**3GPP TSG- Meeting #**

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | [NR\_NTN\_enh-Perf] bigCR for 38.108, NR\_NTN Demodulation requirements |
|  |  |
| ***Source to WG:*** |  |
| ***Source to TSG:*** | RAN4 |
|  |  |
| ***Work item code:*** |  |  | ***Date:*** |  |
|  |  |  |  |  |
| ***Category:*** |  |  | ***Release:*** |  |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | Rel-18 NTN enhancement WI draftCRs (R4-2409860, R4-2409859, R4-2409871, R4-2409869, R4-2409863) |
|  |  |
| ***Summary of change:*** | From R4-2409871:Add the new section in 8.2.5 for PUSCH requirement with DM-RS bundlingFrom R4-2409869:For introducing NTN radiated performance requirements for PUSCH, update clause 11.From R4-2409859:New clause 11.3.1.8From R4-2409863Add performance requiremnts for PRACH for SAN type 2-O in sub-clause 11.4.2.From R4-2409860:New clauses added in Annex A and D |
|  |  |
| ***Consequences if not approved:*** | Rel-18 NTN performance requirements will not be inlcuded in TS 38.108 |
|  |  |
| ***Clauses affected:*** | 8.2.5, 11, Annex A, Annex D |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** | **X** |  |  Test specifications | TS/TR 38.181  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

***<Start of R4-2409871>***

<Start of Change >

### 8.2.5 Requirements for PUSCH with DM-RS bundling

#### 8.2.5.1 General

The performance requirement of PUSCH is determined by a minimum required throughput for a given SNR. The required throughput is expressed as a fraction of maximum throughput for the FRCs listed in annex A. The performance requirements assume HARQ re-transmissions.

Table: 8.2.5.1-1 Test parameters for testing PUSCH with DM-RS bundling

|  |  |
| --- | --- |
| Parameter | Value |
| Transform precoding | Disabled |
| Channel bandwidth  | 15kHz SCS: 5MHz30kHz SCS: 10MHz |
| HARQ | Maximum number of HARQ transmissions | 4 |
| RV sequence | 0, 0, 0, 0 [Note 1] |
| DM-RS | DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS position | pos1 |
| Number of DM-RS CDM group(s) without data | 2 |
| Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
| DM-RS port | 0 |
| DM-RS sequence generation | NID0=0, nSCID =0 |
| Time domain resource assignment | PUSCH mapping type | A, B |
| Start symbol | 0  |
| Allocation length | 14  |
| PUSCH aggregation factor | n4 for 15kHzn8 for 30kHz  |
| pusch-TimeDomainWindowLength | 4 slots for 15kHz 8 slots for 30kHz |
| Frequency domain resource assignment | RB assignment | 6 PRBs in the middle of the test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | Disabled |
| Note 1: The effective RV sequence is {0, 2, 3, 1} with slot aggregation. |

#### 8.2.5.2 Minimum requirements

The throughput shall be equal to or larger than the fraction of maximum throughput for the FRCs stated in tables 8.2.5.2-1 to 8.2.5.2-4 at the given SNR for 1Tx. FRCs are defined in annex A.

Table 8.2.5.2-1: Minimum requirements for PUSCH with DM-RS bundling, Type A, 5 MHz channel bandwidth, 15 kHz SCS in FR1-NTN

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex D) | Fraction of maximum throughput | FRC(Annex A) | Additional DM-RS position | SNR(dB) |
| 1 | 1 | Normal | NTN-TDLA100-200 Low | 70%  | G-FR1-NTN-A3-7 | pos1 | TBD |
| 2 | Normal | NTN-TDLA100-200 Low | 70%  | G-FR1-NTN-A3-7 | pos1 | TBD |

Table 8.2.5.2-2: Minimum requirements for PUSCH with DM-RS bundling, Type A, 10 MHz channel bandwidth, 30 kHz SCS in FR1-NTN

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex D) | Fraction of maximum throughput | FRC(Annex A) | Additional DM-RS position | SNR(dB) |
| 1 | 1 | Normal | NTN-TDLA100-200 Low | 70%  | G-FR1-NTN-A3-8 | pos1 | TBD |
| 2 | Normal | NTN-TDLA100-200 Low | 70%  | G-FR1-NTN-A3-8 | pos1 | TBD |

Table 8.2.5.2-3: Minimum requirements for PUSCH with DM-RS bundling, Type B, 5 MHz channel bandwidth, 15 kHz SCS in FR1-NTN

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex D) | Fraction of maximum throughput | FRC(Annex A) | Additional DM-RS position | SNR(dB) |
| 1 | 1 | Normal | NTN-TDLA100-200 Low | 70%  | G-FR1-NTN-A3-7 | pos1 | TBD |
| 2 | Normal | NTN-TDLA100-200 Low | 70%  | G-FR1-NTN-A3-7 | pos1 | TBD |

Table 8.2.5.2-4: Minimum requirements for PUSCH with DM-RS bundling, Type B, 10 MHz channel bandwidth, 30 kHz SCS in FR1-NTN

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex D) | Fraction of maximum throughput | FRC(Annex A) | Additional DM-RS position | SNR(dB) |
| 1 | 1 | Normal | NTN-TDLA100-200 Low | 70%  | G-FR1-NTN-A3-8 | pos1 | TBD |
| 2 | Normal | NTN-TDLA100-200 Low | 70%  | G-FR1-NTN-A3-8 | pos1 | TBD |

<End of Change >

***<End of R4-2409871>***

***<Start of R4-2409869>***

*<START OF THE CHANGE 1>*

11 Radiated performance requirements

11.1 General

11.1.1 Scope and definitions

Radiated performance requirements specify the ability of the *SAN type 1-O* or *SAN type 2-O* to correctly transmit and receive radiated signals in various conditions and configurations. Radiated performance requirements are specified at the RIB.

Radiated performance requirements for the SAN are specified for the fixed reference channels defined inannex A and for the propagation conditions defined in Recommendation ITU-R P.618 (*Propagation data and prediction methods required for the design of Earth-space telecommunication systems*). The requirements only apply to those FRCs that are supported by the SAN.

The radiated performance requirements for *SAN type 1-O* and for *SAN type 2-O* are limited to two OTA *demodulation branches* as described in clause 11.1.2. Conformance requirements can only be tested for 1 or 2 *demodulation branches* depending on the number of polarizations supported by the SAN, with the required SNR applied separately per polarization.

Unless stated otherwise, radiated performance requirements apply for a single carrier only. Radiated performance requirements for a SAN supporting carrier aggregation are defined in terms of single carrier requirements.

For *SAN type 1-O* in FDD operation the requirements in clause 8 shall be met with the transmitter units associated with the RIB in the *operating* *band* turned ON.

NOTE 1: *SAN type 1-O* in normal operating conditions in FDD operation is configured to transmit and receive at the same time. The transmitter unit(s) associated with the RIB may be OFF for some of the tests as specified in TS 38.181[3].

In tests performed with signal generators a synchronization signal may be provided from the SAN to the signal generator, to enable correct timing of the wanted signal.

Whenever the "RX antennas" term is used for the radiated performance requirements description, it shall refer to the *demodulation branches* (i.e. not physical antennas of the antenna array).

The SNR used in this clause is specified based on a single carrier and defined as:

SNR = S / N

Where:

*S* is the total signal power in a slot on a RIB.

*N* is the noise density integrated in a bandwidth corresponding to the *transmission bandwidth* over the duration where signal energy exists on a RIB.

11.1.2 OTA demodulation branches

Radiated performance requirements are only specified for up to 2 *demodulation branches*.

If the *SAN type 1-O* or the *SAN type 2-O* uses polarization diversity and has the ability to maintain isolation between the signals for each of the *demodulation branches*, then radiated performance requirements can be tested for up to two *demodulation branches* (i.e. 1RX or 2RX test setups). When tested for two *demodulation branches*, each demodulation branch maps to one polarization.

If the *SAN type 1-O* or the *SAN type 2-O* does not use polarization diversity then radiated performance requirements can only be tested for a single *demodulation branch* (i.e. 1RX test setup).

11.2 Performance requirements for PUSCH

### 11.2.1 Requirements for *SAN type 1-O*

#### 11.2.1.1 Requirements for PUSCH with transform precoding disabled

Apply the requirements defined in clause 8.2.1.

#### 11.2.1.2 Requirements for PUSCH with transform precoding enabled

Apply the requirements defined in clause 8.2.2.

#### 11.2.1.3 Requirements for UL timing adjustment

Apply the requirements defined in clause 8.2.3.

#### 11.2.1.4 Requirements for PUSCH repetition Type A

Apply the requirements defined in clause 8.2.4.

### 11.2.2 Requirements for *SAN type 2-O*

11.2.2.1 Requirements for PUSCH with transform precoding disabled

11.2.2.1.1 General

The performance requirement of PUSCH is determined by a minimum required throughput for a given SNR. The required throughput is expressed as a fraction of maximum throughput for the FRCs listed in annex A. The performance requirements assume HARQ retransmissions.

**Table 11.2.2.1.1-1: Test parameters for testing PUSCH**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Transform precoding | Disabled |
| HARQ | Maximum number of HARQ transmissions | 4 |
| RV sequence | 0, 2, 3, 1 |
| DM-RS | DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS symbols | Pos1 |
| Number of DM-RS CDM group(s) without data | 2 |
| Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
| DM-RS port(s) | {0} |
| DM-RS sequence generation | NID=0, nSCID =0 |
| Time domainresource | PUSCH mapping type | B |
| Start symbol index | 0  |
| Allocation length | 10  |
| Frequency domainresource | RB assignment | Full applicable test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | Disabled |
| PT-RSconfiguration | Frequency density (*KPT-RS*) | Disabled |
| Time density (*LPT-RS*) | Disabled |

11.2.2.1.2 Minimum requirements

The throughput shall be equal to or larger than the fraction of maximum throughput stated in the tables 11.2.2.1.2-1 at the given SNR for 1Tx.

**Table 11.2.2.1.2-1: Minimum requirements for PUSCH with 70% of maximum throughput, Type B, 50 MHz channel bandwidth, 120 kHz SCS in FR2-NTN**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of demodulation branches** | **Cyclic prefix** | **Propagation conditions and correlation matrix (Annex D)** | **Fraction of maximum throughput** | **FRC(annex A)** | **Additional DM-RS position** | **SNR****(dB)** |
| 1 | 1 | Normal | NTN-TDLC5-1200 Low | 70 % | G-FR2-NTN-A5-1 | pos1 | [0.0] |
| Normal | NTN-TDLC5-1200 Low | 70 % | G-FR2-NTN-A6-1 | pos1 | [8.9] |
| 2 | Normal | NTN-TDLC5-1200 Low | 70 % | G-FR2-NTN-A5-1 | pos1 | [-3.4] |
| Normal | NTN-TDLC5-1200 Low | 70% | G-FR2-NTN-A6-1 | pos1 | [5.5] |

11.2.2.2 Requirements for PUSCH with transform precoding enabled

11.2.2.2.1 General

The performance requirement of PUSCH is determined by a minimum required throughput for a given SNR. The required throughput is expressed as a fraction of maximum throughput for the FRCs listed in Annex A. The performance requirements assume HARQ retransmissions.

**Table 11.2.2.2.1-1: Test parameters for testing PUSCH**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Transform precoding | Enabled |
| HARQ | Maximum number of HARQ transmissions | 4 |
| RV sequence | 0, 2, 3, 1 |
| DM-RS | DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS symbols | Pos1 |
| Number of DM-RS CDM group(s) without data | 2 |
| Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
| DM-RS port(s) | {0} |
| DM-RS sequence generation | NID=0, nSCID =0 |
| Time domain resource | PUSCH mapping type | B |
| Start symbol index | 0  |
| Allocation length | 10  |
| Frequency domain resource | RB assignment | 30 PRBs in the middle of the test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | Disabled |
| PT-RS configuration | Frequency density (*KPT-RS*) | Disabled |
| Time density (*LPT-RS*) | Disabled |

11.2.2.2.2 Minimum requirements

The throughput shall be equal to or larger than the fraction of maximum throughput stated in the tables 11.2.2.2.2-1 at the given SNR for 1Tx.

**Table 11.2.2.2.2-1: Minimum requirements for PUSCH with 70% of maximum throughput, Type B, 50 MHz Channel Bandwidth, 120 kHz SCS in FR2-NTN**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of demodulation branches** | **Cyclic prefix** | **Propagation conditions and correlation matrix (Annex D)** | **Fraction of maximum throughput** | **FRC(annex A)** | **Additional DM-RS position** | **SNR****(dB)** |
| 1 | 1 | Normal | NTN-TDLC5-1200 Low | 70 % | G-FR2-NTN-A5-2 | pos1 | [0.1] |
| 2 | Normal | NTN-TDLC5-1200 Low | 70 % | G-FR2-NTN-A5-2 | pos1 | [-3.2] |

11.2.2.3 Requirements for PUSCH repetition Type A

11.2.2.3.1 General

The performance requirement of PUSCH is determined by a maximum block error rate (BLER) for a given SNR. The BLER is defined as the probability of incorrectly decoding the PUSCH information when the PUSCH information is sent. The performance requirements assume HARQ retransmissions.

**Table 11.2.2.3.1-1: Test parameters for testing PUSCH repetition Type A**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Transform precoding | Disabled |
| HARQ | Maximum number of HARQ transmissions | 4 |
| RV sequence | 0, 3, 0, 3 [Note 1] |
| DM-RS | DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS symbols | Pos1 |
| Number of DM-RS CDM group(s) without data | 2 |
| Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
| DM-RS port(s) | 0 |
| DM-RS sequence generation | NID=0, nSCID =0 |
| Time domain resource | PUSCH mapping type | B |
| Start symbol index | 0  |
| Allocation length | 10  |
| PUSCH aggregation factor | n2 |
| Frequency domain resource | RB assignment | Full applicable test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | Disabled |
| PT-RS configuration | Frequency density (*KPT-RS*) | Disabled |
| Time density (*LPT-RS*) | Disabled |
| NOTE 1: The effective RV sequence is {0,2,3,1} with slot aggregation |

11.2.2.3.2 Minimum requirements

The BLER shall be equal to or smaller than the required target BLER for the FRCs stated in tables 11.2.2.3.2-1 at the given SNR for 1Tx.

**Table 11.2.2.3.2-1: Minimum requirements for PUSCH, TypeB, 50 MHz channel bandwidth, 120 kHz SCS in FR2-NTN**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of demodulation branches** | **Cyclic prefix** | **Propagation conditions and correlation matrix (Annex D)** | **Target BLER** | **FRC****(Annex A)** | **Additional** **DM-RS position** | **SNR****(dB)** |
| 1 | 1 | Normal | NTN-TDLC5-1200 Low | 1% (Note1) | G-FR2-NTN-A3A-3 | Pos1 | TBD |
| 2 | Normal | NTN-TDLC5-1200 Low | 1% (Note1) | G-FR2-NTN-A3A-3 | Pos1 | TBD |
| NOTE 1: BLER is defined as residual BLER, i.e. ratio of incorrectly received transport blocks/sent transport blocks, independently of the number of HARQ transmission(s) for each transport block |

*<END OF THE CHANGE 1>*

***<End of R4-2409869>***

***<Start of R4-2409863>***

## **<Start of Change 1>**

## 11.4 Performance requirements for PRACH

### 11.4.1 Requirements for SAN type 1-O

#### 11.4.1.1 PRACH False alarm probability

Apply the requirements defined in clause 8.4.1.

#### 11.4.1.2 PRACH detection requirements

Apply the requirements defined in clause 8.4.2.

### 11.4.2 Requirements for SAN type 2-O

#### 11.4.2.1 PRACH False alarm probability

##### 11.4.2.1.1 General

The false alarm requirement is valid for any number of receive antennas, for any channel bandwidth.

The false alarm probability is the conditional total probability of erroneous detection of the preamble (i.e. erroneous detection from any detector) when input is only noise.

##### 11.4.2.1.2 Minimum requirement

The false alarm probability shall be less than or equal to 0.1%.

#### 11.4.2.2 PRACH detection requirements

##### 11.4.2.2.1 General

The probability of detection is the conditional probability of correct detection of the preamble when the signal is present. There are several error cases – detecting different preamble than the one that was sent, not detecting a preamble at all or correct preamble detection but with the wrong timing estimation. For NTN-TDLC5-1200, a timing estimation error occurs if the estimation error of the timing of the strongest path is larger than the time error tolerance given in Table 11.4.2.2.1-1.

Table 11.4.2.2.1-1: Time error tolerance for NTN-TDLC5-1200

|  |  |  |
| --- | --- | --- |
| PRACHpreamble | PRACH SCS(kHz) | Time error tolerance |
| NTN-TDLC5-1200 |
| B4, C2 | 120 | 0.13 us |

The test preambles are listed in table A.4-1 and the test parameter *msg1-FrequencyStart* is set to 0.

##### 11.4.2.2.2 Minimum requirement

The probability of detection shall be equal to or exceed 99% for the SNR levels listed in Table 11.4.2.2.2-1.

Table 11.4.2.2.2-1: PRACH missed detection test requirements, 120 kHz SCS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Propagation conditions and correlation matrix (annex D) | Frequency offset | SNR (dB) |
| Burst format B4 | Burst format C2 |
| 1 | 1 | NTN-TDLC5-1200 Low | 3000 Hz | [-6.3] | [-3.3] |
| 2 | NTN-TDLC5-1200 Low | 3000 Hz | [-11.9] | [-8.6] |

## **<Endd of Change 1>**

***<End of R4-2409863>***

***<Start of R4-2409859>***

***<Start of Change 1>***

## 11.3 Performance requirements for PUCCH

### 11.3.1 Requirements for *SAN type 1-O*

#### 11.3.1.1 DTX to ACK probability

Apply the requirements defined in clause 8.3.1.

#### 11.3.1.2 Performance requirements for PUCCH format 0

Apply the requirements defined in clause 8.3.2 for 1Rx and 2Rx.

#### 11.3.1.3 Performance requirements for PUCCH format 1

Apply the requirements defined in sub-clause 8.3.3 for 1Rx and 2Rx.

#### 11.3.1.4 Performance requirements for PUCCH format 2

Apply the requirements defined in clause 8.3.4 for 1Rx and 2Rx.

#### 11.3.1.5 Performance requirements for PUCCH format 3

Apply the requirements defined in clause 8.3.5 for 1Rx and 2Rx.

#### 11.3.1.6 Performance requirements for PUCCH format 4

Apply the requirements defined in clause 8.3.6 for 1Rx and 2Rx.

#### 11.3.1.7 Performance requirements for multi-slot PUCCH

Apply the requirements defined in clause 8.3.7 for 1Rx and 2Rx.

### 11.3.2 Requirements for *SAN type 2-O*

#### 11.3.2.1 General

The DTX to ACK probability, i.e. the probability that ACK is detected when nothing was sent:

where:

- #(false ACK bits) denotes the number of detected ACK bits.

- #(ACK/NACK bits) denotes the number of encoded bits per slot

- #(PUCCH DTX) denotes the number of DTX occasions

#### 11.3.2.2 Performance requirements for PUCCH format 0

##### 11.3.2.2.1 General

The ACK missed detection probability is the probability of not detecting an ACK when an ACK was sent.

Table 11.3.2.2.1-1: Test Parameters

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Number of UCI information bits | 1 |
| Number of PRBs | 1 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | Enabled |
| First PRB after frequency hopping | The largest PRB index – (Number of PRBs - 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 12 for 2 symbols |
| Test metric | 1% of DTX to ACK probability1% of ACK missed detection probability  |

The transient period as specified in TS 38.101-1 [17] clause 6.3.3.1 and TS 38.101-2 [18] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

##### 11.3.2.2.2 Minimum requirements

The ACK missed detection probability shall not exceed 1% at the SNR given in table 11.3.2.2.2-1.

Table 11.3.2.2.2-1: Minimum requirements for PUCCH format 0 and 120 kHz SCS in FR2-NTN

|  |  |  |  |
| --- | --- | --- | --- |
| Number | Number of | Propagation conditions and |  |
| of TX antennas | demodulation branches | correlation matrix (Annex D) | 50 MHz |
| 1 | 1 | NTN-TDLC5-1200 Low | TBD  |
|  | 2 | NTN-TDLC5-1200 Low | [1.3]  |

#### 11.3.2.3 Performance requirements for PUCCH format 1.

##### 11.3.2.3.1 NACK to ACK requirements

###### 11.3.2.3.1.1 General

The NACK to ACK detection probability is the probability that an ACK bit is falsely detected when an NACK bit was sent on the particular bit position, where the NACK to ACK detection probability is defined as follows:

 

where:

-  denotes the total number of NACK bits transmitted

-  denotes the number of NACK bits decoded as ACK bits at the receiver, i.e. the number of received ACK bits

- NACK bits in the definition do not contain the NACK bits which are mapped from DTX, i.e. NACK bits received when DTX is sent should not be considered.

Random codeword selection is assumed.

Table 11.3.2.3.1.1-1: Test Parameters

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Number of information bits | 2 |
| Number of PRBs | 1 |
| Number of symbols | 14 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index – (nrofPRBs – 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 |

The transient period as specified in TS 38.101-1 [17] and TS 38.101-2 [18] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

###### 11.3.2.3.1.2 Minimum requirements

The NACK to ACK probability shall not exceed 0.1% at the SNR given in Table 11.3.2.3.1.2-1

Table 11.3.2.3.1.2-1: Minimum requirements for PUCCH format 1 with 120 kHz SCS in FR2-NTN

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) |
| of TX antennas | Demodulation Branches | Prefix | conditions and correlation matrix (Annex D) | 50 MHz |
| 1 | 1 | Normal | NTN-TDLC5-1200 Low | [-0.2] |
|  | 2 | Normal | NTN-TDLC5-1200 Low | [-5.3] |

##### 11.3.2.3.2 ACK missed detection requirements

###### 11.3.2.3.2.1 General

The ACK missed detection probability is the probability of not detecting an ACK when an ACK was sent. The test parameters in Table 11.3.2.3.1.1-1 are configured.

The transient period as specified in TS 38.101-1 [17] and TS 38.101-2 [18] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

###### 11.3.2.3.2.2 Minimum requirements

The ACK missed detection probability shall not exceed 1% at the SNR given in Table 11.3.2.3.2.2-1.

Table 11.3.2.3.2.2-1: Minimum requirements for PUCCH format 1 with 120 kHz SCS in FR2-NTN

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) |
| of TX antennas | Demodulation Branches | Prefix | conditions and correlation matrix (Annex D) | 50 MHz |
| 1 | 1 | Normal | NTN-TDLC5-1200 Low | [-1.4] |
|  | 2 | Normal | NTN-TDLC5-1200 Low | [-5.9] |

#### 11.3.2.4 Performance requirements for PUCCH format 2

##### 11.3.2.4.1 ACK missed detection requirements

###### 11.3.2.4.1.1 General

The ACK missed detection probability is the probability of not detecting an ACK when an ACK was sent.

The ACK missed detection requirement only applies to the PUCCH format 2 with 4 UCI bits.

Table 11.3.2.4.1.1-1: Test Parameters

|  |  |
| --- | --- |
| Parameter | Value  |
| Modulation order | QSPK |
| Starting RB location | 0 |
| Intra-slot frequency hopping | N/A |
| Number of PRBs | 4 |
| Number of symbols | 1 |
| The number of UCI information bits | 4 |
| First symbol | 13 |
| DM-RS sequence generation | *NID*0=0 |

###### 11.3.2.4.1.2 Minimum requirements

The ACK missed detection probability shall not exceed 1% at the SNR given in table 11.3.2.4.1.2-1 for 4UCI bits.

Table 11.3.2.4.1.2-1: Minimum requirements for PUCCH format 2 with 120 kHz SCS in FR2-NTN

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) |
| of TX antennas | Demodulation Branches | Prefix | conditions and correlation matrix (Annex D) | 50 MHz |
| 1 | 1 | Normal | NTN-TDLC5-1200 Low | [5.0] |
|  | 2 | Normal | NTN-TDLC5-1200 Low | [0.3] |

##### 11.3.2.4.2 UCI BLER performance requirements

11.3.2.4.2.1 General

The UCI block error probability (BLER) is defined as the probability of incorrectly decoding the UCI information when the UCI information is sent. The UCI information does not contain CSI part 2.

The transient period as specified in TS 38.101-1 [17] and TS 38.101-2 [18] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

The UCI performance only applies to the PUCCH format 2 with 22 UCI bits.

Table 11.3.2.4.2.1-1: Test Parameters

|  |  |
| --- | --- |
| Parameter | Value |
| Modulation order | QSPK |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index – (Number of PRBs – 1) |
| Number of PRBs | 9 |
| Number of symbols | 2 |
| The number of UCI information bits | 22 |
| First symbol | 12 |
| DM-RS sequence generation | *NID*0=0 |

###### 11.3.2.4.2.2 Minimum requirements

The UCI block error probability shall not exceed 1% at the SNR given in table 11.3.2.4.2.2-1 for 22 UCI bits.

Table 11.3.2.4.2.2-1: Minimum requirements for PUCCH format 2 with 120 kHz SCS in FR2-NTN

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) |
| of TX antennas | Demodulation Branches | Prefix | conditions and correlation matrix (Annex D) | 50 MHz |
| 1 | 1 | Normal | NTN-TDLC5-1200 Low | [4.2] |
|  | 2 | Normal | NTN-TDLC5-1200 Low | [-1.6] |

#### 11.3.2.5 Performance requirements for PUCCH format 3

##### 11.3.2.5.1 General

The performance is measured by the required SNR at UCI block error probability not exceeding 1%.

The UCI block error probability is defined as the conditional probability of incorrectly decoding the UCI information when the UCI information is sent. The UCI information does not contain CSI part 2.

The transient period as specified in TS 38.101-2 [18] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

Table 11.3.2.5.1-1: Test parameters

|  |  |
| --- | --- |
| Parameter | Value |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index – (Number of PRBs - 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Number of PRBs | 1 |
| Number of symbols | 14 |
| The number of UCI information bits | 16 |
| First symbol | 0 |

##### 11.3.2.5.2 Minimum requirements

The UCI block error probability shall not exceed 1% at the SNR given in Table 11.3.2.5.2-1.

Table 11.3.2.5.2-2: Required SNR for PUCCH format 3 with 120kHz SCS in FR2-NTN

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX  | Number of demodulation  | Cyclic Prefix | Propagation conditions and  | Additional DM‑RS  | Channel Bandwidth / SNR (dB) |
| antennas | branches |  | correlation matrix (Annex D) | configuration | 50 MHz |
|  | 1 | Normal | NTN-TDLC5-1200 Low | No additional DM-RS | [1.9] |
|  |  |  |  | Additional DM-RS | [1.4] |
| 1 | 2 | Normal | NTN-TDLC5-1200 Low | No additional DM-RS | [-2.0] |
|  |  |  |  | Additional DM-RS | [-2.0] |

#### 11.3.2.6 Performance requirements for PUCCH format 4

##### 11.3.2.6.1 General

The performance is measured by the required SNR at UCI block error probability not exceeding 1%.

The UCI block error probability is defined as the conditional probability of incorrectly decoding the UCI information when the UCI information is sent. The UCI information does not contain CSI part 2.

The transient period as specified in TS 38.101-2 [18] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

Table 11.3.2.6.1-1: Test parameters

|  |  |
| --- | --- |
| Parameter | Value |
| Modulation order | QPSK |
| First PRB prior to frequency hoppingstartingPRB | 0 |
| Number of PRBs | 1 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index – (Number of PRBs – 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Number of symbols | 14 |
| The number of UCI information bits | 22 |
| First symbol | 0 |
| Length of the orthogonal cover code | n2 |
| Index of the orthogonal cover code  | n0 |

##### 11.3.2.6.2 Minimum requirements

The UCI block error probability shall not exceed 1% at the SNR given in Table 11.3.2.6.2-1.

Table 11.3.2.6.2-1: Required SNR for PUCCH format 4 with 120 kHz SCS in FR2-NTN

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX  | Number of demodulation  | Cyclic Prefix | Propagation conditions and  | Additional DM‑RS  | Channel Bandwidth / SNR (dB) |
| antennas | branches |  | correlation matrix (Annex D) | configuration | 50 MHz |
|  | 1 | Normal | NTN-TDLC5-1200 Low | No additional DM-RS | TBD |
|  |  |  |  | Additional DM-RS | TBD |
| 1 | 2 | Normal | NTN-TDLC5-1200 Low | No additional DM-RS | [-0.2] |
|  |  |  |  | Additional DM-RS | [-0.7] |

***<End of Change 1>***

***<End of R4-2409859>***

***<Start of R4-2409859>***

***<Start of change 1>***

***<Start of change 1>***

# A.3 Fixed Reference Channels for performance requirements (QPSK, R=308/1024)

The parameters for the reference measurement channel are specified in table A.3-1 to table A.3-3 for FR1 PUSCH performance requirements:

- FRC parameters are specified in table A.3-1 for FR1 PUSCH with transform precoding disabled, additional DM-RS position = pos0 and 1 transmission layer.

- FRC parameters are specified in table A.3-2 for FR1 PUSCH with transform precoding enabled, additional DM-RS position = pos0 and 1 transmission layer.

* FRC parameters are specified in table A.3-3 for FR1-NTN PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer.

Table A.3-1: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A3-1 | G-FR1-A3-2 | G-FR1-A3-3 | G-FR1-A3-4 |
| Subcarrier spacing (kHz) | 15 | 15 | 30 | 30 |
| Allocated resource blocks | 25 | 12 | 24 | 12 |
| Data bearing CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 |
| Modulation | QPSK | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 | 308/1024 | 308/1024 |
| Payload size (bits) | 2152 | 1032 | 2024 | 1032 |
| Transport block CRC (bits) | 16 | 16 | 16 | 16 |
| Code block CRC size (bits) | - | - | - | - |
| Number of code blocks - C | 1 | 1 | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 2168 | 1048 | 2040 | 1048 |
| Total number of bits per slot | 7200 | 3456 | 6912 | 3456 |
| Total resource elements per slot | 3600 | 1728 | 3456 | 1728 |
| NOTE 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0*= 2 and *l* =11 for PUSCH mapping type A, *l0*= 0 and *l* =10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [5].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [10]. |

Table A.3-2: FRC parameters for FR1 PUSCH performance requirements, transform precoding enabled, additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR1-A3-5 | G-FR1-A3-6 |
| Subcarrier spacing (kHz) | 15 | 30 |
| Allocated resource blocks | 25 | 24 |
| Data bearing CP-OFDM Symbols per slot (Note 1) | 12 | 12 |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 |
| Payload size (bits) | 2152 | 2088 |
| Transport block CRC (bits) | 16 | 16 |
| Code block CRC size (bits) | - | - |
| Number of code blocks - C | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 2168 | 2104 |
| Total number of bits per slot | 7200 | 6912 |
| Total resource elements per slot | 3600 | 3456 |
| NOTE 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0*= 2 and *l* =11 for PUSCH mapping type A, *l0*= 0 and *l* =10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [5].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [10]. |

Table A.3-3: FRC parameters for FR1-NTN PUSCH performance requirements, transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR1-NTN-A3-7 | G-FR1-NTN-A3-8 |
| Subcarrier spacing (kHz) | 15 | 30 |
| Allocated resource blocks | 6 | 6 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 |
| MCS table | 64QAM | 64QAM |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 |
| Payload size (bits) | 528 | 528 |
| Transport block CRC (bits) | 16 | 16 |
| Code block CRC size (bits) | - | - |
| Number of code blocks - C | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 544 | 544 |
| Total number of bits per slot | 1728 | 1728 |
| Total symbols per slot | 864 | 864 |
| NOTE 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, Additional DM-RS position = pos1, and l0= 2 and l = 11 for PUSCH mapping type A and l0= 0 and l = 10 for PUSCH mapping type B, as per table 6.4.1.1.3-3 of TS 38.211 [8].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [7]. |

# A.3A Fixed Reference Channels for performance requirements (QPSK, R=99/1024)

The parameters for the reference measurement channel are specified in table A.3A-1 for FR1 PUSCH performance requirements:

- FRC parameters are specified in table A.3A-1 for FR1 PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer.

The parameters for the reference measurement channel are specified in table A.3A-2 for FR2-NTN PUSCH performance requirements:

* FRC parameters are specified in table A.3A-2 for FR2-NTN PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer.

Table A.3A-1: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=99/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR1-A3A-1 | G-FR1-A3A-2 |
| Subcarrier spacing (kHz) | 15 | 30 |
| Allocated resource blocks | 25 | 24 |
| Data beraing CP-OFDM Symbols per slot (Note 1) | 12 | 12 |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 99/1024 | 99/1024 |
| Payload size (bits) | 704 | 672 |
| Transport block CRC (bits) | 16 | 16 |
| Code block CRC size (bits) | - | - |
| Number of code blocks - C | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 720 | 688 |
| Total number of bits per slot | 7200 | 6912 |
| Total resource elements per slot | 3600 | 3456 |
| NOTE 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0* = 2 and *l* = 11 for PUSCH mapping type A, *l0* = 0 and *l* = 10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [5].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [10]. |

Table A.3A-2: FRC parameters for FR2-NTN PUSCH performance requirements, transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=99/1024)

|  |  |
| --- | --- |
| Reference channel | G-FR2-NTN-A3A-1 |
| Subcarrier spacing (kHz) | 120 |
| Allocated resource blocks | 32 |
| CP-OFDM Symbols per slot (Note 1) | 8 |
| MCS table | 64QAMLowSE |
| Modulation | QPSK |
| Code rate (Note 2) | 99/1024 |
| Payload size (bits) | 608 |
| Transport block CRC (bits) | 16 |
| Code block CRC size (bits) | - |
| Number of code blocks - C | 1 |
| Code block size including CRC (bits) (Note 2) | 624 |
| Total number of bits per slot | 6144 |
| Total symbols per slot | 3072 |
| NOTE 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, Additional DM-RS position = pos1, and l0= 0 and l = 8 for PUSCH mapping type B, as per table 6.4.1.1.3-3 of TS 38.211 [8].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [7]. |

# A.4 PRACH test preambles

Table A.4-1 Test preambles in FR1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Burst format | SCS (kHz) | Ncs | Logical sequence index | v |
| 0 | 1.25 | 13 | 22 | 32 |
| 2 | 1.25 | 13 | 22 | 32 |
| B4, C2 | 15 | 23 | 0 | 0 |
| 30 | 46 | 0 | 0 |

Table A.4-2 Test preambles in FR2-NTN

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Burst format | SCS (kHz) | Ncs | Logical sequence index | v |
| B4, C2 | 120 | 69 | 0 | 0 |

# A.5 Fixed Reference Channels for performance requirements (QPSK, R=193/1024)

The parameters for the reference measurement channels are specified in table A.5-1 to table A.5-2 for FR2-NTN PUSCH performance requirements:

- FRC parameters are specified in table A.5-1 for FR2-NTN PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer.

- FRC parameters are specified in table A.5-2 for FR2-NTN PUSCH with transform precoding enabled, additional DM-RS position = pos1 and 1 transmission layer.

Table A.5-1: FRC parameters for FR2-NTN PUSCH performance requirements, transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=193/1024)

|  |  |
| --- | --- |
| Reference channel | G-FR2-NTN-A5-1 |
| Subcarrier spacing (kHz) | 120 |
| Allocated resource blocks | 32 |
| CP-OFDM Symbols per slot (Note 1) | 8 |
| MCS table | 64QAM |
| Modulation | QPSK |
| Code rate (Note 2) | 193/1024 |
| Payload size (bits) | 1160 |
| Transport block CRC (bits) | 16 |
| Code block CRC size (bits) | - |
| Number of code blocks - C | 1 |
| Code block size including CRC (bits) (Note 2) | 1176 |
| Total number of bits per slot | 6144 |
| Total symbols per slot | 3072 |
| NOTE 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, Additional DM-RS position = pos1, and l0= 0 and l = 8 for PUSCH mapping type B, as per table 6.4.1.1.3-3 of TS 38.211 [8].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [7]. |

Table A.5-2: FRC parameters for FR2-NTN PUSCH performance requirements, transform precoding enabled, additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=193/1024)

|  |  |
| --- | --- |
| Reference channel | G-FR2-NTN-A5-2 |
| Subcarrier spacing (kHz) | 120 |
| Allocated resource blocks | 30 |
| DFT-s-OFDM Symbols per slot (Note 1) | 8 |
| MCS table | 64QAM |
| Modulation | QPSK |
| Code rate (Note 2) | 193/1024 |
| Payload size (bits) | 1128 |
| Transport block CRC (bits) | 16 |
| Code block CRC size (bits) | - |
| Number of code blocks - C | 1 |
| Code block size including CRC (bits) (Note 2) | 1144 |
| Total number of bits per slot | 5760 |
| Total symbols per slot | 2880 |
| NOTE 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, Additional DM-RS position = pos1, and l0= 0 and l = 8 for PUSCH mapping type B, as per table 6.4.1.1.3-3 of TS 38.211 [8].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [7]. |

# A.6 Fixed Reference Channels for performance requirements (16QAM, R=434/1024)

The parameters for the reference measurement channels are specified in table A.6-1 for FR2-NTN PUSCH performance requirements:

- FRC parameters are specified in table A.6-1 for FR2-NTN PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer.

Table A.6-1: FRC parameters for FR2-NTN PUSCH performance requirements, transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer (16QAM, R=434/1024)

|  |  |
| --- | --- |
| Reference channel | G-FR2-NTN-A6-1 |
| Subcarrier spacing (kHz) | 120 |
| Allocated resource blocks | 32 |
| CP-OFDM Symbols per slot (Note 1) | 8 |
| MCS table | 64QAM |
| Modulation | 16QAM |
| Code rate (Note 2) | 434/1024 |
| Payload size (bits) | 5248 |
| Transport block CRC (bits) | 24 |
| Code block CRC size (bits) | - |
| Number of code blocks - C | 1 |
| Code block size including CRC (bits) (Note 2) | 5272 |
| Total number of bits per slot | 12288 |
| Total symbols per slot | 3072 |
| NOTE 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, Additional DM-RS position = pos1, and l0= 0 and l = 8 for PUSCH mapping type B, as per table 6.4.1.1.3-3 of TS 38.211 [8].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [7]. |

***<End of change 1>***

***<Start of change 2>***

# D.2 Multi-path fading propagation conditions

The multipath propagation conditions consist of several parts:

- A delay profile in the form of a "tapped delay-line", characterized by a number of taps at fixed positions on a sampling grid. The profile can be further characterized by the r.m.s. delay spread and the maximum delay spanned by the taps.

- A combination of channel model parameters that include the Delay profile and the Doppler spectrum that is characterized by a classical spectrum shape and a maximum Doppler frequency.

## D.2.1 Delay profiles

The delay profiles are simplified from the TR 38.811 [13] TDL models. The simplification steps are shown below for information. These steps are only used when new delay profiles are created. Otherwise, the delay profiles specified in G.2.1.1 can be used as such.

- Step 1: Use the original TDL model from TR 38.811 [13].

- Step 2: Re-order the taps in ascending delays

- Step 3: Perform delay scaling according to the procedure described in clause 7.7.2 in TR 38.901 [12].

- Step 4: Apply the quantization to the delay resolution 5 ns. This is done simply by rounding the tap delays to the nearest multiple of the delay resolution.

- Step 5: If multiple Rayleigh taps are rounded to the same delay bin, merge them by calculating their linear power sum.

- Step 6: If there is a LOS path in the model, the power for all paths could be slightly adjusted to keep the RMS delay spread is close to target delay spread and mean power is 0dB.

- Step 7: Round the amplitudes of taps to one decimal (e.g. -8.78 dB 🡪 -8.8 dB)

- Step 8: If the delay spread has slightly changed due to the tap merge, adjust the final delay spread by increasing or decreasing the power of the last tap so that the delay spread is corrected.

- Step 9: Re-normalize the highest Rayleigh tap to 0 dB when there is no LOS path in the model.

Note 1: Some values of the delay profile created by the simplification steps may differ from the values in tables G.2.1.1-2, G.2.1.1-3 and G.2.1.2-2 for the corresponding model.

Note 2: For Step 5 and Step 6, the power values are expressed in the linear domain using 6 digits of precision. The operations are in the linear domain.

### D.2.1.1 Delay profiles for FR1

The delay profiles for FR1 are selected to be representative of low, medium and high delay spread environment. The resulting model parameters are specified in table D.2.1.1-1 and the tapped delay line models are specified in tables D.2.1.1-2 ~ D.2.1.1-3.

Table D.2.1.1-1: Delay profiles for NR channel models

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Number of channel taps | Delay spread(r.m.s.) | Maximum excess tap delay (span) | Delay resolution |
| NTN-TDLA100 | 3 | 100 ns | 285 | 5ns |
| NTN-TDLC5 | 2 | 5 ns | 60 | 5ns |

Table D.2.1.1-2: NTN-TDLA100 (DS = 100 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns) | Power (dB) | Fading distribution |
| 1 | 0 | 0 | Rayleigh |
| 2 | 110 | -4.7 | Rayleigh |
| 3 | 285 | -6.5 | Rayleigh |

Table D.2.1.1-3: NTN-TDLC5 (DS = 5 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns) | Power (dB) | Fading distribution |
| 1 | 0 | -0.6 | LOS path |
| 0 | -8.9 | Rayleigh |
| 2 | 60 | -21.5 | Rayleigh |

### D.2.1.2 Delay profiles for FR2-NTN

The delay profiles for FR2 are selected to be representative of low, medium and high delay spread environment. The resulting model parmeters are specified in table D.2.1.2-1 and the tapped delay line models are specified in tables D.2.1.2-2.

Table D.2.1.2-1: Delay profiles for NR channel models

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Number of channel taps | Delay spread(r.m.s.) | Maximum excess tap delay (span) | Delay resolution |
| NTN-TDLC5 | 2 | 5 ns | 60 ns | 5 ns |

Table D.2.1.2-2: NTN-TDLC5 (DS = 5 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns) | Power (dB) | Fading distribution |
| 1 | 0 | -0.6 | LOS path |
| 0 | -8.9 | Rayleigh |
| 2 | 60 | -21.5 | Rayleigh |

## D.2.2 Combinations of channel model parameters

The propagation conditions used for the performance measurements in multi-path fading environment are indicated as a combination of a channel model name and a maximum Doppler frequency, i.e., NTN-TDLA<DS>-<Doppler> or NTN-TDLC<DS>-<Doppler> where '<DS>' indicates the desired delay spread and '<Doppler>' indicates the maximum Doppler frequency (Hz).

Table D.2.2-1 show the propagation conditions that are used for the performance measurements in multi-path fading environment.

Table D.2.2-2 shows the propagation conditions that are used for the performance measurements in multi-path fading environment for low, medium and high Doppler frequencies for FR2-NTN.

Table D.2.2-1: Channel model parameters for FR1

|  |  |  |
| --- | --- | --- |
| Combination name | Tapped delay line model | Maximum Doppler frequency |
| NTN-TDLA100-200 | NTN-TDLA100 | 200 Hz |
| NTN-TDLC5-200 | NTN-TDLC5 | 200 Hz |

Table D.2.2-2: Channel model parameters for FR2-NTN

|  |  |  |
| --- | --- | --- |
| Combination name | Model | Maximum Doppler frequency |
| NTN-TDLC5-1200 | NTN-TDLC5 | 1200 Hz |

***<End of change 2>***

***<End of R4-2409860>***