**3GPP TSG-RAN4 Meeting #90R4-1902614**

**Athens, GR, 25 Feb – 1 Mar, 2019**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *CR-Form-v11.4* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | 38.101-4 | **CR** | 0001 | **rev** | - | **Current version:** | 15.0.0 |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
|  | | | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **×** | Core Network |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | | | |
| ***Title:*** | CR on UE demodulation and CSI requirements for 38.101-4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Samsung | | | | | | | | | |
| ***Source to TSG:*** | R4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_newRAT-Perf | | | | |  | ***Date:*** | | | 2019-03-05 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | ***B*** |  | | | | | ***Release:*** | | | Rel-15 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Combided all endorsed draft CRs into specification. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | This CR comboines all the endorsed draft CRs as list below:  General sections   |  |  |  | | --- | --- | --- | | R4-1902427 | Draft CR on NR UE demodulation requirements applicability | Intel Corporation | | R4-1902576 | Draft CR on General Applicability of Requirements | Qualcomm Incorporated | | R4-1902412 | Editorial cleanup of FR2 Radiated Requirements General section | ANRITSU LTD |   PDSCH   |  |  |  | | --- | --- | --- | | R4-1902414 | Draft CR on FR1 normal PDSCH demodulation requirements | Intel Corporation | | R4-1902415 | Draft CR on FR2 PDSCH Requirements | Qualcomm Incorporated | | R4-1902411 | Draft CR on FR1 SDR requirements | Intel Corporation |   PDCCH   |  |  |  | | --- | --- | --- | | R4-1902416 | Draft CR for updating FR1 PDCCH performance requirements in TS38.101-4 | Huawei, HiSilicon | | R4-1902423 | Draft CR for updating FR2 PDCCH performance requirements in TS38.101-4 section 7.3 | CATT |   PBCH   |  |  |  | | --- | --- | --- | | R4-1902420 | Draft CR on 2Rx PBCH demodulation requirement for FR1 | CMCC | | R4-1902421 | Draft CR on 4Rx PBCH demodulation requirements for FR1 | CMCC | | R4-1902422 | Draft CR on 2Rx PBCH demodulation requirement for FR2 | CMCC |   CSI   |  |  |  | | --- | --- | --- | | R4-1902418 | Draft CR on FR2 CSI Reporting Tests | Qualcomm Incorporated | | R4-1902419 | Draft CR on FR1 CSI Reporting Tests | Qualcomm Incorporated | | R4-1900105 | Draft CR on NR CSI reporting | Intel Corporation | | R4-1902058 | Draft CR for update of FR1 CQI reporting test | Huawei, HiSilicon | | R4-1902059 | Draft CR for update of FR2 CQI reporting test | Intel | | R4-1902426 | Draft CR for PMI test cases: 6.2, 8.2, A.3.2.2.2, A.3.2.2.5 | Samsung | | R4-1902425 | Draft CR for FR1 and FR2 RI test cases | Qualcomm |   Annex   |  |  |  | | --- | --- | --- | | R4-1900369 | Draft CR on PDSCH FRC | Intel Corporation | | R4-1900370 | Draft CR on PDCCH FRC | Intel Corporation | | R4-1902424 | Corrections to 38.101-4 subclause B.2.1 Delay profile calculation | Huawei, HiSilicon | | R4-1902575 | Draft CR on Beamforming Model | Qualcomm | | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Performance requirements for UE can not be updated according endorsed draft CRs. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **×** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | | **×** |  | Test specifications | | | | TS 38.521-4 | | |
| ***(show related CRs)*** | |  | **×** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |

3GPP TS 38.101-4 V15.0.0 (2018-12)

*Technical Specification*

**3rd Generation Partnership Project;**

**Technical Specification Group Radio Access Network;**

**NR;**

**User Equipment (UE) radio transmission and reception;**

**Part 4: Performance requirements**

**(Release 15)**

** 

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Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document establishes the minimum performance requirements for NR User Equipment (UE).

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.521-4: "NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements".

[3] Recommendation ITU-R M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications-2000".

[4] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[5] 3GPP TR 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz".

[6] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[7] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[8] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[9] 3GPP TS 38.211: "NR; Physical channels and modulation".

[10] 3GPP TS 38.212: "NR; Multiplexing and channel coding".

[11] 3GPP TS 38.213: "NR; Physical layer procedures for control ".

[12] 3GPP TS 38.214: "NR; Physical layer procedures for data".

[13] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity", Stage 2.

[14] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**DL BWP**: DL bandwidth part as defined in TS 38.213 [11].

**EN-DC**: E-UTRA-NR Dual Connectivity as defined in TS 37.340 [13, Section 4.1.2].

**FR1**: Frequency range 1 as defined in TS 38.101-3 [8, Section 5.1].

**FR2**: Frequency range 2 as defined in TS 38.101-3 [8, Section 5.1].

**SSB:** SS/PBCH block as defined in TS 38.211 [9, Section 7.8.3].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

 Subcarrier spacing configuration as defined in TS 38.211 [9, Section 4.2]

 The power spectral density of a white noise source with average power per RE normalized to the subcarrier spacing as defined in Section 4.4.3 for conducted requirements and Section 4.5.3 for radiated requirements

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

CA Carrier Aggregation

CC Component Carrier

CCE Control Channel Element

CORESET Control Resource Set

CP Cyclic Prefix

CSI Channel-State Information

CSI-IM CSI Interference Measurement

CSI-RS CSI Reference Signal

CW Codeword

CQI Channel Quality Indicator

CRC Cyclic Redundancy Check

CRI CSI-RS Resource Indicator

DC Dual Connectivity

DCI Downlink Control Information

DL Downlink

DMRS Demodulation Reference Signal

EPRE Energy Per Resource Element

EN-DC E-UTRA-NR Dual Connectivity

FR Frequency Range

FRC Fixed Reference Channel

HARQ Hybrid Automatic Repeat Request

LI Layer Indicator

MAC Medium Access Control

MCS Modulation and Coding Scheme

MIB Master Information Block

NR New Radio

NSA Non-Standalone Operation Mode

OCNG OFDMA Channel Noise Generator

OFDM Orthogonal Frequency Division Multiplexing

OFDMA Orthogonal Frequency Division Multiple Access

PBCH Physical Broadcast Channel

Pcell Primary Cell

PDCCH Physical Downlink Control Channel

PDSCH Physical Downlink Shared Channel

PMI Precoding Matrix Indicator

PRB Physical Resource Block

PRG Physical resource block group

PSS Primary Synchronization Signal

PTRS Phase Tracking Reference Signal

PUCCH Physical Uplink Control Channel

PUSCH Physical Uplink Shared Channel

QCL Quasi Co-location

RB Resource Block

RBG Resource Block Group

RE Resource Element

REG Resource Element Group

RI Rank Indicator

RRC Radio Resource Control

SA Standalone operation mode

SCS Subcarrier Spacing

SINR Signal-to-Interference-and-Noise Ratio

SNR Signal-to-Noise Ratio

SS Synchronization Signal

SSB Synchronization Signal Block

SSS Secondary Synchronization Signal

TCI Transmission Configuration Indicator

TDM Time division multiplexing

TTI Transmission Time Interval

UL Uplink

VRB Virtual Resource Block

4 General

4.1 Relationship between minimum requirements and test requirements

The present document is a Single-RAT and interwork specification for NR UE, covering minimum performance requirements of both conducted and radiated requirements. Conformance to the present specification is demonstrated by fulfilling the test requirements specified in the conformance specification TS 38.521-4 [2].

The Minimum Requirements given in this specification make no allowance for measurement uncertainty. The test specification TS 38.521-4 [2] defines test tolerances. These test tolerances are individually calculated for each test. The test tolerances are used to relax the minimum requirements in this specification to create test requirements.

The measurement results returned by the test system are compared – without any modification – against the test requirements as defined by the shared risk principle.

The shared risk principle is defined in Recommendation ITU‑R M.1545 [3].

The applicability of each requirement is described under each sub-clause in [5.1, 6.1, 7.1 and 8.1].

4.2 Applicability of minimum requirements

The conducted minimum requirements specified in this specification shall be met in all applicable scenarios for FR1. The radiated minimum requirements specified in this specification shall be met in all applicable scenarios for FR2. The interwork minimum requirement specified in this specification shall be met in all applicable scenarios for NR interworking operation.

All minimum performance requirements defined in Sections 5-8 are applicable to both SA and NSA unless otherwise explicitly stated in Section 9 and 10.

All minimum performance requirements defined in Sections 5-10 are applicable to all UE power classes unless otherwise stated.

4.3 Specification suffix information

Unless stated otherwise the following suffixes are used for indicating at 2nd level subclause, shown in table 4.3-1.

**Table 4.3-1: Definition of suffixes**

|  |  |
| --- | --- |
| **Clause suffix** | **Variant** |
| None | Single Carrier |
| A | Carrier Aggregation (CA) |
| B | Dual-Connectivity (DC) |
| C | Supplement Uplink (SUL) |

A terminal which supports the above features needs to meet the requirement defined in the additional subclause (suffix A, B, C) in clauses 5, 6, 7, 8, 9, 10.

4.4 Conducted requirements

4.4.1 Conducted requirement reference point

The reference point for SNR and Noc of DL signal is the UE antenna connector or connectors.

4.4.2 SNR definition

UE demodulation and CSI requirements define the SNR as:

*NRX* denotes the number of receiver antenna connectors and the superscript receiver antenna connector *j*.

The above SNR definition assumes that the REs are not precoded, and does not account for any gain which can be associated to the precoding operation.

Es denotes the averaged received energy per resource element (EPRE) of the wanted signal. Unless otherwise stated, the SNR refers to the SSS wanted signal. The downlink SSS transmit power is defined as the linear average over the power contributions in [W] of all resource elements that carry the SSS within the operating system bandwidth.

The power ratio of other wanted signals to the SSS is defined in each requirement.

*Noc* denotes the power spectral density of a white noise source, with average power per RE normalized to the subcarrier spacing.

4.4.3 Noc

Unless otherwise stated, the spectral density of Noc is [-142dBm/Hz].

4.5 Radiated requirements

4.5.1 Radiated requirement reference point

The reference point for SNR and Noc of DL signal from the UE perspective is the input of UE antenna array.

****

**Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements**

Radiated performance requirements are specified at the Reference point, with signal-to-noise ratio (SNR) SNRRP = SNRBB + **∆BB**

where SNRBB is the baseband SNR level specified by the Minimum performance requirement in clause 7, 8, 9 and 10, and **∆BB**is specified in clause 4.5.3.2. The noise spectral density for Noc is specified in Table 4.5.3.2-1.

4.5.2 SNR definition

UE demodulation and CSI requirements define the SNR as:

*NRX* denotes the number of receiver reference points, and the super script receiver reference point *j*.

The above SNR definition assumes that the REs are not precoded, and does not account for any gain which can be associated to the precoding operation.

denotes the averaged received energy per resource element (EPRE) of the wanted signal. Unless otherwise stated, the SNR refers to the SSS wanted signal. The downlink SSS transmit power is defined as the linear average over the power contributions in [W] of all resource elements that carry the SSS within the operating system bandwidth.

The power ratio of other wanted signals to the SSS is defined in each requirement.

*Noc* denotes the power spectral density of a white noise source, with average power per RE normalized to the subcarrier spacing.

4.5.3 Noc

4.5.3.1 Introduction

For radiated testing of demodulation and CSI requirements it is not feasible in practice to use signal levels high enough to make the noise contribution of the UE negligible. Demodulation requirements are therefore specified with the applied noise higher than the UE peak EIS level in TS 38.101-2 [7] by a defined amount, so that the impact of UE noise floor is limited to no greater than a value **∆BB** at the specified Noc level. As UEs have EIS levels that are dependent on operating band and power class, Noc level is dependent on operating band and power class.

4.5.3.2 Noc for NR operating bands in FR2

Values for Noc according to operating band and power class for single carrier requirements are specified in Table 4.5.3.2-1 for **∆BB** =1dB.

**Table 4.5.3.2-1: Noc power level for different UE power classes and frequency bands**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Operating band** | **UE Power class** | | | |
| **1** | **2** | **3** | **4** |
| n257 | -166.8 | -163.8 | -157.6 | -166.3 |
| n258 | -166.8 | -163.8 | -157.6 | -166.3 |
| n260 | -163.8 |  | -155.0 | -164.3 |
| n261 | -166.8 | -163.8 | -157.6 | -166.3 |
| Note 1: Noc levels are specified in dBm/Hz | | | | |

The handling of Carrier Aggregation is FFS, and the handling of multi-band relaxation is FFS.

4.5.3.3 Derivation of Noc values for NR operating bands in FR2

The Noc values in Table 4.5.3.2-1 are based on Refsens for the Operating band and on the UE Power class, and taking a baseline of UE Power class 3 in Band n260.

Spectral density of Noc = RefsensPC3, n260, 50MHz -10Log10(SCSRefsens x PRBRefsens x 12) – SNRRefsens + ∆thermal

where:

RefsensPC3, n260, 50MHz is the Refsens value in dBm specified for Power Class 3 in Band n260 for 50MHz Channel bandwidth in TS 38.101-2 [7, Table 7.3.2.3-1].

SCSRefsens is a subcarrier spacing associated with NRB for 50MHz in TS 38.101-2 [7, Table 5.3.2-1], chosen as 120kHz.

PRBRefsens is NRB associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-2 [7, Table 5.3.2-1] and is 32.

12 is the number of subcarriers in a PRB

SNRRefsens is the SNR used for simulation of Refsens, and is -1dB

∆thermal is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of **∆BB**. ∆thermal is chosen as 6dB, giving a rise in total noise of 1dB**.**

The calculated Noc value for the baseline of UE Power class 3 in Band n260 is rounded to -155 dBm/Hz.

The following methodology to define the Noc level for power class X (PC\_X) and operating band Y (Band\_Y) and is used for the single carrier case:

Noc(PC\_X, Band\_Y) = -155 dBm/Hz + RefsensPC\_X, Band\_Y, 50MHz – RefsensPC3, n260, 50MHz + ΣMBP

where Refsens and ΣMBP values are specified in TS 38.101-2 [7].

4.5.4 Angle of arrival

Unless otherwise stated, the downlink signal and noise are aligned to arrive in the UE Rx beam peak direction as defined in TS 38.101-2 [7].

5 Demodulation performance requirements (Conducted requirements)

5.1 General

5.1.1 Applicability of requirements

#### 5.1.1.1 General

The minimum performance requirements are applicable to all FR1 operating bands defined in [TS 38.101-1].

The minimum performance requirements in Clause 5 aremandatary for UE supporting NR operation, except test cases listed in Clause 5.1.1.3.

#### 5.1.1.2 Applicability of requirements for different number of RX antenna ports

The number of RX antenna ports for different RF operating bands is up to UE declaration.

The UE shall support 2 or 4 RX antenna ports for different RF operating bands. The operating bands, where 4 RX antenna ports shall be the baseline, are defined in TS 38.101-1[6, Clause 7.4]. The UE requirements applicability for UEs with different number of RX antenna ports is defined in Table 5.1.1.2-1.

Table 5.1.1.2-1: Requirements applicability

|  |  |  |
| --- | --- | --- |
| Supported RX antenna ports | Test type | Test list |
| UE supports only 2RX | PDSCH | All tests in Clause 5.2.2 |
| PDCCH | All tests in Clause 5.3.2 |
| PBCH | All tests in Clause 5.4.2 |
| UE supports only 4RX or both 2RX and 4RX | PDSCH | All tests in Clause 5.2.3 |
| PDCCH | All tests in Clause 5.3.3 |
| PBCH | All tests in Clause 5.4.3 |

#### 5.1.1.3 Applicability of requirements for optional UE capabilities

For UE which supports optional UE capabilities the additional performance requirements from Table 5.1.1.2-1 should be applied.

Table 5.1.1.2-1: Requirements applicability for optional UE capabilities

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE feature/capability | Test type | | Test list | Applicability notes |
| [Enhanced Type X receiver] | FR1 FDD | PDSCH | 5.2.2.1.1 Minimum requirements for PDSCH Mapping Type A (Test 3-1)  5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A (Test 5-1) |  |
| FR1 TDD | PDSCH | 5.2.2.2.1 Minimum requirements for PDSCH Mapping Type A (Test 3-1)  5.2.3.2.1 Minimum requirements for PDSCH Mapping Type A (Test 5-1) |
| [Support alternative additional DMRS position for co-existence with LTE CRS] | FR1 FDD | PDSCH | 5.2.2.1.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence (Test 1-2)  5.2.3.1.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence (Test 1-2) |  |

5.2 PDSCH demodulation requirements

The parameters specified in Table 5.2-1 are valid for all PDSCH tests unless otherwise stated.

**Table 5.2-1: Common test parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Value** |
| PDSCH transmission scheme | | |  | Transmission scheme 1 |
| EPRE ratio of PTRS to PDSCH | | | dB | N/A |
| DL BWP configuration #1 | Cyclic prefix | |  | Normal |
| Common serving cell parameters | Physical Cell ID | |  | 0 |
| SSB position in burst | |  | First SSB in Slot #0 |
| SSB periodicity | | ms | 20 |
| First DMRS position for Type A PDSCH mapping | |  | 2 |
| PDCCH configuration | Slots for PDCCH monitoring | |  | Each slot |
| Symbols with PDCCH | | Symbols | 0, 1 |
| Number of PDCCH candidates and aggregation levels | |  | 1/[AL8]TBD |
| DCI format | |  | 1\_1TBD |
|  | |  | TCI state #1 |
| Cross carrier scheduling | | |  | Not configured |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | |  | k0=0 for CSI-RS resource 1,2,3,4 |
| First OFDM symbol in the PRB used for CSI-RS | |  | l0 = 6 for CSI-RS resource 1 and 3  l0 = 10 for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X) | |  | 1 for CSI-RS resource 1,2,3,4 |
| CDM Type | |  | ‘No CDM’ for CSI-RS resource 1,2,3,4 |
| Density (ρ) | |  | 3 for CSI-RS resource 1,2,3,4 |
| CSI-RS periodicity | | Slots | 15 kHz SCS: 20 for CSI-RS resource 1,2,3,4  30 kHz SCS: 40 for CSI-RS resource 1,2,3,4 |
| CSI-RS offset | | Slots | 15 kHz SCS:  10 for CSI-RS resource 1 and 2  11 for CSI-RS resource 3 and 4  30 kHz SCS:  20 for CSI-RS resource 1 and 2  21 for CSI-RS resource 3 and 4 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #0 |
| NZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS | |  | k0 = 0 |
| First OFDM symbol in the PRB used for CSI-RS | |  | l0 = 12 |
| Number of CSI-RS ports (X) | |  | Same as number of transmit antenna |
| CDM Type | |  | ‘FD-CDM2’ |
| Density (ρ) | |  | 1 |
| CSI-RS periodicity | | Slots | 15 kHz SCS: 20  30 kHz SCS: 40 |
| CSI-RS offset | | Slots | 0 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #1 |
| ZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS | |  | k0 = 4 |
| First OFDM symbol in the PRB used for CSI-RS | |  | l0 = 12 |
| Number of CSI-RS ports (X) | |  | 4 |
| CDM Type | |  | ‘FD-CDM2’ |
| Density (ρ) | |  | 1 |
| CSI-RS periodicity | | Slots | 15 kHz SCS: 20  30 kHz SCS: 40 |
| CSI-RS offset | | Slots | 0 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| 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 |
| 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 |
| TCI state #0 | Type 1 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type C |
| Type 2 QCL information | SSB index |  | N/A |
| QCL Type |  | N/A |
| TCI state #1 | Type 1 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type A |
| Type 2 QCL information | CSI-RS resource |  | N/A |
| QCL Type |  | N/A |
| PTRS configuration | | |  | PTRS 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} |
| Precoding configuration | | |  | SP Type I, Random per slot with PRB bundling granularity |
| Symbols for all unused REs | | |  | OCNG Annex A.5 |
| Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. | | | | |

5.2.1 1RX requirements

(Void)

5.2.2 2RX requirements

5.2.2.1 FDD

5.2.2.1.1 Minimum requirements for PDSCH Mapping Type A

The performance requirements are specified in Table 5.2.2.1.1-3 and Table 5.2.2.1.1-4, with the addition of test parameters in table 5.2.2.1.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.1-1.

**Table 5.2.2.1.1-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs and number of MIMO layers | 1-1, 1-2, 1-3, 2-1, 2-2 |
| Verify the PDSCH mapping Type A HARQ soft combining performance under 2 receive antenna conditions. | 1-4 |
| Verify the PDSCH mapping Type A enhanced performance requirement Type X under 2 receive antenna conditions and with 2 MIMO layers. | 3-1 |

**Table 5.2.2.1.1-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 20 for Test 2-3  10 for other tests |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 51 for Test 2-3  52 for other tests |
| Subcarrier spacing | kHz | 30 for Test 2-3  15 for other tests |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 2 |
| Length (L) |  | 12 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 4 for Test 1-1  2 for other tests |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 2 for Test 1-1 1 for other tests |
| Length |  | Single symbol |
| Number of HARQ Processes | |  | 8 for Tests 1-4, [2-1] 4 for other tests |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | 2 |

**Table 5.2.2.1.1-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-1.1 FDD | QPSK, 0.30 | TDLB100-400 | 2x2, ULA Low | 70 | [-0.8] |
| 1-2 | R.PDSCH.1-1.2 FDD | QPSK, 0.30 | TDLC300-100 | 2x2, ULA Low | 70 | [0.3] |
| 1-3 | R.PDSCH.1-4.1 FDD | 256QAM, 0.82 | TDLA30-10 | 2x2, ULA Low | 70 | [24.6] |
| 1-4 | R.PDSCH.1-2.1 FDD | 16QAM, 0.48 | TDLC300-100 | 2x2, ULA Low | 30 | [1.2] |

**Table 5.2.2.1.1-4: Minimum performance for Rank 2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 2-1 | R.PDSCH.1-3.1 FDD | 64QAM, 0.51 | TDLA30-10 | 2x2, ULA Low | 70 | TBD |
| 2-2 | R.PDSCH.2-1.1 FDD | 64QAM, 0.51 | TDLA30-10 | 2x2, ULA Low | 70 | [19.4] |

Table 5.2.2.1.1-5: Minimum performance for Rank 2 and Enhanced Type X Receiver

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
| Fraction of maximum throughput (%) | SNR (dB) |
| 3-1 | R.PDSCH.1-2.2 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Medium | 70 | [17.6] |

5.2.2.1.2 Minimum requirements for PDSCH Mapping Type A and CSI-RS overlapped with PDSCH

The performance requirements are specified in Table 5.2.2.1.2-3, with the addition of test parameters in table 5.2.2.1.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.2-1.

**Table 5.2.2.1.2-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and CSI-RS overlapped with PDSCH | 1-1 |

**Table 5.2.2.1.2-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 10 |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 52 |
| Subcarrier spacing | kHz | 15 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 2 |
| Length (L) |  | 12 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| NZP CSI-RS for CSI acquisition | OFDM symbols in the PRB used for CSI-RS |  | l0 = 13 |
| CSI-RS periodicity |  | 5 |
| ZP CSI-RS for CSI acquisition | Subcarrier index in the PRB used for CSI-RS |  | (k0, k1, k2, k3)=(2, 4, 6, 8) |
| Number of CSI-RS ports (X) |  | 8 |
| CSI-RS periodicity |  | 5 |
| Number of HARQ Processes | |  | 4 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | 2 |

**Table 5.2.2.1.2-3: Minimum performance for Rank 2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-5.1 FDD | 16QAM, 0.48 | TDLC300-100 | 2x2, ULA Low | 70 | [14.8] |

5.2.2.1.3 Minimum requirements for PDSCH Mapping Type B

The performance requirements are specified in Table 5.2.2.1.3-3, with the addition of test parameters in Table 5.2.2.1.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.3-1.

**Table 5.2.2.1.3-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify PDSCH mapping Type B performance under 2 receive antenna conditions | 1-1 |

**Table 5.2.2.1.3-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 10 |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 52 |
| Subcarrier spacing | kHz | 15 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 |
| PDSCH configuration | Mapping type |  | Type B |
| k0 |  | 0 |
| Starting symbol (S) |  | 5 |
| Length (L) |  | 7 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| Number of HARQ Processes | |  | 4 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | 2 |

**Table 5.2.2.1.3-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-1.4 FDD | QPSK, 0.30 | TDLA30-10 | 2x2, ULA Low | 70 | [-0.9] |

5.2.2.1.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence

The performance requirements are specified in Table 5.2.2.1.4-3, with the addition of test parameters in Table 5.2.2.1.4-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.4-1.

**Table 5.2.2.1.4-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions with CRS rate matching configured | 1-1, 1-2 |

**Table 5.2.2.1.4-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 10 |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 52 |
| Subcarrier spacing | kHz | 15 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 3 |
| Length (L) |  | 9 for Test 1-1 11 for Test 1-2 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| CRS for rate matching | LTE carrier centre subcarrier location |  | Same as NR carrier centre subcarrier location |
| LTE carrier BW | MHz | 10 |
| Number of antenna ports |  | 4 |
| v-shift |  | 0 |
| Number of HARQ Processes | |  | 4 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | 2 |

**Table 5.2.2.1.4-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-1.4 FDD | QPSK, 0.30 | TDLA30-10 | 4x2, ULA Low | 70 | [-1.0] |
| 1-2 | R.PDSCH.1-1.5 FDD | QPSK, 0.30 | TDLA30-10 | 4x2, ULA Low | 70 | [-0.7] |

5.2.2.2 TDD

5.2.2.2.1 Minimum requirements for PDSCH Mapping Type A

The performance requirements are specified in Table 5.2.2.2.1-3 and Table 5.2.2.2.1-4, with the addition of test parameters in Table 5.2.2.2.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.1-1.

**Table 5.2.2.2.1-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs and number of MIMO layers | 1-1, 1-2, 1-3, 1-5, 1-6, 2-1, 2-2 |
| Verify the PDSCH mapping Type A HARQ soft combining performance under 2 receive antenna conditions. | 1-4 |
| Verify the PDSCH mapping Type A enhanced performance requirement Type X under 2 receive antenna conditions and with 2 MIMO layers. | 3-1 |

**Table 5.2.2.2.1-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 20 for Test 2-3  40 for other tests |
| Duplex mode | |  | TDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 51 for Test 2-3  106 for other tests |
| Subcarrier spacing | kHz | 30 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 for Test 2-3  102 for other tests |
| 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 |  | 4 for Tests 1-1  2 for other tests |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 2 for Test 1-1  1 for other tests |
| Length |  | 1 |
| Number of HARQ Processes | |  | 16 for Test 1-4, [2-1]  8 for other tests |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | Specific to each UL-DL pattern |

**Table 5.2.2.2.1-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.2-1.1 TDD | QPSK, 0.30 | FR1.30-1 | TDLB100-400 | 2x2, ULA Low | 70 | [-1.1] |
| 1-2 | R.PDSCH.2-1.2 TDD | QPSK, 0.30 | FR1.30-1 | TDLC300-100 | 2x2, ULA Low | 70 | [0.3] |
| 1-3 | R.PDSCH.2-4.1 TDD | 256QAM, 0.82 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | [25.3] |
| 1-4 | R.PDSCH.2-2.1 TDD | 16QAM, 0.48 | FR1.30-1 | TDLC300-100 | 2x2, ULA Low | 30 | [1.6] |
| 1-5 | R.PDSCH.2-5.1 TDD | QPSK, 0.3 | FR1.30-2 | TDLA30-10 | 2x2, ULA Low | 70 | [-0.8] |
| 1-6 | R.PDSCH.2-6.1 TDD | QPSK, 0.30 | FR1.30-3 | TDLA30-10 | 2x2, ULA Low | 70 | [-0.9] |

**Table 5.2.2.2.1-4: Minimum performance for Rank 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 2-1 | R.PDSCH.2-3.1 TDD | 64QAM, 0.51 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | TBD |
| 2-2 | R.PDSCH.2-3.2 TDD | 64QAM, 0.51 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | [19.8] |

Table 5.2.2.2.1-5: Minimum performance for Rank 2 and Enhanced Type X Receiver

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Modulation format and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
| Fraction of maximum throughput (%) | SNR (dB) |
| 3-1 | R.PDSCH.2-2.2 TDD | 16QAM, 0.48 | FR1.30-1 | TDLA30-10 | 2x2, ULA Medium | 70 | [18.1] |

5.2.2.2.2 Minimum requirements for PDSCH Mapping Type A and CSI-RS overlapped with PDSCH

The performance requirements are specified in Table 5.2.2.2.2-3, with the addition of test parameters in Table 5.2.2.2.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.2-1.

**Table 5.2.2.2.2-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and CSI-RS overlapped with PDSCH | 1-1 |

**Table 5.2.2.2.2-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 40 |
| Duplex mode | |  | TDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 106 |
| Subcarrier spacing | kHz | 30 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 102 |
| 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 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| NZP CSI-RS for CSI acquisition | OFDM symbols in the PRB used for CSI-RS |  | l0 = 13 |
| CSI-RS periodicity |  | 5 |
| ZP CSI-RS for CSI acquisition | Subcarrier index in the PRB used for CSI-RS |  | (k0, k1, k2, k3)=(2, 4, 6, 8) |
| Number of CSI-RS ports (X) |  | 8 |
| CSI-RS periodicity |  | 5 |
| Number of HARQ Processes | |  | 8 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | Specific to each UL-DL pattern |

**Table 5.2.2.2.2-3: Minimum performance for Rank 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.2-7.1 TDD | 16QAM, 0.48 | FR1.30-1 | TDLC300-100 | 2x2, ULA Low | 70 | [14.8] |

5.2.2.2.3 Minimum requirements for PDSCH Mapping Type B

The performance requirements are specified in Table 5.2.2.2.3-3, with the addition of test parameters in Table 5.2.2.2.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.3-1.

**Table 5.2.2.2.3-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify PDSCH mapping Type B performance under 2 receive antenna conditions | 1-1 |

**Table 5.2.2.2.3-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 40 |
| Duplex mode | |  | TDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 106 |
| Subcarrier spacing | kHz | 30 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 102 |
| PDSCH configuration | Mapping type |  | Type B |
| k0 |  | 0 |
| Starting symbol (S) |  | 5 |
| Length (L) |  | 7 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| Number of HARQ Processes | |  | 4 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | Specific to each UL-DL pattern |

**Table 5.2.2.2.3-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation**  **condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH,2-1.3 TDD | QPSK, 0.30 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | [-0.9] |

5.2.3 4RX requirements

5.2.3.1 FDD

5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A

The performance requirements are specified in Table 5.2.3.1.1-3, Table 5.2.3.1.1-4, Table 5.2.3.1.1-5 and Table 5.2.3.1.1-6, with the addition of test parameters in Table 5.2.3.1.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.1-1.

**Table 5.2.3.1.1-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions and with different channel models, MCSs and number of MIMO layers | 1-1, 1-2, 1-3, 2-1, 2-2, 3-1, 4-1 |
| Verify the PDSCH mapping Type A HARQ soft combining performance under 4 receive antenna conditions. | 1-4 |
| Verify the PDSCH mapping Type A enhanced performance requirement Type X under 4 receive antenna conditions and with 3 MIMO layers. | 5-1 |

**Table 5.2.3.1.1-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 20 for Test 2-2  10 for other tests |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 51 for Test 2-2  52 for other tests |
| Subcarrier spacing | kHz | 30 for Test 2-2  15 for other tests |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 51 for Test 2-2  52 for other tests |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 2 |
| Length (L) |  | 12 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 4 for Test 1-1 WB for Test 3-1  2 for other tests |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 2 for Test 1-1  1 for other tests |
| Length |  | 1 |
| Number of HARQ Processes | |  | 8 for Test 1-4, [2-1]  4 for other tests |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | 2 |

**Table 5.2.3.1.1-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-1.1 FDD | QPSK, 0.30 | TDLB100-400 | 2x4, ULA Low | 70 | [-3.5] |
| 1-2 | R.PDSCH.1-1.2 FDD | QPSK, 0.30 | TDLC300-100 | 2x4, ULA Low | 70 | [-2.8] |
| 1-3 | R.PDSCH.1-4.1 FDD | 256QAM, 0.82 | TDLA30-10 | 2x4, ULA Low | 70 | [21.0] |
| 1-4 | R.PDSCH.1-2.1 FDD | 16QAM, 0.48 | TDLC300-100 | 2x4, ULA Low | 30 | [-1.3] |

**Table 5.2.3.1.1-4: Minimum performance for Rank 2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 2-1 | R.PDSCH.1-3.1 FDD | 64QAM, 0.51 | TDLA30-10 | 2x4, ULA Low | 70 | [TBD] |
| 2-2 | R.PDSCH.2-1.1 FDD | 64QAM, 0.51 | TDLA30-10 | 2x4, ULA Low | 70 | [13.4] |

**Table 5.2.3.1.1-5: Minimum performance for Rank 3**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 3-1 | R.PDSCH.1-2.3 FDD | 16QAM, 0.48 | TDLA30-10 | 4x4, ULA Low | 70 | [10.9] |

**Table 5.2.3.1.1-6: Minimum performance for Rank 4**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 4-1 | R.PDSCH.1-2.4 FDD | 16QAM, 0.48 | TDLA30-10 | 4x4, ULA Low | 70 | [15.5] |

Table 5.2.3.1.1-7: Minimum performance for Rank 3 and Enhanced Type X Receiver

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
| Fraction of maximum throughput (%) | SNR (dB) |
| 5-1 | R.PDSCH.1-2.3 FDD | 16QAM, 0.48 | TDLA30-10 | 4x4, ULA Medium A | 70 | [22.1] |

5.2.3.1.2 Minimum requirements for PDSCH Mapping Type A and CSI-RS overlapped with PDSCH

The performance requirements are specified in Table 5.2.3.1.2-3, with the addition of test parameters in table 5.2.3.1.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.2-1.

**Table 5.2.3.1.2-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions and CSI-RS overlapped with PDSCH | 1-1 |

**Table 5.2.3.1.2-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 10 |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 52 |
| Subcarrier spacing | kHz | 15 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 2 |
| Length (L) |  | 12 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| NZP CSI-RS for CSI acquisition | OFDM symbols in the PRB used for CSI-RS |  | l0 = 13 |
| CSI-RS periodicity |  | 5 |
| ZP CSI-RS for CSI acquisition | Subcarrier index in the PRB used for CSI-RS |  | (k0, k1, k2, k3)=(2, 4, 6, 8) |
| Number of CSI-RS ports (X) |  | 8 |
| CSI-RS periodicity |  | 5 |
| Number of HARQ Processes | |  | 4 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | 2 |

**Table 5.2.3.1.2-3: Minimum performance for Rank 2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-5.1 FDD | 16QAM, 0.48 | TDLC300-100 | 4x4, ULA Low | 70 | [9.1] |

5.2.3.1.3 Minimum requirements for PDSCH Mapping Type B

The performance requirements are specified in Table 5.2.3.1.3-3, with the addition of test parameters in Table 5.2.3.1.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.3-1.

**Table 5.2.3.1.3-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| PDSCH mapping Type B performance under 4 receive antenna conditions | 1-1 |

**Table 5.2.3.1.3-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 10 |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 52 |
| Subcarrier spacing | kHz | 15 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 |
| PDSCH configuration | Mapping type |  | Type B |
| k0 |  | 0 |
| Starting symbol (S) |  | 5 |
| Length (L) |  | 7 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| Number of HARQ Processes | |  | 4 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | 2 |

**Table 5.2.3.1.3-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-1.4 FDD | QPSK, 0.30 | TDLA30-10 | 4x4, ULA Low | 70 | [-3.8] |

5.2.3.1.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence

The performance requirements are specified in Table 5.2.3.1.4-3, with the addition of test parameters in Table 5.2.3.1.4-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.4-1.

**Table 5.2.3.1.3-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions with CRS rate matching configured | 1-1, 1-2 |

**Table 5.2.3.1.3-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 10 |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 52 |
| Subcarrier spacing | kHz | 15 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 |
| PDSCH configuration | Mapping type |  | 0 |
| k0 |  | 52 |
| Starting symbol (S) |  | 15 |
| Length (L) |  | 48 |
| PDSCH aggregation factor |  | Type A |
| PRB bundling type |  | 0 |
| PRB bundling size |  | 3 |
| Resource allocation type |  | 9 for Test 1-1 11 for Test 1-2 |
| VRB-to-PRB mapping type |  | 1 |
| VRB-to-PRB mapping interleaver bundle size |  | Static |
| PDSCH DMRS configuration | DMRS Type |  | 2 |
| Number of additional DMRS |  | Type 0 |
| Length |  | Non-interleaved |
| CRS for rate matching | LTE carrier centre subcarrier location |  | Same as NR carrier centre subcarrier location |
| LTE carrier BW | MHz | 10 |
| Number of antenna ports |  | 4 |
| v-shift |  | 0 |
| Number of HARQ Processes | |  | 4 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | 2 |

**Table 5.2.3.1.3-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-1.4 FDD | QPSK, 0.30 | TDLA30-10 | 4x4, ULA Low | 70 | [-4.0] |
| 1-2 | R.PDSCH.1-1.5 FDD | QPSK, 0.30 | TDLA30-10 | 4x4, ULA Low | 70 | -3.7 |

5.2.3.2 TDD

5.2.3.2.1 Minimum requirements for PDSCH Mapping Type A

The performance requirements are specified in Table 5.2.3.2.1-3, Table 5.2.3.2.1-4, Table 5.2.3.2.1-5 and Table 5.2.3.2.1-6, with the addition of test parameters in Table 5.2.3.2.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.1-1.

**Table 5.2.3.2.1-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under4 receive antenna conditions and with different channel models, MCSs and number of MIMO layers | 1-1, 1-2, 1-3, 1-5, 1-6, 2-1, 2-2, 3-1, 4-1 |
| Verify the PDSCH mapping Type A HARQ soft combining performance under 4 receive antenna conditions. | 1-4 |
| Verify the PDSCH mapping Type A enhanced performance requirement Type X under 4 receive antenna conditions and with 3 MIMO layers. | 5-1 |

**Table 5.2.3.2.1-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 20 for Test 2-2  40 for other tests |
| Duplex mode | |  | TDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 51 for Test 2-2  106 for other tests |
| Subcarrier spacing | kHz | 30 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 48 for Test 2-2  102 for other tests |
| 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 |  | 4 for Test 1-1  2 for other tests |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 2 for Tests 1-1 1 for other tests |
| Length |  | 1 |
| Number of HARQ Processes | |  | 16 for Test 1-4, [2-1]  8 for other tests |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | Specific to each UL-DL pattern |

**Table 5.2.3.2.1-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.2-1.1 TDD | QPSK, 0.30 | FR1.30-1 | TDLB100-400 | 2x4, ULA Low | 70 | [-4.1] |
| 1-2 | R.PDSCH.2-1.2 TDD | QPSK, 0.30 | FR1.30-1 | TDLC300-100 | 2x4, ULA Low | 70 | [-2.6] |
| 1-3 | R.PDSCH.2-4.1 TDD | 256QAM, 0.82 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | [21.6] |
| 1-4 | R.PDSCH.2-2.1 TDD | 16QAM, 0.48 | FR1.30-1 | TDLC300-100 | 2x4, ULA Low | 30 | [-1.0] |
| 1-5 | [R.PDSCH.2-5.1 TDD] | QPSK, 0.3 | FR1.30-2 | TDLA30-10 | 2x4, ULA Low | 70 | [-3.3] |
| 1-6 | [R.PDSCH.2-6.1 TDD] | QPSK, 0.30 | FR1.30-3 | TDLA30-10 | 2x4, ULA Low | 70 | [-3.8] |

**Table 5.2.3.2.1-4: Minimum performance for Rank 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 2-1 | R.PDSCH.2-3.1 TDD | 64QAM, 0.51 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | TBD |
| 2-2 | R.PDSCH.2-3.2 TDD | 64QAM, 0.51 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | [13.7] |

**Table 5.2.3.2.1-5: Minimum performance for Rank 3**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 3-1 | R.PDSCH.2-2.3 TDD | 16QAM, 0.48 | FR1.30-1 | TDLA30-10 | 4x4, ULA Low | 70 | [11.1] |

**Table 5.2.3.2.1-6: Minimum performance for Rank 4**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 4-1 | R.PDSCH.2-2.4 TDD | 16QAM, 0.48 | FR1.30-1 | TDLA30-10 | 4x4, ULA Low | 70 | [15.1] |

**Table 5.2.3.2.1-7: Minimum performance for Rank 3 and Enhanced Type X Receiver**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 5-1 | R.PDSCH.2-2.3 TDD | 16QAM, 0.48 | FR1.30-1 | TDLA30-10 | 4x4, ULA Medium A | 70 | [22.9] |

5.2.3.2.2 Minimum requirements for PDSCH Mapping Type A and CSI-RS overlapped with PDSCH

The performance requirements are specified in Table 5.2.3.2.2-3, with the addition of test parameters in table 5.2.3.2.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.2-1.

**Table 5.2.3.2.2-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions and CSI-RS overlapped with PDSCH | 1-1 |

**Table 5.2.3.2.2-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 40 |
| Duplex mode | |  | TDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 106 |
| Subcarrier spacing | kHz | 30 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 102 |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 2 |
| Length (L) |  | 12 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| NZP CSI-RS for CSI acquisition | OFDM symbols in the PRB used for CSI-RS |  | l0 = 13 |
| CSI-RS periodicity |  | 5 |
| ZP CSI-RS for CSI acquisition | Subcarrier index in the PRB used for CSI-RS |  | (k0, k1, k2, k3)=(2, 4, 6, 8) |
| Number of CSI-RS ports (X) |  | 8 |
| CSI-RS periodicity |  | 5 |
| Number of HARQ Processes | |  | 8 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | Specific to each UL-DL pattern |

**Table 5.2.3.2.2-3: Minimum performance for Rank 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.2-7.1 TDD | 16QAM, 0.48 | FR1.30-1 | TDLC300-100 | 4x4, ULA Low | 70 | [9.0] |

5.2.3.2.3 Minimum requirements for PDSCH Mapping Type B

The performance requirements are specified in Table 5.2.3.2.3-3, with the addition of test parameters in Table 5.2.3.2.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.3-1.

**Table 5.2.3.2.3-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| PDSCH mapping Type B performance under 4 receive antenna conditions | 1-1 |

**Table 5.2.3.2.3-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Channel bandwidth | | MHz | 40 |
| Duplex mode | |  | TDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB | PRBs | 106 |
| Subcarrier spacing | kHz | 30 |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | 102 |
| PDSCH configuration | Mapping type |  | Type B |
| k0 |  | 0 |
| Starting symbol (S) |  | 5 |
| Length (L) |  | 7 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | 1 |
| Number of HARQ Processes | |  | 8 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | Specific to each UL-DL pattern |

**Table 5.2.3.2.3-3: Minimum performance for Rank 1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation**  **condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH,2-1.3 TDD | QPSK, 0.30 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | [-3.9] |

5.3 PDCCH demodulation requirements

The receiver characteristics of the PDCCH are determined by the probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg).

The parameters specified in Table 5.3-1 are valid for all PDCCH tests unless otherwise stated.

**Table 5.3-1: Common test Parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Value** |
| DL BWP configuration #1 | Cyclic prefix | |  | Normal |
| Common serving cell parameters | Physical Cell ID | |  | 0 |
| SSB position in burst | |  | 1 |
| SSB periodicity | | ms | 20 |
| PDCCH configuration | Slots for PDCCH monitoring | |  | Each slot |
| Number of PDCCH candidates | |  | 1 |
| TCI state | |  | TCI state #1 |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS (*k0*) | |  | 0 |
| First OFDM symbol in the PRB used for CSI-RS (*l0*) | |  | CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4: 8 |
| Number of CSI-RS ports (*X*) | |  | 1 |
| CDM Type | |  | No CDM |
| Density (*ρ*) | |  | 3 |
| CSI-RS periodicity | | Slots | 15 kHz SCS: 20  30 kHz SCS: 40 |
| CSI-RS offset | | Slots | 15 kHz SCS:  10 for CSI-RS resource 1 and 2  11 for CSI-RS resource 3 and 4  30 kHz SCS:  20 for CSI-RS resource 1 and 2  21 for CSI-RS resource 3 and 4 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #0 |
| TCI state #0 | Type 1 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type C |
| Type 2 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type D |
| TCI state #1 | Type 1 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type A |
| Type 2 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type D |
| Precoding configuration | | |  | SP Type I, Random per slot with REG bundling granularity for number of Tx larger than 1 |
| Symbols for all unused REs | | |  | OCNG in Annex A.5 |

5.3.1 1RX requirements

(Void)

5.3.2 2RX requirements

5.3.2.1 FDD

The parameters specified in Table 5.3.2.1-1 are valid for all FDD tests unless otherwise stated.

**Table 5.3.2.1-1: Test Parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Unit** | **1 Tx Antenna** | **2 Tx Antenna** |
| CCE to REG mapping type |  | nonInterleaved | |
| REG bundle size |  | 6 | |
| Shift index |  | 0 | |

5.3.2.1.1 1 Tx Antenna performances

For the parameters specified in Table 5.3.2.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.2.1.1-1. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.2.1.1-1: Minimum performance for PDCCH with 15 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNR (dB)** |
| 1 | 10 MHz | 24 | 2 | 2 | R.PDCCH. 1-2.1 FDD | TDLA30-10 | 1x2 Low | 1 | [8.0] |
| 2 | 10 MHz | 24 | 2 | 2 | R.PDCCH. 1-2.3 FDD | TDLC300-100 | 1x2 Low | 1 | [8.0] |
| 3 | 10 MHz | 48 | 2 | 4 | R.PDCCH. 1-2.4 FDD | TDLA30-10 | 1x2 Low | 1 | [5.5] |
| 4 | 10 MHz | 48 | 1 | 4 | R.PDCCH.1-1.1 FDD | TDLA30-10 | 1x2 Low | 1 | [4.3] |
| 5 | 10MHz | 48 | 2 | 16 | R.PDCCH. 1-2.6 FDD | TDLA30-10 | 1x2 Low | 1 | [-2.1] |

5.3.2.1.2 2 Tx Antenna performances

For the parameters specified in Table 5.3.2.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.2.1.2-1. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.2.1.2-1: Minimum performance for PDCCH with 15 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNR (dB)** |
| 1 | 10 MHz | 24 | 2 | 4 | R.PDCCH. 1-2.2 FDD | TDLC300-100 | 2x2 Low | 1 | TBD |
| 2 | 10 MHz | 48 | 2 | 8 | R.PDCCH. 1-2.5 FDD | TDLC300-100 | 2x2 Low | 1 | [-1.5] |
| 3 | 10 MHz | 48 | 1 | 8 | R.PDCCH.1-1.3 FDD | TDLA30-10 | 2x2 Low | 1 | [-0.3] |

5.3.2.2 TDD

The parameters specified in Table 5.3.2.2-1 are valid for all TDD tests unless otherwise stated.

**Table 5.3.2.2-1: Test Parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **1 Tx Antenna** | | **2 Tx Antenna** |
| TDD UL-DL pattern |  | FR1.30-1 | | |
| CCE to REG mapping type |  | interleaved | | |
| Interleaver size |  | 3 | | |
| REG bundle size |  | 2 | 6 | |
| Shift Index |  | 0 | | |

5.3.2.2.1 1 Tx Antenna performances

For the parameters specified in Table 5.3.2.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.2.2.1-1. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.2.2.1-1: Minimum performance for PDCCH with 30 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNR (dB)** |
| 1 | 40 MHz | 102 | 1 | 2 | R.PDCCH. 2-1.1 TDD | TDLA30-10 | 1x2 Low | 1 | [6.7] |
| 2 | 40 MHz | 102 | 1 | 4 | R.PDCCH. 2-1.2 TDD | TDLC300- 100 | 1x2 Low | 1 | [2.7] |
| 3 | 40 MHz | 48 | 2 | 16 | R.PDCCH. 2-2.1 TDD | TDLC300- 100 | 1x2 Low | 1 | [-4.4] |

5.3.2.2.2 2 Tx Antenna performances

For the parameters specified in Table 5.3.2.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.2.2.2-1. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.2.2.2-1: Minimum performance for PDCCH with 30 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNR (dB)** |
| 1 | 40 MHz | [90] | 1 | 8 | R.PDCCH. 2-1.3 TDD | TDLC300-100 | 2x2 Low | 1 | [-1.5] |

5.3.3 4RX requirements

5.3.3.1 FDD

The parameters specified in Table 5.3.3.1-1 are valid for all FDD tests unless otherwise stated.

**Table 5.3.3.1-1: Test Parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Unit** | **1 Tx Antenna** | **2 Tx Antenna** |
| CCE to REG mapping type |  | nonInterleaved | |
| REG bundle size |  | 6 | |
| Shift index |  | 0 | |

5.3.3.1.1 1 Tx Antenna performances

For the parameters specified in Table 5.3.3.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.3.1.1-1. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.3.1.1-1: Minimum performance for PDCCH with 15 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNR (dB)** |
| 1 | 10 MHz | 24 | 2 | 2 | R.PDCCH. 1-2.1 FDD | TDLA30-10 | 1x4 Low | 1 | [2.3] |
| 2 | 10 MHz | 24 | 2 | 2 | R.PDCCH. 1-2.3 FDD | TDLC300- 100 | 1x4 Low | 1 | [2.5] |
| 3 | 10 MHz | 48 | 2 | 4 | R.PDCCH. 1-2.4 FDD | TDLA30-10 | 1x4 Low | 1 | [0.0] |
| 4 | 10 MHz | 48 | 1 | 4 | R.PDCCH.1-1.1 FDD | TDLA30-10 | 1x4 Low | 1 | [-0.7] |

5.3.3.1.2 2 Tx Antenna performances

For the parameters specified in Table 5.3.3.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.3.1.2-1. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.3.1.2-1: Minimum performance for PDCCH with 15 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNR (dB)** |
| 1 | 10 MHz | 24 | 2 | 4 | R.PDCCH. 1-2.2 FDD | TDLC300-100 | 2x4 Low | 1 | TBD |
| 2 | 10 MHz | 48 | 2 | 8 | R.PDCCH. 1-2.5 FDD | TDLC300-100 | 2x4 Low | 1 | [-4.8] |
| 3 | 10 MHz | 48 | 1 | 4 | R.PDCCH.1-1.3 FDD | TDLA30-10 | 2x4 Low | 1 | TBD |

5.3.3.2 TDD

The parameters specified in Table 5.3.3.2-1 are valid for all TDD tests unless otherwise stated.

**Table 5.3.3.2-1: Common Test Parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **1 Tx Antenna** | | **2 Tx Antenna** |
| TDD UL-DL pattern |  | FR1.30-1 | | |
| CCE to REG mapping type |  | interleaved | | |
| Interleaver size |  | 3 | | |
| REG bundle size |  | 2 | 6 | |
| Shift Index |  | 0 | | |

5.3.3.2.1 1 Tx Antenna performances

For the parameters specified in Table 5.3.3.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.3.2.1-1. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.3.2.1-1: Minimum performance for PDCCH with 30 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNR (dB)** |
| 1 | 40 MHz | 102 | 1 | 2 | R.PDCCH. 2-1.1 TDD | TDLA30-10 | 1x4 Low | 1 | TBD |
| 2 | 40 MHz | 102 | 1 | 4 | R.PDCCH. 2-1.2 TDD | TDLC300-100 | 1x4 Low | 1 | TBD |
| 3 | 40 MHz | 48 | 2 | 16 | R.PDCCH. 2-2.1 TDD | TDLA30-10 | 1x4 Medium A | 1 | [-4.1] |

5.3.3.2.2 2 Tx Antenna performances

For the parameters specified in Table 5.3.3.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.3.2.2-1. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.3.2.2-1: Minimum performance for PDCCH with 30 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNR (dB)** |
| 1 | 40 MHz | 90 | 1 | 8 | TBD | TDLC300-100 | 2x4 Low | 1 | [-4.6] |

5.4 PBCH demodulation requirements

The receiver characteristics of PBCH are determined by the probability of miss-detection of the PBCH (Pm-bch), which is defined as

Where A is the number of correctly decoded MIB PDUs and B is the number of transmitted MIB PDUs. The Pm-bch is derived with the assumption UE combines the PBCH symbols of the same SS/PBCH block index within the MIB TTI (80ms).

5.4.1 1RX requirements

(Void)

5.4.2 2RX requirements

5.4.2.1 FDD

**Table 5.4.2.1-1: Test parameters for PBCH**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Single antenna port** |
| Physical Cell ID |  | 0 |
| Cyclic prefix |  | Normal |
| Number of SS/PBCH blocks within an SS burst set periodicity |  | 1 |
| SS/PBCH block index Note1 |  | 0 |
| SS/PBCH block periodicity | ms | 20 |
| Note 1: as specified in TS 38.213 [11, Section 4.1] | | |

For the parameters specified in Table 5.4.2.1-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.2.1-2 in case SS/PBCH block index is not known and below the specifies values in Table.5.4.2.1-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.4.2.1-2: Minimum performance PBCH in case SS/PBCH block index is not known**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **Reference channel** | **Propagation condition** | **Antenna configuration and correlation matrix** | **Reference value** | |
| **Pm-bch (%)** | **SNR (dB)** |
| 1 | 10 MHz | R.PBCH.1 | TDLC300-100 | 1 x 2 Low | 1 | [-6.4] |

Table 5.4.2.1-3 Minimum performance PBCH in case SS/PBCH block index is known

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
| Pm-bch (%) | SNR (dB) |
| 1 | 10 MHz | R.PBCH.1 | TDLC300-100 | 1 x 2 Low | 1 | [-8.5] |

5.4.2.2 TDD

**Table 5.4.2.2-1: Test parameters for PBCH**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Single antenna port** |
| Physical Cell ID |  | 0 |
| Cyclic prefix |  | Normal |
| Number of SS/PBCH blocks within an SS burst set periodicity |  | 1 |
| SS/PBCH block index Note1 |  | 0 |
| SS/PBCH block periodicity | ms | 20 |
| TDD UL-DL pattern |  | FR1.30-1 |
| Note 1: as specified in TS 38.213 [11, Section 4.1]  Note 2: as specified in TS 38.213 [11, Section 11.1] | | |

For the parameters specified in Table 5.4.2.2-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.2.2-2 in case SS/PBCH block index is not known known and below the specified values in Table.5.4.2.2-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.4.2.2-2: Minimum performance PBCH in case SS/BPCH block index is not known**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **Reference channel** | **Propagation condition** | **Antenna configuration and correlation matrix** | **Reference value** | |
| **Pm-bch (%)** | **SNR (dB)** |
| 1 | 40 MHz | R.PBCH.2 | TDLA30-10 | 1 x 2 Low | 1 | [-5] |

Table 5.4.2.2-3 Minimum performance PBCH in case SS/BPCH block index is known

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
| Pm-bch (%) | SNR (dB) |
| 1 | 40 MHz | R.PBCH.2 | TDLA30-10 | 1 x 2 Low | 1 | [-6.4] |

### 5.4.3 4RX requirements

#### 5.4.3.1 FDD

Table 5.4.3.1-1: Test parameters for PBCH

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Single antenna port |
| Physical Cell ID |  | 0 |
| Cyclic prefix |  | Normal |
| Number of SS/PBCH blocks within an SS burst set periodicity |  | 1 |
| SS/PBCH block index Note1 |  | 0 |
| SS/PBCH block periodicity | ms | 20 |
| Note 1: as specified in TS 38.213 [11, Section 4.1] | | |

For the parameters specified in Table 5.4.3.1-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.3.1-2 in case SS/PBCH block index is not known and below the specified values in Table.5.4.3.1-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.4.3.1-2: Minimum performance PBCH in case SS/PBCH block index is not known

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
| Pm-bch (%) | SNR (dB) |
| 1 | 10 MHz | R.PBCH.1 | TDLC300-100 | 1 x 4 Low | 1 | [-9.1] |

Table 5.4.3.1-2 Minimum performance PBCH in case SS/PBCH block index is known

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
| Pm-bch (%) | SNR (dB) |
| 1 | 10 MHz | R.PBCH.1 | TDLC300-100 | 1 x 4 Low | 1 | TBD |

#### 5.4.3.2 TDD

Table 5.4.3.2-1: Test parameters for PBCH

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Single antenna port |
| Physical Cell ID |  | 0 |
| Cyclic prefix |  | Normal |
| Number of SS/PBCH blocks within an SS burst set periodicity |  | 1 |
| SS/PBCH block index Note1 |  | 0 |
| SS/PBCH block periodicity | ms | 20 |
| TDD UL-DL pattern |  | FR1.30-1 |
| Note 1: as specified in TS 38.213 [11, Section 4.1]  Note 2: as specified in TS 38.213 [11, Section 11.1] | | |

For the parameters specified in Table 5.4.3.2-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.3.2-2 in case SS/PBCH block index is not known and below the specified values in Table.5.4.3.2-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.4.3.2-2: Minimum performance PBCH in case SS/BPCH block index is not known

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
| Pm-bch (%) | SNR (dB) |
| 1 | 40 MHz | R.PBCH.2 | TDLA30-10 | 1 x 4 Low | 1 | [-8.5] |

Table 5.4.3.2-3: Minimum performance PBCH in case SS/BPCH block index is known

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
| Pm-bch (%) | SNR (dB) |
| 1 | 40 MHz | R.PBCH.2 | TDLA30-10 | 1 x 4 Low | 1 | [-9.9] |

5.5 Sustained downlink data rate provided by lower layers

5.5.1 FR1 single carrier requirements

The requirements in this clause are applicable to the FR1 single carrier case.

The requirements and procedure defined in Clause 5.5A.1 apply using operating band instead of CA configuration, and bandwidth instead of bandwidth combination.

5.5A Sustained downlink data rate provided by lower layers

5.5A.1 FR1 CA requirements

*<Editor’s note: Open issues to be resolved:*

*Sustained rate minimum duration*

*Whether same requirements apply for FR1 DC>*

The Sustained Data Rate (SDR) requirements in this clause are applicable to the FR1 CA.

The purpose of the test is to verify that the Layer 1 and Layer 2 correctly process in a sustained manner the received packets corresponding to the maximum data rate indicated by UE capabilities*.* The sustained downlink data rate shall be verified in terms of the success rate of delivered PDCP SDU(s) by Layer 2. The test case below specifies the RF conditions and the required success rate of delivered TB by Layer 1 to meet the sustained data rate requirement.

The test parameters are determined by the following procedure:

- Select one CA bandwidth combination among all supported CA configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities that provides the largest data rate [TS 38.306 [14, Section 4.1.2]].

- Set of per CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor [TS 38.306 [14, Section 4.1.2]].

- When there are multiple sets of CA bandwidth combinations and UE capabilities (channel bandwidth, subcarrier spacing, number of MIMO layer, modulation format, scaling factor) with same largest data rate, select one among sets with the smallest aggregated channel bandwidth.

- For each CC in CA bandwidth combination, use Table 5.5A-5 to determine MCS based on test parameters and indicated UE capabilities.

The TB success rate shall be higher than 85% when PDSCH is scheduled with MCS defined for the selected CA bandwidth combination and with the downlink physical channel setup according to Annex C.3.1.

The TB success rate is defined as 100%\*NDL\_correct\_rx/ (NDL\_newtx + NDL\_retx), where NDL\_newtx is the number of newly transmitted DL transport blocks, NDL\_retx is the number of retransmitted DL transport blocks, and NDL\_correct\_rx is the number of correctly received DL transport blocks. The TB success rate shall be sustained during at least TBD ms.

The common test parameters are specified in Table 5.5A-1. The parameters specified in Table 5.5A-2 are applicable for tests on FDD CCs and parameters specified in Table 5.5A-3 are applicable for tests on TDD CCs.

Unless otherwise stated, no user data is scheduled on slot #0, 10 and 11 within 20 ms for SCS 15 kHz.

Unless otherwise stated, no user data is scheduled on slot #0, 20 and 21 within 20 ms for SCS 30 kHz.

**Table 5.5A-1: Common test parameters for FDD and TDD component carriers**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Value** |
| PDSCH transmission scheme | | |  | Transmission scheme 1 |
| EPRE ratio of PTRS to PDSCH | | | dB | N/A |
| Channel bandwidth | | | MHz | Channel bandwidth from selected CA bandwidth combination |
| Common serving cell parameters | Physical Cell ID | |  | 0 |
| SSB position in burst | |  | First SSB in Slot #0 |
| SSB periodicity | | ms | 20 |
| First DMRS position for Type A PDSCH mapping | |  | 2 |
| Cross carrier scheduling | | |  | Not configured |
| Active DL BWP index | | |  | 1 |
| DL BWP configuration #1 | First PRB | |  | 0 |
| Number of contiguous PRB | |  | Maximum transmission bandwidth configuration as specified in TS 38.101-1 [6, Section 5.3.2] for tested channel bandwidth and subcarrier spacing |
| Subcarrier spacing | | kHz | [15 or 30] |
| Cyclic prefix | |  | Normal |
| PDCCH configuration | Slots for PDCCH monitoring | |  | Each slot |
| Symbols with PDCCH | |  | Symbols #0 |
| Number of PRBs in CORESET | |  | Table 5.5A-4 |
| Number of PDCCH candidates and aggregation levels | |  | TBD1/[AL 8] |
| DCI format | |  | TBD1\_1 |
| TCI State | |  | TCI state #1 |
| PDSCH configuration | Mapping type | |  | Type A |
| k0 | |  | 0 |
| PDSCH aggregation factor | |  | 1 |
| PRB bundling type | |  | Static |
| PRB bundling size | |  | WB |
| Resource allocation type | |  | Type 0 |
| VRB-to-PRB mapping type | |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size | |  | N/A |
| PDSCH DMRS configuration | DMRS Type | |  | Type 1 |
| Number of additional DMRS | |  | 1 |
| Length | |  | 1 |
| Antenna ports indexes | |  | {1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs  {1000 – 1003} for 4 Layers CCs |
| Number of PDSCH DMRS CDM group(s) without data | |  | 1 for 1 layer and 2 layers CCs  2 for 4 Layers CCs |
| PTRS configuration | | |  | PTRS is not configured |
| CSI-RS for tracking | Subcarrier indexes in the PRB used for CSI-RS | |  | k0 = 3 for CSI-RS resource 1,2,3,4 |
| OFDM symbols in the PRB used for CSI-RS | |  | l0 = 6 for CSI-RS resource 1 and 3  l0 = 10 for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X) | |  | 1 for CSI-RS resource 1,2,3,4 |
| CDM Type | |  | ‘No CDM’ for CSI-RS resource 1,2,3,4 |
| Density (ρ) | |  | 3 for CSI-RS resource 1,2,3,4 |
| CSI-RS periodicity | | Slots | 15 kHz SCS: 20 for CSI-RS resource 1,2,3,4  30 kHz SCS: 40 for CSI-RS resource 1,2,3,4 |
| CSI-RS offset | | Slots | 15 kHz SCS:  10 for CSI-RS resource 1 and 2  11 for CSI-RS resource 3 and 4  30 kHz SCS:  20 for CSI-RS resource 1 and 2  21 for CSI-RS resource 3 and 4 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #0 |
| NZP CSI-RS for CSI acquisition | Subcarrier indexes in the PRB used for CSI-RS | |  | k0 = 4 |
| OFDM symbols in the PRB used for CSI-RS | |  | l0 = 12 |
| Number of CSI-RS ports (X) | |  | Same as number of transmit antenna |
| CDM Type | |  | ‘FD-CDM2’ |
| Density (ρ) | |  | 1 |
| CSI-RS periodicity | |  | 15 kHz SCS: 20  30 kHz SCS: 40 |
| CSI-RS offset | |  | 0 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #1 |
| ZP CSI-RS for CSI acquisition | Subcarrier indexes in the PRB used for CSI-RS | |  | k0 = 0 |
| OFDM symbols in the PRB used for CSI-RS | |  | l0 = 12 |
| Number of CSI-RS ports (X) | |  | 4 |
| CDM Type | |  | ‘FD-CDM2’ |
| Density (ρ) | |  | 1 |
| CSI-RS periodicity | |  | 15 kHz SCS: 20  30 kHz SCS: 40 |
| CSI-RS offset | |  | 0 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| TCI state #0 | Type 1 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type C |
| Type 2 QCL information | SSB index |  | N/A |
| QCL Type |  | N/A |
| TCI state #1  TCI state #0 | Type 1 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type A |
| Type 2 QCL information  Type 1 QCL information | CSI-RS resource |  | N/A |
| SSB index |  | SSB #0 |
| 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} |
| Precoding configuration | | |  | SP Type I, Random per slot with PRB bundling granularity |
| Symbols for all unused Res | | |  | OCNG Annex A.5 |
| Propagation condition | | |  | Static propagation condition  No external noise sources are applied |
| Antenna configuration | 1 layer CCs | |  | [1x2 or 1x4] |
| 2 layers CCs | |  | [2x2 or 2x4] |
| 4 layers CCs | |  | [4x4] |
| Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission | | | | |

**Table 5.5A-2: Additional test parameters for FDD CC**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Duplex mode | |  | FDD |
| PDSCH configuration | Starting symbol (S) |  | 1 |
| Length (L) |  | 13 |
| Number of HARQ Processes | |  | TBD |
| K1 value | |  | 2 |

**Table 5.5A-3: Additional test parameters for TDD CC**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Duplex mode | |  | TDD |
| PDSCH configuration | Starting symbol (S) |  | 1 |
| Length (L) |  | 13 |
| Number of HARQ Processes | |  | TBD |
| K1 value | |  | Specific to each UL-DL pattern |
| TDD UL-DL pattern | |  | 15 kHz SCS: FR1.15-1  30 kHz SCS: FR1.30-1 |
| Note 1: PDSCH is scheduled only on full DL slots | | | |

**Table 5.5A-4: Number of PRBs in CORESET**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SCS (kHz)** | **5MHz** | **10MHz** | **15MHz** | **20 MHz** | **25 MHz** | **30 MHz** | **40 MHz** | **50MHz** | **60 MHz** | **80 MHz** | **100 MHz** |
| 15 | 24 | 48 | 78 | 102 | 132 | 156 | 216 | 270 | N/A | N/A | N/A |
| 30 | 6 | 24 | 36 | 48 | 60 | 78 | 102 | 132 | 162 | 216 | 270 |

**Table 5.5A-5: MCS indexes for indicated UE capabilities**

|  |  |  |  |
| --- | --- | --- | --- |
| **Maximum number of PDSCH MIMO layers** | **Maximum modulation format** | **Scaling factor** | **MCS** |
| 1 | 8 | 1 | [26] |
| 1 | 8 | 0.8 | [21] |
| 1 | 8 | 0.75 | [20] |
| 1 | 8 | 0.4 | [11] |
| 1 | 6 | 1 | [27] |
| 1 | 6 | 0.8 | [23] |
| 1 | 6 | 0.75 | [22] |
| 1 | 6 | 0.4 | [14] |
| 1 | 4 | 1 | [16] |
| 1 | 4 | 0.8 | [16] |
| 1 | 4 | 0.75 | [16] |
| 1 | 4 | 0.4 | [10] |
| 1 | 2 | 1 | [9] |
| 1 | 2 | 0.8 | [9] |
| 1 | 2 | 0.75 | [9] |
| 1 | 2 | 0.4 | [4] |
| 2 | 8 | 1 | [26] |
| 2 | 8 | 0.8 | [21] |
| 2 | 8 | 0.75 | [20] |
| 2 | 8 | 0.4 | [11] |
| 2 | 6 | 1 | [27] |
| 2 | 6 | 0.8 | [23] |
| 2 | 6 | 0.75 | [22] |
| 2 | 6 | 0.4 | [14] |
| 2 | 4 | 1 | [16] |
| 2 | 4 | 0.8 | [16] |
| 2 | 4 | 0.75 | [16] |
| 2 | 4 | 0.4 | [10] |
| 2 | 2 | 1 | [9] |
| 2 | 2 | 0.8 | [9] |
| 2 | 2 | 0.75 | [9] |
| 2 | 2 | 0.4 | [4] |
| 4 | 8 | 1 | [26] |
| 4 | 8 | 0.8 | [23] |
| 4 | 8 | 0.75 | [22] |
| 4 | 8 | 0.4 | [12] |
| 4 | 6 | 1 | [27] |
| 4 | 6 | 0.8 | [24] |
| 4 | 6 | 0.75 | [23] |
| 4 | 6 | 0.4 | [14] |
| 4 | 4 | 1 | [16] |
| 4 | 4 | 0.8 | [16] |
| 4 | 4 | 0.75 | [16] |
| 4 | 4 | 0.4 | [11] |
| 4 | 2 | 1 | [9] |
| 4 | 2 | 0.8 | [9] |
| 4 | 2 | 0.75 | [9] |
| 4 | 2 | 0.4 | [5] |

6 CSI reporting requirements (Conducted requirements)

6.1 General

This section includes conducted requirements for the reporting of channel state information (CSI).

6.1.1 Applicability of requirements

6.1.2 Common test parameters

Parameters specified in Table 6.1.2-1 are applied for all test cases in this section unless otherwise stated.

**Table 6.1.2-1: Test parameters for CSI test cases**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Value** |
| PDSCH transmission scheme | | | |  | Transmission scheme 1 |
| EPRE ratio of PTRS to PDSCH | | | | dB |  |
| Active DL BWP index | | | |  | 1 |
| Cyclic prefix | | | |  | Normal |
| Common serving cell parameters | Physical Cell ID | | |  | 0 |
| SSB position in burst | | |  | First SSB in Slot #0 |
| SSB periodicity | | | ms | 20 |
| PDCCH configuration | Slots for PDCCH monitoring | | |  | Each slot |
| Symbols with PDCCH | | |  | 0,1 |
| Number of PDCCH candidates and aggregation levels | | |  | 1/[8] |
| DCI format | | |  | 1\_1 |
| TCI state | | |  | TCI state #1 |
| Cross carrier scheduling | | | |  | Not configured |
| PDSCH configuration | Mapping type | | |  | Type A |
| *k0* | | |  | 0 |
| Starting symbol (S) | | |  | 2 |
| Length (L) | | |  | 12 |
| PDSCH aggregation factor | | |  | 1 |
| PRB bundling type | | |  | Static |
| PRB bundling size | | |  | 2 |
| Resource allocation type | | |  | 0 |
| VRB-to-PRB mapping type | | |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size | | |  | N/A |
| PDSCH DMRS configuration | DMRS Type | | |  | Type 1 |
| Number of additional DMRS | | |  | 1 |
| Length | | |  | Single-symbol DM-RS |
| DMRS ports indexes | | |  | {1000} for Rank1  {1000,1001} for Rank2  {1000,1001,1002} for Rank3  {1000,1001,1002,1003} for Rank4 |
| Number of PDSCH DMRS CDM group(s) without data | | |  | 2 |
| PTRS configuration | Frequency density (*KPT-RS*) | | |  | N/A |
| Time density (*LPT-RS*) | | |  | N/A |
| CSI-RS for tracking | | First subcarrier index in the PRB used for CSI-RS (*k0*) | |  | [0] |
| First OFDM symbol in the PRB used for CSI-RS (*l0*) | |  | [4] |
| Number of CSI-RS ports (*X*) | |  | 1 |
| CDM Type | |  | No CDM |
| Density (*ρ*) | |  | 3 |
| CSI-RS periodicity | | slot | 15 kHz SCS: 20 30 kHz SCS: 40 |
| CSI-RS offset | | slot | 15 kHz SCS:  10 for CSI-RS resource 1 and 2  11 for CSI-RS resource 3 and 4  30 kHz SCS:  20 for CSI-RS resource 1 and 2  21 for CSI-RS resource 3 and 4 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #0 |
| NZP CSI-RS for CSI acquisition | | Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #1 |
| ZP CSI-RS for CSI acquisition | | Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| TCI state #0 | | Type 1 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type C |
| Type 2 QCL information | SSB index |  | N/A |
| QCL Type |  | N/A |
| TCI state #1 | | Type 1 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type A |
| Type 2 QCL information | CSI-RS resource |  | N/A |
| QCL Type |  | N/A |
| Number of HARQ Processes | | | |  | 4 For FDD  8 for TDD |
| HARQ ACK/NACK bundling | | | |  | Multiplexed |
| Redundancy version coding sequence | | | |  | {0,2,3,1} |
| K1 value (PDSCH-to-HARQ-timing-indicator) | | | |  | 2 for FDD  Defined in Annex A.1.2 for TDD |
| Symbols for unused Res | | | |  | OCNG as specified in A.5 |
| Note 1: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL.  Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. | | | | | |

6.2 Reporting of Channel Quality Indicator (CQI)

*<Editor’s note: The requirements were introduced based on current results from companies; these requirements can be revised based on more results from companies.>*

This section includes the requirements for the reporting of channel quality indicator (CQI).

6.2.1 1RX requirements

(Void)

6.2.2 2RX requirements

This sub-clause includes the requirements for reporting of CQI for UE equipped with 2 receiver antennas.

6.2.2.1 FDD

6.2.2.1.1 CQI reporting definition under AWGN conditions

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 [12]. 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.

6.2.2.1.1.1 Minimum requirement for periodic CQI reporting

For the parameters specified in Table 6.2.2.1.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum 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.

**Table 6.2.2.1.1.1-1: CQI reporting definition test**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 10 | | | |
| Duplex Mode | | | |  | FDD | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 52 | | | |
| Subcarrier spacing | kHz | 15 | | | |
| SNR | | | | dB | [8] | [9] | [14] | [15] |
| Propagation channel | | | |  | AWGN | | | |
| Antenna configuration | | | |  | 2×2 with static channel specified in Annex B.1 | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 5/1 | | | |
| 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 | 5/1 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 5/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Wideband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | N/A | | | |
| CSI-Report periodicity and offset | | | | slot | 5/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | [010000] | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | [PUCCH] | | | |
| CQI/RI/PMI delay | | | | ms | 8 | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.2-2 | | | |

6.2.2.1.2 CQI reporting under fading conditions

6.2.2.1.2.1 Minimum requirement for wideband CQI reporting

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI. To account for sensitivity of the input SNR the sub-band CQI reporting under frequency selective fading conditions 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.

For the parameters specified in Table 6.2.2.1.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least *α*% of the time where *α*% is specified in Table 6.2.2.1.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ *γ*, where *γ* is specified in Table 6.2.2.1.2.1-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to [0.02].

**Table 6.2.2.1.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 10 | | | |
| Duplex Mode | | | |  | FDD | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 52 | | | |
| Subcarrier spacing | kHz | 15 | | | |
| SNR | | | | dB | [6] | [7] | [12] | [13] |
| Propagation channel | | | |  | TDLA30-5 | | | |
| Antenna configuration | | | |  | 2×2 | | | |
| Correlation configuration | | | |  | ULA high | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 5/1 | | | |
| 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 | 5/1 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 5/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Wideband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | [8] | | | |
| Csi-ReportingBand | | | |  | [1111111] | | | |
| CSI-Report periodicity and offset | | | | slot | 5/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | 000001 | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | [PUCCH] | | | |
| CQI/RI/PMI delay | | | | ms | 8 | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.2-1 | | | |

**Table 6.2.2.1.2.1-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| ** [%] | [20] | [20] |
| ** | [1.05] | [1.05] |

6.2.2.1.2.2 Minimum requirement for sub-band CQI reporting

The purpose of the requirements is to verify that the preferred sub-bands can be used for frequency-selective scheduling under the frequency-selective fading conditions.

The accuracy of sub-band channel CQI reporting under the frequency-selective fading conditions is determined by a double-sided percentile of the reported differential CQI offset level 0 per sub-band, and the relative increase of the throughput obtained when transmitting the transport format indicated by the corresponding reported sub-band CQI on a randomly selected sub-band among the sub-bands with the highest reported differential CQI offset level compared to the throughput when transmitting a fixed transport format according to the wideband CQI median on a randomly selected sub-band among all the sub-bands.

For the parameters specified in Table 6.2.2.1.2.2-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A sub-band differential CQI offset level of 0 shall be reported at least *α*% of the time but less than *β*% of the time for each sub-band, where *α* and *β* are specified in Table 6.2.2.1.2.2-2;

b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be ≥ *γ*, where *γ* is specified in Table 6.2.2.1.2.2-2;

c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to TBD.

The requirements only apply for sub-bands of full size and the random scheduling across the sub-bands is done by selecting a new sub-band in each TTI for FDD.

**Table 6.2.2.1.2.2-1: Sub-band CQI reporting test under frequency-selective fading conditions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 10 | | | |
| Duplex Mode | | | |  | FDD | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 52 | | | |
| Subcarrier spacing | kHz | 15 | | | |
| SNR | | | | dB | TBD | TBD | TBD | TBD |
| Propagation channel | | | |  | [Two tap model specified in Annex B.2.4 with *a*=1, *f*D = 5Hz, and τd=0.45μs] | | | |
| Antenna configuration | | | |  | TBD | | | |
| Correlation configuration | | | |  | As per Annex B.1 | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 5/1 | | | |
| 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 | 5/1 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 5/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Subband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | 8 | | | |
| CSI-Report periodicity and offset | | | | slot | 5/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | 000001 | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | TBD | | | |
| CQI/RI/PMI delay | | | | ms | 8 | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | TBD | | | |

**Table 6.2.2.1.2.2-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| *α* [%] | TBD | TBD |
| *β* [%] | TBD | TBD |
| ** | TBD | TBD |

6.2.2.2 TDD

6.2.2.2.1 CQI reporting definition under AWGN conditions

6.2.2.2.1.1 Minimum requirement for periodic CQI reporting

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS38.214 [12]. The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median.

For the parameters specified in Table 6.2.2.2.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum 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.

**Table 6.2.2.2.1.1-1: CQI reporting definition test**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 40 | | | |
| Duplex Mode | | | |  | TDD | | | |
| TDD UL-DL pattern | | | |  | FR1.30-1 | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 106 | | | |
| Subcarrier spacing | kHz | 30 | | | |
| SNR | | | | dB | [8] | [9] | [14] | [15] |
| Propagation channel | | | |  | AWGN | | | |
| Antenna configuration | | | |  | 2×2 with static channel specified in Annex B.1 | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 10/1 | | | |
| 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 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 10/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Wideband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | N/A | | | |
| CSI-Report periodicity and offset | | | | slot | 10/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | [010000] | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | [PUCCH] | | | |
| CQI/RI/PMI delay | | | | ms | [9.5] | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.2-4 | | | |

6.2.2.2.2 Wideband CQI reporting under fading conditions

6.2.2.2.2.1 Minimum requirement for wideband CQI reporting

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI.

For the parameters specified in Table 6.2.2.2.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least *α*% of the time where *α*% is specified in Table 6.2.2.2.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ *γ*, where *γ* is specified in Table 6.2.2.2.2.1-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to [0.02].

**Table 6.2.2.2.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 40 | | | |
| Duplex Mode | | | |  | TDD | | | |
| TDD UL-DL pattern | | | |  | FR1.30-1 | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 106 | | | |
| Subcarrier spacing | kHz | 30 | | | |
| SNR | | | | dB | 6 | 7 | 12 | 13 |
| Propagation channel | | | |  | [TDLA30-5] | | | |
| Antenna configuration | | | |  | 2×2 | | | |
| Correlation configuration | | | |  | ULA high | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 10/1 | | | |
| 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 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 10/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Wideband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | [16] | | | |
| Csi-ReportingBand | | | |  | [1111111] | | | |
| CSI-Report periodicity and offset | | | | slot | 10/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | 000001 | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | [PUCCH] | | | |
| CQI/RI/PMI delay | | | | ms | [9.5] | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.2-3 | | | |

**Table 6.2.2.2.2.1-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| ** [%] | [20] | [20] |
| ** | [1.05] | [1.05] |

6.2.2.2.2.2 Minimum requirement for sub-band CQI reporting

The purpose of the requirements is to verify that the preferred sub-bands can be used for frequency-selective scheduling under the frequency-selective fading conditions.

The accuracy of sub-band channel CQI reporting under the frequency-selective fading conditions is determined by a double-sided percentile of the reported differential CQI offset level 0 per sub-band, and the relative increase of the throughput obtained when transmitting the transport format indicated by the corresponding reported sub-band CQI on a randomly selected sub-band among the sub-bands with the highest reported differential CQI offset level compared to the throughput when transmitting a fixed transport format according to the wideband CQI median on a randomly selected sub-band among all the sub-bands.

For the parameters specified in Table 6.2.2.2.2.2-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A sub-band differential CQI offset level of 0 shall be reported at least α% of the time but less than β% of the time for each sub-band, where α and β are specified in Table 6.2.2.2.2.2-2;

b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be ≥ *γ*, where *γ* is specified in Table 6.2.2.2.2.2-2;

c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to TBD.

The requirements only apply for sub-bands of full size and the random scheduling across the sub-bands is done by selecting a new sub-band in each available downlink transmission instance for TDD.**Table 6.2.2.2.2.2-1: Sub-band CQI reporting test under frequency-selective fading conditions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 40 | | | |
| Duplex Mode | | | |  | TDD | | | |
| TDD UL-DL pattern | | | |  | FR1.30-1 | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 106 | | | |
| Subcarrier spacing | kHz | 30 | | | |
| SNR | | | | dB | TBD | TBD | TBD | TBD |
| Propagation channel | | | |  | [Two tap model specified in Annex B.2.4 with *a*=1, *f*D = 5Hz, and τd=0.1125μs] | | | |
| Antenna configuration | | | |  | TBD | | | |
| Correlation configuration | | | |  | As per Annex B.1 | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 10/1 | | | |
| 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 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 10/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Subband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | 16 | | | |
| CSI-Report periodicity and offset | | | | slot | 10/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | 000001 | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | TBD | | | |
| CQI/RI/PMI delay | | | | ms | [9.5] | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | TBD | | | |

**Table 6.2.2.2.2.2-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| *α* [%] | TBD | TBD |
| *β* [%] | TBD | TBD |
| ** | TBD | TBD |

6.2.3 4RX requirements

This sub-clause includes the requirements for reporting of CQI for UE equipped with 4 receiver antennas.

6.2.3.1 FDD

6.2.3.1.1 CQI reporting definition under AWGN conditions

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS38.214 [12]. The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median.

6.2.3.1.1.1 Minimum requirement for period CQI reporting

For the parameters specified in Table 6.2.3.1.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum 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.

**Table 6.2.2.1.1.1-1: CQI reporting definition test**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 10 | | | |
| Duplex Mode | | | |  | FDD | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 52 | | | |
| Subcarrier spacing | kHz | 15 | | | |
| SNR | | | | dB | [5] | [6] | [11] | [12] |
| Propagation channel | | | |  | AWGN | | | |
| Antenna configuration | | | |  | 2×4 with static channel specified in Annex B.1 | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 5/1 | | | |
| 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 | 5/1 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 5/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Wideband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | N/A | | | |
| CSI-Report periodicity and offset | | | | slot | 5/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | [010000] | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | [PUCCH] | | | |
| CQI/RI/PMI delay | | | | ms | 8 | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.2-2 | | | |

6.2.3.1.2 Wideband CQI reporting under fading conditions

6.2.3.1.2.1 Minimum requirement for wideband CQI reporting

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI.

For the parameters specified in Table 6.2.3.1.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least *α*% of the time where *α*% is specified in Table 6.2.3.1.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ *γ*, where *γ* is specified in Table 6.2.3.1.2.1-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to [0.02].

**Table 6.2.3.1.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 10 | | | |
| Duplex Mode | | | |  | FDD | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 52 | | | |
| Subcarrier spacing | kHz | 15 | | | |
| SNR | | | | dB | [3] | [4] | [9] | [10] |
| Propagation channel | | | |  | TDLA30-5 | | | |
| Antenna configuration | | | |  | 2×4 | | | |
| Correlation configuration | | | |  | XP High | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 5/1 | | | |
| 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 | 5/1 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 5/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Wideband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | [8] | | | |
| csi-ReportingBand | | | |  | [1111111] | | | |
| CSI-Report periodicity and offset | | | | slot | 5/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | 000001 | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | [PUCCH] | | | |
| CQI/RI/PMI delay | | | | ms | 8 | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.2-1 | | | |

**Table 6.2.3.1.2.1-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| ** [%] | [5] | [5] |
| ** | [1.05] | [1.05] |

6.2.3.1.2.2 Minimum requirement for sub-band CQI reporting

The purpose of the requirements is to verify that the preferred sub-bands can be used for frequency-selective scheduling under the frequency-selective fading conditions.

The accuracy of sub-band channel CQI reporting under the frequency-selective fading conditions is determined by a double-sided percentile of the reported differential CQI offset level 0 per sub-band, and the relative increase of the throughput obtained when transmitting the transport format indicated by the corresponding reported sub-band CQI on a randomly selected sub-band among the sub-bands with the highest reported differential CQI offset level compared to the throughput when transmitting a fixed transport format according to the wideband CQI median on a randomly selected sub-band among all the sub-bands.

For the parameters specified in Table 6.2.3.1.2.2-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A sub-band differential CQI offset level of 0 shall be reported at least α% of the time but less than β% of the time for each sub-band, where α and β are specified in Table 6.2.3.1.2.2-2;

b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be ≥ *γ*, where *γ* is specified in Table 6.2.3.1.2.2-2;

c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to TBD.

The requirements only apply for sub-bands of full size and the random scheduling across the sub-bands is done by selecting a new sub-band in each TTI for FDD.

**Table 6.2.3.1.2.2-1: Sub-band CQI reporting test under frequency-selective fading conditions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 10 | | | |
| Duplex Mode | | | |  | FDD | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 52 | | | |
| Subcarrier spacing | kHz | 15 | | | |
| SNR | | | | dB | TBD | TBD | TBD | TBD |
| Propagation channel | | | |  | [Two tap model specified in Annex B.2.4 with *a*=1, *f*D = 5Hz, and τd=0.45μs] | | | |
| Antenna configuration | | | |  | TBD | | | |
| Correlation configuration | | | |  | As per Annex B.1 | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 5/1 | | | |
| 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 | 5/1 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 5/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Subband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | 8 | | | |
| CSI-Report periodicity and offset | | | | slot | 5/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | 000001 | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | TBD | | | |
| CQI/RI/PMI delay | | | | ms | 8 | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | TBD | | | |

**Table 6.2.3.1.2.2-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| *α* [%] | TBD | TBD |
| *β* [%] | TBD | TBD |
| ** | TBD | TBD |

6.2.3.2 TDD

6.2.3.2.1 CQI reporting definition under AWGN

6.2.3.2.1.1 Minimum requirement for CQI periodic reporting

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS38.214 [12]. The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median.

For the parameters specified in Table 6.2.3.2.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum 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.

**Table 6.2.3.2.1.1-1: CQI reporting definition test**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 40 | | | |
| Duplex Mode | | | |  | TDD | | | |
| TDD UL-DL pattern | | | |  | FR1.30-1 | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 106 | | | |
| Subcarrier spacing | kHz | 30 | | | |
| SNR | | | | dB | [5] | [6] | [11] | [12] |
| Propagation channel | | | |  | AWGN | | | |
| Antenna configuration | | | |  | 2×4 with static channel specified in Annex B.1 | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 10/1 | | | |
| 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 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 10/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Wideband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | N/A | | | |
| CSI-Report periodicity and offset | | | | slot | 10/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | [010000] | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | [PUCCH] | | | |
| CQI/RI/PMI delay | | | | ms | [9.5] | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.2-4 | | | |

6.2.3.2.2 Wideband CQI reporting under fading conditions

6.2.3.2.2.1 Minimum requirement for wideband CQI reporting

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI.

For the parameters specified in Table 6.2.3.2.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least *α*% of the time where *α*% is specified in Table 6.2.3.2.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ *γ*, where *γ* is specified in Table 6.2.3.2.2.1-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to [0.02].

**Table 6.2.3.2.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 40 | | | |
| Duplex Mode | | | |  | TDD | | | |
| TDD UL-DL pattern | | | |  | FR1.30-1 | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 106 | | | |
| Subcarrier spacing | kHz | 30 | | | |
| SNR | | | | dB | [3] | [4] | [9] | [10] |
| Propagation channel | | | |  | [TDLA30-5] | | | |
| Antenna configuration | | | |  | 2×4 | | | |
| Correlation configuration | | | |  | XP High | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 10/1 | | | |
| 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 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 10/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Wideband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | [16] | | | |
| csi-ReportingBand | | | |  | [1111111] | | | |
| CSI-Report periodicity and offset | | | | slot | 10/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | 000001 | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | [PUCCH] | | | |
| CQI/RI/PMI delay | | | | ms | [9.5] | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.2-3 | | | |

**Table 6.2.3.2.2.1-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| ** [%] | [5] | [5] |
| ** | [1.05] | [1.05] |

6.2.3.2.2.2 Minimum requirement for sub-band CQI reporting

The purpose of the requirements is to verify that the preferred sub-bands can be used for frequency-selective scheduling under the frequency-selective fading conditions.

The accuracy of sub-band channel CQI reporting under the frequency-selective fading conditions is determined by a double-sided percentile of the reported differential CQI offset level 0 per sub-band, and the relative increase of the throughput obtained when transmitting the transport format indicated by the corresponding reported sub-band CQI on a randomly selected sub-band among the sub-bands with the highest reported differential CQI offset level compared to the throughput when transmitting a fixed transport format according to the wideband CQI median on a randomly selected sub-band among all the sub-bands.

For the parameters specified in Table 6.2.3.2.2.2-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A sub-band differential CQI offset level of 0 shall be reported at least α% of the time but less than β% of the time for each sub-band, where α and β are specified in Table 6.2.3.2.2.2-2;

b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be ≥ *γ*, where *γ* is specified in Table 6.2.3.2.2.2-2;

c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to TBD.

The requirements only apply for sub-bands of full size and the random scheduling across the sub-bands is done by selecting a new sub-band in each available downlink transmission instance for TDD.

**Table 6.2.3.2.2.2-1: Sub-band CQI reporting test under frequency-selective fading conditions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 40 | | | |
| Duplex Mode | | | |  | TDD | | | |
| TDD UL-DL pattern | | | |  | FR1.30-1 | | | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | | |
| Number of contiguous PRB |  | 106 | | | |
| Subcarrier spacing | kHz | 30 | | | |
| SNR | | | | dB | TBD | TBD | TBD | TBD |
| Propagation channel | | | |  | [Two tap model specified in Annex B.2.4 with *a*=1, *f*D = 5Hz, and τd=0.1125μs] | | | |
| Antenna configuration | | | |  | TBD | | | |
| Correlation configuration | | | |  | As per Annex B.1 | | | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | | |
| CDM Type | | |  | FD-CDM2 | | | |
| Density (ρ) | | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | | |  | 9 | | | |
| CSI-RS  periodicity and offset | | | slot | 10/1 | | | |
| 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 | | | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 10/1 | | | |
| ReportConfigType | | | |  | Periodic | | | |
| CQI-table | | | |  | Table 2 | | | |
| reportQuantity | | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | | |  | Not configured | | | |
| cqi-FormatIndicator | | | |  | Subband | | | |
| pmi-FormatIndicator | | | |  | Wideband | | | |
| Sub-band Size | | | | RB | 16 | | | |
| CSI-Report periodicity and offset | | | | slot | 10/1 | | | |
| aperiodicTriggeringOffset | | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | | | |
| Codebook Mode | |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | Not configured | | | |
| CodebookSubsetRestriction | |  | 000001 | | | |
| RI Restriction | |  | [N/A] | | | |
| Physical channel for CSI report | | | |  | TBD | | | |
| CQI/RI/PMI delay | | | | ms | [9.5] | | | |
| Maximum number of HARQ transmission | | | |  | 1 | | | |
| Measurement channel | | | |  | TBD | | | |

**Table 6.2.2.1.2.2-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| *α* [%] | TBD | TBD |
| *β* [%] | TBD | TBD |
| ** | TBD | TBD |

6.3 Reporting of Precoding Matrix Indicator (PMI)

*<Editor’s note: The requirements were introduced based on current results from companies; these requirements can be revised based on more results from companies.>*

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 reports 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 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 *γ*, 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.

6.3.1 1RX requirements

(Void)

6.3.2 2RX requirements

6.3.2.1 FDD

6.3.2.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.1-2.

**Table 6.3.2.1.1-1: Test parameters (single layer)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 10 |
| Duplex Mode | |  | FDD |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | 52 |
| Subcarrier spacing | kHz | 15 |
| Propagation channel | |  | TDLA30-5 |
| Antenna configuration | |  | High XP 4 x 2  (N1,N2) = (2,1) |
| Beamforming Model | |  | TBD |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (9,-) |
| CSI-RS  interval and offset | slot | 5/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 4, (0,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (13,-) |
| CSI-RS  interval and offset |  | 5/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (4,9) |
| CSI-IM timeConfig  interval and offset | slot | 5/1 |
| ReportConfigType | |  | Aperiodic |
| CQI-table | |  | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | |  | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured |
| cqi-FormatIndicator | |  | Wideband |
| pmi-FormatIndicator | |  | Wideband |
| Sub-band Size | | RB | [8] |
| csi-ReportingBand | |  | [1111111] |
| CSI-Report interval and offset | | slot | 5/1 |
| aperiodicTriggeringOffset | |  | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel |
| Codebook Mode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (2,1) |
| CodebookSubsetRestriction |  | 11111111 |
| RI Restriction |  | 00000001 |
| Physical channel for CSI report | |  | PUSCH |
| CQI/RI/PMI delay | | ms | 6 |
| Maximum number of HARQ transmission | |  | 4 |
| Measurement channel | |  | R.PDSCH.1-6.1 FDD |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (1 ms granularity).  Note 2: 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-3)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+3)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | |

**Table 6.3.2.1.1-2: Minimum requirement**

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| ** | [1.3] |

6.3.2.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.1.2-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.2-2.

**Table 6.3.2.1.2-1: Test parameters (dual-layer)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 10 |
| Duplex Mode | |  | FDD |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | 52 |
| Subcarrier spacing | kHz | 15 |
| Propagation channel | |  | TDLA30-5 |
| Antenna configuration | |  | High XP 8 x 2  (N1,N2) = (4,1) |
| Beamforming Model | |  | TBD |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (9,-) |
| CSI-RS  interval and offset | slot | 5/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 8 |
| CDM Type |  | CDM4 (FD2, TD2) |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 8, (4,6) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (5,-) |
| CSI-RS  interval and offset | slot | 5/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (4,9) |
| CSI-IM timeConfig  interval and offset | slot | 5/1 |
| ReportConfigType | |  | Aperiodic |
| CQI-table | |  | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | |  | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured |
| cqi-FormatIndicator | |  | Wideband |
| pmi-FormatIndicator | |  | Wideband |
| Sub-band Size | | RB | [8] |
| csi-ReportingBand | |  | [1111111] |
| CSI-Report interval and offset | | slot | 5/1 |
| aperiodicTriggeringOffset | |  | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel |
| Codebook Mode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (4,1) |
| CodebookSubsetRestriction |  | 0x FFFF |
| RI Restriction |  | 00000010 |
| Physical channel for CSI report | |  | PUSCH |
| CQI/RI/PMI delay | | ms | 8 |
| Maximum number of HARQ transmission | |  | 4 |
| Measurement channel | |  | R.PDSCH.1-6.2 |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (1 ms granularity).  Note 2: 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)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+4)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | |

**Table 6.3.2.1.2-2: Minimum requirement**

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| ** | [1.5] |

6.3.2.2 TDD

6.3.2.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.2.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.1-2.

**Table 6.3.2.2.1-1: Test parameters (single layer)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 40 |
| Duplex Mode | |  | TDD |
| TDD DL-UL configuration | |  | FR1.30-1 as specified in Annex A |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | 106 |
| Subcarrier spacing | kHz | 30 |
| Propagation channel | |  | TDLA30-5 |
| Antenna configuration | |  | High XP 4 x 2  (N1,N2) = (2,1) |
| Beamforming Model | |  | TBD |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (9,-) |
| CSI-RS  interval and offset | slot | 10/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 4, (0,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (13,-) |
| CSI-RS  interval and offset | slot | 10/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (4,9) |
| CSI-IM timeConfig  interval and offset | slot | 10/1 |
| ReportConfigType | |  | Aperiodic |
| CQI-table | |  | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | |  | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured |
| cqi-FormatIndicator | |  | Wideband |
| pmi-FormatIndicator | |  | Wideband |
| Sub-band Size | | RB | [16] |
| csi-ReportingBand | |  | [1111111] |
| CSI-Report interval and offset | | slot | 10/1 |
| aperiodicTriggeringOffset | |  | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel |
| Codebook Mode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (2,1) |
| CodebookSubsetRestriction |  | 11111111 |
| RI Restriction |  | 00000001 |
| Physical channel for CSI report | |  | PUSCH |
| CQI/RI/PMI delay | | ms | 5.5 |
| Maximum number of HARQ transmission | |  | 4 |
| Measurement channel | |  | R.PDSCH.2-8.1 TDD |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity).  Note 2: 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)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+4)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | |

**Table 6.3.2.2.1-2: Minimum requirement**

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| ** | [1.3] |

6.3.2.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.2.2-1, and using the downlink physical channels specified in Annex TBD, the minimum requirements are specified in Table 6.3.2.2.2-2.

**Table 6.3.2.2.2-1: Test parameters (dual-layer)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 40 |
| Duplex Mode | |  | TDD |
| TDD DL-UL configurations | |  | FR1.30-1 as specified in Annex A |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | 106 |
| Subcarrier spacing | kHz | 30 |
| Propagation channel | |  | TDLA30-5 |
| Antenna configuration | |  | High XP 8 x 2  (N1,N2) = (4,1) |
| Beamforming Model | |  | TBD |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (9,-) |
| CSI-RS  interval and offset | slot | 10/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 8 |
| CDM Type |  | CDM4 (FD2, TD2) |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 8, (4,6) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (5,-) |
| CSI-RS  interval and offset | slot | 10/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (4,9) |
| CSI-IM timeConfig  interval and offset | slot | 10/1 |
| ReportConfigType | |  | Aperiodic |
| CQI-table | |  | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI |
| timeRestrictionForIChannelMeasurements | |  | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured |
| cqi-FormatIndicator | |  | Wideband |
| pmi-FormatIndicator | |  | Wideband |
| Sub-band Size | | RB | [16] |
| csi-ReportingBand | |  | [1111111] |
| CSI-Report interval and offset | | slot | 10/1 |
| aperiodicTriggeringOffset | |  | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel |
| Codebook Mode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (4,1) |
| CodebookSubsetRestriction |  | 0x FFFF |
| RI Restriction |  | 00000010 |
| Physical channel for CSI report | |  | PUSCH |
| CQI/RI/PMI delay | | ms | 6.5 |
| Maximum number of HARQ transmission | |  | 4 |
| Measurement channel | |  | R.PDSCH.2-8.2 TDD |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity).  Note 2: 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-6)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+6)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | |

**Table 6.3.2.2.2-2: Minimum requirement**

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| ** | [1.5] |

6.3.3 4RX requirements

6.3.3.1 FDD

6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.1-2.

**Table 6.3.3.1.1-1: Test parameters (single layer)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 10 |
| Duplex Mode | |  | FDD |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | 52 |
| Subcarrier spacing | kHz | 15 |
| Propagation channel | |  | TDLA30-5 |
| Antenna configuration | |  | High XP 4 x 4  (N1,N2) = (2,1) |
| Beamforming Model | |  | TBD |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (9,-) |
| CSI-RS  interval and offset | slot | 5/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 4, (0,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (13,-) |
| CSI-RS  interval and offset | slot | 5/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (4,9) |
| CSI-IM timeConfig  interval and offset | slot | 5/1 |
| ReportConfigType | |  | Aperiodic |
| CQI-table | |  | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | |  | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured |
| cqi-FormatIndicator | |  | Wideband |
| pmi-FormatIndicator | |  | Wideband |
| Sub-band Size | | RB | [8] |
| csi-ReportingBand | |  | [1111111] |
| CSI-Report interval and offset | | slot | 5/1 |
| aperiodicTriggeringOffset | |  | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel |
| Codebook Mode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (2,1) |
| CodebookSubsetRestriction |  | 11111111 |
| RI Restriction |  | 00000001 |
| Physical channel for CSI report | |  | PUSCH |
| CQI/RI/PMI delay | | ms | 6 |
| Maximum number of HARQ transmission | |  | 4 |
| Measurement channel | |  | R.PDSCH.1-6.1 FDD |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (1 ms granularity).  Note 2: 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-3)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+3)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | |

**Table 6.3.3.1.1-2: Minimum requirement**

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| ** | [1.3] |

6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.1.2-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.2-2.

**Table 6.3.3.1.2-1: Test parameters (dual-layer)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 10 |
| Duplex Mode | |  | FDD |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | 52 |
| Subcarrier spacing | kHz | 15 |
| Propagation channel | |  | TDLA30-5 |
| Antenna configuration | |  | High XP 8 x 4  (N1,N2) = (4,1) |
| Beamforming Model | |  | TBD |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (9,-) |
| CSI-RS  interval and offset | slot | 5/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 8 |
| CDM Type |  | CDM4 (FD2, TD2) |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 8, (4,6) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (5,-) |
| CSI-RS  interval and offset | slot | 5/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (4,9) |
| CSI-IM timeConfig  interval and offset | slot | 5/1 |
| ReportConfigType | |  | Aperiodic |
| CQI-table | |  | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | |  | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured |
| cqi-FormatIndicator | |  | Wideband |
| pmi-FormatIndicator | |  | Wideband |
| Sub-band Size | | RB | [8] |
| csi-ReportingBand | |  | [1111111] |
| CSI-Report interval and offset | | slot | 5/1 |
| aperiodicTriggeringOffset | |  | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel |
| Codebook Mode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (4,1) |
| CodebookSubsetRestriction |  | 0x FFFF |
| RI Restriction |  | 00000010 |
| Physical channel for CSI report | |  | PUSCH |
| CQI/RI/PMI delay | | ms | 8 |
| Maximum number of HARQ transmission | |  | 4 |
| Measurement channel | |  | R.PDSCH.1-6.2 FDD |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (1 ms granularity).  Note 2: 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)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+4)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | |

**Table 6.3.3.1.2-2: Minimum requirement**

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| ** | [1.5] |

6.3.3.2 TDD

6.3.3.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.2.1-1, and using the downlink physical channels specified in Annex TBD, the minimum requirements are specified in Table 6.3.3.2.1-2.

**Table 6.3.3.2.1-1: Test parameters (single layer)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 40 |
| Duplex Mode | |  | TDD |
| TDD DL-UL configuration | |  | FR1.30-1 as specified in Annex A |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | 106 |
| Subcarrier spacing | kHz | 30 |
| Propagation channel | |  | TDLA30-5 |
| Antenna configuration | |  | High XP 4 x 4  (N1,N2) = (2,1) |
| Beamforming Model | |  | TBD |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (9,-) |
| CSI-RS  interval and offset | slot | 10/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 4, (0,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (13,-) |
| CSI-RS  interval and offset |  | 10/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (4,9) |
| CSI-IM timeConfig  interval and offset | slot | 10/1 |
| ReportConfigType | |  | Aperiodic |
| CQI-table | |  | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | |  | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured |
| cqi-FormatIndicator | |  | Wideband |
| pmi-FormatIndicator | |  | Wideband |
| Sub-band Size | | RB | [16] |
| csi-ReportingBand | |  | [1111111] |
| CSI-Report interval and offset | | slot | 10/1 |
| aperiodicTriggeringOffset | |  | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel |
| Codebook Mode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (2,1) |
| CodebookSubsetRestriction |  | 11111111 |
| RI Restriction |  | 00000001 |
| Physical channel for CSI report | |  | PUSCH |
| CQI/RI/PMI delay | | ms | 5.5 |
| Maximum number of HARQ transmission | |  | 4 |
| Measurement channel | |  | R.PDSCH.2-8.1 TDD |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity).  Note 2: 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)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+4)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | |

**Table 6.3.3.2.1-2: Minimum requirement**

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| ** | [1.3] |

6.3.3.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.2.2-1, and using the downlink physical channels specified in Annex TBD, the minimum requirements are specified in Table 6.3.3.2.2-2.

**Table 6.3.3.2.2-1: Test parameters (dual-layer)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 40 |
| Duplex Mode | |  | TDD |
| TDD DL-UL configurations | |  | FR1.30-1 as specified in Annex A |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | 106 |
| Subcarrier spacing | kHz | 30 |
| Propagation channel | |  | TDLA30-5 |
| Antenna configuration | |  | High XP 8 x 4  (N1,N2) = (4,1) |
| Beamforming Model | |  | TBD |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 |
| CDM Type |  | FD-CDM2 |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (9,-) |
| CSI-RS  interval and offset | slot | 10/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 8 |
| CDM Type |  | CDM4 (FD2, TD2) |
| Density (ρ) |  | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 8, (4,6) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (5,-) |
| CSI-RS  interval and offset | slot | 10/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (4,9) |
| CSI-IM timeConfig  interval and offset | slot | 10/1 |
| ReportConfigType | |  | Aperiodic |
| CQI-table | |  | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI |
| timeRestrictionForChannnelMeasurements | |  | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured |
| cqi-FormatIndicator | |  | Wideband |
| pmi-FormatIndicator | |  | Wideband |
| Sub-band Size | | RB | [16] |
| csi-ReportingBand | |  | [1111111] |
| CSI-Report interval and offset | | slot | 10/1 |
| aperiodicTriggeringOffset | |  | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel |
| Codebook Mode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (4,1) |
| CodebookSubsetRestriction |  | 0x FFFF |
| RI Restriction |  | 00000010 |
| Physical channel for CSI report | |  | PUSCH |
| CQI/RI/PMI delay | | ms | 6.5 |
| Maximum number of HARQ transmission | |  | 4 |
| Measurement channel | |  | R.PDSCH.2-8.2 TDD |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity).  Note 2: 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-6)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+6)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | |

**Table 6.3.3.2.2-2: Minimum requirement**

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| ** | [1.5] |

6.4 Reporting of Rank Indicator (RI)

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.

6.4.1 1RX requirements

(Void)

6.4.2 2RX requirements

6.4.2.1 FDD

The minimum performance requirement in Table 6.4.2.1-2 is defined as

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

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

For the parameters specified in Table 6.4.2.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.4.2.1-2.

**Table 6.4.2.1-1: RI Test (FDD)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | **Test 2** | **Test 3** |
| Bandwidth | | | | MHz | 10 | 10 | 10 |
| Duplex Mode | | | |  | FDD | FDD | FDD |
| DL BWP configuration #1 | | | First PRB |  | 0 | 0 | 0 |
| Number of contiguous PRB |  | 52 | 52 | 52 |
| Subcarrier spacing | kHz | 15 | 15 | 15 |
| SNR | | | | dB | [0] | [20] | [20] |
| Propagation channel | | | |  | TDLA30-5 | TDLA30-5 | TDLA30-5 |
| Antenna configuration | | | |  | ULA Low 2x2 | ULA Low 2x2 | ULA High 2x2 |
| Beamforming Model | | | |  | As defined in Annex B.4.1 | As defined in Annex B.4.1 | As defined in Annex B.4.1 |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | Periodic | Periodic |
| Number of CSI-RS ports (*X*) | | |  | 4 | 4 | 4 |
| CDM Type | | |  | FD-CDM2 | FD-CDM2 | FD-CDM2 |
| Density (ρ) | | |  | 1 | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | Row 5, (4,-) | Row 5, (4,-) | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | (9,-) | (9,-) | (9,-) |
| CSI-RS  periodicity and offset | | | slot | 5/1 | 5/1 | 5/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | |  | Periodic | Periodic | Periodic |
| Number of CSI-RS ports (*X*) | | |  | 2 | 2 | 2 |
| CDM Type | | |  | FD-CDM2 | FD-CDM2 | FD-CDM2 |
| Density (ρ) | | |  | 1 | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | Row 3 (6,-) | Row 3 (6,-) | Row 3 (6,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | (13,-) | (13,-) | (13,-) |
| NZP CSI-RS-timeConfig  periodicity and offset | | | slot | 5/1 | 5/1 | 5/1 |
| CSI-IM configuration | CSI-IM RE pattern | | |  | Pattern 0 | Pattern 0 | Pattern 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4,9) | (4,9) | (4,9) |
| CSI-IM timeConfig  periodicity and offset | | | slot | 5/1 | 5/1 | 5/1 |
| ReportConfigType | | | |  | Periodic | Periodic | Periodic |
| CQI-table | | | |  | Table 2 | Table 2 | Table 2 |
| reportQuantity | | | |  | cri-RI-PMI-CQI | cri-RI-PMI-CQI | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | |  | not configured | not configured | not configured |
| timeRestrictionForInterferenceMeasurements | | | |  | not configured | not configured | not configured |
| cqi-FormatIndicator | | | |  | Wideband | Wideband | Wideband |
| pmi-FormatIndicator | | | |  | Wideband | Wideband | Wideband |
| Sub-band Size | | | | RB | [8] | [8] | [8] |
| csi-ReportingBand | | | |  | [1111111] | [1111111] | [1111111] |
| CSI-Report periodicity and offset | | | | slot | 5/1 | 5/1 | 5/1 |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | typeI-SinglePanel | typeI-SinglePanel |
| Codebook Mode | |  | 1 | 1 | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | N/A | N/A | N/A |
| 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] |
| RI Restriction | |  | N/A | N/A | N/A |
| Physical channel for CSI report | | | |  | PUCCH | PUCCH | PUCCH |
| CQI/RI/PMI delay | | | | ms | 8 | 8 | 8 |
| Maximum number of HARQ transmission | | | |  | 1 | 1 | 1 |
| RI Configuration | | | |  | Fixed RI = 2 and follow RI | Fixed RI = 1 and follow RI | Fixed RI = 1 and follow RI |

**Table 6.4.2.1-2: Minimum requirement (FDD)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Test 1** | **Test 2** | **Test 3** |
| **1 | N/A | [1.05] | [0.9] |
| **2 | [1.0] | N/A | N/A |

6.4.2.2 TDD

The minimum performance requirement in Table 6.4.2.2-2 is defined as

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

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

For the parameters specified in Table 6.4.2.2-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.4.2.2-2.

**Table 6.4.2.2-1: RI Test (TDD)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | **Test 2** | **Test 3** |
| Bandwidth | | | | MHz | 40 | 40 | 40 |
| Duplex Mode | | | |  | TDD | TDD | TDD |
| TDD Slot Configuration | | | |  | FR1.30-1 | FR1.30-1 | FR1.30-1 |
| DL BWP configuration #1 | | | First PRB |  | 0 | 0 | 0 |
| Number of contiguous PRB |  | 106 | 106 | 106 |
| Subcarrier spacing | kHz | 30 | 30 | 30 |
| SNR | | | | dB | [0] | [20] | [20] |
| Propagation channel | | | |  | TDLA30-5 | TDLA30-5 | TDLA30-5 |
| Antenna configuration | | | |  | ULA Low 2x2 | ULA Low 2x2 | ULA High 2x2 |
| Beamforming Model | | | |  | As defined in Annex B.4.1 | As defined in Annex B.4.1 | As defined in Annex B.4.1 |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | Periodic | Periodic |
| Number of CSI-RS ports (*X*) | | |  | 4 | 4 | 4 |
| CDM Type | | |  | FD-CDM2 | FD-CDM2 | FD-CDM2 |
| Density (ρ) | | |  | 1 | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | Row 5, (4,-) | Row 5, (4,-) | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | (9,-) | (9,-) | (9,-) |
| CSI-RS  periodicity and offset | | | slot | 10/1 | 10/1 | 10/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | |  | Periodic | Periodic | Periodic |
| Number of CSI-RS ports (*X*) | | |  | 2 | 2 | 2 |
| CDM Type | | |  | FD-CDM2 | FD-CDM2 | FD-CDM2 |
| Density (ρ) | | |  | 1 | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | Row 3 (6,-) | Row 3 (6,-) | Row 3 (6,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | (13,-) | (13,-) | (13,-) |
| NZP CSI-RS-timeConfig  periodicity and offset | | | slot | 10/1 | 10/1 | 10/1 |
| CSI-IM configuration | CSI-IM RE pattern | | |  | Pattern 0 | Pattern 0 | Pattern 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4,9) | (4,9) | (4,9) |
| CSI-IM timeConfig  periodicity and offset | | | slot | 10/1 | 10/1 | 10/1 |
| ReportConfigType | | | |  | Periodic | Periodic | Periodic |
| CQI-table | | | |  | Table 2 | Table 2 | Table 2 |
| reportQuantity | | | |  | cri-RI-PMI-CQI | cri-RI-PMI-CQI | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | |  | not configured | not configured | not configured |
| timeRestrictionForInterferenceMeasurements | | | |  | not configured | not configured | not configured |
| cqi-FormatIndicator | | | |  | Wideband | Wideband | Wideband |
| pmi-FormatIndicator | | | |  | Wideband | Wideband | Wideband |
| Sub-band Size | | | | RB | [16] | [16] | [16] |
| csi-ReportingBand | | | |  | [1111111] | [1111111] | [1111111] |
| CSI-Report periodicity and offset | | | | slot | 10/1 | 10/1 | 10/1 |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | typeI-SinglePanel | typeI-SinglePanel |
| Codebook Mode | |  | 1 | 1 | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | N/A | N/A | N/A |
| 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] |
| RI Restriction | |  | N/A | N/A | N/A |
| Physical channel for CSI report | | | |  | PUCCH | PUCCH | PUCCH |
| CQI/RI/PMI delay | | | | ms | 9.5 | 9.5 | 9.5 |
| Maximum number of HARQ transmission | | | |  | 1 | 1 | 1 |
| RI Configuration | | | |  | Fixed RI = 2 and follow RI | Fixed RI = 1 and follow RI | Fixed RI = 1 and follow RI |

**Table 6.4.2.2-2: Minimum requirement (TDD)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Test 1** | **Test 2** | **Test 3** |
| **1 | N/A | [1.05] | [0.9] |
| **2 | [1.0] | N/A | N/A |

6.4.3 4RX requirements

6.4.3.1 FDD

The minimum performance requirement in Table 6.4.3.1-2 is defined as

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

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

For the parameters specified in Table 6.4.3.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.4.3.1-2.

**Table 6.4.3.1-1: RI Test (FDD)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | **Test 2** | **Test 3** | **Test 4** |
| Bandwidth | | | | MHz | 10 | 10 | 10 | 10 |
| Duplex Mode | | | |  | FDD | FDD | FDD | FDD |
| DL BWP configuration #1 | | | First PRB |  | 0 | 0 | 0 | 0 |
| Number of contiguous PRB |  | 52 | 52 | 52 | 52 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 |
| SNR | | | | dB | TBD | [16] | [16] | TBD |
| 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 defined in Annex B.4.1 | As defined in Annex B.4.1 | As defined in Annex B.4.1 | As defined in Annex B.4.1 |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | Periodic | Periodic | Periodic |
| Number of CSI-RS ports (*X*) | | |  | 4 | 4 | 4 | 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 5, (4,-) | Row 5, (4,-) | Row 5, (4,-) | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | (9,-) | (9,-) | (9,-) | (9,-) |
| CSI-RS  periodicity and offset | | | slot | 5/1 | 5/1 | 5/1 | 5/1 |
| 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 | 5/1 | 5/1 | 5/1 | 5/1 |
| CSI-IM configuration | CSI-IM RE pattern | | |  | Pattern 0 | Pattern 0 | Pattern 0 | Pattern 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4,9) | (4,9) | (4,9) | (4,9) |
| CSI-IM timeConfig  periodicity and offset | | | slot | 5/1 | 5/1 | 5/1 | 5/1 |
| 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 |
| timeRestrictionForChannelMeasurements | | | |  | not configured | not configured | not configured | not configured |
| timeRestrictionForInterferenceMeasurements | | | |  | not configured | not configured | not configured | not configured |
| cqi-FormatIndicator | | | |  | Wideband | Wideband | Wideband | Wideband |
| pmi-FormatIndicator | | | |  | Wideband | Wideband | Wideband | Wideband |
| Sub-band Size | | | | RB | [8] | [8] | [8] | [8] |
| csi-ReportingBand | | | |  | [1111111] | [1111111] | [1111111] | [1111111] |
| CSI-Report periodicity and offset | | | | slot | 5/1 | 5/1 | 5/1 | 5/1 |
| 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 |
| Physical channel for CSI report | | | |  | PUCCH | PUCCH | PUCCH | PUCCH |
| CQI/RI/PMI delay | | | | ms | 8 | 8 | 8 | 8 |
| 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 |

**Table 6.4.3.1-2: Minimum requirement (FDD)**

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

6.4.3.2 TDD

The minimum performance requirement in Table 6.4.3.2-2 is defined as

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

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

For the parameters specified in Table 6.4.3.2-1, and using the downlink physical channels specified in Annex TBD, the minimum requirements are specified in Table 6.4.3.2-2.

**Table 6.4.3.2-1: RI Test (TDD)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | **Test 2** | **Test 3** | **Test 4** |
| Bandwidth | | | | MHz | 40 | 40 | 40 | 40 |
| Duplex Mode | | | |  | TDD | TDD | TDD | TDD |
| TDD Slot Configuration | | | |  | FR1.30-1 | FR1.30-1 | FR1.30-1 | FR1.30-1 |
| DL BWP configuration #1 | | | First PRB |  | 0 | 0 | 0 | 0 |
| Number of contiguous PRB |  | 106 | 106 | 106 | 106 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 |
| SNR | | | | dB | TBD | [16] | [16] | TBD |
| 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 defined in Annex B.4.1 | As defined in Annex B.4.1 | As defined in Annex B.4.1 | As defined in Annex B.4.1 |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Periodic | Periodic | Periodic | Periodic |
| Number of CSI-RS ports (*X*) | | |  | 4 | 4 | 4 | 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 5, (4,-) | Row 5, (4,-) | Row 5, (4,-) | Row 5, (4,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | (9,-) | (9,-) | (9,-) | (9,-) |
| CSI-RS  periodicity and offset | | | slot | 10/1 | 10/1 | 10/1 | 10/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | |  | Periodic | Periodic | Periodic | Periodic |
| Number of CSI-RS ports (*X*) | | |  | 2 | 2 | 2 | 2 |
| 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 |
| CSI-IM configuration | CSI-IM RE pattern | | |  | Pattern 0 | Pattern 0 | Pattern 0 | Pattern 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (4,9) | (4,9) | (4,9) | (4,9) |
| CSI-IM 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 |
| timeRestrictionForChannelMeasurements | | | |  | not configured | not configured | not configured | not configured |
| timeRestrictionForInterferenceMeasurements | | | |  | not configured | not configured | not configured | not configured |
| 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 | 10/1 | 10/1 | 10/1 | 10/1 |
| 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 |
| Physical channel for CSI report | | | |  | PUCCH | PUCCH | PUCCH | PUCCH |
| 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 |

**Table 6.4.3.2-2: Minimum requirement (TDD)**

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

7 Demodulation performance requirements (Radiated requirements)

7.1 General

7.1.1 Applicability of requirements

#### 7.1.1.1 General

The minimum performance requirements are applicable to the FR2 operating bands defined in TS 38.101-2 [7] with FDL\_high not exceeding 40000 MHz.

The minimum performance requirements in Clause 7 are mandatary for UE supporting NR operation, except test cases listed in Clause 7.1.1.3.

#### 7.1.1.2 Applicability of requirements for different number of RX antenna ports

UE shall support 2 RX ports for different RF operating bands. The UE requirements applicability is defined in Table 7.1.1.2-1.

Table 7.1.1.2-1: Requirements applicability

|  |  |  |
| --- | --- | --- |
| **Supported RX antenna ports** | **Test type** | **Test list** |
| UE supports 2RX antenna ports | PDSCH | All tests in Clause 7.2.2 |
| PDCCH | All tests in Clause 7.3.2 |
| PBCH | All tests in Clause 7.4.2 |

#### 7.1.1.3 Applicability of requirements for optional UE capabilities

For UE which supports optional UE capabilities the additional performance requirements from Table 7.1.1.3-2 should be applied.

**Table 7.1.1.3-2: Requirements applicability for optional UE capabilities**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE feature/capability** | **Test type** | | **Test list** | **Applicability notes** |
| [Enhanced Type X receiver] | FR2 TDD | PDSCH | 7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A (Test 3-1) |  |

7.2 PDSCH demodulation requirements

The parameters specified in Table 7.2-1 are valid for all PDSCH demodulation tests unless otherwise stated.

**Table 7.2-1: Common Test Parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Value** |
| PDSCH transmission scheme | | |  | Transmission scheme 1 |
| EPRE ratio of PTRS to PDSCH | | | dB | 0 |
| DL BWP configuration #1 | Cyclic prefix | |  | Normal |
| Common serving cell parameters | Physical Cell ID | |  | 0 |
| SSB position in burst | |  | 1 |
| SSB periodicity | | ms | 20 |
| First DMRS position for Type A PDSCH mapping | |  | ~~2~~ |
| PDCCH configuration | Slots for PDCCH monitoring | |  | Each slot |
| Symbols with PDCCH | |  | 0 |
| Number of PDCCH candidates and aggregation levels | |  | 1/[8] |
| DCI format | |  | 1\_1 |
| TCI state | |  | TCI state #1 |
| Cross carrier scheduling | | |  | Not configured |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS (*k0*) | |  | 0 |
| First OFDM symbol in the PRB used for CSI-RS (*l0*) | |  | CSI-RS resource 1: 6 CSI-RS resource 2: 10 CSI-RS resource 3: 6 CSI-RS resource 4: 10 |
| Number of CSI-RS ports (*X*) | |  | 1 |
| CDM Type | |  | No CDM |
| Density (*ρ*) | |  | 3 |
| CSI-RS periodicity | | Slots | 160 |
| CSI-RS offset | | Slots | 80 for CSI-RS resource 1 and 2  81 for CSI-RS resource 3 and 4 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #0 |
| NZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS (*k0*) | |  | 0 |
| First OFDM symbol in the PRB used for CSI-RS (*l0*) | |  | 12 |
| Number of CSI-RS ports (*X*) | |  | 2 |
| CDM Type | |  | FD-CDM2 |
| Density (*ρ*) | |  | 1 |
| CSI-RS periodicity | | Slots | 160 |
| CSI-RS offset | |  | 0 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #1 |
| ZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS (k0) | |  | 4 |
| First OFDM symbol in the PRB used for CSI-RS (*l0*) | |  | 12 |
| Number of CSI-RS ports (*X*) | |  | 4 |
| CDM Type | |  | FD-CDM2 |
| Density (*ρ*) | |  | 1 |
| CSI-RS periodicity | | Slots | 160 |
| CSI-RS offset | |  | 0 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| CSI-RS for beam refinement | First subcarrier index in the PRB used for CSI-RS | |  | k0=0 for CSI-RS resource 1,2 |
| First OFDM symbol in the PRB used for CSI-RS | |  | l0 = 8 for CSI-RS resource 1  l0 = 9 for CSI-RS resource 2 |
| Number of CSI-RS ports (X) | |  | 1 for CSI-RS resource 1,2 |
| CDM Type | |  | ‘No CDM’ for CSI-RS resource 1,2 |
| Density (ρ) | |  | 3 for CSI-RS resource 1,2 |
| CSI-RS periodicity | | Slots | 120 kHz SCS: 160 for CSI-RS resource 1,2 |
| CSI-RS offset | | Slots | 0 for CSI-RS resource 1,2 |
| PDSCH DMRS configuration | Antenna ports indexes | |  | {1000} for Rank 1 tests {1000, 1001} for Rank 2 tests |
| Number of PDSCH DMRS CDM group(s) without data | |  | 1 |
| TCI state #0 | Type 1 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type C |
| Type 2 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type D |
| TCI state #1 | Type 1 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type A |
| Type 2 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type D |
| PTRS configuration | Frequency density (*KPT-RS*) | |  | 2 |
| Time density (*LPT-RS*) | |  | 1 |
| 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} |
| Precoding configuration | | |  | SP Type I, Random per slot with PRB bundling granularity |
| Symbols for all unused Res | | |  | OCNG in Annex A.5 |
| Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. | | | | |

Table 7.2-2: Number of PRBs in CORESET

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SCS (kHz) | 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| 60 | 66 | 132 | 264 | N.A |
| 120 | 30 | 66 | 132 | 264 |

7.2.1 1RX requirements

(Void)

7.2.2 2RX requirements

7.2.2.1 FDD

(Void)

7.2.2.2 TDD

7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A

For PDSCH Type-A scheduling, the requirements are specified in Table 7.2.2.2.1-3, 7.2.2.2.1-4 and 7.2.2.2.1-5, with the addition of the parameters in Table 7.2.2.2.1-2 and the downlink physical channel setup according to Annex C.5.1. The purpose is to verify the performance of PDSCH Type-A scheduling.

The test purposes are specified in Table 7.2.2.1.1-1.

**Table 7.2.2.1.1-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs andnumber of MIMO layers | [1-1, 1-3, 2-1, 2-2, 2-3, 2-4, 2-5, 2-6] |
| Verify the PDSCH mapping Type A HARQ soft combining performance under 2 receive antenna conditions. | [1-2] |
| Verify the PDSCH mapping Type A enhanced performance requirement Type X under 2 receive antenna conditions and with 2 MIMO layers. | [3-1] |

**Table 7.2.2.2.1-2: Test Parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Duplex mode | |  | TDD |
| Active DL BWP index | |  | 1 |
| DL BWP configuration #1 | First PRB |  | 0 |
| Number of contiguous PRB |  | Maximum transmission bandwidth configuration as specified in TS 38.101-2 [7, Section 5.3.2] for tested channel bandwidth and subcarrier spacing |
| PDCCH configuration | Number of PRBs in CORESET | PRBs | As defined in Table 7.2-2 |
| PDSCH configuration | Mapping type |  | Type A |
| *k0* |  | 0 |
| Starting symbol (S) |  | 1 |
| Length (L) |  | As defined in Annex A.1.3 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | WB for 1-1,  2 for other tests |
| Resource allocation type |  | Type 1 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Length |  | Single-symbol DM-RS |
| Antenna ports indexes |  | {1000} for Rank1  {1000,1001} for Rank2 |
| Number of PDSCH DMRS CDM group(s) without data |  | 1 |
| Number of HARQ Processes | |  | 8 for Test 1-1, 1-3, 2-4  10 for Test 2-1, 2-3, 2-5, 2-6, 3-1  16 for Test 1-2  TBD for Test 2-2 |
| K1 value (PDSCH-to-HARQ-timing-indicator) | |  | As defined in Annex A.1.3 |

**Table 7.2.2.2.1-3: Minimum performance for Rank 1 (FRC)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | Bandwidth/Subcarrier spacing | **Modulation and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNRBB (dB)** |
| 1-1 | R.PDSCH. 5-1.1\_TDD | 100MHz/120kHz | QPSK, 0.30 | FR2.120-1 | TDLC60-300 | 2x2 ULA Low | 70 | [-0.4] |
| 1-2 | R.PDSCH. 5-2.1\_TDD | 100MHz/120kHz | 16QAM, 0.48 | FR2.120-1 | TDLA30-300 | 2x2 ULA Low | 30 | [1.7] |
| 1-3 | R.PDSCH. 5-3.1\_TDD | 100MHz/120kHz | 64QAM, 0.45 | FR2.120-1 | TDLA30-300 | 2x2 XPL Med-A | 70 | [12.4] |

**Table 7.2.2.2.1-4: Minimum performance for Rank 2 (FRC)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | Bandwidth/Subcarrier spacing | **Modulation and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNRBB (dB)** |
| 2-1 | R.PDSCH. 5-4.1\_TDD | 100MHz/120kHz | QPSK, 0.30 | FR2.120-2 | TDLA30-75 | 2x2 ULA Low | 70 | [4.1] |
| 2-2 | R.PDSCH. 5-2.2\_TDD | 100MHz/120kHz | 16QAM, 0.48 | FR2.120-1 | TDLA30-300 | 2x2 ULA Low | 70 | [TBD] |
| 2-3 | R.PDSCH. 5-5.2\_TDD | 50MHz/120kHz | 16QAM,0.48 | FR2.120-2 | TDLA30-75 | 2x2 ULA Low | 70 | [14.0] |
| 2-4 | R.PDSCH. 5-2.3\_TDD | 200MHz/120kHz | 16QAM, 0.48 | FR2.120-1 | TDLA30-300 | 2x2 ULA Low | 70 | [14.2] |
| 2-5 | R.PDSCH. 4-1.1\_TDD | 50MHz/60kHz | 16QAM, 0.48 | FR2.60-1 | TDLA30-75 | 2x2 ULA Low | 70 | [14.3] |
| 2-6 | R.PDSCH. 5-6.1\_TDD | 100MHz/120kHz | 64QAM, 0.43 | FR2.120-2 | TBD | 2x2 ULA Low | 70 | [18.6] |

**Table 7.2.2.2.1-5: Minimum performance for Rank 2 (FRC) for Enhanced Type X Receiver**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | Bandwidth/Subcarrier spacing | **Modulation and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNRBB (dB)** |
| 3-1 | R.PDSCH. 5-5.1\_TDD | 100MHz/120kHz | 16QAM, 0.48 | FR2.120-2 | TDLA30-75 | 2x2 ULA Med | 70 | [19.4] |

7.3 PDCCH demodulation requirements

The receiver characteristics of the PDCCH are determined by the probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg).

The parameters specified in Table 7.3-1 are valid for all PDCCH tests unless otherwise stated.

**Table 7.3-1: Common test Parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Value** |
| DL BWP configuration #1 | Cyclic prefix | |  | Normal |
| Common serving cell parameters | Physical Cell ID | |  | 0 |
| SSB position in burst | |  | 1 |
| SSB periodicity | | ms | 20 |
| PDCCH configuration | Slots for PDCCH monitoring | |  | Each slot |
| Number of PDCCH candidates | |  | 1 |
| TCI state | |  | TCI state #1 |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS (k0) | |  | 0 |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4: 8 |
| Number of CSI-RS ports (X) | |  | 1 |
| CDM Type | |  | No CDM |
| Density (ρ) | |  | 3 |
| CSI-RS periodicity | | Slots | 160 |
| CSI-RS offset | | Slots | 80 for CSI-RS resource 1 and 2  81 for CSI-RS resource 3 and 4 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #0 |
| Precoding configuration | | |  | SP Type I, Random per slot with REG bundling granularity for number of Tx larger than 1 |
| TCI state #0 | Type 1 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type C |
| Type 2 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type D |
| TCI state #1 | Type 1 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type A |
| Type 2 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type D |
| Symbols for all unused REs | | |  | OCNG in Annex A.5 |

7.3.1 1RX requirements

(Void)

7.3.2 2RX requirements

7.3.2.1 FDD

(Void)

7.3.2.2 TDD

The parameters specified in Table 7.3.2.2-1 are valid for all TDD tests unless otherwise stated.

**Table 7.3.2.2-1: Test Parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Unit** | **1 Tx Antenna** | **2 Tx Antenna** |
| TDD UL-DL pattern |  | FR2.120-1 | |
| CCE to REG mapping type |  | Interleaved | |
| REG bundle size |  | 2 for test 1-1  6 for test 1-2 | 2 |
| Interleaver size |  | 3 for test 1-1  2 for test 1-2 | 3 |
| Shift index |  | 0 | |

7.3.2.2.1 1 Tx Antenna performances

For the parameters specified in Table 7.3.2.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 7.3.2.2.1-1. The downlink physical setup is in accordance with Annex C.5.1.

**Table 7.3.2.2.1-1: Minimum performance requirements with 120 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNRBB (dB)** |
| 1-1 | 100 MHz | 60 | 1 | 2 CCE | R.PDCCH. 5-1.1 TDD | TDLA30-75 | 1x2 Low | 1 | [6.0] |
| 1-2 | 100 MHz | 60 | 1 | 4 CCE | R.PDCCH. 5-1.2 TDD | TDLA30-300 | 1x2 Low | 1 | [2.6] |

7.3.2.2.2 2 Tx Antenna performances

For the parameters specified in Table 7.3.2.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 7.3.2.2.2-1. The downlink physical setup is in accordance with Annex C.5.1.

**Table 7.3.2.2.2-1: Minimum performance requirements with 120 kHz SCS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **CORESET RB** | **CORESET duration** | **Aggregation level** | **Reference Channel** | **Propagation Condition** | **Antenna configuration and correlation Matrix** | **Reference value** | |
| **Pm-dsg (%)** | **SNRBB (dB)** |
| 2-1 | 100 MHz | 60 | 1 | 8 CCE | R.PDCCH. 5-1.3 TDD | TDLA30-75 | 2x2 Low | 1 | [-0.4] |
| 2-2 | 100 MHz | 60 | 2 | 16 CCE | R.PDCCH. 5-2.1 TDD | TDLA30-75 | 2x2 Low | 1 | [-3.4] |

7.4 PBCH demodulation requirements

The receiver characteristics of PBCH are determined by the probability of miss-detection of the PBCH (Pm-bch), which is defined as

Where A is the number of correctly decoded MIB PDUs and B is the number of transmitted MIB PDUs. The Pm-bch is derived with the assumption UE combines the PBCH symbols of the same SS/PBCH block index within the MIB TTI (80ms).

7.4.1 1RX requirements

(Void)

7.4.2 2RX requirements

7.4.2.1 FDD

(Void)

7.4.2.2 TDD

**Table 7.4.2.2-1: Test parameters for PBCH**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Single antenna port** |
| Physical Cell ID |  | 0 |
| Cyclic prefix |  | Normal |
| Number of SS/PBCH blocks within an SS burst set periodicity |  | 1 |
| SS/PBCH block index Note1 |  | 0 |
| SS/PBCH block periodicity | ms | 20 |
| TDD UL-DL pattern |  | FR2.120-1 |
| Note 1: as specified in TS 38.213 [11, Section 4.1]  Note 2: as specified in TS 38.213 [11, Section 11.1] | | |

For the parameters specified in Table 7.4.2.2-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 7.4.2.2-2 in case SS/PBCH block index is not known and below the specified values in Table.7.4.2.2-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.5.1.

**Table 7.4.2.2-2: Minimum performance PBCH in case SS/PBCH block index is not known**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test number** | **Bandwidth** | **Reference channel** | **Propagation condition** | **Antenna configuration and correlation matrix** | **Reference value** | |
| **Pm-bch (%)** | **SNRBB (dB)** |
| 1 | 100 MHz | R.PBCH.5 | [TDLA30-300] | 1 x 2 Low | 1 | [-6.1] |
| 2 | 100 MHz | R.PBCH.6 | [TDLA30-75] | 1 x 2 Low | 1 | TBD |

Table 7.4.2.2-3 Minimum performance PBCH in case SS/PBCH block index is known

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
| Pm-bch (%) | PBCH SNR (dB) |
| 1 | 100 MHz | R.PBCH.5 | TDLA30-300 | 1 x 2 Low | 1 | [-8] |
| 2 | 100 MHz | R.PBCH.6 | TDLA30-75 | 1 x 2 Low | 1 | [-7.5] |

7.5 Sustained downlink data rate provided by lower layers

<TBA>

8 CSI reporting requirements (Radiated requirements)

8.1 General

This section includes radiated requirements for the reporting of channel state information (CSI).

8.1.1 Applicability of requirements

<TBA>

8.1.2 Common test parameters

Parameters specified in Table 8.1.2-1 are applied for all test cases in this section unless otherwise stated.

**Table 8.1.2-1: Test parameters for CSI test cases**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Value** |
| PDSCH transmission scheme | | | |  | Transmission scheme 1 |
| Duplex Mode | | | |  | TDD |
| EPRE ratio of PTRS to PDSCH | | | | dB | [0] |
| Active DL BWP index | | | |  | 1 |
| Cyclic prefix | | | |  | Normal |
| Common serving cell parameters | Physical Cell ID | | |  | 0 |
| SSB position in burst | | |  | First SSB in Slot #0 |
| SSB periodicity | | | ms | 20 |
| PDCCH configuration | Slots for PDCCH monitoring | | |  | Each slot |
| Symbols with PDCCH | | |  | 0,1 |
| Number of PDCCH candidates and aggregation levels | | |  | 1/[8] |
| DCI format | | |  | 1\_1 |
| TCI state | | |  | TCI state #1 |
| Cross carrier scheduling | | | |  | Not configured |
| PDSCH configuration | Mapping type | | |  | Type A |
| *k0* | | |  | 0 |
| Starting symbol (S) | | |  | 2 |
| Length (L) | | |  | 12 |
| PDSCH aggregation factor | | |  | 1 |
| PRB bundling type | | |  | Static |
| PRB bundling size | | |  | 2 |
| Resource allocation type | | |  | 0 |
| VRB-to-PRB mapping type | | |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size | | |  | N/A |
| PDSCH DMRS configuration | DMRS Type | | |  | Type 1 |
| Number of additional DMRS | | |  | 1 |
| DMRS ports indexes | | |  | {1000} for Rank1  {1000,1001} for Rank2 |
| Length | | |  | Single-symbol DM-RS |
| Number of PDSCH DMRS CDM group(s) without data | | |  | 2 |
| PTRS configuration | Frequency density (*KPT-RS*) | | |  | 2 |
| Time density (*LPT-RS*) | | |  | 1 |
| CSI-RS for tracking | | First subcarrier index in the PRB used for CSI-RS (*k0*) | |  | [0] |
| First OFDM symbol in the PRB used for CSI-RS (*l0*) | |  | [4] |
| Number of CSI-RS ports (*X*) | |  | 1 |
| CDM Type | |  | No CDM |
| Density (*ρ*) | |  | 3 |
| CSI-RS periodicity | | slot | 120kHz SCS: 160 |
| CSI-RS offset | | slot | 120 kHz SCS:  80 for CSI-RS resource 1 and 2  81 for CSI-RS resource 3 and 4 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #0 |
| NZP CSI-RS for CSI acquisition | | Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| QCL info | |  | TCI state #1 |
| ZP CSI-RS for CSI acquisition | | Frequency Occupation | |  | Start PRB 0  Number of PRB = BWP size |
| CSI-RS for beam refinement | | First subcarrier index in the PRB used for CSI-RS | |  | k0=0 for CSI-RS resource 1,2 |
| First OFDM symbol in the PRB used for CSI-RS | |  | l0 = 8 for CSI-RS resource 1  l0 = 9 for CSI-RS resource 2 |
| Number of CSI-RS ports (X) | |  | 1 for CSI-RS resource 1,2 |
| CDM Type | |  | ‘No CDM’ for CSI-RS resource 1,2 |
| Density (ρ) | |  | 3 for CSI-RS resource 1,2 |
| CSI-RS periodicity | | Slots | 120 kHz SCS: 160 for CSI-RS resource 1,2 |
| CSI-RS offset | | Slots | 0 for CSI-RS resource 1,2 |
| Repetition | |  | ON |
| TCI state #0 | | Type 1 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type C |
| Type 2 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type D |
| TCI state #1 | | Type 1 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type A |
| Type 2 QCL information | CSI-RS resource |  | CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration |
| QCL Type |  | Type D |
| Number of HARQ Processes | | | |  | 8 |
| HARQ ACK/NACK bundling | | | |  | Multiplexed |
| Redundancy version coding sequence | | | |  | {0,2,3,1} |
| K1 value (PDSCH-to-HARQ-timing-indicator) | | | |  | For FR2.120-1:  [3] if mod (i.5) = 0,  [6] if mod(i,5) = 2  For FR2.120-2:  [11] if mod(i,8) = 0,  [7] if mod(i,8) = 4,  [6] if mod(i,8) = 5,  where i is slot index per radio fame with values 0-79. |
| Symbols for unused Res | | | |  | OCNG as specified in A.5 |
| Note 1: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL.  Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. | | | | | |

8.2 Reporting of Channel Quality Indicator (CQI)

8.2.1 1RX requirements

(Void)

8.2.2 2RX requirements

8.2.2.1 FDD

(Void)

8.2.2.2 TDD

8.2.2.2.1 CQI reporting under AWGN conditions

*<Editor’s note: The requirements were introduced based on current results from companies; these requirements can be revised based on more results from companies.>*

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 [12]. 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.

8.2.2.2.1.1 Minimum requirement for periodic CQI reporting

For the parameters specified in Table 8.2.2.2.1.1-1, and using the downlink physical channels specified in Annex C.5.1, the minimum requirements are specified by the following:

a) the reported CQI value 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, 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, the BLER using transport format indicated by (median CQI – 1) shall be less than or equal to 0.1.

**Table 8.2.2.2.1.1-1 Test parameters**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 100 | | 100 | |
| Duplex Mode | | | |  | TDD | | TDD | |
| TDD Slot Configuration | | | |  | FR2.120-2 [Annex A.1.3] | | FR2.120-2 [Annex A.1.3] | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | ]0 | |
| Number of contiguous PRB |  | 66 | | 66 | |
| Subcarrier spacing | kHz | 120 | | 120 | |
| SNRBB | | | | dB | [8] | [9] | [14] | [15] |
| Propagation channel | | | |  | AWGN | | AWGN | |
| Antenna configuration | | | |  | 2×2 with static channel specified in [Annex B.1] | | 2×2 with static channel specified in [Annex B.1] | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | As specified in Section [Annex TBD] | |
|  | | | |  |  | |  | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | *Periodic* | | *Periodic* | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | 4 | |
| CDM Type | | |  | *FD-CDM2* | | *FD-CDM2* | |
| Density (ρ) | | |  | 1 | | 1 | |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | 8 | | 8 | |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | 13 | | 13 | |
| CSI-RS  periodicity and offset | | | slot | 8/1 | | 8/1 | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | |  | *Periodic* | | *Periodic* | |
| Number of CSI-RS ports (*X*) | | |  | 2 | | 2 | |
| CDM Type | | |  | *fd-CDM2* | | *fd-CDM2* | |
| Density (ρ) | | |  | 1 | | 1 | |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | 6 | | 6 | |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | 13 | | 13 | |
| NZP CSI-RS-timeConfig  periodicity and offset | | | slot | 8/1 | | 8/1 | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 1 | | 1 | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (8, 13) | | (8, 13) | |
| CSI-IM timeConfig  periodicity and offset | | | slot | 8/1 | | 8/1 | |
| ReportConfigType | | | |  | *Periodic* | | *Periodic* | |
| CQI-table | | | |  | Table 1 | | Table 1 | |
| reportQuantity | | | |  | *cri-RI-PMI-CQI* | | *cri-RI-PMI-CQI* | |
| timeRestrictionForChannelMeasurements | | | |  | *Not configured* | | *Not configured* | |
| timeRestrictionForInterferenceMeasurements | | | |  | *Not configured* | | *Not configured* | |
| cqi-FormatIndicator | | | |  | *Wideband* | | *Wideband* | |
| pmi-FormatIndicator | | | |  | *Wideband* | | *Wideband* | |
| Sub-band Size | | | | RB | [8] | | [8] | |
| csi-ReportingBand | | | |  | [111111111] | | [111111111] | |
| CSI-Report periodicity and offset | | | | slot | 8/1 | | 8/1 | |
| aperiodicTriggeringOffset | | | |  | *Not configured* | | *Not configured* | |
| Codebook configuration | | Codebook Type | |  | *typeI-SinglePanel* | | *typeI-SinglePanel* | |
| Codebook Mode | |  | 1 | | 1 | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | *Not configured* | | *Not configured* | |
| CodebookSubsetRestriction | |  | [010000] | | [010000] | |
| RI Restriction | |  | [N/A] | | [N/A] | |
| Physical channel for CSI report | | | |  | [PUCCH] | | [PUCCH] | |
| CQI/RI/PMI delay | | | | ms | [8.375] | | [8.375] | |
| Maximum number of HARQ transmission | | | |  | 1 | | 1 | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.1-2 | | As specified in Table A.4-1, TBS.1-2 | |

8.2.2.2.2 CQI reporting under fading conditions

8.2.2.2.2.1 Minimum requirement for wideband CQI reporting

*<Editor’s note: Open issues to be resolved:*

*- SNR levels*

*- Test parameters*

*- Requirements values (BLER, α, γ)>*

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI. To account for sensitivity of the input SNR the CQI reporting under frequency non-selective fading conditions 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.

For the parameters specified in Table 8.2.2.2.2.1-1 and using the downlink physical channels specified in Annex C.5.1, the minimum requirements are specified by the following:

a) a CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α % of the time, where α% is specified in Table 8.2.2.2.2.1-2;

b) the ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ γ, where γ is specified in Table 8.2.2.2.2.1-2;

c) when transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater or equal to [0.01].

**Table 8.2.2.2.2.1-1 Test parameters**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | | MHz | 100 | | 100 | |
| Duplex Mode | | | |  | TDD | | TDD | |
| TDD Slot Configuration | | | |  | FR2.120-2 [Annex A.1.3] | | FR2.120-2 [Annex A.1.3] | |
| DL BWP configuration #1 | | | First PRB |  | 0 | | 0 | |
| Number of contiguous PRB |  | 66 | | 66 | |
| Subcarrier spacing | kHz | 120 | | 120 | |
| SNRBB | | | | dB | 6 | 7 | 12 | 13 |
| Propagation channel | | | |  | [TDLA30-35] | | [TDLA30-35] | |
| Antenna configuration | | | |  | 2×2  [ULA High] | | 2×2  [ULA High] | |
| Beamforming Model | | | |  | As specified in Section [Annex TBD] | | As specified in Section [Annex TBD] | |
|  | | | |  |  | |  | |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | *Aperiodic* | | *Aperiodic* | |
| Number of CSI-RS ports (*X*) | | |  | 4 | | 4 | |
| CDM Type | | |  | *FD-CDM2* | | *FD-CDM2* | |
| Density (ρ) | | |  | 1 | | 1 | |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | 8 | | 8 | |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | 13 | | 13 | |
| CSI-RS  interval and offset | | | slot | [8/1] | | [8/1] | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | |  | *Aperiodic* | | *Aperiodic* | |
| Number of CSI-RS ports (*X*) | | |  | 2 | | 2 | |
| CDM Type | | |  | *fd-CDM2* | | *fd-CDM2* | |
| Density (ρ) | | |  | 1 | | 1 | |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | 6 | | 6 | |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | 13 | | 13 | |
| NZP CSI-RS-timeConfig  interval and offset | | | slot | [8/1] | | [8/1] | |
| CSI-IM configuration | CSI-IM RE pattern | | |  | 1 | | 1 | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (8, 13) | | (8, 13) | |
| CSI-IM timeConfig  interval and offset | | | slot | [8/1] | | [8/1] | |
| ReportConfigType | | | |  | *Aperiodic* | | *Aperiodic* | |
| CQI-table | | | |  | Table 1 | | Table 1 | |
| reportQuantity | | | |  | *cri-RI-PMI-CQI* | | *cri-RI-PMI-CQI* | |
| timeRestrictionForChannelMeasurements | | | |  | *Not configured* | | *Not configured* | |
| timeRestrictionForInterferenceMeasurements | | | |  | *Not configured* | | *Not configured* | |
| cqi-FormatIndicator | | | |  | *Wideband* | | *Wideband* | |
| pmi-FormatIndicator | | | |  | *Wideband* | | *Wideband* | |
| Sub-band Size | | | | RB | [8] | | [8] | |
| csi-ReportingBand | | | |  | [111111111] | | [111111111] | |
| CSI-Report periodicity and offset | | | | slot | 8/1 | | 8/1 | |
| aperiodicTriggeringOffset | | | |  | *Not configured* | | *Not configured* | |
| Codebook configuration | | Codebook Type | |  | *typeI-SinglePanel* | | *typeI-SinglePanel* | |
| Codebook Mode | |  | 1 | | 1 | |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | *Not configured* | | *Not configured* | |
| CodebookSubsetRestriction | |  | [000001] | | [000001] | |
| RI Restriction | |  | [N/A] | | [N/A] | |
| Physical channel for CSI report | | | |  | [PUSCH] | | [PUSCH] | |
| CQI/RI/PMI delay | | | | ms | [1.375] | | [1.375] | |
| Maximum number of HARQ transmission | | | |  | 1 | | 1 | |
| Measurement channel | | | |  | As specified in Table A.4-1, TBS.1-1 | | As specified in Table A.4-1, TBS.1-1 | |

**Table 8.2.2.2.2.1-2 Minimum requirements**

|  |  |  |
| --- | --- | --- |
|  | **Test 1** | **Test 2** |
| ** [%] | [2] | [2] |
| ** | [1.05] | [1.05] |

8.3 Reporting of Precoding Matrix Indicator (PMI)

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 reports 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 and applied to the PDSCH. A fixed transport format (FRC) is configured for all requirements.

The requirements for transmission mode 1 with 2TX and higher layer parameter *codebookType* set to ‘typeI-SinglePanel’ are specified in terms of the ratio



In the definition of *γ*, for 2TX 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.

8.3.1 1RX requirements

(Void)

8.3.2 2RX requirements

8.3.2.1 FDD

(Void)

8.3.2.2 TDD

8.3.2.2.1 Single PMI with 2TX TypeI-SinglePanel Codebook

For the parameters specified in Table 8.3.2.2.1-1, and using the downlink physical channels specified in Annex C.5.1, the minimum requirements are specified in Table 8.3.2.2.1-2.

**Table 8.3.2.2.1-1: Test parameters (single layer)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Test 1** | **Test 2** |
| Bandwidth | | MHz | 100 | 100 |
| TDD DL-UL configuration | |  | FR2.120-2 as specified in Annex A | FR2.120-2 as specified in Annex A |
| DL BWP configuration #1 | First PRB |  | 0 | 0 |
| Number of contiguous PRB |  | 66 | 66 |
| Subcarrier spacing | kHz | 120 | 120 |
| Propagation channel | |  | [TDLA30-35] |  |
| Antenna configuration | |  | 2 x 2 [ULA Low] | 2 x 2 [ULA Low] |
| Beamforming Model | |  | TBD |  |
| ZP CSI-RS configuration | CSI-RS resource Type |  | Aperiodic | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 4 | 4 |
| CDM Type |  | FD-CDM2 | FD-CDM2 |
| Density (ρ) |  | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 4, (8,-) | Row 4, (8,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (13,-) | (13,-) |
| CSI-RS  interval and offset | slot | 8/1 | 5/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type |  | Aperiodic | Aperiodic |
| Number of CSI-RS ports (*X*) |  | 2 | 2 |
| CDM Type |  | FD-CDM2 | FD-CDM2 |
| Density (ρ) |  | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) |  | Row 3, (6,-) | Row 3, (6,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) |  | (13,-) | (13,-) |
| CSI-RS  interval and offset | slot | 8/1 | 8/1 |
| CSI-IM configuration | CSI-IM RE pattern |  | Patten 0 | Patten 0 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) |  | (8,13) | (8,13) |
| CSI-IM timeConfig  interval and offset | slot | 8/1 | 5/1 |
| ReportConfigType | |  | Aperiodic | Aperiodic |
| CQI-table | |  | Table 1 | Table 1 |
| reportQuantity | |  | cri-RI-PMI-CQI | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | |  | Not configured | Not configured |
| timeRestrictionForInterferenceMeasurements | |  | Not configured | Not configured |
| cqi-FormatIndicator | |  | Wideband | Wideband |
| pmi-FormatIndicator | |  | Wideband | Wideband |
| Sub-band Size | | RB | [8] | [8] |
| csi-ReportingBand | |  | [111111111] | [111111111] |
| CSI-Report interval and offset | | slot | 8/1 | 5/1 |
| aperiodicTriggeringOffset | |  | 0 | 0 |
| Codebook configuration | Codebook Type |  | typeI-SinglePanel | typeI-SinglePanel |
| Codebook Mode |  | 1 | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | N/A | N/A |
| CodebookSubsetRestriction |  | 001111 | 001111 |
| RI Restriction |  | N/A | N/A |
| Physical channel for CSI report | |  | PUSCH | PUSCH |
| CQI/RI/PMI delay | | ms | 1.375 | 1.75 |
| Maximum number of HARQ transmission | |  | 4 | 4 |
| Measurement channel | |  | R.PDSCH.5-8.1 TDD | R.PDSCH.5-7.1 TDD |
| Note 1: For random precoder selection, the precoder shall be updated in each slot (0.125 ms granularity).  Note 2: 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)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+4)].  Note 3: Randomization of the principle beam direction shall be used as specified in TBD. | | | | |

**Table 8.3.2.2.1-2: Minimum requirement**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Test 1** | **Test 2** |
| ** | [1.05] | [1.05] |

8.4 Reporting of Rank Indicator (RI)

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.

8.4.1 1RX requirements

(Void)

8.4.2 2RX requirements

8.4.2.1 FDD

(Void)

8.4.2.2 TDD

The minimum performance requirement in Table 8.4.2.2-2 is defined as

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

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

For the parameters specified in Table 8.4.2.2-1, and using the downlink physical channels specified in Annex C.5.1, the minimum requirements are specified in Table 8.4.2.2-2.

**Table 8.4.2.2-1: RI Test (TDD)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | **Unit** | **Test 1** | **Test 2** | **Test 3** |
| Bandwidth | | | | MHz | 100 | 100 | 100 |
| Duplex Mode | | | |  | TDD | TDD | TDD |
| TDD Slot Configuration | | | |  | FR1.120-2 | FR1.120-2 | FR1.120-2 |
| DL BWP configuration #1 | | | First PRB |  | 0 | 0 | 0 |
| Number of contiguous PRB |  | 66 | 66 | 66 |
| Subcarrier spacing | kHz | 120 | 120 | 120 |
| SNR | | | | dB | [0] | [20] | [20] |
| Propagation channel | | | |  | [TDLA30-35] | [TDLA30-35] | [TDLA30-35] |
| Antenna configuration | | | |  | ULA Low 2x2 | ULA Low 2x2 | XP High 2x2 |
| Beamforming Model | | | |  | As defined in Annex B.4.1 | As defined in Annex B.4.1 | As defined in Annex B.4.1 |
| ZP CSI-RS configuration | CSI-RS resource Type | | |  | Aperiodic | Aperiodic | Aperiodic |
| Number of CSI-RS ports (*X*) | | |  | 4 | 4 | 4 |
| CDM Type | | |  | FD-CDM2 | FD-CDM2 | FD-CDM2 |
| Density (ρ) | | |  | 1 | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | Row 4, (8,-) | Row 4, (8,-) | Row 4, (8,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | (13,-) | (13,-) | (13,-) |
| CSI-RS  interval and offset | | | slot | 8/1 | 8/1 | 8/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | |  | Aperiodic | Aperiodic | Aperiodic |
| Number of CSI-RS ports (*X*) | | |  | 2 | 2 | 2 |
| CDM Type | | |  | FD-CDM2 | FD-CDM2 | FD-CDM2 |
| Density (ρ) | | |  | 1 | 1 | 1 |
| First subcarrier index in the PRB used for CSI-RS (k0, k1 ) | | |  | Row 3 (6,-) | Row 3 (6,-) | Row 3 (6,-) |
| First OFDM symbol in the PRB used for CSI-RS (l0, l1) | | |  | (13,-) | (13,-) | (13,-) |
| NZP CSI-RS-timeConfig  interval and offset | | | slot | 8/1 | 8/1 | 8/1 |
| CSI-IM configuration | CSI-IM RE pattern | | |  | Pattern 1 | Pattern 1 | Pattern 1 |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | | |  | (8,13) | (8,13) | (8,13) |
| CSI-IM timeConfig  interval and offset | | | slot | 8/1 | 8/1 | 8/1 |
| ReportConfigType | | | |  | Aperiodic | Aperiodic | Aperiodic |
| CQI-table | | | |  | Table 1 | Table 1 | Table 1 |
| reportQuantity | | | |  | cri-RI-PMI-CQI | cri-RI-PMI-CQI | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | |  | not configured | not configured | not configured |
| timeRestrictionForInterferenceMeasurements | | | |  | not configured | not configured | not configured |
| cqi-FormatIndicator | | | |  | Wideband | Wideband | Wideband |
| pmi-FormatIndicator | | | |  | Wideband | Wideband | Wideband |
| Sub-band Size | | | | RB | [8] | [8] | [8] |
| csi-ReportingBand | | | |  | [111111111] | [111111111] | [111111111] |
| CSI-Report interval and offset | | | | slot | 8/1 | 8/1 | 8/1 |
| aperiodicTriggeringOffset | | | |  | 0 | 0 | 0 |
| Codebook configuration | | Codebook Type | |  | typeI-SinglePanel | typeI-SinglePanel | typeI-SinglePanel |
| Codebook Mode | |  | 1 | 1 | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) | |  | N/A | N/A | N/A |
| 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] |
| RI Restriction | |  | N/A | N/A | N/A |
| Physical channel for CSI report | | | |  | PUSCH | PUSCH | PUSCH |
| CQI/RI/PMI delay | | | | ms | 1.375 | 1.375 | 1.375 |
| Maximum number of HARQ transmission | | | |  | 1 | 1 | 1 |
| RI Configuration | | | |  | Fixed RI = 2 and follow RI | Fixed RI = 1 and follow RI | Fixed RI = 1 and follow RI |

**Table 8.4.2.2-2: Minimum requirement (TDD)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Test 1** | **Test 2** | **Test 3** |
| **1 | N/A | [1.05] | [1.05] |
| **2 | [1.0] | N/A | N/A |

9 Demodulation performance requirements for interworking

9.1 General

This clause covers the UE demodulation performance requirements for EN-DC, NE-DC, inter-band NR-DC between FR1 and FR2, and inter-band NR CA between FR1 and FR2.

9.1.1 Applicability of requirements

The following applicability rules are specified for demodulation performance requirements for interworking:

- For UEs supporting both SA and NSA,

- The performance requirements specified in Section 5 will be verified only for SA except for the sustained downlink data rate test specified in Section 5.5 and 5.5A.

- The performance requirements specified in Section 7 will be verified only for SA except for the sustained downlink data rate test specified in Section 7.5.- The sustained downlink data rate tests specified in Sections 5.5, 5.5A and 7.5 for SA and in Section 9.4B for NSA are verified separately.

- The FR1 EN-DC test cases with the NR TDD DL-UL configurations which are not aligned with LTE’s can be tested on the corresponding EN-DC band combinations where UE supports simultaneous transmission and reception.

9.1.2 LTE Pcell setup

This sub-clause provides the parameters for LTE Pcell during the demodulation performance test for EN-DC unless otherwise stated. For EN-DC with multiple LTE carriers or bands, randomly selected one carrier or band that can be used for Pcell as LTE Pcell for the connection setup.

9.1.2.1 FDD

The parameters specified in Table 9.1.2.1-1 and Table 9.1.2.1-2 are used to setup an LTE Pcell. One of test setup in Table 9.1.2.1-2 will be selected for the LTE Pcell depending on the maximum bandwidth of an LTE carrier for all the EN-DC band combinations supported by the UE.

The measurement channels in Table 9.1.2.1-2 and OCNG pattern OP.1 FDD are specified in TS 36.101 [4]. The physical channel setup with downlink power allocation is according to TS36.101 [4, Annex C.3.2].

**Table 9.1.2.1-1: Common Test Parameters (FDD)**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| Cyclic prefix |  | Normal |
| Physical Cell ID |  | 0 |
| Number of PDCCH symbols | symbols | 1 |
| PHICH Ng (Note 1) |  | 1 |
| PHICH duration |  | Normal |
| Number of HARQ processes per component carrier | Processes | [8] |
| Maximum number of HARQ transmission |  | [4] |
| Redundancy version coding sequence |  | {0,0,1,2} for [64QAM] |
| Propagation condition |  | Static propagation condition  No external noise sources are applied |
| Transmission mode |  | [3] |
| Transmission time difference between LTE cell and NR cell(s) | μs | 0 |
| Antenna configuration |  | 2x2 |
| Codebook subset restriction |  | [10] |
| Symbols for all unused Res |  | OCNG in Annex A.5 |

**Table 9.1.2.1-2: Specific Test Parameters (FDD [64QAM])**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test setup** | **Bandwidth (MHz)** | **Downlink power allocation (dB)** | | |
|  |  | **σ** |
| 1 | 5 | -3 | -3 | 0 |
| 2 | 10 | -3 | -3 | 0 |
| 3 | 15 | -3 | -3 | 0 |
| 4 | 20 | -3 | -3 | 0 |

9.1.2.2 TDD

The parameters specified in Table 9.1.2.2-1 and Table 9.1.2.2-2 are used to setup an LTE Pcell. One of test setup in Table 9.1.2.2-2 will be selected for the LTE Pcell depending on the maximum bandwidth of an LTE carrier for all the EN-DC band combinations supported by the UE.

The measurement channels in Table 9.1.2.2-2 and OCNG pattern OP.1 TDD are specified in TS36.101 [4]. The physical channel setup with downlink power allocation is according to TS36.101 [4, Annex C.3.2].

**Table 9.1.2.2-1: Common Test Parameters (TDD)**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| UL DL configuration |  | 2 (Note1) |
| Special subframe configuration |  | 7 |
| Number of PDCCH symbols | symbols | 1 |
| PHICH Ng (Note 3) |  | 1 |
| PHICH duration |  | Normal |
| Cyclic prefix |  | Normal |
| Cell ID |  | 0 |
| Maximum number of HARQ transmission |  | [4] |
| Redundancy version coding sequence |  | {0,0,1,2} for [64QAM] |
| Propagation condition |  | Static propagation condition  No external noise sources are applied |
| Transmission mode |  | [3] |
| Transmission time difference between LTE cell and NR cell(s) | μs | 0 |
| Antenna configuration |  | 2x2 |
| Codebook subset restriction |  | [10] |
| Symbols for all unused Res |  | OCNG in Annex A.5 |
| NOTE 1: The start of transmission of LTE frame is delayed by 2 LTE subframes with respect to the start of transmission of NR frame when TDD-TDD EN-DC configuration is configured during the test. | | |

**Table 9.1.2.2-2: Specific Test Parameters (FDD [64QAM])**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test setup** | **Bandwidth (MHz)** | **Downlink power allocation (dB)** | | |
|  |  | **σ** |
| 1 | 10 | -3 | -3 | 0 |
| 2 | 15 | -3 | -3 | 0 |
| 3 | 20 | -3 | -3 | 0 |

9.2 Void

9.2A PDSCH demodulation for CA

9.2A.1 NR CA between FR1 and FR2

9.2B PDSCH demodulation for DC

9.2B.1 EN-DC

*<Editor note: which NR PDSCH test case(s) will be selected for EN-DC test need FFS.>*

9.2B.1.1 EN-DC within FR1

9.2B.1.1.1 PDSCH

The test setup for LTE Pcell is specified in Section 9.1.2. The NR PDSCH demodulation performance requirements for NR are specified in Section 5.2. During the test, only the PDSCH performance on the NR cell(s) shall be verified.

9.2B.1.2 EN-DC including FR2 NR carrier only

9.2B.1.2.1 PDSCH

The test setup for LTE Pcell is specified in Section 9.1.2. The NR PDSCH demodulation performance requirements for NR are specified in Section 7.2. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers shall be verified.

9.2B.1.3 EN-DC including FR1 and FR2 NR carriers

The demodulation performance requirements are verified according to Section 9.2B.1.1 for EN-DC with FR1 NR carrier only and Section 9.2B.1.2 for EN-DC with FR2 NR carrier only. During the test for EN-DC with FR2 NR carriers, only demodulation performance requirements on the FR2 carriers are verified. No demodulation requirement for FR1 NR or LTE carriers is specified for EN-DC including FR2 carrier(s).

9.2B.2 NR DC between FR1 and FR2

9.3 Void

9.3A PDCCH demodulation for CA

9.3A.1 NR CA between FR1 and FR2

During the test, only the demodulation performance requirements on FR2 carriers are verified. The demodulation performance requirements for NR FR2 are specified in Section 7.3.

9.3B PDCCH demodulation for DC

9.3B.1 EN-DC

*<Editor note: which NR PDCCH test case(s) will be selected for EN-DC test need FFS.>*

9.3B.1.1 EN-DC within FR1

9.3B.1.1.1 PDCCH

The test setup for LTE Pcell is specified in Section 9.1.2. The NR PDCCH demodulation performance requirements for NR are specified in Section 5.3. During the test, only the PDCCH performance on the single NR cell shall be verified.

9.3B.1.2 EN-DC including FR2 NR carrier only

9.3B.1.2.1 PDCCH

The test setup for LTE Pcell is specified in Section 9.1.2. The NR PDCCH demodulation performance requirements are specified in Section 7.3. During the test, only the PDCCH performance on the single NR cell shall be verified.

9.3B.1.3 EN-DC including FR1 and FR2 NR carriers

The demodulation performance requirements are verified according to Section 9.3B.1.1 for EN-DC with FR1 NR carrier only and Section 9.3B.1.2 for EN-DC with FR2 NR carrier only. During the test for EN-DC with FR2 NR carriers, only demodulation performance requirements on the FR2 carriers are verified. No demodulation requirement for FR1 NR or LTE carriers is specified for EN-DC including FR2 carrier(s).

9.3B.2 NR DC between FR1 and FR2

9.4 Void

9.4A SDR test for CA

9.4A.1 NR CA between FR1 and FR2

During the test, only the demodulation performance requirements on FR2 carriers are verified. The demodulation performance requirements for FR2 are specified in Section 7.5.

9.4B SDR test for DC

9.4B.1 EN-DC

*<Editor note: which NR SDR test case(s) will be selected for EN-DC test need FFS.>*

9.4B.1.1 EN-DC within FR1

9.4B.1.1.1 SDR test

The test setup for LTE Pcell is specified in Section 9.1.2. The NR SDR tests are specified in Section 5.5. During the test, the PDSCH performance on both the NR cell(s) and LTE cell(s) shall be verified.

9.4B.1.2 EN-DC including FR2 NR carrier

9.4B.1.2.1 SDR test

The test setup for LTE Pcell is specified in Section 9.1.2. The NR PDSCH SDR tests are specified in Section 7.5. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers is verified.

9.4B.1.3 EN-DC including FR1 and FR2 NR carriers

The SDR tests are verified according to Section 9.4B.1.1 for EN-DC with FR1 NR carrier only and Section 9.4B.1.2 for EN-DC with FR2 NR carrier only. During the test for EN-DC with FR2 NR carriers, only SDR tests on the FR2 carriers are verified. No SDR requirement for FR1 NR or LTE carriers is tested for EN-DC including FR2 carrier(s).

9.4B.2 NR DC between FR1 and FR2

10 CSI reporting requirements for interworking

10.1 General

This clause specifies CSI performance requirements for EN-DC, NE-DC, inter-band NR-DC between FR1 and FR2, and inter-band NR CA between FR1 and FR2.

The definition of frequency ranges (FR1 and FR2) are specified in TS38.101-3 [8, table 5.1-1].

10.1.1 Applicability of requirements

<TBA>

10.2 Void

10.2A Reporting of Channel Quality Indicator (CQI) for CA

10.2B Reporting of Channel Quality Indicator (CQI) for DC

10.2B.1 EN-DC

*<Editor’s note: FFS which test cases from SA will be applied for EN-DC >*

10.2B.1.1 EN-DC within FR1

Unless otherwise stated, the configuration of LTE Pcell specified in [X] applies to LTE carrier.

Unless otherwise stated, NR CQI requirements and test configurations defined in Subclause 6.2 apply to NR cell(s).

Unless otherwise stated, only NR requirements on NR cell(s) shall be verified during test.

10.2B.1.2 EN-DC including FR2 NR carrier

Unless otherwise stated, the configuration of LTE Pcell specified in [X] applies to LTE carrier.

Unless otherwise stated, NR CQI requirements and test configurations defined in Subclause 8.2 apply to NR cell(s).

Unless otherwise stated, only NR requirements on NR cell(s) shall be verified during test.

10.2B.1.3 EN-DC including FR1 and FR2 NR carriers

10.3 Void

10.3A Reporting of Precoding Matrix Indicator (PMI) for CA

10.3B Reporting of Precoding Matrix Indicator (PMI) for DC

10.3B.1 EN-DC

*<Editor’s note: FFS which test cases from SA will be applied for EN-DC >*

10.3B.1.1 EN-DC within FR1

Unless otherwise stated, the configuration of LTE Pcell specified in [X] applies to LTE carrier.

Unless otherwise stated, NR PMI requirements and test configurations defined in Subclause 6.3 apply to NR cell(s).

Unless otherwise stated, only NR requirements on NR carrier(s) shall be verified during test.

10.3B.1.2 EN-DC including NR FR2 carrier

Unless otherwise stated, the configuration of LTE Pcell specified in [X] applies to LTE carrier.

Unless otherwise stated, NR PMI requirements and test configurations defined in Subclause 8.3 apply to NR cell(s).

Unless otherwise stated, only NR requirements on NR cell(s) shall be verified during test.

10.3B.1.3 EN-DC including FR1 and FR2 NR carriers

10.4 Void

10.4A Reporting of Rank Indicator (RI) for CA

10.4B Reporting of Rank Indicator (RI) for DC

10.4B.1 EN-DC

*<Editor’s note: FFS which test cases from SA will be applied for EN-DC >*

10.4B.1.1 EN-DC within FR1

Unless otherwise stated, the configuration of LTE Pcell specified in [X] applies to LTE carrier.

Unless otherwise stated, NR RI requirements and test configurations defined in Subclause 6.4 apply to NR cell(s).

Unless otherwise stated, only NR requirements on NR cell(s) shall be verified during test.

10.4B.1.2 EN-DC including NR FR2 carrier

Unless otherwise stated, the configuration of LTE Pcell specified in [X] applies to LTE carrier.

Unless otherwise stated, NR RI requirements and test configurations defined in Subclause 8.4 apply to NR cell(s) for EN-DC operation with NR carrier(s) in FR2.

Unless otherwise stated, only NR requirements on NR cell(s) shall be verified during test.

10.4B.1.3 EN-DC including FR1 and FR2 NR carriers

Annex A (normative):  
Measurement channels

A.1 General

A.1.1 Throughput definition

The throughput values defined in the measurement channels specified in Annex A, are calculated and are valid per codeword. For multi-codeword transmissions, the throughput referenced in the minimum requirements is the sum of throughputs of all codewords.

A.1.2 TDD UL-DL patterns for FR1

TDD UL-DL patterns configurations for performance requirements are provided in Tables A.1.2-1, A.1.2-2, and A.1.2-3.

**Table A.1.2-1: TDD UL-DL pattern for SCS 15 kHz**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **UL-DL pattern** |
| **FR1.15-1** |
| TDD Slot Configuration pattern (Note 1) | |  | DDDSU |
| Special Slot Configuration (Note 2) | |  | 10D+2G+2U |
| UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*) | *referenceSubcarrierSpacing* | kHz | 15 |
| *dl-UL-TransmissionPeriodicity* | ms | 5 |
| *nrofDownlinkSlots* |  | 3 |
| *nrofDownlinkSymbols* |  | 10 |
| *nrofUplinkSlot* |  | 1 |
| *nrofUplinkSymbols* |  | 2 |
| K1 value  (PDSCH-to-HARQ-timing-indicator) | |  | [4] if mod(I,5) = 0 [3] if mod(i,5) = 1 [2] if mod(i,5) = 2 [6] if mod(i,5) = 3 |
| Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information.  Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.  Note 3: i is the slot index per frame; i = {0,…,9} | | | |

**Table A.1.2-2: TDD UL-DL pattern for SCS 30 kHz**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | **Unit** | **UL-DL pattern** | | | | | |
| **FR1.30-1** | **FR1.30-2** | **FR1.30-3** | **FR1.30-4** | **FR1.30-5** | **FR1.30-6** |
| TDD Slot Configuration pattern (Note 1) | |  | 7DS2U | DDDSU | DDDSUDDSUU | SU | DDSU | DS1S2U |
| Special Slot Configuration (Note 2) | |  | 6D+4G+4U | 10D+2G+2U | 10D+2G+2U | 12D+2G+0U | 10D+2G+2U | S1: 10D+2G+2U S2: 12D+2G+0U |
| UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*) | *referenceSubcarrierSpacing* | kHz | 30 | 30 | 30 | 30 | 30 | 30 |
| *dl-UL-TransmissionPeriodicity* | ms | 5 | 2.5 | 2.5 | 1 | 2 | 1 |
| *nrofDownlinkSlots* |  | 7 | 3 | 3 | 0 | 2 | 1 |
| *nrofDownlinkSymbols* |  | 6 | 10 | 10 | 12 | 10 | 10 |
| *nrofUplinkSlot* |  | 2 | 1 | 1 | 1 | 1 | 0 |
| *nrofUplinkSymbols* |  | 4 | 2 | 2 | 0 | 2 | 2 |
| UL-DL configuration2 (*tdd-UL-DL-ConfigurationCommon2*) | *referenceSubcarrierSpacing* | kHz | N/A | N/A | 30 | N/A | N/A | 30 |
| *dl-UL-TransmissionPeriodicity* | ms | N/A | N/A | 2.5 | N/A | N/A | 1 |
| *nrofDownlinkSlots* |  | N/A | N/A | 2 | N/A | N/A | 0 |
| *nrofDownlinkSymbols* |  | N/A | N/A | 10 | N/A | N/A | 12 |
| *nrofUplinkSlot* |  | N/A | N/A | 2 | N/A | N/A | 1 |
| *nrofUplinkSymbols* |  | N/A | N/A | 2 | N/A | N/A | 0 |
| K1 value  (PDSCH-to-HARQ-timing-indicator) | |  | [7] if mod(i,10) = 0 [6] if mod(i,10) = 1 [5] if mod(i,10) = 2 [5] if mod(i,10) = 3 [4] if mod(i,10) = 4 [3] if mod(i,10) = 5 [3] if mod(i,10) = 6 [2] if mod(i,10) = 7 | [4] if mod(i,5) = 0 [3] if mod(i,5) = 1 [2] if mod(i,5) = 2 [6] if mod(i,5) = 3 | [4] if mod(i,10) = 0 [3] if mod(i,10) = 1 [2] if mod(i,10) = 2 [5] if mod(i,10) = 3 [3] if mod(i,10) = 5 [3] if mod(i,10) = 6 [2] if mod(i,10) = 7 | [3] if mod(i,2) = 0 | [3] if mod(i,4) = 0 [2] if mod(i,4) = 1 [5] if mod(i,4) = 3 | [3] if mod(i,4) = 0 [2] if mod(i,4) = 1 [3] if mod(i,4) = 3 |
| Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information.  Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.  Note 3: i is the slot index per frame; i = {0,…,19} | | | | | | | | |

A.1.3 TDD UL-DL patterns for FR2

TDD UL-DL patterns configurations for performance requirements are provided in Tables A.1.3-1, A.1.3-2.

**Table A.1.3-1: TDD UL-DL pattern for SCS 60 kHz**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **UL-DL pattern** |
| **FR2.60-1** |
| TDD Slot Configuration pattern (Note 1) | |  | DDSU |
| Special Slot Configuration (Note 2) | |  | 11D+3G+0U |
| UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*) | *referenceSubcarrierSpacing* | kHz | 60 |
| *dl-UL-TransmissionPeriodicity* | ms | 1 |
| *nrofDownlinkSlots* |  | 2 |
| *nrofDownlinkSymbols* |  | 11 |
| *nrofUplinkSlot* |  | 1 |
| *nrofUplinkSymbols* |  | 0 |
| K1 value  (PDSCH-to-HARQ-timing-indicator) | |  | K1 = [3] if mod(i,4) = 0 K1 = [2] if mod(i,4) = 1 K1 = [5] if mod(i,4) = 3 |
| Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information.  Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.  Note 3: i is the slot index per frame; i = {0,…,39} | | | |

**Table A.3.1-5: TDD UL-DL pattern for SCS 120 kHz**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | | **Unit** | **UL-DL pattern** | |
| **FR2.120-1** | **FR2.120-2** |
| TDD Slot Configuration pattern (Note 1) | |  | DDDSU | DDSU |
| Special Slot Configuration (Note 2) | |  | 10D+2G+2U | 11D+3G+0U |
| UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*) | *referenceSubcarrierSpacing* | kHz | 120 | 120 |
| *dl-UL-TransmissionPeriodicity* | ms | 0.625 | 0.5 |
| *nrofDownlinkSlots* |  | 3 | 2 |
| *nrofDownlinkSymbols* |  | 10 | 11 |
| *nrofUplinkSlot* |  | 1 | 1 |
| *nrofUplinkSymbols* |  | 2 | 0 |
| K1 value  (PDSCH-to-HARQ-timing-indicator) | |  | K1 = [4] if mod(i,5) = 0 K1 = [3] if mod(i,5) = 1 K1 = [2] if mod(i,5) = 2 K1 = [6] if mod(i,5) = 3 | K1 = [3] if mod(i,4) = 0 K1 = [2] if mod(i,4) = 1 K1 = [5] if mod(i,4) = 3 |
| Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information.  Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.  Note 3: i is the slot index per frame; i = {0,…,79} | | | | |

A.2 Void

*<Editor’s note: Clause A.2 is a placeholder for UL Measurement channels>*

A.3 DL reference measurement channels

A.3.1 General

The transport block size (TBS) determination procedure is described in TS 38.214 [12, Section 5.1.3.2].

[Unless otherwise stated, no user data is scheduled on slot #0 within 20 ms in order to avoid SSB and PDSCH transmissions in one slot and simplify test configuration.]

A.3.2 Reference measurement channels for PDSCH performance requirements

For PDSCH reference channels if more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).

A.3.2.1 FDD

A.3.2.1.1 Reference measurement channels for SCS 15 kHz FR1

**Table A.3.2.1.1-1: PDSCH Reference Channel for FDD (QPSK)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 1-1.1 FDD | R.PDSCH. 1-1.2 FDD | R.PDSCH. 1-1.3 FDD | R.PDSCH. 1-1.4 FDD | R.PDSCH. 1-1.5 FDD |
| Channel bandwidth | MHz | 10 | 10 | 10 | 10 | 10 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 52 | 6 | 52 | 52 | 52 |
| Number of consecutive PDSCH symbols |  | 12 | 12 | 7 | 9 | 11 |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 | 19 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 4 | 4 | 4 | 4 | 4 |
| Modulation |  | QPSK | QPSK | QPSK | QPSK | QPSK |
| Target Coding Rate |  | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Number of MIMO layers |  | 1 | 1 | 1 | 1 | 1 |
| Number of DMRS rEs |  | 18 | 12 | 12 | 12 | 12 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 18 | 18 |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 3904 | 480 | 2280 | 2472 | 3240 |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 24 | 16 | 16 | 16 | 16 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | CBs | 1 | 1 | 1 | 1 | 1 |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 10, 11 | Bits | 12480 | 1512 | 6864 | 7760 | 10256 |
| For Slots i = 3,…, 9, 12, …, 19 | Bits | 13104 | 1584 | 7488 | 8384 | 10880 |
| Max. Throughput averaged over 2 frames | Mbps | 3.709 | 0.456 | 2.166 | 2.348 | 3.078 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.1.1-2: PDSCH Reference Channel for FDD (16QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 1-2.1 FDD | R.PDSCH. 1-2.2 FDD | R.PDSCH. 1-2.3 FDD | R.PDSCH. 1-2.4 FDD |  |
| Channel bandwidth | MHz | 10 | 10 | 10 | 10 |  |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 |  |
| Number of allocated resource blocks | PRBs | 52 | 52 | 52 | 52 |  |
| Number of consecutive PDSCH symbols |  | 12 | 12 | 12 | 12 |  |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 |  |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM |  |
| MCS index |  | 13 | 13 | 13 | 13 |  |
| Modulation |  | 16QAM | 16QAM | 16QAM | 16QAM |  |
| Target Coding Rate |  | 0.48 | 0.48 | 0.48 | 0.48 |  |
| Number of MIMO layers |  | 1 | 2 | 3 | 4 |  |
| Number of DMRS rEs |  | 12 | 12 | 24 | 24 |  |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A |  |
| For Slots i = 1,…, 19 | Bits | 13064 | 26120 | 35856 | 48168 |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A |  |
| For Slots i = 1,…, 19 | Bits | 24 | 24 | 24 | 24 |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A |  |
| For Slots i = 1,…, 19 | CBs | 2 | 4 | 5 | 6 |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A |  |
| For Slots i = 10, 11 | Bits | 26208 | 52416 | 71136 | 94848 |  |
| For Slots i = 1,…, 9, 12, …, 19 | Bits | 27456 | 54912 | 74880 | 99840 |  |
| Max. Throughput averaged over 2 frames | Mbps | 12.411 | 24.814 | 34.063 | 45.760 |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.1.1-3: PDSCH Reference Channel for FDD (64QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 1-3.1 FDD |  |  |  |  |
| Channel bandwidth | MHz | 10 |  |  |  |  |
| Subcarrier spacing | kHz | 15 |  |  |  |  |
| Number of allocated resource blocks | PRBs | 52 |  |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 |  |  |  |  |
| Allocated slots per 2 frames | Slots | 19 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 19 |  |  |  |  |
| Modulation |  | 64QAM |  |  |  |  |
| Target Coding Rate |  | 0.51 |  |  |  |  |
| Number of MIMO layers |  | 2 |  |  |  |  |
| Number of DMRS rEs |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 0 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | Bits | 42016 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | CBs | 5 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 10, 11 | Bits | 78624 |  |  |  |  |
| For Slots i = 1,…, 9, 12, …, 19 | Bits | 82368 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 39.915 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.1.1-4: PDSCH Reference Channel for FDD (256QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 1-4.1 FDD |  |  |  |  |
| Channel bandwidth | MHz | 10 |  |  |  |  |
| Subcarrier spacing | kHz | 15 |  |  |  |  |
| Number of allocated resource blocks | PRBs | 52 |  |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 |  |  |  |  |
| Allocated slots per 2 frames | Slots | 19 |  |  |  |  |
| 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 |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | Bits | 45096 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | CBs | 6 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 10, 11 | Bits | 52416 |  |  |  |  |
| For Slots i = 1,…, 9, 12, …, 19 | Bits | 54912 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 42.841 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.1.1-5: PDSCH Reference Channel for FDD and CSI-RS overlapped with PDSCH**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 1-5.1 FDD |  |  |  |  |
| Channel bandwidth | MHz | 10 |  |  |  |  |
| Subcarrier spacing | kHz | 15 |  |  |  |  |
| Number of allocated resource blocks | PRBs | 52 |  |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 |  |  |  |  |
| Allocated slots per 2 frames | Slots | 19 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 13 |  |  |  |  |
| Modulation |  | 16QAM |  |  |  |  |
| Target Coding Rate |  | 0.48 |  |  |  |  |
| Number of MIMO layers |  | 2 |  |  |  |  |
| Number of DMRS rEs |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 0 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | Bits | 26120 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | CBs | 4 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 5, 15 | Bits | 50752 |  |  |  |  |
| For Slots i = 10 | Bits | 48256 |  |  |  |  |
| For Slots i = 11 | Bits | 52416 |  |  |  |  |
| For Slots i = 1,…,4,6,…, 9,12,…14,16,…,19 | Bits | 54912 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 24.814 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.1.1-6: PDSCH Reference Channel for FDD PMI reporting requirements**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 1-6.1 FDD | R.PDSCH. 1-6.2 FDD |  |  |  |
| Channel bandwidth | MHz | 10 | 10 |  |  |  |
| Subcarrier spacing | kHz | 15 | 15 |  |  |  |
| Number of allocated resource blocks | PRBs | 52 | 52 |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 | 12 |  |  |  |
| Allocated slots per 2 frames | Slots | 15 | 15 |  |  |  |
| MCS table |  | 64QAM | 64QAM |  |  |  |
| MCS index |  | 13 | 13 |  |  |  |
| Modulation |  | 16QAM | 16QAM |  |  |  |
| Target Coding Rate |  | 0.48 | 0.48 |  |  |  |
| Number of MIMO layer |  | 1 | 2 |  |  |  |
| Number of DMRS rEs (Note 3) |  | 24 | 24 |  |  |  |
| Overhead for TBS determination |  | 0 | 0 |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A |  |  |  |
| For CSI Slots i, if mod (i,5) =1, i={0,…,19} |  | N/A | N/A |  |  |  |
| For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..19} | Bits | 12040 | 24072 |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A |  |  |  |
| For CSI Slots i, if mod (i,5) =1, i={0,…,19} |  | N/A | N/A |  |  |  |
| For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..19} | Bits | 24 | 24 |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A |  |  |  |
| For CSI Slots i, if mod (i,5) =1, i={0,…,19} |  | N/A | N/A |  |  |  |
| For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..,19} | CBs | 2 | 3 |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A |  |  |  |
| For CSI Slots i, if mod (i,5) =1, i={0,…,19} |  | N/A | N/A |  |  |  |
| For Slots i = 10 | Bits | 23712 | 47424 |  |  |  |
| For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..9,11,…,19} | Bits | 24960 | 49920 |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 9.030 | 18.054 |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Number of DMRS rEs includes the overhead of the DM-RS CDM groups without data | | | | | | | |

A.3.2.1.2 Reference measurement channels for SCS 30 kHz FR1

**Table A.3.2.1.2-1: PDSCH Reference Channel for FDD (64QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-1.1 FDD |  |  |  |  |
| Channel bandwidth | MHz | 20 |  |  |  |  |
| Subcarrier spacing | kHz | 30 |  |  |  |  |
| Number of allocated resource blocks | PRBs | 51 |  |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 |  |  |  |  |
| Allocated slots per 2 frames | Slots | 39 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 19 |  |  |  |  |
| Modulation |  | 64QAM |  |  |  |  |
| Target Coding Rate |  | 0.51 |  |  |  |  |
| Number of MIMO layers |  | 2 |  |  |  |  |
| Number of DMRS rEs |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 0 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | Bits | 40976 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A |  |  |  |  |
| For Slots i = 1,…, 19 | CBs | 5 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 10, 11 | Bits | 77112 |  |  |  |  |
| For Slots i = 1,…, 9, 12, …, 19 | Bits | 80784 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 79.903 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

A.3.2.2 TDD

A.3.2.2.1 Reference measurement channels for SCS 15 kHz FR1

A.3.2.2.2 Reference measurement channels for SCS 30 kHz FR1

**Table A.3.2.2.2-1: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (QPSK)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-1.1 TDD | R.PDSCH. 2-1.2 TDD | R.PDSCH. 2-1.3 TDD |  |  |
| Channel bandwidth | MHz | 40 | 40 | 40 |  |  |
| Subcarrier spacing | kHz | 30 | 30 | 30 |  |  |
| Allocated resource blocks | PRBs | 106 | 6 | 106 |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 4 | 4 | N/A |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 | 12 | 7 |  |  |
| Allocated slots per 2 frames |  | 31 | 31 | 27 |  |  |
| MCS table |  | 64QAM | 64QAM | 64QAM |  |  |
| MCS index |  | 4 | 4 | 4 |  |  |
| Modulation |  | QPSK | QPSK | QPSK |  |  |
| Target Coding Rate |  | 0.30 | 0.30 | 0.30 |  |  |
| Number of MIMO layers |  | 1 | 1 | 1 |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 6 | 6 | N/A |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 18 | 12 | 12 |  |  |
| Overhead for TBS determination |  | 0 | 0 | 0 |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 2664 | 144 | N/A |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 8064 | 480 | 4608 |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 16 | 16 | N/A |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 24 | 16 | 24 |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | CBs | N/A | N/A | N/A |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 1 | 1 | N/A |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | CBs | 1 | 1 | 1 |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A |  |  |
| For Slots i = 20, 21 | Bits | 25440 | 1512 | 13992 |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 8904 | 504 | N/A |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,19,22,…,39} | Bits | 26712 | 1584 | 15264 |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 11.419 | 0.677 | 6.221 |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-2: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (16QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-2.1 TDD | R.PDSCH. 2-2.2 TDD | R.PDSCH. 2-2.3 TDD | R.PDSCH. 2-2.4 TDD |  |
| Channel bandwidth | MHz | 40 | 40 | 40 | 40 |  |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 |  |
| Allocated resource blocks | PRBs | 106 | 106 | 106 | 106 |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 4 | 4 | 4 | 4 |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 | 12 | 12 | 12 |  |
| Allocated slots per 2 frames |  | 31 | 31 | 31 | 31 |  |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM |  |
| MCS index |  | 13 | 13 | 13 | 13 |  |
| Modulation |  | 16QAM | 16QAM | 16QAM | 16QAM |  |
| Target Coding Rate |  | 0.48 | 0.48 | 0.48 | 0.48 |  |
| Number of MIMO layers |  | 1 | 2 | 3 | 4 |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 6 | 6 | 12 | 12 |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 | 12 | 24 | 24 |  |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 8456 | 16896 | 22032 | 29192 |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 26632 | 53288 | 73776 | 98376 |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 | 24 | 24 | 24 |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 24 | 24 | 24 | 24 |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | CBs | N/A | N/A | N/A | N/A |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 2 | 3 | 3 | 4 |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | CBs | 4 | 7 | 9 | 12 |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A |  |
| For Slots i = 20, 21 | Bits | 53424 | 106848 | 144008 | 193344 |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 17808 | 35616 | 45792 | 61056 |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,19,22,…,39} | Bits | 55968 | 111936 | 152640 | 203520 |  |
| Max. Throughput averaged over 2 frames | Mbps | 37.644 | 75.318 | 104.719 | 138.646 |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-3: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (64QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-3.1 TDD | R.PDSCH. 2-3.2 TDD |  |  |  |
| Channel bandwidth | MHz | 40 | 20 |  |  |  |
| Subcarrier spacing | kHz | 30 | 30 |  |  |  |
| Allocated resource blocks | PRBs | 106 | 51 |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 4 | 4 |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 | 12 |  |  |  |
| Allocated slots per 2 frames |  | 31 | 31 |  |  |  |
| MCS table |  | 64QAM | 64QAM |  |  |  |
| MCS index |  | 19 | 19 |  |  |  |
| Modulation |  | 64QAM | 64QAM |  |  |  |
| Target Coding Rate |  | 0.51 | 0.51 |  |  |  |
| Number of MIMO layers |  | 2 | 2 |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 6 | 6 |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 | 12 |  |  |  |
| Overhead for TBS determination |  | 0 | 0 |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 27144 | 13064 |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 83976 | 40976 |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 | 24 |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 24 | 24 |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | CBs | N/A | N/A |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 4 | 2 |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | CBs | 10 | 5 |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A |  |  |  |
| For Slots i = 20, 21 | Bits | 160272 | 77112 |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 53424 | 25704 |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,19,22,…,39} | Bits | 167904 | 80784 |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 118.796 | 57.930 |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-4: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (256QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-4.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 40 |  |  |  |  |
| Subcarrier spacing | kHz | 30 |  |  |  |  |
| Allocated resource blocks | PRBs | 106 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 4 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 |  |  |  |  |
| Allocated slots per 2 frames |  | 31 |  |  |  |  |
| MCS table |  | 256QAM |  |  |  |  |
| MCS index |  | 24 |  |  |  |  |
| Modulation |  | 256QAM |  |  |  |  |
| Target Coding Rate |  | 0.82 |  |  |  |  |
| Number of MIMO layers |  | 1 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 6 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 0 |  |  |  |  |
| Maximum number of HARQ transmissions |  | 4 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 29192 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 92200 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 4 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | CBs | 11 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slots i = 20, 21 | Bits | 106848 |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 35616 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,19,22,…,39} | Bits | 111936 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 130.308 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-5: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-5.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 40 |  |  |  |  |
| Subcarrier spacing | kHz | 30 |  |  |  |  |
| Allocated resource blocks | PRBs | 106 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} |  | 8 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,39} |  | 12 |  |  |  |  |
| Allocated slots per 2 frames |  | 31 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 4 |  |  |  |  |
| Modulation |  | QPSK |  |  |  |  |
| Target Coding Rate |  | 0.30 |  |  |  |  |
| Number of MIMO layers |  | 1 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} |  | 12 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,39} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 0 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | Bits | 5376 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,39} | Bits | 8456 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | Bits | 24 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,39} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | CBs | 1 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,39} | CBs | 2 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i = 20, 21 | Bits | 26712 |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | Bits | 17808 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,19,22,…,39} | Bits | 27984 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 11.875 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-6: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-3**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-6.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 40 |  |  |  |  |
| Subcarrier spacing | kHz | 30 |  |  |  |  |
| Allocated resource blocks | PRBs | 106 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39} |  | 8 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,5,}) for i from {1,…,39} |  | 12 |  |  |  |  |
| Allocated slots per 2 frames |  | 27 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 4 |  |  |  |  |
| Modulation |  | QPSK |  |  |  |  |
| Target Coding Rate |  | 0.30 |  |  |  |  |
| Number of MIMO layers |  | 1 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39} |  | 12 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,5,}) for i from {1,…,39} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 0 |  |  |  |  |
| Maximum number of HARQ transmissions |  | 4 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39} | Bits | 5376 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,5,}) for i from {1,…,39} | Bits | 8456 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39} | Bits | 24 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,5,}) for i from {1,…,39} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39} | CBs | 1 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,5,}) for i from {1,…,39} | CBs | 2 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i = 20, 21 | Bits | 26712 |  |  |  |  |
| For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39} | Bits | 17808 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,5,}) for i from {1,…,19,22,…,39} | Bits | 27984 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 10.184 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-7: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and CSI-RS overlapped with PDSCH**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-7.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 40 |  |  |  |  |
| Subcarrier spacing | kHz | 30 |  |  |  |  |
| Allocated resource blocks | PRBs | 106 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 4 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 |  |  |  |  |
| Allocated slots per 2 frames |  | 31 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 13 |  |  |  |  |
| Modulation |  | 16QAM |  |  |  |  |
| Target Coding Rate |  | 0.48 |  |  |  |  |
| Number of MIMO layers |  | 2 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 6 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 0 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 16896 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 53288 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 3 |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39} | CBs | 7 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,}) for i from {1,…,19,22,…,39} | Bits | 103456 |  |  |  |  |
| For Slots i = 20 | Bits | 98368 |  |  |  |  |
| For Slots i = 21 | Bits | 106848 |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 35616 |  |  |  |  |
| For Slot i, if mod(i, 10) = {1,2,3,4,}) for i from {1,…,19,22,…,39} | Bits | 111936 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 75.318 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-8: PDSCH Reference Channel for TDD PMI reporting requirements with UL-DL pattern FR1.30-1 (16QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 2-8.1 TDD | R.PDSCH. 2-8.2 TDD |  |  |  |
| Channel bandwidth | MHz | 40 | 40 |  |  |  |
| Subcarrier spacing | kHz | 30 | 30 |  |  |  |
| Allocated resource blocks | PRBs | 106 | 106 |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 | 12 |  |  |  |
| Allocated slots per 2 frames |  | 23 | 23 |  |  |  |
| MCS table |  | 64QAM | 64QAM |  |  |  |
| MCS index |  | 13 | 13 |  |  |  |
| Modulation |  | 16QAM | 16QAM |  |  |  |
| Target Coding Rate |  | 0.48 | 0.48 |  |  |  |
| Number of MIMO layers |  | 1 | 2 |  |  |  |
| Number of DMRS rEs (Note 3) |  | 24 | 24 |  |  |  |
| Overhead for TBS determination |  | 0 | 0 |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A | N/A |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | N/A | N/A |  |  |  |
| For Slot i = 20 | Bits | 24576 | 49176 |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} |  | 24576 | 49176 |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A | N/A |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} |  | N/A | N/A |  |  |  |
| For Slot i = 20 | Bits | 24 | 24 |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 24 | 24 |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | CBs | N/A | N/A |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} |  | N/A | N/A |  |  |  |
| For Slot i = 20 | CBs | 3 | 6 |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | CBs | 3 | 6 |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A | N/A |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | N/A | N/A |  |  |  |
| For Slot i = 20 | Bits | 48336 | 96672 |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 50880 | 101760 |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 28.2624 | 56.5524 |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Number of DMRS rEs includes the overhead of the DM-RS CDM groups without data | | | | | | |

A.3.2.2.3 Reference measurement channels for SCS 60 kHz FR1

A.3.2.2.4 Reference measurement channels for SCS 60 kHz FR2

**Table A.3.2.2.4-1: PDSCH Reference Channel for TDD UL-DL pattern FR2.60-1 (16QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 4-1.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 50 |  |  |  |  |
| Subcarrier spacing | kHz | 60 |  |  |  |  |
| Allocated resource blocks | PRBs | 66 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 79} |  | 10 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,79} |  | 13 |  |  |  |  |
| Allocated slots per 2 frames |  | 59 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 13 |  |  |  |  |
| Modulation |  | 16QAM |  |  |  |  |
| Target Coding Rate |  | 0.48 |  |  |  |  |
| Number of MIMO layers |  | 2 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 79} |  | 12 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,79} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 6 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 79} | Bits | 25608 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,79} | Bits | 34816 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 79} | Bits | 24 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,79} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 79} | CBs | 4 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,79} | CBs | 5 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79} | Bits | N/A |  |  |  |  |
| For Slot i = 40, 41 | Bits | 69960 |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {4,…, 79} | Bits | 54912 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,39,42,…,79} | Bits | 73128 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 93.499 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

A.3.2.2.5 Reference measurement channels for SCS 120 kHz FR2

**Table A.3.2.2.5-1: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 (QPSK)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 5-1.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 100 |  |  |  |  |
| Subcarrier spacing | kHz | 120 |  |  |  |  |
| Allocated resource blocks | PRBs | 66 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} |  | 9 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} |  | 13 |  |  |  |  |
| Allocated slots per 2 frames |  | 127 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 4 |  |  |  |  |
| Modulation |  | QPSK |  |  |  |  |
| Target Coding Rate |  | 0.30 |  |  |  |  |
| Number of MIMO layers |  | 1 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} |  | 12 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 6 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 3624 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | Bits | 5504 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 16 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | CBs | 1 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | CBs | 1 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slots i = 80, 81 | Bits | 17490 |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 12210 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,79,82,…,159} | Bits | 18282 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 31.942 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.5-2: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 (16QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 5-2.1 TDD | R.PDSCH. 5-2.2 TDD | R.PDSCH. 5-2.3 TDD |  |  |
| Channel bandwidth | MHz | 100 | 100 | 200 |  |  |
| Subcarrier spacing | kHz | 120 | 120 | 120 |  |  |
| Allocated resource blocks | PRBs | 66 | 66 | 132 |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} |  | 9 | 9 | 9 |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} |  | 13 | 13 | 13 |  |  |
| Allocated slots per 2 frames |  | 127 | 127 | 127 |  |  |
| MCS table |  | 64QAM | 64QAM | 64QAM |  |  |
| MCS index |  | 13 | 13 | 13 |  |  |
| Modulation |  | 16QAM | 16QAM | 16QAM |  |  |
| Target Coding Rate |  | 0.48 | 0.48 | 0.48 |  |  |
| Number of MIMO layers |  | 1 | 2 | 2 |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} |  | 12 | 12 | 12 |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} |  | 12 | 12 | 12 |  |  |
| Overhead for TBS determination |  | 6 | 6 | 6 |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A | N/A | N/A |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 11272 | 22536 | 45096 |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | Bits | 17424 | 34816 | 69672 |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A | N/A | N/A |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 24 | 24 | 24 |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | Bits | 24 | 24 | 24 |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | CBs | N/A | N/A | N/A |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | CBs | 2 | 3 | 6 |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | CBs | 3 | 5 | 9 |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A | N/A | N/A |  |  |
| For Slots i = 80, 81 | Bits | 34980 | 69960 | 139920 |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 24420 | 48840 | 97680 |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,79,82,…,159} | Bits | 36564 | 73128 | 146256 |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 100.799 | 201.434 | 403.096 |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.5-3: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 (64QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 5-3.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 100 |  |  |  |  |
| Subcarrier spacing | kHz | 120 |  |  |  |  |
| Allocated resource blocks | PRBs | 66 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} |  | 9 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} |  | 13 |  |  |  |  |
| Allocated slots per 2 frames |  | 127 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 18 |  |  |  |  |
| Modulation |  | 64QAM |  |  |  |  |
| Target Coding Rate |  | 0.46 |  |  |  |  |
| Number of MIMO layers |  | 1 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} |  | 12 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 6 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 16136 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | Bits | 25104 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 24 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | CBs | 2 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,159} | CBs | 3 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slots i = 80, 81 | Bits | 52470 |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 36630 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,}) for i from {1,…,79,82,…,159} | Bits | 54846 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 145.062 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.5-4: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2 (QPSK)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 5-4.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 100 |  |  |  |  |
| Subcarrier spacing | kHz | 120 |  |  |  |  |
| Allocated resource blocks | PRBs | 6 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} |  | 10 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} |  | 13 |  |  |  |  |
| Allocated slots per 2 frames |  | 119 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 4 |  |  |  |  |
| Modulation |  | QPSK |  |  |  |  |
| Target Coding Rate |  | 0.30 |  |  |  |  |
| Number of MIMO layers |  | 2 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} |  | 12 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 6 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | Bits | 736 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | Bits | 1032 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | Bits | 16 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | Bits | 16 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | CBs | 1 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | CBs | 1 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i = 80, 81 | Bits | 3180 |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {4,…, 159} | Bits | 2496 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,79,82,…,159} | Bits | 3324 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 5.548 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.5-5: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2 (16QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 5-5.1 TDD | R.PDSCH. 5-5.2 TDD |  |  |  |
| Channel bandwidth | MHz | 100 | 50 |  |  |  |
| Subcarrier spacing | kHz | 120 | 120 |  |  |  |
| Allocated resource blocks | PRBs | 66 | 32 |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} |  | 10 | 10 |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} |  | 13 | 13 |  |  |  |
| Allocated slots per 2 frames |  | 119 | 119 |  |  |  |
| MCS table |  | 64QAM | 64QAM |  |  |  |
| MCS index |  | 13 | 13 |  |  |  |
| Modulation |  | 16QAM | 16QAM |  |  |  |
| Target Coding Rate |  | 0.48 | 0.48 |  |  |  |
| Number of MIMO layers |  | 2 | 2 |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} |  | 12 | 12 |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} |  | 12 | 12 |  |  |  |
| Overhead for TBS determination |  | 6 | 6 |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A | N/A |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | Bits | 25608 | 12552 |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | Bits | 34816 | 16896 |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A | N/A |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | Bits | 24 | 24 |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | Bits | 24 | 24 |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | CBs | N/A | N/A |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | CBs | 4 | 2 |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | CBs | 5 | 3 |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A | N/A |  |  |  |
| For Slot i = 80, 81 | Bits | 69960 | 33920 |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {4,…, 159} | Bits | 54912 | 26624 |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,79,82,…,159} | Bits | 73128 | 35456 |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 188.739 | 91.843 |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.5-6: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2 (64QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 5-6.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 100 |  |  |  |  |
| Subcarrier spacing | kHz | 120 |  |  |  |  |
| Allocated resource blocks | PRBs | 66 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} |  | 10 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} |  | 13 |  |  |  |  |
| Allocated slots per 2 frames |  | 119 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 17 |  |  |  |  |
| Modulation |  | 64QAM |  |  |  |  |
| Target Coding Rate |  | 0.43 |  |  |  |  |
| Number of MIMO layers |  | 2 |  |  |  |  |
| Number of DMRS rEs |  |  |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} |  | 12 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} |  | 12 |  |  |  |  |
| Overhead for TBS determination |  | 6 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | Bits | 34816 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | Bits | 47112 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | Bits | 24 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | CBs | 5 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,159} | CBs | 6 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | Bits | N/A |  |  |  |  |
| For Slot i = 80, 81 | Bits | 114940 |  |  |  |  |
| For Slot i, if mod(i, 4) = 2 for i from {4,…, 159} | Bits | 82368 |  |  |  |  |
| For Slot i, if mod(i, 4) = {0,}) for i from {1,…,79,82,…,159} | Bits | 109692 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 255.724 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |



**Table A.3.2.2.5-7: PDSCH Reference Channel for TDD PMI reporting requirements with UL-DL pattern FR2.120-1 (16QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 5-7.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 100 |  |  |  |  |
| Subcarrier spacing | kHz | 120 |  |  |  |  |
| Allocated resource blocks | PRBs | 66 |  |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 |  |  |  |  |
| Allocated slots per 2 frames |  | 63 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 13 |  |  |  |  |
| Modulation |  | 16QAM |  |  |  |  |
| Target Coding Rate |  | 0.48 |  |  |  |  |
| Number of MIMO layers |  | 1 |  |  |  |  |
| Number of DMRS rEs (Note 3) |  | 6 |  |  |  |  |
| Overhead for TBS determination |  | 4 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | 14344 |  |  |  |  |
| For Slot i = 20 | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} |  | 14344 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} |  | 24 |  |  |  |  |
| For Slot i = 20 | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | CBs | N/A |  |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} |  | 2 |  |  |  |  |
| For Slot i = 20 | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | CBs | 2 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | 28776 |  |  |  |  |
| For Slot i = 20 | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6}for i from {1,…,19,22,…,39} | Bits | 30360 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 45.1836 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Number of DMRS rEs includes the overhead of the DM-RS CDM groups without data | | | | | | |

**Table A.3.2.2.5-8: PDSCH Reference Channel for TDD PMI reporting requirements with UL-DL pattern FR2.120-2 (16QAM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH. 5-8.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 100 |  |  |  |  |
| Subcarrier spacing | kHz | 120 |  |  |  |  |
| Allocated resource blocks | PRBs | 66 |  |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 |  |  |  |  |
| Allocated slots per 2 frames |  | 59 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 13 |  |  |  |  |
| Modulation |  | 16QAM |  |  |  |  |
| Target Coding Rate |  | 0.48 |  |  |  |  |
| Number of MIMO layers |  | 1 |  |  |  |  |
| Number of DMRS rEs (Note 3) |  | 6 |  |  |  |  |
| Overhead for TBS determination |  | 4 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | 14344 |  |  |  |  |
| For Slot i = 20 | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} |  | 14344 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} |  | 24 |  |  |  |  |
| For Slot i = 20 | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | CBs | N/A |  |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} |  | 2 |  |  |  |  |
| For Slot i = 20 | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | CBs | 2 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | N/A |  |  |  |  |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | 28776 |  |  |  |  |
| For Slot i = 20 | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6}for i from {1,…,19,22,…,39} | Bits | 30360 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 42.3148 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Number of DMRS rEs includes the overhead of the DM-RS CDM groups without data | | | | | | |

A.3.3 Reference measurement channels for PDCCH performance requirements

A.3.3.1 FDD

A.3.3.1.1 Reference measurement channels for SCS 15 kHz FR1

**Table A.3.3.1.1-1: PDCCH Reference Channels (Time domain allocation 1 symbol)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH.1-1.1 FDD | R.PDCCH.1-1.2 FDD | R.PDCCH.1-1.3 FDD |  |  |  |
| Subcarrier spacing | kHz | 15 | 15 | 15 |  |  |  |
| CORESET frequency domain allocation |  | 48 | 48 | 48 |  |  |  |
| CORESET time domain allocation |  | 1 | 1 | 1 |  |  |  |
| Aggregation level |  | 4 | 4 | 8 |  |  |  |
| DCI Format |  | 1\_0 | 1\_1 | 1\_1 |  |  |  |
| Payload (without CRC) | Bits | 39 | 52 | 52 |  |  |  |

**Table A.3.3.1.1-2: PDCCH Reference Channel (Time domain allocation 2 symbols)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH. 1-2.1 FDD | R.PDCCH. 1-2.2 FDD | R.PDCCH. 1-2.3 FDD | R.PDCCH. 1-2.4 FDD | R.PDCCH. 1-2.5 FDD | R.PDCCH. 1-2.6 FDD |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 |
| CORESET frequency domain allocation |  | 24 | 24 | 24 | 48 | 48 | 48 |
| CORESET time domain allocation |  | 2 | 2 | 2 | 2 | 2 | 2 |
| Aggregation level |  | 2 | 4 | 2 | 4 | 8 | 16 |
| DCI Format |  | 1\_0 | 1\_0 | 1\_1 | 1\_1 | 1\_1 | 1\_0 |
| Payload (without CRC) | Bits | 39 | 39 | 512 | 52 | 52 | 39 |

A.3.3.1.2 Reference measurement channels for SCS 30 kHz FR1

**Table A.3.3.1.2-1: PDCCH Reference Channels (Time domain allocation 1 symbol)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH.2-1.1 FDD | R.PDCCH.2-1.2 FDD | R.PDCCH.2-1.3 FDD |  |  |  |
| 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 |  |  |  |

**Table A.3.3.1.2-2: PDCCH Reference Channel (Time domain allocation 2 symbols)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH.2-2.1 FDD |  |  |  |  |  |
| Subcarrier spacing | kHz | 30 |  |  |  |  |  |
| CORESET frequency domain allocation |  | 48 |  |  |  |  |  |
| CORESET time domain allocation |  | 2 |  |  |  |  |  |
| Aggregation level |  | 16 |  |  |  |  |  |
| DCI Format |  | 1\_0 |  |  |  |  |  |
| Payload (without CRC) | Bits | 41 |  |  |  |  |  |

A.3.3.2 TDD

A.3.3.2.1 Reference measurement channels for SCS 15 kHz FR1

**Table A.3.3.2.1-1: PDCCH Reference Channels (Time domain allocation 1 symbol)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH.1-1.1 TDD | R.PDCCH.1-1.2 TDD | R.PDCCH.1-1.3 TDD |  |  |  |
| Subcarrier spacing | kHz | 15 | 15 | 15 |  |  |  |
| CORESET frequency domain allocation |  | 48 | 48 | 48 |  |  |  |
| CORESET time domain allocation |  | 1 | 1 | 1 |  |  |  |
| Aggregation level |  | 4 | 4 | 8 |  |  |  |
| DCI Format |  | 1\_0 | 1\_1 | 1\_1 |  |  |  |
| Payload (without CRC) | Bits | 39 | 52 | 52 |  |  |  |

**Table A.3.3.2.1-2: PDCCH Reference Channel (Time domain allocation 2 symbols)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH. 1-2.1 TDD | R.PDCCH. 1-2.2 TDD | R.PDCCH. 1-2.3 TDD | R.PDCCH. 1-2.4 TDD | R.PDCCH. 1-2.5 TDD | R.PDCCH. 1-2.6 TDD |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 |
| CORESET frequency domain allocation |  | 24 | 24 | 24 | 48 | 48 | 48 |
| CORESET time domain allocation |  | 2 | 2 | 2 | 2 | 2 | 2 |
| Aggregation level |  | 2 | 4 | 2 | 4 | 8 | 16 |
| DCI Format |  | 1\_0 | 1\_0 | 1\_1 | 1\_1 | 1\_1 | 1\_0 |
| Payload (without CRC) | Bits | 39 | 39 | 52 | 52 | 52 | 39 |

A.3.3.2.2 Reference measurement channels for SCS 30 kHz FR1

**Table A.3.3.2.2-1: PDCCH Reference Channels (Time domain allocation 1 symbol)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH. 2-1.1 TDD | R.PDCCH. 2-1.2 TDD | R.PDCCH. 2-1.3 TDD |  |  |  |
| 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 |  |  |  |

**Table A.3.3.2.2-2: PDCCH Reference Channel (Time domain allocation 2 symbols)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH. 2-2.1 TDD |  |  |  |  |  |
| Subcarrier spacing | kHz | 30 |  |  |  |  |  |
| CORESET frequency domain allocation |  | 48 |  |  |  |  |  |
| CORESET time domain allocation |  | 2 |  |  |  |  |  |
| Aggregation level |  | 16 |  |  |  |  |  |
| DCI Format |  | 1\_0 |  |  |  |  |  |
| Payload (without CRC) | Bits | 41 |  |  |  |  |  |

A.3.3.2.3 Reference measurement channels for SCS 60 kHz FR1

A.3.3.2.4 Reference measurement channels for SCS 60 kHz FR2

A.3.3.2.5 Reference measurement channels for SCS 120 kHz FR2

**Table A.3.3.2.5-1: PDCCH Reference Channels (Time domain allocation 1 symbol)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH. 5-1.1 TDD | R.PDCCH. 5-1.2 TDD | R.PDCCH. 5-1.3 TDD |  |  |  |
| Subcarrier spacing | kHz | 120 | 120 | 120 |  |  |  |
| CORESET frequency domain allocation |  | 60 | 60 | 60 |  |  |  |
| CORESET time domain allocation |  | 1 | 1 | 1 |  |  |  |
| Aggregation level |  | 2 | 4 | 8 |  |  |  |
| DCI Format |  | 1\_0 | 1\_1 | 1\_1 |  |  |  |
| Payload (without CRC) | Bits | 40 | 56 | 56 |  |  |  |

**Table A.3.3.2.5-2: PDCCH Reference Channel (Time domain allocation 2 symbols)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | |
| Reference channel |  | R.PDCCH. 5-2.1 TDD |  |  |  |  |  |
| Subcarrier spacing | kHz | 120 |  |  |  |  |  |
| CORESET frequency domain allocation |  | 60 |  |  |  |  |  |
| CORESET time domain allocation |  | 2 |  |  |  |  |  |
| Aggregation level |  | 16 |  |  |  |  |  |
| DCI Format |  | 1\_0 |  |  |  |  |  |
| Payload (without CRC) | Bits | 40 |  |  |  |  |  |

A.3.4 Reference measurement channels for PBCH demodulation requirements

A.3.4.1 Reference measurement channels for FR1

**Table A.3.4.1-1: PBCH Reference Channel**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | |
| Reference channel |  | [R.PBCH.1] | [R.PBCH.2] |
| SS/PBCH block subcarrier spacing | kHz | 15 | 30 |
| Modulation |  | QPSK | QPSK |
| Target coding rate |  | 56/864 | 56/864 |
| Payload (without CRC and timing related PBCH payload bits) | bits | 24 | 24 |

A.3.4.2 Reference measurement channels for FR2

**Table A.3.4.2-1: PBCH Reference Channel**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | |
| Reference channels |  | [R.PBCH.5] | [R.PBCH.6] |
| SS/PBCH block subcarrier spacing | kHz | 120 | 240 |
| Modulation |  | QPSK | QPSK |
| Target coding rate |  | 56/864 | 56/864 |
| Payload (without CRC and timing related PBCH payload bits) | bits | 24 | 24 |

A.4 CSI reference measurement channels

This section defines the DL signal applicable to the reporting of channel status information (Clause X).

Tables in this section specifies the mapping of CQI index to Information Bit payload, which complies with the CQI definition specified in TS 38.214 [12, Section 5.2.2.1] and with MCS definition specified in TS 38.214 [12, Section 5.1.3].

**Table A.4-1: Mapping of CQI Index to Information Bit payload (CQI table 1)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TBS Scheme | | | | TBS.1-1 | TBS.1-2 |  |  |  |  |
| MCS table | | | | 64QAM | | | | | |
| Number of allocated PDSCH resource blocks | | | | 66 | 66 |  |  |  |  |
| Number of consecutive PDSCH symbols | | | | 12 | 12 |  |  |  |  |
| Number of PDSCH MIMO layers | | | | 1 | 2 |  |  |  |  |
| Number of DMRS rEs (Note 1) | | | | 24 | 24 |  |  |  |  |
| Overhead for TBS determination | | | | 6 | 6 |  |  |  |  |
| Available RE-s | | | | 7920 | 7920 |  |  |  |  |
| CQI index | Spectral efficiency | MCS index | Modulation | Information Bit Payload per Slot | | | | | |
| 0 | OOR | OOR | OOR | N/A | N/A |  |  |  |  |
| 1 | 0.1523 | 0 | QPSK | 1800 | 3624 |  |  |  |  |
| 2 | 0.2344 | 0 | 1800 | 3624 |  |  |  |  |
| 3 | 0.3770 | 2 | 2856 | 5640 |  |  |  |  |
| 4 | 0.6016 | 4 | 4480 | 8968 |  |  |  |  |
| 5 | 0.8770 | 6 | 6528 | 13064 |  |  |  |  |
| 6 | 1.1758 | 8 | 8712 | 17928 |  |  |  |  |
| 7 | 1.4766 | 11 | 16QAM | 11016 | 22032 |  |  |  |  |
| 8 | 1.9141 | 13 | 14343 | 28680 |  |  |  |  |
| 9 | 2.4063 | 15 | 17928 | 35856 |  |  |  |  |
| 10 | 2.7305 | 18 | 64QAM | 20496 | 40976 |  |  |  |  |
| 11 | 3.3223 | 20 | 25104 | 50184 |  |  |  |  |
| 12 | 3.9023 | 22 | 29192 | 58384 |  |  |  |  |
| 13 | 4.5234 | 24 | 33816 | 67584 |  |  |  |  |
| 14 | 5.1152 | 26 | 38936 | 77896 |  |  |  |  |
| 15 | 5.5547 | 28 | 42016 | 83976 |  |  |  |  |
| Note 1: Number of DMRS rEs includes the overhead of the DM-RS CDM groups without data | | | | | | | | | |

**Table A.4-2: Mapping of CQI Index to Information Bit payload (CQI table 2)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TBS Scheme | | | | TBS.2-1 | TBS.2-2 | TBS.2-3 | TBS.2-4 |  |  |
| MCS table | | | | 256QAM | | | | | |
| Number of allocated PDSCH resource blocks | | | | 52 | 52 | 106 | 106 |  |  |
| Number of consecutive PDSCH symbols | | | | 12 | 12 | 12 | 12 |  |  |
| Number of PDSCH MIMO layers | | | | 1 | 2 | 1 | 2 |  |  |
| Number of DMRS rEs (Note 1) | | | | 24 | 24 | 24 | 24 |  |  |
| Overhead for TBS determination | | | | 0 | 0 | 0 | 0 |  |  |
| Available RE-s for PDSCH | | | | 7920 | 7920 | 12720 | 12720 |  |  |
| CQI index | Spectral efficiency | MCS index | Modulation | Information Bit Payload per Slot | | | | | |
| 0 | OOR | OOR | OOR | N/A | N/A | N/A | N/A |  |  |
| 1 | 0.1523 | 0 | QPSK | 1480 | 2976 | 2976 | 5896 |  |  |
| 2 | 0.3770 | 1 | 2408 | 4744 | 4744 | 9480 |  |  |
| 3 | 0.8770 | 3 | 5504 | 11016 | 11016 | 22536 |  |  |
| 4 | 1.4766 | 5 | 16QAM | 9224 | 18432 | 18960 | 37896 |  |  |
| 5 | 1.9141 | 7 | 12040 | 24072 | 24576 | 49176 |  |  |
| 6 | 2.4063 | 9 | 15112 | 30216 | 30728 | 61480 |  |  |
| 7 | 2.7305 | 11 | 64QAM | 16896 | 33816 | 34816 | 69672 |  |  |
| 8 | 3.3223 | 13 | 20496 | 40976 | 42016 | 83976 |  |  |
| 9 | 3.9023 | 15 | 24576 | 49176 | 49176 | 98376 |  |  |
| 10 | 4.5234 | 17 | 28168 | 56368 | 57376 | 114776 |  |  |
| 11 | 5.1152 | 19 | 31752 | 63528 | 65576 | 131176 |  |  |
| 12 | 5.5547 | 21 | 256QAM | 34816 | 69672 | 69672 | 139376 |  |  |
| 13 | 6.2266 | 23 | 38936 | 77896 | 79896 | 159880 |  |  |
| 14 | 6.9141 | 25 | 43032 | 86040 | 88064 | 176208 |  |  |
| 15 | 7.4063 | 27 | 46104 | 92200 | 94248 | 188576 |  |  |
| Note 1: Number of DMRS rEs includes the overhead of the DM-RS CDM groups without data | | | | | | | | | |

A.5 OFDMA Channel Noise Generator (OCNG)

A.5.1 OCNG Patterns for FDD

A.5.1.1 OCNG FDD pattern 1: Generic OCNG FDD Pattern for all unused rEs

**Table A.5.1.1-1: OP.1 FDD: Generic OCNG FDD Pattern for all unused rEs**

|  |  |  |
| --- | --- | --- |
| **OCNG Appliance**  **OCNG Parameters** | **Control Region  (CORESET)** | **Data Region** |
| Resources allocated | All unused rEs (Note 1) | All unused rEs (Note 2) |
| Structure | PDCCH | PDSCH |
| Content | Uncorrelated pseudo random QPSK modulated data | Uncorrelated pseudo random QPSK modulated data |
| Transmission scheme for multiple  antennas ports transmission | Single Tx port transmission | Spatial multiplexing using any precoding matrix with dimensions same as the precoding matrix for PDSCH |
| Subcarrier Spacing | Same as for RMC PDCCH in the active BWP | Same as for RMC PDSCH in the active BWP |
| Power Level | Same as for RMC PDCCH | Same as for RMC PDSCH |
| Note 1: All unused rEs in the active CORESETS appointed by the search spaces in use.  Note 2: Unused available rEs refer to rEs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals in channel bandwidth. | | |

A.5.2 OCNG Patterns for TDD

A.5.2.1 OCNG TDD pattern 1: Generic OCNG TDD Pattern for all unused rEs

**Table A.5.2.1-1: OP.1 TDD: Generic OCNG TDD Pattern for all unused rEs**

|  |  |  |
| --- | --- | --- |
| **OCNG Appliance**  **OCNG Parameters** | **Control Region  (CORESET)** | **Data Region** |
| Resources allocated | All unused rEs (Note 1) | All unused rEs (Note 2) |
| Structure | PDCCH | PDSCH |
| Content | Uncorrelated pseudo random QPSK modulated data | Uncorrelated pseudo random QPSK modulated data |
| Transmission scheme for multiple  antennas ports transmission | Single Tx port transmission | Spatial multiplexing using any precoding matrix with dimensions same as the precoding matrix for PDSCH |
| Subcarrier Spacing | Same as for RMC PDCCH in the active BWP | Same as for RMC PDSCH in the active BWP |
| Power Level | Same as for RMC PDCCH | Same as for RMC PDSCH |
| Note 1: All unused rEs in the active CORESETS appointed by the search spaces in use.  Note 2: Unused available rEs refer to rEs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals in channel bandwidth. | | |

Annex B (normative):  
Propagation conditions

B.1 Static propagation condition

B.1.1 UE 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



B.1.2 UE Receiver with 4Rx

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



B.2 Multi-path fading propagation conditions

The multipath propagation conditions consist of several parts:

- A delay profile in the form of a "tapped delay-lin", 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 (below 6 GHz) and FR2 (above 6 GHz).

B.2.1 Delay profiles

The delay profiles are simplified from the TR 38.901 [5] 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 B.2.1.1 and B.2.1.2 can be used as such.

Step 1: Use the original TDL model from TR 38.901[5].

Step 2: Re-order the taps in ascending delays

Step 3: Perform delay scaling according to the procedure described in subclause 7.7.3 in TR38.901 [5].

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. Merge two parallel taps with different delays (average delay, sum power) starting from the weakest ones. 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 tap powers such that the strongest tap is at 0dB.

Note: Some values of the delay profile created by the simplification steps may differ from the values in tables B.2.1.1-2, B.2.1.1-3, B.2.1.1-4, B.2.1.2-2, and B.2.1.1-3 for the corresponding model.

B.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 B.2.1.1-1 and the tapped delay line models are specified in Tables B.2.1.1-2 ~ Table B.2.1.1-4.

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

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

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

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

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

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

B.2.1.2 Delay profiles for FR2

The delay profiles for FR2 are specified in B.2.1.2-1 and the tapped delay line models are specified in Tables B.2.1.2-2 and table B.2.1.2-3.

**Table B.2.1.2-1: Delay profiles for NR channel models**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Model** | **Number of  channel taps** | **Delay spread**  **(r.m.s.)** | **Maximum excess tap delay (span)** | **Delay resolution** |
| TDLA30 | 12 | 30 ns | 290 ns | 5 ns |
| TDLC60 | 12 | 60 ns | 520 ns | 5 ns |

**Table B.2.1.2-2 TDLA30 (DS = 30 ns)**

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

**Table B.2.1.2-3 TDLC60 (DS = 60 ns)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Tap #** | **Delay [ns]** | **Power [dB]** | **Fading distribution** |
| 1 | 0 | -7.8 | Rayleigh |
| 2 | 15 | -0.3 | Rayleigh |
| 3 | 40 | 0 | Rayleigh |
| 4 | 50 | -8.9 | Rayleigh |
| 5 | 55 | -14.5 | Rayleigh |
| 6 | 75 | -8.5 | Rayleigh |
| 7 | 80 | -10.2 | Rayleigh |
| 8 | 130 | -12.1 | Rayleigh |
| 9 | 210 | -13.9 | Rayleigh |
| 10 | 300 | -15.2 | Rayleigh |
| 11 | 360 | -16.9 | Rayleigh |
| 12 | 520 | -19.4 | Rayleigh |

B.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 B.2.2-1 and Table B.2.2-2 show the propagation conditions that are used for the performance measurements in multi-path fading environment for low, medium and high Doppler frequencies for FR1 and FR2, respectively.

**Table B.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 |

**Table B.2.2-2 Channel model parameters for FR2**

|  |  |  |
| --- | --- | --- |
| **Combination name** | **Model** | **Maximum Doppler frequency** |
| TDLA30-35 | TDLA30 | 35 Hz |
| TDLA30-75 | TDLA30 | 75 Hz |
| TDLA30-300 | TDLA30 | 300 Hz |
| TDLC60-300 | TDLC60 | 300 Hz |

B.2.3 MIMO Channel Correlation Matrices

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

B.2.3.1 MIMO Correlation Matrices using Uniform Linear Array (ULA)

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

B.2.3.1.1 Definition of MIMO Correlation Matrices

Table B.2.3.1.1-1 defines the correlation matrix for the gNB.

**Table B.2.3.1.1-1 gNB correlation matrix**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **One antenna** | **Two antennas** | **Four antennas** |
| gNB Correlation |  |  |  |

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

**Table B.2.3.1.1-2 UE correlation matrix**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **One antenna** | **Two antennas** | **Four antennas** |
| UE Correlation |  |  |  |

Table B.2.3.1.1-3 defines the channel spatial correlation matrix. The parameters, *α* and *β* in Table B.2.3.1-3 defines the spatial correlation between the antennas at the gNB and UE.

**Table B.2.3.1.1-3: correlation matrices**

|  |  |
| --- | --- |
| **1x2 case** |  |
| **1x4 case** |  |
| **2x1 case** |  |
| **2x2 case** |  |
| **2x4 case** |  |
| **4x1 case** |  |
| **4x2 case** |  |
| **4x4 case** |  |

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

B.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 B.2.3.1.2-1.

**Table B.2.3.1.2-1: The *α* and *β* parameters for ULA MIMO correlation matrices**

|  |  |  |
| --- | --- | --- |
| **Correlation Model** | *α* | *β* |
| **Low correlation** | 0 | 0 |
| **Medium Correlation** | 0.3 | 0.9 |
| **Medium Correlation A** | 0.3 | 0.3874 |
| **High Correlation** | 0.9 | 0.9 |

The correlation matrices for high, medium, medium A and low correlation are defined in Table B.2.3.1.2-2, B.2.3.1.2-3, B.2.3.1.2-4 and B.2.3.1.2-5 as below.

The values in Table B.2.3.1.2-2 have been adjusted for the 4x2 and 4x4 high correlation cases to insure 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 4x2 high correlation case, *a*=0.00010. For the 4x4 high correlation case, *a*=0.00012.

The same method is used to adjust the 2x4 and 4x4 medium correlation matrix in Table B.2.3.1.2-3 to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision with *a* = 0.00010 and *a* = 0.00012.

**Table B.2.3.1.2-2: MIMO correlation matrices for high correlation**

|  |  |
| --- | --- |
| **1x2 case** |  |
| **2x1 case** |  |
| **2x2 case** |  |
| **4x2 case** |  |
| **4x4 case** |  |

**Table B.2.3.1.2-3: MIMO correlation matrices for medium correlation**

|  |  |
| --- | --- |
| **1x2 case** | N/A |
| **2x1 case** | N/A |
| **2x2 case** |  |
| **2x4 case** |  |
| **4x2 case** |  |
| **4x4 case** |  |

**Table B.2.3.1.2-4: MIMO correlation matrices for medium correlation A**

|  |  |
| --- | --- |
| **2x4 case** |  |
| **4x4 case** |  |

**Table B.2.3.1.2-5: MIMO correlation matrices for low correlation**

|  |  |
| --- | --- |
| **1x2 case** |  |
| **1x4 case** |  |
| **2x1 case** |  |
| **2x2 case** |  |
| **2x4 case** |  |
| **4x1 case** |  |
| **4x2 case** |  |
| **4x4 case** |  |

In Table B.2.3.1.2-5, **I**d is the *d*×*d* identity matrix.

B.2.3.2 MIMO Correlation Matrices using Cross Polarized Antennas (X-pol)

The MIMO channel correlation matrices defined in B.2.3.2 apply for the antenna configuration using cross polarized (XP/X-pol) antennas at both gNB and UE. The cross-polarized antenna elements with +/-45 degrees polarization slant angles are deployed at gNB and cross-polarized antenna elements with +90/0 degrees polarization slant angles are deployed at UE.

For the 2D cross-polarized antenna array at eNodeB, the *N* antennas are indexed by , and total number of antennas is , where

-  is the number of antenna elements in first dimension with same polarization,

-  is the number of antenna elements in second dimension with same polarization, and

-  is the number of polarization groups.

For the 2D cross-polarized antennas at gNB, the *N* antennas are labelled such that antennas shall be in increasing order of the second dimension firstly, then the first dimension, and finally the polarization group. For a specific antenna element at *p*-th polarization, *n*1-th row, and *n*2-th column within the 2D antenna array, the following index number is used for antenna labelling:



where *N* is the number of transmit antennas, *p* is the polarization group index, *n*1 is the row index, and *n*2 is the column index of the antenna element.

For the linear (single dimension, 1D) cross-polarized antenna, the *N* antennas are labelled following the above equations with *N*2=1.

B.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 with same polarization,

-  is the spatial correlation matrix at the gNB with same polarization,

- is a polarization correlation matrix, and

- denotes transpose.

The matrix is defined as



A permutation matrix P elements are defined as

.

where *Nt* and *Nr* is the number of transmitter and receiver respectively. This is used to map the spatial correlation coefficients in accordance with the antenna element labelling system described in B.2.3.2.

For the 2D cross-polarized antenna array at gNB, the spatial correlation matrix at the gNB is further expressed as following for 2D cross-polarized antenna array at gNB:



where

- -  is the correlation matrix of antenna elements in first dimension with same polarization, and

- -  is the correlation matrix of antenna elements in second dimension with same polarization.

For the 2D cross polarized antenna array at gNB side, the spatial correlation matrices in one direction of antenna array are as follows:

- For 1 antenna element with the same polarization in one direction,

.

- For 2 antenna elements with the same polarization in one direction,

.

- For 3 antenna elements with the same polarization in one direction,

.

- For 4 antenna elements with the same polarization in one direction,

.

where the index *i* = 1,2 stands for first dimension and second dimension respectively.

For the 1D cross-polarized antenna array at gNB, the matrix ofis determined by follow the equations for 2D cross-polarized antenna array and letting, i.e.,



The spatial correlation matrices at UE side are as follows:

- For 1 antenna element with the same polarization,

.

- For 2 antenna elements with the same polarization,

.

B.2.3.2.2 MIMO Correlation Matrices using cross polarized antennas

The values for parameters *α*, *β* and *γ* for the cross polarized antenna models are given in Table B.2.3.2.2-1.

**Table B.2.3.2.2-1: The *α* and *β* parameters for cross-polarized MIMO correlation matrices**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Correlation Model** | *α*1 | *α*2 | *β* | ** |
| **Medium Correlation A** | 0.3 | N/A | 0.6 | 0.2 |
| **High Correlation** | 0.9 | 0.9 | 0.9 | 0.3 |
| Note 1: Value of *α1* applies when more than one pair of cross-polarized antenna elements in first dimension at gNB side.  Note 2: Value of *α2* applies when more than one pair of cross-polarized antenna elements in second dimension at gNB side.  Note 3: Value of *β* applies when more than one pair of cross-polarized antenna elements at UE side. | | | | |

For the 1D cross polarized antenna array at gNB side, the correlation matrices for high spatial correlation and medium correlation A are defined in Table B.2.3.2.2-2 and Table B.2.3.2.2-3 as below.

The values in Table B.2.3.2.2-2 have been adjusted to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision. This is done using the equation:

 or 

Where the value “*a*” is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 8x2 high spatial correlation case, *a*=0.00010.

**Table B.2.3.2.2-2: MIMO correlation matrices for high spatial correlation**

|  |  |
| --- | --- |
| **4x2 case** |  |
| **8x2 case** |  |

B.2.3.2.3 Beam steering approach

For the 2D cross-polarized antenna array at gNB, given the channel spatial correlation matrix in B.2.3.2.1 and B.2.3.2.2, the corresponding random channel matrix *H* can be calculated. The signal model for the *k*-th slot is denoted as



And the steering matrix is further expressed as following:



where

- *H* is the *N­r*×*Nt* channel matrix per subcarrier.

-  is the steering matrix,

-  is the steering matrix in first dimension with same polarization,

-  is the steering matrix in second dimension with same polarization,

-  is the number of antenna elements in first dimension with same polarization,

-  is the number of antenna elements in second dimension with same polarization,

- For antenna array with only one direction, number of antenna element in second direction equals 1.

For 1 antenna element with the same polarization in one direction,

.

For 2 antenna elements with the same polarization in one direction,

.

For 3 antenna elements with the same polarization in one direction,

.

For 4 antenna elements with the same polarization in one direction,

.

where the index  stands for first dimension and second dimension respectively.

-  controls the phase variation in first dimension and second dimension respectively, and the phase for k-th subframe is denoted by, where is the random start value with the uniform distribution, i.e., ,  is the step of phase variation, which is defined in Table B.2.3B.4-1, and k is the linear increment of 2-μ for every slot throughout the simulation, the index  stands for first dimension and second dimension respectively.

-  is the precoding matrix for Nt transmission antennas,

- *y* is the received signal, *x* is the transmitted signal, and *n* is AWGN.

-  corresponds to subcarrier spacing configuration, 

For the 1D cross-polarized antenna array at gNB, the corresponding random channel matrix *H* can be calculated by letting *N*2=1, i.e.,



**Table B.2.3B.4-1: The step of phase variation**

|  |  |
| --- | --- |
| **Variation Step** | **Value (rad/ms)** |
|  | 1.2566×10-3 |

B.2.4 Two-tap propagation conditions for CQI tests

For Channel Quality Indication (CQI) tests, the following additional multi-path profile is used:



in continuous time representation, with  the delay, a constant value of *a* andthe Doppler frequency. The same *h*(*t*,*τ*) is used to describe the fading channel between every pair of Tx and Rx.

B.3 High Speed Train Scenario

B.4 Beamforming Model

## B.4.1 Generic beamforming model

The transmission on antenna port(s) is defined by using a precoder matrix  of size , where is the number of physical transmit antenna elements configured per test , is the number of ports for a reference signal or physical channel configured per test, and is the first port for that reference signal or physical channel as defined in section 7.3 and 7.4 in TS 38.211 [X]. This precoder takes as an input a block of signals for antenna port(s) , , , with  being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals the elements of which are to be mapped onto the frequency-time index pair as per the test configuration but transmitted on different physical antenna elements:

The precoder matrix is specific to the test case configuration.

Annex C (normative):  
Downlink physical channels

C.1 General

This annex specifies the downlink physical channels that are needed for setting a connection and channels that are needed during a connection.

C.2 Setup (Conducted)

Table C.2-1 describes the downlink Physical Channels that are required for connection set up.

**Table C.2-1: Downlink Physical Channels required for connection set-up**

|  |
| --- |
| **Physical Channel** |
| PBCH |
| SSS |
| PSS |
| PDCCH |
| PDSCH |
| PBCH DMRS |
| PDCCH DMRS |
| PDSCH DMRS |
| CSI-RS |

C.3 Connection (Conducted)

The following clauses, describes the downlink Physical Channels that are transmitted during a connection i.e., when measurements are done.

C.3.1 Measurement of Performance requirements

*<Editor’s note: OCNG for DMRS is FFS in Annex A.>*

Table C.3.1-1 is applicable for measurements in which uniform RS-to-EPRE boosting for all downlink physical channels, unless otherwise stated.

**Table C.3.1-1: Downlink Physical Channels transmitted during a connection (FDD and TDD)**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| SSS transmit power | W | Test specific |
| EPRE ratio of PSS to SSS | dB | 0 |
| EPRE ratio of PBCH DMRS to SSS | dB | 0 |
| EPRE ratio of PBCH to PBCH DMRS | dB | 0 |
| EPRE ratio of PDCCH DMRS to SSS | dB | 0 |
| EPRE ratio of PDCCH to PDCCH DMRS | dB | 0 |
| EPRE ratio of PDSCH DMRS to SSS | dB | 0 |
| EPRE ratio of PDSCH to PDSCH DMRS | dB | 0 |
| EPRE ratio of CSI-RS to SSS | dB | 0 |
| EPRE ratio of OCNG to SSS | dB | 0 |

C.4 Setup (Radiated)

Table C.4-1 describes the downlink Physical Channels that are required for connection set up.

**Table C.4-1: Downlink Physical Channels required for connection set-up**

|  |
| --- |
| **Physical Channel** |
| PBCH |
| SSS |
| PSS |
| PDCCH |
| PDSCH |
| PBCH DMRS |
| PDCCH DMRS |
| PDSCH DMRS |
| CSI-RS |
| PTRS |

C.5 Connection (Radiated)

The following clauses, describes the downlink Physical Channels that are transmitted during a connection i.e., when measurements are done.

C.5.1 Measurement of Receiver Characteristics

*<Editor’s note: OCNG for DMRS is FFS in Annex A.>*

Table C.5.1-1 is applicable for measurements in which uniform RS-to-EPRE boosting for all downlink physical channels, unless otherwise stated.

**Table C.5.1-1: Downlink Physical Channels transmitted during a connection (TDD)**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| SSS transmit power | W | Test specific |
| EPRE ratio of PSS to SSS | dB | 0 |
| EPRE ratio of PBCH DMRS to SSS | dB | 0 |
| EPRE ratio of PBCH to PBCH DMRS | dB | 0 |
| EPRE ratio of PDCCH DMRS to SSS | dB | 0 |
| EPRE ratio of PDCCH to PDCCH DMRS | dB | 0 |
| EPRE ratio of PDSCH DMRS to SSS | dB | 0 |
| EPRE ratio of PDSCH to PDSCH DMRS | dB | 0 |
| EPRE ratio of CSI-RS to SSS | dB | 0 |
| EPRE ratio of PTRS to PDSCH | dB | Test specific |
| EPRE ratio of OCNG to SSS | dB | 0 |

Annex D: Void

Annex E (normative):  
Environmental conditions

E.1 General

This annex specifies the environmental requirements of the UE. Within these limits the requirements of the present documents shall be fulfilled.

E.2 Environmental (Conducted)

The requirements in this clause apply to all types of UE(s).

E.2.1 Temperature

The UE shall fulfil all the requirements in the full temperature range of:

**Table E.2.1-1 Temperature conditions**

|  |  |
| --- | --- |
| +15°C to +35°C | For normal conditions (with relative humidity of 25 % to 75 %) |
| -10°C to +55°C | For extreme conditions (see IEC publications 68‑2‑1 and 68‑2‑2) |

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 38.101-1 [6, Section 6.2] for extreme operation.

E.2.2 Voltage

The UE shall fulfil all the requirements in the full voltage range, i.e. the voltage range between the extreme voltages.

The manufacturer shall declare the lower and higher extreme voltages and the approximate shutdown voltage. For the equipment that can be operated from one or more of the power sources listed below, the lower extreme voltage shall not be higher, and the higher extreme voltage shall not be lower than that specified below.

**Table E.2.2-1 Voltage conditions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Power source** | **Lower extreme**  **voltage** | **Higher extreme**  **voltage** | **Normal conditions**  **voltage** |
| AC mains | 0,9 \* nominal | 1,1 \* nominal | nominal |
| Regulated lead acid battery | 0,9 \* nominal | 1,3 \* nominal | 1,1 \* nominal |
| Non regulated batteries:  Leclanché  Lithium  Mercury/nickel & cadmium | 0,85 \* nominal  0,95 \* nominal  0,90 \* nominal | Nominal  1,1 \* Nominal | Nominal  1,1 \* Nominal  Nominal |

Outside this voltage range the UE if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 38.101-1[6, Section 6.2] for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

E.2.3 Vibration

The UE shall fulfil all the requirements when vibrated at the following frequency/amplitudes.

**Table E.2.3-1 Vibration conditions**

|  |  |
| --- | --- |
| **Frequency** | **ASD (Acceleration Spectral Density) random vibration** |
| 5 Hz to 20 Hz | 0,96 m2/s3 |
| 20 Hz to 500 Hz | 0,96 m2/s3 at 20 Hz, thereafter –3 dB/Octave |

Outside the specified frequency range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 38.101-1[6] for extreme operation.

E.3 Environmental (Radiated)

The requirements in this clause apply to all types of UE(s).

E.3.1 Temperature

All requirements for UEs operating in FR2 are defined over the air and can only be tested in an OTA chamber.

The UE shall fulfil all the requirements in the temperature range defined in Table E.3.1-1.

**Table E.3.1-1: Temperature conditions**

|  |  |
| --- | --- |
| + 25 °C ± 10 °C | For normal (room temperature) conditions with relative humidity of 25% to 75% |
| -10°C to +55°C | For extreme conditions |

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS38.101-2 [7, Section 6.2] for extreme operation.

E.3.2 Voltage

E.3.3 Void

Annex G: Void

Annex H: Void

Annex I: Void

Annex J (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **tDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2018-07 | RAN4 AH18-07 | R4-1809554 |  |  |  | Draft skeleton | 0.0.1 |
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