Application Note

5G NEW RADIO OVER-THE-AIR BASE STATION RECEIVER TESTS

Radiated conformance testing according to TS 38.141-2, Rel. 16

Products:

- R&S®TS8991
- R&S®ATS1800C
- R&S®PWC200
- R&S®SMW200A
- R&S®SMA100B
- R&S®FSW
- R&S®FSV(A)3000
- R&S®FSV(A)

Christian Wicke, Fabian Bette | GFM325 | Version 1e | 06.2020

https://www.rohde-schwarz.com/appnote/GFM325

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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:

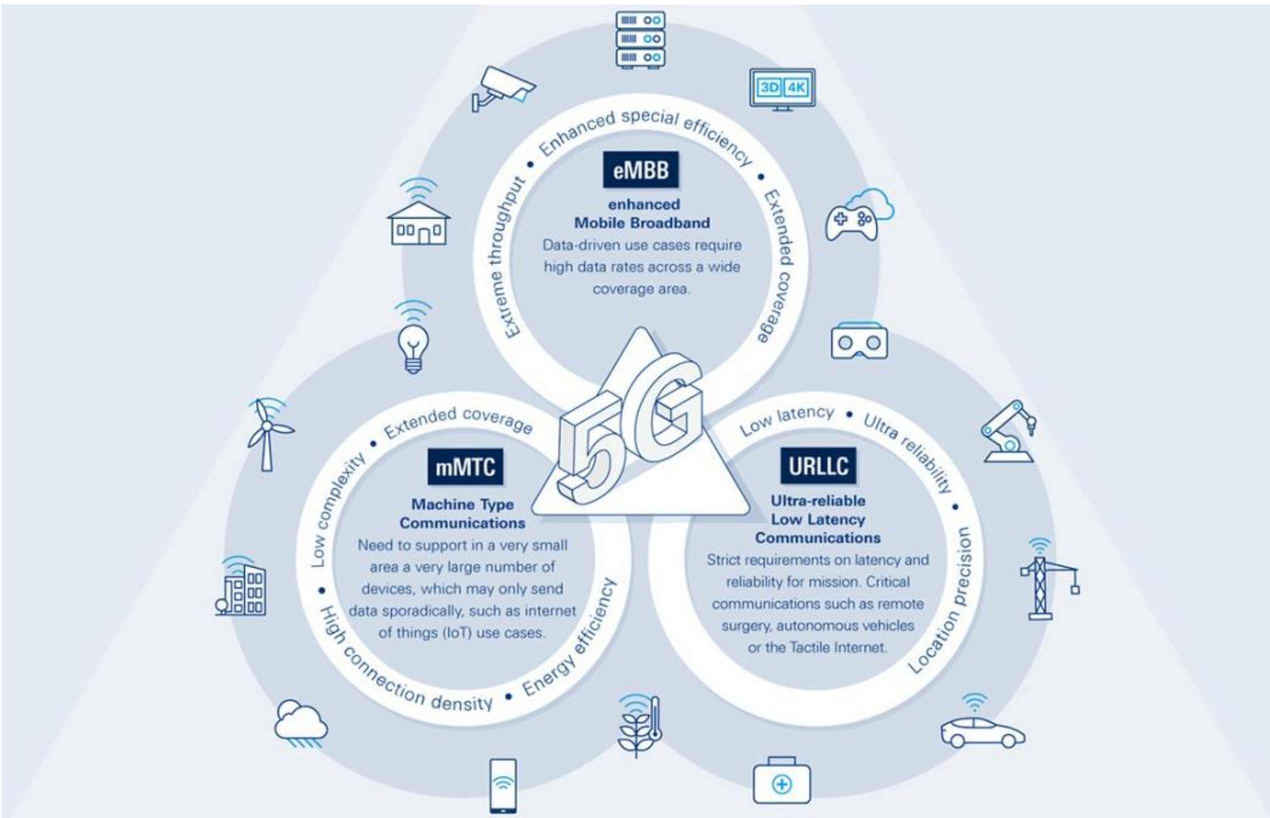


Figure 1: 5G New Radio main service families

- ► 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 all mandatory **RF receiver tests (TS 38.141-2, chapter 7)**, according to Release 16 (V16.3.0). Furthermore, chapter 4 of this document provides a brief introduction about the different R&S OTA antenna test solutions and how they're applicable for base station conformance testing. Rohde & Schwarz offers suitable solutions for any test case that is mentioned in this application note.

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. Next, there comes a step-by-step description of the testing procedure showing the necessary testing parameters and a schematic test setup.

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

Table 1: OTA receiver tests

Chapter	Test	Single Carrier (SC)	Multi Carrier (MC)
7.2	OTA sensitivity	✓	✗
7.3	OTA reference sensitivity level	✓	✗
7.4	OTA dynamic range	✓	✗
7.5.1	OTA adjacent channel selectivity	✓	✗
7.5.2	OTA in-band blocking	✓	✗
7.6	OTA out-of-band blocking	✓	✗
7.7	OTA receiver spurious emissions	✓	✗
7.8	OTA receiver intermodulation	✓	✗
7.9	OTA in-channel selectivity	✓	✗

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

Base station (RF) transmitter tests (TS 38.141-2, chapter 6) are described in GFM324

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 Base station reference points

This application note covers radiated measurements only. In [1] and [4] two different base station types are defined for frequency range one (FR1) and two (FR2). Radiated requirements are also referred to as OTA requirements.

2.2.2 BS type 1-O and 2-O (FR1, FR2, radiated)

For base station type 1-O and 2-O the radiated characteristics are defined over the air where the OTA interface is referred to as Radiated Interface Boundary (RIB). Co-location requirements are specified at the conducted interface of the co-location reference antenna.

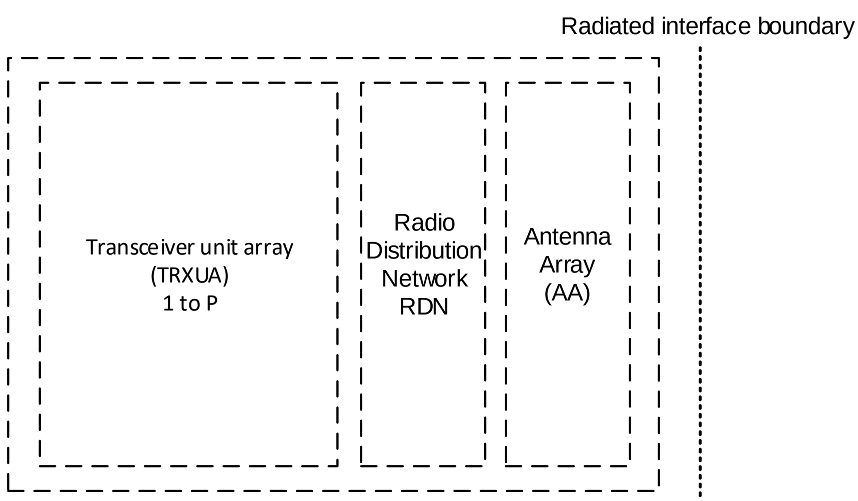


Figure 2: Radiated reference points for BS type 1-O and BS type 2-O [2]

2.2.3 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. The specific requirements and test cases are defined in TS 38.141-1 [1].

Furthermore, the specific conducted measurements are described in extra Rohde & Schwarz application notes [5], [6] and [7].

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]. This application note applies to radiated measurements only at the RIB.

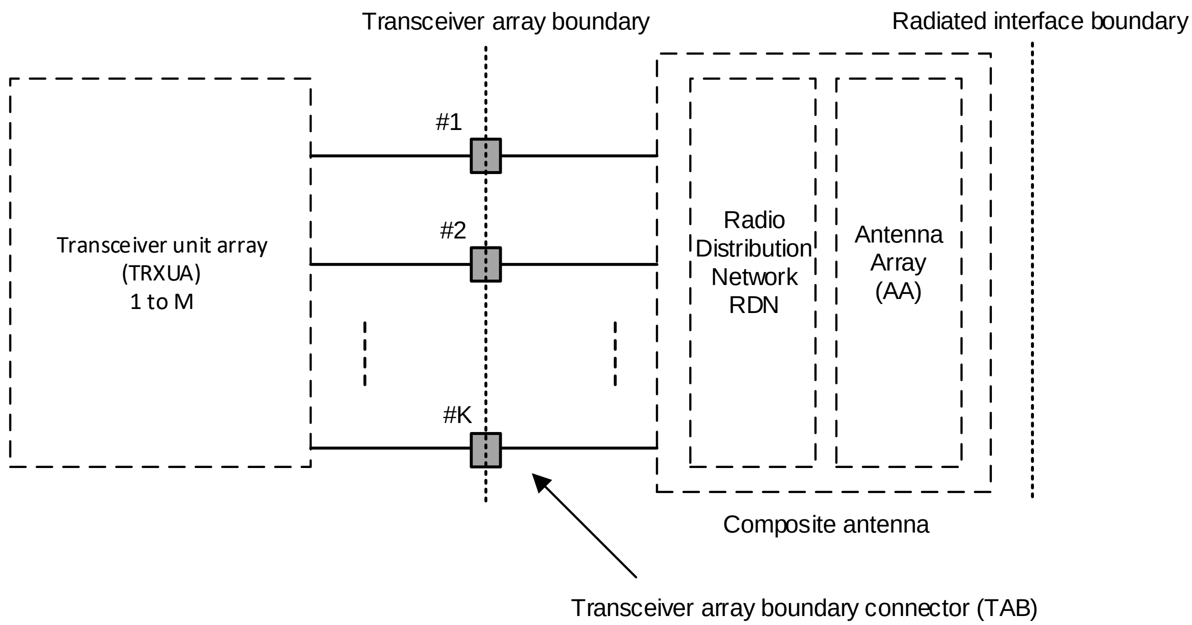


Figure 3: Radiated and conducted reference points for BS type 1-H [2]

2.2.4 BS classes (TS 38.104, chapter 4.4)

The specification distinguishes base station classes by BS type 1-O and 2-O and BS type 1-H.

Table 2: Base station classes - BS to UE minimum distance along the ground

Base station type	Name	Cell size	Minimum distance along the ground
BS type 1-O and BS type 2-O	Wide area	Macro cell	35 m
	Medium range	Micro cell	5 m
	Local area	Pico cell	2 m

Table 3: Base station classes - BS to UE minimum distance along the ground

Base station type	Name	Cell size	Minimum coupling loss
BS type 1-H	Wide area	Macro cell	70 dB
	Medium range	Micro cell	53 dB
	Local area	Pico cell	45 dB

2.3 5G NR frequency ranges

The frequency ranges in which 5G NR can operate according to Release 16 (V16.3.0) specifications are shown in Table 4.

Table 4: 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

For OTA base station receiver tests the following Rohde & Schwarz antenna test solutions can be used:

► R&S®TS8991 OTA Performance Test System with WPTC test chamber **(FR1, FR2)**

► R&S®ATS1800C CATR based 5G NR mmWave test chamber **(FR2)**

► R&S®PWC200 Plane wave converter (shielded in a WPTC test chamber, opt.) **(FR1)**

The following Rohde & Schwarz vector signal generator can be used for the tests described in this document:

► R&S®SMW200A

Furthermore, the **5G New Radio** software option is needed:

► R&S®SMW-K144

For test case OTA out-of-band blocking (7.6) an additional CW signal generator (up to 60 GHz) is required. The following is recommended:

► R&S®SMA100B

with frequency option

► R&S®SMAB-B167: Frequency range: 8KHz to 67 GHz

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

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

The OTA receiver spurious emissions test (7.7) requires a spectrum analyzer. The following ones are suitable:

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

- R&S R&S®TS8991 OTA performance test system is referred to as the **TS8991**
- R&S®ATS1800C CATR based 5G NR mmWave test chamber is referred to as the **ATS1800C**
- R&S®PWC200 Plane wave converter is referred to as the **PWC200**
- R&S®SMW200A vector signal generator is referred to as the **SMW**
- R&S®SMA100B signal generator is referred to as the **SMA100B**
- R&S®FSW spectrum analyzer is referred to as the **FSW**

2.5 Reference coordinate system

For radiated test setups a reference coordinate system is required. The reference coordinate system should be associated to an identifiable physical feature on the base station enclosure.

The reference coordinate system is created of a cartesian coordinate system with rectangular axis x,y,z and spherical angles θ, φ as showed in Figure 4.

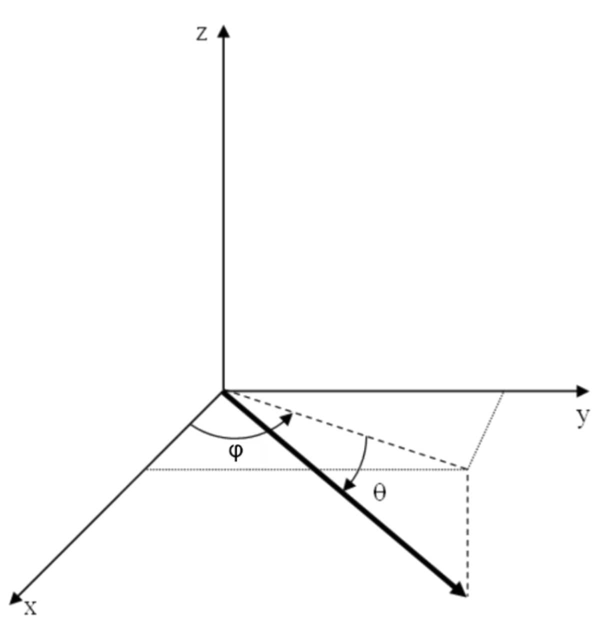


Figure 4: Reference coordinate system [2]

3 Basics about OTA testing

3.1 OTA Calibration

In order to carry out accurate measurements, the OTA system must be calibrated prior to perform the tests. For this purpose, the user defined frequency response correction options SMW-K544 and the FSW-K544 are used. More information about these software options can be found in [8] and [9].

The system loss (cable losses, antennas losses, OTA losses, etc.) is measured with a CW signal, which is swept over the frequency. For every frequency step the received power is measured and an attenuation table is created:

For further reading

► Rohde & Schwarz, Demystifying over-the-air (OTA) testing - White paper, 2019

► Demystifying 5G – System calibration basics for over-the-air (OTA) testing (video content)

► Demystifying 5G – Calibrating OTA test systems using gain transfer method (video content)

3.2 Equivalent isotropic sensitivity (EIS)

The EIS describes the sensitivity for an isotropic directivity device equivalent to the sensitivity of the DUT exposed to an incoming wave from a defined angle of arrival. [10]

In general, the EIS can be expressed as:

$$\mathrm{EIS}(\theta, \varphi) = \frac{\mathrm{P_S}}{\mathrm{G_{x,DUT}}(\theta, \varphi)}$$

Where $\mathrm{P_S}$ is the radiated sensitivity of the DUT´s receiver and $\mathrm{G_{x,DUT}}(\theta, \varphi)$ is the relative isotropic gain (in polarization x) of the DUT´s antenna. Radiated sensitivity corresponds to the minimum signal power at the radio receiver's input (antenna's output) required to meet the airlink's minimum performance criterion (typically expressed in terms of bit, block or frame error rate). [11]

3.2.1 OTA reference sensitivity ($EIS_{REFSENS}$)

The OTA reference sensitivity power level ($EIS_{REFSENS}$) is the minimum mean power received at the radiated interface (RIB) at which a reference performance requirement shall be met for a specified reference measurement channel. The test purpose is to verify that the BS can meet the minimum throughput requirement for a specified measurement channel at the $EIS_{REFSENS}$ level. [10]

For further reading

► 3GPP TR 37.941 [10]

► Test Plan for Wireless Device Over-the-Air Performance [11]

3.3 Effective isotropic radiated power (EIRP)

The EIRP denotes the absolute output power in a given direction. If no direction is defined, the direction of maximum radiation intensity is implied. The EIRP is the power an ideal isotropic radiator requires as input power to achieve the same power density in the given direction. EIRP is the power accepted by the antenna multiplied by the antenna gain, or radiated power multiplied by the directivity [12]:

$$\mathrm{EIRP} = \mathrm{P_{in}} \cdot \mathrm{G}$$

$$\mathrm{EIRP_{dBm}} = \mathrm{P_{in,dBm}} + \mathrm{G_{dBi}}$$

3.4 Total radiated power (TRP)

3.4.1 Theoretical background

The TRP or the radiated power is simply the total power radiated by a base station. It is defined as the radiation intensity at each angle in watts per steradian $I(\theta,\varphi)$ integrated over the whole sphere around the antenna:

The power radiated by the antenna (P_{rad}) is also called the total radiated power (P_{TRP}). It is defined as the radiant intensity $I(\theta,\varphi)$ integrated over the whole sphere around the antenna:

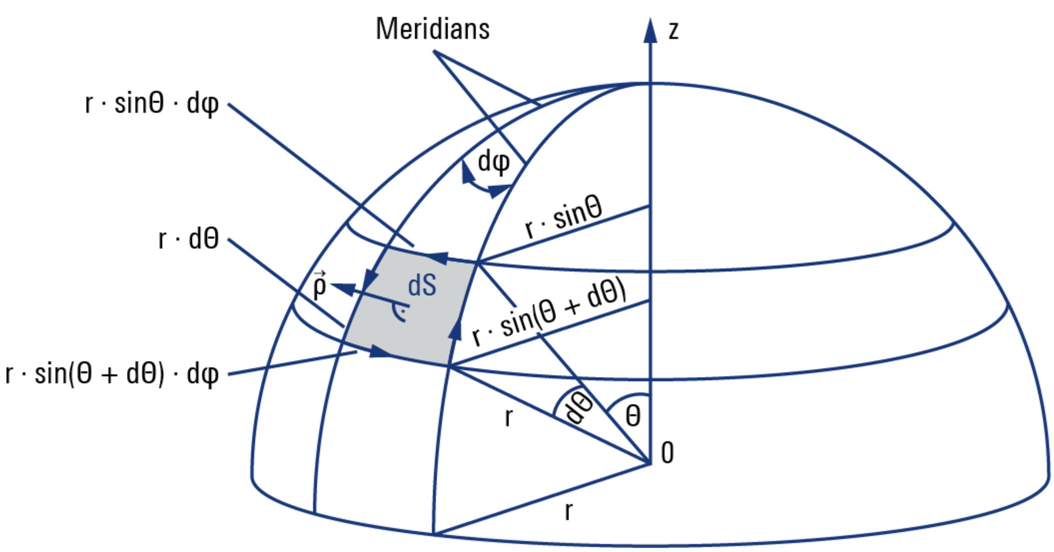


Figure 5: TRP integral

$$P_{TRP} = \int_{\varphi=0}^{2\pi} \int_{\theta=0}^{\pi} I(\theta,\varphi) \cdot \sin\theta \, d\theta d\varphi$$

In the far field the radiation intensity can be defined as:

$$I(\theta,\varphi) = \frac{EIRP(\theta,\varphi)}{4\pi}$$

With this definition of the radiation intensity it is possible to rewrite the TRP integral:

$$P_{TRP} = \frac{1}{4\pi} \int_{\varphi=0}^{2\pi} \int_{\theta=0}^{\pi} EIRP(\theta,\varphi) \cdot \sin\theta \, d\theta d\varphi$$

Even though these above equations are derived under far-field conditions (distance > Fraunhofer distance), they are also valid in closer distances due to energy conservation principle.

Fort further reading

- 3GPP TR 37.941 [10]
- On the shortest range length to measure the total radiated power
- Get ready for over-the-air (OTA) testing! [12]

3.4.2 TRP measurement grids

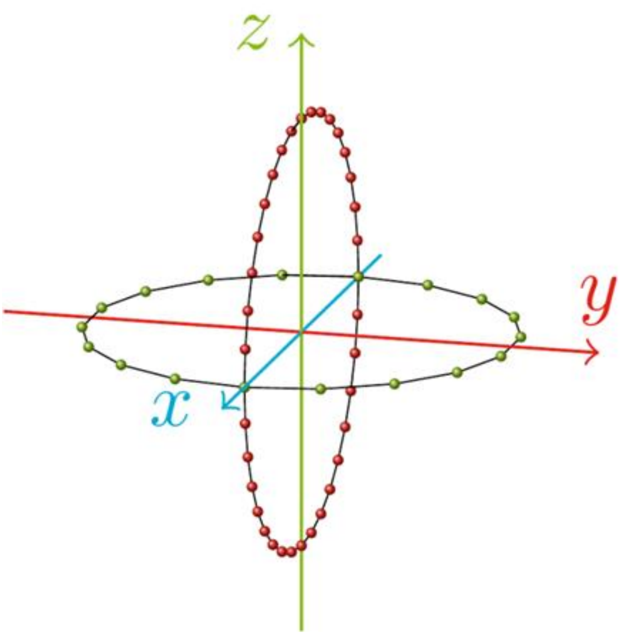


Figure 6: 2-cut grid [10]

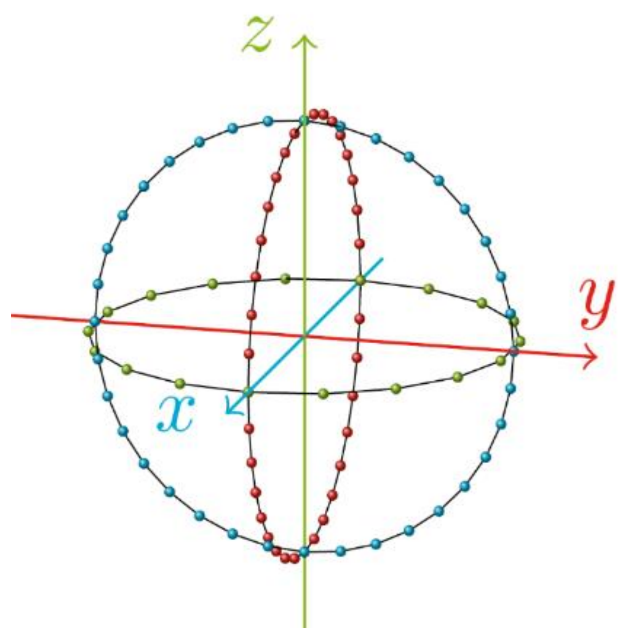


Figure 7: 3-cut grid [10]

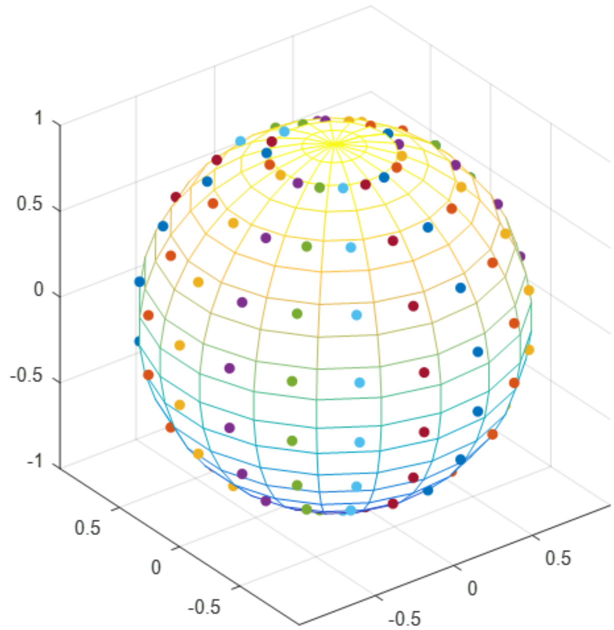


Figure 8: Equal angle grid [10]

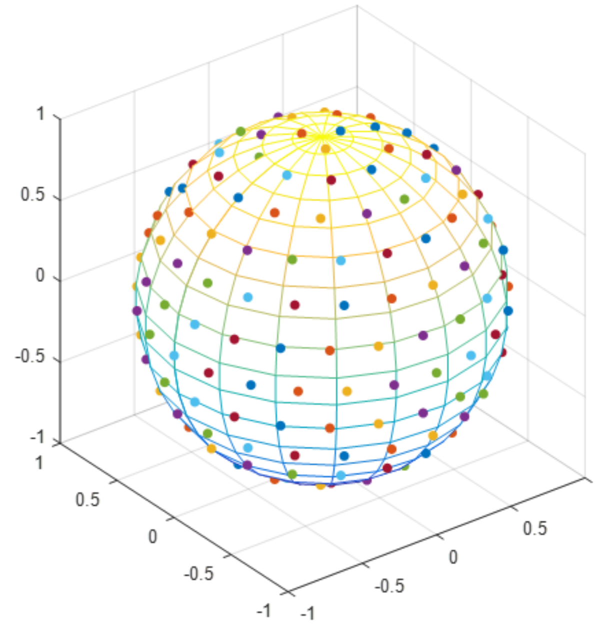


Figure 9: Equal area grid [10]

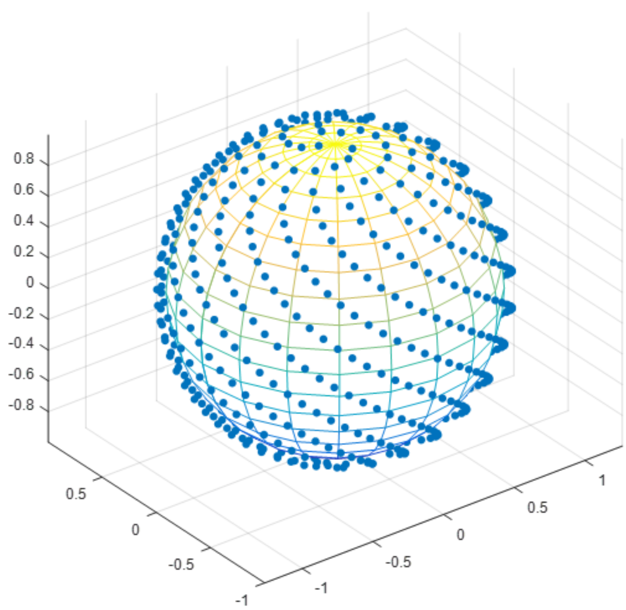


Figure 10: Fibonacci grid [10]

For further reading

► 3GPP TR 37.941 subsection 6.3.4 [10]

4 OTA antenna test solutions from R&S

It is important to know, that not all OTA base station conformance tests can be performed with all available OTA antenna test solutions. In OTA testing different types of test systems are distinguished. The following brief introduction provides an overview of the different R&S OTA antenna test solutions and how they can used for base station conformance tests in accordance with 3GPP TS 38.141-2 [2]. Rohde & Schwarz offers suitable solutions for OTA base station conformance tests. Our sales engineers will happily assist you:

► https://www.rohde-schwarz.com/service-sales-locator

Table 5 gives an overview which OTA antenna test solution is applicable to the specific 3GPP test case.

Table 5: Overview antenna test solutions

Chapter	Test	FR1		FR2	
		PWC200	**WPTC**	**ATS1800C**	**WPTC**
7.2	OTA sensitivity	✓	✓	✓	✓
7.3	OTA reference sensitivity level	✓	✓	✓	✓
7.4	OTA dynamic range	✓	✓	✓	✓
7.5.1	OTA adjacent channel selectivity	✓	✓	✓	✓
7.5.2	OTA in-band blocking	✓	✓	✓	✓
7.6	OTA out-of-band blocking	TBC	TBC	TBC	TBC
7.7	OTA receiver spurious emissions	×	TBC	TBC	TBC
7.8	OTA receiver intermodulation	✓	✓	✓	✓
7.9	OTA in-channel selectivity	✓	✓	✓	✓

✓: Applicable ×: Not applicable

4.1 WPTC indoor anechoic chambers (as part of R&S TS8991)

Rohde & Schwarz offers a turnkey over the air solution for antenna, cellular and non-cellular testing. In cooperation with Albatross Projects GmbH a broad range of standardized Wireless Performance Test Chambers (WPTC) in various dimensions are available. These offered test chambers belong to the category of indoor anechoic chambers or general chambers. When configuring a TS8991 OTA-Performance test system, the configurator gives the choice of different test chamber sizes.

The anechoic chamber for models XS to M have absorber linings to cover frequencies down to approx. 600 MHz while the larger L and XL models have larger absorbers that cover frequencies down to approximately 400 MHz. By default, the upper frequency of the WPTC-series is approximately 18 GHz, but could be increased if needed. For base station tests in FR2 this is mandatory.

It is possible to figure out static measurements as well as 3D pattern measurements with the conical cut positioner.

Table 6 and Figure 11 gives an overview about the different WPTC models. Due to the rather large dimensions of a base station antenna, the larger models are more suitable for the base station conformance tests. The Rohde & Schwarz sales engineers will assist with the selection of a suitable model:

► https://www.rohde-schwarz.com/service-sales-locator

Table 6: WPTC model overview

Model	Outer dimensions [m]	Typical range length [m]
WPTC-XS	2.43 x 2.40 x 2.43	> 0.65
WPTC-S	3.70 x 3.00 x 3.10	> 1.02
WPTC-M	4.60 x 3.45 x 3.70	> 1.30
WPTC-L	5.20 x 4.05 x 4.30	> 1.38
WPTC-XL	5.80 x 5.10 x 5.20	> 1.83

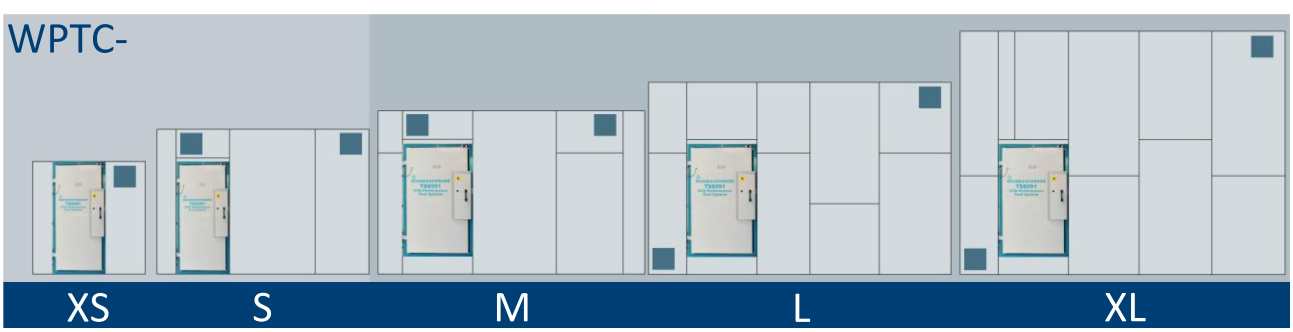


Figure 11: WPTC models

For further reading

► https://rohde-schwarz.com/product/ts8991

► https://www.rohde-schwarz.com/brochure-datasheet/ts8991/

4.2 R&S ATS1800C (CATR)

The R&S ATS1800C is a compact antenna test range (CATR) test system which was designed for 5G NR antennas, modules and devices (user equipment, UE) characterization throughout the entire development lifecycle, from R&D to conformance tests for both active and passive measurements (3D antenna gain patterns, ACLR, EVM, EiRP, TRP, EiS, etc.). The ATS1800C covers an in-band frequency range from 23.5 GHz to 44 GHz and an out-of-band frequency range from 6 GHz to 110 GHz. Therefore, this test chamber is perfectly suited for base station conformance tests in FR2.

The coordinate system used is as follows:

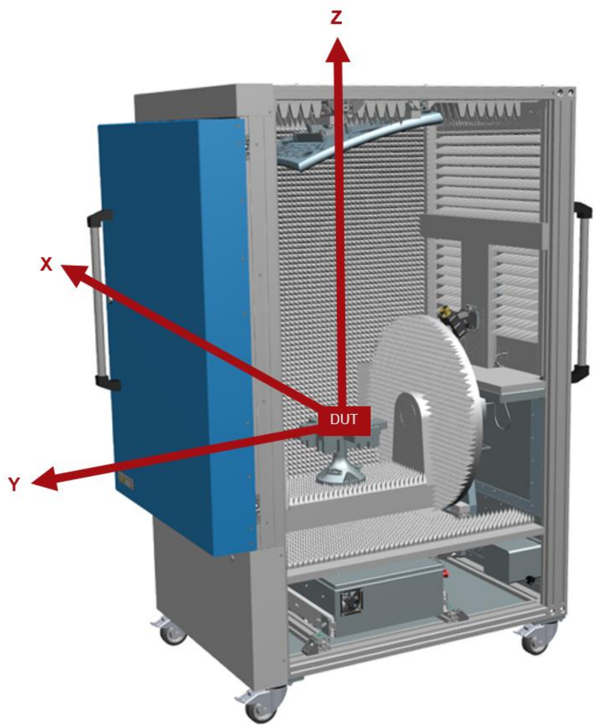


Figure 12: Coordinate system R&S®ATS1800C

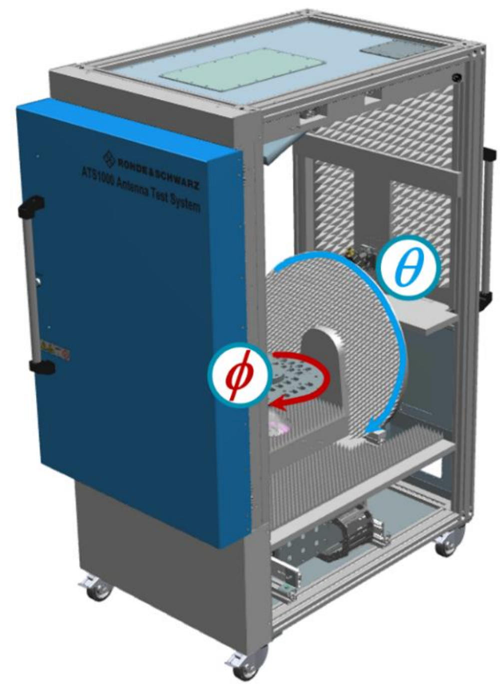


Figure 13: Coordinate system R&S®ATS1800C [13]

The ATS1800C provides RF feedthroughs (CATR-CSRF1: 1.85 mm (f), CATR-FEED2: 2 x 2.4 mm) for connecting the measurement devices that are located at the rear side of the chamber (see Figure 14).

Figure 14: Feedthroughs R&S®ATS1800C

In order to reduce path loss, keeping the measurement devices near to the feedthroughs by using short cables is highly recommended. Chapter 0 provides recommendations for suitable RF cables.

However, the quiet zone of this chamber measures around 30 cm x 30 cm and the DUT load capacity of the positioner is limited to 8 kg. In case of base station modules that exceed these restrictions please contact Rohde & Schwarz for a customized solution.

4.2.1 CATR principles in general

Inside the fully shielded chamber is the compact antenna test range (CATR) consisting of a feed antenna, a bidirectional parabolic reflector and a 3D positioner. The reflector has an extremely high precision surface roughness, which minimizes the errors introduced by the reflection. This allows the reflector to be used in a very wide frequency range for accurate measurement results. [14]

Figure 15: R&S®ATS1800C CATR [14]

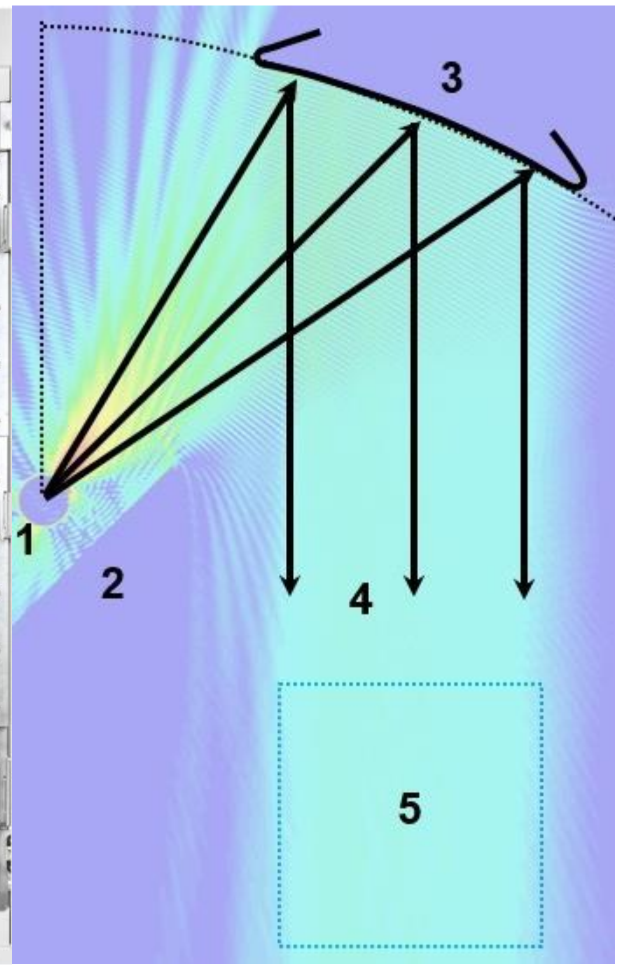


Figure 16: Wave propagation in the CATR setup [13]

1 = Feed antenna at focus of reflector
2 = Blocker to decouple feed from direct path to DUT
3 = Parabolic reflector with blended rolled edges
4 = Reflected plane wave
5 = Quiet zone for DUT

For further reading

► https://rohde-schwarz.com/product/ats1800c

► https://www.rohde-schwarz.com/brochure-datasheet/ats1800c/

4.3 R&S PWC200 Plane Wave Converter (PWC)

The R&S®PWC200, designed for 5G massive MIMO base station testing, offers instantaneous measurements of far-field characteristics at a tremendously reduced distance from the phased antenna array to the DUT. Among other things, this makes it perfectly suited for OTA base station conformance tests in FR1.

The PWC200 plane wave converter is a bidirectional array of 156 wideband Vivaldi antennas placed in the radiating near field of the device under test (DUT). The phased antenna array can form planar waves inside a specified quiet zone (e.g. 1m Ø) within the radiating near field of the 5G massive MIMO base station module for real-time radiated power, transmitter (EVM, ACLR, SEM, etc.) and receiver measurements.

Each antenna includes a phase shifter and attenuator path, allowing arbitrary synthesis of the electromagnetic field directly in front of the array at the spherical quiet zone enclosing the DUT. All signal paths are combined to a single port that can be connected to measurement equipment (e.g. spectrum analyzer). [15]

The R&S®PWC200 generates a 3D spherical quiet zone within a 1 m diameter sphere at a distance of 1.50 meters at a frequency of 3.5 GHz. In comparison, a direct far field measurement already requires a distance of 23.5 m.

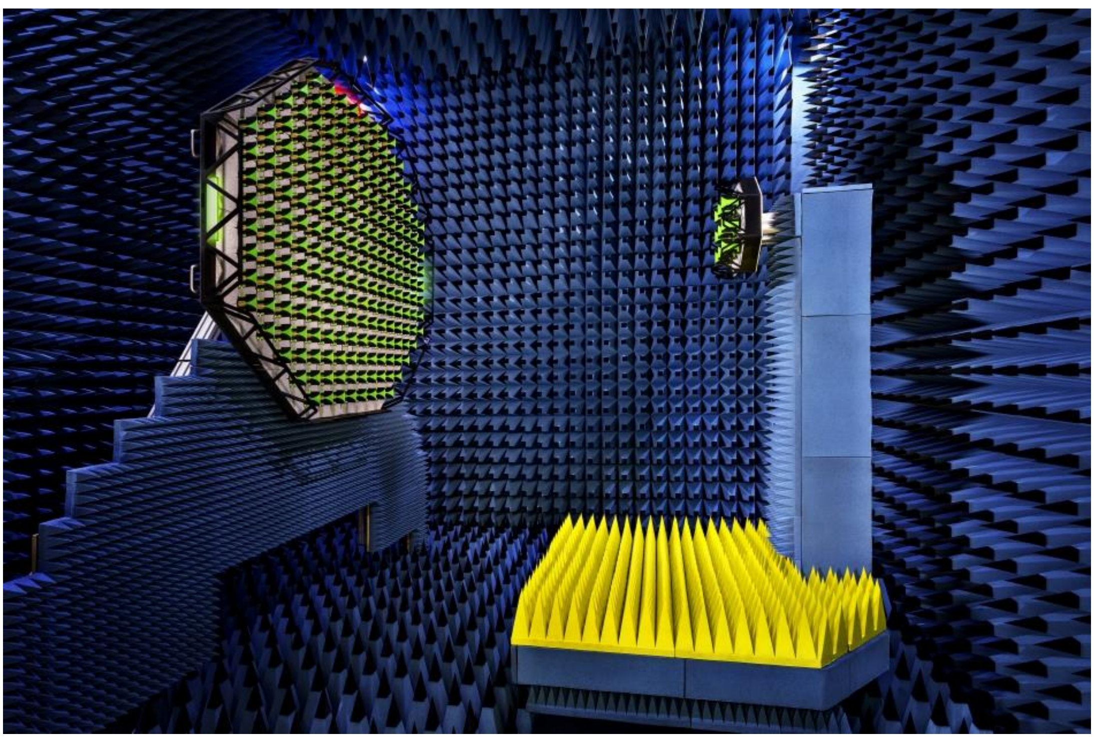


Figure 17: R&S® PWC200 equipped in anechoic test chamber

The R&S®PWC200 has to be shielded in a suitable wireless performance test chamber (e.g. WPTC, offered by Rohde & Schwarz).

For more details on this technology, refer to the EuCAP 2018 publication "Plane Wave Converter for 5G Massive MIMO Basestation Measurements".

For further reading

- https://rohde-schwarz.com/product/pwc200
- https://www.rohde-schwarz.com/brochure-datasheet/pwc200/
- EuCAP 2018 publication "Plane Wave Converter for 5G Massive MIMO Basestation Measurements"

5 Receiver Tests (Chapter 7)

Specification TS 38.141-2 [2] 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 describes single carrier (SC) tests under normal test environment (TE) 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 7 provides an overview of the basic parameters for the individual tests. The channels to be tested (B, M, T) are included.

Table 7: Rx basic parameters overview

Chapter	Test	TE	RFCh
7.2	OTA sensitivity	N	M
7.3	OTA reference sensitivity level	N	B, M, T
7.4	OTA dynamic range	N	M
7.5.1	OTA adjacent channel selectivity	N	M
7.5.2	OTA in-band blocking	N	M
7.6	OTA out-of-band blocking	N	M
7.7	OTA receiver spurious emissions	N	B/T
7.8	OTA receiver intermodulation	N	M
7.9	OTA in-channel selectivity	N	M

As of now, there are still several requirements not available or finalized in TS 38.141-2 (V16.3.0) yet, especially for base station type 1-H. Table 8 shows the requirements as officially published:

Table 8: Available requirements (TS 38.141-2, version 16.3.0)

Chapter	Requirement	Requirement set		
		BS type 1-H	**BS type 1-O**	**BS type 2-O**
7.2	OTA sensitivity	7.2	7.2	N/A
7.3	OTA reference sensitivity level	N/A	7.3	7.3
7.4	OTA dynamic range		7.4	N/A
7.5.1	OTA adjacent channel selectivity		7.5	7.5
7.5.2	OTA in-band blocking		7.5	7.5
7.6	OTA out-of-band blocking		7.6	7.6
7.7	OTA receiver spurious emissions		7.7	7.7
7.8	OTA receiver intermodulation		7.8	7.8
7.9	OTA in-channel selectivity		7.9	7.9

5.1 Requirements classification

Table 9: Classification of radiated receiver requirements [10]

Rx requirement	Description and discussion	Classification
OTA sensitivity	Based on the Rel-13 EIS requirement declaration over the OSDD, the OTA sensitivity is directional requirement by definition. Conformance testing for OTA sensitivity is performed for the five directions same as the Rel-13 AAS OTA sensitivity requirements. This requirement is not applicable for BS type 2-O.	Directional
OTA reference sensitivity level	Conformance testing for OTA reference sensitivity is performed for five directions declared by the manufacturer.	Directional
OTA dynamic range	It was agreed that the requirement assumes that the wanted signal and interfering signal come from the same direction. Testing is defined in the receiver target reference direction, meaning that this is directional requirement. This requirement is not applicable for BS type 2-O.	Directional
OTA in-band selectivity and blocking	The OTA blocking requirement is tested as follows: ► In the reference direction of the minSENS OSDD using the minSENS based requirement level ► In each of the 4 conformance direction at the extremities of the OTA REFSENS RoAoA using the REFSENS based requirement level.	Directional
OTA out-of-band blocking	Out of band blocking is a long test and hence it is optimum to minimize the number of conformance test directions. The antenna gain can be assumed to be maximum at the reference direction, therefore it is sufficient to show conformance at the reference direction only.	Directional, except for co-location requirement applicable for BS type 1-O
OTA receiver spurious emission	The Rx spurious emissions requirement follows the approach for the Tx spurious emissions, i.e. the emissions in the spurious region needs to be measured as TRP due to unknown radiation pattern.	TRP
OTA receiver intermodulation	Since Rx sensitivity and blocking already test at all conformance directions, it is sufficient to test Rx intermodulation only in a single direction.	Directional
OTA in-channel selectivity	In channel selectivity requirement is tested in a single direction.	Directional

5.2 General information about requirements

Unless otherwise stated, the following arrangements apply for radiated receiver characteristics requirements [2]:

- Requirements apply during the base station receive period
- Requirements shall be met for any transmitter setting
- For FDD operation the requirements shall be met with the transmitter unit(s) ON
- Throughput requirements defined for the radiated receiver characteristics do not assume HARQ retransmissions
- For ACS, blocking and intermodulation characteristics, the negative offsets of the interfering signal apply relative to the lower base station RF bandwidth edge or sub-block edge inside a sub-block gap, and the positive offsets of the interfering signal apply relative to the upper base station RF bandwidth edge or sub-block edge inside a sub-block gap.

For FR1 requirements which are to be met over the OTA REFSENS RoAoA absolute requirement values are offset by the following term:

$\Delta_{\mathrm{OTAREFSENS}} = 44.1 - 10 \cdot \log_{10}(\mathrm{BeW}_{\theta,\mathrm{REFSENS}} \cdot \mathrm{BeW}_{\varphi,\mathrm{REFSENS}})$ (for reference direction)

and

$\Delta_{\mathrm{OTAREFSENS}} = 41.1 - 10 \cdot \log_{10}(\mathrm{BeW}_{\theta,\mathrm{REFSENS}} \cdot \mathrm{BeW}_{\varphi,\mathrm{REFSENS}})$ (for all other directions)

For requirements which are to be met over the minSENS RoAoA absolute requirement values are offset by the following term:

$\Delta_{\mathrm{minSENS}} = \mathrm{P}_{\mathrm{REFSENS}} - \mathrm{EIS}_{\mathrm{minSENS}}$

For FR2 requirements which are to be met over the OTA REFSENS RoAoA absolute requirement values are offset by the following term:

$\Delta_{\mathrm{FR2\_REFSENS}} = -3\ \mathrm{dB}$ (for the reference direction)

$\Delta_{\mathrm{FR2\_REFSENS}} = 0\ \mathrm{dB}$ (for all other directions)

5.3 OTA sensitivity (7.2)

The OTA sensitivity requirement is based upon the declaration of one or more OTA sensitivity direction declarations (OSDD). The test purpose is to verify that the BS can meet the throughput requirement for a specified measurement channel at the EIS level and the range of angles of arrival declared in the OSDD.

This test is not applicable for BS type 2-O. For BS type 2-O the OTA sensitivity is the same as the OTA reference sensitivity in subclause 5.4.

For each measured carrier, the throughput measured shall be ≥ 95 % of the maximum throughput of the reference measurement channel with parameters specified in Table 10. [2]

Table 10: Test requirements for BS type 1-H and BS type 1-O; EIS levels [2]

BS channel bandwidth (MHz)	SCS (kHz)	Reference measurement channel	EIS level (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	Declared minimum EIS + 1.3	Declared minimum EIS + 1.4	Declared minimum EIS + 1.6
10, 15	30	G-FR1-A1-2			
10, 15	60	G-FR1-A1-3			
20, 25, 30, 40, 50	15	G-FR1-A1-4			
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5			
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6			

Test setup

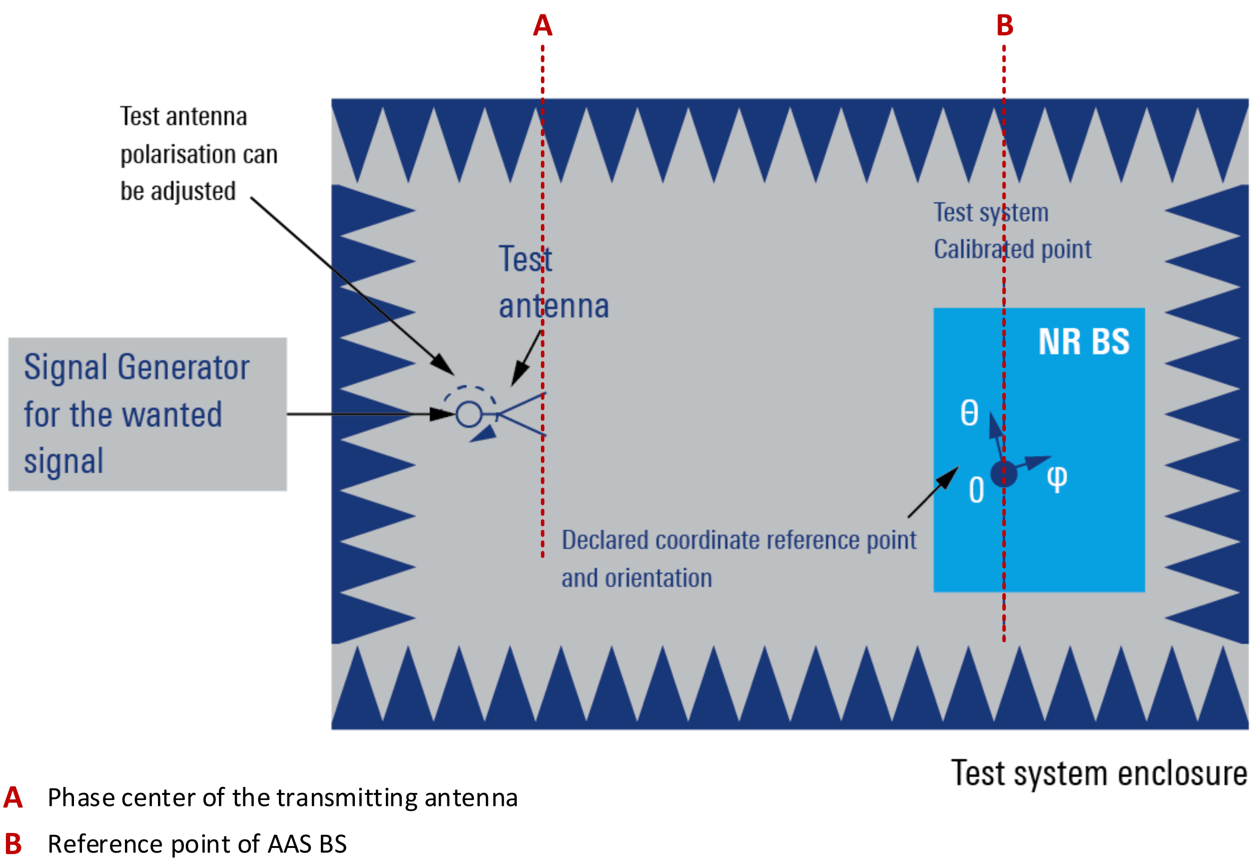


Figure 18: Test setup OTA sensitivity

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested (all the power from the test antenna is captured by the BS)
3. Configure beam peak direction according to the declared reference beam direction pair
4. Set the BS to transmit beams of the same operational band as the OSDD being tested
5. Set the SMW to transmit a 5G NR test signal according to Table 10
6. Measure the throughput for each supported polarization

Repeat steps 3) to 9) for all OSDD(s) declared for the BS and supported polarizations

5.4 OTA reference sensitivity level (7.3)

The OTA reference sensitivity (REFSENS) requirement is a directional requirement and is intended to ensure the minimum OTA reference sensitivity level for a declared OTA REFSENS RoAoA. The OTA reference sensitivity power level $EIS_{REFSENS}$ is the minimum mean power received at the RIB at which a reference performance requirement shall be met for a specified reference measurement channel.

The OTA REFSENS EIS level declaration shall apply to all supported polarizations, under the assumption of polarization match.

The test purpose is to verify that the BS can meet the throughput requirement for a specified measurement channel at the $EIS_{REFSENS}$ level and the range of angles of arrival within the OTA REFSENS RoAoA.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel. [2]

Table 11: Test requirements for BS type 1-O; Wide Area BS $EIS_{REFSENS}$ levels

BS channel bandwidth (MHz)	SCS (kHz)	Reference measurement channel	$EIS_{REFSENS}$ (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	$-100.4 - \Delta_{OTAREFSENS}$	$-100.3 - \Delta_{OTAREFSENS}$	$-100.1 - \Delta_{OTAREFSENS}$
10, 15	30	G-FR1-A1-2	$-100.5 - \Delta_{OTAREFSENS}$	$-100.4 - \Delta_{OTAREFSENS}$	$-100.2 - \Delta_{OTAREFSENS}$
10, 15	60	G-FR1-A1-3	$-97.6 - \Delta_{OTAREFSENS}$	$-97.5 - \Delta_{OTAREFSENS}$	$-97.3 - \Delta_{OTAREFSENS}$
20, 25, 30, 40, 50	15	G-FR1-A1-4	$-94 - \Delta_{OTAREFSENS}$	$-93.9 - \Delta_{OTAREFSENS}$	$-93.7 - \Delta_{OTAREFSENS}$
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	$-94.3 - \Delta_{OTAREFSENS}$	$-94.2 - \Delta_{OTAREFSENS}$	$-94 - \Delta_{OTAREFSENS}$
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	$-94.4 - \Delta_{OTAREFSENS}$	$-94.3 - \Delta_{OTAREFSENS}$	$-94.1 - \Delta_{OTAREFSENS}$

Table 12: Test requirements for BS type 1-O; Medium range BS $EIS_{REFSENS}$ levels

BS channel bandwidth (MHz)	SCS (kHz)	Reference measurement channel	$EIS_{REFSENS}$ (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	-95.4 – $\Delta_{OTAREFSENS}$	-95.3 – $\Delta_{OTAREFSENS}$	-95.1 – $\Delta_{OTAREFSENS}$
10, 15	30	G-FR1-A1-2	-95.5 – $\Delta_{OTAREFSENS}$	-95.4 – $\Delta_{OTAREFSENS}$	-95.2 – $\Delta_{OTAREFSENS}$
10, 15	60	G-FR1-A1-3	-92.6 – $\Delta_{OTAREFSENS}$	-92.5 – $\Delta_{OTAREFSENS}$	-92.3 – $\Delta_{OTAREFSENS}$
20, 25, 30, 40, 50	15	G-FR1-A1-4	-89 – $\Delta_{OTAREFSENS}$	-88.9 – $\Delta_{OTAREFSENS}$	-88.7 – $\Delta_{OTAREFSENS}$
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-89.3 – $\Delta_{OTAREFSENS}$	-89.2 – $\Delta_{OTAREFSENS}$	-89 – $\Delta_{OTAREFSENS}$
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-89.4 – $\Delta_{OTAREFSENS}$	-89.3 – $\Delta_{OTAREFSENS}$	-89.1 – $\Delta_{OTAREFSENS}$

Table 13: Test requirements for BS type 1-O; Local area BS $EIS_{REFSENS}$ levels

BS channel bandwidth (MHz)	SCS (kHz)	Reference measurement channel	$EIS_{REFSENS}$ (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	-92.4 – $\Delta_{OTAREFSENS}$	-92.3 – $\Delta_{OTAREFSENS}$	-92.1 – $\Delta_{OTAREFSENS}$
10, 15	30	G-FR1-A1-2	-92.5 – $\Delta_{OTAREFSENS}$	-92.4 – $\Delta_{OTAREFSENS}$	-92.2 – $\Delta_{OTAREFSENS}$
10, 15	60	G-FR1-A1-3	-89.6 – $\Delta_{OTAREFSENS}$	-89.5 – $\Delta_{OTAREFSENS}$	-89.3 – $\Delta_{OTAREFSENS}$
20, 25, 30, 40, 50	15	G-FR1-A1-4	-86 – $\Delta_{OTAREFSENS}$	-85.9 – $\Delta_{OTAREFSENS}$	-85.7 – $\Delta_{OTAREFSENS}$
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-86.3 – $\Delta_{OTAREFSENS}$	-86.2 – $\Delta_{OTAREFSENS}$	-86 – $\Delta_{OTAREFSENS}$
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-86.4 – $\Delta_{OTAREFSENS}$	-86.3 – $\Delta_{OTAREFSENS}$	-86.1 – $\Delta_{OTAREFSENS}$

Table 14: Test requirements for BS type 2-O; BS $EIS_{REFSENS}$ levels

BS channel bandwidth (MHz)	SCS (kHz)	Reference measurement channel	$EIS_{REFSENS}$ (dBm)
50, 100, 200	60	G-FR2-A1-1	$EIS_{REFSENS\_50M}$ + 2.4 + $\Delta_{FR2\_REFSENS}$
50	120	G-FR2-A1-2	$EIS_{REFSENS\_50M}$ + 2.4 + $\Delta_{FR2\_REFSENS}$
100, 200, 400	120	G-FR2-A1-3	$EIS_{REFSENS\_50M}$ + 3 + 2.4 + $\Delta_{FR2\_REFSENS}$

Table 15: $EIS_{REFSENS\_50M}$ value range

BS class	$EIS_{REFSENS\_50M}$ value range
Wide are BS	-119 dBm ≤ $EIS_{REFSENS\_50M}$ ≤ -96 dBm
Medium range BS	-114 dBm ≤ $EIS_{REFSENS\_50M}$ ≤ -91 dBm
Local area BS	-109 dBm ≤ $EIS_{REFSENS\_50M}$ ≤ -86 dBm

Test setup

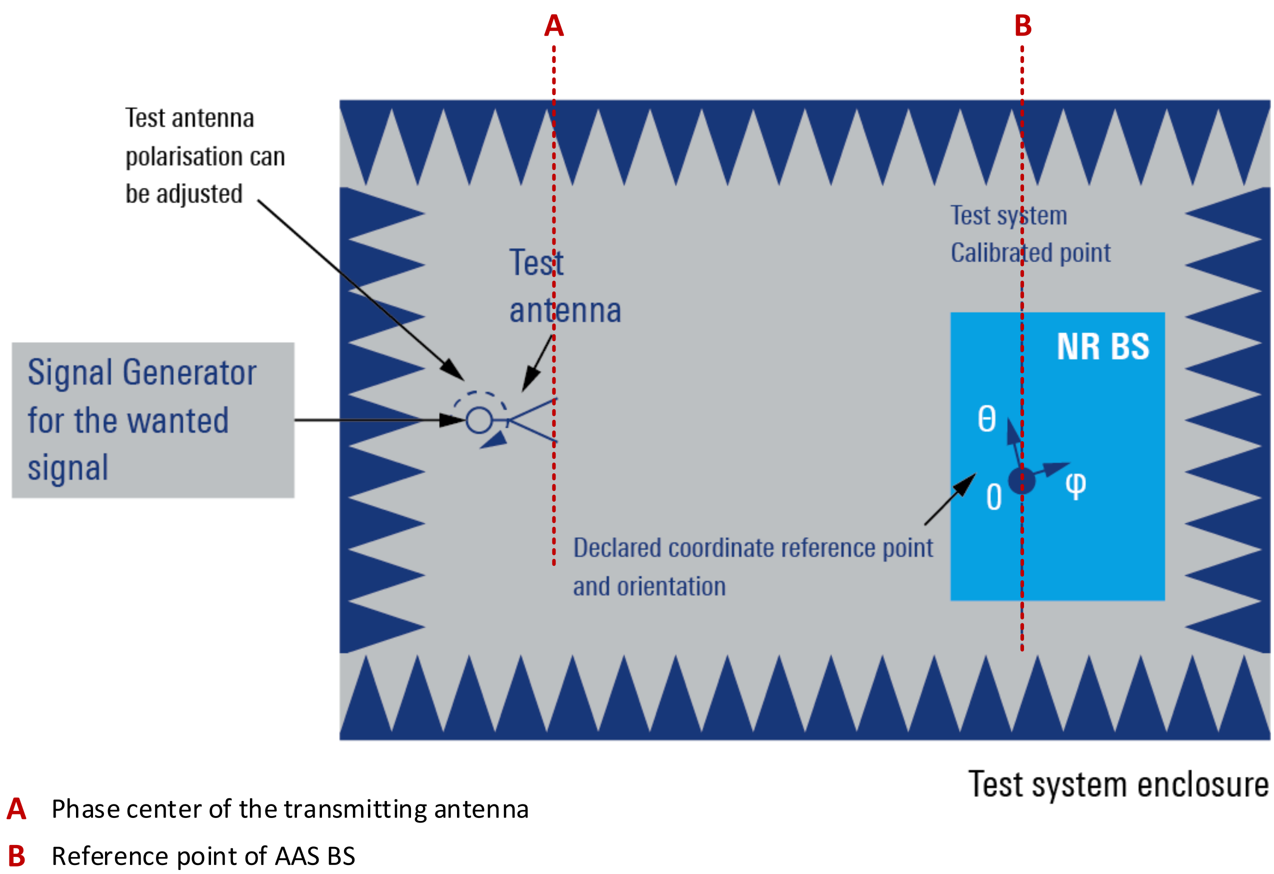


Figure 19: Measurement setup for OTA reference sensitivity level

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested (all the power from the test antenna is captured by the BS)
3. Configure beam peak direction according to the declared reference beam direction pair
4. Set the BS to transmit beams of the same operational band as the OTA REFSENS RoAoA being tested
5. Set the SMW to transmit a 5G NR test signal according to Table 11 to Table 14
6. Measure the throughput for each supported polarization

Repeat steps 3) to 9) for all OSDD(s) declared for the BS and supported polarizations

5.5 OTA dynamic range (7.4)

The OTA dynamic range is a measure of the capability of the receiver unit to receive a wanted signal in the presence of an interfering signal inside the received BS channel bandwidth. The requirement shall apply at the RIB when the AoA of the incident wave of a received signal and the interfering signal are from the same direction and are within the OTA REFSENS RoAoA. The test purpose is to verify that at the BS receiver dynamic range, the relative throughput shall fulfil the specified limit. [2]

The interfering signal is an AWGN signal.

The test requirements can be found in A.1 (at this moment test requirement for BS type 2-O is missing in the specification). For each measured carrier, the measured throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channel. [2]

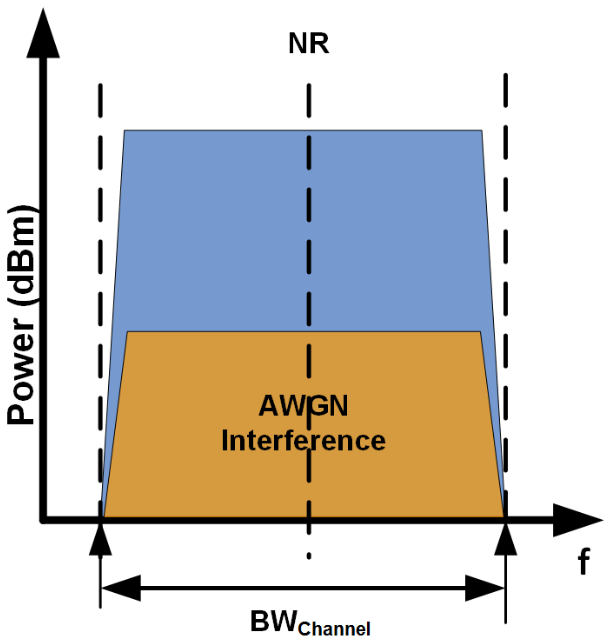


Figure 20: AWGN interfering signal inside the BS channel bandwidth

Test setup

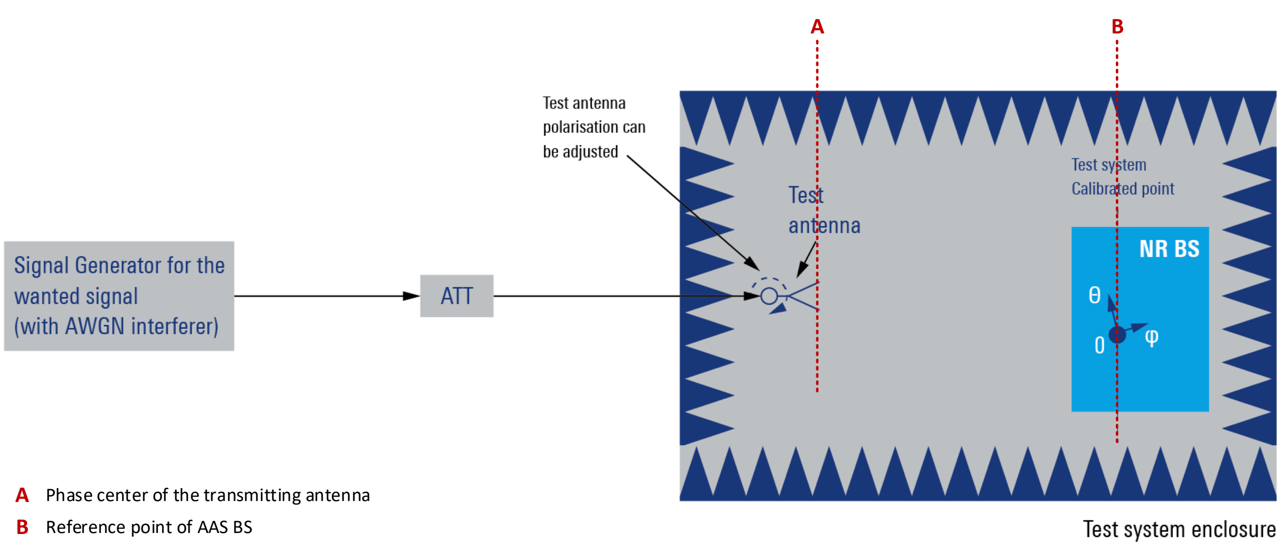


Figure 21: Measurement setup for OTA dynamic range

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested (all the power from the test antenna is captured by the BS)
3. Configure beam peak direction according to the declared reference beam direction pair
4. Set the BS to transmit beams of the same operational band as the OTA REFSENS RoAoA being tested
5. Set the SMW to transmit the test signal (with AWGN interferer in the same channel)
   a) Set the SMW to transmit the 5G NR signal according to Table 44 to Table 46
   b) Set the AWGN frequency at the same frequency as the NR signal with power settings according to Table 44 to Table 46
6. Measure the throughput for each supported polarization

5.6 OTA in-band selectivity and blocking (7.5)

This part demonstrates tests with in-band interferers.

5.6.1 OTA adjacent channel selectivity (7.5.1)

OTA adjacent channel selectivity (ACS) is a measure of the receiver's ability to receive an OTA wanted signal at its assigned channel frequency in the presence of an OTA adjacent channel signal with a specified center frequency offset of the interfering signal to the band edge of a victim system. The wanted and interfering signals apply to all supported polarizations, under the assumption of polarization match. The test purpose is to verify the ability of the BS receiver filter to suppress interfering signals in the channels adjacent to the wanted channel.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel. [2]

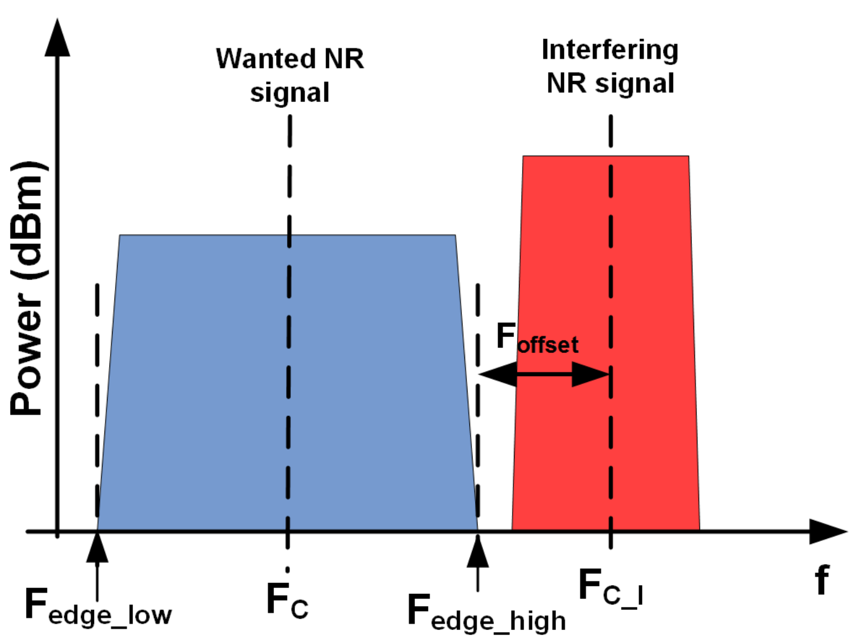


Figure 22: Wanted and interfering signal

Table 16: OTA ACS requirement for BS type 1-O

BS channel bandwidth of the lowest/highest carrier received (MHz)	Wanted signal mean power (dBm)			Interfering signal mean power (dBm)
	f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz	
5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100	$EIS_{minSENS}$ + 6 dB			Wide Area: -52 – $\Delta_{minSENS}$ Medium Range: -47 – $\Delta_{minSENS}$ Local Area: -44 – $\Delta_{minSENS}$

Note: $EIS_{minSENS}$ is specified in TS 38.104 [4].

Table 17: OTA ACS interferer frequency offset for BS type 1-O

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	5MHz DFT-s-OFDM NR signal, 15kHz SCS, 25 RBs
10	±2.5075	
15	±2.5125	
20	±2.5025	
25	±9.4675	20MHz DFT-s-OFDM NR signal, 15kHz 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	

Table 18: OTA ACS requirement for BS 2-O

BS channel bandwidth of the lowest/highest carrier received (MHz)	Wanted signal mean power (dBm)		Interfering signal mean power (dBm)
	24.24 GHz < f ≤ 33.4 GHz	37 GHz < f ≤ 52.6 GHz	
50, 100, 200, 400	$EIS_{REFSENS}$ + 6 dB	$EIS_{REFSENS}$ + 6 dB	$EIS_{REFSENS\_50M}$ + 27.7 + $\Delta_{FR2\_REFSENS}$ (Note 1) $EIS_{REFSENS\_50M}$ + 26.7 + $\Delta_{FR2\_REFSENS}$ (Note 2)

Note 1: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz

Note 2: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz

Table 19: OTA ACS interferer frequency offset for BS type 2-O

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
50	±24.29	50MHz DFT-s-OFDM NR signal, 60 kHz SCS, 64 RBs
100	±24.31	
200	±24.29	
400	±24.31	

Test setup

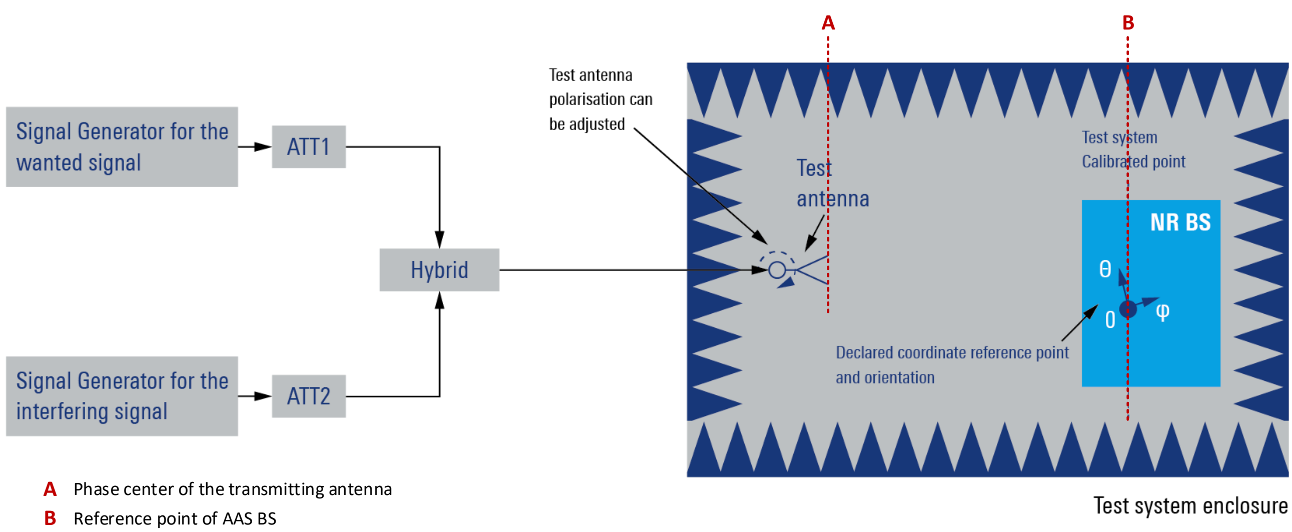


Figure 23: Measurement setup for OTA adjacent channel selectivity

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested (wanted signal and interferer signal is polarization matched with the test antenna)
3. Configure beam peak direction according to the declared reference beam direction pair
4. Set the BS to transmit beams of the same operational band as the OSDD or OTA REFSENS RoAoA being tested
5. SMW settings (use a hybrid combiner to sum all signals)
   c) Path A (wanted signal): Transmit signal according to Table 16 and Table 18
   d) Path B (interfering signal): Transmit signal at the adjacent channel frequency of the wanted signal according to Table 17 and Table 19
6. Measure throughput for each supported polarization

5.6.2 OTA in-band blocking (7.5.2)

The OTA in-band blocking test consists of two tests.

5.6.2.1 General blocking

In in-band blocking tests, the NR interfering signal center frequency is swept with a step size of 1 MHz starting from the minimum offset to the channel edge of the wanted signals.

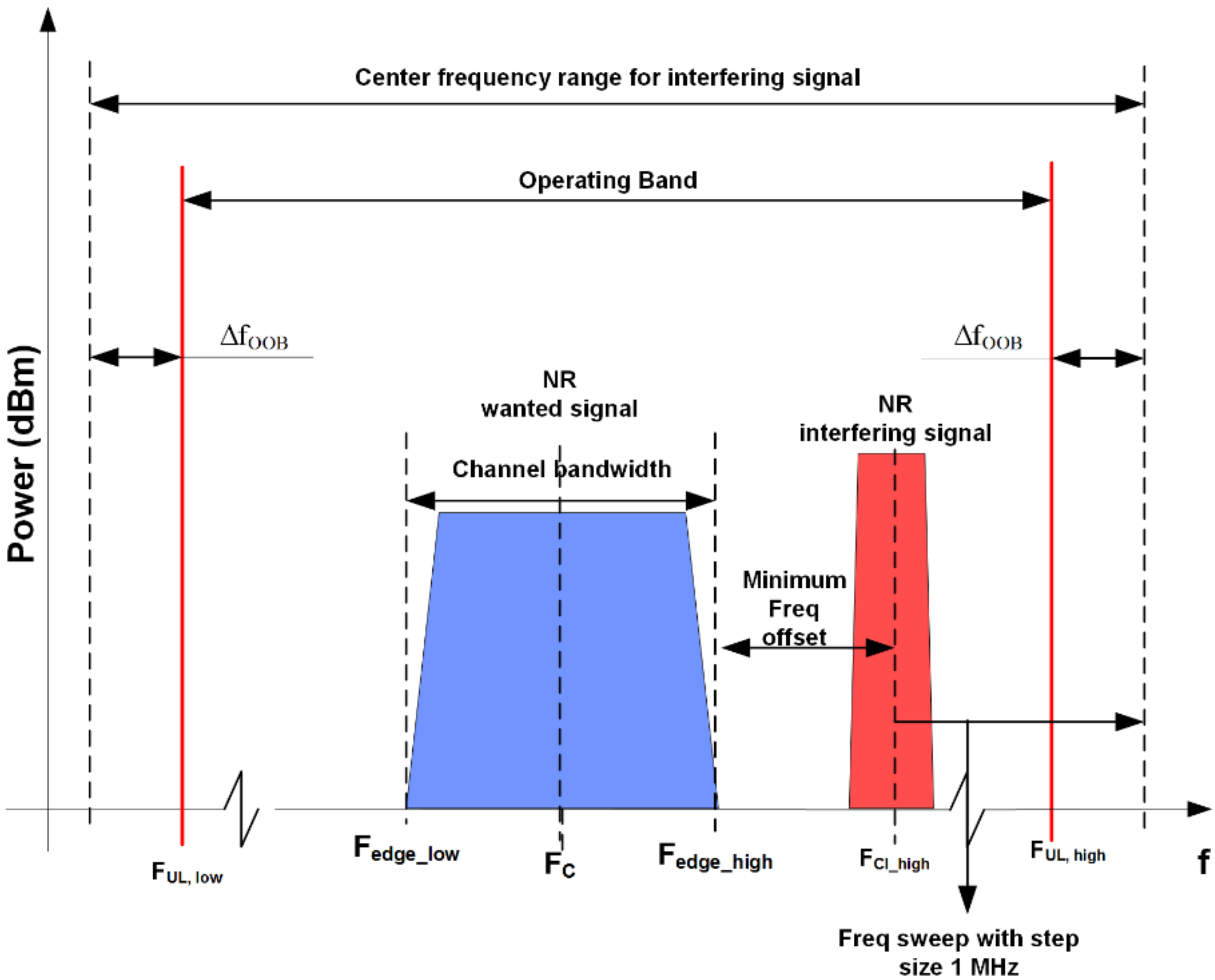


Figure 24: General in-band blocking

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel.

For BS type 1-O the OTA in-band blocking requirement shall apply in the in-band blocking frequency range, which is defined within frequency range from F_{UL_low} - Δf_{OOB} to F_{UL_high} + Δf_{OOB}, excluding the downlink frequency range of the FDD operating band, where the Δf_{OOB} for BS type 1-O is defined in Table 20.

Table 20: Δf_{OOB} offset for NR operating bands in FR1

BS type	Operating band characteristics	Δf_{OOB} (MHz)
BS type 1-O	$F_{UL\_high} - F_{UL\_low} < 100$ MHz	20
	100 MHz $\leq F_{UL\_high} - F_{UL\_low} \leq$ 900 MHz	60

For BS type 2-O the OTA blocking requirement shall apply in the in-band blocking frequency range, which is defined within frequency range from F_{UL_low} - Δf_{OOB} to F_{UL_high} + Δf_{OOB}, where the Δf_{OOB} for BS type 2-O is defined in Table 21.

Table 21: Δf_{OOB} offset for NR operating bands in FR2

BS type	Operating band characteristics	Δf_{OOB} (MHz)
BS type 2-O	F_{UL_high} – F_{UL_low} ≤ 3250 MHz	1500

Table 22: General OTA blocking requirement for BS type 1-O

BS channel bandwidth of the lowest/ highest carrier received (MHz)	Wanted signal mean power (dBm)			Interfering signal mean power (dBm)	Interfering signal center frequency min. offset from the lower/upper BS RF bandwidth edge or sub-block edge inside a sub-block gap (MHz)	Type of interfering signal
	f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz			
5, 10, 15, 20	$EIS_{REFSENS}$ + 6 dB			Wide Area: -43 - $\Delta_{OTAREFSENS}$ Medium Range: -38 - $\Delta_{OTAREFSENS}$ Local Area: -35 - $\Delta_{OTAREFSENS}$	±7.5	5 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 25 RBs
	$EIS_{minSENS}$ + 6 dB			Wide Area: -43 - $\Delta_{minSENS}$ Medium Range: -38 - $\Delta_{minSENS}$ Local Area: -35 - $\Delta_{minSENS}$		
25 ,30, 40, 50, 60, 70, 80, 90, 100	$EIS_{REFSENS}$ + 6 dB			Wide Area: -43 - $\Delta_{OTAREFSENS}$ Medium Range: -38 - $\Delta_{OTAREFSENS}$ Local Area: -35 - $\Delta_{OTAREFSENS}$	±30	20 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 100 RBs
	$EIS_{minSENS}$ + 6 dB			Wide Area: -43 - $\Delta_{minSENS}$ Medium Range: -38 - $\Delta_{minSENS}$ Local Area: -35 - $\Delta_{minSENS}$		

Table 23: General OTA blocking requirement for BS type 2-O

BS channel bandwidth of the lowest/highest carrier received (MHz)	OTA wanted signal mean power (dBm)		OTA interfering signal mean power (dBm)	OTA interfering signal center frequency offset from the lower/upper BS RF bandwidth edge or sub-block edge inside a sub-block gap (MHz)	Type of OTA interfering signal
	24.24 GHz < f ≤ 33.4 GHz	37 GHz < f ≤ 52.6 GHz			
50, 100, 200, 400	$EIS_{REFSENS}$ + 6 dB	$EIS_{REFSENS}$ + 6 dB	$EIS_{REFSENS\_50M}$ + 33 + $\Delta_{FR2\_REFSENS}$ dB	±75	50 MHz DFT-s-OFDM NR signal, 60 kHz SCS, 64 RBs

Test setup

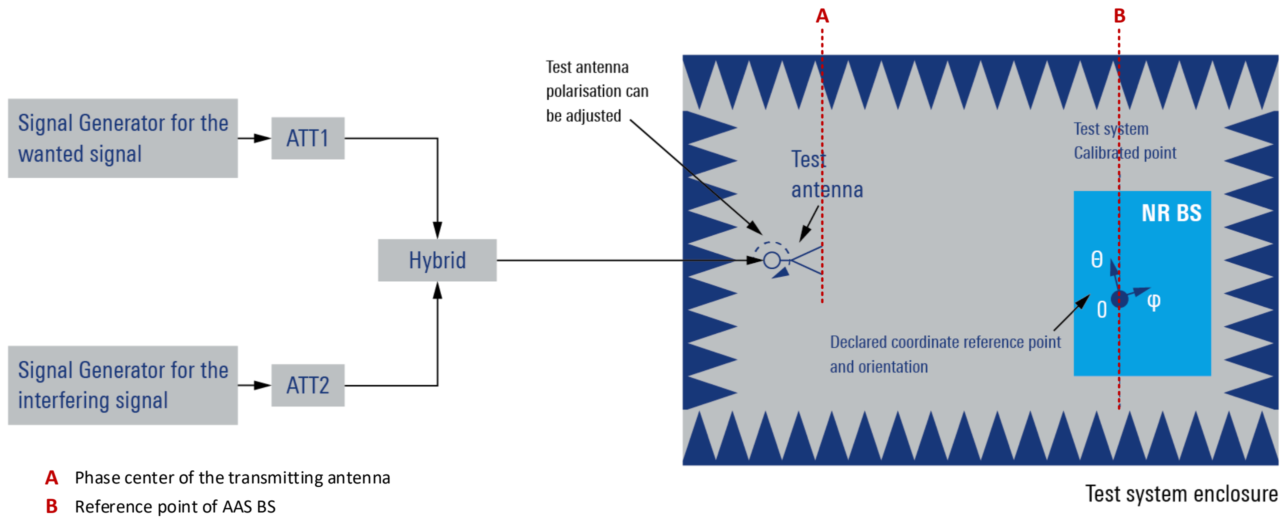


Figure 25: Measurement setup for general OTA blocking

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested (wanted signal and interferer signal is polarization matched with the test antenna)
3. Configure beam peak direction according to the declared reference beam direction pair
4. Set the BS to transmit beam(s) of the same operational band as the OSDD or OTA REFSENS RoAoA being tested
5. SMW settings (use a hybrid combiner to sum all signals)
   a) Path A (wanted signal): Transmit signal according to Table 22 and Table 23
   b) Path B (interfering signal): Set frequency offset from the wanted signal according to Table 22 and Table 23
   Note: Interfering signal shall be swept with a step size of 1 MHz starting from the minimum offset to the channel edges of the wanted signals.
6. Measure throughput for each supported polarization

Repeat steps 2) to 6) for all specified measurement directions

5.6.2.2 Narrowband blocking

The interferer is placed near the wanted signal. This test is available for BS type 1-O only.

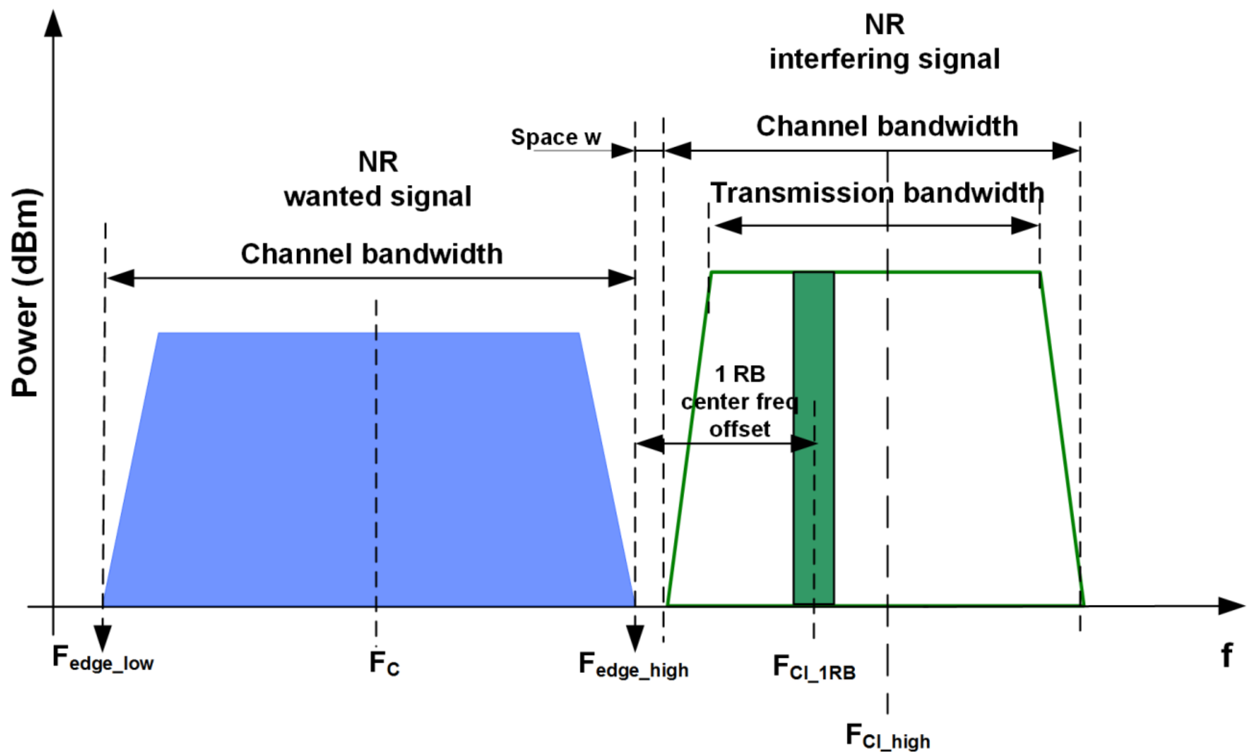


Figure 26: Narrowband blocking

Table 24: OTA narrowband blocking requirement for BS type 1-O

BS channel bandwidth of the lowest/highest carrier received (MHz)	OTA wanted signal mean power (dBm)			OTA Interfering signal mean power (dBm)
	f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz	
5, 10, 15, 20	$EIS_{REFSENS}$ + 6 dB			Wide Area: -49 - $\Delta_{OTAREFSENS}$ Medium Range: -44 - $\Delta_{OTAREFSENS}$ Local Area: -41 - $\Delta_{OTAREFSENS}$
	$EIS_{minSENS}$ + 6 dB			Wide Area: -49 - $\Delta_{minSENS}$ Medium Range: -44 - $\Delta_{minSENS}$ Local Area: -41 - $\Delta_{minSENS}$
25, 30, 40, 50, 60, 70, 80, 90, 100	$EIS_{REFSENS}$ + 6 dB			Wide Area: -49 - $\Delta_{OTAREFSENS}$ Medium Range: -44 - $\Delta_{OTAREFSENS}$ Local Area: -41 - $\Delta_{OTAREFSENS}$
	$EIS_{minSENS}$ + 6 dB			Wide Area: -49 - $\Delta_{minSENS}$ Medium Range: -44 - $\Delta_{minSENS}$ Local Area: -41 - $\Delta_{minSENS}$

Table 25: OTA narrowband blocking interferer frequency offsets from BS type 1-O

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering RB center frequency offset to the lower/upper base station RF bandwidth edge or sub-block edge inside a sub-block gap (kHz)	Type of interfering signal
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
10	±(355 + m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
15	±(360 + m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
20	±(350 + m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
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
30	±(570 + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
40	±(565 + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
50	±(560 + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
60	±(570 + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
70	±(565 + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
80	±(560 + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
90	±(570 + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
100	±(565 + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	

Test setup

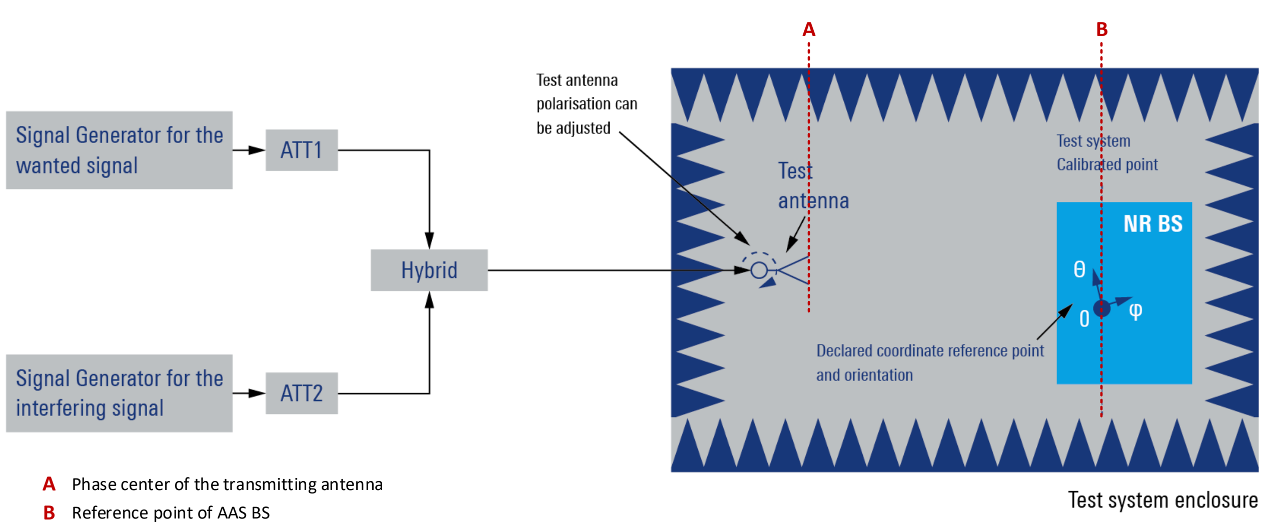


Figure 27: Measurement setup for OTA narrowband blocking

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested (wanted signal and interferer signal is polarization matched with the test antenna)
3. Configure beam peak direction according to the declared reference beam direction pair
4. Set the BS to transmit beam(s) of the same operational band as the OSDD or OTA REFSENS RoAoA being tested
5. SMW settings (use a hybrid combiner to sum all signals)
   a) Path A (wanted signal): Transmit signal according to Table 24
   b) Path B (interfering signal): Set frequency offset from the wanted signal according to Table 24 and Table 25
   Note: Setup and sweep the interfering RB center frequency offset to the channel edge of the wanted signal according to Table 25
6. Measure throughput for each supported polarization

Repeat steps 3) to 6) for all specified measurement directions

5.7 OTA out-of-band blocking (7.6)

The OTA out-of-band blocking characteristics are a measure of the receiver unit ability to receive a wanted signal at the RIB at its assigned channel in the presence of an unwanted interferer. For this test a CW interfering signal is required. [2]

5.7.1 General OTA out-of-band blocking

Table 26: OTA out-of-band blocking performance requirement for BS type 1-O

Wanted signal mean power (dBm)	Interfering signal RMS field-strength (V/m)	Type of interfering signal
$EIS_{minSENS}$ + 6 dB	0.36 V/m	CW carrier

The RMS field-strength level in V/m is related to the interferer EIRP level at a distance described as
$E = \frac{\sqrt{30\,EIRP}}{r}$, where $EIRP$ is in W and r is in m
→ for example: 0.36 V/m is equivalent to 36 dBm at fixed distance of 30 m.

Note: More information about EIRP level can be found in 3.2.

Table 27: OTA out-of-band blocking performance requirement for BS type 2-O

Frequency range of interfering signal (MHz)	Wanted signal mean power (dBm)	Interferer RMS field-strength (V/m)	Type of interfering signal
30 to 12750	$EIS_{REFSENS}$ + 6 dB	0.36	CW
12750 to F_{UL_low} – Δf_{OOB}		0.10	
F_{UL_high} + Δf_{OOB} to min (2nd harmonic of the upper frequency edge of the operating band, 60000)		0.10	

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel.

Table 28: Interferer signal step size

Frequency range (MHz)	Minimum supported BS channel bandwidth (MHz)	Measurement step size (MHz)
30 to 6000	50, 100, 200, 400	1
6000 to 60000	50	15
	100	30
	200	60
	400	60

Test setup

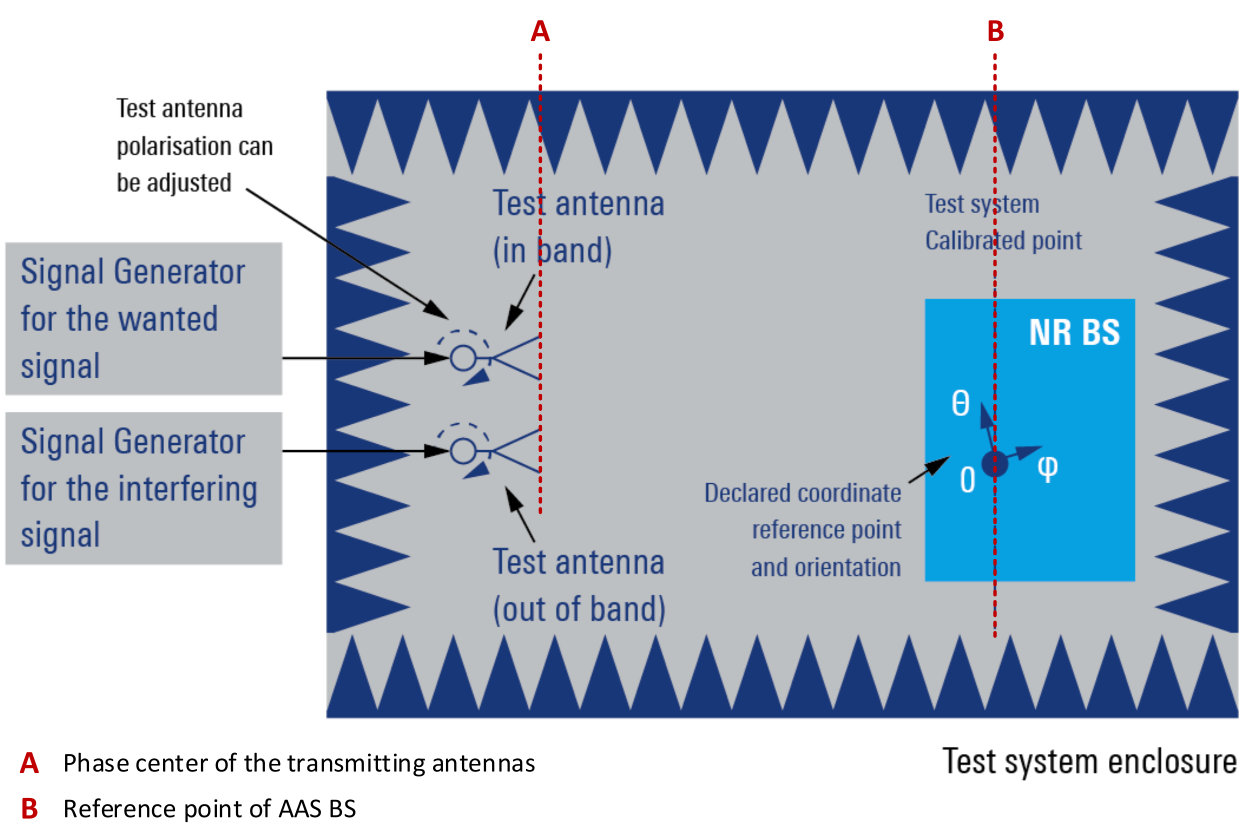


Figure 28: Measurement setup for general OTA out-of-band blocking

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested (wanted signal and interferer signal is polarization matched with the test antenna)
3. Test antenna shall be dual polarized covering the same frequency ranges as the BS and the blocking frequencies. If the test antenna does not cover both, separate test antennas for the wanted and interfering signal are required.
4. The OTA blocking interferer is injected into the test antenna. The interferer shall be polarization matched in-band and the polarization maintained for out-of-band frequencies.
5. Generate the wanted signal according to the applicable test configuration
6. Configure beam peak direction according to the declared reference beam direction pair. The transmitter may be turned OFF for the out-of-band blocker tests when the frequency of the blocker is such that no IM2 or IM3 products fall inside the bandwidth of the wanted signal.
7. Settings for the interfering signal according to Table 26
   For generating the interfering signal an external CW generator is required (e.g. SMA100B)
   a) BS 1-O: The CW interfering signal shall be swept with a step size of 1 MHz within the specified range
   b) BS 2-O: the interfering signal shall be swept within the frequency range and step size specified in Table 28
8. Measure the performance of the wanted signal at the receiver unit
9. Repeat the procedure for all supported polarizations

5.7.2 Co-location blocking

This test is available for BS type 1-O only.

Table 29: OTA blocking for co-location with BS in other frequency bands (for BS type 1-O)

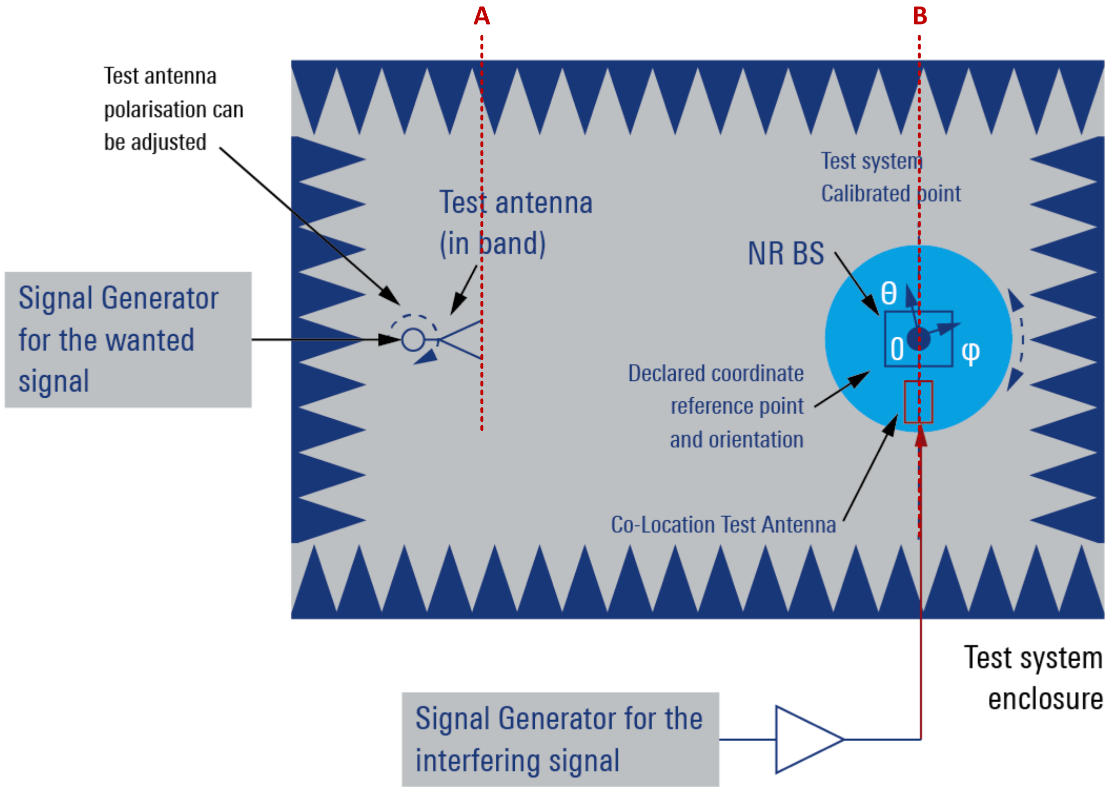
Frequency range of interfering signal	Wanted signal mean power (dBm)	Interfering signal mean power for WA BS (dBm)	Interfering signal mean power for MR BS (dBm)	Interfering signal mean power for LA BS (dBm)	Type of interfering signal
Frequency range of co-located downlink operating band	$EIS_{minSENS}$ + 6 dB	+46	+38	+24	CW carrier

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel.

Table 30: CLTA alignment tolerances

Parameter	Tolerance
Edge-to-edge separation between the NR BS and the CLTA, d	0.1 m ± 0.01 m
Vertical alignment	Centre ± 0.01 m
Front alignment	Radome front ± 0.01 m

Test setup



A Phase center of the transmitting antenna

B Reference point of AAS BS

Figure 29: Measurement setup for OTA co-location blocking

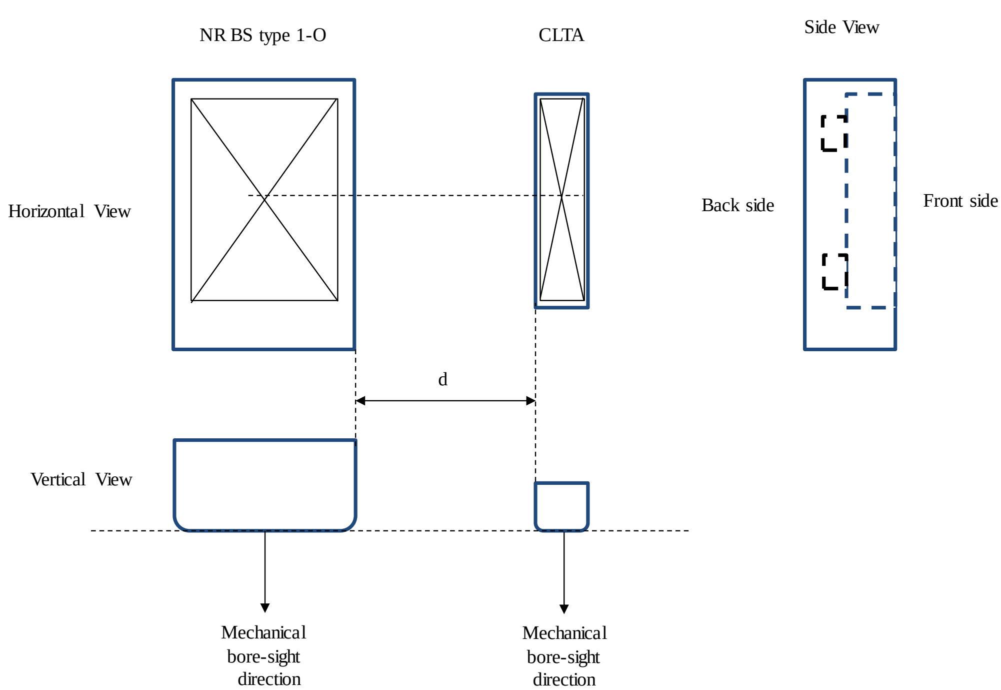


Figure 30: Alignment of NR BS and CLTA [2] (see Table 30)

Procedure

1. Place base station and CLTA (colocation test antenna) according to Table 30 and Figure 30
   Note: Several CLTA are required to cover the whole co-location blocking frequency ranges
2. Align the BS and test antenna according to the directions to be tested
3. The OTA co-location blocking interferer is injected via the CLTA
4. Generate the wanted signal
5. Configure beam peak direction according to the declared reference beam direction pair. The transmitter may be turned OFF for the out-of-band blocker tests when the frequency of the blocker is such that no IM2 or IM3 products fall inside the bandwidth of the wanted signal.
6. Settings for the interfering signal according to Table 29
   The second path of the SMW or an external CW generator can be used to generate the interferer.
   a) BS type 1-O: The CW interfering signal shall be swept with a step size of 1 MHz within the specified range
   b) BS type 2-O: The interfering signal shall be swept within the frequency range specified in Table 28 with the step size specified in Table 28
7. Measure the performance of the wanted signal at the receiver unit

5.8 OTA receiver spurious emissions (7.7)

The OTA receiver spurious emission is the power of the emissions radiated from the antenna array from a receiver unit.

The OTA receiver spurious emission limits for FR1 shall apply from 30 MHz to 12.75 GHz, excluding the frequency range from Δf_{OBUE} (see) below the lowest frequency of each supported downlink operating band, up to Δf_{OBUE} above the highest frequency of each supported downlink operating band.

The OTA receiver spurious emission limits for FR2 shall apply from 30 MHz to 2nd harmonic of the upper frequency edge of the downlink operating band, excluding the frequency range from Δf_{OBUE} (see) below the lowest frequency of each supported downlink operating band, up to Δf_{OBUE} above the highest frequency of each supported downlink operating band.

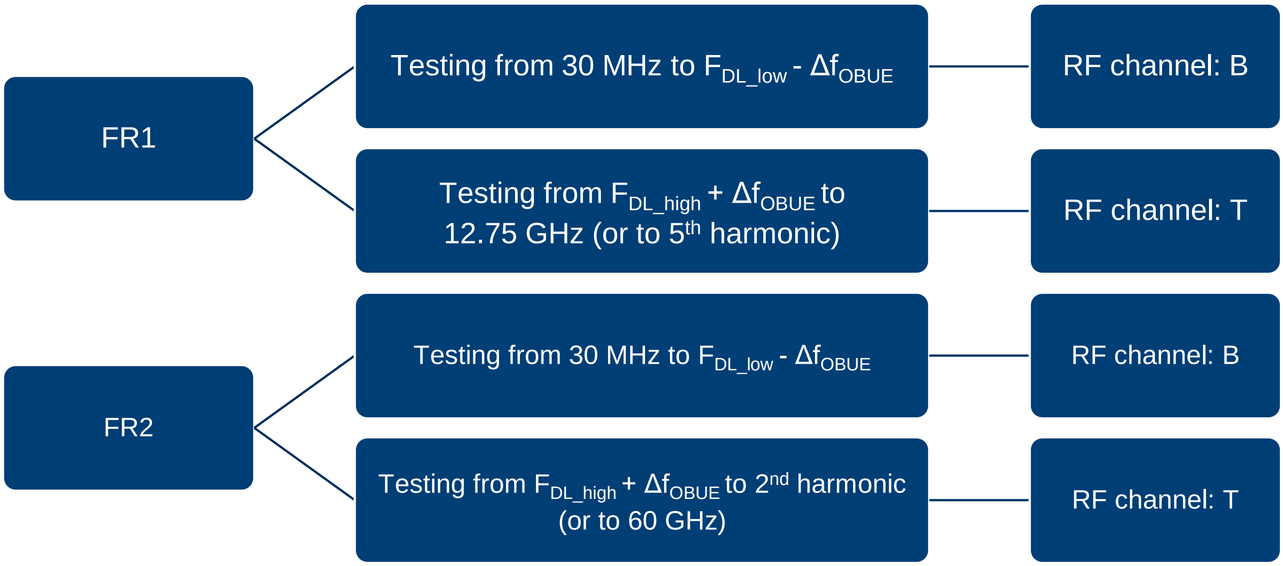
For a BS operating in FDD, OTA RX spurious emissions requirement do not apply as they are superseded by the OTA TX spurious emissions requirement. This is due to the fact that Tx and Rx spurious emissions cannot be distinguished in OTA domain.

For a BS operating in TDD, the OTA RX spurious emissions requirement shall apply during the transmitter OFF period only. [2]

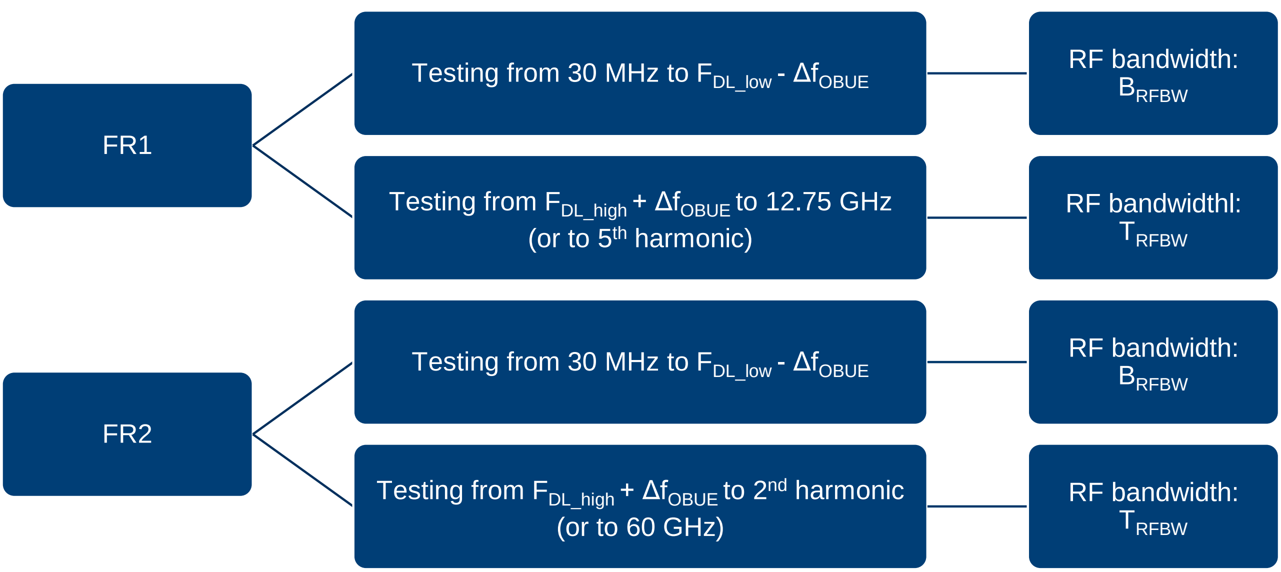
Table 31: Maximum offset ΔfOBUE outside the downlink operating band

BS type	Operating band characteristics	Δf_{OBUE} (MHz)
BS type 1-O	$F_{DL\_high} – F_{DL\_low} < 100$ MHz	10
	100 MHz $\leq F_{DL\_high} – F_{DL\_low} \leq$ 900 MHz	40
BS type 2-O	$F_{DL\_high} – F_{DL\_low} \leq$ 3250 MHz	1500

The RF channels to be tested depend on the frequency ranges:



The RF bandwidth positions to be tested depend on the frequency ranges as well:



B_{RFBW}: maximum base station RF bandwidth located at the bottom of the supported frequency range in the operating band

T_{RFBW}: maximum base station RF bandwidth located at the top of the supported frequency range in the operating band

Table 32: General OTA BS receiver spurious emission limits for BS type 1-O and BS type 2-O

FR	Spurious frequency range	Test limits	Measurement bandwidth
FR1	30 MHz – 1 GHz	-36 + 9 dBm	100 kHz
	1 GHz – 6 GHz	-30 + 9 dBm	1 MHz
	12.75 GHz – 5th harmonic of the upper frequency edge of the UL operating band in GHz	-30 + 9 dBm	1 MHz
FR2	30 MHz ↔ 1 GHz	-36 dBm	100 kHz
	1 GHz ↔ 18 GHz	-30 dBm	1 MHz
	18 GHz ↔ Fstep,1	-20 dBm	10 MHz
	$F_{step,1}$ ↔ $F_{step,2}$	-15 dBm	10 MHz
	$F_{step,2}$ ↔ $F_{step,3}$	-10 dBm	10 MHz
	$F_{step,4}$ ↔ $F_{step,5}$	-10 dBm	10 MHz
	$F_{step,5}$ ↔ $F_{step,6}$	-15 dBm	10 MHz
	$F_{step,6}$ ↔ min(2nd harmonic of the upper frequency edge of the UL operating band in GHz; 60 GHz)	-20 dBm	10 MHz

Table 33: Step frequencies for defining the radiated Rx spurious emission limits for BS type 2-O

Operating band	$F_{step,1}$	$F_{step,2}$	$F_{step,3}$	$F_{step,4}$	$F_{step,5}$	$F_{step,6}$
n257	18 GHz	23.5 GHz	25 GHz	31 GHz	32.5 GHz	41.5 GHz
n258	18 GHz	21 GHz	22.75 GHz	29 GHz	30.75 GHz	40.5 GHz
n260	25 GHz	34 GHz	35.5 GHz	41.5 GHz	43 GHz	52 GHz
n261	18 GHz	25.5 GHz	26.0 GHz	29.85 GHz	30.35 GHz	38.35 GHz

Test setup

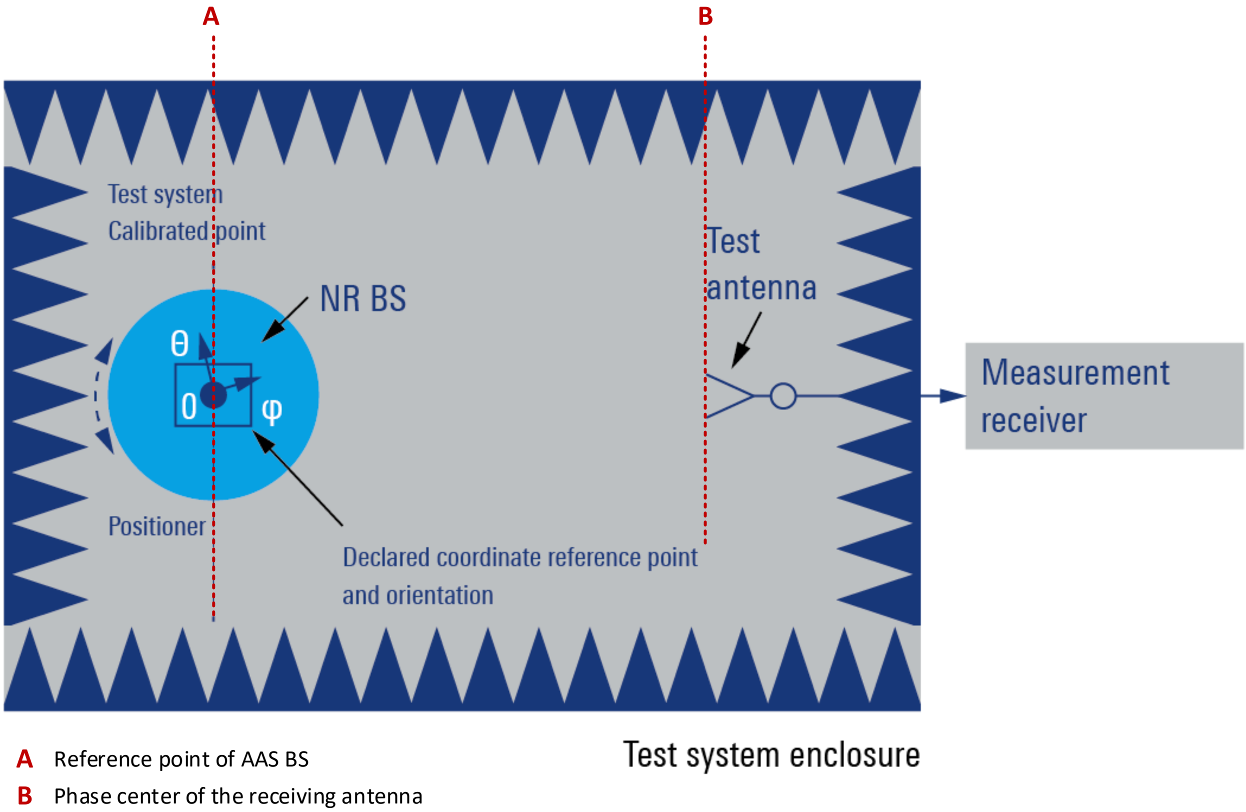


Figure 31: Measurement setup for OTA receiver spurious emissions

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Select detection mode: True RMS
3. Set TDD BSs to receive only
4. Mount the BS and the test antenna such than measurement to determine TRP can be performed
5. Measure the emission (e.g. by using a FSW) at the specified frequencies with specified measurement bandwidth according to Table 32
6. Repeat steps 4 and 5 for all direction in the appropriated TRP measurement grid
7. Calculate TRP at each specified frequency using the directional measurements (more information can be found in 3.4)
8. $TRP = \frac{1}{4\pi}\int_{\varphi=0}^{2\pi}\int_{\theta=0}^{\pi} EIRP(\theta,\varphi) sin\theta d\theta d\varphi$

5.9 OTA receiver intermodulation (7.8)

Intermodulation response rejection is a measure of the capability of the receiver unit 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 a 5G NR signal. [2]

Test setup

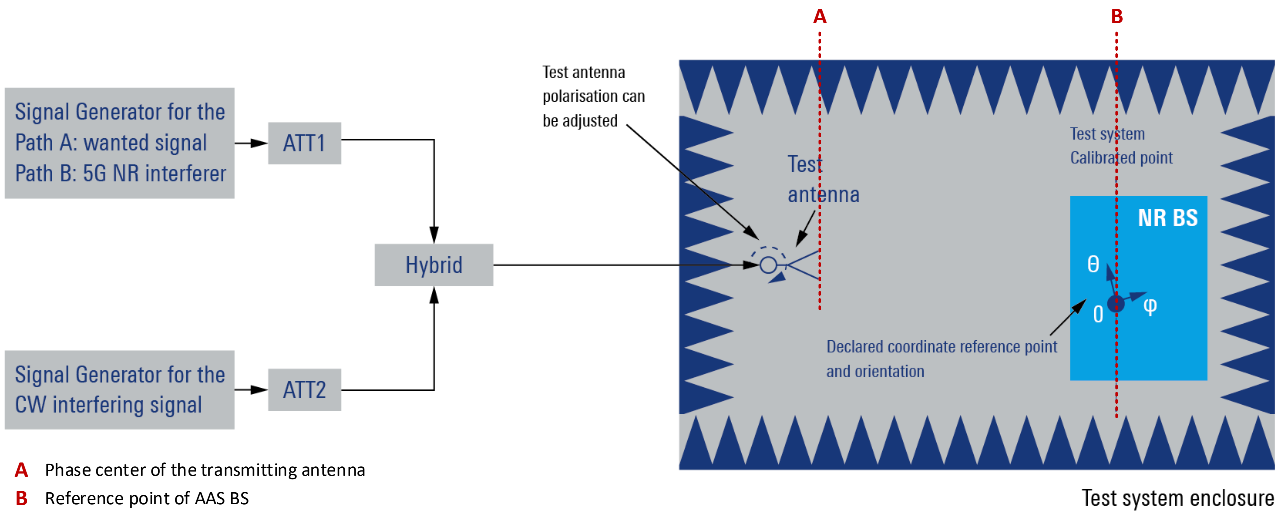


Figure 32: Measurement setup for OTA receiver intermodulation

The 5G NR interfering signal is provided through the second channel of the SMW. The CW signal is generated with the SMW-K62 option (Additive white Gaussian noise option).

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested (all the power from the test antenna is captured by the BS)
3. Configure beam peak direction according to the declared reference beam direction pair
4. Set the BS to transmit beams of the same operational band as the OTA REFSENS RoAoA or OSDD being tested
5. Settings for the signal generators (according to Table 34 to Table 39)
   Use a hybrid combiner to sum all signals
   1. Set the SMW (channel A) to transmit the wanted Signal
   2. Set the SMW (channel B) to transmit the 5G NR interfering signal
   3. Set up the SMW-K62 option for generating the CW interferer (SMW channel A or B)
6. Measure the throughput for each supported polarization
7. Repeat the measurement for all measurement directions and supported polarizations

5.9.1 General intermodulation

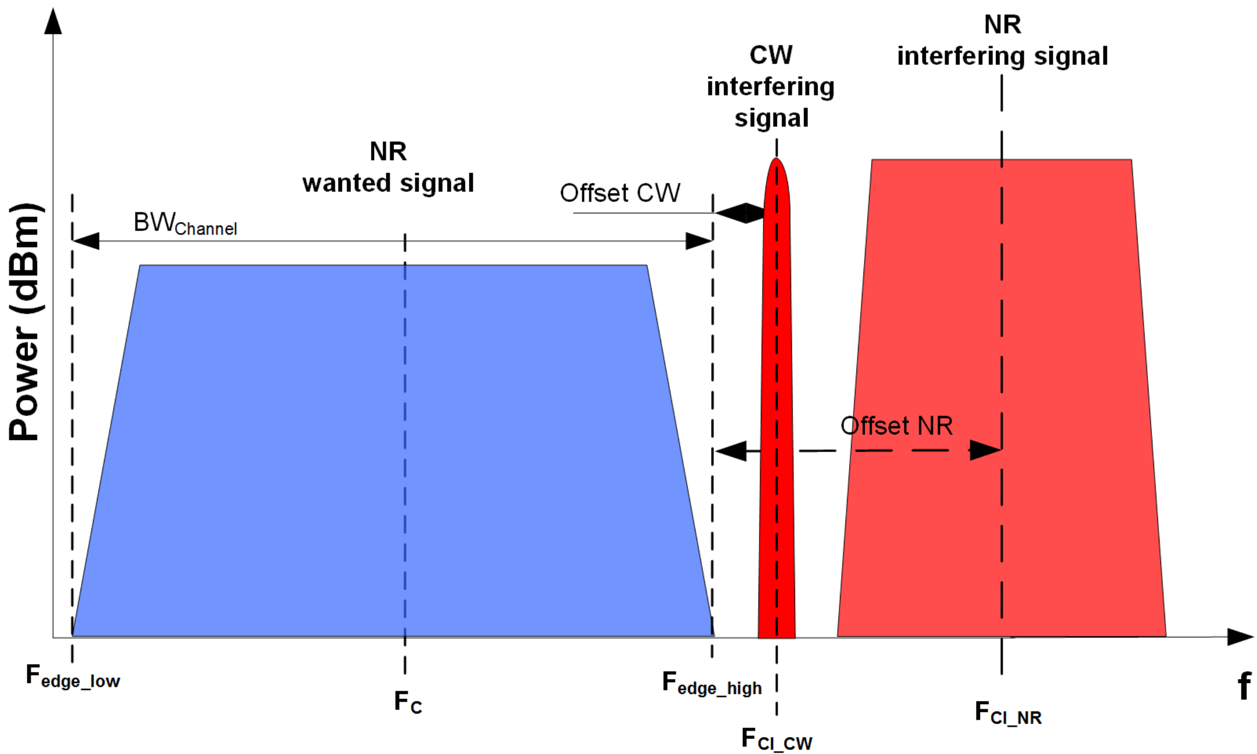


Figure 33: Intermodulation

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel, with a wanted signal at the assigned channel frequency and two interfering signals at the RIB with the conditions specified in the following tables.

Table 34: General intermodulation requirement for BS type 1-O

BS class	Wanted signal mean power (dBm)	Mean power of interfering signals (dBm)	Type of interfering signal
Wide Area BS	$EIS_{REFSENS}$ + 6 dB	-52 - $\Delta_{OTAREFSENS}$	See Table 35
	$EIS_{minSENS}$ + 6 dB	-52 - $\Delta_{minSENS}$	
Medium Range BS	$EIS_{REFSENS}$ + 6 dB	-47 - $\Delta_{OTAREFSENS}$	
	$EIS_{minSENS}$ + 6 dB	-47 - $\Delta_{minSENS}$	
Local Area BS	$EIS_{REFSENS}$ + 6 dB	-44 - $\Delta_{OTAREFSENS}$	
	$EIS_{minSENS}$ + 6 dB	-44 - $\Delta_{minSENS}$	

Table 35: Interfering signals for intermodulation requirement (BS type 1-O)

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering signal center frequency offset from the lower/upper base station RF bandwidth edge (MHz)	Type of interfering signal (Note 3)
5	±7.5	CW
	±17.5	5MHz DFT-s-OFDM NR signal (Note 1)
10	±7.465	CW
	±17.5	5MHz DFT-s-OFDM NR signal (Note 1)
15	±7.43	CW
	±17.5	5MHz DFT-s-OFDM NR signal (Note 1)
20	±7.395	CW
	±17.5	5MHz DFT-s-OFDM NR signal (Note 1)
25	±7.465	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 1)
30	±7.43	CW
	±25	20MHz DFT-s-OFDM NR signal (Note 2)
40	±7.45	CW
	±25	20MHz DFT-s-OFDM NR signal (Note 2)
50	±7.35	CW
	±25	20MHz DFT-s-OFDM NR signal (Note 2)
60	±7.49	CW
	±25	20MHz DFT-s-OFDM NR signal (Note 2)
70	±7.42	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
80	±7.44	CW
	±25	20MHz DFT-s-OFDM NR signal (Note 2)
90	±7.46	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
100	±7.48	CW
	±25	20MHz DFT-s-OFDM NR signal (Note 2)

Note 1: For the 15 kHz subcarrier spacing, the number of RB is 25. For the 30 kHz subcarrier spacing, the number of RB is 10.

Note 2: For the 15 kHz subcarrier spacing, the number of RB is 100. For the 30 kHz subcarrier spacing, the number of RB is 50. For the 60 kHz subcarrier spacing, the number of RB is 24.

Note 3: The RBs shall be placed adjacent to the transmission bandwidth configuration edge which is closer to the base station RF bandwidth edge.

Table 36: General intermodulation requirement BS type 2-O

BS channel bandwidth of the lowest/highest carrier received (MHz)	Mean power of interfering signals (dBm)	Wanted signal mean power (dBm)	Type of interfering signal
50, 100, 200, 400	$EIS_{REFSENS\_50M}$ + 25 + $\Delta_{FR2\_REFSENS}$ dB	$EIS_{REFSENS}$ + 6dB	see Table 37

Table 37: Interfering signals for intermodulation requirement (BS type 2-O)

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering signal center frequency offset from the base station RF bandwidth edge (MHz)	Type of interfering signal
50 MHz	±7.5	CW
	±40	50MHz DFT-s-OFDM NR signal (Note)
100 MHz	±6.88	CW
	±40	50MHz DFT-s-OFDM NR signal (Note)
200 MHz	±5.64	CW
	±40	50MHz DFT-s-OFDM NR signal (Note)
400 MHz	±6.02	CW
	±45	50MHz DFT-s-OFDM NR signal (Note)
Note: For the 60 kHz subcarrier spacing, the number of RBs is 64. For the 120 kHz subcarrier spacing, the number of RBs is 32.		

5.9.2 Narrowband intermodulation

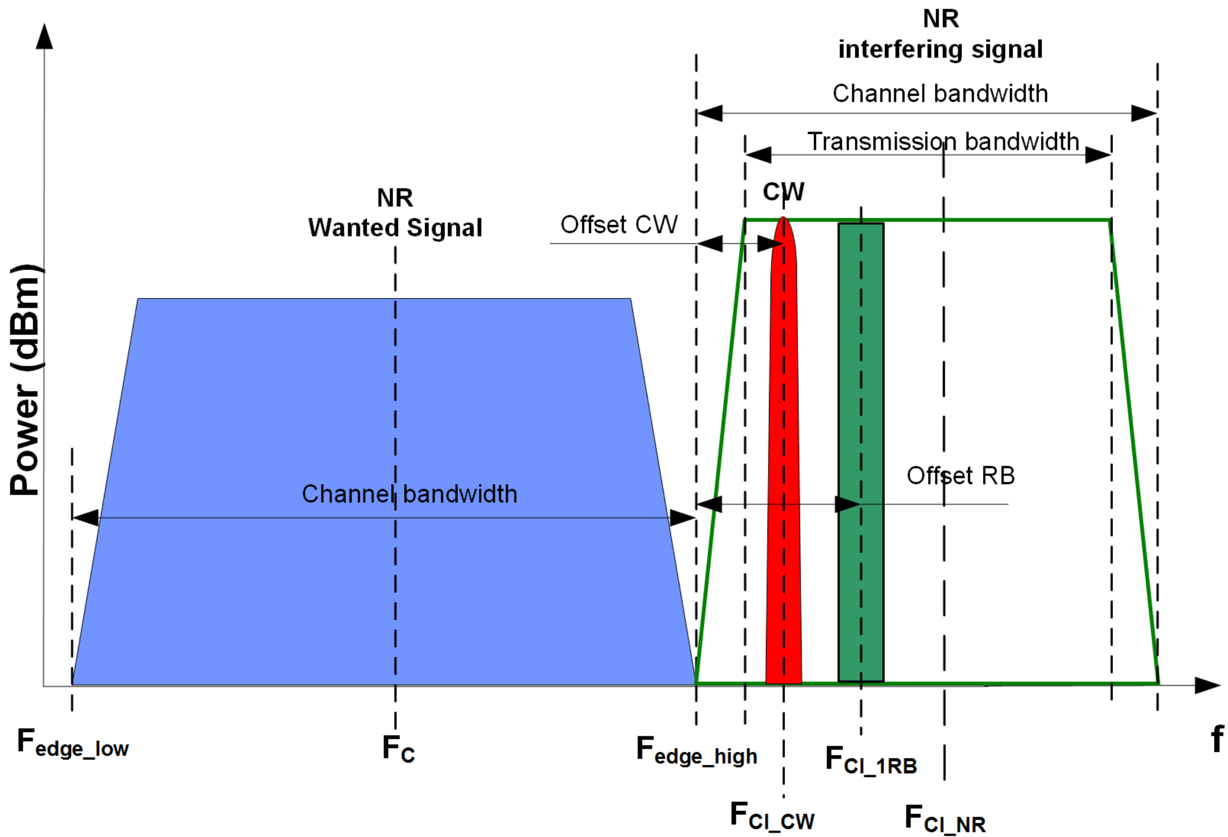


Figure 34: Narrowband intermodulation

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

Table 38: Narrowband intermodulation performance requirement for BS type 1-O

BS class	Wanted signal mean power (dBm)	Interfering signal mean power (dBm)	Type of interfering signal
Wide Area BS	$EIS_{REFSENS}$ + 6 dB	-52 - $\Delta_{OTAREFSENS}$	See Table 39
	$EIS_{minSENS}$ + 6 dB	-52 - $\Delta_{minSENS}$	
Medium Range BS	$EIS_{REFSENS}$ + 6 dB	-47 - $\Delta_{OTAREFSENS}$	
	$EIS_{minSENS}$ + 6 dB	-47 - $\Delta_{minSENS}$	
Local Area BS	$EIS_{REFSENS}$ + 6 dB	-44 - $\Delta_{OTAREFSENS}$	
	$EIS_{minSENS}$ + 6 dB	-44 - $\Delta_{minSENS}$	

Table 39: Interfering signals for narrowband intermodulation requirement for BS type 1-O

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 signal (Note 2)
5	±360	CW
	±1420	5MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
10	±370	CW
	±1960	5MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
15	±380	CW
	±1960	5MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
20	±390	CW
	±2320	5MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
25	±325	CW
	±2350	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
30	±335	CW
	±2350	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
40	±355	CW
	±2710	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
50	±375	CW
	±2710	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
60	±395	CW
	±2710	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
70	±415	CW
	±2710	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
80	±435	CW
	±2710	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
90	±365	CW
	±2530	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
100	±385	CW
	±2530	20MHz DFT-s-OFDM NR signal, 1 RB (Note 1)

Note 1: Interfering signal consisting of one resource block positioned at the stated offset, the BS channel bandwidth of the interfering signal is located adjacently to the lower/upper base station RF bandwidth edge.

Note 2: The center of the interfering RB refers to the frequency location between the two central subcarriers.

5.10 OTA in-channel selectivity (7.9)

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 purpose of this test is to verify the BS receiver ability to suppress the IQ leakage. [2]

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel

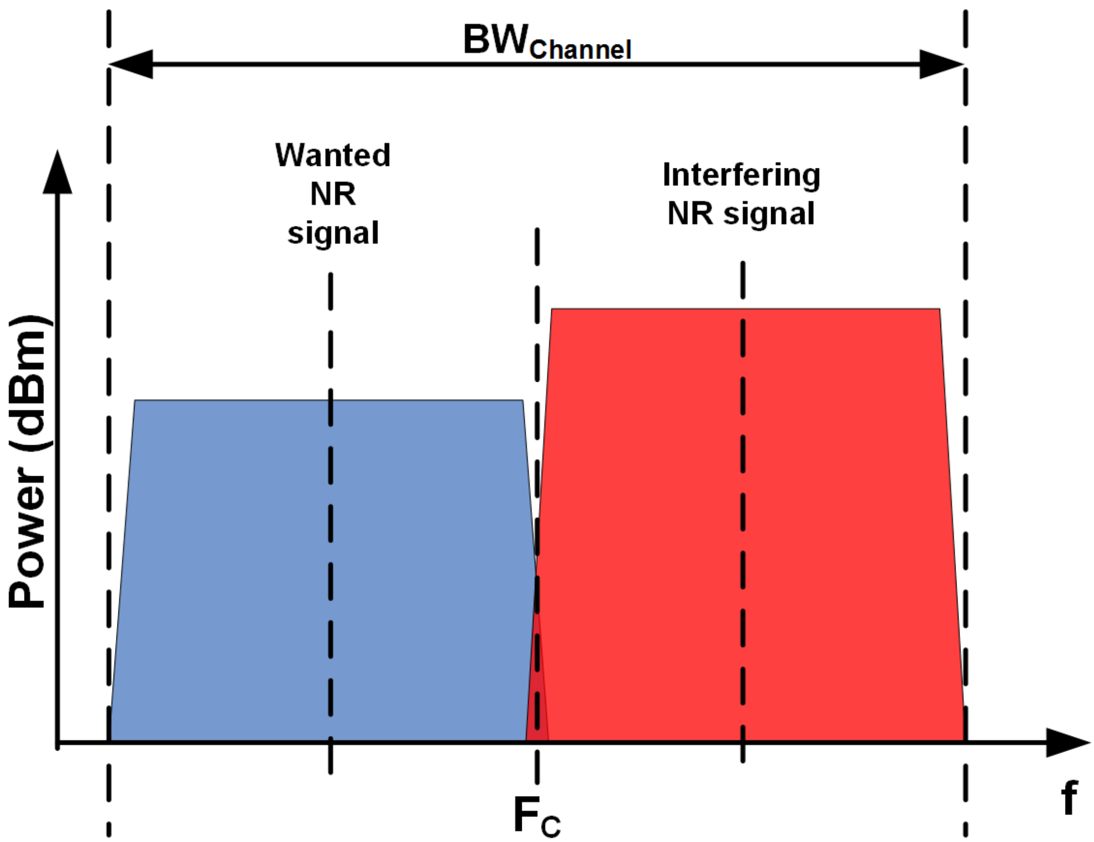


Figure 35: In-channel selectivity

Table 40: Wide area BS in channel selectivity (BS type 1-O)

BS channel BW (MHz)	SCS (kHz)	Reference measurement channel	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	$-98.9-\Delta_{minSENS}$	$-98.5-\Delta_{minSENS}$	$-98.2-\Delta_{minSENS}$	$-81.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 10 RBs
10, 15, 20, 25, 30	15	G-FR1-A1-1	$-97-\Delta_{minSENS}$	$-96.6-\Delta_{minSENS}$	$-96.3-\Delta_{minSENS}$	$-77.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 25 RBs
40, 50	15	G-FR1-A1-4	$-90.6-\Delta_{minSENS}$	$-90.2-\Delta_{minSENS}$	$-89.9-\Delta_{minSENS}$	$-71.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 100 RBs
5	30	G-FR1-A1-8	$-99.6-\Delta_{minSENS}$	$-99.2-\Delta_{minSENS}$	$-98.9-\Delta_{minSENS}$	$-81.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 30 kHz SCS, 5 RBs
10, 15, 20, 25, 30	30	G-FR1-A1-2	$-97.1-\Delta_{minSENS}$	$-96.7-\Delta_{minSENS}$	$-96.4-\Delta_{minSENS}$	$-78.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 30 kHz SCS, 10 RBs
40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	$-90.9-\Delta_{minSENS}$	$-90.5-\Delta_{minSENS}$	$-90.2-\Delta_{minSENS}$	$-71.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 30 kHz SCS, 50 RBs
10, 15, 20, 25, 30	60	G-FR1-A1-9	$-96.5-\Delta_{minSENS}$	$-96.1-\Delta_{minSENS}$	$-95.8-\Delta_{minSENS}$	$-78.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 60 kHz SCS, 5 RBs
40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	$-91-\Delta_{minSENS}$	$-90.6-\Delta_{minSENS}$	$-90.3-\Delta_{minSENS}$	$-71.6 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 60 kHz SCS, 24 RBs

Table 41: Medium range BS in-channel selectivity (BS type 1-O)

BS channel BW (MHz)	SCS (kHz)	Reference measurement channel	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	-93.9- $\Delta_{minSENS}$	-93.5- $\Delta_{minSENS}$	-93.2- $\Delta_{minSENS}$	-76.4 - $\Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 10 RBs
10, 15, 20, 25, 30	15	G-FR1-A1-1	-92-$\Delta_{minSENS}$	-91.6- $\Delta_{minSENS}$	-91.3- $\Delta_{minSENS}$	-72.4 - $\Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 25 RBs
40, 50	15	G-FR1-A1-4	-85.6- $\Delta_{minSENS}$	-85.2- $\Delta_{minSENS}$	-84.9- $\Delta_{minSENS}$	-66.4 - $\Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 100 RBs
5	30	G-FR1-A1-8	-94.6- $\Delta_{minSENS}$	-94.2- $\Delta_{minSENS}$	-93.9- $\Delta_{minSENS}$	-76.4 - $\Delta_{minSENS}$	DFT-s-OFDM NR signal, 30 kHz SCS, 5 RBs
10, 15, 20, 25, 30	30	G-FR1-A1-2	-92.1- $\Delta_{minSENS}$	-91.7- $\Delta_{minSENS}$	-91.4- $\Delta_{minSENS}$	-73.4 - $\Delta_{minSENS}$	DFT-s-OFDM NR signal, 30 kHz SCS, 10 RBs
40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-85.9- $\Delta_{minSENS}$	-85.5- $\Delta_{minSENS}$	-85.2- $\Delta_{minSENS}$	-66.4 - $\Delta_{minSENS}$	DFT-s-OFDM NR signal, 30 kHz SCS, 50 RBs
10, 15, 20, 25, 30	60	G-FR1-A1-9	-91.5- $\Delta_{minSENS}$	-91.1- $\Delta_{minSENS}$	-90.8- $\Delta_{minSENS}$	-73.4 - $\Delta_{minSENS}$	DFT-s-OFDM NR signal, 60 kHz SCS, 5 RBs
40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-86-$\Delta_{minSENS}$	-85.6- $\Delta_{minSENS}$	-85.3- $\Delta_{minSENS}$	-66.6 - $\Delta_{minSENS}$	DFT-s-OFDM NR signal, 60 kHz SCS, 24 RBs

Table 42: Local area BS in-channel selectivity (BS type 1-O)

BS channel BW (MHz)	SCS (kHz)	Reference measurement channel	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	$-90.9-\Delta_{minSENS}$	$-90.5-\Delta_{minSENS}$	$-90.2-\Delta_{minSENS}$	$-73.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 10 RBs
10, 15, 20, 25, 30	15	G-FR1-A1-1	$-89-\Delta_{minSENS}$	$-88.6-\Delta_{minSENS}$	$-88.3-\Delta_{minSENS}$	$-69.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 25 RBs
40, 50	15	G-FR1-A1-4	$-82.6-\Delta_{minSENS}$	$-82.2-\Delta_{minSENS}$	$-81.9-\Delta_{minSENS}$	$-63.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 15 kHz SCS, 100 RBs
5	30	G-FR1-A1-8	$-91.6-\Delta_{minSENS}$	$-91.2-\Delta_{minSENS}$	$-90.9-\Delta_{minSENS}$	$-73.4 - \Delta_{minSENS}$	DFT-s- NR signal, 30 kHz SCS, 5 RBs
10, 15, 20, 25, 30	30	G-FR1-A1-2	$-89.1-\Delta_{minSENS}$	$-88.7-\Delta_{minSENS}$	$-88.4-\Delta_{minSENS}$	$-70.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 30 kHz SCS, 10 RBs
40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	$-82.9-\Delta_{minSENS}$	$-82.5-\Delta_{minSENS}$	$-82.2-\Delta_{minSENS}$	$-63.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 30 kHz SCS, 50 RBs
10, 15, 20, 25, 30	60	G-FR1-A1-9	$-88.5-\Delta_{minSENS}$	$-88.1-\Delta_{minSENS}$	$-87.8-\Delta_{minSENS}$	$-70.4 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 60 kHz SCS, 5 RBs
40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	$-83-\Delta_{minSENS}$	$-82.6-\Delta_{minSENS}$	$-82.3-\Delta_{minSENS}$	$-63.6 - \Delta_{minSENS}$	DFT-s-OFDM NR signal, 60 kHz SCS, 24 RBs

Table 43: OTA in-channel selectivity requirement (BS type 2-O)

BS channel BW (MHz)	SCS (kHz)	Reference measurement channel	Wanted signal mean power (dBm)	Interfering signal mean power (dBm)	Type of interfering signal
50	60	G-FR2-A1-4	$EIS_{REFSENS\_50M}$ + 3.4 + $\Delta_{FR2\_REFSENS}$	$EIS_{REFSENS\_50M}$ + 10 + $\Delta_{FR2\_REFSENS}$	DFT-s-OFDM NR signal, 60 kHz SCS, 32 RBs
100, 200	60	G-FR2-A1-1	$EIS_{REFSENS\_50M}$ + 6.4 + $\Delta_{FR2\_REFSENS}$	$EIS_{REFSENS\_50M}$ + 13 + $\Delta_{FR2\_REFSENS}$	DFT-s-OFDM NR signal, 60 kHz SCS, 64 RBs
50	120	G-FR2-A1-5	$EIS_{REFSENS\_50M}$ + 3.4 + $\Delta_{FR2\_REFSENS}$	$EIS_{REFSENS\_50M}$ + 10 + $\Delta_{FR2\_REFSENS}$	DFT-s-OFDM NR signal, 120 kHz SCS, 16 RBs
100, 200, 400	120	G-FR2-A1-2	$EIS_{REFSENS\_50M}$ + 6.4 + $\Delta_{FR2\_REFSENS}$	$EIS_{REFSENS\_50M}$ + 13 + $\Delta_{FR2\_REFSENS}$	DFT-s-OFDM NR signal, 120 kHz SCS, 32 RBs

Test setup

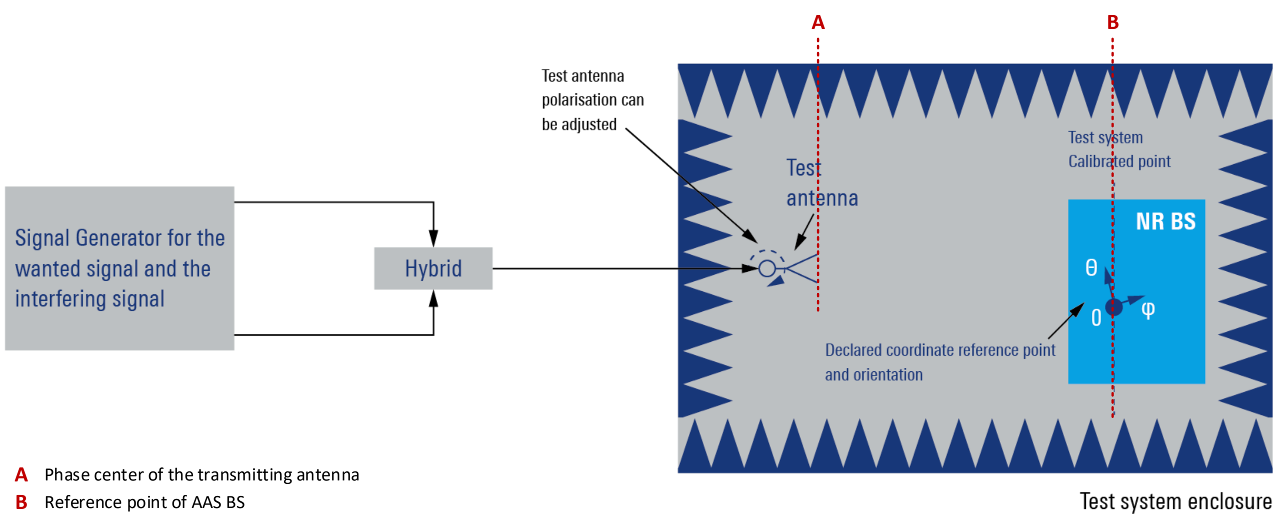


Figure 36: Measurement setup for OTA in-channel selectivity

Procedure

1. Place the base station at the positioner and align the coordinate system
2. Align the base station with the test antenna in the declared direction to be tested
3. Align the BS to that the wanted signal and interferer signal is polarization matched with test antenna
4. Configure beam peak direction according to the declared reference beam direction pair
5. Set the BS to transmit beams of the same operational band as the OTA REFSENS RoAoA or OSDD being tested

6. For each supported NR channel BW:
   a) SMW Settings (use a hybrid combiner to sum all signals)
      a) Transmit 5G NR signal according to Table 40 to Table 43
      b) Settings for the interfering signal (it is provided in the same baseband block and path) according to Table 40 to Table 43
7. Measure throughput for each supported polarization
8. Repeat the measurement with the wanted signal on the other side of the F_C, and the interfering signal at opposite side of the F_C and adjacent to the wanted signal.
9. Repeat the measurement for all measurement directions and supported polarizations

6 Literature

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

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[13] Rohde & Schwarz, R&S®ATS1800C - User manual, 2019

[14] Rohde & Schwarz, "R&S®ATS1800C CATR product brochure",
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[15] Rohde & Schwarz, "R&S PWC200 Plane Wave Converter - Product Flyer", 2019
Available: https://scdn.rohde-schwarz.com/ur/pws/dl_downloads/dl_common_library/dl_brochures_and_datasheets/pdf_1/PWC200_fly_en_5215-5971-32_v0200.pdf

7 Ordering Information

Type	Designation	Order No.
R&S®TS8991	OTA Performance Test System Note: includes WPTC test chambers	1119.4309.02
R&S®ATS1800C	Compact antenna test range (CATR) OTA test system	1534.1800.02
R&S®ATS-C50MF	50 GHz cable, length: 1.2m (M-F)	1535.7977.02
R&S®ATS-C50MM	50 GHz cable, length 1.2m (M-M)	1535.7983.02
R&S®PWC200	Plane Wave Converter	1532.3006.02
R&S®SMW200A	Vector signal generator	1412.0000.02
R&S®SMW-B1031 or **R&S®SMW-B1040** or **R&S®SMW-B1044**	Frequency option	1428.5307.02 or 1428.8506.02 or 1428.5507.02
R&S®SMW-B13XT	Baseband main module option	1413.8005.02
R&S®SMW-B9	Wideband baseband generator option	1413.7350.02
R&S®SMW-B15	Fading simulator and signal processor	1414.4710.02
R&S®SMW-K144	5G New Radio	1414.4990.02
R&S®SMW-K62	Additional white Gaussian noise	1413.3484.02
R&S®SMA100B	Signal generator	1419.8888.02
R&S®SMAB-B167	Frequency option 8 kHz to 67 GHz	1420.9149.02
R&S®SMAB-B92 or **R&S®SMAB-B93**	Unit height option	1420.8288.04 or 1420.8388.04
R&S®FSW67	Signal and spectrum analyzer	1331.5003.67

Please note that the above table does not include all the test instruments and system components needed for 5G NR base station conformance testing.

► For further ordering information please contact your local sales team:

https://www.rohde-schwarz.com/service-sales-locator

8 Appendix

A Test requirements

A.1 OTA dynamic range (7.4)

Table 44: Wide area BS dynamic range

BS channel bandwidth (MHz)	SCS (kHz)	Reference measurement channel	Wanted signal mean power (dBm)			Interfering sig. mean pow. (dBm) / BWConfig	Type of interfer-ing signal
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz		
5	15	G-FR1-A2-1	-70.4 – $\Delta_{OTAREFSENS}$	-70.4 – $\Delta_{OTAREFSENS}$	-70.4 – $\Delta_{OTAREFSENS}$	-82.5 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-2	-71.1 – $\Delta_{OTAREFSENS}$	-71.1 – $\Delta_{OTAREFSENS}$	-71.1 – $\Delta_{OTAREFSENS}$		
10	15	G-FR1-A2-1	-70.4 – $\Delta_{OTAREFSENS}$	-70.4 – $\Delta_{OTAREFSENS}$	-70.4 – $\Delta_{OTAREFSENS}$	-79.3 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-2	-71.1 – $\Delta_{OTAREFSENS}$	-71.1 – $\Delta_{OTAREFSENS}$	-71.1 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-3	-68.1 – $\Delta_{OTAREFSENS}$	-68.1 – $\Delta_{OTAREFSENS}$	-68.1 – $\Delta_{OTAREFSENS}$		
15	15	G-FR1-A2-1	-70.4 – $\Delta_{OTAREFSENS}$	-70.4 – $\Delta_{OTAREFSENS}$	-70.4 – $\Delta_{OTAREFSENS}$	-77.5 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-2	-71.1 – $\Delta_{OTAREFSENS}$	-71.1 – $\Delta_{OTAREFSENS}$	-71.1 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-3	-68.1 – $\Delta_{OTAREFSENS}$	-68.1 – $\Delta_{OTAREFSENS}$	-68.1 – $\Delta_{OTAREFSENS}$		
20	15	G-FR1-A2-4	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-76.2 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		
25	15	G-FR1-A2-4	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-75.2 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		

30	15	G-FR1-A2-4	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-74.4 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		
40	15	G-FR1-A2-4	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-73.1 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		
50	15	G-FR1-A2-4	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-72.1 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		
60	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-71.3 – $\Delta_{OTAREFSENS}$	AWGNs
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		
70	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-70.7 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		
80	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-70.1 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		
90	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-69.5 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		
100	30	G-FR1-A2-5	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-64.2 – $\Delta_{OTAREFSENS}$	-69.1 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$		

Table 45: Medium range BS dynamic range

BS channel bandwidth (MHz)	SCS (kHz)	Reference measurement channel	Wanted signal mean power (dBm)			Interfering signal mean power (dBm) / BWConfig	Type of interfer-ing signal
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz		
5	15	G-FR1-A2-1	-65.4 – ΔOTAREFSENS	-65.4 – ΔOTAREFSENS	-65.4 – ΔOTAREFSENS	-77.5 – ΔOTAREFSENS	AWGN
	30	G-FR1-A2-2	-66.1 – ΔOTAREFSENS	-66.1 – ΔOTAREFSENS	-66.1 – ΔOTAREFSENS		
10	15	G-FR1-A2-1	-65.4 – ΔOTAREFSENS	-65.4 – ΔOTAREFSENS	-65.4 – ΔOTAREFSENS	-74.3 – ΔOTAREFSENS	AWGN
	30	G-FR1-A2-2	-66.1 – ΔOTAREFSENS	-66.1 – ΔOTAREFSENS	-66.1 – ΔOTAREFSENS		
	60	G-FR1-A2-3	-63.1 – ΔOTAREFSENS	-63.1 – ΔOTAREFSENS	-63.1 – ΔOTAREFSENS		
15	15	G-FR1-A2-1	-65.4 – ΔOTAREFSENS	-65.4 – ΔOTAREFSENS	-65.4 – ΔOTAREFSENS	-72.5 – ΔOTAREFSENS	AWGN
	30	G-FR1-A2-2	-66.1 – ΔOTAREFSENS	-66.1 – ΔOTAREFSENS	-66.1 – ΔOTAREFSENS		
	60	G-FR1-A2-3	-63.1 – ΔOTAREFSENS	-63.1 – ΔOTAREFSENS	-63.1 – ΔOTAREFSENS		
20	15	G-FR1-A2-4	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-71.2 – ΔOTAREFSENS	AWGN
	30	G-FR1-A2-5	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS		
	60	G-FR1-A2-6	-59.5 – ΔOTAREFSENS	-59.5 – ΔOTAREFSENS	-59.5 – ΔOTAREFSENS		
25	15	G-FR1-A2-4	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-70.2 – ΔOTAREFSENS	AWGN
	30	G-FR1-A2-5	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS		
	60	G-FR1-A2-6	-59.5 – ΔOTAREFSENS	-59.5 – ΔOTAREFSENS	-59.5 – ΔOTAREFSENS		
30	15	G-FR1-A2-4	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-69.4 – ΔOTAREFSENS	AWGN
	30	G-FR1-A2-5	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS		
	60	G-FR1-A2-6	-59.5 – ΔOTAREFSENS	-59.5 – ΔOTAREFSENS	-59.5 – ΔOTAREFSENS		
40	15	G-FR1-A2-4	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-68.1 – ΔOTAREFSENS	AWGN
	30	G-FR1-A2-5	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS	-59.2 – ΔOTAREFSENS		
	60	G-FR1-A2-6	-59.5 – ΔOTAREFSENS	-59.5 – ΔOTAREFSENS	-59.5 – ΔOTAREFSENS		

50	15	G-FR1-A2-4	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-67.1 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	--59.2 – $\Delta_{OTAREFSENS}$	--59.2 – $\Delta_{OTAREFSENS}$	--59.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$		
60	30	G-FR1-A2-5	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-66.3 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$		
70	30	G-FR1-A2-5	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-65.7 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$		
80	30	G-FR1-A2-5	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-65.1 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$		
90	30	G-FR1-A2-5	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-64.5 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$		
100	30	G-FR1-A2-5	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-59.2 – $\Delta_{OTAREFSENS}$	-64.1 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$	-59.5 – $\Delta_{OTAREFSENS}$		

Table 46: Local area BS dynamic range

BS channel bandwidth (MHz)	SCS (kHz)	Reference measurement channel	Wanted signal mean power (dBm)			Interfering signal mean power (dBm) / BWConfig	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-A2-1	-62.4 – $\Delta_{OTAREFSENS}$	-62.4 – $\Delta_{OTAREFSENS}$	-62.4 – $\Delta_{OTAREFSENS}$	-74.5 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-2	-64.1 – $\Delta_{OTAREFSENS}$	-64.1 – $\Delta_{OTAREFSENS}$	-64.1 – $\Delta_{OTAREFSENS}$		
10	15	G-FR1-A2-1	-62.4 – $\Delta_{OTAREFSENS}$	-62.4 – $\Delta_{OTAREFSENS}$	-62.4 – $\Delta_{OTAREFSENS}$	-71.3 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-2	-64.1 – $\Delta_{OTAREFSENS}$	-64.1 – $\Delta_{OTAREFSENS}$	-64.1 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-3	-60.1 – $\Delta_{OTAREFSENS}$	-60.1 – $\Delta_{OTAREFSENS}$	-60.1 – $\Delta_{OTAREFSENS}$		
15	15	G-FR1-A2-1	-62.4 – $\Delta_{OTAREFSENS}$	-62.4 – $\Delta_{OTAREFSENS}$	-62.4 – $\Delta_{OTAREFSENS}$	-69.5 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-2	-64.1 – $\Delta_{OTAREFSENS}$	-64.1 – $\Delta_{OTAREFSENS}$	-64.1 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-3	-60.1 – $\Delta_{OTAREFSENS}$	-60.1 – $\Delta_{OTAREFSENS}$	-60.1 – $\Delta_{OTAREFSENS}$		
20	15	G-FR1-A2-4	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-68.2 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		
25	15	G-FR1-A2-4	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-67.2 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		
30	15	G-FR1-A2-4	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-66.4 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		
40	15	G-FR1-A2-4	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-65.1 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		

50	15	G-FR1-A2-4	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-64.1 – $\Delta_{OTAREFSENS}$	AWGN
	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$		
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		
60	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-63.3 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		
70	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-62.7 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		
80	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-62.1 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		
90	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-61.5 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		
100	30	G-FR1-A2-5	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-56.2 – $\Delta_{OTAREFSENS}$	-61.1 – $\Delta_{OTAREFSENS}$	AWGN
	60	G-FR1-A2-6	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$	-56.5 – $\Delta_{OTAREFSENS}$		

B Glossary

Abbreviation	Description
5G NR	5G New Radio
ACLR	Adjacent channel leakage power ratio
AoA	Angle of arrival
$BeW_{\theta,REFSENS}$	Beamwidth equivalent to the OTA REFSENS RoAoA in the θ-axis in degrees, applicable for FR1 only
$BeW_{\varphi,REFSENS}$	Beamwidth equivalent to the OTA REFSENS RoAoA in the φ-axis in degrees, applicable for FR1 only
BS	Base station
CA	Carrier aggregation
CATR	Compact antenna test range
CLTA	Colocation test antenna
DUT	Device under test
EIRP	Effective isotropic radiated power
EIS	Equivalent isotropic sensitivity
EVM	Error vector magnitude
FDD	Frequency division duplex
FFS	For further study
FR1	Frequency range 1
IAC	Indoor anechoic chamber
LA	Local area
MIMO	Multiple input multiple output
MR	Medium range
OBUE	Operating band unwanted emissions
OBW	Occupied bandwidth
OSDD	OTA sensitivity directions declaration
OTA	Over the air
PDSCH	Physical downlink shared channel
P_{rat}	Rated output power
Px-	Performance-
RB	Resource block
RBW	Resolution bandwidth
REFSENS	Reference sensitivity
RF	Radio frequency
RIB	Radiated interface boundary

RoAoA	Range of angles of arrival
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
TRP	Total radiated power
Tx-	Transmitter-
UE	User equipment
VSWR	Voltage standing wave ratio
WA	Wider area
WPTC	Wireless Performance Test Chamber

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