Application Note

5G NEW RADIO CONDUCTED BASE STATION RECEIVER TESTS

according to TS 38.141-1 Rel. 15

Products:

- R&S®SMW200A
- R&S®SMBV100B
- R&S®FSW
- R&S®FSV3000
- R&S®FSVA3000
- R&S®FSV
- R&S®FSVA
- R&S®FPS

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https://www.rohde-schwarz.com/appnote/GFM314

Contents

1 Introduction

The 5th generation (5G) of mobile networks introduces a paradigm shift towards a user and application centric technology framework.

The goal of 5G New Radio (NR) is to flexibly support three main service families:

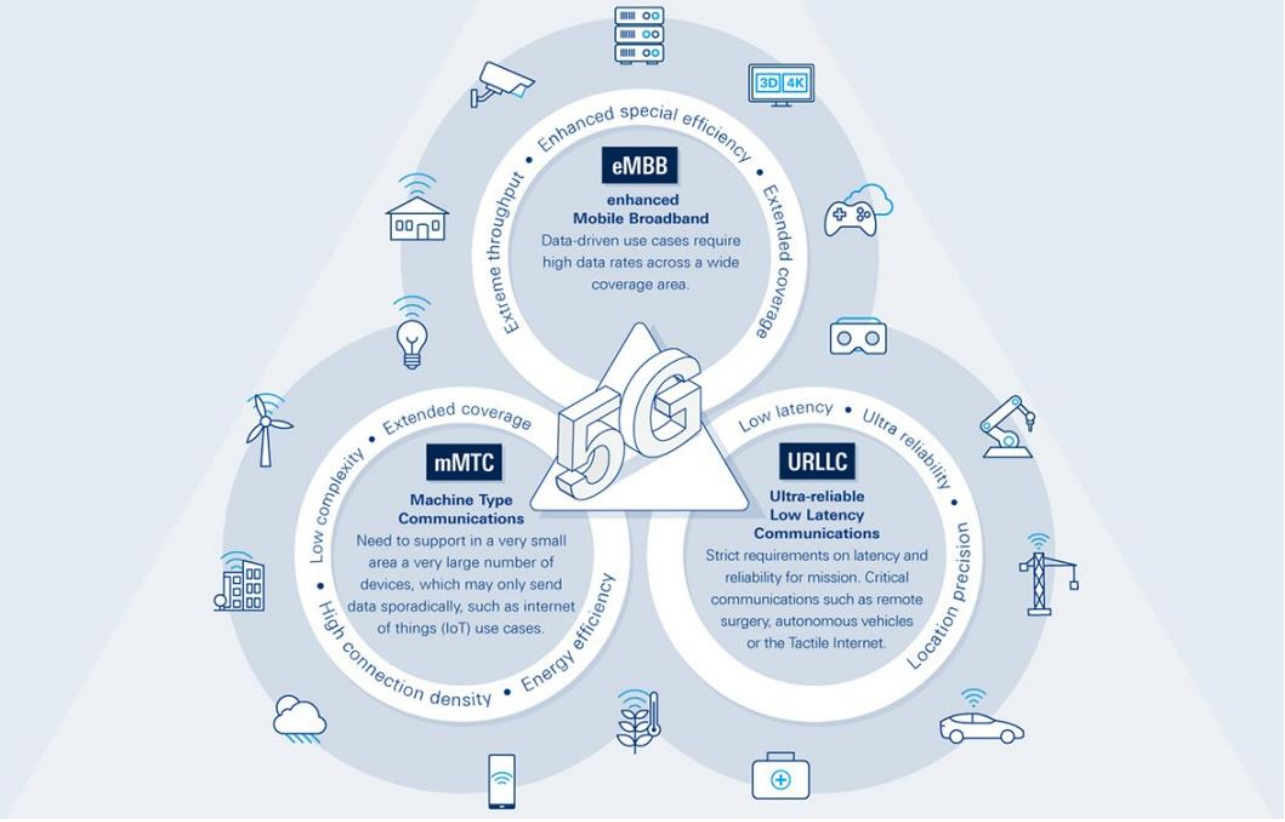


Figure 1: 5G New Radio main service families

- Enhanced mobile broadband (eMBB) for higher end-user data rates
- Massive machine type communications (mMTC) targets cost-efficient and robust D2X connections
- Ultra-reliable, low latency communications (URLLC) supporting new requirements from vertical industries such as autonomous driving, remote surgery or cloud robotics

3GPP, the responsible standardization body, defines the Radio Frequency (RF) conformance test methods and requirements for NR Base Stations (BS) in the technical specifications TS 38.141 which covers transmitter (Tx), receiver (Rx) and performance (Px) testing.

The technical specification **TS 38.141** consists of two parts depending on whether the test methodology has conducted or radiated requirements:

- **TS 38.141-1: Part 1** [1]: Conducted conformance testing
- **TS 38.141-2: Part 2** [2]: Radiated conformance testing

This application note describes how all mandatory **RF receiver tests (TS 38.141-1, chapter 7)**, according to Release 15 (V15.6.0), can be performed quickly and conveniently with signal generators from Rohde & Schwarz by either choosing manual operation or a remote control approach. Moreover, one test case requires a signal or spectrum analyzer from Rohde & Schwarz which is highlighted separately in the corresponding chapter.

Generally, each chapter is structured in three sections:
First, a short introduction at the beginning of a chapter is covering the scope of the individual test case showing the necessary testing parameters and a schematic test setup. Next, there comes the step-by-step description of the procedure for manual testing enhanced by device images and screenshots. Last but not least, each test case is closed by the corresponding SCPI commands sequence required for remote operation or the implementation in user-defined test software.

Hereinafter, Table 1 gives an overview of all 5G base station receiver tests covered individually in this document.

Table 1: Conducted receiver tests (chapter 7)

Chapter (TS 38.141-1)	Test	Single Carrier (SC)	Multi Carrier (MC)
7.2	Reference Sensitivity Level	✓	×
7.3	Dynamic Range	✓	×
7.4	In channel Selectivity and Blocking		
7.4.1	Adjacent Channel Selectivity (ACS)	✓	×
7.4.2a	In-band Blocking: General	✓	×
7.4.2b	In-band Blocking: Narrow-band blocking	✓	×
7.5	Out-of-band Blocking	✓	×
7.6	Receiver Spurious Emissions	✓	×
7.7	Receiver Intermodulation	✓	×
7.8	In-channel selectivity	✓	×

Note: this document covers single carrier (SC) tests only.

Additionally, several software libraries come with this application note. It is meant to demonstrate the remote control approach of base station testing and are provided as is. [A]

Base station (RF) transmitter tests (TS 38.141-1, chapter 6) are described in GFM313.

Base station (RF) performance tests (TS 38.141-1, chapter 8) are described in GFM315.

For further reading

Find a more detailed overview of the technology behind 5G New Radio from this Rohde & Schwarz book [3] and www.rohde-schwarz.com/5G.

2 General Test Conditions

2.1 Safety indication

**VERY HIGH OUTPUT POWERS CAN OCCUR ON BASE STATIONS.
MAKE SURE TO USE SUITABLE ATTENUATORS IN ORDER TO PREVENT DAMAGE TO THE TEST EQUIPMENT.**

2.2 Base station classes and configurations

The minimum RF characteristics and performance requirements for 5G NR in-band base stations are generally described in 3GPP document TS 38.104 [4].

2.2.1 BS type 1-C and 1-H reference points (TS 38.104, chapter 4.3)

This application note covers conducted measurements only. In [1] and [4] two different base station types are defined for frequency range one (FR1).

2.2.1.1 BS type 1-C (FR1, conducted)

For this type of BS, the transceiver antenna connector (port A) is accessible directly. If any external equipment such as an amplifier, a filter or the combination of both is used, the test requirements apply at the far end antenna connector (port B) of the whole system.

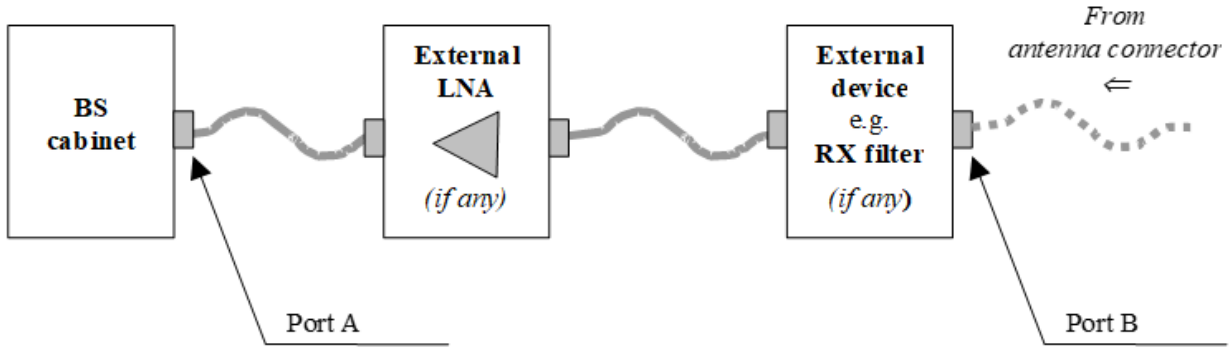


Figure 2: BS type 1-C receiver interface [1]

2.2.1.2 BS type 1-H (FR1, hybrid)

This base station type has two reference points fulfilling both radiated and conducted requirements.

Conducted characteristics are defined at the transceiver array boundary (TAB) which is the conducted interface between the transceiver unit array and the composite antenna equipped with connectors for conducted measurements. All test cases described in this application note apply to conducted measurements at the transceiver array boundary (TAB).

Radiated characteristics are defined over-the-air (OTA) and to be measured at the radiated interface boundary (RIB). The specific requirements and test cases are defined in TS 38.141-2 [2]. Furthermore, the specific OTA measurements are described in extra Rohde & Schwarz application notes [5] and [6].

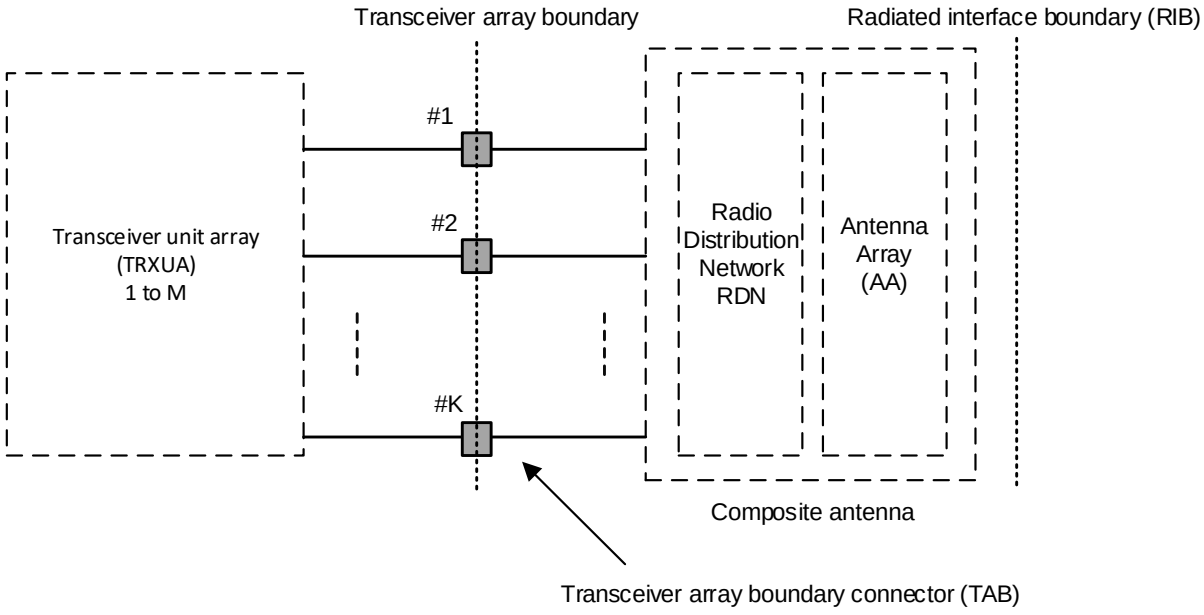


Figure 3: Radiated and conducted reference points for BS type 1-H [1]

2.2.2 BS classes (TS 38.104, chapter 4.4)

This specification distinguishes three different base station classes.

Table 2: Base station classes

Name	Cell size	Minimum coupling loss
Wide area	Macro cell	70 dB
Medium range	Micro cell	53 dB
Local area	Pico cell	45 dB

Different power levels are required and described in detail in GFM313.

2.3 5G NR frequency ranges

The frequency ranges in which 5G NR can operate according to Rel. 15 (V15.8.0) are shown in Table 3.

Table 3: Frequency ranges [4], chapter 5

Frequency range designation	Corresponding frequency range
FR1	410 MHz - 7125 MHz
FR2	24250 MHz - 52600 MHz

2.4 R&S devices and options

Any of the following Rohde & Schwarz vector signal generators can be used for the tests described in this document:

- R&S®SMW200A
- R&S®SMBV100B

Furthermore, the **5G NR** software option is needed for the Rx tests:

- R&S®SMW200A-/SMBV100B-K144 5G New Radio

For further information on R&S signal generators, please see:

https://www.rohde-schwarz.com/signalgenerators

The **Receiver spurious emissions test case (7.6)** does not require a signal generator but it requires a signal- and spectrum analyzer. Any of the following Rohde & Schwarz signal and spectrum analyzers can be used for this test case.

- R&S®FSW
- R&S®FSV3000 and R&S®FSVA3000
- R&S®FSV and R&S®FSVA
- R&S®FPS

For further information on R&S signal and spectrum analyzers, please see:

https://www.rohde-schwarz.com/signal-spectrum-analyzers

The following test equipment and abbreviations are used in this application note:

- The R&S®SMW200A vector signal generator is referred to as the **SMW**
- The R&S®FSW spectrum analyzer is referred to as the **FSW**

3 RF Receiver Tests (TS 38.141-1, chapter 7)

Specification TS 38.141-1 [1] defines the tests required in the various frequency ranges and positions (**B**ottom, **M**iddle, **T**op) in the operating band. In instruments from Rohde & Schwarz, the frequency range can be set to any frequency within the supported range independently of the operating bands.

Please note that this version of the application note supports single carrier (SC) tests only.

In order to allow comparisons between tests, fixed reference channels (FRCs) standardize the resource block (RB) allocations. The FRCs are stored as predefined settings in instruments from Rohde & Schwarz.

Table 4 provides an overview of the basic parameters for the individual tests numbered by the chapters of TS 38.141-1 and linked to the corresponding chapters in this application note.

Table 4: Receiver tests covered in this application note

Chapter (TS 38.141-1)	Name	Channels	Single Carrier	Comment
7.2	Reference Sensitivity Level	B M T	Any SC	
7.3	Dynamic Range	M	Any SC	AWGN Interferer
7.4.1	Adjacent Channel Selectivity (ACS)	M	Any SC	5G NR Interferer
7.4.2a	In-band Blocking: General	M	Any SC	5G NR Interferer
7.4.2b	In-band Blocking: Narrow-band blocking	M	Any SC	5G NR Interferer
7.5[1)]	Out-of-band Blocking	M	Any SC	CW Interferer
7.6	Receiver Spurious Emissions	M	Any SC	
7.7[2)]	Receiver Intermodulation	M	Any SC	CW + 5G NR Interferer
7.8	In-channel selectivity	M	Any SC	5G NR Interferer

[1)] An additional signal generator for the CW signal is optional. The CW interfering signal can also be generated by the second path of the SMW.

[2)] An additional signal generator for the CW signal is optional. The CW interfering signal can also be generated by the AWGN B block in RF path B of the SMW. In this application note we will explain the second option in the respective test case chapter.

3.1 Complete Rx test setup overview

Figure 4 shows the general test setup for receiver tests. A SMW is used to perform the tests. Some tests require a modified setup which is described in the respective sections in detail.

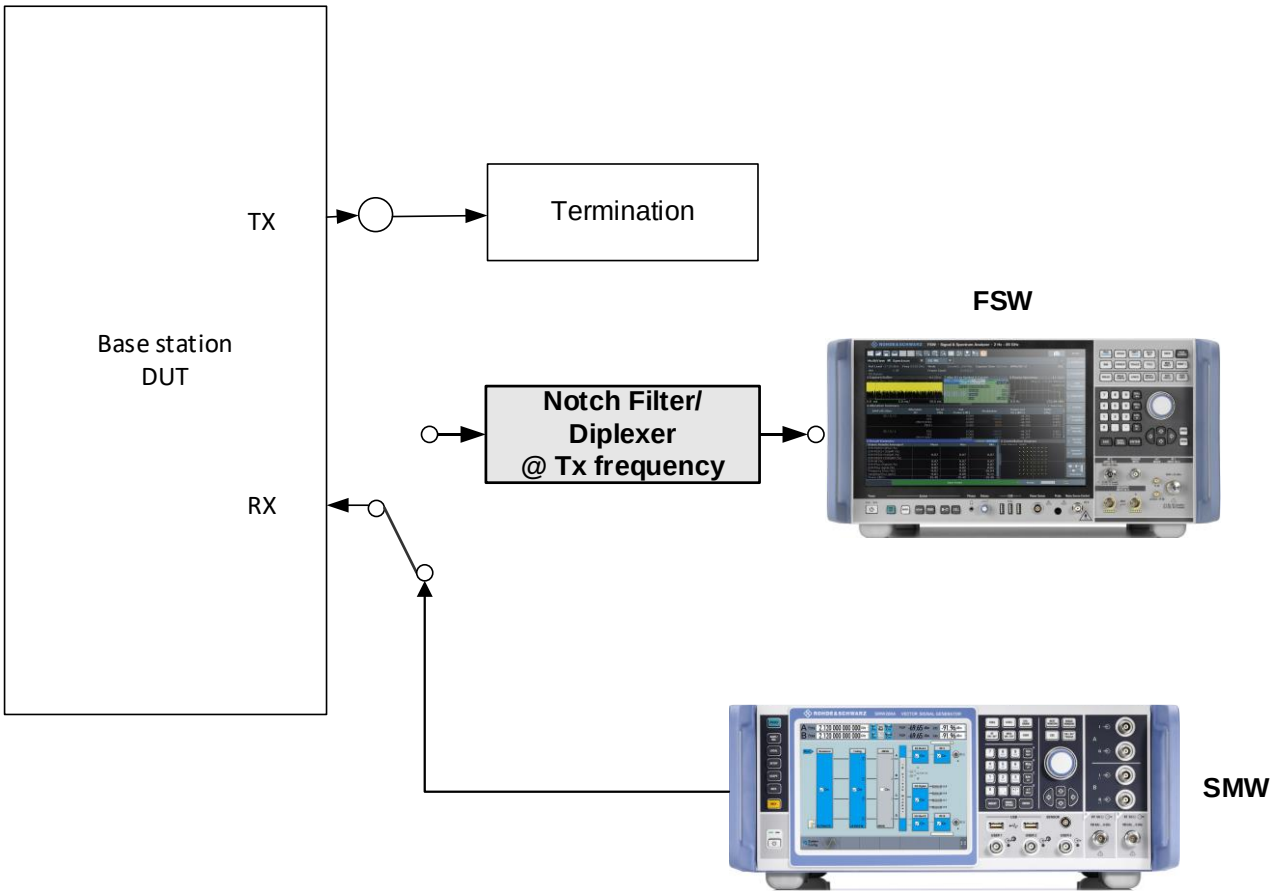


Figure 4: Complete Rx test setup overview

3.2 Recommended R&S devices and options

Table 5: Overview of required instruments and software options

Chapter (TS 38.141-1)	Hardware options (SMW)					Software options (SMW)	
	RF path		Baseband		BB generator	AWGN	5G NR
	A	B	1 path	2 paths			
	e.g. B1007	e.g. B2007	B13 B13XT	B13T B13XT	B10 B9	K62	K144
7.2	1		1		1		1
7.3	1		1		1	1	1
7.4.1	1	1		1	2		2
7.4.2a	1	1		1	2		2
7.4.2b	1	1		1	2		2
7.5[1)]	1	1		1	2		2
7.7[2)]	1	1		1	2	1	2
7.8	1	1		1	2		2

[1)] An additional signal generator for the CW signal is optional. The CW interfering signal can also be generated by the second path of the SMW.

[2)] An additional signal generator for the CW signal is optional. The CW interfering signal can also be generated by the AWGN B block in RF path B of the SMW. In this application note we will explain the second option in the respective test case chapter.

The following equipment and options are required, for receiver characteristics tests:

- 2x option baseband generator (R&S®SMW-B10 or -B9)
- 1x option baseband main module (R&S®SMW-B13T or -B13XT)
- 1x option frequency (e.g. R&S®SMW-B1007)
- 1x option frequency (e.g. R&S®SMW-B2007)
- 1x option additive white Gaussian noise (AWGN) (R&S®SMW-K62)
- 2x option digital standard 5G NR (R&S®SMW-K144)

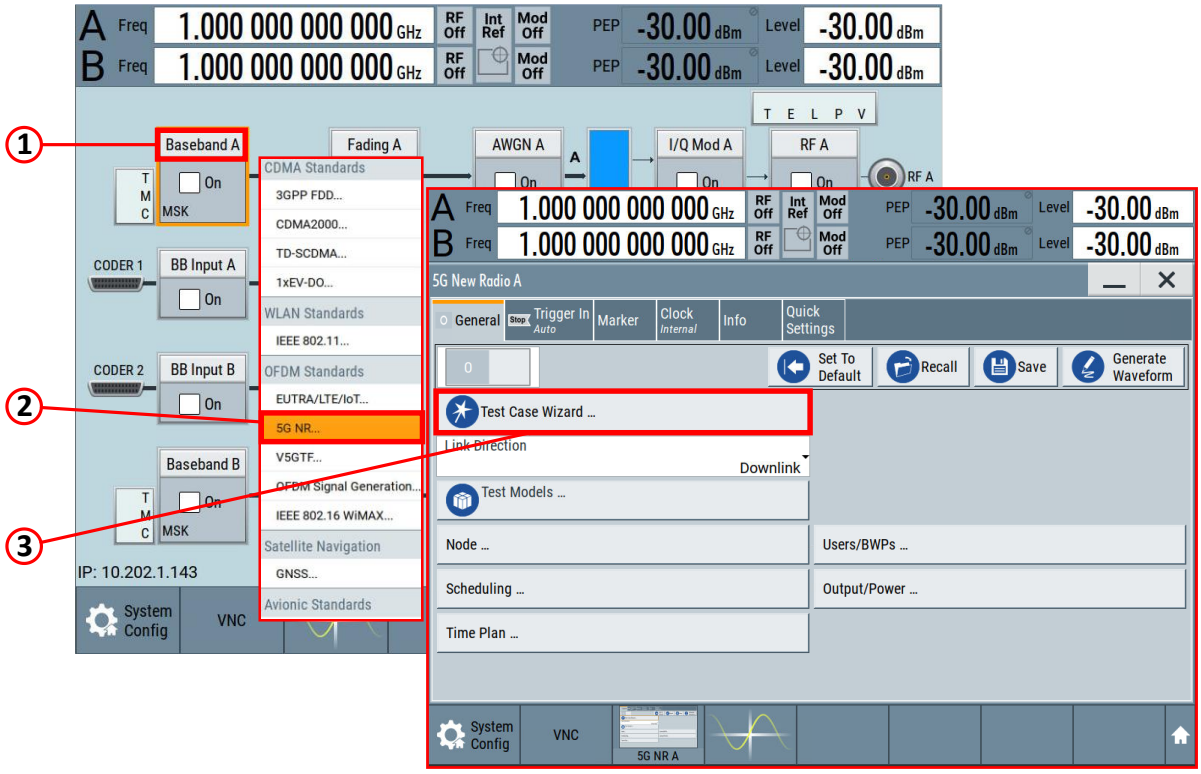
3.3 Basic SMW Test Case Wizard (TCW) operations

The SMW firmware version 4.70.026.51 (and higher) provides a so-called **Test Case Wizard**.
The **Test Case Wizard** supports tests on base stations in conformance with the 3GPP specification TS 38.141. With this wizard it is very easy to perform highly complex test scenarios with just a few keystrokes.

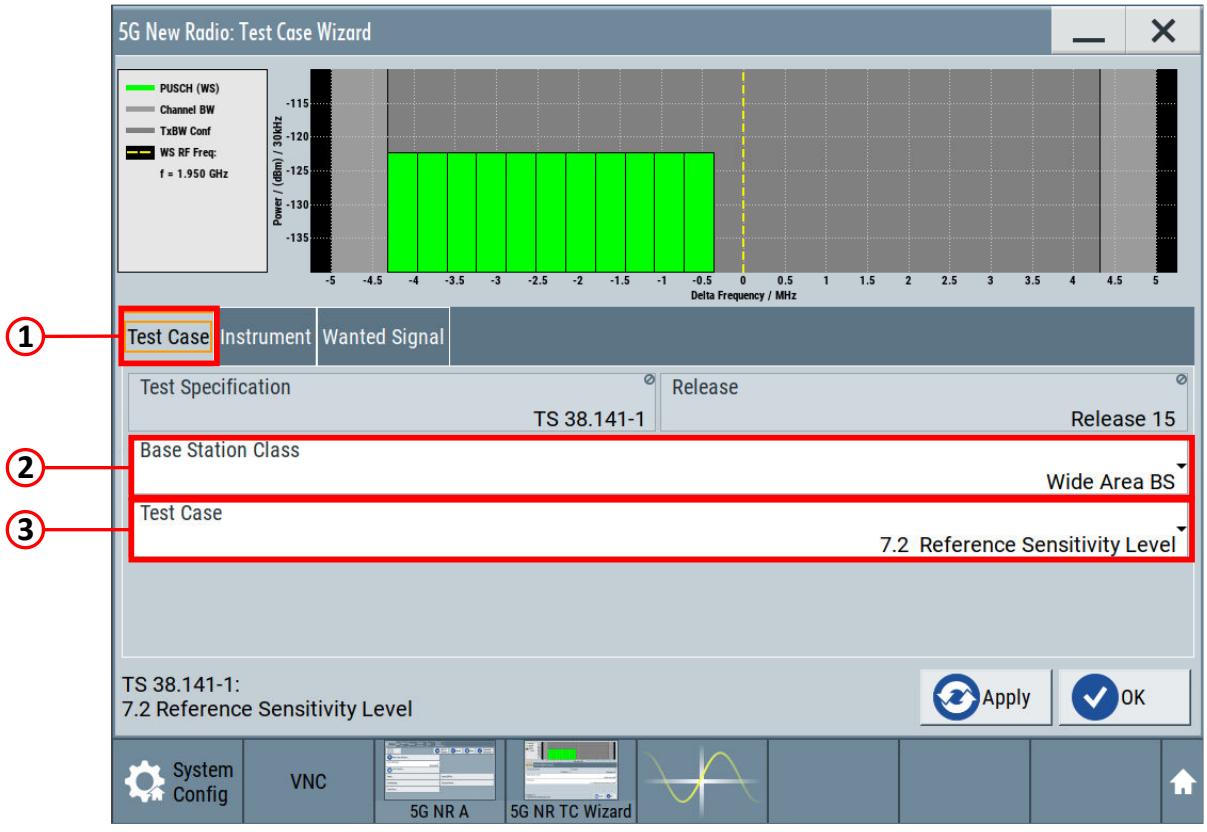
The SMW firmware is implemented on the basis of TS 38.141 Rel. 15, V. 15.6.0.

In the following you will find a short step-by-step guide which describes the usage of the test case wizard. More information about the SCPI syntax can be found in 3.4.

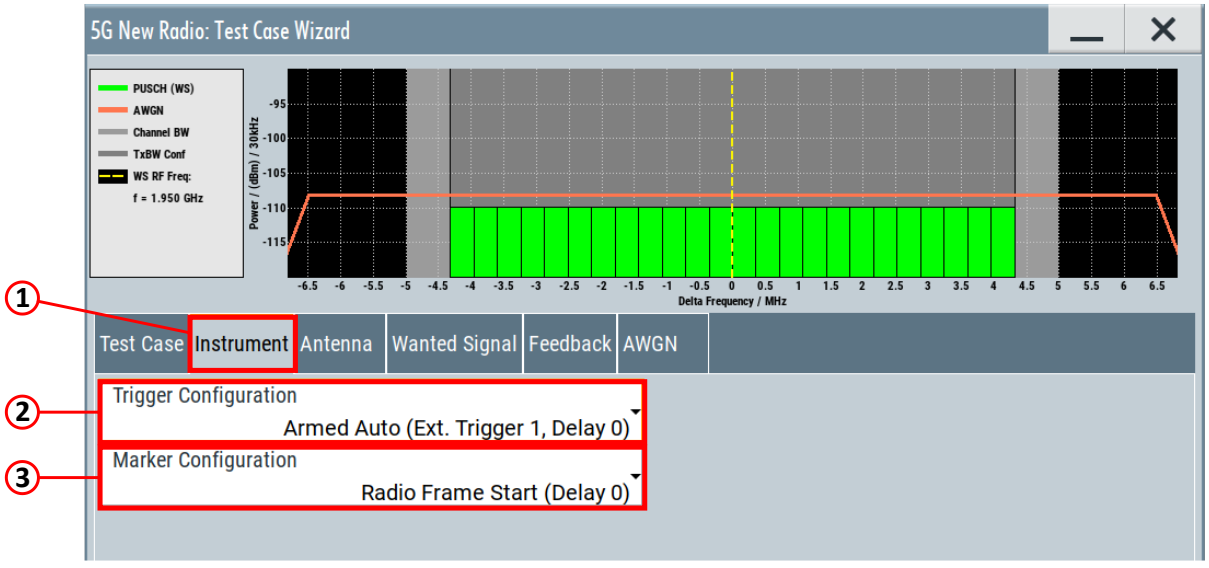
► Open the **Test Case Wizard**.



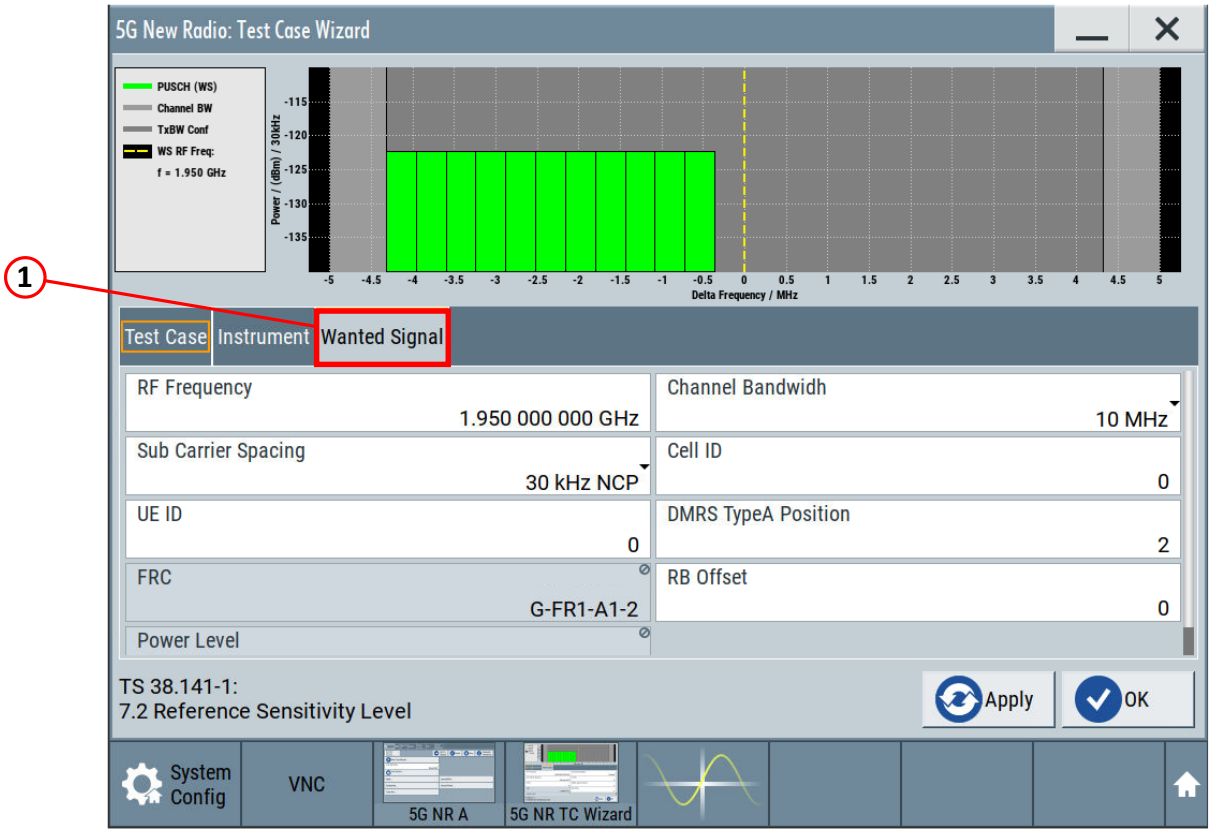
► At tab ① **Test Case** the ② **Base Station Class** and the ③ **Test Case** that should be performed (the numbering refers to the numbering in TS 38.141-1) can be selected.



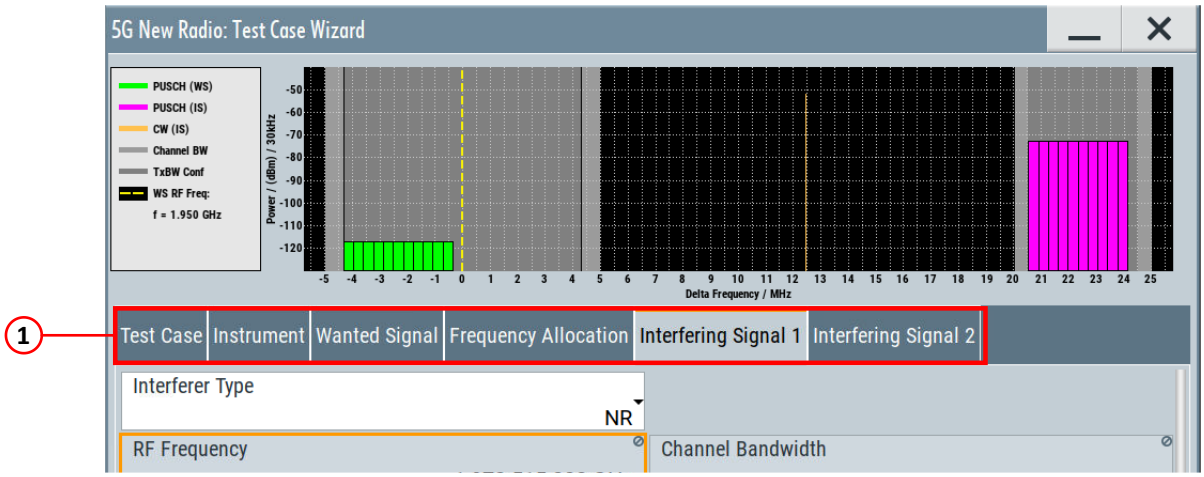
► At tab ① **Instrument** the instrument-related settings can be set, like ② **Trigger Configuration** and ③ **Marker Configuration**.



► At tab ① **Wanted Signal** the basic parameters like RF frequency, channel bandwidth, sub carrier spacing, cell id, etc. can be set.

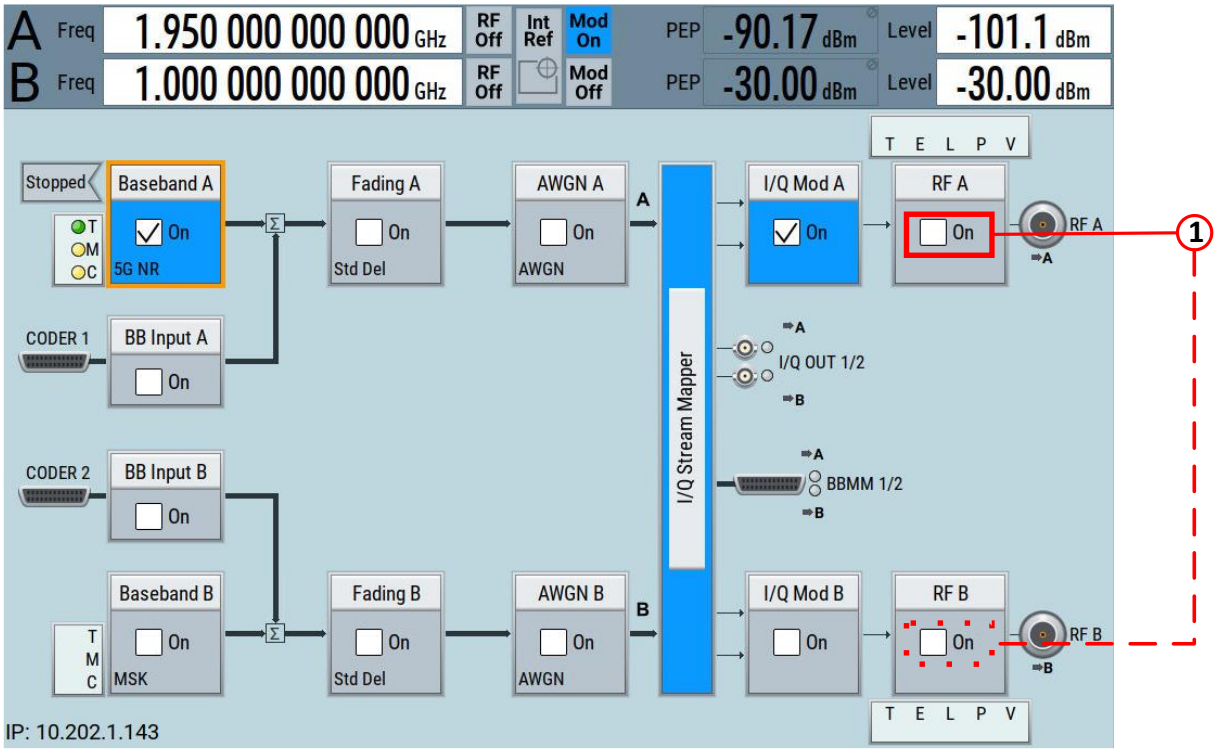


► Depending on the selected test case, new tabs will be added to the header bar. These additional tabs include some test specific parameter settings. More information can be found in the respective test sections. The following screenshot shows the ① **Header bar** of test "7.7 Receiver Intermodulation".



► When all parameters have been set, please press the ① **OK button** to apply all settings.

► Now the ① **RF-outputs** can be switched on.



SCPI commands sequence

The following complete SCPI commands sequence describes the execution of the basic test case wizard operations.

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC <TestCase>
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:WS:RBOFfset <WSRbOffset>
:BB:NR5G:TCW:APPLy
:OUTPut<hw>[:STATe] 1
```

3.4 Remote control operations by using SCPI commands

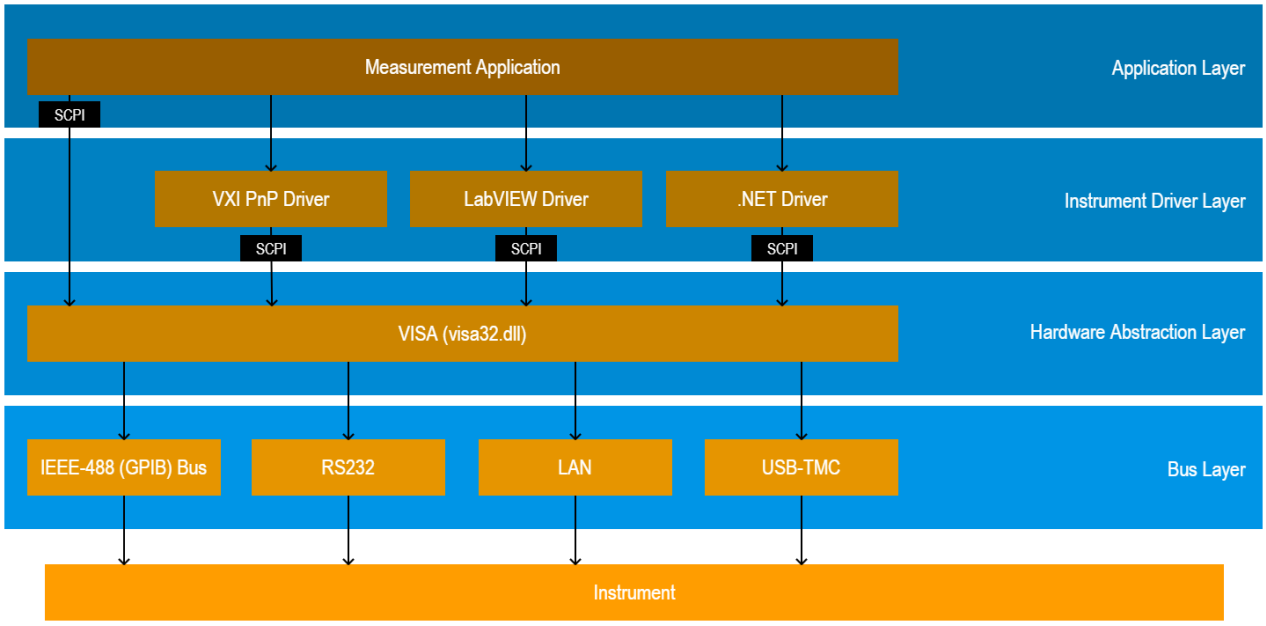


Figure 5: Overview [7]

First released in 1990, the SCPI consortium standardized **SCPI (Standard Commands for Programmable Instruments)** as an additional layer on top of the IEEE 488.2 specification creating a common standard for syntax and commands to use in controlling T&M devices.

SCPI commands are ASCII textual strings sent to an instrument over a physical layer (e.g. GPIB, RS-232, USB, Ethernet, etc.). For further details, refer to the SCPI-99 standard.

All Rohde & Schwarz instruments are using SCPI command sequences for remote control operations. The format used by Rohde & Schwarz is called the **canonical form**. Furthermore, all of our user manuals contain a chapter **Remote Control Commands** which is explaining general conventions and the SCPI commands supported by an instrument. It's also described in there whether the command is available as a set command or a query command or both.

Here, a quick overview [8] of rules to remember by the example of

`'TRIGger<m>:LEVel<n>[:VALue] <Level>'`

- SCPI commands are case-insensitive
- Capital letter parts are mandatory
- Lowercase letters can be omitted (which is then called *short form*)
- Parts within square brackets *'[…]'* are not mandatory and can be left out
- Parts within *'<...>'* brackets are representing parameters
- Multiple SCPI commands can be combined into a single-line string by using a semicolon *';'*
- To reset the command tree path to the root, use the colon character ':' at the beginning of the second command (e.g. `'TRIG1:SOUR CH1;:CHAN2:STATe ON'`)

For further reading

https://www.rohde-schwarz.com/drivers-remote-control

3.5 General workflow for carrying out a receiver test

1. Connect the instrument(s) and the base station according to the corresponding test setup (part of the test case description)
2. Set the base station to the basic state
    1. Initialize the base station
    2. Set the frequency
    3. Set the base station to receive the fixed reference channel (for most receiver test cases)
3. Preset the instrument(s) to ensure a defined instrument state
4. Configure the instrument(s) according to the “Manual testing procedure” part of every test case
5. Start the measurement
6. Calculate the results
   → Except for test 7.6, the base station internally calculates values like BER, BLER, etc.

3.6 Reference sensitivity level (7.2)

The reference sensitivity power level $P_{REFSENS}$ is the minimum mean power received at the antenna connector for BS type 1-C or TAB connector for BS type 1-H at which a throughput requirement shall be met for a specified reference measurement channel. [1]

The level for different base stations depends on the channel bandwidth, the used SCS, the FRC and the base station category as given to. For each measured NR carrier the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

Table 6: NR Wide area BS reference sensitivity levels

BS channel bandwidth (MHz)	Sub-carrier spacing (kHz)	Reference measurement channel	Reference sensitivity power level, $P_{REFSENS}$ (dBm)		
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz
5, 10, 15	15	G-FR1-A1-1	-101.0	-100.7	-100.5
10, 15	30	G-FR1-A1-2	-101.1	-100.8	-100.6
10, 15	60	G-FR1-A1-3	-98.2	-97.9	-97.7
20, 25, 30, 40, 50	15	G-FR1-A1-4	-94.6	-94.3	-94.1
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-94.9	-94.6	-94.4
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-95.0	-94.7	-94.5

Table 7: NR medium are BS reference sensitivity levels

BS channel bandwidth (MHz)	Sub-carrier spacing (kHz)	Reference measurement channel	Reference sensitivity power level, $P_{REFSENS}$ (dBm)		
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz
5, 10, 15	15	G-FR1-A1-1	-96.0	-95.7	-95.5
10, 15	30	G-FR1-A1-2	-96.1	-95.8	-95.6
10, 15	60	G-FR1-A1-3	-93.2	-92.9	-92.7
20, 25, 30, 40, 50	15	G-FR1-A1-4	-89.6	-89.3	-89.1
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-89.9	-89.6	-89.4
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-90.0	-89.7	-89.5

Table 8: NR local area BS reference sensitivity levels

BS channel bandwidth (MHz)	Sub-carrier spacing (kHz)	Reference measurement channel	Reference sensitivity power level, $P_{REFSENS}$ (dBm)		
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz
5, 10, 15	15	G-FR1-A1-1	-93.0	-92.7	-92.5
10, 15	30	G-FR1-A1-2	-93.1	-92.8	-92.6
10, 15	60	G-FR1-A1-3	-90.2	-89.9	-89.7
20, 25, 30, 40, 50	15	G-FR1-A1-4	-86.6	-86.3	-86.1
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-86.9	-86.6	-86.4
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-87.0	-86.7	-86.5

Test setup

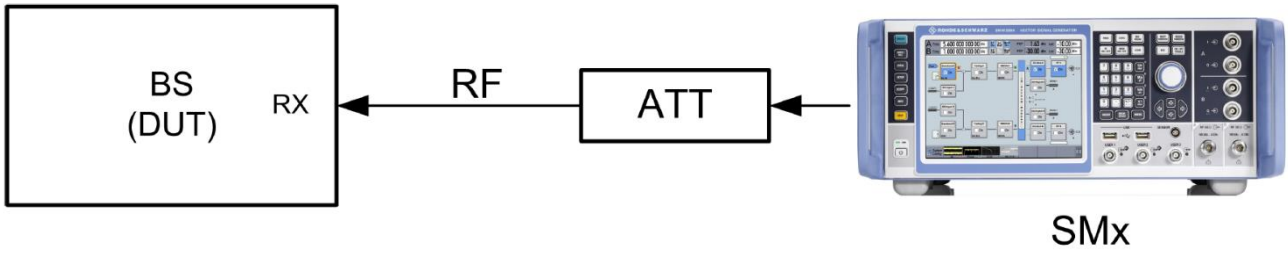


Figure 6: Test setup reference sensitivity level

Settings

► The SMW generates a NR uplink signal with FRC and level settings according to Table 6 to Table 8

Manual testing procedure

1. Open the test case wizard*
2. Select base station class*
3. Select test "7.2 Reference Sensitivity Level"*
4. Set the basic parameters*
   With **RB Offset** you can move the allocated RBs to additional positions inside the channel bandwidth (if possible)
5. Switch RF A on

*Detailed description can be found in 3.3

SCPI commands sequence

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC TS381411_TC72
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:WS:RBOFfset <WSRbOffset>
:BB:NR5G:TCW:APPLy
:OUTPut1:STATe 1
```

3.7 Dynamic range (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.

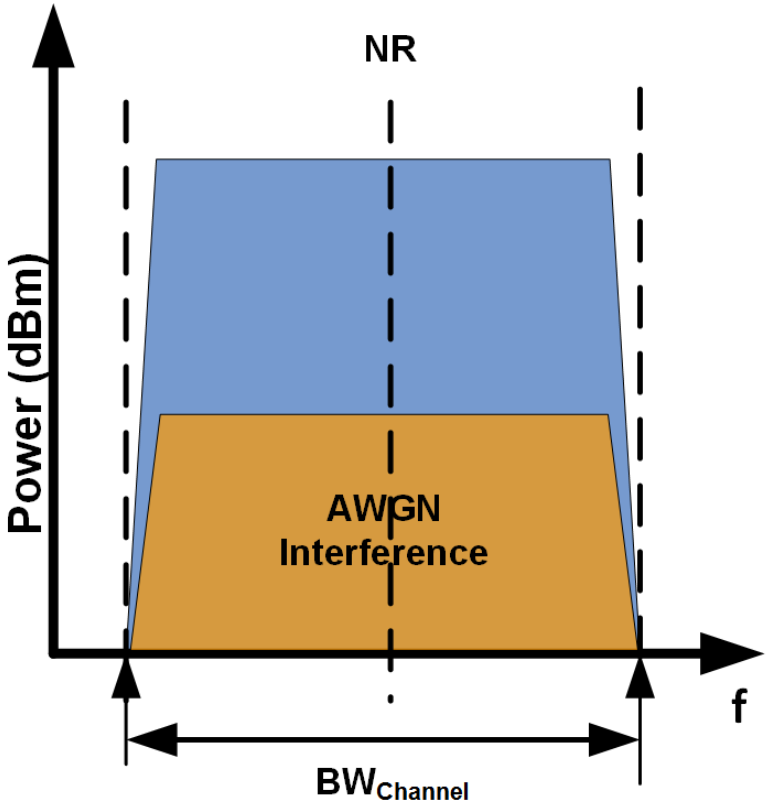


Figure 7: Dynamic range; NR carrier with AWGN interferer

The level for different base stations depends on the channel bandwidth, the FRC, the SCS and the BS category given in Table 9 to Table 11. For each measured NR carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

Table 9: Wide area BS dynamic range

BS channel bandwidth (MHz)	Subcarrier spacing (kHz)	Reference measurement channel	Wanted signal mean power (dBm)	Interfering signal mean power (dBm) / BWConfig	Type of interfering signal
5	15	G-FR1-A2-1	-70.4	-82.5	AWGN
	30	G-FR1-A2-2	-71.1		
10	15	G-FR1-A2-1	-70.4	-79.3	AWGN
	30	G-FR1-A2-2	-71.1		
	60	G-FR1-A2-3	-68.1		
15	15	G-FR1-A2-1	-70.4	-77.5	AWGN
	30	G-FR1-A2-2	-71.1		
	60	G-FR1-A2-3	-68.1		
20	15	G-FR1-A2-4	-64.2	-76.2	AWGN
	30	G-FR1-A2-5	-64.2		
	60	G-FR1-A2-6	-64.5		
25	15	G-FR1-A2-4	-64.2	-75.2	AWGN
	30	G-FR1-A2-5	-64.2		
	60	G-FR1-A2-6	-64.5		
30	15	G-FR1-A2-4	-64.2	-74.4	AWGN
	30	G-FR1-A2-5	-64.2		
	60	G-FR1-A2-6	-64.5		
40	15	G-FR1-A2-4	-64.2	-73.1	AWGN
	30	G-FR1-A2-5	-64.2		
	60	G-FR1-A2-6	-64.5		
50	15	G-FR1-A2-4	-64.2	-72.1	AWGN
	30	G-FR1-A2-5	-64.2		
	60	G-FR1-A2-6	-64.5		
60	30	G-FR1-A2-5	-64.2	-71.3	AWGN
	60	G-FR1-A2-6	-64.5		
70	30	G-FR1-A2-5	-64.2	-70.7	AWGN
	60	G-FR1-A2-6	-64.5		
80	30	G-FR1-A2-5	-64.2	-70.1	AWGN
	60	G-FR1-A2-6	-64.5		
90	30	G-FR1-A2-5	-64.2	-69.5	AWGN
	60	G-FR1-A2-6	-64.5		
100	30	G-FR1-A2-5	-64.2	-69.1	AWGN

Table 10: Medium range BS dynamic range

BS channel bandwidth (MHz)	Subcarrier spacing (kHz)	Reference measurement channel	Wanted signal mean power (dBm)	Interfering signal mean power (dBm) / BWConfig	Type of interfering signal
5	15	G-FR1-A2-1	-65.4	-77.5	AWGN
	30	G-FR1-A2-2	-66.1		
10	15	G-FR1-A2-1	-65.4	-74.3	AWGN
	30	G-FR1-A2-2	-66.1		
	60	G-FR1-A2-3	-63.1		
15	15	G-FR1-A2-1	-65.4	-72.5	AWGN
	30	G-FR1-A2-2	-66.1		
	60	G-FR1-A2-3	-63.1		
20	15	G-FR1-A2-4	-59.2	-71.2	AWGN
	30	G-FR1-A2-5	-59.2		
	60	G-FR1-A2-6	-59.5		
25	15	G-FR1-A2-4	-59.2	-70.2	AWGN
	30	G-FR1-A2-5	-59.2		
	60	G-FR1-A2-6	-59.5		
30	15	G-FR1-A2-4	-59.2	-69.4	AWGN
	30	G-FR1-A2-5	-59.2		
	60	G-FR1-A2-6	-59.5		
40	15	G-FR1-A2-4	-59.2	-68.1	AWGN
	30	G-FR1-A2-5	-59.2		
	60	G-FR1-A2-6	-59.5		
50	15	G-FR1-A2-4	-59.2	-67.1	AWGN
	30	G-FR1-A2-5	-59.8		
	60	G-FR1-A2-6	-59.5		
60	30	G-FR1-A2-5	-59.2	-66.3	AWGN
	60	G-FR1-A2-6	-59.5		
70	30	G-FR1-A2-5	-59.2	-65.7	AWGN
	60	G-FR1-A2-6	-59.5		
80	30	G-FR1-A2-5	-59.2	-65.1	AWGN
	60	G-FR1-A2-6	-59.5		
90	30	G-FR1-A2-5	-59.2	-64.5	AWGN
	60	G-FR1-A2-6	-59.5		
100	30	G-FR1-A2-5	-59.2	-64.1	AWGN

Table 11: Local area BS dynamic range

BS channel bandwidth (MHz)	Subcarrier spacing (kHz)	Reference measurement channel	Wanted signal mean power (dBm)	Interfering signal mean power (dBm) / BWConfig	Type of interfering signal
5	15	G-FR1-A2-1	-62.4	-74.5	AWGN
	30	G-FR1-A2-2	-63.1		
10	15	G-FR1-A2-1	-62.4	-71.3	AWGN
	30	G-FR1-A2-2	-63.1		
	60	G-FR1-A2-3	-60.1		
15	15	G-FR1-A2-1	-62.4	-69.5	AWGN
	30	G-FR1-A2-2	-63.1		
	60	G-FR1-A2-3	-60.1		
20	15	G-FR1-A2-4	-56.2	-68.2	AWGN
	30	G-FR1-A2-5	-56.2		
	60	G-FR1-A2-6	-56.5		
25	15	G-FR1-A2-4	-56.2	-67.2	AWGN
	30	G-FR1-A2-5	-56.2		
	60	G-FR1-A2-6	-56.5		
30	15	G-FR1-A2-4	-56.2	-66.4	AWGN
	30	G-FR1-A2-5	-56.2		
	60	G-FR1-A2-6	-56.5		
40	15	G-FR1-A2-4	-56.2	-65.1	AWGN
	30	G-FR1-A2-5	-56.2		
	60	G-FR1-A2-6	-56.5		
50	15	G-FR1-A2-4	-56.2	-64.1	AWGN
	30	G-FR1-A2-5	-56.2		
	60	G-FR1-A2-6	-56.5		
60	30	G-FR1-A2-5	-56.2	-63.3	AWGN
	60	G-FR1-A2-6	-56.5		
70	30	G-FR1-A2-5	-56.2	-62.7	AWGN
	60	G-FR1-A2-6	-56.5		
80	30	G-FR1-A2-5	-56.2	-62.1	AWGN
	60	G-FR1-A2-6	-56.5		
90	30	G-FR1-A2-5	-56.2	-61.5	AWGN
	60	G-FR1-A2-6	-56.5		
100	30	G-FR1-A2-5	-56.2	-61.1	AWGN

Test setup

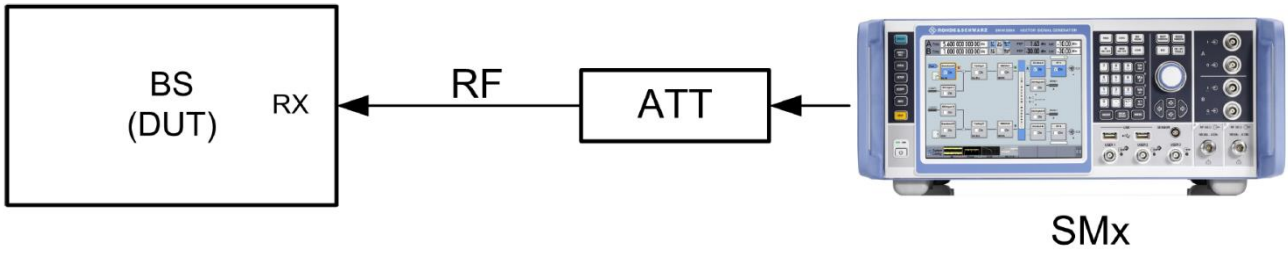


Figure 8: Test setup dynamic range

Settings

► The SMW generates a NR uplink signal with FRC and level settings according to Table 9 to Table 11

Manual testing procedure

1. Open the test case wizard*
2. Select base station class*
3. Select test "7.3 Dynamic Range"*
4. Set the basic parameters*
   With **RB Offset** you can move the allocated RBs to additional positions inside the channel bandwidth (if possible)
5. Switch RF A on

*Detailed description can be found in 3.3

SCPI commands sequence

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC TS381411_TC73
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:WS:RBOFfset <WSRbOffset>
:BB:NR5G:TCW:APPLy
:OUTPut1:STATe 1
```

3.8 In-band selectivity and blocking (7.4)

This part demonstrates tests with in-band interferers.

3.8.1 Adjacent channel selectivity (ACS) (7.4.1)

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 Figure 9, a wanted NR signal is shown along with the interfering NR signal placed with an offset to the higher edge F_{edge_high} of the channel bandwidth. In a second test the NR interferer is placed with an offset to the lower edge F_{edge_low}.

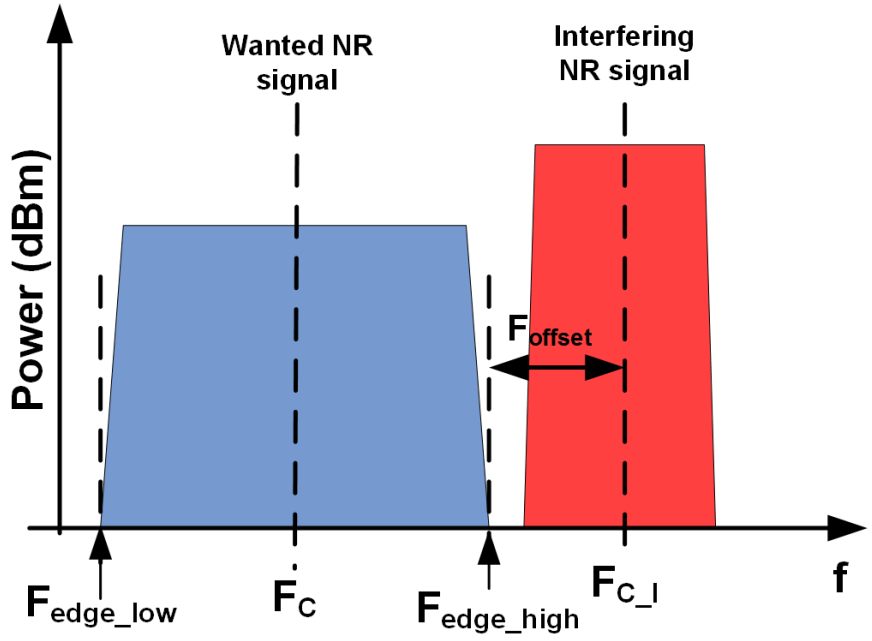


Figure 9: ACS

For each measured NR carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

The wanted level is the reference sensitivity level from TS 38.104 [4] plus 6dB. This leads to following levels:

Table 12: ACS NR wanted levels

SCS	BS channel bandwidth (MHz)	FRC (alloc RB)	Wanted leven (dBm)
15	5, 10, 15	G-FR1-A1-1 25	$P_{REFSENS}$ + 6dB
	20, 25, 30, 40, 50	G- FR1-A1-4 106	
30	10, 15	G- FR1-A1-2 11	
	20, 25, 30, 40, 50, 60, 70, 80, 90, 100	G- FR1-A1-5 51	

60	10, 15	G- FR1-A1-3 11	
	20, 25, 30, 40, 50, 60, 70, 80, 90, 100	G- FR1-A1-6 24	

Table 13: ACS NR interferer levels

	Wide area	Medium range	Local area
Interferer level (dBm)	-52.0	-47.0	-44.0

The interferer is set adjacent to the channel edge of the wanted signal with a certain offset. It is a DFT-s-OFDM signal modulated with QPSK. The bandwidth, SCS, offset and the number of RBs depend on the wanted channel bandwidth.

Table 14: Base station ACS interferer frequency offset values

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering signal center frequency offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap (MHz)	Type of interfering signal
5	±2.5025	5 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 25 RBs
10	±2.5075	
15	±2.5125	
20	±2.5025	
25	±9.4675	20 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 100 RBs
30	±9.4725	
40	±9.4675	
50	±9.4625	
60	±9.4725	
70	±9.4675	
80	±9.4625	
90	±9.4725	
100	±9.4675	

Test setup

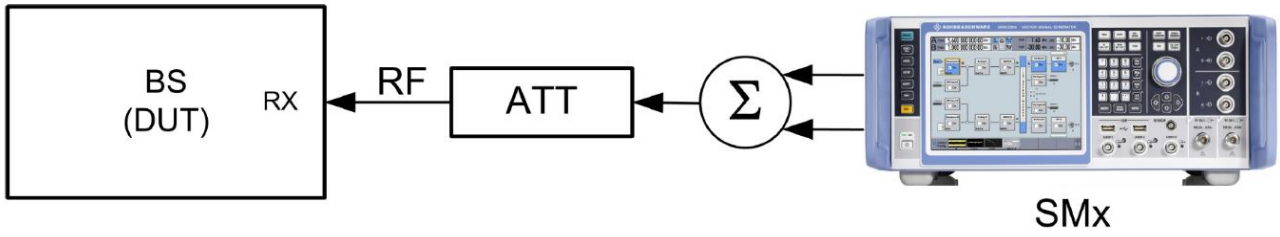


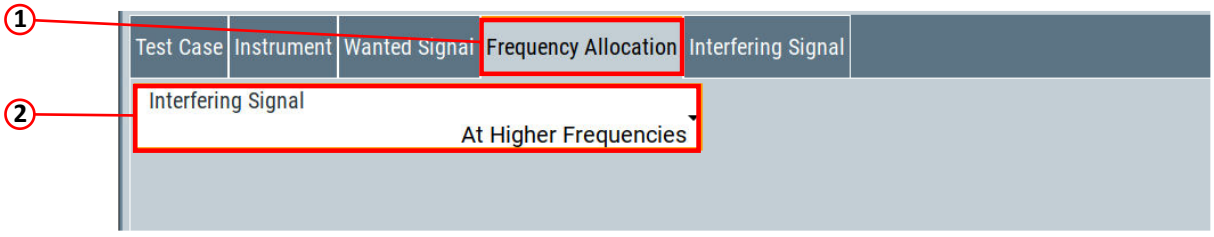
Figure 10: Test setup ACS

Settings

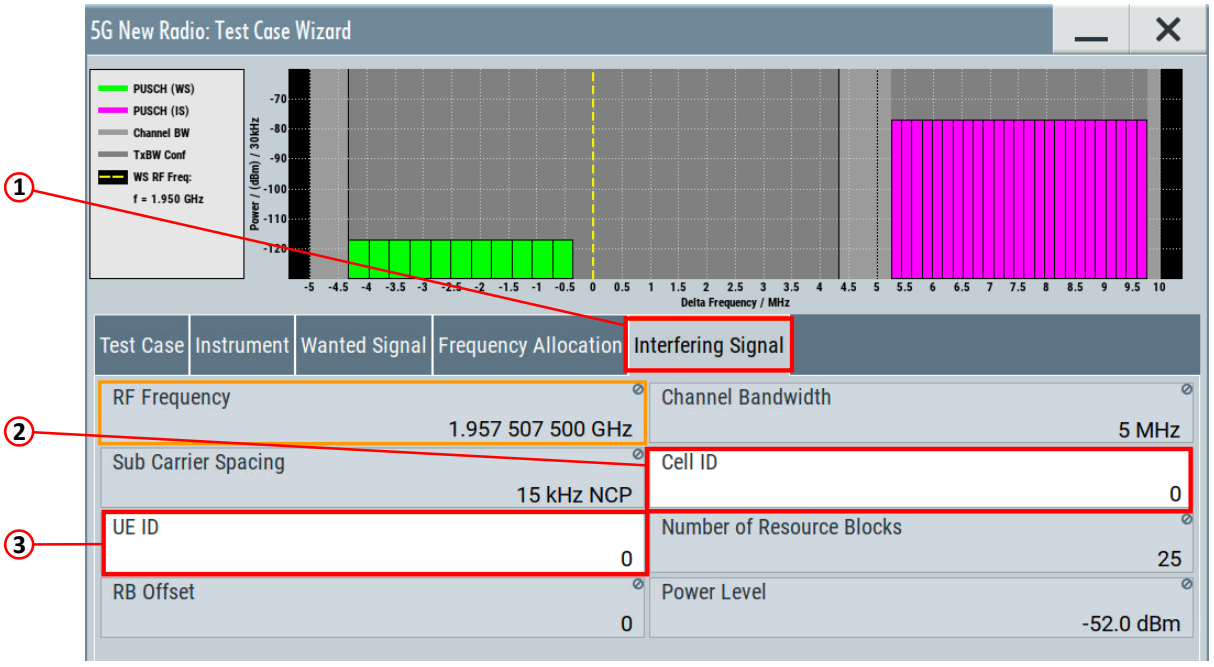
- ► The SMW generates a NR uplink signal with FRC and level settings according to Table 12
- ► The SMW also generates the NR interferer which is provided by the second RF path (RF B)
- ► Use a hybrid combiner to sum all signals

Manual testing procedure

1. Open the test case wizard*
2. Select base station class*
3. Select test "7.4.1 Adjacent Channel Selectivity (ACS)"*
4. Set the basic parameters*
   With **RB Offset** you can move the allocated RBs to additional positions inside the channel bandwidth (if possible)
5. Select the ② **Position of the interferer**



6. Set the ② **Interferer Cell ID** and the ③ **Interferer UE ID**



7. Switch RF A and RF B on

*Detailed description can be found in 3.3

SCPI commands sequence

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC TS381411_TC741
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:FA:FRALlocation <FreqAlloc>
:BB:NR5G:TCW:IS:UEID <ISUEID>
:BB:NR5G:TCW:IS:CLID <ISCellId>
:BB:NR5G:TCW:APPLy
:OUTPut1:STATe 1
:OUTPut2:STATe 1
```

3.8.2 In-band blocking (7.4.2)

The in-band blocking consist of two tests.

3.8.2.1 General blocking (a)

In in-band blocking tests, the NR 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 (Δf_{OOB}).

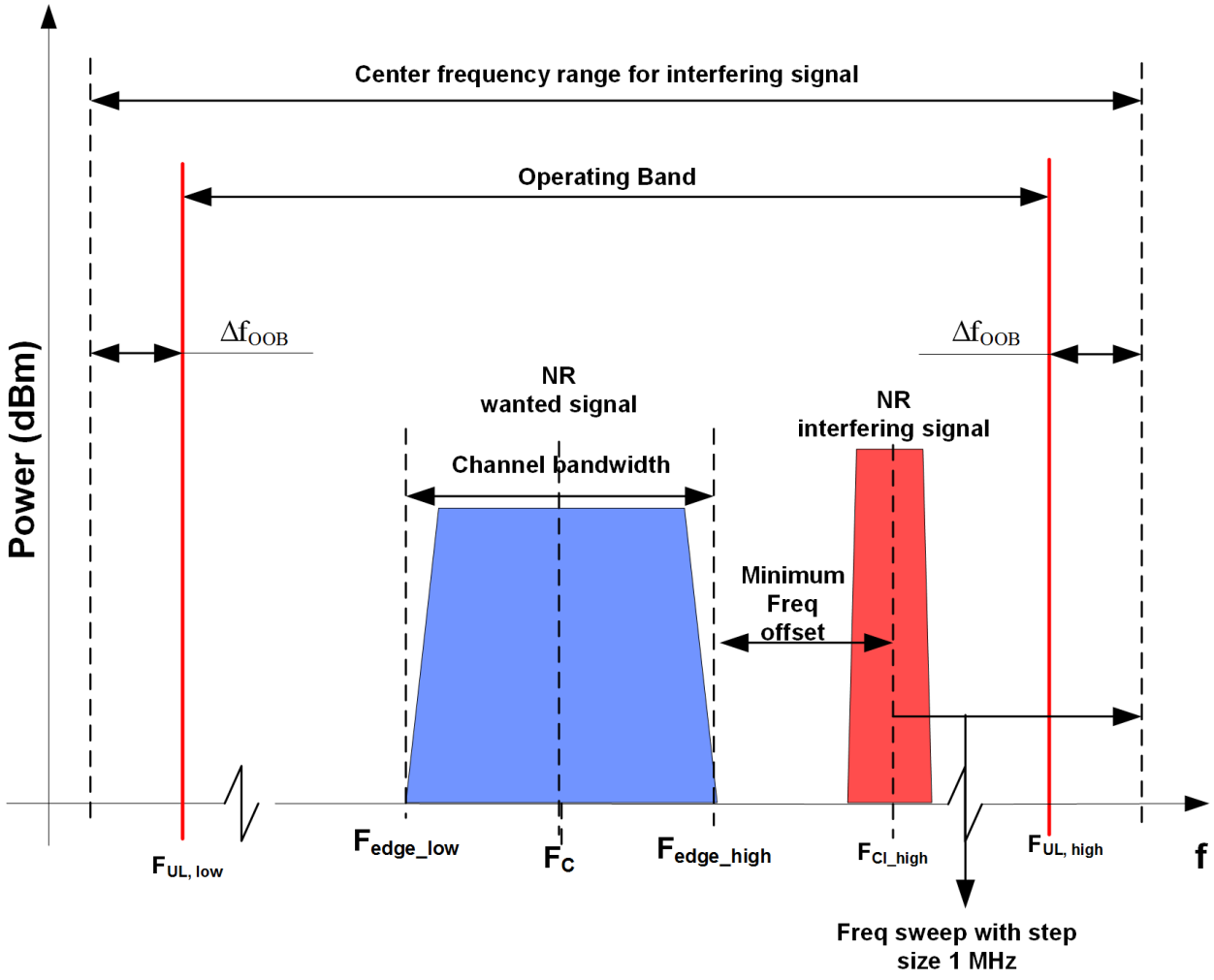


Figure 11: General in-band blocking

For each measured NR carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

Δf_{OOB} depends on the width of the band:

Table 15: Δf_{OOB} offset for NR operating bands

Operating band characteristics	Δf_{OOB} (MHz)
$F_{UL\_high} - F_{UL\_low} \leq 200$ MHz	20
200 MHz < $F_{UL\_high} - F_{UL\_low} \leq 900$ MHz	60

The wanted level is the reference sensitivity level from TS 38.104 [4] plus 6 dB (Table 12).

The interferer is set to the minimum offset to the edge of the wanted signal and then swept in 1-MHz-steps. It is a DFT-s-OFDM signal modulated QPSK. The bandwidth, SCS and the number of RBs depend on the wanted channel bandwidth.

Table 16: 5G NR interfering signals for in-band general blocking tests

BS channel bandwidth of the lowest/highest carrier received (MHz)	Wanted signal mean power (dBm)	Interfering signal mean power (dBm)	Interfering signal center frequency minimum offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap (MHz)	Type of interfering signal
5, 10, 15, 20	PREFSENS + 6 dB	Wide Area BS: -43.0 Medium Range BS: -38.0 Local Area BS: -35.0	±7.5	5 MHz DFT-s-OFDM NR signal 15 kHz SCS 25 RBs
25, 30, 40, 50, 60, 70, 80, 90, 100	PREFSENS + 6 dB	Wide Area BS: -43.0 Medium Range BS: -38.0 Local Area BS: -35.0	±30.0	20 MHz DFT-s-OFDM NR signal 15 kHz SCS 100 RBs

Test setup

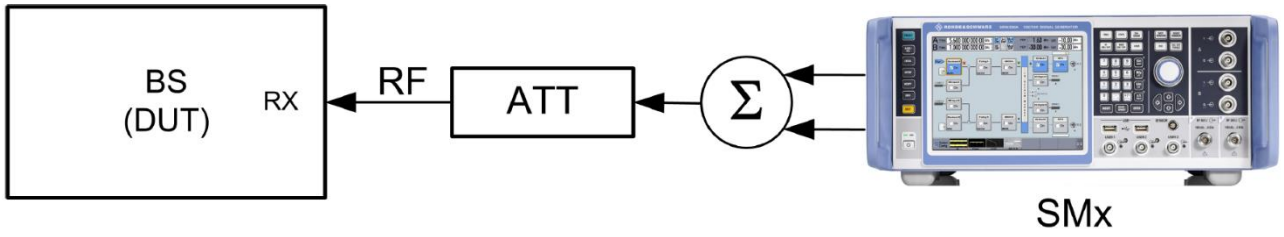


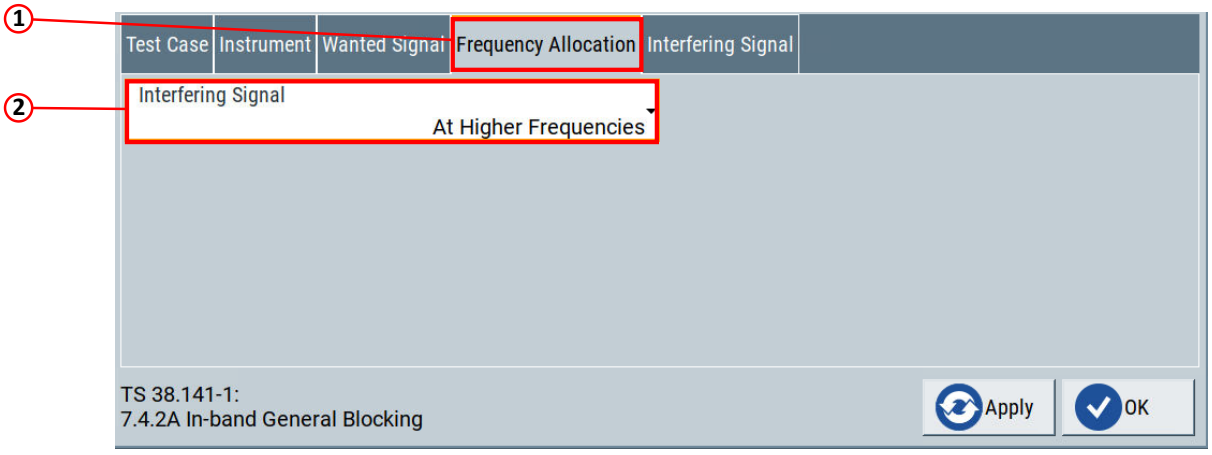
Figure 12: Test setup In-band blocking (general blocking)

Settings

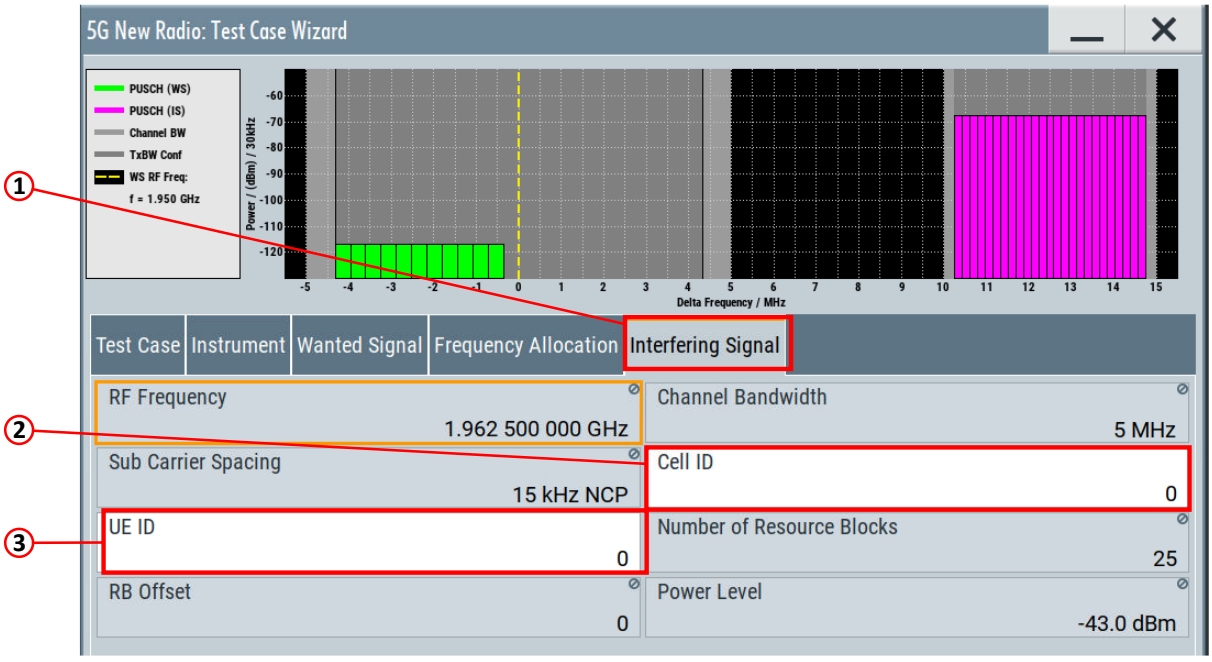
- ► The SMW generates a NR uplink signal with FRC according to Table 6 and level settings according to Table 12 which is applied to the BS receiver port
- ► The SMW also generates the NR interferer which is provided by the second RF path (RF B)
- ► Use a hybrid combiner to sum all signals

Manual testing procedure

1. Open the test case wizard*
2. Select base station class*
3. Select test "7.4.2A In-band General Blocking"*
4. Set the basic parameters*
   With **RB Offset** you can move the allocated RBs to additional positions inside the channel bandwidth (if possible)
5. Select the ② **Position of the interferer**



6. Set the ② **Interferer Cell ID** and the ③ **Interferer UE ID**



7. Switch RF A and RF B on
8. Sweep frequency of source 2

*Detailed description can be found in 3.3

SCPI commands sequence

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC TS381411_TC742A
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:WS:RBOFfset <WSRbOffset>
:BB:NR5G:TCW:FA:FRALlocation <FreqAlloc>
:BB:NR5G:TCW:IS:UEID <ISUEID>
:BB:NR5G:TCW:IS:CLID <ISCellId>
:BB:NR5G:TCW:APPLy
:OUTPut1:STATe 1
:OUTPut2:STATe 1
```

3.8.2.2 Narrow band blocking (b)

Narrow band blocking is similar to ACS (3.8.1) but the interfering signal consists of only one resource block. The uplink interfering signal is set up with QPSK modulation.

The interferer is placed near the wanted signal, but only one RB is allocated (see Figure 13). 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.

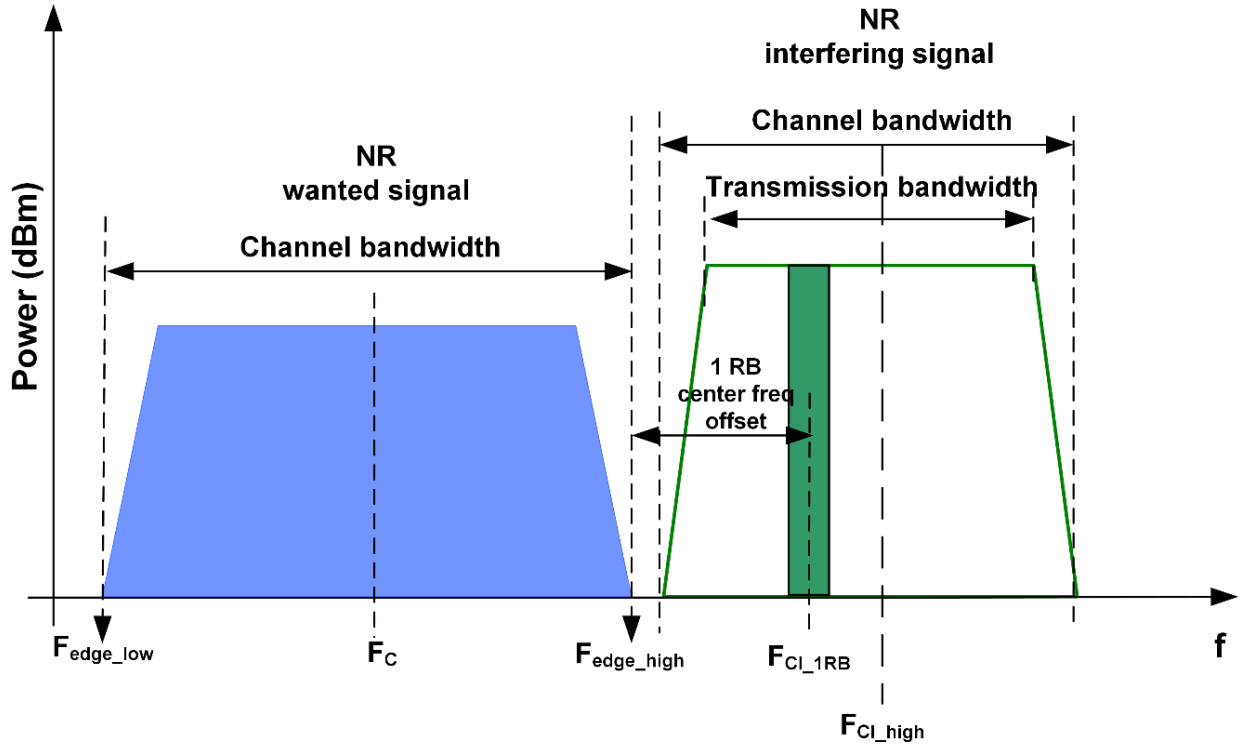
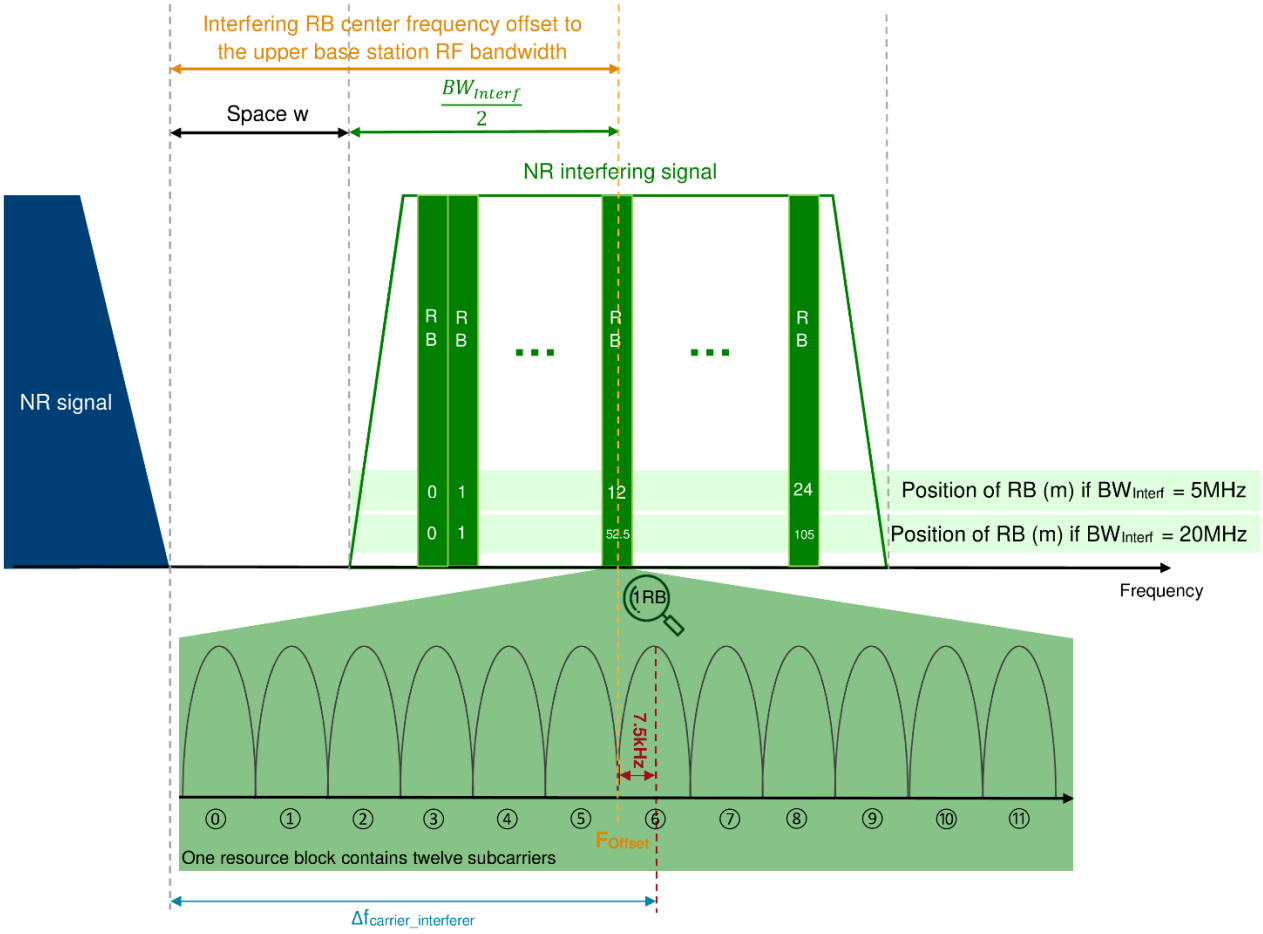


Figure 13: Narrow band blocking: Interfering NR signal, 1 RB allocated only



$$Space\ w = F_{Offset} - \frac{BW_{Interf}}{2}$$

$$F_{Offset} = Offset + m * 180kHz \text{ (TS38.141-1, 7.4.2) with } m = \begin{cases} 12 & if\ BW_{Interf} = 5MHz \\ 52.5 & if\ BW_{Interf} = 20MHz \end{cases}$$

$$\Delta f_{carrier\_interferer} = F_{Offset} + 7.5\ kHz$$

Figure 14: Narrow band blocking; Figure shows offset to upper band edge

For each measured NR carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

The wanted level is the reference sensitivity level form TS 38.104 [4] plus 6 dB (Table 12).

The interfering level depends on the BS category:

Table 17: Interferer levels narrow band blocking

	Wide area	Medium range	Local area
Interferer level (dBm)	-49.0	-44.0	-41.0

In Figure 14 a small gap between the channel edges of both the NR signal 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.

Table 18: Narrow band blocking requirements

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering RB centre frequency offset to the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap (kHz) (Note 2)	Type of interfering signal	Interfering center frequency offset from lower/upper edge (MHz)
5	±(350+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 1 RB	lower: -2.5025 upper: 2.5175
10	±(355+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24		lower: -2.5075 upper: 2.5225
15	±(360+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24		lower: -2.5125 upper: 2.5275
20	±(350+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24		lower: -2.5025 upper: 2.5175
25	±(565+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	20 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 1 RB	lower:-10.0075 upper: 10.0225
30	±(570+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99		lower: -10.0125 upper: 10.0275
40	±(565+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99		lower: -10.0075 upper:: 10.0225
50	±(560+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99		lower: -10.0025 upper: 10.0175
60	±(570+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99		lower: -10.0125 upper: 10.0275
70	±(565+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99		lower: -10.0075 upper: 10.0225
80	±(560+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99		lower: -10.0025 upper: 10.0175
90	±(570+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99		lower: -10.0125 upper: 10.0275
100	±(565+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99		lower: -10.0075 upper: 10.0225

Test setup

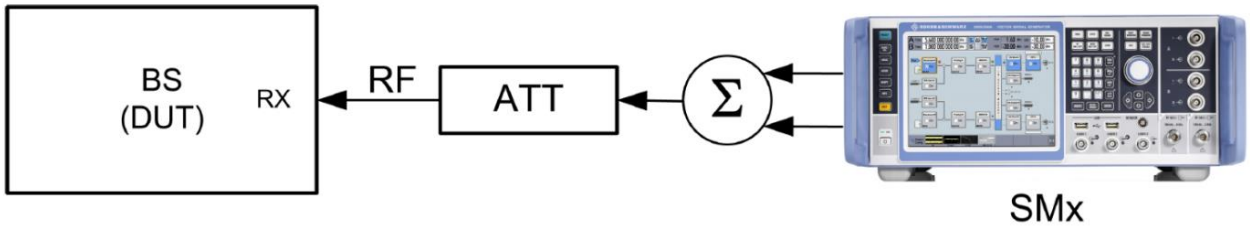


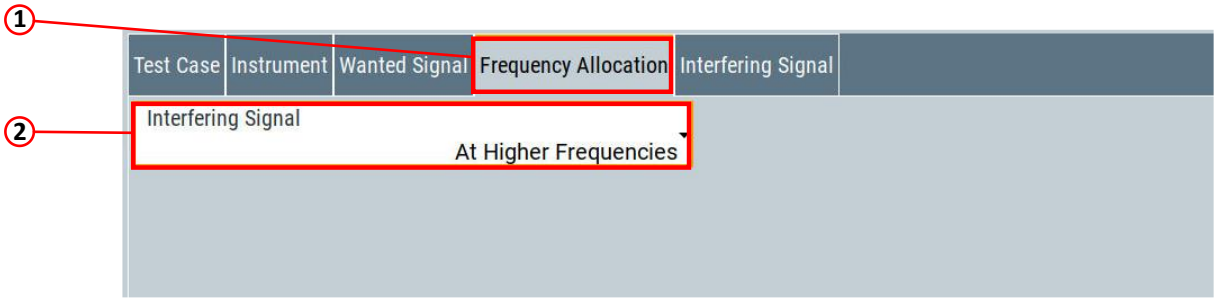
Figure 15: Test setup narrow-band blocking

Settings

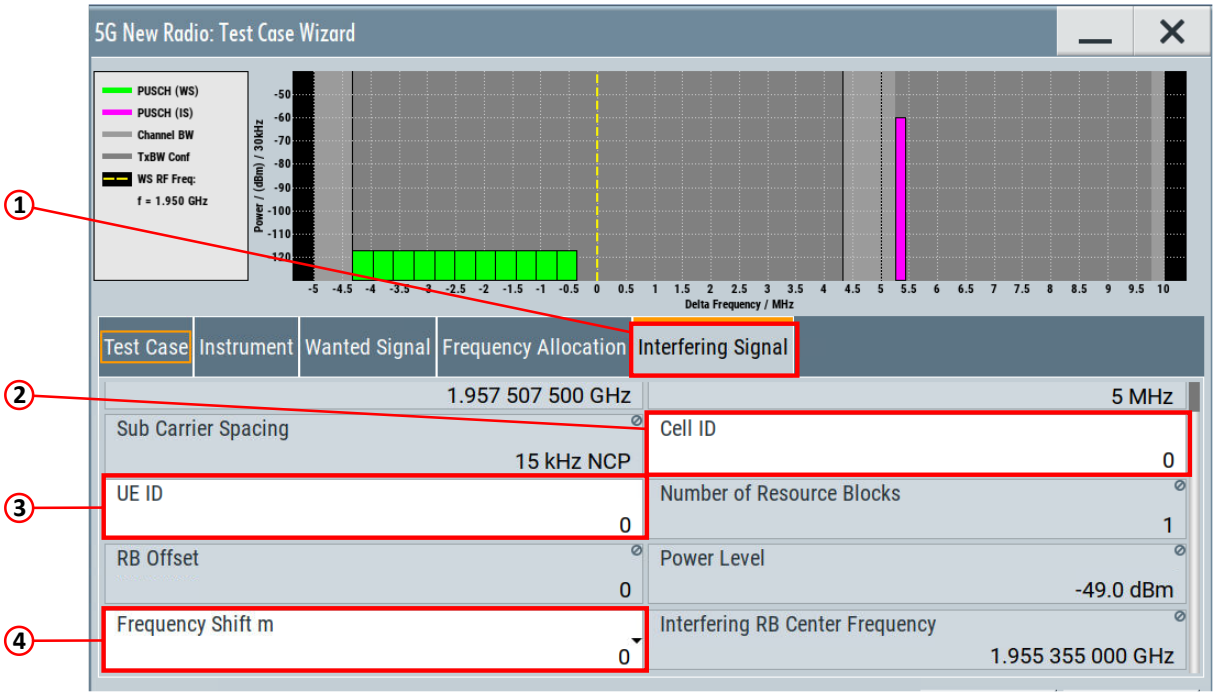
- ► The SMW generates a NR uplink signal with FRC according to Table 6 and level settings according to Table 12 which is applied to the BS receiver port
- ► The SMW also generates the NR interferer with 1 RB only. It is provided in the second RF path (RF B)
- ► Use a hybrid combiner to sum all signals

Manual testing procedure

1. Open the test case wizard*
2. Select base station class*
3. Select test "7.4.2B In-band Narrowband Blocking"*
4. Set the basic parameters*
   With **RB Offset** you can move the allocated RBs to additional positions inside the channel bandwidth (if possible)
5. Select the ② **Position of the interferer**



6. Set the ② **Interferer Cell ID**, the ③ **Interferer UE ID** and the ④ **Frequency Shift m**



7. Switch RF A and RF B on

*Detailed description can be found in 3.3

SCPI commands sequence

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC TS381411_TC742B
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:WS:RBOFfset <WSRbOffset>
:BB:NR5G:TCW:FA:FRALlocation <FreqAlloc>
:BB:NR5G:TCW:IS:UEID <ISUEID>
:BB:NR5G:TCW:IS:CLID <ISCellId>
:BB:NR5G:TCW:IS:FRSHift <ISFreqShift>
:BB:NR5G:TCW:APPLy
:OUTPut1:STATe 1
:OUTPut2:STATe 1
```

3.9 Out-of-band blocking (7.5)

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 (Δf_{OOB}). Figure 16

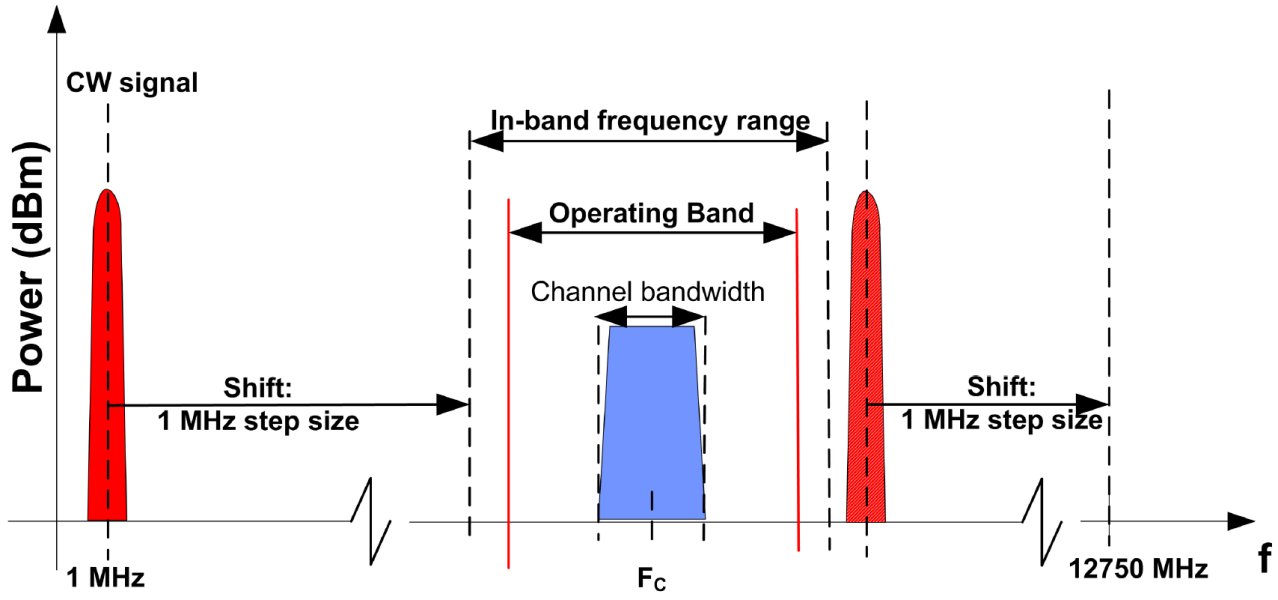


Figure 16: Out-of-band blocking by CW interfering signal

For each measured NR carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

The wanted level is the reference sensitivity level from TS 38.104 plus 6 dB.

Table 19: Parameters out-of-band blocking

Wanted signal mean power (dBm)	Interfering signal mean power (dBm)	Type of interfering signal
$P_{REFSENS}$ + 6 dB	-15.0	CW carrier

The interfering signal is swept from 1 MHz to 12.57 GHz in 1-MHz-setps excluding the operating band plus Δf_{OOB} (see Table 15).

Test setup

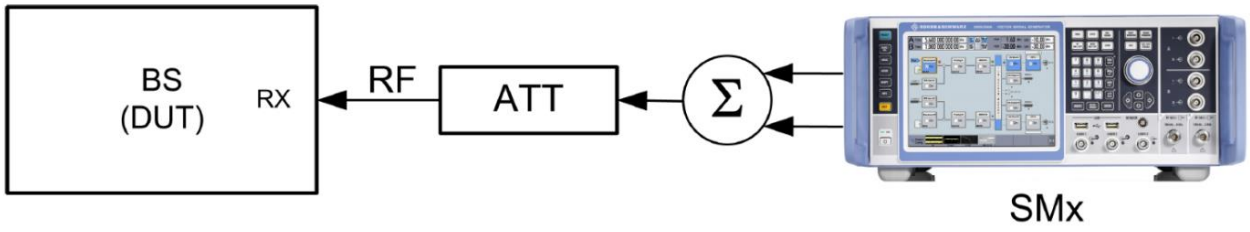


Figure 17: Test setup out-of-band blocking

Settings

- ► The SMW generates a NR uplink signal with FRC and level settings according to Table 12 which is applied to the BS receiver port
- ► The interferer is provided by the second RF path of SMW (it is also possible to use an external CW signal generator)
- ► Use a hybrid combiner to sum all signals

Manual testing procedure

1. Open the test case wizard*
2. Select base station class*
3. Select test "7.5 Out-of-band Blocking"*
4. Set the basic parameters*
   With **RB Offset** you can move the allocated RBs to additional positions inside the channel bandwidth (if possible)
5. CW interferer signal (second path of SMW or external CW generator)
   1. CW interfering signal shall be swept with a step size of 1 MHz from 1 MHz to 12.75 GHz
   2. Set the power level of the CW interfering signal to:

      Test requirement "Blocking performance": -15.0 dBm

      Test requirement "Co-located base station": 16.0 dBm
6. Switch RF A on
7. Start frequency sweep (CW interfering signal)

*Detailed description can be found in 3.3

SCPI commands sequence

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC TS381411_TC75
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:WS:RBOFfset <WSRbOffset>
:BB:NR5G:TCW:IS:TREQuire <ISTestRequire>
:BB:NR5G:TCW:APPLy
:OUTPut1:STATe 1
```

3.10 Receiver spurious emissions (7.6)

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 receiver spurious emission limits apply from 30 MHz to 12.75 GHz, the frequency range ΔfOBUE (see Table 20) below the lowest frequency of the uplink operating band up to ΔfOBUE above the highest frequency of the uplink operating band may be excluded. The frequency range is extended only for operating bands for which the 5th harmonic of the upper frequency edge of the UL operating band is reaching beyond 12.75 GHz.

Table 20: Δf_{OBUE} offset for NR operating bands

Operating band characteristics	Δf_{OBUE} (MHz)
$F_{UL\_high} - F_{UL\_low} \leq 200$ MHz	10
200 MHz < $F_{UL\_high} - F_{UL\_low} \leq 900$ MHz	40

Table 21: Rx spurious emission requirements

Frequency range	Maximum level (dBm)	Measurement bandwidth
30 MHz - 1 GHz	-57.0	100 kHz
1 GHz - 12.75 GHz	-47.0	1 MHz
12.75 GHz - 5th harmonic	-47.0	1 MHz

Test setup

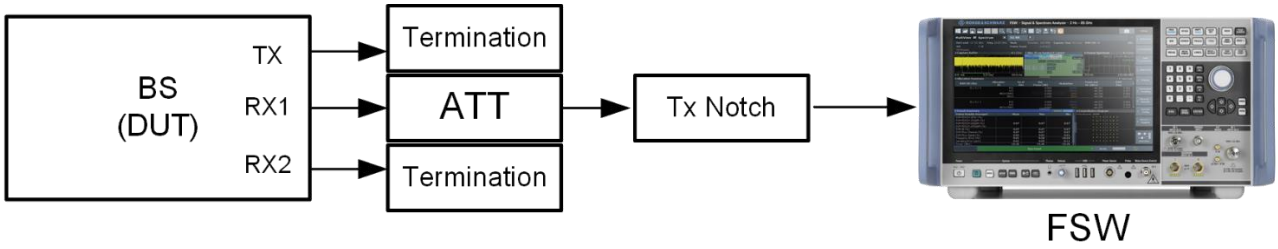


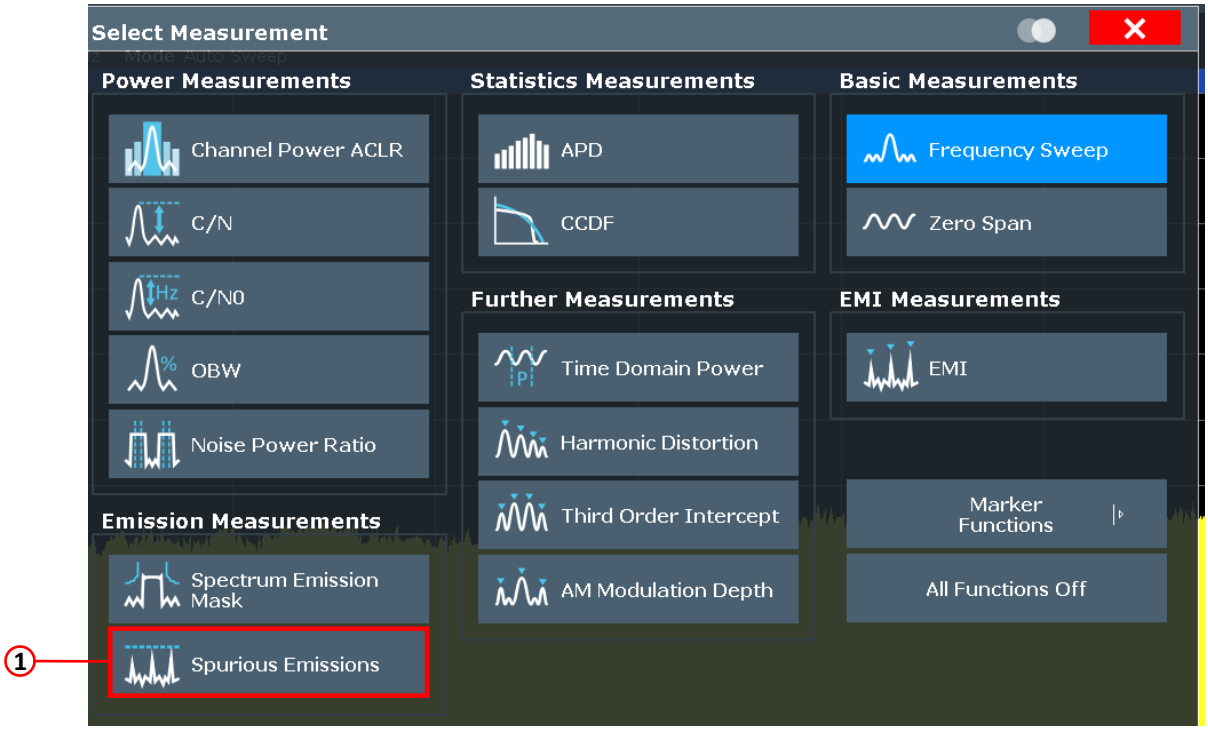
Figure 18: Receiver spurious emissions test setup; A notch filter suppresses the Tx band

Settings

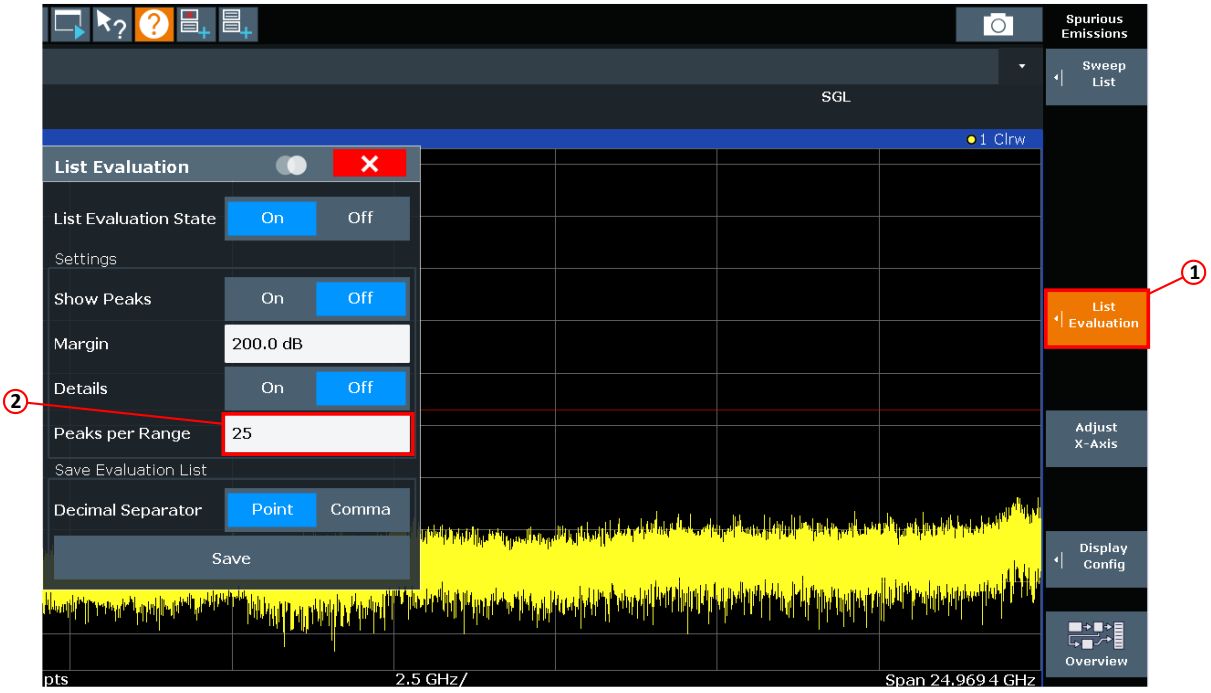
- The base station transmits a NR signal with rated output power according to TM1.1
- The FSW measures the emissions on the Rx via a Tx notch filter
- Tx and other Rx ports are terminated

Manual testing procedure

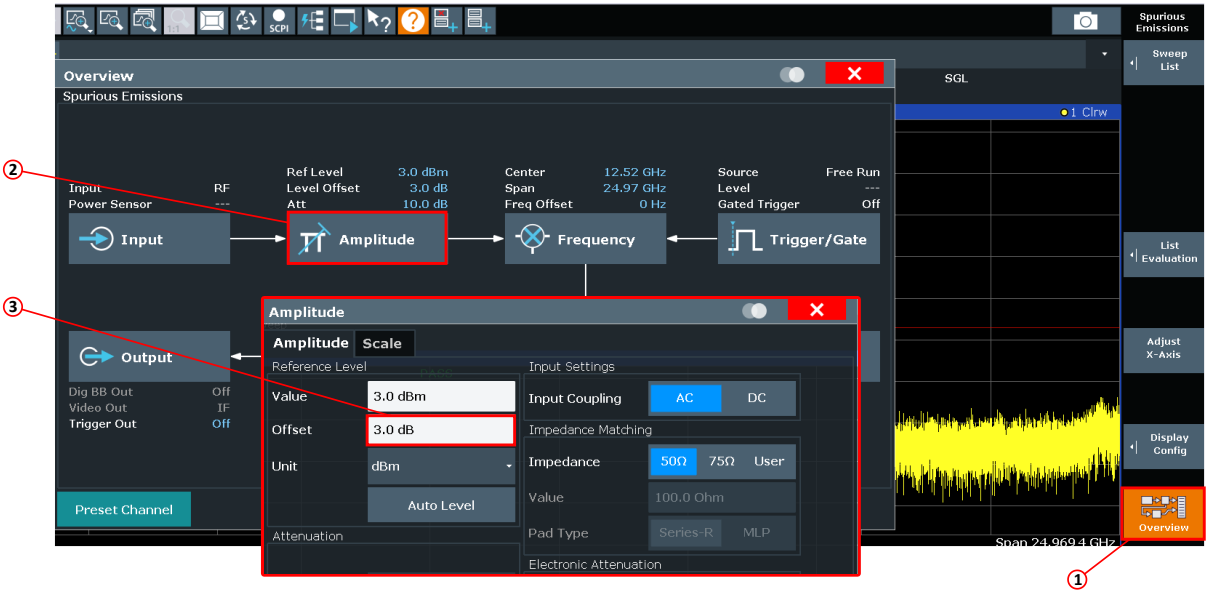
1. Press the **MEAS** hardkey at the front panel of FSW and select ① **Spurious Emissions**



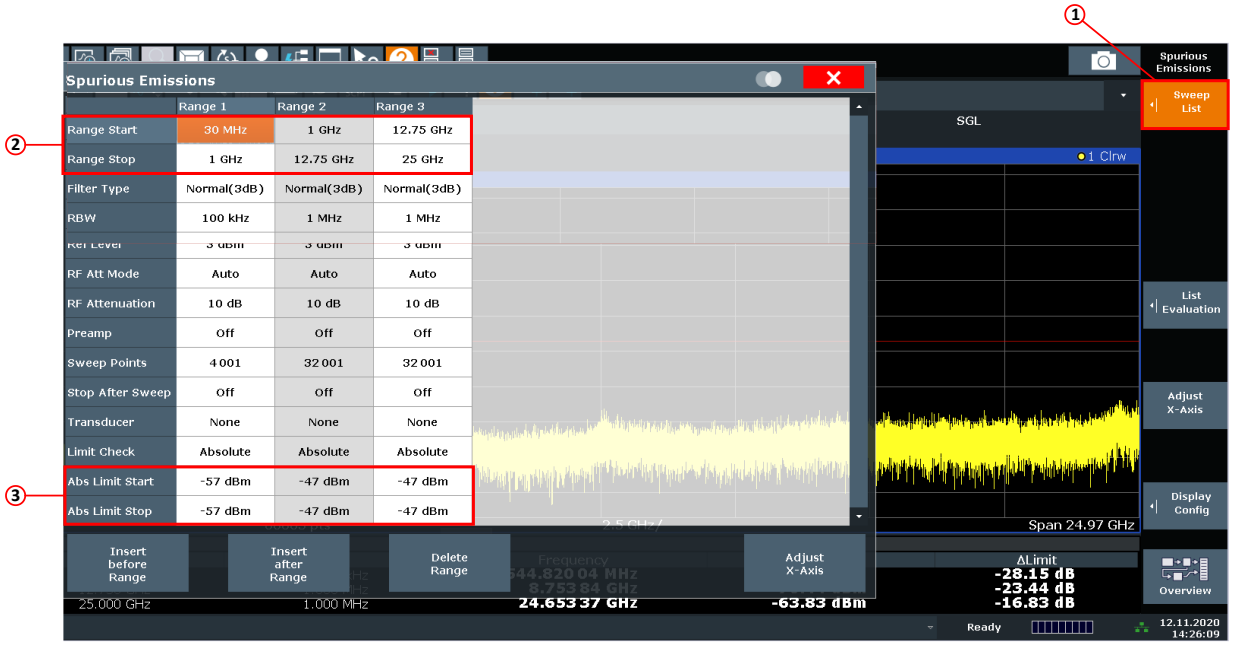
2. Open the ① **List Evaluation** tab and set the ② **Number of peaks**



3. Open the ① **Overview** tab, navigate to the ② **Amplitude** settings tab and enter the ③ **Offset** value



4. Set the ② **Frequency ranges** and ③ **Limits** according to Table 21



5. Start measurement

SCPI commands sequence

```
:SYST:DISP:UPD ON
:SWE:MODE LIST
:INIT:CONT OFF
:CALC:PEAK:SUBR <number>
:DISP:WIND:SUBW:TRAC:Y:SCAL:RLEV:OFFS <offset>
:SENS:LIST:RANG1:DEL
:SENS:LIST:RANG1:FREQ:STAR 30MHZ
:SENS:LIST:RANG1:FREQ:STOP 1GHZ
:SENS:LIST:RANG1:BAND 100KHZ
:SENS:LIST:RANG1:LIM:STAR -57
:SENS:LIST:RANG1:LIM:STOP -57
:SENS:LIST:RANG2:FREQ:STAR 1GHz
:SENS:LIST:RANG2:FREQ:STOP 12.7
:SENS:LIST:RANG2:BAND 1MHZ 5GHz
:SENS:LIST:RANG2:LIM:STAR -47
:SENS:LIST:RANG2:LIM:STOP -47
:SENS:LIST:RANG3:FREQ:STAR 12.75GHz
:SENS:LIST:RANG3:FREQ:STOP <upper frequency 5th harmonic>
:SENS:LIST:RANG3:BAND 1MHZ
:SENS:LIST:RANG3:LIM:STAR -47
:SENS:LIST:RANG3:LIM:STOP -47
:SENS:LIST:XADJ;*WAI
:INIT:SPUR
```

3.11 Receiver intermodulation (7.7)

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 a CW signal and an NR signal with QPSK modulation. [1]

Test setup

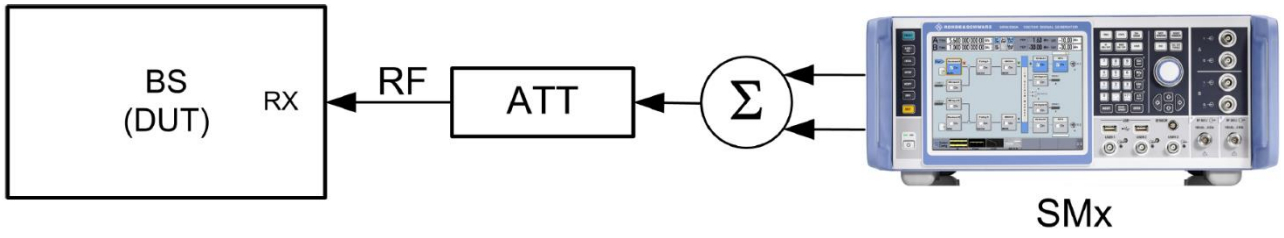
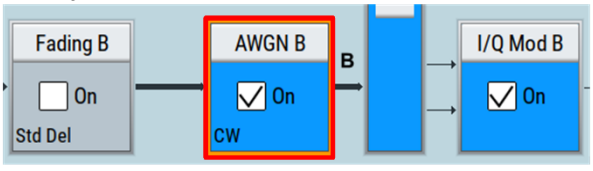


Figure 19: Test setup receiver intermodulation

Settings

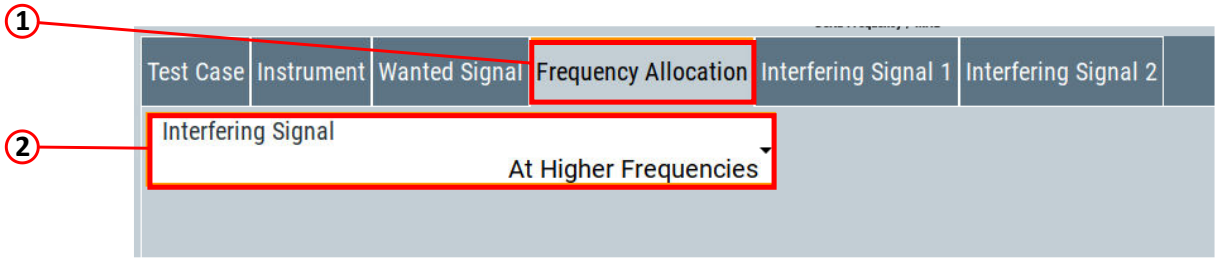
- The SMW generates a NR uplink signal with FRC and level settings (see below) which is applied to the BS receiver port (all parameters are implemented in the test case wizard)
- The NR interferer is generated in baseband B (all parameters are implemented in the test case wizard)
- The CW interferer is generated
  a) in the "AWGN B" block, second RF path of the SMW (This AN will focus on this option) **OR**
  b) by an external signal generator (e.g. R&S®SGS100A or R&S®SMA100B)
    – Then you have to deactivate the AWGN B in the second path of the SMW



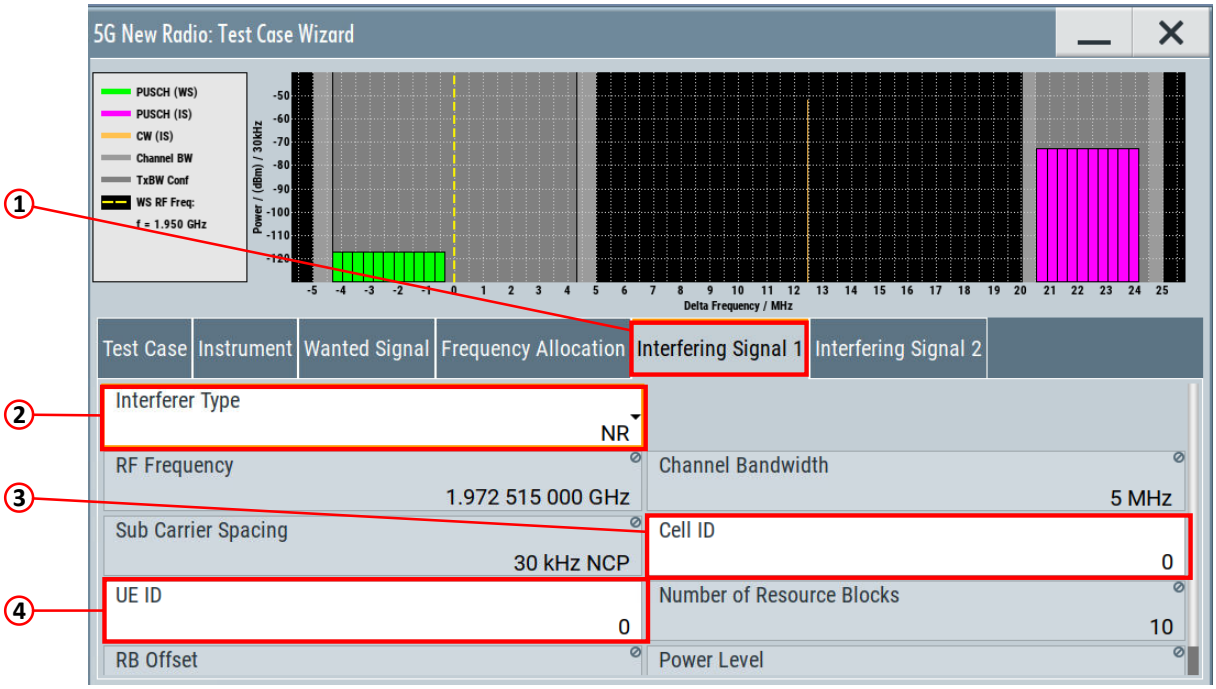
- Use a hybrid combiner to sum all signals

Manual testing procedure

1. Open the test case wizard*
2. Select base station class*
3. Select test "7.7 Receiver Intermodulation"*
4. Set the basic parameters*
   With **RB Offset** you can move the allocated RBs to additional positions inside the channel bandwidth (if possible)
5. Select the ② **Position of the interferer**



6. Set the ② **Interferer Type**, the ③ **Interferer Cell ID** and the ④ **Interferer UE ID**



7. Switch RF A and RF B on

*Detailed description can be found in 3.3

SCPI commands sequence

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC TS381411_TC77
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
```

```
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:WS:RBOFfset <WSRbOffset>
:BB:NR5G:TCW:FA:FRALlocation <FreqAlloc>
:BB:NR5G:TCW:IS:IFTYpe <InterfererType1>
:BB:NR5G:TCW:IS:UEID <ISUEID>
:BB:NR5G:TCW:IS:CLID <ISCellId>
:BB:NR5G:TCW:APPLy
:OUTPut1:STATe 1
:OUTPut2:STATe 1
```

3.11.1 General intermodulation

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 NR signal with QPSK modulation and a CW signal.

Figure 20 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.

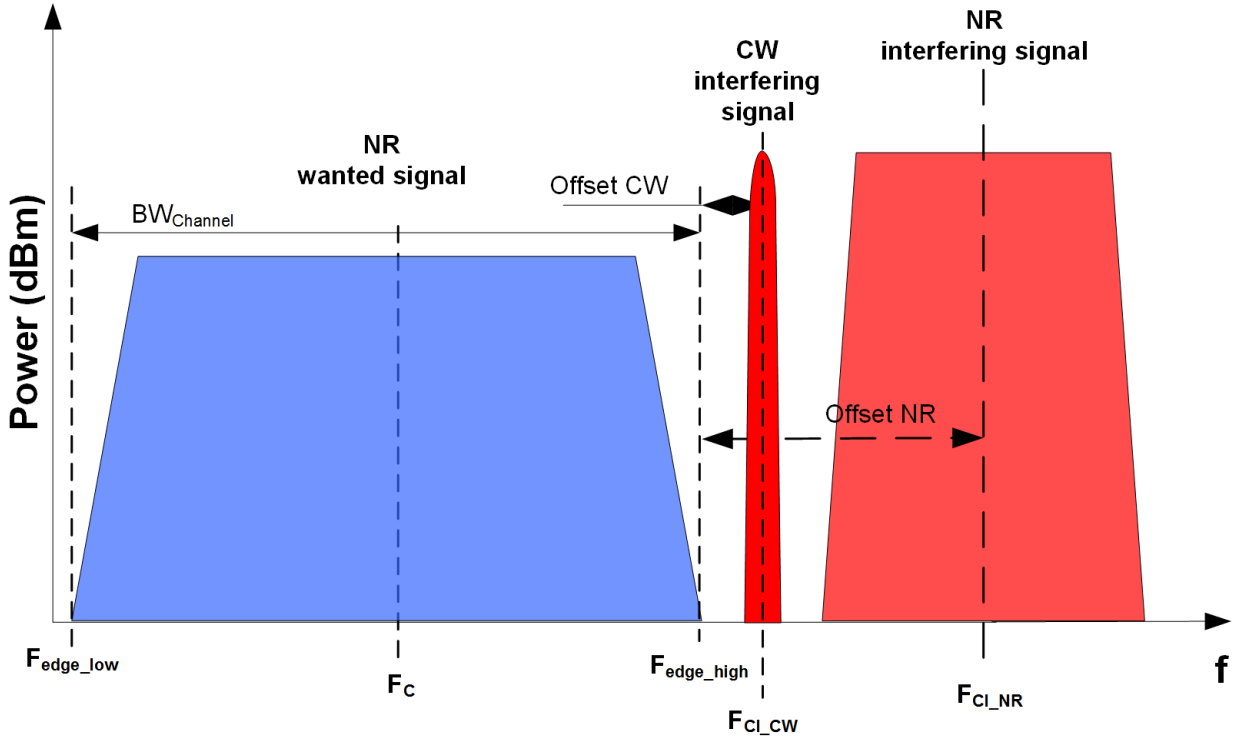


Figure 20: Intermodulation performance

For each measured NR carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

The wanted level is the reference sensitivity level from TS 38.104 [4] plus 6 dB.

The interfering level depends on the BS category:

Table 22: General intermodulation interferer levels

	Wide area	Medium range	Local area
Interferer level (dBm)	-52.0	-47.0	-44.0

The NR interfering level depends on the wanted signal bandwidth:

Table 23: General intermodulation NR interferer

Bandwidth wanted signal (MHz)	NR interferer bandwidth (MHz)	SCS (kHz)	Number of RBs
5, 10, 15, 20	5 MHz DFT-s-OFDM	15	25
		30	10
25, 30, 40, 50, 60, 70, 80, 90, 100	20 MHz DTS-s-OFDM	15	100
		30	50
		60	24

Table 24: General intermodulation interferer offsets

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering signal center frequency offset from the lower/upper BS RF Bandwidth edge (MHz)	Type of interfering signal
5	±7.5	CW
	±17.5	5 MHz NR signal
10	±7.465	CW
	±17.5	5 MHz NR signal
15	±7.43	CW
	±17.5	5 MHz NR signal
20	±7.395	CW
	±17.5	5 MHz NR signal
25	±7.465	CW
	±25	20MHz NR signal
30	±7.43	CW
	±25	20 MHz NR signal
40	±7.45	CW
	±25	20 MHz NR signal
50	±7.35	CW
	±25	20 MHz NR signal

60	±7.49	CW
	±25	20 MHz NR signal
70	±7.42	CW
	±25	20 MHz NR signal
80	±7.44	CW
	±25	20 MHz NR signal
90	±7.46	CW
	±25	20 MHz NR signal
100	±7.48	CW
	±25	20 MHz NR signal

3.11.2 Narrow-band intermodulation

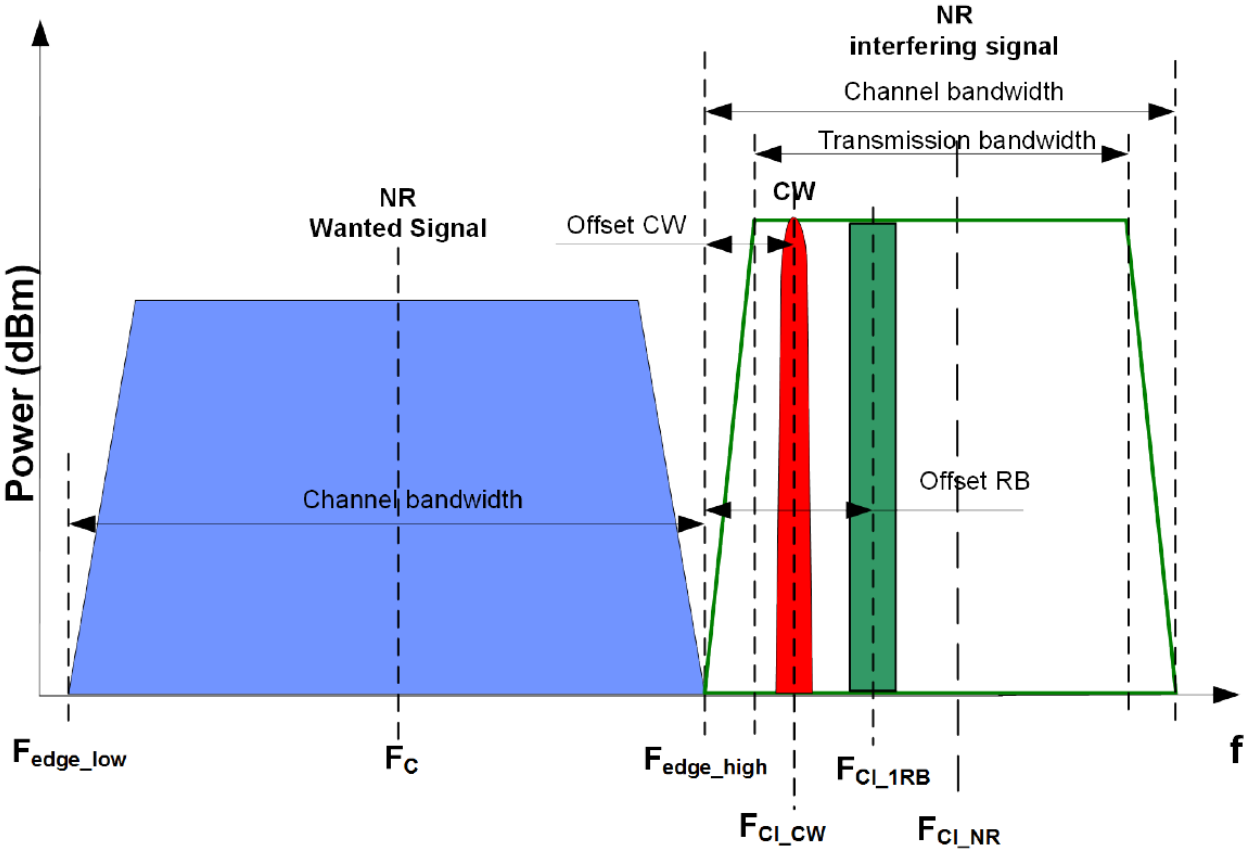


Figure 21: Narrow-band intermodulation

For each measured NR carrier, the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

The wanted level is the reference sensitivity level from TS 38.104 [4] plus 6 dB.

The interfering level depends on the BS category:

Table 25: Narrow-band intermodulation interferer levels

	Wide area	Medium range	Local area
Interferer level (dBm)	-52.0	-47.0	-44.0

Table 26: Narrow-band intermodulation NR interferer

Bandwidth wanted signal (MHz)	NR interferer bandwidth (MHz)	SCS (kHz)	Number of RBs
5, 10, 15, 20	5 MHz DFT-s-OFDM	15	1
		30	
25, 30, 40, 50, 60, 70, 80, 90, 100	20 MHz DTS-s-OFDM	15	1
		30	
		60	

Table 27: Narrow-band intermodulation interferer offsets

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering RB center frequency offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap (kHz)	Type of interfering signals
5	±360	CW
	±1420	5 MHz NR signal
10	±370	CW
	±1960	5 MHz NR signal
15	±380	CW
	±1960	5 MHz NR signal
20	±390	CW
	±2320	5 MHz NR signal
25	±325	CW
	±2350	20 MHz NR signal
30	±335	CW
	±2350	20 MHz NR signal
40	±355	CW
	±2710	20 MHz NR signal
50	±375	CW
	±2710	20 MHz NR signal
60	±395	CW
	±2710	20 MHz NR signal

70	±415	CW
	±2710	20 MHz NR signal
80	±435	CW
	±2710	20 MHz NR signal
90	±365	CW
	±2530	20 MHz NR signal
100	±385	CW
	±2530	20 MHz NR signal

3.12 In-channel selectivity (7.8)

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. [1]

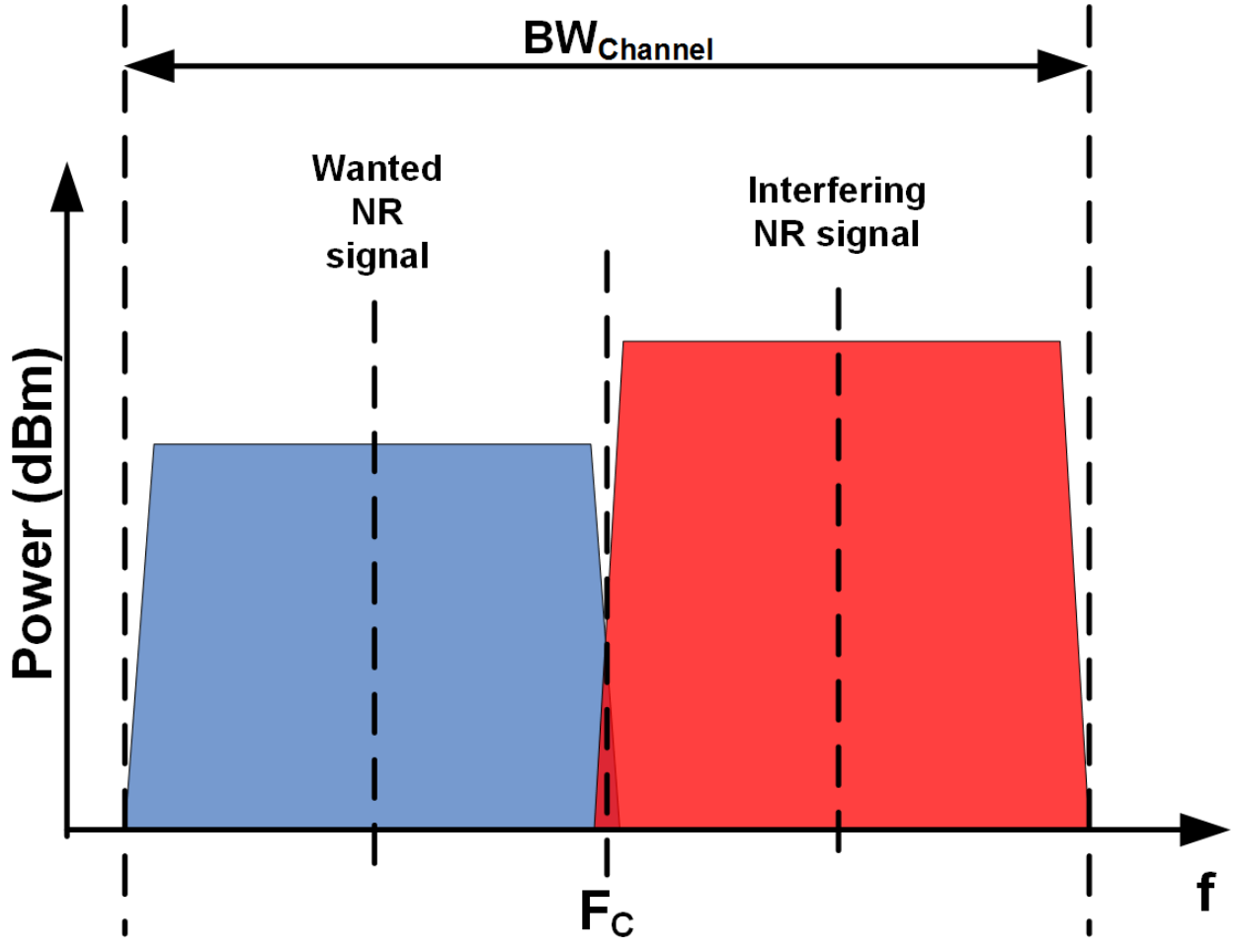


Figure 22: In-channel selectivity

For each measured NR carrier the throughput shall be ≥ 95% of the possible maximum throughput of the reference measurement channel.

The level for different base stations depends on the channel bandwidth, the FRC and the BS category as given in Table 28 to Table 30.

Table 28: Wide area BS in-channel selectivity

NR channel bandwidth (MHz)	SCS (kHz)	FRC	Wanted signal mean power (dBm)			Interfering signal mean power (dBm)	Type of interfering signal: DFT-s-OFDM NR signal
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz		
5	15	G-FR1-A1-7	-99.2	-98.8	-98.5	-81.4	15 kHz SCS 10 RBs
10, 15, 20, 25, 30	15	G-FR1-A1-1	-97.3	-96.9	-96.6	-77.4	15 kHz SCS 25 RBs
40, 50	15	G-FR1-A1-4	-90.9	-90.5	-90.2	-71.4	15 kHz SCS 100 RBs
5	30	G-FR1-A1-8	-99.9	-99.5	-99.2	-81.4	30 kHz SCS 5 RBs
10, 15, 20, 25, 30	30	G-FR1-A1-2	-97.4	-97	-96.7	-78.4	30 kHz SCS 10 RBs
40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-91.2	-90.8	-90.5	-71.4	30 kHz SCS 50 RBs
10, 15, 20, 25, 30	60	G-FR1-A1-9	-96.8	-96.4	-96.1	-78.4	60 kHz SCS 5 RBs
40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-91.3	-90.9	-90.6	-71.6	60 kHz SCS 24 RBs

Table 29: NR medium range BS in-channel selectivity

NR channel bandwidth (MHz)	SCS (kHz)	FRC	Wanted signal mean power (dBm)			Interfering signal mean power (dBm)	Type of interfering signal DFT-s-OFDM NR signal
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz		
5	15	G-FR1-A1-7	-94.2	-93.8	-93.5	-76.4	15 kHz SCS 10 RBs
10, 15, 20, 25, 30	15	G-FR1-A1-1	-92.3	-91.9	-91.6	-72.4	15 kHz SCS 25 RBs
40, 50	15	G-FR1-A1-4	-85.9	-85.5	-85.2	-66.4	15 kHz SCS 100 RBs
5	30	G-FR1-A1-8	-94.9	-94.5	-94.2	-76.4	30 kHz SCS 5 RBs
10, 15, 20, 25, 30	30	G-FR1-A1-2	-92.4	-92	-91.7	-73.4	30 kHz SCS 10 RBs
40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-86.2	-85.8	-85.5	-66.4	30 kHz SCS 50 RBs
10, 15, 20, 25, 30	60	G-FR1-A1-9	-91.8	-91.4	-91.1	-73.4	60 kHz SCS 5 RBs
40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-86.3	-85.9	-85.6	-66.6	60 kHz SCS 24 RBs

Table 30: NR local area BS in-channel selectivity

NR channel bandwidth (MHz)	SCS (kHz)	FRC	Wanted signal mean power (dBm)			Interfering signal mean power (dBm)	Type of interfering signal
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz		
5	15	G-FR1-A1-7	-91.2	-90.8	-90.5	-73.4	15 kHz SCS 10 RBs
10, 15, 20, 25, 30	15	G-FR1-A1-1	-89.3	-88.9	-88.6	-69.4	15 kHz SCS 25 RB
40, 50	15	G-FR1-A1-4	-82.9	-82.5	-82.2	-63.4	15 kHz SCS 100 RBs
5	30	G-FR1-A1-8	-91.9	-91.5	-91.2	-73.4	30 kHz SCS 5 RBs
10, 15, 20, 25, 30	30	G-FR1-A1-2	-89.4	-89	-88.7	-70.4	30 kHz SCS 10 RBs
40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-83.2	-82.8	-82.5	-63.4	30 kHz SCS 50 RBs
10, 15, 20, 25, 30	60	G-FR1-A1-9	-88.8	-88.4	-88.1	-70.4	DFT-s-OFDM NR signal, 60 kHz SCS, 5 RBs
40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-83.3	-82.9	-82.6	-63.6	DFT-s-OFDM NR signal, 60 kHz SCS, 24 RBs

Test setup

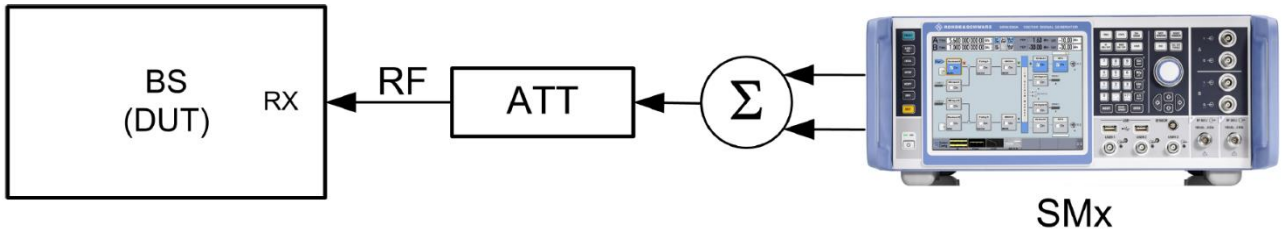


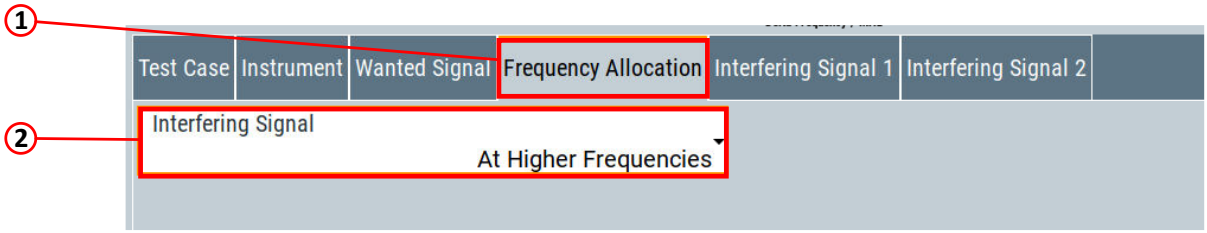
Figure 23: Test setup ICS

Settings

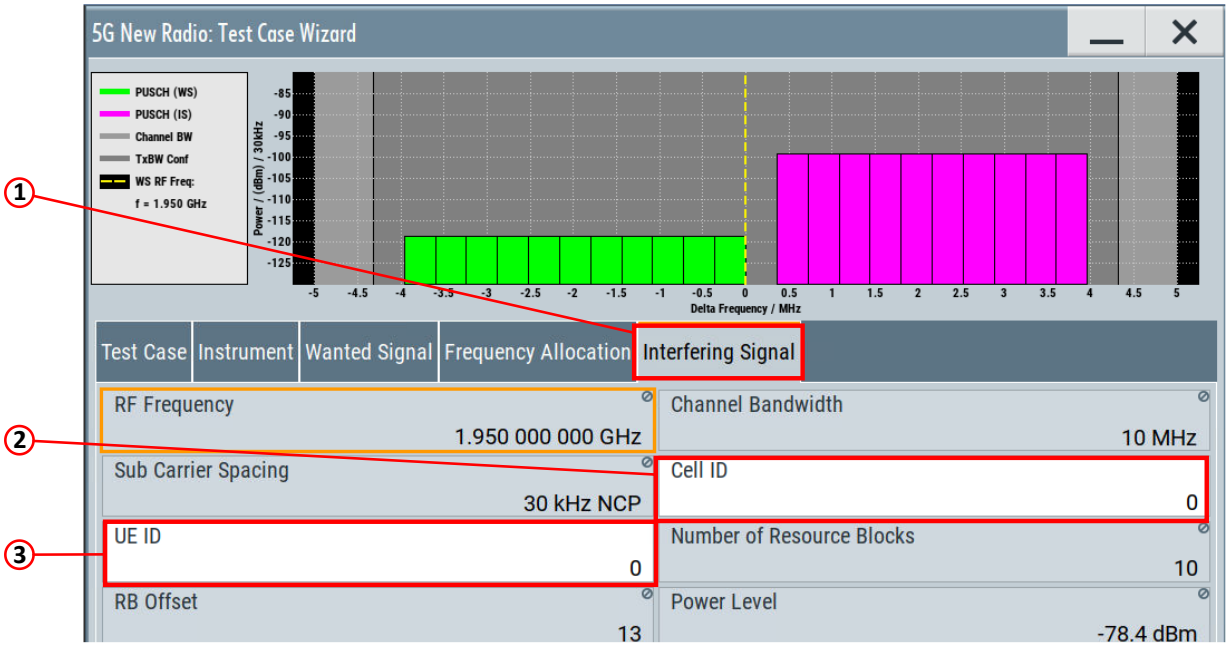
- ► The SMW generates a NR uplink signal with FRC and level settings according to Table 28 to Table 30
- ► In the second path the SMW generates the NR interferer
- ► Use a hybrid combiner to sum all signals

Manual testing procedure

1. Open the test case wizard*
2. Select base station class*
3. Select test "7.8 In-channel Selectivity"*
4. Set the basic parameters*
   With **RB Offset** you can move the allocated RBs to additional positions inside the channel bandwidth (if possible)
5. Select the ② **Position of the interferer**



6. Set the ② **Interferer Cell ID** and the ③ **Interferer UE ID**



7. Switch RF A and RF B on
8. *Detailed description can be found in 3.3

SCPI commands sequence

```
:BB:NR5G:TCW:BSCLass <BSClass>
:BB:NR5G:TCW:TC TS381411_TC78
:BB:NR5G:TCW:TRIGgerconfig <TrigConfig>
:BB:NR5G:TCW:MARKerconfig <MarkerConfig>
:BB:NR5G:TCW:WS:RFFRequency <WSRFFreq>
:BB:NR5G:TCW:WS:CBW <WSChBw>
:BB:NR5G:TCW:WS:SCSPacing <WSSubCarSpacing>
:BB:NR5G:TCW:WS:CELLid <WSCellId>
:BB:NR5G:TCW:WS:UEID <WSUeId>
:BB:NR5G:TCW:WS:TAPos <WSTypeAPos>
:BB:NR5G:TCW:FA:FRALlocation <FreqAlloc>
:BB:NR5G:TCW:IS:IFTYpe <InterfererType1>
:BB:NR5G:TCW:IS:UEID <ISUEID>
:BB:NR5G:TCW:IS:CLID <ISCellId>
:BB:NR5G:TCW:APPLy
:OUTPut1:STATe 1
:OUTPut2:STATe 1
```

4 Literature

[1] 3GPP Technical Specification Group Radio Access Network, "NR Base station conformance testing, Part 1: Conducted conformance testing, Release 15; TS 38.141-1, V15.6.0", 2020
Available: https://www.3gpp.org/DynaReport/38141-1.htm

[2] 3GPP Technical Specification Group Radio Access Network, "NR Base Station (BS) conformance testing Part 2: Radiated conformance testing, Release 15; TS 38.141-2 V.15.6.0", 2020
Available: https://www.3gpp.org/DynaReport/38141-2.htm

[3] Rohde & Schwarz, 5G NR Technology Introduction, 2019

[4] 3GPP Technical Specification Group Radio Access Network, "NR Base Station (BS) radio transmission and reception, Release 15; TS 38.104, V15.8.0", 2020
Available: https://www.3gpp.org/DynaReport/38104.htm

[5] Rohde & Schwarz, "5G NR Base Station OTA Transmitter Tests (GFM324)", 2020
Available: https://www.rohde-schwarz.com/appnote/GFM324

[6] Rohde & Schwarz, "5G NR Base Station OTA Receiver Tests (GFM325)", 2020
Available: https://www.rohde-schwarz.com/appnote/GFM325

[7] Rohde & Schwarz, "Remote Control and Instrument Drivers"
Available: https://www.rohde-schwarz.com/de/driver-pages/fernsteuerung/uebersicht_110753.html

[8] Rohde & Schwarz, "Introducing SCPI Commands"
Available: https://www.rohde-schwarz.com/de/driver-pages/fernsteuerung/remote-programming-environments_231250.html

5 Ordering Information

Type	Designation	Order No.
R&S®SMW200A	Vector signal generator	1412.0000.02
R&S®SMW-B1007	Frequency option	1428.7700.02
R&S®SMW-B2007	Frequency option	1428.7900.02
R&S®SMW-B10 or **R&S®SMW-B9**	Baseband generator option	1413.1200.02 or 1413.7350.02
R&S®SMW-B13T or **R&S®SMW-B13XT**	Baseband main module option	1413.3003.02 or 1413.8005.02
R&S®SMW-K62	AWGN option	1413.3484.02
R&S®SMW-K144	5G New Radio	1414.4990.02
R&S®SMBV100B	Vector signal generator	1423.1003.02
R&S®SMBV-B103	Frequency range 8 kHz to 3 GHz	1423.6270.02
R&S®SMBVBKB106	Frequency extension 6 GHz	1423.6370.02
R&S®SMBV-K520	Baseband realtime extension	1423.7676.02
R&S®SMBV-K62	AWGN	1423.7876.02
R&S®SMBVB-K144	5G New Radio	1423.8608.02
R&S®SGS100A	RF source	1416.0505.02
R&S®SGS-B106	Frequency range: 1MHz to 6GHz, CW only	1416.2308.02
R&S®SGS-B112	Frequency extension to 12.75GHz	1416.1553.02
R&S®SMA100B	RF and Microwave Signal Generator	1419.8888.02
R&S®SMAB-B112	Frequency extension to 12.75GHz	1420.8688.02
R&S®FSW43	Signal and spectrum analyzer	1331.5003.43
R&S®FSV3044	Signal and spectrum analyzer	1330.5000.43
R&S®FSVA3044	Signal and spectrum analyzer	1330.5000.44
R&S®FSV40	Signal and spectrum analyzer	1321.3008.40
R&S®FSVA40	Signal and spectrum analyzer	1312.8000.41
R&S®FPS	Signal and spectrum analyzer	1319.2008.40

6 Appendix

A GFM314_Rx_tests Python package

This Python library is providing chapter 7 test cases defined in TS 38.141-1. These Python classes are meant to be integrated easily into existing Python development environment and projects.

By this, and making extensive use of the Test Case Wizard (TCW) of the RF generator used, the time for searching and testing correct SCPI sequences shall be reduced tremendously.

Another benefit of the lately introduced TCW is that parameters not explicitly specified are using correct default values that are compliant with the specification.

However, for invalid parameters that are not in conformance with the specifications an error handling procedure will be triggered and a detailed exception message will be available.

A.1 Terms and conditions

By downloading the Python package, you are agreeing to be bound by the Terms and conditions for royalty free software.

A.2 Requirements

The following setup is recommended:

- Python version 3.8
- PyCharm IDE
  - The Community Edition version is sufficient
  - https://www.jetbrains.com/pycharm/
- `RsInstrument` Python module is required (1.8.2.45 or higher)
  - pypi.org: https://pypi.org/project/RsInstrument/
  - Further details: How to install / update RsInstrument package

For further reading

Please see the Getting Started remote control example using Python in PyCharm.

A.3 Package structure

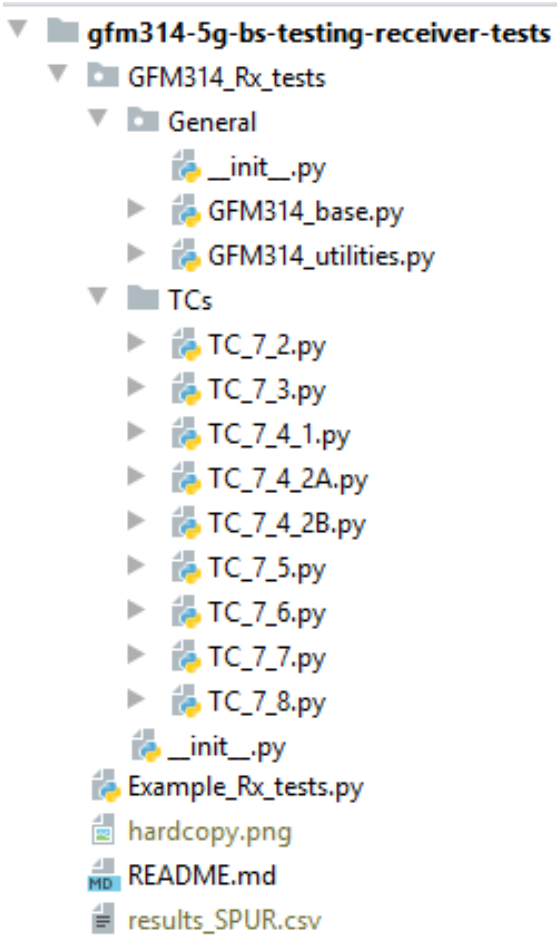


Figure 24: Project tree in PyCharm

A.4 Example_Rx_tests.py

The provided `Example_Rx_tests.py` file shows the usage of this Python library for 5G NR base station receiver tests. This example describes the use of the libraries with the help of two test scenarios (second one is commented out).

```
from GFM314_Rx_tests import *

resource_string_SMW_hislip = 'TCPIP::192.168.1.1::hislip0'  # Hi-Speed LAN connection - see 1MA208
resource_string_SMW_vxi11 = 'TCPIP::192.168.1.1::INSTR'  # VXI-11 connection
resource_string_SMW_usb = 'USB::0x0AAD::0x0119::022019943::INSTR'  # USB-TMC (test and measurement class)
resource_string_FSW = 'TCPIP::192.168.1.2::hislip0'  # required for test case 7.6

try:
    # ---- Test case 7.2 Reference sensitivity level ----
    # Initialization
    mytest72 = TC72(resource_string_SMW_hislip)
    # Set some test specific parameters
    mytest72.channel_bw = 20
    mytest72.dmrs_pos = 2
    # Apply signal configuration
    mytest72.apply_configuration()
    # Switch RF output on
    mytest72.output_on(1)
    # Close the connection
    mytest72.close()

    # # ---- Test case 7.6 Receiver spurious emissions ----
    # # Initialization
    # mytest76 = TC76(resource_string_FSW) # FSW is used
    # # Set some test specific parameters
    # mytest76.offset = 3
    # mytest76.number_peaks = 25
    # mytest76.frequency_5thharmonic = 25
    # # Apply signal configuration
    # mytest76.apply_configuration()
    # # Measurement results
    # print(mytest76.return_results())
    # mytest76.hardcopy()
    # mytest76.csv_export()
    # # Close the connection
    # mytest76.close()
except RsException as e:
    print(e.args[0])
else:
    print('Test execution successful')
```

Figure 25: Example_Rx_tests.py

A.5 Quick Documentation in PyCharm

By pressing the shortcut **Ctrl + Q** the quick documentation can be displayed. This then shows a short description about the corresponding parameter or function.

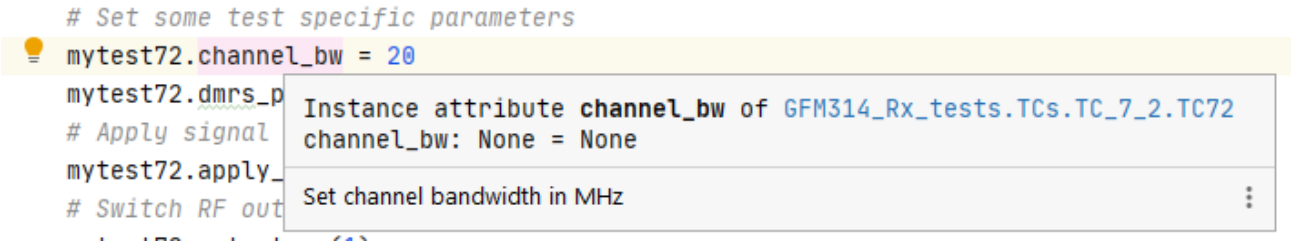


Figure 26: Quick Documentation

A.6 K-Options Availability Check

Whenever a test case is executed, the RF generator is queried for the list of installed options per default. If the minimum software options requirements are not met, the execution of the test case is aborted and a detailed exception message is returned.

Please note: At current only the K-options for meeting the minimum test requirements are checked. Extended test setups that may require additional options are out of scope of this K-options availability check.

B R&S® QuickStep

The QuickStep software application makes it possible to combine testmodules provided by Rohde & Schwarz into test plans to allow rapid and easy remote control of test instruments. The program needs a R&S License. The testmodules for 5G NR base station tests are free of charge.

B.1 Terms and conditions

By downloading the QuickStep package you are agreeing to be bound by the Terms and conditions for royalty free software.

B.2 Requirements

Operating system:

- Windows 10
- Windows 8.1
- Microsoft Windows 7 (64 bit, SP 1, universal C runtime)

General PC requirements: Standard PC

Remote control interface:

- R&S®Visa
- LAN connection

B.3 First steps

Please use the provided **test procedure** as a first step. This allows you to skip very basic settings.

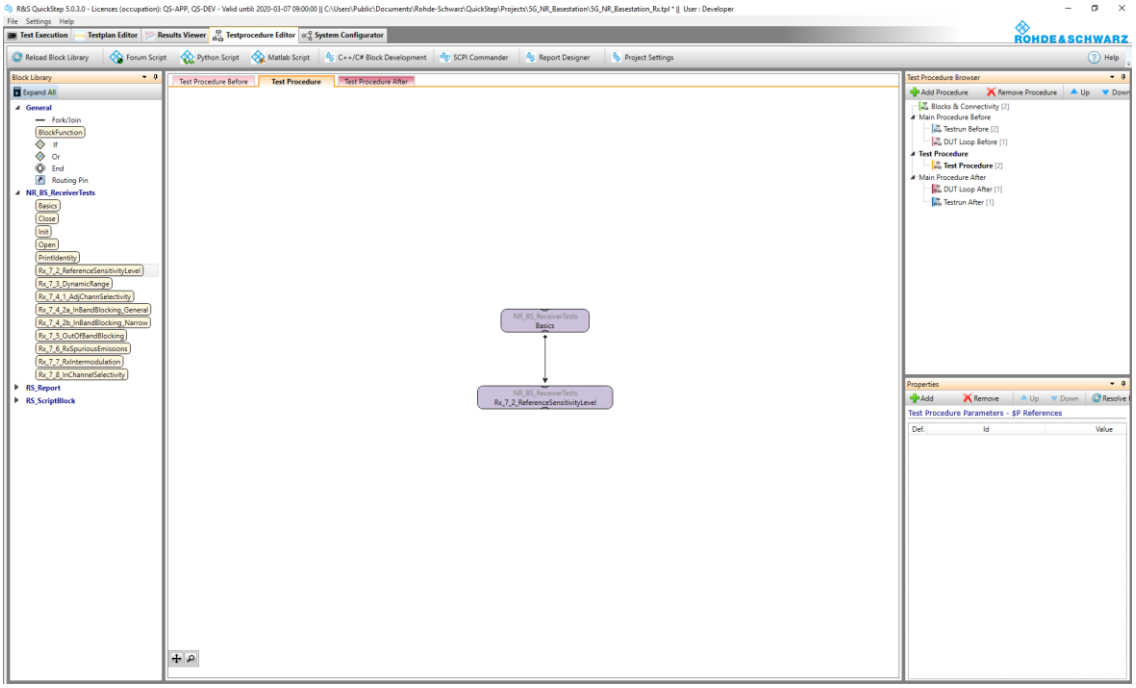


Figure 27: QuickStep overview

All 5G NR base station receiver tests can be found int the block library tab on the left side under **NR_BS_ReceiverTests**. In the middle under **Test Procedure** the activer testsequency can be viewed.

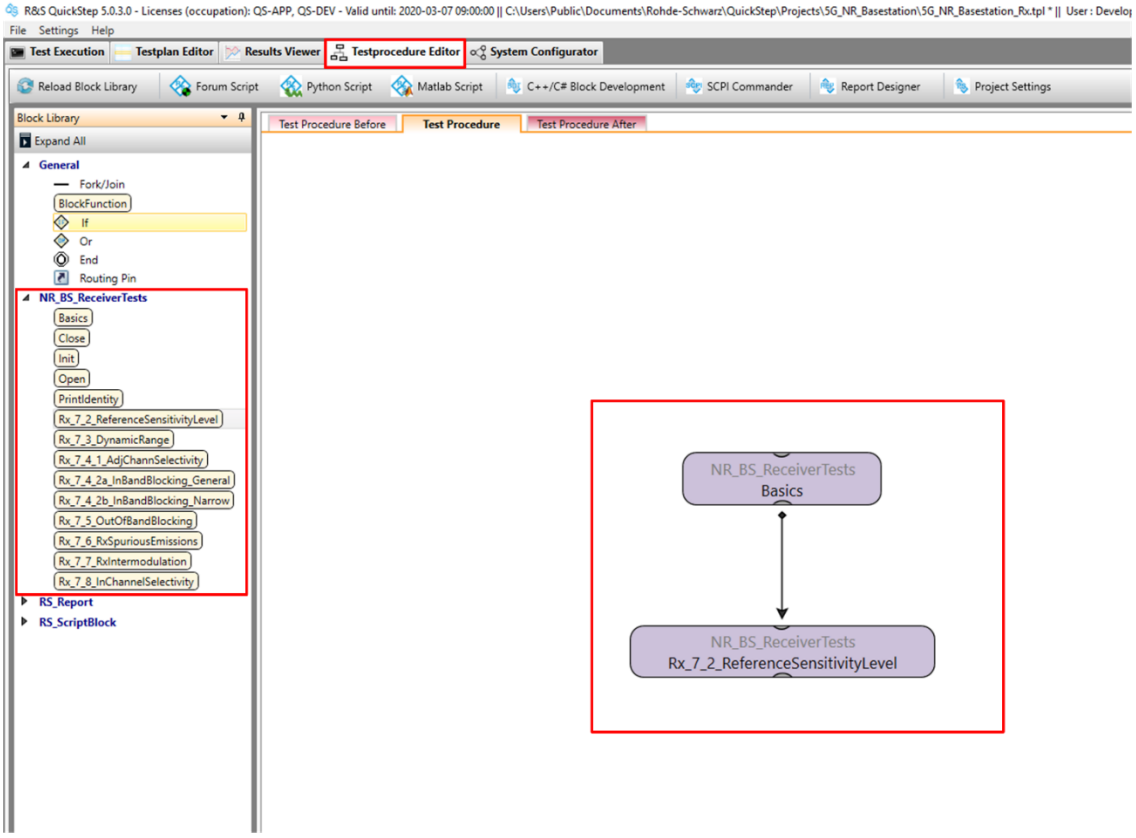


Figure 28: QuickStep test procedure

It is possible to create to create an individual testprocedure by using drag-and-drop. Select a testmodule from the block library and drop it into the **Test Procedure** window. Please make sure to connect the bottom port of a block to the top port of the next block.

To start a test, go to the tab **Testplan Editor** and click on the button **Single Run**.

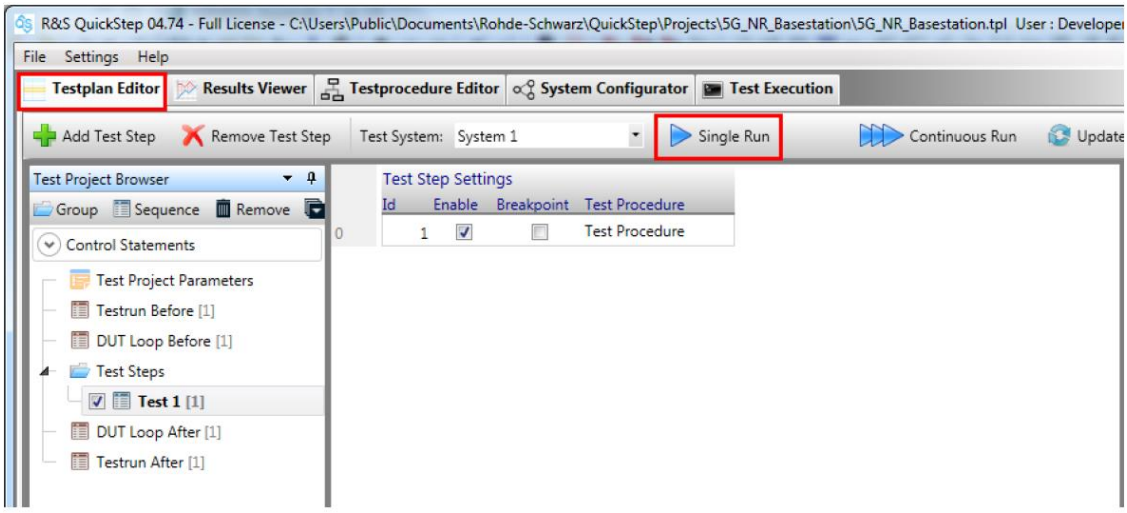


Figure 29: Run a test

After the execution, a test protocol in pdf-format can be found at tab **Results Viewer**.

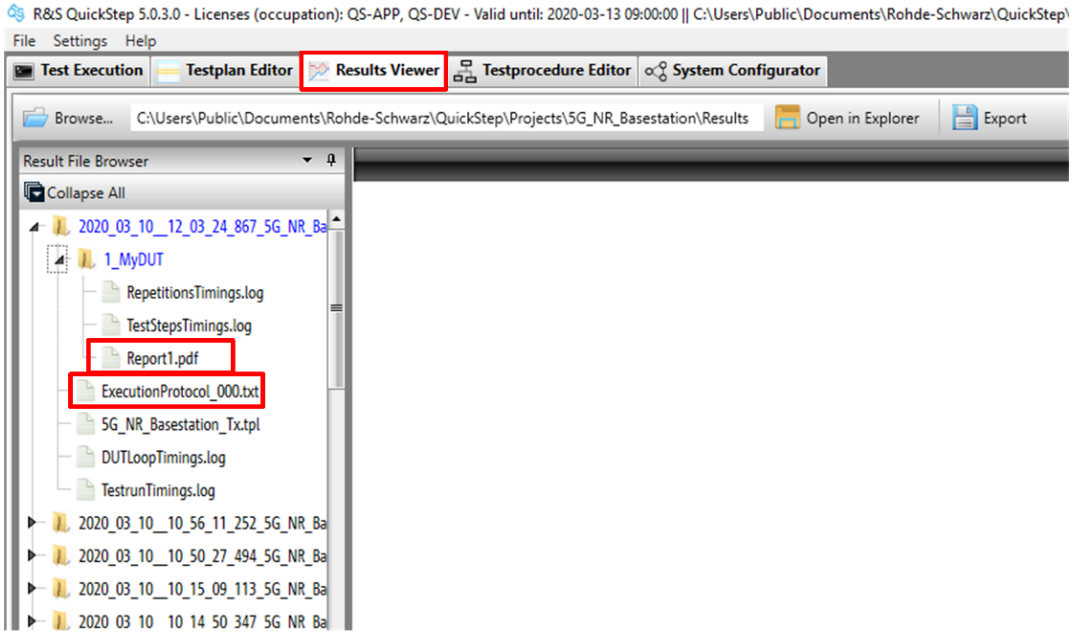


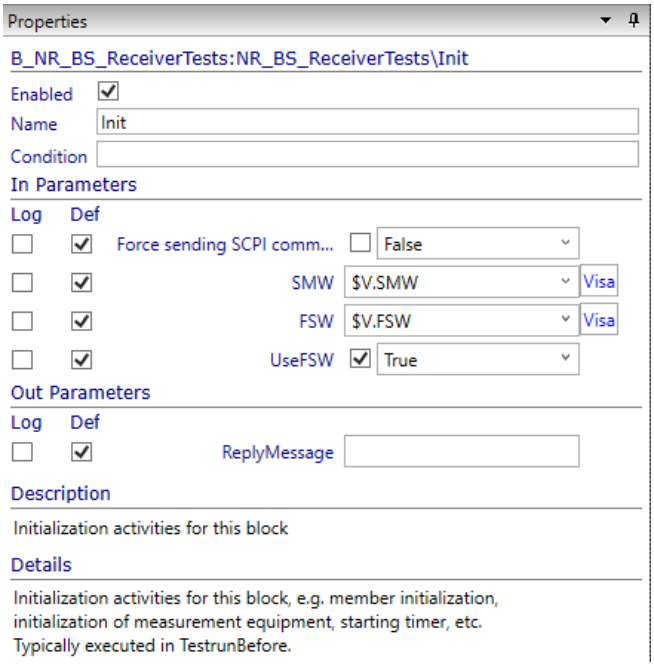
Figure 30: QuickStep results

A click on **<name of report>.pdf** opens the report on the last run.

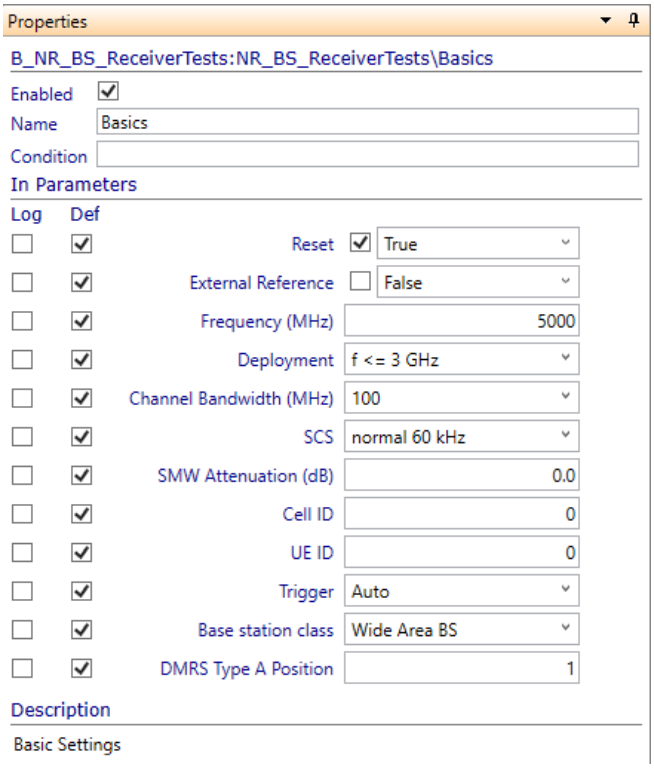
ExecutionProtocol_000.txt shows a protocol of the last run which includes all messages from QuickStep and the sent and received SCPI interactions.

B.4 QuickStep Rx blocks

- Initialization
  - Block name: Init
  - Part of "Testrun Before" procedure

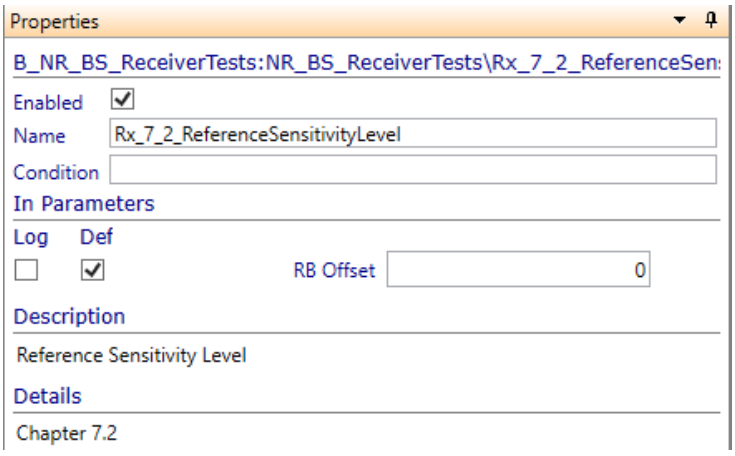


- Basic parameters
  - Block name: Basics
  - Provides principal 5G NR settings independently of further test steps



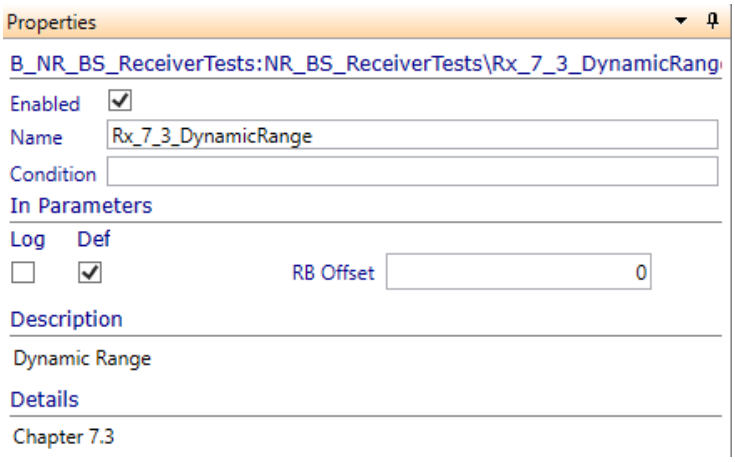
► Test 7.2 Reference sensitivity level

– Block name: Rx_7_2_ReferenceSensitivityLevel



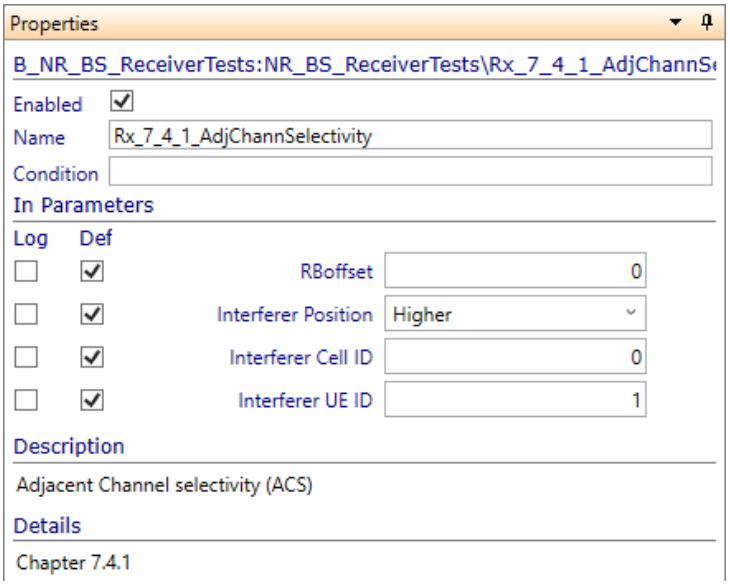
► Test 7.3 Dynamic range

– Block name: Rx_7_3_DynamicRange



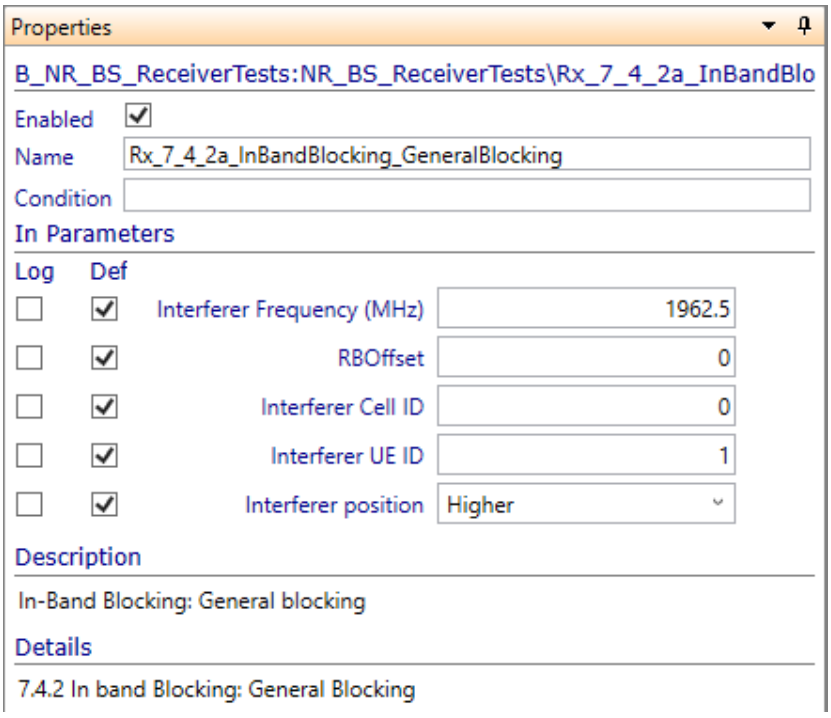
► Test 7.4.1 Adjacent channel selectivity (ACS)

– Block name: Rx_7_4_1_AdjChannSelectivity



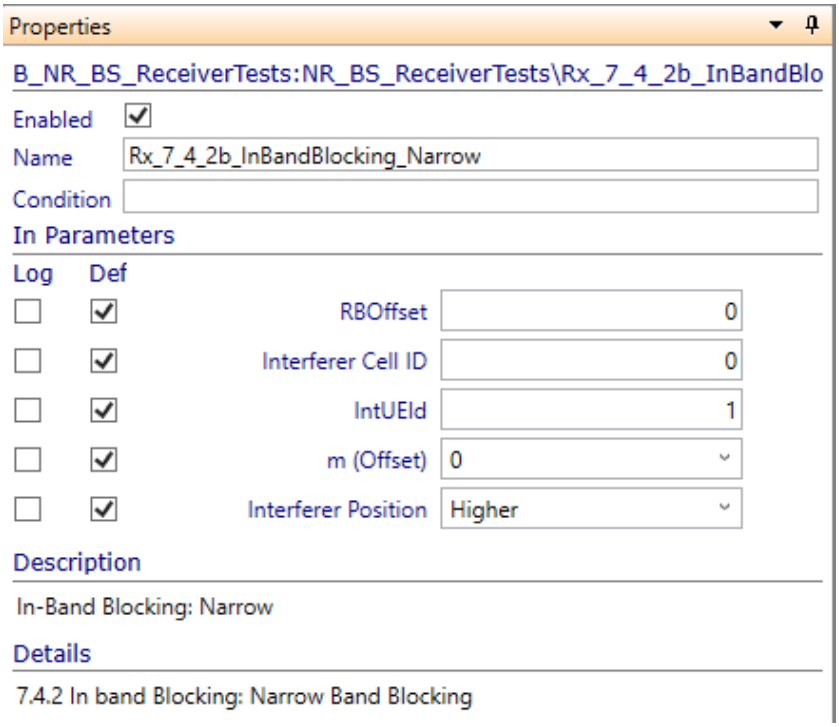
► Test 7.4.2a In-band blocking (general blocking)

– Block name: Rx_7_4_2a_InBandBlockking_GeneralBlocking



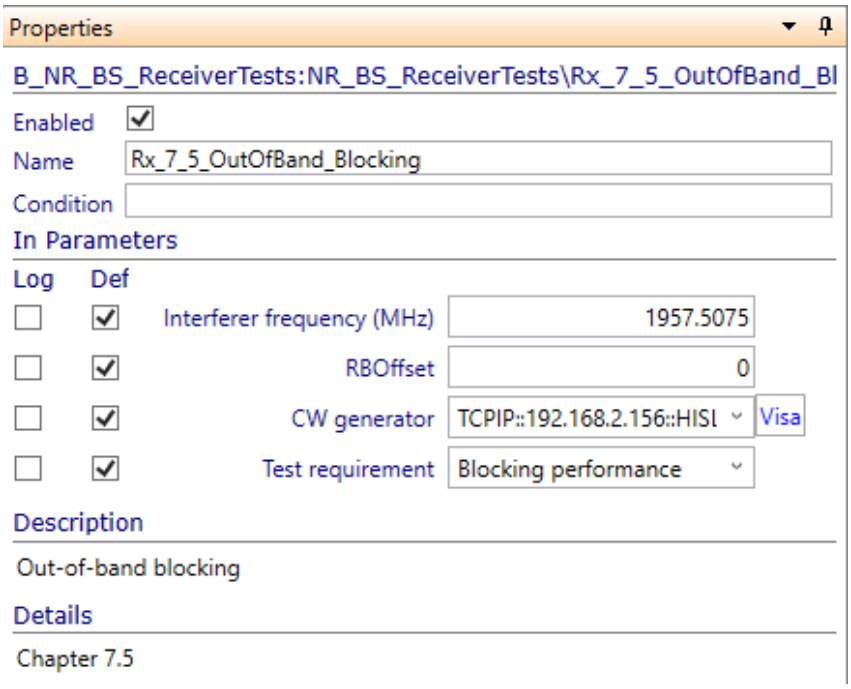
► Test 7.4.2b In-band blocking (narrow band blocking)

– Block name: Rx_7_4_2b_InBandBlocking_Narrow



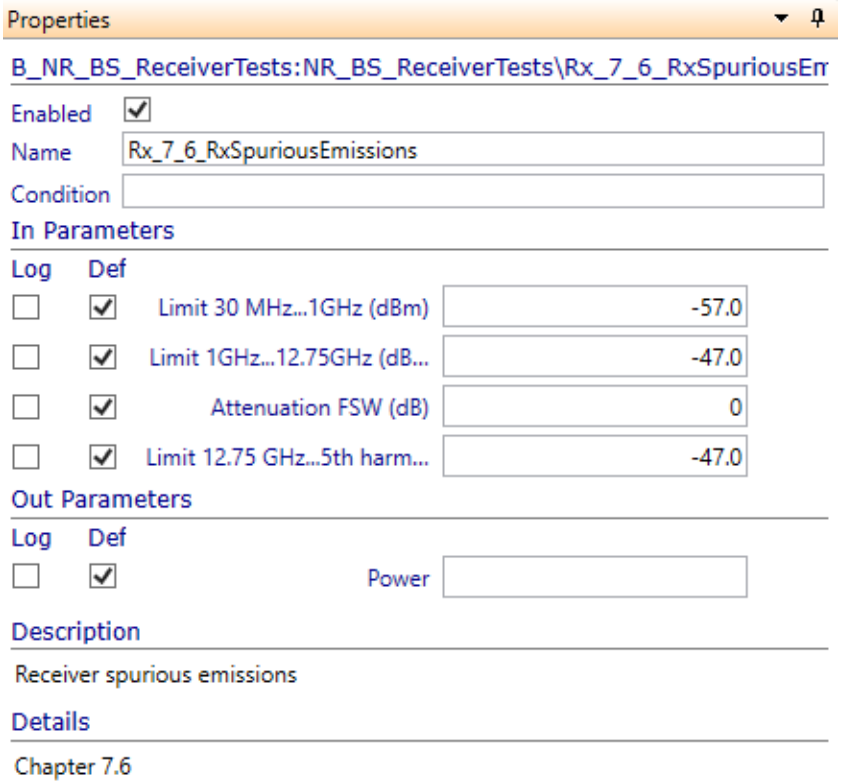
► Test 7.5 Out-of-band blocking

– Block name: Rx_7_5_OutPfBand_Blocking



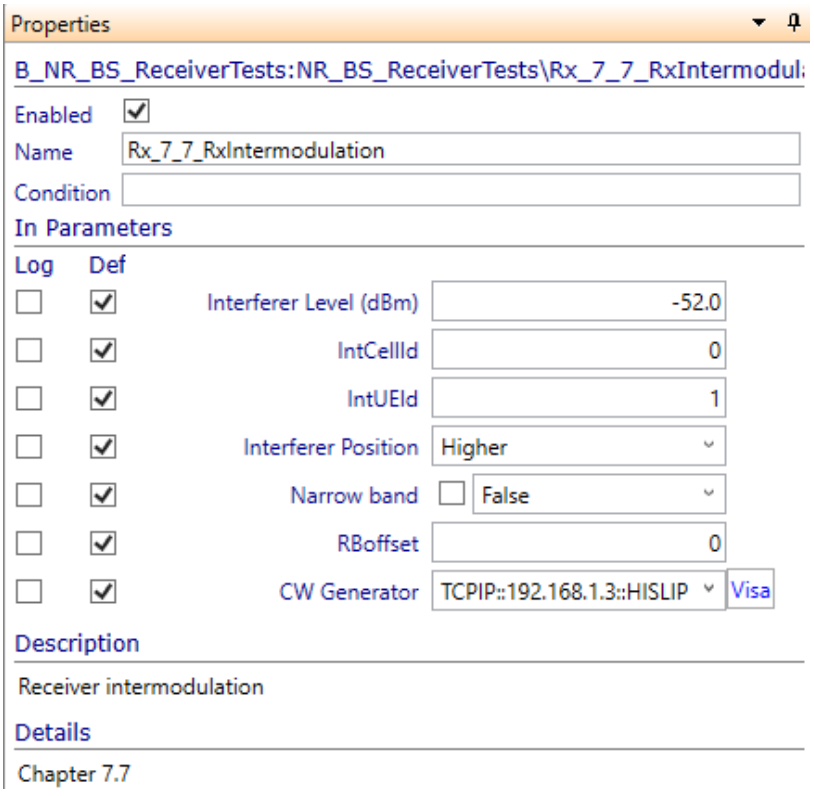
► Test 7.6 Receiver spurious emissions

– Block name: Rx_7_6_RxSpuriousEmissions



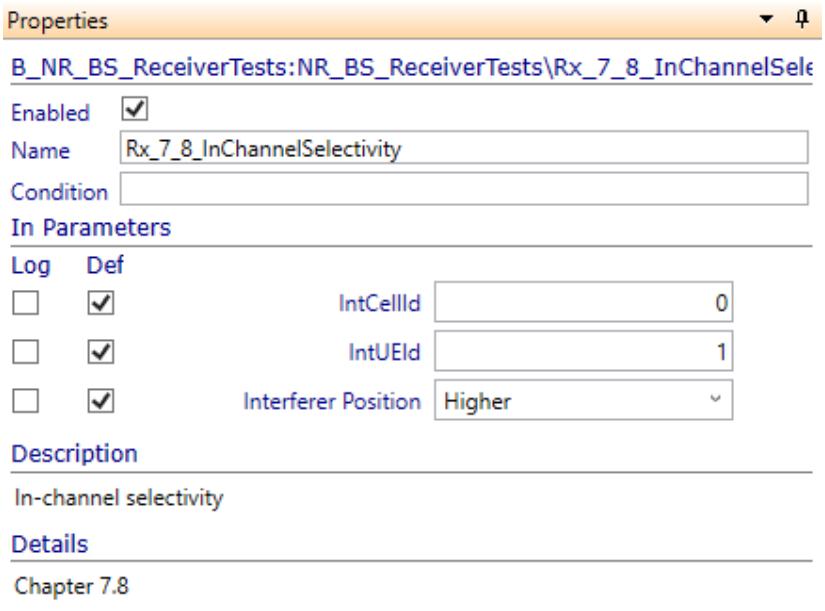
► Test 7.7 Receiver intermodulation

– Block name: Rx_7_7_RxIntermodulation



► Test 7.8 In-channel selectivity

– Block name: Rx_7_8_InChallenSelectivity



C Abbreviations

Table 31: Abbreviations

Abbreviation	Description
5G NR	5G New Radio
ACS	Adjacent channel selectivity
AN	Application Note
AWGN	Additive white gaussian noise
BS	Base station
CA	Carrier aggregation
DUT	Device under test
FDD	Frequency division duplex
FR1	Frequency range 1
FRC	Fixed reference channel
MIMO	Multiple input multiple output
OBUE	Operating band unwanted emissions
OTA	Over the air
PDSCH	Physical downlink shared channel
P_{rat}	Rated output power
Px-	Performance-
RB	Resource block
RBW	Resolution bandwidth
RF	Radio frequency
RIB	Radiated interface boundary
RS	Reference signal
Rx-	Receiver-
SC	Single carrier
SCS	Subcarrier spacing
SSB	Synchronization signal block
TAB	Transceiver array boundary
TAE	Time alignment error
TDD	Time division duplex
TM	Test model
Tx-	Transmitter-
UE	User equipment
VSWR	Voltage standing wave ratio

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Application Note | 5G New Radio Conducted Base Station Receiver Tests
Data without tolerance limits is not binding | Subject to change

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