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| 3GPP TR 38.922 V0.1.0 (2024-05) |
| 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:

Version x.y.z

where:

x the first digit:

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2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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 [2]. It covers the study on transmitter and receiver characteristics for both NR BS and NR UE, and related parameters, addressing the ITU-R W5PD’s requests and answering three additional questions [3].

# 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-240787: “Study on IMT parameters for 4400 to 4800 MHz, 7125 to 8400 MHz and 14800 to 15350 MHz”.

[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”.

…

[x] <doctype> <#>[ ([up to and including]{yyyy[-mm]|V<a[.b[.c]]>}[onwards])]: "<Title>".

It is preferred that the reference to TR 21.905 be the first in the list.

# 3 Definitions of terms, symbols and abbreviations

This clause and its three (sub) clauses are mandatory. The contents shall be shown as "void" if the TS/TR does not define any terms, symbols, or 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].

Definition format (Normal)

**<defined term>:** <definition>.

**example:** text used to clarify abstract rules by applying them literally.

## 3.2 Symbols

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

Symbol format (EW)

<symbol> <Explanation>

## 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].

Abbreviation format (EW)

<ABBREVIATION> <Expansion>

# 4 4400 - 4800 MHz frequency range

## 4.1 General parameters

For the frequency range 4400 to 4800 MHz information can be extracted from requirements defined for band n79.



Figure 4.1-1: Band definition in the frequency range between 4.4 – 5.0 GHz

### 4.1.1 Duplex mode

For this frequency range RAN4 considered TDD as the current duplexing candidate. An enhancement of TDD duplexing, via allowing the simultaneous existence of 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]. RAN4 is developing in Rel-19 the normative work for SBFD operation at the BS side within a TDD carrier [RP-240789]. The requirements and conformance aspects for Rel-19 SBFD work item can be tracked through the list of impacted specs captured in [RP-240789].

### 4.1.2 Channel Bandwidth

A pragmatic, simple and non-ambiguous answers should be provided to ITU-R. While a number of channel bandwidth would be specified for these frequency ranges, 100 MHz has been considered as a representative channel bandwidth that will be used.

Supported channel bandwidths are listed in Table 4.1.2-1.

**Table 4.1.2-1: *BS channel bandwidths***

| **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 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, subclause 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.

#### 4.2.1.2 Spectral mask

For the frequency range 4400 to 4800 MHz the requirement limits for band n79 in TS 38.104, subclause 6.6.4 is listed in Table 4.2.1.2-1 and Table 4.2.1.2-2.

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

From TS 38.104, subclause 6.6.3 the ACLR limit applicable for band n79 is 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 |
| 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 is 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 |
| 12.75 GHz - 26 GHz | -13 dBm | 1 MHz | Note 1, Note 2, Note 5 |
| 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*. NOTE 5: Applies for Band for which the upper frequency edge of the DL *operating band* is greater than 5.2 GHz. |

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 |
| 12.75 GHz - 26 GHz | - 30 dBm | 1 MHz | Note 1, Note 2, Note 5 |
| 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*. NOTE 5: Applies for Band for which the upper frequency edge of the DL *operating band* is greater than 5.2 GHz. |

Additional spurious emissions requirements relevant for band n79 can be found in TS 38.104, subclause 6.6.5.2.3 and subclause 6.6.5.2.4.

#### 4.2.1.5 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 for two polarizations was agreed as shown in Table 4.2.1.5-1 below.

Table 4.2.1.5-1: The 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.

### 4.2.2 Receiver characteristics

#### 4.2.2.1 Noise figure

The BS noise figure relevant for 4400 to 4800 MHz is listed in Figure 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 relevant for 4400 to 4800 MHz is listed in Figure 4.2.2.2-1, Figure 4.2.2.2-2 and Figure 4.2.2.2-3.

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 5: Void.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 relevant for 4400 to 4800 MHz 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.

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: -43Medium Range BS: -38Local Area BS: -35 | ±4.5 | 3 MHz DFT-s-OFDM NR signal15 kHz SCS, 15 RBs |
| 5, 10, 15, 20 | PREFSENS + x dB | Wide Area BS: -43Medium Range BS: -38Local Area BS: -35 | ±7.5 | 5 MHz DFT-s-OFDM NR signal15 kHz SCS, 25 RBs |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | PREFSENS + x dB | Wide Area BS: -43Medium Range BS: -38Local Area BS: -35 | ±30 | 20 MHz DFT-s-OFDM NR signal15 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 [13].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: -49Medium Range BS: -44Local 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 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.NOTE 3: Void |

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 CDMA850x = -4 dBm for NR BS co-located with Pico DCS1800 or Pico PCS1900x = -6 dBm for NR BS co-located with UTRA bands or E-UTRA bands or NR bandsNOTE 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 relevant for 4400 to 4800 MHz is listed in Figure 4.2.2.4-1 and Figure 4.2.2.4-2.

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: -52Medium Range BS: -47Local 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 [13]. |

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 signal15 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 existing 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.

#### 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 GHzNOTE 2: Applies for Band that the upper frequency edge of the UL Band more than 5.2 GHzNOTE 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 [3] 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 [3] 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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NRband | 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 toleranceNOTE 2: Powerclass 3 is default power class unless otherwise statedNOTE 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 dBNOTE 5: Achieved via dual TxNOTE 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.

### 4.3.2 Receiver characteristics

#### 4.3.2.1 Noise figure

The UE noise figure relevant for 4400 to 4800 MHz is 9 dB.

#### 4.3.2.2 Sensitivity

The UE sensitivity requirement 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.

**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 1andBWChannel/2 +FIoffset, case 1 | ≤ -BWChannel/2 –FIoffset, case 2and≥ BWChannel/2 +FIoffset, case 2 |
|  | Finterferer |  | NOTE 2 | FDL\_low – 3\*BWChanneltoFDL\_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 1NOTE 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)orMAX(60,3\*BWChannel) ≤ f – FDL\_high < 150 | 1 ≤ f ≤ FDL\_low – MAX(150,3\*BWChannel)orFDL\_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 signalNOTE 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.

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 subclause 7.1.

#### 4.4.1.2 Antenna parameters

The BS antenna parameters relevant for 4400 to 4800 MHz is 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

For the frequency range 4400 to 4800 MHz the UE will have a conducted interface with an assumed isotropic radiation pattern antenna and no beamforming.

# 5 7125 - 8400 MHz frequency range

## 5.1 General parameters

### 5.1.1 Duplex mode

### 5.1.2 Channel Bandwidth

### 5.1.3 Signal Bandwidth

## 5.2 BS parameters

### 5.2.1 Transmitter characteristics

#### 5.2.1.1 Power dynamic range

#### 5.2.1.2 Spectral mask

#### 5.2.1.3 ACLR

#### 5.2.1.4 Spurious emissions

#### 5.2.1.5 Maximum output power

#### 5.2.1.6 Average output power

### 5.2.2 Receiver characteristics

#### 5.2.2.1 Noise figure

#### 5.2.2.2 Sensitivity

#### 5.2.2.3 Blocking response

#### 5.2.2.4 ACS

## 5.3 UE parameters

### 5.3.1 Transmitter characteristics

#### 5.3.1.1 Power dynamic range

#### 5.3.1.2 Spectral mask

#### 5.3.1.3 ACLR

#### 5.3.1.4 Spurious emissions

#### 5.3.1.5 Maximum output power

#### 5.3.1.6 Average output power

### 5.3.2 Receiver characteristics

#### 5.3.2.1 Noise figure

#### 5.3.2.2 Sensitivity

#### 5.3.2.3 Blocking response

#### 5.3.2.4 ACS

## 5.4 Antenna characteristics

### 5.4.1 BS antenna characteristics

#### 5.4.1.1 Antenna model

#### 5.4.1.2 Antenna parameters

### 5.4.2 UE antenna characteristics

# 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, TBD MHz | NR, TBD MHz | DL to DL | 15 GHz | Indoor hotspot | Second |
| 2 | eMBB | NR, TBD MHz | NR, TBD MHz | DL to DL | 15 GHz | Urban macro | First |
| 3 | eMBB | NR, TBD MHz | NR, TBD MHz | DL to DL | 15 GHz | Dense urban | Third |
| 4 | eMBB | NR, TBD MHz | NR, TBD MHz | UL to UL | 15 GHz | Indoor hotspot | Second |
| 5 | eMBB | NR, TBD MHz | NR, TBD MHz | UL to UL | 15 GHz | Urban macro | First |
| 6 | eMBB | NR, TBD MHz | NR, TBD MHz | 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 (first priority)350 m (second priority)Other (third priority) |  |
| 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: 1.0Between sites: 0.5 |   |

Table 6.1.2.1.1-2: Multi operators layout for urban macro

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Multi operators layout | coordinated/un-coordinated operation (0/100% Grid Shift) |   |

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

Figure 6.1.2.1.1-1: Coordinated operation



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. |



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 |   |
| BS antenna height | 3 m | 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 |   |



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:whereandIndoor 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

###### 6.1.2.3.2.1 Urban macro scenario

Table 6.1.2.3.2.1-1: BS antenna modelling for Urban macro scenario

|  |  |
| --- | --- |
| 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* | 6.4 dBi |
| (Mg, Ng, M, N, P) note |  (1, 1, 64 x 24 / 64 x 32, 2) |
| (dv, dh) | (0.7λ, 0.5λ) |
| Note: An additional 3dB gain is added to the total beamforming gain to account for the two polarization directions. Boresight direction is horizontal. |

###### 6.1.2.3.2.2 Dense urban scenario

Table 6.1.2.3.2.2-1: BS antenna element pattern for Dense urban scenario

|  |  |
| --- | --- |
| 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* | 6.4 dBi |
| (Mg, Ng, M, N, P) note |  (1, 1, 64 x 24 / 64 x 32, 2) |
| (dv, dh) | (0.7λ, 0.5λ) |
| Note: An additional 3dB gain is added to the total beamforming gain to account for the two polarization directions. Boresight direction is horizontal. |

###### 6.1.2.3.2.3 Indoor scenario

Table 6.1.2.3.2.3-1: BS antenna element pattern for Indoor scenario

|  |  |
| --- | --- |
| 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* | 5.5 dBi |
| (Mg, Ng, M, N, P) note |  (1, 1, [8/4, 8/4], 2) |
| (dv, dh) | (0.5λ, 0.5λ) |
| Note: An additional 3dB gain is added to the total beamforming gain to account for the two polarization directions. Boresight direction is perpendicular to the ceiling. |

###### 6.1.2.3.2.4 Array antenna model extension

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 6.1.2.3.2.4-1. The antenna model extension was created to model AAS base station operating within the frequency range 14800 - 15350 MHz required for sharing studies in ITU-R.



Figure 6.1.2.3.2.4-1: Sub-array structure

In Table 6.1.2.3.2.4-1, the parameters used by the parameterized array antenna model supporting sub-array geometries are described.

Table 6.1.2.3.2.4-1: 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 6.1.2.3.2.4-2.

Table 6.1.2.3.2.4-2: 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 6.1.2.3.2.4-3, representable parameter sets relevant for an AAS base station operating within 14800 - 15350 MHz are provided.

Table 6.1.2.3.2.4-3: 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 H90º for V | 90º for H65º for V | 90º for H65º 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 sub-array configuration (Row × Column) (Note 4) | [8 x 8 / 4 x 4] elements | 64 x 24 / 64 x 32 elements | 16 x 24 / 64 x 32 elements |
| Horizontal/Vertical radiating sub-array spacing  | 0.5 of wavelength for H, 0.5 of wavelength for V | 0.5 of wavelength for H, 2.8/5.6 of wavelength for V | 0.5 of wavelength for H, 2.8/5.6 of wavelength for V |
| Number of element rows in sub-array | N/A | 4/8 | 4/8 |
| Vertical element separation in sub-array () | 0.5 of wavelength of V | 0.5 of wavelength of V | 0.5 of wavelength of V |
| Pre-set sub-array down-tilt (degrees) | 3 | 3 | 3 |
| Array Ohmic loss (dB) (Note 2) | 2 | 2 | 2 |
| Conducted power (before Ohmic loss) per sub-array (dBm) (Note 3)  | [-1] | 8/7 | -2/-3 |
| 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 64 x 24/32 x 2 sub-arrays (i.e., power per H/V polarized element).Note 4: 64 × 24/32 means there are 64 vertical and 24/32 horizontal radiating sub-arrays. Note 5: For the case of 4/8 elements per sub array, dv will be 2.8/5.6 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** | 100/200/400 MHz | 100/200/400 MHz | 100/200/400 MHz |
| **Scheduled channel bandwidth per UE (DL)** | 100/200/400 MHz | 100/200/400 MHz | 100/200/400 MHz |
| **Scheduled channel bandwidth per UE (UL)** | 100/200/400 MHz | 100/200/400 MHz | 100/200/400 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** | 23dBm | 43dBm | 33dBm |
| **UE max TX power in dBm** | 23/26dBm | 23/26dBm | 23/26dBm |
| **UE min TX power in dBm** | -40dBm | -40dBm | -40dBm |
| **BS Noise figure in dB** | 16 | 8 | 13 |
| **UE Noise figure in dB** | 11 | 11 | 11 |
| **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 |

# 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 4R4-2410592 TP to TR 38.922: System level simulation methodology and assumptions for co-existence study for 14800 – 15350 MHz frequency rangeR4-2408083 TP to TR 38.922: Addition of array antenna model description in clause 7 | 0.1.0 |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |