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Technical Report

3rd Generation Partnership Project;

Technical Specification Group Radio Access Network;

Time Division Duplex (TDD) operating band in Band n48;

(Release 16)

** 

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# Foreword

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where:

x the first digit:

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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.

# 1 Scope

The present document is a technical report for the work item of TDD operating band in Band n48.

# 2 References

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

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

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

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

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

[2] RP-182865, “New WID on introduction of n48”

# 3 Definitions and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP 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 3GPP TR 21.905 [1].

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

A-MPR Additional Maximum Power Reduction

BS Base Station

CA Carrier Aggregation

CBRS Citizens Broadband Radio Service

CBSD Citizens Broadband Radio Service Device

DC Dual Connectivity

DL Downlink

GSCN Global Synchronization Channel Number

EUD End User Device

E-UTRA Evolved UTRA

NR New Radio

NR-ARFCN NR Absolute Radio Frequency Channel Number

NS Network Signalling

PC3 Power Class 3

REFSENS Reference Sensitivity

SCS Subcarrier Spacing

SS Synchronization Symbol

TDD Time Division Duplex

UE User Equipment

UL Uplink

UMTS Universal Mobile Telecommunications System

UTRA UMTS Terrestrial Radio Access

# 4 Background

On April 21st 2015, the FCC released a Report and Order (R&O) and Second Further Notice of Proposed Rulemaking (Second FNPRM) to establish new rules for commercial use of the 3550-3700 MHz band. This framework creates a contiguous 150 MHz block at 3550 – 3700 MHz (3.5 GHz) for mobile broadband that FCC calls "Citizens Broadband Radio Service (CBRS)" and regulated under new Part 96 of FCC’s Rules. On May 2nd 2016, a second R&O and Order on Reconsideration was released by FCC to finalize the rules. On October 24, 2018, the FCC released an Order revising the licensing and technical rules in the CBRS band.

The objective of the Work Item is to specify a new NR TDD operating band (3550 – 3700 MHz) with support of the following SCS and bandwidths (for PC3 power class only):

| NR Band | SCS  kHz | 5 MHz | 10MHz | 15MHz | 20 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| n48 | 15 | Yes | Yes | Yes | Yes | Yes | Yes1 |  |  |  |  |
| 30 |  | Yes | Yes | Yes | Yes | Yes1 | Yes1 | Yes1 | Yes1 | Yes1 |
| 60 |  | Yes | Yes | Yes | Yes | Yes1 | Yes1 | Yes1 | Yes1 | Yes1 |
| Note 1: This UE channel bandwidth is applicable only to DL  Note 2: Only symmetric UL/DL bandwidths are defined for non-CA operation | | | | | | | | | | | |

# 5 Frequency band arrangements and regulatory background

The 3550 – 3700 MHz band plan is shown in Figure 5.1. The adjacent 3700 – 4200 MHz band is used by C-Band Fixed Satellite Services Earth Stations. On the lower side, the band 3100-3550MHz is used by US Department of Defense (DoD) for operating various types of shipborne, land-based, and aeronautical mobile radar systems.

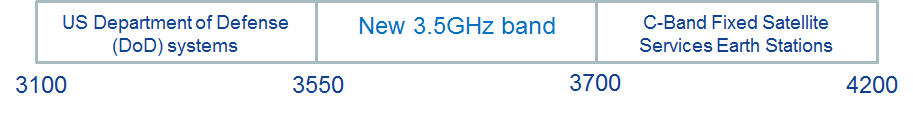


Figure 5.1: Band plan

Summary of the FCC’s rules relevant to RAN4 work to define a new band for US 3.5GHz band are provided below:

*3.5 GHz Emissions and Interference Limits:*

(1) *General protection levels.* Except as otherwise specified below, for CBSD channel and frequency assignments, the conducted power of any CBSD emission outside the fundamental emission (whether in or outside of the authorized band) shall not exceed -13 dBm/MHz within 0-10 megahertz above the upper assigned channel edge and within 0-10 megahertz below the lower assigned channel edge. At all frequencies greater than 10 megahertz above the upper assigned channel edge and less than 10 MHz below the lower assigned channel edge, the conducted power of any CBSD emission shall not exceed -25 dBm/MHz. The upper and lower assigned channel edges are the upper and lower limits of any channel assigned to a CBSD, or in the case of multiple contiguous channels, the upper and lower limits of the combined contiguous channels.

For channel and frequency assignments made by a CBSD to End User Devices, the conducted power of any End User Device emission outside the fundamental emission (whether in or outside of the authorized band) shall not exceed -13 dBm/MHz within 0 to B megahertz (where B is the bandwidth in megahertz of the assigned channel or multiple contiguous channels of the End User Device) above the upper CBSD-assigned channel edge and within 0 to B megahertz below the lower CBSD-assigned channel edge. At all frequencies greater than B megahertz above the upper CBSD assigned channel edge and less than B megahertz below the lower CBSD-assigned channel edge, the conducted power of any End User Device emission shall not exceed -25 dBm/MHz. Notwithstanding the emission limits in this paragraph, the Adjacent Channel Leakage Ratio for End User Devices shall be at least 30 dB.

(2) *Addi*tional protection levels: the conducted power of emissions below 3540 MHz or above 3710 MHz shall not exceed -25 dBm/MHz, and the conducted power of emissions below 3530 MHz or above 3720 MHz shall not exceed -40dBm/MHz.

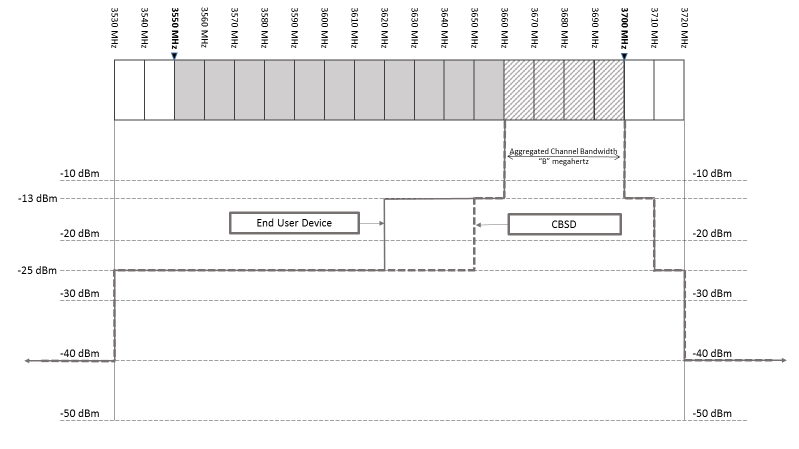


Figure 5.2: CBSD & EUD Emission Limits

(3) *Measurement procedure*:

(i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (*i.e.*, 1 MHz or 1 percent of emission bandwidth, as specified). The fundamental emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

# 6 Operating band, channel bandwidths, channel numbering

**5.2 Operating bands**

Because in this case E-UTRA band 48 is re-farmed the band number is re-used.

|  |  |  |  |
| --- | --- | --- | --- |
| NR operating band | Uplink (UL) *operating band* BS receive / UE transmit  FUL\_low  – FUL\_high | Downlink (DL) *operating band* BS transmit / UE receive  FDL\_low – FDL\_high | Duplex Mode |
| n41 | 2496 MHz – 2690 MHz | 2496 MHz – 2690 MHz | TDD |
| n48 | 3550 MHz – 3700 MHz | 3550 MHz – 3700 MHz | TDD |

**5.3 UE channel bandwidth**

From the WID we can determine the Channel bandwidths. Channel bandwidth of 5 MHz can be used only as a part of DC or CA-configuration as it is not discoverable in initial acquisition because the synchronization raster does not support 15 kHz. Channel bandwidths of 50 MHz – 100 MHz are listed in WID as applicable only for DL. Furthermore, the WID states that only symmetric UL/DL bandwidths are defined for non-CA operation, therefore channel bandwidths of 50 MHz – 100 MHz can be used only as Scell in CA-configuration.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR band / SCS / UE Channel bandwidth | | | | | | | | | | | | | |
| NR Band | SCS  kHz | 5 MHz | 101,2 MHz | 152 MHz | 202 MHz | 252 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz |
| n41 | 15 |  | Yes | Yes | Yes |  |  | Yes | Yes |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes | Yes | Yes | Yes | Yes |
| n48 | 15 | Yes4 | Yes | Yes | Yes |  |  | Yes | Yes5 |  |  |  |  |
| 30 |  | Yes | Yes | Yes |  |  | Yes | Yes5 | Yes5 | Yes5 | Yes5 | Yes5 |
| 60 |  | Yes | Yes | Yes |  |  | Yes | Yes5 | Yes5 | Yes5 | Yes5 | Yes5 |
| NOTE 3: This UE channel bandwidth is applicable only to downlink.  NOTE 4: For this bandwidth, the minimum requirements are restricted to operation when carrier is configured as an Scell part of DC or CA configuration.  NOTE 5: For this bandwidth, the minimum requirements are restricted to operation when carrier is configured as an downlink SCell part of CA configuration | | | | | | | | | | | | | |

**5.4.2.1 NR-ARFCN and channel raster**

Table 5.4.2.3-1: Applicable NR-ARFCN per operating band

|  |  |  |  |
| --- | --- | --- | --- |
| NR Operating Band | ΔFRaster  (kHz) | Uplink  Range of NREF  (First – <Step size> – Last) | Downlink  Range of NREF  (First – <Step size> – Last) |
| n41 | 15 | 499200 – <3> – 537999 | 499200 – <3> – 537999 |
| 30 | 499200 – <6> – 537996 | 499200 – <6> – 537996 |
| n48 | 15 | 636667 – <1> – 646666 | 636667 – <1> – 646666 |
| 30 | 636668 – <2> – 646666 | 636668 – <2> – 646666 |

**5.4.3.1 Synchronization raster and numbering**

Table 5.4.3.3-1: Applicable SS raster entries per operating band

|  |  |  |  |
| --- | --- | --- | --- |
| NR Operating Band | SS Block SCS | SS Block pattern1 | Range of GSCN  (First – <Step size> – Last) |
| n41 | 15kHz | Case A | 6246 – <3> – 6717 |
| 30 kHz | Case C | 6252 – <3> – 6714 |
| n48 | 30 kHz | Case C | 7884 – <1> – 7982 |

# 7 Study of UE and BS requirements

## 7.1 UE requirements

**6.2.1 UE maximum output power**

This work-item is for PC3 power class only. Tolerances are copied from E-UTRA band 48.

Table 6.2.1-1: UE Power Class

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| NR  band | Class 1 (dBm) | Tolerance (dB) | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) |
| n41 |  |  | 26 | +2/-33 | 23 | ±23 |
| n48 |  |  |  |  | 23 | +2/-3 |

**6.2.3 UE additional maximum output power reduction**

NS- signalling is needed due to FCC emission requirements. NS\_27 is copied from E-UTRA band 48. NS\_100 or NS\_27U is not needed as UTRA is not deployed in this band.

Table 6.2.3.1-1: Additional maximum power reduction (A-MPR)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Network Signalling label | Requirements (subclause) | NR Band | Channel bandwidth (MHz) | Resources Blocks (*N*RB) | A-MPR (dB) |
| NS\_27 | 6.5.2.3.8  6.5.3.3.10 | n48 | 5, 10, 15, 20, 40 | Table 6.2.3.15-1 | Table 6.2.3.15-2 |
| NOTE 1: This NS can be signalled for NR bands that have UTRA services deployed  NOTE 2: No A-MPR is applied for 5 MHz CBW where the lower channel edge is ≥ 1930 MHz,10 MHz CBW where the lower channel edge is ≥ 1950 MHz and 15 MHz CBW where the lower channel edge is ≥ 1955 MHz.  NOTE 3: Applicable when the NR carrier is within 1447.9 – 1462.9 MHz | | | | | |

Table 6.2.3.1-1A: Mapping of Network Signaling label

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR band | Value of additionalSpectrumEmission | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| n41 | NS\_01 | NS\_04 |  |  |  |  |  |  |
| n48 | NS\_01 | NS\_27 |  |  |  |  |  |  |
| NOTE: *additionalSpectrumEmission* corresponds to an information element of the same name defined in sub-clause 6.3.2 of TS 38.331 [7]. | | | | | | | | |

**6.2.3.15 A-MPR for NS\_27**

A-MPR studies are presented in clause 7.1.1 of present contribution.

Following A-MPR definition was agreed.

Table 6.2.3.15-1: A-MPR for NS\_27

| Channel Bandwidth, MHz | Carrier Centre Frequency, Fc, MHz | Region A | | | | Region B | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| RBstart\*12\*SCS | RBend\*12\*SCS | LCRB\*12\*SCS | A-MPR | LCRB\*12\*SCS | A-MPR |
| 5 MHz | 3552.5 ≤ FC ≤ 3697.5 |  |  |  |  |  |  |
| 10 MHz | 3555 ≤ FC ≤ 3695 |  |  |  |  |  |  |
| 15 MHz | 3557.5 ≤ FC < 3562.5 | <1.8MHz |  |  | A3 |  |  |
| 3687.5 < FC ≤ 3692.5 | >11.52 MHz |
| 15 MHz | 3562.5 ≤ FC ≤ 3687.5 | Note 1 |  | <1.44MHz | A4 |  |  |
|  | Note 2 |
| 20 MHz | 3560 ≤ FC < 3570 | <3.6MHz |  |  | A5 |  |  |
| 3680 < FC ≤ 3690 | >12.96MHz |
| 20 MHz | 3570 ≤ FC ≤ 3680 | Note 1 |  | <1.44MHz | A6 |  |  |
|  | Note 2 |
| 40 MHz | 3570 ≤ FC < 3600 | <11.34M |  |  | A7 |  |  |
|  | >31.0MHz | <1.8MHz |
| 3650 < FC ≤ 3680 | >24.48MHz |  |  |
|  | <6.48MHz | <1.8MHz |
| 40 MHz | 3600 ≤ FC ≤ 3650 | Note 1 |  | <1.44MHz | A8 | >[20]MHz | [2] |
|  | Note 2 |
| NOTE 1: <[(3530M-Fc)+5\*BW/2]/5, Fc<3567.5M for BW=15M, Fc<3580M for BW=20M, Fc<3625M for BW=40M  NOTE 2: >[(Fc-3720M)+5\*BW/2]/5, Fc>3682.5M for BW=15M, Fc>3670M for BW=20M, Fc>3625M for BW=40M | | | | | | | |

Table 6.2.3.15-2: A-MPR for modulation and waveform type

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Modulation/Waveform | | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 |
| **Outer** | **Outer/Inner** | **Outer/Inner** | **Outer/Inner** | **Outer/Inner** | **Outer/Inner** | **Outer/Inner** | **Outer/Inner** |
| DFT-s-OFDM | PI/2 BPSK |  |  | 4 | 4 | 4 | 4 | 10.5 | 4 |
| QPSK |  |  | 4 | 4 | 4 | 4 | 10.5 | 4 |
| 16 QAM |  |  | 5 | 4 | 5 | 4 | 11 | 4 |
| 64 QAM |  |  | 5 | 4 | 5 | 4 | 11 | 4 |
| 256 QAM |  |  |  |  |  |  | 11 |  |
| CP-OFDM | QPSK |  |  | 6 | 4 | 6 | 4 | 11.5 | 4 |
| 16 QAM |  |  | 6 | 4 | 6 | 4 | 11.5 | 4 |
| 64 QAM |  |  | 6 | 4 | 6 | 4 | 11.5 | 4 |
| 256 QAM |  |  |  |  |  |  | 11.5 |  |
| NOTE 1: The backoff applied is max (MPR, A-MPR) where MPR is defined in Table 6.2.2-1  NOTE 2: Outer and inner allocations are defined in clause 6.2.2 | | | | | | | | | |

**6.5.2.3 Additional spectrum emission mask**

**6.5.2.3.8 Requirements for network signalled value "NS\_27"**

Following the FCC requirements additional spectrum emission mask is defined as follows.

Table 6.5.2.3.8-1: Additional requirements for “NS\_27”

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Spectrum emission limit (dBm) / measurement bandwidth  for each channel bandwidth | | | | | | |
| ΔfOOB  MHz | 5 MHz | 10  MHz | 15  MHz | 20  MHz | 40  MHz | Measurement bandwidth |
| ± 0 - 1 | -13 | | | | | 1 % channel bandwidth |
| ± 1 - X | -13 | | | | | 1 MHz |
| < – X or > X when  3540 MHz < ΔfOOB < 3710 MHz | -25 | | | | |
| NOTE: X is occupied channel bandwidth as defined in Table 6.5.1-1 | | | | | | |

**6.5.3.3 Additional spurious emissions**

**6.5.3.3.9 Requirement for network signalled value “NS\_27”**

Following the FCC requirements additional spurious emissions is defined as follows.

Table 6.5.3.3.9-1: Additional requirements

|  |  |  |
| --- | --- | --- |
| Frequency range  (MHz) | Channel bandwidth / Spectrum emission limit (dBm) | Measurement bandwidth |
| 5, 10, 15, 20, 40 MHz |
| 9 kHz – 3530 MHz | -40 | 1 MHz |
| 3530 MHz – 3540 MHz | -25 |
| 3710 MHz – 3720 MHz | -25 |
| 3720 MHz – 12.75 GHz | -40 |

**7.3.2 Reference sensitivity power level**

n77 and n78 REFSENS is used to allow co-banding. Channel bandwidths larger than 40 MHz can be used only in CA as these bandwidths are DL-only therefore the REFSENS can also only be verified in CA mode.

Table 7.3.2-1: Two antenna port reference sensitivity QPSK PREFSENS

| Operating band / SCS / Channel bandwidth / Duplex-mode | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating Band | SCS kHz | 5  MHz (dBm) | 10  MHz (dBm) | 15  MHz (dBm) | 20  MHz (dBm) | 25  MHz (dBm) | 30 MHz (dBm) | 40  MHz (dBm) | 50  MHz (dBm) | 60  MHz (dBm) | 80  MHz (dBm) | 90  MHz (dBm) | 100 MHz (dBm) | Duplex Mode |
| n411 | 15 |  | -94.8 | -93.0 | -91.8 |  |  | -88.6 | -87.6 |  |  |  |  | TDD |
| 30 |  | -95.1 | -93.1 | -92.0 |  |  | -88.7 | -87.7 | -86.9 | -85.6 | -85.1 | -84.7 |
| 60 |  | -95.5 | -93.4 | -92.2 |  |  | -88.9 | -87.8 | -87.1 | -85.6 | -85.1 | -84.7 |
| n481 | 15 | -99 | -95.8 | -94.0 | -92.7 |  |  | -89.6 | -88.64 |  |  |  |  | TDD |
| 30 |  | -96.1 | -94.1 | -92.9 |  |  | -89.7 | -88.74 | -87.94 | -86.64 | -86.14 | -85.64 |
| 60 |  | -96.5 | -94.4 | -93.1 |  |  | -89.9 | -88.84 | -88.04 | -86.74 | -86.24 | -85.74 |
| NOTE 1: Four Rx antenna ports shall be the baseline for this operating band except for two Rx vehicular UE.  NOTE 4: For these bandwidths, the minimum requirements are restricted to operation when carrier is configured as an downlink carrier part of CA configuration | | | | | | | | | | | | | | |

For UE(s) equipped with 4 Rx antenna ports, reference sensitivity for 2Rx antenna ports in Table 7.3.2-1 shall be modified by the amount given in ΔRIB,4R in Table 7.3.2-2 for the applicable operating bands.

|  |  |
| --- | --- |
| Operating band | ΔRIB,4R (dB) |
| n1, n2, n3, n40, n7, n34, n38, n39, n41, n66, n70 | -2.7 |
| n48, n77, n78, n79 | -2.2 |

The reference receive sensitivity (REFSENS) requirement specified in Table 7.3.2-1 and Table 7.3.2-2 shall be met for an uplink transmission using QPSK DFT-s-OFDM waveforms and for uplink transmission bandwidth less than or equal to that specified in Table 7.3.2-3.

Table 7.3.2-3: Uplink configuration for reference sensitivity

| Operating band / SCS / Channel bandwidth / Duplex mode | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating Band | SCS kHz | 5  MHz | 10  MHz | 15  MHz | 20  MHz | 25 MHz | 30 MHz | 40  MHz | 50  MHz | 60  MHz | 80  MHz | 90  MHz | 100 MHz | Duplex Mode |
| n41 | 15 |  | 50 | 75 | 100 |  |  | 216 | 270 |  |  |  |  | TDD |
| 30 |  | 24 | 36 | 50 |  |  | 100 | 128 | 162 | 216 | 243 | 270 |
| 60 |  | 10 | 18 | 24 |  |  | 50 | 64 | 75 | 100 | 120 | 135 |
| n48 | 15 | 25 | 50 | 75 | 100 |  |  | 216 |  |  |  |  |  | TDD |
| 30 |  | 24 | 36 | 50 |  |  | 100 |  |  |  |  |  |
| 60 |  | 10 | 18 | 24 |  |  | 50 |  |  |  |  |  |
| n50 | 15 | 25 | 50 | 75 | 100 |  |  | 216 | 270 |  |  |  |  | TDD |
| 30 |  | 24 | 36 | 50 |  |  | 100 | 128 | 162 | NOTE 3 |  |  |
| 60 |  | 10 | 18 | 24 |  |  | 50 | 64 | 75 | NOTE 3 |  |  |
| NOTE 1: 1 Refers to the UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.3.2-1).  NOTE 2: 2 refers to Band 20; for 15 kHz SCS, in the case of 15 MHz channel bandwidth, the UL resource blocks shall be located at RBstart 11 and in the case of 20 MHz channel bandwidth, the UL resource blocks shall be located at RBstart 16; for 30 kHz SCS, in the case of 15 MHz channel bandwidth, the UL resource blocks shall be located at RBstart 6 and in the case of 20 MHz channel bandwidth, the UL resource blocks shall be located at RBstart 8; for 60 kHz SCS, in the case of 15 MHz channel bandwidth, the UL resource blocks shall be located at RBstart 3 and in the case of 20 MHz channel bandwidth, the UL resource blocks shall be located at RBstart 4;  NOTE 3: For DL channel bandwidths that do not have symmetric UL channel bandwidth, highest valid UL configuration with lowest duplex distance shall be used. | | | | | | | | | | | | | | |

Unless given by Table 7.3.2-4, the minimum requirements specified in Tables 7.3.2-1 and 7.3.2-2 shall be verified with the network signalling value NS\_01 (Table 6.2.3-1) configured.

Table 7.3.2-4: Network signaling value for reference sensitivity

|  |  |
| --- | --- |
| Operating band | Network Signalling value |
| n2 | NS\_03 |
| n12 | NS\_06 |
| n25 | NS\_03 |
| n48 | NS\_27 |
| n66 | NS\_03 |
| n70 | NS\_03 |
| n71 | NS\_35 |

**7.6.2 In-band blocking**

n48 is added into in-band blocking table.

Table 7.6.2-4: In-band blocking for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Case 1 | Case 2 |
| Pinterferer | dBm | -56 | -44 |
| n48, n77, n78, n79 | Finterferer (offset) | MHz | -CBW/2 –  FIoffset, case 1  and  BW/2 +  FIoffset, case 1 | ≤ -CBW/2 –  FIoffset, case 2  and  ≥ CBW/2 +  FIoffset, case 2 |
| Finterferer |  | NOTE 2 | FDL\_low – 3CBW  to  FDL\_high + 3CBW |
| NOTE 1: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: -CBW/2 – FIoffset, case 1; b: CBW/2 + FIoffset, case 1  NOTE 3: CBW denotes the channel bandwidth of the wanted signal | | | | |

**7.6.3 Out-of-band blocking**

n48 is added into out-of-band blocking table. Note 3 is assigned to band 48 to allow usage of n77/n78 filter. Same approach is used in E-UTRA to allow band 48 share filter with bands 42 and 43.

Table 7.6.3-4: Out of-band blocking for NR bands with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Range1 | Range 2 | Range 3 |
| n48, n77, n78  (NOTE 3) | Pinterferer | dBm | -44 | -30 | -15 |
| Finterferer (CW) | MHz | -60 < f – FDL\_low ≤ -3CBW  or  3CBW ≤ f – FDL\_high < 60 | -200 < f – FDL\_low ≤ -MAX(60,3CBW)  or  MAX(60,3CBW) ≤ f – FDL\_high < 200 | 1 ≤ f ≤ FDL\_low – MAX(200,3CBW)  or  FDL\_high + MAX(200,3CBW)  ≤ f ≤ 12750 |
| n79  (NOTE 4) | Finterferer (CW) | MHz | N/A | -150 < f – FDL\_low ≤ -MAX(60,3CBW)  or  MAX(60,3CBW) ≤ f – FDL\_high < 150 | 1 ≤ f ≤ FDL\_low – MAX(150,3CBW)  or  FDL\_high + MAX(150,3CBW)  ≤ f ≤ 12750 |
| NOTE 1: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm for FInterferer > 6000 MHz.  NOTE 2: CBW denotes the channel bandwidth of the wanted signal  NOTE 3: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 2700 MHz and FInterferer < 4800 MHz. For CBW > 15 MHz, the requirement for Range 1 is not applicable and Range 2 applies from the frequency offset of 3CBW from the band edge. For CBW larger than 60 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3CBW from the band edge.  NOTE 4: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm, for FInterferer > 3650 MHz and FInterferer < 5750 MHz. For CBW ≥ 40 MHz, the requirement for Range 2 is not applicable and Range 3 applies from the frequency offset of 3CBW from the band edge. | | | | | |

### 7.1.1 A-MPR

#### 7.1.1.1 Vendor A

**Simulation assumptions were as follows**

IQ-Image and LO leakage = 28 dBc

CIM3 = 60 dBc

PA calibration point was 20 MHz, 15 kHz, QPSK, DFT-S-OFMA, 100 RB at lower channel edge with 0.5 dB MPR

**A-MPR concept and results**

FCC emission requirements are tighter outside of the band compared to inside the band with an exception that first 10 MHz on high side of that band has same -13 dBm requirement as within the band. Therefore, it would be beneficial to define two different A-MPRs firstly the band edge A-MPR which has higher -25 dBm...-40 dBm emission requirement on IMD3 region and secondly an inner-band A-MPR which would have lower A-MPR as -13 dBm requirement would apply on IMD3 region. This concept is presented in Figure.



Figure 7.1.1.1-1: Two different A-MPRs per CH BW

Based on concept presented in Figure 7.1.1.1-1 we provide simulation results in Tables 7.1.1.1-1 and 7.1.1.1-2 below. Total UE output power backoff is max(MPR, A-MPR).

Table 7.1.1.1-1: A-MPR regions for n48

|  |  |  |
| --- | --- | --- |
| Channel Bandwidth, MHz | Carrier Centre Frequency, Fc, MHz | A-MPR |
| 5 MHz | 3552.5 ≤ FC ≤ 3697.5 | A1 |
| 10 MHz | 3555 ≤ FC ≤ 3695 | A2 |
| 15 MHz | 3557.5 ≤ FC < 3562.5  3687.5 < FC ≤ 3692.5 | A3 |
| 15 MHz | 3562.5 ≤ FC < 3687.5 | A4 |
| 20 MHz | 3560 ≤ FC < 3570  3680 < FC ≤ 3690 | A5 |
| 20 MHz | 3570 ≤ FC < 3680 | A6 |
| 40 MHz | 3570 ≤ FC < 3600  3650 < FC ≤ 3680 | A7 |
| 40 MHz | 3600 ≤ FC < 3650 | A8 |

Table 7.1.1.1-2: n48 A-MPR

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **5 MHz Edge** | | **10 MHz Edge** | | **15 MHz Edge** | | **15 MHz Center** | |
|  |  | **A1** | | **A2** | | **A3** | | **A4** | |
|  |  | Outer | Inner | Outer | Inner | Outer | Inner | Outer | Inner |
| **SC-FDMA** | **pi/2-BPSK** | - | - | - | - | 1,5 | 1,5 | - | - |
| **QPSK** | - | - | - | - | 3 | 2 | - | - |
| **16QAM** | - | - | - | - | 3 | 2,5 | - | - |
| **64QAM** | - | - | - | - | 3 | - | - | - |
| **256QAM** | - | - | - | - | - | - | - | - |
| **OFDMA** | **QPSK** | - | - | - | - | 4 | 3 | - | - |
| **16QAM** | - | - | - | - | 4 | 3 | - | - |
| **64QAM** | - | - | - | - | 4 | - | - | - |
| **256QAM** | - | - | - | - | - | - | - | - |
|  |  | **20 MHz Edge** | | **20 MHz Center** | | **40 MHz Edge** | | **40 MHz Center** | |
|  |  | **A5** | | **A6** | | **A7** | | **A8** | |
|  |  | Outer | Inner | Outer | Inner | Outer | Inner | Outer | Inner |
| **SC-FDMA** | **pi/2-BPSK** | 3 | 1,5 | - | - | 8 | 8 | 1 | - |
| **QPSK** | 3,5 | 2 | 2 | - | 8 | 8 | 2 | - |
| **16QAM** | 4,5 | 2,5 | - | - | 8,5 | 8,5 | 2,5 | - |
| **64QAM** | 4,5 | - | - | - | 8 | 8,5 | - | - |
| **256QAM** | 5 | - | - | - | 8 | 8,5 | - | - |
| **OFDMA** | **QPSK** | 6 | 3,5 | - | - | 8,5 | 8,5 | - | - |
| **16QAM** | 6 | 3,5 | - | - | 8,5 | 9 | - | - |
| **64QAM** | 6 | - | - | - | 8,5 | 9 | - | - |
| **256QAM** | - | - | - | - | 8,5 | 8 | - | - |

As can be seen from results presented in Table 7.1.1.1-2 our results indicate there is no need to specify A-MPR for A1, A2, A4, A6 inner and A8 inner scenarios. A-MPR needed for A6 and A8 outer allocations is limited to only few modulations. For A5 there is an A-MPR need for many modulations but additive backoff compared to MPR is 1.5 – 3 dB. A8 requires always substantial A-MPR.

## 7.2 BS requirements

The following BS specific 38.104 changes are expected due to introduction of Band n48:

**6.6.4.2.1 Basic limits for Wide Area BS (Category A)**

For BS operating in Bands n1, n2, n3, n7, n25, n34, n38, n39, n40, n41, n48, n50, n65, n66, n70, n74, n75, n77, n78, n79, *basic limits* are specified in table 6.6.4.2.1-2:

Table 6.6.4.2.1-2: Wide Area BS *operating band* unwanted emission limits (NR bands above 1 GHz) for Category A

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, f | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Note 1, 2) | Measurement bandwidth |
| 0 MHz  f < 5 MHz | 0.05 MHz  f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz  f <  min(10 MHz, fmax) | 5.05 MHz  f\_offset <  min(10.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 10 MHz  f  fmax | 10.5 MHz  f\_offset < f\_offsetmax | -13 dBm (Note 3) | 1MHz |
| NOTE 1: For a BS supporting non-contiguous spectrum operation within any *operating band*, the emission limits within sub-block gaps is calculated as a cumulative sum of contributions from adjacent sub blocks on each side of the sub block gap, where the contribution from the far-end sub-block shall be scaled according to the measurement bandwidth of the near-end sub-block. Exception is f ≥ 10MHz from both adjacent sub blocks on each side of the sub-block gap, where the emission limits within sub-block gaps shall be ‑13 dBm/1 MHz.  NOTE 2: For a *multi-band connector* with Inter RF Bandwidth gap < 2\*ΔfOBUE the emission limits within the Inter RF Bandwidth gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks or RF Bandwidth on each side of the Inter RF Bandwidth gap, where the contribution from the far-end sub-block or RF Bandwidth shall be scaled according to the measurement bandwidth of the near-end sub-block or RF Bandwidth.  NOTE 3: The requirement is not applicable when fmax < 10 MHz. | | | |

**6.6.4.2.2.1 Category B requirements (Option 1)**

For BS operating in Bands n1, n2, n3, n7, n25, n34, n38, n39, n40, n41, n48, n50, n65, n66, n70, n75, n77, n78, n79, *basic limits* are specified in tables 6.6.4.2.2.1-2:

Table 6.6.4.2.2.1-2: Wide Area BS operating band unwanted emission limits (NR bands above 1 GHz) for Category B

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, f | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Note 1, 2) | Measurement bandwidth |
| 0 MHz  f < 5 MHz | 0.05 MHz  f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz  f <  min(10 MHz, fmax) | 5.05 MHz  f\_offset <  min(10.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 10 MHz  f  fmax | 10.5 MHz  f\_offset < f\_offsetmax | -15 dBm (Note 3) | 1MHz |
| NOTE 1: For a BS supporting non-contiguous spectrum operation within any *operating band*, the emission limits within sub-block gaps is calculated as a cumulative sum of contributions from adjacent sub blocks on each side of the sub block gap, where the contribution from the far-end sub-block shall be scaled according to the measurement bandwidth of the near-end sub-block. Exception is f ≥ 10MHz from both adjacent sub blocks on each side of the sub-block gap, where the emission limits within sub-block gaps shall be ‑15 dBm/1 MHz.  NOTE 2: For a *multi-band connector* with Inter RF Bandwidth gap < 2\*ΔfOBUE the emission limits within the Inter RF Bandwidth gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks or RF Bandwidth on each side of the Inter RF Bandwidth gap, where the contribution from the far-end sub-block or RF Bandwidth shall be scaled according to the measurement bandwidth of the near-end sub-block or RF Bandwidth.  NOTE 3: The requirement is not applicable when fmax < 10 MHz. | | | |

**6.6.4.2.5.3 Additional operating band unwanted emissions limits for Band n48**

The following requirement may apply to BS operating in Band n48 in certain regions. Emissions shall not exceed the maximum levels specified in Table 6.6.4.2.5.3-1.

Table 6.6.4.2.5.3-1: Additional operating band unwanted emission limits for Band n48

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel bandwidth | Frequency offset of measurement filter ‑3dB point, f | Frequency offset of measurement filter centre frequency, f\_offset | Minimum requirement | Measurement bandwidth (Note) |
| All | 0 MHz  f < 10 MHz | 0.5 MHz  f\_offset < 9.5 MHz | -13 dBm | 1 MHz |

Note: The resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

**6.6.5.2.3 Additional spurious emissions requirements**

Table 6.6.5.2.3-1: BS spurious emissions *basic* *limits* for BS for co-existence with systems operating in other frequency bands

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| System type for NR to co-exist with | Frequency range for co-existence requirement | *Basic limits* | Measurement bandwidth | Note |
| UTRA FDD Band XXII or E-UTRA Band 22 | 3510 – 3590 MHz | -52 dBm | 1 MHz | This is not applicable to BS operating in Band n48. |
| 3410 – 3490 MHz | -49 dBm | 1 MHz |  |
| E-UTRA Band 42 | 3400 – 3600 MHz | -52 dBm | 1 MHz | This is not applicable to BS operating in Band n48, n77 and n78. |
| E-UTRA Band 43 | 3600 – 3800 MHz | -52 dBm | 1 MHz | This is not applicable to BS operating in Band n48, n77 and n78. |
| E-UTRA Band 48 or NR Band n48 | 3550 – 3700 MHz | -52 dBm | 1 MHz | This is not applicable to BS operating in Band n48, n77 and n78. |
| NR Band n77 | 3.3 – 4.2 GHz | -52 dBm | 1 MHz | This requirement does not apply to BS operating in Band n48, n77 and n78 |
| NR Band n78 | 3.3 – 3.8 GHz | -52 dBm | 1 MHz | This requirement does not apply to BS operating in Band n48, n77 and n78 |

The following requirement may apply to BS operating in Band n48 in certain regions. The power of any spurious emission shall not exceed:

Table 6.6.5.2.3-6: Additional BS Spurious emissions limits for Band n48

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range | Maximum Level | Measurement Bandwidth (NOTE) | Note |
| 3530MHz – 3720MHz | -25dBm | 1 MHz | Applicable 10MHz from the assigned channel edge |
| 3100MHz – 3530MHz  3720MHz – 4200MHz | -40dBm | 1 MHz |  |

NOTE: The resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

**6.6.5.2.4 Co-location with other base stations**

Table 6.6.5.2.4-1: BS spurious emissions *basic* limits for BS co-located with another BS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Type of co-located BS | Frequency range for co-location requirement | *Basic limits* | | | Measurement bandwidth | Note |
| WA BS | MR BS | LA BS |
| UTRA FDD Band XXII or E-UTRA Band 22 | 3410 – 3490 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to BS operating in Band n48 |
| E-UTRA Band 42 | 3400 – 3600 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to BS operating in Band n48 |
| E-UTRA Band 43 | 3600 – 3800 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to BS operating in Band n48 |
| E-UTRA Band 48 or NR Band n48 | 3550 – 3700 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to BS operating in Band n48 |
| NR Band n77 | 3.3 – 4.2 GHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to BS operating in Band n48 |
| NR Band n78 | 3.3 – 3.8 GHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to BS operating in Band n48 |

Annex A:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2019-04 | RAN4#90bis | R4-1904591 |  |  |  | Initial TR skeleton | 0.0.1 |
| 2019-04 | RAN4#90bis | R4-1904592 |  |  |  | The following agreed text proposals have been included:  [R4-1900392](../AppData/Local/Users/wro02615/AppData/Local/Docs/R4-1900392.zip) TP to TR 38.173: Definitions and abbreviations, Nokia  [R4-1900393](../AppData/Local/Users/wro02615/AppData/Local/Docs/R4-1900393.zip) TP to TR 38.173: Background information, Nokia  [R4-1900395](../AppData/Local/Users/wro02615/AppData/Local/Docs/R4-1900395.zip) TP to TR 38.173: Frequency band arrangements and regulatory background, Nokia  R4-1900055 TP to TR 38.173: n48 A-MPR, Nokia  R4-1902447 TP to TR 38.173: Analysis on UE requirements for n48, Nokia  [R4-1900394](../AppData/Local/Users/wro02615/AppData/Local/Docs/R4-1900394.zip) TP to TR 38.173: BS requirements, Nokia | 0.1.0 |
| 2019-06 | RAN#84 | RP-190910 |  |  |  | V1.0.0 is submitted for 1 step approval | 1.0.0 |
| 2019-06 | RAN#84 |  |  |  |  | Approved by plenary – Rel-16 spec under change control | 16.0.0 |