**3GPP TSG-RAN WG4 Meeting #104-bis-e *draftR4-2217377***

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

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.141-2** | **CR** | **DRAFT** | **rev** | **-** | **Current version:** | **17.7.0** |  |
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| *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:***  | Draft CR 38.141-2: PUCCH requirements for FR2-2 |
|  |  |
| ***Source to WG:*** | Nokia, Nokia Shanghai Bell, Intel Corporation |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_ext\_to\_71GHz-Perf |  | ***Date:*** | 2022-10-14 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | Introduction of the structure of the PUCCH requirements for FR2-2 |
|  |  |
| ***Summary of change:*** | Proposal for scheleton of PUSCH requirements |
|  |  |
| ***Consequences if not approved:*** | No PUCCH requirements for FR2-2 |
|  |  |
| ***Clauses affected:*** | 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **x** |  Test specifications |  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

***<Start of change 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: 1FR2-2: 1, 16 |
| First PRB prior to frequency hopping | 0 | 0 |
| Intra-slot frequency hopping | N/A for 1 symbolEnabled for 2 symbols | N/A for 1 symbolEnabled 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 symbol12 for 2 symbols | 13 for 1 symbol12 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 1>***

***<Start of change 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: 1FR2-2: 1, 16 |
| Number of symbols | 14 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index - (nrofPRBs - 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 |

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: 1FR2-2: 1, 16 |
| Number of symbols | 14 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index – (nrofPRBs – 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 |

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 2>***

***<Start of change 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 3>***

***<Start of change 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 4>***

***<Start of change 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: 1FR2-2: 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 | 10MHz | 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 5>***