**3GPP TSG-RAN4 Meeting #104-eR4-2214391**

**Electronic Meeting, August 15 – August 26, 2022**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.104** | **CR** | **0402** | **rev** | **-** | **Current version:** | **17.6.0** |  |
|  | | | | | | | | |
| *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 | **X** | Radio Access Network |  | Core Network |  |

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|  | | | | | | | | | | |
| ***Title:*** | Big CR for coverage enhancement performance requirements for TS38.104 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | China Telecom | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_cov\_enh-Perf | | | | |  | ***Date:*** | | | 2022-08-30 |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***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:*** | | RAN4 has agreed to introduce BS performance requirements for coverage enhancement including PUSCH TBoMS, PUCCH DMRS bundling and PUSCH DMRS bundling. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Big CR to include changes from the following endorsed draft CRs:   1. R4-2214760 2. R4-2214798 3. R4-2214837 4. R4-2214849 | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | There will be no requirements for for coverage enhancement including PUSCH TBoMS, PUCCH DMRS bundling and PUSCH DMRS bundling. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 8.2, 8.3, 11.2, 11.3, A.3, A3.B | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | | **x** |  | Test specifications | | | | TS 38.141-1, TS 38.141-2 | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | | This big CR is for endorsement only. | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

*-----------------Start Change 1---------------------*

8.2.12 Requirements for PUSCH TB over multi slots (TBoMS)

8.2.12.1 General

The performance requirement of PUSCH TBoMS 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: 8.2.12.1-1 Test parameters for testing PUSCH TBoMS**

|  |  |  |
| --- | --- | --- |
| **Parameter** | | **Value** |
| Transform precoding | | Disabled |
| Channel bandwidth | | 15 kHz SCS: 5MHz  30 kHz SCS: 5MHz |
| Default TDD UL-DL pattern (Note 1) | | 15 kHz SCS:  3D1S1U, S=10D:2G:2U  30 kHz SCS:  7D1S2U, S=6D:4G:4U |
| 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 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 |
| Number of slots allocated for TBoMS PUSCH | 8 for FDD 2 for TDD |
| Number of repetitions of a single TBoMS | 1 |
| Frequency domain resource assignment | RB assignment | 5 RB |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| Note 1: The same requirements are applicable to TDD with different UL-DL pattern. | | |

8.2.12.2 Minimum requirements

The throughput shall be equal to or larger than the fraction of maximum throughput for the FRCs stated in tables 8.2.12.2-1 to 8.2.12.2-4 at the given SNR. FRCs are defined in annex A.

**Table 8.2.12.2-1: Minimum requirements for PUSCH TBoMS, Type A, 15 kHz SCS**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of RX antennas** | **Cyclic prefix** | **Duplex** | **Propagation conditions and correlation matrix (Annex G)** | **Fraction of maximum throughput** | **FRC (Annex A)** | **Additional DM-RS position** | **SNR**  **(dB)** |
| 1 | 2 | Normal | FDD | TDLB100-400 Low | 70% | G-FR1-A3-36 | pos1 | [TBD] |
| 1 | 2 | Normal | TDD | TDLB100-400 Low | 70% | G-FR1-A3-35 | pos1 | [-3.0] |

**Table 8.2.12.2-2: Minimum requirements for PUSCH TBoMS, Type A, 30 kHz SCS**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of RX antennas** | **Cyclic prefix** | **Duplex** | **Propagation conditions and correlation matrix (Annex G)** | **Fraction of maximum throughput** | **FRC (Annex A)** | **Additional DM-RS position** | **SNR**  **(dB)** |
| 1 | 2 | Normal | FDD | TDLB100-400 Low | 70% | G-FR1-A3-38 | pos1 | [TBD] |
| 1 | 2 | Normal | TDD | TDLB100-400 Low | 70% | G-FR1-A3-37 | pos1 | [-2.9] |

**Table 8.2.12.2-3: Minimum requirements for PUSCH TBoMS, Type B, 15 kHz SCS**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of RX antennas** | **Cyclic prefix** | **Duplex** | **Propagation conditions and correlation matrix (Annex G)** | **Fraction of maximum throughput** | **FRC (Annex A)** | **Additional DM-RS position** | **SNR**  **(dB)** |
| 1 | 2 | Normal | FDD | TDLB100-400 Low | 70% | G-FR1-A3-36 | pos1 | [TBD] |
| 1 | 2 | Normal | TDD | TDLB100-400 Low | 70% | G-FR1-A3-35 | pos1 | [-3.0] |

**Table 8.2.12.2-4: Minimum requirements for PUSCH TBoMS, Type B, 30 kHz SCS**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of RX antennas** | **Cyclic prefix** | **Duplex** | **Propagation conditions and correlation matrix (Annex G)** | **Fraction of maximum throughput** | **FRC (Annex A)** | **Additional DM-RS position** | **SNR**  **(dB)** |
| 1 | 2 | Normal | FDD | TDLB100-400 Low | 70% | G-FR1-A3-38 | pos1 | [TBD] |
| 1 | 2 | Normal | TDD | TDLB100-400 Low | 70% | G-FR1-A3-37 | pos1 | [-3.0] |

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

#### 8.2.13.1 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: 8.2.13.1-1 Test parameters for testing PUSCH with DM-RS bundling

|  |  |  |
| --- | --- | --- |
| Parameter | | Value |
| Transform precoding | | Disabled |
| Example UL-DL pattern [Note 1] | | 15 kHz SCS: FDD and TDD  7D1S2U, S=6D:4G:4U  30 kHz SCS: FDD and TDD  7D1S2U, S=6D:4G:4U |
| HARQ | Maximum number of HARQ transmissions | 4 |
| RV sequence | 0, 0, 0, 0 for FDD  0, 3, 0, 3 [Note 2] for TDD |
| DM-RS | DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS position | pos0, 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 | n8 for FDD  n2 for TDD |
| pusch-TimeDomainWindowLength | | 8 slots for FDD  2 slots for TDD |
| Frequency domain resource assignment | RB assignment | Full applicable test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| Note 1: The same TDD requirements are applicable to different UL-DL patterns with more than one consecutive UL slots when both pusch-TimeDomainWindowLength and PUSCH aggregation factor are configured as 2 slots. The UL (re)transmission of PUSCH is only scheduled for the actual TDW including 2 consecutive UL slots..  Note 2: The effective RV sequence is {0, 2, 3, 1} with slot aggregation. | | |

#### 8.2.13.2 Minimum requirements

The throughput shall be equal to or larger than the fraction of maximum throughput for the FRCs stated in tables 8.2.13.2-1 to 8.2.13.2-8 at the given SNR for 1Tx. FRCs are defined in annex A.

Table 8.2.13.2-1: Minimum requirements for PUSCH, Type A, 5 MHz channel bandwidth, 15 kHz SCS FDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC (Annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 4 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 8 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |

Table 8.2.13.2-2: Minimum requirements for PUSCH, Type A, 5 MHz channel bandwidth, 15 kHz SCS TDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC (Annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 4 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 8 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |

Table 8.2.13.2-3: Minimum requirements for PUSCH, Type A, 10 MHz channel bandwidth, 30 kHz SCS FDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC (Annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 4 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 8 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |

Table 8.2.13.2-4: Minimum requirements for PUSCH, Type A, 10 MHz channel bandwidth, 30 kHz SCS TDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC (Annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 4 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 8 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |

Table 8.2.13.2-5: Minimum requirements for PUSCH, Type B, 5 MHz channel bandwidth, 15 kHz SCS FDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC (Annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 4 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 8 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |

Table 8.2.13.2-6: Minimum requirements for PUSCH, Type B, 5 MHz channel bandwidth, 15 kHz SCS TDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC (Annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 4 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 8 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |

Table 8.2.13.2-7: Minimum requirements for PUSCH, Type B, 10 MHz channel bandwidth, 30 kHz SCS FDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC (Annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 4 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 8 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |

Table 8.2.13.2-8: Minimum requirements for PUSCH, Type B, 10 MHz channel bandwidth, 30 kHz SCS TDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC (Annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 4 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |
| 8 | Normal | TDLA30-10 Low | 70% | G-FR1-Ax-y | pos0 | TBD |
| pos1 | TBD |

*-----------------End Change 1---------------------*

*-----------------Start Change 2---------------------*

### 8.3.12 Performance requirements for PUCCH format 1 with DM-RS bundling

#### 8.3.12.1 NACK to ACK requirements

##### 8.3.12.1.1 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.

The NACK to ACK detection probability performance requirement only apply to PUCCH format 1 with 2 UCI bits. The UCI information only contain ACK/NACK information.

The 2bits UCI information is further defined with bitmap as [0 1].

Table 8.3.12.1.1-1: Test Parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Test 1 | Test 2 |
| Example TDD UL-DL pattern (Note1) | 15 kHz SCS:  7D1S1U, S=6D:4G:4U  30 kHz SCS:  7D1S2U, S=6D:4G:4U | 15 kHz SCS:  7D1S1U, S=6D:4G:4U  30 kHz SCS:  7D1S2U, S=6D:4G:4U |
| Number of information bits | 2 | 2 |
| Number of PRBs | 1 | 1 |
| Number of symbols | 14 | 14 |
| First PRB prior to frequency hopping | 0 | 0 |
| Intra-slot frequency hopping | diable | diable |
| Group and sequence hopping | neither | neither |
| Hopping ID | 0 | 0 |
| Initial cyclic shift | 0 | 0 |
| First symbol | 0 | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 | 0 |
| Number of slots for PUCCH repetition | 2 | 8 |
| PUCCH-TimeDomainWindowLength | 2 | 8 |
| Note 1: The same TDD requirements are applicable to different UL-DL patterns with more than one consecutive UL slots when both pucch-TimeDomainWindowLength and PUCCH aggregation factor are configured as 2 slots.  The UL (re)transmission of PUCCH is only scheduled for the actual TDW including 2 consecutive UL slots. | | |

##### 8.3.12.1.2 Minimum requirements

The NACK to ACK probability shall not exceed 0.1% at the SNR given in table 8.3.12.1.2-1 and table 8.3.12.1.2-2

Table 8.3.12.1.2-1: Minimum requirements for PUCCH format 1 with DMRS bundling, 15 kHz SCS, 5MHz channel bandwidth,

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test number | Number of Tx antennas | Number of RX antennas | Cyclic-Prefix | Propagation conditions and correlation matrix (Annex G) | SNR (dB) |
| 1 | 1 | 2 | Normal | TDLA30-10 Low | TBD |
| 2 | 1 | 2 | Normal | TDLA30-10 Low | TBD |

Table 8.3.12.1.2-2: Minimum requirements for PUCCH format 1 with DMRS bundling, 30 kHz SCS, 10MHz channel bandwidth,

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test number | Number of Tx antennas | Number of RX antennas | Cyclic-Prefix | Propagation conditions and correlation matrix (Annex G) | SNR (dB) |
| 1 | 1 | 2 | Normal | TDLA30-10 Low | TBD |
| 2 | 1 | 2 | Normal | TDLA30-10 Low | TBD |

#### 8.3.12.2 ACK missed detection requirements

##### 8.3.12.2.1 General

The ACK missed detection probability is the probability of not detecting an ACK when an ACK was sent. The test parameters in table 8.3.12.1.1-1 are configured.

The ACK missed detection probability performance requirement only apply to PUCCH format 1 with 2 UCI bits. The UCI information only contain ACK/NACK information.

The 2bits UCI information is further defined with bitmap as [0 1].

##### 8.3.12.2.2 Minimum requirements

The ACK missed detection probability shall not exceed 1% at the SNR given in table 8.3.12.2.2-1 and table 8.3.12.2.2-2

Table 8.3.12.2.2-1: Minimum requirements for PUCCH format 1 with DMRS bundling, 15 kHz SCS, 5MHz channel bandwidth,

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test number | Number of Tx antennas | Number of RX antennas | Cyclic-Prefix | Propagation conditions and correlation matrix (Annex G) | SNR (dB) |
| 1 | 1 | 2 | Normal | TDLA30-10 Low | TBD |
| 2 | 1 | 2 | Normal | TDLA30-10 Low | TBD |

Table 8.3.12.2.2-2: Minimum requirements for PUCCH format 1 with DMRS bundling, 30 kHz SCS, 10MHz channel bandwidth,

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test number | Number of Tx antennas | Number of RX antennas | Cyclic-Prefix | Propagation conditions and correlation matrix (Annex G) | SNR (dB) |
| 1 | 1 | 2 | Normal | TDLA30-10 Low | TBD |
| 2 | 1 | 2 | Normal | TDLA30-10 Low | TBD |

### 8.3.13 Performance requirements for PUCCH format 3 with DMRS bundling

#### 8.3.13.1 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.

Table 8.3.13.1-1: Test Parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Test 1 | Test 2 |
| Eample TDD UL-DL pattern (Note1) | 15 kHz SCS:  7D1S1U, S=6D:4G:4U  30 kHz SCS:  7D1S2U, S=6D:4G:4U | 15 kHz SCS:  7D1S1U, S=6D:4G:4U  30 kHz SCS:  7D1S2U, S=6D:4G:4U |
| Modulation order | QPSK | QPSK |
| First PRB prior to frequency hopping | 0 | 0 |
| Intra-slot frequency hopping | disabled | disabled |
| Group and sequence hopping | neither | neither |
| Hopping ID | 0 | 0 |
| Number of PRBs | 1 | 1 |
| Number of symbols | 14 | 14 |
| The number of UCI information bits | 16 | 16 |
| First symbol | 0 | 0 |
| Number of slots for PUCCH repetition | 2 | 8 |
| PUCCH-TimeDomainWindowLength | 2 | 8 |
| Note 1: The same TDD requirements are applicable to different UL-DL patterns with more than one consecutive UL slots when both pucch-TimeDomainWindowLength and PUCCH aggregation factor are configured as 2 slots.  The UL (re)transmission of PUCCH is only scheduled for the actual TDW including 2 consecutive UL slots. | | |

#### 8.3.13.2 Minimum requirements

The UCI block error probability shall not exceed 1% at the SNR given in Table 8.3.5.2-1 and Table 8.3.5.2-2.

Table 8.3.13.2-1: Minimum requirements for PUCCH format 3 with DMRS bundling, 15 kHz SCS, 5MHz channel bandwidth

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test | Number of | Number of | Cyclic | Propagation | Additional | Channel bandwidth / SNR (dB) |
| Number | TX antennas | RX antennas | Prefix | conditions and correlation matrix (Annex G) | DM-RS configuration | 5 MHz |
| 1 | 1 | 2 | Normal | TDLC30-10 Low | No additional DM-RS | TBD |
| Additional DM-RS | TBD |
| 2 | 1 | 2 | Normal | TDLC30-10 Low | No additional DM-RS | TBD |
| Additional DM-RS | TBD |

Table 8.3.13.2-2: Minimum requirements for PUCCH format 3 with DMRS bundling, 30 kHz SCS, 10MHz channel bandwidth

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test | Number of | Number of | Cyclic | Propagation | Additional | Channel bandwidth / SNR (dB) |
| Number | TX antennas | RX antennas | Prefix | conditions and correlation matrix (Annex G) | DM-RS configuration | 10 MHz |
| 1 | 1 | 2 | Normal | TDLC30-10 Low | No additional DM-RS | TBD |
| Additional DM-RS | TBD |
| 2 | `1 | 2 | Normal | TDLC30-10 Low | No additional DM-RS | TBD |
| Additional DM-RS | TBD |

*-----------------End Change 2---------------------*

*-----------------Start Change 3---------------------*

11.2.1.12 Requirements for PUSCH TB over multi slots (TBoMS)

Apply the requirements defined in clause 8.2.12 for 2Rx.

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

Apply the requirements for 2Rx defined in clause 8.2.13 for 2Rx.

*-----------------End Change 3---------------------*

*-----------------Start Change 4---------------------*

11.3.1.8 Performance requirements for PUCCH format 1 with DMRS bundling

Apply the requirements defined in clause 8.3.12 for 2Rx.

11.3.1.9 Performance requirements for PUCCH format 1 with DMRS bundling

Apply the requirements defined in clause 8.3.13 for 2Rx.

*-----------------End Change 4---------------------*

*-----------------Start Change 5---------------------*

11.2.2.9 Requirements for PUSCH TB over multi slots (TBoMS)

11.2.2.9.1 General

The performance requirement of PUSCH TBoMS 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. The performance requirements are applicable for FR2-1 only.

**Table 11.2.2.9.1-1: Test parameters for testing PUSCH TBoMS**

|  |  |  |
| --- | --- | --- |
| **Parameter** | | **Value** |
| Transform precoding | | Disabled |
| Channel bandwidth | | 60 kHz SCS: 50MHz  120 kHz SCS: 50MHz |
| Default TDD UL-DL pattern (Note 1) | | 60 kHz and 120kHz SCS:  3D1S1U, S=10D:2G:2U |
| 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 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 | B |
| Start symbol | 0 |
| Allocation length | 14 |
| Number of slots allocated for TBoMS PUSCH | 2 |
| Number of repetitions of a single TBoMS | 1 |
| Frequency domain resource assignment | RB assignment | 5 RB |
| 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 same requirements are applicable to TDD with different UL-DL pattern. | | |

11.2.2.9.2 Minimum requirements

The throughput shall be equal to or larger than the fraction of maximum throughput for the FRCs stated in tables 11.2.2.9.2-1 to 11.2.2.9.2-2 at the given SNR. FRCs are defined in annex A.

**Table 11.2.2.9.2-1: Minimum requirements for PUSCH TBoMS, Type B, 60 kHz SCS**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of RX antennas** | **Cyclic prefix** | **Duplex** | **Propagation conditions and correlation matrix (Annex G)** | **Fraction of maximum throughput** | **FRC (Annex A)** | **Additional DM-RS position** | **SNR**  **(dB)** |
| 1 | 2 | Normal | TDD | TDLA30-300 Low | 70% | G-FR2-A3-27 | pos1 | [-2.3] |

**Table 11.2.2.9.2-2: Minimum requirements for PUSCH TBoMS, Type B, 120 kHz SCS**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of TX antennas** | **Number of RX antennas** | **Cyclic prefix** | **Duplex** | **Propagation conditions and correlation matrix (Annex G)** | **Fraction of maximum throughput** | **FRC (Annex A)** | **Additional DM-RS position** | **SNR**  **(dB)** |
| 1 | 2 | Normal | TDD | TDLA30-300 Low | 70% | G-FR2-A3-29 | pos1 | [-2.2] |

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

##### 11.2.2.10.1 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 11.2.2.10.1-1: Test parameters for testing PUSCH with DM-RS bundling

|  |  |  |
| --- | --- | --- |
| Parameter | | Value |
| Transform precoding | | Disabled |
| Example TDD UL-DL pattern (Note 1) | | 60 kHz and 120kHz SCS:  DDSUU or DSUUU, S=10D:2G:2U |
| HARQ | Maximum number of HARQ transmissions | 4 |
|  | RV sequence | 0, 3, 0,3 (Note 2) |
| 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 | PUSCH mapping type | B |
| resource | Start symbol index | 0 |
|  | Allocation length | 14 |
|  | PUSCH aggregation factor | n2 |
| pusch-TimeDomainWindowLength | | 2 slots |
| Frequency domain | RB assignment | Full applicable test bandwidth |
| resource | Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| PT-RS | Frequency density (*KPT-RS*) | Disabled |
| configuration | Time density (*LPT-RS*) | Disabled |
| NOTE 1: The same TDD requirements are applicable to different UL-DL patterns with more than one consecutive UL slots when both pusch-TimeDomainWindowLength and PUSCH aggregation factor are configured as 2 slots. The UL (re)transmission of PUSCH is only scheduled for the actual TDW including 2 consecutive UL slots.  NOTE 2: The effective RV sequence is {0,2,3,1} with slot aggregation. | | |

##### 11.2.2.10.2 Minimum requirements

The throughput shall be equal to or larger than the fraction of maximum throughput stated in the tables 11.2.2.10.2-1 and 11.2.2.10.2-2 at the given SNR for 1Tx. FRCs are defined in annex A. Unless stated otherwise, the MIMO correlation matrices for the gNB are defined in annex G for low correlation.

Table 11.2.2.10.2-1: Minimum requirements for PUSCH, TypeB, 50 MHz channel bandwidth, 60 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC  (Annex A) | Additional  DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-75 | 70% | G-FR2-Ax-y | pos1 | TBD |

Table 11.2.2.10.2-2: Minimum requirements for PUSCH, TypeB, 50 MHz channel bandwidth, 120 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic prefix | Propagation conditions and correlation matrix (Annex G) | Fraction of maximum throughput | FRC  (Annex A) | Additional  DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-75 | 70% | G-FR2-Ax-y | pos1 | TBD |

*-----------------End Change 5---------------------*

*-----------------Start Change 6---------------------*

### 11.3.2.7 Performance requirements for PUCCH format 1 with DMRS bundling

#### 11.3.2.7.1 NACK to ACK requirements

##### 11.3.2.7.1.1 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.

The NACK to ACK detection probability performance requirement only apply to PUCCH format 1 with 2 UCI bits. The UCI information only contain ACK/NACK information.

The 2bits UCI information is further defined with bitmap as [0 1].

Table 11.3.2.7.1.1-1: Test Parameters

|  |  |
| --- | --- |
| Parameter | Test |
| Example TDD UL-DL pattern (Note1) | 60 kHz SCS:  DDSUU, S=10D:2G:2U or DSUUU  120 kHz SCS:  DDSUU, S=10D:2G:2U, DSUUU or DSUUU |
| Number of information bits | 2 |
| Number of PRBs | 1 |
| Number of symbols | 14 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | diable |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 |
| Number of slots for PUCCH repetition | 2 |
| PUCCH-TimeDomainWindowLength | 2 |
| Note 1: The same TDD requirements are applicable to different UL-DL patterns with more than one consecutive UL slots when both pucch-TimeDomainWindowLength and PUCCH aggregation factor are configured as 2 slots.  The UL (re)transmission of PUCCH is only scheduled for the actual TDW including 2 consecutive UL slots. | |

##### 11.3.2.7.1.2 Minimum requirements

The NACK to ACK probability shall not exceed 0.1% at the SNR given in table 11.3.2.7.1.2-1 and table 11.3.2.7.1.2-2

Table 11.3.2.7.1.2-1: Minimum requirements for PUCCH format 1 with DMRS bundling, 60 kHz SCS, 50MHz channel bandwidth

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Tx antennas | Number of demodulation branches | Cyclic-Prefix | Propagation conditions and correlation matrix (Annex G) | SNR (dB) |
| 1 | 2 | Normal | TDLA30-75 Low | TBD |

Table 11.3.2.7.1.2-2: Minimum requirements for PUCCH format 1 with DMRS bundling, 120 kHz SCS, 50MHz channel bandwidth

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Tx antennas | Number of demodulation branches | Cyclic-Prefix | Propagation conditions and correlation matrix (Annex G) | SNR (dB) |
| 1 | 2 | Normal | TDLA30-75 Low | TBD |

#### 11.3.2.7.2 ACK missed detection requirements

##### 11.3.2.7.2.1 General

The ACK missed detection probability is the probability of not detecting an ACK when an ACK was sent. The test parameters in table 11.3.2.7.2.1-1 are configured.

The ACK missed detection probability performance requirement only apply to PUCCH format 1 with 2 UCI bits. The UCI information only contain ACK/NACK information.

The 2bits UCI information is further defined with bitmap as [0 1].

##### 11.3.2.7.2.2 Minimum requirements

The ACK missed detection probability shall not exceed 1% at the SNR given in table 11.3.2.7.2.2-1 to table 11.3.2.7.2.2-2

Table 11.3.2.7.2.2-1: Minimum requirements for PUCCH format 1 with JCE, 60 kHz SCS, 50MHz channel bandwidth

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Number | Number of Tx antennas | Number of demodulation branches | Cyclic-Prefix | Propagation conditions and correlation matrix (Annex G) | SNR (dB) |
| 1 | 1 | 2 | Normal | TDLA30-75 Low | TBD |

Table 11.3.2.7.2.2-1: Minimum requirements for PUCCH format 1 with JCE, 120 kHz SCS, 100MHz channel bandwidth

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Number | Number of Tx antennas | Number of demodulation branches | Cyclic-Prefix | Propagation conditions and correlation matrix (Annex G) | SNR (dB) |
| 1 | 1 | 2 | Normal | TDLA30-75 Low | TBD |

### 11.3.2.8 Performance requirements for PUCCH format 3 with DMRS bunding

#### 11.3.2.8.1 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.

Table 11.3.2.8.1-1: Test Parameters

|  |  |
| --- | --- |
| Parameter | Test 1 |
| Example TDD UL-DL pattern (Note 1) | 60 kHz SCS:  DDSUU, S=10D:2G:2U or DSUUU  120 kHz SCS:  DDSUU, S=10D:2G:2U or DSUUU |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | disabled |
| 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 |
| Number of slots for PUCCH repetition | 2 |
| PUCCH-TimeDomainWindowLength | 2 |
| Note 1: The same TDD requirements are applicable to different UL-DL patterns with more than one consecutive UL slots when both pucch-TimeDomainWindowLength and PUCCH aggregation factor are configured as 2 slots.  The UL (re)transmission of PUCCH is only scheduled for the actual TDW including 2 consecutive UL slots. | |

#### 11.3.2.8.2 Minimum requirements

The UCI block error probability shall not exceed 1% at the SNR given in Table 11.3.2.8.2-1 and Table 11.3.2.8.2-2.

Table 11.3.2.8.2-1: Minimum requirements for PUCCH format 3 with JCE, 60 kHz SCS, 50MHz channel bandwidth

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 | 50 MHz |
| 1 | 1 | 2 | Normal | TDLA30-75 Low | No additional DM-RS | TBD |
| Additional DM-RS | TBD |

Table 11.3.2.8.2-2: Minimum requirements for PUCCH format 3 with JCE, 120 kHz SCS, 50MHz channel bandwidth

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 | 50 MHz |
| 1 | 1 | 2 | Normal | TDLA30-75 Low | No additional DM-RS | TBD |
| Additional DM-RS | TBD |

*-----------------End Change 6---------------------*

*-----------------Start Change 7---------------------*

# A.3 Fixed Reference Channels for performance requirements (QPSK, R=193/1024)

The parameters for the reference measurement channels are specified in table A.3-2, table A.3-2A, table A.3-4, and table A.3-6 for FR1 PUSCH performance requirements:

- FRC parameters are specified in table A.3-2 for FR1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

- FRC parameters are specified in table A.3-2A for FR1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos2* and 1 transmission layer.

- FRC parameters are specified in table A.3-4 for FR1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers.

- FRC parameters are specified in table A.3-6 for FR1 PUSCH with transform precoding enabled, *Additional DM-RS position = pos1* and 1 transmission layer.

The parameters for the reference measurement channels are specified in table A.3-X1 for FR1 PUSCH performance requirements for TBoMS:

- FRC parameters are specified in table A.3-X1 for FR1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

The parameters for the reference measurement channels are specified in table A.3-7 to table A.3-12 for FR2 PUSCH performance requirements:

- FRC parameters are specified in table A.3-7 for FR2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer.

- FRC parameters are specified in table A.3-8 for FR2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layers.

- FRC parameters are specified in table A.3-9 for FR2 PUSCH with transform precoding enabled, *Additional DM-RS position = pos0* and 1 transmission layer.

- FRC parameters are specified in table A.3-10 for FR2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

- FRC parameters are specified in table A.3-11 for FR2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers.

- FRC parameters are specified in table A.3-12 for FR2 PUSCH with transform precoding enabled, *Additional DM-RS position = pos1* and 1 transmission layer.

The parameters for the reference measurement channels are specified in table A.3-13 for FR2 PUSCH performance requirements for 2-step RA type:

- FRC parameters are specified in table A.3-13 for FR2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

The parameters for the reference measurement channels are specified in table A.3-X2 for FR2 PUSCH performance requirements for TBoMS:

- FRC parameters are specified in table A.3-X2 for FR2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

*-----------------Unchanged part skipped---------------------*

Table A.3-13: FRC parameters for FR2 PUSCH performance requirements, transform precoding disabled, Additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=193/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR2-A3-25 | G-FR2-A3-26 |
| Subcarrier spacing [kHz] | 60 | 120 |
| Allocated resource blocks | 2 | 2 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 193/1024 | 193/1024 |
| Payload size (bits) | 72 | 72 |
| Transport block CRC (bits) | 16 | 16 |
| Code block CRC size (bits) | 0 | 0 |
| Number of code blocks - C | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 88 | 88 |
| Total number of bits per slot | 384 | 384 |
| Total number of symbols per slot | 192 | 192 |
| 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 with l0= 2 as per Table 6.4.1.1.3-3 of TS 38.211 [9].  NOTE 2: Code block size including CRC (bits) equals to K' in sub-clause 5.2.2 of TS 38.212 [15]. | | |

Table A.3-X1: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, Additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=193/1024)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A3-35 | G-FR1-A3-36 | G-FR1-A3-37 | G-FR1-A3-38 |
| Number of TBoMS slots | 2 | 4 | 2 | 4 |
| Subcarrier spacing [kHz] | 15 | 15 | 30 | 30 |
| Allocated resource blocks per slot | 5 | 5 | 5 | 5 |
| Data bearing CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 |
| Modulation | QPSK | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 193/1024 | 193/1024 | 193/1024 | 193/1024 |
| Payload size (bits) | 552 | 1128 | 552 | 1128 |
| 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) | 568 | 1144 | 568 | 1144 |
| Total number of bits over all TBoMS slots | 2880 | 5760 | 2880 | 5760 |
| Total resource elements over all TBoMS slots | 1440 | 2880 | 1440 | 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 with l0= 2 as per Table 6.4.1.1.3-3 of TS 38.211 [9].  NOTE 2: Code block size including CRC (bits) equals to K' in sub-clause 5.2.2 of TS 38.212 [15]. | | | | |

Table A.3-X2: FRC parameters for FR2 PUSCH performance requirements, transform precoding disabled, Additional DM-RS position = pos1 and 1 transmission layer (QPSK, R=193/1024)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference channel | G-FR2-A3-27 | G-FR2-A3-28 | G-FR2-A3-29 | G-FR2-A3-30 |
| Number of TBoMS slots | 2 | 4 | 2 | 4 |
| Subcarrier spacing [kHz] | 60 | 60 | 120 | 120 |
| Allocated resource blocks per slot | 5 | 5 | 5 | 5 |
| Data bearing CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 |
| Modulation | QPSK | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 193/1024 | 193/1024 | 193/1024 | 193/1024 |
| Payload size (bits) | 552 | 1128 | 552 | 1128 |
| 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) | 568 | 1144 | 568 | 1144 |
| Total number of bits over all TBoMS slots | 2880 | 5760 | 2880 | 5760 |
| Total resource elements over all TBoMS slots | 1440 | 2880 | 1440 | 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 with l0= 2 as per Table 6.4.1.1.3-3 of TS 38.211 [9].  NOTE 2: Code block size including CRC (bits) equals to K' in sub-clause 5.2.2 of TS 38.212 [15]. | | | | |

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

*-----------------End Change 7---------------------*

*-----------------Start Change 8---------------------*

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

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

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

The parameters for the reference measurement channel are specified in table A.3B-Y1 for FR1 PUSCH performance requirements for JCE:

- FRC parameters are specified in table A.3B-Y1 for FR1 PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer.

- FRC parameters are specified in table A.3B-Y2 for FR1 PUSCH with transform precoding disabled, additional DM-RS position = pos0 and 1 transmission layer.

The parameters for the reference measurement channel are specified in table A.3B-Y3 for FR2 PUSCH performance requirements for JCE:

- FRC parameters are specified in table A.3B-Y3 for FR2 PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 1 transmission layer.

Table A.3B-1: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, additional DM-RS position = pos0 and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A3B-1 | G-FR1-A3B-2 | G-FR1-A3B-3 | G-FR1-A3B-4 |
| Subcarrier spacing (kHz) | 15 | 15 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 24 | 106 |
| Data bearing CP-OFDM Symbols per slot (Note 1) | 1 | 1 | 1 | 1 |
| Modulation | QPSK | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 | 308/1024 | 308/1024 |
| Payload size (bits) | 176 | 368 | 168 | 768 |
| 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) | 192 | 384 | 184 | 784 |
| Total number of bits per slot | 600 | 1248 | 576 | 2544 |
| Total resource elements per slot | 300 | 624 | 288 | 1272 |
| 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 = pos0, *l0* = 0 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [9].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [15].. | | | | |

Table A.3B-Y1: 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-FR2-A3B-5 | G-FR2-A3B-6 |
| Subcarrier spacing [kHz] | 15 | 30 |
| Allocated resource blocks | TBD | TBD |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 |
| Payload size (bits) | TBD | TBD |
| Transport block CRC (bits) | TBD | TBD |
| Code block CRC size (bits) | TBD | TBD |
| Number of code blocks - C | TBD | TBD |
| Code block size including CRC (bits) (Note 2) | TBD | TBD |
| Total number of bits per slot | TBD | TBD |
| Total resource elements per slot | TBD | TBD |
| 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* with *l0*= 0 as per Table 6.4.1.1.3-3 of TS 38.211 [9].  NOTE 2: Code block size including CRC (bits) equals to *K'* in sub-clause 5.2.2 of TS 38.212 [15]. | | |

Table A.3B-Y2: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR2-A3B-7 | G-FR2-A3B-8 |
| Subcarrier spacing [kHz] | 15 | 30 |
| Allocated resource blocks | 25 | 24 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 |
| Payload size (bits) | TBD | TBD |
| Transport block CRC (bits) | TBD | TBD |
| Code block CRC size (bits) | TBD | TBD |
| Number of code blocks - C | TBD | TBD |
| Code block size including CRC (bits) (Note 2) | TBD | TBD |
| Total number of bits per slot | TBD | TBD |
| Total resource elements per slot | TBD | TBD |
| 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* with *l0*= 0 as per Table 6.4.1.1.3-3 of TS 38.211 [9].  NOTE 2: Code block size including CRC (bits) equals to *K'* in sub-clause 5.2.2 of TS 38.212 [15]. | | |

Table A.3B-Y3: FRC parameters for FR2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR2-A3B-1 | G-FR2-A3-2 |
| Subcarrier spacing [kHz] | 60 | 120 |
| Allocated resource blocks | 66 | 32 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 |
| Payload size (bits) | 5632 | 2792 |
| Transport block CRC (bits) | 24 | 16 |
| Code block CRC size (bits) | - | - |
| Number of code blocks - C | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 5656 | 2808 |
| Total number of bits per slot | 19008 | 9216 |
| Total resource elements per slot | 9504 | 4608 |
| 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* with *l0*= 0 and *l* =8 as per Table 6.4.1.1.3-3 of TS 38.211 [9].  NOTE 2: Code block size including CRC (bits) equals to *K'* in sub-clause 5.2.2 of TS 38.212 [15]. | | |

*-----------------End Change 8---------------------*