3GPP TSG RAN WG4 Meeting #98-e R4-2102840

Electronic Meeting, 25 January – 5 February, 2020

**Title: LS on Parameters of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-23 (6.425 to 10.5 GHz)**

**Response to: LS RP-200042 on Parameters of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-23 from ITU-R Working Party 5D**

**Release: -**

**Work Item: -**

**Source: TSG RAN WG4**

**To: ITU-R WP5D**

**Cc: TSG RAN**

**Contact person: Johan Sköld**

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**Send any reply LS to: 3GPP Liaisons Coordinator,** [**mailto:3GPPLiaison@etsi.org**](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-23 ([Att. 7.4 to 5D/134](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0134!H07!MSW-E.docx)). A first LS response was given from TSG RAN ([RP-200514](http://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_87e/Docs/RP-200514.zip)), followed by a response from TSG RAN WG4 covering parameters for operation between 470 MHz and 4990 MHz ([RP-200559](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_88e/Docs/RP-200559.zip)) and a second response on antenna parameters for operation in the range 6.425 to 10.5 GHz ([R4-2011932](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2011932.zip)). The feedback on specification parameters given in the LS response from WP5D ([R4-2017799](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_97_e/Docs/R4-2017799.zip)) is also recognized.

This LS is a consolidated response, merging the previous responses and also adding information not submitted before, all summarized in four annexes. Previously submitted parameters where corrections are made are marked yellow. The response in Annex 1 is based on the latest LS received from WP5D ([R4-2017799](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_97_e/Docs/R4-2017799.zip)), where feedback is given through corrections and additions marked yellow. Annex 3 contains specification parameters for 10 – 10.5 GHz not submitted before. Annexes 2 and 4 contain the corresponding antenna characteristics.

The bands within 470 MHz to 4990 MHz is part of what in 3GPP is defined as *Frequency Range 1* (FR1) and the 5G RF parameters for the bands are specified in 3GPP specifications [TS 38.104](http://www.3gpp.org/ftp/Specs/archive/38_series/38.104/38104-g30.zip) for the BS and [TS 38.101-1](http://www.3gpp.org/ftp/Specs/archive/38_series/38.101-1/38101-1-g30.zip) for the UE. The recommended IMT-2020 technology related parameters were given in an earlier LS response ([RP-200559](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_88e/Docs/RP-200559.zip)). and 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-O* for the bands.
* For Duplex method (item no. 1), references to 3GPP specifications are re-introduced since the table intends to show the specification related parameters. It is not sufficient to refer to ITU-R M.1036, since there are multiple overlapping band definitions in some cases and the specific definitions for each operating band is fully described only in the referenced specifications.
* For item 4.2 (spectral mask) and 4.4. (spurious emissions), references to limits identified as both Category A and Category B are given, considering the definitions in [ITU-R SM.329](https://www.itu.int/rec/R-REC-SM.329/recommendation.asp?lang=en&parent=R-REC-SM.329-12-201209-I).

The bands within 6425 MHz to 10500 MHz are presently not part of 3GPP specifications. A study was performed to provide system parameters beamforming antenna characteristics for the band and information relevant to the sharing and compatibility studies (see [3GPP TR 38.921](https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3778)). Regarding the additional information, as documented in TR 38.921, some interference mitigation techniques could be utilized for the co-existence deployments.

* Some items are marked “*To be specified*”. These are parameters pending detailed specification work that would not impact sharing and compatibility studies.

The recommended IMT-2020 antenna characteristics for AAS BS are given in Annex 2 for 1710 to 4990 MHz and in Annex 4 for 6425 to 10500 MHz. 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.
* There is no beamforming assumed for BS below 1.7 GHz.
* For fixed beam antennas, antenna parameters in [ITU-R M.2292](http://www.itu.int/pub/R-REP-M.2292) apply.

# 2 Actions

**To ITU-R WP5D**

**ACTION:** 3GPP TSG RAN asks ITU-R WP 5D to take the above information on IMT system parameters for its consideration.

# 3 Dates of next TSG RAN WG 4 meetings

TSG RAN4 Meeting #98bis-e 12 – 20 April, 2021 Online

TSG RAN4 Meeting #99-e 19 – 27 May, 2021 Online

ANNEX 1

IMT-2020 technology-related and deployment-related parameters for bands between 470 and 4990 MHz

TABLE 1A

IMT-2020 specification related parameters in 470 - 4 990 MHz

|  |  | IMT | | |
| --- | --- | --- | --- | --- |
| **No.** | **Parameter** | **Base station  (non-AAS)** | **Base station (AAS)** | **Mobile station** |
| **1** | **Duplex Method** | FDD / TDD  See [1], § 5.2.  (Note X) | | FDD / TDD  See [2], § 5.2.  (Note X) |
| **2** | **Channel bandwidth (MHz)** | See [1], §5.3.5 (Note X) | | See [2], §5.3.5  (Note X) |
| **3** | **Signal bandwidth** | Derived from Channel Bandwidth, see [1], § 5.3.2.  Signal bandwidth = NRB × SCS × 12. | | Derived from Channel Bandwidth, see [2], § 5.3.2.  Signal bandwidth = NRB × SCS × 12. |
| **4** | **Transmitter characteristics** |  | |  |
| 4.1 | Power dynamic range (dB) | Depends on channel bandwidth,  See [1], § 6.3.3, Table 6.3.3.2-1. | | See [2], § 6.2.1  (UE max output power) and § 6.3.1 (UE min output power, depends on channel bandwidth,). |
| 4.2 | Spectral mask (dB) | Category A:  See [1], § 6.6.4.2.1 (Wide Area BS), §6.6.4.2.3 (Medium Range BS), §6.6.4.2.4 (Local Area BS).  Category B:  See [1], § 6.6.4.2.2 (Wide Area BS), §6.6.4.2.3 (Medium Range BS), §6.6.4.2.4 (Local Area BS). | Category A and B:  See [1], § 9.7.4.2. (With reference to §6.6.4.2, where the same basic limits apply as for non-AAS BS.) | See [2], § 6.5.2.2, Table 6.5.2.2-1. |
| 4.3 | ACLR | See [1], § 6.6.3.2, Table 6.6.3.2-1. | | See [2], § 6.5.2.4.1. |
| 4.4 | Spurious emissions | Category A:  See [1], § 6.6.5, Table 6.6.5.2.1-1.  Category B:  See [1], § 6.6.5, Table 6.6.5.2.1-2. | | See [2], § 6.5.3.1. |
| 4.5 | Maximum/typical output power | See [1], § 6.2, Table 6.2.1-1. (Note X) | See Item No. 1.9  in Table 2 for typical values | See [2], § 6.2.1,  Table 6.2.1-1. (Note X) |
| **5** | **Receiver characteristics** |  |  |  |
| 5.1 | Noise figure (dB) | 5 dB (Macro cell scenario)  10 dB (Micro cell scenario)  13 dB (Indoor small cell scenario)  (Note Y) | | 9 dB |
| 5.2 | Sensitivity (dBm) | Depends on channel bandwidth and BS class, see [1], § 7.2.2. | Depends on channel bandwidth and BS class, see [1], § 10.3.2. | Depends on operating band, see [2], § 7.3.2, Table 7.3.2-1. |
| 5.3 | Blocking response | See [1], § 7.5.2, Table 7.5.2-1  and § 7.4.2, Tables 7.4.2.2-1, 7.4.2.2‑2 and 7.4.2.2-3. | See [1], § 10.6.2, Table 10.6.2.1-1 and § 10.5.2, Tables Table 10.5.2.2-1, 10.5.2.2-2 and 10.5.2.2-3. | Depends on operating band, see [2], § 7.6, Tables 7.6.2-2 and 7.6.2-4, 7.6.3-2 and 7.6.3-4 for blocking levels  and § 7.7, Table 7.7-2 for spurious response. |
| 5.4 | ACS | See [1], § 7.4.1.2. | See [1], § 10.5.1.2. | See [2], § 7.5, Table 7.5-1 and 7.5-2. |
| 5.5 | SINR operating range (dB) | See below “SINR operating range and mapping function” | | |
| References used in the Table:  [1] [3GPP TS 38.104 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.104/38104-g60.zip), “NR; Base Station (BS) radio transmission and reception”.  [2] [3GPP TS 38.101-1 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.101-1/38101-1-g60.zip), “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”.  Note X: Typical values of duplex method, channel bandwidth and max output power for both non-AAS and AAS IMT stations in different frequency bands are provided in Section 3.1.2.1.  Note Y: Wide Area Base Stations are characterised by requirements derived from Macro Cell scenarios, Medium Range Base Stations are characterised by requirements derived from Micro Cell scenarios and Local Area Base Stations are characterised by requirements derived from Pico Cell scenario, see [1], § 4.4. | | | | |

## SINR operating range and mapping function

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

Where:

S(SINR) Shannon bound, S(SINR) =log2(1+SINR) [bps/Hz]  
α Attenuation factor, representing implementation losses  
SINRMIN Minimum SINR of the code set, dB  
SINRMAX Maximum SINR of the code set, dB

The parameters α, SINRMIN and SINRMAX 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 1B: Parameters describing baseline Link Level performance for 5G NR

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **DL** | **UL** | **Notes** |
| α | 0.6 | 0.4 | Represents implementation losses |
| SINRMIN, dB | -10 | -10 | Based on QPSK, 1/8 rate (DL) & 1/5 rate (UL) |
| SINRMAX, dB | 30 | 22 | Based on 256QAM 0.93(DL) & 64QAM 0.93 (UL) |

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ANNEX 2

Antenna characteristics for IMT-2020 AAS base stations   
for bands between 1710 and 4990 MHz

TABLE 2

**Beamforming antenna characteristics for IMT in 1710 – 4990 MHz**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Rural | Macro suburban | Macro urban | Small cell outdoor/ Micro urban | Small cell indoor/ Indoor urban | |
| **1** | **Base station Antenna Characteristics** | | | | | | | |
| 1.1 | Antenna pattern | Refer to Recommendation [ITU-R M.2101](https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2101-0-201702-I!!PDF-E.pdf) | | | | | N/A | |
| 1.2 | Element gain (dBi) (Note 2) | 7.1 | 7.1 | 6.4 | 6.4 | N/A | |
| 1.3 | Horizontal/vertical 3 dB beam width of single element (degree) | 90º for H 54º for V | 90º for H 54º for V | 90º for H 65º for V | 90º for H 65º for V | N/A | |
| 1.4 | Horizontal/vertical front‑to‑back ratio (dB) | 30 for both H/V | 30 for both H/V | 30 for both H/V | 30 for both H/V | N/A | |
| 1.5 | Antenna polarization | Linear ±45º | Linear ±45º | Linear ±45º | Linear ±45º | N/A | |
| 1.6 | Antenna array configuration (Row × Column)  (Note 4) | 8 × 8 elements | 8 × 8 elements | 8 × 8 elements | 8 × 8 elements | N/A | |
| 1.7 | Horizontal/Vertical radiating element spacing | 0.5 of wavelength for H, 0.9 of wavelength for V | 0.5 of wavelength for H, 0.9 of wavelength for V | 0.5 of wavelength for H, 0.7 of wavelength for V | 0.5 of wavelength for H, 0.7 of wavelength for V | N/A | |
| 1.8 | Array Ohmic loss (dB) (Note 2) | 2 | 2 | 2 | 2 | N/A | |
| 1.9 | Conducted power (before Ohmic loss) per antenna element (dBm) (Note 3) | 25 | 25 | 25 | 16 | N/A | |
| 1.10 | Base station maximum coverage angle in the horizontal plane (degrees) | 120 | 120 | 120 | 120 | N/A | |
| 1.11 | Base station vertical coverage range (degrees) (Note 1) | 90-100 | 90-100 | 90-120 | 90-120 | N/A | |
| 1.12 | Mechanical downtilt (degrees) | 3 | 6 | 10 | 10 | N/A | |

Note 1: The vertical coverage range is given for the elevation angle θ, defined between 0° and 180° as   
in [ITU-R M.2101](https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2101-0-201702-I!!PDF-E.pdf).

Note 2: The element gain in row 1.2 includes the loss given in row 1.8.

Note 3: The conducted power per element assumes 8x8x2 elements (i.e. power per H/V polarized element).

Note 4: 8 × 8 means there are 8 vertical and 8 horizontal radiating elements. In the sub-array case, one implementation is 2 vertical radiating elements combined in a 2x1 sub-array.

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ANNEX 3

IMT-2020 technology-related and deployment-related parameters for bands between in 6425 to 7125 MHz and 10 to 10.5 GHz

TABLE 3A

IMT-2020 technology related parameters in 6425 – 7125 MHz and 10 – 10.5 GHz

|  |  | IMT | |
| --- | --- | --- | --- |
| **No.** | **Parameter** | **Base station (AAS)** | **Mobile station** |
| **1** | **Duplex Method** | TDD | TDD |
| **2** | **Channel bandwidth (MHz)** | 100 MHz (typical) | 100 MHz (typical) |
| **3** | **Signal bandwidth (MHz)** | *To be specified.*  Will be derived from  Channel Bandwidth, see [1], § 5.3.2. | *To be specified*.  Will be derived from Channel Bandwidth,  see [2], § 5.3.2. |
| **4** | **Transmitter characteristics** |  |  |
| 4.1 | Power dynamic range (dB) | 0 dB | 56 dB |
| 4.2 | Spectral mask (dB) | Category A: (Note 1) See table 3B (Wide Area BS)  (ΔfOBUE = 100 MHz)  Category B: (Note 1) See table 3C (Wide Area BS)  (ΔfOBUE = 100 MHz) | See Table 3D |
| 4.3 | ACLR (dB) | @6425 – 7125 MHz: 38 dB  @10-10.5 GHz: 37 dB | @6425 – 7125 MHz: 26 dB  @10-10.5 GHz: 24 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)  @6425 – 7125 MHz See [1], § 6.6.5, Table 6.6.5.2.1-2.  @10 – 10.5 GHz:  See Table 3E | See [2], § 6.5.3. |
| 4.5 | Maximum/typical output power (dBm) | Defined by the conducted power per antenna element, see entry 1.9 in Table 4 for typical values. | 23 dBm |
| **5** | **Receiver characteristics** |  |  |
| 5.1 | Noise figure (dB) | @6425 – 7125 MHz: 6 dB (Wide Area BS) 11 dB (Medium Range BS) 14 dB (Local Area BS)  @10-10.5 GHz 7 dB [Wide area) 12 dB (Medium Range BS) 15 dB (Local Area BS)  For BS class definitions, see [1], § 4.4 | [9 dB] |
| 5.2 | Sensitivity (dBm) | *To be specified* | *To be specified* |
| 5.3 | Blocking response | In-band blocking level:  -43 dBm (Wide Area BS) -38 dBm (Medium Range BS) -35 dBm (Local Area BS) Interferer type: 20 MHz DFT-S-OFDM NR signal, 15 kHz SCS, 100 RB.  Out-of-band blocking level: -15 dBm, Interferer type: CW  ΔfOOB = 100 MHz (Note 2) | See [2], §7.6, Tables 7.6.2-4 and 7.6.3-4 |
| 5.4 | ACS | @6425 – 7125 MHz: 42 dB  @10-10.5 GHz: 40 dB | @6425 – 7125 MHz: 32 dB  @10-10.5 GHz: 31 dB |
| 5.5 | SINR operating range (dB) | See “SINR operating range and mapping function” in Annex 1. | |

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.

References used in the Table:

[1] [3GPP TS 38.104 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.104/38104-g60.zip), “NR; Base Station (BS) radio transmission and reception”.

[2] [3GPP TS 38.101-1 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.101-1/38101-1-g60.zip). “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”

TABLE 3B

AAS BS Spectral mask (Operating band unwanted emissions limits) for 6425 – 7125 MHz and 10 – 10.5 GHz operation (Category A)

| **Frequency offset of measurement filter ‑3dB point from the carrier frequency, Δf** | **Basic limits** | **Measurement Bandwidth** |
| --- | --- | --- |
| 0 MHz ≤ Δf < 50MHz |  | 100 kHz |
| 50 MHz ≤ Δf < min(100 MHz, Δfmax) | -14 dBm | 100 kHz |
| 100 MHz ≤ Δf ≤ Δfmax | -13 dBm | 1 MHz |
| NOTE: Δfmax 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 3C

AAS BS Spectral mask (Operating band unwanted emissions limits) for 6425 – 7125 MHz and 10 - 10.5 GHz operation (Category B)

| **Frequency offset of measurement filter ‑3dB point from the carrier frequency, Δf** | **Basic limits** | **Measurement Bandwidth** |
| --- | --- | --- |
| 0 MHz ≤ Δf < 50MHz |  | 100 kHz |
| 50 MHz ≤ Δf < min(100 MHz, Δfmax) | -14 dBm | 100 kHz |
| 100 MHz ≤ Δf ≤ Δfmax | -15 dBm | 1 MHz |
| NOTE: Δfmax 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 3D

Mobile station Spectral mask for 6425 – 7125 MHz and 10 - 10.5 GHz operation

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Spectrum emission limit (dBm) / Channel bandwidth | | | | | | | | | | |
| ΔfOOB  (MHz) | 20  MHz | 25  MHz | 30 MHz | 40  MHz | 50  MHz | 60  MHz | 70  MHz | 80  MHz | 90  MHz | 100  MHz | Measurement bandwidth |
| ± 0-1 | -10 | -10 | -10 | -10 |  |  |  |  |  |  | 1 % channel bandwidth |
| ± 0-1 |  |  |  |  | -21 | -21 | -21 | -21 | -21 | -21 | 30 kHz |
| ± 1-5 | -7 | -7 | -7 | -7 | -7 | -7 | -7 | -7 | -7 | -7 | 1 MHz |
| ± 5-105 | See [2], §6.5.2.2, Table 6.5.2.2-1 | | | | | | | | | | |

TABLE 3E

AAS BS radiated Tx spurious emission limits for 10 - 10.5 GHz operation (Category B)

| **Frequency range** | **Limit** | **Measurement Bandwidth** |
| --- | --- | --- |
| 30 MHz – 1 GHz | -36 dBm | 100 kHz |
| 1 GHz – 18 GHz | -30 dBm | 1 MHz |
| 18 GHz – 26 GHz | -20 dBm | 10 MHz |

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ANNEX 4

Antenna characteristics for IMT-2020 AAS base stations   
for bands between 6425 and 10500 MHz

TABLE 4

**Beamforming antenna characteristics for IMT in 6425 – 10500 MHz**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  | Rural | | Macro suburban | Macro urban | Small cell outdoor/ Micro urban | Small cell indoor/ Indoor urban |
| **1** | **Base station Antenna Characteristics** | | | | | | |
| 1.1 | Antenna pattern | | Refer to Recommendation [ITU-R M.2101](https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2101-0-201702-I!!PDF-E.pdf) | | | | |
| 1.2 | | Element gain (dBi) (Note 1) | N/A | | 6.4 | 5.5 | 5.5 | 5.5 |
| 1.3 | | Horizontal/vertical 3 dB beamwidth of single element (degree) | N/A | | 90º for H 65º for V | 90º for H 90º for V | 90º for H 90º for V | 90º for H 90º for V |
| 1.4 | | Horizontal/vertical front‑to‑back ratio (dB) | N/A | | 30 for both H/V | 30 for both H/V | 30 for both H/V | 30 for both H/V |
| 1.5 | | Antenna polarization | N/A | | Linear ±45º | Linear ±45º | Linear ±45º | Linear ±45º |
| 1.6 | | Antenna array configuration (Row × Column) | N/A | | 16 × 8 elements | 16 × 8 elements | 8 × 8 elements | 4 × 4 elements |
| 1.7 | | Horizontal/Vertical radiating element spacing | N/A | | 0.5 of wavelength for H, 0.7 of wavelength for V | 0.5 of wavelength  for H, 0.5 of wavelength for V | 0.5 of wavelength  for H, 0.5 of wavelength for V | 0.5 of wavelength  for H, 0.5 of wavelength for V |
| 1.8 | | Array Ohmic loss (dB) (Note 1) | N/A | | 2 | 2 | 2 | 2 |
| 1.9 | | Conducted power (before Ohmic loss) per antenna element (dBm) | N/A | | 22  (Note 5) | 22  (Note 5) | 16  (Note 6) | 9  (Note 7) |
| 1.10 | | Base station maximum coverage angle in the horizontal plane (degrees) | N/A | | 120 | 120 | 120 | N/A  (Note 8) |
| 1.11 | | Base station vertical coverage range (degrees) (Note 3, 4) | N/A | | 90-100 | 90-120 | 90-120 | N/A  (Note 8) |
| 1.12 | | Mechanical downtilt (degrees) (Note 4) | N/A | | 6 | 10 | 10 | N/A  (Note 8) |

Note 1: The element gain in row 1.2 includes the loss given in row 1.8.

Note 2: 16 × 8 means there are 16 vertical and 8 horizontal radiating elements. In the sub-array case, one implementation is 2 vertical radiating elements combined in a 2x1 sub-array

Note 3: The vertical coverage range is given for the elevation angle θ, defined between 0° and 180° as in [ITU-R M.2101](https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2101-0-201702-I!!PDF-E.pdf).

Note 4: The vertical coverage range in row 1.11 includes the mechanical downtilt given in row 1.12.

Note 5: The conducted power per element assumes 16x8x2 elements (i.e. power per H/V polarized element).

Note 6: The conducted power per element assumes 8x8x2 elements (i.e. power per H/V polarized element).

Note 7: The conducted power per element assumes 4x4x2 elements (i.e. power per H/V polarized element).

Note 8: The boresight direction is perpendicular to the ceiling.

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