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| 3GPP TR 38.922 V0.3.0 (2024-10) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Network;  NR;  Study on International Mobile Telecommunications (IMT) parameters for 4400 - 4800 MHz, 7125 - 8400 MHz and 14800 - 15350 MHz;  (Release 19) | |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The present document is a technical report for the study item on IMT parameters for 4400 to 4800 MHz, 7125 to 8400 MHz and 14800 to 15350 MHz frequency ranges [2]. It covers the study on transmitter and receiver characteristics for both NR BS and NR UE, and related parameters co-existence studies and AAS antenna models, addressing the ITU-R W5PD’s requests and answering three additional questions received in [3].

Findings and evaluations captured in this technical report are based on the Rel-18 version of the NR specifications, unless otherwise stated.

Related LS replies for each of the frequency ranges in question were sent out to ITU-R W5PD in [4, 5, 6].

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] RP-241326: “Study on IMT parameters for 4400 to 4800 MHz, 7125 to 8400 MHz and 14800 to 15350 MHz”, SID, FS\_NR\_IMT\_4400\_7125\_14800MHz, RAN#104.

[3] R4-2400333: “Parameters of terrestrial component of IMT for sharing and compatibility studies in the frequency bands 4 400-4 800 MHz, 7 125-8 400 MHz and 14.8-15.35 GHz”, ITU-R WP 5D, LSin.

[4] R4-2410576: “LS on Parameters for 4400 to 4800 MHz of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-27”, RAN4#111, LSout

[5] R4-2414449: “LS Reply on Parameters for 7125 to 8400 MHz of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-27”, RAN4#112, LSout

[6] R4-24xxxxx: “LS Reply on Parameters for 14800 to 15350 MHz of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-27”, RAN4#xxx, LSout

[7] 3GPP TR 38.858: “Study on evolution of NR duplex operation”

[8] RP-241614: “Evolution of NR duplex operation: Sub-band full duplex (SBFD)”, WID, NR\_duplex\_evo, RAN#104

[9] 3GPP TS 38.104: “NR; Base Station (BS) radio transmission and reception”

[10] 3GPP TS 36.104: “Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception”

[11] 3GPP TS 38.101-3: “NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios”

[12] 3GPP TS 38.101-1: “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”

[13] ITU-R Recommendation SM.329: "Unwanted emissions in the spurious domain"

[14] 3GPP TR 38.921: “Study on International Mobile Telecommunications (IMT) parameters for 6.425 – 7.025 GHz, 7.025 – 7.125 GHz and 10.0. – 10.5 GHz”

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**array element:** subdivision of a passive *antenna array*, consisting of a single radiating element or a group of radiating elements, with a fixed radiation pattern

**basic limit:** emissions limit relating to the power supplied by a single transmitter to a single antenna transmission line in ITU-R SM.329 [13] used for the formulation of unwanted emission requirements for FR1.

**beam:** beam (of the antenna) is the main lobe of the radiation pattern of an *antenna array*

NOTE: For certain BS *antenna array*, there may be more than one beam.

**beamwidth:** beam which has a half-power contour that is essentially elliptical, the half-power beamwidths in the two pattern cuts that respectively contain the major and minor axis of the ellipse

**BS type 1-C:** NR base station operating at FR1 with requirements set consisting only of conducted requirements defined at individual *antenna connectors*

**BS type 1-H:** NR base station operating at FR1 with a *requirement set* consisting of conducted requirements defined at individual *TAB connectors* and OTA requirements defined at RIB

**BS type 1-O:** NR base station operating at FR1 with a *requirement set* consisting only of OTA requirements defined at the RIB

**front-to-back ratio:** ratio of maximum directivity of an antenna to its directivity in a specified rearward direction

**gain:** ratio of the radiation intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated in an isotropic manner.

NOTE: If the direction is not specified, the direction of maximum radiation intensity is implied.

**operating band:** frequency range in which NR operates (paired or unpaired), that is defined with a specific set of technical requirements

**radiated interface boundary**: *operating band* specific radiated requirements reference where the radiated requirements apply

NOTE: For requirements based on EIRP/EIS, the *radiated interface boundary* is associated to the far-field region

**TAB connector:** *transceiver array boundary* connector

**total radiated power:** is the total power radiated by the antenna

NOTE: The *total radiated power* is the power radiating in all direction for two orthogonal polarizations. *Total radiated power* is defined in both the near-field region and the far-field region

**transceiver array boundary:** conducted interface between the transceiver unit array and the composite antenna

**transmission bandwidth:** RF Bandwidth of an instantaneous transmission from a UE or BS, measured in resource block units

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

*AA* Composite *antenna array* pattern in dBi

*AE* *Array element* pattern in dBi

*Am* Front to back ratio in dB

*dh* Horizontal element separation in meters

*dv* Vertical element separation in meters

*GE,max* Array element peak gain in dBi

*SLAv* Side lobe suppression in dB

*3dB* Horizonal half power beamwidth

*3dB*Vertical half power beamwidth

*etilt* Electrical down-tilt angle in degrees (defined from antenna array normal and downwards)

*escan* Electrical scan angle in degrees

** Horizontal angle (defined between -180° and 180°).

** Vertical angle of the signal direction (defined between -0° and 180°,90° represents the direction perpendicular to the antenna array

NRB Transmission bandwidth configuration, expressed in resource blocks

BWChannel *BS channel bandwidth*

BWConfig *Transmission bandwidth configuration*, where BWConfig = *N*RB x SCS x 12

Δf Separation between the *channel edge* frequency and the nominal -3 dB point of the measuring filter closest to the carrier frequency

Δfmax f\_offsetmax minus half of the bandwidth of the measuring filter

ΔfOBUE Maximum offset of the *operating band* unwanted emissions mask from the downlink *operating band* edge

ΔfOOB Maximum offset of the out-of-band boundary from the uplink *operating band* edge

FC *RF reference frequency* on the channel raster, given in table 5.4.2.2-1

f\_offset Separation between the *channel edge* frequency and the centre of the measuring

f\_offsetmax The offset to the frequency ΔfOBUE outside the downlink *operating band*

FUL,low The lowest frequency of the uplink *operating band*

FUL,high The highest frequency of the uplink *operating band*

PREFSENS Conducted Reference Sensitivity power level

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

AAS Active Antenna System

ACIR Adjacent Channel Interference Ratio

ACLR Adjacent Channel Leakage Ratio

ACS Adjacent Channel Selectivity

AWGN Additive White Gaussian Noise

BS Base Station

BW Bandwidth

EIRP Effective Isotropic Radiated Power

FDD Frequency Division Duplex

FR Frequency Range

FRC Fixed Reference Channel

IMT International Mobile Telecommunications

ITU‑R Radiocommunication Sector of the International Telecommunication Union

LA Local Area

LOS Line-Of-Sight

MR Medium Range

NLOS Non-Line-Of-Sight

NR New Radio

OCNG OFDMA Channel Noise Generator

OTA Over The Air

O-to-I Outdoor-to-Indoor

RB Resource Block

RF Radio Frequency

SBFD Sub-Band Full Duplex

SCS Sub-Carrier Spacing

TAB Transceiver Array Boundary

TDD Time division Duplex

TRP Total Radiated Power

WA Wide Area

# 4 4400 - 4800 MHz frequency range

## 4.1 General parameters

The general parameters can be extracted from requirements defined for NR operating band n79.



Figure 4.1-1: NR band definition in the 4.4 – 5.0 GHz frequency range

### 4.1.1 Duplex mode

RAN4 considered TDD as the current duplexing candidate. An enhancement of TDD duplexing, via allowing the simultaneous existence of non-overlapping downlink and uplink sub-band at the BS side within a TDD carrier in a conventional TDD band (i.e., sub-band non-overlapping full duplex), was studied in Rel-18 TR 38.858 [7]. RAN4 Rel-19 normative work for SBFD operation at the BS side within a TDD carrier was on-going at the time of writing [8]. The requirements and conformance aspects for Rel-19 SBFD work item can be tracked through the list of impacted specifications captured in [8].

### 4.1.2 Channel Bandwidth

While a number of channel bandwidth would be specified for this frequency range, 100 MHz has been considered as a representative channel bandwidth that is expected to be used.

Channel bandwidths supported by n79 in Rel-18 are listed in Table 4.1.2-1.

**Table 4.1.2-1: *BS channel bandwidths* for band n79**

| **NR Band** | **SCS (kHz)** | ***BS channel bandwidth* (MHz)** | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **3** | **5** | **10** | **15** | **20** | **25** | **30** | **35** | **40** | **45** | **50** | **60** | **70** | **80** | **90** | **100** |
|  | 15 |  |  | 10 |  | 20 |  | 30 |  | 40 |  | 50 |  |  |  |  |  |
| n79 | 30 |  |  | 10 |  | 20 |  | 30 |  | 40 |  | 50 | 60 | 70 | 80 | 90 | 100 |
|  | 60 |  |  | 10 |  | 20 |  | 30 |  | 40 |  | 50 | 60 | 70 | 80 | 90 | 100 |

### 4.1.3 Signal Bandwidth

The signal bandwidth for a NR channel bandwidth signal is calculated based on the NR spectrum utilization for 30 kHz SCS:

Signal bandwidth = NRB x SCS x 12

where NRB is the number of resource blocks for particular bandwidth and 30kHz SCS, as specified in TS 38.104 [9], clause 5.3.2.

## 4.2 BS parameters

### 4.2.1 Transmitter characteristics

#### 4.2.1.1 Power dynamic range

There is no power control in downlink and fixed power per resource block is assumed during the study phase. Hence 0 dB power dynamic range was agreed for the LS reply in [4].

#### 4.2.1.2 Spectral mask

The requirement limits applicable for band n79 are re-used. Related extracts from TS 38.104 [9], clause 6.6.4 are listed in Table 4.2.1.2-1 and Table 4.2.1.2-2 below.

Table 4.2.1.2-1: Wide Area BS *operating band* unwanted emission limits   
(NR bands above 1 GHz) for Category A

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf <  min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset <  min(10.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.5 MHz ≤ f\_offset < f\_offsetmax | -13 dBm | 1 MHz |

Table 4.2.1.2-2: Wide Area BS operating band unwanted emission limits   
(NR bands above 1 GHz) for Category B

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf <  min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset <  min(10.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.5 MHz ≤ f\_offset < f\_offsetmax | -15 dBm | 1 MHz |

#### 4.2.1.3 ACLR

The ACLR limit applicable for band n79 are re-used. Related extracts from TS 38.104 [9], clause 6.6.3 are listed in Table 4.2.1.3-1.

Table 4.2.1.3-1: Base station ACLR limit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *BS channel bandwidth* of *lowest/highest carrier* transmitted BWChannel (MHz) | BS adjacent channel centre frequency offset below the lowest or above the highest carrier centre frequency transmitted | Assumed adjacent channel carrier (informative) | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit |
| 10, 20, 30, 40, 50, 60, 70, 80, 90,100 | BWChannel | NR of same BW (Note 2) | Square (BWConfig) | 45 dB |
|  | 2 x BWChannel | NR of same BW (Note 2) | Square (BWConfig) | 45 dB |
| NOTE 1: BWChannel and BWConfig are the *BS channel bandwidth* and *transmission bandwidth configuration* of the *lowest/highest carrier* transmitted on the assigned channel frequency.  NOTE 2: With SCS that provides largest transmission bandwidth configuration (BWConfig). | | | | |

#### 4.2.1.4 Spurious emissions

The spurious emission limits applicable for band n79 are re-used. Related extracts from TS 38.104 [9] are listed in Table 4.2.1.4-1 and Table 4.2.1.4-2.

Table 4.2.1.4-1: General BS transmitter spurious emission limits in FR1, Category A

|  |  |  |  |
| --- | --- | --- | --- |
| Spurious frequency range | *Basic limit* | *Measurement bandwidth* | Notes |
| 9 kHz – 150 kHz |  | 1 kHz | Note 1, Note 4 |
| 150 kHz – 30 MHz |  | 10 kHz | Note 1, Note 4 |
| 30 MHz – 1 GHz |  | 100 kHz | Note 1 |
| 1 GHz 12.75 GHz | -13 dBm | 1 MHz | Note 1, Note 2 |
| 12.75 GHz – 5th harmonic of the upper frequency edge of the DL *operating band* in GHz |  | 1 MHz | Note 1, Note 2, Note 3 |
| NOTE 1: *Measurement bandwidth*s as in ITU-R SM.329, s4.1.  NOTE 2: Upper frequency as in ITU-R SM.329, s2.5 table 1.  NOTE 3: Applies for Band for which the upper frequency edge of the DL *operating band* is greater than 2.55 GHz and less than or equal to 5.2 GHz.  NOTE 4: This spurious frequency range applies only to *BS type 1-C* and *BS type 1-H*. | | | |

Table 4.2.1.4-2: General BS transmitter spurious emission limits in FR1, Category B

|  |  |  |  |
| --- | --- | --- | --- |
| Spurious frequency range | *Basic limit* | *Measurement bandwidth* | Notes |
| 9 kHz – 150 kHz |  | 1 kHz | Note 1, Note 4 |
| 150 kHz – 30 MHz | -36 dBm | 10 kHz | Note 1, Note 4 |
| 30 MHz – 1 GHz |  | 100 kHz | Note 1 |
| 1 GHz – 12.75 GHz |  | 1 MHz | Note 1, Note 2 |
| 12.75 GHz – 5th harmonic of the upper frequency edge of the DL *operating band* in GHz | -30 dBm | 1 MHz | Note 1, Note 2, Note 3 |
| NOTE 1: *Measurement bandwidth*s as in ITU-R SM.329, s4.1.  NOTE 2: Upper frequency as in ITU-R SM.329, s2.5 table 1.  NOTE 3: Applies for Band for which the upper frequency edge of the DL *operating band* is greater than 2.55 GHz and less than or equal to 5.2 GHz.  NOTE 4: This spurious frequency range applies only to *BS type 1-C* and *BS type 1-H*. | | | |

Additional spurious emissions requirements relevant for band n79 can be found in TS 38.104 [9], clause 6.6.5.2.3 and clause 6.6.5.2.4.

#### 4.2.1.5 Maximum output power

The maximum base station output power/ sector (e.i.r.p.) was provided in the antenna parameter table of the LS [4], as extracted in Table 4.2.1.5-1. It was agreed to be aligned with antenna characteristics.

**Table 4.2.1.5-1: Maximum BS output power in 1710 to 4990 MHz**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Rural | Macro suburban | Macro urban | Small cell outdoor/ Micro urban | Small cell indoor/ Indoor urban |
| Maximum base station output power/sector (e.i.r.p.) (dBm) | 72.2 | 72.2 | 72.2 | 61.5 | N/A |

The Total Radiated Power (TRP) for two polarizations was agreed as shown in Table 4.2.1.5-2 below.

Table 4.2.1.5-2: Total Radiated Power

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Rural | Macro Sub-urban | Macro Urban | Micro Urban |
| Total Radiated Power for two polarizations (dBm) | 46 | 46 | 46 | 37 |

#### 4.2.1.6 Average output power

It was agreed the average output power won’t be mentioned in the reply LS in [4].

### 4.2.2 Receiver characteristics

#### 4.2.2.1 Noise figure

The BS noise figure is listed in Table 4.2.2.1-1.

Table 4.2.2.1-1: Noise figure

|  |  |
| --- | --- |
| BS class | Noise figure (dB) |
| Wide Area | 5 |
| Medium Range | 10 |
| Local Area | 13 |

#### 4.2.2.2 Sensitivity

The BS reference sensitivity levels are listed in Table 4.2.2.2-1, Table 4.2.2.2-2 and Table 4.2.2.2-3, as re-used from TS 38.104 [9].

Table 4.2.2.2-1: NR Wide Area BS reference sensitivity levels

|  |  |  |  |
| --- | --- | --- | --- |
| *BS channel bandwidth* (MHz) | Sub-carrier spacing (kHz) | Reference measurement channel | Reference sensitivity power level, PREFSENS  (dBm) |
| 3 | 15 | G-FR1-A1-7 (Note 1) | -103.6 |
| G-FR1-A1-21 (Note 6) | -103.6 |
| 5, 10, 15 | 15 | G-FR1-A1-1 (Note 1) | -101.7 |
|  |  | G-FR1-A1-10 (Note 3) | -101.7 (Note 2) |
| 10, 15 | 30 | G-FR1-A1-2 (Note 1) | -101.8 |
| 10, 15 | 60 | G-FR1-A1-3 (Note 1) | -98.9 |
| 20, 25, 30, 35, 40, 45, 50 | 15 | G-FR1-A1-4 (Note 1) | -95.3 |
|  |  | G-FR1-A1-11 (Note 4) | -95.3 (Note 2) |
| 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | 30 | G-FR1-A1-5 (Note 1) | -95.6 |
| 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | 60 | G-FR1-A1-6 (Note 1) | -95.7 |
| NOTE 1: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of the reference measurement channel mapped to disjoint frequency ranges with a width corresponding to the number of resource blocks of the reference measurement channel each, except for one instance that might overlap one other instance to cover the full *BS channel bandwidth*.  NOTE 2: The requirements apply to BS that supports NB-IoT operation in NR in-band.  NOTE 3: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-10 mapped to the 24 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-1 mapped to disjoint frequency ranges with a width of 25 resource blocks each.  NOTE 4: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-11 mapped to the 105 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-4 mapped to disjoint frequency ranges with a width of 106 resource blocks each.  NOTE 6: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-21 mapped to the 12 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-7 mapped to disjoint frequency ranges with a width of 15 resource blocks each. | | | |

Table 4.2.2.2-2: NR Medium Range BS reference sensitivity levels

|  |  |  |  |
| --- | --- | --- | --- |
| *BS channel bandwidth* (MHz) | Sub-carrier spacing (kHz) | Reference measurement channel  (Note 5) | Reference sensitivity power level, PREFSENS  (dBm) |
| 3 | 15 | G-FR1-A1-7 (Note 1) | -98.6 |
| G-FR1-A1-21 (Note 6) | -98.6 |
| 5, 10, 15 | 15 | G-FR1-A1-1 (Note 1) | -96.7 |
|  |  | G-FR1-A1-10 (Note 3) | -96.7 (Note 2) |
| 10, 15 | 30 | G-FR1-A1-2 (Note 1) | -96.8 |
| 10, 15 | 60 | G-FR1-A1-3 (Note 1) | -93.9 |
| 20, 25, 30, 35, 40, 45, 50 | 15 | G-FR1-A1-4 (Note 1) | -90.3 |
|  |  | G-FR1-A1-11 (Note 4) | -90.3 (Note 2) |
| 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | 30 | G-FR1-A1-5 (Note 1) | -90.6 |
| 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | 60 | G-FR1-A1-6 (Note 1) | -90.7 |
| Note 1: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of the reference measurement channel mapped to disjoint frequency ranges with a width corresponding to the number of resource blocks of the reference measurement channel each, except for one instance that might overlap one other instance to cover the full *BS channel bandwidth*.  Note 2: The requirements apply to BS that supports NB-IoT operation in NR in-band.  Note 3: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-10 mapped to the 24 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-1 mapped to disjoint frequency ranges with a width of 25 resource blocks each.  Note 4: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-11 mapped to the 105 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-4 mapped to disjoint frequency ranges with a width of 106 resource blocks each.  Note 5: These reference measurement channels are not applied for band n46, n96 and n102.  Note 6: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-21 mapped to the 12 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-7 mapped to disjoint frequency ranges with a width of 15 resource blocks each. | | | |

Table 4.2.2.2-3: NR Local Area BS reference sensitivity levels

|  |  |  |  |
| --- | --- | --- | --- |
| *BS channel bandwidth* (MHz) | Sub-carrier spacing (kHz) | Reference measurement channel  (Note 5) | Reference sensitivity power level, PREFSENS  (dBm) |
| 3 | 15 | G-FR1-A1-7 (Note 1) | -95.6 |
| G-FR1-A1-21 (Note 6) | -95.6 |
| 5, 10, 15 | 15 | G-FR1-A1-1 (Note 1) | -93.7 |
|  |  | G-FR1-A1-10 (Note 3) | -93.7 (Note 2) |
| 10, 15 | 30 | G-FR1-A1-2 (Note 1) | -93.8 |
| 10, 15 | 60 | G-FR1-A1-3 (Note 1) | -90.9 |
| 20, 25, 30, 35, 40, 45, 50 | 15 | G-FR1-A1-4 (Note 1) | -87.3 |
|  |  | G-FR1-A1-11 (Note 4) | -87.3 (Note 2) |
| 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | 30 | G-FR1-A1-5 (Note 1) | -87.6 |
| 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | 60 | G-FR1-A1-6 (Note 1) | -87.7 |
| Note 1: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of the reference measurement channel mapped to disjoint frequency ranges with a width corresponding to the number of resource blocks of the reference measurement channel each, except for one instance that might overlap one other instance to cover the full *BS channel bandwidth*.  Note 2: The requirements apply to BS that supports NB-IoT operation in NR in-band.  Note 3: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-10 mapped to the 24 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-1 mapped to disjoint frequency ranges with a width of 25 resource blocks each.  Note 4: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-11 mapped to the 105 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-4 mapped to disjoint frequency ranges with a width of 106 resource blocks each.  Note 5: These reference measurement channels are not applied for band n46, n96 and n102.  Note 6: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of G-FR1-A1-21 mapped to the 12 NR resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of G-FR1-A1-7 mapped to disjoint frequency ranges with a width of 15 resource blocks each. | | | |

#### 4.2.2.3 Blocking response

The BS blocking characteristics is listed in Table 4.2.2.3-1, Table 4.2.2.3-2, Table 4.2.2.3-3 and Table 4.2.2.3-4, are re-used from TS 38.104 [9].

The in-band blocking requirement shall apply from FUL,low - ΔfOOB to FUL,high + ΔfOOB. The ΔfOOB for *BS type 1-C* and *BS type 1-H* is defined in Table 4.2.2.3-1.

Table 4.2.2.3-1: ΔfOOB offset for NR *operating bands*

|  |  |  |
| --- | --- | --- |
| BS type | *Operating band* characteristics | ΔfOOB (MHz) |
|  | FUL,high – FUL,low ≤ 200 MHz | 20 |
| *BS type 1-C* | 200 MHz < FUL,high – FUL,low ≤ 900 MHz | 60 |
|  |  |  |
|  | FUL,high – FUL,low < 100 MHz | 20 |
| *BS type 1-H* | 100 MHz ≤ FUL,high – FUL,low ≤ 900 MHz | 60 |
|  |  |  |

Table 4.2.2.3-2: Base station general blocking requirement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *BS channel bandwidth* of the *lowest/highest carrier* received (MHz) | Wanted signal mean power (dBm)  (Note 2) | Interfering signal mean power (dBm) | Interfering signal centre 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 |
| 3 | PREFSENS + x dB | Wide Area BS: -43  Medium Range BS: -38  Local Area BS: -35 | ±4.5 | 3 MHz DFT-s-OFDM NR signal  15 kHz SCS, 15 RBs |
| 5, 10, 15, 20 | PREFSENS + x dB | Wide Area BS: -43  Medium Range BS: -38  Local Area BS: -35 | ±7.5 | 5 MHz DFT-s-OFDM NR signal  15 kHz SCS, 25 RBs |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | PREFSENS + x dB | Wide Area BS: -43  Medium Range BS: -38  Local Area BS: -35 | ±30 | 20 MHz DFT-s-OFDM NR signal  15 kHz SCS, 100 RBs |
| NOTE 1: PREFSENS depends on the RAT. For NR, PREFSENS depends also on the *BS channel bandwidth* as specified in tables 7.2.2-1, 7.2.2-2 and 7.2.2-3. For band n104, PREFSENS depends on the *BS channel bandwidth* as specified in tables 7.2.2-1a, 7.2.2-2c, and 7.2.2-3c. For NB-IoT, PREFSENS depends also on the *sub-carrier spacing* as specified in tables 7.2.1-5, 7.2.1-5a and 7.2.1-5c of TS 36.104 [10].  NOTE 2: For a BS capable of single band operation only, "x" is equal to 6 dB. For a BS capable of multi-band operation, "x" is equal to 6 dB in case of interfering signals that are in the in-band blocking frequency range of the operating band where the wanted signal is present or in the in-band blocking frequency range of an adjacent or overlapping operating band. For other in-band blocking frequency ranges of the interfering signal for the supported operating bands, "x" is equal to 1.4 dB. | | | | |

Table 4.2.2.3-3: Base Station narrowband blocking requirement

|  |  |  |
| --- | --- | --- |
| *BS channel bandwidth* of the *lowest/highest carrier* received (MHz) | Wanted signal mean power (dBm) | Interfering signal mean power (dBm) |
| 3, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80,90, 100 (Note 1) | PREFSENS + 6 dB | Wide Area BS: -49  Medium Range BS: -44  Local Area BS: -41 |
| NOTE 1: The SCS for the *lowest/highest carrier* received is the lowest SCS supported by the BS for that *BS channel bandwidth*  NOTE 2: PREFSENS depends on the *BS channel bandwidth* as specified in tables 7.2.2-1, 7.2.2-2 and 7.2.2-3.  NOTE 3: 7.5 kHz shift is not applied to the wanted signal. | | |

Table 4.2.2.3-4: Base Station narrowband blocking interferer frequency offsets

|  |  |  |
| --- | --- | --- |
| *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 |
| 3 | ±(255+m\*180),  m=0, 1, 2, 3, 4, 7, 10, 13 | 3 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 1 RB |
| 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 |  |
| 35 | ±(560+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 |  |
| 45 | ±(570+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 |  |
| NOTE 1: Interfering signal consisting of one resource block positioned at the stated offset, the *channel bandwidth* of the interfering signal is located adjacently to the lower/upper *Base Station RF Bandwidth edge* or *sub-block* edge inside a *sub-block gap*.  NOTE 2: The centre of the interfering RB refers to the frequency location between the two central subcarriers. | | |

The out-of-band blocking requirement apply listed in Table 4.2.2.3-5 shall apply from 1 MHz to FUL,low - ΔfOOB and from FUL,high + ΔfOOB up to 12750 MHz.

Table 4.2.2.3-5: Out-of-band blocking performance requirement for NR

|  |  |  |
| --- | --- | --- |
| Wanted Signal mean power (dBm) | Interfering Signal mean power (dBm) | Type of Interfering Signal |
| PREFSENS +6 dB (Note) | -15 | CW carrier |
| NOTE 1: PREFSENS depends on the RAT. For NR, PREFSENS depends also on the *BS channel bandwidth* as specified in Table 7.2.2-1, 7.2.2-2, and 7.2.2-3. For band n104, PREFSENS depends on the *BS channel bandwidth* as specified in tables 7.2.2-1a, 7.2.2-2c, and 7.2.2-3c. For NB-IoT, PREFSENS depends also on the *sub-carrier spacing* as specified in tables 7.2.1-5, 7.2.1-5a and 7.2.1-5c of TS 36.104 [13].  NOTE 2: For NB-IoT, up to 24 exceptions are allowed for spurious response frequencies in each wanted signal frequency when measured using a 1MHz step size. For these exceptions the above throughput requirement shall be met when the blocking signal is set to a level of -40 dBm for 15 kHz subcarrier spacing and -46 dBm for 3.75 kHz subcarrier spacing. In addition, each group of exceptions shall not exceed three contiguous measurements using a 1MHz step size. | | |

The blocking requirement for co-location with BS in other bands is listed in Table 4.2.2.3-6.

Table 4.2.2.3-6: Blocking performance requirement for NR BS when co-located with BS in other frequency bands.

| 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* | PREFSENS +6dB (Note 1) | +16 | +8 | x (Note 2) | CW carrier |
| NOTE 1: PREFSENS depends on the *BS channel bandwidth* as specified in Table 7.2.2-1, 7.2.2-2, and 7.2.2-3.  NOTE 2: x = -7 dBm for NR BS co-located with Pico GSM850 or Pico CDMA850 x = -4 dBm for NR BS co-located with Pico DCS1800 or Pico PCS1900 x = -6 dBm for NR BS co-located with UTRA bands or E-UTRA bands or NR bands  NOTE 3: The requirement does not apply when the interfering signal falls within any of the supported uplink *operating band(s)* or in ΔfOOB immediately outside any of the supported uplink *operating band(s)*.  NOTE 4: For unsynchronized base stations (except in band n46, n96 and n102), special co-location requirements may apply that are not covered by the 3GPP specifications. | | | | | |

#### 4.2.2.4 ACS

The BS ACS is listed in Table 4.2.2.4-1 and Table 4.2.2.4-2, as re-used from TS 38.104 [9].

Table 4.2.2.4-1: Base station ACS requirement

|  |  |  |
| --- | --- | --- |
| *BS channel bandwidth* of the lowest/*highest carrier* received (MHz) | Wanted signal mean power (dBm) | Interfering signal mean power (dBm) |
| 3 | PREFSENS + 8 dB | Wide Area BS: -52  Medium Range BS: -47  Local Area BS: -44 |
| 5, 10, 15, 20,  25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100  (Note 1) | PREFSENS + 6 dB |
| NOTE 1: The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth.  NOTE 2: PREFSENS depends on the RAT. For NR, PREFSENS depends also on the *BS channel bandwidth* as specified in tables 7.2.2-1, 7.2.2-2, 7.2.2-3. For NB-IoT, PREFSENS depends also on the *sub-carrier spacing* as specified in tables 7.2.1-5, 7.2.1-5a and 7.2.1-5c of TS 36.104 [10]. | | |

Table 4.2.2.4-2: Base Station ACS interferer frequency offset values

|  |  |  |
| --- | --- | --- |
| *BS channel bandwidth* of the *lowest/highest carrier* received (MHz) | Interfering signal centre 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 |
| 3 | ±1.5075 | 3 MHz DFT-s-OFDM NR signal  15 kHz SCS, 15 RBs |
| 5 | ±2.5025 |  |
| 10 | ±2.5075 | 5 MHz DFT-s-OFDM NR signal |
| 15 | ±2.5125 | 15 kHz SCS, 25 RBs |
| 20 | ±2.5025 |  |
| 25 | ±9.4675 |  |
| 30 | ±9.4725 |  |
| 35 | ±9.4625 |  |
| 40 | ±9.4675 |  |
| 45 | ±9.4725 |  |
| 50 | ±9.4625 | 20 MHz DFT-s-OFDM NR signal |
| 60 | ±9.4725 | 15 kHz SCS, 100 RBs |
| 70 | ±9.4675 |  |
| 80 | ±9.4625 |  |
| 90 | ±9.4725 |  |
| 100 | ±9.4675 |  |

## 4.3 UE parameters

### 4.3.1 Transmitter characteristics

#### 4.3.1.1 Power dynamic range

The minimum controlled output power of the UE is defined as the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks) when the power is set to a minimum value. For Rel-18 FR1 bands, the minimum output power is -33 dBm for 100 MHz channel bandwidth. Hence, the power dynamic range is 56 dB for 100 MHz channel bandwidth with power class 3 (i.e. 23 dBm maximum output power) UE.

#### 4.3.1.2 Spectral mask

The UE spectral mask is described in Table 4.3.1.2-1.

Table 4.3.1.2-1: General NR spectrum emission mask

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ΔfOOB  (MHz)** | **Channel bandwidth (MHz) / Spectrum emission limit (dBm)** | | | | **Measurement bandwidth** |
| **3** | **5** | **10, 15, 20, 25, 30, 35, 40, 45** | **50, 60, 70, 80, 90, 100** |
| ± 0-1 | -13 | -13 | -13 |  | 1 % of channel BW |
| ± 0-1 |  |  |  | -24 | 30 kHz |
| ± 1-5 | -10 | -10 | -10 | | 1 MHz |
| ± 5-6 | -25 | -13 |  | |
| ± 6-10 |  | -25 |  | |
| ± 5-BWChannel |  |  | -13 | |
| ± BWChannel-(BWChannel+5) |  |  | -25 | |

#### 4.3.1.3 ACLR

The UE ACLR requirement is listed in Table 4.3.1.3-1.

Table 4.3.1.3-1: NR ACLR requirement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Power class 1 | Power class 1.5 | Power class 2 | Power class 3 |
| NR ACLR | 37 dB | 31 dB | 31 dB | 30 dB |

#### 4.3.1.4 Spurious emissions

The UE spurious emission requirement is captured in Table 4.3.1.4-1 and Table 4.3.1.4-2.

Table 4.3.1.4-1: Boundary between NR out of band and general spurious emission domain

|  |  |
| --- | --- |
| Channel bandwidth | OOB boundary FOOB (MHz) |
| 3 | 6 |
| 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | BWChannel + 5 |

Table 4.3.1.4-2: Requirement for general spurious emissions limits

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | Maximum Level | Measurement bandwidth | NOTE |
| 9 kHz ≤ f < 150 kHz | -36 dBm | 1 kHz |  |
| 150 kHz ≤ f < 30 MHz | -36 dBm | 10 kHz |  |
| 30 MHz ≤ f < 1000 MHz | -36 dBm | 100 kHz |  |
| 1 GHz ≤ f < 12.75 GHz | -30 dBm | 1 MHz | 4 |
| -25 dBm | 1 MHz | 3 |
| 12.75 GHz ≤ f < 5th harmonic of the upper frequency edge of the UL operating band in GHz | -30 dBm | 1 MHz | 1 |
| 12.75 GHz < f < 26 GHz | -30 dBm | 1 MHz | 2 |
| NOTE 1: Applies for Band for which the upper frequency edge of the UL Band is greater than 2.55 GHz and less than or equal to 5.2 GHz  NOTE 2: Applies for Band that the upper frequency edge of the UL Band more than 5.2 GHz  NOTE 3: Applies for Band n41, CA configurations including Band n41, and EN-DC configurations that include n41 specified in clause 5.2B of TS 38.101-3 [11] when NS\_04 is signalled.  NOTE 4: Does not apply for Band n41, CA configurations including Band n41, and EN-DC configurations that include n41 specified in subclause 5.2B of TS 38.101-3 [11] when NS\_04 is signalled. | | | |

#### 4.3.1.5 Maximum output power

The UE maximum output power requirement is listed in Table 4.3.1.5-1.

Table 4.3.1.5-1: UE Power Class

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR  band | Class 1 (dBm) | Tolerance (dB) | Class 1.5 (dBm) | Tolerance (dB) | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) |
| n79 |  |  | 295 | +2/-3 | 26 | +2/-3 | 23 | +2/-3 |
| NOTE 1: PPowerClass is the maximum UE power specified without taking into account the tolerance  NOTE 2: Powerclass 3 is default power class unless otherwise stated  NOTE 3: Refers to the transmission bandwidths confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high – 4 MHz and FUL\_high, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB.  NOTE 4: The maximum output power requirement is relaxed by reducing the lower tolerance limit by 0.3 dB  NOTE 5: Achieved via dual Tx  NOTE 6: Generally, PC1 UE is not targeted for smartphone form factor. | | | | | | | | |

#### 4.3.1.6 Average output power

It was agreed the average output power won’t be mentioned in the reply LS to WP5D in [4].

### 4.3.2 Receiver characteristics

#### 4.3.2.1 Noise figure

The UE noise figure is 9 dB.

#### 4.3.2.2 Sensitivity

The UE sensitivity requirement limits applicable for band n79 are re-used. Related extracts from TS 38.101-1 [12] is listed in Table 4.3.2.2-1.

**Table 4.3.2.2-1: Two antenna port reference sensitivity QPSK PREFSENS for TDD, SDL and FDD with variable duplex operation bands**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Operating band / SCS / Channel bandwidth / REFSENS** | | | | |
| **Operating band** | **SCS**  **kHz** | **Channel bandwidth (MHz)** | **REFSENS (dBm)** | **Duplex Mode** |
| n79 | 15 | 10, 20, 30, 40, 50 | -95.8 + 10log10(NRB/52) | TDD |
| 30 | 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 | -96.1 + 10log10(NRB/24) |
| 60 | 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 | -96.5 + 10log10(NRB/11) |

#### 4.3.2.3 Blocking response

The UE blocking requirement is listed in Table 4.3.2.3-1, Table 4.3.2.3-2, Table 4.3.2.3-3 and Table 4.3.2.3-4, as re-used from TS 38.101-1 [12].

**Table 4.3.2.3-1: In-band blocking parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz**

|  |  |  |
| --- | --- | --- |
| **RX parameter** | **Units** | **Channel bandwidth (MHz)** |
|  |  | **10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100** |
| Power in transmission bandwidth configuration | dBm | REFSENS + 6 dB3 |
| BWinterferer | MHz | BWChannel |
| FIoffset, case 1 | MHz | (3/2)\*BWChannel |
| FIoffset, case 2 | MHz | (5/2)\*BWChannel |
| NOTE 1: The transmitter shall be set to 4 dB below PCMAX\_L,f,c at the minimum UL configuration specified in Table 7.3.2-3 with PCMAX\_L,f,c defined in clause 6.2.4.  NOTE 2: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1  NOTE 3: For Band n104, the power in transmission bandwidth configuration is REFSENS + 9 dB | | |

Table 4.3.2.3-2: In-band blocking for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Case 1 | Case 2 |
|  | Pinterferer | dBm | -56 | -44 |
| n77, n78, n79, n104 | Finterferer (offset) | MHz | -BWChannel/2 –  FIoffset, case 1  and  BWChannel/2 +  FIoffset, case 1 | ≤ -BWChannel/2 –  FIoffset, case 2  and  ≥ BWChannel/2 +  FIoffset, case 2 |
|  | Finterferer |  | NOTE 2 | FDL\_low – 3\*BWChannel  to  FDL\_high + 3\*BWChannel |
| NOTE 1: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: -BWChannel/2 – FIoffset, case 1; b: BWChannel/2 + FIoffset, case 1  NOTE 3: BWChannel denotes the channel bandwidth of the wanted signal | | | | |

**Table 4.3.2.3-3: Out-of-band blocking parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **RX parameter** | **Units** | **Channel bandwidth (MHz)** | | |
|  |  | **10** | **15** | **20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100** |
| Power in transmission bandwidth configuration | dBm | REFSENS + 6 dB | REFSENS + 7 dB | REFSENS + 9 dB |
| NOTE: The transmitter shall be set to 4 dB below PCMAX\_L,f,c at the minimum UL configuration specified in Table 7.3.2-3 with PCMAX\_L,f,c defined in clause 6.2.4. | | | | |

Table 4.3.2.3-4: Out of-band blocking for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Range1 | Range 2 | Range 3 |
| n79 (NOTE 4) | Finterferer (CW) | MHz | N/A | -150 < f – FDL\_low ≤ -MAX(60,3\*BWChannel)  or  MAX(60,3\*BWChannel) ≤ f – FDL\_high < 150 | 1 ≤ f ≤ FDL\_low – MAX(150,3\*BWChannel)  or  FDL\_high + MAX(150,3\*BWChannel)  ≤ f ≤ 12750 |
| NOTE 1: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm for FInterferer > 6000 MHz.  NOTE 2: BWChannel denotes the channel bandwidth of the wanted signal  NOTE 3: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 2700 MHz and FInterferer < 4800 MHz. For BWChannel > 15 MHz, the requirement for Range 1 is not applicable and Range 2 applies from the frequency offset of 3\*BWChannel from the band edge. For BWChannel larger than 60 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3\*BWChannel from the band edge.  NOTE 4: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 3650 MHz and FInterferer < 5750 MHz. For BWChannel ≥ 40 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3\*BWChannel from the band edge.  NOTE 5: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 5175 MHz. For BWChannel > 60 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3\*BWChannel from the band edge. The power level of the interferer (PInterferer) for Range 2 shall be modified to -33 dBm for the range 5925– MAX(60,3\*CBW) ≤ f < FDL\_low - MAX(60,3\*CBW). | | | | | |

#### 4.3.2.4 ACS

The UE ACS requirement is listed in Table 4.3.2.4-1 and Table 4.3.2.4-2, as re-used from TS 38.101-1 [12].

Table 4.3.2.4-1: Test parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz, case 1

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth (MHz) |
|  |  | 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 |
| Power in transmission bandwidth configuration | dBm | REFSENS + 14 dB |
| Pinterferer | dBm | REFSENS + 45.5 dB |
| BWinterferer | MHz | BWChannel |
| Finterferer (offset) | MHz | BWChannel  /  -BWChannel |
| NOTE 1: The transmitter shall be set to 4 dB below PCMAX\_L,f,c at the minimum UL configuration specified in Table 7.3.2-3 with PCMAX\_L,f,c defined in clause 6.2.4.  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1. | | |

Table 4.3.2.4-2: Test parameters for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz, case 2

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth (MHz) |
|  |  | 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 |
| Power in transmission bandwidth configuration | dBm | -56.5 |
| Pinterferer | dBm | -25 |
| BWinterferer | MHz | BWChannel |
| Finterferer (offset) | MHz | BWChannel  /  -BWChannel |
| NOTE 1: The transmitter shall be set to 24 dB below PCMAX\_L,f,c at the minimum UL configuration specified in Table 7.3.2-3 with PCMAX\_L,f,c defined in clause 6.2.4.  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1. | | |

## 4.4 Antenna characteristics

### 4.4.1 BS antenna characteristics

#### 4.4.1.1 Antenna model

The antenna model is described in clause 7.1.

#### 4.4.1.2 Antenna parameters

The BS antenna parameters are listed in Table 4.4.1.2-1.

**Table 4.4.1.2-1: IMT parameters relevant for 1710 to 4990 MHz**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Macro Rural** | **Macro suburban** | **Macro urban** | **Micro urban** |
| *Am* | 30 dB | 30 dB | 30 dB | 30 dB |
| *SLAv* | 30 dB | 30 dB | 30 dB | 30 dB |
| *3dB* | 90 deg. | 90 deg. | 90 deg. | 90 deg. |
| *3dB* | 65 deg. | 65 deg. | 65 deg. | 65 deg. |
| *GE,max* | 6.4 dBi | 6.4 dBi | 6.4 dBi | 6.4 dBi |
| *Msub* | 3 | 3 | 3 | N/A |
| *dv,sub* | 0.7l m | 0.7l m | 0.7l m | N/A |
| *subtilt* | 3 deg. | 3 deg. | 3 deg. | N/A |
| *M* | 4 | 4 | 4 | 8 |
| *N* | 8 | 8 | 8 | 8 |
| *dh* | 0.5l m | 0.5l m | 0.5l m | 0.5l m |
| *dv* | 2.1l m | 2.1l m | 2.1l m | 0.7l m |
| *etilt* | deg. | deg. | deg. | deg. |
| *escan* | deg. | deg. | deg. | deg. |
| *r* | 1 | 1 | 1 | 1 |
| *Ptx* | 46 dBm | 46 dBm | 46 dBm | 37 dBm |
| *mech* | 3 deg. | 6 deg. | 6 deg. | N/A |

### 4.4.2 UE antenna characteristics

The UE is expected to have a conducted interface assuming an isotropic radiation pattern antenna and without beamforming.

# 5 7125 - 8400 MHz frequency range

## 5.1 General parameters

### 5.1.1 Duplex mode

Even though FDD is not precluded, most likely TDD will be used in this frequency range. This frequency range is adjacent to existing TDD bands, e.g. n104 (6425 – 7125 MHz) and n79 (4400 – 5000 MHz), making also SBFD as a candidate duplexing method. The core requirements for Rel-19 SBFD work item can be tracked through the list of impacted specifications captured in [8].

### 5.1.2 Channel Bandwidth

While a number of channel bandwidth will be specified for this frequency range, 100 MHz is considered as a typical channel bandwidth. Higher channel bandwidths compared to 100MHz are not precluded for this range. Annex B entails additional information on the impact of higher channel bandwidth on ACIR.

### 5.1.3 Signal Bandwidth

The signal bandwidth for a 100 MHz channel bandwidth signal is calculated based on the NR spectrum utilization for 30 kHz SCS:

Signal bandwidth = NRB x SCS x 12

with NRB: Number of Resource block for 100 MHz channel bandwidth and 30kHz SCS, as specified in TS 38.104 [9], clause 5.3.2.

## 5.2 BS parameters

### 5.2.1 Transmitter characteristics

#### 5.2.1.1 Power dynamic range

There is no power control in downlink and fixed power per resource block is assumed during the study phase. Hence 0 dB power dynamic range was agreed for the LS reply.

#### 5.2.1.2 Spectral mask

Both Category A and B spectral mask are specified. Since the frequency range 7125 to 8400 MHz is just adjacent to existing NR band n104, it is proposed that existing spectral mask (Category B) for band n104 in TS 38.104 subclause 6.6.4 for conducted requirements and subclause 9.7.4.2 for radiated requirements are applicable for the range. Category A limits for Wide Area BS are specified in Table 5.2.1.2-1 for non-AAS BS and in Table 5.2.1.2-2 for AAS BS.

Table 5.2.1.2-1: Wide Area BS operating band unwanted emission limits for non-AAS BS (Category A)

| **Frequency offset of measurement filter ‑3dB point from the carrier frequency, Δf** | **Basic limits** | **Measurement Bandwidth** |
| --- | --- | --- |
| 0 MHz  f < 20MHz |  | 100 kHz |
| 20 MHz  f < min(40 MHz, fmax) | -14 dBm | 100 kHz |
| 40 MHz  f  fmax | -13 dBm | 1 MHz |
| NOTE: fmax is equal to f\_offsetmax minus half of the bandwidth of the measuring filter, where f\_offsetmax is the offset to the frequency ΔfOBUE = 40 MHz outside the downlink operating band. | | |

Table 5.2.1.2-2: Wide Area BS operating band unwanted emission limits for AAS BS (Category A)

| **Frequency offset of measurement filter ‑3dB point from the carrier frequency, Δf** | **Basic limits** | **Measurement Bandwidth** |
| --- | --- | --- |
| 0 MHz  f < 50MHz |  | 100 kHz |
| 50 MHz  f < min(100 MHz, fmax) | -5 dBm | 100 kHz |
| 100 MHz  f  fmax | -4 dBm | 1 MHz |
| NOTE: fmax is equal to f\_offsetmax minus half of the bandwidth of the measuring filter, where f\_offsetmax is the offset to the frequency ΔfOBUE = 100 MHz outside the downlink operating band. | | |

#### 5.2.1.3 ACLR

It is agreed to re-use n104 ACLR. The ACLR should be higher than the value specified in Table 5.2.1.3-1.

Table 5.2.1.3-1: Base station ACLR limit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *BS channel bandwidth* of *lowest/highest carrier* transmitted BWChannel (MHz) | BS adjacent channel centre frequency offset below the lowest or above the highest carrier centre frequency transmitted | Assumed adjacent channel carrier (informative) | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit |
| 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90,100 | BWChannel | NR of same BW (Note 2) | Square (BWConfig) | 38 dB |
|  | 2 x BWChannel | NR of same BW (Note 2) | Square (BWConfig) | 38 dB |
| NOTE 1: BWChannel and BWConfig are the *BS channel bandwidth* and *transmission bandwidth configuration* of the *lowest/highest carrier* transmitted on the assigned channel frequency.  NOTE 2: With SCS that provides largest transmission bandwidth configuration (BWConfig). | | | | |

#### 5.2.1.4 Spurious emissions

The general spurious emissions in TS 38.104 subclause 6.6.5 are applicable for the frequency range 7125 to 8400 MHz. It is agreed to adopt ΔfOBUE = 40 MHz for non-AAS BS and ΔfOBUE = 100 MHz for AAS BS.



#### 5.2.1.5 Maximum output power

The maximum output power will be provided in the antenna parameter table. It was agreed to be aligned with antenna characteristics.

The Total Radiated Power (TRP) for two polarizations was agreed as shown in Table 5.2.1.5-1 below.

Table 5.2.1.5-1: Total Radiated Power

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Macro Sub-urban | Macro Urban | Micro Urban |
| Total Radiated Power for two polarizations (dBm) | 46 | 46 | 37 |

#### 5.2.1.6 Average output power

It was agreed the average output power won’t be mentioned in the reply LS in [5].

### 5.2.2 Receiver characteristics

#### 5.2.2.1 Noise figure

The typical Noise Figure for a Wide Area BS operating was agreed to be 6 dB (11 dB for Medium Range BS and 14 dB for Local Area BS).

#### 5.2.2.2 Sensitivity

The sensitivity is not a critical parameter for sharing and compatibility studies. It was agreed to not mention any value for this parameter.

#### 5.2.2.3 Blocking response

The in-band blocking requirement should apply from FUL,low - ΔfOOB to FUL,high + ΔfOOB, excluding the downlink frequency range of the FDD *operating band*. It is agreed to adopt ΔfOOB = 60 MHz for non-AAS BS and ΔfOOB = 100 MHz for AAS BS. The in-band blocking levels are reused from existing FR1 requirements.

Table 5.2.2.3-1: Base station general blocking requirement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| BS channel bandwidth of the lowest/highest carrier received (MHz) | Wanted signal mean power (dBm) | Interfering signal mean power (dBm) | Interfering signal centre 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 |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | PREFSENS + 6 dB | Wide Area BS: -43  Medium Range BS: -38  Local Area BS: -35 | ±30 | 20 MHz DFT-s-OFDM NR signal  15 kHz SCS, 100 RBs |
| NOTE: PREFSENS depends on the RAT. | | | | |

#### 5.2.2.4 ACS

It is agreed to specify 42 dB.

## 5.3 UE parameters

### 5.3.1 Transmitter characteristics

#### 5.3.1.1 Power dynamic range

The minimum controlled output power of the UE is defined as the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value. For existing FR1 bands, the minimum output power is -33 dBm for 100 MHz channel bandwidth. The minimum output power can be reused for 7.125 – 8.4 GHz, i.e. power dynamic range is 56 dB for 100 MHz channel bandwidth.

#### 5.3.1.2 Spectral mask

The UE spectral mask is described in Table 5.3.1.2-1.

Table 5.3.1.2-1: General NR spectrum emission mask

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ΔfOOB  (MHz)** | **Channel bandwidth (MHz) / Spectrum emission limit (dBm)** | | | | **Measurement bandwidth** |
| **3** | **5** | **10, 15, 20, 25, 30, 35, 40, 45** | **50, 60, 70, 80, 90, 100** |
| ± 0-1 | -13 | -13 | -13 |  | 1 % of channel BW |
| ± 0-1 |  |  |  | -24 | 30 kHz |
| ± 1-5 | -10 | -10 | -10 | | 1 MHz |
| ± 5-6 | -25 | -13 |  | |
| ± 6-10 |  | -25 |  | |
| ± 5-BWChannel |  |  | -13 | |
| ± BWChannel-(BWChannel+5) |  |  | -25 | |

#### 5.3.1.3 ACLR

According to the previous studies and simulation results in TR 38.921 [14] sub-clause 4.3, it was concluded that 26 dB ACLR would be sufficient for 6.425 - 7.125 GHz. Thus, ACLR of 26dB can be considered for the frequency range 7.125 – 8.4 GHz.

The actual ACLR for this frequency range or parts there-of should be further studied in the WI phase.

#### 5.3.1.4 Spurious emissions

The general spurious emissions defined in TS 38.101-1 [12] clause 6.5.3.1 can apply to the frequency range 7.125 – 8.4 GHz.

#### 5.3.1.5 Maximum output power

The UE maximum output power for the considered frequency ranges could be 23 dBm. Other UE power classes, e.g. 20dBm, 26dBm and 29dBm, are not precluded (corresponding ACLR limit will be adapted accordingly to avoid additional interference). Annex B entails additional information on the impact of higher output power on ACIR.

#### 5.3.1.6 Average output power

NOTE: This parameter was not mentioned in the previous response to ITU-R WP5D.

### 5.3.2 Receiver characteristics

#### 5.3.2.1 Noise figure

A noise figure in the [9, 13] dB interval was agreed for 6.425 - 7.125 GHz in the previous response to ITU-R WP5D sharing studies. The noise figure of 12 dB was assumed for the 3GPP band n104. For the frequency range 7.125 – 8.4 GHz noise figure of 13dB can be assumed.

The actual noise figure for this frequency range or parts there-of to define RF requirements should be further studied in the WI phase.

#### 5.3.2.2 Sensitivity

The sensitivity is not a critical parameter for sharing and compatibility studies. It was agreed to not mention any value for this parameter.

#### 5.3.2.3 Blocking response

The blocking characteristic specified in clause 7.6 of TS 38.101-1 [12] for frequency larger than 3300 MHz could be applied for the frequency range 7.125 – 8.4 GHz.

The actual requirements for this frequency range or parts there-of may differ depending on the band plan and possible re-use of RF hardware components.

#### 5.3.2.4 ACS

According to the previous studies and simulation results in TR 38.921 [14] sub-clause 4.3, adjacent channel selectivity (ACS) is agreed as 32 dBc for 6425 – 7125 MHz. Thus, ACS of 32dB can be considered for the frequency range 7.125 – 8.4 GHz.

The actual ACS for this frequency range or parts there-of should be further studied in the WI phase.

## 5.4 Antenna characteristics

### 5.4.1 BS antenna characteristics

#### 5.4.1.1 Antenna model

See antenna model in sub-clause 4.4.1.1.

#### 5.4.1.2 Antenna parameters

**Table 5.2.2.3-1: Beamforming antenna characteristics for IMT in 7125 to 8400 MHz**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Macro suburban** | **Macro urban** | **Small cell outdoor/ Micro urban** | **Small cell indoor/ Indoor urban** |
| **1** | **Base station Antenna Characteristics** | | | | |
| 1.1 | Antenna pattern | Table 3 | | Refer to Recommendation [ITU-R M.2101](https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2101-0-201702-I!!PDF-E.pdf) | N/A |
| 1.2 | Element gain (dBi) (Note 2) | 6.4 | 6.4 | 6.4 | N/A |
| 1.3 | Horizontal/vertical 3 dB beam width of single element (degree) | 90º for H 65º for V | 90º for H 65º for V | 90º for H 65º for V | N/A |
| 1.4 | Horizontal/vertical front‑to‑back ratio (dB) | 30 for both H/V | 30 for both H/V | 30 for both H/V | N/A |
| 1.5 | Antenna polarization | Linear ±45º polarized sub-array | Linear ±45º polarized sub-array | Linear ±45º polarized sub-array | N/A |
| 1.6 | Antenna array configuration (Row × Column)  (Note 4) | 8 x 16 | 8 x 16 | 8 × 8 | N/A |
| 1.7 | Horizontal/Vertical radiating sub-array or element spacing (Note 5) | 0.5 of wavelength for H, 2.1 of wavelength for V | 0.5 of wavelength for H, 2.1 of wavelength for V | 0.5 of wavelength for H, 0.7 of wavelength for V | N/A |
| 1.7a | Number of element rows in sub-array | 3 | 3 | N/A | N/A |
| 1.7b | Vertical element separation in sub-array () | 0.7 of wavelength for V | 0.7 of wavelength for V | N/A | N/A |
| 1.7c | Pre-set sub-array down-tilt (degrees) (Note 6) | 3 | 3 | N/A | N/A |
| 1.8 | Array Ohmic loss (dB) (Note 2) | 2 | 2 | 2 | N/A |
| 1.9 | Conducted power (before Ohmic loss) per sub-array or element (dBm) (Note 3) | 22 | 22 | 16 | N/A |
| 1.10 | Base station horizontal coverage range (degrees) | +/-60 | +/-60 | +/-60 | N/A |
| 1.11 | Base station vertical coverage range (degrees) (Note 1) | 90-100 | 90-100 | 90-120 | N/A |
| 1.12 | Mechanical down-tilt (degrees) | 6 | 6 | N/A | N/A |
| 1.13 | Base station output power/sector (e.i.r.p.) (dBm) (Note 7) | 78.3 | 78.3 | 61.5 | N/A |

Note 1: The vertical coverage range is given in global coordinate system, i.e., 90° being at the horizon. This range includes the mechanical down-tilt given in row 1.12.

Note 2: The element gain in row 1.2 includes the loss given in row 1.8 and is per polarization.

Note 3: Conducted power values are per polarization. The conducted power per sub-array assumes 16 × 8 sub-arrays and 2 polarizations for the suburban and urban macro cases; the conducted power per element assumes 8 × 8 elements and 2 polarizations for the small cell outdoor/micro urban case. This power is typical power, there is no upper limit for Wide Area Base station (For BS class definitions, see 3GPP TS 38.104, § 4.4).

Note 4: 16 × 8 means there are 16 rows and 8 columns of radiating sub-arrays for macro suburban and macro urban cases. 8 × 8 means there are 8 rows and 8 columns of radiating elements for the small cell outdoor/micro urban case.

Note 5: For the case of 3 elements per sub-array, dv will be 2.1 wavelengths.

Note 6: The pre-set sub array down-tilt is a fixed design parameter for a base station. It is envisaged as a passive fixed (non-varying) electrical tilt within the sub-array elements.

Note 7: The base station e.i.r.p per sector is calculated as total power (including power from two orthogonal polarizations).

Note 8: Mechanical down-tilt is handled by a coordinate system transformation described in 3GPP TR 36.814 section A.2.1.6.2.

Note 9: and is the BS array antenna beam steering direction used in Table 3, they should be set so that the beam steering direction is within the vertical and horizontal coverage ranges in row 1.11 and row 1.10, respectively.

### 5.4.2 UE antenna characteristics

The outcome of the RAN WG4 study in TR 38.820 for collecting technical background information relevant for the frequency range 7 to 24 GHz indicated that the frequency range 7.125 - [10-13] GHz would have "FR1 like" requirements. Therefore, a UE implementing the frequency range 7.125 – 8.4 GHz range will have a conducted interface with an assumed isotropic radiation pattern antenna and no analog beamforming.

# 6 14800 - 15350 MHz frequency range

## 6.1 Co-existence study

### 6.1.1 Co-existence simulation scenarios

Table 6.1.1 summarizes the proposed initial simulation scenarios for 14800 - 15350 MHz.

Table 6.1.1-1: Summary of initial simulation scenarios for 14800 - 15350 MHz

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Usage scenario | Aggressor | Victim | Direction | Simulation frequency | Deployment Scenario | Priority |
| 1 | eMBB | NR, 100/200 MHz | Same as aggressor | DL to DL | 15 GHz | Indoor hotspot | Second |
| 2 | eMBB | NR, 100/200 MHz | Same as aggressor | DL to DL | 15 GHz | Urban macro | First |
| 3 | eMBB | NR, 100/200 MHz | Same as aggressor | DL to DL | 15 GHz | Dense urban | Third |
| 4 | eMBB | NR, 100/200 MHz | Same as aggressor | UL to UL | 15 GHz | Indoor hotspot | Second |
| 5 | eMBB | NR, 100/200 MHz | Same as aggressor | UL to UL | 15 GHz | Urban macro | First |
| 6 | eMBB | NR, 100/200 MHz | Same as aggressor | UL to UL | 15 GHz | Dense urban | Third |

### 6.1.2 Co-existence simulation assumption

#### 6.1.2.1 Network layout model

##### 6.1.2.1.1 Urban macro

Details on urban macro network layout model are listed in Table 6.1.2.1.1-1 and 6.1.2.1.1-2.

Table 6.1.2.1.1-1: Single operator layout for urban macro

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | | Values | Remark |
| Network layout | | hexagonal grid, 19 macro sites, 3 sectors per site with wrap around |  |
| Inter-site distance | | 450 m |  |
| BS antenna height | | 25 m |  |
| UE location | Outdoor/indoor | Outdoor and indoor |  |
| Indoor UE ratio | 20/0% |  |
| Low/high Penetration loss ratio | 50% low loss, 50% high loss |  |
| LOS/NLOS | LOS and NLOS |  |
| UE antenna height | Same as 3D-UMa in TR 36.873 |  |
| UE distribution (horizontal) | | Uniform |  |
| Minimum BS - UE distance (2D) | | 35 m |  |
| Channel model | | UMa |  |
| Shadowing correlation | | Between cells: 1.0  Between sites: 0.5 |  |

Table 6.1.2.1.1-2: Multi operators layout for urban macro

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Multi operators layout | Un-coordinated operation (0/100% Grid Shift) for FR1-like UE with omni-directional UE antenna and no beamforming (only for simulation and not reflecting deployment, coverage, implementation, or requirement aspects) |  |

|  |  |
| --- | --- |
| Coordinated Operation: each network with co-location of sites | zero grade shift macro |

Figure 6.1.2.1.1-1: Coordinated operation

A diagram of a cell range

Description automatically generated

Figure 6.1.2.1.1-2: Uncoordinated operation

##### 6.1.2.1.2 Dense urban

Details on dense urban network layout model are listed in Table 6.1.2.1.2-1 and 6.1.2.1.2-2.

Table 6.1.2.1.2-1: Single operator layout for dense urban

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | | Values | Remark |
| Network layout | | Fixed cluster circle within a macro cell. | note1 |
| Number of micro BSs per macro cell | | 3 | 3 cluster circles are in a macro cell. 1 cluster circle has 1 micro BS. |
| Radius of UE dropping within a micro cell | | < 65.03 m (first priority)  < 50.58 m (second priority)  < other (third priority) |  |
| BS antenna height | | 10 m |  |
| UE location | Outdoor/indoor | Outdoor and indoor |  |
| Indoor UE ratio | 80 % |  |
| 50% low loss, 50% high loss | Low/high Penetration loss ratio |  |
| LOS/NLOS | LOS and NLOS |  |
| UE antenna height | Same as 3D-UMi in TR 36.873 |  |
| UE distribution (horizontal) | | Uniform |  |
| Minimum BS - UE distance (2D) | | 3m |  |
| Channel model | | UMi |  |
| Shadowing correlation | | Between cite: 0.5 |  |
| Note 1: Micro BS is randomly dropped on an edge of the cluster circle. All UEs communicate with micro BS, i.e. macro cell is only used for determining position of micro BS. As a layout of macro cell, hexagonal grid, 19 macro sites, 3 sectors per site model with wrap around with ISD = 450/350/other m is assumed. | | | |

A diagram of a cell structure

Description automatically generated

Figure 6.1.2.1.2-1: Network layout for dense urban

Table 6.1.2.1.2-2: Multi operators layout for dense urban

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Multi operator layout | Cluster circle is coordinated | Note 1 |
| Minimum distance between micro BSs in different operator | 10 m |  |
| Note 1: Macro cell is collocated. Micro BS itself is randomly dropped. | | |

##### 6.1.2.1.3 Indoor

Details on indoor network layout model are listed in Table 6.1.2.1.3-1 and 6.1.2.1.3-2.

Table 6.1.2.1.3-1: Single operator layout for indoor

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | | Values | Remark |
| Network layout | | 50m x 120m, 12BSs |  |
| Inter-site distance | | 20m | Single sector per site |
| BS antenna height | | 3 m | Mounted on ceiling |
| UE location | Outdoor/indoor | Indoor |  |
| LOS/NLOS | LOS and NLOS |  |
| UE antenna height | 1 m |  |
| UE distribution (horizontal) | | Uniform |  |
| Minimum BS - UE distance (2D) | | 0 m |  |
| Channel model | | Indoor Office |  |
| Shadowing correlation | | NA |  |

A diagram of a diagram

Description automatically generated

Figure 6.1.2.1.3-1: Network layout for indoor

Table 6.1.2.1.3-2: Multi operators layout for indoor

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Multi operator layout | Coordinated operation (0% Grid Shift) |  |

#### 6.1.2.2 Propagation model

##### 6.1.2.2.1 Pathloss

The pathloss models are summarized in Table 6.1.2.2.1-1 and the distance definitions are indicated in Figure 6.1.2.2.1-1 and Figure 6.1.2.2.1-2. Note that the distribution of the shadow fading is log-normal, and its standard deviation for each scenario is given in Table 6.1.2.2.1-1.

|  |  |
| --- | --- |
|  |  |
| Figure 6.1.2.2.1-1: Definition of *d2D* and *d3D*  for outdoor UTs | Figure 6.1.2.2.1-2: Definition of *d2D-out*, *d2D-in*  and *d3D-out*, *d3D-in* for indoor UTs. |

Note that

 (6.1.2.2-1)

Table 6.1.2.2.1-1: Pathloss models

| Scenario | LOS/NLOS | Pathloss [dB], *fc* is in GHz and *d* is in meters, see note 6 | Shadow  fading  std [dB] | Applicability range,  antenna height  default values |
| --- | --- | --- | --- | --- |
| UMa | LOS | , see note 1 |  |  |
| NLOS | for |  | Explanations: see note 3 |
| Optional |  |  |
| UMi - Street Canyon | LOS | , see note 1 |  |  |
| NLOS | for |  | Explanations: see note 4 |
| Optional |  |  |
| InH - Office | LOS |  |  |  |
| NLOS |  |  |  |
| Optional |  |  |
| Note 1: Breakpoint distance *d*'BP = 4 *h*'BS *h*'UT *f*c/*c*, where *f*c is the centre frequency in Hz, *c* = 3.0×108 m/s is the propagation velocity in free space, and *h*'BS and *h*'UT are the effective antenna heights at the BS and the UT, respectively. The effective antenna heights *h*'BS and *h*'UT are computed as follows: *h*'BS = *h*BS – *h*E, *h*'UT = *h*UT – *h*E, where *h*BS and *h*UT are the actual antenna heights, and hE is the effective environment height. For UMi *h*E = 1.0m. For UMa *h*E=1m with a probability equal to 1/(1+C(*d*2D, *h*UT)) and chosen from a discrete uniform distribution uniform(12,15,…,(*h*UT-1.5)) otherwise. With C(*d*2D, *h*UT) given by  ,  where  .  Note that *h*E depends on *d*2D and *h*UT and thus needs to be independently determined for every link between BS sites and UTs. A BS site may be a single BS or multiple co-located BSs.  Note 2: The applicable frequency range of the PL formula in this table is 0.5 < *fc* < *f*H GHz, where *f*H = 30 GHz for RMa and *f*H = 100 GHz for all the other scenarios. It is noted that RMa pathloss model for >7 GHz is validated based on a single measurement campaign conducted at 24 GHz.  Note 3: UMa NLOS pathloss is from TR36.873 with simplified format and PLUMa-LOS = Pathloss of UMa LOS outdoor scenario.  Note 4: PLUMi-LOS = Pathloss of UMi-Street Canyon LOS outdoor scenario.  Note 5: Break point distance *dBP* = 2π *hBS* *hUT* *fc*/*c*, where *fc* is the centre frequency in Hz, *c* = 3.0 × 108 m/s is the propagation velocity in free space, and *hBS* and *hUT* are the antenna heights at the BS and the UT, respectively.  Note 6: *fc* denotes the center frequency normalized by 1GHz, all distance related values are normalized by 1m, unless it is stated otherwise. | | | | |

##### 6.1.2.2.2 LOS probability

The Line-Of-Sight (LOS) probabilities are given in Table 6.1.2.2.2-1.

Table 6.1.2.2.2-1: LOS probability

|  |  |
| --- | --- |
| Scenario | LOS probability (distance is in meters) |
| UMi – Street canyon | Outdoor users:    Indoor users:  Use *d2D-out* in the formula above instead of *d2D* |
| UMa | Outdoor users:    where    and    Indoor users:  Use *d2D-out* in the formula above instead of *d2D* |
| Indoor – Open office |  |
| Note: The LOS probability is derived with assuming antenna heights of 3m for indoor, 10m for UMi, and 25m for UMa | |

##### 6.1.2.2.3 O-to-I penetration loss

The Path loss incorporating O-to-I building penetration loss is modelled as in the following:

PL = PLb + PLtw + PLin + *N*(0, σ*P2*)

where PLb is the basic outdoor path loss given in Section 6.1.2.2.1. PLtw is the building penetration loss through the external wall, PLin is the inside loss dependent on the depth into the building, and σ*P* is the standard deviation for the penetration loss.

PLtw is characterized as:



 is an additional loss is added to the external wall loss to account for non-perpendicular incidence;

, is the penetration loss of material *i*, example values of which can be found in Table 6.1.2.2.3-1.

*pi* is proportion of *i*-th materials, where ; and

*N* is the number of materials.

Table 6.1.2.2.3-1: Material penetration losses

|  |  |
| --- | --- |
| Material | Penetration loss [dB] |
| Standard multi-pane glass |  |
| IRR glass |  |
| Concrete |  |
| Wood |  |
| Note: f is in GHz | |

Table 6.1.2.2.3-2 gives PLtw, PLin and σ*P* for two O-to-I penetration loss models. The O-to-I penetration is UT-specifically generated, and is added to the SF realization in the log domain.

Table 6.1.2.2.3-2 O-to-I penetration loss model

|  |  |  |  |
| --- | --- | --- | --- |
|  | Path loss through external wall: [dB] | Indoor loss: [dB] | Standard deviation: σ*P* [dB] |
| Low-loss model |  | 0.5*d*2D-in | 4.4 |
| High-loss model |  | 0.5*d*2D-in | 6.5 |

*d2D-in* is minimum of two independently generated uniformly distributed variables between 0 and 25 m for RMa, UMa and UMi-Street Canyon. *d2D-in* shall be UT-specifically generated.

Both low-loss and high-loss models are applicable to UMa and UMi-Street Canyon.

Only the low-loss model is applicable to RMa.

The composition of low and high loss is a simulation parameter that should be determined by the user of the channel models, and is dependent on the use of metal-coated glass in buildings and the deployment scenarios. Such use is expected to differ in different markets and regions of the world and also may increase over years to new regulations and energy saving initiatives. Furthermore, the use of such high-loss glass currently appears to be more predominant in commercial buildings than in residential buildings in some regions of the world.

The pathloss incorporating O-to-I car penetration loss is modelled as in the following:

PL = PLb + *N*(*μ*, σ*P2*)

where PLb is the basic outdoor path loss given in Section 6.1.2.2.1. *μ* = 9, and σ*P* = 5. Optionally, for metallized car windows, *μ* = 20 can be used. The O-to-I car penetration loss models are applicable for at least 0.6-60 GHz.

#### 6.1.2.3 Antenna and beam forming pattern modelling

##### 6.1.2.3.1 General

A general antenna model is a uniform rectangular panel array, comprising MgNg panels, as illustrated in Figure 6.1.2.3.1-1.

- Mg is number of panels in a column

- Ng is number of panels in a row

- Antenna panels are uniformly spaced in the horizontal direction with a spacing of *dg,H* and in the vertical direction with a spacing of *dg,V*.

- On each antenna panel, antenna elements are placed in the vertical and horizontal direction, where N is the number of columns, M is the number of antenna elements with the same polarization in each column.

- Antenna numbering on the panel illustrated in Figure 6.1.2.3.1-1 assumes observation of the antenna array from the front (with x-axis pointing towards broad-side and increasing y-coordinate for increasing column number).

- The antenna elements are uniformly spaced in the horizontal direction with a spacing of *dH* and in the vertical direction with a spacing of *dV*.

- The antenna panel is either single polarized (P=1) or dual polarized (P=2).

The rectangular panel array antenna can be described by the following tuple .



Figure 6.1.2.3.1-1: General antenna model

For a uniformly distributed array (ULA) antenna, as shown in Figure 6.1.2.3.1-2, the radiation elements are placed uniformly along the vertical **z**-axis in the Cartesian coordinate system. The **x-y** plane constructs the horizontal plane. A signal acting at the array elements is in the direction of **u**. The elevation angle of the signal direction is denoted as (defined between 0° and 180°, 90° represents perpendicular angle to the array antenna aperture) and the azimuth angle is denoted as(defined between -180° and 180°).



Figure 6.1.2.3.1-2: Antenna Array Geometry

The linear phase progression based beamforming is assumed, as described in Table 6.1.2.3.1-1.

Table 6.1.2.3.1-1: Composite antenna pattern

|  |  |
| --- | --- |
| Parameter | Values |
| Composite Array radiation pattern in dB | For beam i:    the super position vector is given by:    the weighting is given by: |

In this simulation, there is one beam formed using all the antenna elements. Each beam is directed to one scheduled UE.

Note the above gives the correct antenna array radiation pattern, however the correct gain is only achieved if the element pattern  is selected for the exact element spacing. For other element spacings, the element pattern  must be separately calculated such that it is correct for the element spacing (*dg,H and dg,V*). If  is not linked to the element spacing then the calculated absolute gain may diverge from the correct value in a manner that varies as the beam is steered.

The correct composite array radiation pattern directivity(D) is given by:

,

The composite array radiation pattern gain can then be calculated as:



Where L is the Loss associated with the antenna. This is currently included in the estimate for element gain , and is 1.8dB.

##### 6.1.2.3.2 BS Antenna modelling

To model an AAS BS equipped with a sub-array antenna geometry an extended antenna model is required. A sub-array antenna geometry is created by combining vertical elements to sub-arrays as indicated in Figure 6.1.2.3.2-1. The antenna model extension is used to model AAS base station operating within the frequency range 14800 - 15350 MHz required for sharing studies in ITU-R.



Figure 6.1.2.3.2-1: Sub-array structure

In Table 6.1.2.3.2-1, the parameters used by the parameterized array antenna model supporting sub-array geometries are described.

Table 6.1.2.3.2-1: Extended parameter definitions

| Level | Parameter | Symbol | Unit |
| --- | --- | --- | --- |
| Element | Front to back ratio | *Am* | dB |
| Side lobe suppression | *SLAv* | dB |
| Horizontal half power beamwidth | *3dB* | Degrees |
| Vertical half power beamwidth | *3dB* | Degrees |
| Array element peak gain | *GE,max* | dBi |
| Sub-array | Number of element rows in sub-array | *Msub* | Integer |
| Vertical element separation | *dv,sub* | m |
| Electrical pre-set sub-array down-tilt angle | *subtilt* | Degrees |
| Array | Number of elements/sub-array rows | *M* | Integer |
| Number of elements columns | *N* | Integer |
| Horizontal element separation | *dh* | m |
| Vertical element/sub-array separation | *dv* | m |
| Electrical down-tilt angle | *etilt* | Degrees |
| Electrical scan angle | *escan* | Degrees |

The parameterized antenna model is built around array antenna model where the element factor, array factor and linear phase progressing is characterized as described by equations in Table 6.1.2.3.2-2.

Table 6.1.2.3.2-2: Extended AAS model

| Description | Equation |
| --- | --- |
| Peak normalized element radiation pattern |  |
| Peak gain normalized element radiation pattern |  |
| Sub-array excitation |  |
| Sub-array radiation pattern | , where |
| Array excitation |  |
| Composite array radiation pattern | , where |

In Table 6.1.2.3.2-3, representable parameter sets relevant for an AAS base station operating within 14800 - 15350 MHz are provided.

Table 6.1.2.3.2-3: Antenna array parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Indoor | Urban macro | Dense urban |
| Element gain (dBi) (Note 2) | 5 | 6.4 | 6.4 |
| Horizontal/vertical 3 dB beam width of single element (degree) | 90º for H 90º for V | 90º for H 65º for V | 90º for H 65º for V |
| Horizontal/vertical front‑to‑back ratio (dB) | 30 for both H/V | 30 for both H/V | 30 for both H/V |
| Antenna polarization | Linear ±45º | Linear ±45º | Linear ±45º |
| Antenna array configuration (Row × Column)  (Note 4) | 4 x 4 | 16 x 24 | 16 x 24 |
| Horizontal/Vertical radiating sub-array spacing | 0.5 of wavelength for H, 0.5 of wavelength for V | 0.5 of wavelength for H, 2.8 of wavelength for V (Note 5) | 0.5 of wavelength for H, 2.8 of wavelength for V (Note 5) |
| Number of element rows in sub-array | N/A | 4 | 4 |
| Vertical element separation in sub-array () | 0.5 of wavelength of V | 0.7 of wavelength of V | 0.7 of wavelength of V |
| Pre-set sub-array down-tilt (degrees) | N/A | 3 | 3 |
| Array Ohmic loss (dB) (Note 2) | 2 | 2 | 2 |
| Conducted power (before Ohmic loss) per sub-array or element (dBm) (Note 3) | [2/8] | 17.14 | 7.1 |
| Base station horizontal coverage range (degrees) | +/-90 | +/-60 | +/-60 |
| Base station vertical coverage range (degrees) (Note 1) | 0-180 | 90-100 | 90-100 |
| Mechanical down-tilt (degrees) | 90 | 6 | 6 |
| Note 1: The vertical coverage range is given for the elevation angle θ, defined between 0° and 180°.  Note 2: The element gain includes the loss and is per polarization.  Note 3: The conducted power per sub-array assumes 16 × 24 sub-arrays and 2 polarizations for urban macro and dense urban cases; the conducted power per element assumes 4 x 4 elements and 2 polarizations for indoor case  Note 4: 16 × 24 means there are 16 vertical and 24 horizontal radiating sub-arrays for urban macro and dense urban cases; 4 x 4 means there are 4 vertical and 4 horizontal radiating elements for indoor case.  Note 5: For the case of 4 elements per sub array, dv will be 2.8 wavelengths. | | | |

##### 6.1.2.3.3 UE antenna element pattern

###### 6.1.2.3.3.1 FR1 like

In this approach, a UE will most likely have a conducted interface with an assumed isotropic radiation pattern antenna with [0 or 5] dB receive diversity gain and no beamforming.

###### 6.1.2.3.3.2 FR2 like

Table 6.1.2.3.3.2-1: UE antenna element pattern

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 5 dBi |
| (Mg, Ng, M, N, P) | (1, 1, 2, 2, 2) |
| (dv, dh) | (0.5λ, 0.5λ) |
| UE orientation | Random orientation in the azimuth domain: uniformly distributed between -90 and 90 degrees\*  Fixed elevation: 90 degrees |
| NOTE: This is done to emulate two panels: the configuration is equivalent to 2 panels with 180 shift in horizontal orientation and UE orientation uniformly distributed in the azimuth domain between -180 and 180 degrees. | |

##### 6.1.2.4 Other simulation parameters

Table 6.1.2.4-1: Other simulation parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | Indoor | Urban macro | Dense urban |
| **Channel bandwidth** | 100/200 MHz | 100/200 MHz | 100/200 MHz |
| **Scheduled channel bandwidth per UE (DL)** | 100/200 MHz | 100/200 MHz | 100/200 MHz |
| **Scheduled channel bandwidth per UE (UL)** | 100/200 MHz | 100/200 MHz | 100/200 MHz |
| **The number of active UE (DL)** | Same as the number of BS beam | Same as the number of BS beam | Same as the number of BS beam |
| **The number of active UE (UL)** | 1 UE per slot (first priority)  3 UE per slot (second priority) | 1 UE per slot (first priority)  3 UE per slot (second priority) | 1 UE per slot (first priority)  3 UE per slot (second priority) |
| **Traffic model** | Full buffer | Full buffer | Full buffer |
| **DL power control** | NO | NO | NO |
| **UL power control** | YES | YES | YES |
| **BS max TX power in dBm (2 polarizations)** | 23dBm | 46dBm | 36dBm |
| **UE max TX power in dBm** | 23dBm | 23dBm | 23dBm |
| **UE min TX power in dBm** | -40dBm | -40dBm | -40dBm |
| **BS Noise figure in dB** | 16 | 8 | 13 |
| **UE Noise figure in dB** | 13 | 13 | 13 |
| **Handover margin** | 3dB | 3dB | 3dB |

### 6.1.3 Co-existence simulation results

## 6.2 General parameters

### 6.2.1 Duplex mode

### 6.2.2 Channel Bandwidth

### 6.2.3 Signal Bandwidth

## 6.3 BS parameters

### 6.3.1 Transmitter characteristics

#### 6.3.1.1 Power dynamic range

#### 6.3.1.2 Spectral mask

#### 6.3.1.3 ACLR

#### 6.3.1.4 Spurious emissions

#### 6.3.1.5 Maximum output power

#### 6.3.1.6 Average output power

### 6.3.2 Receiver characteristics

#### 6.3.2.1 Noise figure

#### 6.3.2.2 Sensitivity

#### 6.3.2.3 Blocking response

#### 6.3.2.4 ACS

## 6.4 UE parameters

### 6.4.1 Transmitter characteristics

#### 6.4.1.1 Power dynamic range

#### 6.4.1.2 Spectral mask

#### 6.4.1.3 ACLR

#### 6.4.1.4 Spurious emissions

#### 6.4.1.5 Maximum output power

#### 6.4.1.6 Average output power

### 6.4.2 Receiver characteristics

#### 6.4.2.1 Noise figure

#### 6.4.2.2 Sensitivity

#### 6.4.2.3 Blocking response

#### 6.4.2.4 ACS

## 6.5 Antenna characteristics

### 6.5.1 BS antenna characteristics

#### 6.5.1.1 Antenna model

#### 6.5.1.2 Antenna parameters

### 6.5.2 UE antenna characteristics

# 7 Additional information on AAS

*<Editor’s note: We could capture in this sub-clause the background information used to answer ITU-R additional questions.>*

## 7.1 Array antenna model

### 7.1.1 Overview

A parameterized array antenna model has been developed over time in 3GPP. The technical background and modelling aspects relevant for AAS base stations was originally described in TR 37.840, subclause 5.4.4. The model has been used for numerous studies in RAN4, including AAS, NR, HST, IAB, etc. The model has been adopted in other forums outside RAN4 and is also described in RAN1 in e.g., TR 36.897 and in ITU-R in recommendation M.2101. The extended model including sub-array structures is documented in TR 38.803, subclause 5.2.3.2.4.

The model is defined around a set of equations, which rely on a set of input parameters to describe the array antenna. At a high level the model can be described as shown in Figure 7.1.1-1.



Figure 7.1.1-1: Array antenna model overview

Parameters can be divided into different categories:

- General parameters, which are parameters that will be required for the simulator (spatial angles, considered wavelength).

- Element parameters used to model the radiating elements.

- Sub-array parameters used to model the sub-array.

- Array parameters used to model the array.

The model will produce gain normalized radiation pattern for given *q*, *j* angles defined in the range degrees and degrees.

The wavelength, *ld* is related to the design of the array and is fixed by design, while the excitation wavelength, *le* may vary as function of considered frequency within a specific operating band.

### 7.1.2 Parameters

The input parameters required to describe the antenna is summarized and described in Table 7.1.2-1.

**Table 7.1.2-1: Model input parameters**

| **Category** | **Parameter** | **Description** | **Note** |
| --- | --- | --- | --- |
| General | *ld* | Design wavelength for array antenna in meters | The wavelength is fixed and selected for a given design frequency. The wavelength will not vary within a given operating band for a given design. |
| *le* | Array excitation wavelength in meters | This wavelength varies within the considered band. |
| ** | Vertical angle in degrees |  |
| ** | Horizontal angle in degrees |  |
| *Ptx* | Total conducted power in dBm | For a dual polarized antenna, the total conducted power is calculated over *MxNx2* ports |
| *mech* | BS mechanical down-tilt angle in degrees | The mechanical down-tilt angle is a deployment parameter selected to maximize coverage within a given coverage area. The mechanical tilt can be applied as a coordinate transformation as described in TR 36.814, subclause A.2.1.6.2. |
| Element | *Am* | Element front-to-back ratio in dB |  |
| *SLAv* | Element side-lobe suppression in dB |  |
| *3dB* | Element horizontal half power beamwidth in degrees |  |
| *3dB* | Element vertical half power beamwidth in degrees |  |
| *GE,max* | Element peak gain in dBi | This parameter is related to the selection of *3dB,* *3dB* and *LE*, where  and *DE,max*  is related to *3dB,* *3dB* and array lattice unit area for the element. |
| *LE* | Element loss in dB |  |
| Sub-array | *Msub* | Number of element rows in sub-array |  |
| *dv,sub* | Vertical element separation in sub-array in meters |  |
| *subtilt* | Electrical pre-set sub-array down-tilt angle in degrees | The pre-set sub array down-tilt is a fixed design parameter for a base station. It is envisaged as a passive fixed (non-varying) electrical tilt within the sub-array elements. The deployment configuration (including mechanical tilt) for a base station is dependent on the environment. Thus, a same base station with fixed pre-set subarray tilt could also be used across different environments. The value of the pre-set tilt is determined based on the intended deployment scenarios and targeted user distribution and coverage range. |
| Array | *M* | Number of sub-array rows in array |  |
| *N* | Number of sub-array columns in array |  |
| *dh* | Horizontal sub-array separation in array in meters |  |
| *dv* | Vertical sub-array separation in array in meters | This parameter is related to *Msub* and *dv,sub*. |
| *etilt* | Electrical beam direction down-tilt angle in degrees |  |
| *escan* | Electrical beam direction scan angle in degrees |  |
| *r* | Array excitation correlation factor | For wanted signal , while for unwanted emission the correlation falls of as function of frequency offset from carrier within the interval . |

The total conducted power, *Ptx* at the Transceiver Array Boundary (TAB) is related to Total Radiated Power (TRP) in logarithmical scale as:

, where *Pn* is the power per transmitter branch in dBm. Total conducted power is defined as the total power for all ports, including two orthogonal polarizations.

The equivalent isotropic radiated power (EIRP) is calculated in dBm using the model as:

The peak EIRP can also be derived from parameters as:

When co-existence is evaluated in RAN4, the focus is on the main beam pointing towards the UE, but for other compatibility scenarios, e.g., with other services, the focus is not necessarily just the main beam. Spatial regions outside the main beam may also be highly relevant. Since the sub-array topology will affect the radiating characteristics in the sidelobe region, the model needs to be extended to provide the ability to model the sidelobe region characteristics correctly with reasonable complexity.

For the case where single element array geometries is considered (*Msub=1*), the extended array model collapses to the original model described in TR 37.840.

The antenna element separation is an important parameter that must be selected with care. Obviously, the value is static for a specific base station design, whereas the compatibility analysis may need to cover an entire frequency band. Typically, the antenna is designed to support given element separations for the highest frequency to avoid grating lobes for lower frequencies, but other design principles can be used for base stations supporting multiple bands or very wide operating bands.

Some parameters, such as the element beamwidths are related to the peak element gain via the element loss. This means that these parameters must be selected carefully.

Considering base stations are optimized for various factors including performance, cost, and coverage, it is expected that sub array configurations are relevant for these bands as well as a set of physical antenna elements are combined to form a logical element. The model comprises of a basic element pattern which is then combined appropriately based on the equations to form the sub array pattern and the composite pattern. Since dual polarized elements are used in typical base stations, it is sufficient to model each polarization separately as considered in the specific model. The models are selected so that they are simple and representative to model base station performance with sufficient confidence. The element pattern is based on a simple gaussian beam which has a flat sidelobe level. The Gaussian pattern is sufficiently wide and cover most of the regions of interest, especially in the elevation domain. At high elevation angles, the flat sidelobe level is sufficient to model the side lobes of the antenna element which are significantly lower than the main beam. Thus, the proposed extended antenna model to model sub arrays is sufficient to model the beamforming capability of IMT base stations in considered frequency ranges.

Another aspect also to consider is the performance and coexistence simulator complexity. The antenna model provides is reasonable complex and produce a gain normalized radiation pattern. If parameters are selected properly, no additional directory normalization is required which will reduce complexity and save processing capacity and simulation time.

The antenna model has support to model the array response outside the wanted carrier bandwidth, within adjacent channels using the correlation factor, *r*. When the wanted signal is considered *r* is equal to 1. For unwanted emissions outside the wanted signal bandwidth values within the range can be considered. Further details on the frequency response of *r* require further investigations.

### 7.1.3 Model equations

The array antenna model is built around pattern multiplication between the element radiation pattern, sub-array array factor radiation pattern and array factor radiation pattern, as described by equations listed in Table 7.1.3-1.

**Table 7.1.3-1: Array antenna model equations**

| **Description** | **Equation** |
| --- | --- |
| Peak normalized element radiation pattern |  |
| Peak gain normalized element radiation pattern |  |
| Sub-array excitation |  |
| Sub-array radiation pattern | , where |
| Array excitation |  |
| Composite array radiation pattern | , where |

## 7.3 MIMO modelling

### 7.3.1 Simulation methodologies

##### 7.3.1.1 Methodology 1

##### 7.3.1.2 Methodology 2

### 7.3.2 Simulation results

##### 7.3.1.1 Methodology 1

##### 7.3.1.2 Methodology 2

### 7.3.3 Summary and conclusion

# **Annex A (informative): Change history**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2024-04 | RAN4#110bis | R4-2406614 |  |  |  | TR skeleton | 0.0.1 |
| 2024-05 | RAN4#111 | R4-2408494 |  |  |  | Table of contents corrected | 0.0.2 |
| 2024-05 | RAN4#111 | R4-2410763 |  |  |  | R4-2410722 TP for TR 38.922: Addition of technical background for 4400 to 4800 MHz in clause 4  R4-2410592 TP to TR 38.922: System level simulation methodology and assumptions for co-existence study for 14800 – 15350 MHz frequency range  R4-2408083 TP to TR 38.922: Addition of array antenna model description in clause 7 | 0.1.0 |
| 2024-08 | RAN4#112 | R4-2412608 |  |  |  | R4-2412587 TP to TR 38.922: Corrections and clarifications on IMT parameters for 4400 to 4800 MHz frequency range  R4-2413278 TP for IMT technology related parameters for 4400 to 4800 MHz  R4-2414300 TP for 38.922 on UE IMT parameters for 7125-8400 MHz  R4-2414301 TP for BS IMT parameters for range 7125 to 8400 MHz  R4-2414303 TP to TR 38.922: Revisions of system level simulation assumptions for study on IMT parameters for 14800 to 15350 MHz frequency range | 0.2.0 |
| 2024-10 | RAN4#112bis | R4-2417200 |  |  |  | R4-2417190 TP to TR 38.922: Scope clarification  R4-2417102 TP to TR 38.922 Update Clause 1-4  R4-2417103 TP for TR 38.922: Correction on BS IMT parameters for range 7125 to 8400 MHz  R4-2417101 Text proposal on 7125-8400 MHz IMT parameters in TR 38.922  R4-2417104 TP for TR 38.922: corrections for 7125 to 8400 MHz frequency range  R4-2417105 TP to TR 38.922: Revisions of system level simulation assumptions for study on IMT parameters for 14800 to 15350 MHz frequency range  R4-2417106 TP to TR 38.922: Addition of new subclause for MIMO modelling aspects in subclause 7.3 | 0.3.0 |

# **Annex B: Additional observations for 7125-8400 MHz frequency range**

## B.1 Impact of higher channel bandwidth on the ACLR/ACS

This Annex presents additional simulation studies to compare the throughput loss% as a function of ACIR for both downlink and uplink transmissions in UMa deployments for both 100MHz and 200MHz, as shown in Figure B.1-1.

NOTE 1: The impact of the higher channel bandwidth on the spectral mask is given in B.2-1.

Note that all the network, BS, and UE parameters follow the adjacent channel coexistence conducted in TR 38.921 [14]. It can be observed that the ACIR required to meet the 5% throughput loss degradation target is nearly identical for the 100 MHz and 200 MHz channel bandwidths. Note that in the above simulations, the conducted power is assumed to be the same for both channel configurations. It is expected that with scaling the conducted power to account for the increased channel bandwidth (i.e., equivalent PSD), the wanted and interfering signal will be scaled accordingly, resulting in comparable ACIR values between the two channel bandwidth configurations. As a result, the BS/ UE ACLR and ACS will not be affected by higher channel bandwidths.

|  |  |
| --- | --- |
| CHBW = 100MHz  CHBW = 200MHz |  |

Figure B.1-1 Throughput loss for UMa scenario for 100MHz (black) and 200MHz channel bandwidths (magenta)

## B.2 Impact of higher channel bandwidth on spectral emission mask

## B.3 Impact of higher UE maximum output power on the ACLR/ACS

In order to ensure that the adjacent channel coexistence (i.e., BS and UE ACLR/ACS) derived for PC3 (i.e., UE maximum output power equals 23 dBm) is not impacted when considering higher UE maximum output power (e.g., PC2, with maximum output power equals 26 dBm), we compare the throughput loss % as a function of ACIR for both downlink and uplink transmissions in UMa deployments for both PC3 and PC2 was compared, as shown in Figure B-2. Note that all the network, BS, and UE parameters follow the adjacent channel coexistence conducted in TR 38.921 [4]. It can be observed that the ACIR required to meet the 5% throughput loss degradation mark is nearly the same for both PC3 and PC2. As a result, the BS/ UE ACLR and ACS will not be affected by higher UE maximum output power.



UE max power = 26 dBm

UE max power = 23 dBm

Figure B.3-1 Throughput loss for UL UMa scenario for 23 dBm (magenta) and 26 dBm (black) UE maximum output power