3GPP TSG-RAN WG4 Meeting #99-e R4-2109211

Electronic, 19th – 27th May, 2021

**Agenda item:** **6.3.6**

**Source: Intel Corporation**

**Title: Big TP to TS 38.176-1: IAB demodulation performance requirements**

**Document for: Approval**

# 1 Introduction

According to endorsed pCRs [1-6], we proposed the following TP to TS 38.176-1 to define demodulation performance requirements for IAB nodes.

# 2 Text Proposal to TS 38.176-1

**Start of the text proposal**

## 4.6 Manufacturer declarations

The following IAB declarations listed in table 4.6-1 and table 4.6-2, when applicable to the IAB under test, are required to be provided by the manufacturer for the conducted requirements testing of the *IAB type 1-H* for IAB-DU and IAB-MT.

For the *IAB type 1-H* declarations required for the radiated requirements testing, refer to TS 38.176-2 [TBD].

Table 4.6-1 Manufacturer declarations for *IAB-DU type 1-H* conducted test requirements

|  |  |  |
| --- | --- | --- |
| Declaration identifier | Declaration | Description |
| D.100 | PUSCH mapping type | Declaration of the supported PUSCH mapping type as specified in TS 38.211 [8], i.e., type A, type B or both. |
| D.101 | PUSCH additional DM-RS positions | Declaration of the supported additional DM-RS position(s), i.e., pos0, pos1 or both. |
| D.102 | PUCCH format | Declaration of the supported PUCCH format(s) as specified in TS 38.211 [8], i.e., format 0, format 1, format 2, format 3, format 4. |
| D.103 | PRACH format and SCS | Declaration of the supported PRACH format(s) as specified in TS 38.211 [8], i.e., format: 0, A1, A2, A3, B4, C0, C2.  Declaration of the supported SCS(s) per supported PRACH format with short sequence, as specified in TS 38.211 [8], i.e., 15 kHz, 30 kHz or both. |
| D.104 | Additional DM-RS for PUCCH format 3 | Declaration of the supported additional DM-RS for PUCCH format 3: without additional DM-RS, with additional DM-RS or both. |
| D.105 | Additional DM-RS for PUCCH format 4 | Declaration of the supported additional DM-RS for PUCCH format 4: without additional DM-RS, with additional DM-RS or both. |
| D.106 | PUCCH multi-slot | Declaration of multi-slot PUCCH support. |
| D.107 | UL CA | For the highest supported SCS, declaration of the carrier combination with the largest aggregated bandwidth. If there is more than one combination, the carrier combination with the largest number of carriers shall be declared. |
| D.108 | Modulation order | Declaration of the supported modulation order, i.e. QPSK, 16QAM, 64QAM |
| D.109 | DFT-s-OFDM | Declaration of the supported of DFT-s-OFDM, i.e. supported or not supported. |

Table 4.6-2 Manufacturer declarations for *IAB-MT type 1-H* conducted test requirements

|  |  |  |
| --- | --- | --- |
| Declaration identifier | Declaration | Description |
| D.204 | Testing of PMI reporting | Declaration on the testing of PMI reporting, i.e. tested or not tested. |
| D.205 | Testing of RI reporting | Declaration on the testing of RI reporting, i.e. tested or not tested. |

Editor’s note: Text and sections on applicability will be added here once wording is agreed.

# 8 Conducted performance requirements

## 8.1 IAB-DU performance requirements

### 8.1.1 General

#### 8.1.1.1 Scope and definitions

Conducted performance requirements specify the ability of the *IAB type 1-H* to correctly demodulate signals in various conditions and configurations. Conducted performance requirements are specified at the *TAB connector(s)*.

Conducted performance requirements for the IAB-DU are specified for the fixed reference channels and the propagation conditions defined in TS 38.174 [TBA] annex A and annex G, respectively. The requirements only apply to those FRCs that are supported by the IAB-DU.

Unless stated otherwise, performance requirements apply for a single carrier only. Performance requirements for a IAB-DU supporting CA are defined in terms of single carrier requirements.

The method of synchronization with the TE is left to implementation. Neither the use of downlink signal configuration nor the use of proprietary means is precluded. In tests performed with signal generators a synchronization signal may be provided between the IAB-DU and the signal generator, or a common (e.g., GNSS) source may be provided to both IAB node and the signal generator, to enable correct timing of the wanted signal.

The SNR used in this clause is specified based on a single carrier and defined as:

SNR = S / N

Where:

S is the total signal energy in a slot on a single *TAB connector*.

N is the noise energy in a bandwidth corresponding to the transmission bandwidth over the duration of a slot.

#### 8.1.1.2 Applicability rule

##### 8.1.1.2.1 General

Unless otherwise stated, for a IAB-DU supporting more than 8 *TAB connectors* (see D.37 in table 4.6-1), the performance requirement tests for 8 RX antennas shall apply, and the specific connectors used for testing are based on manufacturer declaration.

Unless otherwise stated, for a IAB-DU supporting different numbers of *TAB connectors* (see D.37 in table 4.6-1), the tests with low MIMO correlation level shall apply only for the lowest and highest numbers of supported connectors, and the specific connectors used for testing are based on manufacturer declaration.

##### 8.1.1.2.2 Applicability of PUSCH performance requirements

8.1.1.2.2.1 Applicability of requirements for different subcarrier spacings

Unless otherwise stated, PUSCH requirement tests shall apply only for each subcarrier spacing declared to be supported (see D.14 in table 4.6-1).

Unless otherwise stated, PUSCH requirement tests with 30% of maximum throughput shall apply only for the lowest subcarrier spacing declared to be supported (see D.14 in table 4.6-1) for each frequency range.

Unless otherwise stated, if IAB-DU supports more than one SCS then PUSCH requirement tests with highest modulation order shall apply only with lowest supported SCS and PUSCH requirement tests with other modulation orders shall apply only with highest supported SCS. Otherwise all modulation orders are tested on supported SCS.

8.1.1.2.2.2 Applicability of requirements for different channel bandwidths

For each subcarrier spacing declared to be supported, the test requirements for a specific channel bandwidth shall apply only if the IAB-DU supports it (see D.14 in table 4.6-1).

Unless otherwise stated, for each subcarrier spacing declared to be supported, the tests shall be done only for the widest supported channel bandwidth. If performance requirement is not specified for this widest supported channel bandwidth, the tests shall be done by using performance requirement for the closest channel bandwidth lower than this widest supported bandwidth; the tested PRBs shall then be centered in this widest supported channel bandwidth.

8.1.1.2.2.3 Applicability of requirements for different configurations

Unless otherwise stated, PUSCH requirement tests shall apply only for the mapping type declared to be supported (see D.100 in table 4.6-1). If both mapping type A and type B are declared to be supported, the tests shall be done for either type A or type B; the same chosen mapping type shall then be used for all tests except the requirement for PUSCH mapping Type B with 2 symbol length allocated.

8.1.1.2.2.4 Applicability of requirements for uplink carrier aggregation

The tests for uplink carrier aggregation shall be carried out according to the declaration (see D.107 in table 4.6-1).

Unless otherwise stated, the tests for uplink carrier aggregation shall apply only for PUSCH with transform precoding disabled and shall be conducted on per component carrier basis.

8.1.1.2.2.5 Applicability of requirements for TDD with different UL-DL patterns

Unless otherwise stated, for each subcarrier spacing declared to be supported, if IAB-DU supports multiple TDD UL-DL patterns, only one of the supported TDD UL-DL patterns shall be used for all tests.

8.1.1.2.2.6 Applicability of requirements for transform precoding

Unless otherwise stated, the tests with transform precoding enabled shall apply only, if the IAB-DU supports it (see D.109 in table 4.6-1).

##### 8.1.1.2.3 Applicability of PUCCH performance requirements

8.1.1.2.3.1 Applicability of requirements for different formats

Unless otherwise stated, PUCCH requirement tests shall apply only for each PUCCH format declared to be supported (see D.102 in table 4.6-1).

8.1.1.2.3.2 Applicability of requirements for different subcarrier spacings

Unless otherwise stated, PUCCH requirement tests shall apply only for each subcarrier spacing declared to be supported (see D.14 in table 4.6-1).

8.1.1.2.3.3 Applicability of requirements for different channel bandwidths

For each subcarrier spacing declared to be supported by the IAB-DU, the test requirements for a specific channel bandwidth shall apply only if the IAB-DU supports it (see D.14 in table 4.6-1).

Unless otherwise stated, for each subcarrier spacing declared to be supported, the tests shall be done only for the widest supported channel bandwidth. If performance requirement is not specified for this widest supported channel bandwidth, the tests shall be done by using performance requirement for the closest channel bandwidth lower than this widest supported bandwidth; the tested PRIAB-DU shall then be centered in this widest supported channel bandwidth.

8.1.1.2.3.4 Applicability of requirements for different configurations

Unless otherwise stated, PUCCH format 3 requirement tests shall apply only for the additional DM-RS configuration declared to be supported (see D.104 in table 4.6-1). If both options (without and with additional DM-RS) are declared to be supported, the tests shall be done for either without or with additional DM-RS; the same chosen option shall then be used for all tests.

Unless otherwise stated, PUCCH format 4 requirement tests shall apply only for the additional DM-RS configuration declared to be supported (see D.105 in table 4.6-1). If both options (without and with additional DM-RS) are declared to be supported, the tests shall be done for either without or with additional DM-RS; the same chosen option shall then be used for all tests.

8.1.1.2.3.5 Applicability of requirements for multi-slot PUCCH

Unless otherwise stated, multi-slot PUCCH requirement tests shall apply only if the IAB-DU supports it (see D.106 in table 4.6-1).

##### 8.1.1.2.4 Applicability of PRACH performance requirements

8.1.1.2.4.1 Applicability of requirements for different formats

Unless otherwise stated, PRACH requirement tests shall apply only for each PRACH format declared to be supported (see D.103 in table 4.6-1).

For IAB-DU declares to support more than one PRACH formats, limit the number of tests to any two cases chosen by the manufacturer. If IAB-DU declares to support more than one PRACH formats where formats for both long and short PRACH sequences are presented, require choosing formats with different sequences (see TBA in table 4.61)

8.1.1.2.4.2 Applicability of requirements for different subcarrier spacings

Unless otherwise stated, for each PRACH format with short sequence declared to be supported, for each FR, the tests shall apply only for the smallest supported subcarrier spacing in the FR (see D.103 in table 4.6-1).

8.1.1.2.4.3 Applicability of requirements for different channel bandwidths

Unless otherwise stated, for the subcarrier spacing to be tested, the test requirements shall apply only for anyone channel bandwidth declared to be supported (see D.14 in table 4.6-1).

### 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
|  | 5 | -86.5 dBm / 4.5MHz |
| 15 kHz | 10 | -83.3 dBm / 9.36MHz |
|  | 20 | -80.2 dBm / 19.08MHz |
|  | 10 | -83.6 dBm / 8.64MHz |
| 30 kHz | 20 | -80.4 dBm / 18.36MHz |
|  | 40 | -77.2 dBm / 38.16MHz |
|  | 100 | -73.1 dBm / 98.28MHz |

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

|  |  |  |
| --- | --- | --- |
| 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 G.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-1 | pos1 | -1.7 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-1 | pos1 | 10.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-1 | pos1 | 12.9 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-1 | pos1 | -5.2 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-1 | pos1 | 6.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-1 | pos1 | 9.4 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-1 | pos1 | -8.1 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-1 | pos1 | 3.6 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-1 | pos1 | 6.2 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-8 | pos1 | 1.8 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-8 | pos1 | 19.0 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-8 | pos1 | -1.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-8 | pos1 | 11.8 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-8 | pos1 | -4.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-8 | pos1 | 7.6 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-2 | pos1 | -1.9 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-2 | pos1 | 10.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-2 | pos1 | 12.8 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-2 | pos1 | -5.4 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-2 | pos1 | 6.9 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-2 | pos1 | 9.2 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-2 | pos1 | -8.1 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-2 | pos1 | 3.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-2 | pos1 | 6.1 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-9 | pos1 | 2.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-9 | pos1 | 19.1 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-9 | pos1 | -1.2 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-9 | pos1 | 12.0 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-9 | pos1 | -4.7 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-9 | pos1 | 7.6 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-3 | pos1 | -1.5 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-3 | pos1 | 10.6 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-3 | pos1 | 13.0 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-3 | pos1 | -4.9 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-3 | pos1 | 6.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-3 | pos1 | 9.2 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-3 | pos1 | -7.9 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-3 | pos1 | 3.6 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-3 | pos1 | 6.1 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-10 | pos1 | 2.9 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-10 | pos1 | 19.1 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-10 | pos1 | -1.0 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-10 | pos1 | 11.9 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-10 | pos1 | -4.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-10 | pos1 | 7.7 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-4 | pos1 | -1.7 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-4 | pos1 | 10.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-4 | pos1 | 13.4 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-4 | pos1 | -5.0 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-4 | pos1 | 7.0 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-4 | pos1 | 9.2 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-4 | pos1 | -8.0 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-4 | pos1 | 3.9 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-4 | pos1 | 6.1 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-11 | pos1 | 2.1 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-11 | pos1 | 19.2 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-11 | pos1 | -1.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-11 | pos1 | 12.0 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-11 | pos1 | -4.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-11 | pos1 | 7.8 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-5 | pos1 | -2.3 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-5 | pos1 | 10.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-5 | pos1 | 13.1 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-5 | pos1 | -5.4 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-5 | pos1 | 7.0 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-5 | pos1 | 9.2 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-5 | pos1 | -8.2 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-5 | pos1 | 3.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-5 | pos1 | 6.1 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-12 | pos1 | 2.1 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-12 | pos1 | 18.9 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-12 | pos1 | -1.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-12 | pos1 | 12.1 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-12 | pos1 | -4.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-12 | pos1 | 7.7 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-6 | pos1 | -1.9 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-6 | pos1 | 10.6 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-6 | pos1 | 13.0 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-6 | pos1 | -5.2 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-6 | pos1 | 6.9 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-6 | pos1 | 9.1 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-6 | pos1 | -8.1 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-6 | pos1 | 3.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-6 | pos1 | 6.0 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-13 | pos1 | 2.1 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-13 | pos1 | 20.3 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-13 | pos1 | -1.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-13 | pos1 | 12.1 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-13 | pos1 | -4.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-13 | pos1 | 7.7 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-7 | pos1 | -2.2 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-7 | pos1 | 10.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-7 | pos1 | 13.6 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-7 | pos1 | -5.2 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-7 | pos1 | 7.1 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-7 | pos1 | 9.6 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-7 | pos1 | -8.1 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-7 | pos1 | 3.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-7 | pos1 | 6.4 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-14 | pos1 | 2.2 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-14 | pos1 | 20.0 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-14 | pos1 | -1.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-14 | pos1 | 12.4 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-14 | pos1 | -4.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-14 | pos1 | 7.9 |

Table 8.1.2.1.5-8: Test requirements for PUSCH with 70% of maximum throughput, Type B, 5 MHz channel bandwidth, 15 kHz SCS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-1 | pos1 | -1.7 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-1 | pos1 | 10.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-1 | pos1 | 13.1 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-1 | pos1 | -5.1 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-1 | pos1 | 6.9 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-1 | pos1 | 9.5 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-1 | pos1 | -8.1 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-1 | pos1 | 3.6 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-1 | pos1 | 6.3 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-8 | pos1 | 2.3 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-8 | pos1 | 19.1 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-8 | pos1 | -1.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-8 | pos1 | 11.9 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-8 | pos1 | -4.6 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-8 | pos1 | 7.6 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-2 | pos1 | -1.7 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-2 | pos1 | 11.1 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-2 | pos1 | 13.2 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-2 | pos1 | -5.1 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-2 | pos1 | 7.1 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-2 | pos1 | 9.5 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-2 | pos1 | -8.4 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-2 | pos1 | 3.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-2 | pos1 | 6.4 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-9 | pos1 | 2.8 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-9 | pos1 | 19.5 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-9 | pos1 | -1.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-9 | pos1 | 12.1 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-9 | pos1 | -4.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-9 | pos1 | 7.8 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-3 | pos1 | -1.5 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-3 | pos1 | 11.0 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-3 | pos1 | 12.9 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-3 | pos1 | -5.1 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-3 | pos1 | 6.9 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-3 | pos1 | 9.4 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-3 | pos1 | -7.9 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-3 | pos1 | 3.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-3 | pos1 | 6.3 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-10 | pos1 | 2.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-10 | pos1 | 18.9 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-10 | pos1 | -1.2 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-10 | pos1 | 12.0 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-10 | pos1 | -4.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-10 | pos1 | 7.7 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-4 | pos1 | -1.8 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-4 | pos1 | 10.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-4 | pos1 | 13.1 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-4 | pos1 | -5.1 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-4 | pos1 | 7.0 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-4 | pos1 | 9.2 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-4 | pos1 | -8.2 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-4 | pos1 | 3.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-4 | pos1 | 6.2 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-11 | pos1 | 1.9 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-11 | pos1 | 19.3 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-11 | pos1 | -1.7 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-11 | pos1 | 12.1 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-11 | pos1 | -4.8 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-11 | pos1 | 7.8 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-5 | pos1 | -2.3 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-5 | pos1 | 10.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-5 | pos1 | 13.1 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-5 | pos1 | -5.4 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-5 | pos1 | 6.9 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-5 | pos1 | 9.2 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-5 | pos1 | -8.4 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-5 | pos1 | 3.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-5 | pos1 | 6.2 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-12 | pos1 | 2.1 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-12 | pos1 | 19.0 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-12 | pos1 | -1.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-12 | pos1 | 12.0 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-12 | pos1 | -4.6 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-12 | pos1 | 7.8 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-6 | pos1 | -1.9 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-6 | pos1 | 10.6 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-6 | pos1 | 13.1 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-6 | pos1 | -5.2 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-6 | pos1 | 6.8 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-6 | pos1 | 9.3 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-6 | pos1 | -8.2 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-6 | pos1 | 3.6 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-6 | pos1 | 6.1 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-13 | pos1 | 2.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-13 | pos1 | 19.5 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-13 | pos1 | -1.3 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-13 | pos1 | 12.0 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-13 | pos1 | -4.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-13 | pos1 | 7.7 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-7 | pos1 | -1.9 |
|  | 2 | TDLC300-100 Low | D-FR1-A.2.3-7 | pos1 | 10.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-7 | pos1 | 13.7 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-7 | pos1 | -5.2 |
| 1 | 4 | TDLC300-100 Low | D-FR1-A.2.3-7 | pos1 | 6.9 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-7 | pos1 | 9.8 |
|  |  | TDLB100-400 Low | D-FR1-A.2.1-7 | pos1 | -8.1 |
|  | 8 | TDLC300-100 Low | D-FR1-A.2.3-7 | pos1 | 3.7 |
|  |  | TDLA30-10 Low | D-FR1-A.2.4-7 | pos1 | 6.5 |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-14 | pos1 | 2.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-14 | pos1 | 20.1 |
| 2 | 4 | TDLB100-400 Low | D-FR1-A.2.1-14 | pos1 | -1.4 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-14 | pos1 | 12.4 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-14 | pos1 | -4.5 |
|  |  | TDLC300-100 Low | D-FR1-A.2.3-14 | pos1 | 7.9 |

#### 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| 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 G.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-15 | pos1 | -1.8 |
| 1 | 4 | TDLB100-400 Low | D-FR1-A.2.1-15 | pos1 | -5.1 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-15 | pos1 | -7.9 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-16 | pos1 | -1.9 |
| 1 | 4 | TDLB100-400 Low | D-FR1-A.2.1-16 | pos1 | -5.1 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-16 | pos1 | -7.8 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-15 | pos1 | -1.7 |
| 1 | 4 | TDLB100-400 Low | D-FR1-A.2.1-15 | pos1 | -5.2 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-15 | pos1 | -8.0 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (annex G) | FRC (annex A) | Additional DM-RS position | SNR  (dB) |
|  | 2 | TDLB100-400 Low | D-FR1-A.2.1-16 | pos1 | -2.1 |
| 1 | 4 | TDLB100-400 Low | D-FR1-A.2.1-16 | pos1 | -5.4 |
|  | 8 | TDLB100-400 Low | D-FR1-A.2.1-16 | pos1 | -8.2 |

#### 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 [TBA] 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.6.

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 G.

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (Annex G) | UCI bits  (CSI part 1, CSI part 2) | Additional DM-RS position | FRC  (Annex A) | SNR (dB) |
| 1 | 2 | TDLC300-100 Low | 7 (5, 2) | pos1 | D-FR1-A.2.3-4 | 6.0 |
|  | 2 | TDLC300-100 Low | 40 (20,20) | pos1 | D-FR1-A.2.3-4 | 4.9 |

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (Annex G) | UCI bits  (CSI part 1, CSI part 2) | Additional DM-RS position | FRC  (Annex A) | SNR (dB) |
| 1 | 2 | TDLC300-100 Low | 7 (5, 2) | pos1 | D-FR1-A.2.3-4 | 6.4 |
|  | 2 | TDLC300-100 Low | 40 (20,20) | pos1 | D-FR1-A.2.3-4 | 4.7 |

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (Annex G) | UCI bits  (CSI part 1, CSI part 2) | Additional DM-RS position | FRC  (Annex A) | SNR (dB) |
| 1 | 2 | TDLC300-100 Low | 7 (5, 2) | pos1 | D-FR1-A.2.3-4 | 0.4 |
|  | 2 | TDLC300-100 Low | 40 (20,20) | pos1 | D-FR1-A.2.3-4 | 3.0 |

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Propagation conditions and correlation matrix (Annex G) | UCI bits  (CSI part 1, CSI part 2) | Additional DM-RS position | FRC  (Annex A) | SNR (dB) |
| 1 | 2 | TDLC300-100 Low | 7 (5, 2) | pos1 | D-FR1-A.2.3-4 | 0.9 |
|  | 2 | TDLC300-100 Low | 40 (20,20) | pos1 | D-FR1-A.2.3-4 | 3.2 |

### 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 [TBA] 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 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Subcarrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08 MHz |
| 30 | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | -70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [TBA] 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 B.

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Number of | Propagation conditions and | Number of | Channel bandwidth / SNR (dB) | | |
| of TX antennas | RX antennas | correlation matrix  (annex G) | OFDM symbols | 5 MHz | 10 MHz | 20 MHz |
| 1 | 2 | TDLC-300-100 Low | 1 | 10.0 | 9.4 | 9.9 |
|  |  |  | 2 | 3.4 | 4.3 | 3.9 |
| 1 | 4 | TDLC-300-100 Low | 1 | 3.6 | 3.5 | 3.8 |
|  |  |  | 2 | -0.4 | 0.1 | -0.2 |
| 1 | 8 | TDLC-300-100 Low | 1 | -0.5 | -0.5 | -0.5 |
|  |  |  | 2 | -3.5 | -3.3 | -3.4 |

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 G) | 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 [TBA] 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 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 kHz | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08 MHz |
| 30 kHz | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | -70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [TBA], 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 G.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of | Number | Propagation | Channel bandwidth / SNR (dB) | | |
| TX antennas | of RX antennas | conditions and correlation matrix (annex G) | 5 MHz | 10 MHz | 20 MHz |
|  | 2 | TDLC-300-100 Low | -3.2 | -3.0 | -3.0 |
| 1 | 4 | TDLC-300-100 Low | -7.8 | -7.0 | -7.8 |
|  | 8 | TDLC-300-100 Low | -11.2 | -10.8 | -10.8 |

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 G) | 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 [TBA] 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 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 kHz | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08 MHz |
| 30 kHz | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | -70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [17], 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 G.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of | Number | Propagation | Channel bandwidth / SNR (dB) | | |
| TX antennas | of RX antennas | conditions and correlation matrix (annex G) | 5 MHz | 10 MHz | 20 MHz |
|  | 2 | TDLC300-100 Low | -4.4 | -3.8 | -4.4 |
| 1 | 4 | TDLC300-100 Low | -8.0 | -7.6 | -7.9 |
|  | 8 | TDLC300-100 Low | -10.1 | -10.9 | -10.9 |

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 G) | 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 [TBA] 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.

8.1.3.3.1.2 Minimum requirement

The minimum requirements are in TS 38.174 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08MHz |
| 30 | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | -70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [TBA], 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 G.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of RX | Propagation | Channel bandwidth / SNR (dB) | | |
| antennas | antennas | conditions and correlation matrix (annex G) | 5 MHz | 10 MHz | 20 MHz |
|  | 2 | TDLC300-100 Low | 6.4 | 6.2 | 6.5 |
| 1 | 4 | TDLC300-100 Low | 1.0 | 1.1 | 0.9 |
|  | 8 | TDLC300-100 Low | -2.9 | -2.9 | -2.9 |

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 G) | 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 [TBA] 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.

8.1.3.3.2.2 Minimum requirement

The minimum requirement is TS 38.174 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08 MHz |
| 30 | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | -70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [TBA], 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 G.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of TX | Number of | Propagation | Channel bandwidth / SNR (dB) | | |
| antennas | RX antennas | conditions and correlation matrix (annex G) | 5 MHz | 10 MHz | 20 MHz |
|  | 2 | TDLC300-100 Low | 0.8 | 1.4 | 1.8 |
| 1 | 4 | TDLC300-100 Low | -3.0 | -2.6 | -2.6 |
|  | 8 | TDLC300-100 Low | -6.2 | -6.1 | -6.2 |

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 G) | 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 [TBA] 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 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08 MHz |
| 30 | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | 70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [TBA]. 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 G.

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Number | Number of TX | Number of RX | Propagation conditions and | Additional DM-RS | Channel bandwidth / SNR (dB) | | |
|  | antennas | antennas | correlation matrix (annex G) | configuration | 5 MHz | 10 MHz | 20 MHz |
| 1 | 1 | 2 | TDLC300-100 Low | No additional DM-RS | 0.8 | 1.7 | 0.9 |
|  |  |  |  | Additional DM-RS | 0.5 | 1.1 | 0.5 |
|  |  | 4 | TDLC300-100 Low | No additional DM-RS | -3.2 | -2.7 | -3.2 |
|  |  |  |  | Additional DM-RS | -3.7 | -3.4 | -3.4 |
|  |  | 8 | TDLC300-100 Low | No additional DM-RS | -6.4 | -6.1 | -6.3 |
|  |  |  |  | Additional DM-RS | -7.1 | -6.9 | -7.1 |
| 2 | 2 | 2 | TDLC300-100 Low | No additional DM-RS | 2.0 | 2.8 | 2.6 |
|  |  | 4 | TDLC300-100 Low | No additional DM-RS | -2.5 | -1.9 | -1.9 |
|  |  | 8 | TDLC300-100 Low | No additional DM-RS | -5.9 | -5.4 | -5.6 |

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 G) | 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 [TBA] 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 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08 MHz |
| 30 | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | -70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [TBA]. 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 G.

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX | Propagation conditions and | Additional DM-RS configuration | Channel bandwidth / SNR (dB) | | |
|  | antennas | correlation matrix (annex G) |  | 5 MHz | 10 MHz | 20 MHz |
| 1 | 2 | TDLC300-100 Low | No additional DM-RS | 2.4 | 3.2 | 2.8 |
|  |  |  | Additional DM-RS | 2.2 | 3.0 | 2.4 |
|  | 4 | TDLC300-100 Low | No additional DM-RS | -1.7 | -1.3 | -1.6 |
|  |  |  | Additional DM-RS | -2.3 | -2.0 | -2.1 |
|  | 8 | TDLC300-100 Low | No additional DM-RS | -5.3 | -5.1 | -5.2 |
|  |  |  | Additional DM-RS | -6.0 | -5.8 | -5.7 |

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 G) |  | 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08 MHz |
| 30 | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | -70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [TBA], 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 G.

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 G) | 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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -83.5 dBm / 4.5 MHz |
|  | 10 | -80.3 dBm / 9.36 MHz |
|  | 20 | -77.2 dBm / 19.08 MHz |
| 30 | 10 | -80.6 dBm / 8.64 MHz |
|  | 20 | -77.4 dBm / 18.36 MHz |
|  | 40 | -74.2 dBm / 38.16 MHz |
|  | 100 | -70.1 dBm / 98.28 MHz |

3) The characteristics of the wanted signal shall be configured according to TS 38.211 [TBA], 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 G.

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 G) | 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 TBA.

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 [TBA] 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.6.

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

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 15 | 5 | -83.5 dBm / 4.5MHz |
|  | 10 | -80.3 dBm / 9.36MHz |
|  | 20 | -77.2 dBm / 19.08MHz |
| 30 | 10 | -80.6 dBm / 8.64MHz |
|  | 20 | -77.4 dBm / 18.36MHz |
|  | 40 | -74.2 dBm / 38.16MHz |
|  | 100 | -70.1 dBm / 98.28MHz |

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 G.

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 G) |  | 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 | Number | Propagation | Frequency | SNR (dB) | | | | | |
| of TX antennas | of RX antennas | conditions and correlation matrix (annex G) | offset | Burst format A1 | Burst format A2 | Burst format A3 | Burst format B4 | Burst format C0 | Burst format C2 |
| 1 | 2 | AWGN | 0 | -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 | Number | Propagation | Frequency | SNR (dB) | | | | | |
| of TX antennas | of RX antennas | conditions and correlation matrix (annex G) | offset | Burst format A1 | Burst format A2 | Burst format A3 | Burst format B4 | Burst format C0 | Burst format C2 |
| 1 | 2 | AWGN | 0 | -8.8 | -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 |

## 8.2 IAB-MT Performance requirements

### 8.2.1 General

#### 8.2.1.1 Scope and definitions

Conducted performance requirements specify the ability of the IAB-MT to correctly demodulate signals in various conditions and configurations. Conducted performance requirements are specified at the TAB connector(s).

Conducted performance requirements for the IAB-MT are specified for the fixed reference channels and the propagation conditions defined in TS 38.174 [TBA] annex A and annex G, respectively. The requirements only apply to those FRCs that are supported by the IAB-MT.

Unless stated otherwise, performance requirements apply for a single carrier only. Performance requirements for an IAB-MT supporting CA are defined in terms of single carrier requirements.

The SNR used in this clause is specified based on a single carrier and defined as:

SNR = S / N

Where:

S is the total signal energy in a slot on a single *TAB connector*.

N is the noise energy in a bandwidth corresponding to the transmission bandwidth over the duration of a slot.

### 8.2.2 Demodulation performance requirements

#### 8.2.2.1 General

{Editors note: Applicability of requirements to be added}

#### 8.2.2.2 Performance requirements for PDSCH

##### 8.2.2.2.1 Definition and applicability

The performance requirement of PDSCH 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.

##### 8.2.2.2.2 Minimum requirement

The minimum requirement is in TS 38.174 [TBA] clause 8.2.2.1.2.

##### 8.2.2.2.3 Test purpose

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

##### 8.2.2.2.4 Method of test

##### 8.2.2.2.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

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

##### 8.2.2.2.4.2 Procedure

1) Connect the IAB tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-MT antenna connectors for diversity reception via a combining network as shown in annex D.6

2) Adjust the AWGN generator and adjust the AWGN power level to -77.2 dBm / 38.16MHz.

3) The characteristics of the wanted signal shall be configured according to the corresponding DL reference measurement channel defined in annex A and the test parameters in table 8.2.2.2.4.2-1.

Table 8.2.2.2.4.2-1: Test parameters for testing PDSCH

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | | Unit | Value |
| Duplex mode | |  | TDD |
| Active BWP index | |  | 1 |
| Default TDD UL-DL pattern (Note 1) | |  | 7D1S2U, S=6D:4G:4U |
| PDSCH transmission scheme | |  | Transmission scheme 1 |
| Carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 1) | RBs | 0 |
|  | Subcarrier spacing | kHz | 30 |
| DL BWP configuration #1 | Cyclic prefix |  | Normal |
|  | RB offset | RBs | 0 |
|  | Number of contiguous PRB | PRBs | 106 |
| PDSCH DMRS configuration | Antenna ports indexes |  | {1000} for Rank 1 tests {1000, 1001} for Rank 2 tests  {1000-1002} for Rank 3 tests  {1000-1003} for Rank 4 tests |
|  | Position of the first DMRS for PDSCH mapping type A |  | 2 |
| Number of PDSCH DMRS CDM group(s) without data |  | 1 for Rank 1 and Rank 2 tests  2 for Rank 3 and Rank 4 tests |
| DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Maximum number of OFDM symbols for DL front loaded DMRS |  | 1 |
| PDSCH configuration | Mapping type |  | Type A |
|  | k0 |  | 0 |
|  | Starting symbol (S) |  | 2 |
|  | Length (L) |  | Specific to each Reference channel |
|  | PDSCH aggregation factor |  | 1 |
|  | PRB bundling type |  | Static |
|  | PRB bundling size |  | 2 |
|  | Resource allocation type |  | Type 0 |
|  | RBG size |  | Config2 |
|  | VRB-to-PRB mapping type |  | Non-interleaved |
|  | VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PT-RS configuration | |  | PT-RS is not configured |
| Maximum number of code block groups for ACK/NACK feedback | |  | 1 |
| Maximum number of HARQ transmission | |  | 4 |
| HARQ ACK/NACK bundling | |  | Multiplexed |
| Redundancy version coding sequence | |  | {0,2,3,1} |
| PDSCH & PDSCH DMRS Precoding configuration | |  | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with PRB bundling granularity |
| Note 1: The same requirements are applicable to TDD with different UL-DL patterns.  Note 2: Point A coincides with minimum guard band as specified in TS 38.174 [2] for tested channel bandwidth and subcarrier spacing. | | | |

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

5) Adjust the equipment so that required SNR specified in tables 8.2.2.2.5.1-1, 8.2.2.2.5.1-2, 8.2.2.2.5.1-3 or 8.2.2.2.5.2-1-4 (as applicable) is achieved at the IAB-MT input.

6) For each of the reference channels in tables 8.2.2.2.5.1-1, 8.2.2.2.5.1-2, 8.2.2.2.5.1-3 or 8.2.2.2.5.2-1-4 applicable for the IAB-MT, measure the throughput.

##### 8.2.2.2.5 Test requirement

The throughput measured according to clause 8.2.2.2.4.2 shall not be below the limits for the SNR levels specified in table 8.2.2.2.5-1, 8.2.2.2.5-2, 8.2.2.2.5-3 and 8.2.2.2.5-4.

Table 8.2.2.2.5-1: Minimum performance for Rank 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
| Fraction of maximum throughput (%) | SNR (dB) |
| 1 | M-FR1-A.3.3-1 | 40 / 30 | 256QAM, 0.82 | TDLA30-10 | 2x4, ULA Low | 70 | [22.5] |
| 2 | M-FR1-A.3.1-1 | 40 / 30 | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 30 | [-0.1] |

Table 8.2.2.2.5-2: Minimum performance for Rank 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
| Fraction of maximum throughput (%) | SNR (dB) |
| 3 | M-FR1-A.3.1-1 | 40 / 30 | 64QAM, 0.50 | TDLA30-10 | 2x4, ULA Low | 70 | [14.6] |

Table 8.2.2.2.5-3: Minimum performance for Rank 3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
| Fraction of maximum throughput (%) | SNR (dB) |
| 4 | M-FR1-A.3.1-3 | 40 / 30 | 16QAM, 0.48 | TDLA30-10 | 4x4, ULA Low | 70 | [12.4] |

Table 8.2.2.2.5-4: Minimum performance for Rank 4

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
| Fraction of maximum throughput (%) | SNR (dB) |
| 5 | M-FR1-A.3.1-4 | 40 / 30 | 16QAM, 0.48 | TDLA30-10 | 4x4, ULA Low | 70 | [16.4] |

#### 8.2.2.3 Performance requirements for PDCCH

##### 8.2.2.3.1 Definition and applicability

The performance requirement of PDCCH is determined by a maximum allowed missed detection rate for a given SNR. The required missed detection rate is expressed for the FRCs listed in annex A.

##### 8.2.2.3.2 Minimum requirement

The minimum requirement is in TS 38.174 [TBA] clause 8.2.2.2.

##### 8.2.2.3.3 Test purpose

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

##### 8.2.2.3.4 Method of test

##### 8.2.2.3.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

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

##### 8.2.2.3.4.2 Procedure

1) Connect the IAB tester generating the wanted signal, multipath fading simulators and AWGN generators to all IAB-MT antenna connectors for diversity reception via a combining network as shown in annex D.6.

2) Adjust the AWGN generator and adjust the AWGN power level to -77.2 dBm / 38.16MHz.

3) The characteristics of the wanted signal shall be configured according to the corresponding DL reference measurement channel defined in annex A and the test parameters in table 8.2.2.3.4.2-1.

Table 8.2.2.3.4.2-1: Test parameters for testing PDCCH

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | Unit | 1 Tx Antenna | | | 2 Tx Antenna |
| CCE to REG mapping type |  | interleaved | | interleaved | |
| Interleaver size |  | 3 | | | |
| REG bundle size |  | 2 | 6 | | |
| Shift Index |  | 0 | | | |

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

5) Adjust the equipment so that required SNR specified in tables 8.2.2.3.5.1-1, 8.2.2.3.5.2-2, 8.2.2.3.6.1-3, 8.2.2.3.6.2-4 (as applicable) is achieved at the IAB-MT input.

6) For each of the reference channels in table 8.2.2.3.5.1-1, 8.2.2.3.5.2-2, 8.2.2.3.6.1-3, 8.2.2.3.6.2-4 applicable for the IAB-MT, measure the missed detection.

##### 8.2.2.3.5 Test requirement

For the parameters specified in Table 8.2.2.3.4.2.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.3.5-1.

Table 8.2.2.3.5-1: Minimum performance for PDCCH

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
| Pm-dsg (%) | SNR (dB) |
| 1 | 40 | 102 | 1 | 2 | TBC | TDLA30-10 | 1x4 Low | 1 | [2.1] |
| 2 | 40 | 102 | 1 | 4 | TBC | TDLA30-10 | 1x4 Low | 1 | [-0.9] |
| 3 | 40 | 90 | 1 | 8 | TBC | TDLA30-10 | 2x4 Low | 1 | [-4.3] |

### 8.2.3 CSI reporting requirements

#### 8.2.3.1 General

##### 8.2.3.1.1 Applicability rule for IAB-MT

###### 8.2.3.1.1.1 General

Unless otherwise stated, for a IAB-MT declared to support more than 2 demodulation branches (for *IAB-MT type 1-O* and *IAB-MT type 2-O*), the performance requirement tests for 2 demodulation branches shall apply, and the mapping between connectors and demodulation branches is up to IAB-MT implementation.

The tests requiring more than [20] dB SNR level are set to N/A in the test requirements.

###### 8.2.3.1.1.2 Applicability of requirements for different subcarrier spacings

Unless otherwise stated, the tests shall apply only for each subcarrier spacing declared to be supported (see D.14 in table 4.6-1).

###### 8.2.3.1.1.3 Applicability of requirements for TDD with different UL-DL patterns

Unless otherwise stated, for each subcarrier spacing declared to be supported, if IAB-MT supports multiple TDD UL-DL patterns, only one of the supported TDD UL-DL patterns shall be used for all tests.

Editor’s note: Text and sections on applicability will be added here once wording is agreed.

#### 8.2.3.2 Reporting Channel Quality Indicator (CQI)

##### 8.2.3.2.1 Definition and applicability

The reporting accuracy of the channel quality indicator (CQI) under frequency non-selective conditions is determined by the reporting variance and the BLER performance using the transport format indicated by the reported CQI median. The purpose is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [TBD]. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

Which specific test(s) are applicable to IAB-MT is based on the test applicability rules defined in clause 8.2.1.2.

##### 8.2.3.2.2 Minimum requirement

The minimum requirement is in TS 38.174 [TBD] clause 8.2.3.1.

##### 8.2.3.2.3 Test purpose

The test shall verify the receiver's ability to report CQI values accordance with the CQI definition given in TS 38.214 [TBD].

##### 8.2.3.2.4 Method of test

###### 8.2.3.2.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

###### 8.2.3.2.4.2 Test procedure

1) Connect the IAB-MT tester generating the wanted signal and AWGN generators to all IAB-MT antenna connectors for diversity reception via a combining network as shown in annex D.5 and D.6.

2) Adjust the AWGN generator, according to the channel bandwidth, defined in table 8.2.3.2.4.2-1.

Table 8.2.3.2.4.2-1: AWGN power level at the IAB-MT input

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 30 kHz | 40 | -77.2 dBm / 38.16MHz |

3) The characteristics of the wanted signal shall be configured according to the corresponding DL reference measurement channel defined in annex A and the test parameters in table 8.2.3.2.4.2-2.

Table 8.2.3.2.4.2-2: Test parameters for testing CQI reporting

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter | | Unit | Test 1 | | Test 2 | |
| Bandwidth | | MHz | 40 | | | |
| Subcarrier spacing | | kHz | 30 | | | |
| Default TDD UL-DL pattern (Note 1) | |  | 7D1S2U, S=6D:4G:4U | | | |
| SNR | | dB | 5 | 6 | 11 | 12 |
| Propagation channel | |  | AWGN | | | |
| Antenna configuration | |  | 2x4 | | | |
| Beamforming Model | |  | As specified in Annex TBA | | | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Periodic | | | |
| Number of CSI-RS ports (*X*) |  | 2 | | | |
| CDM Type |  | FD-CDM2 | | | |
| Density (ρ) |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 3,(6,-) | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) |  | 13 | | | |
| NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | | | |
| ReportConfigType | |  | Periodic | | | |
| CQI-table | |  | Table 2 | | | |
| reportQuantity | |  | cri-RI-PMI-CQI | | | |
| cqi-FormatIndicator | |  | Wideband | | | |
| pmi-FormatIndicator | |  | Wideband | | | |
| Sub-band Size | | RB | 16 | | | |
| Csi-ReportingBand | |  | 1111111 | | | |
| CSI-Report periodicity and offset | | slot | 10/9 | | | |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel | | | |
| Codebook Mode |  | 1 | | | |
| CodebookSubsetRestriction |  | 010000 | | | |
| RI Restriction |  | N/A | | | |
| CQI/RI/PMI delay | | ms | 9.5 | | | |
| Maximum number of HARQ transmission | |  | 1 | | | |
| Measurement channel | |  | M-FR1-A.3.5-2 | | | |
| Note 1: The same requirements are applicable for TDD with different UL-DL pattern. | | | | | | |

4) Adjust the equipment so that required SNR specified in table 8.2.3.2.4.2-2 is achieved at the IAB-MT input.

5) For each test specified in table 8.2.3.2.4.2-2 applicable for the IAB-MT, measure the median CQI and the BLER at median CQI and (median CQI+1 or median CQI-1) as per clause 8.2.3.2.5.

##### 8.2.3.2.5 Test requirement

For the parameters specified in Table 8.2.3.2.4.2-2, and using the downlink physical channels specified in Annex TBA, the test requirements are specified by the following:

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90% of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

#### 8.2.3.3 Reporting of Precoding Matrix Indicator (PMI)

##### 8.2.3.3.1 Definition and applicability

The minimum performance requirements of PMI reporting are defined based on the precoding gain, expressed as the relative increase in throughput when the transmitter is configured according to the UE reported PMI compared to the case when the transmitter is using random precoding, respectively. When the transmitter uses random precoding, for each PDSCH allocation a precoder is randomly generated with equal propability of each applicable i1 and i2 combination and applied to the PDSCH. A fixed transport format (FRC) is configured for all requirements.

The requirements for transmission mode 1 with higher layer parameter *codebookType* set to 'typeI-SinglePanel' are specified in terms of the ratio:



In the definition of **, for 4TX and 8TX PMI requirements, is 90 % of the maximum throughput obtained at  using the precoders configured according to the UE reports, and is the throughput measured at with random precoding.

##### 8.2.3.3.2 Minimum requirement

The minimum requirement is in TS 38.174 [TBD] clause 8.2.3.2.

##### 8.2.3.3.3 Test purpose

The test shall verify the receiver's ability to achieve throughput gain under multipath fading propagation conditions using reporting PMI comparing to using random PMI.

##### 8.2.3.3.4 Method of test

###### 8.2.3.3.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

###### 8.2.3.3.4.2 Test procedure

1) Connect the IAB-MT tester generating the wanted signal and AWGN generators to all IAB-MT antenna connectors for diversity reception via a combining network as shown in annex D.5 and D.6.

2) Adjust the AWGN generator, according to the channel bandwidth, defined in table 8.2.3.3.4.2-1.

Table 8.2.3.3.4.2-1: AWGN power level at the IAB-MT input

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 30 kHz | 40 | -77.2 dBm / 38.16MHz |

3) The characteristics of the wanted signal shall be configured according to the corresponding DL reference measurement channel defined in annex A and the test parameters in table 8.2.3.3.4.2-2.

Table 8.2.3.3.4.2-2: Test parameters for testing PMI reporting

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | | Unit | Test 1 | Test 2 |
| Bandwidth | | MHz | 40 | 40 |
| Subcarrier spacing | | kHz | 30 | 30 |
| Default TDD UL-DL pattern (Note 1) | |  | 7D1S2U, S=6D:4G:4U | 7D1S2U, S=6D:4G:4U |
| Propagation channel | |  | TDLA30-5 | TDLA30-5 |
| Antenna configuration | |  | High XP 4 x 4  (N1,N2) = (2,1) | High XP 8 x 4  (N1,N2) = (4,1) |
| Beamforming Model | |  | As specified in Annex TBA | As specified in Annex TBA |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Periodic | Periodic |
| Number of CSI-RS ports (*X*) |  | 4 | 8 |
| CDM Type |  | FD-CDM2 | CDM4 (FD2, TD2) |
| Density (ρ) |  | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1) |  | Row 4, (0,-) | Row 8, (4,6) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (13,-) | (5,-) |
| NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | 10/1 |
| ReportConfigType | |  | Periodic | Periodic |
| CQI-table | |  | Table 1 | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI | cri-RI-PMI-CQI |
| cqi-FormatIndicator | |  | Wideband | Wideband |
| pmi-FormatIndicator | |  | Wideband | Wideband |
| Sub-band Size | | RB | 16 | 16 |
| csi-ReportingBand | |  | 1111111 | 1111111 |
| CSI-Report periodicity and offset | | slot | 10/9 | 10/9 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel | typeI-SinglePanel |
| Codebook Mode |  | 1 | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (2,1) | (4,1) |
| (CodebookConfig-O1,CodebookConfig-O2) |  | (4,1) | (4,1) |
| CodebookSubsetRestriction |  | 11111111 | 0x FFFF |
| RI Restriction |  | 00000001 | 00000010 |
| CQI/RI/PMI delay | | ms | 5.5 | 6.5 |
| Maximum number of HARQ transmission | |  | 4 | 4 |
| Measurement channel | |  | M-FR1-A.3.1-4 | M-FR1-A.3.1-5 |
| Note 1: The same requirements are applicable for TDD with different UL-DL pattern.  Note 2: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i1, i2 combination.  Note 3: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4) for Test 1 or slot#(n-6) for Test 2, this reported PMI cannot be applied at the gNB downlink before slot#(n+4) for Test 1 or slot#(n+6) for Test 2 respectively.  Note 4: Randomization of the principle beam direction shall be used as specified in Annex G.2.3.2.3. | | | | |

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

5) Adjust the equipment so that required SNR specified in clause 8.2.3.3.1 is achieved at the IAB-MT input.

6) For each test specified in table 8.2.3.3.4.2-2 applicable for the IAB-MT, calculate **.

##### 8.2.3.3.5 Test requirement

For the parameters specified in Table 8.2.3.3.4.2-2, and using the downlink physical channels specified in Annex TBA, the test requirements are specified in Table 8.2.3.3.5-1.

Table 8.2.3.3.5-1 Test requirements for PMI reporting

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Test 1** | **Test 2** |
| ** | 1.29 | 1.49 |

#### 8.2.3.4 Reporting of Rank Indicator (RI)

##### 8.2.3.4.1 General

The purpose of this test is to verify that the reported rank indicator accurately represents the channel rank. The accuracy of RI reporting is determined by the relative increase of the throughput obtained when transmitting based on the reported rank compared to the case for which a fixed rank is used for transmission.

##### 8.2.3.4.2 Minimum requirements

The minimum requirement is in TS 38.174 [TBD] clause 8.2.3.3.

##### 8.2.3.4.3 Test purpose

The test shall verify the receiver's ability to report rank indicator accurately represents the channel rank.

##### 8.2.3.4.4 Method of test

###### 8.2.3.4.4.1 Initial conditions

Test environment: Normal, see annex B.2.

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

###### 8.2.3.4.4.2 Test procedure

1) Connect the IAB-MT tester generating the wanted signal and AWGN generators to all IAB-MT antenna connectors for diversity reception via a combining network as shown in annex D.5 and D.6.

2) Adjust the AWGN generator, according to the channel bandwidth, defined in table 8.2.3.4.4.2-1.

Table 8.2.3.4.4.2-1: AWGN power level at the IAB-MT input

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing (kHz) | Channel bandwidth (MHz) | AWGN power level |
| 30 kHz | 40 | -77.2 dBm / 38.16MHz |

3) The characteristics of the wanted signal shall be configured according to the corresponding DL reference measurement channel defined in annex A and the test parameters in table 8.2.3.4.4.2-2.

Table 8.2.3.4.4.2-2: Test parameters for testing RI reporting

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter | | Unit | Test 1 | Test 2 | Test 3 | Test 4 |
| Bandwidth | | MHz | 40 | 40 | 40 | 40 |
| Subcarrier spacing | | kHz | 30 | 30 | 30 | 30 |
| Default TDD UL-DL pattern (Note 1) | |  | 7D1S2U, S=6D:4G:4U | 7D1S2U, S=6D:4G:4U | 7D1S2U, S=6D:4G:4U | 7D1S2U, S=6D:4G:4U |
| SNR | |  | -2 | 16 | 16 | 22 |
| Propagation channel | |  | TDLA30-5 | TDLA30-5 | TDLA30-5 | TDLA30-5 |
| Antenna configuration | |  | ULA Low 2x4 | ULA Low 2x4 | ULA High 2x4 | ULA Low 4x4 |
| Beamforming Model | |  | As specified in Annex TBA | As specified in Annex TBA | As specified in Annex TBA | As specified in Annex TBA |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Periodic | Periodic | Periodic | Periodic |
| Number of CSI-RS ports (X) |  | 2 | 2 | 2 | 4 |
| CDM Type |  | FD-CDM2 | FD-CDM2 | FD-CDM2 | FD-CDM2 |
| Density (ρ) |  | 1 | 1 | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1) |  | Row 3 (6,-) | Row 3 (6,-) | Row 3 (6,-) | Row 4 (0,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (13,-) | (13,-) | (13,-) | (13,-) |
| NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | 10/1 | 10/1 | 10/1 |
| ReportConfigType | |  | Periodic | Periodic | Periodic | Periodic |
| CQI-table | |  | Table 2 | Table 2 | Table 2 | Table 2 |
| reportQuantity | |  | cri-RI-PMI-CQI | cri-RI-PMI-CQI | cri-RI-PMI-CQI | cri-RI-PMI-CQI |
| cqi-FormatIndicator | |  | Wideband | Wideband | Wideband | Wideband |
| pmi-FormatIndicator | |  | Wideband | Wideband | Wideband | Wideband |
| Sub-band Size | | RB | 16 | 16 | 16 | 16 |
| csi-ReportingBand | |  | 1111111 | 1111111 | 1111111 | 1111111 |
| CSI-Report periodicity and offset | | slot | 10/9 | 10/9 | 10/9 | 10/9 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel | typeI-SinglePanel | typeI-SinglePanel | typeI-SinglePanel |
| Codebook Mode |  | 1 | 1 | 1 | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | N/A | N/A | N/A | (2,1) |
| CodebookSubsetRestriction |  | 010000 for fixed rank 2,  010011 for following rank | 000011 for fixed rank 1,  010011 for following rank | 000011 for fixed rank 1,  010011 for following rank | 11111111 |
| RI Restriction |  | N/A | N/A | N/A | 00000010 for fixed Rank 2 and 00001111 for follow RI |
| CQI/RI/PMI delay | | ms | 9.5 | 9.5 | 9.5 | 9.5 |
| Maximum number of HARQ transmission | |  | 1 | 1 | 1 | 1 |
| RI Configuration | |  | Fixed RI = 2 and follow RI | Fixed RI = 1 and follow RI | Fixed RI = 1 and follow RI | Fixed RI = 2 and follow RI |
| Note 1: The same requirements are applicable for TDD with different UL-DL pattern.  Note 2: Measurements channels are specified in Table A.3.5-1. M-FR1-A.3.5-1 is used for Rank 1 case. M-FR1-A.3.5-2 is used for Rank 2 case. M-FR1-A.3.5-3 is used for Rank 3 case. M-FR1-A.3.5-4 is used for Rank 4 case. | | | | | | |

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

5) Adjust the equipment so that required SNR specified in Table 8.2.3.4.4.2-2 is achieved at the IAB-MT input.

6) For each test specified in table 8.2.3.4.4.2-2 applicable for the IAB-MT, calculate **.

##### 8.2.3.4.5 Test requirement

The test requirement for RI reporting is defined as

a) The ratio of the throughput obtained when transmitting based on IAB-MT reported RI and that obtained when transmitting with fixed rank 1 shall be ≥ ;

b) The ratio of the throughput obtained when transmitting based on IAB-MT reported RI and that obtained when transmitting with fixed rank 2 shall be ≥ ;

For the parameters specified in Table 8.2.3.4.4.2-2 and using the downlink physical channels specified in Annex TBA, the test requirements are specified in Table 8.2.3.4.5-1.

Table 8.2.3.4.5-1 Test requirements for RI reporting

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Test 1** | **Test 2** | **Test 3** | **Test 4** |
| **1 | N/A | 1.05 | 0.9 | N/A |
| **2 | 0.9 | N/A | N/A | 0.9 |

# A.1 IAB-DU Fixed Reference Channels

## A.1.x Fixed Reference Channels for PUSCH performance requirements (QPSK, R = 193/1024)

The parameters for the reference measurement channels are specified in table A.1.x-1 and table A.1.x-2 for FR1 PUSCH performance requirements:

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

- FRC parameters are specified in table A.1.x-2 for FR1 PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 2 transmission layers.

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

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | D-FR1-A.1.x-1 | D-FR1-A.1.x-2 | D-FR1-A.1.x-3 | D-FR1-A.1.x-4 | D-FR1-A.1.x-5 | D-FR1-A.1.x-6 | D-FR1-A.1.x-7 |
| Subcarrier spacing (kHz) | 15 | 15 | 15 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 106 | 24 | 51 | 106 | 273 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Code rate | 193/1024 | 193/1024 | 193/1024 | 193/1024 | 193/1024 | 193/1024 | 193/1024 |
| Payload size (bits) | 1352 | 2856 | 5768 | 1320 | 2792 | 5768 | 14856 |
| Transport block CRC (bits) | 16 | 16 | 24 | 16 | 16 | 24 | 24 |
| Code block CRC size (bits) | - | - | 24 | - | - | 24 | 24 |
| Number of code blocks - C | 1 | 1 | 2 | 1 | 1 | 2 | 4 |
| Code block size including CRC (bits) (Note 2) | 1368 | 2872 | 2920 | 1336 | 2808 | 2920 | 3744 |
| Total number of bits per slot | 7200 | 14976 | 30528 | 6912 | 14688 | 30528 | 78624 |
| Total symbols per slot | 3600 | 7488 | 15264 | 3456 | 7344 | 15264 | 39312 |
| Note 1: DM-RS configuration type= 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0* = 2 and *l* = 11 for PUSCH mapping type A, *l0*= 0 and *l* =10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [8].  Note 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [9]. | | | | | | | |

Table A.1.x-2: FRC parameters for FR1 PUSCH performance requirements, transform precoding disabled, additional DM-RS position = pos1 and 2 transmission layers (QPSK, R=193/1024)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | D-FR1-A.1.x-8 | D-FR1-A.1.x-9 | D-FR1-A.1.x-10 | D-FR1-A.1.x-11 | D-FR1-A.1.x-12 | D-FR1-A.1.x-13 | D-FR1-A.1.x-14 |
| Subcarrier spacing (kHz) | 15 | 15 | 15 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 106 | 24 | 51 | 106 | 273 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Code rate | 193/1024 | 193/1024 | 193/1024 | 193/1024 | 193/1024 | 193/1024 | 193/1024 |
| Payload size (bits) | 2728 | 5640 | 11528 | 2600 | 5512 | 11528 | 29736 |
| Transport block CRC (bits) | 16 | 24 | 24 | 16 | 24 | 24 | 24 |
| Code block CRC size (bits) | - | 24 | 24 | - | 24 | 24 | 24 |
| Number of code blocks - C | 1 | 2 | 4 | 1 | 2 | 4 | 8 |
| Code block size including CRC (bits) (Note 2) | 2744 | 2856 | 2912 | 2616 | 2792 | 2912 | 3744 |
| Total number of bits per slot | 14400 | 29952 | 61056 | 13824 | 29376 | 61056 | 157248 |
| Total symbols per slot | 7200 | 14976 | 30528 | 6912 | 14688 | 30528 | 78624 |
| Note 1: DM-RS configuration type= 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0* = 2 and *l* = 11 for PUSCH mapping type A, *l0* = 0 and *l* = 10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [8].  Note 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [9]. | | | | | | | |

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

|  |  |  |
| --- | --- | --- |
| Reference channel | D-FR1-A.1.x-15 | D-FR1-A.1.x-16 |
| Subcarrier spacing (kHz) | 15 | 30 |
| Allocated resource blocks | 25 | 24 |
| DFT-s-OFDM Symbols per slot (Note 1) | 12 | 12 |
| Modulation | QPSK | QPSK |
| Code rate | 193/1024 | 193/1024 |
| Payload size (bits) | 1352 | 1320 |
| Transport block CRC (bits) | 16 | 16 |
| Code block CRC size (bits) | - | - |
| Number of code blocks - C | 1 | 1 |
| Code block size including CRC (bits) (Note 2) | 1368 | 1336 |
| Total number of bits per slot | 7200 | 6912 |
| Total symbols per slot | 3600 | 3456 |
| Note 1: DM-RS configuration type= 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0* = 2 and *l* = 11 for PUSCH mapping type A, *l0* = 0 and *l*= 10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [8].  Note 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [9]. | | |

## A.1.x Fixed Reference Channels for PUSCH performance requirements (16QAM, R = 658/1024)

The parameters for the reference measurement channels are specified in table A.1.x-1 and table A.1.x-2 for FR1 PUSCH performance requirements:

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

- FRC parameters are specified in table A.1.x-2 for FR1 PUSCH with transform precoding disabled, additional DM-RS position = pos1 and 2 transmission layers.

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | D-FR1-A.1.x-1 | D-FR1-A.1.x-2 | D-FR1-A.1.x-3 | D-FR1-A.1.x-4 | D-FR1-A.1.x-5 | D-FR1-A.1.x-6 | D-FR1-A.1.x-7 |
| Subcarrier spacing (kHz) | 15 | 15 | 15 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 106 | 24 | 51 | 106 | 273 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 9224 | 19464 | 38936 | 8968 | 18960 | 38936 | 100392 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 2 | 3 | 5 | 2 | 3 | 5 | 12 |
| Code block size including CRC (bits) (Note 2) | 4648 | 6520 | 7816 | 4520 | 6352 | 7816 | 8392 |
| Total number of bits per slot | 14400 | 29952 | 61056 | 13824 | 29376 | 61056 | 157248 |
| Total symbols per slot | 3600 | 7488 | 15264 | 3456 | 7344 | 15264 | 39312 |
| Note 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0* = 2 and *l* = 11 for PUSCH mapping type A, *l0* = 0 and *l* = 10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [8].  Note 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [9]. | | | | | | | |

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | D-FR1-A.1.x-8 | D-FR1-A.1.x-9 | D-FR1-A.1.x-10 | D-FR1-A.1.x-11 | D-FR1-A.1.x-12 | D-FR1-A.1.x-13 | D-FR1-A.1.x-14 |
| Subcarrier spacing (kHz) | 15 | 15 | 15 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 106 | 24 | 51 | 106 | 273 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Code rate | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 | 658/1024 |
| Payload size (bits) | 18432 | 38936 | 77896 | 17928 | 37896 | 77896 | 200808 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 3 | 5 | 10 | 3 | 5 | 10 | 24 |
| Code block size including CRC (bits) (Note 2) | 6176 | 7816 | 7816 | 6008 | 7608 | 7816 | 8392 |
| Total number of bits per slot | 28800 | 59904 | 122112 | 27648 | 58752 | 122112 | 314496 |
| Total symbols per slot | 7200 | 14976 | 30528 | 6912 | 14688 | 30528 | 78624 |
| Note 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0* = 2 and *l* = 11 for PUSCH mapping type A, *l0* = 0 and *l* = 10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [8].  Note 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [9]. | | | | | | | |

## A.1.x Fixed Reference Channels for PUSCH performance requirements (64QAM, R = 567/1024)

The parameters for the reference measurement channels are specified in table A.1.x-1 for FR1 PUSCH performance requirements:

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

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | D-FR1-A.1.x-1 | D-FR1-A.1.x-2 | D-FR1-A.1.x-3 | D-FR1-A.1.x-4 | D-FR1-A.1.x-5 | D-FR1-A.1.x-6 | D-FR1-A.1.x-7 |
| Subcarrier spacing (kHz) | 15 | 15 | 15 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 25 | 52 | 106 | 24 | 51 | 106 | 273 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Code rate | 567/1024 | 567/1024 | 567/1024 | 567/1024 | 567/1024 | 567/1024 | 567/1024 |
| Payload size (bits) | 12040 | 25104 | 50184 | 11528 | 24576 | 50184 | 131176 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of code blocks - C | 2 | 3 | 6 | 2 | 3 | 6 | 16 |
| Code block size including CRC (bits) (Note 2) | 6056 | 8400 | 8392 | 5800 | 8224 | 8392 | 8224 |
| Total number of bits per slot | 21600 | 44928 | 91584 | 20736 | 44064 | 91584 | 235872 |
| Total symbols per slot | 3600 | 7488 | 15264 | 3456 | 7344 | 15264 | 39312 |
| Note 1: DM-RS configuration type = 1 with DM-RS duration = single-symbol DM-RS and the number of DM-RS CDM groups without data is 2, additional DM-RS position = pos1, *l0* = 2 and *l* = 11 for PUSCH mapping type A, *l0* = 0 and *l* = 10 for PUSCH mapping type B as per table 6.4.1.1.3-3 of TS 38.211 [8].  Note 2: Code block size including CRC (bits) equals to *K'* in clause 5.2.2 of TS 38.212 [9]. | | | | | | | |

## A.1.x PRACH test preambles

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

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

# A.2 IAB-MT Fixed Reference Channels

## A.2.x Fixed Reference Channels for PDSCH performance requirements (16QAM)

The parameters for the reference measurement channels are specified in table A.2.x-1 for FR1 PDSCH performance requirements and FR1 PMI reporting performance requirements

Table A.2.x-1: Fixed Reference Channels for FR1 PDSCH (16QAM)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference channel | M-FR1-A.2.x-1 | M-FR1-A.2.x-2 | M-FR1-A.2.x-3 | M-FR1-A.2.x-4 | M-FR1-A.2.x-5 |
| Channel bandwidth (MHz) | 40 | 40 | 40 | 40 | 40 |
| Subcarrier spacing (kHz) | 30 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | 106 | 106 | 106 | 106 | 106 |
| Number of consecutive PDSCH symbols | 12 | 12 | 12 | 12 | 12 |
| MCS table | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index | 13 | 13 | 13 | 13 | 13 |
| Modulation | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Target Coding Rate | 490/1024 | 490/1024 | 490/1024 | 490/1024 | 490/1024 |
| Number of MIMO layers | 1 | 3 | 4 | 1 | 2 |
| Number of DMRS REs | 12 | 24 | 24 | 24 | 24 |
| Overhead for TBS determination | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot (bits) | 26632 | 73776 | 98376 | 24576 | 49176 |
| Transport block CRC per Slot (bits) | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot | 4 | 9 | 12 | 3 | 6 |
| Binary Channel Bits Per Slot (bits) | 55968 | 152640 | 203520 | 50880 | 101760 |

## A.2.x Fixed Reference Channels for PDSCH performance requirements (64QAM)

The parameters for the reference measurement channels are specified in table A.2.x-1 for FR1 PDSCH performance requirements.

Table A.2.x-1: Fixed Reference Channels for FR1 PDSCH (64QAM)

|  |  |
| --- | --- |
| Reference channel | M-FR1-A.2.x-1 |
| Channel bandwidth (MHz) | 40 |
| Subcarrier spacing (kHz) | 30 |
| Allocated resource blocks | 106 |
| Number of consecutive PDSCH symbols | 12 |
| MCS table | 64QAM |
| MCS index | 19 |
| Modulation | 64QAM |
| Target Coding Rate | 517/1024 |
| Number of MIMO layers | 2 |
| Number of DMRS REs | 12 |
| Overhead for TBS determination | 0 |
| Information Bit Payload per Slot (bits) | 83976 |
| Transport block CRC per Slot (bits) | 24 |
| Number of Code Blocks per Slot | 10 |
| Binary Channel Bits Per Slot (bits) | 167904 |

## A.2.x Fixed Reference Channels for PDSCH performance requirements (256QAM)

The parameters for the reference measurement channels are specified in table A.2.x-1 for FR1 PDSCH performance requirements.

Table A.2.x-1: Fixed Reference Channels for FR1 PDSCH (256QAM)

|  |  |
| --- | --- |
| Reference channel | M-FR1-A.2.x-1 |
| Channel bandwidth (MHz) | 40 |
| Subcarrier spacing (kHz) | 30 |
| Allocated resource blocks | 106 |
| Number of consecutive PDSCH symbols | 12 |
| MCS table | 256QAM |
| MCS index | 24 |
| Modulation | 256QAM |
| Target Coding Rate | 0.82 |
| Number of MIMO layers | 1 |
| Number of DMRS REs | 12 |
| Overhead for TBS determination | 0 |
| Information Bit Payload per Slot (bits) | 92200 |
| Transport block CRC per Slot (bits) | 24 |
| Number of Code Blocks per Slot | 11 |
| Binary Channel Bits Per Slot (bits) | 111936 |

## A.2.x Fixed Reference Channels for PDCCH performance requirements

The parameters for the reference measurement channels are specified in table A.2.x-1 for FR1 PDCCH performance requirements.

Table A.2.x-1: Fixed Reference Channels for FR1 PDCCH

|  |  |  |  |
| --- | --- | --- | --- |
| Reference channel | M-FR1-A.2.x-1 | M-FR1-A.2.x-2 | M-FR1-A.2.x-3 |
| Subcarrier spacing (kHz) | 30 | 30 | 30 |
| CORESET frequency domain allocation | 102 | 102 | 90 |
| CORESET time domain allocation | 1 | 1 | 1 |
| Aggregation level | 2 | 4 | 8 |
| DCI Format | 1\_0 | 1\_1 | 1\_1 |
| Payload (without CRC) (bits) | 41 | 53 | 53 |

## A.2.x Fixed Reference Channels for CSI reporting performance requirements

This clause defines the DL signal applicable to the reporting of channel state information

Tables A.2.x-1 specifies the mapping of CQI index to Information Bit payload, which complies with the CQI definition specified in clause 5.2.2.1 of TS 38.214 [12] and with MCS definition specified in clause 5.1.3 of TS 38.214 [12].

The parameters for the reference measurement channels are specified in table A.2.x-1 for FR1 FR1 PMI reporting performance requirements

Table A.2.x-1: Fixed Reference Channels for CSI reporting

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | | | | M-FR1-A.2.x-1 | M-FR1-A.2.x-2 | M-FR1-A.2.x-3 | M-FR1-A.2.x-4 |
| MCS table | | | | 256QAM | | | |
| Number of allocated PDSCH resource blocks | | | | 106 | 106 | 106 | 106 |
| Number of consecutive PDSCH symbols | | | | 12 | 12 | 12 | 12 |
| Number of PDSCH MIMO layers | | | | 1 | 2 | 3 | 4 |
| Number of DMRS REs (Note 1) | | | | 24 | 24 | 24 | 24 |
| Overhead for TBS determination | | | | 0 | 0 | 0 | 0 |
| Available RE-s for PDSCH | | | | 12720 | 12720 | 12720 | 12720 |
| CQI index | Spectral efficiency | MCS index | Modulation |  |  |  |  |
| 0 | OOR | OOR | OOR | N/A | N/A | N/A | N/A |
| 1 | 0.1523 | 0 | QPSK | 2976 | 5896 | 8976 | 11784 |
| 2 | 0.3770 | 1 | 4744 | 9480 | 14344 | 18976 |
| 3 | 0.8770 | 3 | 11016 | 22536 | 33816 | 45096 |
| 4 | 1.4766 | 5 | 16QAM | 18960 | 37896 | 56368 | 75792 |
| 5 | 1.9141 | 7 | 24576 | 49176 | 73776 | 98376 |
| 6 | 2.4063 | 9 | 30728 | 61480 | 92200 | 122976 |
| 7 | 2.7305 | 11 | 64QAM | 34816 | 69672 | 104496 | 139376 |
| 8 | 3.3223 | 13 | 42016 | 83976 | 127080 | 167976 |
| 9 | 3.9023 | 15 | 49176 | 98376 | 147576 | 196776 |
| 10 | 4.5234 | 17 | 57376 | 114776 | 172176 | 229576 |
| 11 | 5.1152 | 19 | 65576 | 131176 | 196776 | 262376 |
| 12 | 5.5547 | 21 | 256QAM | 69672 | 139376 | 213176 | 278776 |
| 13 | 6.2266 | 23 | 79896 | 159880 | 237776 | 319784 |
| 14 | 6.9141 | 25 | 88064 | 176208 | 262376 | 352440 |
| 15 | 7.4063 | 27 | 94248 | 188576 | 278776 | 376896 |
| Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data  Note 2: PDSCH is only scheduled on slots which are full DL | | | | | | | |

Table A.2.x-1: Fixed Reference Channels for FR1 PMI reporting

|  |  |  |
| --- | --- | --- |
| Reference channel | M-FR1-A.2.x-1 | M-FR1-A.2.x-2 |
| Channel bandwidth (MHz) | 40 | 40 |
| Subcarrier spacing (kHz) | 30 | 30 |
| Allocated resource blocks | 106 | 106 |
| Number of consecutive PDSCH symbols | 12 | 12 |
| MCS table | 64QAM | 64QAM |
| MCS index | 13 | 13 |
| Modulation | 16QAM | 16QAM |
| Target Coding Rate | 490/1024 | 490/1024 |
| Number of MIMO layers | 1 | 2 |
| Number of DMRS REs | 24 | 24 |
| Overhead for TBS determination | 0 | 0 |
| Information Bit Payload per Slot (bits) | 24576 | 49176 |
| Transport block CRC per Slot (bits) | 24 | 24 |
| Number of Code Blocks per Slot | 3 | 6 |
| Binary Channel Bits Per Slot (bits) | 50880 | 101760 |

## C.3 Measurement of performance requirements

### C.3.1 List IAB-DU TTs

Table C.3-1: Derivation of Test Requirements (Performance tests)

|  |  |  |  |
| --- | --- | --- | --- |
| Test | Minimum Requirement in TS 38.174 [TBA] | Test Tolerance (TT) | Test requirement in the present document |
| Performance requirements for PUSCH with transform precoding disabled | SNRs as specified | 0.6 dB for 1Tx cases  0.8 dB for 2Tx cases | Formula: SNR + TT  T-put limit unchanged |
| Performance requirements for PUSCH with transform precoding enabled | SNRs as specified | 0.6 dB | Formula: SNR + TT  T-put limit unchanged |
| Performance requirements for UCI multiplexed on PUSCH | SNRs as specified | 0.6 dB | Formula: SNR + TT  BLER limit unchanged |
| Performance requirements for PUCCH format 0 | SNRs as specified | 0.6 dB | Formula: SNR + TT  False ACK limit unchanged  Correct ACK limit unchanged |
| Performance requirements for PUCCH format 1 | SNRs as specified | 0.6 dB | Formula: SNR + TT  False ACK limit unchanged  False NACK limit unchanged  Correct ACK limit unchanged |
| Performance requirements for PUCCH format 2 | SNRs as specified | 0.6 dB | Formula: SNR + TT  False ACK limit unchanged  Correct ACK limit unchanged  UCI BLER limit unchanged |
| Performance requirements for PUCCH format 3 | SNRs as specified | 0.6 dB | Formula: SNR + TT  UCI BLER limit unchanged |
| Performance requirements for PUCCH format 4 | SNRs as specified | 0.6 dB | Formula: SNR + TT  UCI BLER limit unchanged |
| Performance requirements for multi-slot PUCCH | SNRs as specified | 0.6 dB | Formula: SNR + TT  False ACK limit unchanged  False NACK limit unchanged  Correct ACK limit unchanged |
| PRACH false alarm probability and missed detection | SNRs as specified | 0.3 dB | Formula: SNR + TT  PRACH false detection limit unchanged  PRACH detection limit unchanged |

### C.3.2 List IAB-MT TTs

Table C.3-2: Derivation of Test Requirements (Performance tests)

|  |  |  |  |
| --- | --- | --- | --- |
| Test | Minimum Requirement in TS 38.174 [TBA] | Test Tolerance (TT) | Test requirement in the present document |
| Performance requirements for PDSCH | SNRs as specified | [1dB] | Formula: SNR + TT  T-put limit unchanged |
| Performance requirements for PDCCH | SNRs as specified | [0.9 dB] for 1TX  [1dB] for 2TX | Formula: SNR + TT  T-put limit unchanged |
| Performance requirements for CSI reporting | SNRs as specified | No test tolerances applied | SNR limit unchanged |

## D.6 IAB type 1-H performance requirements

### D.6.1 Performance requirements for PUSCH and PUCCH on single antenna port in multipath fading conditions

1. 

Figure D.6.1-1: Functional set-up for performance requirements for PUSCH and PUCCH for IAB with Rx diversity (2 Rx case shown)

NOTE 1: The feedback could be done as an RF feedback, either using NR channels or using other means, or as a digital feedback. The HARQ Feedback should be error free.

NOTE 2: In tests performed with signal generators, a synchronization signal may be provided between the IAB node and the signal generator, or a common (e.g., GNSS) source may be provided to both IAB node and the signal generator, to enable correct timing of the wanted signal. Other proprietary means or downlink signal configuration is not precluded.

NOTE 3: It is left up to implementation how L1/L2 is configured for testing.

### D.6.2 Performance requirements for PUSCH, PDSCH, PDCCH transmission and PMI/RI reporting on two antenna ports in multipath fading conditions

1. 

Figure D.6.2-1: Functional set-up for performance requirements for PUSCH, PDSCH and PDCCH transmission on two antenna ports in multipath fading conditions (2 Rx case shown)

NOTE 1: The feedback could be done as an RF feedback, either using NR channels or using other means, or as a digital feedback. The HARQ Feedback should be error free.

NOTE 2: The method of synchronization with the TE is left to implementation. Neither the use of downlink signal configuration nor the use of proprietary means is precluded. In tests performed with signal generators, a synchronization signal may be provided between the IAB node and the signal generator, or a common (eg, GNSS) source may be provided to both IAB node and the signal generator, to enable correct timing of the wanted signal.

NOTE 3: It is left up to implementation how L1/L2 is configured for testing.

### D.6.3 Performance requirements for PUSCH, PRACH transmission and CQI reporting in static conditions

1. 

Figure D.6.3-1: Functional set-up for performance requirements for PUSCH and PRACH in static conditions for IAB-DU with Rx diversity (2 Rx case shown)

NOTE 1: The method of synchronization with the TE is left to implementation. Neither the use of downlink signal configuration nor the use of proprietary means is precluded. In tests performed with signal generators, a synchronization signal may be provided between the IAB node and the signal generator, or a common (eg, GNSS) source may be provided to both IAB node and the signal generator, to enable correct timing of the wanted signal.

NOTE 2: It is left up to implementation how L1/L2 is configured for testing.

Annex G (normative): Propagation conditions

## G.1 Static propagation condition

The propagation for the static performance measurement is an Additive White Gaussian Noise (AWGN) environment. No fading or multi-paths exist for this propagation model.

## G1.1 IAB-MT receiver with 2RX

For 1 port transmission the channel matrix is defined in the frequency domain by:

.

For 2 port transmission the channel matrix is defined in the frequency domain by:

.

For 4 port transmission the channel matrix is defined in the frequency domain by:



For 8 port transmission the channel matrix is defined in the frequency domain by:



## G.2 Multi-path fading propagation conditions

The multipath propagation conditions consist of several parts:

- A delay profile in the form of a "tapped delay-line", characterized by a number of taps at fixed positions on a sampling grid. The profile can be further characterized by the r.m.s. delay spread and the maximum delay spanned by the taps.

- A combination of channel model parameters that include the Delay profile and the Doppler spectrum that is characterized by a classical spectrum shape and a maximum Doppler frequency.

- Different models are used for FR1 (410 MHz - 7.125 GHz) and FR2 (24.25 GHz – 52.6 GHz).

### G.2.1 Delay profiles

The delay profiles are simplified from the TR 38.901 [TBA] TDL models. The simplification steps are shown below for information. These steps are only used when new delay profiles are created. Otherwise, the delay profiles specified in G.2.1.1 can be used as such.

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

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

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

- Step 4: Apply the quantization to the delay resolution 5 ns. This is done simply by rounding the tap delays to the nearest multiple of the delay resolution.

- Step 5: If multiple taps are rounded to the same delay bin, merge them by calculating their linear power sum.

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

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

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

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

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

- Remove the second delay tap.

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

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

- Remove the second-to-last tap.

- Otherwise

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

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

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

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

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

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

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

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

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

- Step 7: Round the amplitudes of taps to one decimal (e.g. -8.78 dB 🡪 -8.8 dB)

- Step 8: If the delay spread has slightly changed due to the tap merge, adjust the final delay spread by increasing or decreasing the power of the last tap so that the delay spread is corrected.

- Step 9: Re-normalize the highest tap to 0 dB.

Note 1: Some values of the delay profile created by the simplification steps may differ from the values in tables G.2.1.1-2, G.2.1.1-3, and G.2.1.1-4 for the corresponding model.

Note 2: For Step 5 and Step 6, the power values are expressed in the linear domain using 6 digits of precision. The operations are in the linear domain.

#### G.2.1.1 Delay profiles for FR1

The delay profiles for FR1 are selected to be representative of low, medium and high delay spread environment. The resulting model parameters are specified in G.2.1.1-1 and the tapped delay line models are specified in tables G.2.1.1-2 ~ table G.2.1.1-4.

Table G.2.1.1-1: Delay profiles for NR channel models

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Number of  channel taps | Delay spread  (r.m.s.) | Maximum excess tap delay (span) | Delay resolution |
| TDLA30 | 12 | 30 ns | 290 ns | 5 ns |
| TDLB100 | 12 | 100 ns | 480 ns | 5 ns |
| TDLC300 | 12 | 300 ns | 2595 ns | 5 ns |

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

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

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

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

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

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

### G.2.2 Combinations of channel model parameters

The propagation conditions used for the performance measurements in multi-path fading environment are indicated as a combination of a channel model name and a maximum Doppler frequency, i.e., TDLA<DS>-<Doppler>, TDLB<DS>-<Doppler> or TDLC<DS>-<Doppler> where '<DS>' indicates the desired delay spread and '<Doppler>' indicates the maximum Doppler frequency (Hz).

Table G.2.2-1 show the propagation conditions that are used for the performance measurements in multi-path fading environment for low, medium and high Doppler frequencies for FR1.

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

|  |  |  |
| --- | --- | --- |
| Combination name | Model | Maximum Doppler frequency |
| TDLA30-5 | TDLA30 | 5 Hz |
| TDLA30-10 | TDLA30 | 10 Hz |
| TDLB100-400 | TDLB100 | 400 Hz |
| TDLC300-100 | TDLC300 | 100 Hz |

### G.2.3 MIMO channel correlation matrices

The MIMO channel correlation matrices defined in annex G.2.3 apply for the antenna configuration using uniform linear arrays at both IAB and UE and for the antenna configuration using cross polarized antennas.

#### G.2.3.1 MIMO correlation matrices using Uniform Linear Array

The MIMO channel correlation matrices defined in annex G.2.3.1 apply for the antenna configuration using uniform linear array (ULA) at both IAB and UE.

##### G.2.3.1.1 Definition of MIMO correlation matrices

Table G.2.3.1.1-1 defines the correlation matrix for the IAB.

Table G.2.3.1.1-1: IAB-DU or gNB correlation matrix

|  |  |
| --- | --- |
|  | IAB-DU or gNB correlation |
| One antenna |  |
| Two antennas |  |
| Four antennas |  |
| Eight antennas |  |
| Note: The matrix applies to the IAB-DU for IAB-DU requirements and gNB for IAB-MT requirements. | |

Table G.2.3.1.1-2 defines the correlation matrix for the UE:

Table G.2.3.1.1-2: IAB-MT or UE correlation matrix

|  |  |  |  |
| --- | --- | --- | --- |
|  | One antenna | Two antennas | Four antennas |
| IAB-MT / UE correlation |  |  |  |
| Note: The matrix applies to th UE for IAB-DU requirements and IAB-MT for IAB-MT requirements. | | | |

Table G.2.3.1.1-3 defines the channel spatial correlation matrix. The parameters, *α* and *β* in table G.2.3.1.1-3 defines the spatial correlation between the antennas at the IAB and UE respectively.

Table G.2.3.1.1-3: correlation matrices

|  |  |
| --- | --- |
| 1x2 case |  |
| 1x4 case |  |
| 2x2 case |  |
| 2x4 case |  |
| 4x4 case |  |
| NOTE 1: RgNB refers to an IAB-DU for IAB-DU requirements or a gNB for IAB-MT requirements.  NOTE 2: RUE refers to an UE for IAB-DU requirements or and IAB-MT for IAB-MT requirements | |

For cases with more antennas at either IAB or gNB/UE or both, the channel spatial correlation matrix can still be expressed as the Kronecker product of  and according to****.

##### G.2.3.1.2 MIMO correlation matrices at high, medium and low level

The α and β for different correlation types are given in table G.2.3.1.2-1.

Table G.2.3.1.2-1: Correlation for high, medium and low level

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Low correlation | | Medium correlation | | High correlation | |
| α | β | α | β | α | β |
| 0 | 0 | 0.9 | 0.3 | 0.9 | 0.9 |

The correlation matrices for high, medium and low correlation are defined in table G.2.3.1.2-2, G.2.3.1.2-3 and G.2.3.1.2-4 as below.

The values in table G.2.3.1.2-2 have been adjusted for the 2x4 and 4x4 high correlation cases to ensure the correlation matrix is positive semi-definite after round-off to 4 digit precision. This is done using the equation:



Where the value "a" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 2x4 high correlation case, a = 0.00010. For the 4x4 high correlation case, a = 0.00012.

The same method is used to adjust the 4x4 medium correlation matrix in table G.2.3.1.2-3 to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision with a = 0.00012.

Table G.2.3.1.2-2: MIMO correlation matrices for high correlation

|  |  |
| --- | --- |
| 1x2 case |  |
| 2x2 case |  |
| 2x4 case |  |
| 4x4 case |  |

Table G.2.3.1.2-3: MIMO correlation matrices for medium correlation

|  |  |
| --- | --- |
| 1x2 case | [N/A] |
| 2x2 case |  |
| 2x4 case |  |
| 4x4 case |  |

Table G.2.3.1.2-4: MIMO correlation matrices for low correlation

|  |  |
| --- | --- |
| 1x2 case |  |
| 1x4 case |  |
| 1x8 case |  |
| 2x2 case |  |
| 2x4 case |  |
| 2x4 case |  |
| 4x4 case |  |

In table G.2.3.1.2-4,  is a  identity matrix.

NOTE: For completeness, the correlation matrices were defined for high, medium and low correlation but performance requirements exist only for low correlation.

#### G.2.3.2 Multi-antenna channel models using cross polarized antennas

The MIMO channel correlation matrices defined in annex G.2.3.2 apply to two cases as presented below:

- One TX antenna and multiple RX antennas case, with cross polarized antennas used at IAB

- Multiple TX antennas and multiple RX antennas case, with cross polarized antennas used at both UE and IAB

The cross-polarized antenna elements with +/-45 degrees polarization slant angles are deployed at IAB. For one TX antenna case, antenna element with +90 degree polarization slant angle is deployed at UE. For multiple TX antennas case, cross-polarized antenna elements with +90/0 degrees polarization slant angles are deployed at UE.

For the cross-polarized antennas, the N antennas are labelled such that antennas for one polarization are listed from 1 to N/2 and antennas for the other polarization are listed from N/2+1 to N, where N is the number of TX or RX antennas.

##### G.2.3.2.1 Definition of MIMO correlation matrices using cross polarized antennas

For the channel spatial correlation matrix, the following is used:



Where

-  is the spatial correlation matrix at the UE (IAB-DU requirements) or IAB-MT (IAB-MT requirements) with same polarization,

-  is the spatial correlation matrix at the IAB-DU (IAB-DU requirements) or gNB (IAB-MT requirements) with same polarization,

-  is a polarization correlation matrix,

-  is a permutation matrix, and

- denotes transpose.

Table G.2.3.2.1-1 defines the polarization correlation matrix.

Table G.2.3.2.1-1: Polarization correlation matrix

|  |  |  |
| --- | --- | --- |
|  | One TX antenna | Multiple TX antennas |
| Polarization correlation matrix |  |  |

The matrixis defined as



where  and  is the number of TX and RX antennas respectively, and  is the ceiling operator.

The matrix  is used to map the spatial correlation coefficients in accordance with the antenna element labelling system described in G.2.3.2.

##### G.2.3.2.2 Spatial correlation matrices at UE/IAB-MT and IAB-DU/gNB sides

##### G.2.3.2.2.1 Spatial correlation matrices at IAB-MT/UE side

In this subsection, RUE refers to a UE for IAB-DU requirements or an IAB-MT for IAB-MT requirements.

For 1-antenna transmitter, .

For 2-antenna transmitter using one pair of cross-polarized antenna elements, .

For 4-antenna transmitter using two pairs of cross-polarized antenna elements, .

##### G.2.3.2.2.2 Spatial correlation matrices at IAB-DU/gNB side

In this subsection, RgNB refers to an IAB-DU for IAB-DU requirements or a gNB for IAB-MT requirements.

For 2-antenna receiver using one pair of cross-polarized antenna elements, ****.

For 4-antenna receiver using two pairs of cross-polarized antenna elements,****.

For 8-antenna receiver using four pairs of cross-polarized antenna elements,.

##### G.2.3.2.3 MIMO correlation matrices using cross polarized antennas

The values for parameters *α*, *β* and *γ* for low spatial correlation are given in table G.2.3.2.3-1.

Table G.2.3.2.3-1: Values for parameters α,  and γ

|  |  |  |
| --- | --- | --- |
| Low spatial correlation | | |
| α |  | γ |
| 0 | 0 | 0 |
| Note 1: Value of *α* applies when more than one pair of cross-polarized antenna elements at gNB side.  Note 2: Value of *β* applies when more than one pair of cross-polarized antenna elements at UE side. | | |

The correlation matrices for low spatial correlation are defined in table G.2.3.2.3-2 as below.

Table G.2.3.2.3-2: MIMO correlation matrices for low spatial correlation

|  |  |
| --- | --- |
| 1x8 case |  |
| 2x8 case |  |

In table G.2.3.2.3-2,  is a  identity matrix.

**End of the text proposal**

# References

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