**3GPP TSG-<TSG/WG> Meeting # 104-bis-e *R4-2216024***

**Electronic Meeting, Oct 10th – 19th , 2022**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **TS 38.104** | **CR** | **<CR#>** | **rev** |  | **Current version:** | **17.7.0** |  |
|  | | | | | | | | |
| *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:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei.HiSilicon | | | | | | | | | |
| ***Source to TSG:*** | R4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_ext\_to\_71GHz-Perf | | | | |  | ***Date:*** | | | 2022-09-30 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-17 |
|  | *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 can be 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-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Based on the work plan, RAN 4 should submit the draft CR for FR2-2 UE and BS performance requirements | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Introduce PUCCH performance requirments in TS 38.104 | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | The requirements will be missing | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 11.3.2 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  |  | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS38.141-2 | | |
| ***(show related CRs)*** | |  |  | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

## 11.3 Performance requirements for PUCCH

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

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

#### 11.3.2.1 DTX to ACK probability

Apply the requirements defined in clause 8.3.1.

#### 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 | Test |
| Number of UCI information bits | 1 |
| Number of PRBs | For cases in Table 11.3.2.2.2-1 and Table 11.3.2.2.2-2: 1.  For cases in Table 11.3.2.2.2-3 and Table 11.3.2.2.2-4: 1 for 1 OFDM symbol and 2 for 2 OFDM symbols |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | N/A for 1 symbol Enabled for 2 symbols |
| 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 | 13 for 1 symbol  12 for 2 symbols |

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 to 11.3.2.2.2-4

Table 11.3.2.2.2-1: Minimum requirements for PUCCH format 0 and 60 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number | Number of | Propagation conditions and | Number of | Channel bandwidth / SNR (dB) | |
| of TX antennas | demodulation branches | correlation matrix (Annex G) | OFDM symbols | 50 MHz | 100 MHz |
| 1 | 2 | TDLA30-300 Low | 1 | 9.3 | 9.0 |
|  |  |  | 2 | 4.2 | 4.0 |

Table 11.3.2.2.2-2: Minimum requirements for PUCCH format 0 and 120 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number of | Propagation conditions and | Number of | Channel bandwidth / SNR (dB) | | |
| of TX antennas | demodulation branches | correlation matrix (Annex G) | OFDM symbols | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | TDLA30-300 Low | 1 | 9.5 | 9.2 | 9.7 |
|  |  |  | 2 | 4.1 | 3.8 | 4.0 |

Table 11.3.2.2.2-3: Minimum requirements for PUCCH format 0 and 120 kHz SCS for BS type 2-O operating FR2-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number  of TX | Number of demodulation | Propagation conditions and | Number of | Channel bandwidth / SNR (dB) |
| antennas | branches | correlation matrix (Annex G) | OFDM symbols | 100 MHz |
| 1 | 2 | TDLA30-650 Low | 1 | TBD |
|  |  |  | 2 | TBD |

Table 11.3.2.2.2-4: Minimum requirements for PUCCH format 0 and 480 kHz SCS for BS type 2-O operating FR2-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number  of TX | Number of demodulation | Propagation conditions and | Number of  OFDM | Channel bandwidth / SNR (dB) |
| antennas | branches | correlation matrix (Annex G) | symbols | 400 MHz |
| 1 | 2 | TDLA10-650 Low | 1 | TBD |
|  |  |  | 2 | TBD |

#### 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 | Test |
| Number of information bits | 2 |
| Number of PRBs | For cases in Table 11.3.2.3.1.2-1 and Table 11.3.2.3.1.2-2:1  For cases in Table 11.3.2.3.1.2-1 and Table 11.3.2.3.1.2-2:1 and 16 |
| 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 and Table 11.3.2.3.1.2‑2.

Table 11.3.2.3.1.2-1: Minimum requirements for PUCCH format 1 with 60 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and correlation matrix | Channel bandwidth / SNR (dB) | |
| antennas | Branches |  | (Annex G) | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | -1.2 | -4.2 |

Table 11.3.2.3.1.2-2: Minimum requirements for PUCCH format 1 with 120 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | | |
| of TX antennas | Demodulation Branches | Prefix | conditions and correlation matrix (Annex G) | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | -3.9 | -3.9 | -3.0 |

Table 11.3.2.3.1.2-3: Minimum requirements for PUCCH format 1 and 120 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number  of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Number of  RBs | Channel bandwidth / SNR (dB) |
| antennas | branches |  | correlation matrix (Annex G) |  | 100 MHz |
| 1 | 2 | Normal | TDLA30-650 Low | 1 | TBD |
|  |  |  |  | 16 | TBD |

Table 11.3.2.3.1.2-4: Minimum requirements for PUCCH format 1 and 480 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number  of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Number of  RBs | Channel bandwidth / SNR (dB) |
| antennas | branches |  | correlation matrix (Annex G) |  | 400 MHz |
| 1 | 2 | Normal | TDLA10-650 Low | 1 | TBD |
|  |  |  |  | 2 | TBD |

##### 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 to Table

Table 11.3.2.3.2.2-1: Minimum requirements for PUCCH format 1 with 60 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and correlation matrix | Channel bandwidth / SNR (dB) | |
| antennas | Branches |  | (Annex G) | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | -3.9 | -4.2 |

Table 11.3.2.3.2.2-2: Minimum requirements for PUCCH format 1 with 120 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | | |
| of TX antennas | Demodulation Branches | Prefix | conditions and correlation matrix (Annex G) | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | -4.7 | -4.6 | -4.6 |

Table 11.3.2.3.2.2-3: Minimum requirements for PUCCH format 1 and 120 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number  of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Number of  RBs | Channel bandwidth / SNR (dB) |
| antennas | branches |  | correlation matrix (Annex G) |  | 100 MHz |
| 1 | 2 | Normal | TDLA30-650 Low | 1 | TBD |
|  |  |  |  | 2 | TBD |

Table 11.3.2.3.2.2-4: Minimum requirements for PUCCH format 1 and 480 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number  of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Number of  RBs | Channel bandwidth / SNR (dB) |
| antennas | branches |  | correlation matrix (Annex G) |  | 400 MHz |
| 1 | 2 | Normal | TDLA10-650 Low | 1 | TBD |
|  |  |  |  | 2 | TBD |

#### 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 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | N/A |
| First PRB after frequency hopping | The largest PRB index – (Number of PRBs-1) |
| 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 |

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 center, i.e. intra-slot frequency hopping is enabled.

###### 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 to 11.3.2.4.1.2-4 for 4UCI bits.

Table 11.3.2.4.1.2-1: Minimum requirements for PUCCH format 2 with 60 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and correlation matrix | Channel bandwidth / SNR (dB) | |
| antennas | Branches |  | (Annex G) | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | 6.7 | 7.2 |

Table 11.3.2.4.1.2-2: Minimum requirements for PUCCH format 2 with 120 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | | |
| of TX antennas | Demodulation Branches | Prefix | conditions and correlation matrix (Annex G) | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | 6.6 | 6.3 | 6.6 |

**Table 11.3.2.4.1.2-3: Minimum requirements for PUCCH format 2 and 120 kHz SCS for BS type 2-O operating in FR2-2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number  **of TX** | **Number of demodulation** | **Cyclic Prefix** | **Propagation conditions and** | **Channel bandwidth / SNR (dB)** |
| **antennas** | **branches** |  | **correlation matrix (Annex G)** | **100 MHz** |
| 1 | 2 | Normal | TDLA30-650 Low | TBD |

**Table 11.3.2.4.1.2-4: Minimum requirements for PUCCH format 2 and 480 kHz SCS for BS type 2-O operating in FR2-2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number  **of TX** | **Number of demodulation** | **Cyclic Prefix** | **Propagation conditions and** | **Channel bandwidth / SNR (dB)** |
| **antennas** | **branches** |  | **correlation matrix (Annex G)** | **400 MHz** |
| 1 | 2 | Normal | TDLA10-650 Low | TBD |

##### 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 to 11.3.2.4.2.2-4 for 22 UCI bits.

Table 11.3.2.4.2.2-1: Minimum requirements for PUCCH format 2 with 60 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and correlation matrix | Channel bandwidth / SNR (dB) | |
| antennas | Branches |  | (Annex G) | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | 2.6 | 1.1 |

Table 11.3.2.4.2.2-2: Minimum requirements for PUCCH format 2 with 120 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | | |
| of TX antennas | Demodulation Branches | Prefix | conditions and correlation matrix (Annex G) | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | 1.2 | 1.2 | 1.1 |

**Table 11.3.2.4.2.2-3: Minimum requirements for PUCCH format 2 and 120 kHz SCS for BS type 2-O operating in FR2-2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number  **of TX** | **Number of demodulation** | **Cyclic Prefix** | **Propagation conditions and** | **Channel bandwidth / SNR (dB)** |
| **antennas** | **branches** |  | **correlation matrix (Annex G)** | **100 MHz** |
| 1 | 2 | Normal | TDLA30-650 Low | TBD |

**Table 11.3.2.4.2.2-4: Minimum requirements for PUCCH format 2 and 480 kHz SCS for BS type 2-O operating in FR2-2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number  **of TX** | **Number of demodulation** | **Cyclic Prefix** | **Propagation conditions and** | **Channel bandwidth / SNR (dB)** |
| **antennas** | **branches** |  | **correlation matrix (Annex G)** | **400 MHz** |
| 1 | 2 | Normal | TDLA10-650 Low | TBD |

#### 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 | Test 1 | Test 2 |
| 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 | 3 |
| Number of symbols | 14 | 4 |
| The number of UCI information bits | 16 | 16 |
| First symbol | 0 | 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 to 11.3.2.5.2-4.

Table 11.3.2.5.2-1: Required SNR for PUCCH format 3 with 60kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Number | Number of TX antennas | Number of demodulation branches | Cyclic Prefix | Propagation conditions and correlation matrix | Additional DM‑RS configuration | Channel Bandwidth / SNR (dB) | |
|  |  |  |  | (Annex G) |  | 50 MHz | 100 MHz |
| 1 | 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 1.6 | 0.7 |
|  |  |  |  |  | Additional DM-RS | 1.3 | 0.9 |
| 2 | 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 3.0 | 2.4 |

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test Number | Number of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Additional DM‑RS configuration | Channel Bandwidth / SNR (dB) | | |
|  | antennas | branches |  | correlation matrix (Annex G) |  | 50 MHz | 100 MHz | 200 MHz |
| 1 | 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 1.4 | 0.7 | 0.7 |
|  |  |  |  |  | Additional DM-RS | 1.3 | 1.4 | 0.9 |
| 2 | 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 1.1 | 2.9 | 1.4 |

**Table 11.3.2.5.2-3: Minimum requirements for PUCCH format 3 and 120 kHz SCS for BS type 2-O operating in FR2-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test | Number of | Number of | Cyclic | Propagation | Additional | Channel bandwidth / SNR (dB) |
| Number | TX antennas | Demodulation  branches | Prefix | conditions and correlation matrix (Annex G) | DM-RS configuration | 100 |
| 1 | 1 | 2 | Normal | TDLA30-650 Low | No additional DM-RS | TBD |
|  |  |  |  |  | Additional DM-RS | TBD |
| 2 | 1 | 2 | Normal | TDLA30-650 Low | No additional DM-RS | TBD |
|  |  |

**Table 11.3.2.5.2-4: Minimum requirements for PUCCH format 3 and 480 kHz SCS for BS type 2-O operating in FR2-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test | Number of | Number of | Cyclic | Propagation | Additional | Channel bandwidth / SNR (dB) |
| Number | TX antennas | Demodulation  branches | Prefix | conditions and correlation matrix (Annex G) | DM-RS configuration | 400 |
| 1 | 1 | 2 | Normal | TDLA10-650 Low | No additional DM-RS | TBD |
|  |  |  |  |  | Additional DM-RS | TBD |
| 2 | 1 | 2 | Normal | TDLA10-650 Low | No additional DM-RS | TBD |

#### 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 | For tests in Table 11.3.2.6.2-1 and Table 11.3.2.6.2-2 and test 1 in Table 11.3.2.6.2-1 and Table 11.3.2.6.2-2 : 1.  For test 2 in Table 11.3.2.6.2-3 and Table 11.3.2.6.2-4 :16 |
| 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 to 11.3.2.6.2-4.

Table 11.3.2.6.2-1: Required SNR for PUCCH format 4 with 60 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic Prefix | Propagation conditions and correlation matrix | Additional DM‑RS configuration | Channel Bandwidth / SNR (dB) | |
|  |  |  | (Annex G) |  | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 3.0 | 2.7 |
|  |  |  |  | Additional DM-RS | 3.1 | 3.5 |

Table 11.3.2.6.2-2: Required SNR for PUCCH format 4 with 120 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Additional DM‑RS configuration | Channel Bandwidth / SNR (dB) | | |
| antennas | branches |  | correlation matrix (Annex G) |  | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 2.8 | 2.8 | 3.5 |
|  |  |  |  | Additional DM-RS | 3.6 | 3.8 | 3.2 |

**Table 11.3.2.6.2-3: Minimum requirements for PUCCH format 4 and 120 kHz SCS for BS type 2-O operating in FR2-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test | Number of | Number of | Cyclic | Propagation | Additional | Channel bandwidth / SNR (dB) |
| Number | TX antennas | Demodulation  branches | Prefix | conditions and correlation matrix (Annex G) | DM-RS configuration | 100 |
| 1 | 1 | 2 | Normal | TDLA30-650 Low | No additional DM-RS | TBD |
|  |  |  |  |  | Additional DM-RS | TBD |
| 2 | 1 | 2 | Normal | TDLA30-650 Low | No additional DM-RS | TBD |
|  |  | Additional DM-RS | TBD |

**Table 11.3.2.6.2-4: Minimum requirements for PUCCH format 4 and 480 kHz SCS for BS type 2-O operating in FR2-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test | Number of | Number of | Cyclic | Propagation | Additional | Channel bandwidth / SNR (dB) |
| Number | TX antennas | Demodulation  branches | Prefix | conditions and correlation matrix (Annex G) | DM-RS configuration | 400 |
| 1 | 1 | 2 | Normal | TDLA10-650 Low | No additional DM-RS | TBD |
|  |  |  |  |  | Additional DM-RS | TBD |
| 2 | 1 | 2 | Normal | TDLA10-650 Low | No additional DM-RS | TBD |
|  |  | Additional DM-RS | TBD |