**3GPP TSG-RAN WG4 Meeting #100-e *R4-2115712***

**Online, , August 16 - 27, 2021**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **38.176-1** | **CR** | **DraftCR** | **rev** | **1** | **Current version:** | **16.0.0** |  |
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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:*** | draftCR to TS 38.176-1 IAB-DU performance requirements | | | | | | | | | |
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| ***Source to WG:*** | Nokia, Nokia Shanghai Bell | | | | | | | | | |
| ***Source to TSG:*** | R4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_IAB-Perf | | | | |  | ***Date:*** | | | 2021-08-24 |
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| ***Category:*** | **F** |  | | | | | ***Release:*** | | | Rel-16 |
|  | *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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
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| ***Reason for change:*** | | Provide corrections to the first published version of the TS sections on IAB-DU perefomance requirements as per work split | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | 1. Editorial changes to the references and tables 2. Removal of 5MHz CBW 3. Voding applicability rules | | | | | | | | |
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| ***Consequences if not approved:*** | | It will be inconsistencies in the specification 38.176-1 | | | | | | | | |
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| ***Clauses affected:*** | | 8.1 | | | | | | | | |
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|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | 38.174 | | |
| ***affected:*** | | **X** |  | Test specifications | | | | 38.176-2 | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | | Agenda item 6.1.2.6.2 - IAB-DU performance requirements | | | | | | | | |
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| ***This CR's revision history:*** | | Revision of R4-2114540 | | | | | | | | |

**<<start of change>>**

### 8.1.2 Performance requirements for PUSCH

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

##### 8.1.2.1.1 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 IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.2.

##### 8.1.2.1.2 Minimum requirement

The minimum requirement is in TS 38.174 [2] clause 8.1.2.1.

##### 8.1.2.1.3 Test purpose

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

##### 8.1.2.1.4 Method of test

8.1.2.1.4.1 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.

8.1.2.1.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the channel bandwidth, defined in table 8.1.2.1.4.2-1.

Table 8.1.2.1.4.2-1: AWGN power level at the IAB-DU input

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3) The characteristics of the wanted signal shall be configured according to the corresponding UL reference measurement channel defined in annex A and the test parameters in table 8.2.1.4.2-2.

Table 8.2.1.4.2-2: Test parameters for testing PUSCH

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| Parameter | | Value |
| Transform precoding | | Disabled |
| Cyclic prefix | | Normal |
| Default TDD UL-DL pattern (Note 1) | | 15 kHz SCS:  3D1S1U, S=10D:2G:2U  30 kHz SCS:  7D1S2U, S=6D:4G:4U |
| HARQ | Maximum number of HARQ transmissions | 4 |
|  | RV sequence | 0, 2, 3, 1 |
| DM-RS | DM-RS configuration type | 1 |
|  | DM-RS duration | single-symbol DM-RS |
|  | Additional DM-RS position | pos1 |
|  | Number of DM-RS CDM group(s) without data | 2 |
|  | Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
|  | DM-RS port(s) | {0}, {0, 1} |
|  | DM-RS sequence generation | NID0=0, nSCID =0 |
| Time domain resource assignment | PUSCH mapping type | A, B |
|  | Start symbol | 0 |
|  | Allocation length | 14 |
| Frequency domain resource assignment | RB assignment | Full applicable test bandwidth |
|  | Frequency hopping | Disabled |
| TPMI index for 2Tx two layer spatial multiplexing transmission | | 0 |
| Code block group based PUSCH transmission | | Disabled |
| NOTE 1: The same requirements are applicable with different UL-DL patterns. | | |

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

5) Adjust the equipment so that required SNR specified in table 8.1.2.1.5-1 to 8.1.2.1.5-14 is achieved at the IAB-DU input.

6) For each of the reference channels in table 8.1.2.1.5-1 to 8.1.2.1.5-14 applicable for the base station, measure the throughput.

##### 8.1.2.1.5 Test requirement

The throughput measured according to clause 8.1.2.1.4.2 shall not be below the limits for the SNR levels specified in table 8.1.2.1.5-1 to 8.1.2.1.5-14.

Table 8.1.2.1.5-1: Void



Table 8.1.2.1.5-2: Test requirements for PUSCH with 70% of maximum throughput, Type A, 10 MHz channel bandwidth, 15 kHz SCS

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Table 8.1.2.1.5-3: Test requirements for PUSCH with 70% of maximum throughput, Type A, 20 MHz channel bandwidth, 15 kHz SCS

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Table 8.1.2.1.5-4: Test requirements for PUSCH with 70% of maximum throughput, Type A, 10 MHz channel bandwidth, 30 kHz SCS

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Table 8.1.2.1.5-5: Test requirements for PUSCH with 70% of maximum throughput, Type A, 20 MHz channel bandwidth, 30 kHz SCS

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Table 8.1.2.1.5-6: Test requirements for PUSCH with 70% of maximum throughput, Type A, 40 MHz channel bandwidth, 30 kHz SCS

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Table 8.1.2.1.5-7: Test requirements for PUSCH with 70% of maximum throughput, Type A, 100 MHz channel bandwidth, 30 kHz SCS

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Table 8.1.2.1.5-8: Void



Table 8.1.2.1.5-9: Test requirements for PUSCH with 70% of maximum throughput, Type B, 10 MHz channel bandwidth, 15 kHz SCS

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Table 8.1.2.1.5-10: Test requirements for PUSCH with 70% of maximum throughput, Type B, 20 MHz channel bandwidth, 15 kHz SCS

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Table 8.1.2.1.5-11: Test requirements for PUSCH with 70% of maximum throughput, Type B, 10 MHz channel bandwidth, 30 kHz SCS

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Table 8.1.2.1.5-12: Test requirements for PUSCH with 70% of maximum throughput, Type B, 20 MHz channel bandwidth, 30 kHz SCS

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Table 8.1.2.1.5-13: Test requirements for PUSCH with 70% of maximum throughput, Type B, 40 MHz channel bandwidth, 30 kHz SCS

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Table 8.1.2.1.5-14: Test requirements for PUSCH with 70% of maximum throughput, Type B, 100 MHz channel bandwidth, 30 kHz SCS

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

##### 8.1.2.2.1 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 IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.2.

##### 8.1.2.2.2 Minimum requirement

The minimum requirement is in TS 38.174 [2], clause 8.1.2.2.

##### 8.1.2.2.3 Test purpose

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

##### 8.1.2.2.4 Method of test

8.1.2.2.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

8.1.2.2.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the SCS and channel bandwidth, defined in table 8.1.2.2.4.2-1.

Table 8.1.2.2.4.2-1: AWGN power level at the IAB-DU input

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| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -86.5 dBm / 4.5MHz |
| 30 | 10 | -83.6 dBm / 8.64MHz |

3) The characteristics of the wanted signal shall be configured according to the corresponding UL reference measurement channel defined in annex A and the test parameters in table 8.1.2.2.4.2-2.

Table 8.1.2.2.4.2-2: Test parameters for testing PUSCH

|  |  |  |
| --- | --- | --- |
| Parameter | | Value |
| Transform precoding | | Enabled |
| Cyclic prefix | | Normal |
| Default TDD UL-DL pattern (Note 1) | | 15 kHz SCS:  3D1S1U, S=10D:2G:2U  30 kHz SCS:  7D1S2U, S=6D:4G:4U |
| HARQ | Maximum number of HARQ transmissions | 4 |
|  | RV sequence | 0, 2, 3, 1 |
| DM-RS | DM-RS configuration type | 1 |
|  | DM-RS duration | single-symbol DM-RS |
|  | Additional DM-RS position | pos1 |
|  | Number of DM-RS CDM group(s) without data | 2 |
|  | Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
|  | DM-RS port(s) | 0 |
|  | DM-RS sequence generation | NID0=0, group hopping and sequence hopping are disabled |
| Time domain resource assignment | PUSCH mapping type | A, B |
|  | Start symbol | 0 |
|  | Allocation length | 14 |
| 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 |
|  | Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| NOTE 1: The same requirements are applicable to different UL-DL patterns. | | |

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

5) Adjust the equipment so that required SNR specified in table 8.1.2.2.5-1 to 8.1.2.2.5-4 is achieved at the IAB-DU input.

6) For each of the reference channels in table 8.1.2.2.5-1 to 8.1.2.2.5-4 applicable for the base station, measure the throughput.

##### 8.1.2.2.5 Test requirement

The throughput measured according to clause 8.1.2.2.4.2 shall not be below the limits for the SNR levels specified in table 8.1.2.2.5-1 to 8.1.2.2.5-4.

Table 8.1.2.2.5-1: Test requirements for PUSCH with 70% of maximum throughput, Type A, 5 MHz channel bandwidth, 15 kHz SCS

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Table 8.1.2.2.5-2: Test requirements for PUSCH with 70% of maximum throughput, Type A, 10 MHz channel bandwidth, 30 kHz SCS

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Table 8.1.2.2.5-3: Test requirements for PUSCH with 70% of maximum throughput, Type B, 5 MHz channel bandwidth, 15 kHz SCS

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Table 8.1.2.2.5-4: Test requirements for PUSCH with 70% of maximum throughput, Type B, 10 MHz channel bandwidth, 30 kHz SCS

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#### 8.1.2.3 Performance requirements for UCI multiplexed on PUSCH

##### 8.1.2.3.1 Definition and applicability

The performance requirement of UCI multiplexed on PUSCH is determined by two parameters: block error probability (BLER) of CSI part 1 and block error probability of CSI part 2. The performance is measured by the required SNR at block error probability of CSI part 1 not exceeding 0.1 %, and the required SNR at block error probability of CSI part 2 not exceeding 1 %.

The CSI part 1 BLER is defined as the probability of incorrectly decoding the CSI part 1 information when the CSI part 1 information is sent.

The CSI part 2 BLER is defined as the probability of incorrectly decoding the CSI part 2 information when the CSI part 2 information is sent.

In the test of UCI multiplexed on PUSCH, the UCI information only contains CSI part 1 and CSI part 2 information, there is no HACK/ACK information transmitted.

The number of UCI information bit payload per slot is defined for two cases as follows:

- 7 bits: 5 bits in CSI part 1, 2 bits in CSI part 2,

- 40 bits: 20 bits in CSI part 1, 20 bits in CSI part 2.

The 7 bits UCI information case is further defined with the bitmap [c0 c1 c2 c3 c4] = [0 1 0 1 0] for CSI part 1 information, where c0 is mapping to the RI information, and with the bitmap [c0 c1] = [1 0] for CSI part 2 information.

The 40 bits UCI information case is assumed random information bit selection.

In both tests, PUSCH data, CSI part 1 and CSI part 2 are transmitted simultaneously.

Which specific test(s) is applicable to IAB-DU is based on the test applicability rule defined in clause 8.1.1.2.2.

##### 8.1.2.3.2 Minimum requirement

The minimum requirements are in TS 38.174 [2] clause 8.1.2.3.

##### 8.1.2.3.3 Test purpose

The test shall verify the receiver's ability to detect UCI with CSI part 1 and CSI part 2 bits multiplexed on PUSCH under multipath fading propagation conditions for a given SNR.

##### 8.1.2.3.4 Method of test

8.1.2.3.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

8.1.2.3.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to combination of SCS and channel bandwidth defined in table 8.1.2.3.4.2-1.

Table 8.2.3.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
| **Sub-carrier spacing (kHz)** | **Channel bandwidth (MHz)** | **AWGN power level** |
| 30 | 10 | -80.6 dBm / 8.64 MHz |

3) The characteristics of the wanted signal shall be configured according to the corresponding UL reference measurement channel defined in annex A and the specific test parameters are configured as below. The UCI information bit payload per slot is equal to 7 bits with CSI part 1 5bits, CSI part 2 2bit; and the UCI information bit payload per slot is equal to 40 bits with CSI part 1 20bits, CSI part 2 20bits.

Table: 8.1.2.3.4.2-2: Test parameters for testing UCI multiplexed on PUSCH

|  |  |  |
| --- | --- | --- |
| Parameter | | Value |
| Transform precoding | | Disabled |
| Cyclic prefix | | Normal |
| Default TDD UL-DL pattern (Note 1) | | 30 kHz SCS:  7D1S2U, S=6D:4G:4U |
| HARQ | Maximum number of HARQ transmissions | 1 |
|  | RV sequence | 0 |
| DM-RS | DM-RS configuration type | 1 |
|  | DM-RS duration | Single-symbol DM-RS |
|  | Additional DM-RS position | pos1 |
|  | Number of DM-RS CDM group(s) without data | 2 |
|  | Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
|  | DM-RS port(s) | {0} |
|  | DM-RS sequence generation | *NID0* = 0, *nSCID* = 0 |
| Time domain resource assignment | PUSCH mapping type | A, B |
|  | Start symbol | 0 |
|  | Allocation length | 14 |
| Frequency domain resource assignment | RB assignment | Full applicable test bandwidth |
|  | Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| UCI | Number of CSI part 1 and CSI part 2 information bit payload | {5,2}, {20, 20} |
|  | *scaling* | 1 |
|  | *betaOffsetACK-Index1* | 11 |
|  | *betaOffsetCSI-Part1-Index1 and betaOffsetCSI-Part1-Index2* | 13 |
|  | *betaOffsetCSI-Part2-Index1 and betaOffsetCSI-Part2-Index2* | 13 |
|  | UCI partition for frequency hopping | Disabled |
| NOTE 1: The same requirements are applicable to different UL-DL patterns. | | |

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

5) Adjust the equipment so that required SNR specified in table 8.1.2.3.5-1 to 8.1.2.3.5-4 is achieved at the IAB-DU input during the UCI multiplexed on PUSCH transmissions.

6) The tester sends a test pattern where UCI with CSI part 1 and CSI part 2 information can be multiplexed on PUSCH. The following statistics are kept: the number of incorrectly decoded CSI part 1 information transmission, the number of incorrectly decoded CSI part 2 information transmission during UCI multiplexed on PUSCH transmission.

##### 8.1.2.3.5 Test requirement

The fractional of incorrectly decoded UCI with CSI part 1 according to clause 8.1.2.3.4.2 shall be less than 0.1 % for SNR listed in table 8.1.2.3.5-1 and table 8.1.2.3.5-2. The fractional of incorrectly decoded UCI with CSI part 2 according to clause 8.1.2.3.4.2 shall be less than 1 % for SNR listed in table 8.1.2.3.5-3 and table 8.1.2.3.5-4.

Table 8.1.2.3.5-1: Test requirements for UCI multiplexed on PUSCH, Type A, CSI part 1, 10 MHz channel bandwidth, 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Table 8.1.2.3.5-2: Test requirements for UCI multiplexed on PUSCH, Type B, CSI part 1, 10 MHz channel bandwidth, 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Table 8.1.2.3.5-3: Test requirements for UCI multiplexed on PUSCH, Type A, CSI part 2, 10 MHz channel bandwidth, 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Table 8.1.2.3.5-4: Test requirements for UCI multiplexed on PUSCH, Type B, CSI part 2, 10 MHz channel bandwidth, 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

### 8.1.3 Performance requirements for PUCCH

#### 8.1.3.1 Performance requirements for PUCCH format 0

##### 8.1.3.1.1 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 [23] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

Which specific test(s) are applicable to IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.3.

##### 8.1.3.1.2 Minimum requirement

The minimum requirements are in TS 38.174 [2] clause 8.1.3.2.

##### 8.1.3.1.3 Test purpose

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

##### 8.1.3.1.4 Method of test

8.1.3.1.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

8.1.3.1.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the channel bandwidth and sub-carrier spacing defined in table 8.1.3.1.4.2-1.

Table 8.1.3.1.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 |  |  |
|  |  |  |
|  |  |  |
| 30 |  |  |
|  |  |  |
|  |  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9] and the specific test parameters are configured as mentioned in table 8.1.3.1.4.2-2:

Table 8.1.3.1.4.2-2: Test Parameters

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

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

5) Adjust the equipment so that the SNR specified in table 8.1.3.1.5-1 or table 8.1.3.1.5-2 is achieved at the IAB-DU input during the ACK transmissions.

6) The tester sends a test pattern with the pattern outlined in figure 8.1.3.1.4.2-1. The following statistics are kept: the number of ACKs detected in the idle periods and the number of missed ACKs.



Figure 8.1.3.1.4.2-1: Test signal pattern for single user PUCCH format 0 demodulation tests

##### 8.1.3.1.5 Test requirement

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 8.1.3.1.5-1 and in table 8.1.3.1.5-2.

Table 8.1.3.1.5-1: Test requirements for PUCCH format 0 and 15 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | | | |
|  |  |  |  |  | |  | |
|  |  |  |  |  | |  | |
|  |  | |  | |
|  |  |  |  |  | |  | |
|  |  | |  | |
|  |  |  |  |  | |  | |
|  |  | |  | |

Table 8.1.3.1.5-2: Test requirements for PUCCH format 0 and 30 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number | Number | Propagation conditions | Number of | Channel bandwidth / SNR (dB) | | | |
| of TX antennas | of RX antennas | and correlation matrix  (annex F) | OFDM symbols | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
| 1 | 2 | TDLC-300-100 Low | 1 | 10.4 | 10.4 | 10.1 | 9.8 |
| 2 | 4.8 | 4.2 | 4.4 | 4.1 |
| 1 | 4 | TDLC-300-100 Low | 1 | 4.0 | 4.0 | 3.6 | 3.9 |
| 2 | 0.3 | 0.2 | 0.1 | -0.2 |
| 1 | 8 | TDLC-300-100 Low | 1 | -0.4 | -0.4 | -0.5 | -0.4 |
| 2 | -3.1 | -3.2 | -3.4 | -3.3 |

#### 8.1.3.2 Performance requirements for PUCCH format 1

##### 8.1.3.2.1 NACK to ACK detection

8.1.3.2.1.1 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 [23] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

Which specific test(s) are applicable to IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.3.

8.1.3.2.1.2 Minimum requirement

The minimum requirement is in TS 38.174 [2] clause 8.1.3.3.1

8.1.3.2.1.3 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.

8.1.3.2.1.4 Method of test

8.1.3.2.1.4.1 Initial conditions

Test environment: Normal; see annex B.2.

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

8.1.3.2.1.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the combinations of SCS and channel bandwidth defined in table 8.1.3.2.1.4.2-1.

Table 8.1.3.2.1.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 kHz |  |  |
|  |  |
|  |  |  |
|  |  |
|  |  |
|  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9], and the specific test parameters are configured as below:

Table 8.1.3.2.1.4.2-2: Test parameters

|  |  |
| --- | --- |
| Parameter | Values |
| Cyclic prefix | Normal |
| Number of information bits | 2 |
| Number of PRBs | 1 |
| 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 |

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

5) Adjusting the equipment so that the SNR specified in table 8.1.3.2.1.5-1 and table 8.1.3.2.1.5-2 is achieved at the IAB-DU input during the transmissions.

6) 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.

8.1.3.2.1.5 Test requirement

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 8.1.3.2.1.5-1 and table 8.1.3.2.1.5-2.

Table 8.1.3.2.1.5-1: Required SNR for PUCCH format 1 with 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | | | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |

Table 8.1.3.2.1.5-2: Required SNR for PUCCH format 1 with 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number | Propagation | Channel bandwidth / SNR (dB) | | | |
| of TX antennas | of RX antennas | conditions and correlation matrix (annex F) | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
|  | 2 | TDLC-300-100 Low | -2.2 | -2.7 | -3.3 | -2.9 |
| 1 | 4 | TDLC-300-100 Low | -7.5 | -7.7 | -6.9 | -7.4 |
|  | 8 | TDLC-300-100 Low | -10.9 | -10.6 | -10.1 | -10.7 |

##### 8.1.3.2.2 ACK missed detection

8.1.3.2.2.1 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 [23] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

Which specific test(s) are applicable to IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.3.

8.1.3.2.2.2 Minimum requirement

The minimum requirement is in TS 38.174 [2] clause 8.1.3.3.2

8.1.3.2.2.3 Test purpose

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

8.1.3.2.2.4 Method of test

8.1.3.2.2.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested: for single carrier (SC): M; see clause 4.9.1.

8.1.3.2.2.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the combinations of SCS and channel bandwidth defined in table 8.1.3.2.2.4.2-1.

Table 8.1.3.2.2.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 kHz |  |  |
|  |  |
|  |  |  |
|  |  |
|  |  |
|  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9], and the specific test parameters are configured as below:

Table 8.3.2.2.4.2-2: Test parameters

|  |  |
| --- | --- |
| Parameter | Values |
| Cyclic prefix | Normal |
| Number of information bits | 2 |
| Number of PRBs | 1 |
| Number of symbols | 14 |
| First PRB prior to frequency hopping | 0 |
| Intra-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 |

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

5) Adjusting the equipment so that the SNR specified in table 8.3.2.2.5-1 and table 8.3.2.2.5-2 is achieved at the IAB-DU input during the transmissions.

6) The tester 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 8.1.3.2.1.4.2 for NACK to ACK detection. Both statistics are measured in the same testing.

8.1.3.2.2.5 Test requirement

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 8.1.3.2.2.5-1 and table 8.1.3.2.2.5-2.

Table 8.1.3.2.2.5-1 Required SNR for PUCCH format 1 with 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | | | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |

Table 8.1.3.2.2.5-2 Required SNR for PUCCH format 1 with 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number | Propagation | Channel bandwidth / SNR (dB) | | | |
| of TX antennas | of RX antennas | conditions and correlation matrix (annex F) | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
|  | 2 | TDLC300-100 Low | -3.3 | -3.8 | -3.8 | -3.6 |
| 1 | 4 | TDLC300-100 Low | -7.4 | -7.5 | -7.8 | -7.7 |
|  | 8 | TDLC300-100 Low | -10.8 | -10.8 | -10.8 | -10.8 |

#### 8.1.3.3 Performance requirements for PUCCH format 2

##### 8.1.3.3.1 ACK missed detection

8.1.3.3.1.1 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. 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 IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.3.

The transient period as specified in TS 38.101-1 [23] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

8.1.3.3.1.2 Minimum requirement

The minimum requirements are in TS 38.174 [2] clause 8.1.3.4.1

8.1.3.3.1.3 Test purpose

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

8.1.3.3.1.4 Method of test

8.1.3.3.1.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

8.1.3.3.1.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the channel bandwidth defined in table 8.1.3.3.1.4.2-1.

Table 8.1.3.3.1.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 |  |  |
|  |  |
|  |  |  |
|  |  |
|  |  |
|  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9], and the specific test parameters are configured as blow:

Table 8.3.3.1.4.2-2: Test parameters

|  |  |
| --- | --- |
| Parameter | Values |
| Cyclic prefix | Normal |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | N/A |
| First PRB after frequency hopping | The largest PRB index - (Number of PRBs - 1) |
| Number of PRBs | 4 |
| Number of symbols | 1 |
| The number of UCI information bits | 4 |
| First symbol | 13 |
| DM-RS sequence generation | *NID*0=0 |

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

5) Adjust the equipment so that the SNR specified in table 8.1.3.3.1.5-1 and table 8.1.3.3.1.5-2 is achieved at the IAB-DU input during the UCI transmissions.

6) The tester sends a test pattern with the pattern outlined in figure 8.1.3.3.1.4.2-1. The following statistics are kept: the number of ACKs detected in the idle periods and the number of missed ACKs.



Figure 8.1.3.3.1.4.2-1: Test signal pattern for PUCCH format 2 demodulation tests

8.1.3.3.1.5 Test requirement

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 8.1.3.3.1.5-1 and table 8.1.3.3.1.5-2.

Table 8.1.3.3.1.5-1: Required SNR for PUCCH format 2 with 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | | | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |

Table 8.1.3.3.1.5-2: Required SNR for PUCCH format 2 with 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of RX | Propagation | Channel bandwidth / SNR (dB) | | | |
| antennas | antennas | conditions and correlation matrix (annex F) | 10MHz | 20MHz | 40MHz | 100MHz |
|  | 2 | TDLC300-100 Low | 6.1 | 6.2 | 6.1 | 6.3 |
| 1 | 4 | TDLC300-100 Low | 0.9 | 0.8 | 0.9 | 1.0 |
|  | 8 | TDLC300-100 Low | -3.0 | -3.0 | -2.9 | -2.7 |

##### 8.1.3.3.2 UCI BLER performance requirements

8.1.3.3.2.1 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 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 IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.3.

The transient period as specified in TS 38.101-1 [23] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

8.1.3.3.2.2 Minimum requirement

The minimum requirement is TS 38.174 [2] clause 8.1.3.4.2

8.1.3.3.2.3 Test purpose

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

8.1.3.3.2.4 Method of test

8.1.3.3.2.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

8.1.3.3.2.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the channel bandwidth defined in table 8.1.3.3.2.4.2-1.

Table 8.1.3.3.2.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 |  |  |
|  |  |
|  |  |  |
|  |  |
|  |  |
|  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9], and the specific test parameters are configured as blow:

Table 8.1.3.3.2.4.2-2: Test parameters

|  |  |
| --- | --- |
| Parameter | Values |
| Cyclic prefix | Normal |
| 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 |

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

5) Adjust the equipment so that the SNR specified in table 8.1.3.3.2.5-1 or table 8.1.3.3.2.5-2 is achieved at the IAB-DU input during the UCI transmissions.

6) The tester sends a test pattern with the pattern outlined in figure 8.1.3.3.2.4.2-1. The following statistics are kept: the number of incorrectly decoded UCI.



Figure 8.1.3.3.2.4.2-1: Test signal pattern for PUCCH format 2 demodulation tests

8.1.3.3.2.5 Test requirement

The fraction of incorrectly decoded UCI shall be less than 1% for the SNR listed in table 8.1.3.3.2.5-1 and table 8.1.3.3.2.5-2.

Table 8.1.3.3.2.5-1: Required SNR for PUCCH format 2 with 15 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | | | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |
|  |  |  |  | |  | |

Table 8.1.3.3.2.5-2: Required SNR for PUCCH format 2 with 30 kHz SCS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of | Propagation | Channel bandwidth / SNR (dB) | | | |
| antennas | RX antennas | conditions and correlation matrix (annex F) | 10MHz | 20MHz | 40MHz | 100MHz |
|  | 2 | TDLC300-100 Low | 1.1 | 1.7 | 1.0 | 0.9 |
| 1 | 4 | TDLC300-100 Low | -2.7 | -2.3 | -2.7 | -2.8 |
|  | 8 | TDLC300-100 Low | -5.2 | -5.2 | -6.1 | -5.3 |

#### 8.1.3.4 Performance requirements for PUCCH format 3

##### 8.1.3.4.1 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 [23] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

Which specific test(s) are applicable to IAB-DU is based on the test applicability rules defined in clause 8.1.2.2.3.

##### 8.1.3.4.2 Minimum requirement

The minimum requirement is in TS 38.174 [2] clause 8.1.3.5.

##### 8.1.3.4.3 Test purpose

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

##### 8.1.3.4.4 Method of test

8.1.3.4.4.1 Initial conditions

Test environment: Normal; see annex B.2.

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

8.1.3.4.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the subcarrier spacing and channel bandwidth defined in table 8.1.3.4.4.2-1.

Table 8.1.3.4.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 |  |  |
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|  |  |  |
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|  |  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9]. The specific test parameters are configured as below:

Table 8.1.3.4.4.2-2: Test parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Test 1 | Test 2 |
| Cyclic prefix | Normal | |
| 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 |

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

5) Adjust the equipment so that the SNR specified in table 8.1.3.4.5-1 or table 8.1.3.4.5-2 is achieved at the IAB-DU input during the UCI transmissions.

6) The tester sends a test pattern with the pattern outlined in figure 8.1.3.4.4.2-1. The following statistics are kept: the number of incorrectly decoded UCI.



Figure 8.1.3.4.4.2-1: Test signal pattern for PUCCH format 3 demodulation tests

##### 8.1.3.4.5 Test requirement

The fraction of incorrectly decoded UCI is shall be less than 1% for the SNR listed in table 8.1.3.4.5-1 and table 8.1.3.4.5-2.

Table 8.1.3.4.5-1: Required SNR for PUCCH format 3 with 15 kHz SCS

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | | | |
|  |  |  |  |  |  | |  | |
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Table 8.1.3.4.5-2: Required SNR for PUCCH format 3 with 30 kHz SCS

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test Number | Number of TX | Number of RX | Propagation conditions | Additional DM-RS | Channel bandwidth / SNR (dB) | | | |
|  | antennas | antennas | and correlation matrix  (annex F) | configuration | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
| 1 | 1 | 2 | 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 |
| 4 | TDLC300-100 Low | No additional DM-RS | -2.5 | -2.8 | -2.6 | -2.9 |
| Additional DM-RS | -3.1 | -3.5 | -3.4 | -3.6 |
| 8 | TDLC300-100 Low | No additional DM-RS | -6.0 | -6.1 | -6.2 | -6.2 |
| Additional DM-RS | -6.9 | -7.0 | -7.0 | -7.1 |
| 2 | 1 | 2 | TDLC300-100 Low | No additional DM-RS | 2.4 | 2.6 | 2.6 | 2.1 |
| 4 | TDLC300-100 Low | No additional DM-RS | -2.3 | -2.4 | -1.8 | -2.4 |
| 8 | TDLC300-100 Low | No additional DM-RS | -5.8 | -5.4 | -5.8 | -5.6 |

#### 8.1.3.5 Performance requirements for PUCCH format 4

##### 8.1.3.5.1 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 [23] clause 6.3.3.1 is not taken into account for performance requirement testing, where the RB hopping is symmetric to the CC centre, i.e. intra-slot frequency hopping is enabled.

Which specific test(s) are applicable to IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.3.

##### 8.1.3.5.2 Minimum requirement

The minimum requirement is in TS 38.104 [11] clause 8.1.3.6.

##### 8.1.3.5.3 Test purpose

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

##### 8.1.3.5.4 Method of test

8.1.3.5.4.1 Initial conditions

Test environment: Normal; see annex B.2.

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

8.1.3.5.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the subcarrier spacing and channel bandwidth defined in table 8.1.3.5.4.2-1.

Table 8.1.3.5.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
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|  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9]. The test parameters are configured as below:

Table 8.1.3.5.4.2-2: Test parameters

|  |  |
| --- | --- |
| Parameter | Values |
| Cyclic prefix | Normal |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Number of PRBs | 1 |
| 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 |

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

5) Adjust the equipment so that the SNR specified in table 8.1.3.5.5-1 or table 8.1.3.5.5-2 is achieved at the IAB-DU input during the UCI transmissions.

6) The tester sends a test pattern with the pattern outlined in figure 8.1.3.5.4.2-1. The following statistics are kept: the number of incorrectly decoded UCI.



Figure 8.1.3.5.4.2-1: Test signal pattern for PUCCH format 4 demodulation tests

##### 8.1.3.5.5 Test requirement

The fraction of incorrectly decoded UCI is shall be less than 1% for the SNR listed in table 8.1.3.5.5-1 and table 8.1.3.5.5-2.

Table 8.1.3.5.5-1: Required SNR for PUCCH format 4 with 15 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | | | |
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Table 8.1.3.5.5-2: Required SNR for PUCCH format 4 with 30 kHz SCS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of TX | Number of RX | Propagation conditions and | Additional DM-RS configuration | Channel bandwidth / SNR (dB) | | | |
| antennas | antennas | correlation matrix (annex F) |  | 10 MHz | 20 MHz | 40 MHz | 100 MHz |
| 1 | 2 | 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 |
| 4 | TDLC300-100 Low | No additional DM-RS | -1.1 | -1.3 | -1.1 | -1.5 |
| Additional DM-RS | -1.4 | -1.9 | -1.9 | -1.8 |
| 8 | TDLC300-100 Low | No additional DM-RS | -5.0 | -4.9 | -4.9 | -4.9 |
| Additional DM-RS | -5.6 | -5.5 | -5.8 | -5.6 |

#### 8.1.3.6 Performance requirements for multi-slot PUCCH

##### 8.1.3.6.1 Performance requirements for multi-slot PUCCH format 1

8.1.3.6.1.1 NACK to ACK detection

8.1.3.6.1.1.1 Definition and applicability

The performance requirement of multi-slot 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.

Which specific test(s) are applicable to IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.3.

8.1.3.6.1.1.2 Minimum requirement

The minimum requirement is in TS 38.174 [2] clause 8.1.3.7.2.1.

8.1.3.6.1.1.3 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.

8.1.3.6.1.1.4 Method of test

8.1.3.6.1.1.4.1 Initial conditions

Test environment: Normal; see annex B.2.

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

8.1.3.6.1.1.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the combinations of SCS and channel bandwidth defined in Table 8.1.3.6.1.1.4.2-1.

Table 8.1.3.6.1.1.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 |  |  |
|  |  |
|  |  |  |
|  |  |
|  |  |
|  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9], and the specific test parameters are configured as below:

Table 8.1.3.6.1.1.4.2-2: Test parameters for multi-slot PUCCH format 1

|  |  |
| --- | --- |
| Parameter | Test |
| Cyclic prefix | Normal |
| Number of information bits | 2 |
| Number of PRBs | 1 |
| Number of symbols | 14 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | disabled |
| Inter-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 |
| Number of slots for PUCCH repetition | 2 |

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

5) Adjusting the equipment so that the SNR specified in table 8.1.3.6.1.1.5-1 is achieved at the IAB-DU input during the transmissions.

6) The tester 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.

8.1.3.6.1.1.5 Test requirement

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 table 8.1.3.6.1.1.5-1.

Table 8.1.3.6.1.1.5-1: Minimum requirements for multi-slot PUCCH format 1 with 30 kHz SCS

|  |  |  |  |
| --- | --- | --- | --- |
| Number of TX antennas | Number of RX | Propagation conditions and | Channel bandwidth / SNR (dB) |
|  | antennas | correlation matrix (annex F) | 40 MHz |
| 1 | 2 | TDLC-300-100 Low | -5.7 |

8.1.3.6.1.2 ACK missed detection

8.1.3.6.1.2.1 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.

8.1.3.6.1.2.2 Minimum requirement

The minimum requirement is in TS 38.174 [2] clause 8.1.3.7.2.2.

8.1.3.6.1.2.3 Test purpose

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

8.1.3.6.1.2.4 Method of test

8.1.3.6.1.2.4.1 Initial conditions

Test environment: Normal; see annex B.2.

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

8.1.3.6.1.2.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the combinations of SCS and channel bandwidth defined in table 8.1.3.6.1.2.4.2-1.

Table 8.1.3.6.1.2.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 |  |  |
|  |  |
|  |  |  |
|  |  |
|  |  |
|  |  |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [9], and the specific test parameters are configured as below:

Table 8.1.3.6.1.2.4.2-2: Test parameters for multi-slot PUCCH format 1

|  |  |
| --- | --- |
| Parameter | Test |
| Cyclic prefix | Normal |
| Number of information bits | 2 |
| Number of PRBs | 1 |
| Number of symbols | 14 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | disabled |
| Inter-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 |
| Number of slots for PUCCH repetition | 2 |

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

5) Adjusting the equipment so that the SNR specified in table 8.1.3.6.1.2.5-1 is achieved at the IAB-DU input during the transmissions.

6) The tester 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 8.1.3.6.1.1.4.2 for NACK to ACK detection. Both statistics are measured in the same testing.

8.1.3.6.1.2.5 Test requirement

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 table 8.1.3.6.1.2.5-1.

Table 8.1.3.6.1.2.5-1: Minimum requirements for multi-slot PUCCH format 1 with 30 kHz SCS

|  |  |  |  |
| --- | --- | --- | --- |
| Number of TX antennas | Number of RX | Propagation conditions and | Channel bandwidth / SNR (dB) |
|  | antennas | correlation matrix (annex F) | 40 MHz |
| 1 | 2 | TDLC-300-100 Low | -7.0 |

### 8.1.4 Performance requirements for PRACH

#### 8.1.4.1 PRACH false alarm probability and missed detection requirements

##### 8.1.4.1.1 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 and TDLC300-100, 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 8.1.4.1.1-1.

Table 8.1.4.1.1-1: Time error tolerance for AWGN and TDLC300-100

|  |  |  |  |
| --- | --- | --- | --- |
| PRACH | PRACH SCS | Time error tolerance | |
| preamble | (kHz) | AWGN | TDLC300-100 |
| 0 | 1.25 | 1.04 us | 2.55 us |
| A1, A2, A3, B4, | 15 | 0.52 us | 2.03 us |
| C0, C2 | 30 | 0.26 us | 1.77 us |

The test preambles for normal mode are listed in A.2.5-1.

Which specific test(s) are applicable to IAB-DU is based on the test applicability rules defined in clause 8.1.1.2.4.

##### 8.1.4.1.2 Minimum requirement

The minimum requirement is in TS 38.174 [2] clause 8.1.4.1 and 8.1.4.2.

##### 8.1.4.1.3 Test purpose

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

##### 8.1.4.1.4 Method of test

8.1.4.1.4.1 Initial conditions

Test environment: Normal; see annex B.2.

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

8.1.4.1.4.2 Test procedure

1) Connect the IAB-DU tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-DU antenna connectors for diversity reception via a combining network as shown in annex D.3.

2) Adjust the AWGN generator, according to the SCS and channel bandwidth.

Table 8.1.4.1.4.2-1: AWGN power level at the IAB-DU input

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 15 |  |  |
|  |  |
|  |  |  |
|  |  |
|  |  |
|  |  |

3) 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.

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

5) Adjust the frequency offset of the test signal according to table 8.1.4.1.5-1 or 8.1.4.1.5-2 or 8.1.4.1.5-3 or 8.1.4.1.6-1 or 8.1.4.1.6-2 or 8.1.4.1.6-3 or 8.1.4.1.6-4.

6) Adjust the equipment so that the SNR specified in table 8.1.4.1.5-1 or 8.1.4.1.5-2 or 8.1.4.1.5-3 or 8.1.4.1.6-1 or 8.1.4.1.6-2 or 8.1.4.1.6-3 or 8.1.4.1.6-4 is achieved at the IAB-DU input during the PRACH preambles.

7) The test signal generator sends a preamble and the receiver tries to detect the preamble. This pattern is repeated as illustrated in figure 8.1.4.1.4.2-1. 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 8.1.4.1.4.2-1: PRACH preamble test pattern

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 8.1.4.1.4.2-2.



Figure 8.1.4.1.4.2-2: Timing offset scheme for PRACH preamble format 0

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 0.8 us. 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 8.1.4.1.4.2-3.



Figure 8.1.4.1.4.2-3: Timing offset scheme for PRACH preamble format A1 A2, A3, B4, C0 and C2

##### 8.1.4.1.5 Test requirement

Pfa shall not exceed 0.1%. Pd shall not be below 99% for the SNRs in tables 8.1.4.1.5-1 to 8.1.4.1.5-3.

Table 8.1.4.1.5-1: PRACH missed detection test requirements for Normal Mode, 1.25 kHz SCS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of TX | Number of RX | Propagation conditions | Frequency offset | SNR (dB) |
| antennas | antennas | and correlation matrix (annex F) |  | Burst format 0 |
| 1 | 2 | AWGN | 0 | -14.2 |
| TDLC300-100 Low | 400 Hz | -6.0 |
| 4 | AWGN | 0 | -16.4 |
| TDLC300-100 Low | 400 Hz | -11.3 |
| 8 | AWGN | 0 | -18.6 |
| TDLC300-100 Low | 400 Hz | -15.2 |

Table 8.1.4.1.5-2: PRACH missed detection test requirements for Normal Mode, 15 kHz SCS

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number  of TX antennas | Number  of RX antennas | Propagation  conditions and correlation matrix  (annex F) | Frequency  offset | SNR (dB) | | | | | |
| Burst format A1 | Burst format A2 | Burst format A3 | Burst format B4 | Burst format C0 | Burst format C2 |
| 1 | 2 | AWGN | 0 | -9.0 | -12.3 | -13.9 | -16.5 | -6.0 | -12.2 |
| TDLC300-100 Low | 400 Hz | -1.5 | -4.2 | -6.0 | -8.2 | 1.4 | -4.3 |
| 4 | AWGN | 0 | -11.3 | -14.0 | -15.7 | -18.7 | -8.4 | -13.8 |
| TDLC300-100 Low | 400 Hz | -6.7 | -9.7 | -11.1 | -13.2 | -3.7 | -9.6 |
| 8 | AWGN | 0 | -13.5 | -16.4 | -17.9 | -20.9 | -10.8 | -16.3 |
| TDLC300-100 Low | 400 Hz | -10.4 | -13.3 | -14.6 | -16.7 | -7.5 | -13.3 |

Table 8.1.4.1.5-3: PRACH missed detection test requirements for Normal Mode, 30 kHz SCS

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number  of TX antennas | Number  of RX antennas | Propagation  conditions and correlation matrix  (annex F) | Frequency  offset | SNR (dB) | | | | | |
| Burst format A1 | Burst format A2 | Burst format A3 | Burst format B4 | Burst format C0 | Burst format C2 |
| 1 | 2 | AWGN | 0 | -8.8 | -11.7 | -13.5 | -16.2 | -5.8 | -11.6 |
| TDLC300-100 Low | 400 Hz | -2.2 | -5.1 | -6.8 | -9.3 | 0.7 | -5.0 |
| 4 | AWGN | 0 | -11.1 | -13.9 | -15.6 | -18.7 | -8.3 | -13.8 |
| TDLC300-100 Low | 400 Hz | -6.6 | -9.8 | -11.4 | -13.9 | -3.9 | -9.8 |
| 8 | AWGN | 0 | -13.4 | -16.3 | -17.8 | -20.8 | -10.7 | -16.2 |
| TDLC300-100 Low | 400 Hz | -10.1 | -13.1 | -14.5 | -17.0 | -7.2 | -13.1 |

**<<end of change>>**