TSG-RAN Working Group 4 (Radio) meeting #112R4-2411194

Maastricht, Netherlands, 19th to 23rd August 2024

**Title: LS Reply on Parameters for 7125 to 8400 MHz of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-27**

**Response to: LS R4-2400333 on 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**

**Release: Rel-19**

**Work Item: FS\_NR\_IMT\_4400\_7125\_14800MHz**

**Source: TSG RAN WG4**

**To: ITU-R WP 5D**

**Cc: RAN**

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**Send any reply LS to: 3GPP Liaisons Coordinator,** mailto:3GPPLiaison@etsi.org

**Attachments:** -

1 Overall description

RAN WG4 received the incoming LS from ITU-R Working Party 5D on Parameters of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-27 ([Att. 7.4 to 5D/134](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0134%21H07%21MSW-E.docx)) and would like to thank for the opportunity to give input on this topic.

RAN WG4 has already replied for the 4400-4800 MHz frequency range (R4-2410576) and has now studied the frequency range 7125-8400 MHz, considering the adjacent band n104 (6425-7125 MHz) parameters as input. The recommended IMT technology related parameters for the frequency range 7125 to 8400 MHz are given in Annex 1 of this LS with references to those two specifications. The following should be noted:

* Where AAS and non-AAS limits may be expressed differently, there are separate entries in table 1. AAS limits always apply Over-the-Air (OTA).
* In the BS specification TS 38.104, non-AAS BS are identified as *BS Type 1-C*, while AAS BS are identified as *BS Type 1-H* or *BS Type 1-O* for the bands.

The recommended IMT antenna characteristics are given in Annex 2 of this LS. The following should be noted:

* Parameters are interdependent and derived as a package, based on deployment scenarios and other requirements.
* There is no beam forming assumed for the UE in the frequency ranges covered. UEs are therefore not included in the table.

2 Actions

**To ITU-R WP5D**

**ACTION:** 3GPP RAN WG4 asks ITU-R WP 5D to consider the following information provided for 7125 to 8400 MHz in Annex 1 and Annex 2.

3 Dates of next TSG RAN WG 4 meetings

TSG-RAN4 Meeting #112-bis TBD, China 14-18 October, 2024

TSG-RAN4 Meeting #113 Orlando, US 18-22 November, 2024

TSG-RAN4 Meeting #114 Athens, Greece 17-21 February, 2025

ANNEX 1

**IMT technology-related and deployment-related parameters for bands between 7125 and 8400 MHz**

**Table 1: IMT technology related parameters in 7125 – 8400 MHz**

|  |  | **IMT**  |
| --- | --- | --- |
| **No.** | **Parameter** | **Base station (non-AAS)** | **Base station(AAS)** | **Mobile station** |
| **1** | **Duplex Method** | TDD |
| **2** | **Channel bandwidth (MHz)** | 100 MHz typical (Note 3)  |
| **3** | **Signal bandwidth (MHz)** | Signal bandwidth = NRB x SCS x 12Will be derived from Channel Bandwidth, see [1], § 5.3.2. |
| **4** | **Transmitter characteristics** |  |
| 4.1 | Power dynamic range (dB) | 0 dB | 56 dB typical |
| 4.2 | Spectral mask (dB) | Category A: (Note 1)See table 1A (Wide Area BS) (ΔfOBUE = 40 MHz)Category B: (Note 1)See [1], § 6.6.4, Tables 6.6.4.2.2.1-2a and 6.6.4.2.2.1-2b (Wide Area BS)(ΔfOBUE = 40 MHz) | Category A: (Note 1)See table 1B (Wide Area BS) (ΔfOBUE = 100 MHz)Category B: (Note 1)See [1], § 9.7.4.2 and related Tables 6.6.4.2.2.1-2a and 6.6.4.2.2.1-2b (Wide Area BS)(ΔfOBUE = 100 MHz) | See [2], § 6.5.2.2 |
| 4.3 | ACLR  | 38 dB | 26 dB  |
| 4.4 | Spurious emissions | Category A: (Note 1)See [1], § 6.6.5, Table 6.6.5.2.1-1.Category B: (Note 1) See [1], § 6.6.5, Table 6.6.5.2.1-2. | See [2], § 6.5.3. |
| 4.5 | Maximum output power | See [1], § 6.2. | See Item No. 1.13 in Table 4 for typical values | 23 dBm typical (Note 4) |
| **5** | **Receiver characteristics** |  |
| 5.1 | Noise figure (dB) | 6 dB (Wide Area BS)11 dB (Medium Range BS)14 dB (Local Area BS)For BS class definitions, see [1], § 4.4 | 13 dB |
| 5.2 | Sensitivity (dBm) | To be specifiedBased on [1], § 7.2.2, Tables 7.2.2-1a, 7.2.2-2a and 7.2.2-3a | To be specifiedBased on [1], § 10.3.2, Tables 10.3.2-1a, 10.3.2-2a and 10.3.2-3a | To be specified |
| 5.3 | Blocking response  | In-band blocking level: See [1], § 7.4.2, Table 7.4.2.2-1Out-of-band blocking level: See [1], § 7.2.2, Table 7.5.2-1a (band n104)ΔfOOB = 60 MHz (Note 2)  | In-band blocking level: See [1], § 10.5.2.2Out-of-band blocking level: See [1], § 10.6.2.1ΔfOOB = 100 MHz (Note 2)  | See [2], § 7.6 Tables 7.6.2-3 and 7.6.2-4, 7.6.3-3 and 7.6.3-4 for blocking levelsand § 7.7 Tables 7.7-1a and 7.7-2 for spurious response |
| 5.4 | ACS  | 42 dB | 32 dB |
| 5.5 | SINR operating range (dB) | See below “SINR operating range and mapping function”  |

Note 1: Base station Operating band unwanted emissions define all unwanted emissions in the supported downlink operating band plus the frequency ranges extending ΔfOBUE above and ΔfOBUE below each band. Base station Unwanted emissions outside of this frequency range are limited by the spurious emissions requirement.

Note 2: Base Station In-band blocking applies in the supported uplink operating band plus the frequency ranges extending ΔfOOB above and ΔfOOB below each band, excluding the downlink frequency range in case of an FDD operating band. Out-of-band blocking applies from 1 MHz to 12.75 GHz, excluding the in-band blocking frequency range, but including the downlink frequency range in case of an FDD operating band. Requirements are defined assuming a receiver desensitization of 6 dB.

Note 3: Wider channel bandwidths are not precluded for this frequency range, see [3]

Note 4: Other output powers are not precluded, see [3]

References used in the Table:

[1] 3GPP TS 38.104 v.18.6.0, “NR; Base Station (BS) radio transmission and reception”

[2] 3GPP TS 38.101-1 v.18.6.0, “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”

[3] 3GPP TR 38.922 Study on International Mobile Telecommunications (IMT) parameters for 4400 - 4800 MHz, 7125 - 8400 MHz and 14800 - 15350 MHz

TABLE 1A

Non-AAS BS Spectral mask (Operating band unwanted emissions limits) for 7125 - 8400 MHz operation (Category A)

| **Frequency offset of measurement filter ‑3dB point from the carrier frequency, Δf** | **Basic limits** | **Measurement Bandwidth** |
| --- | --- | --- |
| 0 MHz £ Df < 50MHz | $$-7dBm-\frac{7}{50}\left(\frac{f\\_offset}{MHz}-0.05\right)$$ | 100 kHz |
| 50 MHz £ Df < min(100 MHz, Dfmax) | -14 dBm | 100 kHz |
| 100 MHz £ Df £ Dfmax | -13 dBm | 1 MHz |
| NOTE: Dfmax 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. |

TABLE 1B

AAS BS Spectral mask (Operating band unwanted emissions limits) for 7125 - 8400 MHz operation (Category A)

| **Frequency offset of measurement filter ‑3dB point from the carrier frequency, Δf** | **Basic limits** | **Measurement Bandwidth** |
| --- | --- | --- |
| 0 MHz £ Df < 50MHz | $$2dBm-\frac{7}{50}\left(\frac{f\\_offset}{MHz}-0.05\right)$$ | 100 kHz |
| 50 MHz £ Df < min(100 MHz, Dfmax) | -5 dBm | 100 kHz |
| 100 MHz £ Df £ Dfmax | -4 dBm | 1 MHz |
| NOTE: Dfmax 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. |

**SINR operating range and mapping function**

The following equations approximate the throughput over a channel with a given SINR, when using link adaptation:

$$Throughput \left(SINR\right) [bps/Hz] =\left\{\begin{array}{c}0 for SINR\leq SINR\_{MIN} \\α∙S\left(SINR\right) for SINR\_{MIN}<SINR<SINR\_{MAX} \\α∙S\left(SINR\_{MAX}\right) for SINR \geq SINR\_{MAX} \end{array}\right.$$

Where:

* $S\left(SINR\right)$: Shannon bound, $S(SINR) =log\_{2}(1+SINR) [bps/Hz]$;
* $α$: Attenuation factor, representing implementation losses;
* $SINR\_{MIN}$: Minimum SINR of the code set [dB];
* $SINR\_{Max}$: Maximum SINR of the code set [dB];
* $The SINR values specified in Table 2 below are in dB but must be converted to linear scale in the formula above.$

The parameters, $SINR\_{MIN}$ and $SINR\_{MAX}$ can be chosen to represent different modem implementations and link conditions. The parameters proposed in Table 2 represent a baseline case, which assumes:

* 1:1 antenna configurations
* AWGN channel model
* Link Adaptation (see Table 2 for details of the highest and lowest rate codes)
* No HARQ

**Table 2: Parameters describing baseline Link Level performance for 5G NR**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter**  | **DL**  | **UL**  | **Notes**  |
| $$α$$ | 0.6  | 0.4  | Represents implementation losses  |
| $SINR\_{MIN}$ [dB] | -10  | -10  | Based on QPSK, 1/8 rate (DL) & 1/5 rate (UL)  |
| $SINR\_{Max}$ [dB] | 30  | 22  | Based on 256QAM 0.93(DL) & 64QAM 0.93 (UL)  |

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ANNEX 2

**Antenna characteristics for IMT AAS base stations**

An extended version of the AAS array antenna model is created to support vertical sub-array geometries with fixed sub-array down-tilt. The model equations are summarized in Table 3.

**Table 3: Extended AAS model**

| **Description** | **Equation** |
| --- | --- |
| Peak normalized element radiation pattern | $$A\left(θ,φ\right)=-min\left[-\left(-min\left[12\left(\frac{φ}{φ\_{3dB}}\right)^{2},A\_{m}\right]-min\left[12\left(\frac{θ-90}{θ\_{3dB}}\right)^{2},SLA\_{v}\right] \right),A\_{m}\right]$$ |
| Peak gain normalized element radiation pattern | $$A\_{E}\left(θ,φ\right)=G\_{E,max}+A\left(θ,φ\right)$$ |
| Sub-array excitation | $$w\_{m}=\frac{1}{\sqrt{M\_{sub}}}exp\left(j2π\left(m-1\right)\frac{d\_{v,sub}}{λ}sin\left(θ\_{subtilt}\right)\right)$$ |
| Sub-array radiation pattern | $$A\_{sub}\left(θ,φ\right)=A\_{E}\left(θ,φ\right)+10log\_{10}\left(\left|\sum\_{m=1}^{M\_{sub}}w\_{m}v\_{m}\right|^{2}\right)$$, where$$v\_{m}=exp\left(j2π\left(m-1\right)\frac{d\_{v,sub}}{λ}cos\left(θ\right)\right)$$ |
| Array excitation | $$w\_{m,n}=\frac{1}{\sqrt{MN}}exp\left(j2π\left(\left(m-1\right)\frac{d\_{v}}{λ}sin\left(θ\_{etilt}\right)-\left(n-1\right)\frac{d\_{h}}{λ}cos\left(θ\_{etilt}\right)sin\left(φ\_{escan}\right)\right)\right)$$Where *M* and *N* is corresponding to (Row × Column) in Table 4, row 1.6. |
| Composite array radiation pattern | $$A\_{A}\left(θ,φ\right)=A\_{sub}\left(θ,φ\right)+10log\_{10}\left(\left|\sum\_{m=1}^{M}\sum\_{n=1}^{N}w\_{m,n}v\_{m,n}\right|^{2}\right)$$, where$$v\_{m,n}=exp\left(j2π\left(\left(m-1\right)\frac{d\_{v}}{λ}cos\left(θ\right)+\left(n-1\right)\frac{d\_{h}}{λ}sin\left(θ\right)sin\left(φ\right)\right)\right)$$Where *M* and *N* is corresponding to (Row × Column) in Table 4, row 1.6. |

Considering base stations are optimized for various factors including performance, cost, and coverage, it is expected that sub array configurations are relevant where 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, each polarization separately is considered in the models. The models are selected so that they are simple and representative to model BS 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. Thus, the extended antenna model with sub arrays is recommended to represent the beamforming capability of IMT base stations in considered frequency ranges.

**Table 4:** **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%21%21PDF-E.pdf) |
| 1.2 | Element gain (dBi) (Note 2) | 6.4 | 6.4 | 6.4 | 5.5 |
| 1.3 | Horizontal/vertical 3 dB beam width of single element (degree)  | 90º for H65º for V | 90º for H65º for V | 90º for H65º for V | 90º for H90º for V |
| 1.4 | Horizontal/vertical front‑to‑back ratio (dB) | 30 for both H/V | 30 for both H/V | 30 for both H/V | 30 for both H/V |
| 1.5 | Antenna polarization  | Linear ±45º polarized sub-array | Linear ±45º polarized sub-array | Linear ±45º polarized sub-array | Linear ±45º polarized sub-array |
| 1.6 | Antenna sub-array configuration (Row × Column) (Note 4) | 8 x 16 sub-arrays/elements | 8 x 16 sub-arrays/elements | 8 × 8 elements | 4 × 4 elements |
| 1.7 | Horizontal/Vertical radiating sub-array 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 | 0.5 of wavelength for H, 0.5 of wavelength for V |
| 1.7a | Number of element rows in sub-array | 3 | 3 | N/A | N/A |
| 1.7b | Vertical element separation in sub-array ($d\_{v,sub}$) | 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 | 2 |
| 1.9 | Conducted power (before Ohmic loss) per sub-array/element (dBm) (Note 3) | 22 | 22 | 16 | 9 |
| 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 |  |

Note 1: The vertical coverage range is given in global coordinate system, i.e., 90° being at the horizon.

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

Note 3: The conducted power per sub-array or element (i.e., power per H/V polarized sub-array or element). This power is typical power, there is no upper limit for Wide Area Base station.

Note 4: 4 × 8 means there are 4 vertical and 8 horizontal radiating sub-arrays or elements (no sub-array).

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: $θ\_{etilt}$ and $φ\_{escan}$ is the BS array antenna beam steering direction used in the coexistence study.

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