**3GPP TSG- Meeting #**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **X** | Core Network |  |

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|  | | | | | | | | | | |
| ***Title:*** | Big draftCR to 38.141-2: demodulation requirements introduction for FR2-2 | | | | | | | | | |
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| ***Source to WG:*** |  | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
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| ***Work item code:*** |  | | | | |  | ***Date:*** | | |  |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***Release:*** | | |  |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Big Draft CR including changes of R4-2217377, R4-2217379, R4-2217380, R4-2217388, and R4-2217390  R4-2217377   * Introduction of the structure of the PUCCH requirements for FR2-2   R4-2217379   * 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.   R4-2217380   * It’s time to submit the FR2-2 PUSCH conformance testing requirements in this meeting.   R4-2217388   * Introduction of the structure of the PRACH requirements for FR2-2   R4-2217390   * 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:*** | | R4-2217377   * Proposal for scheleton of PUSCH requirements   R4-2217379   * 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.   R4-2217380   * Introduce FR2-2 PUSCH conformance testing requirments in TS 38.141-2   R4-2217388   * Proposal for scheleton of PRACH requirements   R4-2217390   * Add the test PRACH premable and propagation condition | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | R4-2217377   * No PUCCH requirements for FR2-2   R4-2217379   * There will be no FRC table for FR2-2 PUSCH demodulation requirments.   R4-2217380   * The requirements will be missing   R4-2217388   * No PRACH requirements for FR2-2   R4-2217390   * The requirement can be not verfied properly | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | R4-2217377   * 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5   R4-2217379   * A.3B, A.4, A.5   R4-2217380   * 8.2.1.5   R4-2217388   * 8.4.1.4.2, 8.4.1.5.2, 8.4.1.7.x (new)   R4-2217390   * A.6, J.2 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | | New clause 8.4.1.7.x would be preferably implemented as 8.4.1.7.2. | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

### <Start of Change R4-2217380- 1>

## 8.2 OTA performance requirements for PUSCH

### 8.2.1 Performance requirements for PUSCH with transform precoding disabled

#### 8.2.1.1 Definition and applicability

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

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.1.

#### 8.2.1.2 Minimum Requirement

For *BS type 1-O*, the minimum requirement is in TS 38.104 [2], clause 11.2.1.1.

For *BS type 2-O*, the minimum requirement is in TS 38.104 [2], clause 11.2.2.1.

#### 8.2.1.3 Test purpose

The test shall verify the receiver's ability to achieve throughput under multipath fading propagation conditions for a given SNR.

#### 8.2.1.4 Method of test

##### 8.2.1.4.1 Initial conditions

Test environment: Normal, see annex B.2.

RF channels to be tested for single carrier: M, see clause 4.9.1.

RF channels to be tested for carrier aggregation: MBW Channel CA; see clause 4.9.1.

Direction to be tested: OTA REFSENS *receiver target reference direction* (see D.54 in table 4.6-1).

##### 8.2.1.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted on one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to the corresponding UL reference measurement channel defined in annex A, and according to additional test parameters listed in table 8.2.1.4.2-1.

Table 8.2.1.4.2-1: Test parameters for testing PUSCH

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | | BS type 1-O | BS type 2-O |
| Transform precoding | | Disabled | |
| Default TDD UL-DL pattern (Note 1) | | 15 kHz SCS:  3D1S1U, S=10D:2G:2U  30 kHz SCS:  7D1S2U, S=6D:4G:4U | 60 kHz and 120kHz SCS:  3D1S1U, S=10D:2G:2U  480kHz 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 | pos1 | {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 | NID0=0, nSCID=0 | |
| Time | PUSCH mapping type | A, B | B |
| domain | Start symbol | 0 | 0 |
| resource assignment | Allocation length | 14 | 10 |
| Frequency | RB assignment | Full applicable test bandwidth | |
| domain resource assignment | Frequency hopping | Disabled | |
| TPMI index for 2Tx two layer spatial multiplexing transmission | | 0 | |
| Code block group based PUSCH transmission | | Disabled | |
| PTRS | Frequency density (*KPT-RS*) | N.A. | *2*, Disabled |
| configuration | Time density (*LPT-RS*) | N.A. | 1, Disabled |
| Note 1: The same requirements are applicable to FDD and TDD with different UL-DL patterns for BS type 1-O, and the same requirements are applicable to TDD with different UL-DL patterns for BS type 2-O. | | | |

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.2.1.5.1 and 8.2.1.5.2 for *BS type 1-O* and *BS type 2-O* respectively, and that the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.2.1.4.2-2.

Table 8.2.1.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| BS type 1-O  (Note 4) | 15 | 5 | -86.5 - ΔOTAREFSENS dBm / 4.5 MHz |
|  |  | 10 | -83.3 - ΔOTAREFSENS dBm / 9.36 MHz |
|  |  | 20 | -80.2 - ΔOTAREFSENS dBm / 19.08 MHz |
|  | 30 | 10 | -83.6 - ΔOTAREFSENS dBm / 8.64 MHz |
|  |  | 20 | -80.4 - ΔOTAREFSENS dBm / 18.36 MHz |
|  |  | 40 | -77.2 - ΔOTAREFSENS dBm / 38.16 MHz |
|  |  | 100 | -73.1 - ΔOTAREFSENS dBm / 98.28 MHz |
| BS type 2-O (Note 5) | 60 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 47.52 MHz |
|  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
| 120 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 46.08 MHz |
|  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm / 190.08 MHz |
| 480 | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as described in clause 7.1, since the OTA REFSENS reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

8) For reference channels applicable to the BS, measure the throughput.

#### 8.2.1.5 Test Requirement

##### 8.2.1.5.1 Test requirement for *BS type 1-O*

### <End of Change R4-2217380- 1>

### <Start of Change R4-2217380- 2>

##### 8.2.1.5.2 Test requirement for *BS type 2-O*

The throughput measured according to clause 8.2.1.4.2 shall not be below the limits for the SNR levels specified in table 8.2.1.5.2-1 to 8.2.1.5.2-10.

Table 8.2.1.5.2-1: Test 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 | -1.4 |
|  |  |  |  |  | G-FR2-A3-13 | pos1 | No | -1.6 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-1 | pos0 | Yes | 12.6 |
|  |  |  |  |  |  |  | No | 12.1 |
|  |  |  |  |  | G-FR2-A4-11 | pos1 | Yes | 11.3 |
|  |  |  |  |  |  |  | No | 11.3 |
|  |  | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-1 | pos0 | Yes | 14.3 |
|  |  |  |  |  |  |  | No | 13.7 |
|  |  |  |  |  | G-FR2-A5-6 | pos1 | Yes | 14.0 |
|  |  |  |  |  |  |  | No | 13.5 |
| 2 |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-6 | pos0 | No | 2.3 |
|  |  |  |  |  | G-FR2-A3-18 | pos1 | No | 2.0 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A7-1 | pos0 | Yes | 16.0 |
|  |  |  |  |  |  |  | No | 15.1 |
|  |  |  |  |  | G-FR2-A7-6 | pos1 | Yes | 14.6 |
|  |  |  |  |  |  |  | No | 13.8 |

Table 8.2.1.5.2-2: Test 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 | -1.5 |
|  |  |  |  |  | G-FR2-A3-14 | pos1 | No | -1.8 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-2 | pos0 | Yes | 12.8 |
|  |  |  |  |  |  |  | No | 11.8 |
|  |  |  |  |  | G-FR2-A4-12 | pos1 | Yes | 11.8 |
|  |  |  |  |  |  |  | No | 11.2 |
|  |  | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-2 | pos0 | Yes | 14.8 |
|  |  |  |  |  |  |  | No | 13.9 |
|  |  |  |  |  | G-FR2-A5-7 | pos1 | Yes | 14.3 |
|  |  |  |  |  |  |  | No | 13.7 |
| 2 |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-7 | pos0 | No | 2.3 |
|  |  |  |  |  | G-FR2-A3-19 | pos1 | No | 2.0 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A7-2 | pos0 | Yes | 16.8 |
|  |  |  |  |  |  |  | No | 15.7 |
|  |  |  |  |  | G-FR2-A7-7 | pos1 | Yes | 14.6 |
|  |  |  |  |  |  |  | No | 13.9 |

Table 8.2.1.5.2-3: Test 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) |
| 1 | 2 | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-3 | pos0 | No | -1.2 |
|  |  |  |  |  | G-FR2-A3-15 | pos1 | No | -1.5 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-3 | pos0 | Yes | 12.2 |
|  |  |  |  |  |  |  | No | 11.5 |
|  |  |  |  |  | G-FR2-A4-13 | pos1 | Yes | 11.5 |
|  |  |  |  |  |  |  | No | 11.1 |
|  |  | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-3 | pos0 | Yes | 14.3 |
|  |  |  |  |  |  |  | No | 13.7 |
|  |  |  |  |  | G-FR2-A5-8 | pos1 | Yes | 13.8 |
|  |  |  |  |  |  |  | No | 13.6 |
| 2 |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-8 | pos0 | No | 2.2 |
|  |  |  |  |  | G-FR2-A3-20 | pos1 | No | 2.1 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A7-3 | pos0 | Yes | 15.0 |
|  |  |  |  |  |  |  | No | 14.4 |
|  |  |  |  |  | G-FR2-A7-8 | Pos1 | Yes | 14.7 |
|  |  |  |  |  |  |  | No | 13.9 |

Table 8.2.1.5.2-4: Test 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) |
| 1 | 2 | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-4 | pos0 | No | -1.8 |
|  |  |  |  |  | G-FR2-A3-16 | pos1 | No | -1.9 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-4 | pos0 | Yes | 12.5 |
|  |  |  |  |  |  |  | No | 11.1 |
|  |  |  |  |  | G-FR2-A4-14 | pos1 | Yes | 11.7 |
|  |  |  |  |  |  |  | No | 11.1 |
|  |  | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-4 | pos0 | Yes | 14.1 |
|  |  |  |  |  |  |  | No | 13.5 |
|  |  |  |  |  | G-FR2-A5-9 | pos1 | Yes | 14.0 |
|  |  |  |  |  |  |  | No | 13.4 |
| 2 |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-9 | pos0 | No | 2.2 |
|  |  |  |  |  | G-FR2-A3-21 | pos1 | No | 2.0 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A7-4 | pos0 | Yes | 14.7 |
|  |  |  |  |  |  |  | No | 14.0 |
|  |  |  |  |  | G-FR2-A7-9 | pos1 | Yes | 14.3 |
|  |  |  |  |  |  |  | No | 13.7 |

Table 8.2.1.5.2-5: Test 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) |
| 1 | 2 | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-5 | pos0 | No | -1.5 |
|  |  |  |  |  | G-FR2-A3-17 | pos1 | No | -1.8 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A4-5 | pos0 | Yes | 11.9 |
|  |  |  |  |  |  |  | No | 11.5 |
|  |  |  |  |  | G-FR2-A4-15 | pos1 | Yes | 11.8 |
|  |  |  |  |  |  |  | No | 11.3 |
|  |  | Normal | TDLA30-75 Low | 70 % | G-FR2-A5-5 | pos0 | Yes | 14.7 |
|  |  |  |  |  |  |  | No | 14.0 |
|  |  |  |  |  | G-FR2-A5-10 | pos1 | Yes | 14.3 |
|  |  |  |  |  |  |  | No | 13.9 |
| 2 |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A3-10 | pos0 | No | 2.2 |
|  |  |  |  |  | G-FR2-A3-22 | pos1 | No | 1.9 |
|  |  | Normal | TDLA30-300 Low | 70 % | G-FR2-A7-5 | pos0 | Yes | 14.8 |
|  |  |  |  |  |  |  | No | 14.1 |
|  |  |  |  |  | G-FR2-A7-10 | pos1 | Yes | 14.4 |
|  |  |  |  |  |  |  | No | 13.8 |

Table 8.2.1.5.2-6: Test 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) |
| 1 | 2 | Normal | TDLA30-300 Low | 30 % | G-FR2-A4-1 | pos0 | Yes | 4.6 |
|  |  |  |  |  |  |  | No | 4.1 |
|  |  |  |  |  | G-FR2-A4-11 | pos1 | Yes | 4.3 |
|  |  |  |  |  |  |  | No | 3.7 |

Table 8.2.1.5.2-7: Test 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) |
| 1 | 2 | Normal | TDLA30-300 Low | 30 % | G-FR2-A4-3 | pos0 | Yes | 4.6 |
|  |  |  |  |  |  |  | No | 4.2 |
|  |  |  |  |  | G-FR2-A4-13 | pos1 | Yes | 4.3 |
|  |  |  |  |  |  |  | No | 3.8 |

Table 8.2.1.5.2-8: 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 8.2.1.5.2-9: 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 8.2.1.5.2-10: 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 |

NOTE: If the above Test Requirement differs from the Minimum Requirement then the Test Tolerance applied for this test is non-zero. The Test Tolerance for this test and the explanation of how the Minimum Requirement has been relaxed by the Test Tolerance is given in annex C.

### 8.2.2 Performance requirements for PUSCH with transform precoding enabled

#### 8.2.2.1 Definition and applicability

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

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.

#### 8.2.2.2 Minimum Requirement

For *BS type 1-O*, the minimum requirement is in TS 38.104 [2], clause 11.2.1.2.

For *BS type 2-O*, the minimum requirement is in TS 38.104 [2], clause 11.2.2.2.

#### 8.2.2.3 Test Purpose

The test shall verify the receiver's ability to achieve throughput under multipath fading propagation conditions for a given SNR.

#### 8.2.2.4 Method of test

##### 8.2.2.4.1 Initial Conditions

Test environment: Normal, see clause B.2.

RF channels to be tested for single carrier: M, see clause 4.9.1.

Direction to be tested: OTA REFSENS *receiver target reference direction* (see D.54 in table 4.6-1).

##### 8.2.2.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted on one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to the corresponding UL reference measurement channel defined in annex A, and according to additional test parameters listed in table 8.2.2.4.2-1.

Table 8.2.2.4.2-1: Test parameters for testing PUSCH

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | | BS type 1-O | BS type 2-O |
| Transform precoding | | Enabled | |
| Default TDD UL-DL pattern (Note 1) | | 15 kHz SCS:  3D1S1U, S=10D:2G:2U  30 kHz SCS:  7D1S2U, S=6D:4G:4U | 60 kHz and 120kHz SCS:  3D1S1U, S=10D:2G:2U  480kHz 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 | pos1 | 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 | *NID*0=0, group hopping and sequence hopping are disabled | |
| Time | PUSCH mapping type | A, B | B |
| domain | Start symbol | 0 | 0 |
| resource assignment | Allocation length | 14 | 10 |
| Frequency domain resource assignment | RB assignment | 15 kHz SCS: 25 PRBs in the middle of the test bandwidth  30 kHz SCS: 24 PRBs in the middle of the test bandwidth | 30 PRBs in the middle of the test bandwidth |
|  | Frequency hopping | Disabled | |
| Code block group based PUSCH transmission | | Disabled | |
| PT-RS | | Not configured | |
| NOTE 1: The same requirements are applicable to FDD and TDD with different UL-DL patterns for BS type 1-O, and the same requirements are applicable to TDD with different UL-DL patterns for BS type 2-O. | | | |

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.2.2.5.1 and 8.2.2.5.2 for *BS type 1-O* and *BS type 2-O* respectively, and that the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.2.2.4.2-2.

Table 8.2.2.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| *BS type 1-O* (Note 4) | 15 | 5 | -86.5 - ΔOTAREFSENS dBm / 4.5 MHz |
|  | 30 | 10 | -83.6 - ΔOTAREFSENS dBm / 8.64 MHz |
| *BS type 2-O* (Note 5) | 60 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 47.52MHz |
| 120 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 46.08 MHz |
| 480 | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as described in clause 7.1, since the OTA REFSENS reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

8) For reference channels applicable to the BS, measure the throughput.

#### 8.2.2.5 Test Requirement

##### 8.2.2.5.1 Test requirement for *BS type 1-O*

The throughput measured according to clause 8.2.2.4.2 shall not be below the limits for the SNR levels specified in table 8.2.2.5.1-1 to table 8.2.2.5.1-4.

Table 8.2.2.5.1-1: Test requirements for PUSCH with 70% of maximum throughput, Type A, 5 MHz channel bandwidth, 15 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic prefix | Propagation conditions and correlation matrix (annex J) | Fraction of maximum throughput | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLB100-400 Low | 70 % | G-FR1-A3-31 | pos1 | -1.8 |

Table 8.2.2.5.1-2: Test requirements for PUSCH with 70% of maximum throughput, Type A, 10 MHz channel bandwidth, 30 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic prefix | Propagation conditions and correlation matrix (annex J) | Fraction of maximum throughput | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLB100-400 Low | 70 % | G-FR1-A3-32 | pos1 | -1.9 |

Table 8.2.2.5.1-3: Test requirements for PUSCH with 70% of maximum throughput, Type B, 5 MHz channel bandwidth, 15 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic prefix | Propagation conditions and correlation matrix (annex J) | Fraction of maximum throughput | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLB100-400 Low | 70 % | G-FR1-A3-31 | pos1 | -1.7 |

Table 8.2.2.5.1-4: Test requirements for PUSCH with 70% of maximum throughput, Type B, 10 MHz channel bandwidth, 30 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic prefix | Propagation conditions and correlation matrix (annex J) | Fraction of maximum throughput | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLB100-400 Low | 70 % | G-FR1-A3-32 | pos1 | -2.1 |

##### 8.2.2.5.2 Test requirement for *BS type 2-O*

The throughput measured according to clause 8.2.2.4.2 shall not be below the limits for the SNR levels specified in table 8.2.2.5.2-1 to table 8.2.2.5.2-2.

Table 8.2.2.5.2-1: Test 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 J) | 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 | -1.2 |
|  |  |  |  |  | G-FR2-A3-23 | pos1 | -1.3 |

Table 8.2.2.5.2-2: Test 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 J) | 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 | -1.2 |
|  |  |  |  |  | G-FR2-A3-24 | pos1 | -1.3 |

Table 8.2.2.5.2-1: Test 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 J) | Fraction of maximum throughput | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA30-650 Low | 70 % | TBD | pos1 | TBD |

Table 8.2.2.5.2-2: Test 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 J) | Fraction of maximum throughput | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
| 1 | 2 | Normal | TDLA10-650 Low | 70 % | TBD | pos1 | TBD |

### <End of Change R4-2217380- 2>

### <Start of Change R4-2217377 - 1>

### 8.3.1 Performance requirements for PUCCH format 0

#### 8.3.1.1 Definition and applicability

The performance requirement of single user PUCCH format 0 for ACK missed detection is determined by the two parameters: probability of false detection of the ACK and the probability of detection of ACK. The performance is measured by the required SNR at probability of detection equal to 0.99. The probability of false detection of the ACK shall be 0.01 or less.

The probability of false detection of the ACK is defined as a conditional probability of erroneous detection of the ACK when input is only noise.

The probability of detection of ACK is defined as conditional probability of detection of the ACK when the signal is present.

The transient period as specified in TS 38.101-1 [24] clause 6.3.3.1 and TS 38.101-2 [25] 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.

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.

#### 8.3.1.2 Minimum Requirement

For *BS type 1-O*, the minimum requirements are in TS 38.104 [2] clause 11.3.1.1 and 11.3.1.2.

For *BS type 2-O*, the minimum requirements are in TS 38.104 [2] clause 11.3.2.1 and 11.3.2.2.

#### 8.3.1.3 Test purpose

The test shall verify the receiver's ability to detect ACK under multipath fading propagation conditions for a given SNR.

#### 8.3.1.4 Method of test

##### 8.3.1.4.1 Initial conditions

Test environment: Normal, see annex B.2.

RF channels to be tested: single carrier M; see clause 4.9.1.

Direction to be tested: OTA REFSENS *receiver target reference direction* (see D.54 in table 4.6-1).

##### 8.3.1.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted on one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to TS 38.211 [20] and according to additional test parameters listed in table 8.3.1.4.2-1.

Table 8.3.1.4.2-1: Test parameters

|  |  |  |
| --- | --- | --- |
| Parameter | BS type 1-O | BS type 2-O |
| number of UCI information bits | 1 | 1 |
| Number of PRBs | 1 | FR2-1: 1  FR2-2: 1, 16 |
| First PRB prior to frequency hopping | 0 | 0 |
| Intra-slot frequency hopping | N/A for 1 symbol  Enabled for 2 symbols | N/A for 1 symbol  Enabled for 2 symbols |
| First PRB after frequency hopping | The largest PRB index – (number of PRBs – 1) | The largest PRB index – (number of PRBs – 1) |
| Group and sequence hopping | neither | neither |
| Hopping ID | 0 | 0 |
| Initial cyclic shift | 0 | 0 |
| First symbol | 13 for 1 symbol  12 for 2 symbols | 13 for 1 symbol  12 for 2 symbols |

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.2.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.3.1.5.1 and 8.3.1.5.2 for *BS type 1-O* and *BS type 2-O* respectively, and that the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level quoted in table 8.3.1.4.2-2.

Table 8.3.1.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| BS type 1-O (Note 4) | 15 | 5 | -83.5 - ΔOTAREFSENS dBm / 4.5 MHz |
|  |  | 10 | -80.3 - ΔOTAREFSENS dBm / 9.36 MHz |
|  |  | 20 | -77.2 - ΔOTAREFSENS dBm / 19.08 MHz |
|  | 30 | 10 | -80.6 - ΔOTAREFSENS dBm / 8.64 MHz |
|  |  | 20 | -77.4 - ΔOTAREFSENS dBm / 18.36 MHz |
|  |  | 40 | -74.2 - ΔOTAREFSENS dBm / 38.16 MHz |
|  |  | 100 | -70.1 - ΔOTAREFSENS dBm / 98.28 MHz |
| BS type 2-O (Note 5) | 60 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 47.52 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  | 120 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 46.08 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  |  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm / 190.08 MHz |
|  | 480 | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as described in clause 7.1 since the OTA REFSENS reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

8) The signal generator sends a test pattern with the pattern outlined in figure 8.3.1.4.2-1. The following statistics are kept: the number of ACKs detected in the idle periods and the number of missed ACKs.



Figure 8.3.1.4.2-1: Test signal pattern for single user PUCCH format 0 demodulation tests

#### 8.3.1.5 Test Requirement

##### 8.3.1.5.1 Test requirement for *BS type 1-O*

The fraction of falsely detected ACKs shall be less than 1% and the fraction of correctly detected ACKs shall be larger than 99% for the SNR listed in table 8.3.1.5.1-1 and in table 8.3.1.5.1-2.

Table 8.3.1.5.1-1: Test requirements for PUCCH format 0 and 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number of | Propagation conditions and | Number of | Channel bandwidth / SNR (dB) | | |
| of TX antennas | demodulation branches | correlation matrix (annex J) | OFDM symbols | 5 MHz | 10 MHz | 20 MHz |
| 1 | 2 | TDLC300-100 Low | 1 | 10.0 | 9.4 | 9.9 |
|  |  |  | 2 | 3.4 | 4.3 | 3.9 |

Table 8.3.1.5.1-2: Test requirements for PUCCH format 0 and 30 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number | Number of | Propagation conditions | Number | Channel bandwidth / SNR (dB) | | | |
| of TX antennas | demodulation branches | and correlation matrix (annex J) | of OFDM symbols | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
| 1 | 2 | TDLC300-100 Low | 1 | 10.4 | 10.4 | 10.1 | 9.8 |
|  |  |  | 2 | 4.8 | 4.2 | 4.4 | 4.1 |

##### 8.3.1.5.2 Test requirement for *BS type 2-O*

The fraction of falsely detected ACKs shall be less than 1% and the fraction of correctly detected ACKs shall be larger than 99% for the SNR listed in table 8.3.1.5.2-1 to table 8.3.1.5.2-4.

Table 8.3.1.5.2-1: Test requirements for PUCCH format 0 and 60 kHz SCS in FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of demodulation | Propagation conditions and correlation matrix (annex J) | Number of OFDM | Channel bandwidth / SNR (dB) | |
| antennas | branches |  | symbols | 50 MHz | 100 MHz |
| 1 | 2 | TDLA30-300 Low | 1 | 9.9 | 9.6 |
|  |  |  | 2 | 4.8 | 4.6 |

Table 8.3.1.5.2-2: Test requirements for PUCCH format 0 and 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of demodulation | Propagation conditions and correlation matrix (annex J) | Number of OFDM | Channel bandwidth / SNR (dB) | | |
| antennas | branches |  | symbols | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | TDLA30-300 Low | 1 | 10.1 | 9.8 | 10.3 |
|  |  |  | 2 | 4.7 | 4.4 | 4.6 |

Table 8.3.1.5.2-3: Test requirements for PUCCH format 0 and 120 kHz SCS in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of demodulation | Propagation conditions and correlation matrix (annex J) | Number of OFDM | Number of PRB | Channel bandwidth / SNR (dB) |
| antennas | branches |  | symbols |  | 100 MHz |
| 1 | 2 | TDLA30-650 Low | 1 | 1 | TBD |
|  |  |  | 2 | 16 | TBD |

Table 8.3.1.5.2-4: Test requirements for PUCCH format 0 and 480 kHz SCS in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of demodulation | Propagation conditions and correlation matrix (annex J) | Number of OFDM | Number of PRB | Channel bandwidth / SNR (dB) |
| antennas | branches |  | symbols |  | 400 MHz |
| 1 | 2 | TDLA10-650 Low | 1 | 1 | TBD |
|  |  |  | 2 | 16 | TBD |

### <End of Change R4-2217377 - 1>

### <Start of Change R4-2217377 - 2>

### 8.3.2 Performance requirements for PUCCH format 1

#### 8.3.2.1 NACK to ACK detection

##### 8.3.2.1.1 Definition and applicability

The performance requirement of PUCCH format 1 for NACK to ACK detection is determined by the two parameters: probability of false detection of the ACK and the NACK to ACK detection probability. The performance is measured by the required SNR at probability of the NACK to ACK detection equal to 0.1% or less. The probability of false detection of the ACK shall be 0.01 or less.

The probability of false detection of the ACK is defined as a conditional probability of erroneous detection of the ACK at particular bit position when input is only noise. Each false bit detection is counted as one error.

The NACK to ACK detection probability is the probability of detecting an ACK bit when an NACK bit was sent on particular bit position. Each NACK bit erroneously detected as ACK bit is counted as one error. Erroneously detected NACK bits in the definition do not contain the NACK bits which are mapped from DTX, i.e. NACK bits received when DTX is sent should not be considered.

The transient period as specified in TS 38.101-1 [24] and TS 38.101-2 [25] 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.

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.

##### 8.3.2.1.2 Minimum Requirement

For BS type 1-O, the minimum requirement is in TS 38.104 [2], clause 11.3.1.3.

For BS type 2-O, the minimum requirement is in TS 38.104 [2], clause 11.3.2.3.

##### 8.3.2.1.3 Test purpose

The test shall verify the receiver's ability not to falsely detect NACK bits as ACK bits under multipath fading propagation conditions for a given SNR.

##### 8.3.2.1.4 Method of test

8.3.2.1.4.1 Initial Conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: M; see clause 4.9.1

Direction to be tested: OTA REFSENS receiver target reference direction (see D.54 in table 4.6-1).

8.3.2.1.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted on one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to TS 38.211 [20], and according to additional test parameters listed in table 8.3.2.1.4.2-1.

Table 8.3.2.1.4.2-1: Test parameters

|  |  |
| --- | --- |
| Parameter | Test |
| Number of information bits | 2 |
| Number of PRBs | FR1 and FR2-1: 1  FR2-2: 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 |

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.3.2.1.5.1 and 8.3.2.1.5.2 for BS type 1-O and BS type 2-O respectively, and that the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.3.2.1.4.2-2.

Table 8.3.2.1.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Subcarrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| BS type 1-O (Note 4) | 15 kHz | 5 | -83.5 - ΔOTAREFSENS dBm / 4.5 MHz |
|  |  | 10 | -80.3 – ΔOTAREFSENS dBm / 9.36 MHz |
|  |  | 20 | -77.2 – ΔOTAREFSENS dBm / 19.08 MHz |
|  | 30 kHz | 10 | -80.6 – ΔOTAREFSENS dBm / 8.64 MHz |
|  |  | 20 | -77.4 – ΔOTAREFSENS dBm / 18.36 MHz |
|  |  | 40 | -74.2 – ΔOTAREFSENS dBm / 38.16 MHz |
|  |  | 100 | -70.1 – ΔOTAREFSENS dBm / 98.28 MHz |
| BS type 2-O (Note 5) | 60 kHz | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 47.52 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  | 120 kHz | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 46.08 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  |  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm / 190.08 MHz |
|  | 480 kHz | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as described in clause 7.1, since the OTA REFSENS reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

8) The signal generator sends random codeword from applicable codebook, in regular time periods. The following statistics are kept: the number of ACK bits detected in the idle periods and the number of NACK bits detected as ACK.

##### 8.3.2.1.5 Test Requirement

8.3.2.1.5.1 Test Requirement for *BS type 1-O*

The fraction of falsely detected ACK bits shall be less than 1 % and the fraction of NACK bits falsely detected as ACK shall be less than 0.1 % for the SNR listed in tables 8.3.2.1.5.1-1 and table 8.3.2.1.5.1-2.

Table 8.3.2.1.5.1-1: Required SNR for PUCCH format 1 with 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and | Channel bandwidth / SNR (dB) | | |
| antennas | Branches |  | correlation matrix (annex J) | 5 MHz | 10 MHz | 20 MHz |
| 1 | 2 | Normal | TDLC300-100 Low | -3.2 | -3.0 | -3.0 |

Table 8.3.2.1.5.1-2: Required SNR for PUCCH format 1 with 30 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and | Channel bandwidth / SNR (dB) | | | |
| antennas | Branches |  | correlation matrix (annex J) | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
| 1 | 2 | Normal | TDLC300-100 Low | -2.2 | -2.7 | -3.3 | -2.9 |

8.3.2.1.5.2 Test Requirement for BS type 2-O

The fraction of falsely detected ACK bits shall be less than 1 % and the fraction of NACK bits falsely detected as ACK shall be less than 0.1 % for the SNR listed in tables 8.3.2.1.5.2-1 to table 8.3.2.1.5.2-4.

Table 8.3.2.1.5.2-1: Required SNR for PUCCH format 1 with 60 kHz SCS in FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and | Channel bandwidth / SNR (dB) | |
| antennas | Branches |  | correlation matrix (annex J) | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | -0.6 | -3.6 |

Table 8.3.2.1.5.2-2: Required SNR for PUCCH format 1 with 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and | Channel bandwidth / SNR (dB) | | |
| antennas | Branches |  | correlation matrix (annex J) | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | -3.3 | -3.3 | -2.4 |

Table 8.3.2.1.5.2-3: Required SNR for PUCCH format 1 and 120 kHz SCS in FR2-2

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

Table 8.3.2.1.5.2-4: Required SNR for PUCCH format 1 and 480 kHz SCS in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and correlation matrix (annex J) | Number of PRB | Channel bandwidth / SNR (dB) |
| antennas | branches |  |  |  | 400 MHz |
| 1 | 2 | Normal | TDLA10-650 Low | 1 | TBD |
|  |  |  |  | 16 | TBD |

#### 8.3.2.2 ACK missed detection

##### 8.3.2.2.1 Definition and applicability

The performance requirement of PUCCH format 1 for ACK missed detection is determined by the two parameters: probability of false detection of the ACK and the probability of detection of ACK. The performance is measured by the required SNR at probability of detection equal to 0.99. The probability of false detection of the ACK shall be 0.01 or less.

The probability of false detection of the ACK is defined as a conditional probability of erroneous detection of the ACK when input is only noise.

The probability of detection of ACK is defined as conditional probability of detection of the ACK when the signal is present.

The transient period as specified in TS 38.101-1 [24] and TS 38.101-2 [25] 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.

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.

##### 8.3.2.2.2 Minimum Requirement

For BS type 1-O, the minimum requirement is in TS 38.104 [2], clause 11.3.1.3.

For BS type 2-O, the minimum requirement is in TS 38.104 [2], clause 11.3.2.3.

##### 8.3.2.2.3 Test purpose

The test shall verify the receiver's ability to detect ACK bits under multipath fading propagation conditions for a given SNR.

##### 8.3.2.2.4 Method of test

8.3.2.2.4.1 Initial Conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: M; see clause 4.9.1

Direction to be tested: OTA REFSENS receiver target reference direction (see D.54 in table 4.6-1).

8.3.2.2.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted on one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to TS 38.211 [20], and according to additional test parameters listed in table 8.3.2.2.4.2-1.

Table 8.3.2.2.4.2-1: Test Parameters

|  |  |
| --- | --- |
| Parameter | Value |
| Number of information bits | 2 |
| Number of PRBs | FR1 and FR2-1: 1  FR2-2: 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 |

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.2.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.3.2.2.5.1 and 8.3.2.2.5.2 for BS type 1-O and BS type 2-O respectively, and that the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.3.2.2.4.2-2.

Table 8.3.2.2.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Subcarrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| BS type 1-O (Note 4) | 15 kHz | 5 | -83.5 – ΔOTAREFSENS dBm / 4.5 MHz |
|  |  | 10 | -80.3 – ΔOTAREFSENS dBm / 9.36 MHz |
|  |  | 20 | -77.2 – ΔOTAREFSENS dBm / 19.08 MHz |
|  | 30 kHz | 10 | -80.6 – ΔOTAREFSENS dBm / 8.64 MHz |
|  |  | 20 | -77.4 – ΔOTAREFSENS dBm / 18.36 MHz |
|  |  | 40 | -74.2 – ΔOTAREFSENS dBm / 38.16 MHz |
|  |  | 100 | -70.1 – ΔOTAREFSENS dBm / 98.28 MHz |
| BS type 2-O (Note 5) | 60 kHz | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 47.52 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  | 120 kHz | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 46.08 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  |  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm / 47.52 MHz |
|  | 480 kHz | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as described in clause 7.1, since the OTA REFSENS reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

8) The signal generator sends random codewords from applicable codebook, in regular time periods. The following statistics are kept: the number of ACK bits falsely detected in the idle periods and the number of missed ACK bits. Each falsely detected ACK bit in the idle periods is accounted as one error for the statistics of false ACK detection, and each missed ACK bit is accounted as one error for the statistics of missed ACK detection.

Note that the procedure described in this clause for ACK missed detection has the same condition as that described in clause 8.3.2.1.4.2 for NACK to ACK detection. Both statistics are measured in the same testing.

Figure 8.3.2.2.4.2-1: Void

##### 8.3.2.2.5 Test Requirement

8.3.2.2.5.1 Test Requirement for BS type 1-O

The fraction of falsely detected ACK bits shall be less than 1% and the fraction of correctly detected ACK bits shall be larger than 99% for the SNR listed in tables 8.3.2.2.5-1 and table 8.3.2.2.5-2.

Table 8.3.2.2.5.1-1: Required SNR for PUCCH format 1 with 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and | Channel bandwidth / SNR (dB) | | |
| antennas | Branches |  | correlation matrix (annex J) | 5 MHz | 10 MHz | 20 MHz |
| 1 | 2 | Normal | TDLC300-100 Low | -4.4 | -3.8 | -4.4 |

Table 8.3.2.2.5.1-2: Required SNR for PUCCH format 1 with 30 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and | Channel bandwidth / SNR (dB) | | | |
| antennas | Branches |  | correlation matrix (annex J) | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
| 1 | 2 | Normal | TDLC300-100 Low | -3.3 | -3.8 | -3.8 | -3.6 |

8.3.2.2.5.2 Test Requirement for BS type 2-O

The fraction of falsely detected ACK bits shall be less than 1% and the fraction of correctly detected ACK bits shall be larger than 99% for the SNR listed in tables 8.3.2.2.5.2-1 to table 8.3.2.2.5.2-4.

Table 8.3.2.2.5.2-1: Required SNR for PUCCH format 1 with 60 kHz SCS in FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and | Channel bandwidth / SNR (dB) | |
| antennas | Branches |  | correlation matrix (annex J) | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | -3.3 | -3.6 |

Table 8.3.2.2.5.2-2: Required SNR for PUCCH format 1 with 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of Demodulation | Cyclic Prefix | Propagation conditions and | Channel bandwidth / SNR (dB) | | |
| antennas | Branches |  | correlation matrix (annex J) | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | -4.1 | -4.0 | -4.0 |

Table 8.3.2.2.5.2-3: Required SNR for PUCCH format 1 and 120 kHz SCS in FR2-2

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

Table 8.3.2.2.5.2-4: Required SNR for PUCCH format 1 and 480 kHz SCS in FR2-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and correlation matrix (annex J) | Number of PRB | Channel bandwidth / SNR (dB) |
| antennas | branches |  |  |  | 400 MHz |
| 1 | 2 | Normal | TDLA10-650 Low | 1 | TBD |
|  |  |  |  | 16 | TBD |

### <End of Change R4-2217377 - 2>

### <Start of Change R4-2217377 - 3>

### 8.3.3 Performance requirements for PUCCH format 2

#### 8.3.3.1 ACK missed detection performance requirements

##### 8.3.3.1.1 Definition and applicability

The performance requirement of PUCCH format 2 for ACK missed detection is determined by the two parameters: probability of false detection of the ACK and the probability of detection of ACK on the wanted signal. The performance is measured by the required SNR at probability of detection equal to 0.99. The probability of false detection of the ACK shall be 0.01 or less.

The probability of false detection of the ACK is defined as a probability of erroneous detection of the ACK when input is only noise.

The probability of detection of ACK is defined as probability of detection of the ACK when the signal is present.

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.

##### 8.3.3.1.2 Minimum Requirement

For *BS type 1-O*, the minimum requirement is in TS 38.104 [2] clause 11.3.1.4.

For *BS type 2-O*, the minimum requirement is in TS 38.104 [2] clause 11.3.2.4.

##### 8.3.3.1.3 Test Purpose

The test shall verify the receiver's ability to detect ACK bits under multipath fading propagation conditions for a given SNR.

##### 8.3.3.1.4 Method of test

8.3.3.1.4.1 Initial conditions

Test environment: Normal, see clause B.2.

RF channels to be tested for single carrier; M; see clause 4.9.1

Direction to be tested: OTA REFSENS *receiver target reference direction* (see D.54 in table.4.6-1).

8.3.3.1.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to TS 38.211 [20], and according to additional test parameters listed in table 8.3.3.1.4.2-1.

Table 8.3.3.1.4.2-1: Test parameters

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

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.3.3.1.5.1 and 8.3.3.1.5.2 for *BS type 1-O* and *BS type 2-O* respectively, and that the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.3.3.1.4.2-2.

Table 8.3.3.1.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Sub-carrier spacing  (kHz) | Channel bandwidth  (MHz) | AWGN power level |
| BS type 1-O (Note 4) | 15 kHz | 5 | -83.5 - ΔOTAREFSENS dBm / 4.5 MHz |
|  |  | 10 | -80.3 - ΔOTAREFSENS dBm / 9.36 MHz |
|  |  | 20 | -77.2 -ΔOTAREFSENS dBm / 19.08 MHz |
|  | 30 kHz | 10 | -80.6 - ΔOTAREFSENS dBm / 8.64 MHz |
|  |  | 20 | -77.4 - ΔOTAREFSENS dBm / 18.36 MHz |
|  |  | 40 | -74.2 - ΔOTAREFSENS dBm / 38.16 MHz |
|  |  | 100 | -70.1 - ΔOTAREFSENS dBm / 98.28 MHz |
| BS type 2-O (Note 5) | 60 kHz | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 47.52MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  | 120 kHz | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 46.08 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  |  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm / 190.08 MHz |
|  | 480 kHz | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as declared in clause 7.1, since the OTA REFSENS receiver target reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

8) The signal generator sends a test pattern with pattern outlined in figure 8.3.3.1.4.2-1. The following statistics are kept: the number of ACK bits detected in the idle periods and the number of missed ACKs.



Figure 8.3.3.1.4.2-1: Test signal pattern for PUCCH format 2 demodulation tests

##### 8.3.3.1.5 Test requirement

8.3.3.1.5.1 Requirements for BS type 1-O

The fraction of falsely detected ACKs shall be less than 1% and the fraction of correctly detected ACKs shall be larger than 99% for the SNR listed in table 8.3.3.1.5.1-1 and table 8.3.3.1.5.1-2.

Table 8.3.3.1.5.1-1: Required SNR for PUCCH format 2 with 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | 5 MHz | 10 MHz | 20 MHz |
| 1 | 2 | Normal | TDLC300-100 Low | 6.4 | 6.2 | 6.5 |

Table 8.3.3.1.5.1-2: Required SNR for PUCCH format 2 with 30 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Channel bandwidth/ SNR (dB) | | | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | 10MHz | 20MHz | 40MHz | 100MHz |
| 1 | 2 | Normal | TDLC300-100 Low | 6.1 | 6.2 | 6.1 | 6.3 |

8.3.3.1.5.2 Requirements for BS type 2-O

The fraction of falsely detected ACKs shall be less than 1% and the fraction of correctly detected ACKs shall be larger than 99% for the SNR listed in table 8.3.3.1.5.2-1 to table 8.3.3.1.5.2.-4.

Table 8.3.3.1.5.2-1: Required SNR for PUCCH format 2 with 60 kHz SCS in FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | 7.3 | 7.8 |

Table 8.3.3.1.5.2-2: Required SNR for PUCCH format 2 with 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | 7.2 | 6.9 | 7.2 |

Table 8.3.3.1.5.2-3: Required SNR for PUCCH format 2 and 120 kHz SCS in FR2-2

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

Table 8.3.3.1.5.2-4: Required SNR for PUCCH format 2 and 480 kHz SCS in FR2-2

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

#### 8.3.3.2 UCI BLER performance requirements

##### 8.3.3.2.1 Definition and applicability

The UCI block error probability 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.

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.

The transient period as specified in TS 38.101-1 [24] and TS 38.101-2 [25] 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.

##### 8.3.3.2.2 Minimum Requirement

For *BS type 1-O*, the minimum requirement is in TS 38.104 [2] clause 11.3.1.4.

For *BS type 2-O*, the minimum requirement is in TS 38.104 [2] clause 11.3.2.4.

##### 8.3.3.2.3 Test Purpose

The test shall verify the receiver's ability to detect UCI under multipath fading propagation conditions for a given SNR.

##### 8.3.3.2.4 Method of test

8.3.3.2.4.1 Initial conditions

Test environment: Normal, see clause B.2.

RF channels to be tested for single carrier: M; see clause 4.9.1

Direction to be tested: OTA REFSENS *receiver target reference direction* (see D.54 in table 4.6-1).

8.3.3.2.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branches signals should be transmitted on each polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to TS 38.211 [20], and according to additional test parameters listed in table 8.3.3.2.4.2-1.

Table 8.3.3.2.4.2-1: Test parameters

|  |  |
| --- | --- |
| Parameter | Value |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index - (Number of PRBs-1) |
| 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 |

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.3.3.2.5.1 and 8.3.3.2.5.2 for *BS type 1-O* and *BS type 2-O* respectively, and that the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.3.3.2.4.2-2.

Table 8.3.3.2.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Sub-carrier spacing  (kHz) | Channel bandwidth  (MHz) | AWGN power level |
| BS type 1-O (Note 4) | 15 kHz | 5 | -83.5 - ΔOTAREFSENS dBm / 4.5 MHz |
|  |  | 10 | -80.3 - ΔOTAREFSENS dBm / 9.36 MHz |
|  |  | 20 | -77.2 -ΔOTAREFSENS dBm / 19.08 MHz |
|  | 30 kHz | 10 | -80.6 - ΔOTAREFSENS dBm / 8.64 MHz |
|  |  | 20 | -77.4 - ΔOTAREFSENS dBm / 18.36 MHz |
|  |  | 40 | -74.2 - ΔOTAREFSENS dBm / 38.16 MHz |
|  |  | 100 | -70.1 - ΔOTAREFSENS dBm / 98.28 MHz |
| BS type 2-O (Note 5) | 60 kHz | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 47.52MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  | 120 kHz | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 46.08 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  |  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm / 190.08 MHz |
|  | 480 kHz | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as declared in clause 7.1.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

8) The signal generator sends a test pattern with the pattern outlined in figure 8.3.3.2.4.2-1. The following statistics are kept: the number of incorrectly decoded UCI.



Figure 8.3.3.2.4.2-1: Test signal pattern for PUCCH format 2 demodulation tests

##### 8.3.3.2.5 Test requirement

8.3.3.2.5.1 Requirements for BS type 1-O

The fraction of incorrectly decoded UCI is shall be less than 1% for the SNR listed in table 8.3.3.2.5.1-1 and table 8.3.3.2.5.1-2.

Table 8.3.3.2.5.1-1: Required SNR for PUCCH format 2 with 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | 5 MHz | 10 MHz | 20 MHz |
| 1 | 2 | Normal | TDLC300-100 Low | 0.8 | 1.4 | 1.8 |

Table 8.3.3.2.5.1-2: Required SNR for PUCCH format 2 with 30 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Channel bandwidth/ SNR (dB) | | | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | 10MHz | 20MHz | 40MHz | 100MHz |
| 1 | 2 | Normal | TDLC300-100 Low | 1.1 | 1.7 | 1.0 | 0.9 |

8.3.3.2.5.2 Requirements for *BS type 2-O*

The fraction of incorrectly decoded UCI is shall be less than 1% for the SNR listed in table 8.3.3.2.5.2-1 to table 8.3.3.2.5.2-4.

Table 8.3.3.2.5.2-1: Required SNR for PUCCH format 2 with 60 kHz SCS in FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | 3.2 | 1.7 |

Table 8.3.3.2.5.2-2: Required SNR for PUCCH format 2 with 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Channel bandwidth / SNR (dB) | | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | 50 MHz | 100 MHz | 200 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | 1.8 | 1.8 | 1.7 |

Table 8.3.3.2.5.2-3: Required SNR for PUCCH format 2 and 120 kHz SCS in FR2-2

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

Table 8.3.3.2.5.2-4: Required SNR for PUCCH format 2 and 480 kHz SCS in FR2-2

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

### <End of Change R4-2217377 - 3>

### <Start of Change R4-2217377 - 4>

### 8.3.4 Performance requirements for PUCCH format 3

#### 8.3.4.1 Definition and applicability

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 38.101-1 [24] clause 6.3.3.1 and TS 38.101-2 [25] 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.

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.2.

#### 8.3.4.2 Minimum requirement

For *BS type 1-O*, the minimum requirement is in TS 38.104 [2], clause 11.3.1.5.

For *BS type 2-O*, the minimum requirement is in TS 38.104 [2], clause 11.3.2.5.

#### 8.3.4.3 Test purpose

The test shall verify the receiver's ability to detect UCI under multipath fading propagation conditions for a given SNR.

#### 8.3.4.4 Method of test

##### 8.3.4.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: M; see clause 4.9.1

Direction to be tested:

- OTA REFSENS *receiver target reference direction* (see D.54 in table 4.6-1).

##### 8.3.4.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted on one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to TS 38.211 [20], and according to additional test parameters listed in table 8.3.4.4.2-1.

Table 8.3.4.4.2-1: 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 |

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.3.4.5.1 and 8.3.4.5.2 for *BS type 1-O* and *BS type 2-O* respectively, and the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.3.4.4.2-2.

Table 8.3.4.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Subcarrier spacing  (kHz) | Channel bandwidth (MHz) | AWGN power level |
| BS type 1-O (Note 4) | 15 | 5 | -83.5 - ΔOTAREFSENS dBm / 4.5MHz |
|  |  | 10 | -80.3 - ΔOTAREFSENS dBm / 9.36MHz |
|  |  | 20 | -77.2 - ΔOTAREFSENS dBm / 19.08MHz |
|  | 30 | 10 | -80.6 - ΔOTAREFSENS dBm / 8.64MHz |
|  |  | 20 | -77.4 - ΔOTAREFSENS dBm / 18.36MHz |
|  |  | 40 | -74.2 - ΔOTAREFSENS dBm / 38.16MHz |
|  |  | 100 | -70.1 - ΔOTAREFSENS dBm / 98.28MHz |
| BS type 2-O (Note 5) | 60 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm/ 47.52MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm/ 95.04 MHz |
|  | 120 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm/ 46.08 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm/ 95.04 MHz |
|  |  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm/ 190.08 MHz |
|  | 480 | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as described in clause 7.1, since the OTA REFSENS receiver target reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

#### 8.3.4.5 Test requirement

##### 8.3.4.5.1 Test requirement for *BS type 1-O*

The fraction of incorrectly decoded UCI is shall be less than 1% for the SNR listed in table 8.3.4.5.1-1 and table 8.3.4.5.1-2.

Table 8.3.4.5.1-1: Required SNR for PUCCH format 3 with 15 kHz SCS

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test Number | Number of TX | Number of | Cyclic Prefix | Propagation conditions | Additional DM-RS | Channel bandwidth / SNR (dB) | | |
|  | antennas | demodulation branches |  | and correlation matrix (annex J) | configuration | 5 MHz | 10 MHz | 20 MHz |
| 1 | 1 | 2 | Normal | TDLC300-100 Low | No additional DM-RS | 0.8 | 1.7 | 0.9 |
|  |  |  |  |  | Additional DM-RS | 0.5 | 1.1 | 0.5 |
| 2 | 1 | 2 | Normal | TDLC300-100 Low | No additional DM-RS | 2.0 | 2.8 | 2.6 |

Table 8.3.4.5.1-2: Required SNR for PUCCH format 3 with 30 kHz SCS

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test Number | Number of TX | Number of | Cyclic Prefix | Propagation conditions | Additional DM-RS | Channel bandwidth / SNR (dB) | | | |
|  | antennas | demodulation branches |  | and correlation matrix (annex J) | configuration | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
| 1 | 1 | 2 | Normal | TDLC300-100 Low | No additional DM-RS | 1.5 | 1.2 | 1.2 | 1.5 |
|  |  |  |  |  | Additional DM-RS | 1.1 | 0.9 | 0.6 | 0.7 |
| 2 | 1 | 2 | Normal | TDLC300-100 Low | No additional DM-RS | 2.4 | 2.6 | 2.6 | 2.1 |

##### 8.3.4.5.2 Test requirement for *BS type 2-O*

The fraction of incorrectly decoded UCI is shall be less than 1% for the SNR listed in table 8.3.4.5.2-1 to table 8.3.4.5.2-4.

Table 8.3.4.5.2-1: Required SNR for PUCCH format 3 with 60 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Number | Number of TX | Number of | Cyclic Prefix | Propagation conditions | Additional DM-RS | Channel bandwidth / SNR (dB) | |
|  | antennas | demodulation branches |  | and correlation matrix (annex J) | configuration | 50 MHz | 100 MHz |
| 1 | 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 2.2 | 1.3 |
|  |  |  |  |  | Additional DM-RS | 1.9 | 1.5 |
| 2 | 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 3.6 | 3.0 |

Table 8.3.4.5.2-2: Required SNR for PUCCH format 3 with 120 kHz SCS in FR2-1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test | Number | Number of | Cyclic | Propagation | Additional | Channel bandwidth / SNR (dB) | | |
| Number | of TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | DM-RS configuration | 50 MHz | 100 MHz | 200 MHz |
| 1 | 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 2.0 | 1.3 | 1.3 |
|  |  |  |  |  | Additional DM-RS | 1.9 | 2.0 | 1.5 |
| 2 | 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 1.7 | 3.5 | 2.0 |

Table 8.3.4.5.2-3: Required SNR for PUCCH format 3 with 120 kHz SCS in FR2-2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 J) |  | 100 MHz |
| 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 8.3.4.5.2-4: Required SNR for PUCCH format 3 with 480 kHz SCS in FR2-2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 J) |  | 400 MHz |
| 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 |

### <End of Change R4-2217377 - 4>

### <Start of Change R4-2217377 - 5>

### 8.3.5 Performance requirements for PUCCH format 4

#### 8.3.5.1 Definition and applicability

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 38.101-1 [24] and TS 38.101-2 [25] 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.

Which specific test(s) are applicable to BS is based on the test applicability rules defined in clause 8.1.2.2.

#### 8.3.5.2 Minimum requirement

For *BS type 1-O*, the minimum requirement is in TS 38.104 [2], clause 11.3.1.6.

For *BS type 2-O*, the minimum requirement is in TS 38.104 [2], clause 11.3.2.6.

#### 8.3.5.3 Test purpose

The test shall verify the receiver's ability to detect UCI under multipath fading propagation conditions for a given SNR.

#### 8.3.5.4 Method of test

##### 8.3.5.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: M; see clause 4.9.1

Direction to be tested:

- OTA REFSENS *receiver target reference direction* (see D.54 in table 4.6-1).

##### 8.3.5.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted on one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to TS 38.211 [20], and according to additional test parameters listed in table 8.3.4.4.2-1.

Table 8.3.5.4.2-1: Test parameters

|  |  |
| --- | --- |
| Parameter | Value |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Number of PRBs | FR1 and FR2-1: 1  FR2-2: 1, 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 |

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.

7) Adjust the test signal mean power so the calibrated radiated SNR value at the BS receiver is as specified in clause 8.3.5.5.1 and 8.3.5.5.2 for *BS type 1-O* and *BS type 2-O* respectively, and that the SNR at the BS receiver is not impacted by the noise floor.

The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.3.5.4.2-2.

Table 8.3.5.4.2-2: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Subcarrier spacing  (kHz) | Channel bandwidth (MHz) | AWGN power level |
| BS type 1-O | 15 | 5 | -83.5 - ΔOTAREFSENS dBm / 4.5MHz |
|  |  | 10 | -80.3 - ΔOTAREFSENS dBm / 9.36MHz |
|  |  | 20 | -77.2 - ΔOTAREFSENS dBm / 19.08MHz |
|  | 30 | 10 | -80.6 - ΔOTAREFSENS dBm / 8.64MHz |
|  |  | 20 | -77.4 - ΔOTAREFSENS dBm / 18.36MHz |
|  |  | 40 | -74.2 - ΔOTAREFSENS dBm / 38.16MHz |
|  |  | 100 | -70.1 - ΔOTAREFSENS dBm / 98.28MHz |
| BS type 2-O | 60 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm/ 47.52 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm/ 95.04 MHz |
|  | 120 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm/ 46.08 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm/ 95.04 MHz |
|  |  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm/ 190.08 MHz |
|  | 480 | 400 | TBD |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as described in clause 7.1, since the OTA REFSENS receiver target reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1. | | | |

#### 8.3.5.5 Test requirement

##### 8.3.5.5.1 Test requirement for *BS type 1-O*

The fraction of incorrectly decoded UCI is shall be less than 1% for the SNR listed in table 8.3.5.5.1-1 and table 8.3.5.5.1-2.

Table 8.3.5.5.1-1: Required SNR for PUCCH format 4 with 15 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation | Cyclic Prefix | Propagation conditions and correlation matrix | Additional DM‑RS | Channel bandwidth / SNR (dB) | | |
|  | branches |  | (annex J) | configuration | 5 MHz | 10 MHz | 20 MHz |
| 1 | 2 | Normal | TDLC300-100 Low | No additional DM-RS | 2.4 | 3.2 | 2.8 |
|  |  |  |  | Additional DM‑RS | 2.2 | 3.0 | 2.4 |

Table 8.3.5.5.1-2: Required SNR for PUCCH format 4 with 30 kHz SCS

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number of | Number of | Cyclic | Propagation | Additional | Channel bandwidth / SNR (dB) | | | |
| TX antennas | demodulation branches | Prefix | conditions and correlation matrix (annex J) | DM‑RS configuration | 10  MHz | 20 MHz | 40 MHz | 100 MHz |
| 1 | 2 | Normal | TDLC300-100 Low | No additional DM-RS | 3.7 | 3.4 | 3.7 | 3.4 |
|  |  |  |  | Additional DM‑RS | 3.4 | 2.9 | 3.7 | 2.8 |

##### 8.3.5.5.2 Test requirement for *BS type 2-O*

The fraction of incorrectly decoded UCI is shall be less than 1% for the SNR listed in table 8.3.5.5.2-1 to table 8.3.5.5.2-4.

Table 8.3.5.5.2-1: Required SNR for PUCCH format 4 with 60 kHz SCS in FR2-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation | Cyclic Prefix | Propagation conditions and | Additional DM‑RS configuration | Channel bandwidth / SNR (dB) | |
|  | branches |  | correlation matrix (annex J) |  | 50 MHz | 100 MHz |
| 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 3.6 | 3.3 |
|  |  |  |  | Additional DM-RS | 3.7 | 4.1 |

Table 8.3.5.5.2-2: Required SNR for PUCCH format 4 with 120 kHz SCS in FR2-2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of demodulation | Cyclic Prefix | Propagation conditions and | Additional DM‑RS configuration | Channel bandwidth / SNR (dB) | | |
| antennas | branches |  | correlation matrix (annex J) |  | 50 MHz | 100 MHz | 200MHz |
| 1 | 2 | Normal | TDLA30-300 Low | No additional DM-RS | 3.4 | 3.4 | 4.1 |
|  |  |  |  | Additional DM-RS | 4.2 | 4.4 | 3.8 |

Table 8.3.5.5.2-3: Required SNR for PUCCH format 4 with 120 kHz SCS in FR2-2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic Prefix | Propagation conditions and correlation matrix | Number of PRBs | Additional DM-RS configuration | Channel bandwidth / SNR (dB) |
|  |  |  | (annex J) |  |  | 100 MHz |
| 1 | 2 | Normal | TDLA30-650 Low | 1 | No additional DM-RS | TBD |
|  |  |  |  |  | Additional DM-RS | TBD |
| 1 | 2 | Normal | TDLA30-650 Low | 16 | No additional DM-RS | TBD |
|  |  |  |  |  | Additional DM-RS | TBD |

Table 8.3.5.5.2-4: Required SNR for PUCCH format 4 with 480 kHz SCS in FR2-2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of demodulation branches | Cyclic Prefix | Propagation conditions and correlation matrix | Number of PRBs | Additional DM-RS configuration | Channel bandwidth / SNR (dB) |
|  |  |  | (annex J) |  |  | 400 MHz |
| 1 | 2 | Normal | TDLA10-650 Low | 1 | No additional DM-RS | TBD |
|  |  |  |  |  | Additional DM-RS | TBD |
| 1 | 2 | Normal | TDLA10-650 Low | 16 | No additional DM-RS | TBD |
|  |  |  |  |  | Additional DM-RS | TBD |

### <End of Change R4-2217377 - 5>

### <Start of Change R4-2217388 -1>

## 8.4 OTA performance requirements for PRACH

### 8.4.1 PRACH false alarm probability and missed detection

#### 8.4.1.1 Definition and applicability

The performance requirement of PRACH for preamble detection is determined by the two parameters: total probability of false detection of the preamble (Pfa) and the probability of detection of preamble (Pd). The performance is measured by the required SNR at probability of detection, Pd of 99%. Pfa shall be 0.1% or less.

Pfa is defined as a conditional total probability of erroneous detection of the preamble (i.e. erroneous detection from any detector) when input is only noise.

Pd is defined as conditional probability of detection of the preamble when the signal is present. The erroneous detection consists of several error cases – detecting only different preamble(s) than the one that was sent, not detecting any preamble at all, or detecting the correct preamble but with the out-of-bounds timing estimation value. For AWGN, TDLC300-100, TDLA30-10, TDLA30-300, TDLA30-650, and TDLA10-650, a timing estimation error occurs if the estimation error of the timing of the strongest path is larger than the time error tolerance values given in table 8.4.1.1-1.

Table 8.4.1.1-1: Time error tolerance for AWGN, TDLC300-100, TDLA30-10, TDLA30-300, TDLA30-650 and TDLA10-650

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PRACH | PRACH SCS |  | Time error tolerance | | | | |
| preamble | (kHz) | AWGN | TDLC300-100 | TDLA30-10 | TDLA30-300 | TDLA30-650 | TDLA10-650 |
| 0 | 1.25 | 1.04 us | 2.55 us | N/A | N/A | N/A | N/A |
| A1, A2, A3, B4, C0, C2 | 15 | 0.52 us | 2.03 us | 0.67 us | N/A | N/A | N/A |
|  | 30 | 0.26 us | 1.77 us | 0.41 us | N/A | N/A | N/A |
|  | 60 (FR2) | 0.13 us | N/A | N/A | 0.28 us | N/A | N/A |
|  | 120 | 0.07 us | N/A | N/A | 0.22 us | 0.22 us | N/A |
|  | 480 | 18 ns | N/A | N/A | N/A | N/A | 68 ns |

The test preambles for normal mode are listed in table A.6-1 and A.6-2. The test preambles for high speed train restricted set type A are listed in table A.6-3 and the test preambles for high speed train restricted set type B are listed in table A.6-4. The test preambles for high speed train short formats are listed in table A.6-5.

### <End of Change R4-2217388 -1>

### <Start of Change R4-2217388 -2>

##### 8.4.1.4.2 Procedure

1) Place the BS with its manufacturer declared coordinate system reference point in the same place as calibrated point in the test system, as shown in annex E.3.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Set the BS in the declared direction to be tested.

4) Connect the BS tester generating the wanted signal, multipath fading simulators and AWGN generators to a test antenna via a combining network in OTA test setup, as shown in annex E.3. Each of the demodulation branch signals should be transmitted on one polarization of the test antenna(s).

5) The characteristics of the wanted signal shall be configured according to the corresponding UL reference measurement channel defined in annex A and the test parameter *msg1-FrequencyStart* is set to 0.

6) The multipath fading emulators shall be configured according to the corresponding channel model defined in annex J.

7) Adjust the AWGN generator, according to the SCS and channel bandwidth. The power level for the transmission may be set such that the AWGN level at the RIB is equal to the AWGN level in table 8.4.1.4.2-1.

Table 8.4.1.4.2-1: AWGN power level at the BS input

|  |  |  |  |
| --- | --- | --- | --- |
| BS type | Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| BS type 1-O (Note 4) | 15 | 5 | -83.5 - ΔOTAREFSENS dBm / 4.5MHz |
|  |  | 10 | -80.3 - ΔOTAREFSENS dBm / 9.36MHz |
|  |  | 20 | -77.2 - ΔOTAREFSENS dBm / 19.08MHz |
|  | 30 | 10 | -80.6 - ΔOTAREFSENS dBm / 8.64MHz |
|  |  | 20 | -77.4 - ΔOTAREFSENS dBm / 18.36MHz |
|  |  | 40 | -74.2 - ΔOTAREFSENS dBm / 38.16MHz |
|  |  | 100 | -70.1 - ΔOTAREFSENS dBm / 98.28MHz |
| BS type 2-O (Note 5) | 60 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 47.52 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  | 120 | 50 | EISREFSENS\_50M + ΔFR2\_REFSENS + 15 dBm / 46.08 MHz |
|  |  | 100 | EISREFSENS\_50M + ΔFR2\_REFSENS + 18 dBm / 95.04 MHz |
|  |  | 200 | EISREFSENS\_50M + ΔFR2\_REFSENS + 21 dBm / 190.08 MHz |
|  | 480 | 400 | FFS |
| NOTE 1: ΔOTAREFSENS as declared in D.53 in table 4.6-1 and clause 7.1.  NOTE 2: ΔFR2\_REFSENS = -3 dB as described in clause 7.1, since the OTA REFSENS receiver target reference direction (as declared in D.54 in table 4.6-1) is used for testing.  NOTE 3: EISREFSENS\_50M as declared in D.28 in table 4.6-1.  NOTE 4: The AWGN power level contains an AWGN offset of 16dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 16dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level.  NOTE 5: The AWGN power level contains an AWGN offset of 15dB by default. If needed for test purposes, the AWGN level can be reduced from the default by any value in the range 0dB to 15dB. Changing the AWGN level does not impact the validity of the test, as it reduces the effective base band SNR level. | | | |

8) Adjust the frequency offset of the test signal according to table 8.4.1.5.1-1 or 8.4.1.5.1-2 or 8.4.1.5.1-3 or 8.4.1.6.1-1 or 8.4.1.6.1-2 or 8.4.1.6.1-3 or 8.4.1.6.1-4 or 8.4.1.5.2-1 or 8.4.1.5.2-2 or 8.4.1.5.2-3 or 8.4.1.5.2-4 or 8.4.1.5.2-5 or 8.4.1.7.1-1 or 8.4.1.7.1-2 or 8.4.1.6.2-1 or 8.4.1.7.x-1 or 8.4.1.7.x-2 or 8.4.1.7.x-3.

9) Adjust the equipment so that the SNR specified in table 8.4.1.5.1-1 or 8.4.1.5.1-2 or 8.4.1.5.1-3 or 8.4.1.6.1-1 or 8.4.1.6.1-2 or 8.4.1.6.1-3 or 8.4.1.6.1-4 or 8.4.1.5.2-1 or 8.4.1.5.2-2 or 8.4.1.5.2-3 or 8.4.1.5.2-4 or 8.4.1.5.2-5 or 8.4.1.7.1-1 or 8.4.1.7.1-2 or 8.4.1.6.2-1 or 8.4.1.7.x-1 or 8.4.1.7.x-2 or 8.4.1.7.x-3 is achieved at the BS input during the PRACH preambles.

10) The test signal generator sends a preamble and the receiver tries to detect the preamble. This pattern is repeated as illustrated in figure 8.4.1.4.2-1. The preambles are sent with certain timing offsets as described below. The following statistics are kept: the number of preambles detected in the idle period and the number of missed preambles.



Figure 8.4.1.4.2-1: PRACH preamble test pattern

Unless otherwise stated, the timing offset base value for PRACH preamble format 0 is set to 50% of Ncs. This offset is increased within the loop, by adding in each step a value of 0.1us, until the end of the tested range, which is 0.9us. Then the loop is being reset and the timing offset is set again to 50% of Ncs. The timing offset scheme for PRACH preamble format 0 is presented in Figure 8.4.1.4.2-2.



Figure 8.4.1.4.2-2: Timing offset scheme for PRACH preamble format 0

Unless otherwise stated, the timing offset base value for PRACH preamble format A1, A2, A3, B4, C0 and C2 is set to 0. This offset is increased within the loop, by adding in each step a value of 0.1us, until the end of the tested range, which is 0.8us. Then the loop is being reset and the timing offset is set again to 0. The timing offset scheme for PRACH preamble format A1, A2, A3, B4, C0 and C2 is presented in Figure 8.4.1.4.2-3 for 15 kHz, 30 kHz, 60 kHz, and 120 kHz SCS.



Figure 8.4.1.4.2-3: Timing offset scheme for PRACH preamble format A1 A2, A3, B4, C0 and C2 using 15 kHz, 30 kHz, 60 kHz, and 120 kHz SCS

For test requirement specified in Table 8.4.1.6.2-1, the timing offset base value for PRACH preamble format C2 is set to 0. This offset is increased within the loop, by adding in each step a value of 0.48us, until the end of the tested range, which is 4.8us. Then the loop is being reset and the timing offset is set again to 0. The timing offset scheme for PRACH preamble format C2 is presented in Figure 8.4.1.4.2-4.

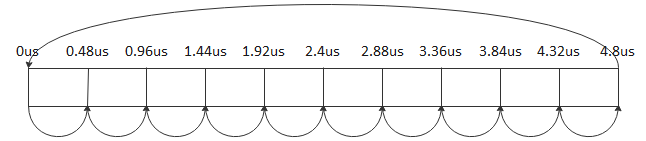


Figure 8.4.1.4.2-4: Timing offset scheme for PRACH preamble format C2

For test requirements with 480 kHz SCS, the timing offset base value for PRACH preamble format A2, B4, and C2 is set to 0. This offset is increased within the loop, by adding in each step a value of 0.1us, until the end of the tested range, which is 0.8us. Then the loop is being reset and the timing offset is set again to 0. The timing offset scheme for PRACH preamble format A2, B4, and C2 is presented in Figure 8.4.1.4.2-x.



Figure 8.4.1.4.2-x: Timing offset scheme for PRACH preamble format A2, B4, and C2 using 480 kHz SCS

### <End of Change R4-2217388 -2>

### <Start of Change R4-2217388 -3>

##### 8.4.1.5.2 Test requirement for *BS type 2-O*

Pfa shall not exceed 0.1%. Pd shall not be below 99% for the SNRs in tables 8.4.1.5.2-1 to 8.4.1.5.2-5.

Table 8.4.1.5.2-1: PRACH missed detection test 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 J) | offset | Burst format A1 | Burst format A2 | Burst format A3 | Burst format B4 | Burst format C0 | Burst format C2 |
| 1 | 2 | AWGN | 0 | -8.6 | -11.6 | -13.2 | -15.5 | -5.7 | -11.5 |
|  |  | TDLA30-300 Low | 4000 Hz | -1.0 | -3.2 | -4.2 | -6.3 | 1.7 | -3.3 |

Table 8.4.1.5.2-2: PRACH missed detection test 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 J) | offset | Burst format A1 | Burst format A2 | Burst format A3 | Burst format B4 | Burst format C0 | Burst format C2 |
| 1 | 2 | AWGN | 0 | -8.4 | -11.2 | -13.0 | -15.5 | -5.5 | -11.1 |
|  |  | TDLA30-300 Low | 4000 Hz | -1.1 | -3.8 | -5.2 | -6.9 | 1.8 | -3.6 |

Table 8.4.1.5.2-3: 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 | FFS | FFS | FFS |

Table 8.4.1.5.2-4: 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 | FFS | FFS | FFS |

### <End of Change R4-2217388 -3>

### <Start of Change R4-2217388 -4>

#### 8.4.1.7 Test requirement for PRACH with LRA=1151 and LRA=571

##### 8.4.1.7.1 Test requirement for *BS type 1-O*

Pfa shall not exceed 0.1%. Pd shall not be below 99% for the SNRs in tables 8.4.1.7.1-1 to 8.4.1.7.1-4.

Table 8.4.1.7.1-1: Missed detection requirements for PRACH with LRA=1151, 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 | -20.8 | -24.8 | -20.8 |
|  |  | TDLA30-10 Low | 400 Hz | -14.5 | -17.7 | -14.6 |

Table 8.4.1.7.1-2: Missed detection requirements for PRACH with LRA=571, 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 | -17.8 | -21.7 | -17.8 |
|  |  | TDLA30-10 Low | 400 Hz | -11.5 | -15.2 | -11.5 |

##### 8.4.1.7.x Test requirement for *BS type 2-O*

Pfa shall not exceed 0.1%. Pd shall not be below 99% for the SNRs in tables 8.4.1.7.x-1 to 8.4.1.7.x-3.

Table 8.4.1.7.x-1: Missed detection requirements for PRACH with LRA=571, 120 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 | FFS | FFS | FFS |

Table 8.4.1.7.x-2: Missed detection requirements for PRACH with LRA=1151, 120 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 | FFS | FFS | FFS |

Table 8.4.1.7.x-3: Missed detection requirements for PRACH with LRA=571, 480 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 | FFS | FFS | FFS |

Annex A (normative):  
Reference measurement channels

### <End of Change R4-2217388 - 4>

### <Start of Change R4-2217379 - 1>

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

The parameters for the reference measurement channels 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, no additional DM-RS 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, no additional DM-RS 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 |
| 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 symbols 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 as per table 6.4.1.1.3-3 of TS 38.211 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [19]. | | | | |

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 parameters for FR2-2 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 UL timing adjustment, 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 [5].  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 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [19]. | | | | |

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A4-31A | G-FR1-A4-31 | G-FR1-A4-32A | G-FR1-A4-32 |
| Subcarrier spacing [kHz] | 15 | 15 | 30 | 30 |
| Allocated resource blocks | 12 | 25 | 12 | 50 |
| 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) | 4032 | 8456 | 4032 | 16896 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | - | 24 | - | 24 |
| Number of code blocks - C | 1 | 2 | 1 | 3 |
| Code block size including CRC (bits) (Note 2) | 4056 | 4264 | 4056 | 5664 |
| Total number of bits per slot | 6336 | 13200 | 6336 | 26400 |
| Total data bearing resource elements per slot | 1584 | 3300 | 1584 | 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, *l0* = 0 for PUSCH mapping type B, as per table 6.4.1.1.3-3 of TS 38.211 [5].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [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 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [19]. | | | | | | | |

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 [20].  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.  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 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in 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 | 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 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [19].  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 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [19].  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 for FR1 PUSCH performance requirements 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 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [19]. | | | | | | | |

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 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [19].  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 [20].  NOTE 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [19].  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 FR1interlaced 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 [5].  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 R4-2217379 - 1>

### <Start of Change R4-2217390 - 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.6-7: 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 120kHz and 480kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Burst format | SCS (kHz) | LRA | Ncs | Logical sequence index | v |
| A2,  , B4, C2 | 120 | 571 | 285 | 0 | 0 |
| 120 | 1151 | 575 | 0 | 0 |
| 480 | 139 | 69 | 0 | 0 |
| 480 | 571 | 285 | 0 | 0 |

### <End of Change R4-2217390 - 1>

### <Start of Change R4-2217390 - 2>

# J.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 (410 MHz - 7.125GHz), FR2 and FR2-2 (52.6GHz – 71 GHz).

## J.2.1 Delay profiles

The delay profiles are simplified from the TR 38.901 [23] 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 annex J.2.1.1 and J.2.1.2 can be used as such.

Step 1: Use the original TDL model from TR 38.901 [23].

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 [23].

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.

- 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.

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

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

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

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

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

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

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

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

### J.2.1.2 Delay profiles for FR2

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

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

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

Table J.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 J.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 J.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. | | | |

## J.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 J.2.2-1 and J.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, FR2 (24.25 GHz – 71 GHz), respectively.

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

|  |  |  |
| --- | --- | --- |
| Combination name | 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 J.2.2-2: Channel model parameters for FR2

|  |  |  |
| --- | --- | --- |
| Combination name | 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 |

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