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| 3GPP TR 38.741 V18.0.0 (2023-12) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Network;  Non-Terrestrial Networks (NTN) L-/S-band for NR;  (Release 18) | |
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# Foreword

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

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

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where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

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

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

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

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

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

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

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

**should** indicates a recommendation to do something

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

**may** indicates permission to do something

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

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

**can** indicates that something is possible

**cannot** indicates that something is impossible

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

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

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

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

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

In addition:

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

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

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

# 1 Scope

The present document is a technical report for the work item of the NTN L-S-band.

# 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] 3GPP TS 38.108: "NR; Satellite Access Node radio transmission and reception"

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

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

**Non-terrestrial networks:** Networks, or segments of networks, using an airborne or space-borne vehicle to embark a transmission equipment relay node or base station.

**Satellite:** A space-borne vehicle embarking a bent pipe payload or a regenerative payload telecommunication transmitter, placed into Low-Earth Orbit (LEO), Medium-Earth Orbit (MEO), or Geostationary Earth Orbit (GEO).

**Satellite Access Node:** see definition in TS 38.108 [2].

**UE transmission bandwidth configuration**: Set of resource blocks located within the UE channel bandwidth which may be used for transmitting or receiving by the UE.

## 3.2 Symbols

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

ΔFGlobal Granularity of the global frequency raster

ΔFRaster Band dependent channel raster granularity

BWChannel Channel bandwidth

BWinterferer Bandwidth of the interferer

FDL\_low The lowest frequency of the downlink *operating band*

FDL\_high The highest frequency of the downlink *operating band*

FUL\_low The lowest frequency of the uplink *operating band*

FUL\_high The highest frequency of the uplink *operating band*

FInterferer Frequency of the interferer

FInterferer (offset) Frequency offset of the interferer (between the center frequency of the interferer and the carrier frequency of the carrier measured)

FIoffset Frequency offset of the interferer (between the center frequency of the interferer and the closest edge of the carrier measured)

FOOB The boundary between the NR out of band emission and spurious emission domains

FREF RF reference frequency

FREF-Offs Offset used for calculating FREF

Fuw (offset) The frequency separation of the center frequency of the carrier closest to the interferer and the center frequency of the interferer

NRB Transmission bandwidth configuration, expressed in units of resource blocks

NREF NR Absolute Radio Frequency Channel Number (NR-ARFCN)

NREF-Offs Offset used for calculating NREF

PInterferer Modulated mean power of the interferer

Puw Power of an unwanted DL signal

## 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].

ACLR Adjacent Channel Leakage Ratio

ACS Adjacent Channel Selectivity

A-MPR Additional Maximum Power Reduction

BW Bandwidth

BWP Bandwidth Part

CP-OFDM Cyclic Prefix-OFDM

CW Continuous Wave

DFT-s-OFDM Discrete Fourier Transform-spread-OFDM

EIRP Equivalent Isotropically Radiated Power

EVM Error Vector Magnitude

FR Frequency Range

FRC Fixed Reference Channel

GEO Geosynchronous Earth Orbit

GSCN Global Synchronization Channel Number

IBB In-band Blocking

ITU-R Radiocommunication Sector of the International Telecommunication Union

LEO Low Earth Orbiting

MOP Maximum Output Power

MPR Allowed maximum power reduction

MSD Maximum Sensitivity Degradation

NR New Radio

NR-ARFCN NR Absolute Radio Frequency Channel Number

NS Network Signalling

NTN Non-Terrestrial Network

OOB Out-of-band

PRB Physical Resource Block

QAM Quadrature Amplitude Modulation

RAN Radio Access Network

RE Resource Element

REFSENS REFerence SENSitivity

RF Radio Frequency

RMS Root Mean Square (value)

RX Receiver

SAN Satellite Access Node

SC Single Carrier

SCS Subcarrier spacing

SEM Spectrum Emission Mask

SNR Signal-to-Noise Ratio

SS Synchronization Symbol

TN Terrestrial Network

TX Transmitter

UE User Equipment

# 4 Background

3GPP RAN#86 meeting approved the Rel-17 WI that aimed to enable support of the 5G/NR radio access technology for non-terrestrial satellite deployments. One of the WI objectives was to define and introduce the corresponding bands into the 3GPP specifications. The outcome of these discussions was two NTN bands – L-band and S-band – which were added as bands n255 and n256, respectively. At the same time there exist other satellite deployments, some of which use mixed L-/S-band pairing, whereupon the UL part is on the L-band, while the DL part is on the S-band. To limit the overall workload in Rel-17, it was decided by RAN WG4 to focus on L- and S-bands with the common understanding that other potential NTN bands should follow the "normal" process of submitting a new spectrum WI.

3GPP RAN#98 meeting agreed a new spectrum WI to add support for a new NTN band with the DL part on the S-band (2500MHz) and the UL part on the L-band (1600MHz).

# 5 Regulations

NOTE: The purpose of this section is to collect information from existing regulatory documents concerning regulatory rules applicable to this NTN L-/S-band.

## 5.1 FCC

### 5.1.1 47 CFR § 25.202

According to paragraph (a)(4)(i), the following frequencies are available for use by the 1.6/2.4 GHz Mobile-Satellite Service:

- 1610-1626.5 MHz: User-to-Satellite Link

- 1613.8-1626.5 MHz: Satellite-to-User Link (secondary)

- 2483.5-2500 MHz: Satellite-to-User Link

According to paragraph (f) on emission limitations, except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section:

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;

(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

### 5.1.2 47 CFR § 25.216

(c) The e.i.r.p. density of emissions from mobile earth stations placed in service after July 21, 2002 with assigned uplink frequencies between 1610 MHz and 1660.5 MHz shall not exceed −70 dBW/MHz, averaged over any 2 millisecond active transmission interval, in the band 1559-1605 MHz. The e.i.r.p. of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed −80 dBW, averaged over any 2 millisecond active transmission interval, in the 1559-1605 MHz band.

## 5.2 ETSI

### 5.2.1 ETSI EN 301 441

Table 5.2.1-1: Mobile Satellite Service frequency bands

|  |  |
| --- | --- |
| MES | MSS frequency bands |
| Transmit | 1610 – 1626.5 MHz |
| Receive | 1613.8 – 1626.5 MHz |
| Receive | 2483.5 – 2500 MHz |

Table 5.2.1-2: Maximum unwanted emissions outside the band 1610 MHz to 1626.5 MHz and the band 1626.5 MHz to 1628.5MHz.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | Carrier-on | | |
| EIRP (dBW) | Measurement bandwidth | Measurement method |
| 0.1 to 30 | -66 | 10 kHz | Peak-hold |
| 30 to 1 000 | -66 | 100 kHz | Peak-hold |
| 1000 to 1559 | -60 | 1 MHz | Average |
| 1559 to 1580.42 | -70 | 1 MHz | Average |
| 1580.42 to 1605 | -70 | 1 MHz | Average |
| 1605 to 1610 | -70 to -10 | 1 MHz | Average |
| 1610 to 1626.5 | N/A | N/A | N/A |
| 1626.5 to 1628.5 | N/A | N/A | N/A |
| 1628.5 to 1631.5 | -60 | 30 kHz | Average |
| 1631.5 to 1636.5 | -60 | 100 kHz | Average |
| 1636.5 to 1646.5 | -60 | 300 kHz | Average |
| 1646.5 to 1666.5 | -60 | 1 MHz | Average |
| 1666.5 to 2200 | -60 | 3 MHz | Average |
| 2200 to 12750 | -60 | 3 MHz | Peak-hold |
| NOTE 1: In the sub-band 1 573,42 MHz to 1 580,42 MHz, the average measurement time is 20 ms.  NOTE 2: Linearly interpolated in dBW vs. frequency offset. | | | |

Table 5.2.1-3: Maximum unwanted emissions within the band 1610MHz to 1 626.5MHz and the band 1626.5 MHz to 1628.5MHz of MES operating such that the nominated bandwidth is entirely or partially contained in the frequency band 1618.25 MHz to 1626.5MHz.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset (kHz) | Carrier-on | | |
| EIRP (dBW) | Measurement bandwidth | Measurement method |
| 0 to 160 | -35 | 30 kHz | Average |
| 160 to 225 | -35 to -38.5 | 30 kHz | Average |
| 225 to 650 | -38.5 to -45 | 30 kHz | Average |
| 650 to 1365 | -45 | 30 kHz | Average |
| 1365 to 1800 | -53 to -56 | 30 kHz | Average |
| 1800 to 16500 | -56 | 30 kHz | Average |
| NOTE 1: Frequency offset is determined from: i) the nearest edge of the nominated bandwidth of the nominal carrier closest to the MSS system operating in another operational band within the band 1 610 MHz to 1 626,5 MHz. The frequency offset is measured in the direction of the adjacent MSS system; ii) the upper edge of the nominated bandwidth of the carrier under test for emissions within the band 1626.5MHz to 1628.5MHz.  NOTE 2: The measurement bandwidth used may be 3 kHz if the unwanted EIRP limits are reduced correspondingly.  NOTE 3: Linearly interpolated in dBW vs. frequency offset. | | | |

Table 5.2.1-4: Maximum unwanted emissions within the band 1610MHz to 1626.5 MHz and the band 1626.5MHz to 1628.5MHz of MES operating such that the nominated bandwidth is entirely contained in the frequency band 1610MHz to 1618.25MHz.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset (kHz) | Carrier-on | | |
| EIRP (dBW) | Measurement bandwidth | Measurement method |
| 0 to 160 | -32 | 30 kHz | Average |
| 160 to 2300 | -32 to -56 | 30 kHz | Average |
| 2300 to 18500 | -56 | 30 kHz | Average |
| NOTE 1: Frequency offset is determined from: i) the nearest edge of the nominated bandwidth of the nominal carrier closest to the MSS system operating in another operational band within the band 1 610 to 1 626,5 MHz The frequency offset is measured in the direction of the adjacent MSS system; ii) the upper edge of the nominated bandwidth of the carrier under test for emissions within the band 1626.5 to 1628.5MHz.  NOTE 2: The measurement bandwidth used may be 3 kHz if the unwanted EIRP limits are reduced correspondingly.  NOTE 3: Linearly interpolated in dBW vs. frequency offset. | | | |

Table 5.2.1-5: Maximum unwanted emissions of MES carriers within the operational band of CDMA carriers.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset (kHz) | Carrier-on | | |
| EIRP (dBW) | Measurement bandwidth | Measurement method |
| 0 to 70 | -6 to -20 | 30 kHz | Average |
| 70 to 600 | -20 to -28 | 30 kHz | Average |
| 600 to 2000 | -28 to -45 | 30 kHz | Average |
| 2000 to 5000 | -45 to -69 | 30 kHz | Average |
| 5000 to 16500 | -69 | 30 kHz | Average |
| NOTE 1: Frequency offset is determined from edge of nominated bandwidth.  NOTE 2: Linearly interpolated in dBW vs. frequency offset. | | | |

The frequency offset and relative power level of the adjacent signal compared to the wanted signal shall take the values given in table 5.2.1-6. The adjacent signal shall occupy the same bandwidth as the wanted signal where BW is the wanted signal occupied bandwidth. There shall be no more than 0.5dB degradation in the receiver signal to noise ratio under these conditions.

Table 5.2.1-6: Adjacent Channel frequency and power level

|  |  |  |
| --- | --- | --- |
| Signal | Centre frequency offset from wanted signal | Power level relative to wanted signal |
| Adjacent signal | Signal bandwidth | 12 dB |

Receiver blocking characteristics are to prevent high power signals outside the receive frequency band from blocking the reception of signals inside the receive frequency band. The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. Receiver blocking is specified for in-band signals. In-band signals are signals in the range:

BEL-10MHz to BEU +10 MHz, where BEL and BEU are the lower and upper edges of the operating band respectively.

The receiver performance degradation, in terms of signal to noise ratio, shall not exceed 1dB when the unwanted signal as specified in Table 5.2.1-7 is present.

Table 5.2.1-7: Test parameters for in-band blocking characteristics

|  |  |  |  |
| --- | --- | --- | --- |
| Interfering Signal | In-band Frequency Range (MHz) | Frequency offset from wanted carrier (MHz) | Level (dBm) |
| CW | BEL-10MHz to BEU +10 MHz | 5 | -40 |

# 6 NR

## 6.1 Band plan and system parameters

Table 6.1-1: NTN L-/S-band n254

|  |  |  |  |
| --- | --- | --- | --- |
| NTN satellite operating band | Uplink (UL) operating band Satellite Access Node receive / UE transmit  FUL,low – FUL,high | Downlink (DL) operating band Satellite Access Node transmit / UE receive  FDL,low – FDL,high | Duplex mode |
| n254 | 1610 – 1626.5 MHz | 2483.5 – 2500 MHz | FDD |
| NOTE: NTN satellite bands are numbered in descending order from n256. | | | |

Table 6.1-2: NTN L-/S-band n254 channel bandwidths

| NTN satellite band | SCS  kHz | UE Channel bandwidth (MHz) | | | |
| --- | --- | --- | --- | --- | --- |
| 5 | 10 | 15 |  |
| n254 | 15 | 5 | 10 | 15 |  |
| 30 |  | 10 | 15 |  |
| 60 |  | 10 | 15 |  |

Table 6.1-3: NTN L-/S-band n254 applicable NR-ARFCN

|  |  |  |  |
| --- | --- | --- | --- |
| NTN satellite operating band | ΔFRaster  (kHz) | Uplink  Range of NREF  (First – <Step size> – Last) | Downlink  Range of NREF  (First – <Step size> – Last) |
| n254 | 100 | 322000 – <20> – 325300 | 496700 – <20> – 500000 |
| NOTE : The channel numbers that designate carrier frequencies so close to the operating band edges that the carrier extends beyond the operating band edge shall not be used. | | | |

Table 6.1-4: NTN L-/S-band n254 applicable SS raster entries

|  |  |  |  |
| --- | --- | --- | --- |
| NTN satellite operating band | SS Block SCS | SS Block pattern1 | Range of GSCN  (First – <Step size> – Last) |
| n254 | 15kHz | Case A | 6215 – <1> – 6244 |
| 30 kHz | Case C | 6218 – <1> – 6241 |
| NOTE : SS Block pattern is defined in clause 4.1 in 3GPP TS 38.213 [7]. | | | |

Table 6.1-5: NTN L-/S-band asymmetric UL and DL channel bandwidth combinations

|  |  |  |  |
| --- | --- | --- | --- |
| NR Band | Channel bandwidths for UL (MHz) | Channel bandwidths for DL (MHz) | Asymmetric channel bandwidth combination set |
| n254 | 5 | 10,15 | 0 |
| 10 | 15 | 0 |
| NOTE 1: The assignment of the paired UL and DL channels are subject to a TX-RX separation as specified in clause 5.4.4.  NOTE 2: As indicated in TS38.306 [15], it is mandatory for UEs to support asymmetric channel BCS0 if there is an asymmetric BCS0 defined for the band. | | | |

Table6.1-6: NTN L-/S-band UE TX-RX frequency separation

| NTN Satellite Operating Band | TX – RX  carrier centre frequency separation |
| --- | --- |
| n254 | 862 – 885 MHz |

## 6.2 UE requirements

Table 6.2-1 and 6.2-2 below summarise UE Tx and Rx requirements indicating which requirements are specific for this band and, if so, are captured in the corresponding sub-clauses of this TR.

Table 6.2-1: NTN L-/S-band TX requirements

|  |  |
| --- | --- |
| Tx requirements |  |
| 6.2.1 Maximum output power | clause 6.2.1.1 |
| 6.2.2 MPR | clause 6.2.1.2 |
| 6.2.3 A-MPR | clause 6.2.1.3 |
| 6.2.4 Configured transmitted power | reuse TS 38.101-5 requirement |
| 6.3.1 Minimum output power | reuse TS 38.101-5 requirement |
| 6.3.2 Transmit OFF power | reuse TS 38.101-5 requirement |
| 6.3.3 Transmit ON/OFF time mask | reuse TS 38.101-5 requirement |
| 6.3.4 Power control | reuse TS 38.101-5 requirement |
| 6.4.1 Frequency error | reuse TS 38.101-5 requirement |
| 6.4.2 Transmit modulation quality | reuse TS 38.101-5 requirement |
| 6.5.1 Occupied bandwidth | reuse TS 38.101-5 requirement |
| 6.5.2 Out of band emission | reuse TS 38.101-5 requirement |
| 6.5.3 Spurious emission | additional spurious emission in clause 6.2.1.3  co-existence requirement in clause 6.2.1.4  for other requirements reuse TS 38.101-5 requirement |
| 6.5.4 Transmit intermodulation | reuse TS 38.101-5 requirement |

Table 6.2-2: NTN L-/S-band RX requirements

|  |  |
| --- | --- |
| Rx requirement |  |
| 7.3 Reference sensitivity | clause 6.2.2.1 |
| 7.4 Maximum input level | reuse TS 38.101-5 requirement |
| 7.5 Adjacent channel selectivity | reuse TS 38.101-5 requirement |
| 7.6 Blocking characteristics | in-band blocking in clause 6.2.2.2  out-of-band blocking in clause 6.2.2.3 |
| 7.7 Spurious response | reuse TS 38.101-5 requirement |
| 7.8 Intermodulation characteristics | reuse TS 38.101-5 requirement |
| 7.9 Spurious emissions | reuse TS 38.101-5 requirement |

### 6.2.1 UE transmitter characteristics

#### 6.2.1.1 Maximum output power

Table 6.2.1.1-1: NTN L-/S-band n254 Power Class

|  |  |  |
| --- | --- | --- |
| NR satellite band | Class 3 (dBm) | Tolerance (dB) |
| n254 | 23 | ±2 |
| NOTE 1: PPowerClass is the maximum UE power specified without taking into account the tolerance  NOTE 2: Powerclass 3 is default power class unless otherwise stated | | |

#### 6.2.1.2 MPR/A-MPR

##### 6.2.1.2.1 Maximum power reduction

Maximum power reduction for the NTN L-/S-band is the same as for other NTN bands, such as L-band n255 and S-band n256.

Table 6.2.1.2.1-1: Maximum power reduction (MPR) for power class 3.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation | | MPR (dB) | | |
|  | | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 3.51 | ≤ 1.21 | ≤ 0.21 |
|  |  | ≤ 0.52 | ≤ 0.52 | 02 |
|  | Pi/2 BPSK w Pi/2 BPSK DMRS | ≤ 0.52 | 02 | 02 |
|  | QPSK | ≤ 1 | | 0 |
|  | 16 QAM | ≤ 2 | | ≤ 1 |
|  | 64 QAM | ≤ 2.5 | | |
|  | 256 QAM | ≤ 4.5 | | |
| CP-OFDM | QPSK | ≤ 3 | | ≤ 1.5 |
|  | 16 QAM | ≤ 3 | | ≤ 2 |
|  | 64 QAM | ≤ 3.5 | | |
|  | 256 QAM | ≤ 6.5 | | |
| NOTE 1: Applicable for UE operating in TDD mode with Pi/2 BPSK modulation and UE indicates support for UE capability *powerBoosting-pi2BPSK* and if the IE *powerBoostPi2BPSK* is set to 1 and 40 % or less slots in radio frame are used for UL transmission for bands n40, n41, n77, n78 and n79. The reference power of 0 dB MPR is 26 dBm.  NOTE 2: Applicable for UE operating in FDD mode, or in TDD mode in bands other than n40, n41, n77, n78 and n79 with Pi/2 BPSK modulation and if the IE *powerBoostPi2BPSK* is set to 0 and if more than 40 % of slots in radio frame are used for UL transmission for bands n40, n41, n77, n78 and n79. | | | | |

##### 6.2.1.2.2 Additional maximum power reduction (company #1)

Maximum power reduction for the NTN L-/S-band is the same as for other NTN bands, such as L-band n255 and S-band n256.

6.2.1.2.2.1 Configuration cases

For the power back-off simulations the following common parameters are assumed:

- Tx power: PC3 +23dBm

- LO placement: always in the centre of the carrier

- Regulations: ETSI and FCC

The following channel sizes with centre frequencies are considered:

- NR 5MHz channel at the following centre frequencies:

a) Fc=1612.5MHz

b) Fc=1613.9MHz

c) Fc=1615.5MHz

d) Fc=1620.5MHz

e) Fc=1622.4MHz

f) Fc=1624MHz

- NR 10MHz channel at the following centre frequencies:

a) Fc=1615MHz.

b) Fc=1620MHz

c) Fc=1621.5MHz

- NR 15MHz channel at the following centre frequencies:

a) Fc=1617.5MHz

b) Fc=1619MHz



Figure 6.2.1.2.2.1-1: Considered channels for A-MPR simulations.

6.2.1.2.2.2 Power back-off results for ETSI

6.2.1.2.2.2.1 5MHz channel

A picture containing text, plot, diagram, line

Description automatically generated

Figure 6.2.1.2.2.2.1-1: Power back-off values for the 5MHz channel at Fc=1612.5MHz.

A graph with different colored squares

Description automatically generated

Figure 6.2.1.2.2.2.1-2: Power back-off values for the 5MHz channel at Fc=1613.9MHz.

A screen shot of a graph

Description automatically generated

Figure 6.2.1.2.2.2.1-3: Power back-off values for the 5MHz channel at Fc=1615.5MHz.

A picture containing plot, diagram, line, screenshot

Description automatically generated

Figure 6.2.1.2.2.2.1-4: Power back-off values for the 5MHz channel at Fc=1620.5MHz.

A graph with different colored squares

Description automatically generated

Figure 6.2.1.2.2.2.1-5: Power back-off values for the 5MHz channel at Fc=1622.4MHz.

A picture containing diagram, plot, line, text

Description automatically generated

Figure 6.2.1.2.2.2.1-6: Power back-off values for the 5MHz channel at Fc=1624MHz.

6.2.1.2.2.2.2 10MHz channel

A picture containing diagram, plot, line, text

Description automatically generated

Figure 6.2.1.2.2.2.2-1: Power back-off values for the 10MHz channel at Fc=1615MHz.

A graph of different colored lines

Description automatically generated with medium confidence

Figure 6.2.1.2.2.2.2-2: Power back-off values for the 10MHz channel at Fc=1620MHz.

A picture containing plot, diagram, line, screenshot

Description automatically generated

Figure 6.2.1.2.2.2.2-3: Power back-off values for the 10MHz channel at Fc=1621.5MHz.

6.2.1.2.2.2.3 15MHz channel

A picture containing text, plot, diagram, multimedia software

Description automatically generated

Figure 6.2.1.2.2.2.3-1: Power back-off values for the 15MHz channel at Fc=1617.5MHz.

A picture containing text, plot, multimedia software, diagram

Description automatically generated

Figure 6.2.1.2.2.2.3-2: Power back-off values for the 15MHz channel at Fc=1619MHz.

###### 6.2.1.2.2.3 Power back-off results for FCC

6.2.1.2.2.3.1 5MHz channel

A screen shot of a graph

Description automatically generated

Figure 6.2.1.2.2.3.1-1: Power back-off values for the 5MHz channel at Fc=1612.5MHz.

A graph with different colored squares

Description automatically generated

Figure 6.2.1.2.2.2.1-2: Power back-off values for the 5MHz channel at Fc=1613.9MHz.

A graph showing a number of colored squares

Description automatically generated with medium confidence

Figure 6.2.1.2.2.3.1-3: Power back-off values for the 5MHz channel at Fc=1615.5MHz.

A graph of a diagram

Description automatically generated with medium confidence

Figure 6.2.1.2.2.3.1-4: Power back-off values for the 5MHz channel at Fc=1620.5MHz.

A graph with different colored squares

Description automatically generated

Figure 6.2.1.2.2.3.1-5: Power back-off values for the 5MHz channel at Fc=1624MHz.

6.2.1.2.2.3.2 10MHz channel

A graph of a graph

Description automatically generated with medium confidence

Figure 6.2.1.2.2.3.2-1: Power back-off values for the 10MHz channel at Fc=1615MHz.

A graph of a graph

Description automatically generated with medium confidence

Figure 6.2.1.2.2.3.2-2: Power back-off values for the 10MHz channel at Fc=1620MHz.

A graph showing different colored lines

Description automatically generated with medium confidence

Figure 6.2.1.2.2.3.2-3: Power back-off values for the 10MHz channel at Fc=1621.5MHz.

6.2.1.2.2.3.3 15MHz channel

A graph of different colored lines

Description automatically generated with medium confidence

Figure 6.2.1.2.2.3.3-1: Power back-off values for the 15MHz channel at Fc=1617.5MHz.

A rainbow colored graph on a grey background

Description automatically generated

Figure 6.2.1.2.2.3.3-2: Power back-off values for the 15MHz channel at Fc=1619MHz.

6.2.1.2.2.4 Summary of the power back-off values

Presented power back-off values can be summarised as follows:

- NR channels placed at the leftmost edge of the band might need power back-off, exact value of which depends on the number of the scheduled RBs and their location. Results are the same for both FCC and ETSI requirements because the main limiting factor is the out-of-band emission requirements, which are the same for both regulatory domains. In other words, even though ETSI has additional in-band emission requirements for 1610-1618MHz, they do not impact results. 6.2.1.2.2.4-1 illustrates power spectrum of the fully allocated 5MHz channel right at the lower edge of the band showing that unless power back-off is applied out of band emission requirements will be violated.

- As somewhat anticipated, RBs scheduled at the centre of the NR channel do not require any power back-off; but RBs scheduled at the leftmost edge of the configured NR channel do require power back-off to meet out-of-band emission requirements. Similarly, power back-off is needed when all RBs are scheduled to mitigate emissions coming from the full-channel transmissions.

- In case of the 5MHz channel, once the channel is shifted farther from the left edge of the band where the GNSS services are, the required power back-off goes down a lot and is caused mostly by the in-band emission requirements. For instance, if the 5MHz NR channel is shifted by 1.4MHz from the lower edge, then small RB allocations will not require any power back-off at all. Some of the channel edge allocations might need power back-off, but it does not exceed baseline MPR. For both FCC and ETSI regulations the switching point is around the center frequency of 1615.7MHz, after which power back-off values remain limited to the basic MPR requirements for any configuration case.

- The 5MHz channel placed at the rightmost edge of the band may need some A-MPR for the RBs scheduled at the right edge of the channel under the ETSI regulations because the latter have out-of-band emission requirements for higher frequencies. 6.2.1.2.2.4-2 shows the power spectrum plot for the right-most channel, from which one can see that unless a UE applies power back-off the ETSI out-of-band emission requirements can be violated. Nevertheless, once the channel is shifted away from the upper edge by 1.6MHz, no A-MPR is needed at least for small allocations. And under the FCC regulations no A-MPR is needed even for the right-most channel because there are no out-of-band emission requirements for higher frequencies.

- As for the 10 and 15MHz channels, even if we shift the channel to the right from the leftmost band edge, some configuration cases would still require A-MPR irrespective of whether it is ETSI or FCC requirements. As in cases for other channels at the band edge, A-MPR is needed mostly for the case when all RBs are scheduled. The only difference between FCC and ETSI power back-off values is that FCC will trigger lower A-MPR because there are no out-of-band emission requirements for upper frequencies and no in-band emission requirements.

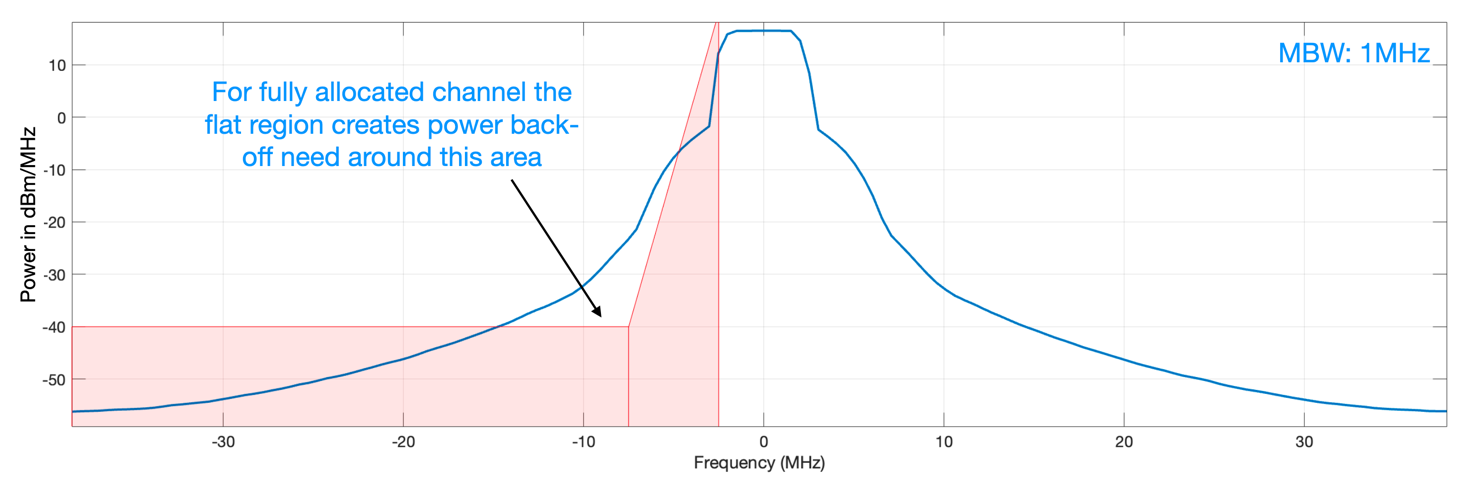


Figure 6.2.1.2.2.4-1: Power spectrum plot for the CP-OFDM 5MHz fully allocated transmission (Fc=1612.5MHz).

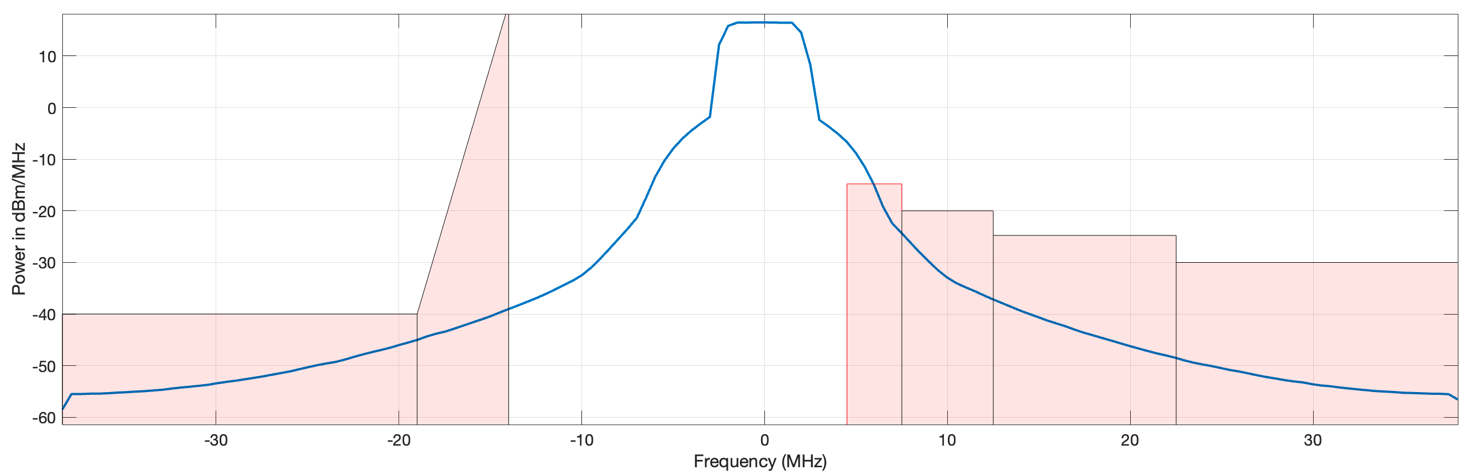


Figure 6.2.1.2.2.4-2: Power spectrum plot for the CP-OFDM 5MHz fully allocated transmission (Fc=1624MHz MHz).

If an operator decides to ensure lower power back-off, then one of the possible approaches is to rely upon 5MHz channels and to configure them with offsets from the lower/upper band edges. Then to avoid wasting 1.4/1.6MHz at the edges of the band it is possible to deploy other technologies, such as LTE CatM and NB-IOT. Figure 6.2.1.2.2.4-3 shows an exemplary allocation of channels, where an operator may consider one LTE CatM channel or seven NB-IOT channels at the lower edge of the band. For the upper edge, either eight NB-IOT channels can be configured, or one LTE CatM channel can be combined with one NB-IOT channel.



Figure 6.2.1.2.2.4-3: Exemplary allocations of channels at the edges of the band.

##### 6.2.1.2.3 Additional maximum power reduction (company #2)

This sub-clause contains additional simulations to evaluate the magnitude of A-MPR. The simulations assumptions are as presented below:

- PA calibration point: ACLR of 30 dBc is met with DFT-s-OFDM waveform with StartRB = 0, L\_CRB = 100

- IQ-image: -28 dBc

- LO-leakage: -28 dBc

- CIM3: -60 dBc

- Additional requirements: NR ACLR, SEM, Spurious emissions, EVM, Additional out of band bands emissions from ETSI EN 301 441

6.2.1.2.3.1 5MHz channel

A graph of different colored squares

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Description automatically generated with medium confidence

Figure 6.2.1.2.3.1-1: Power back-off values for the 5MHz channel at Fc=1612.5MHz.

A graph with a number of colors

Description automatically generated with medium confidence A graph of different colored squares

Description automatically generated A graph of a diagram

Description automatically generated with medium confidence

Figure 6.2.1.2.3.1-2: Power back-off values for the 5MHz channel at Fc=1615.5MHz.

A graph of different colored squares

Description automatically generatedA graph of a diagram

Description automatically generated with medium confidence

Figure 6.2.1.2.3.1-3: Power back-off values for the 5MHz channel at Fc=1620.5MHz.

A graph of different colored squares

Description automatically generated A graph of different colored squares

Description automatically generated A graph of a diagram

Description automatically generated with medium confidence

Figure 6.2.1.2.3.1-4: Power back-off values for the 5MHz channel at Fc=1624MHz.

6.2.1.2.3.2 10MHz channel

A graph of different colored lines

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Description automatically generatedA graph of a color chart

Description automatically generated with medium confidence

Figure 6.2.1.2.3.2-1: Power back-off values for the 5MHz channel at Fc=1615MHz.

A graph of different colored lines

Description automatically generated with medium confidence A graph of a diagram

Description automatically generated with medium confidence A diagram of a graph

Description automatically generated with medium confidence

Figure 6.2.1.2.3.2-2: Power back-off values for the 5MHz channel at Fc=1621.5MHz.

6.2.1.2.3.3 15MHz channel

A graph of a graph

Description automatically generated with medium confidence A graph of different colors

Description automatically generated A graph of a diagram

Description automatically generated with medium confidence

Figure 6.2.1.2.3.3-1: Power back-off values for the 5MHz channel at Fc=1617.5MHz.

A graph of a graph of a number of colored lines

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Description automatically generated with medium confidence A graph of a graph

Description automatically generated with medium confidence

Figure 6.2.1.2.3.3-2: Power back-off values for the 5MHz channel at Fc=1619MHz.

##### 6.2.1.2.4 Additional maximum power reduction (company #3)

This section presents results from the power back-off measurements taken for the left-most 5, 10 and 15MHz channels following the out-of-band emission requirements that are common for both the ETSI and FCC:

- PC3 PA calibrated for 4dB post PA losses, 30dB ACLR at MPR1 for 20MHz DFT-s-OFDM QPSK

- Fully allocated waveform for QPSK DFT-s-OFDM and CP-OFDM

- Measurement every 0.5MHz in the slope and peak in 1MHz for the -40dBm/MHz floor.

Measurements results are presented in Table 6.2.1.2.4-1 below, for which the following summary can be made:

- For the 5MHz channel:

- Back-off is needed for emissions at 3.5MHz offset

- MPR is not sufficient for DFT-s-OFDM but is sufficient for CP-OFDM up to 4.5MHz offset

- Maximum back-off is needed to meet -40dBm/MHz floor at 5MHz offset at:

- 2.0dB for DFT-s-OFDM

- 5.5dB for CP-OFDM.

- For the 10MHz channel:

- Back-off is needed for emissions at 2.5MHz offset

- MPR is sufficient up to 3MHz offset for DFT-s-OFDM and CP-OFDM

- Maximum back-off is needed to meet -40dBm/MHz floor at 5MHz offset at:

- 6.0dB for DFT-s-OFDM

- 8.3dB for CP-OFDM.

- For the 15MHz channel:

- Back-off is needed for emissions at 2.5MHz offset

- MPR is sufficient up to 3MHz offset for DFT-s-OFDM and CP-OFDM

- Maximum back-off is needed to meet -40dBm/MHz floor at 5MHz offset at:

- 5.2dB for DFT-s-OFDM

- 8.5dB for CP-OFDM.

Table 6.2.1.2.4-1: Back-off measurement results for frequencies with issues

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | CBW (MHz) | 5 | | 10 | | 15 | | 5 | | 10 | | 15 | |
| Freq. (MHz) | Mask  (dBm/MHz) | back-off (dB) | | | | | | Margin at MPR | | | | | |
| DFT | CP | DFT | CP | DFT | CP | DFT | CP | DFT | CP | DFT | CP |
| 1607.5 | -10 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.8 | 7 | 9 | 6 | 8 | 8 | 9 |
| 1607 | -16 | 0.7 | 1.6 | 0.8 | 2.4 | 0.5 | 2.3 | 2 | 6 | 1 | 3 | 2 | 3 |
| 1606.5 | -22 | 1.1 | 1.9 | 2.2 | 3.8 | 1.8 | 3.8 | 0 | 4 | -5 | -3 | -3 | -2 |
| 1606 | -28 | 1.2 | 2.4 | 3.3 | 5.1 | 3.1 | 5.0 | 0 | 3 | -10 | -8 | -9 | -8 |
| 1605.5 | -34 | 0.8 | 2.8 | 4.6 | 6.4 | 4.2 | 6.4 | 1 | 1 | -15 | -13 | -15 | -13 |
| 1605 | -40 | 2.0 | 5.5 | 5.7 | 8.3 | 5.2 | 8.5 | -2 | -4 | -20 | -17 | -20 | -19 |
| 1604.9 | -40 | 2.0 | 5.3 | 6.0 | 8.2 | 5.2 | 8.4 | -7 | -10 | -20 | -18 | -20 | -19 |

##### 6.2.1.2.5 Harmonised A-MPR values

Tables 6.2.1.2.5-1 - 6.2.1.2.5-3 below present "harmonised" A-MPR values for 5, 10 and 15MHz channels at reference frequencies considered for the power back-off simulations and measurements. For the sake of simplicity only "full" RB allocation cases are used to compare results from different sources.

Table 6.2.1.2.5-1: Harmonised A-MPR values for the 5MHz channel.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 5MHz channel center frequency | | | | | | | | | | | | | | | | | |
| 1612.5MHz | | | 1613.9MHz | | | 1615.5MHz | | | 1620.5MHz | | | 1622.4MHz | | | 1624MHz | | |
| CP  QP | DFT | | CP  QP | DFT | | CP  QP | DFT | | CP  QP | DFT | | CP  QP | DFT | | CP  QP | DFT | |
| QP | PI | QP | PI | QP | PI | QP | PI | QP | PI | QP | PI |
|  | **ETSI regulatory domain** | | | | | | | | | | | | | | | | | |
| #1 | 6 | 3.5 | 2.5 | 4 | 2.5 | 1 | 3 | 1 | 0.5 | 3 | 1 | 0.5 | 3 | 1 | 1 | 3 | 1.5 | 1.5 |
| #2 | 6 | 4 | 3 | - | - | - | 3 | 1.5 | 0.1 | 3 | 0.8 | - | - | - | - | 3 | 1.2 | 0.7 |
| #3 | 5.5 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **=>** | 6 | 4 | 3 | 4 | 2.5 | 1 |  |  |  |  |  |  | 3 | 1 | 1 | 3 | 1.5 | 1.5 |
|  | **FCC regulatory domain** | | | | | | | | | | | | | | | | | |
| #1 | 6 | 3.5 | 2.5 | 4 | 2.5 | 1 | 3 | 1 | 0.5 | 3 | 1 | 0.5 |  |  |  | 3 | 1 | 0.5 |
| #3 | 5.5 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **=>** | 6 | 4 | 3 | 4 | 2.5 | 1 |  |  |  |  |  |  |  |  |  | 3 | 1 | 0.5 |

Table 6.2.1.2.5-2: Harmonised A-MPR values for the 10MHz channel.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 10MHz channel center frequency | | | | | | | | |
| 1615MHz | | | 1620MHz | | | 1621.5MHz | | |
| CP-OFDM  QPSK | DFT-s-OFDM | | CP-OFDM  QPSK | DFT-s-OFDM | | CP-OFDM  QPSK | DTT-s-OFDM | |
| QPSK | PI/2 BPSK | QPSK | PI/2 BPSK | QPSK | PI/2 BPSK |
|  | **ETSI regulatory domain** | | | | | | | | |
| #1 | 12.5 | 7 | 6 | 4 | 3 | 2 | 4 | 2.5 | 2 |
| #2 | 7.5 | 5 | 3.5 |  |  |  | 4.5 | 2.5 | 2 |
| #3 | 7 | 5 |  |  |  |  |  |  |  |
| **=>** | 9 | 6 | 4 | 4.5 | 3 | 2 | 4.5 | 2.5 | 2 |
|  | **FCC regulatory domain** | | | | | | | | |
| #1 | 12.5 | 7 | 6 | 4 | 2 | 1.5 | 3 | 2 | 1.5 |
| #3 | 7 | 5 |  |  |  |  |  |  |  |
| **=>** | 9 | 6 | 4 | 4 | 2 | 1.5 | 3 | 2 | 1.5 |

Table 6.2.1.2.5-3: Harmonised A-MPR values for the 15MHz channel.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 15MHz channel center frequency | | | | | |
| 1617.5MHz | | | 1619MHz | | |
| CP-OFDM  QPSK | DTF-s-OFDM | | CP-OFDM  QPSK | DTF-s-OFDM | |
| QPSK | PI/2 BPSK | QPSK | PI/2 BPSK |
|  | **ETSI regulatory domain** | | | | | |
| #1 | 13.5 | 11.5 | 11.5 | 11 | 9.5 | 7.5 |
| #2 | 7.5 | 5 | 6.5 | 7 | 4.5 | 3.5 |
| #3 | 8.5 | 5.5 |  |  |  |  |
| **=>** | 10 | 7 | 6.5 | 9 | 6 | 5.5 |
|  | **FCC regulatory domain** | | | | | |
| #1 | 13.5 | 9.5 | 9 | 11 | 8.5 | 6 |
| #3 | 8.5 | 5.5 |  |  |  |  |
| **=>** | 10 | 7 | 6.5 | 9 | 6 | 5.5 |

#### 6.2.1.3 Emission requirements and NS values

There are three additional NS values defined for this band as summarised in Table 6.2.1.3-1 below:

a) NS\_03N is for the FCC regulatory domain. Since FCC does not introduce any special in-band emission requirements for sub-ranges, same requirements will be applicable for the whole range and for all the channel sizes.

b) ETSI regulations have different in-band emission masks depending on the operating sub-range, so two NS flags are needed to differentiate between them.

c) NS\_04N applicable range is limited to 1610-1618.25MHz according to the ETSI requirements. And since the total spectrum block size is 8.25MHz, it can accommodate only 5MHz standard NR channel, i.e. the applicable NR channel size is 5MHz.

d) NS\_04N is for the ETSI range 1618.25-1626.5MHz, which can also accommodate only 5MHz standard NR channel. However, ETSI document also clarifies that the same in-band emission requirements will apply if the channel is partially configured in that range. It means that any 10 and 15MHz channel configured in 1610-1626.5MHz range will inevitably fall into the 1618.25-1626.5MHz range and thus they will follow NS\_04N requirements.

Table 6.2.1.3-1: NTN L-/S-band NS values

|  |  |  |  |
| --- | --- | --- | --- |
| Regulatory domain | NS value | Applicable range (MHz) | Applicable channel (MHz) |
| FCC | NS\_03N | 1610-1626.5 | 5, 10, 15 |
| ETSI | NS\_04N | 1610-1618.25 | 5 |
| NS\_05N | 1618.25-1626.5 | 5 |
| 1610-1626.5 | 10, 15 |

Mapping between values of additionalSpectrumEmission and NS values is given in the Table 6.2.3.1-2 below.

Table 6.2.1.3-2: Mapping of network signalling label

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR satellite band | Value of additionalSpectrumEmission | | | | | | | |
|  | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| n254 | NS\_01 | NS\_03N | NS\_04N | NS\_05N |  |  |  |  |
|  | | | | | | | | |

#### 6.2.1.3a NS values and associated A-MPR

For the 5MHz channel, Figure 6.2.1.3a-1 below presents a graphical summary of the required power back-off values for different 5MHz channels:

- The 5MHz channel right at the lower edge of the band requires power back-off even for small RB allocations irrespective of the fact whether it is FCC or ETSI regulations. If the channel is shifted by 1.4MHz, then at least small RB allocations will not require power back-off exceeding baseline MPR requirements. Shifting the 5MHz channel beyond the 1615.7MHz centre frequency results in no A-MPR at all.

- As for the upper edge of the band, the 5MHz channel under the FCC regulations will not require any additional A-MPR requirements even if it is right at the edge because there are no out-of-band emission requirements for the upper frequencies. However, with the ETSI regulations we will need to provide offset of 1.6MHz, upon which we will not be exceeding baseline MPR requirements.

- Because of the same regulations for the lower frequencies, A-MPR values can be the same for NS\_03N (FCC) and NS\_04N (ETSI lower range) at centre frequencies 1612.5 <= fc < 1615.7MHz. Furthermore, it is possible to split A-MPR values into two regions – 1612.5 <= fc < 1613.9MHz and 1613.9 <= fc < 1615.7MHz – whereupon the second region will not require A-MPR for small RB allocations.

- There is no need for A-MPR for NS\_03N (FCC) at centre frequencies above 1615.7MHz, but NS\_05N (ETSI upper range) requires A-MPR for center frequencies at 1622.4 < fc <= 1624MHz.





Figure 6.2.1.3a-1: Summary of required power back-off regions for the 5MHz channel for FCC (top) and ETSI (bottom) regulations.

For the 10MHz channel:

- For the channel right at the lower edge of the band, A-MPR might be needed even for small RB allocations at the channel edges because of the strict out-of-band emission requirements. Shifting the channel farther away from the lower edge basically improves A-MPR with the switching point at the centre frequency of around 1620.1MHz (i.e. 1.4MHz offset from the upper edge), after which at least for the ETSI requirements emission requirements from the upper frequencies start influencing allocations at the channel’s upper edge. Based on that A-MPR values can be considered the same for NS\_03N (FCC) and NS\_05N (ETSI) for the centre frequencies at 1615 <= fc < 1620.1MHz.

- For the channel right at the upper edge of the band, A-MPR is generally not needed for small allocations under the FCC regulations, which is reflected in the corresponding A-MPR for NS\_03 for the channel at 1621.5MHz. However, with NS\_05N (ETSI) A-MPR is still required because of the out-of-band emission requirements for upper frequencies.

- As can be seen from Figure 6.2.1.3a-2 below, the only major difference between the FCC and ETSI A-MPR regions is that the former can have optimised 10MHz channel placed right at the upper edge of the band.





Figure 6.2.1.3a-2: Summary of required power back-off regions for the 10MHz channel for FCC (top) and ETSI (bottom) regulations.

For the 15MHz channel, more or less same A-MPR is needed for NS\_03N (FCC) and NS\_05N (ETSI) irrespective of the fact where exactly the channel is configured and whether it is under the FCC or ETSI regulations.

A comparison of a graph

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A comparison of a graph

Description automatically generated with medium confidence

A diagram of a variety of colors

Description automatically generated

Figure 6.2.1.3a-3: A-MPR regions for NS\_03N (5, 10 and 15MHz channels).

Table 6.2.1.3a-1: A-MPR values for NS\_03N (FCC)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel BW | Carrier Center Frequency | RB\_start\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 5MHz | 1612.5 <= fc < 1613.9 | <= 0.36 | <= 0.36 | A1 |
|  | >= 2.88 | A2 |
| 1613.9 <= fc < 1615.7 |  | >= 3.24 | A3 |
| 10MHz | 1615 <= fc < 1620.1 | <= 1.8 | <= 5.04 | A4 |
| <= 1.8 | > 5.04 | A5 |
| > 7.2 | > 0 | A6 |
| > 1.8 | >= 2.88 | A2 |
| 1620.1 <= fc < 1621.5 |  | <= 6.48 | A6 |
| <= 0.36 | <= 0.36 | A1 |
|  | fc = 1621.5 |  | >= 7.2 | A1 |
| 15MHz | all | <= 3.6 | <= 5.04 | A4 |
| <= 3.6 | > 5.04 | A5 |
| > 10.44 |  | A6 |
| > 3.6 | >= 4.32 | A2 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Modulation | A1 | A2 | A3 | A4 | A5 | A6 |
| DFT-s-OFDM | Pi/2 BPSK | [2.5] | [3.0] | [1.0] | [4.0] | [6.5] | [1.5] |
| QPSK | [2.5] | [4.0] | [2.5] | [6.0] | [7.0] | [2.0] |
| 16QAM | [2.5] | [4.0] | [2.5] | [6.0] | [7.0] | [2.0] |
| 64QAM |  | [4.0] | [2.5] | [6.0] | [7.0] | [2.0] |
| 256QAM |  |  |  |  |  |  |
| CP-OFDM | QPSK | [3.5] | [6.0] | [4.0] | [8.0] | [10.0] | [4.0] |
| 16QAM | [3.5] | [6.0] | [4.0] | [8.0] | [10.0] | [4.0] |
| 64QAM | [3.5] | [6.0] | [4.0] | [8.0] | [10.0] | [4.0] |
| 256QAM |  | [6.0] |  | [8.0] | [10.0] |  |

A comparison of a graph

Description automatically generated

Figure 6.2.1.3a-4: A-MPR regions for NS\_04N (5MHz channels).

Table 6.2.1.3a-2: A-MPR values for NS\_04N (ETSI lower sub-range)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel BW | Carrier Center Frequency | RB\_start\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 5MHz | 1612.5 <= fc < 1613.9 | <= 0.36 | <= 0.36 | A1 |
|  | >= 2.88 | A2 |
| 1613.9 <= fc < 1615.7 |  | >= 3.24 | A3 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Modulation | A1 | A2 | A3 |
| DFT-s-OFDM | Pi/2 BPSK | [2.5] | [3.0] | [1.0] |
| QPSK | [2.5] | [4.0] | [2.5] |
| 16QAM | [2.5] | [4.0] | [2.5] |
| 64QAM |  | [4.0] | [2.5] |
| 256QAM |  |  |  |
| CP-OFDM | QPSK | [3.5] | [6.0] | [4.0] |
| 16QAM | [3.5] | [6.0] | [4.0] |
| 64QAM | [3.5] | [6.0] | [4.0] |
| 256QAM |  | [6.0] |  |

A graph with different colored squares

Description automatically generated

A comparison of a graph

Description automatically generated with medium confidence

A diagram of a variety of colors

Description automatically generated

Figure 6.2.1.3a-5: A-MPR regions for NS\_05N (5, 10 and 15MHz channels).

Table 6.2.1.3a-3: A-MPR values for NS\_05N (ETSI upper sub-range)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel BW | Carrier Center Frequency | RB\_start\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 5MHz | 1622.4 < fc <= 1624 | <= 3.6 | > 0.36 | A3 |
|  | >= 2.88 | A1 |
| 10MHz | 1615 <= fc < 1620.1 | <= 1.8 | <= 5.04 | A4 |
| <= 1.8 | > 5.04 | A5 |
| > 7.2 | > 0 | A6 |
| > 1.8 | >= 2.88 | A2 |
| 1620.1 <= fc <= 1621.5 |  | <= 7.2 | A6 |
| <= 0.36 | <= 0.36 | A1 |
| > 7.2 | > 0 | A6 |
| 15MHz | all | <= 3.6 | <= 5.04 | A4 |
| <= 3.6 | > 5.04 | A5 |
| > 10.44 |  | A6 |
| > 3.6 | >= 4.32 | A2 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Modulation | A1 | A2 | A3 | A4 | A5 | A6 |
| DFT-s-OFDM | Pi/2 BPSK | [1.5] | [5.0] | [1.5] | [6.5] | [6.5] | [2.0] |
| QPSK | [1.5] | [5.0] | [1.5] | [6.5] | [7.0] | [2.5] |
| 16QAM | [1.5] | [5.0] | [1.5] | [6.5] | [7.0] | [2.5] |
| 64QAM |  | [5.0] |  | [6.5] | [7.0] | [2.5] |
| 256QAM |  |  |  |  |  |  |
| CP-OFDM | QPSK | [3.0] | [6.5] |  | [8.0] | [10.0] | [4.5] |
| 16QAM | [3.0] | [6.5] |  | [8.0] | [10.0] | [4.5] |
| 64QAM | [3.0] | [6.5] |  | [8.0] | [10.0] | [4.5] |
| 256QAM |  | [6.5] |  | [8.0] | [10.0] |  |

#### 6.2.1.4 UE co-existence requirements

Table 6.2.1.4-1: Requirements for spurious emissions for UE co-existence

| NR NTN satellite Band | Spurious emission for UE co-existence | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| n254 | NR Band n1, n2, n3, n5, n7, n8, n12, n13, n14, n18, n20, n24, n25, n26, n28, n29, n30, n34, n38, n39, n40, n41, n48, n50, n51, n53, n54, n65, n66, n67, n70, n71, n74, n75, n76, n77, n78, n85, n90, n91, n92, n93, n94, n100, n101, n105, n255, n256 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 31, 54, 72, 73, 87, 88, 103 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n79, n104 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |

### 6.2.2 UE receiver characteristics

#### 6.2.2.1 Reference sensitivity

For band n254, band n53 REFSENS is re-used with additional 0.5dB insertion loss. The corresponding band n254 REFSENS values are presented in Table 6.2.2.1-1 below.

Table 6.2.2.1-1: NTN L-/S-band two antenna port reference sensitivity QPSK PREFSENS

| Operating band / SCS / Channel bandwidth | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating Band | SCS kHz | 5  MHz (dBm) | 10  MHz (dBm) | 15  MHz (dBm) | 20  MHz (dBm) | 25  MHz (dBm) | 30 MHz (dBm) | 35 MHz (dBm) | 40  MHz (dBm) | 45 MHz (dBm) | 50  MHz (dBm) |
| n254 | 15 | -99.5 | -96.3 | -94.5 |  |  |  |  |  |  |  |
| 30 |  | -96.6 | -94.6 |  |  |  |  |  |  |  |
| 60 |  | -97.0 | -94.9 |  |  |  |  |  |  |  |

#### 6.2.2.2 In-band blocking

Table 6.2.2.2-1: NTN L-/S-band in-band blocking

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Operating Band | Parameter | Unit | Case 1 | Case 2 |
|  | Pinterferer | dBm | -56 | -44 |
| n254 | Finterferer (offset) | MHz | -BWChannel/2 –  FIoffset, case 1  and  BWChannel/2 +  FIoffset, case 1 | ≤ -BWChannel/2 –  FIoffset, case 2  and  ≥ BWChannel/2 +  FIoffset, case 2 |
|  | Finterferer | MHz | NOTE 2 | FDL\_low – 15  to  FDL\_high + 15 |
| 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 15 kHz SCS.  NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: -BWChannel/2 – FIoffset, case 1; b: BWChannel/2 + FIoffset, case 1 | | | | |

#### 6.2.2.3 Out-of-band blocking

For band n254, same out-of-band blocking requirements as for the band n53 are re-used, whereupon Range 3 exception is adjusted accordingly accounting for the fact that band n254 upper bound is at 2500MHz.

Table 6.2.2.3-1: Out of-band blocking requirements.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Operating Band | Parameter | Unit | Range 1 | Range 2 | Range 3 |
|  | Pinterferer | dBm | -44 | -30 | -15 |
| n254 | Finterferer (CW) | MHz | -60 < f – FDL\_low < -15  or  15 < f – FDL\_high < 60 | -85 < f – FDL\_low ≤ -60  or  60 ≤ f – FDL\_high < 85 | 1 ≤ f ≤ FDL\_low – 85  or  FDL\_high + 85 ≤ f  ≤ 12750 |
| NOTE: Band n254 power level of the interferer (Pinterferer) for Range 3 shall be modified to -20 dBm for Finterferer > 2585 MHz and FInterferer < 2775 MHz. | | | | | |

### 6.2.3 UE RRM requirements

There are no RRM specific requirements associated with this band.

## 6.3 SAN requirements

There are no SAN RF specific requirements associated with this band.

Annex A (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2023-05 | RAN4#107 | R4-2309600 |  |  |  | TR skeleton | 0.0.0 |
| 2023-08 | RAN4#108 | R4-2314707 |  |  |  | Implementation of TPs agreed at RAN4#107 meeting | 0.1.0 |
| 2023-10 | RAN4#108bis |  |  |  |  | Implementation of agreements made at RAN4#108 meeting | 0.2.0 |
| 2023-10 | RAN4#108bis | R4-2311218 |  |  |  | TP containing power back-off values | 0.2.0 |
| 2023-10 | RAN4#108bis | R4-2315365 |  |  |  | TP containing summary of the NS values | 0.2.1 |
| 2023-10 | RAN4#108bis | R4-2315369 |  |  |  | TP containing summary of the RRM requirements | 0.2.1 |
| 2023-10 | RAN4#108bis | R4-2316134 |  |  |  | TP containing further clarifications for the REFSENS values | 0.2.1 |
| 2023-11 | RAN4#109 | R4-2321805 |  |  |  | TP with editorial corrections for terms, symbols and acronyms | 0.3.0 |
| 2023-11 | RAN4#109 | R4-2321806 |  |  |  | TP with further clarifications for Rx and Tx requirements | 0.3.0 |
| 2023-11 | RAN4#109 | R4-2321807 |  |  |  | TP with additional A-MPR simulations and measurements | 0.3.0 |
| 2023-11 | RAN4#109 | R4-2320649 |  |  |  | TP with additional A-MPR simulations | 0.3.0 |
| 2023-11 | RAN4#109 | R4-2321808 |  |  |  | TP with a summary of A-MPR values | 0.3.0 |
| 2023-12 | RAN#102 | RP-233309 |  |  |  | TR for RAN plenary approval | 1.0.0 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2023-12 | RAN#102 |  |  |  |  | Approved by plenary – Rel-18 spec under change control | 18.0.0 |