**3GPP TSG-RAN WG4 Meeting #104-bis-e *R4-2217516***

**Electronic, , 10th - 19th October 2022**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.104** | **CR** | **DRAFT** | **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:***  | Big draftCR to 38.104: demodulation requirements introduction for FR2-2 |
|  |  |
| ***Source to WG:*** | Nokia, Nokia Shanghai Bell |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_ext\_to\_71GHz-Perf |  | ***Date:*** | 2022-30-09 |
|  |  |  |  |  |
| ***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 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-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | Big Draft CR including changes of R4-2217376, R4-2217378, R4-2217384, R4-2217387, and R4-2217389R4-2217376* Introduction of the structure of the PUSCH requirements for FR2-2

R4-2217378* The FR2-2 PUSCH demodulation requirements are agreed to be introduced for Rel-17. The FRC table for PUSCH requirements should be added according to agreed resource allocations.

R4-2217384* Based on the work plan, RAN 4 should submit the draft CR for FR2-2 UE and BS performance requirements

R4-2217387* Introduction of the structure of the PRACH requirements for FR2-2

R4-2217389* PRACH requirement has been introuduced in Rel-17 NR extend to 71GHz WI. The test preamble and test propagation conditions are ageed
 |
|  |  |
| ***Summary of change:*** | R4-2217376* Proposal for scheleton of PUSCH requirements

R4-2217378* Following changes are added:
1. Adding FRC tables for 120kHz and 480kHz SCS with MCS4, DM-RS additional pos0 and pos1, 1 layer and precoding disabled/enabled.
2. Adding FRC tables for 120kHz and 480kHz SCS with MCS4, DM-RS additional pos0 and pos1, 2 layers and precoding disabled.
3. Adding FRC tables for 480kHz SCS with MCS16, DM-RS additional pos0 and pos1, 1 layer and precoding disabled.
4. Adding FRC tables for 480kHz SCS with MCS16, DM-RS additional pos0 and pos1, 2 layers and precoding disabled.
5. Adding FRC tables for 480kHz SCS with MCS20, DM-RS additional pos0 and pos1, 1 layer and precoding disabled.
6. Corrections on the values in previous draft CR.
7. Modify “FR2” to “FR2-1” and “FR2-2” seperately in table titles.

R4-2217384* Introduce PUCCH performance requirments in TS 38.104

R4-2217387* Proposal for scheleton of PRACH requirements

R4-2217389* Add the test PRACH premable and propagation condition
 |
|  |  |
| ***Consequences if not approved:*** | R4-2217376* No PUSCH requirements for FR2-2

R4-2217378* There will be no FRC table for FR2-2 PUSCH demodulation requirments.

R4-2217384* The requirements will be missing

R4-2217387* No PRACH requirements for FR2-2

R4-2217389* The requirement can be not verfied properly
 |
|  |  |
| ***Clauses affected:*** | R4-2217376* 11.2.2.1, 11.2.2.2

R4-2217378* A.3B, A.4, A.5

R4-2217384* 11.3.2

R4-2217387* 11.4.2.2.2 and 11.4.2.2.x (new)

R4-2217389* A.6, G.2
 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** | **X** |  |  Test specifications | TS 38.141-2  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** | New clause 11.4.2.2.x to be implemented preferably as 11.4.2.2.3. |
|  |  |
| ***This CR's revision history:*** |  |

### <Start of Change R4-2217376 - 1>

#### 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 |
| Default TDD UL-DL pattern (Note 1) | 60 kHz and 120kHz SCS:3D1S1U, S=10D:2G:2U480kHz SCS:14D2S4U, S1=12D:2G0U, S2=0D:6G:8U |
| 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 | 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(s) | {0}, {0, 1} |
|  | DM-RS sequence generation | NID=0, nSCID =0 |
| Time domain | PUSCH mapping type | B |
| resource | Start symbol index | 0  |
|  | Allocation length | 10  |
| Frequency domain | RB assignment | Full applicable test bandwidth |
| resource | Frequency hopping | Disabled |
| TPMI index for 2Tx two-layer spatial multiplexing transmission  | 0 |
| Code block group based PUSCH transmission | Disabled |
| PT-RS | Frequency density (*KPT-RS*) | 2, Disabled |
| configuration | Time density (*LPT-RS*) | 1, Disabled |
| NOTE 1: The same requirements are applicable to TDD with different UL-DL patterns |

##### 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 to 11.2.2.1.2-10 at the given SNR for 1Tx and for 2Tx two-layer spatial multiplexing transmission.

Table 11.2.2.1.2-1: Minimum requirements for PUSCH with 70% of maximum throughput, 50 MHz channel bandwidth, 60 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | PT-RS | SNR(dB) |
| 1 | 2 | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-1 | pos0 | No | -2.0 |
|  |  |  |  |  | G-FR2-A3-13 | pos1 | No | -2.2 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-1 |  pos0 | Yes | 12.0 |
|  |  |  |  |  |  |  | No | 11.5 |
|  |  |  |  |  | G-FR2-A4-11 |  pos1 | Yes | 10.7 |
|  |  |  |  |  |  |  | No | 10.7 |
|  |  | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-1 |  pos0 | Yes | 13.7 |
|  |  |  |  |  |  |  | No | 13.1 |
|  |  |  |  |  | G-FR2-A5-6 |  pos1 | Yes | 13.4 |
|  |  |  |  |  |  |  | No | 12.9 |
| 2 |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-6 |  pos0 | No | 1.5 |
|  |  |  |  |  | G-FR2-A3-18 |  pos1 | No | 1.2 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A7-1 | pos0 | Yes | 15.2 |
|  |  |  |  |  |  |  | No | 14.3 |
|  |  |  |  |  | G-FR2-A7-6 |  pos1 | Yes | 13.8 |
|  |  |  |  |  |  |  | No | 13.0 |

Table 11.2.2.1.2-2: Minimum requirements for PUSCH with 70% of maximum throughput, 100 MHz channel bandwidth, 60 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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  | PT-RS | SNR(dB) |
| 1 | 2 | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-2 | pos0 | No | -2.1 |
|  |  |  |  |  | G-FR2-A3-14 | pos1 | No | -2.4 |
|  |  |  | TDLA30-300 Low | 70 % | G-FR2-A4-2 | pos0 | Yes | 12.2 |
|  |  |  |  |  |  |  | No | 11.2 |
|  |  |  |  |  | G-FR2-A4-12 | pos1 | Yes | 11.2 |
|  |  |  |  |  |  |  | No | 10.6 |
|  |  |  | TDLA30-75 Low | 70 % | G-FR2-A5-2 | pos0 | Yes | 14.2 |
|  |  |  |  |  |  |  | No | 13.3 |
|  |  |  |  |  | G-FR2-A5-7 | pos1 | Yes | 13.7 |
|  |  |  |  |  |  |  | No | 13.1 |
| 2 |  |  | TDLA30-300 Low | 70 % | G-FR2-A3-7 | pos0 | No | 1.5 |
|  |  |  |  |  | G-FR2-A3-19 | pos1 | No | 1.2 |
|  |  |  | TDLA30-300 Low | 70 % | G-FR2-A7-2 | pos0 | Yes | 16.0 |
|  |  |  |  |  |  |  | No | 14.9 |
|  |  |  |  |  | G-FR2-A7-7 | pos1 | Yes | 13.8 |
|  |  |  |  |  |  |  | No | 13.1 |

Table 11.2.2.1.2-3: Minimum requirements for PUSCH with 70% of maximum throughput, 50 MHz channel bandwidth, 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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  | PT-RS | SNR(dB) |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-3 |  pos0 | No | -1.8 |
|  |  |  |  |  | G-FR2-A3-15 |  pos1 | No | -2.1 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-3 |  pos0 | Yes | 11.6 |
|  |  |  |  |  |  |  | No | 10.9 |
| 1 |  |  |  |  | G-FR2-A4-13 |  pos1 | Yes | 10.9 |
|  |  |  |  |  |  |  | No | 10.5 |
|  | 2 | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-3 |  pos0 | Yes | 13.7 |
|  |  |  |  |  |  |  | No | 13.1 |
|  |  |  |  |  | G-FR2-A5-8 |  pos1 | Yes | 13.2 |
|  |  |  |  |  |  |  | No | 13.0 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-8 |  pos0 | No | 1.4 |
|  |  |  |  |  | G-FR2-A3-20 |  pos1 | No | 1.3 |
| 2 |  | Normal | TDLA30-300 Low | 70 % |  G-FR2-A7-3 |  pos0 | Yes | 14.2 |
|  |  |  |  |  |  |  | No | 13.6 |
|  |  |  |  |  | G-FR2-A7-8 |  pos1 | Yes | 13.9 |
|  |  |  |  |  |  |  |  |  |

Table 11.2.2.1.2-4: Minimum requirements for PUSCH with 70% of maximum throughput, 100 MHz channel bandwidth, 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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  | PT-RS | SNR(dB) |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-4 |  pos0 | No | -2.4 |
|  |  |  |  |  | G-FR2-A3-16 |  pos1 | No | -2.5 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-4 |  pos0 | Yes | 11.9 |
|  |  |  |  |  |  |  | No | 10.5 |
| 1 |  |  |  |  | G-FR2-A4-14 |  pos1 | Yes | 11.1 |
|  |  |  |  |  |  |  | No | 10.5 |
|  | 2 | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-4 |  pos0 | Yes | 13.5 |
|  |  |  |  |  |  |  | No | 12.9 |
|  |  |  |  |  | G-FR2-A5-9 |  pos1 | Yes | 13.4 |
|  |  |  |  |  |  |  | No | 12.8 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-9 |  pos0 | No | 1.4 |
|  |  |  |  |  | G-FR21-A3-21 |  pos1 | No | 1.2 |
| 2 |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A7-4 | pos0 | Yes | 13.9 |
|  |  |  |  |  |  |  | No | 13.2 |
|  |  |  |  |  | G-FR2-A7-9 | pos1 | Yes | 13.5 |
|  |  |  |  |  |  |  | No | 12.9 |

Table 11.2.2.1.2-5: Minimum requirements for PUSCH with 70% of maximum throughput, 200 MHz channel bandwidth, 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | PT-RS | SNR(dB) |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-5 |  pos0 | No | -2.1 |
|  |  |  |  |  | G-FR2-A3-17 |  pos1 | No | -2.4 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-5 |  pos0 | Yes | 11.3 |
|  |  |  |  |  |  |  | No | 10.9 |
| 1 |  |  |  |  | G-FR2-A4-15 |  pos1 | Yes | 11.2 |
|  |  |  |  |  |  |  | No | 10.7 |
|  | 2 | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-5 |  pos0 | Yes | 14.1 |
|  |  |  |  |  |  |  | No | 13.4 |
|  |  |  |  |  | G-FR2-A5-10 |  pos1 | Yes | 13.7 |
|  |  |  |  |  |  |  | No | 13.3 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-10 |  pos0 | No | 1.4 |
|  |  |  |  |  | G-FR2-A3-22 |  pos1 | No | 1.1 |
| 2 |  | Normal | TDLA30-300 Low | 70 % |  G-FR2-A7-5 |  pos0 | Yes | 14.0 |
|  |  |  |  |  |  |  | No | 13.3 |
|  |  |  |  |  |  G-FR2-A7-10 |  pos1 | Yes | 13.6 |
|  |  |  |  |  |  |  | No | 13.0 |

Table 11.2.2.1.2-6: Minimum requirements for PUSCH with 30% of maximum throughput, 50 MHz channel bandwidth, 60 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | PT-RS | SNR(dB) |
|  |  |  |  |  | G-FR2-A4-1 | pos0 | Yes | 4.0 |
| 1 | 2 | Normal | TDLA30-300 Low | 30 % |  |  | No | 3.5 |
|  |  |  |  |  | G-FR2-A4-11 | pos1 | Yes | 3.7 |
|  |  |  |  |  |  |  | No | 3.1 |

Table 11.2.2.1.2-7: Minimum requirements for PUSCH with 30% of maximum throughput, 50 MHz channel bandwidth, 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | PT-RS | SNR(dB) |
|  |  |  |  |  | G-FR2-A4-3 | pos0 | Yes | 4.0 |
| 1 | 2 | Normal | TDLA30-300 Low | 30 % |  |  | No | 3.6 |
|  |  |  |  |  | G-FR2-A4-13 | pos1 | Yes | 3.7 |
|  |  |  |  |  |  |  | No | 3.2 |

Table 11.2.2.1.2-8: Test requirements for PUSCH with 70% of maximum throughput, 100 MHz Channel Bandwidth, 120 kHz SCS in FR2-2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | PT-RS | SNR(dB) |
| 1 | 2 | Normal | TDLA30-650 | 70 % | TBD | pos1 | [No] | TBD |
|  |  | Normal | TDLA30-650 | 70 % | TBD | pos1 | Yes | TBD |
|  |  | Normal | TDLD30-200 | 70 % | TBD | pos1 | Yes | TBD |
| 2 |  | Normal | TDLA30-650 | 70 % | TBD | pos1 | [No] | TBD |
|  |  | Normal | [TDLA30-650] | 70 % | TBD | pos1 | Yes | TBD |
|  |  | Normal | TDLD30-200 | 70 % | TBD | pos1 | Yes | TBD |

Table 11.2.2.1.2-9: Test requirements for PUSCH with 70% of maximum throughput, 400 MHz Channel Bandwidth, 120 kHz SCS in FR2-2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | PT-RS | SNR(dB) |
| 1 | 2 | Normal | TDLA10-650 | 70 % | TBD | pos1 | [No] | TBD |
|  |  | Normal | TDLA10-650 | 70 % | TBD | pos1 | Yes | TBD |
|  |  | Normal | TDLD10-200 | 70 % | TBD | pos1 | Yes | TBD |
| 2 |  | Normal | TDLA10-650 | 70 % | TBD | pos1 | [No] | TBD |
|  |  | Normal | [TDLA10-650] | 70 % | TBD | pos1 | Yes | TBD |
|  |  | Normal | TDLD10-200 | 70 % | TBD | pos1 | Yes | TBD |

Table 11.2.2.1.2-10: Test requirements for PUSCH with 70% of maximum throughput, 400 MHz Channel Bandwidth, 480 kHz SCS in FR2-2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | PT-RS | SNR(dB) |
| 1 | 2 | Normal | TDLA10-650 | 70 % | TBD | pos1 | [No] | TBD |
|  |  | Normal | TDLA10-650 | 70 % | TBD | pos1 | Yes | TBD |
|  |  | Normal | TDLD10-200 | 70 % | TBD | pos1 | Yes | TBD |
| 2 |  | Normal | TDLA10-650 | 70 % | TBD | pos1 | [No] | TBD |
|  |  | Normal | [TDLA10-650] | 70 % | TBD | pos1 | Yes | TBD |
|  |  | Normal | TDLD10-200 | 70 % | TBD | pos1 | Yes | TBD |

### <End of Change R4-2217376 - 1>

### <Start of Change R4-2217376 - 2>

#### 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 |
| Default TDD UL-DL pattern (Note 1) | 60 kHz and 120kHz SCS:3D1S1U, S=10D:2G:2U480kHz SCS:14D2S4U, S1=12D:2G0U, S2=0D:6G:8U |
| 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 | 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(s) | 0 |
|  | DM-RS sequence generation | NID0=0, group hopping and sequence hopping are disabled |
| Time domain | PUSCH mapping type | B |
| resource | Start symbol | 0  |
| assignment | Allocation length | 10  |
| Frequency domain resource | RB assignment | FR2-1: 30 PRBs in the middle of the test bandwidthFR2-2: Full applicable test bandwidth |
| assignment | Frequency hopping | Disabled |
| Code block group based PUSCH transmission | Disabled |
| PT-RS | Not configured |
| NOTE 1: The same requirements are applicable to TDD with different UL-DL patterns. |

##### 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 to 11.2.2.2.2-4 at the given SNR.

Table 11.2.2.2.2-1: Minimum requirements for PUSCH with 70% of maximum throughput, Type B, 50 MHz Channel Bandwidth, 60 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | TDLA30-300 Low | 70 % | G-FR2-A3-11 | pos0 | -1.8 |
|  |  |  |  |  | G-FR2-A3-23 | pos1 | -1.9 |

Table 11.2.2.2.2-2: Minimum requirements for PUSCH with 70% of maximum throughput, Type B, 50 MHz Channel Bandwidth, 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | TDLA30-300 Low | 70 % | G-FR2-A3-12 | pos0 | -1.8  |
|  |  |  |  |  | G-FR2-A3-24 | pos1 | -1.9 |

Table 11.2.2.2.2-3: Minimum requirements for PUSCH with 70% of maximum throughput, Type B, 100 MHz Channel Bandwidth, 120 kHz SCS in FR2-2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | TDLA30-650 | 70 % | TBD | pos1 | TBD  |

Table 11.2.2.2.2-4: Minimum requirements for PUSCH with 70% of maximum throughput, Type B, 400 MHz Channel Bandwidth, 480 kHz SCS in FR2-2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | TDLA10-650 | 70 % | TBD | pos1 | TBD  |

### <End of Change R4-2217376 - 2>

### <Start of Change R4-2217384 - 1>

## 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 | FR2-1: 1.FR2-2:1,16 |
| 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 symbol12 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Numberof TX | Number of demodulation | Propagation conditions and | Number ofOFDM | Number ofPRBs | Channel bandwidth / SNR (dB) |
| antennas | branches | correlation matrix (Annex G) | symbols |  | 100 MHz |
| 1 | 2 | TDLA30-650 Low | 1 | 1 | TBD |
|  |  |  | 2 | 16 | TBD |

Table 11.3.2.2.2-4: Minimum requirements for PUCCH format 0 and 480 kHz SCS in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Numberof TX | Number of demodulation | Propagation conditions and | Number ofOFDM | Number ofPRBs | Channel bandwidth / SNR (dB) |
| antennas | branches | correlation matrix (Annex G) | symbols |  | 400 MHz |
| 1 | 2 | TDLA10-650 Low | 1 | 1 | TBD |
|  |  |  | 2 | 16 | 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 | FR2-1:1FR2-2:1,16 |
| 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Numberof TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Number ofRBs | 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 in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Numberof TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Number ofRBs | Channel bandwidth / SNR (dB) |
| antennas | branches |  | correlation matrix (Annex G) |  | 400 MHz |
| 1 | 2 | Normal | TDLA10-650 Low | 1 | TBD |
|  |  |  |  | 16 | 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 in FR2-2

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

Table 11.3.2.3.2.2-4: Minimum requirements for PUCCH format 1 and 480 kHz SCS in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Numberof TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Number ofRBs | Channel bandwidth / SNR (dB) |
| antennas | branches |  | correlation matrix (Annex G) |  | 400 MHz |
| 1 | 2 | Normal | TDLA10-650 Low | 1 | TBD |
|  |  |  |  | 16 | 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 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 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 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 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 in FR2-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 in FR2-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 in FR2-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test  | Number of | Number of | Cyclic  | Propagation | Additional  | Channel bandwidth / SNR (dB) |
| Number | TX antennas | Demodulationbranches | 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 in FR2-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test  | Number of | Number of | Cyclic  | Propagation | Additional  | Channel bandwidth / SNR (dB) |
| Number | TX antennas | Demodulationbranches | 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 with FR2-1 : 1.For tests 2 with FR2-2:16 |
| 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 in FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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 in FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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 in FR2-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test  | Number of | Number of | Cyclic  | Propagation | Additional  | Channel bandwidth / SNR (dB) |
| Number | TX antennas | Demodulationbranches | 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 in FR2-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test  | Number of | Number of | Cyclic  | Propagation | Additional  | Channel bandwidth / SNR (dB) |
| Number | TX antennas | Demodulationbranches | 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 |

### <End of Change R4-2217384- 1>

### <Start of Change R4-2217387 - 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 AWGN and TDLA30-300, 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.

The performance requirements for high speed train (table 11.4.2.2.3-1) are optional and only applicable for FR2-1 below 30GHz.

Table 11.4.2.2-1: Time error tolerance for AWGN, TDLA30-300, and TDLA10-650

|  |  |  |
| --- | --- | --- |
| PRACH  | PRACH SCS  | Time error tolerance |
| preamble | (kHz) | AWGN | TDLA30-300 | TDLA10-650 |
| A1, A2, A3, B4, | 60 | 0.13 us | 0.28 us | N/A |
| C0, C2 | 120 | 0.07 us | 0.22 us | N/A |
|  | 480 | 18 ns | N/A | 68 ns |

The test preambles for normal mode are listed in table A.6-2 and the test parameter *msg1-FrequencyStart* is set to 0. The test preambles for high speed train short formats are listed in table A.6-7 and the test parameter *msg1-FrequencyStart* for high speed train is set to 0.

##### 11.4.2.2.2 Minimum requirements for Normal mode

The probability of detection shall be equal to or exceed 99% for the SNR levels listed in Tables 11.4.2.2.2-1 to 11.4.2.2.2-2.

Table 11.4.2.2.2-1: PRACH missed detection requirements for Normal Mode, 60 kHz SCS in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Number of | Propagation | Frequency  | SNR (dB) |
| of TX antennas | demodulation branches | conditions and correlation matrix (Annex G) | offset | Burst format A1 | Burst format A2 | Burst format A3 | Burst format B4 | Burst format C0 | Burst format C2 |
| 1 | 2 | AWGN | 0 | -8.9 | -11.9 | -13.5 | -15.8 | -6.0 | -11.8 |
|  |  | TDLA30-300 Low | 4000 Hz | -1.6 | -3.8 | -4.8 | -6.9 | 1.1 | -3.9 |

Table 11.4.2.2.2-2: PRACH missed detection requirements for Normal Mode, 120 kHz SCS in FR2-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Number of | Propagation | Frequency  | SNR (dB) |
| of TX antennas | demodulation branches | conditions and correlation matrix (Annex G) | offset | Burst format A1 | Burst format A2 | Burst format A3 | Burst format B4 | Burst format C0 | Burst format C2 |
| 1 | 2 | AWGN | 0 | -8.7 | -11.5 | -13.3 | -15.8 | -5.8 | -11.4 |
|  |  | TDLA30-300 Low | 4000 Hz | -1.7 | -4.4 | -5.8 | -7.5 | 1.2 | -4.2 |

Table 11.4.2.2.2-3: PRACH missed detection test requirements for Normal Mode, 120 kHz SCS in FR2-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of  | Number of | Propagation | Frequency | SNR (dB) |
| TX antennas | demodulation branches | conditions and correlation matrix (Annex G) | offset | Burst format A2 | Burst format B4 | Burst format C2 |
| 1 | 2 | AWGN | 0 | FFS | FFS | FFS |
|  |  | TDLA30-650 Low | 7100 Hz | FFS | FFS | FFS |

Table 11.4.2.2.22-4: PRACH missed detection test requirements for Normal Mode, 480 kHz SCS in FR2-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of  | Number of | Propagation | Frequency | SNR (dB) |
| TX antennas | demodulation branches | conditions and correlation matrix (Annex G) | offset | Burst format A2 | Burst format B4 | Burst format C2 |
| 1 | 2 | AWGN | 0 | FFS | FFS | FFS |
|  |  | TDLA10-650 Low | 7100 Hz | FFS | FFS | FFS |

##### 11.4.2.2.3 Minimum requirements for high speed train

The probability of detection shall be equal to or exceed 99% for the SNR levels listed in Table 11.4.2.2.3-1.

Table 11.4.2.2.3-1: PRACH missed detection requirements for high speed train, 120 kHz SCS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number ofTX antennas | Number ofRX antennas | Propagationconditions (Annex G) | Frequencyoffset | SNR (dB) |
| Burst format C2 |
| 1 | 2 | AWGN | 19444 Hz | -10.4 |

### <End of Change R4-2217387- 1>

### <Start of Change R4-2217387 - 2>

##### 11.4.2.2.x Minimum requirements for PRACH with LRA=1151 and LRA=571

The probability of detection shall be equal to or exceed 99% for the SNR levels listed in Tables 11.4.2.2.x-1 to 11.4.2.2.x-3.

Table 11.4.2.2.x-1: Missed detection requirements for PRACH with LRA=571, 120 kHz SCS in FR2-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of  | Number of | Propagation | Frequency | SNR (dB) |
| TX antennas | demodulation branches | conditions and correlation matrix (Annex G) | offset | Burst format A2 | Burst format B4 | Burst format C2 |
| 1 | 2 | AWGN | 0 | FFS | FFS | FFS |
|  |  | TDLA30-650 Low | 7100 Hz | FFS | FFS | FFS |

Table 11.4.2.2.x-2: Missed detection requirements for PRACH with LRA=1151, 120 kHz SCS in FR2-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of  | Number of | Propagation | Frequency | SNR (dB) |
| TX antennas | demodulation branches | conditions and correlation matrix (Annex G) | offset | Burst format A2 | Burst format B4 | Burst format C2 |
| 1 | 2 | AWGN | 0 | FFS | FFS | FFS |
|  |  | TDLA10-650 | 7100 Hz | FFS | FFS | FFS |

Table 11.4.2.2.x-3: Missed detection requirements for PRACH with LRA=571, 480 kHz SCS in FR2-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of  | Number of | Propagation | Frequency | SNR (dB) |
| TX antennas | demodulation branches | conditions and correlation matrix (Annex G) | offset | Burst format A2 | Burst format B4 | Burst format C2 |
| 1 | 2 | AWGN | 0 | FFS | FFS | FFS |
|  |  | TDLA10-650 | 7100 Hz | FFS | FFS | FFS |

### <End of Change R4-2217387- 2>

### <Start of Change R4-2217378 - 1>

# 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-2 to table A.3B-7 for FR2-2 PUSCH performance requirements:

- FRC parameters are specified in table A.3B-2 for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer.

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

- FRC parameters are specified in table A.3B-4 for FR2-2 PUSCH with transform precoding enabled, *Additional DM-RS position = pos0* and 1 transmission layer.

- FRC parameters are specified in table A.3B-5 for FR2-2 PUSCH with transform precoding enabled, *Additional DM-RS position = pos1* and 1 transmission layer.

- FRC parameters are specified in table A.3B-6 for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layers.

- FRC parameters are specified in table A.3B-7 for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers.

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-2: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A3B-5 | G-FR2-A3B-6 | G-FR2-A3B-7 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 |
| Modulation | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 | 308/1024 |
| Payload size (bits) | 4224 | 16896 | 4224 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | - | 24 | - |
| Number of code blocks - C | 1 | 3 | 1 |
| Code block size including CRC (bits) (Note 2) | 4248 | 5664 | 4248 |
| Total number of bits per slot without PT-RS | 14256 | 57024 | 14256 |
| Total number of bits per slot with PT-RS (Note 4) | 13662 | 54648 | 13662 |
| Total symbols per slot without PT-RS | 7128 | 28512 | 7128 |
| Total symbols per slot with PT-RS (Note 4) | 6831 | 27324 | 6831 |
| 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* 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.3B-3: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A3B-8 | G-FR2-A3B-9 | G-FR2-A3B-10 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 |
| Modulation | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 | 308/1024 |
| Payload size (bits) | 3824 | 15112 | 3824 |
| Transport block CRC (bits) | 16 | 24 | 16 |
| Code block CRC size (bits) | - | 24 | - |
| Number of code blocks - C | 1 | 2 | 1 |
| Code block size including CRC (bits) (Note 2) | 3840 | 7592 | 3840 |
| Total number of bits per slot without PT-RS | 12672 | 50688 | 12672 |
| Total number of bits per slot with PT-RS (Note 4) | 12144 | 48576 | 12144 |
| Total symbols per slot without PT-RS | 6336 | 25344 | 6336 |
| Total symbols per slot with PT-RS (Note 4) | 6072 | 24288 | 6072 |
| 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.3B-4: FRC-2 parameters for FR2 PUSCH performance requirements, transform precoding enabled, *Additional DM-RS position = pos0* and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR2-A3B-11 | G-FR2-A3B-12 |
| Subcarrier spacing [kHz] | 120 | 480 |
| Allocated resource blocks | 64 | 64 |
| DFT-s-OFDM Symbols per slot (Note 1) | 9 | 9 |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 |
| Payload size (bits) | 4096 | 4096 |
| Transport block CRC (bits) | 24 | 24 |
| Code block CRC size (bits) | - | - |
| Number of code blocks - C | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 4120 | 4120 |
| Total number of bits per slot without PT-RS | 13824 | 13824 |
| Total number of bits per slot with PT-RS (Note 4) | 13248 | 13248 |
| Total symbols per slot without PT-RS | 6912 | 6912 |
| Total symbols per slot with PT-RS (Note 4) | 6624 | 6624 |
| 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* 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.3B-5: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding enabled, *Additional DM-RS position = pos1* and 1 transmission layer (QPSK, R=308/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR2-A3B-13 | G-FR2-A3B-14 |
| Subcarrier spacing [kHz] | 120 | 480 |
| Allocated resource blocks | 64 | 64 |
| DFT-s-OFDM Symbols per slot (Note 1) | 8 | 8 |
| Modulation | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 |
| Payload size (bits) | 3624 | 3624 |
| 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) | 3640 | 3640 |
| Total number of bits per slot without PT-RS | 12288 | 12288 |
| Total number of bits per slot with PT-RS (Note 4) | 11776 | 11776 |
| Total symbols per slot without PT-RS | 6144 | 6144 |
| Total symbols per slot with PT-RS (Note 4) | 5888 | 5888 |
| 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.3B-6: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layers (QPSK, R=308/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A3B-15 | G-FR2-A3B-16 | G-FR2-A3B-17 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 |
| Modulation | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 | 308/1024 |
| Payload size (bits) | 8456 | 33816 | 8456 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 2 | 5 | 2 |
| Code block size including CRC (bits) (Note 2) | 4264 | 6792 | 4264 |
| Total number of bits per slot without PT-RS | 28512 | 114048 | 28512 |
| Total number of bits per slot with PT-RS (Note 4) | 27324 | 109296 | 27324 |
| Total symbols per slot without PT-RS | 14256 | 57024 | 14256 |
| Total symbols per slot with PT-RS (Note 4) | 13662 | 54648 | 13662 |
| 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* 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.3B-7: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers (QPSK, R=308/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A3B-18 | G-FR2-A3B-19 | G-FR2-A3B-20 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 |
| Modulation | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 308/1024 | 308/1024 | 308/1024 |
| Payload size (bits) | 7552 | 30728 | 7552 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | - | 24 | - |
| Number of code blocks - C | 1 | 4 | 1 |
| Code block size including CRC (bits) (Note 2) | 7576 | 7712 | 7576 |
| Total number of bits per slot without PT-RS | 25344 | 101376 | 25344 |
| Total number of bits per slot with PT-RS (Note 4) | 24288 | 97152 | 24288 |
| Total symbols per slot without PT-RS | 12672 | 50688 | 12672 |
| Total symbols per slot with PT-RS (Note 4) | 12144 | 48576 | 12144 |
| 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

# A.4 Fixed Reference Channels for performance requirements (16QAM, R=658/1024)

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

- FRC parameters are specified in table A.4-2 for FR1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

- FRC parameters are specified in table A.4-2A for FR1 PUSCH with transform precoding disabled, additional DM-RS position = pos 2 and 1 transmission layer.

- FRC parameters are specified in table A.4-2B for FR1 PUSCH with transform-precoding disabled, *Additional DM-RS position = pos2* and 1 transmission layer

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

The parameters for the reference measurement channels are specified in table A.4-5 to table A.4-8 for FR2-1 PUSCH performance requirements:

- FRC parameters are specified in table A.4-5 for FR2-1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer.

- FRC parameters are specified in table A.4-6 for FR2-1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layers.

- FRC parameters are specified in table A.4-7 for FR2-1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

- FRC parameters are specified in table A.4-8 for FR2-1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers.

The parameters for the reference measurement channels are specified in table A.4-5A to table A.4-8A for FR2-2 PUSCH performance requirements:

- FRC parameters are specified in table A.4-5A for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer.

- FRC parameters are specified in table A.4-6A for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layers.

- FRC parameters are specified in table A.4-7A for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

- FRC parameters are specified in table A.4-8A for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers.

Table A.4-1: Void

Table A.4-2: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer (16QAM, R=658/1024)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A4-8 | G-FR1-A4-9 | G-FR1-A4-10 | G-FR1-A4-11 (Note 3) | G-FR1-A4-12 | G-FR1-A4-13 | G-FR1-A4-14 |
| Subcarrier spacing [kHz] | 15 | 15 | 15 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 106 | 24 | 51 | 106 | 273 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 9224 | 19464 | 38936 | 8968 | 18960 | 38936 | 100392 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 2 | 3 | 5 | 2 | 3 | 5 | 12 |
| Code block size including CRC (bits) (Note 2) | 4648 | 6520 | 7816 | 4520 | 6352 | 7816 | 8392 |
| Total number of bits per slot | 14400 | 29952 | 61056 | 13824 | 29376 | 61056 | 157248 |
| Total symbols per slot | 3600 | 7488 | 15264 | 3456 | 7344 | 15264 | 39312 |
| 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 [9].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [15].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present. |

Table A.4-2A: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos2* and 1 transmission layer (16QAM, R=658/1024)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A4-29 | G-FR1-A4-29A | G-FR1-A4-30 | G-FR1-A4-30A |
| Subcarrier spacing [kHz] | 15 | 15 | 30 | 30 |
| Allocated resource blocks | 52 | 25 | 106 | 24 |
| Data bearing CP-OFDM Symbols per slot (Note 1) | 11 | 11 | 11 | 11 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 17424 | 8456 | 35856 | 8064 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | - |
| Number of code blocks - C | 3 | 2 | 5 | 1 |
| Code block size including CRC (bits) (Note 2) | 5840 | 4264 | 7200 | 8080 |
| Total number of bits per slot | 27456 | 13200 | 55968 | 12672 |
| Total resource elements per slot | 6846 | 3300 | 13992 | 3168 |
| 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 = pos2*, and *l0*= 2 or 3 for PUSCH mapping type A, 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.4-2B: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos2* and 1 transmission layer (16QAM, R=658/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR1-A4-31 | G-FR1-A4-32 |
| Subcarrier spacing [kHz] | 15 | 30 |
| Allocated resource blocks | 25 | 50 |
| Data bearing CP-OFDM Symbols per slot (Note 1) | 11 | 11 |
| Modulation | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 |
| Payload size (bits) | 8456 | 16896 |
| Transport block CRC (bits) | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 |
| Number of code blocks - C | 2 | 3 |
| Code block size including CRC (bits) (Note 2) | 4264 | 5664 |
| Total number of bits per slot | 13200 | 26400 |
| Total data bearing resource elements per slot | 3300 | 6600 |
| 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 = pos2*, and *l0* = 2 for PUSCH mapping type A, 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.4-3: Void

Table A.4-4: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers (16QAM, R=658/1024)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A4-22 | G-FR1-A4-23 | G-FR1-A4-24 | G-FR1-A4-25 | G-FR1-A4-26 | G-FR1-A4-27 | G-FR1-A4-28 |
| Subcarrier spacing [kHz] | 15 | 15 | 15 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 106 | 24 | 51 | 106 | 273 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 18432 | 38936 | 77896 | 17928 | 37896 | 77896 | 200808 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 3 | 5 | 10 | 3 | 5 | 10 | 24 |
| Code block size including CRC (bits) (Note 2) | 6176 | 7816 | 7816 | 6008 | 7608 | 7816 | 8392 |
| Total number of bits per slot | 28800 | 59904 | 122112 | 27648 | 58752 | 122112 | 314496 |
| Total symbols per slot | 7200 | 14976 | 30528 | 6912 | 14688 | 30528 | 78624 |
| 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 [9].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [15]. |

Table A.4-5: FRC parameters for FR2-1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer (16QAM, R=658/1024)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR2-A4-1 | G-FR2-A4-2 | G-FR2-A4-3 (Note 3) | G-FR2-A4-4 | G-FR2-A4-5 |
| Subcarrier spacing [kHz] | 60 | 60 | 120 | 120 | 120 |
| Allocated resource blocks | 66 | 132 | 32 | 66 | 132 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 | 9 | 9 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 18432 | 36896 | 8968 | 18432 | 36896 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 3 | 5 | 2 | 3 | 5 |
| Code block size including CRC (bits) (Note 2) | 6176 | 7408 | 4520 | 6176 | 7408 |
| Total number of bits per slot without PT-RS | 28512 | 57024 | 13824 | 28512 | 57024 |
| Total number of bits per slot with PT-RS (Note 4) | 27324 | 54648 | 13248 | 27324 | 54648 |
| Total symbols per slot without PT-RS | 7128 | 14256 | 3456 | 7128 | 14256 |
| Total symbols per slot with PT-RS (Note 4) | 6831 | 13662 | 3312 | 6831 | 13662 |
| 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* 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.4-5A: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer (16QAM, R=658/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A4-21 | G-FR2-A4-22 | G-FR2-A4-23 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 |
| Modulation | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 18432 | 73776 | 18432 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 3 | 9 | 3 |
| Code block size including CRC (bits) (Note 2) | 6176 | 8224 | 6176 |
| Total number of bits per slot without PT-RS | 28512 | 114048 | 28512 |
| Total number of bits per slot with PT-RS (Note 4) | 27324 | 109296 | 27324 |
| Total symbols per slot without PT-RS | 7128 | 28512 | 7128 |
| Total symbols per slot with PT-RS (Note 4) | 6831 | 27324 | 6831 |
| 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* 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.4-6: FRC parameters for FR2-1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layers (16QAM, R=658/1024)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR2-A4-6 | G-FR2-A4-7 | G-FR2-A4-8 | G-FR2-A4-9 | G-FR2-A4-10 |
| Subcarrier spacing [kHz] | 60 | 60 | 120 | 120 | 120 |
| Allocated resource blocks | 66 | 132 | 32 | 66 | 132 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 | 9 | 9 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 36896 | 73776 | 17928 | 36896 | 73776 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 5 | 9 | 3 | 5 | 9 |
| Code block size including CRC (bits) (Note 2) | 7408 | 8224 | 6008 | 7408 | 8224 |
| Total number of bits per slot without PT-RS | 57024 | 114048 | 27648 | 57024 | 114048 |
| Total number of bits per slot with PT-RS (Note 3) | 54648 | 109296 | 26496 | 54648 | 109296 |
| Total symbols per slot without PT-RS | 14256 | 28512 | 6912 | 14256 | 28512 |
| Total symbols per slot with PT-RS (Note 3) | 13662 | 27324 | 6624 | 13662 | 27324 |
| 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* 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].NOTE 3: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.4-6A: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layers (16QAM, R=658/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A4-24 | G-FR2-A4-25 | G-FR2-A4-26 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 |
| Modulation | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 36896 | 147576 | 36896 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 5 | 18 | 5 |
| Code block size including CRC (bits) (Note 2) | 7408 | 8224 | 7408 |
| Total number of bits per slot without PT-RS | 57024 | 228096 | 57024 |
| Total number of bits per slot with PT-RS (Note 4) | 54648 | 218592 | 54648 |
| Total symbols per slot without PT-RS | 14256 | 57024 | 14256 |
| Total symbols per slot with PT-RS (Note 4) | 13662 | 54648 | 13662 |
| 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* 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.4-7: FRC parameters for FR2-1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer (16QAM, R=658/1024)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR2-A4-11 | G-FR2-A4-12 | G-FR2-A4-13 (Note 3) | G-FR2-A4-14 | G-FR2-A4-15 |
| Subcarrier spacing [kHz] | 60 | 60 | 120 | 120 | 120 |
| Allocated resource blocks | 66 | 132 | 32 | 66 | 132 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 | 8 | 8 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 16392 | 32776 | 7936 | 16392 | 32776 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | - | 24 | 24 |
| Number of code blocks - C | 2 | 4 | 1 | 2 | 4 |
| Code block size including CRC (bits) (Note 2) | 8232 | 8224 | 7960 | 8232　 | 8224　 |
| Total number of bits per slot without PT-RS | 25344 | 50688 | 12288 | 25344 | 50688 |
| Total number of bits per slot with PT-RS (Note 4) | 24288 | 48576 | 11776 | 24288 | 48576 |
| Total symbols per slot without PT-RS | 6336 | 12672 | 3072 | 6336 | 12672 |
| Total symbols per slot with PT-RS (Note 4) | 6072 | 12144 | 2944 | 6072 | 12144 |
| 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.4-7A: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer (16QAM, R=658/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A4-27 | G-FR2-A4-28 | G-FR2-A4-29 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 |
| Modulation | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 16392 | 65576 | 16392 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 2 | 8 | 2 |
| Code block size including CRC (bits) (Note 2) | 8232　 | 8224 | 8232　 |
| Total number of bits per slot without PT-RS | 25344 | 101376 | 25344 |
| Total number of bits per slot with PT-RS (Note 4) | 24288 | 97152 | 24288 |
| Total symbols per slot without PT-RS | 6336 | 25344 | 6336 |
| Total symbols per slot with PT-RS (Note 4) | 6072 | 24288 | 6072 |
| 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.4-8: FRC parameters for FR2-1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers (16QAM, R=658/1024)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR2-A4-16 | G-FR2-A4-17 | G-FR2-A4-18 | G-FR2-A4-19 | G-FR2-A4-20 |
| Subcarrier spacing [kHz] | 60 | 60 | 120 | 120 | 120 |
| Allocated resource blocks | 66 | 132 | 32 | 66 | 132 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 | 8 | 8 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 32776 | 65576 | 15880 | 32776 | 65576 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 4 | 8 | 2 | 4 | 8 |
| Code block size including CRC (bits) (Note 2) | 8224 | 8224 | 7976 | 8224 | 8224 |
| Total number of bits per slot without PT-RS | 50688 | 101376 | 24576 | 50688 | 101376 |
| Total number of bits per slot with PT-RS (Note 3) | 48576 | 97152 | 23552 | 48576 | 97152 |
| Total symbols per slot without PT-RS | 12672 | 25344 | 6144 | 12672 | 25344 |
| Total symbols per slot with PT-RS (Note 3) | 12144 | 24288 | 5888 | 12144 | 24288 |
| 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].NOTE 3: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.4-8A: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers (16QAM, R=658/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A4-30 | G-FR2-A4-31 | G-FR2-A4-32 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 |
| Modulation | 16QAM | 16QAM | 16QAM |
| Code rate (Note 2) | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 32776 | 131176 | 32776 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 4 | 16 | 4 |
| Code block size including CRC (bits) (Note 2) | 8224 | 8224 | 8224 |
| Total number of bits per slot without PT-RS | 50688 | 202752 | 50688 |
| Total number of bits per slot with PT-RS (Note 4) | 48576 | 194304 | 48576 |
| Total symbols per slot without PT-RS | 12672 | 50688 | 12672 |
| Total symbols per slot with PT-RS (Note 4) | 12144 | 48576 | 12144 |
| 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].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CSI part 1 and CSI part 2, if present.NOTE 4: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

# A.5 Fixed Reference Channels for performance requirements (64QAM, R=567/1024)

The parameters for the reference measurement channels are specified in table A.5-2 and table A.5-5 for FR1 PUSCH performance requirements:

- FRC parameters are specified in table A.5-2 for FR1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

- FRC parameters are specified in table A.5-5 for FR1 interlaced 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.5-3 to table A.5-4 for FR2-1 PUSCH performance requirements:

- FRC parameters are specified in table A.5-3 for FR2-1 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer.

- FRC parameters are specified in table A.5-4 for FR2-1 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.5-3A to table A.5-7 for FR2-2 PUSCH performance requirements:

- FRC parameters are specified in table A.5-3A for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer.

- FRC parameters are specified in table A.5-4A for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer.

- FRC parameters are specified in table A.5-6 for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layers.

- FRC parameters are specified in table A.5-7 for FR2-2 PUSCH with transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layers.

Table A.5-1: Void

Table A.5-2: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer (64QAM, R=567/1024)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A5-8 | G-FR1-A5-9 | G-FR1-A5-10 | G-FR1-A5-11 | G-FR1-A5-12 | G-FR1-A5-13 | G-FR1-A5-14 |
| Subcarrier spacing [kHz] | 15 | 15 | 15 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 106 | 24 | 51 | 106 | 273 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Code rate (Note 2) | 567/1024 | 567/1024 | 567/1024 | 567/1024 | 567/1024 | 567/1024 | 567/1024 |
| Payload size (bits) | 12040 | 25104 | 50184 | 11528 | 24576 | 50184 | 131176 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 2 | 3 | 6 | 2 | 3 | 6 | 16 |
| Code block size including CRC (bits) (Note 2) | 6056 | 8400 | 8392 | 5800 | 8224 | 8392 | 8224 |
| Total number of bits per slot | 21600 | 44928 | 91584 | 20736 | 44064 | 91584 | 235872 |
| Total symbols per slot | 3600 | 7488 | 15264 | 3456 | 7344 | 15264 | 39312 |
| 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 [9].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [15]. |

Table A.5-3: FRC parameters for FR2-1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer (64QAM, R=567/1024)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR2-A5-1 | G-FR2-A5-2 | G-FR2-A5-3 | G-FR2-A5-4 | G-FR2-A5-5 |
| Subcarrier spacing [kHz] | 60 | 60 | 120 | 120 | 120 |
| Allocated resource blocks | 66 | 132 | 32 | 66 | 132 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 | 9 | 9 |
| Modulation | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Code rate (Note 2) | 567/1024 | 567/1024 | 567/1024 | 567/1024 | 567/1024 |
| Payload size (bits) | 23568 | 47112 | 11528 | 23568 | 47112 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 3 | 6 | 2 | 3 | 6 |
| Code block size including CRC (bits) (Note 2) | 7888 | 7880 | 5800 | 7888 | 7880 |
| Total number of bits per slot without PT-RS | 42768 | 85536 | 20736 | 42768 | 85536 |
| Total number of bits per slot with PT-RS (Note 3) | 40986 | 81972 | 19872 | 40986 | 81972 |
| Total symbols per slot without PT-RS | 7128 | 14256 | 3456 | 7128 | 14256 |
| Total symbols per slot with PT-RS (Note 3) | 6831 | 13662 | 3312 | 6831 | 13662 |
| 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* 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].NOTE 3: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.5-3A: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 1 transmission layer (64QAM, R=567/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A5-17 | G-FR2-A5-18 | G-FR2-A5-19 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 |
| Modulation | 64QAM | 64QAM | 64QAM |
| Code rate (Note 2) | 567/1024 | 567/1024 | 567/1024 |
| Payload size (bits) | 23568 | 94248 | 23568 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 3 | 12 | 3 |
| Code block size including CRC (bits) (Note 2) | 7888 | 7880 | 7888 |
| Total number of bits per slot without PT-RS | 42768 | 171072 | 42768 |
| Total number of bits per slot with PT-RS (Note 3) | 40986 | 163944 | 40986 |
| Total symbols per slot without PT-RS | 7128 | 28512 | 7128 |
| Total symbols per slot with PT-RS (Note 3) | 6831 | 27324 | 6831 |
| 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* 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].NOTE 3: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.5-4: FRC parameters for FR2-1 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer (64QAM, R=567/1024)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR2-A5-6 | G-FR2-A5-7 | G-FR2-A5-8 | G-FR2-A5-9 | G-FR2-A5-10 |
| Subcarrier spacing [kHz] | 60 | 60 | 120 | 120 | 120 |
| Allocated resource blocks | 66 | 132 | 32 | 66 | 132 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 | 8 | 8 |
| Modulation | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Code rate (Note 2) | 567/1024 | 567/1024 | 567/1024 | 567/1024 | 567/1024 |
| Payload size (bits) | 21000 | 42016 | 10248 | 21000 | 42016 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 3 | 5 | 2 | 3 | 5 |
| Code block size including CRC (bits) (Note 2) | 7032 | 8432 | 5160 | 7032 | 8432 |
| Total number of bits per slot without PT-RS | 38016 | 76032 | 18432 | 38016 | 76032 |
| Total number of bits per slot with PT-RS (Note 3) | 36432 | 72864 | 17664 | 36432 | 72864 |
| Total symbols per slot without PT-RS | 6336 | 12672 | 3072 | 6336 | 12672 |
| Total symbols per slot with PT-RS (Note 3) | 6072 | 12144 | 2944 | 6072 | 12144 |
| 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].NOTE 3: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.5-4A: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 1 transmission layer (64QAM, R=567/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A5-20 | G-FR2-A5-21 | G-FR2-A5-22 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 66 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 |
| Modulation | 64QAM | 64QAM | 64QAM |
| Code rate (Note 2) | 567/1024 | 567/1024 | 567/1024 |
| Payload size (bits) | 21000 | 83976 | 21000 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 3 | 10 | 3 |
| Code block size including CRC (bits) (Note 2) | 7032 | 8424 | 7032 |
| Total number of bits per slot without PT-RS | 38016 | 152064 | 38016 |
| Total number of bits per slot with PT-RS (Note 3) | 36432 | 145728 | 36432 |
| Total symbols per slot without PT-RS | 6336 | 25344 | 6336 |
| Total symbols per slot with PT-RS (Note 3) | 6072 | 24288 | 6072 |
| 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].NOTE 3: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.5-5: FRC parameters for FR1 interlaced PUSCH performance requirements, transform precoding disabled, *additional DM-RS position = pos1* and 1 transmission layer (64QAM, R=567/1024)

|  |  |  |
| --- | --- | --- |
| Reference channel | G-FR1-A5-15 | G-FR1-A5-16 |
| Subcarrier spacing [kHz] | 15 | 30 |
| Allocated resource blocks | 11 | 11 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 |
| Modulation | 64QAM | 64QAM |
| Code rate  | 567/1024 | 567/1024 |
| Payload size (bits) | 5248 | 5248 |
| Transport block CRC (bits) | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 |
| Number of code blocks - C | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 5272 | 5272 |
| Total number of bits per slot (Note 3) | 9504 | 9504 |
| Total symbols per slot (Note 3) | 1584 | 1584 |
| 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 [9].NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [15].NOTE 3: The calculation of the “Total number of bits per slot” and “Total symbols per slot” fields include the REs taken up by CG-UCI, if present. |

Table A.5-6: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos0* and 2 transmission layer (64QAM, R=567/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A5-23 | G-FR2-A5-24 | G-FR2-A5-25 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 9 | 9 | 9 |
| Modulation | 64QAM | 64QAM | 64QAM |
| Code rate (Note 2) | 567/1024 | 567/1024 | 567/1024 |
| Payload size (bits) | 47112 | 188576 | 47112 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 6 | 23 | 6 |
| Code block size including CRC (bits) (Note 2) | 7880 | 8224 | 7880 |
| Total number of bits per slot without PT-RS | 85536 | 342144 | 85536 |
| Total number of bits per slot with PT-RS (Note 3) | 81972 | 327888 | 81972 |
| Total symbols per slot without PT-RS | 14256 | 57024 | 14256 |
| Total symbols per slot with PT-RS (Note 3) | 13662 | 54648 | 13662 |
| 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* 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].NOTE 3: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

Table A.5-7: FRC parameters for FR2-2 PUSCH performance requirements, transform precoding disabled, *Additional DM-RS position = pos1* and 2 transmission layer (64QAM, R=567/1024)

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | G-FR2-A5-26 | G-FR2-A5-27 | G-FR2-A5-28 |
| Subcarrier spacing [kHz] | 120 | 120 | 480 |
| Allocated resource blocks | 66 | 264 | 66 |
| CP-OFDM Symbols per slot (Note 1) | 8 | 8 | 8 |
| Modulation | 64QAM | 64QAM | 64QAM |
| Code rate (Note 2) | 567/1024 | 567/1024 | 567/1024 |
| Payload size (bits) | 42016 | 167976 | 42016 |
| Transport block CRC (bits) | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 |
| Number of code blocks - C | 5 | 20 | 5 |
| Code block size including CRC (bits) (Note 2) | 8432 | 8424 | 8432 |
| Total number of bits per slot without PT-RS | 76032 | 304128 | 76032 |
| Total number of bits per slot with PT-RS (Note 3) | 72864 | 291456 | 72864 |
| Total symbols per slot without PT-RS | 12672 | 50688 | 12672 |
| Total symbols per slot with PT-RS (Note 3) | 12144 | 48576 | 12144 |
| 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* 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].NOTE 3: PT-RS configuration *KPT-RS =2, LPT-RS =1*. |

# A.6 PRACH Test preambles

### <End of Change R4-2217378- 1>

### <Start of Change R4-2217389 - 1>

# A.6 PRACH Test preambles

Table A.6-1: Test preambles for Normal Mode in FR1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Burst format | SCS (kHz) | Ncs | Logical sequence index | v |
| 0 | 1.25 | 13 | 22 | 32 |
| A1, A2, A3, | 15 | 23 | 0 | 0 |
| B4, C0, C2 | 30 | 46 | 0 | 0 |

Table A.6-2: Test preambles for Normal Mode in FR2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Burst format | SCS (kHz) | Ncs | Logical sequence index | v |
| A1, A2, A3, | 60 | 69 | 0 | 0 |
| B4, C0, C2 | 120 | 69 | 0 | 0 |

Table A.6-6: Test preambles for PRACH with LRA=1151 and LRA=571

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Burst format | SCS (kHz) | Ncs | Logical sequence index | v |
| A2, B4, C2 | 15 | 164 | 0 | 0 |
|  | 30 | 190 | 0 | 0 |

Table A.6-7: Test preambles for high speed train short formats in FR2

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

Table A.6-8: Test preambles for PRACH with LRA=139, LRA=571 and LRA=1151 for 120 kHZ and 480 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Burst format | SCS (kHz) | LRA | Ncs | Logical sequence index | v |
| A2B4, C2 | 120 | 571 | 285 | 0 | 0 |
| 120 | 1151 | 575 | 0 | 0 |
| 480 | 139 | 69 | 0 | 0 |
| 480 | 571 | 285 | 0 | 0 |

### <End of Change R4-2217389- 1>

### <Start of Change R4-2217389 - 2>

# G.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.

- Different models are used for FR1, FR2(24.25 GHz – 71 GHz).

## G.2.1 Delay profiles

The delay profiles are simplified from the TR 38.901 [16] 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, G.2.1.2 and G.2.1.3 can be used as such.

 Step 1: Use the original TDL model from TR 38.901 [16].

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

 Step 3: Perform delay scaling according to the procedure described in clause 7.7.3 in TR 38.901 [16].

 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 taps are rounded to the same delay bin, merge them by calculating their linear power sum.

 Step 6: If there are more than 12 taps in the quantized model, merge the taps as follows

- Find the weakest tap from all taps (both merged and unmerged taps are considered)

• If there are two or more taps having the same value and are the weakest, select the tap with the smallest delay as the weakest tap.

- When the weakest tap is the first delay tap, merge taps as follows

• Update the power of the first delay tap as the linear power sum of the weakest tap and the second delay tap.

• Remove the second delay tap.

- When the weakest tap is the last delay tap, merge taps as follows

• Update the power of the last delay tap as the linear power sum of the second-to-last tap and the last tap.

• Remove the second-to-last tap.

- Otherwise

• For each side of the weakest tap, identify the neighbour tap that has the smaller delay difference to the weakest tap.

o When the delay difference between the weakest tap and the identified neighbour tap on one side equals the delay difference between the weakest tap and the identified neighbour tap on the other side.

▪ Select the neighbour tap that is weaker in power for merging.

o Otherwise, select the neighbour tap that has smaller delay difference for merging.

• To merge, the power of the merged tap is the linear sum of the power of the weakest tap and the selected tap.

• When the selected tap is the first tap, the location of the merged tap is the location of the first tap. The weakest tap is removed.

• When the selected tap is the last tap, the location of the merged tap is the location of the last tap. The weakest tap is removed.

• Otherwise, the location of the merged tap is based on the average delay of the weakest tap and selected tap. If the average delay is on the sampling grid, the location of the merged tap is the average delay. Otherwise, the location of the merged tap is rounded towards the direction of the selected tap (e.g. 10 ns & 20 ns 🡪 15 ns, 10 ns & 25 ns 🡪 20 ns, if 25 ns had higher or equal power; 15 ns, if 10 ns had higher power) . The weakest tap and the selected tap are removed.

- Repeat step 6 until the final number of taps is 12.

 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 tap to 0 dB.

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, G.2.1.1-4, G.2.1.2-2, G.2.1.2-3, G.2.1.2-4 and G.2.1.2-5 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.

### G.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 G.2.1.1-1 and the tapped delay line models are specified in tables G.2.1.1-2 ~ G.2.1.1-4.

Table G.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 |
| TDLA30 | 12 | 30 ns | 290 ns | 5 ns |
| TDLB100 | 12 | 100 ns | 480 ns | 5 ns |
| TDLC300 | 12 | 300 ns | 2595 ns | 5 ns |

Table G.2.1.1-2: TDLA30 (DS = 30 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns) | Power (dB) | Fading distribution |
| 1 | 0 | -15.5 | Rayleigh |
| 2 | 10 | 0 | Rayleigh |
| 3 | 15 | -5.1 | Rayleigh |
| 4 | 20 | -5.1 | Rayleigh |
| 5 | 25 | -9.6 | Rayleigh |
| 6 | 50 | -8.2 | Rayleigh |
| 7 | 65 | -13.1 | Rayleigh |
|  8 | 75 | -11.5 | Rayleigh |
| 9 | 105 | -11.0 | Rayleigh |
| 10 | 135 | -16.2 | Rayleigh |
| 11 | 150 | -16.6 | Rayleigh |
| 12 | 290 | -26.2 | Rayleigh |

Table G.2.1.1-3: TDLB100 (DS = 100 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns) | Power (dB) | Fading distribution |
| 1 | 0 | 0 | Rayleigh |
| 2 | 10 | -2.2 | Rayleigh |
| 3 | 20 | -0.6 | Rayleigh |
| 4 | 30 | -0.6 | Rayleigh |
| 5 | 35 | -0.3 | Rayleigh |
| 6 | 45 | -1.2 | Rayleigh |
| 7 | 55 | -5.9 | Rayleigh |
| 8 | 120 | -2.2 | Rayleigh |
| 9 | 170 | -0.8 | Rayleigh |
| 10 | 245 | -6.3 | Rayleigh |
| 11 | 330 | -7.5 | Rayleigh |
| 12 | 480 | -7.1 | Rayleigh |

Table G.2.1.1-4: TDLC300 (DS = 300 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns) | Power (dB) | Fading distribution |
| 1 | 0 | -6.9 | Rayleigh |
| 2 | 65 | 0 | Rayleigh |
| 3 | 70 | -7.7 | Rayleigh |
| 4 | 190 | -2.5 | Rayleigh |
| 5 | 195 | -2.4 | Rayleigh |
| 6 | 200 | -9.9 | Rayleigh |
| 7 | 240 | -8.0 | Rayleigh |
| 8 | 325 | -6.6 | Rayleigh |
| 9 | 520 | -7.1 | Rayleigh |
| 10 | 1045 | -13.0 | Rayleigh |
| 11 | 1510 | -14.2 | Rayleigh |
| 12 | 2595 | -16.0 | Rayleigh |

### G.2.1.2 Delay profiles for FR2

The delay profiles for FR2 are specified in table G.2.1.2-1 and the tapped delay line models are specified in table G.2.1.2-2- G.2.1.2-5.

Table G.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 |
| TDLA30 | 12 | 30 ns | 290 ns | 5 ns |
| TDLA10 | 16 | 10 ns | 96 ns | 2 ns |
| TDLD10 | 10 | 10 ns | 126 ns | 2 ns |
| TDLD30 | 10 | 30 ns | 375 ns | 5 ns |

Table G.2.1.2-2: TDLA30 (DS = 30 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns) | Power (dB) | Fading distribution |
| 1 | 0 | -15.5 | Rayleigh |
| 2 | 10 | 0 | Rayleigh |
| 3 | 15 | -5.1 | Rayleigh |
| 4 | 20 | -5.1 | Rayleigh |
| 5 | 25 | -9.6 | Rayleigh |
| 6 | 50 | -8.2 | Rayleigh |
| 7 | 65 | -13.1 | Rayleigh |
|  8 | 75 | -11.5 | Rayleigh |
| 9 | 105 | -11.0 | Rayleigh |
| 10 | 135 | -16.2 | Rayleigh |
| 11 | 150 | -16.6 | Rayleigh |
| 12 | 290 | -26.2 | Rayleigh |

Table G.2.1.2-3: TDLA10 (DS = 10 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns] | Power (dB) | Fading distribution |
| 1 | 0 | -16.1 | Rayleigh |
| 2 | 4 | 0 |  |
| 3 | 6 | -4 |  |
| 4 | 8 | -10.2 |  |
| 5 | 16 | -18.6 |  |
| 6 | 18 | -9.3 |  |
| 7 | 22 | -13.7 |  |
|  8 | 24 | -17.9 |  |
| 9 | 26 | -13.5 |  |
| 10 | 30 | -14 |  |
| 11 | 40 | -15.4 |  |
| 12 | 44 | -18.9 |  |
| 13 | 46 | -21.0 |  |
| 14 | 48 | -21.6 |  |
| 15 | 50 | -19.3 |  |
| 16 | 96 | -25.9 |  |

Table G.2.1.2-4: TDLD10 (DS = 10 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns] | Power (dB) | Fading distribution |
| 1 | 0 | -15.5 | LOS |
| 0 | 0 | Rayleigh |
| 2 | 6 | -5.1 |  |
| 3 | 14 | -5.1 |  |
| 4 | 18 | -9.6 |  |
| 5 | 26 | -8.2 |  |
| 6 | 40 | -13.1 |  |
|  7 | 80 | -11.5 |  |
| 8 | 94 | -11.0 |  |
| 9 | 98 | -16.2 |  |
| 10 | 126 | -16.6 |  |
| Note 1: Tap #1 follows a Ricean distribution. |

Table G.2.1.2-5: TDLD30 (DS = 30 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay (ns] | Power (dB) | Fading distribution |
| 1 | 0 | -0.2 | LOS |
| 0 | -12.4 | Rayleigh |
| 2 | 20 | -21 |  |
| 3 | 40 | -16.7 |  |
| 4 | 55 | -18.3 |  |
| 5 | 80 | -21.9 |  |
| 6 | 120 | -27.8 |  |
|  7 | 240 | -23.6 |  |
| 8 | 285 | -24.8 |  |
| 9 | 290 | -30.0 |  |
| 10 | 375 | -27.6 |  |
| Note 1: Tap #1 follows a Ricean distribution. |

## G.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., TDLA<DS>-<Doppler>, TDLB<DS>-<Doppler> or TDLC<DS>-<Doppler> where '<DS>' indicates the desired delay spread and '<Doppler>' indicates the maximum Doppler frequency (Hz).

Table G.2.2-1 and G.2.2-2 show the propagation conditions that are used for the performance measurements in multi-path fading environment for low, medium and high Doppler frequencies for FR1 and FR2 (24.25 GHz – 71 GHz) , respectively.

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

|  |  |  |
| --- | --- | --- |
| Combination name | Tapped delay line model | Maximum Doppler frequency |
| TDLA30-5 | TDLA30 | 5 Hz |
| TDLA30-10 | TDLA30 | 10 Hz |
| TDLB100-400 | TDLB100 | 400 Hz |
| TDLC300-100 | TDLC300 | 100 Hz |
| TDLC300-600 | TDLC300 | 600 Hz |
| TDLC300-1200 | TDLC300 | 1200 Hz |

Table G.2.2-2: Channel model parameters for FR2

|  |  |  |
| --- | --- | --- |
| Combination name | Tapped delay line model | Maximum Doppler frequency |
| TDLA30-75 | TDLA30 | 75 Hz |
| TDLA30-300 | TDLA30 | 300 Hz |
| TDLA10-650 | TDLA10 | 650 Hz |
| TDLA30-650 | TDLA30 | 650 Hz |
| TDLD10-200 | TDLD10 | 200 Hz |
| TDLD30-200 | TDLD30 | 200 Hz |

### <End of Change R4-2217389- 2>