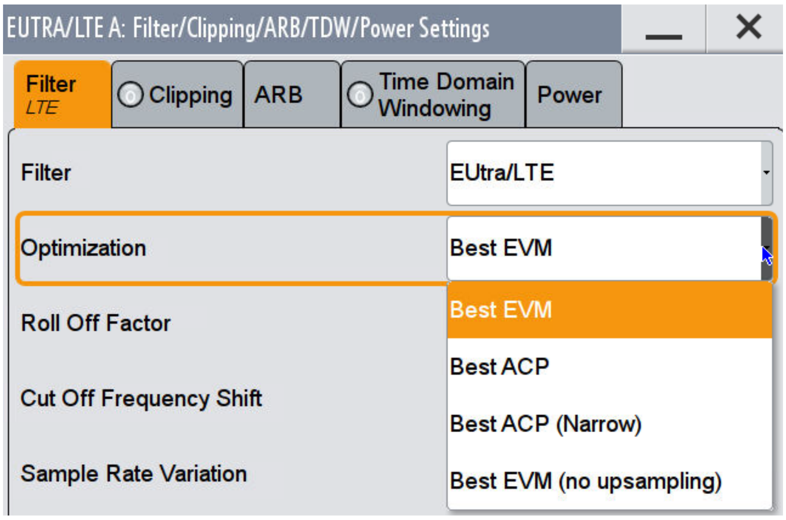


Fig. 3-24: LTE Filter Settings

SMW: extension with SGS

The SMW is able to generate up to eight baseband signals. It supports two RF paths directly inside one instrument. To support more RF channels, additional instruments like the SGS and the SGT can be connected via IQ to the SMW. The SMW then controls those external instruments and acts like one instrument with additional RF channels.

An example with a SGS connected via IQ OUT1 to the SMW is used to explain the settings.

1. Open the **System Configuration** (e.g. click on **I/Q Stream mapper**) and click on the tab **External RF and IQ**
2. Click in the row External Instrument in line I/Q OUT 1. (Fig. 3-25)

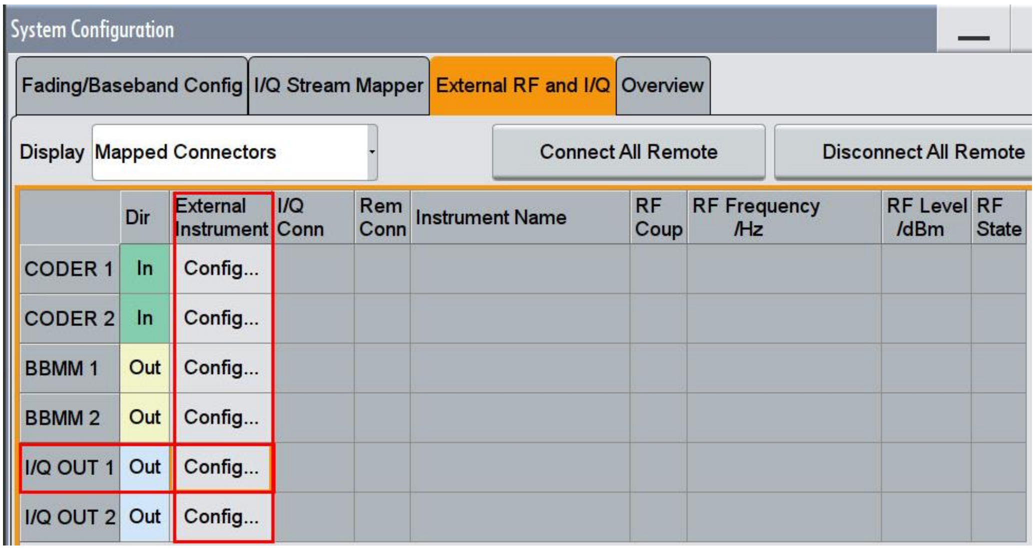


Fig. 3-25: Configuring external instrument at IQ1 Out

3. Click on the button **SCAN**. The SMW searches for available instruments on the LAN.
4. Select the wanted instrument under **External Instrument**. Check the shown settings and click **Apply and Connect**. The reference path is RF A. (Fig. 3-26)

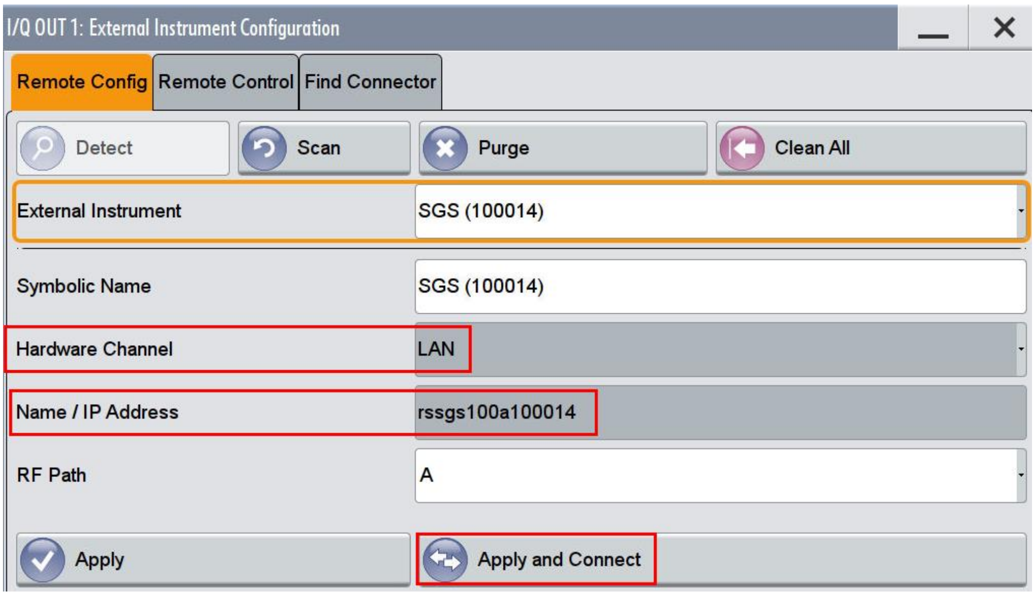


Fig. 3-26: Choose an external instrument

5. If **RF Coup** is marked, the instrument uses the same frequency, level and RF state like the SMW (e.g. RF A). Offsets can be entered relatively to the reference path. (Fig. 3-27)

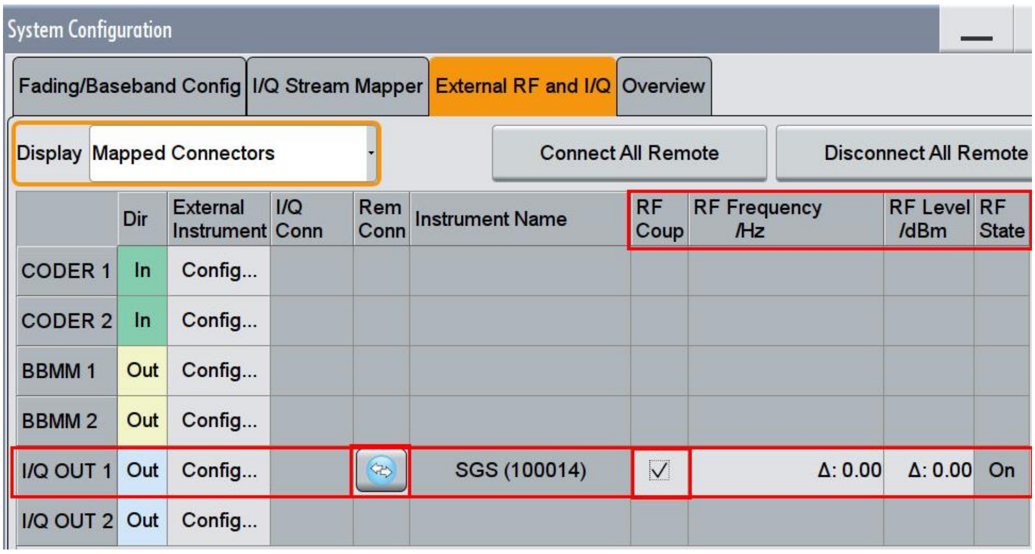


Fig. 3-27: External instrument is RF coupled to RF A. It uses the same frequency, level and RF state like RF A.

6. Switch **On** the used IQ Modulators.

The SGT can be connected the same way as the SGS to the SMW. The SGT uses DIG IQ connections e.g. via FADERx.

Resources

The mandatory tests require up to three LTE signals (basebands and RF paths) and one additional CW signal. The optional tests require even four LTE signals (basebands and RF paths) and two CW signals.

Single Carrier					
Test	**Wanted Signal**		**Interferer LTE**		**Interferer CW**
	Baseband	RF	Baseband	RF	
7.2	A	A	-	-	-
7.3	A	A	-	-	-
7.4	A	A	-	-	-
7.5 a)	A	A	B	B	-
7.5 b)	A	A	B	B	-
7.6 a)	A	A	B	B	-
7.6 b)	A	A	-	-	extern
7.8	A	A	B	B	extern

Table 3-3: Used resources for single carrier

Multicarrier / CA with Bandwidth ≤ 160 MHz								
Test	mandatory					optional		
	Wanted Signal		Interferer LTE		Interferer CW	Interferer LTE 2		Interferer CW 2
	Baseband	RF	Baseband	RF		Baseband	RF	
7.2	A	A	-	-	-	-	-	-
7.3	A	A	-	-	-	-	-	-
7.4	A + B	A + B	-	-	-	-	-	-
7.5 a)	A	A	B	B	-	C	IQ1 (SGS)	-
7.5 b)	A	A	B	B	-	C	IQ1 (SGS)	-
7.6 a)	A	A	B	B	-	-	-	-
7.6 b)	A	A	-	-	extern	-	-	-
7.8	A	A	B	B	extern	C	IQ1 (SGS)	extern

Table 3-4: Used resources for multi carrier

Multicarrier / CA with Bandwidth > 160 MHz								
Test	mandatory					optional		
	Wanted Signal		Interferer LTE		Interferer CW	Interferer LTE 2		Interferer CW 2
	Baseband	RF	Baseband	RF		Baseband	RF	
7.2	A + B	A + B	-	-	-	-	-	-
7.3	A + B	A + B	-	-	-	-	-	-
7.4	A + B	A + B	-	-	-	-	-	-
7.5 a)	A + B	A + B	C	IQ1 (SGS)	-	D	IQ2 (SGS)	-
7.5 b)	A + B	A + B	C	IQ1 (SGS)	-	D	IQ2 (SGS)	-
7.6 a)	A + B	A + B	C	IQ1 (SGS)	-	-	-	-
7.6 b)	A + B	A + B	-	-	extern	-	-	-
7.8	A + B	A + B	C	IQ1 (SGS)	extern	D	IQ2 (SGS)	extern

Table 3-5: Used resources for multi carrier with a distance more than 160 MHz

3.1.3 Demo Program R&S TSrun

This Application Note comes with a demonstration program module called **LTE BS Rx Test** for the software TSrun, which is free of charge. The module covers all required tests. The **LTE BS Rx 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.

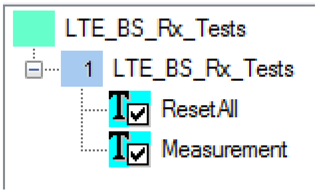
Following SCPI, resources are needed:

- SMx
- CWx
- CWx2
- FSx

Getting started

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

The test consists of two independent test cases:



- The test case **ResetAll** resets all instruments (SMx, CWx, CWx2 and FSx)
- The test case **Measurement** is the main part.

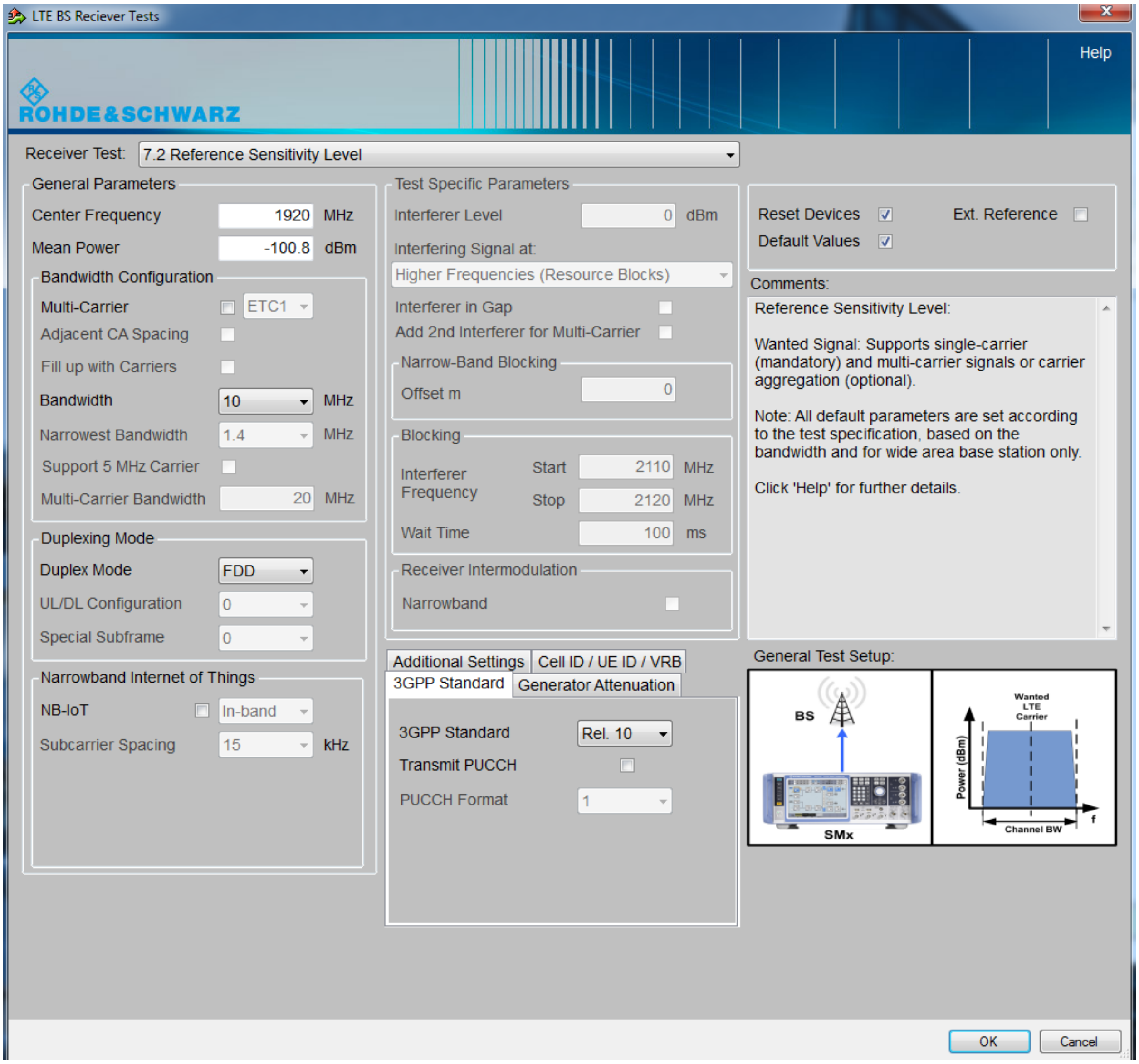


Fig. 3-28: Full overview: setting parameters for the LTE BS Rx test.

General settings

The basic parameters are set at the top right:

- **Reset Devices**: Sends a reset command to all connected instruments
- **External ref**: Switches the SMW over to an external reference source (typ. 10 MHz).

Please note that the external SGS has to be connected to the SMW before remote controlling the SMW. See [7] for more details (section **How to Connect External Instruments and Configure the Signal Flow**).

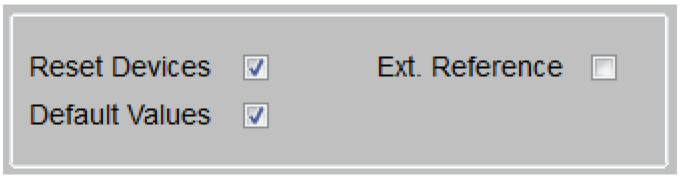


Fig. 3-29: General settings.

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.

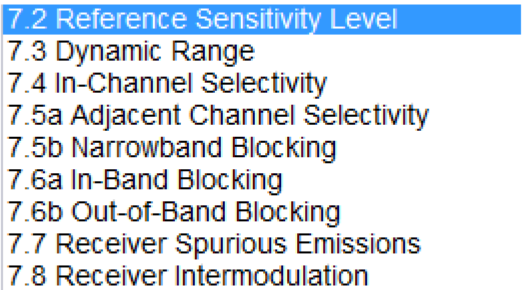


Fig. 3-30: Available test cases.

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

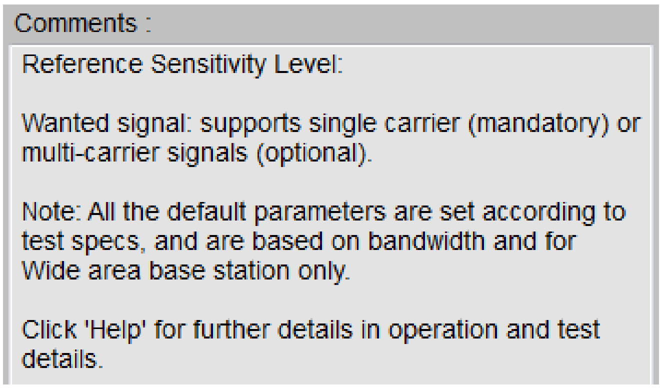


Fig. 3-31: Brief notes are provided in the Comments **section (top right) based on the selected test case.**

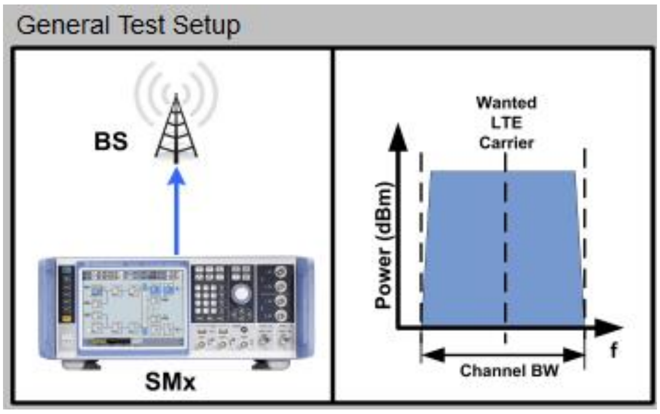


Fig. 3-32: The Test Setup **section (bottom right) displays a basic setup for the selected test case along with the location of the signals in the spectrum.**

Settings for wanted signal: General Parameters

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

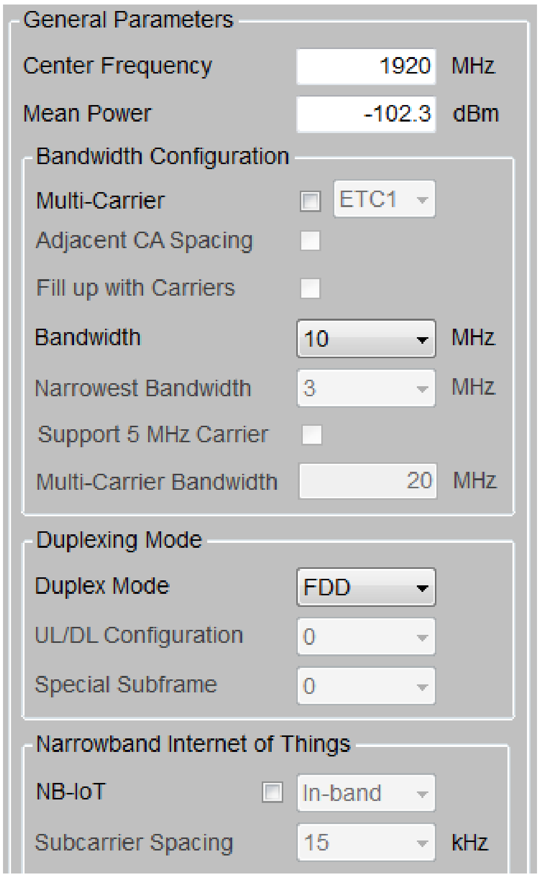


Fig. 3-33: General Parameters

- **Center Frequency** for SC
- **Mean Power** level

- **Bandwidth configuration**
  - Bandwidth for SC
  - Check Multi-Carrier for MC

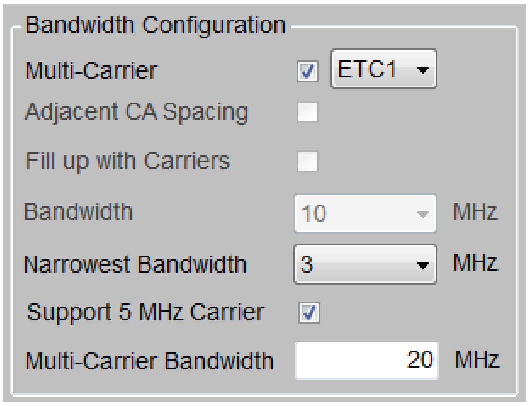


Fig. 3-34: Bandwidth settings for MC

  - Select between ETC1 and ETC3 (and ETC6 and ETC7 for NB-IoT)
  - **Fill up with Carriers** allows two additional carriers in ETC3 (see 2.3.4.2)
  - **Adjacent CA spacing** uses small offsets between carrier acc. Fig. 2-6.
  - **Bandwidth** is the main single carrier setting**.** *0.2 MHz* selects NB-IoT standalone mode.
  - **Narrowest Bandwidth, Support 5 MHz Carrier** and **Multi-carrier Bandwidth** are for **Multi-Carrier** mode only**.**

- **Duplexing Mode**
  - For TDD in addition **UL/DL configuration** and **Special Subframe**
- **Narrowband Internet of Things**

This area shows and sets NB-IoT parameters. The available settings depend on the settings in the section **Bandwidth Configuration.** If the Bandwidth is 0.2 MHz, standalone mode is used, for all others settings, you can switch on **In-band** or **Guard band** mode**.**

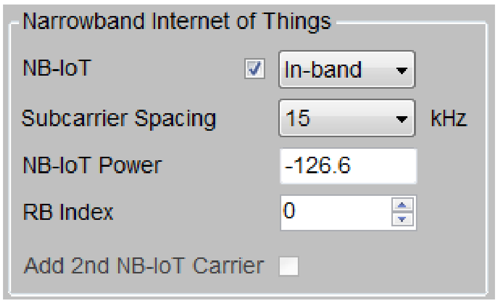


Fig. 3-35: Example for NB-IoT settings (here: In-Band)

Tab Block

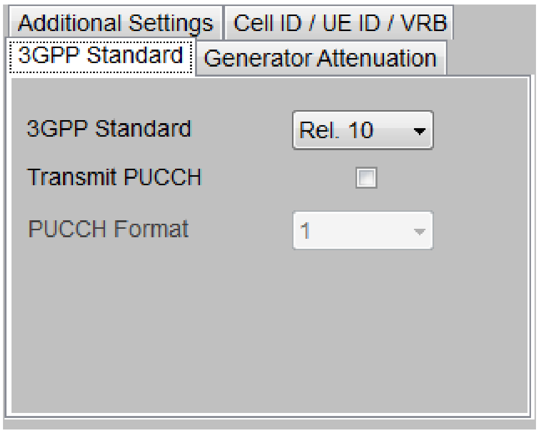


Fig. 3-36: Additional parameters in the tab area

A special area provides four tabs:

- **3GPP standard**
  - **Rel 8/9 or 10**
  - **Transmit PUCCH** transmits PUCCH in parallel with Format (Rel. 10)
- **Additional Settings**
  - **Filter Optimization:**
  - **Trigger Mode**
- **Cell ID, UE ID / VRB**

  Settings for the wanted and the interferer
- **Generator Attenuation**

  This section is used to enter compensations for external path attenuations.

Test Specific Parameters

More advanced settings for specific tests cases are described in the corresponding sections below.

3.2 Reference Sensitivity Level (Clause 7.2)

The reference sensitivity power level is the minimum mean power received at the antenna connector at which a given throughput requirement shall be met for a specified reference measurement channel [1].

The level for different Base Stations depends on the channel bandwidth, the FRC and the BS category as given in Table 3-. For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

Reference sensitivity levels for different channel bandwidth and BS categories					
LTE channel bandwidth [MHz]	Reference measurement channel	BS Type	Reference sensitivity power level, PREFSENS [dBm]		
			f ≤ 3 GHz	3 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz
1.4	FRC A1-1	Wide Area	-106.1	-105.8	
		Medium Range BS	-101.1	-100.8	
		Local Area	-98.1	-97.8	
		Home BS	-98.1	-97.8	
3	FRC A1-2	Wide Area	-102.3	-102.0	
		Medium Range BS	-97.3	-97.0	
		Local Area	-94.3	-94.0	
		Home BS	-94.3	-94.0	
5	FRC A1-3	Wide Area	-100.8	-100.5	
		Medium Range BS	-95.8	-95.5	
		Local Area	-92.8	-92.5	
		Home BS	-92.8	-92.5	
10	FRC A1-3* (2 Meas.)	Wide Area	-100.8	-100.5	
		Medium Range BS	-95.8	-95.5	-97.7
		Local Area	-92.8	-92.5	-94.7
		Home BS	-92.8	-92.5	
15	FRC A1-3* (3 Meas.)	Wide Area	-100.8	-100.5	
		Medium Range BS	-95.8	-95.5	
		Local Area	-92.8	-92.5	
		Home BS	-92.8	-92.5	
20	FRC A1-3* (4 Meas.)	Wide Area	-100.8	-100.5	
		Medium Range BS	-95.8	-95.5	-97.7
		Local Area	-92.8	-92.5	-94.7
		Home BS	-92.8	-92.5	
*This requirement shall be met for each consecutive application of a single instance of FRC A1-3 mapped to disjoint frequency ranges with a width of 25 resource blocks each.					

Table 3-6: Requirements for reference sensitivity level

LAA Band 46

The test cases for band 46 are not supported yet (FRCs A1-8 and A1-9 are not supported).

Test Setup

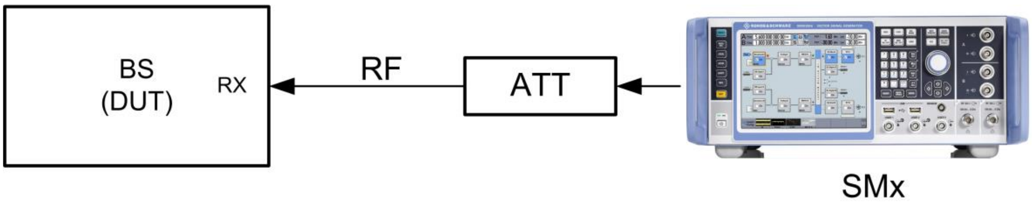


Fig. 3-37: Test setup reference sensitivity level. The SMW generates the LTE uplink signal

Settings:

- The Base Station transmits an LTE signal with maximum output power according to E-TM1.1.
- The SMW generates a LTE uplink signal with FRC and level settings according to Table 3- which is applied to the BS receiver port.

NB-IoT

NB-IoT tests are defined for standalone and in-band deployments.

NB-IoT standalone			
Channel bandwidth [MHz]	Reference measurement channel	Subcarrier spacing [kHz]	Reference sensitivity power level [dBm]
0.2	A14-1	15	126.6
0.2	A14-2	3.75	132.6

Table 3-7: Requirements for reference sensitivity level NB-IoT standalone

For in-band deployment, the LTE RBs are in principle adjacent to the NB-IoT RB with 24 RBs. For the channel bandwidths 10 MHz, 15 MHz and 20 MHz additional measurements with shifted allocations are required. Here, the FRC A1-3 with 25 RBs is needed.

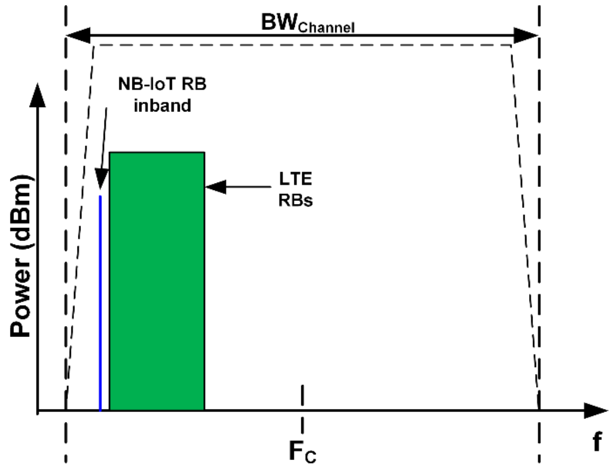


Fig. 3-38: Deployment reference sensitivity level NB-IoT. The LTE RBs are adjacent to the NB-IoT RB. For channel bandwidths 5 MHz, 15 MHz and 20 MHz additional measurements with shifted LTE RBs apply

NB-IoT in-band, Wide Area, f ≤ 3 GHz			
Channel bandwidth [MHz]	Reference measurement channel	Comment	Reference sensitivity power level [dBm]
3	A1-6	LTE RBs adjacent to NB-IoT RB	102.3
5	A1-7		100.8
10	A1-7* (A1-3) (2 Meas)	LTE allocation with 24 RBs adjacent + LTE allocation with 25 RBs shifted	100.8
15	A1-7* (A1-3) (3 Meas)	LTE allocation with 25 RBs adjacent and shifted	100.8
20	A1-7* (A1-3) (4 Meas)	LTE allocation with 25 RBs adjacent and shifted	100.8
*This requirement shall be met for a single instance of FRC A1-7 mapped to the 24 E-UTRA resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of FRC A1-3 mapped to disjoint frequency ranges with a width of 25 resource blocks each.			

Table 3-8: Requirements for reference sensitivity level for NB-IoT in-band

Test Procedure

As an example, settings for a Wide Area BS, $BW_{Channel}$ 10 MHz with FRC A1-3 are mentioned.

Setup at SMW

1. Use the standard procedure (see 3.1.2) to generate the uplink signal (example: Bandwidth 10 MHz and FRC A1-3). Use the VRB offset to shift the FRC application for additional measurements for bandwidths 10 MHz, 15 MHz and 20 MHz (see Table 3- and Table 3-).
2. Set the frequency and the level (example: -100.8 dBm)
3. Measure the throughput at the Base Station Receiver ports.

Demo Program

No further special settings are needed for this test. For MC tests, the second carrier is provided via path 2. The settings are reported.

*********** 7.2 Reference Sensitivity Level ***********

Generator Settings:
3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920 MHz
Mean Power: -100.8 dBm
Wanted Signal Attenuation: 0 dB
VRB Wanted Signal: 0

Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC	Power (dBm)	Status
7.2 Reference Selectivity Level					
LTE Wanted Signal	1920	10	FRC A1-3	-100.8	

Fig. 3-39: Example report for test case 7.2.

3.3 Dynamic Range (Clause 7.3)

The dynamic range is specified as a measure of the capability of the receiver to receive the wanted signal in the presence of an interfering signal inside the received channel bandwidth [1]. The interfering signal is an AWGN signal.

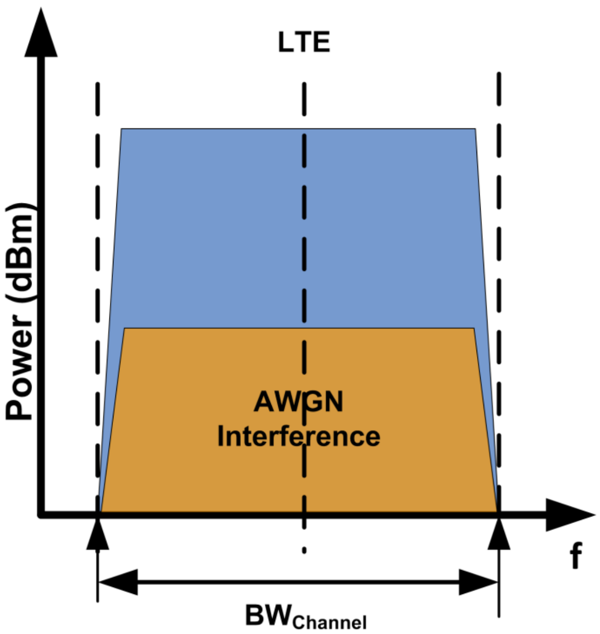


Fig. 3-40: Dynamic range. LTE carrier with AWGN interferer

The level for different Base Stations depends on the channel bandwidth, the FRC and the BS category as given in Table 3-. For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

BS Dynamic Range requirements						
LTE Channel bandwidth [MHz]	Reference measurement channel	BS Type	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]/BW	C/N [dB]	Type of interfering signal
1.4	FRC A2-1	Wide Area	-76.0	-88.7	12.7	AWGN
		Medium Range BS	-71.0	-83.7		
		Local Area	-68.0	-80.7		
		Home BS	-31.5	-44.2		
3	FRC A2-2	Wide Area	-72.1	-84.7	12.6	
		Medium Range BS	-67.1	-79.7		
		Local Area	-64.1	-76.7		
		Home BS	-27.6	-40.2		
5	FRC A2-3	Wide Area	-69.9	-82.5	12.6	
		Medium Range BS	-64.9	-77.5		
		Local Area	-61.9	-74.5		
		Home BS	-25.4	-38.0		
10	FRC A2-3	Wide Area	-69.9	-79.5	9.6	
		Medium Range BS	-64.9	-74.5		
		Local Area	-61.9	-71.5		
		Home BS	-25.4	-35.0		
15	FRC A2-3	Wide Area	-69.9	-77.7	7.8	
		Medium Range BS	-64.9	-72.7		
		Local Area	-61.9	-69.7		
		Home BS	-25.4	-33.2		
20	FRC A2-3	Wide Area	-69.9	-76.4	6.5	
		Medium Range BS	-64.9	-71.4		
		Local Area	-61.9	-68.4		
		Home BS	-25.4	-31.9		

Table 3-9: Requirements for Dynamic Range. In the SMW, AWGN is set via C/N ratio (which is calculated wanted power – Interferer power).

Test Setup

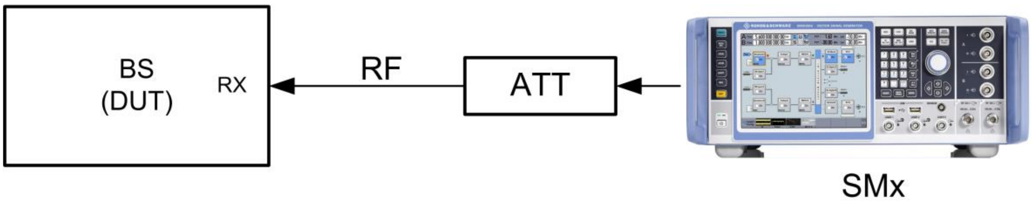


Fig. 3-41: Test setup Dynamic Range. The SMW generates the LTE uplink signal and the AWGN interferer.

Settings:

- The SMW generates a LTE uplink signal with FRC and level settings according to Table 3- which is applied to the BS receiver port.
- The SMW also generates the AWGN interferer

NB-IoT

NB-IoT tests are defined for standalone and in-band deployments.

NB-IoT standalone					
Channel bandwidth [MHz]	Reference measurement channel	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]/BW	C/N [dB]	Type of interfering signal
0.2	A15-1	-99.4	-96	-3.4	AWGN
0.2	A15-2	-105.3	-96	-9.3	

Table 3-10: Requirements for Dynamic Range NB-IoT standalone. In the SMW, AWGN is set via C/N ratio (which is calculated wanted power – Interferer power).

For in-band and guardband deployments, the AWGN is required for the whole channel bandwidth even if no LTE RBs are involved.

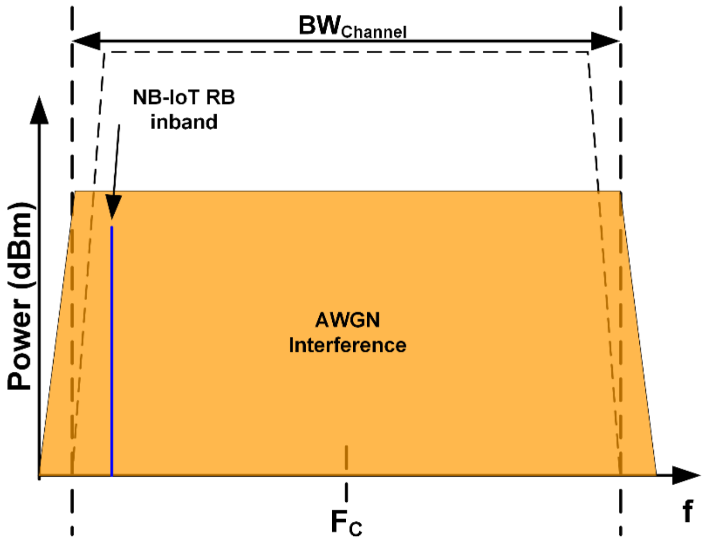


Fig. 3-42: Dynamic range with NB-IoT in-band. LTE carrier with AWGN interferer

NB-IoT in-band or guard band					
Channel bandwidth [MHz]	Reference measurement channel	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]/BW	C/N [dB]	Type of interfering signal
3	A15-1	-99.4	-84.2	- 15.2	AWGN
	A15-2	-105.3		-21.1	
5	A15-1	-99.4	-82.0	- 17.4	
	A15-2	-105.3		-23.3	
10	A15-1	-99.4	-79.0	- 20.4	
	A15-2	-105.3		-26.3	
15	A15-1	-99.4	-77.2	- 22.2	
	A15-2	-105.3		-28.1	
20	A15-1	-99.4	-76.0	- 23.4	
	A15-2	-105.3		-29.3	

Table 3-11: Requirements for Dynamic Range NB-IoT in-band or guard band. In the SMW, AWGN is set via C/N ratio (which is calculated wanted power – Interferer power).

Test Procedure

As an example, settings for a Wide Area BS, $BW_{Channel}$ 10 MHz with FRC A1-3 are mentioned.

Setup LTE Uplink

1. Use the standard procedure (see 3.1.2) to generate the uplink signal (example: Bandwidth 10 MHz and FRC A1-3)
2. Set the frequency and the level (example: -69.9 dBm)

Setup AWGN

3. Switch On the AWGN block and set the **System Bandwidth** according Table 3- (example in Fig. 3-43: $BW_{Channel}$ 10 MHz -> System bandwidth 9 MHz)
4. In the SMW the AWGN level is set relatively to the carrier power via Carrier to noise ratio. Set under Carrier/noise Ratio the C/N value of Table 3-. The **Carrier Power** and **Noise Power** are displayed (Fig. 3-44).

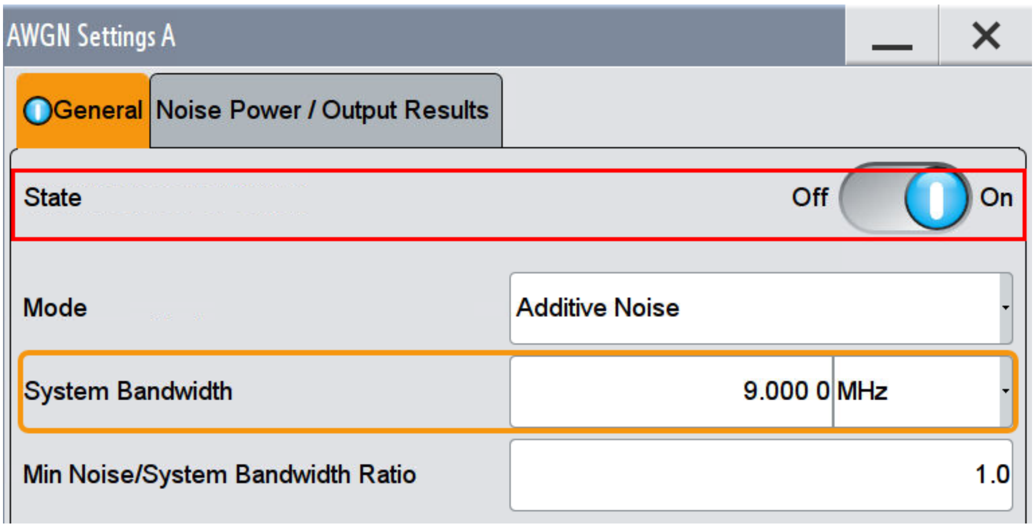


Fig. 3-43: AWGN block and system bandwidth

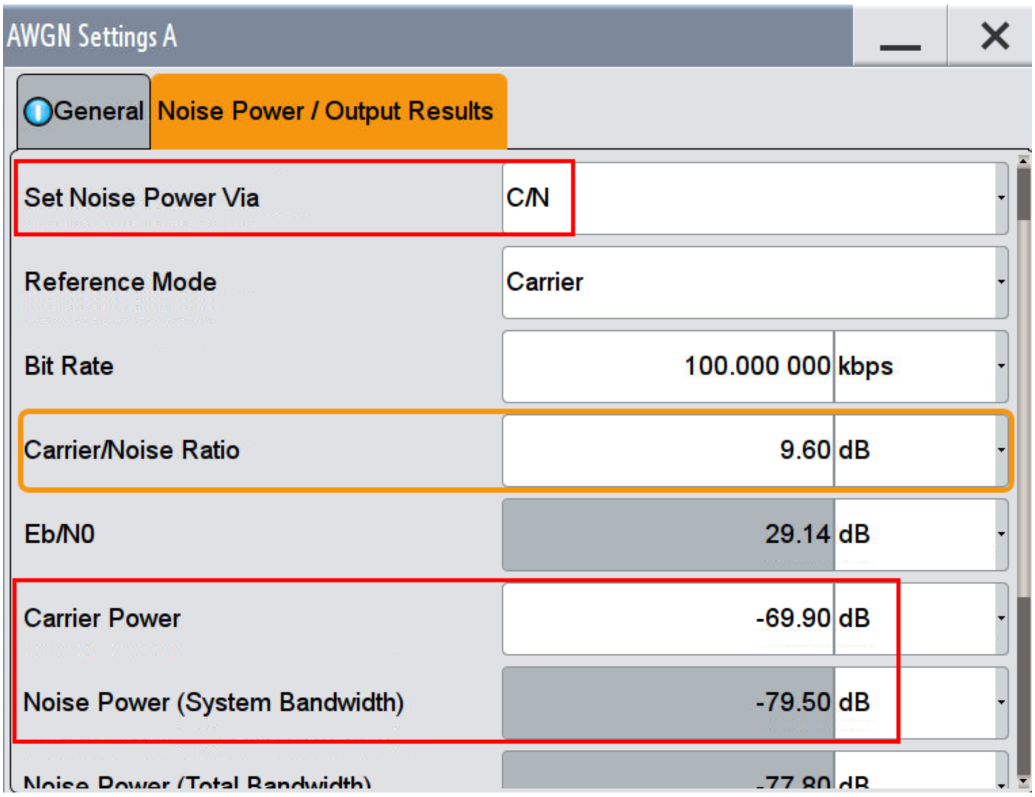


Fig. 3-44: AWGN settings are set by Carrier/Noise ratio relative to the Carrier power

5. Measure the throughput at the Base Station Receiver ports.
6. Repeat the measurement for all supported $BW_{Channel}$.

Relation between $BW_{Channel}$ and transmission bandwidth							
$BW_{Channel}$	0.2 MHz	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Resource Blocks (RB)	1	6	15	25	50	75	100
Transmission BW (AWGN System Bandwidth)	0.180 MHz	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz

Table 3-12: Relation between $BW_{Channel}$ and transmission bandwidth. The Transmission BW is used as the AWGN system bandwidth

Demo Program

For this test, one additional parameter must be defined. For MC tests the second carrier is provided via path 2. The settings are reported.

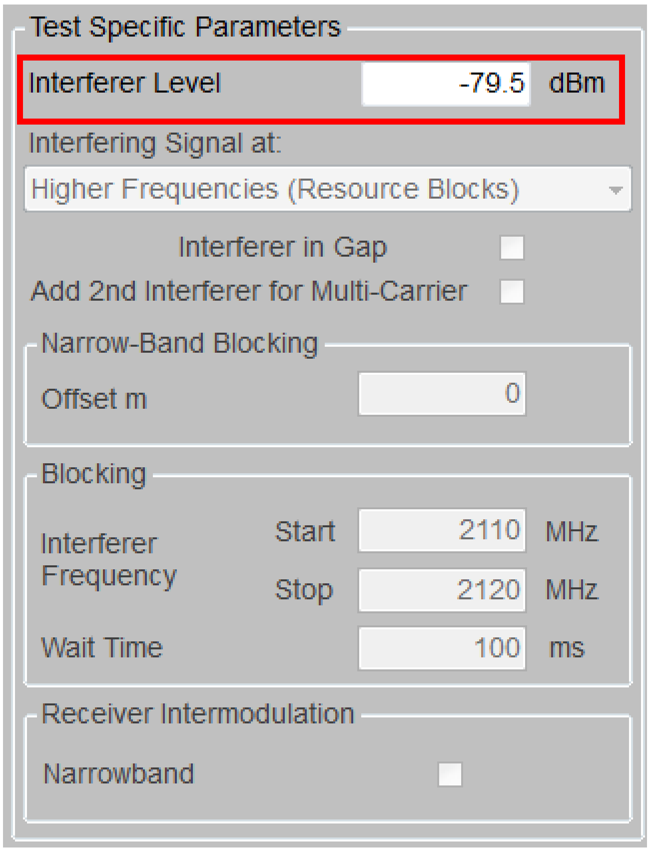


Fig. 3-45: Special settings for dynamic range.

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

*********** 7.3 Dynamic Range ***********

Generator Settings:
3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920 MHz
Mean Power: -69.9 dBm
AWGN Interference
C/N: 9.6 dB
Wanted Signal Attenuation: 0 dB
VRB Wanted Signal: 0

Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC	Power (dBm)	Status
7.3 Dynamic Range					
LTE Wanted Signal	1920	10	FRC A2-3	-69.9	
AWGN Interfering Signal	1920	9	---	-79.5	

Fig. 3-46: Example report for test case 7.3.

3.4 In-channel selectivity (Clause 7.4)

In-channel selectivity (ICS) is a measure of the receiver ability to receive a wanted signal at its assigned Resource Block locations in the presence of an interfering signal received at a larger power spectral density. The uplink interfering signal is set up with 16QAM modulation [1].

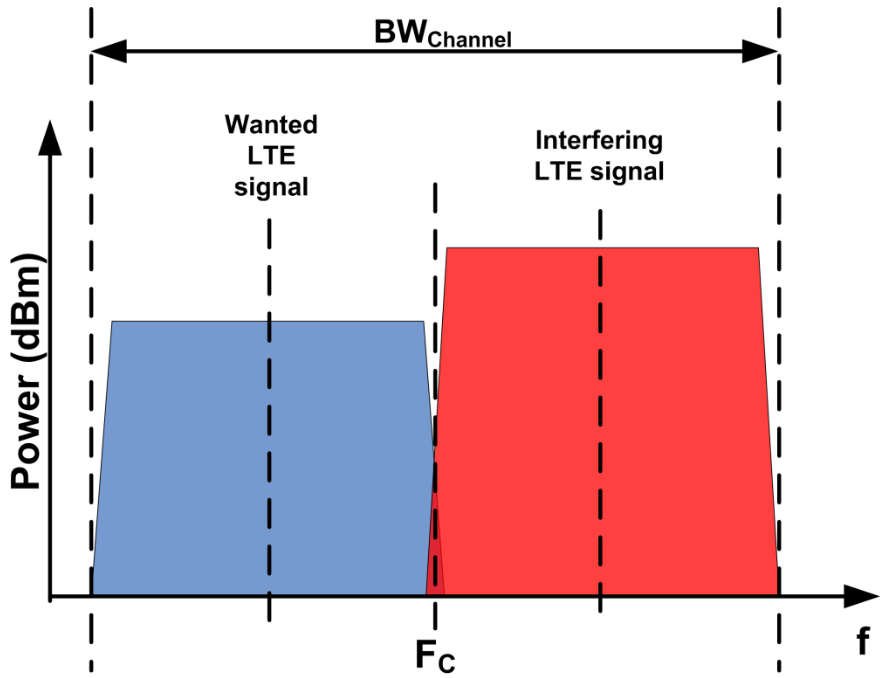


Fig. 3-47: In-channel selectivity. The wanted signal and interfering signal positioned around the center frequency.

The level for different Base Stations depends on the channel bandwidth, the FRC and the BS category as given in Table 3-. For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

In-channel selectivity requirements											
LTE Channel bandwidth [MHz]	Reference measurement channel	BS Type	**Wanted Signal**							**Interferer**	
			Wanted signal mean power						Offset (VRB)	Interfering signal mean power [dBm]	Type of interfering signal (16QAM) and offset (VRB)
			f ≤ 3 GHz		3 GHz < f ≤ 4.2 GHz		4.2 GHz < f ≤ 6.0 GHz				
			Abs. [dBm]	Rel [dB]	Abs. [dBm]	Rel [dB]	Abs. [dBm]	Rel [dB]			
1.4	FRC A1-4	Wide Area	-105.5	-18.5	-105.1	-18.1	-	-	0	-87	1.4 MHz LTE signal 3 RBs VRB: 3
		Medium Range	-100.5		-100.1					-82	
		Local Area	-97.5		-97.1					-79	
		Home	-97.5		-97.1					-79	
3	FRC A1-5	Wide Area	-100.7	-16.7	-100.3	-16.3	-	-	0	-84	3 MHz LTE signal 6 RBs VRB: 9
		Medium Range	-95.7		-95.3					-79	
		Local Area	-92.7		-92.3					-76	
		Home	-92.7		-92.3					-76	
5	FRC A1-2	Wide Area	-98.6	-17.6	-98.2	-17.2	-	-	0	-81	5 MHz LTE signal 10 RBs VRB: 15
		Medium Range	-93.6		-93.2					-76	
		Local Area	-90.6		-90.2					-73	
		Home	-90.6		-90.2					-73	
10	FRC A1-3	Wide Area	-97.1	-20.1	-96.7	-19.7	-	-	0	-77	10 MHz LTE signal 25 RBs VRB: 25
		Medium Range	-92.1		-91.7		-93.7	-21.7		-72	
		Local Area	-89.1		-88.7		-90.7	-21.7		-69	
		Home	-89.1		-88.7		-	-		-69	
15	FRC A1-3	Wide Area	-97.1	-20.1	-96.7	-19.7	-	-	12	-77	15 MHz LTE signal 25 RBs VRB: 38
		Medium Range	-92.1		-91.7					-72	
		Local Area	-89.1		-88.7					-69	
		Home	-89.1		-88.7					-69	
20	FRC A1-3	Wide Area	-97.1	-20.1	-96.7	-19.7	-	-	25	-77	20 MHz LTE signal 25 RBs VRB: 50
		Medium Range	-92.1		-91.7		-93.7	-21.7		-72	
		Local Area	-89.1		-88.7		-90.7	-21.7		-69	
		Home	-89.1		-88.7		-	-		-69	

Table 3-13: Requirements for ICS. The level of the wanted signal in the SMW is set relatively to interfering level.

LAA Band 46

The test cases for band 46 are not supported yet (FRCs A1-8 and A1-9 are not supported).

Test Setup

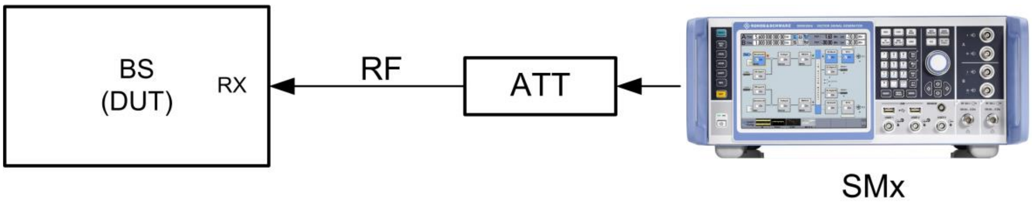


Fig. 3-48: Test setup ICS. The SMW generates the LTE uplink wanted and interfering signals

Settings:

- The SMW generates a LTE uplink signal with FRC and level settings according to Table 3-, which is applied to the BS receiver port.
- The SMW also generates the LTE interferer. It is provided in the same baseband block and path.

NB-IoT

NB-IoT tests are defined for in-band deployments.

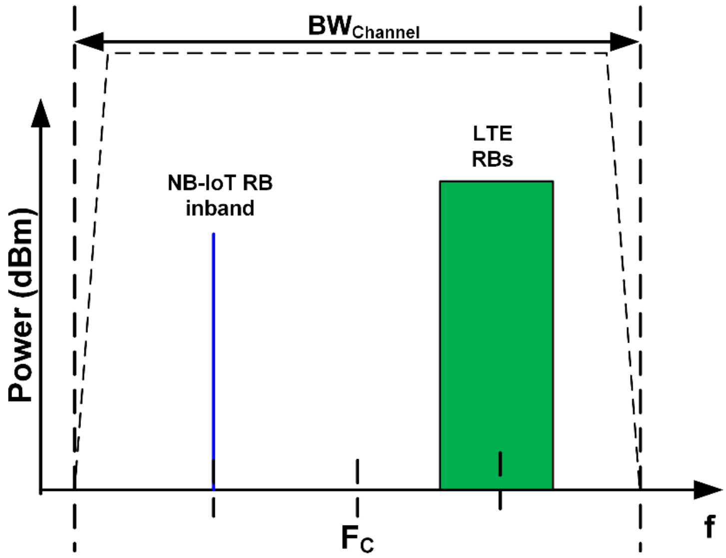


Fig. 3-49: In-channel selectivity for NB-IoT in-band. The wanted signal and interfering signal positioned on both sides of the center frequency in the middle of the available RBs.

Interfering signal is placed in one side of the F_c, while the NB-IoT PRB is placed on the other side. Both interfering signal and NB-IoT PRB are placed at the middle of the available PRB locations. The wanted NB-IoT tone is placed at the center of this NB-IoT PRB [1].

Use the setting from Table 3- and Table 3-3.

In-channel selectivity NB-IoT in-band with 15 kHz spacing							
LTE Channel bandwidth [MHz]	**Reference measurement channel**		**Wanted Signal**			**Interferer**	
	FRC	Tone offset	Mean power (f ≤ 3 GHz)		Offset VRB	Mean power	Type of interfering signal (16QAM) and offset (VRB)
			Abs [dBm]	Rel [dB]			
3	A14-1	5	-122.9	-38.9	0	-84	3 MHz LTE signal 6 RBs VRB: 10
5				-41.9	1	-81	5 MHz LTE signal 10 RBs VRB: 17
10				-45.9	0	-77	10 MHz LTE signal 25 RBs VRB: 37
15					6		15 MHz LTE signal 25 RBs VRB: 56
20					12		20 MHz LTE signal 25 RBs VRB: 75

Table 3-14: Requirements for ICS for NB-IoT with 15 kHz spacing. The level of the wanted signal in the SMW is set relatively to interfering level.

In-channel selectivity NB-IoT in-band with 3.75 kHz spacing							
LTE Channel bandwidth [MHz]	**Reference measurement channel**		**Wanted Signal**			**Interferer**	
	FRC	Tone offset	Mean power (f ≤ 3 GHz)		Offset VRB	Mean power	Type of interfering signal (16QAM) and offset (VRB)
			Abs [dBm]	Rel [dB]			
3	A14-2	23	-128.8	-44.8	0	-84	3 MHz LTE signal 6 RBs VRB: 10
5				-47.8	1	-81	5 MHz LTE signal 10 RBs VRB: 17
10				-51.8	0	-77	10 MHz LTE signal 25 RBs VRB: 37
15					6		15 MHz LTE signal 25 RBs VRB: 56
20					12		20 MHz LTE signal 25 RBs VRB: 75

Table 3-3: Requirements for ICS for NB-IoT with 3.75 kHz spacing. The level of the wanted signal in the SMW is set relatively to interfering level.

Test Procedure

The in-channel selectivity test is performed with a wanted LTE signal that does not have all resource blocks allocated and is positioned adjacent on one side of the center frequency. As FRC A1-3 with 25 RBs is used also in channel bandwidths of 15 MHz and 20 MHz, not all RBs are allocated in the wanted signal. Here the RB allocation has to be shifted to be adjacent to the center frequency.

The LTE interferer with 16QAM modulation is set adjacent to the wanted signal and on the opposite side of the center frequency. Here again the RB allocation has to be shifted.

The wanted and the interfering LTE signals can both be generated using the same path (baseband and RF) in the SMW. An additional User Equipment (UE) in the uplink is configured for the interfering signal. The level difference is handled in the baseband. As the interferer level is higher, this is used as the reference level and the level of the wanted signal is set relatively lower to the interferer level.

The test shall also be performed by exchanging the wanted and interfering signal.

As an example, settings for a Wide Area BS, $BW_{Channel}$ 20 MHz with FRC A1-3 are mentioned.

Setup of the wanted LTE signal (UE1)

1. Use the standard procedure (see 3.1.2) to generate the UE1 uplink signal according to Table 3- (example: Bandwidth 20 MHz and FRC A1-3).
2. Adjust the **Offset VRB** according to Table 3-.
3. Set an **UE ID/n_RNTI** (see Fig. 3-50: example: 1)

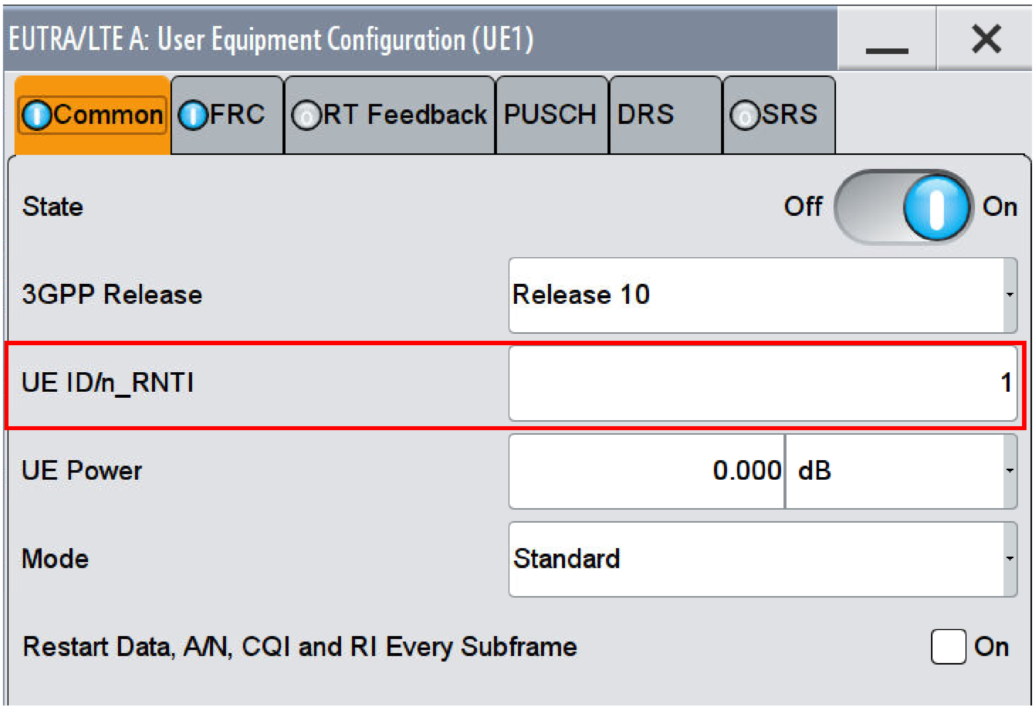


Fig. 3-50: Setting of the UE ID of the wanted signal (UE1)

Setup of the interfering LTE signal (UE2)

4. Enable **UE2** as the interfering signal (Fig. 3-51)
5. Set the **UE ID** of UE2 to another value than UE1 (same way like in Fig. 3-50)

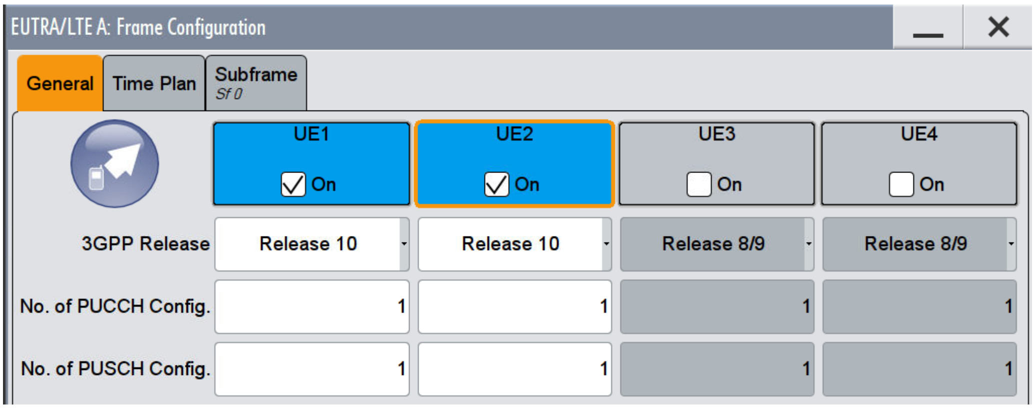


Fig. 3-51: ICS uses two UEs. UE1 is the wanted signal, UE2 is the interfering signal.

6. In **Frame Configuration** click tab **Subframe**.

7. Set for UE2 the Modulation 16QAM, the RB number and the Offset VRB according to Table 3-. (example: RB 25 and Offset 50)

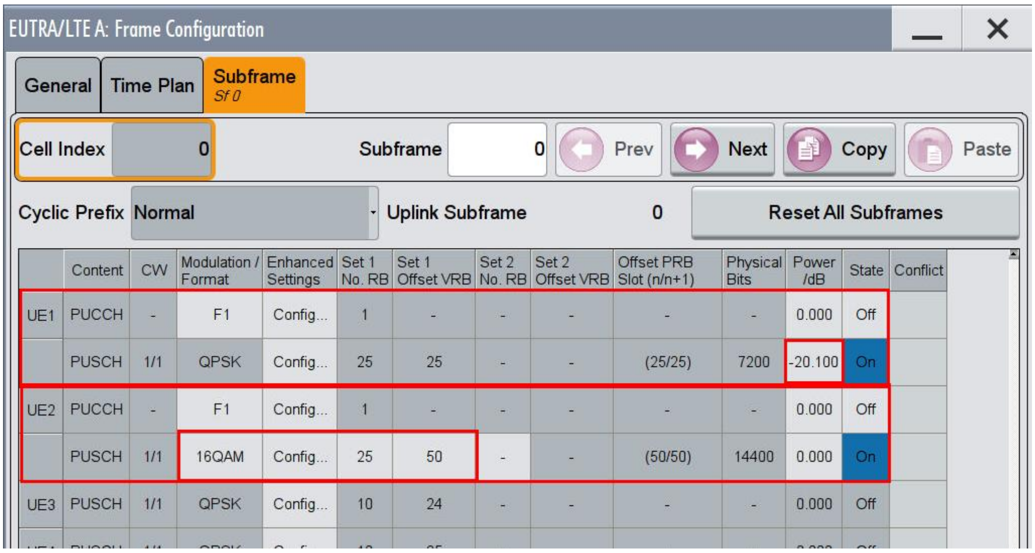


Fig. 3-52: UE1 (wanted signal) uses FRC settings. The level is set relatively to UE2. UE2 (Interferer) uses 16QAM modulation. RB allocation is shifted by Offset VRB.

8. Set the **frequency.** Set the main **level** to the **sum** of wanted and interfering level according to Table 3- (example: -97.1 dBm - 77 dBm = - 76.96 dBm)

9. Set the **Power** (relative level) (Fig. 3-52) of UE1 (wanted signal) according to Table 3- (example -20.1 dB)

10. Measure the throughput at the Base Station Receiver ports.

11. Repeat measurement with switched wanted and interfering signal (Wanted signal at higher RB, Interferer at lower RB)

12. Repeat the measurement for all supported $BW_{Channel}$.

Demo Program

For this test, additional parameters must be defined. For MC tests, the second carrier is provided via baseband B and RF path B. The settings are reported.

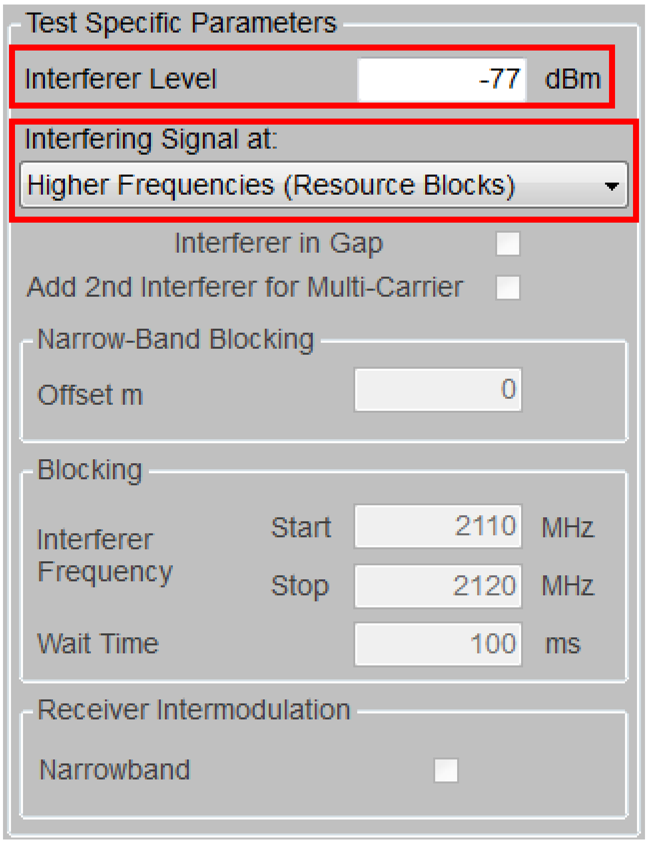


Fig. 3-53: Special settings for in-channel selectivity.

The level for the in-channel LTE interferer can be entered directly. Select the position of the interferer. Please note the settings from the specification listed in Table 3-.

*********** 7.4 In-Channel Selectivity ***********

3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920MHz
Mean Power: -76.96 dBm
Wanted Signal Modulation: QPSK
Interfering Signal Modulation: 16-QAM
Wanted Signal Attenuation: 0 dB
VRB Wanted Signal: 0
VRB Interfering Signal: 25
Interfering Signal at : Higher Frequencies (Resource Blocks)

Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC	Power (dBm)	Status
7.4 In-Channel Selectivity					
LTE Wanted Signal	1920	10	FRC A1-3	-97.1	
LTE Interfering Signal	1920	10	---	-77	

Fig. 3-54: Example report for test case 7.4.

3.5 Adjacent Channel Selectivity and narrow-band blocking (Clause 7.5)

3.5.1 Adjacent Channel Selectivity (ACS)

Adjacent channel selectivity (ACS) is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an adjacent channel signal with a specified center frequency offset of the interfering signal to the band edge of a victim system. The uplink interfering signal is set up with QPSK modulation [1].

In Fig. 3-55, a wanted LTE signal is shown along with the interfering LTE signal placed with an offset to the higher edge F_{edge_high} of the channel bandwidth. In a second test, the LTE Interferer is placed with an offset to the lower edge F_{edge_low}.

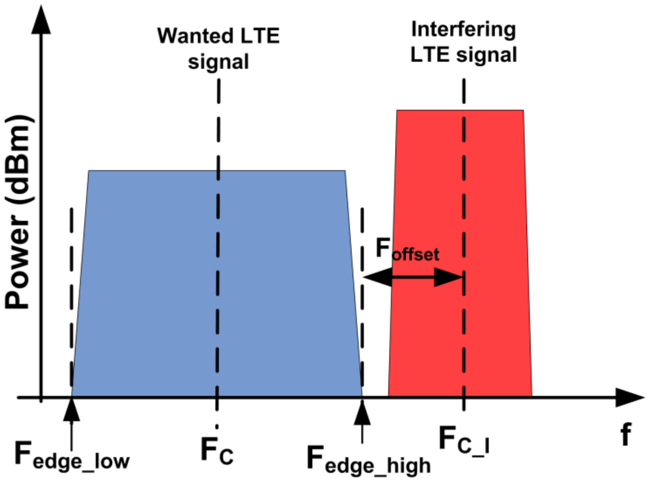


Fig. 3-55: ACS. the interfering signal is placed with an offset from higher edge of the channel.

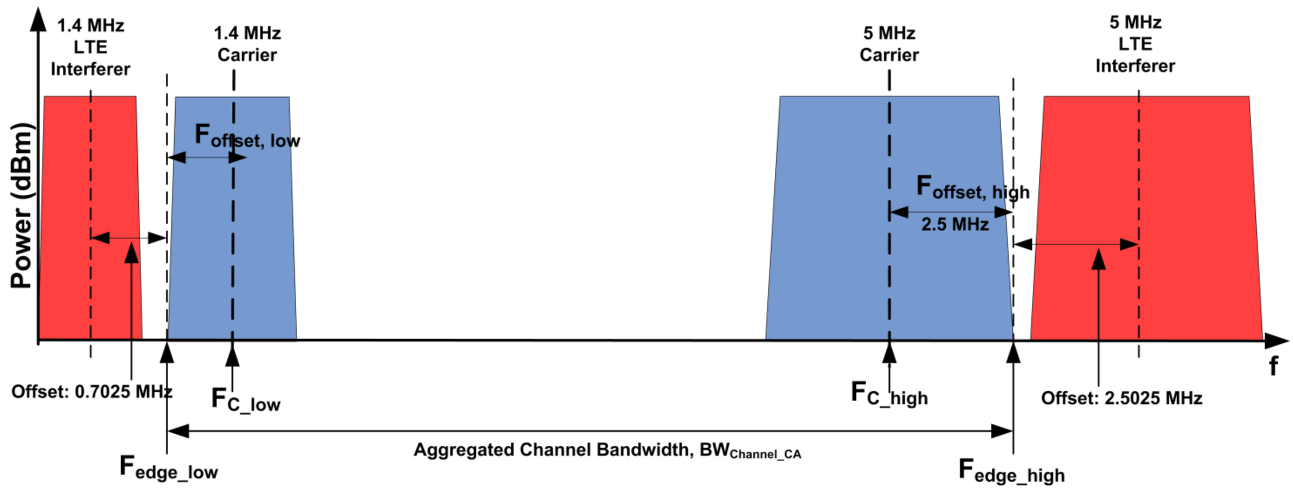


Fig. 3-56: Adjacent Channel Selectivity for multi-carrier signal (example: wanted signal of aggregated bandwidth of 20 MHz with carriers of 5 MHz and 1.4 MHz).

Non-contiguous Spectrum

The ACS requirement applies additionally inside any sub-block gap, in case the sub-block gap size is at least as wide as the LTE interfering signal according to Table 3-4 for wide area, medium range and local area base stations (see Fig. 3-57).

The interfering signal offset is defined relative to the sub-block edges inside the sub-block gap [1].

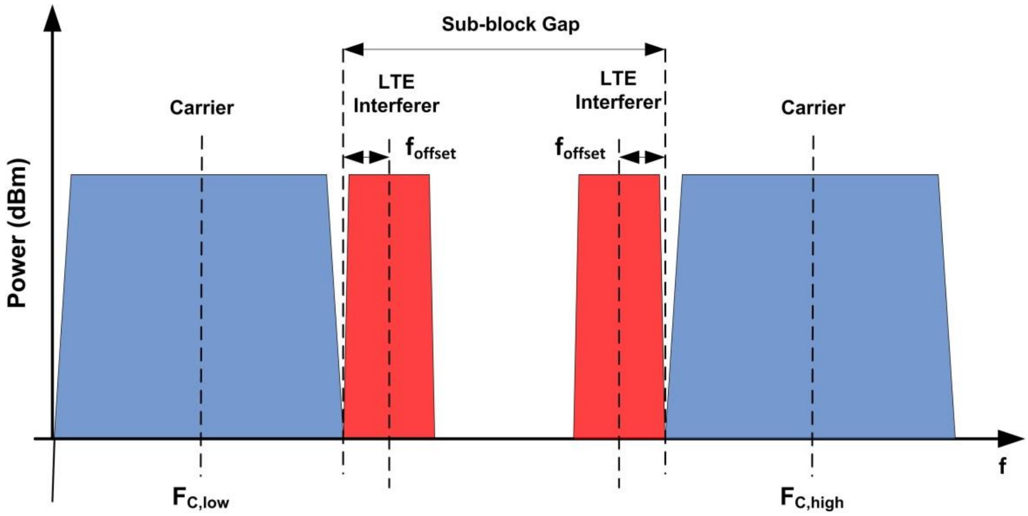


Fig. 3-57: Adjacent Channel Selectivity for non-continuous spectrum. Interfering signals are located in sub-block gap.

Multi-band Operation

The ACS requirement applies additionally inside any gap between the operating bands, in case the gap size is at least as wide as the LTE interfering signal according to Table 3-4 for wide area, medium range and local area base stations.

The interfering signal offset is defined relative to the RF bandwidth edges inside the gap.

The level for different Base Stations depends on the channel bandwidth, the FRC and the BS category as given in Table 3-4. For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

ACS requirements for different BS categories						
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	Reference measurement channel	BS Type	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal (Modulation: QPSK)
1.4	FRC A1-1	Wide Area	-95.8	-52	± 0.7025	1.4 MHz LTE signal
		Medium Range BS	-90.8	-47		
		Local Area	-87.8	-44		
		Home BS	-71.8	-28		
3	FRC A1-2	Wide Area	-95.0	-52	± 1.5075	3 MHz LTE signal
		Medium Range BS	-90.0	-47		
		Local Area	-87.0	-44		
		Home BS	-71.0	-28		
5	FRC A1-3	Wide Area	-95.5	-52	± 2.5025	5 MHz LTE signal
		Medium Range BS	-90.5	-47		
		Local Area	-87.5	-44		
		Home BS	-71.5	-28		
10	FRC A1-3	Wide Area	-95.5	-52	± 2.5075	5 MHz LTE signal
		Medium Range BS	-90.5	-47		
		Local Area	-87.5	-44		
		Home BS	-71.5	-28		
15	FRC A1-3	Wide Area	-95.5	-52	± 2.5125	5 MHz LTE signal
		Medium Range BS	-90.5	-47		
		Local Area	-87.5	-44		
		Home BS	-71.5	-28		
20	FRC A1-3	Wide Area	-95.5	-52	± 2.5025	5 MHz LTE signal
		Medium Range BS	-90.5	-47		
		Local Area	-87.5	-44		
		Home BS	-71.5	-28		

Table 3-4: Requirements for ACS

LAA Band 46

ACS requirements for different BS categories for band 46						
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	Reference measurement channel	BS Type	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal (Modulation: QPSK)
10	FRC A1-3	Medium Range BS	-90.5	-47	± 10.0175	20 MHz LTE signal
		Local Area	-87.5	-44		
20	FRC A1-3	Medium Range BS	-90.5	-47	± 10.0175	20 MHz LTE signal
		Local Area	-87.5	-44		

Table 3-17: ACLS Requirements for band 46

NB-IoT

NB-IoT tests are defined for all deployments.

For standalone, a NB-IoT interferer is placed with 100 kHz offset. For in-band or guard band, a LTE interferer is placed with an offset to channel edge. For all settings see Table 3-, Table 3- and Table 3-.

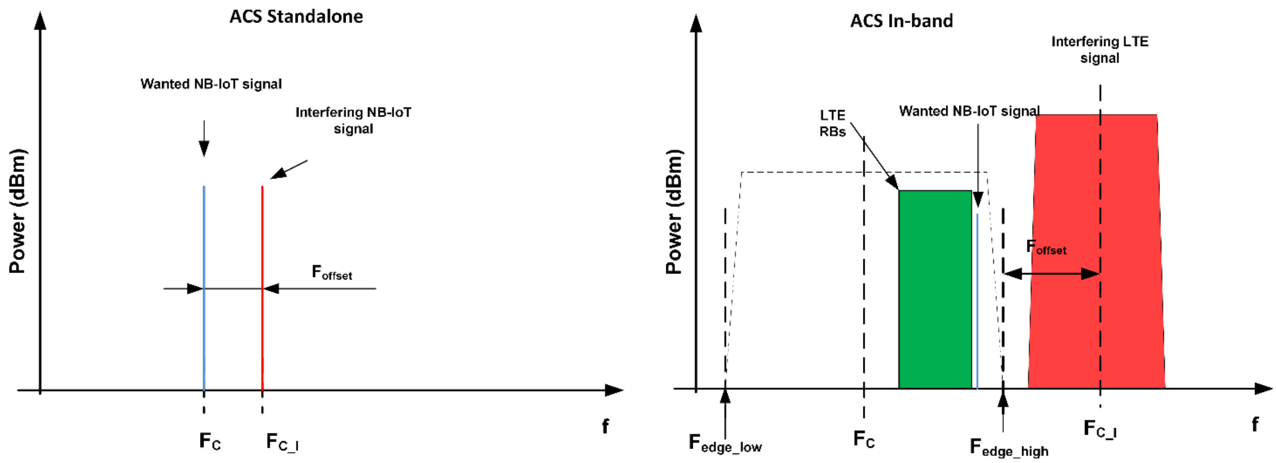


Fig. 3-58: ACS with NB-IoT standalone (left) and in-band (right). The interfering signal is placed with an offset.

ACS NB-IoT standalone						
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	Reference measurement channel	Carrier spacing	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal
0.2	A14-1	15	-107.1	-52	± 100	NB-IoT
	A14-2	3.75	-113.1			

Table 3-18: Requirements for ACS NB-IoT standalone

ACS NB-IoT in-band						
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	Reference measurement channel	Carrier spacing	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal (QPSK)
3	A14-1	15	-118.6	-52	± 1.5075	3 MHz LTE
	A14-2	3.75	-124.6			
5	A14-1	15	-120.6		± 2.5025	5 MHz LTE
	A14-2	3.75	-126.6			
10	A14-1	15	-120.6		± 2.5075	
	A14-2	3.75	-126.6			
15	A14-1	15	-120.6		± 2.5125	
	A14-2	3.75	-126.6			
20	A14-1	15	-120.6		± 2.5025	
	A14-2	3.75	-126.6			

Table 3-19: Requirements for ACS NB-IoT in-band

ACS NB-IoT guard band						
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	Reference measurement channel	Carrier spacing	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal (QPSK)
5	A14-1	15	-120.6	-52	± 2.5025	5 MHz LTE
	A14-2	3.75	-126.6			
10	A14-1	15	-120.6		± 2.5075	
	A14-2	3.75	-126.6			
15	A14-1	15	-120.6		± 2.5125	
	A14-2	3.75	-126.6			
20	A14-1	15	-120.6		± 2.5025	
	A14-2	3.75	-126.6			

Table 3-20: Requirements for ACS NB-IoT guard band

Test Setup

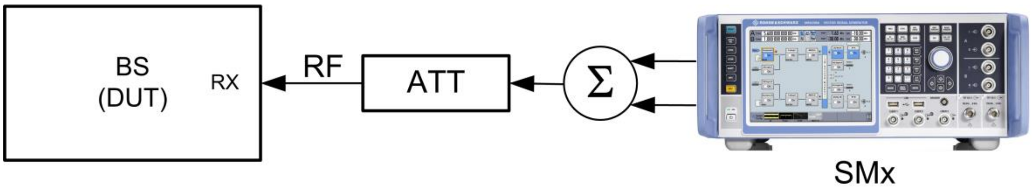


Fig. 3-59: Test setup ACS for SC and MC with BWaggr smaller 160 MHz. The SMW generates the LTE uplink wanted and interfering signals with two paths.

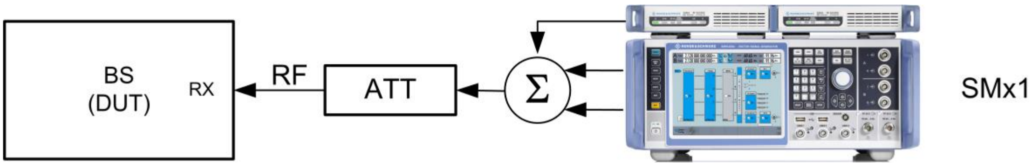


Fig. 3-60: Test setup ACS for MC with BWaggr greater 160 MHz. The SMW generates the MC LTE uplink wanted signal with two paths. The SMW generates the LTE interfering signal and uses the SGS as an additional RF path.

Settings:

- The SMW generates a LTE uplink signal with FRC and level settings according to Table 3-4, which is applied to the BS receiver port.
- In SC, the SMW also generates the LTE interferer. It is provided in the second path.
- In MC, the SMW generates the wanted signal in BB A and the LTE interferer in BB B. If the wanted carriers are separated by more than 160 MHz, two basebands A + B generate the wanted signal, the baseband C generates the LTE interferer and is routed via IQ to the SGS
- Use a Hybrid Combiner to sum all signals.

Test Procedure Single Carrier

The wanted and the interfering LTE signals are generated using different paths (baseband and RF) in the SMW.

The test shall also be performed by changing the position of interfering signal to the lower edge.

As an example, settings for a Wide Area BS, $BW_{Channel}$ 20 MHz with FRC A1-3 are mentioned.

Setup of the wanted LTE signal (path A)

1. Use the standard procedure (see 3.1.2) to generate the UE1 uplink signal according to Table 3-4 (example: Bandwidth 20 MHz, FRC A1-3 and level -95.5 dBm).

Setup of the interfering LTE signal (path B)

2. Set up an uplink LTE signal with the settings Level, $BW_{Channel}$ according to Table 3-4. (Example: Level -52 dBm, BW 5 MHz)
3. Set up the full **RB** allocation. (see Fig. 3-61, example in 5 MHz 25 RB are allocated)

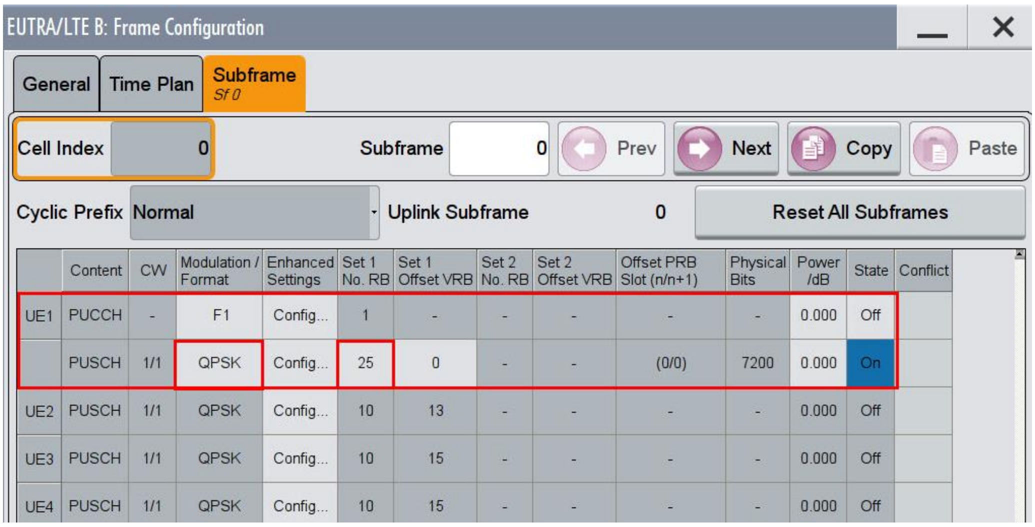


Fig. 3-61: ACS interferer is generated by path B. Instead of a FRC, use the full RB allocation (example 25 RB). Modulation is QPSK.

4. Set the frequency F_{c_I} of the interferer (example: $F_{c\_I} = F_c + BW_{Channel} / 2 + 2.5025$ MHz)
5. Measure the throughput at the Base Station Receiver ports.
6. Repeat measurement with interfering signal at lower edge

Test Procedure Multicarrier

For MC both carriers of the wanted signal are generated by path A only if the aggregated bandwidth is smaller than 160 MHz. Else two basebands are used (A + B). Both simulated UEs have to be time aligned. The Interferer is generated by one additional baseband and RF path. If BW_{aggr} is smaller 160 MHz, baseband B and RF B are used. Else Baseband C and the connected SGS are used.

As an example, the multi carrier example from ETC1 of 2.3.4.1 is used.

1. Set in the System Configuration 2 x 1 x 1 for a BW_{aggr} is smaller 160 MHz, else

   3 x 1 x 1
2. Set up each carrier according the standard procedure in 3.1.2.

   Set the LTE interferer in an additional baseband (see Fig. 3-61). If BW_{aggr} is smaller 160 MHz use BB B and route it to RF B, else use BB C and route it via IQ OUT 1 to the connected SGS.

Demo Program

For this test, additional parameters must be defined. The settings are reported.

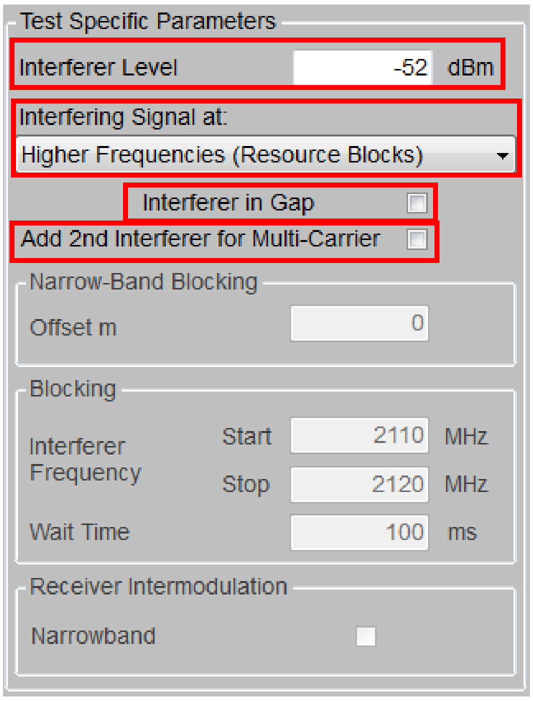


Fig. 3-62: Special settings for ACS.

The level for the adjacent LTE interferer can be entered directly. Select the position of the interferer. For MC tests, **Add 2nd Interferer for Multi-Carrier** enables two Interferers in parallel. If ETC3 is selected, you can place the **Interferer in Gap**. Please note the settings from the specification listed in Table 3-4.

*********** 7.5a Adjacent Channel Selectivity ***********

3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920 MHz
Mean Power: -95.5 dBm
Wanted Signal Attenuation: 0 dB
Interfering Signal Attenuation: 0 dB
VRB Wanted Signal: 0
Interfering Signal at : Higher Frequencies (Resource Blocks)

Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC	Power (dBm)	Status
7.5a Adjacent Channel Selectivity					
LTE Wanted Signal Transmitted	1920	10	FRC A1-3	-95.5	
Adjacent LTE Interfering Signal	1927.5075	5		-52	

Fig. 3-63: Example report for test case 7.5a.

3.5.2 Narrow-band blocking

Narrow Band Blocking is similar to ACS but the interfering signal consists of only one resource block. The uplink interfering signal is set up with QPSK modulation.

The interferer is placed adjacent to the wanted signal, but only one RB is allocated (see Fig. 3-64). The measurement is repeated with shifting this one RB inside the transmission bandwidth of the interferer. Again, the whole measurements are repeated at the lower edge of the wanted signal.

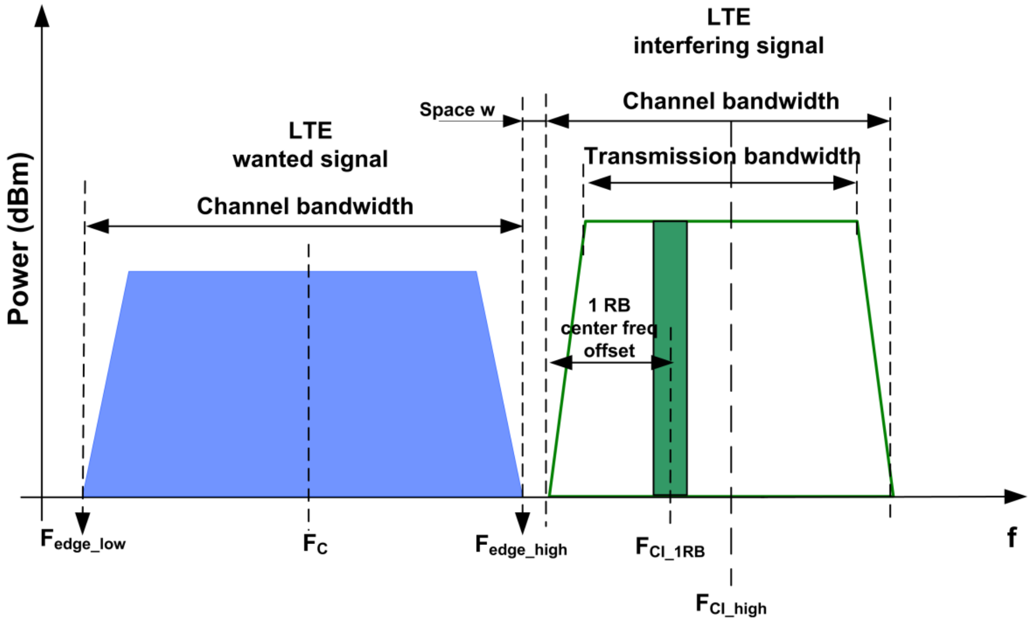


Fig. 3-64: Narrowband blocking: Interfering LTE signal, 1 RB only allocated, is placed adjacent from the upper edge of the wanted signal channel bandwidth. Space w is declared in the test procedure.

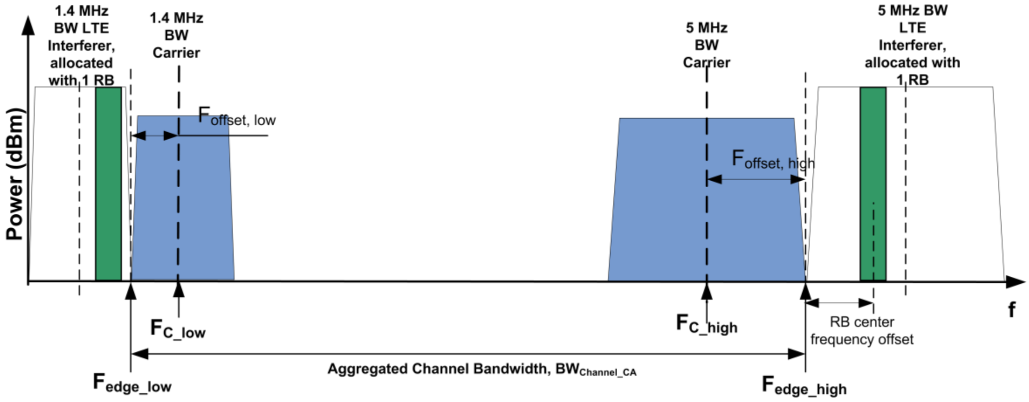


Fig. 3-65: Narrowband blocking for multi-carrier signal (example: wanted signal of aggregated bandwidth of 20 MHz with Carrier of 5 MHz and 1.4 MHz).

Non-contiguous Spectrum

The narrowband blocking requirement applies in addition inside any sub-block gap, in case the sub-block gap size is at least as wide as the channel bandwidth of the LTE interfering signal according to Table 3-.

The interfering signal offset is defined relative to the sub-block edges inside the sub-block gap. [1]

The location for the interfering signal is analog to Fig. 3-57 for Adjacent Channel Selectivity, except that the interfering signal is allocated with 1 RB.

Multiband Operation

The narrowband blocking requirement applies in addition inside any gap between the operating bands in case the gap size is at least as wide as the LTE interfering signal according to Table 3-.

The interfering signal offset is defined relative to the RF bandwidth edges inside the gap.

For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput with the settings of Table 3-.

Narrow-band blocking requirements						
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	**Reference measurement channel**	**BS Type**	**Wanted signal mean power [dBm]**	**Interfering signal mean power [dBm]**	**Interfering RB center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]**	**Type of interfering signal with 1 RB and QPSK Modulation**
1.4	FRC A1-1	Wide Area	-100.8	-49	± (0.2525+m*0.18), m = 0,1,2,3,4,5	1.4 MHz LTE signal
		Medium Range BS	-95.8	-44		
		Local Area	-92.8	-41		
		Home BS	-84.8	-33		
3	FRC A1-2	Wide Area	-97.0	-49	± (0.2475+m*0.18), m = 0,1,2,3,4,7,10,13	3 MHz LTE signal
		Medium Range BS	-92.0	-44		
		Local Area	-89.0	-41		
		Home BS	-81.0	-33		
5	FRC A1-3	Wide Area	-95.5	-49	± (0.3425+m*0.18), m = 0,1,2,3,4,9,14,19,24	5 MHz LTE signal
		Medium Range BS	-90.5	-44		
		Local Area	-87.5	-41		
		Home BS	-79.5	-33		
10	FRC A1-3	Wide Area	-95.5	-49	± (0.3475+m*0.18), m = 0,1,2,3,4,9,14,19,24	5 MHz LTE signal
		Medium Range BS	-90.5	-44		
		Local Area	-87.5	-41		
		Home BS	-79.5	-33		
15	FRC A1-3	Wide Area	-95.5	-49	± (0.3525+m*0.18), m = 0,1,2,3,4,9,14,19,24	5 MHz LTE signal
		Medium Range BS	-90.5	-44		
		Local Area	-87.5	-41		
		Home BS	-79.5	-33		
20	FRC A1-3	Wide Area	-95.5	-49	± (0.3425+m*0.18), m = 0,1,2,3,4,9,14,19,24	5 MHz LTE signal
		Medium Range BS	-90.5	-44		
		Local Area	-87.5	-41		
		Home BS	-79.5	-33		

Table 3-21: narrow band blocking requirements

NB-IoT

NB-IoT tests are defined for all deployments.

For standalone, a NB-IoT interferer is placed with an offset to the channel edge of the wanted NB-IoT signal. For in-band or guard band, a LTE interferer is placed with an offset to channel edge. For all settings see Table 3-, Table 3- and Table 3-.

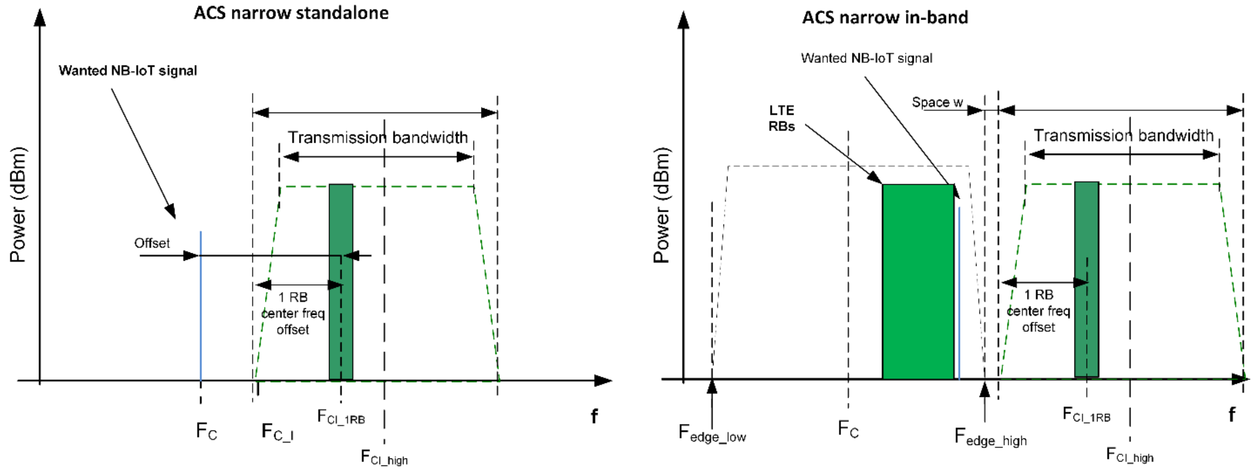


Fig. 3-66: Narrowband blocking NB-IoT Standalone (left) and in-band (right): Interfering LTE signal, 1 RB only allocated, is placed adjacent from the upper edge of the wanted signal channel bandwidth. Space w is declared in the test procedure.

Narrow-band blocking requirements NB-IoT standalone					
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	Reference measurement channel	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering RB center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal with 1 RB and QPSK Modulation
0.2	FRC A14-1	-114.6	-49	±(240 +m*180), m=0, 1, 2, 3, 4, 9, 14	3 MHz LTE signal
	FRC A14-2	-120.6			

Table 3-22: narrow band blocking requirements NB-IoT standalone

Narrow-band blocking requirements NB-IoT in-band					
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	Reference measurement channel	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering RB center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal with 1 RB and QPSK Modulation
3	FRC A14-1	-115.6	-49	±(247.5+m*180), m=0, 1, 2, 3, 4, 7, 10, 13	3 MHz LTE signal
	FRC A14-2	-121.6			
5	FRC A14-1	-118.6		±(342.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz LTE signal
	FRC A14-2	-124.6			
10	FRC A14-1	-120.6		±(347.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
	FRC A14-2	-126.6			
15	FRC A14-1	-120.6		±(352.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
	FRC A14-2	-126.6			
20	FRC A14-1	-120.6		±(342.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
	FRC A14-2	.126.6			

Table 3-23: narrow band blocking requirements NB-IoT in-band

Narrow-band blocking requirements NB-IoT guard band					
LTE Channel bandwidth of the lowest (highest) carrier received [MHz] ($BW_{Channel}$)	Reference measurement channel	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering RB center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal with 1 RB and QPSK Modulation
5	FRC A14-1	-118.6	-49	±(342.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz LTE signal
	FRC A14-2	-124.6			
10	FRC A14-1	-120.6		±(347.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
	FRC A14-2	-126.6			
15	FRC A14-1	-120.6		±(352.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
	FRC A14-2	-126.6			
20	FRC A14-1	-120.6		±(342.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
	FRC A14-2	.126.6			

Table 3-24: narrow band blocking requirements NB-IoT guard band

Test Procedure

In Fig. 3-64, a small gap between the channel edges of both the LTE signals is shown and mentioned as **space w**. This value adjusts the interfering signal center frequency, such that the value of ‘m’ positions the RB at the stated offset frequency. Then, in SMW, the value of ‘m’ can be configured in a simple way by using the **Offset VRB**. It shifts the RBs center frequency from lower edge to upper edge within the transmission bandwidth, for example m = 0, VRB = 0 and m = 1, VRB = 1 and so on. Space w and the resulting frequency of the interferer are summarized in Table 3-.

Center Frequency offset and space w			
LTE Channel bandwidth ($BW_{Channel}$) [MHz]	LTE interferer with 1RB [MHz]	Space **w** [kHz]	Interfering center frequency offset from the lower (higher) edge (± $BW_{Interferer\_Channel}/2$ ± w) [MHz]
0.2 (NB-IoT standalone)	3	0	± 1.5000
1.4	1.4	2.5	± 0.7025
3	3	7.5	± 1.5075
5	5	2.5	± 2.5025
10	5	7.5	± 2.5075
15	5	12.5	± 2.5125
20	5	2.5	± 2.5025

Table 3-25: Resulting Interferer frequency and space w

Test Procedure Single Carrier

The wanted and the interfering LTE signals are generated using different paths (baseband and RF) in the SMW.

The test shall also be performed by changing the position of interfering signal to the lower edge.

As an example, settings for a Wide Area BS, $BW_{Channel}$ 20 MHz with FRC A1-3 are mentioned.

Setup of the wanted LTE signal (path A)

1. Use the standard procedure (see 3.1.2) to generate the UE1 uplink signal according to Table 3- (example: Bandwidth 20 MHz, FRC A1-3 and level -95.5 dBm).

Setup of the interfering LTE signal (path B)

2. Set up an uplink LTE signal with the settings Level, $BW_{Channel}$ according to Table 3- (Example: Level -49 dBm, BW 5 MHz)
3. Set up only one **RB**. (see Fig. 3-67) and enter “m” via **Offset VRB** (example: for m = 0 set **Offset VRB** = 0)

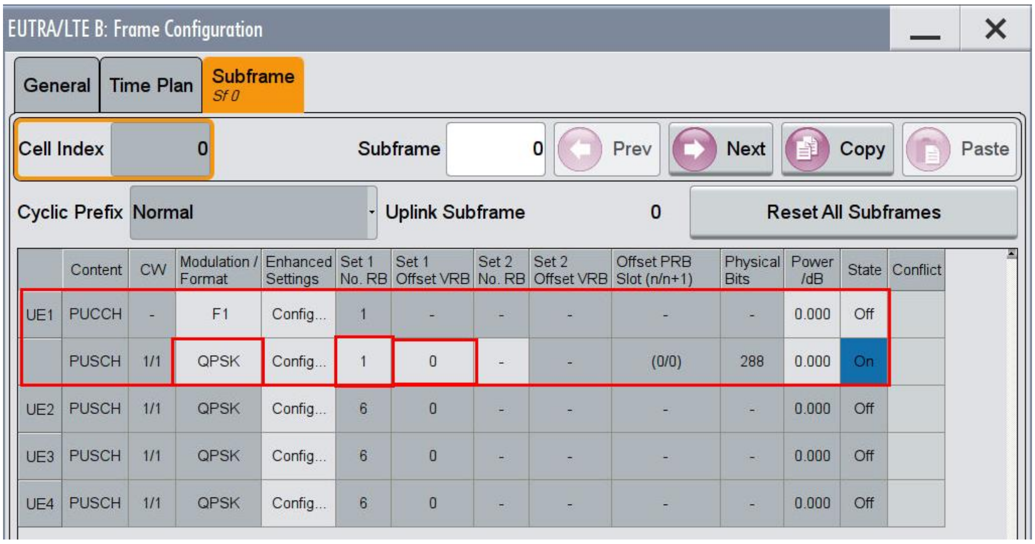


Fig. 3-67: narrow band blocking interferer is generated by path B. Instead of a FRC, use only one RB. Modulation is QPSK. The offset ‘m’ is handled by Offset VRB (example m=0 -> Offset VRB = 0)

4. Set the frequency **Fc_I** of the interferer to $F_c + BW_{Channel} / 2 + BW_{Channel\_Interferer} / 2 + w$ (example: $F_{c\_I} = F_c$ + 10 MHz + 2.5025 MHz) (see Table 3-).
5. Measure the throughput at the Base Station Receiver port.
6. Repeat measurement with varying ‘m’ according Table 3-.
7. Repeat measurement with interfering signal at lower edge. For this change the frequency **Fc_I** of the interferer to $F_c - BW_{Channel} / 2 - BW_{Channel\_Interferer} / 2 - w$ (example: $F_{c\_I} = F_c$ - 10 MHz - 2.5025 MHz) (see Table 3-). Set the **Offset VRB** mirror-wise to max(RB ($BW_{Interferer\_Channel}$)) – ‘m’. (example for 5 MHz: 25 –m)
8. Repeat all Measurements at other Base Station Receiver ports.

Test Procedure Multi-Carrier

For MC both carriers of the wanted signal are generated by path A only if the aggregated bandwidth is smaller than 160 MHz. Else two basebands are used (A + B). Both simulated UEs have to be time aligned. The Interferer is generated by one additional baseband and RF path. If BW_{aggr} is smaller 160 MHz, baseband B and RF B are used. Else Baseband C and the connected SGS are used.

As an example, the multi carrier example from ETC1 of 2.3.4.1 is used.

1. Set in the System Configuration 2 x 1 x 1 for a BW_{aggr} is smaller 160 MHz, else 3 x 1 x 1
2. Set up each carrier according the standard procedure in 3.1.2.

   Set the LTE interferer in an additional baseband (see Fig. 3-67). If BW_{aggr} is smaller 160 MHz use BB B and route it to RF B, else use BB C and route it via IQ OUT 1 to the connected SGS.

Demo Program

For this test, additional parameters must be defined. The settings are reported.

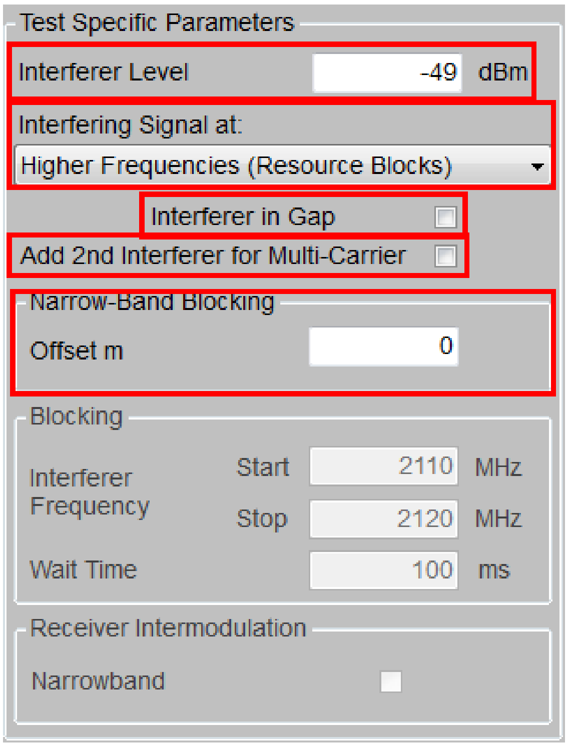


Fig. 3-68: Special settings for narrow band blocking.

The level for the adjacent LTE interferer can be entered directly. Select the position of the interferer. Set the offset **m**. For MC tests, **Add 2nd Interferer for Multi-Carrier** enables two Interferers in parallel. If ETC3 is selected, you can place the **Interferer in Gap**. Please note the settings from the specification listed in Table 3-.

********** 7.5b Narrow-Band Blocking **********

3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920 MHz
Mean Power: -95.5 dBm
Wanted Signal Attenuation: 0 dB
Interfering Signal Attenuation: 0 dB
VRB Wanted Signal: 0
Offset m (Interfering Signal with 1 RB): 0
1 RB Center Frequency: 1925.3475 MHz
(Given by: CF ± 1/2 (Carrier Bandwidth) ± Offset m x 180 kHz (MHz)
Interfering Signal at : Higher Frequencies (Resource Blocks)

Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC	Power (dBm)	Status
7.5b Narrowband Blocking					
LTE Wanted Signal	1920	10	FRC A1-3	-95.5	
LTE Interfering Signal *with 1 RB*	1927.5075	5		-49	

Fig. 3-69: Example report for test case 7.5b.

3.6 Blocking (Clause 7.6)

The blocking characteristics is a measure of the receiver ability to receive a wanted signal at its assigned channel in the presence of an unwanted interferer, which is either a 1.4 MHz, 3 MHz or 5 MHz LTE signal with QPSK modulation for in-band blocking or a CW signal for out-of-band blocking [1].

3.6.1 In-band blocking

In in-band blocking tests, the LTE interfering signal center frequency is swept with a step size of 1 MHz starting from a minimum offset to the channel edge of the wanted signal to the operating band edges plus an additional range (typically 20 MHz). The requirement shall be tested with lowest and highest supported bandwidth.

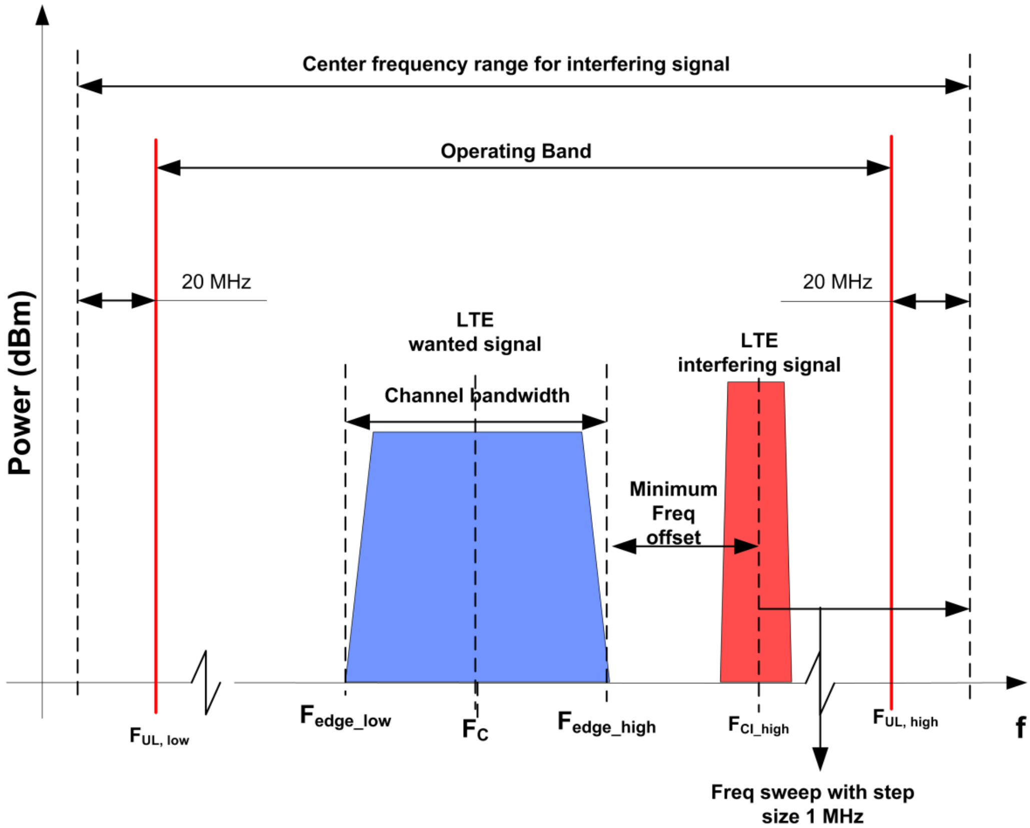


Fig. 3-70: In-band blocking

Non-contiguous Spectrum

The blocking requirement applies additionally inside any sub-block gap, in case the sub-block gap size is at least as wide as twice the interfering signal minimum offset in Table 3- to Table 3-.

The interfering signal offset is defined relative to the sub-block edges inside the sub-block gap. As an example for the interfering signal in the sub-block gap, see Fig. 3-57 and use it for the in-band blocking test.

Multiband Operation

The requirement in the in-band blocking frequency ranges applies for each supported operating band. The requirement applies in addition inside any gap between the operating bands, in case the inter RF bandwidth gap size is at least as wide as twice the interfering signal minimum offset according to Table 3- to Table 3-.

For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput with the settings of Table 3- to Table 3-.

In-band blocking requirements, part 1								
Operat-ing Band	BW of Wanted signal [MHz]	FRC	Center Frequency of Interfering Signal [MHz]	BW of Interfering signal [MHz]	Interfering signal center frequency minimum offset to the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	BS Type	Interfering signal mean power [dBm]	Wanted signal mean power [dBm]
1-7, 9-11, 13, 14, 18, 19, 21-23, 24, 27, 30, 33-44	1.4	FRC A1-1	(F_{UL_low} – 20) To (F_{UL_high} + 20)	1.4	±2.1	Wide	-43	-100.8
						Medium	-38	-95.8
						Local	-35	-92.8
						Home	-27	-84.8
	3	FRC A1-2		3	±4.5	Wide	-43	-97.0
						Medium	-38	-92.0
						Local	-35	-89.0
						Home	-27	-81.0
	5	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	10	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	15	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	20	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
8, 26, 28	1.4	FRC A1-1	(F_{UL_low} – 20) to (F_{UL_high} + 10)	1.4	±2.1	Wide	-43	-100.8
						Medium	-38	-95.8
						Local	-35	-92.8
						Home	-27	-84.8
	3	FRC A1-2		3	±4.5	Wide	-43	-97.0
						Medium	-38	-92.0
						Local	-35	-89.0
						Home	-27	-81.0
	5	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5

Table 3-26: In-band blocking requirements part 1

In-band blocking requirements, part 2								
Operat-ing Band	BW of Wanted signal [MHz]	FRC	Center Frequency of Interfering Signal [MHz]	BW of Interfering signal [MHz]	Interfering signal center frequency minimum offset to the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	BS Type	Interfering signal mean power [dBm]	Wanted signal mean power [dBm]
8, 26, 28	10	FRC A1-3	$(F_{UL\_low} – 20)$ to $(F_{UL\_high} + 10)$	5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	15	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	20	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
12	1.4	FRC A1-1	$(F_{UL\_low} – 20)$ To $(F_{UL\_high} + 13)$	1.4	±2.1	Wide	-43	-100.8
						Medium	-38	-95.8
						Local	-35	-92.8
						Home	-27	-84.8
	3	FRC A1-2		3	±4.5	Wide	-43	-97.0
						Medium	-38	-92.0
						Local	-35	-89.0
						Home	-27	-81.0
	5	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	10	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	15	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	20	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5

Table 3-27: In-band blocking requirements part 2

In-band blocking requirements, part 3								
Operat-ing Band	BW of Wanted signal [MHz]	FRC	Center Frequency of Interfering Signal [MHz]	BW of Interfering signal [MHz]	Interfering signal center frequency minimum offset to the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	BS Type	Interfering signal mean power [dBm]	Wanted signal mean power [dBm]
17	1.4	FRC A1-1	(F_{UL_low} – 20) To (F_{UL_high} + 18)	1.4	±2.1	Wide	-43	-100.8
						Medium	-38	-95.8
						Local	-35	-92.8
						Home	-27	-84.8
	3	FRC A1-2		3	±4.5	Wide	-43	-97.0
						Medium	-38	-92.0
						Local	-35	-89.0
						Home	-27	-81.0
	5	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	10	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	15	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	20	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
20	1.4	FRC A1-1	(F_{UL_low} – 11) to (F_{UL_high} + 20)	1.4	±2.1	Wide	-43	-100.8
						Medium	-38	-95.8
						Local	-35	-92.8
						Home	-27	-84.8
	3	FRC A1-2		3	±4.5	Wide	-43	-97.0
						Medium	-38	-92.0
						Local	-35	-89.0
						Home	-27	-81.0
	5	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	10	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5

Table 3-28: In-band blocking requirements part 3

In-band blocking requirements, part 4								
Operat-ing Band	BW of Wanted signal [MHz]	FRC	Center Frequency of Interfering Signal [MHz]	BW of Interfering signal [MHz]	Interfering signal center frequency minimum offset to the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	BS Type	Interfering signal mean power [dBm]	Wanted signal mean power [dBm]
20	15	FRC A1-3	(F_{UL_low} – 11) To (F_{UL_high} + 20)	5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	20	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
25	1.4	FRC A1-1	(F_{UL_low} – 20) to (F_{UL_high} + 15)	1.4	±2.1	Wide	-43	-100.8
						Medium	-38	-95.8
						Local	-35	-92.8
						Home	-27	-84.8
	3	FRC A1-2		3	±4.5	Wide	-43	-97.0
						Medium	-38	-92.0
						Local	-35	-89.0
						Home	-27	-81.0
	5	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	10	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	15	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
	20	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
						Home	-27	-79.5
31	1.4	FRC A1-1	(F_{UL_low} – 20) to (F_{UL_high} + 5)	1.4	±2.1	Wide	-43	-100.8
						Medium	-38	-95.8
						Local	-35	-92.8
	3	FRC A1-2		3	±4.5	Wide	-43	-97.0
						Medium	-38	-92.0
						Local	-35	-89.0
	5	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5

Table 3-29: In-band blocking requirements part 4

In-band blocking requirements, part 5								
Operat-ing Band	BW of Wanted signal [MHz]	FRC	Center Frequency of Interfering Signal [MHz]	BW of Interfering signal [MHz]	Interfering signal center frequency minimum offset to the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	BS Type	Interfering signal mean power [dBm]	Wanted signal mean power [dBm]
31	10	FRC A1-3	(F_{UL_low} – 20) to (F_{UL_high} + 5)	5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
	15	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
	20	FRC A1-3		5	±7.5	Wide	-43	-95.5
						Medium	-38	-90.5
						Local	-35	-87.5
46	10	FRC A1-3	(F_{UL_low} – 20) to (F_{UL_high} + 20)	5	±7.5	Wide		
						Medium	-38	-89.5
						Local	-35	-87.5
	20	FRC A1-3		20	±30	Wide		
						Medium	-35	-89.5
						Local	-35	-87.5

Table 3-30: In-band blocking requirements part 5

NB-IoT

NB-IoT tests are defined for all deployments. For NB-IoT standalone, an interferer with 5 MHz is placed with an offset of 7.5 MHz. For NB-IoT in-band and guard band, the requirements are the same as for LTE. See Table 3- and Table 3- for detailed settings.

In-band blocking requirements NB-IoT standalone

Operat-ing Band	FRC	Center Frequency of Interfering Signal [MHz]	BW of Interfering signal [MHz]	Interfering signal center frequency minimum offset to the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]	Interfering signal mean power [dBm]	Wanted signal mean power [dBm]
1-3, 5, 13,18,19, 26, 66	A14-1	F_{UL_low} – 20) to (F_{UL_high} + 5)	5 MHz LTE	±7.5	-43	-120.6
	A14-2					-126.6
8, 26, 28	A14-1	($F_{UL\ low}$ – 20) to ($F_{UL\ high}$ + 10)				-120.6
	A14-2					-126.6
12	A14-1	(F_{UL_low} – 20) To ($F_{UL\ high}$ + 13)				-120.6
	A14-2					-126.6
17	A14-1	(F_{UL_low} – 20) To ($F_{UL\ high}$ + 18)				-120.6
	A14-2					-126.6
20	A14-1	(F_{UL_low} – 11) To ($F_{UL\ high}$ + 20)				-120.6
	A14-2					-126.6
25	A14-1	($F_{UL\ low}$ – 20) To (F_{UL_high} + 15)				-120.6
	A14-2					-126.6
31	A14-1	(F_{UL_low} – 20) To (F_{UL_high} + 5)				-120.6
	A14-2					-126.6

Table 3-31: In-band blocking requirements NB-IoT standalone

In-band blocking requirements NB-IoT in-band and guard band							
Operat-ing Band	**BW of Wanted signal [MHz]**	**FRC**	**Center Frequency of Interfering Signal [MHz]**	**BW of Interfering signal [MHz]**	**Interfering signal center frequency minimum offset to the lower (upper) edge or sub-block edge inside a sub-block gap [MHz]**	**Interfering signal mean power [dBm]**	**Wanted signal mean power [dBm]**
1-3, 5, 13,18,19, 26, 66	3	A14-1	F_{UL_low} – 20) to (F_{UL_high} + 5)	3	±4.5		-120.6
		A14-2					-126.6
	5, 10, 15, 20	A14-1		5	±7.5		-120.6
		A14-2					-126.6
8, 26, 28	3	A14-1	(F_{UL_low} – 20) to (F_{UL_high} + 10)	3	±4.5		-120.6
		A14-2					-126.6
	5, 10, 15, 20	A14-1		5	±7.5		-120.6
		A14-2					-126.6
12	3	A14-1	(F_{UL_low} – 20) To (F_{UL_high} + 13)	3	±4.5	-43	-120.6
		A14-2					-126.6
	5, 10, 15, 20	A14-1		5	±7.5		-120.6
		A14-2					-126.6
17	3	A14-1	(F_{UL_low} – 20) To (F_{UL_high} + 18)	3	±4.5		-120.6
		A14-2					-126.6
	5, 10, 15, 20	A14-1		5	±7.5		-120.6
		A14-2					-126.6
20	3	A14-1	(F_{UL_low} – 11) To (F_{UL_high} + 20)	3	±4.5		-120.6
		A14-2					-126.6
	5, 10, 15, 20	A14-1		5	±7.5		-120.6
		A14-2					-126.6

Table 3-32: In-band blocking requirements NB-IoT in-band and guard band, 3 MHz channel bandwidth is not applicable to guard band operation

Test Setup

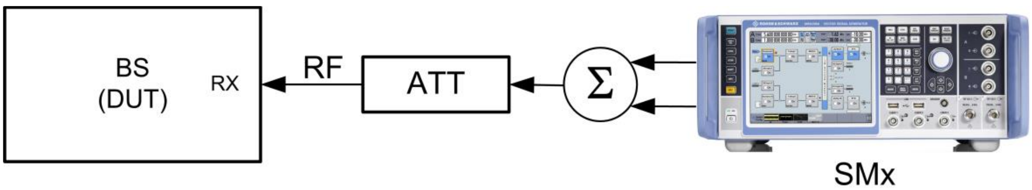


Fig. 3-71: Test setup blocking for SC and MC with BWaggr smaller 160 MHz. The SMW generates the LTE uplink wanted and interfering signals with two paths.

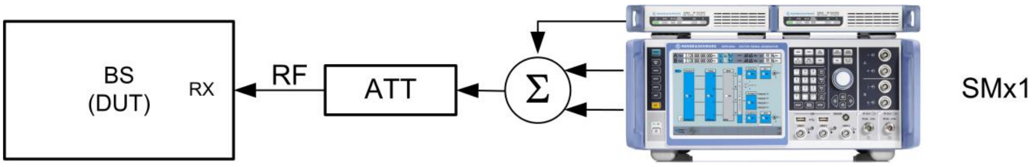


Fig. 3-72: Test setup blocking for MC with BWaggr greater 160 MHz. The SMW generates the MC LTE uplink wanted signal with two paths. The SMW generates the LTE interfering signal and uses the SGS as an additional RF path.

Settings:

- The Base Station transmits an LTE signal with maximum output power according to E-TM1.1.
- The SMW generates a LTE uplink signal with FRC and level settings according to Table 3- ff., which is applied to the BS receiver port.
- In SC, the SMW also generates the LTE interferer. It is provided in the second path.
- In MC, the SMW generates the wanted signal in BB A and the LTE interferer in BB B. If the wanted carriers are separated by more than 160 MHz, two basebands A + B generate the wanted signal, the baseband C generates the LTE interferer and is routed via IQ to the SGS
- Use a Hybrid Combiner to sum all signals.

Test Procedure

The measurements shall be carried out within the frequency range provided in Table 3- ff. according to the supported operating bands. The interfering signal is swept with a step size of 1 MHz as shown in Fig. 3-70.

Test Procedure Single Carrier

The wanted and the interfering LTE signals are generated using different paths (baseband and RF) in the SMW.

As an example, settings for a Wide Area BS, $BW_{Channel}$ 20 MHz with FRC A1-3 in operating band 1 are mentioned.

Setup of the wanted LTE signal (path A)

1. Use the standard procedure (see 3.1.2) to generate the UE1 uplink signal according to Table 3- ff. (example: Bandwidth 20 MHz, FRC A1-3 and level -95.5 dBm).

Setup of the interfering LTE signal (path B)

2. Set up an uplink LTE signal with the settings Level, $BW_{Channel}$ according to Table 3- ff. (Example: Level -43 dBm, BW 5 MHz)
3. Set up the full **RB** allocation. (see Fig. 3-73, example in 5 MHz 25 RB are allocated)

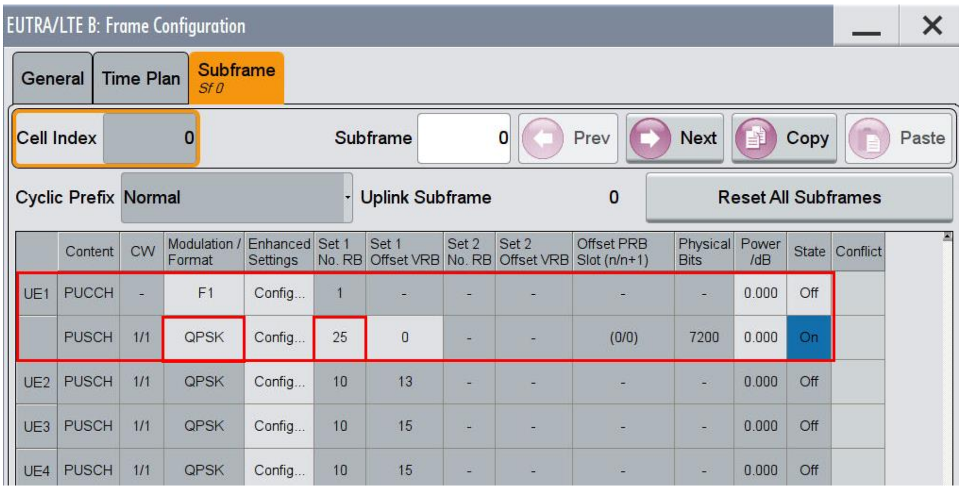


Fig. 3-73: In-band blocking interferer is generated by path B. Instead of a FRC, use the full RB allocation (example 25 RB). Modulation is QPSK.

4. Set the start frequency F_{c_I} of the interferer (example: $F_{c\_I} = F_{edge\ high}$ + 7.5 MHz) and start a measurement
5. Shift the interferer in 1MHz steps up in the range and repeat measurement
6. Repeat measurement with interfering signal in the lower edge range
7. Measure the throughput at other Base Station Receiver ports.

Test Procedure Multi-Carrier and/or CA operation

For MC both carriers of the wanted signal are generated by path A only if the aggregated bandwidth is smaller than 160 MHz. Else two basebands are used (A + B). Both simulated UEs have to be time aligned. The Interferer is generated by one additional baseband and RF path. If BW_{aggr} is smaller 160 MHz, baseband B and RF B are used. Else Baseband C and the connected SGS are used.

As an example, the multi carrier example from ETC1 of 2.3.4.1 is used.

1. Set in the System Configuration 2 x 1 x 1 for a BW_{aggr} is smaller 160 MHz, else

   3 x 1 x 1
2. Set up each carrier according the standard procedure in 3.1.2.

   Set the LTE interferer in an additional baseband (see Fig. 3-61). If BW_{aggr} is smaller 160 MHz use BB B and route it to RF B, else use BB C and route it via IQ OUT 1 to the connected SGS.

Demo Program

For this test, additional parameters must be defined. The settings are reported.

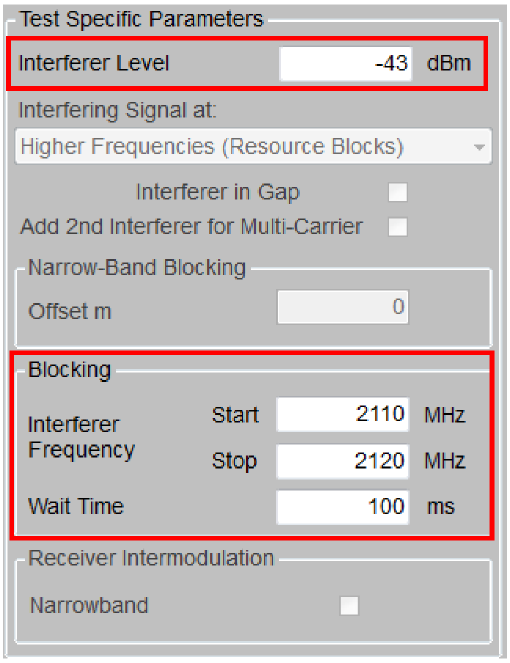


Fig. 3-74: Special settings for in-band blocking.

The level for the blocking LTE interferer can be entered directly. Set the start and stop frequency of the interferer. Set the wait time between two steps. Please note the settings from the specification listed in Table 3- to Table 3-.

*********** 7.6a In-Band Blocking ***********

3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920 MHz
Mean Power: -95.5 dBm
Wanted Signal Attenuation: 0 dB
Interfering Signal Attenuation: 0 dB
VRB Wanted Signal: 0
Wait Time between two consecutive Settings of LTE Interfering Signal: 100 ms

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Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC Model	Power (dBm)	Status
7.6a In-Band Blocking					
LTE Wanted Signal	1920	10	FRC A1-3	-95.5	
LTE Interfering Signal	2110	5		-43	
LTE Interfering Signal	2111	5		-43	
LTE Interfering Signal	2112	5		-43	
LTE Interfering Signal	2113	5		-43	
LTE Interfering Signal	2114	5		-43	
LTE Interfering Signal	2115	5		-43	
LTE Interfering Signal	2116	5		-43	
LTE Interfering Signal	2117	5		-43	
LTE Interfering Signal	2118	5		-43	
LTE Interfering Signal	2119	5		-43	
LTE Interfering Signal	2120	5		-43	

Fig. 3-75: Example report for test case 7.6a.

3.6.2 Out-of-band blocking

In out-of-band blocking tests, the CW interfering signal center frequency is swept with a step size of 1 MHz in the range of 1 MHz up to 12.75 GHz excluding the operating band plus an additional range (typically 20 MHz). The requirement shall be tested with lowest supported bandwidth.

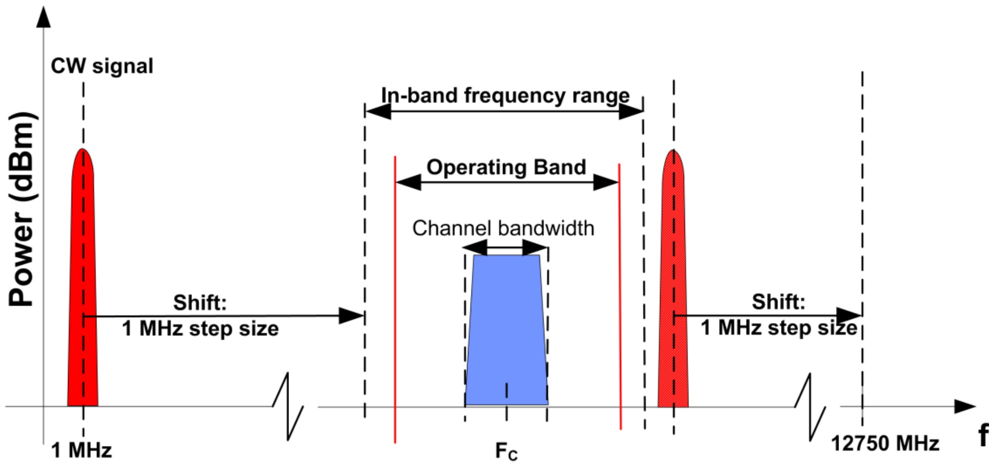


Fig. 3-76: Out-of-band blocking by CW interfering signal swept in the frequency range outside the operating band plus an additional range.

Non-contiguous Spectrum

The blocking requirement applies additionally inside any sub-block gap, in case the sub-block gap size is at least as wide as twice the interfering signal minimum offset in Table 3- and Table 3-.

The interfering signal offset is defined relative to the sub-block edges inside the sub-block gap. [1] As an example for the interfering signal in the sub-block gap, see Fig. 3-57 and use it for the out-of-band blocking test.

Multiband Operation

The requirement in the out-of-band blocking frequency ranges apply for each operating band, with the exception that the in-band blocking frequency ranges of all supported operating bands according to Table 3- for wide area, medium range and local area base stations shall be excluded from the out-of-band blocking requirement. [1]

Co-location with other Base Stations

This additional blocking requirement may be applied for the protection of LTE BS receivers when GSM, CDMA, UTRA or LTE BS operating in a different frequency band are co-located with the wanted LTE BS of different categories. The interferer is a CW signal with certain frequency ranges.

The requirements are summarized in table 7.6-4 in section 7.6.5.2 [1].

For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput with the settings of Table 3-.

Out-of-band blocking requirements for single band operation

Operating Band	BW of Wanted signal [MHz]	Wanted signal mean power [dBm]				FRC	Center Frequency of Interfering Signal [MHz]	Interfering signal mean power [dBm]
		Wide	Local	Home	Medium			
1-7, 9-11, 13, 14, 18, 19, 21-23, 24, 27, 30 33-44	1.4	-100.8	-92.8	-84.8	-95.8	FRC A1-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 20) to 12750	-15
	3	-97.0	-89	-81	-92.0	FRC A1-2		
	5	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	10	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	15	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	20	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
8, 26, 28	1.4	-100.8	-92.8	-84.8	-95.8	FRC A1-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 10) to 12750	
	3	-97.0	-89	-81	-92.0	FRC A1-2		
	5	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	10	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	15	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	20	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
12	1.4	-100.8	-92.8	-84.8	-95.8	FRC A1-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 13) to 12750	
	3	-97.0	-89	-81	-92.0	FRC A1-2		
	5	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	10	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	15	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	20	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
17	1.4	-100.8	-92.8	-84.8	-95.8	FRC A1-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 18) to 12750	
	3	-97.0	-89	-81	-92.0	FRC A1-2		
	5	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	10	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	15	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	20	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
20	1.4	-100.8	-92.8	-84.8	-95.8	FRC A1-1	1 to (F_{UL_low} – 11) (F_{UL_high} + 20) to 12750	
	3	-97.0	-89	-81	-92.0	FRC A1-2		
	5	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	10	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	15	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	20	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
25	1.4	-100.8	-92.8	-84.8	-95.8	FRC A1-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 15) to 12750	
	3	-97.0	-89	-81	-92.0	FRC A1-2		
	5	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	10	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	15	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
	20	-95.5	-87.5	-79.5	-90.5	FRC A1-3		
31	1.4	-100.8	-92.8	—	-95.8	FRC A1-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 5) to 12750	
	3	-97.0	-89	—	-92.0	FRC A1-2		
	5	-95.5	-87.5	—	-90.5	FRC A1-3		
	10	-95.5	-87.5	—	-90.5	FRC A1-3		
	15	-95.5	-87.5	—	-90.5	FRC A1-3		
	20	-95.5	-87.5	—	-90.5	FRC A1-3		

Table 3-33: Out-of-band blocking requirements for single band operation

Out-of-band blocking requirements for multiband operation								
Operating Band	BW of Wanted signal [MHz]	Wanted signal mean power [dBm]				FRC	Center Frequency of Interfering Signal [MHz]	Interfering signal mean power [dBm]
		Wide	Local	Home	Medium			
1-7, 9-11, 13, 14, 18, 19, 21-23, 24, 27, 30 33-44	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	1 to $(F_{UL\_low} – 20)$ $(F_{UL\_high} + 20)$ to 12750	-15
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		
8, 26, 28	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	1 to $(F_{UL\_low} – 20)$ $(F_{UL\_high} + 10)$ to 12750	
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		
12	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	1 to $(F_{UL\_low} – 20)$ $(F_{UL\_high} + 13)$ to 12750	
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		
17	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	1 to $(F_{UL\_low} – 20)$ $(F_{UL\_high} + 18)$ to 12750	
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		
20	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	1 to $(F_{UL\_low} – 11)$ $(F_{UL\_high} + 20)$ to 12750	
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		
25	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	1 to $(F_{UL\_low} – 20)$ $(F_{UL\_high} + 15)$ to 12750	
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		
31	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	1 to $(F_{UL\_low} – 20)$ $(F_{UL\_high} + 5)$ to 12750	
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		

46*	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	(FUL_low – 500) to (FUL_low - 20) (FUL_high + 20) to (FUL_high+ 500)	-35
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		
	1.4	-105.4	-97.4	—	-100.4	FRC A1-1	1 to (FUL_low – 500) (FUL_high + 500) to 12750	-15
	3	-101.6	-93.6	—	-96.6	FRC A1-2		
	5	-100.1	-92.1	—	-95.1	FRC A1-3		
	10	-100.1	-92.1	—	-95.1	FRC A1-3		
	15	-100.1	-92.1	—	-95.1	FRC A1-3		
	20	-100.1	-92.1	—	-95.1	FRC A1-3		
*only for Local BS and Medium Range BS								

Table 3-34: Out-of-band blocking requirements for multiband operation

NB-IoT

NB-IoT tests are defined for all deployments. For NB-IoT, the settings in Table 3- and Table 3- apply.

Up to 24 exceptions are allowed for spurious response frequencies in each wanted signal frequency. For these exceptions the throughput requirement shall be met when the blocking signal is set to a level of -40 dBm for 15 kHz subcarrier spacing and -46 dBm for 3.75 kHz subcarrier spacing. In addition, each group of exceptions shall not exceed three contiguous measurements.

Out-of-band blocking NB-IoT standalone				
Operating Band	**Wanted signal mean power [dBm]**	**FRC**	**Center Frequency of Interfering Signal [MHz]**	**Interfering signal mean power [dBm]**
1-3, 5, 13,18,19, 26, 66	-120.6	A14-1	1 to (F_{UL_low} – 20)	-15
	-126.6	A14-2	(F_{UL_high} + 20) to 12750	
8, 26, 28	-120.6	A14-1	1 to (F_{UL_low} – 20)	
	-126.6	A14-2	(F_{UL_high} + 10) to 12750	
12	-120.6	A14-1	1 to (F_{UL_low} – 20)	
	-126.6	A14-2	(F_{UL_high} + 13) to 12750	
17	-120.6	A14-1	1 to (F_{UL_low} – 20)	
	-126.6	A14-2	(F_{UL_high} + 18) to 12750	
20	-120.6	A14-1	1 to (F_{UL_low} – 11)	
	-126.6	A14-2	(FU_{L_high} + 20) to 12750	
25	-120.6	A14-1	1 to (F_{UL_low} - 20)	-15*
	-126.6	A14-2	(FU_{L_high} + 15) to 12750	
31	-120.6	A14-1	1 to (F_{UL_low} – 20)	
	-126.6	A14-2	(FU_{L_high} + 5) to 12750	
*Up to 24 exceptions are allowed for spurious response frequencies in each wanted signal frequency when measured using a 1MHz step size. For these exceptions the above throughput requirement shall be met when the blocking signal is set to a level of -40 dBm for 15 kHz subcarrier spacing and -46 dBm for 3.75 kHz subcarrier spacing. In addition, each group of exceptions shall not exceed three contiguous measurements using a 1MHz step size.				

Table 3-35: Out-of-band blocking requirements NB-IoT standalone

Out-of-band blocking NB-IoT in-band and guard band					
Operating Band	**BW of Wanted signal [MHz]**	**Wanted signal mean power [dBm]**	**FRC**	**Center Frequency of Interfering Signal [MHz]**	**Interfering signal mean power [dBm]**
1-3, 5, 13,18,19, 26, 66	3		A14-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 20) to 12750	-15
			A14-2		
	5, 10, 15, 20		A14-1		
			A14-2		
8, 26, 28	3		A14-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 10) to 12750	
			A14-2		
	5, 10, 15, 20		A14-1		
			A14-2		
12	3		A14-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 13) to 12750	
			A14-2		
	5, 10, 15, 20		A14-1		
			A14-2		
17	3		A14-1	1 to (F_{UL_low} – 20) (F_{UL_high} + 18) to 12750	
			A14-2		
	5, 10, 15, 20		A14-1		
			A14-2		
20	3		A14-1	1 to (F_{UL_low} – 11) (FU_{L_high} + 20) to 12750	
			A14-2		
	5, 10, 15, 20		A14-1		
			A14-2		

Table 3-36: Out-of-band blocking requirements NB-IoT in-band and guard band, 3 MHz channel bandwidth is not applicable to guard band operation

Test Setup

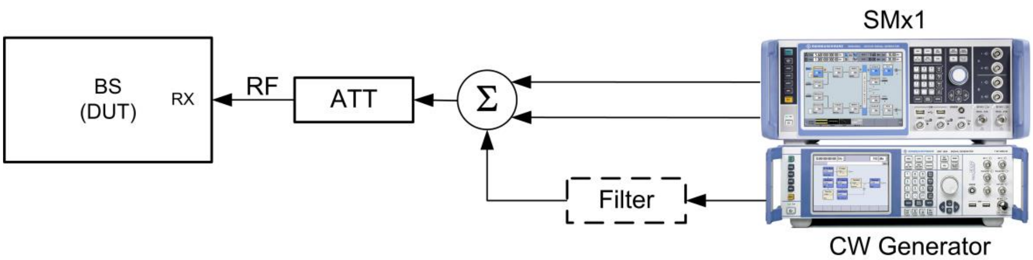


Fig. 3-77: Blocking test setup: Additional CW Interferer with test frequency range up to 12750 MHz.

Settings:

- The Base Station transmits an LTE signal with maximum output power according to E-TM1.1.
- The SMW generates a LTE uplink signal with FRC and level settings according to Table 3-, which is applied to the BS receiver port.
- In MC, the SMW also generates the second LTE carrier.
- The interferer is provided by the CW generator. Use a filter to suppress harmonics in the receive band.
- Use a Hybrid Combiner to sum all signals.

Test Procedure SC

The wanted LTE signals are generated using one path only (baseband and RF) in the SMW. The CW interferer is provided by a CW generator.

As an example, settings for a Wide Area BS, $BW_{Channel}$ 20 MHz with FRC A1-3 in operating band 1 are mentioned.

1. Use the standard procedure (see 3.1.2) to generate the UE1 uplink signal according to Table 3- (example: Bandwidth 20 MHz, FRC A1-3 and level -95.5 dBm).
2. Set level and frequency in the CW generator and start a measurement. (start frequency 1 MHz, level -15 dBm) and start a measurement
3. Shift the interferer in 1MHz steps up in the range and repeat measurement. Skip the operating band plus additional range (example: ± 20 MHz)
4. Measure the throughput at other Base Station Receiver ports.

Test Procedure MC

For MC both carriers of the wanted signal are generated by path A only if the aggregated bandwidth is smaller than 160 MHz. Else two basebands are used (A + B). Both simulated UEs have to be time aligned. If BW_{aggr} is smaller 160 MHz, baseband B and RF B are used. Else, Baseband C and the connected SGS are used. The Interferer is generated by the external CW generator.

As an example, the multi carrier example from ETC1 of 2.3.4.1 is used.

1. Set in the System Configuration 2 x 1 x 1 for a BW_{aggr} is smaller 160 MHz, else

   3 x 1 x 1
2. Set up each carrier according the standard procedure in 3.1.2.

   Set the LTE interferer in an additional baseband (see Fig. 3-61). If BW_{aggr} is smaller 160 MHz use BB B and route it to RF B, else use BB C and route it via IQ OUT 1 to the connected SGS.

3. Set level and frequency in the CW generator and start a measurement. (start frequency 1 MHz, level -15 dBm) and start a measurement
4. Shift the interferer in 1MHz steps up in the range and repeat measurement. Skip the operating band plus additional range (example: ± 20 MHz)
5. Measure the throughput at other Base Station Receiver ports.

Demo Program

For this test, additional parameters must be defined. The settings are reported. An additional CW generator is used.

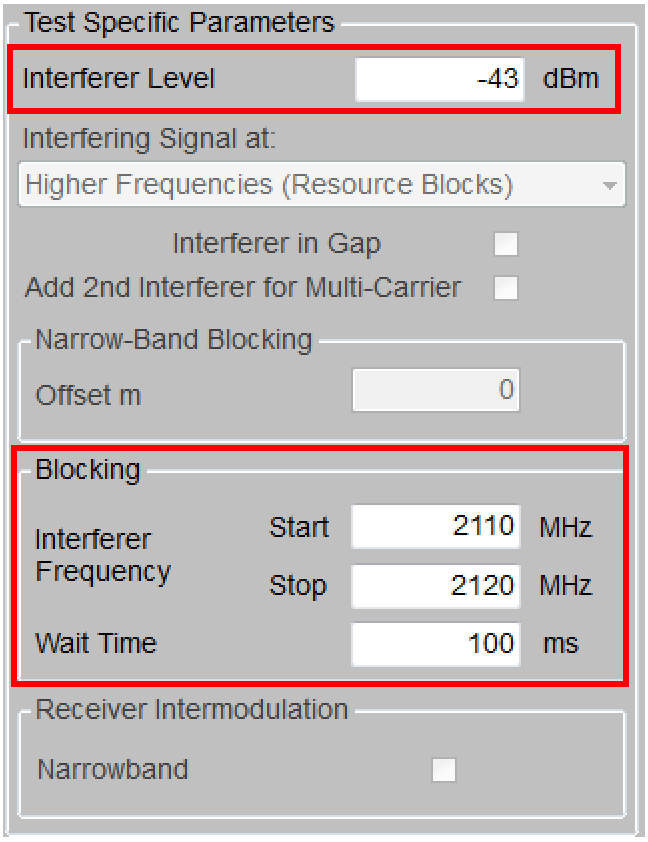


Fig. 3-78: Special settings for out-of-band blocking.

The level for the CW interferer can be entered directly. Set the start and stop frequency of the CW interferer. Set the wait time between two steps. Please note the settings from the specification listed in Table 3- to Table 3-.

********* 7.6b Out-of-Band Blocking ************

3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920 MHz
Mean Power: -95.5 dBm
Wanted Signal Attenuation: 0 dB
Interfering Signal Attenuation: 0 dB
VRB Wanted Signal: 0
Start Frequency: 2110 MHz - Stop Frequency: 2120 MHz
Wait Time between two consecutive Settings of CW Interfering Signal: 100 ms

----

Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC Model	Power (dBm)	Status
7.6b Out-of-Band Blocking					
LTE Wanted Signal	1920	10	FRC A1-3	-95.5	
CW Interfering Signal	2110	---	---	-15	
CW Interfering Signal	2111	---	---	-15	
CW Interfering Signal	2112	---	---	-15	
CW Interfering Signal	2113	---	---	-15	
CW Interfering Signal	2114	---	---	-15	
CW Interfering Signal	2115	---	---	-15	
CW Interfering Signal	2116	---	---	-15	
CW Interfering Signal	2117	---	---	-15	
CW Interfering Signal	2118	---	---	-15	
CW Interfering Signal	2119	---	---	-15	
CW Interfering Signal	2120	---	---	-15	

Fig. 3-79: Example report for test case 7.6b.

3.7 Receiver Spurious Emissions (Clause 7.7)

The spurious emissions power is the power of the emissions generated or amplified in a receiver that appears at the BS receiver antenna connector. The requirements apply to all BS with separate RX and TX antenna ports. The test shall be performed when both TX and RX are on, with TX port terminated.

The transmitter spurious emission limits apply from 30 MHz to 12.75 GHz, the frequency range 10 MHz below the lowest frequency of the uplink operating band up to 10 MHz above the highest frequency of the uplink operating band may be excluded. In operating bands 22, 42 and 43 the frequency range is extended to the 5th harmonic, in band 46 the frequency range goes up to 26 GHz.

Spurious emissions		
Frequency Range	Maximum Level (dBm)	Measurement Bandwidth
30 MHz – 1 GHz	-57	100 kHz
1 GHz – 12.75 GHz	-47	1 MHz

Table 3-37: RX Spurious emission requirements

Multi-band Operation

For base stations capable of multi-band operation where multiple bands are mapped on separate antenna connectors, the single-band requirements apply. The excluded frequency range is only applicable for the operating band supported on each antenna connector. [1]

Additional Co-existing requirements

Additional requirements may apply:

- Protection of own receiver (clause 6.6.4.5.3 in [1])
- Co-existence with systems in the same region (clause 6.6.4.5.4 in [1])
- Co-existence with co-located BS (clause 6.6.4.5.5 in [1])

Test Setup

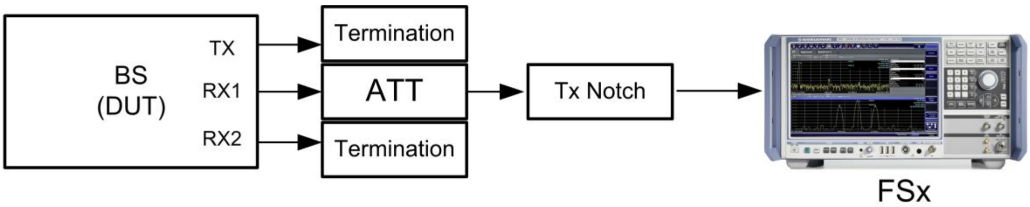


Fig. 3-80: Receiver Spurious emissions test setup. A notch filter suppresses the TX band

Settings:

- The Base Station transmits an LTE signal with maximum output power according to E-TM1.1.
- The FSx measures the emissions on the RX via a Tx notch filter
- TX and other RX ports are terminated

Test Procedure

The measurement Spurious Emissions is a predefined measurement in the base software of the FSx

The Base Station transmits an LTE signal with maximum power according to E-TM 1.1 and the transmitter port is terminated (Fig. 3-37).

For a FDD base station capable of multi-carrier and/or CA operation, set the base station according to E-TM 1.1 on all carriers. Use the test configuration and power setting specified in Section 2.

Measurement at FSx

1. Select in mode **Spectrum**, via button MEAS "Spurious Emissions".
2. In **Sweep List,** delete the ranges 1 and 2. Adjust the limit settings in the remaining two ranges to -57 dBm and -47 dBm. Check the other settings.
3. Press **Adjust X-Axis**. This applies the settings.

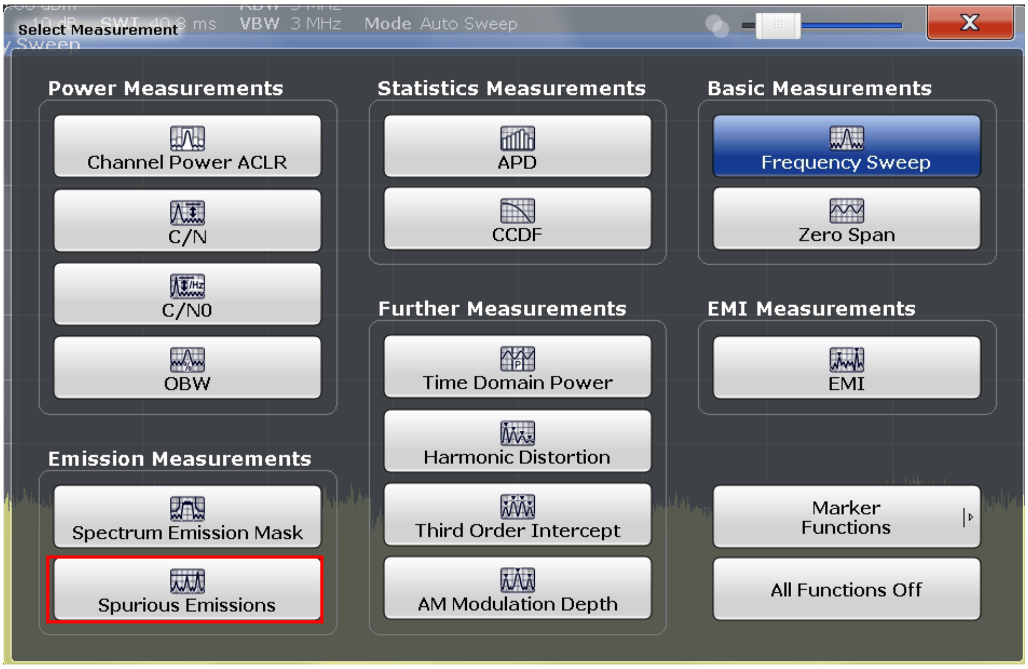
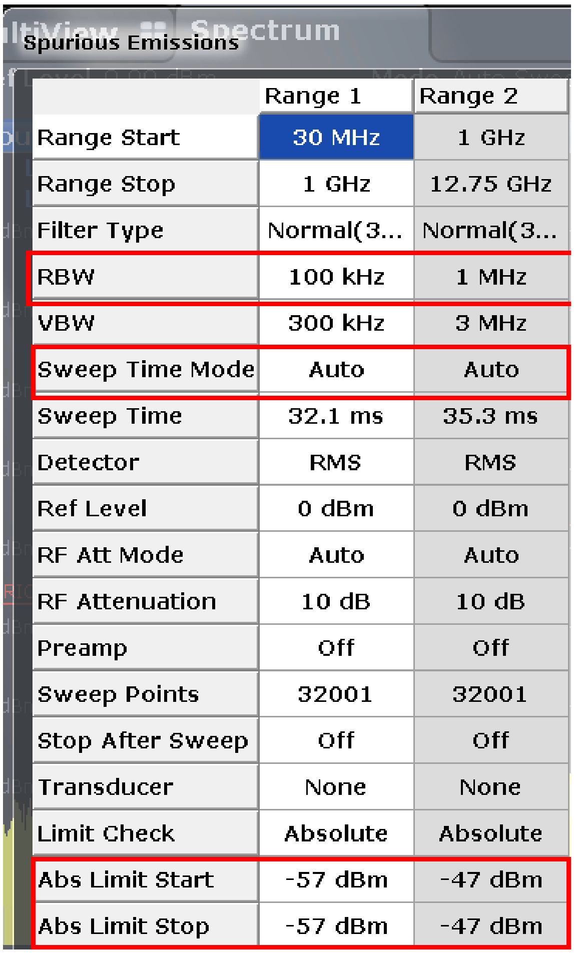


Fig. 3-81: Select the Spurious Emissions measurement in the FSW



Spurious Emissions

	Range 1	Range 2
Range Start	30 MHz	1 GHz
Range Stop	1 GHz	12.75 GHz
Filter Type	Normal(3...	Normal(3...
RBW	100 kHz	1 MHz
VBW	300 kHz	3 MHz
Sweep Time Mode	Auto	Auto
Sweep Time	32.1 ms	35.3 ms
Detector	RMS	RMS
Ref Level	0 dBm	0 dBm
RF Att Mode	Auto	Auto
RF Attenuation	10 dB	10 dB
Preamp	Off	Off
Sweep Points	32001	32001
Stop After Sweep	Off	Off
Transducer	None	None
Limit Check	Absolute	Absolute
Abs Limit Start	-57 dBm	-47 dBm
Abs Limit Stop	-57 dBm	-47 dBm

Fig. 3-82: Setting the ranges for Rx spurious emissions

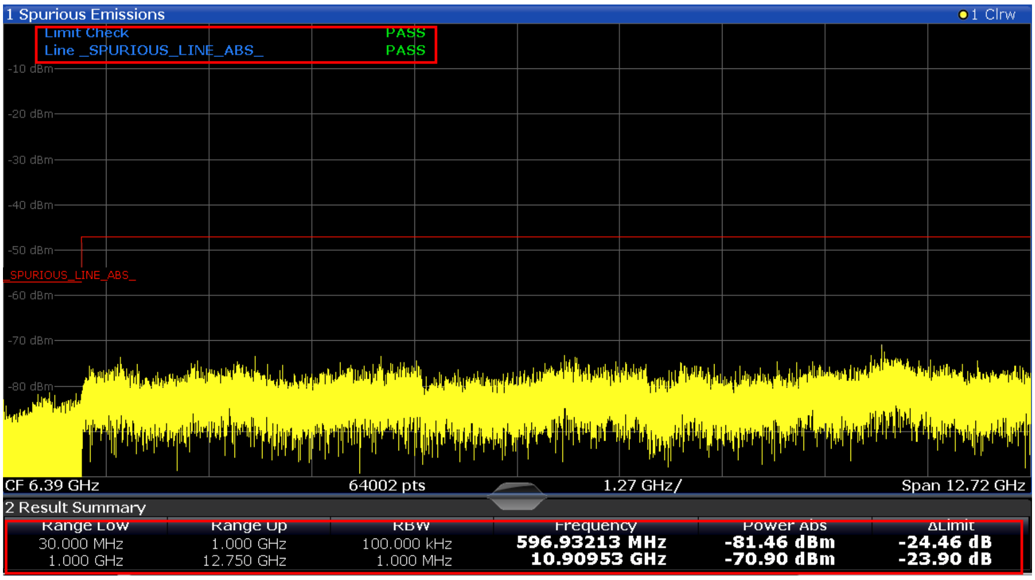


Fig. 3-83: RX Spurious Emissions

Demo Program

For this test, additional parameters must be defined. The settings are reported. A spectrum analyzer is used.

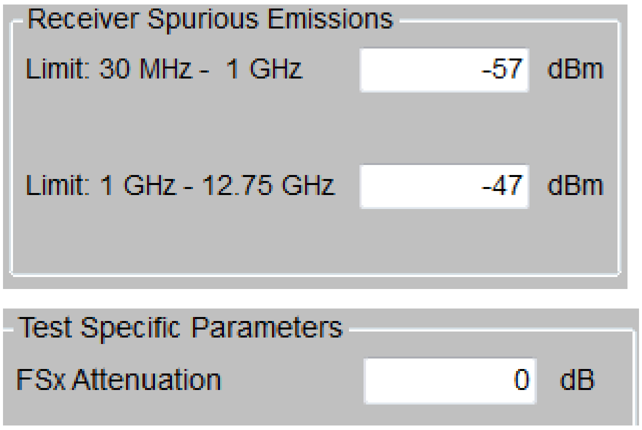


Fig. 3-84: Special settings receiver spurious emissions.

The limits for the spectrum measurement can be entered directly. Set the FSx attenuation. Please note the settings from the specification listed in Table 3-.

********** 7.7 Receiver Spurious Emissions *************

FSx Attenuation level: 0 dB

Test Frequency Range	---	---	Power (dBm)	Limit (dBm)	Status
7.7 Receiver Spurious Emissions					
30 MHz - 1 GHz	---	---	-93.57435608	-57	Passed
1 GHz - 12.75 GHz	---	---	-73.10357666	-47	Passed

Fig. 3-85: Example report for test case 7.7.

3.8 Receiver Intermodulation (Clause 7.8)

Intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal on its assigned channel frequency in the presence of two interfering signals, which have a specific frequency relationship to the wanted signal. Third and higher order mixing of the two interfering RF signals can produce an interfering signal in the band of the desired channel. Interfering signals shall be CW signal and an LTE signal with QPSK modulation [1].

Test Setup

Please note that it is also possible to generate the CW interferer with the internal AWGN option of the SMW. Here the use of the additional CW generator is described.

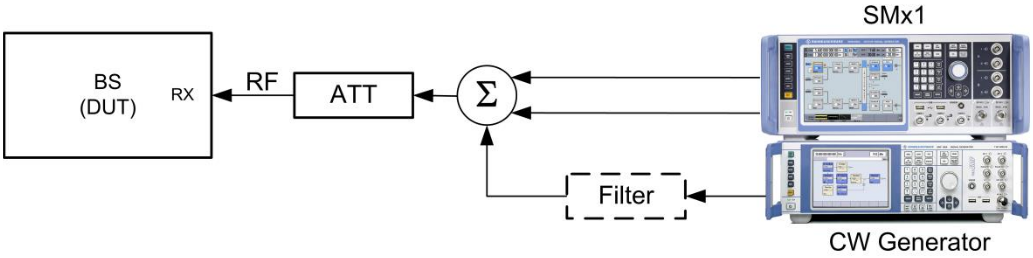


Fig. 3-86: Test setup receiver intermodulation for SC. The SMW generates the LTE uplink wanted and interfering signals with two paths. The CW generator provides the CW Interferer.

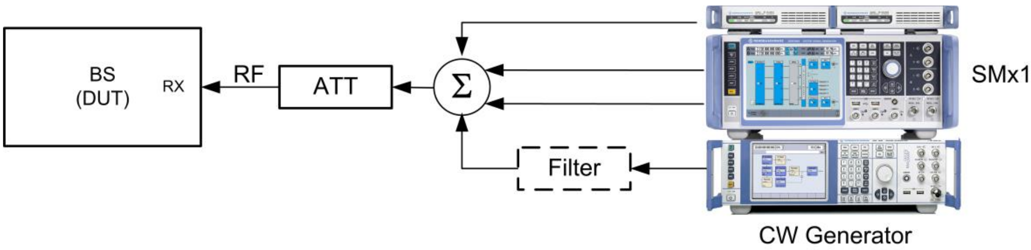


Fig. 3-87: Test setup blocking for MC with BWaggr greater 160 MHz. The SMW generates the MC LTE uplink wanted signal with two paths. The SMW generates the LTE interfering signal and uses the SGS as an additional RF path. The CW generator provides the CW Interferer.

Settings:

- The Base Station transmits an LTE signal with maximum output power according to E-TM1.1.
- The SMW generates a LTE uplink signal with FRC and level settings (see below) which is applied to the BS receiver port.
- In MC, the SMW also generates the second LTE carrier
- The LTE interferer is generated
  - For SC in BB B and RF B
  - For MC in BB C and routed via IQ to the SGS.
- The CW generator provides the CW interferer. Use a filter to suppress harmonics in the receive band.
- Use a Hybrid Combiner to sum all signals.

3.8.1 Intermodulation performance

The intermodulation performance requirement is applicable to measure the throughput at the receiver port of BS with intermodulation effect. The intermodulation effect on the wanted signal consists of an LTE signal with QPSK modulation and a CW signal.

Fig. 3-88 shows the wanted signal along with interfering signals with respective offsets from the higher edge F_{edge_high} of the channel bandwidth. Similarly, it shall be implemented for interfering signals placed with an offset from the lower edge F_{edge_low} of the channel bandwidth.

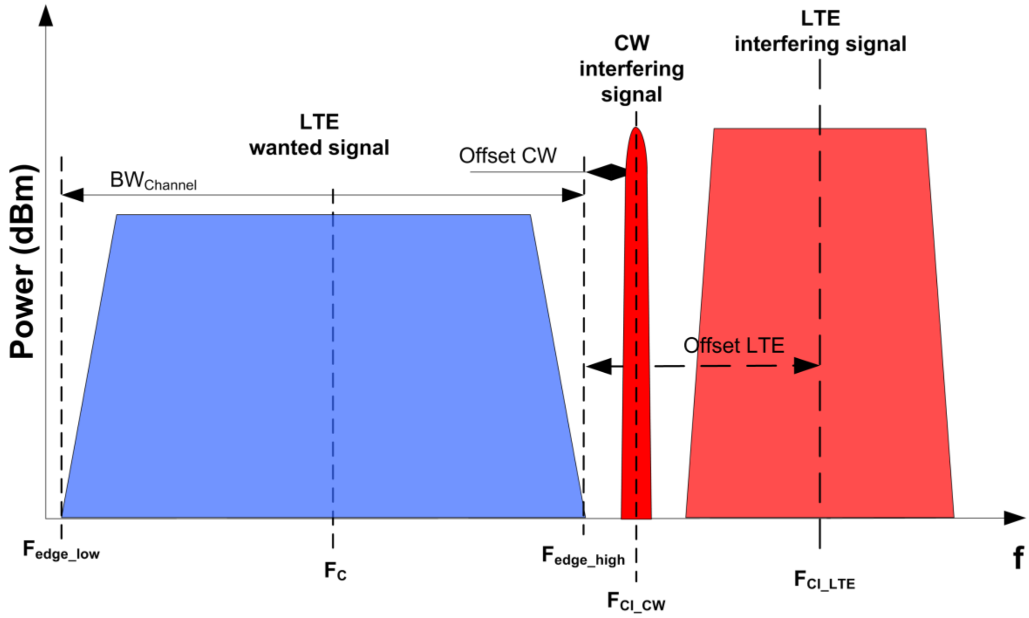


Fig. 3-88: Intermodulation performance. LTE and CW interfering signals causes an interfering signal in the wanted band.

Multi-band Operation

If the gap between two operating bands is wider than at least twice the LTE offset (see Fig. 3-88), the interfering signal can be located in the gap with the same requirements as for single-band operations.

For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput with the settings of Table 3- and Table 3-.

Intermodulation performance requirement, part 1						
LTE Channel bandwidth of the lowest (highest) carrier received [MHz]	FRC	BS Type	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower [upper] edge [MHz]	Type of interfering signal
1.4	FRC A1-1	Wide Area	-100.8	-52	±2.1	CW
					±4.9	1.4 MHz LTE
		Medium Range BS	-95.8	-47	±2.1	CW
					±4.9	1.4 MHz LTE
		Local Area	-92.8	-44	±2.1	CW
					±4.9	1.4 MHz LTE
		Home BS	-84.8	-36	±2.1	CW
					±4.9	1.4 MHz LTE
3	FRC A1-2	Wide Area	-97.0	-52	±4.5	CW
					±10.5	3 MHz LTE
		Medium Range BS	-92.0	-47	±4.5	CW
					±10.5	3 MHz LTE
		Local Area	-89.0	-44	±4.5	CW
					±10.5	3 MHz LTE
		Home BS	-81.0	-36	±4.5	CW
					±10.5	3 MHz LTE
5	FRC A1-3	Wide Area	-95.5	-52	±7.5	CW
					±17.5	5 MHz LTE
		Medium Range BS	-90.5	-47	±7.5	CW
					±17.5	5 MHz LTE
		Local Area	-87.5	-44	±7.5	CW
					±17.5	5 MHz LTE
		Home BS	-79.5	-36	±7.5	CW
					±17.5	5 MHz LTE
10	FRC A1-3	Wide Area	-95.5	-52	±7.375	CW
					±17.5	5 MHz LTE
		Medium Range BS	-90.5	-47	±7.375	CW
					±17.5	5 MHz LTE
		Local Area	-87.5	-44	±7.375	CW
					±17.5	5 MHz LTE
		Home BS	-79.5	-36	±7.375	CW
					±17.5	5 MHz LTE
15	FRC A1-3	Wide Area	-95.5	-52	±7.25	CW
					±17.5	5 MHz LTE
		Medium Range BS	-90.5	-47	±7.25	CW
					±17.5	5 MHz LTE
		Local Area	-87.5	-44	±7.25	CW
					±17.5	5 MHz LTE
		Home BS	-79.5	-36	±7.25	CW
					±17.5	5 MHz LTE

Table 3-38: Intermodulation performance requirements part 1

Intermodulation performance requirement, part 2						
LTE Channel bandwidth of the lowest (highest) carrier received [MHz]	FRC	BS Type	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower (upper) edge [MHz]	Type of interfering signal
20	FRC A1-3	Wide Area	-95.5	-52	±7.125	CW
					±17.5	5 MHz LTE
					±24	20 MHz LTE
		Medium Range BS	-90.5	-47	±7.125	CW
					±17.5	5 MHz LTE
					±24	20 MHz LTE
		Local Area	-87.5	-44	±7.125	CW
					±17.5	5 MHz LTE
					±24	20 MHz LTE
		Home BS	-79.5	-36	±7.125	CW
					±17.5	5 MHz LTE
					±24	20 MHz LTE

Table 3-39: **Intermodulation performance requirements part 2**

NB-IoT

NB-IoT tests are defined for all deployments. For NB-IoT, the settings in Table 3- and Table 3- apply.

Intermodulation performance requirement NB-IoT standalone					
LTE Channel bandwidth of the lowest (highest) carrier received [MHz]	FRC	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower (upper) edge [MHz]	Type of interfering signal
0.2	A14-1	-120.6	-52	±7.575	CW
	A14-2	-126.6		±17.5	5 MHz LTE

Table 3-40: Intermodulation performance requirements NB-IoT standalone

Intermodulation performance requirement NB-IoT in-band and guard band					
LTE Channel bandwidth of the lowest (highest) carrier received [MHz]	FRC	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal center frequency offset from the lower (upper) edge [MHz]	Type of interfering signal
3	A14-1	-95.5	-52	±4.5	CW
	A14-2			±10.5	3 MHz LTE
5	A14-1			±7.5	CW
	A14-2			±17.5	5 MHz LTE
10	A14-1			±7.375	CW
	A14-2			±17.5	5 MHz LTE
15	A14-1			±7.25	CW
	A14-2			±17.5	5 MHz LTE
20	A14-1			±7.125	CW
	A14-2			±17.5	5 MHz LTE
	A14-2			±24	20 MHz LTE

Table 3-41: Intermodulation performance requirements NB-IoT in-band and guard band; 3 MHz channel bandwidth is not applicable to guard band operation

Test Procedure SC

The wanted LTE signal is generated using different paths (baseband and RF) in the SMW. The interfering signal shall be allocated adjacent to the wanted signal.

As an example, settings for a Wide Area BS, $BW_{Channel}$ 20 MHz with FRC A1-3 in operating band 1 are mentioned.

Setup wanted signal

1. Use the standard procedure (see 3.1.2) to generate the UE1 uplink signal according to Table 3- and Table 3- (example: Bandwidth 20 MHz, FRC A1-3 and level -95.5 dBm).

Setup LTE Interferer

2. Set up an uplink LTE signal with the settings Level, $BW_{Channel}$ Table 3- and Table 3-. (Example: Level -52 dBm, BW 5 MHz)
3. Set up the full **RB** allocation. (see Fig. 3-89 ,example in 5 MHz 25 RB are allocated)

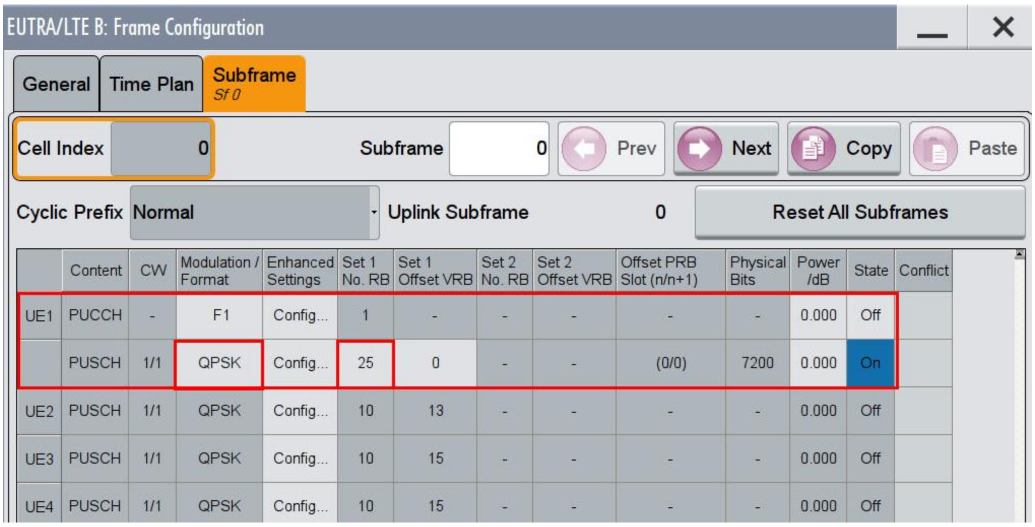


Fig. 3-89: LTE interferer is generated by path B. Instead of a FRC, use the full RB allocation (example 25 RB). Modulation is QPSK.

4. Set the Interferer frequency F_{c_LTE} (example: $F_{c\_LTE} = F_{edge\ high}$ + 17.5 MHz)

Setup CW Interferer

5. Set level and frequency in the CW generator and start a measurement. (example: $F_{c\_CW} = F_{edge\ high}$ + 7.125 MHz, level -52 dBm)
6. Measure the throughput at other Base Station Receiver ports.
7. Repeat measurement with interfering signal in the lower edge range

Test Procedure Multi-Carrier

For MC both carriers of the wanted signal are generated by path A only if the aggregated bandwidth is smaller than 160 MHz. Else two basebands are used (A + B). Both simulated UEs have to be time aligned. If BW_{aggr} is smaller 160 MHz, baseband B and RF B are used for the LTE Interferer. Else, Baseband C and the connected SGS are used. The CW Interferer is generated by the external CW generator.

As an example, the multi carrier example from ETC1 of 2.3.4.1 is used.

1. Set in the System Configuration 2 x 1 x 1 for a BW_{aggr} is smaller 160 MHz, else

   3 x 1 x 1
2. Set up each carrier according the standard procedure in 3.1.2.

   Set the LTE interferer in an additional baseband (see Fig. 3-89). If BW_{aggr} is smaller 160 MHz use BB B and route it to RF B, else use BB C and route it via IQ OUT 1 to the connected SGS.
3. Set level and frequency in the CW generator. (start frequency 1 MHz, level -15 dBm) and start a measurement
4. Measure the throughput at other Base Station Receiver ports.

Demo Program

For this test, additional parameters must be defined. The settings are reported. An additional CW generator is used.

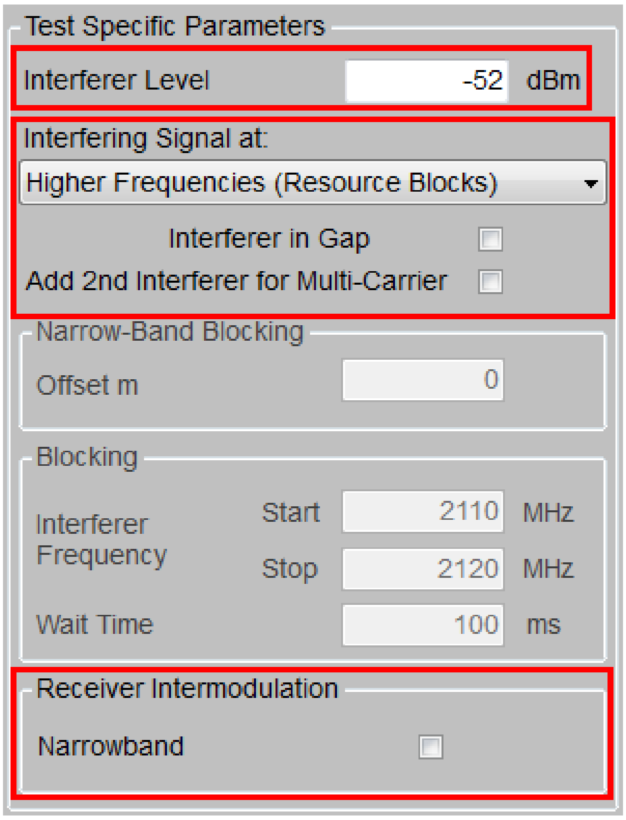


Fig. 3-90: Special settings for intermodulation.

The level for the LTE interferer can be entered directly. Select the position of the interferer. For MC tests, **Add 2nd Interferer for Multi-Carrier** enables two Interferers in parallel. If ETC3 is selected, you can place the **Interferer in Gap**. Please note the settings from the specification listed in Table 3- to Table 3-.

*********** 7.8 Receiver Intermodulation ***********

3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920 MHz
Mean Power: -95.5 dBm
Wanted Signal Attenuation: 0 dB
LTE Interfering Signal Attenuation: 0 dB
CW Interfering Signal Attenuation: 0 dB
VRB Wanted Signal: 0
Interfering Signal at : Higher Frequencies (Resource Blocks)

Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC Model	Power (dBm)	Status
7.8 Receiver Intermodulation					
LTE Wanted Signal	1920	10	FRC A1-3	-95.5	
LTE Interfering Signal	1942.5	5	---	-52	
CW Interfering Signal	1932.375	---	---	-52	

Fig. 3-91: Example report for test case 7.8.

3.8.2 Narrowband intermodulation performance

The narrowband intermodulation performance requirement is applicable to measure the throughput at the receiver port of BS with the intermodulation effect on wanted signal due to LTE signal with QPSK modulation and a CW signal. In the LTE signal, only 1 RB is allocated.

The channel bandwidth of the interfering LTE signal is located adjacently to the lower (upper) edge. The CW carrier may overlap with interfering signal channel bandwidth (see Fig. 3-92).

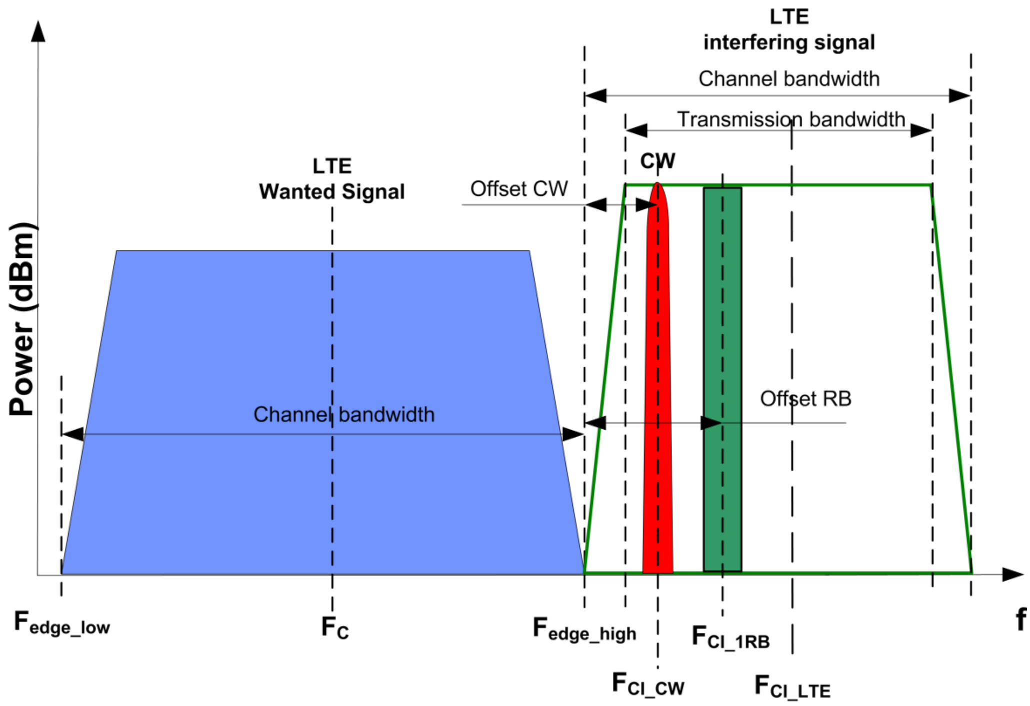


Fig. 3-92: Narrowband intermodulation. The LTE Interferer is placed with the channel bandwidth adjacent to the wanted signal, but only 1 RB is allocated.

Non-contiguous Spectrum within any Operating Band

The narrowband intermodulation requirement applies in addition inside any sub-block gap in case the sub-block gap is at least as wide as the channel bandwidth of the LTE interfering signal according to Table 3- and Table 3- for wide area base stations. The interfering signal offset is defined relative to the sub-block edges inside the sub-block gap. Both sub-blocks are regarded individually for the narrowband intermodulation performance.

Multi-band Operation

If the gap between two operating bands is at least as wide as the LTE interfering signal according to Table 3- and Table 3- for wide area, medium range and local area base stations, the interfering signal can be located in the gap with the same requirements as for single-band operations. The interfering signal offset is defined relative to the RF bandwidth edges inside the gap between the operating bands.

For each measured LTE carrier, the throughput shall be ≥ 95% of the possible maximum throughput with the settings of Table 3- and Table 3-.

Narrowband intermodulation performance requirements, part 1						
LTE channel bandwidth of the lowest (highest) carrier received [MHz]	FRC	BS Type	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering RB center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal
1.4	FRC A1-1	Wide Area	-100.8	-52	±270	CW
					±790	1.4 MHz LTE
		Medium Range BS	-95.8	-47	±270	CW
					±790	1.4 MHz LTE
		Local Area	-92.8	-44	±270	CW
					±790	1.4 MHz LTE
		Home BS	-84.8	-36	±270	CW
					±790	1.4 MHz LTE
3	FRC A1-2	Wide Area	-97.0	-52	±270	CW
					±780	3 MHz LTE
		Medium Range BS	-92.0	-47	±270	CW
					±780	3 MHz LTE
		Local Area	-89.0	-44	±275	CW
					±790	3 MHz LTE
		Home BS	-81.0	-36	±270	CW
					±780	3 MHz LTE
5	FRC A1-3	Wide Area	-95.5	-52	±360	CW
					±1060	5 MHz LTE
		Medium Range BS	-90.5	-47	±360	CW
					±1060	5 MHz LTE
		Local Area	-87.5	-44	±360	CW
					±1060	5 MHz LTE
		Home BS	-79.5	-36	±360	CW
					±1060	5 MHz LTE
10	FRC A1-3	Wide Area	-95.5	-52	±325	CW
					±1240	5 MHz LTE
		Medium Range BS	-90.5	-47	±325	CW
					±1240	5 MHz LTE
		Local Area	-87.5	-44	±415	CW
					±1420	5 MHz LTE
		Home BS	-79.5	-36	±325	CW
					±1240	5 MHz LTE
15	FRC A1-3	Wide Area	-95.5	-52	±380	CW
					±1600	5 MHz LTE
		Medium Range BS	-90.5	-47	±380	CW
					±1600	5 MHz LTE
		Local Area	-87.5	-44	±380	CW
					±1600	5 MHz LTE
		Home BS	-79.5	-36	±380	CW
					±1600	5 MHz LTE

Table 3-42: Narrowband intermodulation performance requirements, part 1

Narrowband intermodulation performance requirements, part 2						
LTE channel bandwidth of the lowest (highest) carrier received [MHz]	FRC	BS Type	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering RB center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal
20	FRC A1-3	Wide Area	-95.5	-52	±345	CW
					±1780	5 MHz LTE
		Medium Range BS	-90.5	-47	±345	CW
					±1780	5 MHz LTE
		Local Area	-87.5	-44	±345	CW
					±1780	5 MHz LTE
		Home BS	-79.5	-36	±345	CW
					±1780	5 MHz LTE

Table 3-43: Narrowband intermodulation performance requirements, part 2

NB-IoT

NB-IoT tests are defined for all deployments. For NB-IoT, the settings in Table 3- and Table 3- apply.

Narrowband Intermodulation performance requirement NB-IoT standalone					
LTE Channel bandwidth of the lowest (highest) carrier received [MHz]	FRC	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering RB center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal
0.2	A14-1	-120.6	-52	±340	CW
	A14-2	-126.6		±880	5 MHz LTE

Table 3-44: Narrowband intermodulation performance requirements NB-IoT standalone

Narrowband Intermodulation performance requirement NB-IoT in-band and guard band					
LTE Channel bandwidth of the lowest (highest) carrier received [MHz]	FRC	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering RB center frequency offset from the lower (upper) edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal
3	A14-1		-52	±270	CW
	A14-2			±780	3 MHz LTE
5	A14-1			±360	CW
	A14-2			±1060	5 MHz LTE
10	A14-1			±325	CW
	A14-2			±1240	5 MHz LTE
15	A14-1			±380	CW
	A14-2			±1600	5 MHz LTE
20	A14-1			±345	CW
	A14-2			±1780	5 MHz LTE

Table 3-45: Narrowband intermodulation performance requirements NB-IoT in-band and guard band; 3 MHz channel bandwidth is not applicable to guard band operation

Test Procedure

The wanted LTE and LTE Interfere signals are generated using different paths (baseband and RF) in the SMW.

The interfering signal shall be allocated adjacent to the wanted signal. For bandwidths not allocating all RBs, the allocation has to be aligned using the Offset VRB possibility of the SMW. This applies to the bandwidths 10 MHz, 15 MHz and 20 MHz.

The channel bandwidth of the interfering signal shall be adjacent to the wanted signal. The center frequency of the interfering signal can be calculated:

$F_{CI\_LTE} = BW_{Channel\_wanted} / 2 \pm BW_{Channel\_interferer}$

The position of the one used RB then can be set via Offset VRB. Table 3- shows the settings.

Center Frequency offset and Offset VRB							
LTE Channel bandwidth ($BW_{Channel}$) [MHz]	LTE interferer with 1RB [MHz]	Wanted signal Offset VRB		Interfering center frequency offset from center frequency (± $BW_{Interferer\_Channel}/2$ ± $BW_{Channel\_interferer}$) [MHz]	Offset VRB Interferer First row: Higher edge Sec. row: Lower edge		
		Lower edge	Higher edge		Wide	Local	Home
1.4	1.4	-	-	±1.4	3 2	3 2	3 2
3	3	-	-	± 3	3 11	3 11	3 11
5	5	-	-	± 5	4 20	4 20	4 20
10	5	0	25	± 7.5	5 19	6 18	5 19
15	5	0	50	± 10	7 17	7 17	7 17
20	5	0	75	± 12.5	8 16	8 16	8 16

Table 3-46: position for narrowband intermodulation

As an example, settings for a Wide Area BS, $BW_{Channel}$ 20 MHz with FRC A1-3 in operating band 1 are mentioned.

Setup wanted signal

1. Use the standard procedure (see 3.1.2) to generate the UE1 uplink signal according to Table 3- and Table 3- (example: Bandwidth 20 MHz, FRC A1-3 and level -95.5 dBm). Set the Offset VRB according to Table 3-.

Setup LTE Interferer

2. Set up an uplink LTE signal with the settings Level, $BW_{Channel}$ Table 3- and Table 3- (Example: Level -52 dBm, BW 5 MHz)
3. Set up only one **RB**. (see Fig. 3-93,example in 5 MHz, 1RB is allocated). Set the Offset VRB according to Table 3- (example higher edge: offset = 8)

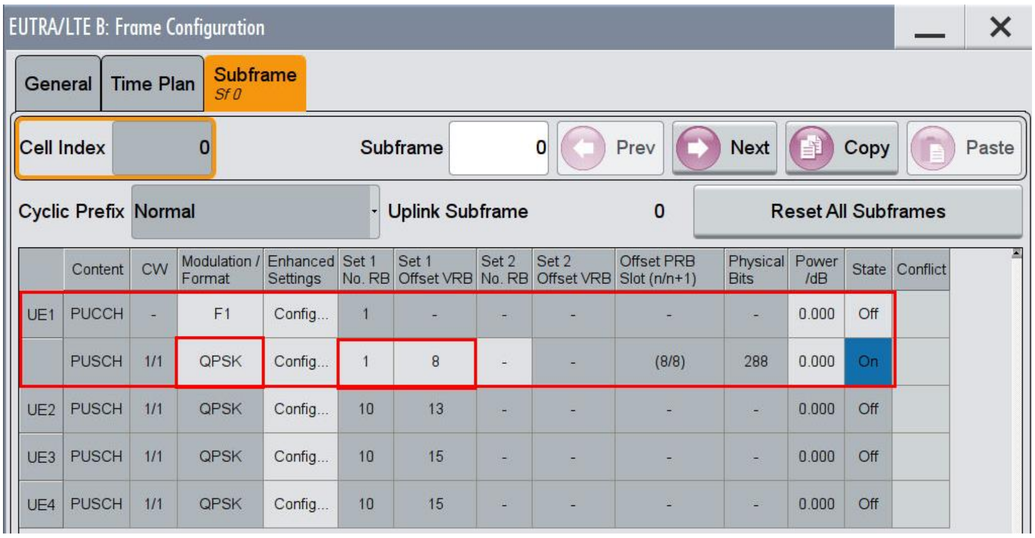


Fig. 3-93: LTE interferer is generated by path B. Instead of a FRC, use 1 RB allocation. Modulation is QPSK.

4. Set the Interferer frequency F_{c_LTE} according Table 3- (example: $F_{c\_LTE} = F_c + 12.5$ MHz)

Setup CW Interferer

5. Set level and frequency in the CW generator according Table 3- and start a measurement. (example: $F_{c\_CW} = F_{edge\ high} + 345$ kHz, level -52 dBm)
6. Measure the throughput at other Base Station Receiver ports.
7. Repeat measurement with interfering signal in the lower edge range

Test Procedure Multi-Carrier

For MC both carriers of the wanted signal are generated by path A only if the aggregated bandwidth is smaller than 160 MHz. Else two basebands are used (A + B). Both simulated UEs have to be time aligned. If BW_{aggr} is smaller 160 MHz, baseband B and RF B are used for the LTE Interferer. Else Baseband C and the connected SGS are used. The CW Interferer is generated by the external CW generator.

As an example, the multi carrier example from ETC1 of 2.3.4.1 is used.

1. Set in the System Configuration 2 x 1 x 1 for a BW_{aggr} is smaller 160 MHz, else

   3 x 1 x 1
2. Set up each carrier according the standard procedure in 3.1.2.

   Set the LTE interferer in an additional baseband (see Fig. 3-61). If BW_{aggr} is smaller 160 MHz use BB B and route it to RF B, else use BB C and route it via IQ OUT 1 to the connected SGS.

3. Set level and frequency in the CW generator. (start frequency 1 MHz, level -15 dBm) and start a measurement
4. Measure the throughput at other Base Station Receiver ports.

Demo Program

For this test, additional parameters must be defined. The settings are reported. An additional CW generator is used.

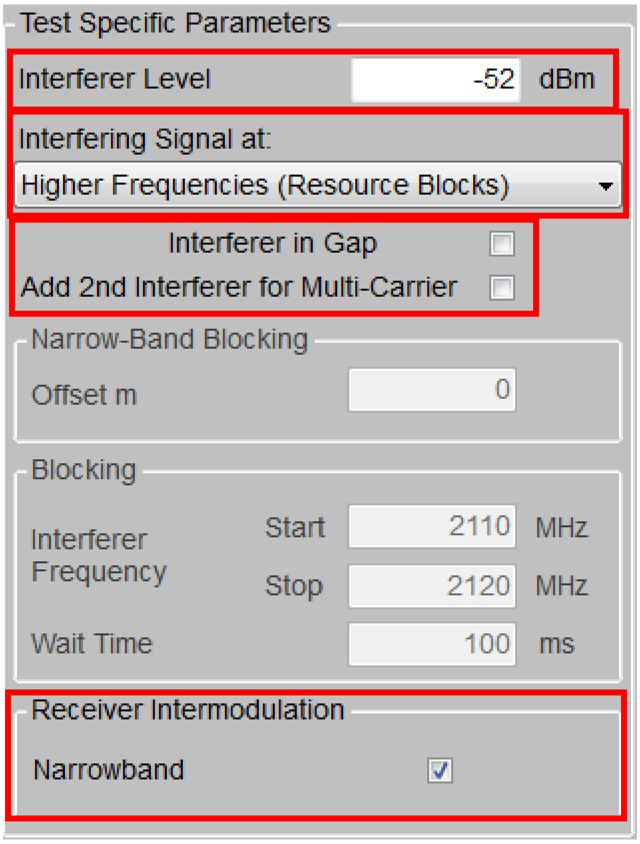


Fig. 3-94: Special settings for intermodulation.

The level for the LTE interferer can be entered directly. Select the position of the interferer. For MC tests, **Add 2nd Interferer for Multi-Carrier** enables two Interferers in parallel. If ETC3 is selected, you can place the **Interferer in Gap**.

The settings are the same like in the Intermodulation test case. Just switch on **Narrowband.**

*********** 7.8 Receiver Intermodulation ***********

3GPP Standard: Rel. 10
Filter Optimization: Balanced
Trigger Mode: Auto
Single Carrier
Duplexing Mode: FDD
Center Frequency: 1920 MHz
Mean Power: -95.5 dBm
Wanted Signal Attenuation: 0 dB
LTE Interfering Signal Attenuation: 0 dB
CW Interfering Signal Attenuation: 0 dB
VRB Wanted Signal: 0
Interfering Signal at : Higher Frequencies (Resource Blocks)

Test Item	Carrier Frequency (MHz)	Carrier Bandwidth (MHz)	FRC Model	Power (dBm)	Status
7.8 Narrowband Receiver Intermodulation					
LTE Wanted Signal	1920	10	FRC A1-3	-95.5	
LTE Interfering Signal	1927.5	5	---	-52	
1 RB Center Frequency *(of LTE Interfering Signal)*	1926.24	---	---	-52	
CW Interfering Signal	1925.325	---	---	-52	

Fig. 3-95: Example report for test case 7.8 narrow band.

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
- .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 connectionAfter TSrun is launched, the following splash screen appears:

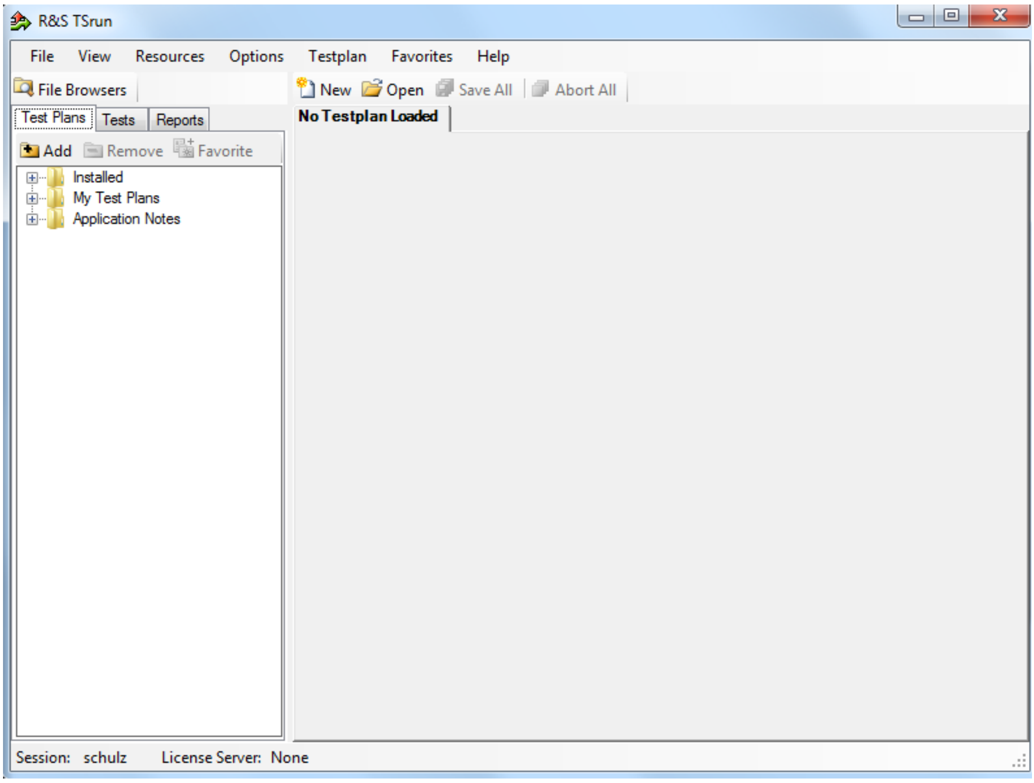


Fig. 4-1: Overview TSrun

Tests and test plans

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

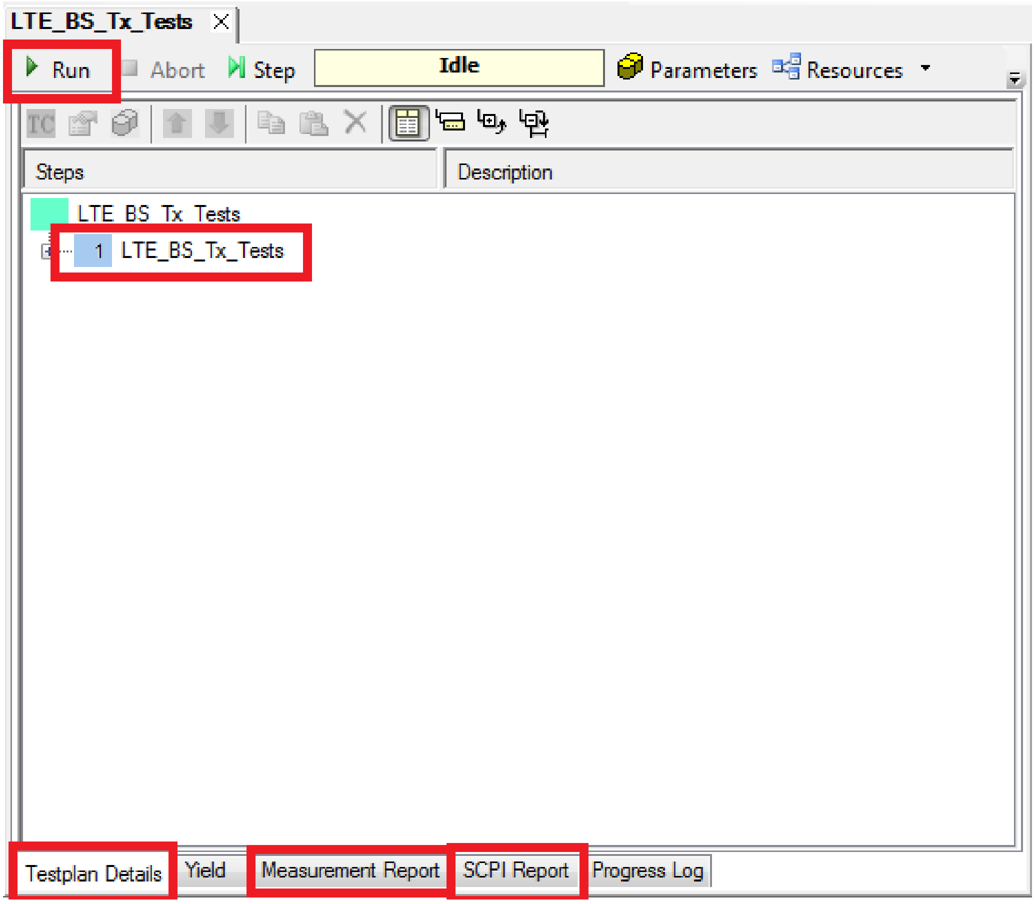


Fig. 4-2: Overview of a test plan in TSrun. The test plan in the example contains only one test (LTE_BS_Tx_Tests). After the test is completed, the bar along the bottom can be used to display the measurement and SCPI reports.

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.

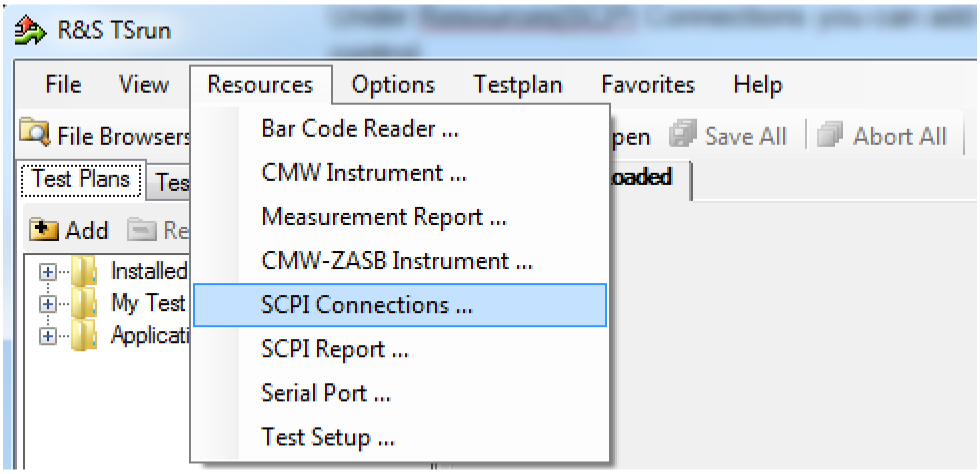


Fig. 4-3: Setting the SCPI connections.

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.

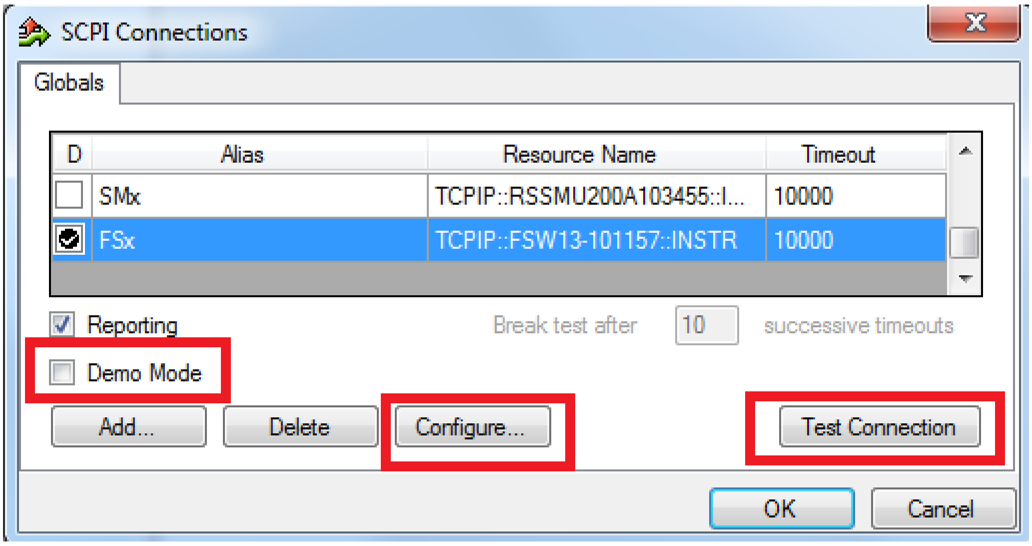


Fig. 4-4: SCPI connections.

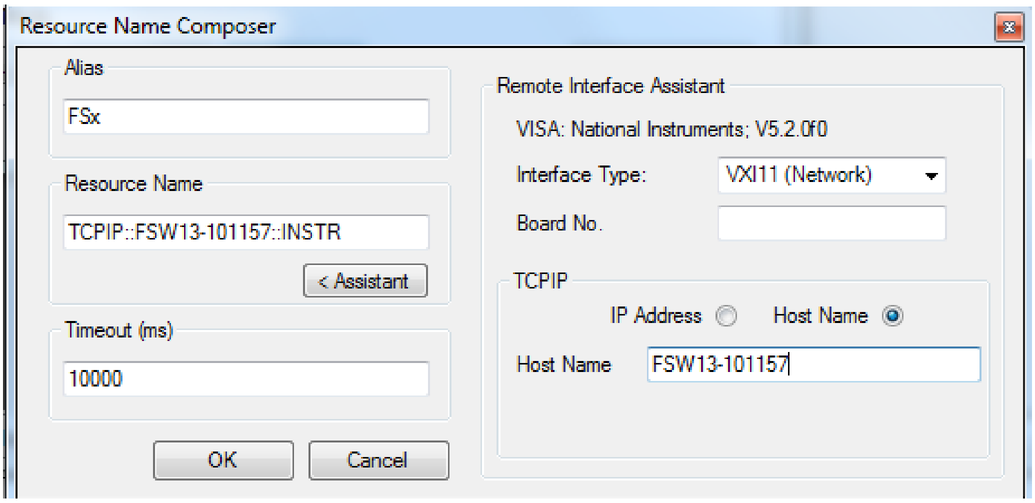


Fig. 4-5: Wizard for entering VISA parameters. Both the IP address and a host name can be entered directly.

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.

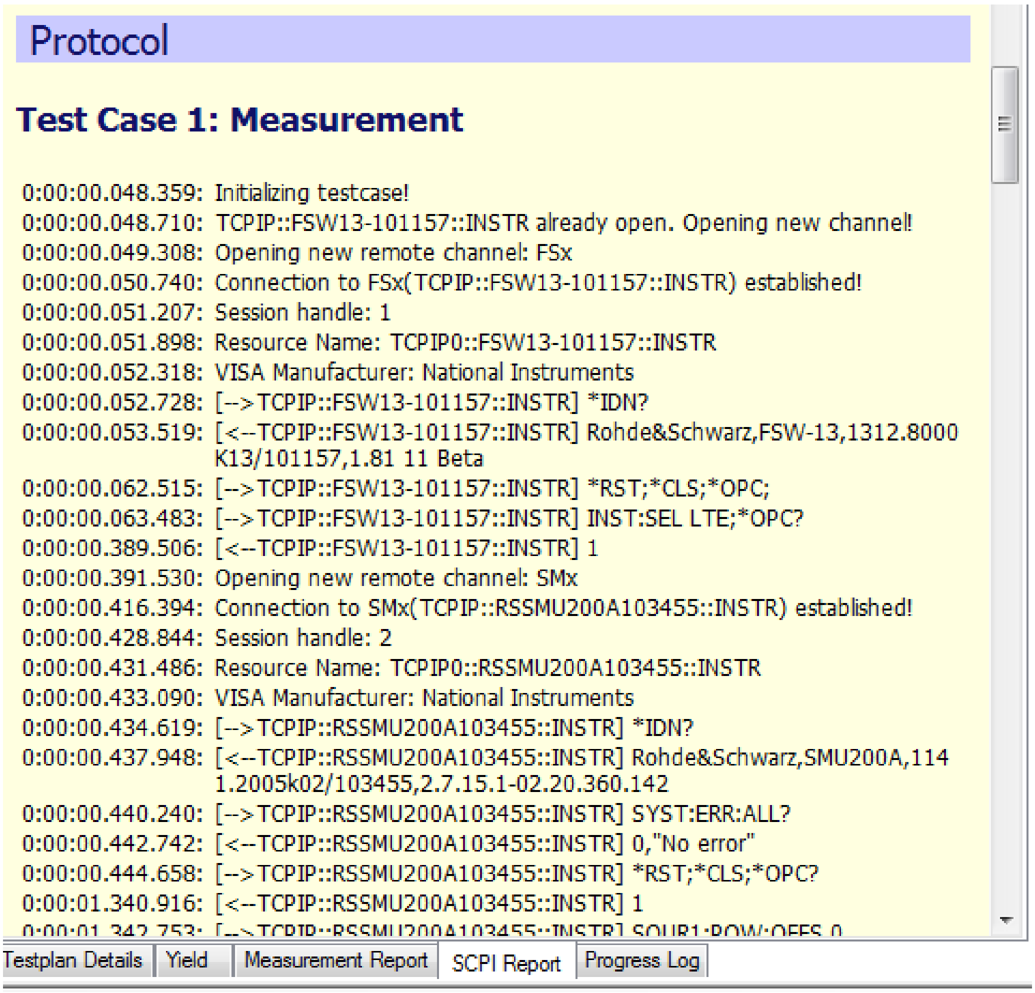


Fig. 4-6: SCPI report.

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 Transmitter Tests according to TS 36.141 Rel. 14,** Application Note 1MA154, 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; Multi-Standard 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: **SMW200A Vector Signal Generator,** User Manual, 1175.6632.02 – 05

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

[9] 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 Signal Generators		
Vector Signal Generator		
Product Description	**Type**	**Ordering No.**
Vector Signal Generator	**SMW200A**	**1412.0000.02**
Baseband Generator	SMW-B10	1413.1200.02
Baseband Main Module, one path	SMW-B13	1413.2807.02
Baseband Main Module, two paths	SMW-B13T	1413.3003.02
1st RF path	SMW-B10x	
2nd RF path	SMW-B20x	
AWGN	SMW-K62	1413.3484.02
Digital Standard LTE/EUTRA	SMW-K55	1413.4180.02
LTE Release 10 / LTE-Advanced	SMW-K85	1413.5487.02
LTE/EUTRA Release 12	SMW-K113	1414.1933.02
LTE/EUTRA Release 13/14	SMW-K119	1414.3542.02
Cellular IoT	SMW-K115	1414.2723.02
MIMO Fading/Routing	SMW-K74	1413.3384.02

Ordering Information for Signal Generators		
Signal Generator		
Product Description	**Type**	**Ordering No.**
Microwave Signal Generator	SMF100A	1167.0000.02
RF and Microwave Signal Generator	SMB100A	1406.6000.02
SGMA RF Source	SGS100A	1416.0505.02
SGMA RF Source	SGT100A	1419.4501.02

Ordering Information for Analyzers		
Signal and Spectrum Analyzers		
Product Description	**Type**	**Ordering No.**
Up to 13, 26, 43, 50 or 67 GHz	FSW	1312.8000Kxx
Up to 13, 30, or 40 GHz	FSV	1307.9002Kxx
Up to 4, 7, 13, 30, or 40 GHz	FSVA	1321.3008.xx
Up to 4, 7, 13, 30 or 40 GHz	FPS	1319.2008.xx

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Regional contact

Europe, Africa, Middle East
+49 89 4129 12345
customersupport@rohde-schwarz.com

North America
1-888-TEST-RSA (1-888-837-8772)
customer.support@rsa.rohde-schwarz.com

Latin America
+1-410-910-7988
customersupport.la@rohde-schwarz.com

Asia/Pacific
+65 65 13 04 88
customersupport.asia@rohde-schwarz.com

China
+86-800-810-8228 /+86-400-650-5896
customersupport.china@rohde-schwarz.com

Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

This application note and the supplied programs may only be used subject to the conditions of use set forth in the download area of the Rohde & Schwarz website.

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

Rohde & Schwarz GmbH & Co. KG
Mühldorfstraße 15 | D - 81671 München
Phone + 49 89 4129 - 0 | Fax + 49 89 4129 – 13777

www.rohde-schwarz.com