# ETSI TS 138 101-4 V16.6.0 (2021-10)

TECHNICAL SPECIFICATION

**5G;**
**NR;**
**User Equipment (UE) radio transmission and reception;**
**Part 4: Performance requirements**
**(3GPP TS 38.101-4 version 16.6.0 Release 16)**

Reference
RTS/TSGR-0438101-4vg60

Keywords
5G

***ETSI***

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

***Important notice***

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

***Copyright Notification***

# Intellectual Property Rights

## Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

## Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

# Legal Notice

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

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

# Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

# Contents

# 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.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 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".

[15] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation".

[16] 3GPP TS38.521-4, "User Equipment (UE) conformance specification; Radio transmission and reception; Part 4: Performance"

[17] 3GPP TS 38.331: “Radio Resource Control (RRC) protocol specification”.

# 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 clause 4.1.2 of TS 37.340 [13].

**Enhanced Receiver Type 1:** SU-MIMO interference mitigation advanced receiver [14]

- R-ML (reduced complexity ML) receiver with enhanced inter-stream interference suppression for SU-MIMO transmissions with rank 2 with 2 RX antennas
- R-ML (reduced complexity ML) receiver with enhanced inter-stream interference suppression for SU-MIMO transmissions with rank 2, 3, and 4 with 4 RX antennas

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

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

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

## 3.2 Symbols

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

| | |
|---|---|
| $E_s$ | The averaged received energy per Hz of the wanted signal during the useful part of the symbol, i.e. excluding the cyclic prefix, at the UE antenna connector; average power is computed within a set of REs used for the transmission of physical, divided transmission bandwidth within the set |
| $\mu$ | Subcarrier spacing configuration as defined in clause 4.2 of TS 38.211 [9] |
| $N_{oc}$ | The power spectral density of a white noise source with average power per Hz as defined in Clause 4.4.3 for conducted requirements and Clause 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 |
| DPS | Dynamic Point Selection |
| EPRE | Energy Per Resource Element |
| EN-DC | E-UTRA-NR Dual Connectivity |
| FR | Frequency Range |
| FRC | Fixed Reference Channel |
| GNSS | Global Navigation Satellite System |
| HARQ | Hybrid Automatic Repeat Request |
| HST | High Speed Train |
| HST-SFN | High Speed Train Single Frequency Network |
| 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 |
| PSBCH | Physical Sidelink Broadcast Channel |
| PSCCH | Physical Sidelink Control Channel |
| PSFCH | Physical Sidelink Feedback Channel |
| PSS | Primary Synchronization Signal |
| PSSCH | Physical Sidelink Shared Channel |
| 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 |
| SCI | Sidelink Control Information |
| SCS | Subcarrier Spacing |
| SINR | Signal-to-Interference-and-Noise Ratio |
| SL | Sidelink |
| SLSS | Sidelink Synchronization Signal |
| SNR | Signal-to-Noise Ratio |
| SS | Synchronization Signal |
| SSB | Synchronization Signal Block |
| SSS | Secondary Synchronization Signal |
| TCI | Transmission Configuration Indicator |
| TDM | Time division multiplexing |
| TRxP | Transmission and Reception Point |
| TTI | Transmission Time Interval |
| UL | Uplink |
| V2X | Vehicle to Everything |
| 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, 8.1, 9.1 and 10.1.

## 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 minimum requirements for interworking specified in this specification shall be met in all applicable scenarios for NR interworking operation.

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

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

For radiated minimum requirements specified in the specification, if maximum achievable SNR in the test system for certain test conditions is less than the defined SNR requirement for those tests, those requirements shall not be tested.

## 4.3 Specification suffix information

Unless stated otherwise the following suffixes are used for indicating at 2$^{nd}$ level clause, 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 clause (suffix A, B, C) in clauses 5, 6, 7, 8, 9, 10.

## 4.4 Conducted requirements

### 4.4.0 Introduction

The requirements are defined for the following modes:

- Mode 1: Conditions with external noise source
  - Wanted signal with power level Es is transmitted.
  - External white noise source with power spectral density Noc is used.
  - *Es* and *Noc* levels are selected to achieve target SNR as described in Clause 4.4.2.
- Mode 2: Noise free conditions
  - Wanted signal with power level Es is transmitted.
  - No external noise transmitted.

## 4.4.1 Reference point

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

## 4.4.2 SNR definition

For Mode 1 conditions conducted UE demodulation and CSI requirements the SNR is defined as:

$$SNR = \frac{\sum_{j=1}^{N_{RX}} E_s^{(j)}}{\sum_{j=1}^{N_{RX}} N_{oc}^{(j)}}$$

Where

- $N_{RX}$ 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.
- 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 clause C.3.1.

## 4.4.3 Noc

### 4.4.3.1 Introduction

This clause describes the Noc power level for Mode 1 conditions conducted testing of demodulation and CSI requirements.

Unless otherwise stated for CA and EN-DC testing, the same Noc level shall be provided on different component carriers.

### 4.4.3.2 Noc for NR operating bands in FR1

The Noc power spectrum density shall be larger or equal to the minimum Noc power level for each operating band supported by the UE as defined in clause 4.4.3.2.1.

Unless otherwise stated, a fixed Noc power level of -134 dBm/Hz shall be used for all operating bands.

#### 4.4.3.2.1 Derivation of Noc values for NR operating bands in FR1

The minimum Noc power level for an operating band, subcarrier spacing and channel bandwidth is derived based on the following equation:

$Noc_{Band\_X, SCS\_Y, CBW\_Z} = REFSENS_{Band\_X, SCS\_Y, CBW\_Z} – 10*\log10(12*SCS\_Y*nPRB) + D – SNR_{REFSENS} + \Delta_{thermal}$

where

- $REFSENS_{Band\_X, SCS\_Y, CBW\_Z}$ is the REFSENS value in dBm for Band X, SCS Y and CBW Z specified in Table 7.3.2-1 of TS 38.101-1 [6]
- 12 is the number of subcarriers in a PRB
- SCS Y is the subcarrier spacing associated with the REFSENS value
- nPRB is the maximum number of PRB for SCS Y and CBW Z associated with the REFSENS value, and is specified in Table 5.3.2-1 of TS 38.101-1 [6]
- D is diversity gain equal to 3 dB
- $SNR_{REFSENS}$ = -1 dB is the SNR used for simulation of REFSENS
- $\Delta_{thermal}$ is the amount of dB that the wanted noise is set above UE thermal noise, giving a defined rise in total noise. $\Delta_{thermal}$ = 16dB, giving a rise in total noise of 0.1dB, regarded as insignificant**.**

The calculated Noc value for the baseline of Band n12, 15 kHz SCS, 15 MHz CBW is -135.5 dBm/Hz.

An allowance of 1.5dB is made for CA and for future bands, giving an Noc power level of -134 dBm/Hz.

## 4.4.4 Es

### 4.4.4.1 Introduction

This clause describes the Es power level for Mode 2 conditions conducted testing of demodulation and CSI requirements.

Unless otherwise stated for CA and EN-DC testing, the same Es level shall be provided on different component carriers.

### 4.4.4.2 Es for NR operating bands in FR1

The Es power spectrum density shall be larger or equal to the minimum Es power level for each operating band supported by the UE as defined in Clause 4.4.4.2.1.

Unless otherwise stated, a fixed Es power level of -112 dBm/Hz shall be used for all operating bands.

#### 4.4.4.2.1 Derivation of Es values for NR operating bands in FR1

The minimum Es power level for an operating band, subcarrier spacing and channel bandwidth is derived based on the following equation:

$Es_{Band\_X, SCS\_Y, CBW\_Z} = REFSENS_{Band\_X, SCS\_Y, CBW\_Z} – 10*\log10(12*SCS\_Y*nPRB) + D – SNR_{REFSENS} + dB_{EVM} +\Delta_{thermal}$

where:

- $REFSENS_{Band\_X, SCS\_Y, CBW\_Z}$ is the REFSENS value in dBm for Band X, SCS Y and CBW Z specified in Table 7.3.2-1 of TS 38.101-1 [6]
- 12 is the number of subcarriers in a PRB
- SCS Y is the subcarrier spacing associated with the REFSENS value
- nPRB is the maximum number of PRB for SCS Y and CBW Z associated with the REFSENS value, and is specified in Table 5.3.2-1 of TS 38.101-1 [6]
- D is diversity gain equal to 3 dB
- $SNR_{REFSENS}$ = -1 dB is the SNR used for simulation of REFSENS

- $dB_{EVM}$ is the SNR of the applied signal due to EVM impairment on the wanted Es. An allowed EVM of 3% gives a $dB_{EVM}$ of 30.5dB, derived as 20*log10(1/0.03).
- $\Delta_{thermal}$ is the amount of dB that the impairment due to EVM on the wanted Es is set above UE thermal noise, giving a defined rise in total impairment. $\Delta_{thermal}$ = 7.6dB, giving a rise in total impairment of 0.7dB, regarded as acceptable.

The calculated Es value for the baseline of Band n12, 15kHz SCS, 15MHz CBW is -113.5 dBm/Hz.

An allowance of 1.5dB is made for CA and for future bands, giving an Es power level of -112 dBm/Hz.

# 4.5 Radiated requirements

## 4.5.0 Introduction

The requirements are defined for the following modes:

- Mode 1: conditions with external noise source
    - Wanted signal with power level Es is transmitted.
    - External white noise source with power spectral density Noc is used.
    - Es and Noc levels are selected to achieve target SNR as described in Clause 4.5.2.
- Mode 2: Noise free conditions
    - Wanted signal with power level Es is transmitted.
    - No external noise transmitted.

## 4.5.1 Reference point

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

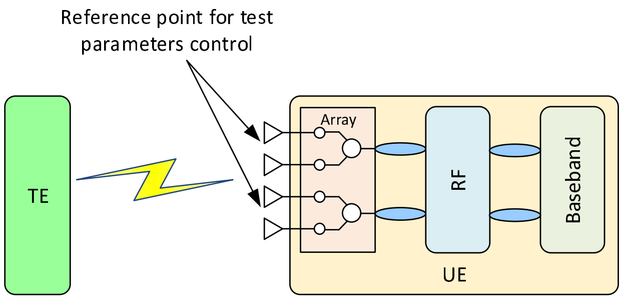



**Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements**

## 4.5.2 SNR definition

For Mode 1 conditions UE demodulation and CSI requirements, the Minimum performance requirement in clause 7, 8, 9 and 10 are defined relative to the baseband SNR level $SNR_{BB}$. The SNR at the reference point is defined as

$$SNR = SNR_{BB} + \Delta_{BB}$$

where $\Delta_{BB}$ is specified in clause 4.5.3.

The reference point SNR is defined as:

$$SNR = \frac{\sum_{j=1}^{N_{RX}} E_s^{(j)}}{\sum_{j=1}^{N_{RX}} N_{oc}^{(j)}}$$

- $N_{RX}$ 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.
- 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 Clause C.3.1.

## 4.5.3 Noc

### 4.5.3.1 Introduction

For Mode 1 conditions 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 $\Delta_{BB}$ 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 $\Delta_{BB}$ =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 | -167.3 | -161. 8 | -158.1 | -166. 8 |
| n258 | -167.3 | -161. 8 | -158.1 | -166. 8 |
| n259 | | | -154. 5 | |
| n260 | -164.3 | | -155. 5 | -164. 8 |
| n261 | -167.3 | -161. 8 | -158.1 | -166. 8 |
| Note 1: Noc levels are specified in dBm/Hz | | | | |

For PC3 multi-band devices, the Noc power level ($Noc_{MB}$) shall increase by multi-band relaxation defined in Table 6.2.1.3-4 of TS 38.101-2 [7]:

$$Noc_{MB} = Noc_{SB} + \Delta MB_{P,n}$$

- $Noc_{SB}$ is the Noc defined in Table 4.5.3.2-1
- $\Delta MB_{P,n}$ values are specified in TS 38.101-2 [7].

For CA case, the Noc power level ($Noc_{CA}$) shall increase by a relaxation factor defined in TS 38.101-2 [7] Table 7.3A.2.1-1:

$$Noc_{CA} = Noc_{SC} + \Delta R_{IB}$$

- $Noc_{SC}$ is derived by assuming UE supports single carrier.
- $\Delta R_{IB}$ values are specified in TS 38.101-2 [7].

### 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 X and on the UE Power class P, derived based on the following equation:

$$Noc_{PC\_P,\ Band\_X} = REFSENS_{PC\_P,\ Band\_X,\ 50MHz} - 10Log_{10}(12 \text{ x } 120kHz \text{ x } PRB_{REFSENS}) - SNR_{REFSENS} + \Delta_{thermal}$$

where:

- $REFSENS_{PC\_P, Band X, 50MHz}$ is the REFSENS value in dBm specified for the Power Class P of UE in Band X for 50MHz Channel bandwidth in clause 7.3.2 of TS 38.101-2 [7].
- 12 is the number of subcarriers in a PRB
- 120 kHz is chosen as a subcarrier spacing to select $PRB_{REFSENS}$.
- $PRB_{REFSENS}$ is $N_{RB}$ associated with subcarrier spacing 120 kHz for 50MHz in Table 5.3.2-1 of TS 38.101-2 [7] and is 32.
- $SNR_{REFSENS}$ = -1 dB is the SNR used for simulation of REFSENS
- $\Delta_{thermal}$ is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of $\Delta_{BB}$. $\Delta_{thermal} = -10Log_{10}(10^\wedge(\Delta_{BB}/10)-1) = 5.87dB$, giving a rise in total noise $\Delta_{BB}$ of 1 dB.

For example, the calculated Noc value for UE Power class 3 in Band n260 is -155.5 dBm/Hz, rounded to 0.1dB.

### 4.5.4 Angle of arrival

Unless otherwise stated, the downlink signal and noise are aligned to the direction with the following criteria:

- Select the known Rx beam peak direction reused from RF testing if available, as far as it satisfies the minimum isolation requirement defined in TS 38.521-4 [16] and rank number in TS 38.521-4 [16] corresponding to the test cases
- Otherwise select one direction which satisfies the REFSENS defined in TS 38.101-2 [7], minimum isolation requirement defined in TS 38.521-4 [16] and rank number in TS 38.521-4 [16] corresponding to the test cases.

### 4.5.5 Es

For Mode 2 the test system shall transmit the wanted signal with power level Es which is the best achievable power level by the test system.

The test system shall be able to determine achievable Es level and the maximum achievable SNR level.

# 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[6].

The minimum performance requirements in Clause 5 are mandatory for UE supporting NR operation, except test cases listed in Clauses 5.1.1.3, 5.1.1.4, 5.1.1.5, 5.1.1.6, 5.1.1.7, 5.1.1.8.

If same test is listed for different UE features/capabilities in Clauses 5.1.1.3 and 5.1.1.4, then this test shall apply for UEs which support all corresponding UE features/capabilities.

#### 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 Clause 7.2 of TS 38.101-1 [6]. 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 (Note 2) |
| | PDCCH | All tests in Clause 5.3.3 (Note 2) |
| | PBCH | All tests in Clause 5.4.2 or 5.4.3 (Note) |
| Note 1: Requirements for PBCH with 4Rx is up to UE declaration<br>Note 2: '*maxMIMO-Layers-r16*' is not configured during the performance requirements testing for UE supporting Release 16 per-BWP MIMO layer adaptation. | | |

## 5.1.1.3 Applicability of requirements for optional UE features

The performance requirements in Table 5.1.1.3-1 shall apply for UEs which support optional UE features only.

**Table 5.1.1.3-1: Requirements applicability for optional UE features**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| SU-MIMO Interference Mitigation advanced receiver | FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Test 3-1)<br><br>Clause 5.2.3.1.1 (Test 5-1) | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.1 (Test 3-1)<br><br>Clause 5.2.3.2.1 (Test 5-1) | |
| Alternative additional DMRS position for co-existence with LTE CRS *(additionalDMRS-DL-Alt)* | FR1 FDD | PDSCH | Clause 5.2.2.1.4 (Test 1-2)<br><br>Clause 5.2.3.1.4 (Test 1-2) | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.4 (Test 1-2)<br><br>Clause 5.2.3.2.4 (Test 1-2) | |
| Basic DL NR-NR CA operation (*supportedBandCombinationList*) | NR CA | SDR | Clause 5.5A.1 | 1)Up to 16 DL carriers<br>2)Same numerology across carrier for data/control channel at a given time |
| Enhanced demodulation processing for HST-SFN joint transmission scheme with velocity up to 500km/h | FR1 FDD | PDSCH | Clause 5.2.2.1.9 (Test 1-1)<br><br>Clause 5.2.3.1.9 (Test 1-1) | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.9 (Test 1-1)<br><br>Clause 5.2.3.2.9 (Test 1-1) | |
| Alternative 64QAM MCS table for PDSCHNew 64QAM MCS table for PDSCH (*dl-64QAM-MCS-TableAlt*) | FR1 FDD | PDSCH | Clause 5.2.2.1.5<br>Clause 5.2.3.1.5<br>Clause 5.2.2.1.6<br>Clause 5.2.3.1.6 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.5<br>Clause 5.2.3.2.5<br>Clause 5.2.2.2.6<br>Clause 5.2.3.2.6 | |
| CQI table with target BLER of 10^-5New CQI table (cqi-TableAlt) | FR1 FDD | PDSCH | Clause 5.2.2.1.5<br>Clause 5.2.3.1.5 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.5<br>Clause 5.2.3.2.5 | |
| PDSCH repetitions over multiple slots *(pdsch-RepetitionMultiSlots)* | FR1 FDD | PDSCH | Clause 5.2.2.1.6<br>Clause 5.2.3.1.6 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.6<br>Clause 5.2.3.2.6 | |
| UE PDSCH processing capability #2 *(pdsch-ProcessingType2)* | FR1 FDD | PDSCH | Clause 5.2.2.1.7<br>Clause 5.2.3.1.7 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.7<br>Clause 5.2.3.2.7 | |
| Pre-emption indication for DL *(pre-EmptIndication-DL)* | FR1 FDD | PDSCH | Clause 5.2.2.1.8<br>Clause 5.2.3.1.8 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.8<br>Clause 5.2.3.2.8 | |
| Single DCI based SDM transmission for multi-TRxP (singleDCI-SDM-scheme-r16) | FR1 FDD | PDSCH | Clause 5.2.2.1.11<br>Clause 5.2.3.1.11 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.11<br>Clause 5.2.3.2.11 | |
| Multi DCI based multi-TRxP support (multiDCI-MultiTRP-r16) | FR1 FDD | PDSCH | Clause 5.2.2.1.12<br>Clause 5.2.3.1.12 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.12<br>Clause 5.2.3.2.12 | |
| Single DCI based FDM Scheme-A for multi-TRxP(supportFDM-SchemeA-r16) | FR1 FDD | PDSCH | Clause 5.2.2.1.13<br>Clause 5.2.3.1.13 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.13<br>Clause 5.2.3.2.13 | |

| | | | | |
|---|---|---|---|---|
| Single DCI based inter-slot TDM for multi-TRxP (supportInter-slotTDM-r16) | FR1 FDD | PDSCH | Clause 5.2.2.1.14<br>Clause 5.2.3.1.14 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.14<br>Clause 5.2.3.2.14 | |
| Maximum number of TCI states in Single-DCI based inter-slot TDM (maxNumberTCI-states-r16) | FR1 FDD | PDSCH | Clause 5.2.2.1.14<br>Clause 5.2.3.1.14 | The requirements apply only when maxNumberTCI-states-r16 = 2. |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.14<br>Clause 5.2.3.2.14 | |
| DRX Adaptation (*drx-Adaptation-r16*) | FR1 FDD | PDCCH | Clause 5.3.2.1.3 | If the Test 1 in Clause 5.3.2.1.3 is passed, the test coverage can be considered fulfilled without executing Test 3 in clause 5.3.2.1.1. |
| | FR1 TDD | PDCCH | Clause 5.3.2.2.3 | If the Test 1 in Clause 5.3.2.2.3 is passed, the test coverage can be considered fulfilled without executing Test 2 in clause 5.3.2.2.1. |
| | FR1 FDD | PDCCH | Clause 5.3.3.1.3 | If the Test 1 in Clause 5.3.3.1.3 is passed, the test coverage can be considered fulfilled without executing Test 3 in clause 5.3.3.1.1. |
| | FR1 TDD | PDCCH | Clause 5.3.3.2.3 | If the Test 1 in Clause 5.3.3.2.3 is passed, the test coverage can be considered fulfilled without executing Test 2 in clause 5.3.3.2.1. |
| Validating P/SP-CSI-RS reception (*periodicAndSemi-PersistentCSI-RS-r16*) | FR1 TDD | PDSCH | Clause 5.2.2.2.15<br>Clause 5.2.3.2.15<br>Clause 5.2A.2.3<br>Clause 5.2A.3.3 | The requirements apply only in case tested UE supporting operations in shared spectrum access and validation of P/SP-CSI-RS reception based on DCI |
| Supported UL channels for dynamic channel access mode (*ul-DynamicChAccess-r16*) or UL channel access for semi-static channel access mode (ul-Semi-StaticChAccess-r16) or both | FR1 TDD | PDSCH | Clause 5.2.2.2.15<br>Clause 5.2.3.2.15 | The requirements apply only in case tested UE supports one of UL channels for dynamic channel access mode and UL channel access for semi-static channel access mode |

#### 5.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

The performance requirements in Table 5.1.1.4-1 shall apply for UEs which support mandatory UE features with capability signalling only.

**Table 5.1.1.4-1: Requirements applicability for mandatory features with UE capability signalling**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| 256QAM modulation scheme for PDSCH for FR1 (*pdsch-256QAM-FR1*) | FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Test 1-3)<br>Clause 5.2.3.1.1 (Test 1-3) | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.1 (Test 1-3)<br>Clause 5.2.3.2.1 (Test 1-3) | |
| PDSCH mapping type B (*pdsch-MappingTypeB*) | FR1 FDD | PDSCH | Clause 5.2.2.1.3<br>Clause 5.2.3.1.3<br>Clause 5.2.2.1.7<br>Clause 5.2.3.1.7 | |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.3<br>Clause 5.2.3.2.3<br>Clause 5.2.2.2.7<br>Clause 5.2.3.2.7 | |
| Rate-matching around LTE CRS (*rateMatchingLTE-CRS*) | FR1 FDD | PDSCH | Clause 5.2.2.1.4<br>Clause 5.2.3.1.4 | For UEs supporting “Alternative additional DMRS position for co-existence with LTE CRS”, if Test 1-2 is tested, the test coverage can be considered fulfilled without executing Test 1-1. Otherwise, only Test 1-1 is tested. |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.4<br>Clause 5.2.3.2.4 | |
| Supported maximum number of ports across all configured NZP-CSI-RS resources per CC (*maxConfigNumberPortsAcrossNZP-CSI-RS-PerCC*) | FR1 FDD | PDSCH | Clause 5.2.2.1.4 (Tests 1-1, 1-2)<br>Clause 5.2.3.1.1 (Tests 3-1, 4-1, 5-1)<br>Clause 5.2.3.1.4 (Tests 1-1, 1-2) | The requirements apply only in case the number of NZP-CSI-RS ports in the test case satisfies UE capability on maximum number of NZP-CSI-RS ports |
| | FR1 TDD | PDSCH | Clause 5.2.3.2.1 (Test 3-1, 4-1, 5-1) | |
| Supported maximum number of PDSCH MIMO layers (*maxNumberMIMO-LayersPDSCH*) | FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Tests 2-1, 2-2, 3-1)<br>Clause 5.2.2.1.2<br>Clause 5.2.3.1.1 (Tests 2-1, 2-2, 3-1, 4-1, 5-1)<br>Clause 5.2.3.1.2 | The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.1 (Tests 2-1, 2-2, 3-1)<br>Clause 5.2.2.2.2<br>Clause 5.2.3.2.1 (Tests 2-1, 2-2, 3-1, 4-1, 5-1)<br>Clause 5.2.3.2.2 | |
| Support number of active TCI states per BWP per CC, including control and data *(maxNumberActiveTCI-PerBWP)* | FR1 FDD | PDSCH | Clause 5.2.2.1.10 (Test 1-2)<br>Clause 5.2.3.1.10 (Test 1-2) | The requirements apply only when *maxNumberActiveTCI-PerBWP* is other than n1. |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.10 (Test 1-2)<br>Clause 5.2.3.2.10 (Test 1-2) | |

| | | | | |
|---|---|---|---|---|
| Support for maximum number of TRS resource sets per CC which the UE can track simultaneously (maxSimultaneousResourceSetsPerCC) | FR1 FDD | PDSCH | Clause 5.2.2.1.10 (Test 1-2)<br>Clause 5.2.3.1.10 (Test 1-2)<br>Clause 5.2.2.1.11<br>Clause 5.2.2.1.12<br>Clause 5.2.2.1.13<br>Clause 5.2.2.1.14<br>Clause 5.2.3.1.11<br>Clause 5.2.3.1.12<br>Clause 5.2.3.1.13<br>Clause 5.2.3.1.14 | The requirements apply only when maxSimultaneousResourceSetsPerCC ≥ 2 |
| | FR1 TDD | PDSCH | Clause 5.2.2.2.10 (Test 1-2)<br>Clause 5.2.3.2.10 (Test 1-2)<br>Clause 5.2.2.2.11<br>Clause 5.2.2.2.12<br>Clause 5.2.2.2.13<br>Clause 5.2.2.2.14<br>Clause 5.2.3.2.11<br>Clause 5.2.3.2.12<br>Clause 5.2.3.2.13<br>Clause 5.2.3.2.14 | |

### 5.1.1.5 Applicability of different requirements for HST

The applicability rules for different HST requirements in section 5 are specified in Table 5.1.1.5-1.

**Table 5.1.1.5-1: Applicability of requirements for HST**

| If UE has passed | | | UE can skip | | | Applicability notes |
|---|---|---|---|---|---|---|
| Test type | | Test list | Test type | | Test list | |
| FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Test 1-6) | FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Test 1-5) | |
| FR1 TDD | PDSCH | Clause 5.2.2.2.1 (Test 1-11) | FR1 TDD | PDSCH | Clause 5.2.2.2.1 (Test 1-7) | |
| FR1 FDD | PDSCH | Clause 5.2.3.1.1 (Test 1-6) | FR1 FDD | PDSCH | Clause 5.2.3.1.1 (Test 1-5) | |
| FR1 TDD | PDSCH | Clause 5.2.3.2.1 (Test 1-11) | FR1 TDD | PDSCH | Clause 5.2.3.2.1 (Test 1-7) | |
| FR1 FDD | PDSCH | Clause 5.2.2.1.9 (Test 1-1) | FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Test 1-5 ) | |
| FR1 TDD | PDSCH | Clause 5.2.2.2.9 (Test 1-1) | FR1 TDD | PDSCH | Clause 5.2.2.2.1 (Test 1-7 and 1-11) | |
| FR1 FDD | PDSCH | Clause 5.2.3.1.9 (Test 1-1) | FR1 FDD | PDSCH | Clause 5.2.3.1.1 (Test 1-5) | |
| FR1 TDD | PDSCH | Clause 5.2.3.2.9 (Test 1-1) | FR1 TDD | PDSCH | Clause 5.2.3.2.1 (Test 1-7 and 1-11) | |
| FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Test 1-7) | FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Test 1-1) | |
| FR1 FDD | PDSCH | Clause 5.2.3.1.1 (Test 1-7) | FR1 FDD | PDSCH | Clause 5.2.3.1.1 (Test 1-1) | |
| FR1 FDD | PDSCH | Clause 5.2.2.1.10 (Test 1-1 or 1-2) | FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Test 1-5 ) | |
| FR1 TDD | PDSCH | Clause 5.2.2.2.10 (Test 1-1 or 1-2) | FR1 TDD | PDSCH | Clause 5.2.2.2.1 (Test 1-7 and 1-11) | |
| FR1 FDD | PDSCH | Clause 5.2.3.1.10 (Test 1-1 or 1-2) | FR1 FDD | PDSCH | Clause 5.2.3.1.1 (Test 1-5) | |
| FR1 TDD | PDSCH | Clause 5.2.3.2.10 (Test 1-1 or 1-2) | FR1 TDD | PDSCH | Clause 5.2.3.2.1 (Test 1-7 and 1-11) | |
| FR1 FDD | PDSCH | Clause 5.2.2.1.10 (Test 1-2) | FR1 FDD | PDSCH | Clause 5.2.2.1.10 (Test 1-1) | |
| FR1 TDD | PDSCH | Clause 5.2.2.2.10 (Test 1-2) | FR1 TDD | PDSCH | Clause 5.2.2.2.10 (Test 1-1) | |
| FR1 FDD | PDSCH | Clause 5.2.3.1.10 (Test 1-2) | FR1 FDD | PDSCH | Clause 5.2.3.1.10 (Test 1-1) | |
| FR1 TDD | PDSCH | Clause 5.2.3.2.10 (Test 1-2) | FR1 TDD | PDSCH | Clause 5.2.3.2.10 (Test 1-1) | |

#### 5.1.1.6 Applicability and test rules for PDSCH performance requirements with power imbalance for intra-band contiguous CA

For UE passing the FDD and TDD CA power imbalance performance requirements with 2 DL CCs as defined in sections 5.2A.2.2 and 5.2A.3.2, the test coverage can be considered fulfilled with FDD or TDD intra-band contiguous CA with 3 or more DL CCs supported by the UE. During the test, UE is required to test the supported intra-band contiguous CA configurations with 2 DL CCs covering the lowest and highest operating bands.

The channel bandwidth combination for testing is determined by following procedure:

- First select the bandwidth combinations with the same bandwidth in each carrier.
  - If there is no such bandwidth combination, select the bandwidth combinations with smallest bandwidth difference between the two carriers, and the carrier with smaller bandwidth will be used for test.
- Among the bandwidth combinations selected, select the CA combination with largest aggregated bandwidth combination.

#### 5.1.1.7 Applicability of CA requirements

##### 5.1.1.7.1 Definition of CA capability

The definition with respect to CA capabilities is given as in Table 5.1.1.7.1-1.

**Table 5.1.1.7.1-1: Definition of CA capability**

| CA Capability | CA Capability Description |
|---|---|
| CA_C | Intra-band contiguous CA |
| CA_N | Intra-band non-contiguous CA |
| CA_AX | Inter-band CA (X bands) |
| NOTE 1: CA_C corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.1 of TS 38.101-1 [6].<br>CA_N corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.2 of TS 38.101-1 [6].<br>CA_AX corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.3 of TS 38.101-1 [6]. | |

##### 5.1.1.7.2 Applicability and test rules for different CA configurations and bandwidth combination sets

The performance requirement for CA UE demodulation tests in Clause 5.2A are defined independent of CA configurations and bandwidth combination sets specified in Clause 5.5A of TS 38.101-1. For UEs supporting different CA configurations and bandwidth combination sets, the applicability and test rules are defined in Table 5.1.1.7.2-1 and Table 5.1.1.7.2-2. For simplicity, CA configuration below refers to combination of CA configuration and bandwidth combination set.

**Table 5.1.1.7.2-1: Applicability and test rules for CA UE demodulation tests**

| Tests | CA capability where the tests apply | CA configuration from the selected CA capability where the tests apply | CA Bandwidth combination to be tested in priority order | PCell CC configuration |
|---|---|---|---|---|
| Test 1 in Clause 5.2A.2.1 and 5.2A.3.1 | CA_C, CA_N, CA_AX | Table 5.1.1.7.2-2 | Largest aggregated CA bandwidth combination | Any of CCs |
| Test 2 in Clause 5.2A.2.1 and 5.2A.3.1 | CA_C, CA_N, CA_AX | Table 5.1.1.7.2-2 | Largest aggregated CA bandwidth combination | Any of CCs |
| Test 3 in Clause 5.2A.2.1 and 5.2A.3.1 | CA_AX | Table 5.1.1.7.2-2 | Largest aggregated CA bandwidth combination | TDD CC if supported, otherwise FDD CC |
| Test 4 in Clause 5.2A.2.1 and 5.2A.3.1 (NOTE 2) | CA_AX | Table 5.1.1.7.2-2 | Largest aggregated CA bandwidth combination | Any of CCs |
| Test 5 in Clause 5.2A.2.1 and 5.2A.3.1 (NOTE 3) | CA_AX | Table 5.1.1.7.2-2 | Largest aggregated CA bandwidth combination | 15 kHz CC if supported, otherwise 30 kHz CC |
| NOTE 1: In case CA_AX with different number of X is supported then one or two CA configurations are selected based on procedure from Table 5.1.1.7.2-2.<br>NOTE 2: These scenarios are only tested for UEs which are not verified with Test 3 in Clause 5.2A.2.1 and 5.2A.3.1.<br>NOTE 3: These scenarios are only tested for UEs which are not verified with Test 2 in Clause 5.2A.2.1 and 5.2A.3.1. | | | | |

**Table 5.1.1.7.2-2: Selection of CA configurations**

| CA capability | Step 1 | Step 2 | Step 3 | Step 4 |
|---|---|---|---|---|
| CA_C or CA_N | Select the CA configurations with the maximum number of CCs, for which the supported maximum number of MIMO layers is not lower than 2. | Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 1. | N/A | N/A |
| CA_AX | Select the CA configurations with the maximum number of CCs, for which the supported maximum number of MIMO layers is not lower than 2. | Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 1. | Select the CA configurations with the largest number of bands and with the maximum number of CCs, for which the supported maximum number of MIMO layers is not lower than 2. | Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 3. |
| NOTE 1: For CA_AX capability, if CA configuration from step 2 is CA configuration with the largest number of bands then Step 3 and Step 4 are skipped. Otherwise, the two CA configurations selected from Step 2 and Step 4 are used for testing.<br>NOTE 2: Maximum supported data rate for Step 2 and Step 4 is calculated based clause 4.1.2 of TS 38.306 [14].<br>NOTE 3: Tested data rate for Step 2 and Step 4 is calculated based on the equation $DataRate = 10^{-3}\sum_{j=1}^{J} TBS_j 2^{\mu_j}$ and FRCs used in the test. | | | | |

#### 5.1.1.7.3 Applicability rule and antenna connection for CA tests with 4 RX

Within the CA configuration if any of the PCell and/or the SCells is a 2Rx supported RF band, 2 out of the 4Rx should be connected with data source from system simulator, depending on UE's declaration and AP configuration. Requirements from Clause 5.2A.2.1 are applied.

Within the CA configuration if any of the PCell and/or the SCells is a 4Rx supported RF band, all 4Rx should be connected with data source from system simulator. Requirements from Clause5.2A.3.1 are applied.

For 4Rx capable UEs, the 2Rx supported RF bands and 4Rx supported RF bands are up to UE's declaration.

### 5.1.1.8 Applicability of different requirements with Multi-TRxP

The applicability rules for requirements with multi-TRxP transmission schemes in section 5 are specified in Table 5.1.1.8-1.

**Table 5.1.1.8-1: Applicability of requirements with Multi-TRxP Transmission**

| If UE has passed | | | UE can skip | | | Applicability notes |
|---|---|---|---|---|---|---|
| Test type | | Test list | Test type | | Test list | |
| FR1 FDD | PDSCH | Clause 5.2.2.1.12 (Test 1-1) | FR1 FDD | PDSCH | Clause 5.2.2.1.11 (Test 1-1) | |
| FR1 FDD | PDSCH | Clause 5.2.2.1.12 (Test 1-1) | FR1 FDD | PDSCH | Clause 5.2.2.1.13 (Test 1-1) | |
| FR1 FDD | PDSCH | Clause 5.2.2.1.6 (Test 1-1) | FR1 FDD | PDSCH | Clause 5.2.2.1.14 (Test 1-1) | |
| FR1 TDD | PDSCH | Clause 5.2.2.2.12 (Test 1-1) | FR1 TDD | PDSCH | Clause 5.2.2.2.11 (Test 1-1) | |
| FR1 TDD | PDSCH | Clause 5.2.2.2.12 (Test 1-1) | FR1 TDD | PDSCH | Clause 5.2.2.2.13 (Test 1-1) | |
| FR1 TDD | PDSCH | Clause 5.2.2.2.6 (Test 1-1) | FR1 TDD | PDSCH | Clause 5.2.2.2.14 (Test 1-1) | |
| FR1 FDD | PDSCH | Clause 5.2.3.1.12 (Test 1-1) | FR1 FDD | PDSCH | Clause 5.2.3.1.11 (Test 1-1) | |
| FR1 FDD | PDSCH | Clause 5.2.3.1.12 (Test 1-1) | FR1 FDD | PDSCH | Clause 5.2.3.1.13 (Test 1-1) | |
| FR1 FDD | PDSCH | Clause 5.2.3.1.6 (Test 1-1) | FR1 FDD | PDSCH | Clause 5.2.3.1.14 (Test 1-1) | |
| FR1 TDD | PDSCH | Clause 5.2.3.2.12 (Test 1-1) | FR1 TDD | PDSCH | Clause 5.2.3.2.11 (Test 1-1) | |
| FR1 TDD | PDSCH | Clause 5.2.3.2.12 (Test 1-1) | FR1 TDD | PDSCH | Clause 5.2.3.2.13 (Test 1-1) | |
| FR1 TDD | PDSCH | Clause 5.2.3.2.6 (Test 1-1) | FR1 TDD | PDSCH | Clause 5.2.3.2.14 (Test 1-1) | |

### 5.1.1.9 Applicability of requirements for PDSCH on bands with shared spectrum access

| Tests | Applicability notes |
|---|---|
| All tests in Clause 5.2.2.2.15 and 5.2.3.2.15 | Only test the supported largest channel bandwidth. |
| All tests in Clause 5.2A.2.3 and 5.2A.3.3 | Only test the supported largest channel bandwidth on SCell. |

## 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 |
| Carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 2) | RBs | 0 |
| | Subcarrier spacing | kHz | 15 or 30 |
| DL BWP configuration #1 | Cyclic prefix | | Normal |
| | RB offset | RBs | 0 |
| | Number of contiguous PRB | PRBs | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing |
| 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 | Symbols | 0, 1 |
| | Number of PRBs in CORESET | | Table 5.2-2 for tested channel bandwidth and subcarrier spacing |
| | Number of PDCCH candidates and aggregation levels | | 1/AL8 |
| | CCE-to-REG mapping type | | Non-interleaved |
| | DCI format | | 1_1 |
| | TCI state | | TCI state #1 |
| | PDCCH & PDCCH DMRS Precoding configuration | | Single Panel Type I, Random per slot with equal probability of each applicable $i_1$, $i_2$ combination, and with REG bundling granularity for number of Tx larger than 1 |
| Cross carrier scheduling | | | Not configured |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | $k_0$=0 for CSI-RS resource 1,2,3,4 |
| | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 6 for CSI-RS resource 1 and 3<br>$l_0$ = 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<br>30 kHz SCS: 40 for CSI-RS resource 1,2,3,4 |
| | CSI-RS offset | Slots | 15 kHz SCS:<br>10 for CSI-RS resource 1 and 2<br>11 for CSI-RS resource 3 and 4<br><br>30 kHz SCS:<br>20 for CSI-RS resource 1 and 2<br>21 for CSI-RS resource 3 and 4 |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | QCL info | | TCI state #0 |
| NZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS | | $k_0$ = 0 |
| | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 12 |
| | Number of CSI-RS ports (X) | | Same as number of transmit antenna |
| | CDM Type | | 'No CDM' for 1 transmit antenna<br>'FD-CDM2' for 2 and 4 transmit antenna |
| | Density (ρ) | | 1 |
| | CSI-RS periodicity | Slots | 15 kHz SCS: 20<br>30 kHz SCS: 40 |
| | CSI-RS offset | Slots | 0 |

| | | | | |
|---|---|---|---|---|
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | QCL info | | | TCI state #1 |
| ZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS | | | $k_0 = 4$ |
| | First OFDM symbol in the PRB used for CSI-RS | | | $l_0 = 12$ |
| | Number of CSI-RS ports (X) | | | 4 |
| | CDM Type | | | 'FD-CDM2' |
| | Density (ρ) | | | 1 |
| | CSI-RS periodicity | | Slots | 15 kHz SCS: 20<br>30 kHz SCS: 40 |
| | CSI-RS offset | | Slots | 0 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| PDSCH DMRS configuration | Antenna ports indexes | | | {1000} for Rank 1 tests<br>{1000, 1001} for Rank 2 tests<br>{1000-1002} for Rank 3 tests<br>{1000-1003} for Rank 4 tests |
| | Position of the first DMRS for PDSCH mapping type A | | | 2 |
| | Number of PDSCH DMRS CDM group(s) without data | | | 1 for Rank 1 and Rank 2 tests<br>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 |
| PT-RS configuration | | | | PT-RS is not configured |
| Maximum number of code block groups for ACK/NACK feedback | | | | 1 |
| Maximum number of HARQ transmission | | | | 4 |
| HARQ ACK/NACK bundling | | | | Multiplexed |
| Redundancy version coding sequence | | | | {0,2,3,1} |
| PDSCH & PDSCH DMRS Precoding configuration | | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with PRB bundling granularity |
| Symbols for all unused REs | | | | OP.1 FDD as defined in Annex A.5.1.1<br>OP.1 TDD as defined in Annex A.5.2.1 |
| Physical signals, channels mapping and precoding | | | | As specified in Annex B.4.1 |
| Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission.<br>Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. | | | | |

**Table 5.2-2: Number of PRBs in CORESET**

| SCS (kHz) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 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 |

### 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, 1-5, 1-6, 1-7, 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 performance requirements for Enhanced Receiver Type 1 under 2 receive antenna conditions. | 3-1 |

**Table 5.2.2.1.1-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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<br>2 for other tests |
| | Resource allocation type | | Test 1-2: Type 1 with start RB = 23, $L_{RBs}$ = 6<br>Other tests: Type 0 |
| | RBG size | | Test 1-2: N/A<br>Other tests: Config2 |
| | 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, 1-5, 1-6, 1-7<br>1 for other tests |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | CSI-RS periodicity | Slots | Test 1-5, 1-6, 1-7:<br>10 for CSI-RS resource 1,2,3,4.<br><br>Other tests: Table 5.2-1. |
| | CSI-RS offset | Slots | Test 1-5, 1-6, 1-7:<br>1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4.<br><br>Other tests: Table 5.2-1. |
| Number of HARQ Processes | | | 8 for Test 1-4<br>4 for other tests |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-1.1 FDD | 10 / 15 | QPSK, 0.30 | TDLB100-400 | 2x2, ULA Low | 70 | -0.8 |
| 1-2 | R.PDSCH.1-1.2 FDD | 10 / 15 | QPSK, 0.30 | TDLC300-100 | 2x2, ULA Low | 70 | 0.2 |
| 1-3 | R.PDSCH.1-4.1 FDD | 10 / 15 | 256QAM, 0.82 | TDLA30-10 | 2x2, ULA Low | 70 | 24.6 |
| 1-4 | R.PDSCH.1-2.1 FDD | 10 / 15 | 16QAM, 0.48 | TDLC300-100 | 2x2, ULA Low | 30 | 1.1 |
| 1-5 | R.PDSCH.1-8.1 FDD | 10 / 15 | 16QAM, 0.48 | HST-750 | 1x2 | 70 | 6.2 |
| 1-6 | R.PDSCH.1-8.2 FDD | 10 / 15 | 64QAM, 0.43 | HST-972 | 1x2 | 70 | [9.9] |
| 1-7 | R.PDSCH.1-8.1 FDD | 10 / 15 | 16QAM, 0.48 | TDLC300-600 | 2x2 | 70 | [8.6] |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 2-1 | R.PDSCH.1-3.1 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x2, ULA Low | 70 | 19.4 |
| 2-2 | R.PDSCH.2-1.1 FDD | 20 / 30 | 64QAM, 0.50 | TDLA30-10 | 2x2, ULA Low | 70 | 19.7 |

**Table 5.2.2.1.1-5: Minimum performance for Rank 2 and Enhanced Receiver Type 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 3-1 | R.PDSCH.1-2.2 FDD | 10 / 15 | 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 |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| NZP CSI-RS for CSI acquisition | OFDM symbols in the PRB used for CSI-RS | | $l_0$ = 13 |
| | CSI-RS periodicity | Slots | 5 |
| ZP CSI-RS for CSI acquisition | Subcarrier index in the PRB used for CSI-RS | | ($k_0$, $k_1$, $k_2$, $k_3$)=(2, 4, 6, 8) |
| | Number of CSI-RS ports (X) | | 8 |
| | CSI-RS periodicity | Slots | 5 |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-5.1 FDD | 10 / 15 | 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 |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-1.3 FDD | 10 / 15 | 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 |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| NR UL transmission with a 7.5 kHz shift to the LTE raster | | | true |
| PDCCH configuration | Symbols with PDCCH | | Symbol# 2 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 3 |
| | Length (L) | | 9 for Test 1-1<br>11 for Test 1-2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Position of the first DM-RS for downlink | | 3 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CRS for rate matching (Note 1) | 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 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |
| Note 1: No MBSFN is configured on LTE carrier | | | |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-7.1 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 4x2, ULA Low | 70 | -1.0 |
| 1-2 | R.PDSCH.1-7.2 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 4x2, ULA Low | 70 | -1.0 |

### 5.2.2.1.5 Minimum requirements for PDSCH 0.001% BLER

The performance requirements are specified in Table 5.2.2.1.5-3, with the addition of test parameters in Table 5.2.2.1.5-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.5-1.

**Table 5.2.2.1.5-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH 0.001% BLER performance under 2 receive antenna conditions | 1-1 |

**Table 5.2.2.1.5-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Maximum number of HARQ transmission | | | 1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

**Table 5.2.2.1.5-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH.1-1.4 FDD | 10 / 15 | QPSK, 0.59 | AWGN | 1x2, ULA Low | 0.001% | 3.2 |

### 5.2.2.1.6 Minimum requirements for PDSCH repetitions over multiple slots

The performance requirements are specified in Table 5.2.2.1.6-3, with the addition of test parameters in Table 5.2.2.1.6-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.6-1.

**Table 5.2.2.1.6-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH repetitions over multiple slots performance under 2 receive antenna conditions | 1-1 |

**Table 5.2.2.1.6-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | 12 |
| | PDSCH aggregation factor | | 2 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information | | | 2 |

**Table 5.2.2.1.6-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH.1-11.1 FDD | 10 / 15 | 16QAM, 0.54 | TDLA30-10 | 2x2, ULA Low | 1% (Note 1) | 1.6 |
| Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. | | | | | | | |

### 5.2.2.1.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2

The performance requirements are specified in Table 5.2.2.1.7-3, with the addition of test parameters in Table 5.2.2.1.7-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.7-1.

**Table 5.2.2.1.7-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH mapping Type B performance and UE processing capability 2 under two receive antenna conditions | 1-1 |

**Table 5.2.2.1.7-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type B |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | 2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 0 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Maximum number of HARQ transmission | | | 1 |
| Number of HARQ Processes | | | 2 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 0 |

**Table 5.2.2.1.7-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-12.1 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 2x2, ULA Low | 70 | [0.8] |

## 5.2.2.1.8 Minimum requirements for PDSCH pre-emption

The performance requirements are specified in Table 5.2.2.1.8-3, with the addition of test parameters in Table 5.2.2.1.8-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.8-1.

**Table 5.2.2.1.8-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH pre-emption performance under 2 receive antenna conditions | 1-1 |

**Table 5.2.2.1.8-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| PDCCH configuration (Note 4) | Symbols with PDCCH | | 0, 1 |
| | DCI format | | 2_1 |
| | timeFrequencySet | | 14x1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Pre-emption configuration (Note 2) | Starting symbol (S) | | 3 |
| | Length (L) | | 2 |
| | Pre-emption periodicity and offset (Note 3) | Slots | 10/1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |
| Note 1: Void<br>Note 2: Interference modelled as random data on pre-empted REs.<br>Note 3: Pre-emption is scheduled with a fixed scheduling with 10% probability within 10ms periodicity.<br>Note 4: In addition to PDCCH configuration in Table 5.2-1. | | | |

**Table 5.2.2.1.8-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH. 1-2.6 FDD | 10 / 15 | 16QAM 0.64 | TDLA30-10 | 2x2, ULA Low | 70 | 10.5 |

### 5.2.2.1.9 Minimum requirements for PDSCH HST-SFN

The performance requirements are specified in Table 5.2.2.1.9-3, with the addition of test parameters in Table 5.2.2.1.9-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.9-1.

**Table 5.2.2.1.9-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 2 receive antenna conditions in the HST-SFN scenario defined in B.3.2 when highSpeedDemodFlag-r16 IE [17] is configured | 1-1 |

**Table 5.2.2.1.9-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | CSI-RS periodicity | Slots | 10 for CSI-RS resource 1,2,3,4. |
| | CSI-RS offset | Slots | 1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4. |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

**Table 5.2.2.1.9-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-8.3 FDD | 10 / 15 | 16QAM, 0.48 | HST-SFN | 2x2 | 70 | 13.0 |

### 5.2.2.1.10 Minimum requirements for HST-DPS

The performance requirements are specified in Table 5.2.2.1.10-3, with the addition of test parameters in Table 5.2.2.1.10-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.10-1.

**Table 5.2.2.1.10-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify UE performance in the HST-DPS scenario defined in B.3.3 | 1-1, 1-2 |

**Table 5.2.2.1.10-2: Test parameters**

| Parameter | | | Unit | Value |
|---|---|---|---|---|
| Duplex mode | | | | FDD |
| Active DL BWP index | | | | 1 |
| PDCCH configuration | TCI state | | | Note 1 |
| 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 |
| | RBG size | | | Config2 |
| | VRB-to-PRB mapping type | | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A |
| | TCI state | | | Note 1 |
| PDSCH DMRS configuration | DMRS Type | | | Type 1 |
| | Number of additional DMRS | | | 2 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 |
| CSI-RS for tracking | Resource set #1 | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 5 for CSI-RS resource 1 and 3<br>$l_0$ = 9 for CSI-RS resource 2 and 4 |
| | | CSI-RS periodicity | Slots | 10 for CSI-RS resource 1,2,3,4. |
| | | CSI-RS offset | Slots | 1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4 |
| | | QCL info | | TCI state #2 |
| | Resource set #2 | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 6 for CSI-RS resource 5 and 6<br>$l_0$ = 10 for CSI-RS resource 7 and 8 |
| | | CSI-RS periodicity | Slots | 10 for CSI-RS resource 5,6,7,8. |
| | | CSI-RS offset | Slots | 1 for CSI-RS resource 5 and 6<br>2 for CSI-RS resource 7 and 8 |
| | | QCL info | | TCI state #3 |
| NZP CSI-RS for CSI acquisition | Resource set #3 | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 12 |
| | | CSI-RS periodicity | Slots | 20 |
| | | CSI-RS offset | Slots | 0 |
| | | QCL info | | TCI state #0 |
| | Resource set #4 | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 13 |
| | | CSI-RS periodicity | Slots | 20 |
| | | CSI-RS offset | Slots | 0 |
| | | QCL info | | TCI state #1 |
| TCI state #0 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration |
| | | QCL Type | | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A |
| | | QCL Type | | N/A |
| TCI state #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration |
| | | QCL Type | | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A |
| | | QCL Type | | N/A |
| TCI state #2 | 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 #3 | Type 1 QCL information | SSB index | | SSB #1 |
| | | QCL Type | | Type C |
| | Type 2 QCL information | SSB index | | N/A |
| | | QCL Type | | N/A |
| Number of HARQ Processes | | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | 2 |
| Note 1: SSB # (k mod 2) , CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by k<sup>th</sup> RRH.<br>For Test 1-1, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i}, 2\mathrm{n}) = \mathrm{n}$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k<sup>th</sup> RRH from slot#<br>$\max[(2\mathrm{k}-1)\mathrm{n}+1+\mathrm{T}_{\mathrm{HARQ}}+\mathrm{T}_{\mathrm{MAC\ proc}}+\mathrm{T}_{\mathrm{firstTRS}}+\mathrm{T}_{\mathrm{TRS\ proc}}, 0]$<br>to slot#<br>$(2\mathrm{k}+1)\mathrm{n}+\mathrm{T}_{\mathrm{HARQ}}+\mathrm{T}_{\mathrm{MAC\ proc}}$,<br>PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.<br>For Test 1-2, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i}, 2\mathrm{n}) = \mathrm{n}$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k<sup>th</sup> RRH from slot#<br>$\max[(2\mathrm{k}-1)\mathrm{n}+1+\mathrm{T}_{\mathrm{HARQ}}+\mathrm{T}_{\mathrm{MAC\ proc}}, 0]$<br>to slot#<br>$(2\mathrm{k}+1)\mathrm{n}+\mathrm{T}_{\mathrm{HARQ}}+\mathrm{T}_{\mathrm{MAC\ proc}}$<br>Where k=0, 1, 2… is the RRH number, n = 2520 is half of the number of slots between two RRH, $\mathrm{T}_{\mathrm{HARQ}}$ = 2 is the number of slots between PDSCH and corresponding HARQ-ACK information, $\mathrm{T}_{\mathrm{MAC\ proc}}$ = 3 is the number of slots for MAC CE processing, $\mathrm{T}_{\mathrm{firstTRS}}$ = 6 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $\mathrm{T}_{\mathrm{TRS\ proc}}$ = 2 is the number of slots for TRS processing. | | | | |

**Table 5.2.2.1.10-3: Minimum performance for HST-DPS**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Number of active PDSCH TCI states | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-8.4 FDD | 10 / 15 | 64QAM, 0.43 | HST-DPS | 1 | 2x2 | 70 | 13.4 |
| 1-2 | R.PDSCH.1-8.4 FDD | 10 / 15 | 64QAM, 0.43 | HST-DPS | 2 | 2x2 | 70 | 13.4 |

#### 5.2.2.1.11 Minimum requirements for PDSCH Single-DCI based SDM scheme

The performance requirements are specified in Table 5.2.2.1.11-3, with the addition of test parameters in Table 5.2.2.1.11-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.11-1.

**Table 5.2.2.1.11-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance with Single-DCI based SDM scheme under 2 receive antenna conditions | 1-1,1-2 |

**Table 5.2.2.1.11-2: Test parameters**

<table>
<tr><th colspan="3" rowspan="2">Parameter</th><th rowspan="2">Unit</th><th colspan="2">Value</th></tr>
<tr><th>TRxP #1(Note 1)</th><th>TRxP #2(Note 1)</th></tr>
<tr><td colspan="3">Transmit TRxP of SSB</td><td></td><td colspan="2">TRxP #1</td></tr>
<tr><td rowspan="2">PDCCH configuration</td><td colspan="2">TCI state</td><td></td><td colspan="2">TCI State #1</td></tr>
<tr><td colspan="2">CORESETPoolIndex</td><td></td><td colspan="2">0</td></tr>
<tr><td rowspan="9">CSI-RS for tracking</td><td colspan="2">First subcarrier index in the PRB used for CSI-RS</td><td></td><td>k0=0 for CSI-RS resources 1,2,3,4</td><td>k0=1 for CSI-RS resources 5,6,7,8</td></tr>
<tr><td colspan="2">First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4</td><td>l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8</td></tr>
<tr><td colspan="2">Number of CSI-RS ports (X)</td><td></td><td>1 for CSI-RS resource 1,2,3,4</td><td>1 for CSI-RS resource 5,6,7,8</td></tr>
<tr><td colspan="2">CDM Type</td><td></td><td colspan="2">'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8</td></tr>
<tr><td colspan="2">Density</td><td></td><td colspan="2">3</td></tr>
<tr><td colspan="2">CSI-RS periodicity</td><td>Slots</td><td colspan="2">20</td></tr>
<tr><td colspan="2">CSI-RS offset</td><td>Slots</td><td>10 for CSI-RS resources 1 and 2<br>11 for CSI-RS resources 3 and 4</td><td>10 for CSI-RS resources 5 and 6<br>11 for CSI-RS resources 7 and 8</td></tr>
<tr><td colspan="2">QCL info</td><td></td><td colspan="2">TCI state #0</td></tr>
<tr><td colspan="3">Duplex mode</td><td></td><td colspan="2">FDD</td></tr>
<tr><td colspan="3">Active DL BWP index</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="10">PDSCH configuration</td><td colspan="2">Mapping type</td><td></td><td colspan="2">Type A</td></tr>
<tr><td colspan="2">k0</td><td></td><td colspan="2">0</td></tr>
<tr><td colspan="2">Starting symbol (S)</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Length (L)</td><td></td><td colspan="2">12</td></tr>
<tr><td colspan="2">PRB bundling type</td><td></td><td colspan="2">Static</td></tr>
<tr><td colspan="2">PRB bundling size</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Resource allocation type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">RBG size</td><td></td><td colspan="2">Config2</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping type</td><td></td><td colspan="2">Non-interleaved</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping interleaver bundle size</td><td></td><td colspan="2">N/A</td></tr>
<tr><td rowspan="5">PDSCH DMRS configuration</td><td colspan="2">Antenna port indexes</td><td></td><td>1000</td><td>1002</td></tr>
<tr><td colspan="2">TCI state</td><td></td><td>TCI State #1</td><td>TCI State #2</td></tr>
<tr><td colspan="2">DMRS Type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">Number of additional DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Maximum number of OFDM symbols for DL front loaded DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="4">TCI State #1</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>CSI-RS resource 1 from 'CSI-RS for tracking' configuration</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>Type A</td><td>N/A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="4">TCI State #2</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>CSI-RS resource 5 from 'CSI-RS for tracking' configuration</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>Type A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">Resource allocation</td><td></td><td colspan="2">Full-overlapping</td></tr>
<tr><td colspan="3">Timing offset of the second TRxP from the first TRxP</td><td>us</td><td colspan="2">-0.5 for test 1-1<br>2 for test 1-2</td></tr>
<tr><td colspan="3">Frequency offset of the second TRxP from the first TRxP</td><td>Hz</td><td colspan="2">200 for test 1-1<br>0 for test 1-2</td></tr>
<tr><td colspan="3">Number of HARQ Processes</td><td></td><td colspan="2">4</td></tr>
<tr><td colspan="3">The number of slots between PDSCH and corresponding HARQ-ACK information</td><td></td><td colspan="2">2</td></tr>
</table>

| | | |
|---|---|---|
| Precoding configuration | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity |
| Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2) | | |

**Table 5.2.2.1.11-3: Minimum performance**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition(Note 1) | Correlation matrix and antenna configuration(Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB)(Note 3) |
| 1-1 | R.PDSCH.1-3.2 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x2, ULA Low | 70 | 20.7 |
| 1-2 | R.PDSCH.1-3.2 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x2, ULA Low | 70 | 20.1 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 with scaling factor as 1/sqrt(2) for transmitted signal from each TRxP | | | | | | | |

### 5.2.2.1.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme

The performance requirements are specified in Table 5.2.2.1.12-3, with the addition of test parameters in Table 5.2.2.1.12-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.12-1.

**Table 5.2.2.1.12-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance when UE is configured two different values of CORESETPoolIndex in ControlResourceSet and when UE receives multiple PDCCHs scheduling PDSCHs | 1-1 |

**Table 5.2.2.1.12-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1(Note 1) | TRxP #2(Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | TCI State #2 |
| | CORESETPoolIndex | | | 0,1 | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 20 | |
| | CSI-RS offset | | Slots | 10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4 | 10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | FDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | 2 | |
| | Resource allocation type | | | Type 1 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | {1000,1001} | {1002,1003} |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Resource allocation | | | | Non-overlapping | |
| Timing offset of the second TRxP from the first TRxP | | | us | -0.5 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 200 | |
| Number of HARQ Processes | | | | 4 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | 2 | |
| Precoding configuration | | | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity | |

| |
|---|
| Note 1: PDSCH transmission is done from both TRxPs. Transmission from TRxP #1 uses CORESETPoolIndex 0 and transmission from TRxP #2 uses CORESETPoolIndex 1 |

**Table 5.2.2.1.12-3: Minimum performance**

| Test num. | Reference channel | | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition(Note 1) | Correlation matrix and antenna configuration(Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB)(Note 3) |
| | TRxP #1 | TRxP #2 | | | | | | |
| 1-1 | R.PDSCH. 1-3.3 FDD | R.PDSCH. 1-3.4 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x2, ULA Low | 70 | 20.6 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | | |

#### 5.2.2.1.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A

The performance requirements are specified in Table 5.2.2.1.13-3, with the addition of test parameters in Table 5.2.2.1.13-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.13-1.

**Table 5.2.2.1.13-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 2 receive antenna conditions when UE is configured with “FDMSchemeA” in “RepetitionScheme-r16” defined in clause 5.1 of TS 38.214 [12] | 1-1 |

**Table 5.2.2.1.13-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1 (Note 1) | TRxP #2 (Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | |
| | CORESETPoolIndex | | | Not configured | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 20 | |
| | CSI-RS offset | | Slots | 10 for CSI-RS resources 1 and 2<br>11 for CSI-RS resources 3 and 4 | 10 for CSI-RS resources 5 and 6<br>11 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | FDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | wideband | |
| | Resource allocation type | | | Type 0 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | 1000, 1001 | 1000, 1001 |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Timing offset of the second TRxP from the first TRxP | | | us | -0.5 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 200 | |
| Number of HARQ Processes | | | | 4 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | 2 | |
| Precoding configuration | | | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity. | |
| Note 1: PDSCH transmission is done from both TRxPs | | | | | |

**Table 5.2.2.1.13-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition (Note 1) | Correlation matrix and antenna configuration (Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) (Note 3) |
| 1-1 | R.PDSCH.1-2.5 FDD | 10 / 15 | 16QAM, 0.54 | TDLA30-10 | 2x2, ULA Low | 70 | 17. 3 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent.<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2.<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | |

#### 5.2.2.1.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme

The performance requirements are specified in Table 5.2.2.1.14-3, with the addition of test parameters in Table 5.2.2.1.14-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.14-1.

**Table 5.2.2.1.14-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 2 receive antenna conditions when UE is configured with repetitionNumber-r16 with multiple slot level PDSCH transmission occasions of the same TB with two TCI states defined in clause 5.1 of TS 38.214 [12] | 1-1 |

**Table 5.2.2.1.14-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1 (Note 1) | TRxP #2 (Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | |
| | CORESETPoolIndex | | | Not configured | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 20 | |
| | CSI-RS offset | | Slots | 10 for CSI-RS resources 1 and 2<br>11 for CSI-RS resources 3 and 4 | 10 for CSI-RS resources 5 and 6<br>11 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | FDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | Repetition number | | | 2 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | 2 | |
| | Resource allocation type | | | Type 0 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | 1000 | 1000 |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Timing offset of the second TRxP from the first TRxP | | | us | 2 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 200 | |
| Number of HARQ Processes | | | | 4 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | 2 | |
| Precoding configuration | | | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity. | |

| |
|---|
| Note 1: PDSCH transmission is done from both TRxPs |

**Table 5.2.2.1.14-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition (Note 1) | Correlation matrix and antenna configuration Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | BLER (%) | SNR (dB) (Note 4) |
| 1-1 | R.PDSCH.1-11.2 FDD | 10 / 15 | 16QAM, 0.54 | TDLA30-10 | 2x2, ULA Low | 1 (Note 3) | 2. 9 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent.<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2.<br>Note 3: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block.<br>Note 4: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | |

### 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, 1-7, 1-8, 1-9, 1-10, 1-11, 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 performance requirements for Enhanced Receiver Type 1 under 2 receive antenna conditions. | 3-1 |

**Table 5.2.2.2.1-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | Specific to each Reference channel |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 4 for Tests 1-1, 1-8, 1-9<br>2 for other tests |
| | Resource allocation type | | Test 1-2: Type 1 with start RB = 50, $L_{RBs}$ = 6<br>Other tests: Type 0 |
| | RBG size | | Test 1-2: N/A<br>Other tests: Config2 |
| | 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, 1-7, 1-8, 1-9, 1-10, 1-11<br>1 for other tests |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | First OFDM symbol in the PRB used for CSI-RS | | Tests 1-8, 1-9:<br>$l_0$ = 4 for CSI-RS resource 1 and 3<br>$l_0$ = 8 for CSI-RS resource 2 and 4<br><br>Other tests; Table 5.2-1. |
| | CSI-RS periodicity | Slots | Test 1-7, 1-10, 1-11:<br>20 for CSI-RS resource 1,2,3,4.<br><br>Other tests: Table 5.2-1. |
| | CSI-RS offset | Slots | Test 1-7, 1-10, 1-11:<br>1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4.<br><br>Other tests: Table 5.2-1. |
| | Frequency Occupation | | Test 1-7, 1-10, 1-11:<br>Start PRB 0<br>Number of PRB = 52<br><br>Other tests: Table 5.2-1. |
| Number of HARQ Processes | | | 16 for Test 1-4<br>10 for Test 1-9<br>8 for other tests |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | QPSK, 0.30 | FR1.30-1A | TDLB100-400 | 2x2, ULA Low | 70 | -1.1 |
| 1-2 | R.PDSCH.2-1.2 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-1 | TDLC300-100 | 2x2, ULA Low | 70 | 0.2 |
| 1-3 | R.PDSCH.2-4.1 TDD | 40 / 30 | 256QAM, 0.82 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | 25.3 |
| 1-4 | R.PDSCH.2-2.1 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | TDLC300-100 | 2x2, ULA Low | 30 | 1.6 |
| 1-5 | R.PDSCH.2-5.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-2 | TDLA30-10 | 2x2, ULA Low | 70 | -0.9 |
| 1-6 | R.PDSCH.2-6.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-3 | TDLA30-10 | 2x2, ULA Low | 70 | -0.8 |
| 1-7 | R.PDSCH.2-10.1 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | HST-1000 | 1x2 | 70 | 6.4 |
| 1-8 | R.PDSCH.2-11.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-5 | TDLB100-400 | 2x2, ULA Low | 70 | -1.0 |
| 1-9 | R.PDSCH.2-12.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-6 | TDLB100-400 | 2x2, ULA Low | 70 | -1.1 |
| 1-10 | R.PDSCH.2-10.2 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | TDLC300-1200 | 2x2 | 70 | 9.5 |
| 1-11 | R.PDSCH.2-10.3 TDD | 40 / 30 | 64QAM, 0.43 | FR1.30-1 | HST-1667 | 1x2 | 70 | 9.6 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | 19.8 |
| 2-2 | R.PDSCH.2-9.1 TDD | 20 / 30 | 64QAM, 0.50 | FR1.30-4 | TDLA30-10 | 2x2, ULA Low | 70 | 19.8 |

**Table 5.2.2.2.1-5: Minimum performance for Rank 2 and Enhanced Receiver Type 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | TDLA30-10 | 2x2, ULA Medium | 70 | 18.0 |

#### 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 |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | Specific to each Reference channel |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| NZP CSI-RS for CSI acquisition | OFDM symbols in the PRB used for CSI-RS | | $l_0$ = 13 |
| | CSI-RS periodicity | Slots | 5 |
| ZP CSI-RS for CSI acquisition | Subcarrier index in the PRB used for CSI-RS | | ($k_0$, $k_1$, $k_2$, $k_3$)=(2, 4, 6, 8) |
| | Number of CSI-RS ports (X) | | 8 |
| | CSI-RS periodicity | Slots | 5 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | 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 |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | QPSK, 0.30 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | -0.9 |

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

The performance requirements are specified in Table 5.2.2.2.4-3, with the addition of test parameters in Table 5.2.2.2.4-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.4-1.

**Table 5.2.2.2.4-1: 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 5.2.2.2.4-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| NR UL transmission with a 7.5 kHz shift to the LTE raster | | | true |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 3 |
| | Length (L) | | 9 for Test 1-1<br>11 for Test 1-2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Position of the first DM-RS for downlink | | 3 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CRS for rate matching (Note 1) | 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 | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |
| Note 1: No MBSFN is configured on LTE carrier | | | |

**Table 5.2.2.2.4-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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.1-1.1 TDD | 10 / 15 | QPSK, 0.30 | FR1.15-1 | TDLA30-10 | 4x2, ULA Low | 70 | -0.8 |
| 1-2 | R.PDSCH.1-1.2 TDD | 10 / 15 | QPSK, 0.30 | FR1.15-1 | TDLA30-10 | 4x2, ULA Low | 70 | -0.8 |

### 5.2.2.2.5 Minimum requirements for PDSCH 0.001% BLER

The performance requirements are specified in Table 5.2.2.2.5-3, with the addition of test parameters in Table 5.2.2.2.5-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.5-1.

**Table 5.2.2.2.5-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH 0.001% BLER performance under 2 receive antenna conditions | 1-1 |

**Table 5.2.2.2.5-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Maximum number of HARQ transmission | | | 1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Defined in Annex A.1.2 for TDD pattern FR1.30-1 |

**Table 5.2.2.2.5-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH.2-1.4 TDD | 40 / 30 | QPSK, 0.59 | FR1.30-1 | AWGN | 1x2, ULA Low | 0.001% | 3.3 |

### 5.2.2.2.6 Minimum requirements for PDSCH repetitions over multiple slots

The performance requirements are specified in Table 5.2.2.2.6-3, with the addition of test parameters in Table 5.2.2.2.6-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.6-1.

**Table 5.2.2.2.6-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH repetitions over multiple slots performance under 2 receive antenna conditions | 1-1 |

**Table 5.2.2.2.6-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | 12 |
| | PDSCH aggregation factor | | 2 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 (Note 1) |
| Note 1: ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,10) = {2, 4, 6}. | | | |

**Table 5.2.2.2.6-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH.2-16.1 TDD | 40 / 30 | 16QAM, 0.54 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 1% (Note 1) | 1.4 |
| Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. | | | | | | | | |

### 5.2.2.2.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2

The performance requirements are specified in Table 5.2.2.2.7-3, with the addition of test parameters in Table 5.2.2.2.7-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.7-1.

**Table 5.2.2.2.7-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH mapping Type B performance and UE processing capability 2 under two receive antenna conditions | 1-1 |

**Table 5.2.2.2.7-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type B |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | 2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 0 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Maximum number of HARQ transmission | | | 1 |
| Number of HARQ Processes | | | 2 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 0 |

**Table 5.2.2.2.7-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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.2-17.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-2 | TDLA30-10 | 2x2, ULA Low | 70 | 0.6 |

### 5.2.2.2.8 Minimum requirements for PDSCH pre-emption

The performance requirements are specified in Table 5.2.2.2.8-3, with the addition of test parameters in Table 5.2.2.2.8-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.8-1.

**Table 5.2.2.2.8-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH pre-emption performance under 2 receive antenna conditions | 1-1 |

**Table 5.2.2.2.8-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDCCH configuration (Note 4) | Symbols with PDCCH | | 0, 1 |
| | DCI format | | 2_1 |
| | timeFrequencySet | | 14x1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Pre-emption configuration (Note 2) | Starting symbol (S) | | 3 |
| | Length (L) | | 2 |
| | Pre-emption periodicity and offset | Slots | 40/(1,12,23,34) (Note 3) |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | FR1.30-1 |
| Note 1: Void<br>Note 2: Interference modelled as random data on pre-empted REs.<br>Note 3: Pre-emption is scheduled with 10% probability within 20ms periodicity.<br>Note 4: In addition to PDCCH configuration in Table 5.2-1. | | | |

**Table 5.2.2.2.8-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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. 2-2.6 TDD | 40 / 30 | 16QAM 0.64 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | 12.5 |

### 5.2.2.2.9 Minimum requirements for HST-SFN

The performance requirements are specified in Table 5.2.2.2.9-3, with the addition of test parameters in Table 5.2.2.2.9-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.9-1.

**Table 5.2.2.2.9-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 2 receive antenna conditions in the HST-SFN scenario defined in B.3.2 when *highSpeedDemodFlag-r16* [17] is configured | 1-1 |

**Table 5.2.2.2.9-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | CSI-RS periodicity | Slots | 20 for CSI-RS resource 1,2,3,4. |
| | CSI-RS offset | Slots | 1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4. |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = 52 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

**Table 5.2.2.2.9-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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.2-10.4 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | HST-SFN | 2x2 | 70 | 14.2 |

## 5.2.2.2.10 Minimum requirements for HST-DPS

The performance requirements are specified in Table 5.2.2.2.10-3, with the addition of test parameters in Table 5.2.2.2.10-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.10-1.

**Table 5.2.2.2.10-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify UE performance in the HST-DPS scenario defined in B.3.3 | 1-1, 1-2 |

**Table 5.2.2.2.10-2: Test parameters**

| Parameter | | | Unit | Value |
|---|---|---|---|---|
| Duplex mode | | | | TDD |
| Active DL BWP index | | | | 1 |
| PDCCH configuration | TCI state | | | Note 1 |
| PDSCH configuration | Mapping type | | | Type A |
| | k0 | | | 0 |
| | Starting symbol (S) | | | 2 |
| | Length (L) | | | Specific to each Reference channel |
| | PDSCH aggregation factor | | | 1 |
| | PRB bundling type | | | Static |
| | PRB bundling size | | | 2 |
| | Resource allocation type | | | Type 0 |
| | RBG size | | | Config2 |
| | VRB-to-PRB mapping type | | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A |
| | TCI state | | | Note 1 |
| PDSCH DMRS configuration | DMRS Type | | | Type 1 |
| | Number of additional DMRS | | | 2 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 |
| CSI-RS for tracking | Resource set #1 | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 5 for CSI-RS resource 1 and 3 |
| | | | | $l_0$ = 9 for CSI-RS resource 2 and 4 |
| | | CSI-RS periodicity | Slots | 20 for CSI-RS resource 1,2,3,4 |
| | | CSI-RS offset | Slots | 1 for CSI-RS resource 1 and 2 |
| | | | | 2 for CSI-RS resource 3 and 4 |
| | | QCL info | | TCI state #2 |
| | | Frequency Occupation | | Start PRB 0 |
| | | | | Number of PRB = 52 |
| | Resource set #2 | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 6 for CSI-RS resource 5 and 6 |
| | | | | $l_0$ = 10 for CSI-RS resource 7 and 8 |
| | | CSI-RS periodicity | Slots | 20 for CSI-RS resource 5,6,7,8. |
| | | CSI-RS offset | Slots | 1 for CSI-RS resource 5 and 6 |
| | | | | 2 for CSI-RS resource 7 and 8 |
| | | QCL info | | TCI state #3 |
| | | Frequency Occupation | | Start PRB 0 |
| | | | | Number of PRB = 52 |
| NZP CSI-RS for CSI acquisition | Resource set #3 | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 12 |
| | | CSI-RS periodicity | Slots | 40 |
| | | CSI-RS offset | Slots | 0 |
| | | QCL info | | TCI state #0 |
| | Resource set #4 | First OFDM symbol in the PRB used for CSI-RS | | l0 = 13 |
| | | CSI-RS periodicity | Slots | 40 |
| | | CSI-RS offset | Slots | 0 |
| | | QCL info | | TCI state #1 |
| TCI state #0 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration |
| | | QCL Type | | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A |
| | | QCL Type | | N/A |
| TCI state #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration |
| | | QCL Type | | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A |
| | | QCL Type | | N/A |
| TCI state #2 | 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 #3 | Type 1 QCL information | SSB index | | SSB #1 |
| | | QCL Type | | Type C |
| | Type 2 QCL information | SSB index | | N/A |
| | | QCL Type | | N/A |

| | | |
|---|---|---|
| Number of HARQ Processes | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |
| Note 1: SSB # (k mod 2) , CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by k[th] RRH.<br>For Test 1-1, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot# $$\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\ proc} + T_{firstTRS} + T_{TRS\ proc}, 0]$$ to slot# $$(2k+1)n + T_{HARQ} + T_{MAC\ proc},$$ PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.<br>For Test 1-2, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot# $$\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\ proc}, 0]$$ to slot# $$(2k+1)n + T_{HARQ} + T_{MAC\ proc}$$ Where k=0, 1, 2… is the RRH number, n = 5040 is half of the number of slots between two RRH, $T_{HARQ}$ = 8 is the number of slots between PDSCH and corresponding HARQ-ACK information, $T_{MAC\ proc}$ = 6 is the number of slots for MAC CE processing, $T_{firstTRS}$ = 7 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $T_{TRS\ proc}$ = 4 is the number of slots for TRS processing. | | |

**Table 5.2.2.2.10-3: Minimum performance for HST-DPS**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Number of active PDSCH TCI states | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.2-10.5 TDD | 40 / 30 | 64QAM, 0.43 | HST-DPS | 1 | 2x2 | 70 | 13.0 |
| 1-2 | R.PDSCH.2-10.5 TDD | 40 / 30 | 64QAM, 0.43 | HST-DPS | 2 | 2x2 | 70 | 13.0 |

### 5.2.2.2.11 Minimum requirements for PDSCH Single-DCI based SDM scheme

The performance requirements are specified in Table 5.2.2.2.11-3, with the addition of test parameters in Table 5.2.2.2.11-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.11-1.

**Table 5.2.2.2.11-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance with Single-DCI based SDM scheme under 2 receive antenna conditions. | 1-1,1-2 |

**Table 5.2.2.2.11-2: Test parameters**

<table>
<tr><th colspan="3" rowspan="2">Parameter</th><th rowspan="2">Unit</th><th colspan="2">Value</th></tr>
<tr><th>TRxP #1(Note 1)</th><th>TRxP #2(Note 1)</th></tr>
<tr><td colspan="3">Transmit TRxP of SSB</td><td></td><td colspan="2">TRxP #1</td></tr>
<tr><td rowspan="2">PDCCH configuration</td><td colspan="2">TCI state</td><td></td><td colspan="2">TCI State #1</td></tr>
<tr><td colspan="2">CORESETPoolIndex</td><td></td><td colspan="2">0</td></tr>
<tr><td rowspan="8">CSI-RS for tracking</td><td colspan="2">First subcarrier index in the PRB used for CSI-RS</td><td></td><td>k0=0 for CSI-RS resources 1,2,3,4</td><td>k0=1 for CSI-RS resources 5,6,7,8</td></tr>
<tr><td colspan="2">First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4</td><td>l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8</td></tr>
<tr><td colspan="2">Number of CSI-RS ports (X)</td><td></td><td>1 for CSI-RS resource 1,2,3,4</td><td>1 for CSI-RS resource 5,6,7,8</td></tr>
<tr><td colspan="2">CDM Type</td><td></td><td colspan="2">‘No CDM’ for CSI-RS resource 1,2,3,4,5,6,7,8</td></tr>
<tr><td colspan="2">Density</td><td></td><td colspan="2">3</td></tr>
<tr><td colspan="2">CSI-RS periodicity</td><td>Slots</td><td colspan="2">40</td></tr>
<tr><td colspan="2">CSI-RS offset</td><td>Slots</td><td>20 for CSI-RS resources 1 and 2<br>21 for CSI-RS resources 3 and 4</td><td>20 for CSI-RS resources 5 and 6<br>21 for CSI-RS resources 7 and 8</td></tr>
<tr><td colspan="2">QCL info</td><td></td><td colspan="2">TCI state #0</td></tr>
<tr><td colspan="3">Duplex mode</td><td></td><td colspan="2">TDD</td></tr>
<tr><td colspan="3">Active DL BWP index</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="10">PDSCH configuration</td><td colspan="2">Mapping type</td><td></td><td colspan="2">Type A</td></tr>
<tr><td colspan="2">k0</td><td></td><td colspan="2">0</td></tr>
<tr><td colspan="2">Starting symbol (S)</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Length (L)</td><td></td><td colspan="2">12</td></tr>
<tr><td colspan="2">PRB bundling type</td><td></td><td colspan="2">Static</td></tr>
<tr><td colspan="2">PRB bundling size</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Resource allocation type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">RBG size</td><td></td><td colspan="2">Config2</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping type</td><td></td><td colspan="2">Non-interleaved</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping interleaver bundle size</td><td></td><td colspan="2">N/A</td></tr>
<tr><td rowspan="5">PDSCH DMRS configuration</td><td colspan="2">Antenna port indexes</td><td></td><td>1000</td><td>1002</td></tr>
<tr><td colspan="2">TCI state</td><td></td><td>TCI State #1</td><td>TCI State #2</td></tr>
<tr><td colspan="2">DMRS Type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">Number of additional DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Maximum number of OFDM symbols for DL front loaded DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="4">TCI State #1</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>CSI-RS resource 1 from ‘CSI-RS for tracking’ configuration</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>Type A</td><td>N/A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="4">TCI State #2</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>CSI-RS resource 5 from ‘CSI-RS for tracking’ configuration</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>Type A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">Resource allocation</td><td></td><td colspan="2">Full-overlapping</td></tr>
<tr><td colspan="3">Timing offset of the second TRxP from the first TRxP</td><td>us</td><td colspan="2">-0.25 for test 1-1<br>1 for test 1-2</td></tr>
<tr><td colspan="3">Frequency offset of the second TRxP from the first TRxP</td><td>Hz</td><td colspan="2">300 for test 1-1<br>0 for test 1-2</td></tr>
<tr><td colspan="3">Number of HARQ Processes</td><td></td><td colspan="2">8</td></tr>
<tr><td colspan="3">The number of slots between PDSCH and corresponding HARQ-ACK information</td><td></td><td colspan="2">Specific to each TDD UL-DL pattern and as defined in Annex A.1.2</td></tr>
</table>

| | | |
|---|---|---|
| Precoding configuration | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity. |
| Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2) | | |

**Table 5.2.2.2.11-3: Minimum performance**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition(Note 1) | Correlation matrix and antenna configuration(Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB)(Note 3) |
| 1-1 | R.PDSCH. 2-3.2 TDD | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | 20.2 |
| 1-2 | R.PDSCH. 2-3.2 TDD | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | 20.0 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 with scaling factor as 1/sqrt(2) for transmitted signal from each TRxP | | | | | | | | |

### 5.2.2.2.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme

The performance requirements are specified in Table 5.2.2.2.12-3, with the addition of test parameters in Table 5.2.2.2.12-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.12-1.

**Table 5.2.2.2.12-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance when UE is configured two different values of CORESETPoolIndex in ControlResourceSet and when UE receives multiple PDCCHs scheduling PDSCHs | 1-1 |

**Table 5.2.2.2.12-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1(Note 1) | TRxP #2(Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | TCI State #2 |
| | CORESETPoolIndex | | | 0,1 | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 40 | |
| | CSI-RS offset | | Slots | 20 for CSI-RS resources 1 and 2<br>21 for CSI-RS resources 3 and 4 | 20 for CSI-RS resources 5 and 6<br>21 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | TDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | 2 | |
| | Resource allocation type | | | Type 1 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | {1000,1001} | {1002,1003} |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Resource allocation | | | | Non-overlapping | |
| Timing offset of the second TRxP from the first TRxP | | | us | -0.25 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 300 | |
| Number of HARQ Processes | | | | 8 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 | |
| Precoding configuration | | | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity | |

| |
|---|
| Note 1: PDSCH transmission is done from both TRxPs. Transmission from TRxP #1 uses CORESETPoolIndex 0 and transmission from TRxP #2 uses CORESETPoolIndex 1 |

**Table 5.2.2.2.12-3: Minimum performance**

| Test num. | Reference channel | | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition(Note 1) | Correlation matrix and antenna configuration(Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Fraction of maximum throughput (%) | SNR (dB)(Note 3) |
| | TRxP #1 | TRxP #2 | | | | | | | |
| 1-1 | R.PDSCH.2-3.3 TDD | R.PDSCH.2-3.4 TDD | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | 20.4 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | | | |

### 5.2.2.2.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A

The performance requirements are specified in Table 5.2.2.2.13-3, with the addition of test parameters in Table 5.2.2.2.13-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.13-1.

**Table 5.2.2.2.13-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 2 receive antenna conditions when UE is configured with “FDMSchemeA” in “RepetitionScheme-r16” defined in clause 5.1 of TS 38.214 [12]] | 1-1 |

**Table 5.2.2.1.13-2: Test parameters**

<table>
<tr><th colspan="3" rowspan="2">Parameter</th><th rowspan="2">Unit</th><th colspan="2">Value</th></tr>
<tr><th>TRxP #1 (Note 1)</th><th>TRxP #2 (Note 1)</th></tr>
<tr><td colspan="3">Transmit TRxP of SSB</td><td></td><td colspan="2">TRxP #1</td></tr>
<tr><td rowspan="2">PDCCH configuration</td><td colspan="2">TCI state</td><td></td><td colspan="2">TCI State #1</td></tr>
<tr><td colspan="2">CORESETPoolIndex</td><td></td><td colspan="2">Not configured</td></tr>
<tr><td rowspan="8">CSI-RS for tracking</td><td colspan="2">First subcarrier index in the PRB used for CSI-RS</td><td></td><td>k0=0 for CSI-RS resources 1,2,3,4</td><td>k0=1 for CSI-RS resources 5,6,7,8</td></tr>
<tr><td colspan="2">First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4</td><td>l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8</td></tr>
<tr><td colspan="2">Number of CSI-RS ports (X)</td><td></td><td>1 for CSI-RS resource 1,2,3,4</td><td>1 for CSI-RS resource 5,6,7,8</td></tr>
<tr><td colspan="2">CDM Type</td><td></td><td colspan="2">'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8</td></tr>
<tr><td colspan="2">Density</td><td></td><td colspan="2">3</td></tr>
<tr><td colspan="2">CSI-RS periodicity</td><td>Slots</td><td colspan="2">40</td></tr>
<tr><td colspan="2">CSI-RS offset</td><td>Slots</td><td>20 for CSI-RS resources 1 and 2<br>21 for CSI-RS resources 3 and 4</td><td>20 for CSI-RS resources 5 and 6<br>21 for CSI-RS resources 7 and 8</td></tr>
<tr><td colspan="2">QCL info</td><td></td><td colspan="2">TCI state #0</td></tr>
<tr><td colspan="3">Duplex mode</td><td></td><td colspan="2">TDD</td></tr>
<tr><td colspan="3">Active DL BWP index</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="10">PDSCH configuration</td><td colspan="2">Mapping type</td><td></td><td colspan="2">Type A</td></tr>
<tr><td colspan="2">k0</td><td></td><td colspan="2">0</td></tr>
<tr><td colspan="2">Starting symbol (S)</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Length (L)</td><td></td><td colspan="2">12</td></tr>
<tr><td colspan="2">PRB bundling type</td><td></td><td colspan="2">Static</td></tr>
<tr><td colspan="2">PRB bundling size</td><td></td><td colspan="2">wideband</td></tr>
<tr><td colspan="2">Resource allocation type</td><td></td><td colspan="2">Type 0</td></tr>
<tr><td colspan="2">RBG size</td><td></td><td colspan="2">Config2</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping type</td><td></td><td colspan="2">Non-interleaved</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping interleaver bundle size</td><td></td><td colspan="2">N/A</td></tr>
<tr><td rowspan="5">PDSCH DMRS configuration</td><td colspan="2">Antenna port indexes</td><td></td><td>1000, 1001</td><td>1000, 1001</td></tr>
<tr><td colspan="2">TCI state</td><td></td><td>TCI State #1</td><td>TCI State #2</td></tr>
<tr><td colspan="2">DMRS Type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">Number of additional DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Maximum number of OFDM symbols for DL front loaded DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="4">TCI State #1</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>CSI-RS resource 1 from 'CSI-RS for tracking' configuration</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>Type A</td><td>N/A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="4">TCI State #2</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>CSI-RS resource 5 from 'CSI-RS for tracking' configuration</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>Type A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">Timing offset of the second TRxP from the first TRxP</td><td>us</td><td colspan="2">-0.25</td></tr>
<tr><td colspan="3">Frequency offset the second TRxP from the first TRxP</td><td>Hz</td><td colspan="2">300</td></tr>
<tr><td colspan="3">Number of HARQ Processes</td><td></td><td colspan="2">8</td></tr>
<tr><td colspan="3">The number of slots between PDSCH and corresponding HARQ-ACK information</td><td></td><td colspan="2">Specific to each TDD UL-DL pattern and as defined in Annex A.1.2</td></tr>
<tr><td colspan="3">Precoding configuration</td><td></td><td colspan="2">SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.</td></tr>
<tr><td colspan="6">Note 1: PDSCH transmission is done from both TRxPs</td></tr>
</table>

**Table 5.2.2.2.13-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition (Note 1) | Correlation matrix and antenna configuration (Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB) (Note 3) |
| 1-1 | R.PDSCH.2-2.5 TDD | 40 / 30 | 16QAM, 0.54 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 70 | 17.6 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent.<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2.<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | | |

### 5.2.2.2.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme

The performance requirements are specified in Table 5.2.2.2.14-3, with the addition of test parameters in Table 5.2.2.2.14-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.14-1.

**Table 5.2.2.2.14-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 2 receive antenna conditions when UE is configured with repetitionNumber-r16 with multiple slot level PDSCH transmission occasions of the same TB with two TCI states defined in clause 5.1 of TS 38.214 [12] | 1-1 |

**Table 5.2.2.2.14-2: Test parameters**

<table>
<tr><th colspan="3" rowspan="2">Parameter</th><th rowspan="2">Unit</th><th colspan="2">Value</th></tr>
<tr><th>TRxP #1 (Note 1)</th><th>TRxP #2 (Note 1)</th></tr>
<tr><td colspan="3">Transmit TRxP of SSB</td><td></td><td colspan="2">TRxP #1</td></tr>
<tr><td rowspan="2">PDCCH configuration</td><td colspan="2">TCI state</td><td></td><td colspan="2">TCI State #1</td></tr>
<tr><td colspan="2">CORESETPoolIndex</td><td></td><td colspan="2">Not configured</td></tr>
<tr><td rowspan="9">CSI-RS for tracking</td><td colspan="2">First subcarrier index in the PRB used for CSI-RS</td><td></td><td>k0=0 for CSI-RS resources 1,2,3,4</td><td>k0=1 for CSI-RS resources 5,6,7,8</td></tr>
<tr><td colspan="2">First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4</td><td>l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8</td></tr>
<tr><td colspan="2">Number of CSI-RS ports (X)</td><td></td><td>1 for CSI-RS resource 1,2,3,4</td><td>1 for CSI-RS resource 5,6,7,8</td></tr>
<tr><td colspan="2">CDM Type</td><td></td><td colspan="2">'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8</td></tr>
<tr><td colspan="2">Density</td><td></td><td colspan="2">3</td></tr>
<tr><td colspan="2">CSI-RS periodicity</td><td>Slots</td><td colspan="2">40</td></tr>
<tr><td colspan="2">CSI-RS offset</td><td>Slots</td><td>20 for CSI-RS resources 1 and 2<br>21 for CSI-RS resources 3 and 4</td><td>20 for CSI-RS resources 5 and 6<br>21 for CSI-RS resources 7 and 8</td></tr>
<tr><td colspan="2">QCL info</td><td></td><td colspan="2">TCI state #0</td></tr>
<tr><td colspan="3">Duplex mode</td><td></td><td colspan="2">TDD</td></tr>
<tr><td colspan="3">Active DL BWP index</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="11">PDSCH configuration</td><td colspan="2">Mapping type</td><td></td><td colspan="2">Type A</td></tr>
<tr><td colspan="2">k0</td><td></td><td colspan="2">0</td></tr>
<tr><td colspan="2">Starting symbol (S)</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Length (L)</td><td></td><td colspan="2">12</td></tr>
<tr><td colspan="2">Repetition number</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">PRB bundling type</td><td></td><td colspan="2">Static</td></tr>
<tr><td colspan="2">PRB bundling size</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Resource allocation type</td><td></td><td colspan="2">Type 0</td></tr>
<tr><td colspan="2">RBG size</td><td></td><td colspan="2">Config2</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping type</td><td></td><td colspan="2">Non-interleaved</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping interleaver bundle size</td><td></td><td colspan="2">N/A</td></tr>
<tr><td rowspan="5">PDSCH DMRS configuration</td><td colspan="2">Antenna port indexes</td><td></td><td>1000</td><td>1000</td></tr>
<tr><td colspan="2">TCI state</td><td></td><td>TCI State #1</td><td>TCI State #2</td></tr>
<tr><td colspan="2">DMRS Type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">Number of additional DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Maximum number of OFDM symbols for DL front loaded DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="4">TCI State #1</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>CSI-RS resource 1 from 'CSI-RS for tracking' configuration</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>Type A</td><td>N/A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="4">TCI State #2</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>CSI-RS resource 5 from 'CSI-RS for tracking' configuration</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>Type A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">Timing offset of the second TRxP from the first TRxP</td><td>us</td><td colspan="2">1</td></tr>
<tr><td colspan="3">Frequency offset of the second TRxP from the first TRxP</td><td>Hz</td><td colspan="2">300</td></tr>
<tr><td colspan="3">Number of HARQ Processes</td><td></td><td colspan="2">4</td></tr>
<tr><td colspan="3">The number of slots between PDSCH and corresponding HARQ-ACK information</td><td></td><td colspan="2">Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 (Note 2)</td></tr>
<tr><td colspan="3">Precoding configuration</td><td></td><td colspan="2">SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.</td></tr>
</table>

| | |
|---|---|
| Note 1: | PDSCH transmission is done from both TRxPs |
| Note 2: | ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,10) = {2, 4, 6}. |

**Table 5.2.2.2.14-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition (Note 1) | Correlation matrix and antenna configuration (Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | BLER (%) | SNR (dB) (Note 4) |
| 1-1 | R.PDSCH.2-16.2 TDD | 40 / 30 | 16QAM, 0.54 | FR1.30-1 | TDLA30-10 | 2x2, ULA Low | 1 (Note 3) | 2. 8 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent.<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2.<br>Note 3: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block.<br>Note 4: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | | |

#### 5.2.2.2.15 Minimum requirements for PDSCH of PCell on band with shared spectrum access

The performance requirements are specified in Table 5.2.2.2.15-3, with the addition of test parameters in Table 5.2.2.2.15-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.15-1.

**Table 5.2.2.2.15-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance for UE supporting operations in shared spectrum access | 1-1, 1-2, 1-3, 1-4 |

**Table 5.2.2.2.15-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| DL transmission model | | | As specified in B.5 |
| Downlink Model Parameters | SSB Q factor | | 8 |
| | Downlink transmission duration values | Slots | {2,4,6,7} |
| | Occupied OFDM symbols in slot other than the last slot of the downlink duration | Symbols | 14 |
| | Occupied OFDM symbols in the last slot of the downlink duration | Symbols | {6,9,12,14} (Note 1) |
| | Downlink period | ms | 5 |
| | LBT failure probability ($p_{LBT}$) | | 0.25 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | dmrs-AdditionalPosition | | pos1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |
| Note 1: If DL Transmission duration is 2 Slot, the occupied OFDM symbols in the last slot of the downlink duration is 14. | | | |

**Table 5.2.2.2.15-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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.2-18.1 TDD | 20 / 30 | 16QAM, 0.48 | FR1.30-7 | TDLA30-10 | 2x2, ULA Low | 70 | 13.8 |
| 1-2 | R.PDSCH.2-18.2 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-7 | TDLA30-10 | 2x2, ULA Low | 70 | 14.1 |
| 1-3 | R.PDSCH.2-18.3 TDD | 60 / 30 | 16QAM, 0.48 | FR1.30-7 | TDLA30-10 | 2x2, ULA Low | 70 | 14.2 |
| 1-4 | R.PDSCH.2-18.4 TDD | 80 / 30 | 16QAM, 0.48 | FR1.30-7 | TDLA30-10 | 2x2, ULA Low | 70 | 14.5 |

## 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, 1-5, 1-6, 1-7, 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 performance requirements for Enhanced Receiver Type 1 under 4 receive antenna conditions. | 5-1 |

**Table 5.2.3.1.1-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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<br>wideband for Test 3-1<br>2 for other tests |
| | Resource allocation type | | Test 1-2: Type 1 with start RB = 23, $L_{RBs}$ = 6<br>Other test: Type 0 |
| | RBG size | | Test 1-2: N/A<br>Other tests: Config2 |
| | 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, 1-5, 1-6, 1-7<br>1 for other tests |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | CSI-RS periodicity | Slots | Test 1-5, 1-6, 1-7:<br>10 for CSI-RS resource 1,2,3,4.<br><br>Other tests: Table 5.2-1. |
| | CSI-RS offset | Slots | Test 1-5, 1-6, 1-7:<br>1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4.<br><br>Other tests: Table 5.2-1. |
| Number of HARQ Processes | | | 8 for Test 1-4, 2-1<br>4 for other tests |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-1.1 FDD | 10 / 15 | QPSK, 0.30 | TDLB100-400 | 2x4, ULA Low | 70 | -3.5 |
| 1-2 | R.PDSCH.1-1.2 FDD | 10 / 15 | QPSK, 0.30 | TDLC300-100 | 2x4, ULA Low | 70 | -2.9 |
| 1-3 | R.PDSCH.1-4.1 FDD | 10 / 15 | 256QAM, 0.82 | TDLA30-10 | 2x4, ULA Low | 70 | 21.0 |
| 1-4 | R.PDSCH.1-2.1 FDD | 10 / 15 | 16QAM, 0.48 | TDLC300-100 | 2x4, ULA Low | 30 | -1.5 |
| 1-5 | R.PDSCH.1-8.1 FDD | 10 / 15 | 16QAM, 0.48 | HST-750 | 1x4 | 70 | 3.3 |
| 1-6 | R.PDSCH.1-8.2 FDD | 10 / 15 | 64QAM, 0.43 | HST-972 | 1x4 | 70 | [7.0] |
| 1-7 | R.PDSCH.1-8.1 FDD | 10 / 15 | 16QAM, 0.48 | TDLC300-600 | 2x4 | 70 | [5.0] |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 2-1 | R.PDSCH.1-3.1 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x4, ULA Low | 70 | 13.5 |
| 2-2 | R.PDSCH.2-1.1 FDD | 20 / 30 | 64QAM, 0.50 | TDLA30-10 | 2x4, ULA Low | 70 | 13.7 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 3-1 | R.PDSCH.1-2.3 FDD | 10 / 15 | 16QAM, 0.48 | TDLA30-10 | 4x4, ULA Low | 70 | 11.0 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 4-1 | R.PDSCH.1-2.4 FDD | 10 / 15 | 16QAM, 0.48 | TDLA30-10 | 4x4, ULA Low | 70 | 15.6 |

**Table 5.2.3.1.1-7: Minimum performance for Rank 3 and Enhanced Receiver Type 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 5-1 | R.PDSCH.1-2.3 FDD | 10 / 15 | 16QAM, 0.48 | TDLA30-10 | 4x4, ULA Medium A | 70 | 22.3 |

### 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 |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| NZP CSI-RS for CSI acquisition | OFDM symbols in the PRB used for CSI-RS | | $l_0$ = 13 |
| | CSI-RS periodicity | Slots | 5 |
| ZP CSI-RS for CSI acquisition | Subcarrier index in the PRB used for CSI-RS | | $(k_0, k_1, k_2, k_3)$=(2, 4, 6, 8) |
| | Number of CSI-RS ports (X) | | 8 |
| | CSI-RS periodicity | Slots | 5 |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-5.1 FDD | 10 / 15 | 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 |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-1.3 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 2x4, 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 5.2.3.1.4-1: 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 5.2.3.1.4-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| NR UL transmission with a 7.5 kHz shift to the LTE raster | | | true |
| PDCCH configuration | Symbols with PDCCH | | Symbol# 2 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 3 |
| | Length (L) | | 9 for Test 1-1<br>11 for Test 1-2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Position of the first DM-RS for downlink | | 3 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CRS for rate matching (Note 1) | 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 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |
| Note 1: No MBSFN is configured on LTE carrier | | | |

**Table 5.2.3.1.4-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-7.1 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 4x4, ULA Low | 70 | -4.0 |
| 1-2 | R.PDSCH.1-7.2 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 4x4, ULA Low | 70 | -4.0 |

#### 5.2.3.1.5 Minimum requirements for PDSCH 0.001% BLER

The performance requirements are specified in Table 5.2.3.1.5-3, with the addition of test parameters in Table 5.2.3.1.5-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.5-1.

**Table 5.2.3.1.5-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH 0.001% BLER performance under 4 receive antenna conditions | 1-1 |

**Table 5.2.3.1.5-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Maximum number of HARQ transmission | | | 1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

**Table 5.2.3.1.5-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH.1-1.4 FDD | 10 / 15 | QPSK, 0.59 | AWGN | 1x4, ULA Low | 0.001% | 0. 7 |

#### 5.2.3.1.6 Minimum requirements for PDSCH repetitions over multiple slots

The performance requirements are specified in Table 5.2.3.1.6-3, with the addition of test parameters in Table 5.2.3.1.6-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.6-1.

**Table 5.2.3.1.6-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH repetitions over multiple slots performance under 4 receive antenna conditions | 1-1 |

**Table 5.2.3.1.6-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | 12 |
| | PDSCH aggregation factor | | 2 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information | | | 2 |

**Table 5.2.3.1.6-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH.1-11.1 FDD | 10 / 15 | 16QAM, 0.54 | TDLA30-10 | 2x4, ULA Low | 1% (Note 1) | -2.3 |
| Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. | | | | | | | |

### 5.2.3.1.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2

The performance requirements are specified in Table 5.2.3.1.7-3, with the addition of test parameters in Table 5.2.3.1.7-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.7-1.

**Table 5.2.3.1.7-1: Tests purpose**

| Purpose | Test index |
|---|---|
| PDSCH mapping Type B performance and UE processing capability 2 under four receive antenna conditions | 1-1 |

**Table 5.2.3.1.7-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type B |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | 2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 0 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Maximum number of HARQ transmission | | | 1 |
| Number of HARQ Processes | | | 2 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 0 |

**Table 5.2.3.1.7-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-12.1 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 2x4, ULA Low | 70 | [-2.3] |

### 5.2.3.1.8 Minimum requirements for PDSCH pre-emption

The performance requirements are specified in Table 5.2.3.1.8-3, with the addition of test parameters in Table 5.2.3.1.8-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.8-1.

**Table 5.2.3.1.8-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH pre-emption performance under 4 receive antenna conditions | 1-1 |

**Table 5.2.3.1.8-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| PDCCH configuration (Note 4) | Symbols with PDCCH | | 0, 1 |
| | DCI format | | 2_1 |
| | timeFrequencySet | | 14x1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Pre-emption configuration (Note 2) | Starting symbol (S) | | 3 |
| | Length (L) | | 2 |
| | Pre-emption periodicity and offset (Note 3) | Slots | 10/1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |
| Note 1: Void<br>Note 2: Interference modelled as random data on pre-empted REs.<br>Note 3: Pre-emption is scheduled with a fixed scheduling with 10% probability within 10ms periodicity.<br>Note 4: In addition to PDCCH configuration in Table 5.2-1. | | | |

**Table 5.2.3.1.8-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH. 1-2.6 FDD | 10 / 15 | 16QAM 0.64 | TDLA30-10 | 2x4, ULA Low | 70 | 6. 6 |

### 5.2.3.1.9 Minimum requirements for PDSCH HST-SFN

The performance requirements are specified in Table 5.2.3.1.9-3, with the addition of test parameters in Table 5.2.3.1.9-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.9-1.

**Table 5.2.3.1.9-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 4 receive antenna conditions in the HST-SFN scenario defined in B.3.2 when highSpeedDemodFlag-r16 IE [17] is configured | 1-1 |

**Table 5.2.3.1.9-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | CSI-RS periodicity | Slots | 10 for CSI-RS resource 1,2,3,4. |
| | CSI-RS offset | Slots | 1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4. |
| Number of HARQ Processes | | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 2 |

**Table 5.2.3.1.9-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-8.3 FDD | 10 / 15 | 16QAM, 0.48 | HST-SFN | 2x4 | 70 | 10.4 |

### 5.2.3.1.10 Minimum requirements for HST-DPS

The performance requirements are specified in Table 5.2.3.1.10-3, with the addition of test parameters in Table 5.2.3.1.10-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.10-1.

**Table 5.2.3.1.10-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify UE performance in the HST-DPS scenario defined in B.3.3 | 1-1, 1-2 |

**Table 5.2.3.1.10-2: Test parameters**

<table>
<tr><th colspan="3">Parameter</th><th>Unit</th><th>Value</th></tr>
<tr><td colspan="3">Duplex mode</td><td></td><td>FDD</td></tr>
<tr><td colspan="3">Active DL BWP index</td><td></td><td>1</td></tr>
<tr><td>PDCCH configuration</td><td colspan="2">TCI state</td><td></td><td>Note 1</td></tr>
<tr><td rowspan="12">PDSCH configuration</td><td colspan="2">Mapping type</td><td></td><td>Type A</td></tr>
<tr><td colspan="2">k0</td><td></td><td>0</td></tr>
<tr><td colspan="2">Starting symbol (S)</td><td></td><td>2</td></tr>
<tr><td colspan="2">Length (L)</td><td></td><td>12</td></tr>
<tr><td colspan="2">PDSCH aggregation factor</td><td></td><td>1</td></tr>
<tr><td colspan="2">PRB bundling type</td><td></td><td>Static</td></tr>
<tr><td colspan="2">PRB bundling size</td><td></td><td>2</td></tr>
<tr><td colspan="2">Resource allocation type</td><td></td><td>Type 0</td></tr>
<tr><td colspan="2">RBG size</td><td></td><td>Config2</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping type</td><td></td><td>Non-interleaved</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping interleaver bundle size</td><td></td><td>N/A</td></tr>
<tr><td colspan="2">TCI state</td><td></td><td>Note 1</td></tr>
<tr><td rowspan="3">PDSCH DMRS configuration</td><td colspan="2">DMRS Type</td><td></td><td>Type 1</td></tr>
<tr><td colspan="2">Number of additional DMRS</td><td></td><td>2</td></tr>
<tr><td colspan="2">Maximum number of OFDM symbols for DL front loaded DMRS</td><td></td><td>1</td></tr>
<tr><td rowspan="8">CSI-RS for tracking</td><td rowspan="4">Resource set #1</td><td>First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>$l_0$ = 5 for CSI-RS resource 1 and 3<br>$l_0$ = 9 for CSI-RS resource 2 and 4</td></tr>
<tr><td>CSI-RS periodicity</td><td>Slots</td><td>10 for CSI-RS resource 1,2,3,4.</td></tr>
<tr><td>CSI-RS offset</td><td>Slots</td><td>1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4</td></tr>
<tr><td>QCL info</td><td></td><td>TCI state #2</td></tr>
<tr><td rowspan="4">Resource set #2</td><td>First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>$l_0$ = 6 for CSI-RS resource 5 and 6<br>$l_0$ = 10 for CSI-RS resource 7 and 8</td></tr>
<tr><td>CSI-RS periodicity</td><td>Slots</td><td>10 for CSI-RS resource 5,6,7,8.</td></tr>
<tr><td>CSI-RS offset</td><td>Slots</td><td>1 for CSI-RS resource 5 and 6<br>2 for CSI-RS resource 7 and 8</td></tr>
<tr><td>QCL info</td><td></td><td>TCI state #3</td></tr>
<tr><td rowspan="8">NZP CSI-RS for CSI acquisition</td><td rowspan="4">Resource set #3</td><td>First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>$l_0$ = 12</td></tr>
<tr><td>CSI-RS periodicity</td><td>Slots</td><td>20</td></tr>
<tr><td>CSI-RS offset</td><td>Slots</td><td>0</td></tr>
<tr><td>QCL info</td><td></td><td>TCI state #0</td></tr>
<tr><td rowspan="4">Resource set #4</td><td>First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>$l_0$ = 13</td></tr>
<tr><td>CSI-RS periodicity</td><td>Slots</td><td>20</td></tr>
<tr><td>CSI-RS offset</td><td>Slots</td><td>0</td></tr>
<tr><td>QCL info</td><td></td><td>TCI state #1</td></tr>
<tr><td rowspan="4">TCI state #0</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration</td></tr>
<tr><td>QCL Type</td><td></td><td>Type A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td></tr>
<tr><td rowspan="4">TCI state #1</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration</td></tr>
<tr><td>QCL Type</td><td></td><td>Type A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td></tr>
<tr><td rowspan="4">TCI state #2</td><td rowspan="2">Type 1 QCL information</td><td>SSB index</td><td></td><td>SSB #0</td></tr>
<tr><td>QCL Type</td><td></td><td>Type C</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>SSB index</td><td></td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td></tr>
<tr><td rowspan="4">TCI state #3</td><td rowspan="2">Type 1 QCL information</td><td>SSB index</td><td></td><td>SSB #1</td></tr>
<tr><td>QCL Type</td><td></td><td>Type C</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>SSB index</td><td></td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td></tr>
</table>

| | | |
|---|---|---|
| Number of HARQ Processes | | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | 2 |
| Note 1: SSB # (k mod 2), CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by k[th] RRH.<br>For Test 1-1, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot# $\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\ proc} + T_{firstTRS} + T_{TRS\ proc}, 0]$<br>to slot#<br>$(2k+1)n + T_{HARQ} + T_{MAC\ proc}$,<br>PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.<br>For Test 1-2, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot# $\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\ proc}, 0]$<br>to slot#<br>$(2k+1)n + T_{HARQ} + T_{MAC\ proc}$<br>Where k=0, 1, 2… is the RRH number, n = 2520 is half of the number of slots between two RRH, $T_{HARQ}$ = 2 is the number of slots between PDSCH and corresponding HARQ-ACK information, $T_{MAC\ proc}$ = 3 is the number of slots for MAC CE processing, $T_{firstTRS}$ = 6 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $T_{TRS\ proc}$ = 2 is the number of slots for TRS processing. | | |

**Table 5.2.3.1.10-3: Minimum performance for HST-DPS**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Number of active PDSCH TCI states | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.1-8.4 FDD | 10 / 15 | 64QAM, 0.43 | HST-DPS | 1 | 2x4 | 70 | 10.6 |
| 1-2 | R.PDSCH.1-8.4 FDD | 10 / 15 | 64QAM, 0.43 | HST-DPS | 2 | 2x4 | 70 | 10.6 |

### 5.2.3.1.11 Minimum requirements for PDSCH Single-DCI based SDM scheme

The performance requirements are specified in Table 5.2.3.1.11-3, with the addition of test parameters in Table 5.2.3.1.11-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.11-1.

**Table 5.2.3.1.11-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance with Single-DCI based SDM scheme under 4 receive antenna conditions | 1-1,1-2 |

**Table 5.2.3.1.11-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1(Note 1) | TRxP #2(Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | |
| | CORESETPoolIndex | | | 0 | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 20 | |
| | CSI-RS offset | | Slots | 10 for CSI-RS resources 1 and 2<br>11 for CSI-RS resources 3 and 4 | 10 for CSI-RS resources 5 and 6<br>11 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | FDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | 2 | |
| | Resource allocation type | | | Type 1 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | 1000 | 1002 |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Resource allocation | | | | Full-overlapping | |
| Timing offset of the second TRxP from the first TRxP | | | us | -0.5 for test 1-1<br>2 for test 1-2 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 200 for test 1-1<br>0 for test 1-2 | |
| Number of HARQ Processes | | | | 4 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | 2 | |

| | | |
|---|---|---|
| Precoding configuration | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity. |
| Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2) | | |

**Table 5.2.3.1.11-3: Minimum performance**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition(Note 1) | Correlation matrix and antenna configuration(Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB)(Note 3) |
| 1-1 | R.PDSCH.1-3.2 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x4, ULA Low | 70 | 14.6 |
| 1-2 | R.PDSCH.1-3.2 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x4, ULA Low | 70 | 13.9 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 with scaling factor as 1/sqrt(2) for transmitted signal from each TRxP | | | | | | | |

### 5.2.3.1.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme

The performance requirements are specified in Table 5.2.3.1.12-3, with the addition of test parameters in Table 5.2.3.1.12-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.12-1.

**Table 5.2.3.1.12-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance when UE is configured two different values of CORESETPoolIndex in ControlResourceSet and when UE receives multiple PDCCHs scheduling PDSCHs | 1-1 |

**Table 5.2.3.1.12-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | **TRxP #1(Note 1)** | **TRxP #2(Note 1)** |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | TCI State #2 |
| | CORESETPoolIndex | | | 0,1 | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 20 | |
| | CSI-RS offset | | Slots | 10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4 | 10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | FDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | 2 | |
| | Resource allocation type | | | Type 1 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | {1000,1001} | {1002,1003} |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Resource allocation | | | | Non-overlapping | |
| Timing offset of the second TRxP from the first TRxP | | | us | -0.5 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 200 | |
| Number of HARQ Processes | | | | 4 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | 2 | |
| Precoding configuration | | | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity | |

| | |
|---|---|
| Note 1: | PDSCH transmission is done from both TRxPs. Transmission from TRxP #1 uses CORESETPoolIndex 0 and transmission from TRxP #2 uses CORESETPoolIndex 1 |

**Table 5.2.3.1.12-3: Minimum performance**

| Test num. | Reference channel | | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition(Note 1) | Correlation matrix and antenna configuration(Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB)(Note 3) |
| 1-1 | R.PDSCH.1-3.3 FDD | R.PDSCH.1-3.4 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x4, ULA Low | 70 | 14.6 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | | |

#### 5.2.3.1.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A

The performance requirements are specified in Table 5.2.3.1.13-3, with the addition of test parameters in Table 5.2.3.1.13-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.13-1.

**Table 5.2.3.1.13-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 4 receive antenna conditions when UE is configured with “FDMSchemeA” in “RepetitionScheme-r16” defined in clause 5.1 of TS 38.214 [12] | 1-1 |

**Table 5.2.3.1.13-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1 (Note 1) | TRxP #2 (Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | |
| | CORESETPoolIndex | | | Not configured | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 20 | |
| | CSI-RS offset | | Slots | 10 for CSI-RS resources 1 and 2<br>11 for CSI-RS resources 3 and 4 | 10 for CSI-RS resources 5 and 6<br>11 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | FDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | wideband | |
| | Resource allocation type | | | Type 0 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | 1000, 1001 | 1000, 1001 |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Timing offset of the second TRxP from the first TRxP | | | us | -0.5 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 200 | |
| Number of HARQ Processes | | | | 4 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | 2 | |
| Precoding configuration | | | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity. | |
| Note 1: PDSCH transmission is done from both TRxPs | | | | | |

**Table 5.2.3.1.13-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition (Note 1) | Correlation matrix and antenna configuration (Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fraction of maximum throughput (%) | SNR (dB) (Note 3) |
| 1-1 | R.PDSCH.1-2.5 FDD | 10 / 15 | 16QAM, 0.54 | TDLA30-10 | 2x4, ULA Low | 70 | 10. 9 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent.<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2.<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | |

### 5.2.3.1.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme

The performance requirements are specified in Table 5.2.3.1.14-3, with the addition of test parameters in Table 5.2.3.1.14-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.14-1.

**Table 5.2.3.1.14-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 4 receive antenna conditions when UE is configured with repetitionNumber-r16 with multiple slot level PDSCH transmission occasions of the same TB with two TCI states defined in clause 5.1 of TS 38.214 [12] | 1-1 |

**Table 5.2.3.1.14-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1 (Note 1) | TRxP #2 (Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | |
| | CORESETPoolIndex | | | Not configured | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 20 | |
| | CSI-RS offset | | Slots | 10 for CSI-RS resources 1 and 2<br>11 for CSI-RS resources 3 and 4 | 10 for CSI-RS resources 5 and 6<br>11 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | FDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | Repetition number | | | 2 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | 2 | |
| | Resource allocation type | | | Type 0 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | 1000 | 1000 |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Timing offset of the second TRxP from the first TRxP | | | us | 2 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 200 | |
| Number of HARQ Processes | | | | 4 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | 2 | |
| Precoding configuration | | | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity. | |

| Note 1: PDSCH transmission is done from both TRxPs |
|---|

**Table 5.2.3.1.14-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition (Note 1) | Correlation matrix and antenna configuration (Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | BLER (%) | SNR (dB) (Note 4) |
| 1-1 | R.PDSCH.1-11.2 FDD | 10 / 15 | 16QAM, 0.54 | TDLA30-10 | 2x4, ULA Low | 1 (Note 3) | -0. 4 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent.<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2.<br>Note 3: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block.<br>Note 4: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | |

## 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, 1-7, 1-8, 1-9, 1-10, 1-11, 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 performance requirements for Enhanced Receiver Type 1 under 4 receive antenna conditions. | 5-1 |

**Table 5.2.3.2.1-2: Test parameters**

<table>
<tr><th colspan="2">Parameter</th><th>Unit</th><th>Value</th></tr>
<tr><td colspan="2">Duplex mode</td><td></td><td>TDD</td></tr>
<tr><td colspan="2">Active DL BWP index</td><td></td><td>1</td></tr>
<tr><td rowspan="11">PDSCH configuration</td><td>Mapping type</td><td></td><td>Type A</td></tr>
<tr><td>k0</td><td></td><td>0</td></tr>
<tr><td>Starting symbol (S)</td><td></td><td>2</td></tr>
<tr><td>Length (L)</td><td></td><td>Specific to each Reference channel</td></tr>
<tr><td>PDSCH aggregation factor</td><td></td><td>1</td></tr>
<tr><td>PRB bundling type</td><td></td><td>Static</td></tr>
<tr><td>PRB bundling size</td><td></td><td>4 for Tests 1-1, 1-8, 1-9<br>wideband for Test 3-1<br>2 for other tests</td></tr>
<tr><td>Resource allocation type</td><td></td><td>Test 1-2: Type 1 with start RB = 50, $L_{RBs}$ = 6<br>Other tests: Type 0</td></tr>
<tr><td>RBG size</td><td></td><td>Test 1-2: N/A<br>Other tests: Config2</td></tr>
<tr><td>VRB-to-PRB mapping type</td><td></td><td>Non-interleaved</td></tr>
<tr><td>VRB-to-PRB mapping interleaver bundle size</td><td></td><td>N/A</td></tr>
<tr><td rowspan="3">PDSCH DMRS configuration</td><td>DMRS Type</td><td></td><td>Type 1</td></tr>
<tr><td>Number of additional DMRS</td><td></td><td>2 for Tests 1-1, 1-7, 1-8, 1-9, 1-10, 1-11<br>1 for other tests</td></tr>
<tr><td>Maximum number of OFDM symbols for DL front loaded DMRS</td><td></td><td>1</td></tr>
<tr><td rowspan="4">CSI-RS for tracking</td><td>First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>Tests 1-8, 1-9:<br>$l_0$ = 4 for CSI-RS resource 1 and 3<br>$l_0$ = 8 for CSI-RS resource 2 and 4<br><br>Other tests; Table 5.2-1.</td></tr>
<tr><td>CSI-RS periodicity</td><td>Slots</td><td>Test 1-7, 1-10, 1-11:<br>20 for CSI-RS resource 1,2,3,4.<br><br>Other tests: Table 5.2-1.</td></tr>
<tr><td>CSI-RS offset</td><td>Slots</td><td>Test 1-7, 1-10, 1-11:<br>1 for CSI-RS resource 1 and 2<br>2 for CSI-RS resource 3 and 4.<br><br>Other tests: Table 5.2-1.</td></tr>
<tr><td>Frequency Occupation</td><td></td><td>Test 1-7, 1-10, 1-11:<br>Start PRB 0<br>Number of PRB = 52<br><br>Other tests: Table 5.2-1.</td></tr>
<tr><td colspan="2">Number of HARQ Processes</td><td></td><td>16 for Test 1-4<br>10 for Test 1-9<br>8 for other tests</td></tr>
<tr><td colspan="2">The number of slots between PDSCH and corresponding HARQ-ACK information</td><td></td><td>Specific to each TDD UL-DL pattern and as defined in Annex A.1.2</td></tr>
</table>

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | QPSK, 0.30 | FR1.30-1A | TDLB100-400 | 2x4, ULA Low | 70 | -4.1 |
| 1-2 | R.PDSCH.2-1.2 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-1 | TDLC300-100 | 2x4, ULA Low | 70 | -2.7 |
| 1-3 | R.PDSCH.2-4.1 TDD | 40 / 30 | 256QAM, 0.82 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | 21.6 |
| 1-4 | R.PDSCH.2-2.1 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | TDLC300-100 | 2x4, ULA Low | 30 | -1.2 |
| 1-5 | R.PDSCH.2-5.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-2 | TDLA30-10 | 2x4, ULA Low | 70 | -3.8 |
| 1-6 | R.PDSCH.2-6.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-3 | TDLA30-10 | 2x4, ULA Low | 70 | -3.6 |
| 1-7 | R.PDSCH.2-10.1 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | HST-1000 | 1x4 | 70 | 3.4 |
| 1-8 | R.PDSCH.2-11.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-5 | TDLB100-400 | 2x4, ULA Low | 70 | -4.0 |
| 1-9 | R.PDSCH.2-12.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-6 | TDLB100-400 | 2x4, ULA Low | 70 | -4.0 |
| 1-10 | R.PDSCH.2-10.2 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | TDLC300-1200 | 2x4 | 70 | 5.8 |
| 1-11 | R.PDSCH.2-10.3 TDD | 40 / 30 | 64QAM, 0.43 | FR1.30-1 | HST-1667 | 1x4 | 70 | 6.8 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | 13.6 |
| 2-2 | R.PDSCH.2-9.1 TDD | 20 / 30 | 64QAM, 0.50 | FR1.30-4 | TDLA30-10 | 2x4, ULA Low | 70 | 13.7 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | 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 | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | TDLA30-10 | 4x4, ULA Low | 70 | 15.4 |

**Table 5.2.3.2.1-7: Minimum performance for Rank 3 and Enhanced Receiver Type 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | 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 |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| NZP CSI-RS for CSI acquisition | OFDM symbols in the PRB used for CSI-RS | | $l_0$ = 13 |
| | CSI-RS periodicity | Slots | 5 |
| ZP CSI-RS for CSI acquisition | Subcarrier index in the PRB used for CSI-RS | | ($k_0$, $k_1$, $k_2$, $k_3$)=(2, 4, 6, 8) |
| | Number of CSI-RS ports (X) | | 8 |
| | CSI-RS periodicity | Slots | 5 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | TDLC300-100 | 2x4, 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 |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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 | 40 / 30 | QPSK, 0.30 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | -3.9 |

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

The performance requirements are specified in Table 5.2.3.2.4-3, with the addition of test parameters in Table 5.2.3.2.4-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.4-1.

**Table 5.2.3.2.4-1: 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 5.2.3.2.4-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| NR UL transmission with a 7.5 kHz shift to the LTE raster | | | true |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 3 |
| | Length (L) | | 9 for Test 1-1<br>11 for Test 1-2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Position of the first DM-RS for downlink | | 3 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CRS for rate matching (Note 1) | 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 | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |
| Note 1: No MBSFN is configured on LTE carrier | | | |

**Table 5.2.3.2.4-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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.1-1.1 TDD | 10 / 15 | QPSK, 0.30 | FR1.15-1 | TDLA30-10 | 4x4, ULA Low | 70 | -3.6 |
| 1-2 | R.PDSCH.1-1.2 TDD | 10 / 15 | QPSK, 0.30 | FR1.15-1 | TDLA30-10 | 4x4, ULA Low | 70 | -3.5 |

### 5.2.3.2.5 Minimum requirements for PDSCH 0.001% BLER

The performance requirements are specified in Table 5.2.3.2.5-3, with the addition of test parameters in Table 5.2.3.2.5-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.5-1.

**Table 5.2.3.2.5-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH 0.001% BLER performance under 4 receive antenna conditions | 1-1 |

**Table 5.2.3.2.5-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Maximum number of HARQ transmission | | | 1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Defined in Annex A.1.2 for TDD pattern FR1.30-1 |

**Table 5.2.3.2.5-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH.2-1.4 TDD | 40 / 30 | QPSK, 0.59 | FR1.30-1 | AWGN | 1x4, ULA Low | 0.001% | 0. 7 |

### 5.2.3.2.6 Minimum requirements for PDSCH repetitions over multiple slots

The performance requirements are specified in Table 5.2.3.2.6-3, with the addition of test parameters in Table 5.2.3.2.6-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.6-1.

**Table 5.2.3.2.6-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH repetitions over multiple slots performance under 4 receive antenna conditions | 1-1 |

**Table 5.2.3.2.6-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | 12 |
| | PDSCH aggregation factor | | 2 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 4 |
| The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 (Note 1) |
| Note 1: ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,10) = {2, 4, 6}. | | | |

**Table 5.2.3.2.6-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH.2-16.1 TDD | 40 / 30 | 16QAM, 0.54 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 1% (Note 1) | -2.6 |
| Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. | | | | | | | | |

### 5.2.3.2.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2

The performance requirements are specified in Table 5.2.3.2.7-3, with the addition of test parameters in Table 5.2.3.2.7-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.7-1.

**Table 5.2.3.2.7-1: Tests purpose**

| Purpose | Test index |
|---|---|
| PDSCH mapping Type B performance and UE processing capability 2 under four receive antenna conditions | 1-1 |

**Table 5.2.3.2.7-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type B |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |

| | | | |
|---|---|---|---|
| | Length (L) | | 2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 0 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Maximum number of HARQ transmission | | | 1 |
| Number of HARQ Processes | | | 2 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 0 |

**Table 5.2.3.2.7-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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.2-17.1 TDD | 40 / 30 | QPSK, 0.30 | FR1.30-2 | TDLA30-10 | 2x4, ULA Low | 70 | -2.5 |

### 5.2.3.2.8 Minimum requirements for PDSCH pre-emption

The performance requirements are specified in Table 5.2.3.2.8-3, with the addition of test parameters in Table 5.2.3.2.8-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.8-1.

**Table 5.2.3.2.8-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH pre-emption performance under 4 receive antenna conditions | 1-1 |

**Table 5.2.3.2.8-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDCCH configuration (Note 4) | Symbols with PDCCH | | 0, 1 |
| | DCI format | | 2_1 |
| | timeFrequencySet | | 14x1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Pre-emption configuration (Note 2) | Starting symbol (S) | | 3 |
| | Length (L) | | 2 |
| | Pre-emption periodicity and offset | Slots | 40/(1,12,23,34) (Note 3) |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | FR1.30-1 |
| Note 1: Void<br>Note 2: Interference modelled as random data on pre-empted REs.<br>Note 3: Pre-emption is scheduled with with 10% probability with 20ms periodicity.<br>Note 4: In addition to PDCCH configuration in Table 5.2-1. | | | |

**Table 5.2.3.2.8-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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. 2-2.6 TDD | 40 / 30 | 16QAM 0.64 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | 8.7 |

### 5.2.3.2.9 Minimum requirements for HST-SFN

The performance requirements are specified in Table 5.2.3.2.9-3, with the addition of test parameters in Table 5.2.3.2.9-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.9-1.

**Table 5.2.3.2.9-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 4 receive antenna conditions in the HST-SFN scenario defined in B.3.2 when *highSpeedDemodFlag-r16* [17] is configured. | 1-1 |

**Table 5.2.3.2.9-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| 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 |
| | RBG size | | Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | CSI-RS periodicity | Slots | 20 for CSI-RS resource 1,2,3,4. |
| | CSI-RS offset | Slots | 1 for CSI-RS resource 1 and 22 for CSI-RS resource 3 and 4. |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = 52 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

**Table 5.2.3.2.9-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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.2-10.4 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-1 | HST-SFN | 2x4 | 70 | 11.7 |

### 5.2.3.2.10 Minimum requirements for HST-DPS

The performance requirements are specified in Table 5.2.3.2.10-3, with the addition of test parameters in Table 5.2.3.2.10-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.10-1.

**Table 5.2.3.2.10-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify UE performance in the HST-DPS scenario defined in B.3.3 | 1-1, 1-2 |

**Table 5.2.3.2.10-2: Test parameters**

| Parameter | | | Unit | Value |
|---|---|---|---|---|
| Duplex mode | | | | TDD |
| Active DL BWP index | | | | 1 |
| PDCCH configuration | TCI state | | | Note 1 |
| PDSCH configuration | Mapping type | | | Type A |
| | k0 | | | 0 |
| | Starting symbol (S) | | | 2 |
| | Length (L) | | | Specific to each Reference channel |
| | PDSCH aggregation factor | | | 1 |
| | PRB bundling type | | | Static |
| | PRB bundling size | | | 2 |
| | Resource allocation type | | | Type 0 |
| | RBG size | | | Config2 |
| | VRB-to-PRB mapping type | | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A |
| | TCI state | | | Note 1 |
| PDSCH DMRS configuration | DMRS Type | | | Type 1 |
| | Number of additional DMRS | | | 2 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 |
| CSI-RS for tracking | Resource set #1 | First OFDM symbol in the PRB used for CSI-RS | | l0 = 5 for CSI-RS resource 1 and 3 |
| | | | | l0 = 9 for CSI-RS resource 2 and 4 |
| | | CSI-RS periodicity | Slots | 20 for CSI-RS resource 1,2,3,4 |
| | | CSI-RS offset | Slots | 1 for CSI-RS resource 1 and 2 |
| | | | | 2 for CSI-RS resource 3 and 4 |
| | | QCL info | | TCI state #2 |
| | | Frequency Occupation | | Start PRB 0 |
| | | | | Number of PRB = 52 |
| | Resource set #2 | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 6 for CSI-RS resource 5 and 6 |
| | | | | $l_0$ = 10 for CSI-RS resource 7 and 8 |
| | | CSI-RS periodicity | Slots | 20 for CSI-RS resource 5,6,7,8. |
| | | CSI-RS offset | Slots | 1 for CSI-RS resource 5 and 6 |
| | | | | 2 for CSI-RS resource 7 and 8 |
| | | QCL info | | TCI state #3 |
| | | Frequency Occupation | | Start PRB 0 |
| | | | | Number of PRB = 52 |
| NZP CSI-RS for CSI acquisition | Resource set #3 | First OFDM symbol in the PRB used for CSI-RS | | l0 = 12 |
| | | CSI-RS periodicity | Slots | 40 |
| | | CSI-RS offset | Slots | 0 |
| | | QCL info | | TCI state #0 |
| | Resource set #4 | First OFDM symbol in the PRB used for CSI-RS | | l0 = 13 |
| | | CSI-RS periodicity | Slots | 40 |
| | | CSI-RS offset | Slots | 0 |
| | | QCL info | | TCI state #1 |
| TCI state #0 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration |
| | | QCL Type | | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A |
| | | QCL Type | | N/A |
| TCI state #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration |
| | | QCL Type | | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A |
| | | QCL Type | | N/A |
| TCI state #2 | 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 #3 | Type 1 QCL information | SSB index | | SSB #1 |
| | | QCL Type | | Type C |
| | Type 2 QCL information | SSB index | | N/A |
| | | QCL Type | | N/A |

| | | |
|---|---|---|
| Number of HARQ Processes | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |
| Note 1: SSB # (k mod 2) , CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by k[th] RRH.<br>For Test 1-1, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i}, 2\mathrm{n}) = \mathrm{n}$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot# $\max[(2\mathrm{k}-1)\mathrm{n}+1+\mathrm{T_{HARQ}}+\mathrm{T_{MAC\ proc}}+\mathrm{T_{firstTRS}}+\mathrm{T_{TRS\ proc}}, 0]$<br>to slot# $(2\mathrm{k}+1)\mathrm{n}+\mathrm{T_{HARQ}}+\mathrm{T_{MAC\ proc}},$<br>PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.<br>For Test 1-2, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i}, 2\mathrm{n}) = \mathrm{n}$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot# $\max[(2\mathrm{k}-1)\mathrm{n}+1+\mathrm{T_{HARQ}}+\mathrm{T_{MAC\ proc}}, 0]$<br>to slot# $(2\mathrm{k}+1)\mathrm{n}+\mathrm{T_{HARQ}}+\mathrm{T_{MAC\ proc}}$<br>Where k=0, 1, 2… is the RRH number, n = 5040 is half of the number of slots between two RRH, $\mathrm{T_{HARQ}}$ = 8 is the number of slots between PDSCH and corresponding HARQ-ACK information, $\mathrm{T_{MAC\ proc}}$ = 6 is the number of slots for MAC CE processing, $\mathrm{T_{firstTRS}}$ = 7 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $\mathrm{T_{TRS\ proc}}$ = 4 is the number of slots for TRS processing. | | |

**Table 5.2.3.2.10-3: Minimum performance for HST-DPS**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Number of active PDSCH TCI states | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 1-1 | R.PDSCH.2-10.5 TDD | 40 / 30 | 64QAM, 0.43 | HST-DPS | 1 | 2x4 | 70 | 10.2 |
| 1-2 | R.PDSCH.2-10.5 TDD | 40 / 30 | 64QAM, 0.43 | HST-DPS | 2 | 2x4 | 70 | 10.2 |

### 5.2.3.2.11 Minimum requirements for PDSCH Single-DCI based SDM scheme

The performance requirements are specified in Table 5.2.3.2.11-3, with the addition of test parameters in Table 5.2.3.2.11-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.11-1.

**Table 5.2.3.2.11-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance with Single-DCI based SDM scheme under 4 receive antenna conditions. | 1-1,1-2 |

**Table 5.2.3.2.11-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1(Note 1) | TRxP #2(Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | |
| | CORESETPoolIndex | | | 0 | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 40 | |
| | CSI-RS offset | | Slots | 20 for CSI-RS resources 1 and 2<br>21 for CSI-RS resources 3 and 4 | 20 for CSI-RS resources 5 and 6<br>21 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | TDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | 2 | |
| | Resource allocation type | | | Type 1 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | 1000 | 1002 |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Resource allocation | | | | Full-overlappling | |
| Timing offset of the second TRxP from the first TRxP | | | us | -0.25 for test 1-1<br>1 for test 1-2 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 300 for test 1-1<br>0 for test 1-2 | |
| Number of HARQ Processes | | | | 8 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 | |

| | | |
|---|---|---|
| Precoding configuration | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity. |
| Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2) | | |

**Table 5.2.3.2.11-3: Minimum performance**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition(Note 1) | Correlation matrix and antenna configuration(Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB)(Note 3) |
| 1-1 | R.PDSCH.2-3.2 TDD | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | 14.5 |
| 1-2 | R.PDSCH.2-3.2 TDD | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | 13.9 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 with scaling factor as 1/sqrt(2) for transmitted signal from each TRxP | | | | | | | | |

### 5.2.3.2.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme

The performance requirements are specified in Table 5.2.3.2.12-3, with the addition of test parameters in Table 5.2.3.2.12-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.12-1.

**Table 5.2.3.2.12-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance when UE is configured two different values of CORESETPoolIndex in ControlResourceSet and when UE receives multiple PDCCHs scheduling PDSCHs | 1-1 |

**Table 5.2.3.2.12-2: Test parameters**

<table>
<tr><th colspan="3" rowspan="2">Parameter</th><th rowspan="2">Unit</th><th colspan="2">Value</th></tr>
<tr><th>TRxP #1(Note 1)</th><th>TRxP #2(Note 1)</th></tr>
<tr><td colspan="3">Transmit TRxP of SSB</td><td></td><td colspan="2">TRxP #1</td></tr>
<tr><td rowspan="2">PDCCH configuration</td><td colspan="2">TCI state</td><td></td><td>TCI State #1</td><td>TCI State #2</td></tr>
<tr><td colspan="2">CORESETPoolIndex</td><td></td><td colspan="2">0,1</td></tr>
<tr><td rowspan="8">CSI-RS for tracking</td><td colspan="2">First subcarrier index in the PRB used for CSI-RS</td><td></td><td>k0=0 for CSI-RS resources 1,2,3,4</td><td>k0=1 for CSI-RS resources 5,6,7,8</td></tr>
<tr><td colspan="2">First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4</td><td>l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8</td></tr>
<tr><td colspan="2">Number of CSI-RS ports (X)</td><td></td><td>1 for CSI-RS resource 1,2,3,4</td><td>1 for CSI-RS resource 5,6,7,8</td></tr>
<tr><td colspan="2">CDM Type</td><td></td><td colspan="2">'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8</td></tr>
<tr><td colspan="2">Density</td><td></td><td colspan="2">3</td></tr>
<tr><td colspan="2">CSI-RS periodicity</td><td>Slots</td><td colspan="2">40</td></tr>
<tr><td colspan="2">CSI-RS offset</td><td>Slots</td><td>20 for CSI-RS resources 1 and 2<br>21 for CSI-RS resources 3 and 4</td><td>20 for CSI-RS resources 5 and 6<br>21 for CSI-RS resources 7 and 8</td></tr>
<tr><td colspan="2">QCL info</td><td></td><td colspan="2">TCI state #0</td></tr>
<tr><td colspan="3">Duplex mode</td><td></td><td colspan="2">TDD</td></tr>
<tr><td colspan="3">Active DL BWP index</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="10">PDSCH configuration</td><td colspan="2">Mapping type</td><td></td><td colspan="2">Type A</td></tr>
<tr><td colspan="2">k0</td><td></td><td colspan="2">0</td></tr>
<tr><td colspan="2">Starting symbol (S)</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Length (L)</td><td></td><td colspan="2">12</td></tr>
<tr><td colspan="2">PRB bundling type</td><td></td><td colspan="2">Static</td></tr>
<tr><td colspan="2">PRB bundling size</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Resource allocation type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">RBG size</td><td></td><td colspan="2">Config2</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping type</td><td></td><td colspan="2">Non-interleaved</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping interleaver bundle size</td><td></td><td colspan="2">N/A</td></tr>
<tr><td rowspan="5">PDSCH DMRS configuration</td><td colspan="2">Antenna port indexes</td><td></td><td>{1000,1001}</td><td>{1002,1003}</td></tr>
<tr><td colspan="2">TCI state</td><td></td><td>TCI State #1</td><td>TCI State #2</td></tr>
<tr><td colspan="2">DMRS Type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">Number of additional DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Maximum number of OFDM symbols for DL front loaded DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="4">TCI State #1</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>CSI-RS resource 1 from 'CSI-RS for tracking' configuration</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>Type A</td><td>N/A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="4">TCI State #2</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>CSI-RS resource 5 from 'CSI-RS for tracking' configuration</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>Type A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">Resource allocation</td><td></td><td colspan="2">Non-overlapping</td></tr>
<tr><td colspan="3">Timing offset of the second TRxP from the first TRxP</td><td>us</td><td colspan="2">-0.25</td></tr>
<tr><td colspan="3">Frequency offset of the second TRxP from the first TRxP</td><td>Hz</td><td colspan="2">300</td></tr>
<tr><td colspan="3">Number of HARQ Processes</td><td></td><td colspan="2">8</td></tr>
<tr><td colspan="3">The number of slots between PDSCH and corresponding HARQ-ACK information</td><td></td><td colspan="2">Specific to each TDD UL-DL pattern and as defined in Annex A.1.2</td></tr>
<tr><td colspan="3">Precoding configuration</td><td></td><td colspan="2">SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity</td></tr>
</table>

| |
|---|
| Note 1: PDSCH transmission is done from both TRxPs. Transmission from TRxP #1 uses CORESETPoolIndex 0 and transmission from TRxP #2 uses CORESETPoolIndex 1 |

**Table 5.2.3.2.12-3: Minimum performance**

| Test num. | Reference channel | | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition(Note 1) | Correlation matrix and antenna configuration(Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Fraction of maximum throughput (%) | SNR (dB)(Note 3) |
| | TRxP #1 | TRxP #2 | | | | | | | |
| 1-1 | R.PDSCH.2-3.3 TDD | R.PDSCH.2-3.4 TDD | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | 14. 6 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | | | |

### 5.2.3.2.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A

The performance requirements are specified in Table 5.2.3.2.13-3, with the addition of test parameters in Table 5.2.3.2.13-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.13-1.

**Table 5.2.3.2.13-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 4 receive antenna conditions when UE is configured with "FDMSchemeA" in "RepetitionScheme-r16" defined in clause 5.1 of TS 38.214 [12] | 1-1 |

**Table 5.2.3.1.13-2: Test parameters**

| Parameter | | | Unit | Value | |
|---|---|---|---|---|---|
| | | | | TRxP #1 (Note 1) | TRxP #2 (Note 1) |
| Transmit TRxP of SSB | | | | TRxP #1 | |
| PDCCH configuration | TCI state | | | TCI State #1 | |
| | CORESETPoolIndex | | | Not configured | |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS | | | k0=0 for CSI-RS resources 1,2,3,4 | k0=1 for CSI-RS resources 5,6,7,8 |
| | First OFDM symbol in the PRB used for CSI-RS | | | l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4 | l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8 |
| | Number of CSI-RS ports (X) | | | 1 for CSI-RS resource 1,2,3,4 | 1 for CSI-RS resource 5,6,7,8 |
| | CDM Type | | | 'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8 | |
| | Density | | | 3 | |
| | CSI-RS periodicity | | Slots | 40 | |
| | CSI-RS offset | | Slots | 20 for CSI-RS resources 1 and 2<br>21 for CSI-RS resources 3 and 4 | 20 for CSI-RS resources 5 and 6<br>21 for CSI-RS resources 7 and 8 |
| | QCL info | | | TCI state #0 | |
| Duplex mode | | | | TDD | |
| Active DL BWP index | | | | 1 | |
| PDSCH configuration | Mapping type | | | Type A | |
| | k0 | | | 0 | |
| | Starting symbol (S) | | | 2 | |
| | Length (L) | | | 12 | |
| | PRB bundling type | | | Static | |
| | PRB bundling size | | | wideband | |
| | Resource allocation type | | | Type 0 | |
| | RBG size | | | Config2 | |
| | VRB-to-PRB mapping type | | | Non-interleaved | |
| | VRB-to-PRB mapping interleaver bundle size | | | N/A | |
| PDSCH DMRS configuration | Antenna port indexes | | | 1000, 1001 | 1000, 1001 |
| | TCI state | | | TCI State #1 | TCI State #2 |
| | DMRS Type | | | Type 1 | |
| | Number of additional DMRS | | | 1 | |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | | 1 | |
| TCI State #1 | Type 1 QCL information | CSI-RS resource | | CSI-RS resource 1 from 'CSI-RS for tracking' configuration | N/A |
| | | QCL Type | | Type A | N/A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| TCI State #2 | Type 1 QCL information | CSI-RS resource | | N/A | CSI-RS resource 5 from 'CSI-RS for tracking' configuration |
| | | QCL Type | | N/A | Type A |
| | Type 2 QCL information | CSI-RS resource | | N/A | N/A |
| | | QCL Type | | N/A | N/A |
| Timing offset of the second TRxP from the first TRxP | | | us | -0.25 | |
| Frequency offset of the second TRxP from the first TRxP | | | Hz | 300 | |
| Number of HARQ Processes | | | | 8 | |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 | |
| Precoding configuration | | | | SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity. | |
| Note 1: PDSCH transmission is done from both TRxPs | | | | | |

**Table 5.2.3.2.13-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition (Note 1) | Correlation matrix and antenna configuration (Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | SNR (dB) (Note 3) |
| 1-1 | R.PDSCH.2-2.5 TDD | 40 / 30 | 16QAM, 0.54 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 70 | 10.5 |
| Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent.<br>Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2.<br>Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 | | | | | | | | |

#### 5.2.3.2.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme

The performance requirements are specified in Table 5.2.3.2.14-3, with the addition of test parameters in Table 5.2.3.2.14-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.14-1.

**Table 5.2.3.2.14-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance under 4 receive antenna conditions when UE is configured with repetitionNumber-r16 with multiple slot level PDSCH transmission occasions of the same TB with two TCI states defined in clause 5.1 of TS 38.214 [12] | 1-1 |

**Table 5.2.3.2.14-2: Test parameters**

<table>
<tr><th colspan="3" rowspan="2">Parameter</th><th rowspan="2">Unit</th><th colspan="2">Value</th></tr>
<tr><th>TRxP #1 (Note 1)</th><th>TRxP #2 (Note 1)</th></tr>
<tr><td colspan="3">Transmit TRxP of SSB</td><td></td><td colspan="2">TRxP #1</td></tr>
<tr><td rowspan="2">PDCCH configuration</td><td colspan="2">TCI state</td><td></td><td colspan="2">TCI State #1</td></tr>
<tr><td colspan="2">CORESETPoolIndex</td><td></td><td colspan="2">Not configured</td></tr>
<tr><td rowspan="9">CSI-RS for tracking</td><td colspan="2">First subcarrier index in the PRB used for CSI-RS</td><td></td><td>k0=0 for CSI-RS resources 1,2,3,4</td><td>k0=1 for CSI-RS resources 5,6,7,8</td></tr>
<tr><td colspan="2">First OFDM symbol in the PRB used for CSI-RS</td><td></td><td>l0 = 6 for CSI-RS resources 1 and 3<br>l0 = 10 for CSI-RS resources 2 and 4</td><td>l0 = 6 for CSI-RS resources 5 and 7<br>l0 = 10 for CSI-RS resources 6 and 8</td></tr>
<tr><td colspan="2">Number of CSI-RS ports (X)</td><td></td><td>1 for CSI-RS resource 1,2,3,4</td><td>1 for CSI-RS resource 5,6,7,8</td></tr>
<tr><td colspan="2">CDM Type</td><td></td><td colspan="2">'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8</td></tr>
<tr><td colspan="2">Density</td><td></td><td colspan="2">3</td></tr>
<tr><td colspan="2">CSI-RS periodicity</td><td>Slots</td><td colspan="2">40</td></tr>
<tr><td colspan="2">CSI-RS offset</td><td>Slots</td><td>20 for CSI-RS resources 1 and 2<br>21 for CSI-RS resources 3 and 4</td><td>20 for CSI-RS resources 5 and 6<br>21 for CSI-RS resources 7 and 8</td></tr>
<tr><td colspan="2">QCL info</td><td></td><td colspan="2">TCI state #0</td></tr>
<tr><td colspan="3">Duplex mode</td><td></td><td colspan="2">TDD</td></tr>
<tr><td colspan="3">Active DL BWP index</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="11">PDSCH configuration</td><td colspan="2">Mapping type</td><td></td><td colspan="2">Type A</td></tr>
<tr><td colspan="2">k0</td><td></td><td colspan="2">0</td></tr>
<tr><td colspan="2">Starting symbol (S)</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Length (L)</td><td></td><td colspan="2">12</td></tr>
<tr><td colspan="2">Repetition number</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">PRB bundling type</td><td></td><td colspan="2">Static</td></tr>
<tr><td colspan="2">PRB bundling size</td><td></td><td colspan="2">2</td></tr>
<tr><td colspan="2">Resource allocation type</td><td></td><td colspan="2">Type 0</td></tr>
<tr><td colspan="2">RBG size</td><td></td><td colspan="2">Config2</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping type</td><td></td><td colspan="2">Non-interleaved</td></tr>
<tr><td colspan="2">VRB-to-PRB mapping interleaver bundle size</td><td></td><td colspan="2">N/A</td></tr>
<tr><td rowspan="5">PDSCH DMRS configuration</td><td colspan="2">Antenna port indexes</td><td></td><td>1000</td><td>1000</td></tr>
<tr><td colspan="2">TCI state</td><td></td><td>TCI State #1</td><td>TCI State #2</td></tr>
<tr><td colspan="2">DMRS Type</td><td></td><td colspan="2">Type 1</td></tr>
<tr><td colspan="2">Number of additional DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Maximum number of OFDM symbols for DL front loaded DMRS</td><td></td><td colspan="2">1</td></tr>
<tr><td rowspan="4">TCI State #1</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>CSI-RS resource 1 from 'CSI-RS for tracking' configuration</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>Type A</td><td>N/A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="4">TCI State #2</td><td rowspan="2">Type 1 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>CSI-RS resource 5 from 'CSI-RS for tracking' configuration</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>Type A</td></tr>
<tr><td rowspan="2">Type 2 QCL information</td><td>CSI-RS resource</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td>QCL Type</td><td></td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">Timing offset of the second TRxP from the first TRxP</td><td>us</td><td colspan="2">1</td></tr>
<tr><td colspan="3">Frequency offset of the second TRxP from the first TRxP</td><td>Hz</td><td colspan="2">300</td></tr>
<tr><td colspan="3">Number of HARQ Processes</td><td></td><td colspan="2">4</td></tr>
<tr><td colspan="3">The number of slots between PDSCH and corresponding HARQ-ACK information</td><td></td><td colspan="2">Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 (Note 2)</td></tr>
<tr><td colspan="3">Precoding configuration</td><td></td><td colspan="2">SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.</td></tr>
</table>

| | |
|---|---|
| Note 1: | PDSCH transmission is done from both TRxPs |
| Note 2: | ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,10) = {2, 4, 6}. |

**Table 5.2.3.2.14-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | TDD UL-DL pattern | Propagation condition (Note 1) | Correlation matrix and antenna configuration (Note 2) | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | BLER (%) | SNR (dB) (Note 4) |
| 1-1 | R.PDSCH.2-16.2 TDD | 40 / 30 | 16QAM, 0.54 | FR1.30-1 | TDLA30-10 | 2x4, ULA Low | 1 (Note 3) | -0.5 |

| | |
|---|---|
| Note 1: | The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. |
| Note 2: | Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. |
| Note 3: | BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. |
| Note 4: | SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 |

#### 5.2.3.2.15 Minimum requirements for PDSCH of PCell on band with shared spectrum access

The performance requirements are specified in Table 5.2.3.2.15-3, with the addition of test parameters in Table 5.2.3.2.15-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.15-1.

**Table 5.2.3.2.15-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify PDSCH performance for UE supporting operations in shared spectrum access | 1-1, 1-2, 1-3, 1-4 |

**Table 5.2.3.2.15-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| DL transmission model | | | As specified in B.5 |
| Downlink Model Parameters | SSB Q factor | | 8 |
| | Downlink transmission duration values | Slots | {2,4,6,7} |
| | Occupied OFDM symbols in slot other than the last slot of the downlink duration | Symbols | 14 |
| | Occupied OFDM symbols in the last slot of the downlink duration | Symbols | {6,9,12,14} (Note 1) |
| | Downlink period | ms | 5 |
| | LBT failure probability ($p_{LBT}$) | | 0.25 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | dmrs-AdditionalPosition | | pos1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |
| Note 1: If DL Transmission duration is 2 Slot, the occupied OFDM symbols in the last slot of the downlink duration is 14. | | | |

**Table 5.2.3.2.15-3: Minimum performance for Rank 2**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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.2-18.1 TDD | 20 / 30 | 16QAM, 0.48 | FR1.30-7 | TDLA30-10 | 2x4, ULA Low | 70 | 8.7 |
| 1-2 | R.PDSCH.2-18.2 TDD | 40 / 30 | 16QAM, 0.48 | FR1.30-7 | TDLA30-10 | 2x4, ULA Low | 70 | 8.7 |
| 1-3 | R.PDSCH.2-18.3 TDD | 60 / 30 | 16QAM, 0.48 | FR1.30-7 | TDLA30-10 | 2x4, ULA Low | 70 | 8.9 |
| 1-4 | R.PDSCH.2-18.4 TDD | 80 / 30 | 16QAM, 0.48 | FR1.30-7 | TDLA30-10 | 2x4, ULA Low | 70 | 9.1 |

# 5.2A PDSCH demodulation requirements for CA

The parameters specified in Table 5.2-1 for PDSCH single carrier tests are reused for PDSCH CA tests unless otherwise stated.

**Table 5.2A-1: Common test parameters for CA**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD and TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | FDD: 12TDD: Specific to each Reference channel |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | As defined in Table 5.2A-2 |
| TDD UL-DL pattern | | | 15kHz SCS: FR1.15-1<br>30kHz SCS: FR1.30-1 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | As defined in Table 5.2A-3 |
| Number of PUCCH ResourceGroups | | | 1 |
| PUCCH format for HARQ-ACK feedback | | | PUCCH format 1 for cases with no more chan 2 DL CCs<br>PUCCH format 3 for cases with more than 2 DL CCs |

**Table 5.2A-2: Test parameters for number of HARQ processes**

| HARQ process number | | CCs with the same duplex mode & SCS with Pcell | CCs with different duplex mode / SCS with Pcell |
|---|---|---|---|
| FDD 15 kHz + TDD 30 kHz CA | FDD PCell | 4 | 8 |
| | TDD PCell | 8 | 8 |
| FDD 15 kHz + TDD 15 kHz CA | FDD PCell | 4 | 4 |
| | TDD PCell | 8 | 8 |
| TDD 15 kHz + TDD 30 kHz CA | 15kHz PCell | 8 | 12 |
| | 30kHz PCell | 8 | 8 |
| FDD 15 kHz + FDD 15 kHz CA | FDD PCell | 4 | N/A |
| TDD 30 kHz + TDD 30 kHz CA | TDD PCell | 8 | N/A |

**Table 5.2A-3: Test parameters for K1 values**

| The number of slots between PDSCH and corresponding HARQ-ACK information | | CCs with the same duplex mode and SCS with Pcell | CCs with different duplex mode and/or SCS with Pcell |
|---|---|---|---|
| FDD 15 kHz + TDD 30 kHz CA | FDD PCell | {2} | {2} |
| | TDD PCell | {8,7,6,5,5,4,3,2} | {7,5,4,11,9} |
| FDD 15 kHz + TDD 15 kHz CA | FDD PCell | {2} | {2} |
| | TDD PCell | {4,3,2,6} | {4,3,2,6,5} |
| TDD 15 kHz + TDD 30 kHz CA | 15kHz PCell | {4,3,2,6} | {4,4,3,3,2,2,6,6} |
| | 30kHz PCell | {8,7,6,5,5,4,3,2} | {7,5,4,11} |
| FDD 15 kHz + FDD 15 kHz CA | FDD PCell | {2} | N/A |
| TDD 30 kHz + TDD 30 kHz CA | TDD PCell | {8,7,6,5,5,4,3,2} | N/A |

## 5.2A.1 1RX requirements

(Void)

## 5.2A.2 2RX requirements

### 5.2A.2.1 Minimum requirements

For CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.2.1-4 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.2.1-1 ~ Table 5.2A.2.1-3, with the parameters in Table 5.2A-1 ~ Table 5.2A-3 and the downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-cluase do not apply for UE single carrier test.

**Table 5.2A.2.1-1: Single carrier performance for FDD 15 kHz SCS for CA configurations**

| Bandwidth (MHz) | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 5 | R.PDSCH.1-9.1 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.6 |
| 10 | R.PDSCH.1-2.2 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.6 |
| 15 | R.PDSCH.1-9.2 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.6 |
| 20 | R.PDSCH.1-9.3 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.8 |
| 25 | R.PDSCH.1-9.4 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.0 |
| 30 | R.PDSCH.1-9.5 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.8 |
| 40 | R.PDSCH.1-10.1 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.0 |
| 50 | R.PDSCH.1-10.2 FDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.4 |

**Table 5.2A.2.1-2 Single carrier performance for TDD 15 kHz SCS for CA configurations**

| Bandwidth (MHz) | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 5 | R.PDSCH.1-2.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.6 |
| 10 | R.PDSCH.1-2.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.8 |
| 15 | R.PDSCH.1-2.3 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.8 |
| 20 | R.PDSCH.1-2.4 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.9 |
| 25 | R.PDSCH.1-2.5 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.0 |
| 30 | R.PDSCH.1-3.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.9 |
| 40 | R.PDSCH.1-3.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.2 |
| 50 | R.PDSCH.1-3.3 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.5 |

**Table 5.2A.2.1-3 Single carrier performance for TDD 30 kHz SCS for CA configurations**

| Bandwidth (MHz) | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 5 | R.PDSCH.2-13.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.6 |
| 10 | R.PDSCH.2-13.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.6 |
| 15 | R.PDSCH.2-13.3 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.6 |
| 20 | R.PDSCH.2-13.4 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.7 |
| 25 | R.PDSCH.2-13.5 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.7 |
| 30 | R.PDSCH.2-14.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.7 |
| 40 | R.PDSCH.2-2.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 13.9 |
| 50 | R.PDSCH.2-14.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.1 |
| 60 | R.PDSCH.2-14.3 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.0 |
| 80 | R.PDSCH.2-14.4 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.5 |
| 90 | R.PDSCH.2-14.5 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.3 |
| 100 | R.PDSCH.2-15.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x2, ULA Low | 70 | 14.7 |

**Table 5.2A.2.1-4: Minimum performance for multiple CA configurations**

| Test number | CA duplex mode | Minimum performance requirements |
|---|---|---|
| 1 | FDD 15 kHz + FDD 15 kHz | As defined in Table 5.2A.2.1-1 |
| 2 | TDD 30 kHz + TDD 30 kHz | As defined in Table 5.2A.2.1-3 |
| 3 | FDD 15 kHz + TDD 30 kHz | As defined in Table 5.2A.2.1-1 and Table 5.2A.2.1-3 per CC |
| 4 | FDD 15 kHz + TDD 15 kHz | As defined in Table 5.2A.2.1-1 and Table 5.2A.2.1-2 per CC |
| 5 | TDD 15 kHz + TDD 30 kHz | As defined in Table 5.2A.2.1-2 and Table 5.2A.2.1-3 per CC |
| Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.5. | | |

## 5.2A.2.2 Minimum requirements for carrier aggregation with power imbalance

The performance requirements are specified in Table 5.2A.2.2-3 and Table 5.2A.2.2-4, with the addition of test parameters in Table 5.2A.2.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2A.2.2-1.

**Table 5.2A.2.2-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the ability of an intra-band adjacent carrier aggregation UE to demodulate the signal transmitted by the PCell or SCell in the presence of a stronger SCell or PCell signal on an adjacent frequency. Throughput is measured on the PCell or SCell only | |

**Table 5.2A.2.2-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD and TDD |
| Active DL BWP index | | | 1 |
| Propagation condition | | | Static propagation condition<br>No external noise sources are applied |
| Antenna configuration | | | 1x2 |
| PDSCH configuration | Length (L) | | FDD: 12TDD: 12 for DL slot, 4 for special slot |
| | PRB bundling size | | WB |
| Modulation and code rate | | | 64QAM, MCS 26 |
| Number of HARQ Processes | | | FDD: 4<br>TDD: 8 |
| Maximum number of HARQ transmission | | | 1 |
| Redundancy version coding sequence | | | {0} |
| TDD UL-DL pattern | | | 30kHz SCS: FR1.30-1 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | As defined in Table A.1.2-2 for FR1.30-1 |
| PUCCH format for HARQ-ACK feedback | | | PUCCH format 1 |
| Overhead for TBS determination | | | 0 |
| SSB transmission | | | Slot#0 with periodicity 20ms |
| RB assignment | | | Full applicable test bandwidth as defined in Table 5.3.5-1 of TS 38.101-1 [6] |

**Table 5.2A.2.2-3: Minimum performance for FDD CA with 15 kHz SCS**

| Test Number | Bandwidth (MHz) | | Reference channel | | Power at antenna port (dBm/Hz) | | Reference value Fraction of Maximum Throughput (%) | |
|---|---|---|---|---|---|---|---|---|
| | PCell | SCell | PCell | SCell | $\hat{E}_{s\_PCell}$ for PCell | $\hat{E}_{s\_SCell}$ for Scell | PCell | SCell |
| 1 | Selected Channel bandwidth as per section 5.1.1.6 | | Derived as per section 5.1.3.2 of TS 38.214 [12] | NA | -112 | -106 | 85 | NA |

**Table 5.2A.2.2-4: Minimum performance for TDD CA with 30 kHz SCS**

| Test Number | Bandwidth (MHz) | | Reference channel | | Power at antenna port (dBm/Hz) | | Reference value Fraction of Maximum Throughput (%) | |
|---|---|---|---|---|---|---|---|---|
| | PCell | SCell | PCell | SCell | $\hat{E}_{s\_PCell}$ for PCell | $\hat{E}_{s\_SCell}$ for Scell | PCell | SCell |
| 1 | Selected Channel bandwidth as per section 5.1.1.6 | | Derived as per section 5.1.3.2 of TS 38.214 [12] | NA | -112 | -106 | 85 | NA |

### 5.2A.2.3 Minimum requirements for PDSCH of SCell on band with shared spectrum access

The performance requirements for SCell on band with shared spectrum access are specified in Table 5.2.2.2.15-3, with the additional test parameters for SCell in Table 5.2.2.2.15-2, the test parameters for PCell in Table 5.2A.2.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2A.2.3-1. During the test, only the PDSCH performance of the SCell should be verified.

**Table 5.2A.2.3-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance of SCell for UE supporting operations in shared spectrum access | 1-1, 1-2, 1-3, 1-4 |

**Table 5.2A.2.3-2: Test parameters for PCell**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Bandwidth | | MHz | 20 |
| Subcarrier spacing | | kHz | 30 |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | Specific to each Reference channel |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Dmrs-AdditionalPosition | | pos1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | First OFDM symbol in the PRB used for CSI-RS | | Table 5.2-1 |
| | CSI-RS periodicity | Slots | Table 5.2-1 |
| | CSI-RS offset | Slots | Table 5.2-1 |
| | Frequency Occupation | | Table 5.2-1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

## 5.2A.3 4RX requirements

### 5.2A.3.1 Minimum requirements

For CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.3.1-4 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.3.1-1 ~ Table 5.2A.3.1-3, with the parameters in Table 5.2A-1 ~ Table 5.2A-3 and the downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-cluase do not apply for UE single carrier test.

**Table 5.2A.3.1-1: Single carrier performance for FDD 15 kHz SCS for CA configurations**

| Bandwidth (MHz) | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 5 | R.PDSCH.1-9.1 FDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.5] |
| 10 | R.PDSCH.1-2.2 FDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.5] |
| 15 | R.PDSCH.1-9.2 FDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 20 | R.PDSCH.1-9.3 FDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 25 | R.PDSCH.1-9.4 FDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.7] |
| 30 | R.PDSCH.1-9.5 FDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 40 | R.PDSCH.1-10.1 FDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.7] |
| 50 | R.PDSCH.1-10.2 FDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.9] |

**Table 5.2A.3.1-2: Single carrier performance for TDD 15 kHz SCS for CA configurations**

| Bandwidth (MHz) | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 5 | R.PDSCH.1-2.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.5] |
| 10 | R.PDSCH.1-2.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 15 | R.PDSCH.1-2.3 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.7] |
| 20 | R.PDSCH.1-2.4 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 25 | R.PDSCH.1-2.5 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.8] |
| 30 | R.PDSCH.1-3.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 40 | R.PDSCH.1-3.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.8] |
| 50 | R.PDSCH.1-3.3 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [9.0] |

**Table 5.2A.3.1-3: Single carrier performance for TDD 30 kHz SCS for CA configurations**

| Bandwidth (MHz) | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 5 | R.PDSCH.2-13.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.5] |
| 10 | R.PDSCH.2-13.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.5] |
| 15 | R.PDSCH.2-13.3 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.5] |
| 20 | R.PDSCH.2-13.4 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 25 | R.PDSCH.2-13.5 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 30 | R.PDSCH.2-14.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.6] |
| 40 | R.PDSCH.2-2.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.7] |
| 50 | R.PDSCH.2-14.2 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.9] |
| 60 | R.PDSCH.2-14.3 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [8.8] |
| 80 | R.PDSCH.2-14.4 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [9.1] |
| 90 | R.PDSCH.2-14.5 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [9.0] |
| 100 | R.PDSCH.2-15.1 TDD | 16QAM, 0.48 | TDLA30-10 | 2x4, ULA Low | 70 | [9.3] |

**Table 5.2A.3.1-4: Minimum performance for multiple CA configurations**

| Test number | CA duplex mode | Minimum performance requirements |
|---|---|---|
| 1 | FDD 15 kHz + FDD 15 kHz | As defined in Table 5.2A.3.1-1 |
| 2 | TDD 30 kHz + TDD 30 kHz | As defined in Table 5.2A.3.1-3 |
| 3 | FDD 15 kHz + TDD 30 kHz | As defined in Table 5.2A.3.1-1 and Table 5.2A.3.1-3 per CC |
| 4 | FDD 15 kHz + TDD 15 kHz | As defined in Table 5.2A.3.1-1 and Table 5.2A.3.1-2 per CC |
| 5 | TDD 15 kHz + TDD 30 kHz | As defined in Table 5.2A.3.1-2 and Table 5.2A.3.1-3 per CC |
| Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.5. | | |

### 5.2A.3.2 Minimum requirements for carrier aggregation with power imbalance

The performance requirements are specified in Table 5.2A.3.2-3 and Table 5.2A.3.2-4, with the addition of test parameters in Table 5.2A.3.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2A.3.2-1.

**Table 5.2A.3.2-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the ability of an intra-band adjacent carrier aggregation UE to demodulate the signal transmitted by the PCell or SCell in the presence of a stronger SCell or PCell signal on an adjacent frequency. Throughput is measured on the PCell or SCell only | |

**Table 5.2A.3.2-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | FDD and TDD |
| Active DL BWP index | | | 1 |
| Propagation condition | | | Static propagation condition<br>No external noise sources are applied |
| Antenna configuration | | | 1x4 |
| PDSCH configuration | Length (L) | | FDD: 12TDD: 12 for DL slot, 4 for special slot |
| | PRB bundling size | | WB |
| Modulation and code rate | | | 64QAM, MCS 27 |
| Number of HARQ Processes | | | FDD: 4<br>TDD: 8 |
| Maximum number of HARQ transmission | | | 1 |
| Redundancy version coding sequence | | | {0} |
| TDD UL-DL pattern | | | 30kHz SCS: FR1.30-1 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | As defined in Table A.1.2-2 for FR1.30-1 |
| PUCCH format for HARQ-ACK feedback | | | PUCCH format 1 |
| Overhead for TBS determination | | | 0 |
| SSB transmission | | | Slot#0 with periodicity 20ms |
| RB assignment | | | Full applicable test bandwidth as defined in Table 5.3.5-1 of TS 38.101-1 [6] |

**Table 5.2A.3.2-3: Minimum performance for FDD CA with 15 kHz SCS**

| Test Number | Bandwidth (MHz) | | Reference channel | | Power at antenna port (dBm/Hz) | | Reference value Fraction of Maximum Throughput (%) | |
|---|---|---|---|---|---|---|---|---|
| | PCell | SCell | PCell | SCell | $\hat{E}_{s\_PCell}$ for PCell | $\hat{E}_{s\_SCell}$ for Scell | PCell | SCell |
| 1 | Selected Channel bandwidth as per section 5.1.1.6 | | Derived as per section 5.1.3.2 of TS 38.214 [12] | NA | -112 | -106 | 85 | NA |

**Table 5.2A.3.2-4: Minimum performance for TDD CA with 30 kHz SCS**

| Test Number | Bandwidth (MHz) | | Reference channel | | Power at antenna port (dBm/Hz) | | Reference value Fraction of Maximum Throughput (%) | |
|---|---|---|---|---|---|---|---|---|
| | PCell | SCell | PCell | SCell | $\hat{E}_{s\_PCell}$ for PCell | $\hat{E}_{s\_SCell}$ for Scell | PCell | SCell |
| 1 | Selected Channel bandwidth as per section 5.1.1.6 | | Derived as per section 5.1.3.2 of TS 38.214 [12] | NA | -112 | -106 | 85 | NA |

### 5.2A.3.3 Minimum requirements for PDSCH of SCell on band with shared spectrum access

The performance requirements for SCell on band with shared spectrum access are specified in Table 5.2.3.2.15-3, with the additional test parameters for SCell in Table 5.2.3.2.15-2, the test parameters for PCell in Table 5.2A.3.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2A.3.3-1. During the test, only the PDSCH performance of the SCell should be verified.

**Table 5.2A.3.3-1: Tests purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH performance of SCell for UE supporting operations in shared spectrum access | 1-1, 1-2, 1-3, 1-4 |

**Table 5.2A.3.3-2: Test parameters for PCell**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Bandwidth | | MHz | 20 |
| Subcarrier spacing | | kHz | 30 |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 2 |
| | Length (L) | | Specific to each Reference channel |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Dmrs-AdditionalPosition | | pos1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| CSI-RS for tracking | First OFDM symbol in the PRB used for CSI-RS | | Table 5.2-1 |
| | CSI-RS periodicity | Slots | Table 5.2-1 |
| | CSI-RS offset | Slots | Table 5.2-1 |
| | Frequency Occupation | | Table 5.2-1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

# 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 |
|---|---|---|---|---|
| Carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 1) | | | 0 |
| DL BWP configuration #1 | Cyclic prefix | | | Normal |
| | RB offset | | RBs | 0 |
| 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 |
| | Frequency domain resource allocation for CORESET | | | Start from RB = 0 with contiguous RB allocation |
| | TCI state | | | TCI state #1 |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | | 0 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | | CSI-RS resource 1: 4<br>CSI-RS resource 2: 8<br>CSI-RS resource 3: 4<br>CSI-RS resource 4: 8 |
| | Number of CSI-RS ports (*X*) | | | 1 |
| | CDM Type | | | No CDM |
| | Density ($\rho$) | | | 3 |
| | CSI-RS periodicity | | Slots | 15 kHz SCS: 20<br>30 kHz SCS: 40 |
| | CSI-RS offset | | Slots | 15 kHz SCS:<br>10 for CSI-RS resource 1 and 2<br>11 for CSI-RS resource 3 and 4<br><br>30 kHz SCS:<br>20 for CSI-RS resource 1 and 2<br>21 for CSI-RS resource 3 and 4 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |
| | 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 |

| | | |
|---|---|---|
| PDCCH & PDCCH DMRS Precoding configuration | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination with REG bundling granularity for number of Tx larger than 1 |
| Physical signals, channels mapping and precoding | | As specified in Annex B.4.1 |
| Symbols for all unused REs | | OP.1 FDD as defined in Annex A.5.1.1<br>OP.1 TDD as defined in Annex A.5.2.1 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | 2 for FDD.<br>For TDD, specific to each TDD UL-DL pattern and as defined in Annex A.1.2. |
| Note 1: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. | | |

## 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 10 | 24 | 2 | 2 | R.PDCCH. 1-2.1 FDD | TDLA30-10 | 1x2 Low | 1 | 8.1 |
| 2 | 10 | 24 | 2 | 2 | R.PDCCH. 1-2.3 FDD | TDLC300-100 | 1x2 Low | 1 | 8.2 |
| 3 | 10 | 48 | 2 | 4 | R.PDCCH. 1-2.4 FDD | TDLA30-10 | 1x2 Low | 1 | 5.5 |
| 4 | 10 | 48 | 1 | 4 | R.PDCCH. 1-1.1 FDD | TDLA30-10 | 1x2 Low | 1 | 4.4 |
| 5 | 10 | 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 10 | 24 | 2 | 4 | R.PDCCH. 1-2.2 FDD | TDLC300-100 | 2x2 Low | 1 | 2.0 |
| 2 | 10 | 48 | 2 | 8 | R.PDCCH. 1-2.5 FDD | TDLC300-100 | 2x2 Low | 1 | -1.3 |
| 3 | 10 | 48 | 1 | 8 | R.PDCCH. 1-1.3 FDD | TDLA30-10 | 2x2 Low | 1 | -0.2 |

#### 5.3.2.1.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

The parameters specified in Table 5.3.2.1.3-1 are valid for FDD test unless otherwise stated.

**Table 5.3.2.1.3-1: Test Parameters**

| Parameter | | Unit | 1 Tx Antenna |
|---|---|---|---|
| CCE to REG mapping type | | | nonInterleaved |
| REG bundle size | | | 6 |
| Shift Index | | | 0 |
| DRX cycle | | ms | 10 |
| ps-WakeUp-r16 | | | absent |
| Wake-up indication bit in DCI format 2_6 | | | 1 |
| PDCCH DCI format 2_6 configuration | PS-offset | | $(T_{minimumTimeGap} + 1)/2^{\mu}/0.125$ |
| | Number of PDCCH candidates | | 1 |
| | Frequency domain resource allocation for CORESET | | Start from RB = 0 with contiguous RB allocation |
| | TCI state | | TCI state #1 |
| PDCCH configuration | Slots for PDCCH monitoring | | Each slot during DRX-on period |
| | | | |
| Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability. | | | |

For the parameters specified in Table 5.3.2.1.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 5.3.2.1.3-2. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.2.1.3-2: Minimum performance for PDCCH with 15 kHz SCS**

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 10 | 48 | 2 | 4 | R.PDCCH.1-2.4 FDD | TDLA30-10 | 1x2 Low | 1 | [5.5] |
| | | | 2 | 8 | R.PDCCH.1-2.7 FDD | | | | |

## 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 | | Test 3: non-interleaved<br>Other tests: interleaved | interleaved |
| Interleaver size | | 3 | |
| REG bundle size | | Test 3: 6<br>Other tests: 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 40 | 102 | 1 | 2 | R.PDCCH.2-1.1 TDD | TDLA30-10 | 1x2 Low | 1 | 7.0 |
| 2 | 40 | 102 | 1 | 4 | R.PDCCH.2-1.2 TDD | TDLC300-100 | 1x2 Low | 1 | 3.0 |
| 3 | 40 | 48 | 2 | 16 | R.PDCCH.2-2.1 TDD | TDLC300-100 | 1x2 Low | 1 | -3.8 |

### 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 40 | 90 | 1 | 8 | R.PDCCH.2-1.3 TDD | TDLC300-100 | 2x2 Low | 1 | -1.2 |

### 5.3.2.2.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

The parameters specified in Table 5.3.2.2.3-1 are valid for all TDD tests for power saving unless otherwise stated.

**Table 5.3.2.2.3-1: Test Parameters**

| Parameter | | Unit | 1 Tx Antenna |
|---|---|---|---|
| TDD UL-DL pattern | | | FR1.30-1 |
| CCE to REG mapping type | | | interleaved |
| Interleaver size | | | 3 |
| REG bundle size | | | 2 |
| Shift Index | | | 0 |
| DRX cycle | | ms | 10 |
| ps-WakeUp-r16 | | | absent |
| Wake-up indication bit in DCI format 2_6 | | | 1 |
| PDCCH DCI format 2_6 configuration | PS-offset | | $(T_{minimumTimeGap}+1)/2^{\mu}/0.125$ |
| | Number of PDCCH candidates | | 1 |
| | Frequency domain resource allocation for CORESET | | Start from RB = 0 with contiguous RB allocation |
| | TCI state | | TCI state #1 |
| PDCCH configuration | Slots for PDCCH monitoring | | Each slot during DRX-on period |
| | | | |
| Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability. | | | |

For the parameters specified in Table 5.3.2.2.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 5.3.2.2.3-2. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.2.2.3-2: Minimum performance with 30 kHz SCS**

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 40 | 102 | 1 | 4 | R.PDCCH. 2-1.2 TDD | TDLC300-100 | 1x2 Low | 1 | 3.0 |
| | | | | 8 | R.PDCCH. 2-1.4 TDD | | | | |

## 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 10 | 24 | 2 | 2 | R.PDCCH. 1-2.1 FDD | TDLA30-10 | 1x4 Low | 1 | 2.2 |
| 2 | 10 | 24 | 2 | 2 | R.PDCCH. 1-2.3 FDD | TDLC300-100 | 1x4 Low | 1 | 2.7 |
| 3 | 10 | 48 | 2 | 4 | R.PDCCH. 1-2.4 FDD | TDLA30-10 | 1x4 Low | 1 | 0.2 |
| 4 | 10 | 48 | 1 | 4 | R.PDCCH. 1-1.1 FDD | TDLA30-10 | 1x4 Low | 1 | -0.4 |
| 5 | 10 | 48 | 2 | 16 | R.PDCCH. 1-2.6 FDD | TDLA30-10 | 1x4 Medium A | 1 | -3.2 |

#### 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 10 | 24 | 2 | 4 | R.PDCCH. 1-2.2 FDD | TDLC300-100 | 2x4 Low | 1 | -1.9 |
| 2 | 10 | 48 | 2 | 8 | R.PDCCH. 1-2.5 FDD | TDLC300-100 | 2x4 Low | 1 | -4.5 |
| 3 | 10 | 48 | 1 | 4 | R.PDCCH. 1-1.2 FDD | TDLA30-10 | 2x4 Low | 1 | -1.0 |

#### 5.3.3.1.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

The parameters specified in Table 5.3.3.1.3-1 are valid for FDD test unless otherwise stated.

**Table 5.3.3.1.3-1: Test Parameters**

| Parameter | | Unit | 1 Tx Antenna |
|---|---|---|---|
| CCE to REG mapping type | | | nonInterleaved |
| REG bundle size | | | 6 |
| Shift Index | | | 0 |
| DRX cycle | | ms | 10 |
| ps-WakeUp-r16 | | | absent |
| Wake-up indication bit in DCI format 2_6 | | | 1 |
| PDCCH DCI format 2_6 configuration | PS-offset | | $(T_{minimumTimeGap}+1)/2^{\mu}/0.125$ |
| | Number of PDCCH candidates | | 1 |
| | Frequency domain resource allocation for CORESET | | Start from RB = 0 with contiguous RB allocation |
| | TCI state | | TCI state #1 |
| Slots for PDCCH monitoring | | | Each slot during DRX-on period |
| Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability. | | | |

For the parameters specified in Table 5.3.3.1.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 5.3.3.1.3-2. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.3.1.3-2: Minimum performance for PDCCH with 15 kHz SCS**

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 10 | 48 | 2 | 4 | R.PDCCH. 1-2.4 FDD | TDLA30-10 | 1x4 Low | 1 | 0.2 |
| | | | 2 | 8 | R.PDCCH. 1-2.7 FDD | | | | |

### 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 | | Test 3: Non-interleaved<br>Other tests: interleaved | interleaved |
| Interleaver size | | 3 | |
| REG bundle size | | Test 3: 6<br>Other tests: 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 40 | 102 | 1 | 2 | R.PDCCH. 2-1.1 TDD | TDLA30-10 | 1x4 Low | 1 | 2.1 |
| 2 | 40 | 102 | 1 | 4 | R.PDCCH. 2-1.2 TDD | TDLC300-100 | 1x4 Low | 1 | -0.9 |
| 3 | 40 | 48 | 2 | 16 | R.PDCCH. 2-2.1 TDD | TDLA30-10 | 1x4 Medium A | 1 | -3.6 |

#### 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 40 | 90 | 1 | 8 | R.PDCCH. 2-1.3 TDD | TDLC300-100 | 2x4 Low | 1 | -4.3 |

#### 5.3.3.2.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

For the parameters specified in Table 5.3.3.2.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 5.3.3.2.3-2. The downlink physical setup is in accordance with Annex C.3.1.

**Table 5.3.3.2.3-1: Test Parameters**

| Parameter | | Unit | 1 Tx Antenna |
|---|---|---|---|
| TDD UL-DL pattern | | | FR1.30-1 |
| CCE to REG mapping type | | | interleaved |
| Interleaver size | | | 3 |
| REG bundle size | | | 2 |
| Shift Index | | | 0 |
| DRX cycle | | ms | 10 |
| ps-WakeUp-r16 | | | absent |
| Wake-up indication bit in DCI format 2_6 | | | 1 |
| PDCCH DCI format 2_6 configuration | PS-offset | | $(T_{minimumTimeGap}+1)/2^{\mu}/0.125$ |
| | Number of PDCCH candidates | | 1 |
| | Frequency domain resource allocation for CORESET | | Start from RB = 0 with contiguous RB allocation |
| | TCI state | | TCI state #1 |
| Slots for PDCCH monitoring | | | Each slot during DRX-on period |
| Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability. | | | |

**Table 5.3.3.2.3-2: Minimum performance with 30 kHz SCS**

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | SNR (dB) |
| 1 | 40 | 102 | 1 | 4 | R.PDCCH. 2-1.2 TDD | TDLC300-100 | 1x4 Low | 1 | -0.9 |
| | | | | 8 | R.PDCCH. 2-1.4 TDD | | | | |

# 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

$$\mathrm{Pm-bch} = 1 - \frac{A}{B}$$

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 clause 4.1 of TS 38.213 [11] | | |

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 (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | SNR (dB) |
| 1 | 10 / 15 | R.PBCH.1 | TDLC300-100 | 1 x 2 Low | 1 | -6.7 |

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

| Test number | Bandwidth (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | SNR (dB) |
| 1 | 10 / 15 | R.PBCH.1 | TDLC300-100 | 1 x 2 Low | 1 | -8.3 |

### 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 clause 4.1 of TS 38.213 [11]<br>Note 2: as specified in clause 11.1 of TS 38.213 [11] | | |

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 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 (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | SNR (dB) |
| 1 | 40 / 30 | R.PBCH.2 | TDLA30-10 | 1 x 2 Low | 1 | -5.3 |

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

| Test number | Bandwidth (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | SNR (dB) |
| 1 | 40 / 30 | R.PBCH.2 | TDLA30-10 | 1 x 2 Low | 1 | -6.5 |

## 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 clause 11.1 of TS 38.213 [11] | | |

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 (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | SNR (dB) |
| 1 | 10 / 15 | R.PBCH.1 | TDLC300-100 | 1 x 4 Low | 1 | -8.9 |

**Table 5.4.3.1-3: Minimum performance PBCH in case SS/PBCH block index is known**

| Test number | Bandwidth (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | SNR (dB) |
| 1 | 10 / 15 | R.PBCH.1 | TDLC300-100 | 1 x 4 Low | 1 | -10.9 |

#### 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 clause 4.1 of TS 38.213 [11]<br>Note 2: as specified in clause 11.1 of TS 38.213 [11] | | |

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 (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | SNR (dB) |
| 1 | 40 / 30 | R.PBCH.2 | TDLA30-10 | 1 x 4 Low | 1 | -8.6 |

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

| Test number | Bandwidth (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | SNR (dB) |
| 1 | 40 / 30 | R.PBCH.2 | TDLA30-10 | 1 x 4 Low | 1 | -9.6 |

## 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:*

*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 in accordance with clause 4.1.2 of TS 38.306 [14].
    - Set of per CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor in accordance with clause 4.1.2 of TS 38.306 [14].
    - 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%*$N_{DL\_correct\_rx}$ / ($N_{DL\_newtx}$ + $N_{DL\_retx}$), where $N_{DL\_newtx}$ is the number of newly transmitted DL transport blocks, $N_{DL\_retx}$ is the number of retransmitted DL transport blocks, and $N_{DL\_correct\_rx}$ is the number of correctly received DL transport blocks.

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 |
| Actual carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 2) | RBs | 0 |
| | Subcarrier spacing | kHz | 15 or 30 |
| DL BWP configuration #1 | RB offset | RBs | 0 |
| | Number of contiguous PRB | | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] 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 | | 1/AL 1 for 30 kHz / 5 MHz<br>1/AL4 for 15 kHz / 5 MHz, 30 kHz / 10 MHz and 30 kHz / 15 MHz<br>1/AL 8 for other combinations |
| | CCE-to-REG mapping type | | Non-interleaved |
| | DCI format | | 1_1 |
| | TCI State | | TCI state #1 |
| | PDCCH & PDCCH DMRS Precoding configuration | | For 2Tx:<br>Single Panel Type I, Random precoder chosen from precoder index 0 and 2, selection updated per slot<br><br>For 4Tx:<br>Single Panel Type I, Random precoder chosen from precoders with i_1,1 in {1,2,3,5,6,7} and i_2 in {0,2}, selection updated per slot |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | wideband |
| | 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<br>{1000, 1001} for 2 Layers CCs<br>{1000 – 1003} for 4 Layers CCs |
| | Number of PDSCH DMRS CDM group(s) without data | | 1 for 1 layer and 2 layers CCs<br>2 for 4 Layers CCs |
| PTRS configuration | | | PTRS is not configured |
| CSI-RS for tracking | Subcarrier indexes in the PRB used for CSI-RS | | $k_0$ = 3 for CSI-RS resource 1,2,3,4 |
| | OFDM symbols in the PRB used for CSI-RS | | $l_0$ = 6 for CSI-RS resource 1 and 3<br>$l_0$ = 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<br>30 kHz SCS: 40 for CSI-RS resource 1,2,3,4 |
| | CSI-RS offset | | Slots | 15 kHz SCS:<br>10 for CSI-RS resource 1 and 2<br>11 for CSI-RS resource 3 and 4<br><br>30 kHz SCS:<br>20 for CSI-RS resource 1 and 2<br>21 for CSI-RS resource 3 and 4 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |
| | QCL info | | | TCI state #0 |
| NZP CSI-RS for CSI acquisition | Subcarrier indexes in the PRB used for CSI-RS | | | $k_0 = 4$ |
| | OFDM symbols in the PRB used for CSI-RS | | | $l_0 = 12$ |
| | 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<br>30 kHz SCS: 40 |
| | CSI-RS offset | | | 0 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |
| | QCL info | | | TCI state #1 |
| ZP CSI-RS for CSI acquisition | Subcarrier indexes in the PRB used for CSI-RS | | | $k_0 = 0$ |
| | OFDM symbols in the PRB used for CSI-RS | | | $l_0 = 12$ |
| | Number of CSI-RS ports (X) | | | 4 |
| | CDM Type | | | 'FD-CDM2' |
| | Density (ρ) | | | 1 |
| | CSI-RS periodicity | | | 15 kHz SCS: 20<br>30 kHz SCS: 40 |
| | CSI-RS offset | | | 0 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| 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 |
| Maximum number of code block groups for ACK/NACK feedback | | | | 1 |
| Maximum number of HARQ transmission | | | | 4 |
| HARQ ACK/NACK bundling | | | | Multiplexed |
| Redundancy version coding sequence | | | | {0,2,3,1} |
| PDSCH & PDSCH DMRS Precoding configuration | | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination with PRB bundling granularity |
| Symbols for all unused REs | | | | OP.1 FDD as defined in Annex A.5.1.1<br>OP.1 TDD as defined in Annex A.5.2.1 |
| Propagation condition | | | | Static propagation condition<br>No external noise sources are applied |
| Antenna configuration | 1 layer CCs | | | 1x2 or 1x4 |
| | 2 layers CCs | | | 2x2 or 2x4 |
| | 4 layers CCs | | | 4x4 |

| | | |
|---|---|---|
| Physical signals, channels mapping and precoding | | As specified in Annex B.4.1 |
| Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission<br>Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing | | |

**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 | | | 4 |
| 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 | | | 8 |
| K1 value | | | Specific to each UL-DL pattern |
| TDD UL-DL pattern | | | 15 kHz SCS: FR1.15-1<br>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) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 100MHz |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| Note 1: MCS Index for maximum modulation format 2,4 and 6 is based on MCS index Table 1 defined in clause 5.1.3.1 of TS 38.214 [12]<br>Note 2: MCS Index for maximum modulation format 8 is based on MCS index Table 2 defined in clause 5.1.3.1 of TS 38.214 [12] | | | |

# 6 CSI reporting requirements (Conducted requirements)

## 6.1 General

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

### 6.1.1 Applicability of requirements

#### 6.1.1.1 General

The minimum performance requirements are applicable to all FR1 operating bands defined in TS 38.101-1 [6] except for test cases listed in Clause 6.2.2.2.1.4, Clause 6.2.3.2.1.4, Clause 6.2A.3.1.2 and Clause 6.2A.4.1.2 which are only applicable for FR1 bands restricted to operation with shared spectrum.

The minimum performance requirements in Clause 6 are mandatary for UE supporting NR operation, except test cases listed in Clause 6.1.1.3, 6.1.1.4, 6.1.1.5.

If same test is listed for different UE features/capabilities in Clauses 6.1.1.3 and 6.1.1.4, then this test shall apply for UEs which support all corresponding UE features/capabilities.

#### 6.1.1.2 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 clause 7.2 of TS 38.101-1 [6]. The UE requirements applicability for UEs with different number of RX antenna ports is defined in Table 6.1.1.2-1.

**Table 6.1.1.2-1: Requirements applicability**

| Supported RX antenna ports | Test type | Test list |
|---|---|---|
| UE supports only 2RX | CQI | All tests in Clause 6.2.2 |
| | PMI | All tests in Clause 6.3.2 |
| | RI | All tests in Clause 6.4.2 |
| UE supports only 4RX or both 2RX and 4RX | CQI | All tests in Clause 6.2.3 |
| | PMI | All tests in Clause 6.3.3 |
| | RI | All tests in Clause 6.4.3 |

#### 6.1.1.3 Applicability of requirements for optional UE features

The performance requirements in Table 6.1.1.3-1 shall apply for UEs which support optional UE features with capability signalling only.

**Table 6.1.1.3-1: Requirements applicability for optional features with UE capability signalling**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| CQI table with target BLER of 10^-5New CQI table (cqi-TableAlt) | FR1 FDD | CQI | Clause 6.2.2.1.1.2<br>Clause 6.2.3.1.1.2 | |
| | FR1 TDD | CQI | Clause 6.2.2.2.1.2<br>Clause 6.2.3.2.1.2 | |
| Alternative 64QAM MCS table for PDSCH New 64QAM MCS table for PDSCH (*dl-64QAM-MCS-TableAlt*) | FR1 FDD | CQI | Clause 6.2.2.1.1.2<br>Clause 6.2.3.1.1.2 | |
| | FR1 TDD | CQI | Clause 6.2.2.2.1.2<br>Clause 6.2.3.2.1.2 | |
| Validating P/SP-CSI-RS reception (*periodicAndSemi-PersistentCSI-RS-r16*) | FR1 TDD | CQI | Clause 6.2.2.2.1.4<br>Clause 6.2.3.2.1.4<br>Clause 6.2A.3.1.2<br>Clause 6.2A.4.1.1 | The requirements apply only in case tested UE supporting operations in shared spectrum access and validation of P/SP-CSI-RS reception based on DCI |
| Supported UL channels for dynamic channel access mode (*ul-DynamicChAccess-r16* ) or UL channel access for semi-static channel access mode (*ul-Semi-StaticChAccess-r16*) or both | FR1 TDD | CQI | Clause 6.2.2.2.1.4<br>Clause 6.2.3.2.1.4 | The requirements apply only in case tested UE supports one of UL channels for dynamic channel access mode and UL channel access for semi-static channel access mode |

The performance requirements in Table 6.1.1.3-2 shall apply for UEs which support optional UE features only.

**Table 6.1.1.3-2: Requirements applicability for optional UE features**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| Support of Type II codebook (*CodebookParameters* contains *type2, supportedCSI-RS-ResourceList, parameterLx, amplitudeScalingType, amplitudeSubsetRestriction*) | FR1 FDD | PMI | Clause 6.3.2.1.5<br>Clause 6.3.3.1.5 | |
| | FR1 TDD | PMI | Clause 6.3.2.2.5<br>Clause 6.3.3.2.5 | |
| Support of Enhanced Type II codebook with at least 16 ports per CSI-RS resource(*codebookParametersAddition-r16* contains *etype2R1-r16, supportedCSI-RS-ResourceListAdd-r16, maxNumberTxPortsPerResource*) | FR1 FDD | PMI | Clause 6.3.2.1.6<br>Clause 6.3.3.1.6 | |
| | FR1 TDD | PMI | Cluase 6.3.2.2.6<br>Cluase 6.3.3.2.6 | |

### 6.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

The performance requirements in Table 6.1.1.4-1 shall apply for UEs which support mandatory UE features with capability signalling only.

**Table 6.1.1.4-1: Requirements applicability for mandatory features with UE capability signalling**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| Supported maximum number of PDSCH MIMO layers (*maxNumberMIMO-LayersPDSCH*) | FR1 FDD | CQI | Clause 6.2.3.1.1.1 | The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability |
| | | PMI | Clause 6.3.3.1.2 | |
| | | RI | Clause 6.4.2.1<br>Clause 6.4.3.1 | |
| | FR1 TDD | CQI | Clause 6.2.3.2.1.1 | |
| | | PMI | Clause 6.3.3.2.2 | |
| | | RI | Clause 6.4.2.2<br>Clause 6.4.3.2 | |
| Supported maximum number of ports across all configured NZP-CSI-RS resources per CC (*maxConfigNumberPortsAcross NZP-CSI-RS-PerCC*) | FR1 FDD | PMI | Clause 6.3.2.1.1<br>Clause 6.3.2.1.2<br>Clause 6.3.2.1.3<br>Clause 6.3.2.1.4<br>Clause 6.3.3.1.1<br>Clause 6.3.3.1.2<br>Clause 6.3.3.1.3<br>Clause 6.3.3.1.4 | The requirements apply only in case the number of NZP-CSI-RS ports in the test case satisfies UE capability on maximum number of NZP-CSI-RS ports |
| | | RI | Clause 6.4.3.1 (Test 4) | |
| | FR1 TDD | PMI | Clause 6.3.2.2.1<br>Clause 6.3.2.2.2<br>Clause 6.3.2.2.3<br>Clause 6.3.2.2.4<br>Clause 6.3.3.2.1<br>Clause 6.3.3.2.2<br>Clause 6.3.3.2.3<br>Clause 6.3.3.2.4 | |
| | | RI | Clause 6.4.3.2 (Test 4) | |

## 6.1.1.5 Applicability of Channel Quality Indicator (CQI) reporting requirements for CA

### 6.1.1.5.1 Applicability and test rules for different duplex modes and SCS combinations

The applicability and test rules for different duplex modes and SCS combinations are defined in Table 6.1.1.5.1-1.

**Table 6.1.1.5.1-1: Applicability for different duplex modes and SCS combinations**

| Tests | PCell CC configuration |
|---|---|
| Test 1 in Clause 6.2A.3.1.1 | TDD CC if supported, otherwise FDD CC |
| Test 2 in Clause 6.2A.3.1.1 (NOTE 2) | Any of CCs |
| Test 3 in Clause 6.2A.3.1.1 | Any of CCs |
| NOTE 1: The test coverage can be considered fulfilled if UE passes one of the CC as PCell in Test 1.<br>NOTE 2: These scenarios are only tested for UEs which are not verified with Test 1 in Clause 6.2A.3.1.1. | |

### 6.1.1.5.2 Applicability and test rules for different CA configurations and bandwidth combination sets

The performance requirement for CA CQI tests in clause 6.2A are defined independent of CA configurations and bandwidth combination sets specified in clasue 5.5A in TS 38.101-1 [6].

For UEs supporting multiple CA capabilities, test any one of the supported CA capabilities with largest aggregated CA bandwidth combination. The categorization of CA capability is specified in clasue 5.1.1.7.1.

For UEs supporting multiple CA configurations from the selected CA capability, test any one of the supported CA configurations with largest aggregated CA bandwidth combination. For simplicity, the CA configuration refers to combination of CA configuration and bandwidth combination set.

A single uplink CC is configured for all tests.

#### 6.1.1.5.3 Test coverage for different number of componenet carriers

For CA CQI tests specified in clause 6.2A, among all supported CA capabilities, if corresponding CA tests with the largest number of CCs supported by the UE are tested, the test coverage can be considered fulfilled without executing the CA tests with less than the largest number of CCs supported by the UE.

#### 6.1.1.5.4 Applicability rule and antenna connection for CA tests with 4 RX

All the requirements specified in clause 6.2A for CA with 2 RX are applied for 4 RX capable UEs by connecting all 4 RX with data source from system simulator and reducing the signal power density by 3 dB compared to the signal power density for 2 RX in the test configurations.

## 6.1.2 Common test parameters

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

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

| Parameter | | Unit | Value |
|---|---|---|---|
| PDSCH transmission scheme | | | Transmission scheme 1 |
| Actual carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 3) | RBs | 0 |
| | Subcarrier spacing | kHz | 15 or 30 |
| DL BWP configuration #1 | Cyclic prefix | | Normal |
| | RB offset | RBs | 0 |
| | Number of contiguous PRB | PRBs | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing |
| Additional PDCCH Configuration for Aperiodic Reporting (Note 4) | Slots for PDCCH monitoring | | Each slot |
| | Symbols with PDCCH | | 0,1 |
| | Number of PDCCH candidates and aggregation levels | | 1/AL8 |
| | DCI format | | 0_1 |
| | TCI state | | TCI state #1 |
| | PDCCH & PDCCH DMRS Precoding configuration | | Multi-path fading propagation conditions: Single Panel Type I, Random per slot with equal probability of each applicable i1, i2 combination, and with REG bundling granularity for number of Tx larger than 1 |
| Active DL BWP index | | | 1 |
| 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/AL8 |
| | 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 | | type 0 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |

| | | | |
|---|---|---|---|
| | PDCCH & PDCCH DMRS Precoding configuration | | Multi-path fading propagation conditions: Single Panel Type I, Random per slot with equal probability of each applicable i1, i2 combination, and with REG bundling granularity for number of Tx larger than 1<br><br>Static propagation conditions: Single Panel Type I, Random precoder chosen from precoder index 0 an 2, selection updated per slot |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| | 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 ($K_{PT-RS}$) | | N/A |
| | Time density ($L_{PT-RS}$) | | N/A |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | 0 for CSI-RS resource 1,2,3,4 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 4 for CSI-RS resource 1 and 3<br>8 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 ($\rho$) | | 3 for CSI-RS resource 1,2,3,4 |
| | CSI-RS periodicity | slot | 15 kHz SCS: 20 for CSI-RS resource 1,2,3,4<br>30 kHz SCS: 40 for CSI-RS resource |
| | CSI-RS offset | slot | 15 kHz SCS:<br>10 for CSI-RS resource 1 and 2<br>11 for CSI-RS resource 3 and 4<br><br>30 kHz SCS:<br>20 for CSI-RS resource 1 and 2<br>21 for CSI-RS resource 3 and 4 |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |

| | | | | |
|---|---|---|---|---|
| | QCL info | | | TCI state #0 |
| NZP CSI-RS for CSI acquisition | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |
| | QCL info | | | TCI state #1 |
| ZP CSI-RS for CSI acquisition | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |
| 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<br>8 for TDD |
| HARQ ACK/NACK bundling | | | | Multiplexed |
| Redundancy version coding sequence | | | | {0,2,3,1} |
| K1 value<br>(PDSCH-to-HARQ-timing-indicator) | | | | 2 for FDD<br>For FR1.30-1:<br>8 if mod(i,10) = 0<br>6 if mod(i,10) = 2<br>5 if mod(i,10) = 3<br>5 if mod(i,10) = 4<br>4 if mod(i,10) = 5<br>3 if mod(i,10) = 6<br>Where i is slot index per radio frame with 0~19<br>For FR1.30-7:<br>8 if mod(i,10) = 0<br>7 if mod(i,10) = 1<br>6 if mod(i,10) = 2<br>5 if mod(i,10) = 3<br>4 if mod(i,10) = 4<br>3 if mod(i,10) = 5<br>2 if mod(i,10) = 6<br>Where i is the slot index of all slots in every 5ms i = {0,…,9} |
| Symbols for unused REs | | | | OP.1 FDD as defined in Annex A.5.1.1<br>OP.1 TDD as defined in Annex A.5.2.1 |
| Physical signals, channels mapping and precoding | | | | As specified in Annex B.4.1 |
| Note 1: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL.<br>Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission.<br>Note 3: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing.<br>Note 4: Additional PDCCH configuration for aperiodic reporting is only for test cases with aperiodic CSI reporting configured. | | | | |

# 6.2 Reporting of Channel Quality Indicator (CQI)

This clause 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 | | | |
| 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 Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 5/0 | | | |
| 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.4-2, TBS.2-2 | | | |

#### 6.2.2.1.1.2 Minimum requirement for periodic CQI reporting with Table 3

For the parameters specified in Table 6.2.2.1.1.2-1, 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 $10^{-5}$, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than $10^{-5}$. If the PDSCH BLER using the transport format indicated by the median CQI is greater than $10^{-5}$, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to $10^{-5}$.

c) The reported CQI value according to the reference channel shall be ≥ 1.

**Table 6.2.2.1.1.2-1: CQI reporting test parameters**

| Parameter | | Unit | Test 1 | |
|---|---|---|---|---|
| Bandwidth | | MHz | 10 | |
| Duplex Mode | | | FDD | |
| Subcarrier spacing | | kHz | 15 | |
| SNR | | dB | 1 | 2 |
| Propagation channel | | | AWGN | |
| Antenna configuration | | | 1×2 with static channel specified in Annex B.1 | |
| Beamforming Model | | | As specified in Annex B.4.1 | |
| 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 ($k_0$) | | Row 5,4 | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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*) | | 1 | |
| | CDM Type | | No CDM | |
| | Density (ρ) | | 3 | |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$ ) | | Row 1,(0,-) | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | |
| | CSI-IM RE pattern | | 0 | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | |
| | CSI-IM timeConfig periodicity and offset | slot | 5/1 | |
| ReportConfigType | | | Periodic | |
| CQI-table | | | Table 3 | |
| 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 | 5/0 | |
| 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.4-4, TBS.4-1 |

### 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 wideband 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 $\alpha$% of the time where $\alpha$% 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 $\geq \gamma$, where $\gamma$ 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 | | | |
| Subcarrier spacing | | kHz | 15 | | | |
| Duplex Mode | | | FDD | | | |
| SNR | | dB | 6 | 7 | 12 | 13 |
| Propagation channel | | | TDLA30-5 | | | |
| Antenna configuration | | | 2×2 | | | |
| Correlation configuration | | | ULA high | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI\text{-}IM}$,$l_{CSI\text{-}IM}$) | | (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 | 5/0 | | | |
| 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.4-2, TBS.2-1 | | | |

**Table 6.2.2.1.2.1-2: Minimum requirements**

| Parameters | Test 1 | Test 2 |
|---|---|---|
| $\alpha$ [%] | 20 | 20 |
| $\gamma$ | 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. 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 6.2.2.1.2.2-1 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 $\alpha$% of the time but less than $\beta$% of the time for each sub-band, where $\alpha$ and $\beta$ 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 $\geq \gamma$, where $\gamma$ 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 0.02.

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 | | | |
| Subcarrier spacing | | kHz | 15 | | | |
| Duplex Mode | | | FDD | | | |
| SNR | | dB | 8 | 9 | 14 | 15 |
| Propagation channel | | | Two tap model specified in Annex B.2.4 with *a*=1, $f_D$ = 5Hz, and $\tau_d$=0.45μs | | | |
| Antenna configuration | | | 2×2 | | | |
| Correlation configuration | | | As per Annex B.1 | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | | | |
| | CSI-IM timeConfig periodicity and offset | slot | 5/1 | | | |
| ReportConfigType | | | Aperiodic | | | |
| 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-ReportingBand | | | 1111111 | | | |
| CSI-Report periodicity and offset | | slot | Not configured | | | |
| Aperiodic Report Slot Offset | | | 5 | | | |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 | | | |
| reportTriggerSize | | | 1 | | | |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM | | | |
| 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 | | | PUSCH | | | |
| CQI/RI/PMI delay | | ms | 8 | | | |

| | | |
|---|---|---|
| Maximum number of HARQ transmission | | 1 |
| Measurement channel | | As specified in Table A.4-2, TBS.2-5 |

**Table 6.2.2.1.2.2-2: Minimum requirements**

| Parameters | Test 1 | Test 2 |
|---|---|---|
| $\alpha$ [%] | 2 | 2 |
| $\beta$ [%] | 55 | 55 |
| $\gamma$ | 1.05 | 1.05 |

## 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 TS 38.214 [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. 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.

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 | | | |
| Subcarrier spacing | | kHz | 30 | | | |
| Duplex Mode | | | TDD | | | |
| TDD UL-DL pattern | | | FR1.30-1 | | | |
| 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 Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 10/9 | | | |
| 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.4-2, TBS.2-4 | | | |

#### 6.2.2.2.1.2 Minimum requirement for periodic CQI reporting with Table 3

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [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. 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.

For the parameters specified in Table 6.2.2.2.1.2-1, 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 $10^{-5}$, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than $10^{-5}$. If the PDSCH BLER using the transport format indicated by the median CQI is greater than $10^{-5}$, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to $10^{-5}$.

c) The reported CQI value according to the reference channel shall be ≥ 1.

**Table 6.2.2.2.1.2-1: CQI reporting test parameters**

| Parameter | | Unit | Test 1 | |
|---|---|---|---|---|
| Bandwidth | | MHz | 40 | |
| Subcarrier spacing | | kHz | 30 | |
| Duplex Mode | | | TDD | |
| TDD UL-DL pattern | | | FR1.30-1 | |
| SNR | | dB | 1 | 2 |
| Propagation channel | | | AWGN | |
| Antenna configuration | | | 1×2 with static channel specified in Annex B.1 | |
| Beamforming Model | | | As specified in Annex B.4.1 | |
| 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 ($k_0$) | | Row 5,4 | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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*) | | 1 | |
| | CDM Type | | No CDM | |
| | Density (ρ) | | 3 | |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$ ) | | Row 1,(0,-) | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 1 | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | |
| | CSI-IM RE pattern | | 0 | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | |
| | CSI-IM timeConfig periodicity and offset | slot | 10/1 | |

| | | | |
|---|---|---|---|
| ReportConfigType | | | Periodic |
| CQI-table | | | Table 3 |
| 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 | 10/9 |
| 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.4-4, TBS.4-2 |

##### 6.2.2.2.1.3 Minimum requirement for CQI reporting for PCell on band with shared spectrum access

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [12] for PCell on band with shared spectrum access. For each Downlink Transmission Duration the transmission power offset is randomly chosen between [0, +6] dB and 2 sets of CQI reports are obtained for each transmission power offset. 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 each power offset. 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.

For the parameters specified in Table 6.2.2.2.1.3-1, and using the downlink physical channels specified in Annex A.4, the minimum requirements are specified by the following:

a) For each transmission power offset 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) For each transmission power offset, 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. For each transmission power offset, 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.

c) The absolute difference in median CQI for each of transmission power offset shall be ≥ 2.

**Table 6.2.2.2.1.3-1: CQI reporting test parameters for PCell on band with shared spectrum access**

| Parameter | | Unit | Test 1 | |
|---|---|---|---|---|
| Bandwidth | | MHz | 20 | |
| Subcarrier spacing | | kHz | 30 | |
| Duplex Mode | | | TDD | |
| Downlink Transmission Model | | | As specified in Annex B.5 | |
| Downlink Transmission Model Parameters | Downlink period | ms | 5 | |
| | LBT failure probability ($p_{LBT}$) | | 0.25 | |
| | Downlink transmission duration values set | slot | {4,6,7} | |
| | Occupied OFDM symbols in slot other than the last slot of the downlink duration | symbol | 14 | |
| | Occupied OFDM symbols in the last slot set of the downlink duration | symbol | 14 | |
| TDD UL-DL pattern | | | FR1.30-7 | |
| SNR | | dB | 8 | 9 |
| $\widehat{E_s}$ for power offset 1 | | dBm/Hz | -112 | |
| $\widehat{E_s}$ for power offset 2 | | dBm/Hz | -106 | |
| Propagation channel | | | AWGN | |
| Antenna configuration | | | 2×2 with static channel specified in Annex B.1 | |
| Beamforming Model | | | As specified in Annex B.4.1 | |
| 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 ($k_0$) | | Row 5,4 | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 9 | |
| | CSI-RS interval and offset | slot | Not configured | |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic | |
| | Number of CSI-RS ports ($X$) | | 2 | |
| | CDM Type | | FD-CDM2 | |
| | Density (ρ) | | 1 | |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | Row 3, 6 | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 3 | |
| | CSI-RS interval and offset | slot | Not configured | |
| | aperiodicTriggeringOffset | slot | 0 | |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic | |
| | CSI-IM RE pattern | | 0 | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | |
| | CSI-IM timeConfig interval and offset | slot | Not configured | |

| | | | |
|---|---|---|---|
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 2 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | configured |
| timeRestrictionForInterferenceMeasurements | | | configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Wideband |
| Sub-band Size | | RB | 8 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 7 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggrtSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| 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 | | | PUSCH |
| CQI/RI/PMI delay | | ms | 9.5 |
| Maximum number of HARQ transmission | | | 1 |
| Measurement channel | | | As specified in Table A.4-2, TBS.2-8 |

### 6.2.2.2.2 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. 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.

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 $\alpha$% of the time where $\alpha$% 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 $\geq \gamma$, where $\gamma$ 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 | | | |
| Subcarrier spacing | | kHz | 30 | | | |
| Duplex Mode | | | TDD | | | |
| TDD UL-DL pattern | | | FR1.30-1 | | | |
| SNR | | dB | 6 | 7 | 12 | 13 |
| Propagation channel | | | TDLA30-5 | | | |
| Antenna configuration | | | 2×2 | | | |
| Correlation configuration | | | ULA high | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 10/9 | | | |
| 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.4-2, TBS.2-3 | | | |

**Table 6.2.2.2.2.1-2: Minimum requirements**

| Parameters | Test 1 | Test 2 |
|---|---|---|
| $\alpha$ [%] | 20 | 20 |
| $\gamma$ | 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. 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 6.2.2.2.2.2-1 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 $\geq \gamma$, where $\gamma$ 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 0.02.

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 | | | |
| Subcarrier spacing | | kHz | 30 | | | |
| Duplex Mode | | | TDD | | | |
| TDD UL-DL pattern | | | FR1.30-1 | | | |
| SNR | | dB | 8 | 9 | 14 | 15 |
| Propagation channel | | | Two tap model specified in Annex B.2.4 with $a$=1, $f_D$ = 5Hz, and $\tau_d$=0.1125μs | | | |
| Antenna configuration | | | 2×2 | | | |
| Correlation configuration | | | As per Annex B.1 | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | | | |
| | CSI-IM timeConfig periodicity and offset | slot | 10/1 | | | |
| ReportConfigType | | | Aperiodic | | | |
| 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-ReportingBand | | | 1111111 | | | |
| CSI-Report periodicity and offset | | slot | Not configured | | | |
| Aperiodic Report Slot Offset | | | 8 | | | |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 | | | |
| reportTriggerSize | | | 1 | | | |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM | | | |
| 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 | | | PUSCH | | | |

| | | |
|---|---|---|
| CQI/RI/PMI delay | ms | 9.5 |
| Maximum number of HARQ transmission | | 1 |
| Measurement channel | | As specified in Table A.4-2, TBS.2-6 |

**Table 6.2.2.2.2.2-2: Minimum requirements**

| Parameters | Test 1 | Test 2 |
|---|---|---|
| $\alpha$ [%] | 2 | 2 |
| $\beta$ [%] | 55 | 55 |
| $\gamma$ | 1.05 | 1.05 |

## 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 TS 38.214 [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. 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.

##### 6.2.3.1.1.1 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 6.2.3.1.1.1-1: CQI reporting definition test**

| Parameter | | Unit | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Bandwidth | | MHz | 10 | | | |
| Subcarrier spacing | | kHz | 15 | | | |
| Duplex Mode | | | FDD | | | |
| 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 Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 5/0 | | | |
| 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.4-2, TBS.2-2 | | | |

#### 6.2.3.1.1.2 Minimum requirement for period CQI reporting with Table 3

For the parameters specified in Table 6.2.3.1.1.2-1, 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 $10^{-5}$, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than $10^{-5}$. If the PDSCH BLER using the transport format indicated by the median CQI is greater than $10^{-5}$, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to $10^{-5}$.

c) The reported CQI value according to the reference channel shall be ≥ 1.

**Table 6.2.3.1.1.2-1: CQI reporting test parameters**

| Parameter | | Unit | Test 1 | |
|---|---|---|---|---|
| Bandwidth | | MHz | 10 | |
| Subcarrier spacing | | kHz | 15 | |
| Duplex Mode | | | FDD | |
| SNR | | dB | -2 | -1 |
| Propagation channel | | | AWGN | |
| Antenna configuration | | | 1×4 with static channel specified in Annex B.1 | |
| Beamforming Model | | | As specified in Annex B.4.1 | |
| 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 ($k_0$) | | Row 5,4 | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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*) | | 1 | |
| | CDM Type | | No CDM | |
| | Density (ρ) | | 3 | |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$ ) | | Row 1,(0,-) | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 1 | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | |
| | CSI-IM RE pattern | | 0 | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | |
| | CSI-IM timeConfig periodicity and offset | slot | 5/1 | |
| ReportConfigType | | | Periodic | |
| CQI-table | | | Table 3 | |
| 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 | 5/0 | |
| 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.4-4, TBS.4-1 |

#### 6.2.3.1.2 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. 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.

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 $\alpha$% of the time where $\alpha$% 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 $\geq \gamma$, where $\gamma$ 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 | | | |
| Subcarrier spacing | | kHz | 15 | | | |
| Duplex Mode | | | FDD | | | |
| SNR | | dB | 3 | 4 | 9 | 10 |
| Propagation channel | | | TDLA30-5 | | | |
| Antenna configuration | | | 2×4 | | | |
| Correlation configuration | | | XP High | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | | Periodic | | | |
| ZP CSI-RS configuration | Number of CSI-RS ports (*X*) | | 4 | | | |
| ZP CSI-RS configuration | CDM Type | | FD-CDM2 | | | |
| ZP CSI-RS configuration | Density (ρ) | | 1 | | | |
| ZP CSI-RS configuration | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | Row 5, (4) | | | |
| ZP CSI-RS configuration | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 9 | | | |
| ZP CSI-RS configuration | CSI-RS periodicity and offset | slot | 5/1 | | | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Periodic | | | |
| NZP CSI-RS for CSI acquisition | Number of CSI-RS ports (*X*) | | 2 | | | |
| NZP CSI-RS for CSI acquisition | CDM Type | | FD-CDM2 | | | |
| NZP CSI-RS for CSI acquisition | Density (ρ) | | 1 | | | |
| NZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | Row 3,(6) | | | |
| NZP CSI-RS for CSI acquisition | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| NZP CSI-RS for CSI acquisition | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| CSI-IM configuration | CSI-IM RE pattern | | 0 | | | |
| CSI-IM configuration | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | | | |
| CSI-IM configuration | 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 | 5/0 | | | |
| aperiodicTriggeringOffset | | | Not configured | | | |
| Codebook configuration | Codebook Type | | typeI-SinglePanel | | | |
| Codebook configuration | Codebook Mode | | 1 | | | |
| Codebook configuration | (CodebookConfig-N1,CodebookConfig-N2) | | Not configured | | | |
| Codebook configuration | CodebookSubsetRestriction | | 000001 | | | |
| Codebook configuration | 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.4-2, TBS.2-1 | | | |

**Table 6.2.3.1.2.1-2: Minimum requirements**

| Parameters | Test 1 | Test 2 |
|---|---|---|
| $\alpha$ [%] | 5 | 5 |
| $\gamma$ | 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. 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 6.2.3.1.2.2-1 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 ≥ $\gamma$, where $\gamma$ 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 0.02.

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 | | | |
| Subcarrier spacing | | kHz | 15 | | | |
| Duplex Mode | | | FDD | | | |
| SNR | | dB | 5 | 6 | 11 | 12 |
| Propagation channel | | | Two tap model specified in Annex B.2.4 with *a*=1, $f_D$ = 5Hz, and $\tau_d$=0.45μs | | | |
| Antenna configuration | | | 2×4 | | | |
| Correlation configuration | | | As per Annex B.1 | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | | | |
| | CSI-IM timeConfig periodicity and offset | slot | 5/1 | | | |
| ReportConfigType | | | Aperiodic | | | |
| 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-ReportingBand | | | 1111111 | | | |
| CSI-Report periodicity and offset | | slot | Not configured | | | |
| Aperiodic Report Slot Offset | | | 5 | | | |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 | | | |
| reportTriggerSize | | | 1 | | | |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM | | | |
| 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 | | | PUSCH | | | |
| CQI/RI/PMI delay | | ms | 8 | | | |

| | | |
|---|---|---|
| Maximum number of HARQ transmission | | 1 |
| Measurement channel | | As specified in Table A.4-2, TBS.2-5 |

**Table 6.2.3.1.2.2-2: Minimum requirements**

| Parameters | Test 1 | Test 2 |
|---|---|---|
| $\alpha$ [%] | 2 | 2 |
| $\beta$ [%] | 55 | 55 |
| $\gamma$ | 1.05 | 1.05 |

## 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. 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.

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 | | | |
| Subcarrier spacing | | kHz | 30 | | | |
| Duplex Mode | | | TDD | | | |
| TDD UL-DL pattern | | | FR1.30-1 | | | |
| 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 Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 10/9 | | | |
| 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.4-2, TBS.2-4 | | | |

#### 6.2.3.2.1.2 Minimum requirement for CQI periodic reporting with Table 3

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. 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.

For the parameters specified in Table 6.2.3.2.1.2-1, 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 $10^{-5}$, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than $10^{-5}$. If the PDSCH BLER using the transport format indicated by the median CQI is greater than $10^{-5}$, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to $10^{-5}$.

c) The reported CQI value according to the reference channel shall be ≥ 1.

**Table 6.2.3.2.1.2-1: CQI reporting test parameters**

<table>
<tr><th colspan="2">Parameter</th><th>Unit</th><th colspan="2">Test 1</th></tr>
<tr><td colspan="2">Bandwidth</td><td>MHz</td><td colspan="2">40</td></tr>
<tr><td colspan="2">Subcarrier spacing</td><td>kHz</td><td colspan="2">30</td></tr>
<tr><td colspan="2">Duplex Mode</td><td></td><td colspan="2">TDD</td></tr>
<tr><td colspan="2">TDD UL-DL pattern</td><td></td><td colspan="2">FR1.30-1</td></tr>
<tr><td colspan="2">SNR</td><td>dB</td><td>-2</td><td>-1</td></tr>
<tr><td colspan="2">Propagation channel</td><td></td><td colspan="2">AWGN</td></tr>
<tr><td colspan="2">Antenna configuration</td><td></td><td colspan="2">1×4 with static channel specified in Annex B.1</td></tr>
<tr><td colspan="2">Beamforming Model</td><td></td><td colspan="2">As specified in Annex B.4.1</td></tr>
<tr><td rowspan="7">ZP CSI-RS configuration</td><td>CSI-RS resource Type</td><td></td><td colspan="2">Periodic</td></tr>
<tr><td>Number of CSI-RS ports (X)</td><td></td><td colspan="2">4</td></tr>
<tr><td>CDM Type</td><td></td><td colspan="2">FD-CDM2</td></tr>
<tr><td>Density (ρ)</td><td></td><td colspan="2">1</td></tr>
<tr><td>First subcarrier index in the PRB used for CSI-RS ($k_0$)</td><td></td><td colspan="2">Row 5,4</td></tr>
<tr><td>First OFDM symbol in the PRB used for CSI-RS ($l_0$)</td><td></td><td colspan="2">9</td></tr>
<tr><td>CSI-RS periodicity and offset</td><td>slot</td><td colspan="2">10/1</td></tr>
<tr><td rowspan="8">NZP CSI-RS for CSI acquisition</td><td>CSI-RS resource Type</td><td></td><td colspan="2">Periodic</td></tr>
<tr><td>Number of CSI-RS ports (X)</td><td></td><td colspan="2">1</td></tr>
<tr><td>CDM Type</td><td></td><td colspan="2">No CDM</td></tr>
<tr><td>Density (ρ)</td><td></td><td colspan="2">3</td></tr>
<tr><td></td><td></td><td colspan="2"></td></tr>
<tr><td>First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$ )</td><td></td><td colspan="2">Row 1,(0,-)</td></tr>
<tr><td>First OFDM symbol in the PRB used for CSI-RS ($l_0$)</td><td></td><td colspan="2">1</td></tr>
<tr><td>NZP CSI-RS-timeConfig periodicity and offset</td><td>slot</td><td colspan="2">10/1</td></tr>
<tr><td rowspan="4">CSI-IM configuration</td><td>CSI-IM resource Type</td><td></td><td colspan="2">Periodic</td></tr>
<tr><td>CSI-IM RE pattern</td><td></td><td colspan="2">0</td></tr>
<tr><td>CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$)</td><td></td><td colspan="2">(4, 9)</td></tr>
<tr><td>CSI-IM timeConfig periodicity and offset</td><td>slot</td><td colspan="2">10/1</td></tr>
</table>

| | | | |
|---|---|---|---|
| ReportConfigType | | | Periodic |
| CQI-table | | | Table 3 |
| 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 | 10/9 |
| 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.4-4, TBS.4-2 |

##### 6.2.3.2.1.3 Minimum requirement for CQI reporting for PCell on band with shared spectrum access

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [12] for PCell on band with shared spectrum access.  For each Downlink Transmission Duration the transmission power offset is randomly chosen between [0, +6] dB and 2 sets of CQI reports are obtained for each transmission power offset. 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 each power offset. 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.

For the parameters specified in Table 6.2.3.2.1.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) For each transmission power offset 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) For each transmission power offset, 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. For each transmission power offset, 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.

c) The absolute difference in median CQI for each of transmission power offset shall be ≥ 2.

**Table 6.2. 3.2.1.3-1: CQI reporting test parameters for PCell on band with shared spectrum access**

<table>
<tr><th colspan="2">Parameter</th><th>Unit</th><th colspan="2">Test 1</th></tr>
<tr><td colspan="2">Bandwidth</td><td>MHz</td><td colspan="2">20</td></tr>
<tr><td colspan="2">Subcarrier spacing</td><td>kHz</td><td colspan="2">30</td></tr>
<tr><td colspan="2">Duplex Mode</td><td></td><td colspan="2">TDD</td></tr>
<tr><td colspan="2">Downlink Transmission Model</td><td></td><td colspan="2">As specified in Annex B.5</td></tr>
<tr><td rowspan="5">Downlink Transmission Model Parameters</td><td>Downlink period</td><td></td><td colspan="2">5</td></tr>
<tr><td>LBT failure probability ($p_{LBT}$)</td><td></td><td colspan="2">0.25</td></tr>
<tr><td>Downlink transmission duration values set</td><td></td><td colspan="2">{4,6,7}</td></tr>
<tr><td>Occupied OFDM symbols in slot other than the last slot of the downlink duration</td><td></td><td colspan="2">14</td></tr>
<tr><td>Occupied OFDM symbols in the last slot set of the downlink duration</td><td></td><td colspan="2">14</td></tr>
<tr><td colspan="2">TDD UL-DL pattern</td><td></td><td colspan="2">FR1.30-7</td></tr>
<tr><td colspan="2">SNR</td><td>dB</td><td>5</td><td>6</td></tr>
<tr><td colspan="2">$\widehat{E_s}$ for power offset 1</td><td>dBm/Hz</td><td colspan="2">-112</td></tr>
<tr><td colspan="2">$\widehat{E_s}$ for power offset 2</td><td>dBm/Hz</td><td colspan="2">-106</td></tr>
<tr><td colspan="2">Propagation channel</td><td></td><td colspan="2">AWGN</td></tr>
<tr><td colspan="2">Antenna configuration</td><td></td><td colspan="2">2×4 with static channel specified in Annex B.1</td></tr>
<tr><td colspan="2">Beamforming Model</td><td></td><td colspan="2">As specified in Annex B.4.1</td></tr>
<tr><td rowspan="8">ZP CSI-RS configuration</td><td>CSI-RS resource Type</td><td></td><td colspan="2">Aperiodic</td></tr>
<tr><td>Number of CSI-RS ports (X)</td><td></td><td colspan="2">4</td></tr>
<tr><td>CDM Type</td><td></td><td colspan="2">FD-CDM2</td></tr>
<tr><td>Density (ρ)</td><td></td><td colspan="2">1</td></tr>
<tr><td>First subcarrier index in the PRB used for CSI-RS ($k_0$)</td><td></td><td colspan="2">Row 5,4</td></tr>
<tr><td>First OFDM symbol in the PRB used for CSI-RS ($l_0$)</td><td></td><td colspan="2">9</td></tr>
<tr><td>CSI-RS<br>interval and offset</td><td>slot</td><td colspan="2">Not configured</td></tr>
<tr><td>ZP CSI-RS trigger</td><td></td><td colspan="2">1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0</td></tr>
<tr><td rowspan="8">NZP CSI-RS for CSI acquisition</td><td>CSI-RS resource Type</td><td></td><td colspan="2">Periodic</td></tr>
<tr><td>Number of CSI-RS ports (X)</td><td></td><td colspan="2">2</td></tr>
<tr><td>CDM Type</td><td></td><td colspan="2">FD-CDM2</td></tr>
<tr><td>Density (ρ)</td><td></td><td colspan="2">1</td></tr>
<tr><td>First subcarrier index in the PRB used for CSI-RS ($k_0$)</td><td></td><td colspan="2">Row 3, 6</td></tr>
<tr><td>First OFDM symbol in the PRB used for CSI-RS ($l_0$)</td><td></td><td colspan="2">3</td></tr>
<tr><td>CSI-RS<br>interval and offset</td><td>slot</td><td colspan="2">Not configured</td></tr>
<tr><td>aperiodicTriggeringOffset</td><td></td><td colspan="2">0</td></tr>
<tr><td rowspan="4">CSI-IM configuration</td><td>CSI-IM resource Type</td><td></td><td colspan="2">Aperiodic</td></tr>
<tr><td>CSI-IM RE pattern</td><td></td><td colspan="2">0</td></tr>
<tr><td>CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$)</td><td></td><td colspan="2">(4, 9)</td></tr>
<tr><td>CSI-IM timeConfig<br>interval and offset</td><td>slot</td><td colspan="2">Not configured</td></tr>
</table>

| | | | |
|---|---|---|---|
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 2 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | configured |
| timeRestrictionForInterferenceMeasurements | | | configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Wideband |
| Sub-band Size | | RB | 8 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 7 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggrtSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| 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 | | | PUSCH |
| CQI/RI/PMI delay | | ms | 9.5 |
| Maximum number of HARQ transmission | | | 1 |
| Measurement channel | | | As specified in Table A.4-2, TBS.2-8 |

### 6.2.3.2.2 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. 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.

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 $\alpha$% of the time where $\alpha$% 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 $\geq \gamma$, where $\gamma$ 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 | | | |
| Subcarrier spacing | | kHz | 30 | | | |
| Duplex Mode | | | TDD | | | |
| TDD UL-DL pattern | | | FR1.30-1 | | | |
| SNR | | dB | 3 | 4 | 9 | 10 |
| Propagation channel | | | TDLA30-5 | | | |
| Antenna configuration | | | 2×4 | | | |
| Correlation configuration | | | XP High | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 10/9 | | | |
| 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.4-2, TBS.2-3 | | | |

**Table 6.2.3.2.2.1-2: Minimum requirements**

| Parameters | Test 1 | Test 2 |
|---|---|---|
| $\alpha$ [%] | 5 | 5 |
| $\gamma$ | 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. 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 6.2.3.2.2.2-1 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 $\geq \gamma$, where $\gamma$ 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 0.02.

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 | | | |
| Subcarrier spacing | | kHz | 30 | | | |
| Duplex Mode | | | TDD | | | |
| TDD UL-DL pattern | | | FR1.30-1 | | | |
| SNR | | dB | 5 | 6 | 11 | 12 |
| Propagation channel | | | Two tap model specified in Annex B.2.4 with $a$=1, $f_D$ = 5Hz, and $\tau_d$=0.1125μs | | | |
| Antenna configuration | | | 2×4 | | | |
| Correlation configuration | | | As per Annex B.1 | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | |
| 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 ($k_0$) | | Row 5, (4) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 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 ($k_0$) | | Row 3,(6) | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 0 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | | | |
| | CSI-IM timeConfig periodicity and offset | slot | 10/1 | | | |
| ReportConfigType | | | Aperiodic | | | |
| 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-ReportingBand | | | 1111111 | | | |
| CSI-Report periodicity and offset | | slot | Not configured | | | |
| Aperiodic Report Slot Offset | | | 8 | | | |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 | | | |
| reportTriggerSize | | | 1 | | | |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM | | | |
| aperiodicTriggeringOffset | | | 0 | | | |
| 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 | | | PUSCH | | | |

| | | |
|---|---|---|
| CQI/RI/PMI delay | ms | 9.5 |
| Maximum number of HARQ transmission | | 1 |
| Measurement channel | | As specified in Table A.4-2, TBS.2-6 |

**Table 6.2.2.1.2.2-2: Minimum requirements**

| Parameters | Test 1 | Test 2 |
|---|---|---|
| $\alpha$ [%] | 2 | 2 |
| $\beta$ [%] | 55 | 55 |
| $\gamma$ | 1.05 | 1.05 |

# 6.2A Reporting of Channel Quality Indicator (CQI) for CA

## 6.2A.1 General

This clause includes the requirements for the reporting of channel quality indicator (CQI) with the UE configured for CA. The purpose is to verify that the CQI is correctly reported in accordance with the CQI definition given in TS 38.214 [12] for each CC with multiple cells configured for periodic reporting.

## 6.2A.2 1RX requirements

(Void)

## 6.2A.3 2RX requirements

### 6.2A.3.1 CQI reporting definition under AWGN conditions

#### 6.2A.3.1.1 Minimum requirement for periodic CQI reporting

For each CA CQI reporting test defined in Table 6.2A.3.1.1-6, the test requirements and the test parameters are defined as below.

For each CC, the test parameters are specified in Table 6.2A.3.1.1-1. The additional parameters specified in Table 6.2A.3.1.1-2 are applicable for tests on FDD CC. The additional parameters specified in Table 6.2A.3.1.1-3 are applicable for tests on TDD CC.

For CA with 2 DL CC, for the SNR configuration specified in Table 6.2A.3.1.1-4, and using the downlink physical channels specified in Annex C.3.1 on each CC, the difference between the wideband CQI indices of PCell and SCell reported shall be such that

$$\text{wideband CQI}_{\text{PCell}} - \text{wideband CQI}_{\text{SCell}} \geq 2$$

for more than 90% of the time.

For CA with 3 or more DL CC, for the SNR configuration specified in Table 6.2A.3.1.1-5, and using the downlink physical channels specified in Annex C.3.1 on each cell, the difference between the wideband CQI indices of PCell and SCell1 reported, and the difference between the wideband CQI indices of SCell1 and SCell2, 3… reported shall be such that

$$\text{wideband CQI}_{\text{PCell}} - \text{wideband CQI}_{\text{SCell1}} \geq 2$$

$$\text{wideband CQI}_{\text{SCell1}} - \text{wideband CQI}_{\text{SCell2, 3…}} \geq 2$$

for more than 90% of the time.

**Table 6.2A.3.1.1-1: CA CQI reporting test parameters for FDD and TDD CC**

| Parameter | | Unit | Value |
|---|---|---|---|
| Propagation channel | | | AWGN |
| Antenna configuration | | | 1×2 with static channel specified in Annex B.1 |
| 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 ($k_0$) | | Row 5, 4 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 9 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Periodic |
| | Number of CSI-RS ports (*X*) | | 1 |
| | CDM Type | | No CDM |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | Row 2, 6 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 13 |
| CSI-IM configuration | CSI-IM resource Type | | Periodic |
| | CSI-IM RE pattern | | 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) |
| ReportConfigType | | | Periodic |
| CQI-table | | | Table 2 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Wideband |
| Csi-ReportingBand | | | 1111111 |
| aperiodicTriggeringOffset | | | Not configured |
| Physical channel for CSI report | | | PUCCH |
| Maximum number of HARQ transmission | | | 1 |
| Measurement channel | | | Derived as per section 5.1.3.2 of TS 38.214 [12] |

**Table 6.2A.3.1.1-2: Additional test parameters for FDD CC**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex Mode | | | FDD |
| Subcarrier spacing | | kHz | 15 |
| ZP CSI-RS configuration | CSI-RS periodicity and offset | slot | 5/1 |
| NZP CSI-RS for CSI acquisition | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 |
| CSI-IM configuration | CSI-IM timeConfig periodicity and offset | slot | 5/1 |
| CSI-Report periodicity and offset | | slot | 5/0 |
| CQI/RI/PMI delay | | ms | 8 |
| Sub-band Size | | RB | 8 for 5MHz and 10MHz,<br>16 for 15MHz, 20MHz and 25MHz,<br>32 for 30MHz, 40MHz and 50MHz |

**Table 6.2A.3.1.1-3: Additional test parameters for TDD CC**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex Mode | | | TDD |
| Subcarrier spacing | | kHz | 30 |
| TDD UL-DL pattern | | | FR1.30-1 |
| ZP CSI-RS configuration | CSI-RS periodicity and offset | slot | 10/1 |
| NZP CSI-RS for CSI acquisition | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 |
| CSI-IM configuration | CSI-IM timeConfig periodicity and offset | slot | 10/1 |
| CSI-Report periodicity and offset | | slot | 10/9 |
| CQI/RI/PMI delay | | ms | 9.5 |
| Sub-band Size | | RB | 8 for 10MHz, 15MHz, 20MHz and 25MHz,<br>16 for 30MHz, 40MHz and 50MHz,<br>32 for 60MHz, 80MHz, 90MHz and 100MHz |

**Table 6.2A.3.1.1-4: SNR configurations for 2 DL CA**

| Parameter | PCell | SCell |
|---|---|---|
| SNR (dB) | 10.0 | 4.0 |

**Table 6.2A.3.1.1-5: SNR configurations for 3 or more DL CA**

| Parameter | PCell | SCell1 | SCell2, 3… |
|---|---|---|---|
| SNR (dB) | 12.0 | 6.0 | 0.0 |

**Table 6.2A.3.1.1-6: List of CA CQI reporting test**

| Test number | CA duplex mode and SCS combination |
|---|---|
| 1 | FDD 15 kHz + TDD 30 kHz |
| 2 | FDD 15 kHz + FDD 15 kHz |
| 3 | TDD 30 kHz + TDD 30 kHz |
| Note 1: The applicability of requirements for different CA duplex modes, SCSs, is defined in 6.1.1.5.1.<br>Note 2: The applicability of requirements for different CA configurations and bandwidth combination sets is defined in 6.1.1.5.2. | |

#### 6.2A.3.1.2 Minimum requirement for CQI reporting for SCell on band with shared spectrum access

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [12] for Scell on band with shared spectrum access. For each downlink transmission duration the transmission power offset is randomly chosen between [0, +6] dB and 2 sets of CQI reports are obtained for each transmission power offset. 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 each power offset. 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.

For the parameters specified in Table 6.2A.3.1.2-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) For each transmission power offset 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) For each transmission power offset, 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. For each transmission power offset, 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.

c) The absolute difference in median CQI for each of transmission power offset shall be ≥ 2.

The test parameters for configuring the PCell are specified in Table 6.2A.3.1.2-2, but requirements are only applicable to SCell on band with shared spectrum access.

**Table 6.2A.3.1.2-1: CQI reporting test parameters for SCell on band with shared spectrum access**

| Parameter | | Unit | Test 1 | |
|---|---|---|---|---|
| Bandwidth | | MHz | 20 | |
| Subcarrier spacing | | kHz | 30 | |
| Duplex Mode | | | TDD | |
| Downlink Transmission Model | | | As specified in Annex B.5 | |
| Downlink Transmission Model Parameters | Downlink period | ms | 5 | |
| | LBT failure probability ($p_{LBT}$) | | 0.25 | |
| | Downlink transmission duration values set | slot | {4,6,7} | |
| | Occupied OFDM symbols in slot other than the last slot of the downlink duration | symbols | 14 | |
| | Occupied OFDM symbols in the last slot of the downlink duration | symbols | 14 | |
| TDD UL-DL pattern | | | FR1.30-7 | |
| SNR | | dB | 8 | 9 |
| $\widehat{E_s}$ for power offset 1 | | dBm/Hz | -112 | |
| $\widehat{E_s}$ for power offset 2 | | dBm/Hz | -106 | |
| Propagation channel | | | AWGN | |
| Antenna configuration | | | 2×2 with static channel specified in Annex B.1 | |
| Beamforming Model | | | As specified in Annex B.4.1 | |
| 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 ($k_0$) | | Row 5,4 | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 9 | |
| | CSI-RS periodicity and offset | slot | 10/1 | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic | |
| | Number of CSI-RS ports (*X*) | | 2 | |
| | CDM Type | | FD-CDM2 | |
| | Density (ρ) | | 1 | |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$ ) | | Row 3,(6,-) | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 3 | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | Not configured | |
| | aperiodicTriggeringOffset | | 0 | |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic | |
| | CSI-IM RE pattern | | 0 | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4, 9) | |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured | |
| Codebook configuration | Codebook Type | | typeI-SinglePanel | |
| | Codebook Mode | | 1 | |
| | (CodebookConfig-N1,CodebookConfig-N2) | | Not configured | |
| | CodebookSubsetRestriction | | 010000 | |

| | | | |
|---|---|---|---|
| | RI Restriction | | N/A |
| CQI/RI/PMI delay | | ms | 9.5 |
| Maximum number of HARQ transmission | | | 1 |
| Measurement channel | | | As specified in Table A.4-2, TBS.2-8 |

**Table 6.2A.3.1.2-2: Configuration parameters for PCell**

| Parameter | Unit | Test 1 |
|---|---|---|
| Bandwidth | MHz | 20 |
| Subcarrier spacing | kHz | 30 |
| Duplex Mode | | TDD |
| TDD UL-DL pattern | | FR1.30-1 |
| Propagation channel | | AWGN |
| Antenna configuration | | 2×2 with static channel specified in Annex B.1 |
| Beamforming Model | | As specified in Annex B.4.1 |
| ReportConfigType | | Aperiodic |
| CQI-table | | Table 2 |
| reportQuantity | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | configured |
| timeRestrictionForInterferenceMeasurements | | configured |
| cqi-FormatIndicator | | Wideband |
| pmi-FormatIndicator | | Wideband |
| Sub-band Size | RB | 8 |
| Csi-ReportingBand | | 1111111 |
| CSI-Report periodicity and offset | slot | Not configured |
| aperiodicTriggeringOffset | | 7 |
| CSI request | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | 1 |
| CSI-AperiodicTriggerStateList | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Physical channel for CSI report | | PUSCH |

## 6.2A.4 4RX requirements

### 6.2A.4.1 CQI reporting definition under AWGN conditions

#### 6.2A.4.1.1 Minimum requirement for CQI reporting for SCell on band with shared spectrum access

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [12] for Scell on band with shared spectrum access. For each downlink transmission duration the transmission power offset is randomly chosen between [0, +6] dB and 2 sets of CQI reports are obtained for each transmission power offset. 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 each power offset. 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.

For the parameters specified in Table 6.2A.4.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) For each transmission power offset 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) For each transmission power offset, 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. For each transmission power offset, 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.

c) The absolute difference in median CQI for each of transmission power offset shall be ≥ 2.

The test parameters for configuring the PCell are specified in Table 6.2A.4.1.1-2, but requirements are only applicable to SCell on band with shared spectrum access.

**Table 6.2A.4.1.1-1: CQI reporting test parameters for SCell on band with shared spectrum access**

<table>
<tr><th colspan="2">Parameter</th><th>Unit</th><th colspan="2">Test 1</th></tr>
<tr><td colspan="2">Bandwidth</td><td>MHz</td><td colspan="2">20</td></tr>
<tr><td colspan="2">Subcarrier spacing</td><td>kHz</td><td colspan="2">30</td></tr>
<tr><td colspan="2">Duplex Mode</td><td></td><td colspan="2">TDD</td></tr>
<tr><td colspan="2">Downlink Transmission Model</td><td></td><td colspan="2">As specified in Annex B.5</td></tr>
<tr><td rowspan="5">Downlink Transmission Model Parameters</td><td>Downlink period</td><td>ms</td><td colspan="2">5</td></tr>
<tr><td>LBT failure probability ($p_{LBT}$)</td><td></td><td colspan="2">0.25</td></tr>
<tr><td>Downlink transmission duration values set</td><td>slot</td><td colspan="2">{4,6,7}</td></tr>
<tr><td>Occupied OFDM symbols in slot other than the last slot of the downlink duration</td><td>symbols</td><td colspan="2">14</td></tr>
<tr><td>Occupied OFDM symbols in the last slot of the downlink duration</td><td>symbols</td><td colspan="2">14</td></tr>
<tr><td colspan="2">TDD UL-DL pattern</td><td></td><td colspan="2">FR1.30-7</td></tr>
<tr><td colspan="2">SNR</td><td>dB</td><td>5</td><td>6</td></tr>
<tr><td colspan="2">$\widehat{E_s}$ for power offset 1</td><td>dBm/Hz</td><td colspan="2">-112</td></tr>
<tr><td colspan="2">$\widehat{E_s}$ for power offset 2</td><td>dBm/Hz</td><td colspan="2">-106</td></tr>
<tr><td colspan="2">Propagation channel</td><td></td><td colspan="2">AWGN</td></tr>
<tr><td colspan="2">Antenna configuration</td><td></td><td colspan="2">2×4 with static channel specified in Annex B.1</td></tr>
<tr><td colspan="2">Beamforming Model</td><td></td><td colspan="2">As specified in Annex B.4.1</td></tr>
<tr><td rowspan="7">ZP CSI-RS configuration</td><td>CSI-RS resource Type</td><td></td><td colspan="2">Periodic</td></tr>
<tr><td>Number of CSI-RS ports (X)</td><td></td><td colspan="2">4</td></tr>
<tr><td>CDM Type</td><td></td><td colspan="2">FD-CDM2</td></tr>
<tr><td>Density (ρ)</td><td></td><td colspan="2">1</td></tr>
<tr><td>First subcarrier index in the PRB used for CSI-RS ($k_0$)</td><td></td><td colspan="2">Row 5,4</td></tr>
<tr><td>First OFDM symbol in the PRB used for CSI-RS ($l_0$)</td><td></td><td colspan="2">9</td></tr>
<tr><td>CSI-RS periodicity and offset</td><td>slot</td><td colspan="2">10/1</td></tr>
<tr><td rowspan="8">NZP CSI-RS for CSI acquisition</td><td>CSI-RS resource Type</td><td></td><td colspan="2">Aperiodic</td></tr>
<tr><td>Number of CSI-RS ports (X)</td><td></td><td colspan="2">2</td></tr>
<tr><td>CDM Type</td><td></td><td colspan="2">FD-CDM2</td></tr>
<tr><td>Density (ρ)</td><td></td><td colspan="2">1</td></tr>
<tr><td>First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$ )</td><td></td><td colspan="2">Row 3,(6,-)</td></tr>
<tr><td>First OFDM symbol in the PRB used for CSI-RS ($l_0$)</td><td></td><td colspan="2">3</td></tr>
<tr><td>NZP CSI-RS-timeConfig periodicity and offset</td><td>slot</td><td colspan="2">Not configured</td></tr>
<tr><td>aperiodicTriggeringOffset</td><td></td><td colspan="2">0</td></tr>
<tr><td rowspan="4">CSI-IM configuration</td><td>CSI-IM resource Type</td><td></td><td colspan="2">Aperiodic</td></tr>
<tr><td>CSI-IM RE pattern</td><td></td><td colspan="2">0</td></tr>
<tr><td>CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$)</td><td></td><td colspan="2">(4, 9)</td></tr>
<tr><td>CSI-IM timeConfig periodicity and offset</td><td>slot</td><td colspan="2">Not configured</td></tr>
<tr><td rowspan="4">Codebook configuration</td><td>Codebook Type</td><td></td><td colspan="2">typeI-SinglePanel</td></tr>
<tr><td>Codebook Mode</td><td></td><td colspan="2">1</td></tr>
<tr><td>(CodebookConfig-N1,CodebookConfig-N2)</td><td></td><td colspan="2">Not configured</td></tr>
<tr><td>CodebookSubsetRestriction</td><td></td><td colspan="2">010000</td></tr>
</table>

| | | | |
|---|---|---|---|
| | RI Restriction | | N/A |
| CQI/RI/PMI delay | | ms | 9.5 |
| Maximum number of HARQ transmission | | | 1 |
| Measurement channel | | | As specified in Table A.4-2, TBS.2-8 |

**Table 6.2A.4.1.1-2: Configuration parameters for PCell**

| Parameter | Unit | Test 1 |
|---|---|---|
| Bandwidth | MHz | 20 |
| Subcarrier spacing | kHz | 30 |
| Duplex Mode | | TDD |
| TDD UL-DL pattern | | FR1.30-1 |
| Propagation channel | | AWGN |
| Antenna configuration | | 2×4 with static channel specified in Annex B.1 |
| Beamforming Model | | As specified in Annex B.4.1 |
| ReportConfigType | | Aperiodic |
| CQI-table | | Table 2 |
| reportQuantity | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | configured |
| timeRestrictionForInterferenceMeasurements | | configured |
| cqi-FormatIndicator | | Wideband |
| pmi-FormatIndicator | | Wideband |
| Sub-band Size | RB | 8 |
| Csi-ReportingBand | | 1111111 |
| CSI-Report periodicity and offset | slot | Not configured |
| aperiodicTriggeringOffset | | 7 |
| CSI request | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | 1 |
| CSI-AperiodicTriggerStateList | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Physical channel for CSI report | | PUSCH |

# 6.3 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 reported PMI compared to the case when the transmitter is using random precoding, respectively. When the transmitter uses random precoding, for each PDSCH allocation a precoder is randomly generated with equal propability of each applicable $i_1$ and $i_2$ combination and applied to the PDSCH. A fixed transport format (FRC) is configured for all requirements.

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

$$\gamma = \frac{t_{ue}}{t_{rnd}}$$

In the definition of $\gamma$, for 4TX, 8TX, 16TX, and 32TX PMI requirements, $t_{ue}$ is 90 % of the maximum throughput obtained at $SNR_{ue}$ using the precoders configured according to the UE reports, and $t_{rnd}$ is the throughput measured at $SNR_{ue}$ with random precoding.

The requirements for transmission scheme 1 with higher layer parameter *codebookType* set to 'typeII' or 'typeII-r16' are specified in terms of the ratio:

$$\gamma = \frac{t_{ue,follow1,follow2}}{t_{rnd1,\ rnd2}}$$

In the definition of $\gamma$, for 16TX PMI requirements, $t_{ue,\,follow1,\,follow2}$ is 90 % of the maximum throughput obtained at $SNR_{follow1,\,follow2}$ using the precoders configured according to the UE reports, and $t_{rnd1,\,rnd2}$ is the throughput measured at $SNR_{follow1,\,follow2}$ 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 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 4 x 2 (N1,N2) = (2,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$) | | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (9) |
| | CSI-RS periodicity 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 ($k_0$) | | Row 4, (0) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (13) |
| | CSI-RS periodicity and offset | | Not configured |
| | aperiodicTriggering Offset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured |
| 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 periodicity and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 4 |

| | | | |
|---|---|---|---|
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (2,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,1) |
| | 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 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+3).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.2.1.1-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 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 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 8 x 2<br>(N1,N2) = (4,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$) | | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (9) |
| | CSI-RS periodicity 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 ($k_0$, $k_1$ ) | | Row 8, (4,6) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (5) |
| | CSI-RS periodicity and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured |
| 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 periodicity and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |

| | | | |
|---|---|---|---|
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (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 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.2.1.2-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 1.5 |

### 6.3.2.1.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.1.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.3-2.

**Table 6.3.2.1.3-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLC300-5 |
| Antenna configuration | | | High XP 16 x 2<br>(N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |

| | | | |
|---|---|---|---|
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Subband |
| Sub-band Size | | RB | 8 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubset Restriction | | 0x<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF 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.1-6.3 |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.2.1.3-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 2.5 |

### 6.3.2.1.4 Single PMI with 32TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.1.4-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.4-2.

**Table 6.3.2.1.4-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 32 x 2<br>(N1,N2) = (4,4) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 32 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 17, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, 12) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |

| | | | |
|---|---|---|---|
| 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 | Not configured |
| Aperiodic Report Slot Offset | | | 5 |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,4) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubset Restriction | | 0x<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF 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.1-6.3 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.2.1.4-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 5.0 |

#### 6.3.2.1.5 Multiple PMI with 16TX TypeII Codebook

For the parameters specified in Table 6.3.2.1.5-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.5-2.

**Table 6.3.2.1.5-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | XP Medium 16 x 2 (N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Subband |
| Sub-band Size | | RB | 8 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |

| | | | |
|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeII |
| | L (*numberOfBeams*) | | 2 |
| | $N_{PSK}$ (*phaseAlphabetSize*) | | 8 |
| | *subbandAmplitude* | | True |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubsetRestriction | | 0x 7FF<br>FFFF FFFF FFFF FFFF |
| | RI Restriction (typeII-RI-Restriction) | | 10 |
| Physical channel for CSI report | | | PUSCH |
| CQI/RI/PMI delay | | ms | 8 |
| Maximum number of HARQ transmission | | | 4 |
| Measurement channel | | | R.PDSCH.1-6.3 |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.2.1.3-1.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test. | | | |

**Table 6.3.2.1.5-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 1.9 |

### 6.3.2.1.6 Multiple PMI with 16TX Enhanced Type II Codebook

For the parameters specified in Table 6.3.2.1.6-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.6-2.

**Table 6.3.2.1.6-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | XP Medium 16 x 2<br>(N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Not configured |
| Sub-band Size | | RB | 4 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |

| | | | |
|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeII-r16 |
| | *paramCombination-r16* | | 6 (L =4, $p_v$ =1/2, β=1/2 ) |
| | R*(numberOfPMISubbandsPerCQISubband-r16)* | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubsetRestriction | | 0x 7FF FFFF FFFF FFFF FFFF |
| | RI Restriction (typeII-RI-Restriction-r16) | | 0010 |
| Physical channel for CSI report | | | PUSCH |
| CQI/RI/PMI delay | | ms | 8 |
| Maximum number of HARQ transmission | | | 4 |
| Measurement channel | | | R.PDSCH.1-6.3 |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.2.1.3-1.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the dual-cluster beam directions shall be used as specified in AnnexB.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test. | | | |

**Table 6.3.2.1.6-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 2.2 |

## 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 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configuration | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 4 x 2<br>(N1,N2) = (2,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$) | | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (9) |
| | CSI-RS periodicity 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 ($k_0$) | | Row 4, (0) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (13) |
| | CSI-RS periodicity and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured |
| 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 periodicity and offset | | slot | Not configured |

| | | | |
|---|---|---|---|
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (2,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,1) |
| | CodebookSubset Restriction | | 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 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.2.2.1-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 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 C.3.1, 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 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 8 x 2<br>(N1,N2) = (4,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$) | | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (9) |
| | CSI-RS periodicity 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 ($k_0$, $k_1$) | | Row 8, (4,6) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (5) |
| | CSI-RS periodicity and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured |
| 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 periodicity and offset | | slot | Not configured |

| | | | |
|---|---|---|---|
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,1) |
| | CodebookSubset Restriction | | 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 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.2.2.2-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 1.5 |

### 6.3.2.2.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.2.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.3-2.

**Table 6.3.2.2.3-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLC300-5 |
| Antenna configuration | | | High XP 16 x 2 (N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |

| | | | |
|---|---|---|---|
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForIChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Subband |
| Sub-band Size | | RB | 16 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubset Restriction | | 0x<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF 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.2-8.3 TDD |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.2.2.3-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 2.5 |

#### 6.3.2.2.4 Single PMI with 32TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.2.4-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.4-2.

**Table 6.3.2.2.4-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 32 x 2<br>(N1,N2) = (4,4) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 32 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 17, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, 12) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |

| | | | |
|---|---|---|---|
| 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 | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,4) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubset Restriction | | 0x<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF 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.2-8.3 TDD |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.2.2.4-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 5.0 |

##### 6.3.2.2.5 Multiple PMI with 16TX TypeII Codebook

For the parameters specified in Table 6.3.2.2.5-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.5-2.

**Table 6.3.2.2.5-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | XP Medium 16 x 2 (N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForIChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Subband |
| Sub-band Size | | RB | 16 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |

| | | | |
|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeII |
| | L (*numberOfBeams*) | | 2 |
| | $N_{PSK}$ (*phaseAlphabetSize*) | | 8 |
| | *subbandAmplitude* | | True |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubsetRestriction | | 0x 7FF FFFF FFFF FFFF FFFF |
| | RI Restriction (typeII-RI-Restriction) | | 10 |
| Physical channel for CSI report | | | PUSCH |
| CQI/RI/PMI delay | | ms | 6.5 |
| Maximum number of HARQ transmission | | | 4 |
| Measurement channel | | | R.PDSCH.2-8.3 TDD |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.2.2.3-1.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test. | | | |

**Table 6.3.2.2.5-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| □ | 1.9 |

### 6.3.2.2.6 Multiple PMI with 16Tx Enhanced Type II Codebook

For the parameters specified in Table 6.3.2.2.6-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.6-2.

**Table 6.3.2.2.6-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | XP Medium 16 x 2 (N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForIChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Not configured |
| Sub-band Size | | RB | 8 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |

| | | | |
|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeII-r16 |
| | *paramCombination-r16* | | 6<br>(L =4, $p_v$ =1/2, β=1/2 ) |
| | R*(numberOfPMISubbandsPerCQISubband-r16)* | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubsetRestriction | | 0x 7FF FFFF FFFF FFFF FFFF |
| | RI Restriction (typeII-RI-Restriction-r16) | | 0010 |
| Physical channel for CSI report | | | PUSCH |
| CQI/RI/PMI delay | | ms | 6.5 |
| Maximum number of HARQ transmission | | | 4 |
| Measurement channel | | | R.PDSCH.2-8.3 TDD |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.2.2.3-1.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test. | | | |

**Table 6.3.2.2.6-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 2.2 |

## 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 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 4 x 4<br>(N1,N2) = (2,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$) | | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (9) |
| | CSI-RS periodicity 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 ($k_0$) | | Row 4, (0) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (13) |
| | CSI-RS periodicity and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured |
| 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 periodicity and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 4 |

| | | | |
|---|---|---|---|
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (2,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,1) |
| | CodebookSubset Restriction | | 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 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+3).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.3.1.1-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 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 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 8 x 4<br>(N1,N2) = (4,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$) | | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (9) |
| | CSI-RS periodicity 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 ($k_0$, $k_1$) | | Row 8, (4,6) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (5) |
| | CSI-RS periodicity and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured |
| 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 periodicity and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |

| | | | |
|---|---|---|---|
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,1) |
| | CodebookSubset Restriction | | 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 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.3.1.2-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 1.5 |

### 6.3.3.1.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.1.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.3-2.

**Table 6.3.3.1.3-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLC300-5 |
| Antenna configuration | | | High XP 16 x 4<br>(N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |

| | | | |
|---|---|---|---|
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Subband |
| Sub-band Size | | RB | 8 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubset Restriction | | 0x<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF 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.1-6.3 FDD |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.3.1.3-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 3.0 |

#### 6.3.3.1.4 Single PMI with 32TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.1.4-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.4-2.

**Table 6.3.3.1.4-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 32 x 4<br>(N1,N2) = (4,4) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 32 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 17, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, 12) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |

| | | | |
|---|---|---|---|
| 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 | Not configured |
| Aperiodic Report Slot Offset | | | 5 |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,4) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubset Restriction | | 0x<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF 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.1-6.3 FDD |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.3.1.4-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 7.0 |

#### 6.3.3.1.5 Multiple PMI with 16TX TypeII Codebook

For the parameters specified in Table 6.3.3.1.5-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.5-2.

**Table 6.3.3.1.5-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | XP Medium 16 x 4<br>(N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Subband |
| Sub-band Size | | RB | 8 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |

| | | | |
|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeII |
| | L (*numberOfBeams*) | | 2 |
| | $N_{PSK}$ (*phaseAlphabetSize*) | | 8 |
| | *subbandAmplitude* | | True |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubsetRestriction | | 0x 7FF<br>FFFF FFFF FFFF FFFF |
| | RI Restriction (typeII-RI-Restriction) | | 10 |
| Physical channel for CSI report | | | PUSCH |
| CQI/RI/PMI delay | | ms | 8 |
| Maximum number of HARQ transmission | | | 4 |
| Measurement channel | | | R.PDSCH.1-6.3 |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.3.1.3-1.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test. | | | |

**Table 6.3.3.1.5-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 1.9 |

### 6.3.3.1.6 Multiple PMI with 16Tx Enhanced Type II Codebook

For the parameters specified in Table 6.3.3.1.6-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.6-2.

**Table 6.3.3.1.6-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | XP Medium 16 x 4 (N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Not configured |
| Sub-band Size | | RB | 4 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |

| | | | |
|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeII-r16 |
| | *paramCombination-r16* | | 6<br>(L =4, $p_v$ =1/2, β=1/2 ) |
| | R*(numberOfPMISubbandsPerCQISubband-r16)* | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubsetRestriction | | 0x 7FF<br>FFFF FFFF FFFF FFFF |
| | RI Restriction (typeII-RI-Restriction-r16) | | 0010 |
| Physical channel for CSI report | | | PUSCH |
| CQI/RI/PMI delay | | ms | 8 |
| Maximum number of HARQ transmission | | | 4 |
| Measurement channel | | | R.PDSCH.1-6.3 |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.3.1.3-1.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test. | | | |

**Table 6.3.3.1.6-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 2.2 |

## 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 C.3.1, 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 | 10 |
| Subcarrier spacing | | kHz | 15 |
| Duplex Mode | | | FDD |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 8 x 4<br>(N1,N2) = (4,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$) | | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (9) |
| | CSI-RS periodicity 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 ($k_0$) | | Row 8, (4,6) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5,-) |
| | CSI-RS periodicity and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured |
| 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 periodicity and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 5 |

| | | | |
|---|---|---|---|
| CSI request | | | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (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: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+4).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |
| **Parameter** | | **Unit** | **Test 1** |
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configuration | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 4 x 4<br>(N1,N2) = (2,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$ ) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (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 ($k_0$, $k_1$ ) | | Row 4, (0,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (13,-) |
| | CSI-RS interval and offset | | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| 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 | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (2,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,1) |
| | 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 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |

| | |
|---|---|
| Note 1: | When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. |
| 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 gNB downlink before slot#(n+4). |
| Note 3: | Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. |

**Table 6.3.3.2.1-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 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 C.3.1, 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 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 8 x 4<br>(N1,N2) = (4,1) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$) | | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (9) |
| | CSI-RS periodicity 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 ($k_0$, $k_1$ ) | | Row 8, (4,6) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (5) |
| | CSI-RS periodicity and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured |
| 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 periodicity and offset | | slot | Not configured |

| | | | |
|---|---|---|---|
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,1) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,1) |
| | CodebookSubset Restriction | | 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 |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.3.2.2-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 1.5 |

### 6.3.3.2.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.2.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.3-2.

**Table 6.3.3.2.3-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLC300-5 |
| Antenna configuration | | | High XP 16 x 4 (N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |

| | | | |
|---|---|---|---|
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForChannnelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Subband |
| Sub-band Size | | RB | 16 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubset Restriction | | 0x<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF 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.2-8.3 TDD |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.3.2.3-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 3.0 |

#### 6.3.3.2.4 Single PMI with 32TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.2.4-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.4-2.

**Table 6.3.3.2.4-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | High XP 32 x 4<br>(N1,N2) = (4,4) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 32 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 17, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, 12) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |

| | | | |
|---|---|---|---|
| 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 | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeI-SinglePanel |
| | Codebook Mode | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,4) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubset Restriction | | 0x<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF FFFF<br>FFFF FFFF FFFF 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.2-8.3 TDD |
| PDSCH & PDSCH DMRS Precoding configuration for random Precoding | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, and with Wideband granularity |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | |

**Table 6.3.3.2.4-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 7.0 |

#### 6.3.3.2.5 Multiple PMI with 16TX TypeII Codebook

For the parameters specified in Table 6.3.3.2.5-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.5-2.

**Table 6.3.3.2.5-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | XP Medium 16 x 4 (N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForIChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Subband |
| Sub-band Size | | RB | 16 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |

| | | | |
|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeII |
| | L (*numberOfBeams*) | | 2 |
| | $N_{PSK}$ (*phaseAlphabetSize*) | | 8 |
| | *subbandAmplitude* | | True |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubsetRestriction | | 0x 7FF FFFF FFFF FFFF FFFF |
| | RI Restriction (typeII-RI-Restriction) | | 10 |
| Physical channel for CSI report | | | PUSCH |
| CQI/RI/PMI delay | | ms | 6.5 |
| Maximum number of HARQ transmission | | | 4 |
| Measurement channel | | | R.PDSCH.2-8.3 TDD |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.3.2.3-1.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test. | | | |

**Table 6.3.3.2.5-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 1.8 |

## 6.3.3.2.6 Multiple PMI with 16Tx Enhanced Type II Codebook

For the parameters specified in Table 6.3.3.2.6-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.6-2.

**Table 6.3.3.2.6-1: Test parameters (dual-layer)**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Bandwidth | | MHz | 40 |
| Subcarrier spacing | | kHz | 30 |
| Duplex Mode | | | TDD |
| TDD DL-UL configurations | | | FR1.30-1 as specified in Annex A |
| Propagation channel | | | TDLA30-5 |
| Antenna configuration | | | XP Medium 16 x 4 (N1,N2) = (4,2) |
| Beamforming Model | | | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$) | | Row 5, (4,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (9,-) |
| | CSI-RS interval and offset | slot | Not configured |
| | ZP CSI-RS trigger | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Aperiodic |
| | Number of CSI-RS ports (*X*) | | 16 |
| | CDM Type | | CDM4 (FD2, TD2) |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$, $k_2$, $k_3$) | | Row 12, (2, 4, 6, 8) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (5, -) |
| | CSI-RS interval and offset | slot | Not configured |
| | aperiodicTriggeringOffset | | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic |
| | CSI-IM RE pattern | | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (4,9) |
| | CSI-IM timeConfig interval and offset | slot | Not configured |
| ReportConfigType | | | Aperiodic |
| CQI-table | | | Table 1 |
| reportQuantity | | | cri-RI-PMI-CQI |
| timeRestrictionForIChannelMeasurements | | | Not configured |
| timeRestrictionForInterferenceMeasurements | | | Not configured |
| cqi-FormatIndicator | | | Wideband |
| pmi-FormatIndicator | | | Not configured |
| Sub-band Size | | RB | 8 |
| csi-ReportingBand | | | 1111111 |
| CSI-Report interval and offset | | slot | Not configured |
| Aperiodic Report Slot Offset | | | 8 |
| CSI request | | | 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 |

| | | | |
|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| Codebook configuration | Codebook Type | | typeII-r16 |
| | *paramCombination-r16* | | 6<br>(L =4, $p_v$ =1/2, β=1/2 ) |
| | R*(numberOfPMISubbandsPerCQISubband-r16)* | | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | (4,2) |
| | (CodebookConfig-O1,CodebookConfig-O2) | | (4,4) |
| | CodebookSubsetRestriction | | 0x 7FF<br>FFFF FFFF FFFF FFFF |
| | RI Restriction (typeII-RI-Restriction-r16) | | 0010 |
| Physical channel for CSI report | | | PUSCH |
| CQI/RI/PMI delay | | ms | 6.5 |
| Maximum number of HARQ transmission | | | 4 |
| Measurement channel | | | R.PDSCH.2-8.3 TDD |
| Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable $i_1$, $i_2$ combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.3.2.3-1.<br>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 gNB downlink before slot#(n+6).<br>Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test. | | | |

**Table 6.3.3.2.6-2: Minimum requirement**

| Parameter | Test 1 |
|---|---|
| $\gamma$ | 2.2 |

# 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 ≥ $\gamma_1$;

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 $\geq \gamma_2$;

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 |
| Subcarrier spacing | | kHz | 15 | 15 | 15 |
| Duplex Mode | | | FDD | FDD | FDD |
| 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 ($k_0$) | | Row 5,(4) | Row 5,(4) | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (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 ($k_0$) | | Row 3 (6) | Row 3 (6) | Row 3 (6) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (13) | (13) | (13) |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 5/1 | 5/1 | 5/1 |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | Periodic | Periodic |
| | CSI-IM RE pattern | | Pattern 0 | Pattern 0 | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 5/0 | 5/0 | 5/0 |
| 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 | | | 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 |
| Note 1: Measurements channels are specified in Table A.4-2. TBS.2-1 is used for Rank 1 case. TBS.2-2 is used for Rank 2 case. | | | | | |

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

| | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| $\gamma_1$ | N/A | 1.05 | 0.9 |
| $\gamma_2$ | 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 $\geq \gamma_1$;

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 $\geq \gamma_2$;

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 |
| Subcarrier spacing | | kHz | 30 | 30 | 30 |
| Duplex Mode | | | TDD | TDD | TDD |
| TDD Slot Configuration | | | FR1.30-1 | FR1.30-1 | FR1.30-1 |
| 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 ($k_0$) | | Row 5,(4) | Row 5,(4) | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (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 ($k_0$) | | Row 3 (6) | Row 3 (6) | Row 3 (6) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (13) | (13) | (13) |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 10/1 | 10/1 | 10/1 |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | Periodic | Periodic |
| | CSI-IM RE pattern | | Pattern 0 | Pattern 0 | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 10/9 | 10/9 | 10/9 |
| 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 |
| Note 1: Measurements channels are specified in Table A.4-2. TBS.2-3 is used for Rank 1 case. TBS.2-4 is used for Rank 2 case. | | | | | |

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

| | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| $\gamma_1$ | N/A | 1.05 | 0.9 |
| $\gamma_2$ | 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 $\geq \gamma_1$;

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 $\geq \gamma_2$;

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 |
| Subcarrier spacing | | kHz | 15 | 15 | 15 | 15 |
| Duplex Mode | | | FDD | FDD | FDD | FDD |
| SNR | | dB | -2 | 16 | 16 | 22 |
| Propagation channel | | | TDLA30-5 | TDLA30-5 | TDLA30-5 | TDLA30-5 |
| Antenna configuration | | | ULA Low 2x4 | ULA Low 2x4 | ULA High 2x4 | ULA Low 4x4 |
| Beamforming Model | | | As 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 ($k_0$) | | Row 5,(4) | Row 5,(4) | Row 5,(4) | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (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 ($k_0$) | | Row 3 (6) | Row 3 (6) | Row 3 (6) | Row 4 (0) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (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 resource Type | | Periodic | Periodic | Periodic | Periodic |
| | CSI-IM RE pattern | | Pattern 0 | Pattern 0 | Pattern 0 | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 5/0 | 5/0 | 5/0 | 5/0 |
| 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 |
| Note 1: Measurements channels are specified in Table A.4-2 and Table A.4-3. TBS.2-1 is used for Rank 1 case. TBS.2-2 is used for Rank 2 case. TBS.3-1 is used for Rank 3 case. TBS.3-2 is used for Rank 4 case. | | | | | |

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

| | Test 1 | Test 2 | Test 3 | Test 4 |
|---|---|---|---|---|
| $\gamma_1$ | N/A | 1.05 | 0.9 | N/A |
| $\gamma_2$ | 0.9 | N/A | N/A | 0.9 |

### 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 $\geq \gamma_1$;

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 $\geq \gamma_2$;

For the parameters specified in Table 6.4.3.2-1, and using the downlink physical channels specified in Annex C.3.1, 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 |
| Subcarrier spacing | | kHz | 30 | 30 | 30 | 30 |
| Duplex Mode | | | TDD | TDD | TDD | TDD |
| TDD Slot Configuration | | | FR1.30-1 | FR1.30-1 | FR1.30-1 | FR1.30-1 |
| SNR | | dB | -2 | 16 | 16 | 22 |
| Propagation channel | | | TDLA30-5 | TDLA30-5 | TDLA30-5 | TDLA30-5 |
| Antenna configuration | | | ULA Low 2x4 | ULA Low 2x4 | ULA High 2x4 | ULA Low 4x4 |
| Beamforming Model | | | As 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 ($k_0$) | | Row 5,(4) | Row 5,(4) | Row 5,(4) | Row 5,(4) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (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 | 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 ($k_0$) | | Row 3 (6) | Row 3 (6) | Row 3 (6) | Row 4 (0) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | (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 resource Type | | Periodic | Periodic | Periodic | Periodic |
| | CSI-IM RE pattern | | Pattern 0 | Pattern 0 | Pattern 0 | Pattern 0 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (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 | 10/9 | 10/9 | 10/9 | 10/9 |
| Codebook configuration | Codebook Type | | typeI-SinglePanel | typeI-SinglePanel | typeI-SinglePanel | typeI-SinglePanel |
| | Codebook Mode | | 1 | 1 | 1 | 1 |
| | (CodebookConfig-N1,CodebookConfig-N2) | | N/A | N/A | N/A | (2,1) |
| | CodebookSubsetRestriction | | 010000 for fixed rank 2, 010011 for following rank | 000011 for fixed rank 1, 010011 for following rank | 000011 for fixed rank 1, 010011 for following rank | 11111111 |
| | RI Restriction | | N/A | N/A | N/A | 00000010 for fixed Rank 2 and 00001111 for follow RI |
| 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 |
| Note 1: Measurements channels are specified in Table A.4-2 and Table A.4-3. TBS.2-3 is used for Rank 1 case. TBS.2-4 is used for Rank 2 case. TBS.3-3 is used for Rank 3 case. TBS.3-4 is used for Rank 4 case. | | | | | |

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

| | Test 1 | Test 2 | Test 3 | Test 4 |
|---|---|---|---|---|
| $\gamma_1$ | N/A | 1.05 | 0.9 | N/A |
| $\gamma_2$ | 0.9 | N/A | N/A | 0.9 |

# 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 $F_{DL\_high}$ 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, 7.1.1.4, 7.1.1.5.

If same test is listed for different UE features/capabilities in Clauses 7.1.1.3 and 7.1.1.4, then this test shall apply for UEs which support all corresponding UE features/capabilities.

#### 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 features

The performance requirements in Table 7.1.1.3-1 shall apply for UEs which support optional UE features only.

**Table 7.1.1.3-1: Requirements applicability for optional UE features**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| SU-MIMO Interference Mitigation advanced receiver | FR2 TDD | PDSCH | Clause 7.2.2.2.1 (Test 3-1) | |
| Basic DL NR-NR CA operation (*supportedBandCombinationList*) | NR CA | SDR | Clause 7.5A.1 | 1) Up to 16 DL carriers<br>2) Same numerology across carrier for data/control channel at a given time |
| PDSCH repetitions over multiple slots *(pdsch-RepetitionMultiSlots)* | FR2 TDD | PDSCH | Clause 7.2.2.2.2 | |
| DRX Adaptation (*drx-Adaptation-r16*) | FR2 TDD | PDCCH | Clause 7.3.2.2.3 | If the Test 3-1 in Clause 7.3.2.2.3 is passed, the test coverage can be considered fulfilled without executing Test 1-2 in clause 7.3.2.2.1. |
| 256QAM for PDSCH (*pdsch-256QAM-FR2*) | FR2 TDD | PDSCH | Clause 7.2.2.2.1 (Test 1-4) | |
| 256QAM for PDSCH (*pdsch-256QAM-FR2*) | FR2 TDD | SDR | Clause 7.5A.1 | For UE capable of *pdsch-256QAM-FR2* for certain band(s), *mcs-Table* is configured to '64QAM' for SDR test. |

## 7.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

The performance requirements in Table 7.1.1.4-1 shall apply for UEs which support mandatory UE features with capability signalling only.

**Table 7.1.1.4-1: Requirements applicability for mandatory features with UE capability signalling**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| Supported maximum number of PDSCH MIMO layers (*maxNumberMIMO-LayersPDSCH)* | FR2 TDD | PDSCH | Clause 7.2.2.2.1 (Tests from 2-1 to 2-6) | The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability |
| Support of PT-RS with one antenna port for DL reception (*onePortsPTRS*) | FR2 TDD | PDSCH | Clause 7.2 | |
| | | SDR | Clause 7.5.1<br>Clause 7.5A.1 | |
| PCell operation on FR2 (*pCell-FR2*) | FR2 TDD | SDR | Clause 7.5A.1 | |
| PDSCH mapping type B (*pdsch-MappingTypeB*) | FR2 TDD | PDSCH | Clause 7.2.2.2.3 | |

## 7.1.1.5 Applicability of CA requirements

### 7.1.1.5.1 Definition of CA capability

The definition with respect to CA capabilities is given as in Table 7.1.1.5.1-1.

**Table 7.1.1.5.1-1: Definition of CA capability**

| CA Capability | CA Capability Description |
|---|---|
| CA_C | Intra-band contiguous CA |
| CA_N | Intra-band non-contiguous CA |
| CA_AX | Inter-band CA (X bands) |
| NOTE 1: CA_C corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.1 of TS 38.101-2 [7].<br>CA_N corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.2 of TS 38.101-2 [7].<br>CA_AX corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.3 of TS 38.101-2 [7]. | |

#### 7.1.1.5.2 Applicability and test rules for different CA configurations and bandwidth combination sets

The performance requirement for CA UE demodulation tests in Clause 7.2A are defined independent of CA configurations and bandwidth combination sets specified in Clause 5.5A of TS 38.101-2. For UEs supporting different CA configurations and bandwidth combination sets, the applicability and test rules are defined in Table 7.1.1.5.2-1 and Table 7.1.1.5.2-2. For simplicity, CA configuration below refers to combination of CA configuration and bandwidth combination set.

**Table 7.1.1.5.2-1: Applicability and test rules for CA UE demodulation tests**

| Tests | CA capability where the tests apply | CA configuration from the selected CA capability where the tests apply | CA Bandwidth combination to be tested in priority order | PCell CC configuration |
|---|---|---|---|---|
| Test 1 in Clause 7.2A.2.1 | CA_C, CA_N, CA_AX | Table 7.1.1.5.2-2 | Largest aggregated CA bandwidth combination | Any of CCs |

**Table 7.1.1.5.2-2: Selection of CA configurations**

| CA capability | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| CA_C or CA_N or CA_AX | Select CA configuration(s), which contain all CA bandwidth combinations requiring SNR below test equipment maximum achievable SNR | Select the CA configurations with the maximum number of CCs, for which the supported maximum number of MIMO layers is not lower than 2, among all the selected CA configurations from Step 1. | Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 2. |
| NOTE 1: Maximum supported data rate for Step 3 is calculated based clause 4.1.2 of TS 38.306 [14]<br>NOTE 2: Tested data rate for Step 3 is calculated based on the equation $DataRate = 10^{-3} \sum_{j=1}^{J} TBS_j 2^{\mu_j}$ and FRCs used in the test. | | | |

## 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 |
| PTRS *epre-Ratio* | | | 0 |
| Actual carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 2) | RBs | 0 |
| | Subcarrier spacing | kHz | 60 or 120 |
| DL BWP configuration #1 | Cyclic prefix | | Normal |
| | RB offset | RBs | 0 |
| | Number of contiguous PRB | PRBs | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing |
| 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 |
| | Symbols with PDCCH | | 0 |
| | Number of PRBs in CORESET | | Table 7.2-2 for tested channel bandwidth and subcarrier spacing |
| | Number of PDCCH candidates and aggregation levels | | 1/AL8 |
| | CCE-to-REG mapping type | | Non-interleaved |
| | DCI format | | 1_1 |
| | TCI state | | TCI state #1 |
| | PDCCH & PDCCH DMRS Precoding configuration | | Single Panel Type I, Random per slot with equal probability of each applicable $i_1$, $i_2$ combination, and with REG bundling granularity for number of Tx larger than 1 |
| Cross carrier scheduling | | | Not configured |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | 0 for CSI-RS resource 1,2,3,4 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 6 for CSI-RS resource 1 and 3<br>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 | 60 kHz SCS: 80 for CSI-RS resource 1,2,3,4<br>120 kHz SCS: 160 for CSI-RS resource 1,2,3,4 |
| | CSI-RS offset | Slots | 60 kHz SCS:<br>40 for CSI-RS resource 1 and 2<br>41 for CSI-RS resource 3 and 4<br><br>120 kHz SCS:<br>80 for CSI-RS resource 1 and 2<br>81 for CSI-RS resource 3 and 4 |

| | | | |
|---|---|---|---|
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | QCL info | | TCI state #0 |
| NZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | 0 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 12 |
| | Number of CSI-RS ports ($X$) | | 2 |
| | CDM Type | | FD-CDM2 |
| | Density ($\rho$) | | 1 |
| | CSI-RS periodicity | Slots | 60 kHz SCS: 80<br>120 kHz SCS: 160 |
| | CSI-RS offset | | 0 |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size/4) *4 |
| | QCL info | | TCI state #1 |
| ZP CSI-RS for CSI acquisition | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | 4 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 12 |
| | Number of CSI-RS ports ($X$) | | 4 |
| | CDM Type | | FD-CDM2 |
| | Density ($\rho$) | | 1 |
| | CSI-RS periodicity | Slots | 60 kHz SCS: 80<br>120 kHz SCS: 160 |
| | CSI-RS offset | | 0 |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size/4) *4 |
| CSI-RS for beam refinement | First subcarrier index in the PRB used for CSI-RS | | $k_0$=0 for CSI-RS resource 1,2 |
| | First OFDM symbol in the PRB used for CSI-RS | | $l_0$ = 8 for CSI-RS resource 1<br>$l_0$ = 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 | 60 kHz SCS: 80 for CSI-RS resource 1,2<br>120 kHz SCS: 160 for CSI-RS resource 1,2 |
| | CSI-RS offset | Slots | 0 for CSI-RS resource 1,2 |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | Repetition | | ON |
| | QCL info | | TCI state #1 |
| PDSCH DMRS configuration | Antenna ports indexes | | {1000} for Rank 1 tests<br>{1000, 1001} for Rank 2 tests |
| | Position of the first DMRS for PDSCH mapping type A | | 2 |
| | Number of PDSCH DMRS CDM group(s) without data | | 1 |
| TCI state #0 | SSB index | | SSB #0 |

| | | | | |
|---|---|---|---|---|
| | Type 1 QCL information | 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 ($K_{PT-RS}$) | | | 2 |
| | Time density ($L_{PT-RS}$) | | | 1 |
| | Resource Element Offset | | | 2 |
| Maximum number of code block groups for ACK/NACK feedback | | | | 1 |
| Maximum number of HARQ transmission | | | | 4 |
| HARQ ACK/NACK bundling | | | | Multiplexed |
| Redundancy version coding sequence | | | | {0,2,3,1} |
| PDSCH & PDSCH DMRS Precoding configuration | | | | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1$, $i_2$ combination, andwith Wideband granularity |
| Symbols for all unused REs | | | | OP.1 FDD as defined in Annex A.5.1.1<br>OP.1 TDD as defined in Annex A.5.2.1 |
| Physical signals, channels mapping and precoding | | | | As specified in Annex B.4.1 |
| Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission.<br>Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing. | | | | |

**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, 1-4, 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 performance requirements for Enhanced Receiver Type 1 under 2 receive antenna conditions. | 3-1 |

**Table 7.2.2.2.1-2: Test Parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| CSI-RS for tracking | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | For Test 1-1 and 1-2:<br>3 for CSI-RS resource 1 and 3<br>7 for CSI-RS resource 2 and 4 |
| | CSI-RS offset | Slots | For Test 1-2:<br>82 for CSI-RS resource 1 and 2<br>83 for CSI-RS resource 3 and 4 |
| PDCCH configuration | Number of PDCCH candidates and aggregation levels | | 1/AL4 for Test 1-4 and 2-3<br>1/AL8 for other tests |
| PDSCH configuration | Mapping type | | Type A |
| | *k0* | | 0 |
| | Starting symbol (S) | | 1 |
| | Length (L) | | Specific to each Reference channel as defined in A.3.2.2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | wideband for Test 1-1,<br>2 for other tests |
| | Resource allocation type | | Test 2-1: Type 1 with start RB = 30, $L_{RBs}$ = 6<br>Other tests: Type 0 |
| | RBG size | | Test 2-1: N/A<br>Other tests: Config2 |
| | 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 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 8 for Test 1-1, 1-3, 1-4, 2-2, 2-4<br>10 for Test 2-1, 2-3, 2-5, 2-6, 3-1<br>16 for Test 1-2 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | 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 (MHz) / Subcarrier spacing (kHz) | Modulation and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | $SNR_{BB}$ (dB) |
| 1-1 | R.PDSCH.5-1.1 TDD | 100 / 120 | QPSK, 0.30 | FR2.120-1A | TDLC60-300 | 2x2 ULA Low | 70 | -0.4 |
| 1-2 | R.PDSCH.5-2.1 TDD | 100 / 120 | 16QAM, 0.48 | FR2.120-1 | TDLA30-300 | 2x2 ULA Low | 30 | 1.7 |
| 1-3 | R.PDSCH.5-3.1 TDD | 100 / 120 | 64QAM, 0.46 | FR2.120-1 | TDLA30-300 | 2x2 XPL Medium | 70 | 12.4 |
| 1-4 | R.PDSCH.5-10.1 TDD | 50 / 120 | 256QAM 0.67 | FR2.120-1 | TDLD30-75 | 2x2 ULA Low | 70 | 20.2 |

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

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | $SNR_{BB}$ (dB) |
| 2-1 | R.PDSCH.5-4.1 TDD | 100 / 120 | QPSK, 0.30 | FR2.120-2 | TDLA30-75 | 2x2 ULA Low | 70 | 4.1 |
| 2-2 | R.PDSCH.5-2.2 TDD | 100 / 120 | 16QAM, 0.48 | FR2.120-1 | TDLA30-300 | 2x2 ULA Low | 70 | 14.4 |
| 2-3 | R.PDSCH.5-5.2 TDD | 50 / 120 | 16QAM,0.48 | FR2.120-2 | TDLA30-75 | 2x2 ULA Low | 70 | 14.0 |
| 2-4 | R.PDSCH.5-2.3 TDD | 200 / 120 | 16QAM, 0.48 | FR2.120-1 | TDLA30-300 | 2x2 ULA Low | 70 | 14.2 |
| 2-5 | R.PDSCH.4-1.1 TDD | 50 / 60 | 16QAM, 0.48 | FR2.60-1 | TDLA30-75 | 2x2 ULA Low | 70 | 14.3 |
| 2-6 | R.PDSCH.5-6.1 TDD | 100 / 120 | 64QAM, 0.43 | FR2.120-2 | TDLA30-75 | 2x2 ULA Low | 70 | 18.6 |

**Table 7.2.2.2.1-5: Minimum performance for Rank 2 (FRC) for Enhanced Receiver Type 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fraction of maximum throughput (%) | $SNR_{BB}$ (dB) |
| 3-1 | R.PDSCH.5-5.1 TDD | 100 / 120 | 16QAM, 0.48 | FR2.120-2 | TDLA30-75 | 2x2 ULA Medium | 70 | 19.0 |

#### 7.2.2.2.2 Minimum requirements for PDSCH repetitions over multiple slots

For PDSCH with slot aggregation, the requirements are specified in Table 7.2.2.2.2-3, additional parameters in Table 7.2.2.2.2-2 and the downlink physical channel setup according to Annex C.5.1.

The test purpose is specified in Table 7.2.2.2.2-1.

**Table 7.2.2.2.2-1: Test purpose**

| Purpose | Test index |
|---|---|
| Verify the PDSCH repetitions over multiple slots performance under 2 receive antenna conditions | 1-1 |

**Table 7.2.2.2.2-2: Test Parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | *k0* | | 0 |
| | Starting symbol (S) | | 1 |
| | Length (L) | | 13 |
| | PDSCH aggregation factor | | 2 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 2 |
| The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information | | | As defined in Annex A.1.3 (Note 1) |
| Note 1: ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,4) = 1, where i is the slot index per frame; i = {0,...,79} | | | |

**Table 7.2.2.2.2-3: Minimum performance for Rank 1 (FRC)**

| Test num | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation and code rate | TDD UL-DL pattern | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Target BLER | SNR (dB) |
| 1-1 | R.PDSCH. 5-11.1 TDD | 100 / 120 | 16QAM, 0.37 | FR2.120-2 | TDLA30-75 | 2x2 ULA Low | 1% (Note 1) | -1.1 |
| Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. | | | | | | | | |

#### 7.2.2.2.3 Minimum requirements for PDSCH Mapping Type B

The performance requirements are specified in Table 7.2.2.2.3-3, with the addition of test parameters in Table 7.2.2.2.3-2 and the downlink physical channel setup according to Annex C.5.1. The purpose is to verify the performance of PDSCH Type B scheduling.

The test purposes are specified in Table 7.2.2.2.3-1.

**Table 7.2.2.2.3-1: Test purpose**

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

**Table 7.2.2.2.3-2: Test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDCCH configuration | Number of PDCCH candidates and aggregation levels | | 1/AL8 |
| PDSCH configuration | Mapping type | | Type B |
| | k0 | | 0 |
| | Starting symbol (S) | | 1 |
| | Length (L) | | 2 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 0 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 8 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.3 |

**Table 7.2.2.2.3-3: Minimum performance for Rank 1**

| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | 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. 5-1.2 TDD | 100 / 120 | QPSK, 0.30 | FR2.120-1 | [TDLA30-75] | 2x2, ULA Low | 70 | 1.3 |

# 7.2A PDSCH demodulation requirements for CA

The parameters specified in Table 7.2-1 for PDSCH single carrier tests are reused for PDSCH CA test unless otherwise stated.

## 7.2A.1 1RX requirements

(Void)

## 7.2A.2 2RX requirements

### 7.2A.2.1 Minimum requirements

For CA with different numbers of DL component carriers, the requirements are defined in Table 7.2A.2.1-3 based on the single carrier requirements for different bandwidth specified in Table 7.2A.2.1-2, with the parameters in Table 7.2A.2.1-1 and the downlink physical channel setup according to Annex C.5.1. The performance requirements specified in this sub-cluase do not apply for UE single carrier test.

**Table 7.2A.2.1-1: Test parameters for CA**

| Parameter | | Unit | Value |
|---|---|---|---|
| Duplex mode | | | TDD |
| Active DL BWP index | | | 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | Starting symbol (S) | | 1 |
| | Length (L) | | Specific to each Reference channel |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | 2 |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| Number of HARQ Processes | | | 8 |
| TDD UL-DL pattern | | | 120kHz SCS: FR2.120-1 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | As defined in Annex A.1.3 |

**Table 7.2A.2.1-2: Single carrier performance for TDD 120 kHz SCS for CA configurations**

| Bandwidth (MHz) | Reference channel | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Fraction of maximum throughput (%) | SNR (dB) |
| 50 | R.PDSCH.5-9.1 TDD | 16QAM, 0.33 | TDLA30-75 | 2x2, ULA Low | 70 | [10.4] |
| 100 | R.PDSCH.5-9.2 TDD | 16QAM, 0.33 | TDLA30-75 | 2x2, ULA Low | 70 | [10.2] |
| 200 | R.PDSCH.5-9.3 TDD | 16QAM, 0.33 | TDLA30-75 | 2x2, ULA Low | 70 | [10.3] |
| 400 | R.PDSCH.5-9.4 TDD | 16QAM, 0.33 | TDLA30-75 | 2x2, ULA Low | 70 | [10.3] |

**Table 7.2A.2.1-3: Minimum performance for multiple CA configurations**

| Test number | CA duplex mode | Minimum performance requirements |
|---|---|---|
| 1 | TDD 120 kHz + TDD 120 kHz | As defined in Table 7.2A.2.1-2 |
| Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 7.1.1.5. | | |

# 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 |
|---|---|---|---|
| Carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 1) | | 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 |
| PDCCH configuration | Slots for PDCCH monitoring | | Each slot |
| | Number of PDCCH candidates | | 1 |
| | Frequency domain resource allocation for CORESET | | Start from RB = 0 with contiguous RB allocation |
| | 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<br>CSI-RS resource 2: 8<br>CSI-RS resource 3: 4<br>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<br>81 for CSI-RS resource 3 and 4 |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | QCL info | | TCI state #0 |
| NZP CSI-RS for beam refinement | 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: 8<br>CSI-RS resource 2: 9 |
| | Number of CSI-RS ports (X) | | 1 |
| | CDM Type | | No CDM |
| | Density (ρ) | | 3 |
| | 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 |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size/4) *4 |
| | Repetition | | ON |
| | QCL info | | TCI state #1 |
| PDCCH & PDCCH DMRS Precoding configuration | | | Single Panel Type I, Random per slot with equal probability of each applicable $i_1$, $i_2$ combination, and with REG bundling granularity for number of Tx larger than 1 |
| TCI state #0 | SSB index | | SSB #0 |

| | | | | |
|---|---|---|---|---|
| | Type 1 QCL information | 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 | | | | OP.1 FDD as defined in Annex A.5.1.1<br>OP.1 TDD as defined in Annex A.5.2.1 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | | | | Specific to each TDD UL-DL pattern and as defined in Annex A.1.3. |
| Note 1: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. | | | | |

## 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<br>6 for test 1-2 | 2 |
| Interleaver size | | 3 for test 1-1<br>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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | $SNR_{BB}$ (dB) |
| 1-1 | 100 | 60 | 1 | 2 | R.PDCCH. 5-1.1 TDD | TDLA30-75 | 1x2 Low | 1 | 6.4 |
| 1-2 | 100 | 60 | 1 | 4 | R.PDCCH. 5-1.2 TDD | TDLA30-300 | 1x2 Low | 1 | 3.0 |

### 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 (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | $SNR_{BB}$ (dB) |
| 2-1 | 100 | 60 | 1 | 8 | R.PDCCH. 5-1.3 TDD | TDLA30-75 | 2x2 Low | 1 | 0.1 |
| 2-2 | 100 | 60 | 2 | 16 | R.PDCCH. 5-2.1 TDD | TDLA30-75 | 2x2 Low | 1 | -3.0 |

### 7.3.2.2.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

The parameters specified in Table 7.3.2.2.3-1 are valid for normal PDCCH in DRX on period and PDCCH in DRX off period.

**Table 7.3.2.2.3-1: Test Parameters**

| Parameter | | Unit | 1 Tx Antenna |
|---|---|---|---|
| TDD UL-DL pattern | | | FR2.120-1 |
| CCE to REG mapping type | | | Interleaved |
| REG bundle size | | | 6 |
| Interleaver size | | | 2 |
| Shift index | | | 0 |
| | | | |
| DRX cycle | | ms | 10 |
| *ps-WakeUp-r16* | | | absent |
| Wake-up indication bit in DCI format 2_6 | | | 1 |
| PDCCH DCI format 2_6 configuration | PS-offset | | $(T_{minimumTimeGap}+1)/2^{\mu}/0.125$ |
| | Number of PDCCH candidates | | 1 |
| | Frequency domain resource allocation for CORESET | | Start from RB = 0 with contiguous RB allocation |
| | TCI state | | TCI state #1 |
| PDCCH configuration | Slots for PDCCH monitoring | | Each slot during DRX-on period |
| | | | |
| Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability. | | | |

For the parameters specified in Table 7.3.2.2.3-2, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 7.3.2.2.3-2. The downlink physical setup is in accordance with Annex C.5.1.

**Table 7.3.2.2.3-2: Minimum performance requirements with 120 kHz SCS**

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pm-dsg (%) | $SNR_{BB}$ (dB) |
| 3-1 | 100 | 60 | 1 | 4 | R.PDCCH. 5-1.2 TDD | TDLA30-300 | 1x2 Low | 1 | 3.0 |
| | | | | 8 | R.PDCCH. 5-1.4 TDD | | | | |

# 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

$$\mathrm{Pm} - \mathrm{bch} = 1 - \frac{A}{B}$$

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 clause 4.1 of TS 38.213 [11]<br>Note 2: as specified in clause 11.1 of TS 38.213 [11] | | |

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 (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | $SNR_{BB}$ (dB) |
| 1 | 100 / 120 | R.PBCH.5 | TDLA30-300 | 1 x 2 Low | 1 | -6.3 |
| 2 | 100 / 240 | R.PBCH.6 | TDLA30-75 | 1 x 2 Low | 1 | -6.1 |

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

| Test number | Bandwidth (MHz) / Subcarrier spacing (kHz) | Reference channel | Propagation condition | Antenna configuration and correlation matrix | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | Pm-bch (%) | PBCH SNR (dB) |
| 1 | 100 / 120 | R.PBCH.5 | TDLA30-300 | 1 x 2 Low | 1 | -7.9 |
| 2 | 100 / 240 | R.PBCH.6 | TDLA30-75 | 1 x 2 Low | 1 | -7.6 |

# 7.5 Sustained downlink data rate provided by lower layers

## 7.5.1 FR2 single carrier requirements

The requirements in this clause are applicable to the FR2 single carrier case.

The requirements and procedure defined in Clause 7.5A.1 apply using operating band instead of CA configuration, and bandwidth instead of bandwidth combination.

# 7.5A Sustained downlink data rate provided by lower layers

## 7.5A.1 FR2 CA requirements

The Sustained Data Rate (SDR) requirements in this clause are applicable to the FR2 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:

- Step 1: Calculate the date rate for all supported CA configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities:

  - Use Table 7.5A.1-3 to determine the MCS (=MCS1) achieving the largest data rate [clause 4.1.2 of TS 38.306 [14]] based on UE capabilities.

  - Use Table 7.5A.1-4 to determine the largest MCS (=MCS2) requiring SNR below test equipment maximum achievable SNR for that CA configuration.

  - Compute the data rate for CA configuration using the MCS = min(MCS1,MCS2) and the following equation for each CC in CA bandwidth combination.

$$DataRate = 10^{-3} \sum_{j=1}^{J} TBS_j 2^{\mu_j}$$

where

J is the number of aggregated component carriers in CA bandwidth combination

$TBS_j$ is the total number of DL-SCH transport block bits calculated based on methodology in Clause 5.1.3.2 of TS 38.214 [12] and using parameters from Table 7.5A.1-1

$\mu_j$ is provided in Clause 4.2 of TS 38.211 for different subcarrier spacing values

- Step 2: Choose the CA bandwidth combination among all supported CA configurations that achieves maximum data rate in step 1 among all UE capabilities.
  - Set of per CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor in accordance with clause 4.1.2 of TS 38.306 [14].
  - 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 data rate, select one among sets with the smallest aggregated channel bandwidth.
- Step 3: For each CC in chosen CA bandwidth combination, use determined MCS for each CC in step 1 for that CA configuration 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%*$N_{DL\_correct\_rx}$ / ($N_{DL\_newtx}$ + $N_{DL\_retx}$), where $N_{DL\_newtx}$ is the number of newly transmitted DL transport blocks, $N_{DL\_retx}$ is the number of retransmitted DL transport blocks, and $N_{DL\_correct\_rx}$ is the number of correctly received DL transport blocks.

The test parameters are specified in Table 7.5A.1-1.

Unless otherwise stated, no user data is scheduled on slot #0, 40 and 41 within 20 ms for SCS 60 kHz.

Unless otherwise stated, no user data is scheduled on slot #0, 80 and 81 within 20 ms for SCS 120 kHz.

**Table 7.5A.1-1: Test parameters for FR2 TDD**

| Parameter | | Unit | Value |
|---|---|---|---|
| PDSCH transmission scheme | | | Transmission scheme 1 |
| PTRS epre-Ratio | | | 0 |
| 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 |
| Actual carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 3) | RBs | 0 |
| | Subcarrier spacing | kHz | 60 or 120 |
| DL BWP configuration #1 | RB Offset | | 0 |
| | Number of contiguous PRB | | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing |
| | Subcarrier spacing | kHz | 60 or 120 |
| | Cyclic prefix | | Normal |
| PDCCH configuration | Slots for PDCCH monitoring | | Each slot |
| | Symbols with PDCCH | | Symbols #0 |
| | Number of PRBs in CORESET | | Table 7.5A.1-2 |
| | Number of PDCCH candidates and aggregation levels | | 1/8 |
| | CCE-to-REG mapping type | | Non-interleaved |
| | DCI format | | 1-1 |
| | TCI State | | TCI state #1 |
| | PDCCH &PDCCH DMRS Precoding configuration | | Single Panel Type I, Random per slot with equal probability of precoder index 0 and 2, and with REG bundling granularity for number of Tx larger than 1 |
| PDSCH configuration | Mapping type | | Type A |
| | k0 | | 0 |
| | PDSCH aggregation factor | | 1 |
| | PRB bundling type | | Static |
| | PRB bundling size | | wideband |
| | Resource allocation type | | Type 0 |
| | RBG size | | Config2 |
| | VRB-to-PRB mapping type | | Non-interleaved |
| | VRB-to-PRB mapping interleaver bundle size | | N/A |
| | Starting symbol (S) | | 1 |
| | Length (L) | | 13 |
| PDSCH DMRS configuration | DMRS Type | | Type 1 |
| | Number of additional DMRS | | 1 |
| | Length | | 1 |
| | Antenna ports indexes | | {1000} for 1 Layer CCs<br>{1000, 1001} for 2 Layers CCs |
| | Number of PDSCH DMRS CDM group(s) without data | | 1 |
| PTRS configuration | Frequency density ($K_{PT-RS}$) | | 2 |
| | Time density ($L_{PT-RS}$) | | 1 |
| CSI-RS for tracking | Subcarrier indexes in the PRB used for CSI-RS | | $k_0$ = 3 for CSI-RS resource 1,2,3,4 |
| | OFDM symbols in the PRB used for CSI-RS | | $l_0$ = 6 for CSI-RS resource 1 and 3<br>$l_0$ = 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 | 60 kHz SCS: 80 for CSI-RS resource 1,2,3,4<br>120 kHz SCS: 160 for CSI-RS resource 1,2,3,4 |
| | CSI-RS offset | | Slots | 60 kHz SCS:<br>40 for CSI-RS resource 1 and 2<br>41 for CSI-RS resource 3 and 4<br><br>120 kHz SCS:<br>80 for CSI-RS resource 1 and 2<br>81 for CSI-RS resource 3 and 4 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | QCL info | | | TCI state #0 |
| NZP CSI-RS for CSI acquisition | Subcarrier indexes in the PRB used for CSI-RS | | | $k_0 = 4$ |
| | OFDM symbols in the PRB used for CSI-RS | | | $l_0 = 13$ |
| | Number of CSI-RS ports (X) | | | Same as number of transmit antenna |
| | CDM Type | | | 'FD-CDM2' |
| | Density (ρ) | | | 1 |
| | CSI-RS periodicity | | Slots | 60 kHz SCS: 80<br>120 kHz SCS: 160 |
| | CSI-RS offset | | | 0 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | QCL info | | | TCI state #1 |
| ZP CSI-RS for CSI acquisition | Subcarrier indexes in the PRB used for CSI-RS | | | $k_0 = 0$ |
| | OFDM symbols in the PRB used for CSI-RS | | | $l_0 = 12$ |
| | Number of CSI-RS ports (X) | | | 4 |
| | CDM Type | | | 'FD-CDM2' |
| | Density (ρ) | | | 1 |
| | CSI-RS periodicity | | Slots | 60 kHz SCS: 80<br>120 kHz SCS: 160 |
| | CSI-RS offset | | | 0 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| CSI-RS for beam refinement | First subcarrier index in the PRB used for CSI-RS | | | $k_0$=0 for CSI-RS resource 1,2 |
| | First OFDM symbol in the PRB used for CSI-RS | | | $l_0$ = 8 for CSI-RS resource 1<br>$l_0$ = 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 | 60 kHz SCS: 80 for CSI-RS resource 1,2<br>120 kHz SCS: 160 for CSI-RS resource 1,2 |
| | CSI-RS offset | | Slots | 0 for CSI-RS resource 1,2 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | Repetition | | | ON |
| | QCL info | | | TCI state #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 |
| Maximum number of code block groups for ACK/NACK feedback | | | | 1 |

| | | | |
|---|---|---|---|
| Number of HARQ Processes | | | 10 for FR2.60-1 and 8 for FR2.120-1 |
| K1 value | | | Specific to each UL-DL pattern |
| Maximum number of HARQ transmission | | | 4 |
| HARQ ACK/NACK bundling | | | Multiplexed |
| Redundancy version coding sequence | | | {0,2,3,1} |
| TDD UL-DL pattern | | | 60 kHz SCS: FR2.60-1<br>120 kHz SCS: FR2.120-1 |
| PDSCH & PDSCH DMRS Precoding configuration | | | Single Panel Type I, Precoder index 0 per slot with Wideband granularity for Rank 2 |
| Symbols for all unused REs | | | OP.1 FDD as defined in Annex A.5.1.1<br>OP.1 TDD as defined in Annex A.5.2.1 |
| Propagation condition | | | Static propagation condition<br>No external noise sources are applied |
| Antenna configuration | 1 layer CCs | | 1x2 or 1x4 |
| | 2 layers CCs | | 2x2 or 2x4 |
| Physical signals, channels mapping and precoding | | | As specified in Annex B.4.1 |
| Note 1: PDSCH is scheduled only on full DL slots not containing SSB or TRS.<br>Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission.<br>Note 3: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing. | | | |

**Table 7.5A.1-2: 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 |

**Table 7.5A.1-3: MCS indexes for indicated UE capabilities**

| Maximum number of PDSCH MIMO layers | Maximum modulation format (Note 1) | Scaling factor | MCS (Note 2) |
|---|---|---|---|
| 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 | 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 |
| Note 1: For the band(s) on which UE supporting "Maximum modulation format" of 8, the MCS index is derived from the rows with "Maximum modulation format" of 6.<br>Note 2: MCS Index is based on MCS index Table 1 defined in clause 5.1.3.1 of TS 38.214 [12]. | | | |

**Table 7.5A.1-4: SNR required to achieve 85% of peak throughput under AWGN conditions**

| MCS Index (Note 1) | $SNR_{BB}$(dB) for maximum number of PDSCH MIMO Layers = 1 | $SNR_{BB}$(dB) for maximum number of PDSCH MIMO Layers = 2 |
|---|---|---|
| 13 | 6.2 | 9.0 |
| 14 | 7.2 | 9.9 |
| 15 | 8.2 | 10.9 |
| 16 | 8.7 | 11.6 |
| 17 | 10.1 | 13.2 |
| 18 | 10.7 | 13.7 |
| 19 | 11.7 | 14.7 |
| 20 | 12.7 | 15.6 |
| 21 | 13.6 | 16.5 |
| 22 | 14.8 | 17.6 |
| 23 | 15.6 | 18.6 |
| 24 | 16.9 | 19.7 |
| 25 | 18.3 | 21.2 |
| 26 | 19.3 | 22.3 |
| 27 | 20.5 | 23.3 |
| Note 1: MCS Index is based on MCS index Table 1 defined in clause 5.1.3.1 of TS 38.214 [12]. | | |

# 8 CSI reporting requirements (Radiated requirements)

## 8.1 General

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

### 8.1.1 Applicability of requirements

#### 8.1.1.1 General

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

The minimum performance requirements in Clause 8 are mandatory for UE supporting NR operation, except test cases listed in Clause 8.1.1.3, 8.1.1.4, 8.1.1.5.

If same test is listed for different UE features/capabilities in Clauses 8.1.1.3 and 8.1.1.4, then this test shall apply for UEs which support all corresponding UE features/capabilities.

#### 8.1.1.2 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 8.1.1.2-1.

**Table 8.1.1.2-1: Requirements applicability**

| Supported RX antenna ports | Test type | Test list |
|---|---|---|
| UE supports 2RX antenna | CQI | All tests in Clause 8.2.2 |
| | PMI | All tests in Clause 8.3.2 |
| | RI | All tests in Clause 8.4.2 |

#### 8.1.1.3 Applicability of requirements for optional UE features

The performance requirements in Table 8.1.1.3-1 shall apply for UEs which support optional UE features only.

**Table 8.1.1.3-1: Requirements applicability for optional UE features**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| 256QAM modulation scheme for PDSCH for FR2 (*pdsch-256QAM-FR2*) | FR2 TDD | CQI | Clause 8.2.2.2. 2.1 (Tests 3 and 4) | The test coverage can be considered fulfilled without executing of Test 1 and 2 from Clause 8.2.2.2. 2.1 if UE passes Test 3 and 4 from Clause 8.2.2.2.2.1 |

#### 8.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

The performance requirements in Table 8.1.1.4-1 shall apply for UEs which support mandatory UE features with capability signalling only.

.

**Table 8.1.1.4-1: Requirements applicability for mandatory features with UE capability signalling**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| Supported maximum number of PDSCH MIMO layers (*maxNumberMIMO-LayersPDSCH)* | FR2 TDD | CQI | Clause 8.2.2.2.1.1 | The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability |
| | | RI | Clause 8.4.2.2 | |
| Support of 1 port PTRS (*onePortsPTRS*) | FR2 TDD | CQI | Clause 8.2 | |
| | | PMI | Clause 8.3 | |
| | | RI | Clause 8.4 | |
| | | | | |
| | | | | |

### 8.1.1.5 Applicability of Channel Quality Indicator (CQI) reporting requirements for CA

#### 8.1.1.5.1 Applicability and test rules for different CA configurations and bandwidth combination sets

The performance requirement for CA CQI tests in clause 8.2A are defined independent of CA configurations and bandwidth combination sets specified in clasue 5.5A in TS 38.101-2 [7].

For UEs supporting multiple CA capabilities, test any one of the supported CA capabilities with largest aggregated CA bandwidth combination. The categorization of CA capability is specified in clasue 7.1.1.5.1.

For UEs supporting multiple CA configurations from the selected CA capability, test any one of the supported CA configurations with largest aggregated CA bandwidth combination. For simplicity, the CA configuration refers to combination of CA configuration and bandwidth combination set.

A single uplink CC is configured for all tests.

#### 8.1.1.5.2 Test coverage for different number of componenet carriers

For CA CQI tests specified in clause 8.2A, among all supported CA capabilities, if corresponding CA tests with the largest number of CCs supported by the UE are tested, the test coverage can be considered fulfilled without executing the CA tests with less than the largest number of CCs supported by the UE.

## 8.1.2 Common test parameters

Parameters specified in Table 8.1.2-1 are applied for all test cases in this clause 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 |
| PTRS *epre-Ratio* | | | 0 |
| Actual carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 3) | RBs | 0 |
| | Subcarrier spacing | kHz | 120 |
| DL BWP configuration #1 | Cyclic prefix | | Normal |
| | RB offset | RBs | 0 |
| | Number of contiguous PRB | PRBs | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing |
| Active DL BWP index | | | 1 |
| 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/AL8 |
| | DCI format | | 1_1 |
| | TCI state | | TCI state #1 |
| | PDCCH & PDCCH DMRS Precoding configuration | | Multi-path fading propagation conditions: Single Panel Type I, Random per slot with equal probability of each applicable i1, i2 combination, and with REG bundling granularity for number of Tx larger than 1<br><br>Static propagation conditions: Single Panel Type I, Random precoder chosen from precoder index 0 and 2, selection updated per slot |
| Additional PDCCH Configuration for Aperiodic Reporting (Note 4) | Slots for PDCCH monitoring | | Each slot |
| | Symbols with PDCCH | | 0,1 |
| | Number of PDCCH candidates and aggregation levels | | 1/AL8 |
| | DCI format | | 0_1 |
| | TCI state | | TCI state #1 |

| | | | |
|---|---|---|---|
| | PDCCH & PDCCH DMRS Precoding configuration | | Multi-path fading propagation conditions: Single Panel Type I, Random per slot with equal probability of each applicable i1, i2 combination, and with REG bundling granularity for number of Tx larger than 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 | | Type 0 |
| | RBG size | | Config2 |
| | 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<br>{1000,1001} for Rank2 |
| | Maximum number of OFDM symbols for DL front loaded DMRS | | 1 |
| | Number of PDSCH DMRS CDM group(s) without data | | 2 |
| PTRS configuration | Frequency density ($K_{PT-RS}$) | | 2 |
| | Time density ($L_{PT-RS}$) | | 1 |
| | Resource Element Offset | | 2 |
| CSI-RS for tracking | First subcarrier index in the PRB used for CSI-RS ($k_0$) | | 0 for CSI-RS resource 1,2,3,4 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$) | | 4 for CSI-RS resource 1 and 3<br>8 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 ($\rho$) | | 3 for CSI-RS resource 1,2,3,4 |
| | CSI-RS periodicity | slot | 120kHz SCS: 160 for CSI-RS resource 1,2,3,4 |
| | CSI-RS offset | slot | 120 kHz SCS:<br>80 for CSI-RS resource 1 and 2<br>81 for CSI-RS resource 3 and 4 |
| | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size/4)*4 |
| | QCL info | | TCI state #0 |
| NZP CSI-RS for CSI acquisition | Frequency Occupation | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |
| | QCL info | | TCI state #1 |

| | | | | |
|---|---|---|---|---|
| ZP CSI-RS for CSI acquisition | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |
| CSI-RS for beam refinement | First subcarrier index in the PRB used for CSI-RS | | | $k_0$=0 for CSI-RS resource 1,2 |
| | First OFDM symbol in the PRB used for CSI-RS | | | $l_0$ = 8 for CSI-RS resource 1<br>$l_0$ = 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 |
| | Frequency Occupation | | | Start PRB 0<br>Number of PRB = ceil(BWP size /4)*4 |
| | Repetition | | | ON |
| | QCL info | | | TCI state #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 |
| Number of HARQ Processes | | | | 8 |
| HARQ ACK/NACK bundling | | | | Multiplexed |
| Redundancy version coding sequence | | | | {0,2,3,1} |
| K1 value<br>(PDSCH-to-HARQ-timing-indicator) | | | | For FR2.120-1:<br>3 if mod (i.5) = 0,<br>6 if mod(i,5) = 2<br>For FR2.120-2:<br>11 if mod(i,8) = 0,<br>7]if mod(i,8) = 4,<br>6]if mod(i,8) = 5,<br>where i is slot index per radio fame with values 0-79. |
| Symbols for unused REs | | | | OP.1 FDD as defined in Annex A.5.1.1<br>OP.1 TDD as defined in Annex A.5.2.1 |
| Physical signals, channels mapping and precoding | | | | As specified in Annex B.4.1 |

| | |
|---|---|
| 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. |
| Note 3: | Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing. |
| Note 4: | Additional PDCCH configuration for aperiodic reporting is only for test cases with aperiodic CSI reporting configured. |

# 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

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 | | | |
| Subcarrier spacing | | kHz | 120 | | | |
| Duplex Mode | | | TDD | | | |
| TDD Slot Configuration | | | FR2.120-2 Annex A.1.3 | | | |
| $SNR_{BB}$ | | 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 Annex B.4.1 | | | |
| 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 ($k_0$, $k_1$ ) | | 8 | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | 13 | | | |
| | CSI-RS periodicity and offset | slot | 8/1 | | | |
| 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 ($k_0$, $k_1$ ) | | 6 | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | 13 | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 8/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | | Periodic | | | |
| | CSI-IM RE pattern | | 1 | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (8, 13) | | | |
| | CSI-IM timeConfig periodicity and offset | slot | 8/1 | | | |
| ReportConfigType | | | *Periodic* | | | |
| 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 | | | 111111111 | | | |
| CSI-Report periodicity and offset | | slot | 8/3 | | | |
| 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 | 8.375 | | | |
| Maximum number of HARQ transmission | | | 1 | | | |
| Measurement channel | | | 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

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 | | Test 3 | | Test 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Bandwidth | | MHz | 100 | | | | 50 | | | |
| Subcarrier spacing | | kHz | 120 | | | | | | | |
| Duplex Mode | | | TDD | | | | | | | |
| TDD Slot Configuration | | | FR2.120-2 Annex A.1.3 | | | | | | | |
| $SNR_{BB}$ | | dB | 6 | 7 | 12 | 13 | 7 | 8 | 20 | 21 |
| Propagation channel | | | TDLA30-35 | | | | | | | |
| Antenna configuration | | | 2×2<br>ULA High | | | | | | | |
| Beamforming Model | | | As specified in Annex B.4.1 | | | | | | | |
| 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 ($k_0$, $k_1$ ) | | 8 | | | | | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | 13 | | | | | | | |
| | CSI-RS periodicity and offset | slot | 8/1 | | | | | | | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | *Aperiodic* | | | | | | | |
| | Number of CSI-RS ports (*X*) | | 2 | | | | | | | |
| | CDM Type | | *fd-CDM2* | | | | | | | |
| | Density (ρ) | | 1 | | | | | | | |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$ ) | | 6 | | | | | | | |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | 13 | | | | | | | |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | Not configured | | | | | | | |
| | aperiodicTriggeringOffset | | 0 | | | | | | | |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic | | | | | | | |
| | CSI-IM RE pattern | | 1 | | | | | | | |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (8, 13) | | | | | | | |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured | | | | | | | |
| ReportConfigType | | | *Aperiodic* | | | | | | | |
| CQI-table | | | Table 1 | | | | 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 | | | 111111111 | | | | | | | |
| CSI-Report periodicity and offset | | slot | Not configured | | | | | | | |
| Aperiodic Report Slot Offset | | | 6 | | | | | | | |
| CSI request | | | 1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0 | | | | | | | |
| reportTriggerSize | | | 1 | | | | | | | |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration<br>Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM | | | | | | | |
| 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 | | | PUSCH | | | | | | | |
| CQI/RI/PMI delay | | ms | 1.375 | | | | | | | |
| Maximum number of HARQ transmission | | | 1 | | | | | | | |
| Measurement channel | | | As specified in Table A.4-1, TBS.1-1 | | | | As specified in Table A.4-2, TBS.2-7 | | | |

**Table 8.2.2.2.2.1-2 Minimum requirements**

| | Test 1 | Test 2 | Test 3 | Test 4 |
|---|---|---|---|---|
| $\alpha$ [%] | 2 | 2 | 2 | 2 |
| $\gamma$ | 1.05 | 1.05 | 1.05 | 1.05 |

# 8.2A Reporting of Channel Quality Indicator (CQI) for CA

## 8.2A.1 General

This clause includes the requirements for the reporting of channel quality indicator (CQI) with the UE configured for CA. The purpose is to verify that the CQI is correctly reported in accordance with the CQI definition given in TS 38.214 [12] for each CC with multiple cells configured for periodic reporting.

## 8.2A.2 1RX requirements

(Void)

## 8.2A.3 2RX requirements

### 8.2A.3.1 CQI reporting definition under AWGN conditions

#### 8.2A.3.1.1 Minimum requirement for periodic CQI reporting

For the CA CQI reporting test defined in Table 8.2A.3.1.1-4, the test requirements and the test parameters are defined as below.

For each CC, the test parameters are specified in Table 8.2A.3.1.1-1.

For CA with 2 DL CC, for the SNR configuration specified in Table 8.2A.3.1.1-2, and using the downlink physical channels specified in Annex C.5.1 on each CC, the difference between the wideband CQI indices of PCell and SCell reported shall be such that

$$\text{wideband CQI}_{\text{PCell}} - \text{wideband CQI}_{\text{SCell}} \geq 2$$

for more than 90% of the time.

For CA with 3 or more DL CC, for the SNR configuration specified in Table 8.2A.3.1.1-3, and using the downlink physical channels specified in Annex C.5.1 on each cell, the difference between the wideband CQI indices of PCell and SCell1 reported, and the difference between the wideband CQI indices of SCell1 and SCell2, 3… reported shall be such that

$$\text{wideband CQI}_{\text{PCell}} - \text{wideband CQI}_{\text{SCell1}} \geq 2$$

$$\text{wideband CQI}_{\text{SCell1}} - \text{wideband CQI}_{\text{SCell2, 3…}} \geq 2$$

for more than 90% of the time.

**Table 8.2A.3.1.1-1: CA CQI reporting test parameters for each CC**

| Parameter | | Unit | Value |
|---|---|---|---|
| Subcarrier spacing | | kHz | 120 |
| Duplex Mode | | | TDD |
| TDD Slot Configuration | | | FR2.120-2 Annex A.1.3 |
| Propagation channel | | | AWGN |
| Antenna configuration | | | 1×2 with static channel specified in Annex B.1 |
| 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 ($k_0$, $k_1$ ) | | 8 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | 13 |
| | CSI-RS periodicity and offset | slot | 8/1 |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | | Periodic |
| | Number of CSI-RS ports (*X*) | | 1 |
| | CDM Type | | No CDM |
| | Density (ρ) | | 1 |
| | First subcarrier index in the PRB used for CSI-RS ($k_0$, $k_1$ ) | | 6 |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | 13 |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | 8/1 |
| CSI-IM configuration | CSI-IM resource Type | | Periodic |
| | CSI-IM RE pattern | | 1 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (8, 13) |
| | CSI-IM timeConfig periodicity and offset | slot | 8/1 |
| ReportConfigType | | | Periodic |
| 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 for 50MHz, 100MHz,<br>16 for 200MHz,<br>32 for 400MHz |
| csi-ReportingBand | | | 111111111 |
| CSI-Report periodicity and offset | | slot | 8/3 |
| aperiodicTriggeringOffset | | | Not configured |
| Physical channel for CSI report | | | PUCCH |
| CQI/RI/PMI delay | | ms | 8.375 |
| Maximum number of HARQ transmission | | | 1 |
| Measurement channel | | | Derived as per section 5.1.3.2 of TS 38.214 [12] |

**Table 8.2A.3.1.1-2: SNR configurations for 2 DL CA**

| Parameter | PCell | SCell |
|---|---|---|
| SNR (dB) | 10.0 | 4.0 |

**Table 8.2A.3.1.1-3: SNR configurations for 3 or more DL CA**

| Parameter | PCell | SCell1 | SCell2, 3… |
|---|---|---|---|
| SNR (dB) | 12.0 | 6.0 | 0.0 |

**Table 8.2A.3.1.1-4: List of CA CQI reporting test**

| Test number | CA duplex mode and SCS combination |
|---|---|
| 1 | TDD 120 kHz + TDD 120 kHz |
| Note 1: The applicability of requirements for different CA configurations and bandwidth combination sets is defined in 8.1.1.5.1. | |

# 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 scheme 1 with 2TX and higher layer parameter *codebookType* set to 'typeI-SinglePanel' are specified in terms of the ratio

$$\gamma = \frac{t_{ue}}{t_{rnd}}$$

In the definition of $\gamma$, for 2TX PMI requirements, $t_{ue}$ is 90 % of the maximum throughput obtained at $SNR_{ue}$ using the precoders configured according to the UE reports, and $t_{rnd}$ is the throughput measured at $SNR_{ue}$ 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 |
| Subcarrier spacing | | kHz | 120 | 120 |
| TDD DL-UL configuration | | | FR2.120-2 as specified in Annex A.1.3 | FR2.120-1 as specified in Annex A.1.3 |
| Propagation channel | | | TDLA30-35 | TDLA30-35 |
| Antenna configuration | | | 2 x 2 ULA Low | 2 x 2 ULA Low |
| Beamforming Model | | | As specified in Annex B.4.1 | As specified in Annex B.4.1 |
| 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 ($k_0$, $k_1$ ) | | Row 4, (8,-) | Row 4, (8,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (13,-) | (13,-) |
| | CSI-RS periodicity 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 ($k_0$, $k_1$ ) | | Row 3, (6,-) | Row 3, (6,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (13,-) | (13,-) |
| | CSI-RS periodicity and offset | slot | Not configured | Not configured |
| | aperiodicTriggering Offset | | 0 | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic | Aperiodic |
| | CSI-IM RE pattern | | Pattern 1 | Pattern 1 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (8,13) | (8,13) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured | Not configured |
| 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 | Not configured | Not configured |
| Aperiodic Report Slot Offset | | | 6 | 8 |
| CSI request | | | 1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0 | 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 | 1 |
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| 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).<br>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 gNB downlink before slot#(n+4)].<br>Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. | | | | |

**Table 8.3.2.2.1-2: Minimum requirement**

| Parameter | Test 1 | Test 2 |
|---|---|---|
| $\gamma$ | 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 $\geq \gamma_1$;

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 $\geq \gamma_2$;

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 |
| Subcarrier spacing | | kHz | 120 | 120 | 120 |
| Duplex Mode | | | TDD | TDD | TDD |
| TDD Slot Configuration | | | FR2.120-2 | FR2.120-2 | FR2.120-2 |
| SNR | | dB | 0 | 16 | 16 |
| 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 | | 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 ($k_0$, $k_1$ ) | | Row 4, (8,-) | Row 4, (8,-) | Row 4, (8,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (13,-) | (13,-) | (13,-) |
| | CSI-RS periodicity 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 ($k_0$, $k_1$ ) | | Row 3 (6,-) | Row 3 (6,-) | Row 3 (6,-) |
| | First OFDM symbol in the PRB used for CSI-RS ($l_0$, $l_1$) | | (13,-) | (13,-) | (13,-) |
| | NZP CSI-RS-timeConfig periodicity and offset | slot | Not configured | Not configured | Not configured |
| | aperiodicTriggeringOffset | | 0 | 0 | 0 |
| CSI-IM configuration | CSI-IM resource Type | | Aperiodic | Aperiodic | Aperiodic |
| | CSI-IM RE pattern | | Pattern 1 | Pattern 1 | Pattern 1 |
| | CSI-IM Resource Mapping ($k_{CSI-IM}$,$l_{CSI-IM}$) | | (8,13) | (8,13) | (8,13) |
| | CSI-IM timeConfig periodicity and offset | slot | Not configured | Not configured | Not configured |
| 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 periodicity and offset | | slot | Not configured | Not configured | Not configured |
| Aperiodic Report Slot Offset | | | 6 | 6 | 6 |
| CSI request | | | 1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0 | 1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0 | 1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0 |
| reportTriggerSize | | | 1 | 1 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| CSI-AperiodicTriggerStateList | | | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM | One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM |
| 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 |
| Note 1: Measurements channels are specified in Table A.4-1. TBS.1-1 is used for Rank 1 case. TBS.1-2 is used for Rank 2 case. | | | | | |

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

| | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| $\gamma_1$ | N/A | 1.05 | 1.05 |
| $\gamma_2$ | 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 Clause 5 will be verified only for SA except for the sustained downlink data rate test specified in Clause 5.5 and 5.5A.
  - The performance requirements specified in Clause 7 will be verified only for SA except for the sustained downlink data rate test specified in Clause 7.5 and 7.5A.
  - The sustained downlink data rate tests specified in Clauses 5.5, 5.5A and 7.5, 7.5A for SA and in Clause 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.

- For UEs supporting NR FR1 CA and/or NR CA including FR1 and FR2, the requirements applicability is specified in Table 9.1.1-1.

**Table 9.1.1-1: Requirements applicability for UEs supporting NR FR2 CA and NR CA including FR1 and FR2**

| Supported scenarios | Requirements |
|---|---|
| NR FR2 CA | Clause 7.5A |
| NR CA including FR1 and FR2 | Clause 9.4A.1 |
| Both NR FR2 CA and NR CA including FR1 and FR2 | Clause 7.5A |

- For UEs supporting EN-DC including FR2 and/or EN-DC including FR1 and FR2, the requirements applicability is specified in Table 9.1.1-2.

**Table 9.1.1-2: Requirements applicability for UEs supporting EN-DC including FR2 and EN-DC including FR1 and FR2**

| Supported scenarios | SDR requirements | PDSCH requirements | PDCCH requirements |
|---|---|---|---|
| EN-DC including FR2 | Clause 9.4B.1.2 | Clause 9.2B.1.2 | Clause 9.3B.1.2 |
| EN-DC including FR1 and FR2 | Clause 9.4B.1.3 | Clause 9.2B.1.3 | Clause 9.3B.1.3 |
| Both EN-DC including FR2 and EN-DC including FR1 and FR2 | Clause 9.4B.1.2 | Clause 9.2B.1.2 | Clause 9.3B.1.2 |

- For UEs supporting NR-DC including FR1 and FR2, if the FR2 requirements in Clause 7.2 and Clause 7.3 are tested, the test coverage can be considered fulfilled without executing requirements in Clause 9.2B.2 and Clause 9.3B.2.

- For UEs supporting NR-DC between FR1 and FR2, if requirements in Clause 9.4A.1 are tested under same or higher data rate as in Clause 9.4B.2, the test coverage can be considered fulfilled without executing the requirements in Clause 9.4B.2.

- For UEs supporting NE-DC and EN-DC, the test coverage of demodulation performance requirements can be considered fulfilled, if the demodulation requirements in Clause 5 and Clause 9.4B.1 are executed for UE under test in the standalone mode.

- For UEs supporting NE-DC and not supporting EN-DC, the test coverage of demodulation performance requirements can be considered fulfilled, if the demodulation requirements in Clause 5 and Clause 9.4B.3 are executed for UE under test.

- For UEs supporting NGEN-DC, the test coverage of demodulation performance requirements can be considered fulfilled, if the demodulation requirements in Clause 5 and Clause 9.4B.1 are executed for UE under test.

- For UEs supporting FR1 intra-band contiguous and non-contiguous EN-DC, the requirements applicability is specified in Table 9.1.1-3.

**Table 9.1.1-3: Requirements applicability for UE supporting FR1 intra-band and inter-band EN-DC**

| | Inter-band scenarios are not supported | UE indicates “interBandContiguousMRDC” (Note 1, Note 2) | UE does not indicate “interBandContiguousMRDC” (Note 1, Note 3) |
|---|---|---|---|
| Intra-band scenarios are not supported | N/A | Clause 9.5B.1.1 is executed for inter-band EN-DC scenarios | Clause 9.5B.1.2 is executed for inter-band EN-DC scenarios |
| UE does not indicate “intraBandENDC-Support” or UE indicates “both” in “intraBandENDC-Support” (Note 4) | Clause 9.5B.1.1 is only executed for intra-band EN-DC scenarios | Clause 9.5B.1.1 is executed for both intra-band and inter-band EN-DC scenarios | Clause 9.5B.1.1 is only executed for intra-band EN-DC scenarios |
| UE indicates “non-contiguous” in “intraBandENDC-Support” (Note 5) | Clause 9.5B.1.2 is only executed for intra-band EN-DC scenarios | Clause 9.5B.1.1 is executed for inter-band EN-DC scenarios | Clause 9.5B.1.2 is executed for both intra-band and inter-band EN-DC scenarios |
| Note 1: Requirements are applicable to intra-band scenarios and only inter-band scenarios from Table 5.5B.4.1-1 of TS 38.101-3 [8] for which Note 4 is applied.<br>Note 2: UE supports both intra-band contiguous and non-contiguous EN-DC requirements for supported inter-band EN-DC combinations.<br>Note 3: UE supports intra-band non-contiguous EN-DC requirements for supported inter-band EN-DC combinations.<br>Note 4: UE supports intra-band contiguous EN-DC, or both intra-band contiguous and non-contiguous EN-DC for supported intra-band EN-DC combinations.<br>Note 5: UE supports only intra-band non-contiguous EN-DC for supported intra-band EN-DC combinations. | | | |

#### 9.1.1.1 Applicability of requirements for optional UE features

**Table 9.1.1.1-1: Void**

The applicability rule defined in Clause 5.1.1.3 shall be applied for performance requirements in Clauses 9.2B.1.1 and 9.4B.1.1.

The applicability rule defined in Clause 7.1.1.3 shall be applied for performance requirements in Clauses 9.2B.1.2, 9.4A.1, 9.4B.1.2 and 9.4B.1.3.

#### 9.1.1.2 Applicability of requirements for mandatory UE features with capability signalling

The applicability rule defined in Clause 5.1.1.4 shall be applied for performance requirements in Clauses 9.2B.1.1 and 9.4B.1.1.

The applicability rule defined in Clause 7.1.1.4 shall be applied for performance requirements in Clauses 9.2B.1.2, 9.4A.1, 9.4B.1.2 and 9.4B.1.3.

### 9.1.2 E-UTRA Cell setup

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

#### 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 E-UTRA cell. One of test setup in Table 9.1.2.1-2 will be selected for the E-UTRA Cell depending on the maximum bandwidth of an E-UTRA 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 Annex C.3.2 of TS 36.101 [4].

**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<br>No external noise sources are applied |
| Transmission mode | | 1 |
| Transmission time difference between E-UTRA cell and NR cell(s) | μs | 0 |
| Antenna configuration | | All NR cells are in FR1: 1x2<br>Any NR cell is in FR2: 1 Tx[Note 1] |
| Codebook subset restriction | | 10 |
| Symbols for all unused REs | | OCNG in Annex A.5 |
| Note 1: As the link can be provided over the air, the UE Rx antenna configuration is not relevant for the test configuration and has no impact on the test implementation. | | |

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

| Test setup | Bandwidth (MHz) | Downlink power allocation (dB) | | |
|---|---|---|---|---|
| | | $\rho_A$ | $\rho_B$ | σ |
| 1 | 5 | 0 | 0 | 0 |
| 2 | 10 | 0 | 0 | 0 |
| 3 | 15 | 0 | 0 | 0 |
| 4 | 20 | 0 | 0 | 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 E-UTRA cell. One of test setup in Table 9.1.2.2-2 will be selected for the E-UTRA Cell depending on the maximum bandwidth of an E-UTRA 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 TS 36.101 [4]. The physical channel setup with downlink power allocation is according to Annex C.3.2 of TS 36.101 [4].

**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<br>No external noise sources are applied |
| Transmission mode | | 1 |
| Transmission time difference between E-UTRA cell and NR cell(s) | µs | 0 |
| Antenna configuration | | All NR cells are in FR1: 1x2<br>Any NR cell is in FR2: 1 Tx[Note 2] |
| 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.<br>Note 2: As the link can be provided over the air, the UE Rx antenna configuration is not relevant for the test configuration and has no impact on the test implementation. | | |

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

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

# 9.2 PDSCH Demodulation

# 9.2A PDSCH demodulation for CA

## 9.2A.1 NR CA between FR1 and FR2

(Void)

# 9.2B PDSCH demodulation for DC

## 9.2B.1 EN-DC

### 9.2B.1.1 EN-DC within FR1

#### 9.2B.1.1.1 PDSCH

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PDSCH demodulation performance requirements for NR are specified in Clause 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 E-UTRA PCell is specified in Clause 9.1.2. The NR PDSCH demodulation performance requirements for NR are specified in Clause 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 test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PDSCH demodulation performance requirements for NR are specified in Clause 9.2B.1.1 and Clause 9.2B.1.2. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers shall be verified.

## 9.2B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2. The PDSCH demodulation performance requirements for NR FR2 cell(s) are specified in Clause 7.2. During the test, only the PDSCH performance on FR2 NR cell(s) shall be verified.

# 9.3 PDCCH demodulation

# 9.3A PDCCH demodulation for CA

## 9.3A.1 NR CA between FR1 and FR2

(Void)

# 9.3B PDCCH demodulation for DC

## 9.3B.1 EN-DC

### 9.3B.1.1 EN-DC within FR1

#### 9.3B.1.1.1 PDCCH

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PDCCH demodulation performance requirements for NR are specified in Clause 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 E-UTRA PCell is specified in Clause 9.1.2. The NR PDCCH demodulation performance requirements are specified in Clause 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 test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PDCCH demodulation performance requirements are specified in Clause 9.3B.1.1 and Clause 9.3B.1.2. During the test, only the PDCCH performance on the NR cell(s) on FR2 carriers shall be verified.

### 9.3B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2. The PDCCH demodulation performance requirements for NR FR2 cell are specified in Clause 7.3. During the test, only the PDCCH performance on FR2 NR cell shall be verified.

## 9.4 Void

## 9.4A SDR test for CA

### 9.4A.1 NR CA between FR1 and FR2

The Sustained Data Rate (SDR) requirements in this clause are applicable to the NR CA between FR1 and FR2 NR carriers.

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 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:

- Step 1: Calculate the NR FR1 data rate for CA bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported CA configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
    - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 2: Calculate the NR FR2 data rate for CA bandwidth combinations, using a procedure from Clause 7.5A, for all supported CA configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
    - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 3: Select the CA bandwidth combination among all supported CA configurations that achieves maximum total data rate in steps 1 and 2 among all UE capabilities:
    - When there are multiple sets of CA bandwidth combinations and UE capabilities with the same largest data rate, select a single set with the smallest aggregated channel bandwidth.
- Step 4: For each NR FR2 CC in the selected CA bandwidth combination, use MCS determined in step 2 for that CA bandwidth combination based on test parameters and indicated UE capabilities.

The test setup for NR FR1 PCell is specified in Clause 5.5A. The NR FR2 SDR tests setup is specified in Clause 7.5A. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers is verified and only NR FR1 PCell is activated from all FR1 CCs for the tested CA bandwidth combination.

The TB success rate shall be higher than 85% when NR FR2 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.

# 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 Sustained Data Rate (SDR) requirements in this clause are applicable to the EN-DC within FR1.

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 EN-DC bandwidth combination among all supported EN-DC configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities that provides the largest data rate [in accordance with clause 4.1.2 of TS 38.306 [14]].
    - Set of per NR CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor in accordance with clause 4.1.2 of TS 38.306 [14].
    - Set of per E-UTRA CC UE capabilities includes channel bandwidth, number of PDSCH MIMO layers and modulation format in accordance with clause 4.1.2 of TS 38.306 [14].
    - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with same largest data rate, select one among sets with the smallest aggregated channel bandwidth.
- For each NR FR1 CC in EN-DC bandwidth combination, use Table 5.5A-5 in Clause 5.5A to determine MCS based on test parameters and indicated UE capabilities.
- For each E-UTRA CC in EN-DC bandwidth combination, use Table 9.4B.1.1.1-2 and Table 9.4B.1.1.1-3 to determine FRC based on test parameters and indicated UE capabilities.

The test setup for E-UTRA Pcell is specified in Clause 9.1.2 and Table 9.4B.1.1.1-1. The NR SDR tests setup is specified in Clause 5.5A. During the test, the PDSCH performance on both the NR cell(s) and LTE cell(s) shall be verified.

The TB success rate shall be higher than 85% when NR PDSCH is scheduled with MCS defined for the selected EN-DC bandwidth combination and with the downlink physical channel setup according to Annex C.3.1 and when E-UTRA PDSCH is scheduled with FRC defined for the selected EN-DC bandwidth combination and with the downlink physical channel setup according to Annex C.3.2 from TS 36.101 [4]. The TB success rate of delivered PDCP SDU(s) by Layer2 is defined according to the different DRB type: Split bearer, MCG or SCG bearer.

- For the configuration of DRB type of Split bearer, the TB success rate across CGs is defined as TB success rate = 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. All the above numbers of transmitted, retransmitted or correctly received DL transport blocks are calculated as the sum of the numbers of DL transport blocks across all the CGs used for DC transmission or reception.

- For the configuration of DRB type of MCG or SCG bearer, the TB success rate across CGs is defined as TB success rate = 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 DL_correct_rx is the number of correctly received DL transport blocks. All the above numbers of transmitted, retransmitted or correctly received DL transport blocks are calculated as the sum of the numbers of DL transport blocks per CG used for DC.

**Table 9.4B.1.1.1-1: Additional test setup for E-UTRA CC**

| Parameter | Unit | Value |
|---|---|---|
| Inter-TTI Distance | | 1 |
| Number of OFDM symbols for PDCCH per component carrier | OFDM symbols | 1 |
| Cross carrier scheduling | | Not configured |
| Propagation condition | | Static propagation condition<br>No external noise sources are applied |
| $\hat{E}_s$ at antenna port | dBm/15kHz | -85 |
| Antenna configuration | 2 layer CC | 2x2 or 2x4 |
| | 4 layer CC | 4x4 |
| Codebook subset restriction | 2 layer CC | 10 |
| | 4 layer CC | 1000 |
| Downlink power allocation | 2 layer CC | $\rho_A$ = -3dB, $\rho_B$ = -3dB, σ = 0dB |
| | 4 layer CC | $\rho_A$ = -6dB, $\rho_B$ = -6dB, σ = 3dB |

**Table 9.4B.1.1.1-2: E-UTRA FRC for SDR test (FDD)**

| MIMO layer | Bandwidth | Reference channel | | |
|---|---|---|---|---|
| | | 64QAM | 256QAM | 1024QAM |
| 2 layer | 5 | R.PDSCH.4-1.1 FDD | R.PDSCH.4-3.1 FDD | R.PDSCH.4-5.1 FDD |
| | 10 | R.PDSCH.4-1.2 FDD | R.PDSCH.4-3.2 FDD | R.PDSCH.4-5.2 FDD |
| | 15 | R.PDSCH.4-1.3 FDD | R.PDSCH.4-3.3 FDD | R.PDSCH.4-5.3 FDD |
| | 20 | R.PDSCH.4-1.4 FDD | R.PDSCH.4-3.4 FDD | R.PDSCH.4-5.4 FDD |
| 4 layer | 5 | R.PDSCH.4-2.1 FDD | R.PDSCH.4-4.1 FDD | R.PDSCH.4-6.1 FDD |
| | 10 | R.PDSCH.4-2.2 FDD | R.PDSCH.4-4.2 FDD | R.PDSCH.4-6.2 FDD |
| | 15 | R.PDSCH.4-2.3 FDD | R.PDSCH.4-4.3 FDD | R.PDSCH.4-6.3 FDD |
| | 20 | R.PDSCH.4-2.4 FDD | R.PDSCH.4-4.4 FDD | R.PDSCH.4-6.4 FDD |

**Table 9.4B.1.1.1-3: E-UTRA FRC for SDR test (TDD)**

| MIMO layer | Bandwidth | Reference channel | | |
|---|---|---|---|---|
| | | 64QAM | 256QAM | 1024QAM |
| 2 layer | 10 | R.PDSCH.6-1.1 TDD | R.PDSCH.6-3.1 TDD | R.PDSCH.6-5.1 TDD |
| | 15 | R.PDSCH.6-1.2 TDD | R.PDSCH.6-3.2 TDD | R.PDSCH.6-5.2 TDD |
| | 20 | R.PDSCH.6-1.3 TDD | R.PDSCH.6-3.3 TDD | R.PDSCH.6-5.3 TDD |
| 4 layer | 10 | R.PDSCH.6-2.1 TDD | R.PDSCH.6-4.1 TDD | R.PDSCH.6-6.1 TDD |
| | 15 | R.PDSCH.6-2.2 TDD | R.PDSCH.6-4.2 TDD | R.PDSCH.6-6.2 TDD |
| | 20 | R.PDSCH.6-2.3 TDD | R.PDSCH.6-4.3 TDD | R.PDSCH.6-6.3 TDD |

## 9.4B.1.2 EN-DC including FR2 NR carrier

### 9.4B.1.2.1 SDR test

The Sustained Data Rate (SDR) requirements in this clause are applicable to the EN-DC including FR2 NR carrier.

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 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:

- Step 1: Calculate the NR FR2 data rate for EN-DC bandwidth combinations, using a procedure from Clause 7.5A, for all supported EN-DC configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
  - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 2: Calculate the E-UTRA data rate for EN-DC bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported EN-DC configurations and set of per E-UTRA component carrier (CC) UE capabilities among all supported UE capabilities:
  - Set of per E-UTRA CC UE capabilities includes a channel bandwidth, number of PDSCH MIMO layers and modulation format as defined in clause 4.1.2 of TS 38.306 [14].
- Step 3: Select the EN-DC bandwidth combination among all supported EN-DC configurations that achieves maximum total data rate in steps 1 and 2 among all UE capabilities:
  - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with the same largest data rate, select a single set with the smallest aggregated channel bandwidth.
- Step 4: For each NR FR2 CC in the selected EN-DC bandwidth combination, use MCS determined in step 1 for that EN-DC bandwidth combination based on test parameters and indicated UE capabilities.

The test setup for E-UTRA Pcell is specified in Clause 9.1.2 and Table 9.4B.1.1.1-1. The NR PDSCH SDR tests setup is specified in Clause 7.5A. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers is verified.

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

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

The Sustained Data Rate (SDR) requirements in this clause are applicable to the EN-DC including both FR1 and FR2 NR carriers.

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 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:

- Step 1: Calculate the NR FR1 data rate for EN-DC bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported EN-DC configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
  - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 2: Calculate the NR FR2 data rate for EN-DC bandwidth combinations, using a procedure from Clause 7.5A, for all supported EN-DC configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
  - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 3: Calculate the E-UTRA data rate for EN-DC bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported EN-DC configurations and set of per E-UTRA component carrier (CC) UE capabilities among all supported UE capabilities:
  - Set of per E-UTRA CC UE capabilities includes a channel bandwidth, number of PDSCH MIMO layers and modulation format as defined in clause 4.1.2 of TS 38.306 [14].

- Step 4: Select the EN-DC bandwidth combination among all supported EN-DC configurations that achieves the maximum total data rate in steps 1, 2 and 3 among all UE capabilities:
    - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with the same largest data rate, select a single set among sets with the smallest aggregated channel bandwidth.
- Step 5: For each NR FR2 CC in the selected EN-DC bandwidth combination, use MCS determined in step 2 for that EN-DC bandwidth combination based on test parameters and indicated UE capabilities.

The test setup for E-UTRA Pcell is specified in Clause 9.1.2 and Table 9.4B.1.1.1-1. The NR FR2 PDSCH SDR tests setup is specified in Clause 7.5A. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers is verified.

The TB success rate shall be higher than 85% when NR FR2 PDSCH is scheduled with MCS defined for the selected EN-DC bandwidth combination and with the downlink physical channel setup according to Annex C.3.1.

## 9.4B.2 NR DC between FR1 and FR2

The methodology for selection of tested NR DC bandwidth combination and the requirements are specified in Clause 9.4A.1.

## 9.4B.3 NE-DC

### 9.4B.3.1 NE-DC within FR1

The methodology for selection of tested NE-DC bandwidth combination and the requirements are specified in Clause 9.4B.1.1.

# 9.5B PDSCH demodulation for DC with power imbalance

## 9.5B.1 EN-DC

### 9.5B.1.1 Intra-band contiguous EN-DC within FR1

#### 9.5B.1.1.1 PDSCH

The requirements in this section verify the ability of intra-band contiguous EN-DC UE to demodulate the signal transmitted by the NR SCG in the presence of a stronger E-UTRA MCG. The parameters specified in Table 5.2A.2.2-2 and Table 5.2A.3.2-2 are valid for all intra-band contiguous EN-DC power imbalance tests unless otherwise stated. The test setup for each E-UTRA MCG CC is specified in Clause 9.1.2. During the test, only the PDSCH performance on the NR SCG CC shall be verified.

The test parameters of channel bandwidth and allocated resource blocks are determined by the following procedure:

- Step 1: First select the CBW combinations with the same BWs between E-UTRA MCG carrier(s) and NR SCG carrier. If there is no such CBW combination, go to Step 1a. Otherwise go to step 2.
    - Step 1a: Select the CBW combinations that the BW of NR SCG carrier is smaller than the BW of E-UTRA MCG carrier(s). If there is no such CBW combination, go to Step 1c.
    - Step 1b: Among the CBW combinations selected from Step 1a, select the CBW combinations with the smallest CBW difference between NR SCG carrier and E-UTRA MCG carrier(s). Go to step 2.
    - Step 1c: Select the EN-DC combinations with smallest CBW difference between the NR SCG carrier and E-UTRA MCG carrier(s). Go to step 2.
- Step 2: Among the CBW combinations selected from Step 1, select the EN-DC combination with the largest aggregated CBW.

- When the BW of NR SCG carrier is smaller than or equal to the BW of E-UTRA MCG carrier(s), test full allocated PRBs
- When the BW of NR SCG carrier is larger than the BW of E-UTRA MCG carrier(s), test partial allocated PRBs, and the PRB number for testing equals to the PRB number in the full bandwidth of E-UTRA MCG carrier(s).
  - If frequency of NR SCG carrier is higher than E-UTRA MCG carrier, then the test RBs will be allocated on the highest part of NR SCG carrier.
  - If frequency of NR SCG carrier is lower than E-UTRA MCG carrier, then the test RBs will be allocated on the lowest part of NR SCG carrier.

The performance requirements are specified in Table 9.5B.1.1.1-1 and Table 9.5B.1.1.1-2. The downlink physical channel setup according to Annex C.3.1.

**Table 9.5B.1.1.1-1: Minimum performance for FDD EN-DC with 15kHz SCS**

| Test Number | Bandwidth (MHz) | Reference channel | | Power at antenna port (dBm/Hz) | | Reference value Fraction of Maximum Throughput (%) | |
|---|---|---|---|---|---|---|---|
| | NR SCG CC | E-UTRA MCG CC (Note 1) | NR SCG CC | E-UTRA MCG CC | NR SCG CC | E-UTRA MCG CC (Note 1) | NR SCG CC |
| 1 | Selected EN-DC combination as per the test procedure | NA | Derived as per section 5.1.3.2 of TS 38.214 [12] | -106 | -112 | NA | 85 |
| Note 1: The number of E-UTRA MCG carriers depend on the intra-band and inter-band contiguous EN-DC configuration and bandwidth combination set | | | | | | | |

**Table 9.5B.1.1.1-2: Minimum performance for TDD EN-DC with 30kHz SCS**

| Test Number | Bandwidth (MHz) | Reference channel | | Power at antenna port (dBm/Hz) | | Reference value Fraction of Maximum Throughput (%) | |
|---|---|---|---|---|---|---|---|
| | NR SCG CC | E-UTRA MCG CC (Note 1) | NR SCG CC | E-UTRA MCG CC | NR SCG CC | E-UTRA MCG CC (Note 1) | NR SCG CC |
| 1 | Selected EN-DC combination as per the test procedure | NA | Derived as per section 5.1.3.2 of TS 38.214 [12] | -106 | -112 | NA | 85 |
| Note 1: The number of E-UTRA MCG carriers depend on the intra-band and inter-band contiguous EN-DC configuration and bandwidth combination set | | | | | | | |

### 9.5B.1.2 Intra-band non-contiguous EN-DC within FR1

#### 9.5B.1.2.1 PDSCH

The requirements in this section verify the ability of intra-band non-contiguous EN-DC UE to demodulate the signal transmitted by the NR SCG in the presence of a stronger E-UTRA MCG. The parameters specified in Table 5.2A.2.2-2 and Table 5.2A.3.2-2 are valid for all intra-band non-contiguous EN-DC power imbalance tests unless otherwise stated. The test setup for each E-UTRA MCG CC is specified in Clause 9.1.2. During the test, only the PDSCH performance on the NR SCG CC shall be verified.

The test parameters of channel bandwidth and allocated resource blocks are determined by the following procedure:

- Step 1: First select the CBW combinations with the same BWs between E-UTRA MCG carrier(s) and NR SCG carrier. If there is no such CBW combination, go to Step 1a. Otherwise go to step 2.
  - Step 1a: Select the CBW combinations that the BW of NR SCG carrier is smaller than the BW of E-UTRA MCG carrier(s). If there is no such CBW combination, go to Step 1c.
  - Step 1b: Among the CBW combinations selected from Step 1a, select the CBW combinations with the smallest CBW difference between NR SCG carrier and E-UTRA MCG carrier(s). Go to step 2.
  - Step 1c: Select the EN-DC combinations with smallest CBW difference between the NR SCG carrier and E-UTRA MCG carrier(s). Go to step 2.
- Step 2: Among the CBW combinations selected from Step 1, select the EN-DC combination with the largest aggregated CBW.
  - When the BW of NR SCG carrier is smaller than or equal to the BW of E-UTRA MCG carrier(s), test full allocated PRBs
  - When the BW of NR SCG carrier is larger than the BW of E-UTRA MCG carrier(s), test partial allocated PRBs, and the PRB number for testing equals to the PRB number in the full bandwidth of E-UTRA MCG carrier(s).
    - If frequency of NR SCG carrier is higher than E-UTRA MCG carrier, then the test RBs will be allocated on the highest part of NR SCG carrier.
    - If frequency of NR SCG carrier is lower than E-UTRA MCG carrier, then the test RBs will be allocated on the lowest part of NR SCG carrier.

The performance requirements are specified in Table 9.5B.1.2.1-1 and Table 9.5B.1.2.1-2. The downlink physical channel setup according to Annex C.3.1.

**Table 9.5B.1.2.1-1: Minimum performance for FDD EN-DC with 15kHz SCS**

| Test Number | Bandwidth (MHz) | Reference channel | | Power at antenna port (dBm/Hz) | | Reference value Fraction of Maximum Throughput (%) | |
|---|---|---|---|---|---|---|---|
| | NR SCG CC | E-UTRA MCG CC (Note 1) | NR SCG CC | E-UTRA MCG CC | NR SCG CC | E-UTRA MCG CC (Note 1) | NR SCG CC |
| 1 | Selected EN-DC combination as per the test procedure | NA | Derived as per section 5.1.3.2 of TS 38.214 [12] | -106 | -112 | NA | 85 |
| Note 1: | The number of E-UTRA MCG carriers depend on the intra-band and inter-band non-contiguous EN-DC configuration and bandwidth combination set | | | | | | |

**Table 9.5B.1.2.1-2: Minimum performance for TDD EN-DC with 30kHz SCS**

| Test Number | Bandwidth (MHz) | Reference channel | | Power at antenna port (dBm/Hz) | | Reference value Fraction of Maximum Throughput (%) | |
|---|---|---|---|---|---|---|---|
| | NR SCG CC | E-UTRA MCG CC (Note 1) | NR SCG CC | E-UTRA MCG CC | NR SCG CC | E-UTRA MCG CC (Note 1) | NR SCG CC |
| 1 | Selected EN-DC combination as per the test procedure | NA | Derived as per section 5.1.3.2 of TS 38.214 [12] | -106 | -112 | NA | 85 |
| Note 1: The number of E-UTRA MCG carriers depend on the intra-band and inter-band non-contiguous EN-DC configuration and bandwidth combination set | | | | | | | |

# 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 Table 5.1-1 of TS 38.101-3 [8].

### 10.1.1 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 Clause 6 will be verified only for SA.
    - The performance requirements specified in Clause 8 will be verified only for SA.
- 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.
- For UEs supporting NR-DC including FR1 and FR2, if the FR2 requirements in Clause 8.2, Clause 8.3 and Clause 8.4 are tested, the test coverage can be considered fulfilled without executing requirements in Clause 10.2B.2, Clause 10.3B.2 and Clause 10.4B.2.
- For UEs supporting NE-DC, the test coverage of CSI reporting requirements can be considered fulfilled, if the CSI reporting requirements in Clause 6 are executed for UE under test in the standalone mode.
- For UEs supporting NGEN-DC, the test coverage of CSI reporting requirements can be considered fulfilled, if the CSI reporting requirements in Clause 6 are executed for UE under test.
- For UEs supporting EN-DC including FR2 and/or EN-DC including FR1 and FR2, the requirements applicability is specified in Table 10.1.1-1.

**Table 10.1.1-1: Requirements applicability for UEs supporting EN-DC including FR2 and/or EN-DC including FR1 and FR2**

| Supported scenarios | CQI requirements | PMI requirements | RI requirements |
|---|---|---|---|
| EN-DC including FR2 | Clause 10.2B.1.2 | Clause 10.3B.1.2 | Clause 10.4B.1.2 |
| EN-DC including FR1 and FR2 | Clause 10.2B.1.3 | Clause 10.3B.1.3 | Clause 10.4B.1.3 |
| Both EN-DC including FR2 and EN-DC including FR1 and FR2 | Clause 10.2B.1.2 | Clause 10.3B.1.2 | Clause 10.4B.1.2 |

#### 10.1.1.1 Applicability of requirements for optional UE features

**Table 10.1.1.1-1: Void**

#### 10.1.1.2 Applicability of requirements for mandatory UE features with capability signalling

The applicability rule defined in Clause 6.1.1.4 shall be applied for performance requirements in Clauses 10.2B.1.1, 10.3B.1.1 and 10.4B.1.1.

The applicability rule defined in Clause 8.1.1.4 shall be applied for performance requirements in Clauses 10.2B.1.2, 10.3B.1.2 and 10.4B.1.2.

## 10.2 Reporting of Channel Quality Indicator (CQI)

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

(Void)

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

### 10.2B.1 EN-DC

#### 10.2B.1.1 EN-DC within FR1

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR CQI reporting requirements are specified in Clause 6.2. During the test, only the performance based on NR requirements on the NR cell(s) shall be verified.

#### 10.2B.1.2 EN-DC including FR2 NR carrier

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR CQI reporting requirements are specified in Clause 8.2. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

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

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR CQI reporting requirements are specified in Clause 10.2B.1.1 and Clause 10.2B.1.2. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

### 10.2B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2. The test setup for FR2 cell is specified in Clause 8.1.2 and Clause 8.2. The NR CQI reporting requirements are specified in Clause 8.2. During the test, only the CQI performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

## 10.3 Reporting of Precoding Matrix Indicator (PMI)

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

(Void)

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

### 10.3B.1 EN-DC

#### 10.3B.1.1 EN-DC within FR1

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PMI reporting requirements are specified in Clause 6.3. During the test, only the performance based on NR requirements on the NR cell(s) shall be verified.

#### 10.3B.1.2 EN-DC including NR FR2 carrier

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PMI reporting requirements are specified in Clause 8.3. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

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

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PMI reporting requirements are specified in Clause 10.3B.1.1 and Clause 10.3B.1.2. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

### 10.3B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2. The test setup for FR2 cell is specified in Clause 8.1.2 and Clause 8.3. The PMI reporting requirements are specified in Clause 8.3. During the test, only the PMI performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

## 10.4 Reporting of Rank Indicator (RI)

## 10.4A Reporting of Rank Indicator (RI) for CA

## 10.4B Reporting of Rank Indicator (RI) for DC

### 10.4B.1 EN-DC

#### 10.4B.1.1 EN-DC within FR1

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR RI reporting requirements are specified in Clause 6.4. During the test, only the performance based on NR requirements on the NR cell(s) shall be verified.

#### 10.4B.1.2 EN-DC including NR FR2 carrier

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR RI reporting requirements are specified in Clause 8.4. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

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

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PMI reporting requirements are specified in Clause 10.4B.1.1 and Clause 10.4B.1.2. During the test, only the performance based on the NR requirements on the NR cell(s) on FR2 carriers shall be verified.

### 10.4B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2.The test setup for FR2 cell is specified in Clause 8.1.2 and Clause 8.4. The NR RI reporting requirements for NR FR2 cell are specified in Clause 8.4. During the test, only the RI performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

# 11 V2X requirements

This clause contains the performance requirements for the sidelink physical channels specified for V2X Sidelink Communication.

## 11.1 Demodulation performance requirements (Conducted requirements)

### 11.1.1 General

#### 11.1.1.1 Applicability of requirements

##### 11.1.1.1.1 General

The minimum performance requirements are applicable to all V2X operating bands defined in TS 38.101-1[6] Clause 5.2E.

The minimum performance requirements in Clause 11.1 are mandatory for UE supporting NR SL operation (*sl-Reception-r16*), except test cases listed in Clauses 11.1.1.1.2.

##### 11.1.1.1.2 Applicability of requirements for mandatory UE V2X features with capability signalling

The performance requirements in Table 11.1.1.1.2-1 shall apply for V2X UEs which support mandatory UE features with capability signalling only.

**Table 11.1.1.1.2-1: Requirements applicability for mandatory features with UE capability signalling**

| UE feature/capability [14] | Test type | | Test list | Applicability notes |
|---|---|---|---|---|
| Support of synchronization sources for NR sidelink (*sync-Sidelink-r16*) | FR1 | PSBCH | Clause 11.1.4.1.1 | |
| Supports of PSFCH format 0 (*psfch-FormatZeroSidelink-r16)* | FR1 | PSSCH | Clause 11.1.2.1.1<br>Clause 11.1.6.1.1<br>Clause 11.1.7.1.1 | |
| | | PSCCH | Clause 11.1.3.1.1 | |
| | | PSFCH | Clause 11.1.5.1.1<br>Clause 11.1.9.1.1 | |

### 11.1.1.2 Common test parameters

Parameters specified in Table 11.1.1.2-1 are applied for all test cases in this clause unless otherwise stated.

**Table 11.1.1.2-1: Common test parameters**

| Parameter | | Unit | Value |
|---|---|---|---|
| Carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 1) | RBs | 0 |
| | Subcarrier spacing | kHz | 30 |
| SL BWP configuration #1 | Cyclic prefix | | Normal |
| | RB offset | RBs | 0 |
| | Number of contiguous PRB | PRBs | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing |
| PT-RS configuration | | | PT-RS is not configured |
| Resource pool configuration | PSCCH Time resource | Symbols | 2 |
| | PSCCH Frequency resource | PRBs | 10 |
| | PSFCH number of cyclic shift pairs | | n1 |
| | PSFCH hopping ID | | 0 |
| | PSFCH candidate resource type | | allocSubCH |
| | Set of PRBs for PSFCH transmission | | ones(1,100) for 40 MHz and ones(1,50) for 20 MHz |
| | PSSCH RSRP threshold | | 66 (infinity dBm) |
| | Synchronization reference | | GNSS |
| | Subchannel size | PRBs | 10 |
| | Number of sub-channels | | 5 for 20 MHz and 10 for 40 MHz |
| | Start PRB for first sub-channel | | 0 |
| | Time resource bitmap | | ones(1, 160) |
| Note 1: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. | | | |

## 11.1.2 PSSCH demodulation requirements

### 11.1.2.1 2Rx requirements

#### 11.1.2.1.1 Minimum requirements

The purpose of the requirements in this subclause is to verify the PSSCH for V2X demodulation performance with a single active PSSCH link.

The minimum requirements are specified in Table 11.1.2.1.1-2 with the test parameters specified in Table 11.1.2.1.1-1. In this test scenario, GNSS or GNSS-equivalent synchronization source is used and sidelink UE 1 transmits PSCCH and PSSCH.

**Table 11.1.2.1.1-1: Test parameters**

| Parameter | | Unit | Value | | |
|---|---|---|---|---|---|
| | | | Test 1 | Test 2 | Test 3 |
| Active cell(s) | | | None | | |
| Sidelink UE 1 | Sidelink transmissions | | PSCCH + PSSCH | | |
| | PSSCH DMRS pattern (Note 1) | | {3,4} | {2,3} | {2,2} |
| | Index of sub-channel allocation | | [0,1] | [0,1] | [0] |
| | Timing offset (Note 2) | µs | CP/2-12*64*Tc | | |
| | Frequency offset (Note 3) | Hz | +600 | | |
| | Synchronization | | GNSS or GNSS-equivalent | | |
| | Antenna configuration | | 1x2 Low | | |
| PSFCH resource period | | Slot | 4 | 4 | 4 |
| MinTimeGapPSFCH | | Slot | 3 | 3 | 3 |
| Note 1: {x, y}: x and y means the number of DMRS symbols for slot with PSFCH transmission and without PSFCH transmission, respectively.<br>Note 2: Time offset of sidelink UE receive signal with respect to GNSS referring timing.<br>Note 3: Frequency offset of sidelink UE receive signal with respect to GNSS reference frequency. | | | | | |

**Table 11.1.2.1.1-2: Minimum performance**

| Test num. | Reference channel | Bandwidth (MHz)/ Subcarrier spacing(kHz) | Modulation format and code rate | Propagation condition | Reference value | |
|---|---|---|---|---|---|---|
| | | | | | PSSCH BLER (%) | SNR(dB) of PSSCH |
| 1 | R.PSSCH.2-1.1 | 20 / 30 | QPSK, 0.30 | TDLA30-2700 | 10% | 3.4 |
| 2 | R.PSSCH.2-1.2 | 20 / 30 | 16QAM, 0.37 | TDLA30-1400 | | 8.8 |
| 3 | R.PSSCH.2-1.3 | 20 / 30 | 64QAM, 0.43 | TDLA30-180 | | 14.8 |

## 11.1.3 PSCCH demodulation requirements

### 11.1.3.1 2Rx requirements

#### 11.1.3.1.1 Minimum requirements

The purpose of the requirements in this subclause is to verify the PSCCH for V2X demodulation performance with a single active PSSCH link.

The minimum requirements are specified in Table 11.1.3.1.1-2 with the test parameters specified in Table 11.1.3.1.1-1. In this test scenario, GNSS or GNSS-equivalent synchronization source is used and Sidelink UE 1 transmits PSCCH and PSSCH.

**Table 11.1.3.1.1-1: Test Parameters**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Active cell(s) | | | None |
| Sidelink UE 1 | Sidelink Transmissions | | PSCCH+PSSCH |
| | Timing offset (Note 1) | µs | CP/2-12*64*Tc |
| | Frequency offset (Note 2) | Hz | +600 |
| | Synchronization | | GNSS or GNSS-equivalent |
| | Antenna configuration | | 1x2 Low |
| | PSSCH RMC | | R.PSSCH.2-1.1 |
| NOTE 1: Time offset of Sidelink UE receive signal with respect to GNSS reference timing.<br>NOTE 2: Frequency offset of Sidelink UE receive signal with respect to GNSS reference frequency.<br>NOTE 3: OCC index i for PSCCH DMRS is randomly selected from {0, 1, 2} for each PSCCH transmission. | | | |

**Table 11.1.3.1.1-2: Minimum performance**

| Test number | PSCCH Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation condition | Reference value | |
|---|---|---|---|---|---|
| | | | | Probability of missed PSCCH (%) | SNR (dB) of PSCCH |
| 1 | R.PSCCH.2-1.1 | 20 / 30 | TDLA30-1400 | 1 | 4.7 |

# 11.1.4 PSBCH demodulation requirements

## 11.1.4.1 2Rx requirements

### 11.1.4.1.1 Minimum requirements

The purpose of the requirements in this subclause is to verify the PSBCH demodulation performance with a single active link.

The minimum requirements are specified in Table 11.1.4.1.1-2 with the test parameters specified in Table 11.1.4.1.1-1. The Sidelink UE 1 is synchronized to SLSS as synchronization reference.

**Table 11.1.4.1.1-1: Test Parameters**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Active cell(s) | | | None |
| Sidelink UE 1 | Sidelink Transmissions | | SLSS+PSBCH (Note 3) |
| | slssid | | 0 |
| | Time offset (Note 1) | µs | 0 |
| | Frequency offset (Note 2) | Hz | 0 |
| | Synchronization source | | SLSS |
| | Antenna configuration | | 1x2 Low |
| Note 1: Time offset of Sidelink UE receive signal with respect to GNSS reference timing.<br>Note 2: Frequency offset of Sidelink UE receive signal with respect to GNSS reference frequency.<br>Note 3: PSBCH transmits together with corresponding SLSS in the same slot. | | | |

**Table 11.1.4.1.1-2: Minimum performance**

| Test number | Bandwidth (MHz) / Subcarrier spacing (kHz) | PSBCH Reference channel | Propagation condition | Reference value | |
|---|---|---|---|---|---|
| | | | | Probability of missed PSBCH (%) | SNR (dB) |
| 1 | 20 / 30 | R.PSBCH.2-1 | TDLA30-180 | 1 | 0.1 |

# 11.1.5 PSFCH demodulation requirements

## 11.1.5.1 2Rx requirements

### 11.1.5.1.1 Minimum requirements

#### 11.1.5.1.1.1 NACK missed detection requirements

The NACK missed detection probability is the probability of not detecting an NACK when an NACK was sent. The test parameters are configured in table 11.1.5.1.1.1-1.

**Table 11.1.5.1.1.1-1: Test Parameters**

| Parameter | unit | Test 1 |
|---|---|---|
| Allocated resource blocks | RB | 1 |
| The number of PSFCH symbols (Note 1) | symbol | 2 |
| Number of information bits | bit | 1 |
| Synchronization source | | GNSS |
| Timing offset (Note 2) | µs | CP/2-12*64*Tc |
| Frequency offset (Note 3) | Hz | 600 |
| PSFCH resource period | Slots | 1 |
| Antenna configuration | | 1x2 Low |
| Note 1: First symbol is included. First symbol is used for AGC and not used for demodulation.<br>Note 2: Time offset of sidelink UE receive signal with respect to GNSS referring timing.<br>Note 3: Frequency offset of sidelink UE receive signal with respect to GNSS reference frequency. | | |

The NACK missed detection probability shall not exceed 1% at the SNR given in table 11.1.5.1.1.1-2.

**Table 11.1.5.1.1.1-2: Minimum requirements**

| Test num. | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation condition | Reference value | |
|---|---|---|---|---|
| | | | NACK missed detection probability (%) | SNR (dB) |
| 1 | 20 / 30 | TDLA30-180 | 1 | 9.5 |

#### 11.1.5.1.1.2 DTX to NACK requirements

The DTX to NACK probability, i.e. the probability that NACK is detected when nothing was sent:

$$\mathrm{Prob}(\mathrm{PSFCH\ DTX} \rightarrow \mathrm{NACK\ bits}) = \frac{\#(false\ \mathrm{NACK}\ bits)}{\#(\mathrm{PSFCH\ DTX}) * \#(NACK\ bits)}$$

where:

- #(false NACK bits) denotes the number of detected NACK bits.
- #(NACK bits) denotes the number of encoded bits per slot
- #(PSFCH DTX) denotes the number of DTX occasions

The test parameters are configured in table 11.5.1.1.1-1.

The DTX to NACK probability shall not exceed 1%.

## 11.1.6 Power imbalance performance with two links

### 11.1.6.1 2RX requirements

#### 11.1.6.1.1 Minimum requirements

The purpose of this test is to check the demodulation performance when receiving PSSCH transmissions from two Sidelink UEs with power imbalance in one slot.

The minimum requirements are specified in Table 11.1.6.1.1-2 with the test parameters specified in Table 11.1.6.1.1-1. The Sidelink UE 1 and 2 are synchronized to GNSS or GNSS-equivalent synchronization reference.

**Table 11.1.6.1.1-1: Test Parameters**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Active cell(s) | | | None |
| Active Sidelink UE(s) | | | Sidelink UE 1, Sidelink UE 2 |
| Sidelink UE 1 | Sidelink Transmissions | | PSCCH + PSSCH |
| | PSSCH DMRS pattern(Note 1) | | {2,3} |
| | Sub-channel allocation | | Sub-channel 0 |
| | Time offset (Note 2) | µs | 0 |
| | Frequency offset (Note 3) | Hz | 0 |
| | Antenna configuration | | 1x2 Low |
| | PSFCH periodicity | Slots | 4 |
| | MinTimeGapPSFCH | Slots | 3 |
| Sidelink UE 2 | Sidelink Transmissions | | PSCCH + PSSCH |
| | PSSCH DMRS pattern(Note 1) | | {2,3} |
| | Sub-channel allocation | | Sub-channnel 3 |
| | Time offset (Note 2) | µs | 0 |
| | Frequency offset (Note 3) | Hz | 0 |
| | Antenna configuration | | 1x2 Low |
| | PSFCH periodicity | Slots | 4 |
| | MinTimeGapPSFCH | Slots | 3 |
| Note 1: {x, y}: x and y means the number of DMRS symbols for slot with PSFCH transmission and without PSFCH transmission, respectively.<br>Note 2: Time offset of received signal by Sidelink UE with respect to GNSS reference timing.<br>Note 3: Frequency offset of received signal by Sidelink UE with respect to GNSS reference frequency. | | | |

**Table 11.1.6.1.1-2: Minimum performance**

| Test number | Bandwidth (MHz)/ Subcarrier spacing(kHz) | Sidelink UE | PSSCH Reference channel | Modulation format and code rate | Propagation condition | Reference value | |
|---|---|---|---|---|---|---|---|
| | | | | | | PSSCH BLER (%) | SNR (dB) of PSSCH |
| 1 | 20 / 30 | 1 | R.PSSCH.2-1.4 | QPSK, 0.30 | AWGN | (Note 1) | 30.35 |
| | | 2 | R.PSSCH.2-1.4 | QPSK, 0.30 | AWGN | 10 | 4.8 |
| Note 1: There is no BLER requirement for Sidelink UE 1. | | | | | | | |

## 11.1.7 HARQ buffer soft combining test

### 11.1.7.1 2Rx requirement

#### 11.1.7.1.1 Minimum requirement

The purpose of this test is to verify the maximum number of HARQ processes per TTI supported by the V2X UE.

The minimum requirement is specified in Table 11.1.7.1.1-2 with the test parameters specified in Table 11.1.7.1.1-1.

**Table 11.1.7.1.1-1: Test Parameters**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| Active cell(s) | | | None |
| Active Sidelink UE(s) | | | Sidelink UE i, 0 ≤ i ≤ *n* (Note 1,2) |
| Sidelink UE i, 0 ≤ i ≤ *n* | Sidelink Transmissions | | PSCCH + PSSCH |
| | PSSCH DMRS pattern | | {2} |
| | Time gap between initial transmission and retransmission | Slots | [*n* (Note 3)] |
| | Timing offset (Note 4) | µs | 0 |
| | Frequency offset (Note 5) | Hz | 0 |
| | Synchronization source | | GNSS or GNSS-equivalent |
| | Antenna configuration | | 1x2 Low |
| | Redundancy version coding sequence | | {0,2} |
| PSFCH resource period | | Slots | 1 |
| Note 1: *n* is the number of HARQ process UE can support (based on IE harq-RxProcessSidelink)<br>Note 2: When *n* = 16 or 24, sidelink UEs transmit one by one circularly for every slot;<br>When *n*=32, the first 31 UEs transmit signal one by one circularly for every slot and in the first subchannel, and the 32nd UE transmits signal in the first slot but in the second subchannel;<br>When *n*=48, the first 31 UEs transmit signal one by one circularly for every slot and in the first subchannel, the next 17 UEs transmit signal in the same slot as the first 17 UEs but in the second subchannel;<br>When *n*=64, first 31 UEs transmit signal one by one circularly for every slot and in the first subchannel, the next 31 UEs transmit signal one by one circularly for every slot and in the second subchannel, the last 2 UEs transmit signal in the same slot as the first 2 UEs in the third subchannel<br>Note 3: *k* = *n* if *n* < 32, otherwise *k* = 31<br>Note 4: Time offset of Sidelink UE receive signal is with respect to GNSS reference timing.<br>Note 5: Frequency offset of Sidelink UE receive signal is with respect to GNSS reference frequency. | | | |

**Table 11.1.7.1.1-2: Minimum performance**

| Test num. | Bandwidth (MHz) / Subcarrier spacing(kHz) | PSSCH Reference channel | Propagation condition | Reference value | |
|---|---|---|---|---|---|
| | | | | PSSCH BLER (%) | SNR (dB) of PSSCH |
| 1 | 20 / 30 | R.PSSCH.2-1.5 | AWGN | 5 | 10.9 |

## 11.1.8 PSCCH decoding capability test

### 11.1.8.1 2RX requirements

#### 11.1.8.1.1 Minimum requirements

The purpose of this test is to verify the maximum number of received PSCCHs per TTI supported by the V2X UE.

The minimum requirements are specified in Table 11.1.8.1.1-2 with the test parameters specified in Table 11.1.8.1.1-1 and the test procedure is specified as follows:

- 10 UEs transmit PSCCHs and corresponding PSSCHs to the tested UE per slot with each UE occupying one subchannel.

- x UEs transmit PSCCHs and corresponding PSSCHs with high priority level on x subchannels that are randomly selected from 10 subchannels per slot and 10-x UEs transmit PSCCHs and corresponding PSSCHs with low priority level on the remaining subchannels. The indication of priority level specified in Clause 5.4.3.3 of TS 23.287 [12] and Clause 5.22.1.3.1 of TS 38.321 [8] is included in PSCCH.

Where x equals to:

- The number of PSFCH(s) resources that the tested UE can transmit in a slot (i.e. IE *psfch-TxNumber* specified in clause 4.2.16.1.6 of TS 38.306 [14]) if the number of PSFCH(s) resources that the tested UE can transmit in a slot is less than 10

- 10, otherwise.

The probability of PSCCH miss detection is calculated as follows:

$$Prob(PSCCH\ miss\ detection\ ) = \frac{\#(missing\ ACK/\mathrm{NACK})}{\#(Tx\ high\ priority\ PSCCH/PSSCH)}$$

Where:

- # (Tx high priority PSCCH/PSSCH) denotes the total number of transmitted PSCCH/PSSCH with high priority level.
- # (missing ACK/NACK) denotes the total number of missing ACK/NACK with high priority.

**Table 11.1.8.1.1-1: Test Parameters**

<table>
<tr><th colspan="3">Parameter</th><th>Unit</th><th>Value</th></tr>
<tr><td colspan="3">Member ID (Note 1)</td><td></td><td>0</td></tr>
<tr><td rowspan="12">Sidelink UE i, 0 ≤ i ≤ 9 (Note 5)</td><td colspan="2">Sidelink Transmissions</td><td></td><td>PSCCH + PSSCH</td></tr>
<tr><td colspan="2">Timing offset (Note 2)</td><td>µs</td><td>0</td></tr>
<tr><td colspan="2">Frequency offset (Note 3)</td><td>Hz</td><td>0</td></tr>
<tr><td colspan="2">Synchronization source</td><td></td><td>GNSS</td></tr>
<tr><td colspan="2">Propagation Channel</td><td></td><td>Static propagation condition without external noise</td></tr>
<tr><td colspan="2">Antenna configuration</td><td></td><td>1x2 Low</td></tr>
<tr><td colspan="2">PSSCH RMC</td><td></td><td>R.PSSCH.2-1.1</td></tr>
<tr><td colspan="2">PSCCH RMC (Note 4)</td><td></td><td>R.PSCCH.2-1.1</td></tr>
<tr><td colspan="2">Source ID</td><td></td><td>0</td></tr>
<tr><td colspan="2">PSFCH periodicity</td><td>Slots</td><td>1</td></tr>
<tr><td colspan="2">MinTimeGapPSFCH</td><td>Slots</td><td>2</td></tr>
<tr><td rowspan="2">PSFCH Resource (Note 6)</td><td>RB index</td><td></td><td>10*i</td></tr>
<tr><td></td><td>CS pair index</td><td></td><td>0</td></tr>
<tr><td colspan="5">Note 1: Member ID is an identifier uniquely identifying a member.<br>Note 2: Time offset of received signal by Sidelink UE with respect to GNSS reference timing.<br>Note 3: Frequency offset of Sidelink UE received signal by with respect to GNSS reference frequency.<br>Note 4: OCC index for PSCCH DMRS is randomly selected between {0, 1, 2} for each PSCCH transmission as per in Clause 8.4.1.3.2 of TS 38.211[9].<br>Note 5: Each UE occupies one sub-channel so that all sub-channels are filled.<br>Note 6: The mapping procedure of PSSCH resource and PSFCH resource is specified in Clause 16.3 of TS 38.213 [11].</td></tr>
</table>

**Table 11.1.8.1.1-2: Minimum performance**

| Test Number | Bandwidth (MHz) / Subcarrier spacing(kHz) | PSCCH Reference channel | Propagation Channel | Reference value<br>Probability of missed PSCCH (%) |
|---|---|---|---|---|
| 1 | 40 / 30 | R.PSCCH.2-1.1 | Static propagation condition without external noise | 1 |

## 11.1.9 PSFCH decoding capability test

### 11.1.9.1 2RX requirements

#### 11.1.9.1.1 Minimum requirements

The purpose of this test is to verify the maximum number of PSFCHs received by UE per slot in group cast scenario by using ACK/NACK feedback mode. In each slot, a group of UEs transmits PSFCHs to the tested UE. Information transmitted in each PSFCH is randomly selected from Option A, Option B and Option C with probability of 50%, 25%

and 25% respectively. Transmitted PSFCHs are related to one PSSCH which is transmitted by tested UE and occupies all the subchannels.

- Option A: All the UEs in the group transmit ACKs
- Option B: One UE transmits NACK and the rest of UEs transmit ACKs. The PSFCH resource index with NACK is random per slot
- Option C: One UE transmits nothing (i.e.DTX) and the rest of UEs transmit ACKs. The PSFCH resource index of the DTX is random per slot.

The minimum requirements are specified in Table 11.1.9.1.1-2 with the test parameters specified in Table 11.1.9.1.1-

**Table 11.1.9.1.1-1: Test parameters**

| Parameter | | Unit | Test 1 |
|---|---|---|---|
| HARQ-ACK information | | | ACK or NACK |
| Source ID of tested UE | | | 0 |
| Sidelink UE i, 0 ≤ i ≤ N-1(Note 3) | Sidelink transmissions for | | PSFCH |
| | Timing offset (Note 1) | µs | 0 |
| | Frequency offset (Note 2) | Hz | 0 |
| | Synchronization source | | GNSS or GNSS-equivalent |
| | Propagation Channel | | Static propagation condition<br>No external noise sources are applied |
| | Antenna configuration | | 1x2 Low |
| | Member ID(Note 4) | | i |
| | PSFCH resource allocation(Note 5) | | N UEs transmit PSFCHs one by one on each RB with CS pair index 0. i.e. UE 0 transmits PSFCH on RB 0, UE 1 transmits PSFCH on RB 1,…, UE (N-1) transmits PSFCH on RB N-1 |
| | PSFCH periodicity | Slots | 1 |
| Note 1: Time offset of received signal by Sidelink UE with respect to GNSS reference timing.<br>Note 2: Frequency offset of received signal by Sidelink UE with respect to GNSS reference frequency.<br>Note 3: N equals to the number of PSFCH(s) resources that UE can receive in a slot as specified in Clause 4.2.16.1.6 of TS 38.306[14]( IE *psfch-RxNumber*)) .<br>Note 4: Member ID is an identifier uniquely identifying a member<br>Note 5: All PSFCHs in a slot are corresponding to one PSSCH that occupies all sub channels. | | | |

**Table 11.1.9.1.1-2: Minimum requirement**

| Test Number | Bandwidth (MHz) / Subcarrier spacing(kHz) | Propagation Channel | Reference value | |
|---|---|---|---|---|
| | | | Probability of success detection slot with ACK only | Probability of success detection slot with NACK or DTX |
| 1 | 40 / 30 | Static propagation condition without external noise | 99 | 99 |
| Note 1: The probability of success detection slot with ACK only is the probability that the corresponding PSSCH is not retransmitted when Option A is selected.<br>Note 2: The probability of success detection slot with NACK or DTX is the probability that the corresponding PSSCH is retransmitted when Option B or option C is selected. | | | | |

# 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 configurations for FR1

TDD UL-DL 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 configuration 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 |
| *referenceSubcarrierSpacing* | | kHz | 15 |
| pattern1 | *dl-UL-TransmissionPeriodicity* | ms | 5 |
| | *nrofDownlinkSlots* | | 3 |
| | *nrofDownlinkSymbols* | | 10 |
| | *nrofUplinkSlot* | | 1 |
| | *nrofUplinkSymbols* | | 2 |
| The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3) | | | 4 if mod(i,5) = 0<br>3 if mod(i,5) = 1<br>2 if mod(i,5) = 2<br>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.<br>Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.<br>Note 3: i is the slot index per frame; i = {0,…,9}. | | | |

**Table A.1.2-2: TDD UL-DL configuration 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 | DDDSUUDDDD | DSUU | $DS_1S_2U$ |
| Special Slot Configuration (Note 2) | | | 6D+4G+4U | 10D+2G+2U | 10D+2G+2U | 6D+4G+4U | 12D+2G | S1: 10D+2G+2U S2: 12D+2G+0U |
| *referenceSubcarrierSpacing* | | kHz | 30 | 30 | 30 | 30 | 30 | 30 |
| pattern1 | | | | | | | | |
| | *dl-UL-TransmissionPeriodicity* | ms | 5 | 2.5 | 2.5 | 3 | 2 | 1 |
| | *nrofDownlinkSlots* | | 7 | 3 | 3 | 3 | 1 | 1 |
| | *nrofDownlinkSymbols* | | 6 | 10 | 10 | 6 | 12 | 10 |
| | *nrofUplinkSlot* | | 2 | 1 | 1 | 2 | 2 | 0 |
| | *nrofUplinkSymbols* | | 4 | 2 | 2 | 4 | 0 | 2 |
| pattern2 | | | | | | | | |
| | *dl-UL-TransmissionPeriodicity* | ms | N/A | N/A | 2.5 | 2 | N/A | 1 |
| | *nrofDownlinkSlots* | | N/A | N/A | 2 | 4 | N/A | 0 |
| | *nrofDownlinkSymbols* | | N/A | N/A | 10 | 0 | N/A | 12 |
| | *nrofUplinkSlot* | | N/A | N/A | 2 | 0 | N/A | 1 |
| | *nrofUplinkSymbols* | | N/A | N/A | 2 | 0 | N/A | 0 |
| The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3) | | | 8 if mod(i,10) = 0<br>7 if mod(i,10) = 1<br>6 if mod(i,10) = 2<br>5 if mod(i,10) = 3<br>5 if mod(i,10) = 4<br>4 if mod(i,10) = 5<br>3 if mod(i,10) = 6<br>2 if mod(i,10) = 7 | 4 if mod(i,5) = 0<br>3 if mod(i,5) = 1<br>2 if mod(i,5) = 2<br>6 if mod(i,5) = 3 | 4 if mod(i,10) = 0<br>3 if mod(i,10) = 1<br>2 if mod(i,10) = 2<br>5 if mod(i,10) = 3<br>3 if mod(i,10) = 5<br>3 if mod(i,10) = 6<br>2 if mod(i,10) = 7 | 5 if mod(i,10) = 0<br>4 if mod(i,10) = 1<br>3 if mod(i,10) = 2<br>2 if mod(i,10) = 3<br>8 if mod(i,10) = 6<br>7 if mod(i,10) = 7<br>6 if mod(i,10) = 8<br>5 if mod(i,10) = 9 | 3 if mod(i,4) = 0<br>2 if mod(i,4) = 1 | 3 if mod(i,4) = 0<br>2 if mod(i,4) = 1<br>3 if mod(i,4) = 2 |

| | |
|---|---|
| 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} |

**Table A.1.2-2a: TDD UL-DL configuration for SCS 30 kHz for DCI-based dynamic UL/DL detection**

| Parameter | | Unit | UL-DL pattern |
|---|---|---|---|
| | | | **FR1.30-1A** |
| TDD Slot Configuration pattern (Note 1) | | | 7DS2U |
| Special Slot Configuration (Note 2) | | | 6D+4G+4U |
| *referenceSubcarrierSpacing* | | kHz | N/A |
| pattern1 (Note 4) | | | |
| | *dl-UL-TransmissionPeriodicity* | ms | N/A |
| | *nrofDownlinkSlots* | | N/A |
| | *nrofDownlinkSymbols* | | N/A |
| | *nrofUplinkSlot* | | N/A |
| | *nrofUplinkSymbols* | | N/A |
| PDCCH DCI Configuration | DCI Format | | 1-1 for slot indices with mod(i,10) = 0,1,2,3,4,5,6,7 |
| | Scheduled Grant | | Symbol 2-13 for slot indices with mod(i,10) = 0,1,2,3,4,5,6 and Symbol 2-5 for slot indices with mod(i,10) = 7 |
| The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3) (PDSCH-to-HARQ-timing-indicator) | | | 8 if mod(i,10) = 0<br>7 if mod(i,10) = 1<br>6 if mod(i,10) = 2<br>5 if mod(i,10) = 3<br>5 if mod(i,10) = 4<br>4 if mod(i,10) = 5<br>3 if mod(i,10) = 6<br>2 if mod(i,10) = 7 |
| 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.<br>Note 2: D, G and U denote DL, guard and UL symbols, respectively. The field is for information.<br>Note 3: i is the slot index per frame; i = {0,…,19}<br>Note 4: Do not configure *tdd-UL-DL-ConfigurationCommon* using RRC configuration | | | |

**Table A.1.2-2b: TDD UL-DL configuration for SCS 30 kHz for PDSCH on band with shared spectrum access**

| Parameter | | Unit | UL-DL pattern |
|---|---|---|---|
| | | | **FR1.30-7** |
| TDD Slot Configuration pattern (Note 1) | | | 7DS2U |
| Special Slot Configuration (Note 2) | | | 6D+4G+4U |
| *referenceSubcarrierSpacing* | | kHz | 30 |
| *Pattern 1* | *dl-UL-TransmissionPeriodicity* | ms | 5 |
| | *nrofDownlinkSlots* | slot | 7 |
| | *nrofDownlinkSymbols* | symbol | 6 |
| | *nrofUplinkSlot* | slot | 2 |
| | *nrofUplinkSymbols* | symbol | 4 |
| *Pattern 2* | *dl-UL-TransmissionPeriodicity* | ms | N/A |
| | *nrofDownlinkSlots* | | N/A |
| | *nrofDownlinkSymbols* | | N/A |
| | *nrofUplinkSlot* | | N/A |
| | *nrofUplinkSymbols* | | N/A |
| The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3) | | | 8 if mod(i,10) = 0<br>7 if mod(i,10) = 1<br>6 if mod(i,10) = 2<br>5 if mod(i,10) = 3<br>4 if mod(i,10) = 4<br>3 if mod(i,10) = 5<br>2 if mod(i,10) = 6 |
| 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.<br>Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.<br>Note 3: i is the slot index of all slots in every 5ms i = {0,…,9}Note 4: The slot i, mod (i,10)=9 is idle slot with no UL transmission. | | | |

# A.1.3 TDD UL-DL configurations 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 |
| *referenceSubcarrierSpacing* | | kHz | 60 |
| pattern1 | *dl-UL-TransmissionPeriodicity* | ms | 1 |
| | *nrofDownlinkSlots* | | 2 |
| | *nrofDownlinkSymbols* | | 11 |
| | *nrofUplinkSlot* | | 1 |
| | *nrofUplinkSymbols* | | 0 |
| The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3) | | | 3 if mod(i,4) = 0<br>2 if mod(i,4) = 1<br>5 if mod(i,4) = 2 |
| 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.<br>Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.<br>Note 3: i is the slot index per frame; i = {0,…,39} | | | |

**Table A.1.3-2: TDD UL-DL configuration 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 |
| *referenceSubcarrierSpacing* | | kHz | 120 | 120 |
| pattern1 | *dl-UL-TransmissionPeriodicity* | ms | 0.625 | 0.5 |
| | *nrofDownlinkSlots* | | 3 | 2 |
| | *nrofDownlinkSymbols* | | 10 | 11 |
| | *nrofUplinkSlot* | | 1 | 1 |
| | *nrofUplinkSymbols* | | 2 | 0 |
| The number of slots between PDSCH and corresponding HARQ-ACK information(Note 3) | | | 4 if mod(i,5) = 0<br>3 if mod(i,5) = 1<br>2 if mod(i,5) = 2<br>6 if mod(i,5) = 3 | 3 if mod(i,4) = 0<br>2 if mod(i,4) = 1<br>5 if mod(i,4) = 2 |
| 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.<br>Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.<br>Note 3: i is the slot index per frame; i = {0,…,79} | | | | |

**Table A.1.3-2a: TDD UL-DL configuration for SCS 120 kHz for DCI-based dynamic UL/DL detection**

| Parameter | | Unit | UL-DL pattern |
|---|---|---|---|
| | | | **FR2.120-1A** |
| TDD Slot Configuration pattern (Note 1) | | | DDDSU |
| Special Slot Configuration (Note 2) | | | 10D+2G+2U |
| *referenceSubcarrierSpacing* | | kHz | N/A |
| pattern1 (Note 4) | *dl-UL-TransmissionPeriodicity* | ms | N/A |
| | *nrofDownlinkSlots* | | N/A |
| | *nrofDownlinkSymbols* | | N/A |
| | *nrofUplinkSlot* | | N/A |
| | *nrofUplinkSymbols* | | N/A |
| PDCCH DCI Configuration | DCI Format | | 1-1 for slot indices with mod(i,5) = 0,1,2,3 |
| | Scheduled Grant | | Symbol 1-13 for slot indices with mod(i,5) = 0,1,2 and Symbol 1-9 for slot indices with mod(i,5) = 3 |
| The number of slots between PDSCH and corresponding HARQ-ACK information(Note 3) | | | 4 if mod(i,5) = 0<br>3 if mod(i,5) = 1<br>2 if mod(i,5) = 2<br>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.<br>Note 2: D, G and U denote DL, guard and UL symbols, respectively. The field is for information.<br>Note 3: i is the slot index per frame; i = {0,…,79}<br>Note 4: Do not configure *tdd-UL-DL-ConfigurationCommon* using RRC configuration. | | | |

# 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 clause 5.1.3.2 of TS 38.214 [12].

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 | |
| Channel bandwidth | MHz | 10 | 10 | 10 | 10 | |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | |
| Number of allocated resource blocks | PRBs | 52 | 6 | 52 | 52 | |
| Number of consecutive PDSCH symbols | | 12 | 12 | 7 | 12 | |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 | |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAMLowSE | |
| MCS index | | 4 | 4 | 4 | 14 | |
| Modulation | | QPSK | QPSK | QPSK | QPSK | |
| Target Coding Rate | | 0.30 | 0.30 | 0.30 | 0.59 | |
| Number of MIMO layers | | 1 | 1 | 1 | 1 | |
| Number of DMRS REs | | 18 | 12 | 12 | 12 | |
| 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 | 3904 | 480 | 2280 | 8064 | |
| 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 | 16 | 16 | 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 | 1 | 1 | 1 | 1 | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | |
| For Slots i = 10, 11 | Bits | 12480 | 1512 | 6864 | 13104 | |
| For Slots i =1,…, 9, 12, …, 19 | Bits | 13104 | 1584 | 7488 | 13728 | |
| Max. Throughput averaged over 2 frames | Mbps | 3.709 | 0.456 | 2.166 | 7.661 | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>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 | R.PDSCH.1-2.5 FDD | R.PDSCH.1-2.6 FDD |
| Channel bandwidth | MHz | 10 | 10 | 10 | 10 | 10 | 10 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 52 | 52 | 52 | 52 | 52 | 52 |
| Number of consecutive PDSCH symbols | | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 | 19 | 19 |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index | | 13 | 13 | 13 | 13 | 16 | 16 |
| Modulation | | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Target Coding Rate | | 0.48 | 0.48 | 0.48 | 0.48 | 0.64 | 0.64 |
| Number of MIMO layers | | 1 | 2 | 3 | 4 | 1 | 1 |
| Number of DMRS REs | | 12 | 12 | 24 | 24 | 12 | 12 |
| Overhead for TBS determination | | 0 | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot | | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 13064 | 26120 | 35856 | 48168 | 17424 | 17424 |
| Transport block CRC per Slot | | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot | | | | | | | |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | CBs | 2 | 4 | 5 | 6 | 3 | 3 |
| Binary Channel Bits Per Slot | | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 10, 11 | Bits | 26208 | 52416 | 71136 | 94848 | 26208 | 26208 |
| For Slots i = 1,…, 9, 12, …, 19 | Bits | 27456 | 54912 | 74880 | 99840 | 27456 | 27456 |
| Max. Throughput averaged over 2 frames | Mbps | 12.411 | 24.814 | 34.063 | 45.760 | 16.553 | 16.553 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>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 | R.PDSCH.1-3.2 FDD | R.PDSCH.1-3.3 FDD | R.PDSCH.1-3.4 FDD | |
| Channel bandwidth | MHz | 10 | 10 | 10 | 10 | |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | |
| Number of allocated resource blocks | PRBs | 52 | 52 | 26 (Note 3) | 26 (Note 4) | |
| 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 | | 19 | 19 | 19 | 19 | |
| Modulation | | 64QAM | 64QAM | 64QAM | 64QAM | |
| Target Coding Rate | | 0.51 | 0.51 | 0.51 | 0.51 | |
| Number of MIMO layers | | 2 | 2 | 2 | 2 | |
| Number of DMRS REs | | 12 | 24 | 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 | 42016 | 37896 | 18960 | 18960 | |
| 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 | 5 | 5 | 3 | 3 | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | |
| For Slots i = 10, 11 | Bits | 78624 | 67392 | 33696 | 33696 | |
| For Slots i = 1,…, 9, 12, …, 19 | Bits | 82368 | 74880 | 37440 | 37440 | |
| Max. Throughput averaged over 2 frames | Mbps | 39.915 | 36.001 | 18.012 | 18.012 | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: PDSCH is scheduled in PRB numbers from 0 to 25.<br>Note 4: PDSCH is scheduled in PRB numbers from 26 to 51. | | | | | | |

**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<br>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<br>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 | R.PDSCH.1-6.3 FDD | | |
| Channel bandwidth | MHz | 10 | 10 | 10 | | |
| Subcarrier spacing | kHz | 15 | 15 | 15 | | |
| Number of allocated resource blocks | PRBs | 52 | 52 | 52 | | |
| Number of consecutive PDSCH symbols | | 12 | 12 | 12 | | |
| Allocated slots per 2 frames | Slots | 15 | 15 | 15 | | |
| MCS table | | 64QAM | 64QAM | 64QAM | | |
| MCS index | | 13 | 13 | 20 | | |
| Modulation | | 16QAM | 16QAM | 64QAM | | |
| Target Coding Rate | | 0.48 | 0.48 | 0.55 | | |
| Number of MIMO layer | | 1 | 2 | 2 | | |
| Number of DMRS REs (Note 3) | | 24 | 24 | 24 | | |
| Overhead for TBS determination | | 0 | 0 | 0 | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | | |
| For CSI Slots i, if mod (i,5) =1, i={0,…,19} | | N/A | N/A | N/A | | |
| For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..19} | Bits | 12040 | 24072 | 40976 | | |
| Transport block CRC per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | | |
| For CSI Slots i, if mod (i,5) =1, i={0,…,19} | | N/A | N/A | N/A | | |
| For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..19} | Bits | 24 | 24 | 24 | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i = 0 | CBs | N/A | N/A | N/A | | |
| For CSI Slots i, if mod (i,5) =1, i={0,…,19} | | N/A | N/A | N/A | | |
| For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..,19} | CBs | 2 | 3 | 5 | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | | |
| For CSI Slots i, if mod (i,5) =1, i={0,…,19} | | N/A | N/A | N/A | | |
| For Slots i = 10 | Bits | 23712 | 47424 | 71136 | | |
| For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..9,11,…,19} | Bits | 24960 | 49920 | 74880 | | |
| Max. Throughput averaged over 2 frames | Mbps | 9.030 | 18.054 | 30.732 | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data | | | | | | |

**Table A.3.2.1.1-7: PDSCH Reference Channel for FDD LTE-NR coexistence scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-7.1 FDD | R.PDSCH.1-7.2 FDD | | | |
| Channel bandwidth | MHz | 10 | 10 | | | |
| Subcarrier spacing | kHz | 15 | 15 | | | |
| Number of allocated resource blocks | PRBs | 52 | 52 | | | |
| Number of consecutive PDSCH symbols | | 9 | 11 | | | |
| Allocated slots per 2 frames | Slots | 16 | 16 | | | |
| MCS table | | 64QAM | 64QAM | | | |
| MCS index | | 4 | 4 | | | |
| Modulation | | QPSK | QPSK | | | |
| Target Coding Rate | | 0.30 | 0.30 | | | |
| Number of MIMO layers | | 1 | 1 | | | |
| Number of DMRS REs | | 12 | 12 | | | |
| Overhead for TBS determination | | 18 | 18 | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slots i = 0,5,10,15 | Bits | N/A | N/A | | | |
| For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19} | Bits | 2472 | 3240 | | | |
| Transport block CRC per Slot | | | | | | |
| For Slots i = 0,5,10,15 | Bits | N/A | N/A | | | |
| For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19} | Bits | 16 | 16 | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slots i = 0,5,10,15 | CBs | N/A | N/A | | | |
| For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19} | CBs | 1 | 1 | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slots i = 0,5,10,15 | Bits | N/A | N/A | | | |
| For Slots i = 11 | Bits | 7760 | 10256 | | | |
| For Slots i, if mod(i, 5) = {1,2,3,4} for i from {1,…, 9, 12, …, 19} | Bits | 8384 | 10880 | | | |
| Max. Throughput averaged over 2 frames | Mbps | 1.978 | 2.592 | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: No user data is scheduled on slots with LTE PBCH/PSS/SSS | | | | | | |

**Table A.3.2.1.1-8: PDSCH Reference Channel for FDD HST scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-8.1 FDD | R.PDSCH.1-8.2 FDD | R.PDSCH.1-8.3 FDD | R.PDSCH.1-8.4 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 | 17 | 13 | 17 | |
| Modulation | | 16QAM | 64QAM | 16QAM | 64QAM | |
| Target Coding Rate | | 0.48 | 0.43 | 0.48 | 0.43 | |
| Number of MIMO layers | | 1 | 1 | 2 | 2 | |
| Number of DMRS REs | | 18 | 18 | 18 | 18 | |
| 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 | 12552 | 16896 | 25104 | 33816 | |
| 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 | 3 | 3 | 5 | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | |
| For Slots i = 1,2,11,12 | Bits | 24960 | 37440 | 49920 | 74880 | |
| For Slots i = 3,…, 10, 13, …, 19 | Bits | 26208 | 39312 | 52416 | 78624 | |
| Max. Throughput averaged over 2 frames | Mbps | 11.924 | 16.0512 | 23.8488 | 32.1252 | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.1.1-9: PDSCH Reference Channel for FDD CC and CA scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-9.1 FDD | R.PDSCH.1-9.2 FDD | R.PDSCH.1-9.3 FDD | R.PDSCH.1-9.4 FDD | R.PDSCH.1-9.5 FDD |
| Channel bandwidth | MHz | 5 | 15 | 20 | 25 | 30 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 25 | 79 | 106 | 133 | 160 |
| Number of consecutive PDSCH symbols | | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 | 19 |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index | | 13 | 13 | 13 | 13 | 13 |
| Modulation | | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Target Coding Rate | | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| Number of MIMO layers | | 2 | 2 | 2 | 2 | 2 |
| Number of DMRS REs | | 12 | 12 | 12 | 12 | 12 |
| Overhead for TBS determination | | 0 | 0 | 0 | 0 | 0 |
| 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 | 12552 | 39936 | 53288 | 67584 | 79896 |
| 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 | 24 | 24 | 24 | 24 |
| 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 | 2 | 5 | 7 | 9 | 10 |
| 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 | 25200 | 79632 | 106848 | 134064 | 161280 |
| For Slots i =1,…, 9, 12, …, 19 | Bits | 26400 | 83424 | 111936 | 140448 | 168960 |
| Max. Throughput averaged over 2 frames | Mbps | 11.924 | 37.939 | 50.624 | 64.205 | 75.901 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.1.1-10: PDSCH Reference Channel for FDD CC and CA scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-10.1 FDD | R.PDSCH.1-10.2 FDD | | | |
| Channel bandwidth | MHz | 40 | 50 | | | |
| Subcarrier spacing | kHz | 15 | 15 | | | |
| Number of allocated resource blocks | PRBs | 216 | 270 | | | |
| Number of consecutive PDSCH symbols | | 12 | 12 | | | |
| Allocated slots per 2 frames | Slots | 19 | 19 | | | |
| 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 | | 12 | 12 | | | |
| Overhead for TBS determination | | 0 | 0 | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | | | |
| For Slots i = 1,…, 19 | Bits | 108552 | 135296 | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | | | |
| For Slots i = 1,…, 19 | Bits | 24 | 24 | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i = 0 | CBs | N/A | N/A | | | |
| For Slots i = 1,…, 19 | CBs | 13 | 17 | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | | | |
| For Slots i = 10, 11 | Bits | 217728 | 272160 | | | |
| For Slots i =1,…, 9, 12, …, 19 | Bits | 228096 | 285120 | | | |
| Max. Throughput averaged over 2 frames | Mbps | 103.124 | 128.531 | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.1.1-11: PDSCH Reference Channel for FDD**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-11.1 FDD | R.PDSCH.1-11.2 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 | 18 | 18 | | | |
| MCS table | | 64QAMLowSE | 64QAMLowSE | | | |
| MCS index | | 19 | 19 | | | |
| Modulation | | 16QAM | 16QAM | | | |
| Target Coding Rate | | 0.54 | 0.54 | | | |
| Number of MIMO layers | | 1 | 1 | | | |
| Number of DMRS REs | | 12 | 12 | | | |
| Overhead for TBS determination | | 0 | 0 | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot i = 0,1 | Bits | N/A | N/A | | | |
| For Slots i = 2,…, 19 | Bits | 14856 | 14856 | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot i = 0,1 | Bits | N/A | N/A | | | |
| For Slots i = 2,…, 19 | Bits | 24 | 24 | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i = 0,1 | CBs | N/A | N/A | | | |
| For Slots i = 2,…, 19 | CBs | 2 | 2 | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0,1 | Bits | N/A | N/A | | | |
| For Slots i = 10, 11 | Bits | 26208 | 24960 | | | |
| For Slots i =2,…, 9, 12, …, 19 | Bits | 27456 | 27456 | | | |
| Max. Throughput averaged over 2 frames | Mbps | 6.685 (NOTE 3) | 6.685 (NOTE 4) | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: Throughput is calculated under assumption of aggregation factor 2.<br>Note 4: Throughput is calculated under assumption of repetition number 2 | | | | | | |

**Table A.3.2.1.1-12: PDSCH Reference Channel for FDD**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-12.1 FDD | | | | |
| Channel bandwidth | MHz | 10 | | | | |
| Subcarrier spacing | kHz | 15 | | | | |
| Number of allocated resource blocks | PRBs | 52 | | | | |
| Number of consecutive PDSCH symbols | | 2 | | | | |
| Allocated slots per 2 frames | Slots | 19 | | | | |
| MCS table | | 64QAM | | | | |
| MCS index | | 4 | | | | |
| Modulation | | QPSK | | | | |
| Target Coding Rate | | 0.3 | | | | |
| Number of MIMO layers | | 1 | | | | |
| Number of DMRS REs | | 6 | | | | |
| Overhead for TBS determination | | 0 | | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | | | | |
| For Slots i = 1,…, 19 | Bits | 576 | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | | | | |
| For Slots i = 1,…, 19 | Bits | 16 | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i = 0 | CBs | N/A | | | | |
| For Slots i = 1,…, 19 | CBs | 1 | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | | | | |
| For Slots i = 10, 11 | Bits | 1872 | | | | |
| For Slots i =1,…, 9, 12, …, 19 | Bits | 1872 | | | | |
| Max. Throughput averaged over 2 frames | Mbps | 0.547 | | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

### 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,…, 39 | Bits | 40976 | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | | | | |
| For Slots i = 1,…, 39 | Bits | 24 | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i = 0 | CBs | N/A | | | | |
| For Slots i = 1,…, 39 | CBs | 5 | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | | | | |
| For Slots i = 20, 21 | Bits | 77112 | | | | |
| For Slots i = 1,…, 19, 22, …, 39 | 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<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

### A.3.2.1.3 Reference measurement channels for SCS 60 kHz FR1

### A.3.2.1.4 Reference measurement channels for E-UTRA

**Table A.3.2.1.4-1: PDSCH Reference Channel for sustained data-rate test (64QAM, 2 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.4-1.1 FDD | R.PDSCH.4-1.2 FDD | R.PDSCH.4-1.3 FDD | R.PDSCH.4-1.4 FDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 |
| Allocated resource blocks | | Note 6 | Note 7 | Note 8 | Note 9 |
| Allocated subframes per Radio Frame | | 9 | 10 | 10 | 10 |
| Modulation | | 64QAM | 64QAM | 64QAM | 64QAM |
| Coding Rate | | | | | |
| For Sub-Frames 1,2,3,4,6,7,8,9, | | 0.85 | 0.85 | 0.85 | 0.88 |
| For Sub-Frame 5 | | N/A | 0.89 | 0.91 | 0.87 |
| For Sub-Frame 0 | | 0.83 | 0.90 | 0.88 | 0.90 |
| Information Bit Payload (Note 3) | | | | | |
| For Sub-Frames 1,2,3,4,6,7,8,9 | Bits | 18336 | 36696 | 55056 | 75376 |
| For Sub-Frame 5 | Bits | N/A | 35160 | 52752 | 71112 |
| For Sub-Frame 0 | Bits | 15840 | 36696 | 55056 | 75376 |
| Number of Code Blocks (Notes 3 and 4) | | | | | |
| For Sub-Frames 1,2,3,4,6,7,8,9 | CBs | 3 | 6 | 9 | 13 |
| For Sub-Frame 5 | CBs | N/A | 6 | 9 | 12 |
| For Sub-Frame 0 | CBs | 3 | 6 | 9 | 13 |
| Binary Channel Bits (Note 3) | | | | | |
| For Sub-Frames 1,2,3,4,6,7,8,9 | Bits | 21600 | 43200 | 64800 | 86400 |
| For Sub-Frame 5 | Bits | N/A | 39744 | 60480 | 82080 |
| For Sub-Frame 0 | Bits | 19152 | 40752 | 62352 | 83952 |
| Number of layers | | 2 | 2 | 2 | 2 |
| Max. Throughput averaged over 1 frame (Note 3) | Mbps | 16.253 | 36.542 | 54.826 | 74.950 |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: Given per component carrier per codeword.
Note 4: 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).
Note 5: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks $n_{PRB}$ = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

**Table A.3.2.1.4-2: PDSCH Reference Channel for sustained data-rate test (64QAM, 4 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.4-2.1 FDD | R.PDSCH.4-2.2 FDD | R.PDSCH.4-2.3 FDD | R.PDSCH.4-2.4 FDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 |
| Allocated resource blocks | | Note 6 | Note 7 | Note 8 | Note 9 |
| Allocated subframes per Radio Frame | | 9 | 10 | 10 | 10 |
| Modulation | | 64QAM | 64QAM | 64QAM | 64QAM |
| Coding Rate | | | | | |
| For Sub-Frames 1,2,3,4,6,7,8,9, | | 0.78 | 0.78 | 0.77 | 0.79 |
| For Sub-Frame 5 | | N/A | 0.80 | 0.79 | 0.81 |
| For Sub-Frame 0 | | 0.85 | 0.83 | 0.8 | 0.81 |
| Information Bit Payload (Note 3) | | | | | |
| For Sub-Frames 1,2,3,4,6,7,8,9 | Bits | 31704 | 63776 | 93800 | 128496 |
| For Sub-Frame 5 | Bits | N/A | 59256 | 90816 | 124464 |
| For Sub-Frame 0 | Bits | 30576 | 63776 | 93800 | 128496 |
| Number of Code Blocks (Notes 3 and 4) | | | | | |
| For Sub-Frames 1,2,3,4,6,7,8,9 | CBs | 6 | 11 | 16 | 21 |
| For Sub-Frame 5 | CBs | N/A | 10 | 15 | 21 |
| For Sub-Frame 0 | CBs | 5 | 11 | 16 | 21 |
| Binary Channel Bits (Note 3) | | | | | |
| For Sub-Frames 1,2,3,4,6,7,8,9 | Bits | 40800 | 81600 | 122400 | 163200 |
| For Sub-Frame 5 | Bits | N/A | 74976 | 114144 | 154944 |
| For Sub-Frame 0 | Bits | 36192 | 76992 | 117792 | 158592 |
| Number of layers | | 4 | 4 | 4 | 4 |
| Max. Throughput averaged over 1 frame (Note 3) | Mbps | 28.421 | 63.324 | 93.502 | 128.093 |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: Given per component carrier per codeword.
Note 4: 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).
Note 5: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks $n_{PRB}$ = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

**Table A.3.2.1.4-3: PDSCH Reference Channel for sustained data-rate test (256QAM, 2 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.4-3.1 FDD | R.PDSCH.4-3.2 FDD | R.PDSCH.4-3.3 FDD | R.PDSCH.4-3.4 FDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 |
| Allocated resource blocks | | Note 6 | Note 7 | Note 8 | Note 9 |
| Allocated subframes per Radio Frame | | 10 | 10 | 10 | 10 |
| Modulation | | 256QAM | 256QAM | 256QAM | 256QAM |
| Coding Rate | | | | | |
| For Sub-Frames 3,4,8,9 | | 0.85 | 0.85 | 0.88 | 0.85 |
| For Sub-Frames 1,2,6,7 | | 0.77 | 0.74 | 0.74 | 0.74 |
| For Sub-Frame 5 | | 0.79 | 0.77 | 0.77 | 0.75 |
| For Sub-Frame 0 | | 0.84 | 0.78 | 0.77 | 0.76 |
| Information Bit Payload (Note 3) | | | | | |
| For Sub-Frames 3,4,8,9 | Bits | 24496 | 48936 | 75376 | 97896 |
| For Sub-Frames 1,2,6,7 | Bits | 21384 | 42368 | 63776 | 84760 |
| For Sub-Frame 5 | Bits | 19848 | 40576 | 61664 | 81176 |
| For Sub-Frame 0 | Bits | 21384 | 42368 | 63776 | 84760 |
| Number of Code Blocks (Notes 3 and 4) | | | | | |
| For Sub-Frames 3,4,8,9 | CBs | 4 | 8 | 13 | 16 |
| For Sub-Frames 1,2,6,7 | CBs | 4 | 7 | 11 | 14 |
| For Sub-Frame 5 | CBs | 4 | 7 | 11 | 14 |
| For Sub-Frame 0 | CBs | 4 | 7 | 11 | 14 |
| Binary Channel Bits (Note 3) | | | | | |
| For Sub-Frames 3,4,8,9 | Bits | 28800 | 57600 | 86400 | 115200 |
| For Sub-Frames 1,2,6,7 | Bits | 28800 | 57600 | 86400 | 115200 |
| For Sub-Frame 5 | Bits | 25344 | 52992 | 80640 | 109440 |
| For Sub-Frame 0 | Bits | 25536 | 54336 | 83136 | 111936 |
| Number of layers | | 2 | 2 | 2 | 2 |
| Max. Throughput averaged over 1 frame (Note 3) | Mbps | 22.475 | 44.816 | 68.205 | 89.656 |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: Given per component carrier per codeword.
Note 4: 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).
Note 5: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks $n_{PRB}$ = 2..24 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

**Table A.3.2.1.4-4: PDSCH Reference Channel for sustained data-rate test (256QAM, 4 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.4-4.1 FDD | R.PDSCH.4-4.2 FDD | R.PDSCH.4-4.3 FDD | R.PDSCH.4-4.4 FDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 |
| Allocated resource blocks | | Note 6 | Note 7 | Note 8 | Note 9 |
| Allocated subframes per Radio Frame | | 10 | 10 | 10 | 10 |
| Modulation | | 256QAM | 256QAM | 256QAM | 256QAM |
| Coding Rate | | | | | |
| For Sub-Frames 3,4,8,9 | | 0.85 | 0.78 | 0.79 | 0.78 |
| For Sub-Frames 1,2,6,7 | | 0.77 | 0.78 | 0.79 | 0.78 |
| For Sub-Frame 5 | | 0.79 | 0.82 | 0.82 | 0.786 |
| For Sub-Frame 0 | | 0.84 | 0.83 | 0.82 | 0.80 |
| Information Bit Payload (Note 3) | | | | | |
| For Sub-Frames 3,4,8,9 | Bits | 42368 | 84760 | 128496 | 169544 |
| For Sub-Frames 1,2,6,7 | Bits | 42368 | 84760 | 128496 | 169544 |
| For Sub-Frame 5 | Bits | 39232 | 81176 | 124464 | 161760 |
| For Sub-Frame 0 | Bits | 39232 | 84760 | 128496 | 169544 |
| Number of Code Blocks (Notes 3 and 4) | | | | | |
| For Sub-Frames 3,4,8,9 | CBs | 7 | 14 | 21 | 28 |
| For Sub-Frames 1,2,6,7 | CBs | 7 | 14 | 21 | 28 |
| For Sub-Frame 5 | CBs | 7 | 14 | 21 | 27 |
| For Sub-Frame 0 | CBs | 7 | 14 | 21 | 28 |
| Binary Channel Bits (Note 3) | | | | | |
| For Sub-Frames 3,4,8,9 | Bits | 54400 | 108800 | 163200 | 217600 |
| For Sub-Frames 1,2,6,7 | Bits | 54400 | 108800 | 163200 | 217600 |
| For Sub-Frame 5 | Bits | 47744 | 99968 | 152192 | 206592 |
| For Sub-Frame 0 | Bits | 48256 | 102656 | 157056 | 211456 |
| Number of layers | | 4 | 4 | 4 | 4 |
| Max. Throughput averaged over 1 frame (Note 3) | Mbps | 41.741 | 84.4016 | 128.093 | 168.766 |
| Note 1: 1 symbol allocated to PDCCH for all tests.<br>Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].<br>Note 3: Given per component carrier per codeword.<br>Note 4: 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).<br>Note 5: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.<br>Note 6: Resource blocks $n_{PRB}$ = 2..24 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.<br>Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.<br>Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.<br>Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9. | | | | | |

**Table A.3.2.1.4-5: PDSCH Reference Channel for sustained data-rate test (1024QAM, 2 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.4-5.1 FDD | R.PDSCH.4-5.2 FDD | R.PDSCH.4-5.3 FDD | R.PDSCH.4-5.4 FDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 |
| Allocated resource blocks | | Note 6 | Note 7 | Note 8 | Note 9 |
| Allocated subframes per Radio Frame | | 10 | 10 | 10 | 10 |
| Modulation | | 1024QAM | 1024QAM | 1024QAM | 1024QAM |
| Coding Rate | | | | | |
| For Sub-Frames 3,4,8,9 | | 0.76 | 0.73 | 0.75 | 0.76 |
| For Sub-Frames 1,2,6,7 | | 0.76 | 0.73 | 0.75 | 0.76 |
| For Sub-Frame 5 | | 0.80 | 0.77 | 0.78 | 0.77 |
| For Sub-Frame 0 | | 0.86 | 0.78 | 0.78 | 0.79 |
| Information Bit Payload (Note 3) | | | | | |
| For Sub-Frames 3,4,8,9 | Bits | 27376 | 52752 | 81176 | 110136 |
| For Sub-Frames 1,2,6,7 | Bits | 27376 | 52752 | 81176 | 110136 |
| For Sub-Frame 5 | Bits | 25456 | 51024 | 78704 | 105528 |
| For Sub-Frame 0 | Bits | 27376 | 52752 | 81176 | 110136 |
| Number of Code Blocks (Notes 3 and 4) | | | | | |
| For Sub-Frames 3,4,8,9 | CBs | 5 | 9 | 14 | 18 |
| For Sub-Frames 1,2,6,7 | CBs | 5 | 9 | 14 | 18 |
| For Sub-Frame 5 | CBs | 5 | 9 | 13 | 18 |
| For Sub-Frame 0 | CBs | 5 | 9 | 14 | 18 |
| Binary Channel Bits (Note 3) | | | | | |
| For Sub-Frames 3,4,8,9 | Bits | 36000 | 72000 | 108000 | 144000 |
| For Sub-Frames 1,2,6,7 | Bits | 36000 | 72000 | 108000 | 144000 |
| For Sub-Frame 5 | Bits | 31680 | 66240 | 100800 | 136800 |
| For Sub-Frame 0 | Bits | 31920 | 67920 | 103920 | 139920 |
| Number of layers | | 2 | 2 | 2 | 2 |
| Max. Throughput averaged over 1 frame (Note 3) | Mbps | 27.18 | 52.58 | 80.93 | 109.68 |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: Given per component carrier per codeword.
Note 4: 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).
Note 5: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks $n_{PRB}$ = 2..24 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

**Table A.3.2.1.4-6: PDSCH Reference Channel for sustained data-rate test (1024QAM, 4 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.4-6.1 FDD | R.PDSCH.4-6.2 FDD | R.PDSCH.4-6.3 FDD | R.PDSCH.4-6.4 FDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 |
| Allocated resource blocks | | Note 6 | Note 7 | Note 8 | Note 9 |
| Allocated subframes per Radio Frame | | 10 | 10 | 10 | 10 |
| Modulation | | 1024QAM | 1024QAM | 1024QAM | 1024QAM |
| Coding Rate | | | | | |
| For Sub-Frames 3,4,8,9 | | 0.78 | 0.81 | 0.79 | 0.81 |
| For Sub-Frames 1,2,6,7 | | 0.78 | 0.81 | 0.79 | 0.81 |
| For Sub-Frame 5 | | 0.82 | 0.81 | 0.83 | 0.82 |
| For Sub-Frame 0 | | 0.87 | 0.86 | 0.82 | 0.83 |
| Information Bit Payload (Note 3) | | | | | |
| For Sub-Frames 3,4,8,9 | Bits | 52752 | 110136 | 161760 | 220296 |
| For Sub-Frames 1,2,6,7 | Bits | 52752 | 110136 | 161760 | 220296 |
| For Sub-Frame 5 | Bits | 48936 | 101840 | 157432 | 211936 |
| For Sub-Frame 0 | Bits | 52752 | 110136 | 161760 | 220296 |
| Number of Code Blocks (Notes 3 and 4) | | | | | |
| For Sub-Frames 3,4,8,9 | CBs | 9 | 18 | 27 | 36 |
| For Sub-Frames 1,2,6,7 | CBs | 9 | 18 | 27 | 36 |
| For Sub-Frame 5 | CBs | 8 | 17 | 26 | 35 |
| For Sub-Frame 0 | CBs | 9 | 18 | 27 | 36 |
| Binary Channel Bits (Note 3) | | | | | |
| For Sub-Frames 3,4,8,9 | Bits | 68000 | 136000 | 204000 | 272000 |
| For Sub-Frames 1,2,6,7 | Bits | 68000 | 136000 | 204000 | 272000 |
| For Sub-Frame 5 | Bits | 59680 | 124960 | 190240 | 258240 |
| For Sub-Frame 0 | Bits | 60320 | 128320 | 196320 | 264320 |
| Number of layers | | 4 | 4 | 4 | 4 |
| Max. Throughput averaged over 1 frame (Note 3) | Mbps | 52.37 | 109.31 | 161.33 | 219.46 |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: Given per component carrier per codeword.
Note 4: 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).
Note 5: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks $n_{PRB}$ = 2..24 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

## A.3.2.2 TDD

### A.3.2.2.1 Reference measurement channels for SCS 15 kHz FR1

**Table A.3.2.2.1-1: PDSCH Reference Channel for TDD UL-DL pattern FR1.15-1 and LTE-NR coexistence scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-1.1 TDD | R.PDSCH.1-1.2 TDD | | | |
| Channel bandwidth | MHz | 10 | 10 | | | |
| Subcarrier spacing | kHz | 15 | 15 | | | |
| Allocated resource blocks | PRBs | 52 | 52 | | | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | N/A | N/A | N/A | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | | N/A | N/A | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | | 9 | 11 | | | |
| Allocated slots per 2 frames | | 7 | 7 | | | |
| MCS table | | 64QAM | 64QAM | | | |
| MCS index | | 4 | 4 | | | |
| Modulation | | QPSK | QPSK | | | |
| Target Coding Rate | | 0.30 | 0.30 | | | |
| Number of MIMO layers | | 1 | 1 | | | |
| Number of DMRS REs | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | N/A | N/A | N/A | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | | N/A | N/A | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | | 12 | 12 | | | |
| Overhead for TBS determination | | 18 | 18 | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19} | Bits | N/A | N/A | | | |
| For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19} | Bits | 2472 | 3240 | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19} | Bits | N/A | N/A | | | |
| For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19} | Bits | 16 | 16 | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19} | CBs | N/A | N/A | | | |
| For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19} | CBs | 1 | 1 | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19} | Bits | N/A | N/A | | | |
| For Slots i = 10, 11 | Bits | 7760 | 10256 | | | |
| For Slot i, if mod(i, 5) = {0,1} for i from {1,…,9,12,…,19} | Bits | 8384 | 10880 | | | |
| Max. Throughput averaged over 2 frames | Mbps | 0.865 | 1.134 | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: No user data is scheduled on slots with LTE PBCH/PSS/SSS | | | | | | |

**Table A.3.2.2.1-2: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.15-1 and CA scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-2.1 TDD | R.PDSCH.1-2.2 TDD | R.PDSCH.1-2.3 TDD | R.PDSCH.1-2.4 TDD | R.PDSCH.1-2.5 TDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 25 | 52 | 79 | 106 | 133 |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | | 8 | 8 | 8 | 8 | 8 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 15 | 15 | 15 | 15 | 15 |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index | | 13 | 13 | 13 | 13 | 13 |
| Modulation | | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Target Coding Rate | | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| Number of MIMO layers | | 2 | 2 | 2 | 2 | 2 |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | | 12 | 12 | 12 | 12 | 12 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | | 12 | 12 | 12 | 12 | 12 |
| Overhead for TBS determination | | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 8064 | 16896 | 25608 | 33816 | 43032 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | Bits | 12552 | 26120 | 39936 | 53288 | 67584 |
| Transport block CRC per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 24 | 24 | 24 | 24 | 24 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | Bits | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | CBs | 1 | 3 | 4 | 5 | 6 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | CBs | 2 | 4 | 5 | 7 | 9 |
| 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 | 25200 | 52416 | 79632 | 106848 | 134064 |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 16800 | 34944 | 53088 | 71232 | 89376 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,9,12,…,19} | Bits | 26400 | 54912 | 83424 | 111936 | 140448 |
| Max. Throughput averaged over 2 frames | Mbps | 8.516 | 17.745 | 27.086 | 36.072 | 45.778 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.1-3: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.15-1 and CA scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.1-3.1 TDD | R.PDSCH.1-3.2 TDD | R.PDSCH.1-3.3 TDD | | |
| Channel bandwidth | MHz | 30 | 40 | 50 | | |
| Subcarrier spacing | kHz | 15 | 15 | 15 | | |
| Number of allocated resource blocks | PRBs | 160 | 216 | 270 | | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | | 8 | 8 | 8 | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | | 12 | 12 | 12 | | |
| Allocated slots per 2 frames | Slots | 15 | 15 | 15 | | |
| 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 | | 2 | 2 | 2 | | |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | | 12 | 12 | 12 | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | | 12 | 12 | 12 | | |
| Overhead for TBS determination | | 0 | 0 | 0 | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 51216 | 69672 | 86040 | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | Bits | 79896 | 108552 | 135296 | | |
| Transport block CRC per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 24 | 24 | 24 | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | Bits | 24 | 24 | 24 | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i = 0 | CBs | N/A | N/A | N/A | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | CBs | 7 | 9 | 11 | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | CBs | 10 | 13 | 17 | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i = 0 | Bits | N/A | N/A | N/A | | |
| For Slots i = 10, 11 | Bits | 161280 | 217728 | 272160 | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 107520 | 145152 | 181440 | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,9,12,…,19} | Bits | 168960 | 228096 | 285120 | | |
| Max. Throughput averaged over 2 frames | Mbps | 54.186 | 73.638 | 91.621 | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

### 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 and FR1.30-1A (QPSK)**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-1.1 TDD | R.PDSCH.2-1.2 TDD | R.PDSCH.2-1.3 TDD | R.PDSCH.2-1.4 TDD | |
| Channel bandwidth | MHz | 40 | 40 | 40 | 40 | |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | |
| Allocated resource blocks | PRBs | 106 | 6 | 106 | 106 | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 4 | 4 | N/A | N/A | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | 7 | 12 | |
| Allocated slots per 2 frames | | 31 | 31 | 27 | 27 | |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAMLowSE | |
| MCS index | | 4 | 4 | 4 | 14 | |
| Modulation | | QPSK | QPSK | QPSK | QPSK | |
| Target Coding Rate | | 0.30 | 0.30 | 0.30 | 0.59 | |
| Number of MIMO layers | | 1 | 1 | 1 | 1 | |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 6 | 6 | N/A | N/A | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 18 | 12 | 12 | 12 | |
| 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 | 2664 | 144 | N/A | N/A | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 8064 | 480 | 4608 | 16392 | |
| 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 | 16 | 16 | N/A | N/A | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 24 | 16 | 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 | 1 | 1 | N/A | N/A | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 1 | 1 | 1 | 2 | |
| 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 | 25440 | 1512 | 13992 | 26712 | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 8904 | 504 | N/A | N/A | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 26712 | 1584 | 15264 | 27984 | |
| Max. Throughput averaged over 2 frames | Mbps | 11.419 | 0.677 | 6.221 | 22.129 | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>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 | R.PDSCH.2-2.5 TDD | R.PDSCH.2-2.6 TDD |
| Channel bandwidth | MHz | 40 | 40 | 40 | 40 | 40 | 40 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | PRBs | 106 | 106 | 106 | 106 | 106 | 106 |
| Number of consecutive PDSCH symbols | | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 4 | 4 | 4 | 4 | 4 | 4 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | | 31 | 31 | 31 | 31 | 31 | 31 |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAM | 64QAMLowSE | 64QAM |
| MCS index | | 13 | 13 | 13 | 13 | 19 | 16 |
| Modulation | | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Target Coding Rate | | 0.48 | 0.48 | 0.48 | 0.48 | 0.54 | 0.64 |
| Number of MIMO layers | | 1 | 2 | 3 | 4 | 2 | 1 |
| Number of DMRS REs | | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 6 | 6 | 12 | 12 | 6 | 6 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | 24 | 24 | 12 | 12 |
| Overhead for TBS determination | | 0 | 0 | 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 | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 8456 | 16896 | 22032 | 29192 | 19464 | 11528 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 26632 | 53288 | 73776 | 98376 | 60456 | 35856 |
| 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 | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 | 24 | 24 | 24 | 24 | 24 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6}for i from {1,…,39} | Bits | 24 | 24 | 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 | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 2 | 3 | 3 | 4 | 3 | 2 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 4 | 7 | 9 | 12 | 8 | 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 | N/A | N/A | N/A | N/A |
| For Slots i = 20, 21 | Bits | 53424 | 106848 | 144008 | 193344 | 101760 | 53424 |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 17808 | 35616 | 45792 | 61056 | 35616 | 17808 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39 } | Bits | 55968 | 111936 | 152640 | 203520 | 111936 | 55968 |
| Max. Throughput averaged over 2 frames | Mbps | 37.644 | 75.318 | 104.004 | 138.646 | 85.508 | 50.711 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>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 | R.PDSCH.2-3.3 TDD | R.PDSCH.2-3.4 TDD | |
| Channel bandwidth | MHz | 40 | 40 | 40 | 40 | |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | |
| Allocated resource blocks | PRBs | 106 | 106 | 53 (Note 3) | 53 (Note 4) | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | N/A | N/A | N/A | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 4 | 4 | 4 | 4 | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} 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 | | 19 | 19 | 19 | 19 | |
| Modulation | | 64QAM | 64QAM | 64QAM | 64QAM | |
| Target Coding Rate | | 0.51 | 0.51 | 0.51 | 0.51 | |
| Number of MIMO layers | | 2 | 2 | 2 | 2 | |
| Number of DMRS REs | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | N/A | N/A | N/A | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 6 | 12 | 12 | 12 | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 24 | 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 | 27144 | 23040 | 11528 | 11528 | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 83976 | 77896 | 38936 | 38936 | |
| 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) = {0,1,2,3,4,5,6}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 | 4 | 3 | 2 | 2 | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 10 | 10 | 5 | 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 | N/A | N/A | |
| For Slots i = 20, 21 | Bits | 160272 | 137376 | 68688 | 68688 | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 53424 | 45792 | 22896 | 22896 | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 167904 | 152640 | 76320 | 76320 | |
| Max. Throughput averaged over 2 frames | Mbps | 118.796 | 109.768 | 54.869 | 54.869 | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: PDSCH is scheduled in PRB numbers from 0 to 52.<br>Note 4: PDSCH is scheduled in PRB numbers from 53 to 105. | | | | | | |

**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 Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 4 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} 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 Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 6 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} 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 | 29192 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} 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) = {0,1,2,3,4,5,6} 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) = {0,1,2,3,4,5,6} 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) = {0,1,2,3,4,5,6} 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<br>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 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | | 8 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} 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 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | | 12 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} 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) = {0,1,2} 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) = {0,1,2} 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) = {0,1,2} 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) = {0,1,2} 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<br>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 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39} | | 8 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,5,6} 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 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39} | | 12 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,5,6} 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, 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) = {0,1,2,5,6} 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) = {0,1,2,5,6} 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) = {0,1,2,5,6} 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) = {0,1,2,5,6} 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<br>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 Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 4 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} 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 Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 6 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} 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) = {0,1,2,3,4,5,6} 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) = {0,1,2,3,4,5,6} 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) = {0,1,2,3,4,5,6} 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) = {0,5} 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) = {1,2,3,4,6} 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<br>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**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-8.1 TDD | R.PDSCH.2-8.2 TDD | R.PDSCH.2-8.3 TDD | | |
| Channel bandwidth | MHz | 40 | 40 | 40 | | |
| Subcarrier spacing | kHz | 30 | 30 | 30 | | |
| Allocated resource blocks | PRBs | 106 | 106 | 106 | | |
| Number of consecutive PDSCH symbols | | 12 | 12 | 12 | | |
| Allocated slots per 2 frames | | 23 | 23 | 23 | | |
| MCS table | | 64QAM | 64QAM | 64QAM | | |
| MCS index | | 13 | 13 | 20 | | |
| Modulation | | 16QAM | 16QAM | 64QAM | | |
| Target Coding Rate | | 0.48 | 0.48 | 0.55 | | |
| Number of MIMO layers | | 1 | 2 | 2 | | |
| Number of DMRS REs (Note 3) | | 24 | 24 | 24 | | |
| Overhead for TBS determination | | 0 | 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 | N/A | | |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | N/A | N/A | N/A | | |
| For Slot i = 20 | Bits | 24576 | 49176 | 83976 | | |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 24576 | 49176 | 83976 | | |
| 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 | N/A | | |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | N/A | N/A | N/A | | |
| For Slot i = 20 | Bits | 24 | 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 | 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 | N/A | | |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | CBs | N/A | N/A | N/A | | |
| For Slot i = 20 | CBs | 3 | 6 | 10 | | |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | CBs | 3 | 6 | 10 | | |
| 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 | N/A | | |
| For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39} | Bits | N/A | N/A | N/A | | |
| For Slot i = 20 | Bits | 48336 | 96672 | 145008 | | |
| For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 50880 | 101760 | 152640 | | |
| Max. Throughput averaged over 2 frames | Mbps | 28.2624 | 56.5524 | 96.5724 | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data | | | | | | |

**Table A.3.2.2.2-9: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-4 (64QAM)**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-9.1 TDD | | | | |
| Channel bandwidth | MHz | 20 | | | | |
| Subcarrier spacing | kHz | 30 | | | | |
| Allocated resource blocks | PRBs | 51 | | | | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 10) = 3 for i from {0,…,39} | | 4 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39} | | 12 | | | | |
| Allocated slots per 2 frames | | 31 | | | | |
| MCS table | | 64QAM | | | | |
| MCS index | | 19 | | | | |
| Modulation | | 64QAM | | | | |
| Target Coding Rate | | 0.51 | | | | |
| Number of MIMO layers | | 2 | | | | |
| Number of DMRS REs | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 10) = 3 for i from {0,…,39} | | 6 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} 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) = {4,5} for i from {0,…,39} | Bits | N/A | | | | |
| For Slot i, if mod(i, 10) = 3 for i from {0,…,39} | Bits | 13064 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39} | Bits | 40976 | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39} | Bits | N/A | | | | |
| For Slot i, if mod(i, 10) = 3 for i from {0,…,39} | Bits | 24 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39} | Bits | 24 | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39} | CBs | N/A | | | | |
| For Slot i, if mod(i, 10) = 3 for i from {0,…,39} | CBs | 2 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39} | CBs | 5 | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39} | Bits | N/A | | | | |
| For Slots i = 20, 21 | Bits | 77112 | | | | |
| For Slot i, if mod(i, 10) = 3 for i from {0,…,39} | Bits | 25704 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,19,22,…,39} | Bits | 80784 | | | | |
| Max. Throughput averaged over 2 frames | Mbps | 57.930 | | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-10: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-10.1 TDD | R.PDSCH.2-10.2 TDD | R.PDSCH.2-10.3 TDD | R.PDSCH.2-10.4 TDD | R.PDSCH.2-10.5 TDD |
| Channel bandwidth | MHz | 40 | 40 | 40 | 40 | 40 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | PRBs | 106 | 106 | 106 | 106 | 106 |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 4 | N/A | 4 | N/A | 4 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | | 31 | 27 | 31 | 27 | 31 |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index | | 13 | 13 | 17 | 13 | 17 |
| Modulation | | 16QAM | 16QAM | 64QAM | 16QAM | 64QAM |
| Target Coding Rate | | 0.48 | 0.48 | 0.43 | 0.48 | 0.43 |
| Number of MIMO layers | | 1 | 1 | 1 | 2 | 2 |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 6 | N/A | 6 | N/A | 6 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 18 | 18 | 18 | 18 | 18 |
| Overhead for TBS determination | | 0 | 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 8456 | N/A | 11528 | N/A | 23040 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 25608 | 25608 | 33816 | 51216 | 67584 |
| 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 | N/A | 24 | N/A | 24 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 24 | 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 2 | N/A | 2 | N/A | 3 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 4 | 4 | 5 | 7 | 9 |
| 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 | N/A |
| For Slots i = 1,2,21,22 (Note 3) | Bits | 52176 | 52176 | 78264 | 104352 | 156528 |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 17808 | N/A | 26712 | N/A | 53424 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39} | Bits | 53424 | 53424 | 80136 | 106848 | 160272 |
| Max. Throughput averaged over 2 frames | Mbps | 36.262 | 34.5708 | 47.9572 | 69.1416 | 95.8464 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation. | | | | | | |

**Table A.3.2.2.2-11: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-5**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-11.1 TDD | | | | |
| Channel bandwidth | MHz | 40 | | | | |
| Subcarrier spacing | kHz | 30 | | | | |
| Allocated resource blocks | PRBs | 106 | | | | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | | 12 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | | 10 | | | | |
| 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 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | | 18 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | | 18 | | | | |
| Overhead for TBS determination | | 0 | | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39} | Bits | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | Bits | 8064 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | Bits | 6528 | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39} | Bits | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | Bits | 24 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | Bits | 24 | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39} | CBs | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | CBs | 1 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | CBs | 1 | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39} | Bits | N/A | | | | |
| For Slot i = 20 | Bits | 25440 | | | | |
| For Slot i = 21 | Bits | 20352 | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,19,22,…,39} | Bits | 26712 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,19,22,…,39} | Bits | 21624 | | | | |
| Max. Throughput averaged over 2 frames | Mbps | 6.893 | | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-12: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-6**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-12.1 TDD | | | | |
| Channel bandwidth | MHz | 40 | | | | |
| Subcarrier spacing | kHz | 30 | | | | |
| Allocated resource blocks | PRBs | 106 | | | | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | | 12 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | | 8 | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {0,…,39} | | 10 | | | | |
| 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 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | | 18 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | | 18 | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {0,…,39} | | 18 | | | | |
| Overhead for TBS determination | | 0 | | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39} | Bits | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | Bits | 8064 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | Bits | 4992 | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {0,…,39} | Bits | 6528 | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39} | Bits | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | Bits | 24 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | Bits | 24 | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {0,…,39} | Bits | 24 | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39} | CBs | N/A | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,39} | CBs | 1 | | | | |
| For Slot i, if mod(i, 4) = 1 for i from {0,…,39} | CBs | 1 | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {0,…,39} | CBs | 1 | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39} | Bits | N/A | | | | |
| For Slot i = 20 | Bits | 25440 | | | | |
| For Slot i = 21 | Bits | 15264 | | | | |
| For Slot i, if mod(i, 4) = 0 for i from {1,…,19,22,…,39} | Bits | 26712 | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| For Slot i, if mod(i, 4) = 1 for i from {1,…,19,22,…,39} | Bits | 16536 | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {0,…,39} | Bits | 21624 | | | | |
| Max. Throughput averaged over 2 frames | Mbps | 9.389 | | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-13: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-13.1 TDD | R.PDSCH.2-13.2 TDD | R.PDSCH.2-13.3 TDD | R.PDSCH.2-13.4 TDD | R.PDSCH.2-13.5 TDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | PRBs | 11 | 24 | 38 | 51 | 65 |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 4 | 4 | 4 | 4 | 4 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | | 31 | 31 | 31 | 31 | 31 |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index | | 13 | 13 | 13 | 13 | 13 |
| Modulation | | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Target Coding Rate | | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| Number of MIMO layers | | 2 | 2 | 2 | 2 | 2 |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 6 | 6 | 6 | 6 | 6 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | 12 | 12 | 12 |
| Overhead for TBS determination | | 0 | 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 1800 | 3840 | 6144 | 8192 | 10504 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 5504 | 12040 | 18960 | 25608 | 32776 |
| 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 16 | 24 | 24 | 24 | 24 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 24 | 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 1 | 1 | 1 | 1 | 2 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 1 | 2 | 3 | 4 | 4 |
| 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 | N/A |
| For Slots i = 20, 21 | Bits | 11088 | 24192 | 38304 | 51408 | 65520 |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 3696 | 8064 | 12768 | 17136 | 21840 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 11616 | 25344 | 40128 | 53856 | 68640 |
| Max. Throughput averaged over 2 frames | Mbps | 7.790 | 17.022 | 26.825 | 36.209 | 46.348 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-14: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-14.1 TDD | R.PDSCH.2-14.2 TDD | R.PDSCH.2-14.3 TDD | R.PDSCH.2-14.4 TDD | R.PDSCH.2-14.5 TDD |
| Channel bandwidth | MHz | 30 | 50 | 60 | 80 | 90 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | PRBs | 78 | 133 | 162 | 217 | 245 |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 4 | 4 | 4 | 4 | 4 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | | 31 | 31 | 31 | 31 | 31 |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index | | 13 | 13 | 13 | 13 | 13 |
| Modulation | | 16QAM | 16QAM | 16QAM | 16QAM | 16QAM |
| Target Coding Rate | | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| Number of MIMO layers | | 2 | 2 | 2 | 2 | 2 |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | | 6 | 6 | 6 | 6 | 6 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | 12 | 12 | 12 |
| Overhead for TBS determination | | 0 | 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 12552 | 21504 | 26120 | 34816 | 38936 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 38936 | 67584 | 81976 | 110632 | 122976 |
| 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 | 24 | 24 | 24 | 24 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 24 | 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 | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 2 | 3 | 4 | 5 | 5 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 5 | 9 | 10 | 14 | 15 |
| 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 | N/A |
| For Slots i = 20, 21 | Bits | 78624 | 134064 | 163296 | 218736 | 246960 |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 26208 | 44688 | 54432 | 72912 | 82320 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 82368 | 140448 | 171072 | 229152 | 258720 |
| Max. Throughput averaged over 2 frames | Mbps | 55.074 | 95.539 | 115.892 | 156.316 | 173.805 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-15: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-15.1 TDD | | | | |
| Channel bandwidth | MHz | 100 | | | | |
| Subcarrier spacing | kHz | 30 | | | | |
| Allocated resource blocks | PRBs | 273 | | | | |
| 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) = {0,1,2,3,4,5,6} 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) = {0,1,2,3,4,5,6} 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 | 44040 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 139376 | | | | |
| 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) = {0,1,2,3,4,5,6} 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 | 6 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 17 | | | | |
| 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 | 275184 | | | | |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 91728 | | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 288288 | | | | |
| Max. Throughput averaged over 2 frames | Mbps | 196.966 | | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

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

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-16.1 TDD | R.PDSCH.2-16.2 TDD | | | |
| Channel bandwidth | MHz | 40 | 40 | | | |
| Subcarrier spacing | kHz | 30 | 30 | | | |
| Allocated resource blocks | PRBs | 106 | 106 | | | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot i, if mod(i, 10) = {0, 7} for i from {0,…,39} | | N/A | N/A | | | |
| For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | | | |
| Allocated slots per 2 frames | | 24 | 24 | | | |
| MCS table | | 64QAMLowSE | 64QAMLowSE | | | |
| MCS index | | 19 | 19 | | | |
| Modulation | | 16QAM | 16QAM | | | |
| Target Coding Rate | | 0.54 | 0.54 | | | |
| Number of MIMO layers | | 1 | 1 | | | |
| Number of DMRS REs | | | 12 | | | |
| For Slot i, if mod(i, 10) = {0, 7} for i from {0,…,39} | | N/A | N/A | | | |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | | 12 | 12 | | | |
| Overhead for TBS determination | | 0 | 0 | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39} | Bits | N/A | N/A | | | |
| For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39} | Bits | 30216 | 30216 | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39} | Bits | N/A | N/A | | | |
| For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39} | Bits | 24 | 24 | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39} | CBs | N/A | N/A | | | |
| For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39} | CBs | 4 | 4 | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39} | Bits | N/A | N/A | | | |
| For Slot i = 21 | Bits | 53424 | 50880 | | | |
| For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 55968 | 55968 | | | |
| Max. Throughput averaged over 2 frames | Mbps | 18.130 (NOTE 3) | 18.130 (NOTE 4) | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: Throughput is calculated under assumption of aggregation factor 2.<br>Note 4: Throughtput is calculated under assumption of repettion number 2 | | | | | | |

**Table A.3.2.2.2-17: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-2**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-17.1 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} | | 2 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39} | | N/A | | | | |
| Allocated slots per 2 frames | | 8 | | | | |
| MCS table | | | | | | |
| MCS index | | 4 | | | | |
| Modulation | | QPSK | | | | |
| Target Coding Rate | | 0.3 | | | | |
| Number of MIMO layers | | 1 | | | | |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | | 6 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39} | | N/A | | | | |
| Overhead for TBS determination | | 0 | | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | Bits | 1160 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39} | Bits | N/A | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | Bits | 16 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39} | Bits | N/A | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | CBs | 1 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39} | CBs | N/A | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,39} | Bits | 3816 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39} | Bits | N/A | | | | |
| Max. Throughput averaged over 2 frames | Mbps | 0.464 | | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.2-18: PDSCH Reference Channel for PDSCH on band with shared spectrum access with TDD UL-DL pattern FR1.30-7**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.2-18.1 TDD | R.PDSCH.2-18.2 TDD | R.PDSCH.2-18.3 TDD | R.PDSCH.2-18.4 TDD |
| Channel bandwidth | MHz | 20 | 40 | 60 | 80 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 |
| Allocated resource blocks | PRBs | 51 | 106 | 162 | 217 |
| Number of consecutive PDSCH symbols | | | | | |
| For Slot 0 and slot i, if mod(i, 10) =7 for i from {0,…,39} | | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5) | symbol | {4,7,10,12} | {4,7,10,12} | {4,7,10,12} | {4,7,10,12} |
| For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5) | symbol | 12 | 12 | 12 | 12 |
| 3<br>Allocated slots per 2 frames | slot | 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 | | 2 | 2 | 2 | 2 |
| Number of DMRS REs | | | | | |
| For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39} | | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5) | symbol | {6, 6,12,12} | {6, 6,12,12} | {6, 6,12,12} | {6, 6,12,12} |
| For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5) | symbol | 12 | 12 | 12 | 12 |
| Overhead for TBS determination | | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot | | | | | |
| For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5) | Bits | {8192,14088, 16392,25608} | {16896,29192, 44040,53288} | {26120,45096, 67584,81976,} | {34816,60456, 90176,110632} |
| For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5) | Bits | 25608 | 53288 | 81976 | 110632 |
| Transport block CRC per Slot | | | | | |
| For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} (Note 5) | Bits | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot | | | | | |
| For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5) | CBs | {1,2,4,4} | {3,4,6,7} | {4,6,9,10} | {5,8,11,14} |

| | | | | | |
|---|---|---|---|---|---|
| For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5) | CBs | 4 | 7 | 10 | 14 |
| Binary Channel Bits Per Slot | | | | | |
| For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5) | Bits | {17136,29376, 44064,53865} | {35616,61056, 91854,11193} | {54432,93312, 139968,171072} | {72912,124992, 187488,229152} |
| For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5) | Bits | 53865 | 111936 | 171073 | 229152 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: For {a1,a2,a3,a4 }, a1, a2, a3 and a4 stand for the setup when the number of OFDM symbols is 6,9,12,14 respectively. It applies only to the last slot within the Downlink Transmission duration (specified in Annex B.5). For all other slots the setup when the number of OFDM symbols is 14 should apply.<br>Note 4: The slot i, mod (i,10)=9 is idle slot with no UL transmission.<br>Note 5: The per Slot value applies only to slots included within the Downlink Transmission duration. For all other slots not included in the Downlink Transmission Duration, N/A should apply | | | | | |

#### 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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 79} | | 10 | | | | |
| For Slot i, if mod(i, 4) = {0,1} 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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 79} | | 12 | | | | |
| For Slot i, if mod(i, 4) = {0,1} 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) = {0,1} 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) = {0,1} 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) = {0,1} 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) = {0,1} 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<br>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 and FR2.120-1A (QPSK)**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.5-1.1 TDD | R.PDSCH.5-1.2 TDD | | | |
| Channel bandwidth | MHz | 100 | 100 | | | |
| Subcarrier spacing | kHz | 120 | 120 | | | |
| Allocated resource blocks | PRBs | 66 | 66 | | | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | | N/A | N/A | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | | 9 | 2 | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | | 13 | 2 | | | |
| Allocated slots per 2 frames | | 127 | 127 | | | |
| MCS table | | 64QAM | 64QAM | | | |
| MCS index | | 4 | 4 | | | |
| Modulation | | QPSK | QPSK | | | |
| Target Coding Rate | | 0.30 | 0.30 | | | |
| Number of MIMO layers | | 1 | 1 | | | |
| Number of DMRS REs | | | | | | |
| For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | | N/A | N/A | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | | 12 | 6 | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | | 12 | 6 | | | |
| Overhead for TBS determination | | 6 | 0 | | | |
| 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 | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 3624 | 736 | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | Bits | 5504 | 736 | | | |
| 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 | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 16 | 16 | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | Bits | 24 | 16 | | | |
| 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 | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | CBs | 1 | 1 | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | CBs | 1 | 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 | N/A | | | |
| For Slots i = 80, 81 | Bits | 17490 | 2310 | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 12210 | 2310 | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,82,…,159} | Bits | 18282 | 2310 | | | |
| Max. Throughput averaged over 2 frames | Mbps | 31.942 | 4.673 | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>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 Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | | N/A | N/A | N/A | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | | 9 | 9 | 9 | | |
| For Slot i, if mod(i, 5) = {0,1,2} 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 Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | | N/A | N/A | N/A | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | | 12 | 12 | 12 | | |
| For Slot i, if mod(i, 5) = {0,1,2} 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) = {0,1,2} 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) = {0,1,2} 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) = {0,1,2} 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 | 36564 | 69960 | 139920 | | |
| For Slots i = 82 | Bits | 34980 | 73128 | 146256 | | |
| For Slots i = 83 | Bits | 22308 | 48840 | 97680 | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 24420 | 48840 | 97680 | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,84,…,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<br>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 Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | | N/A | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | | 9 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} 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 Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159} | | N/A | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | | 12 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} 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) = {0,1,2} 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) = {0,1,2} 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) = {0,1,2} 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) = {0,1,2} 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<br>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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | | 10 | | | | |
| For Slot i, if mod(i, 4) = {0,1} 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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | | 12 | | | | |
| For Slot i, if mod(i, 4) = {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, 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) = {0,1} 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) = {0,1} 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) = {0,1} 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) = {0,1} 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<br>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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | | N/A | N/A | | | |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | | 10 | 10 | | | |
| For Slot i, if mod(i, 4) = {0,1} 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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | | N/A | N/A | | | |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | | 12 | 12 | | | |
| For Slot i, if mod(i, 4) = {0,1} 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) = {0,1} 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) = {0,1} 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) = {0,1} 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) = {0,1} 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<br>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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | | 10 | | | | |
| For Slot i, if mod(i, 4) = {0,1} 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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159} | | N/A | | | | |
| For Slot i, if mod(i, 4) = 2 for i from {1,…, 159} | | 12 | | | | |
| For Slot i, if mod(i, 4) = {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, 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) = {0,1} 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) = {0,1} 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) = {0,1} 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) = {0,1} 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<br>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) | | 24 | | | | |
| Overhead for TBS determination | | 6 | | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159} | Bits | N/A | | | | |
| For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i = 80 | Bits | 14344 | | | | |
| For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159} | Bits | 14344 | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159} | Bits | N/A | | | | |
| For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i = 80 | Bits | 24 | | | | |
| For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159} | Bits | 24 | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159} | CBs | N/A | | | | |
| For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159} | CBs | N/A | | | | |
| For Slot i = 80 | CBs | 2 | | | | |
| For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159} | CBs | 2 | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159} | Bits | N/A | | | | |
| For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i = 80 | Bits | 28776 | | | | |
| For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159} | 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<br>Note 2: Slot i is slot index per 2 frames<br>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) | | 24 | | | | |
| Overhead for TBS determination | | 6 | | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159} | Bits | N/A | | | | |
| For CSI-RS Slot i, if mod(i,8) =1 for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i = 80 | Bits | 14344 | | | | |
| For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159} | Bits | 14344 | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159} | Bits | N/A | | | | |
| For CSI-RS Slot i, if mod(i,8) =1 for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i = 80 | Bits | 24 | | | | |
| For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159} | Bits | 24 | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159} | CBs | N/A | | | | |
| For CSI-RS Slot i, if mod(i,8) =1 for i from {0,…,159} | CBs | N/A | | | | |
| For Slot i = 80 | CBs | 2 | | | | |
| For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159} | CBs | 2 | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159} | Bits | N/A | | | | |
| For CSI-RS Slot i, if mod(i,8) =1 for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i = 80 | Bits | 28776 | | | | |
| For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159} | 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<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data | | | | | | |

**Table A.3.2.2.5-9: PDSCH Reference Channel for TDD CC with UL-DL pattern FR2.120-1 and CA scenario**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.5-9.1 TDD | R.PDSCH.5-9.2 TDD | R.PDSCH.5-9.3 TDD | R.PDSCH.5-9.4 TDD | |
| Channel bandwidth | MHz | 50 | 100 | 200 | 400 | |
| Subcarrier spacing | kHz | 120 | 120 | 120 | 120 | |
| Allocated resource blocks | PRBs | 32 | 66 | 132 | 264 | |
| Number of consecutive PDSCH symbols | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | | 9 | 9 | 9 | 9 | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | | 13 | 13 | 13 | 13 | |
| Allocated slots per 2 frames | | 127 | 127 | 127 | 127 | |
| MCS table | | 64QAM | 64QAM | 64QAM | 64QAM | |
| MCS index | | 10 | 10 | 10 | 10 | |
| Modulation | | 16QAM | 16QAM | 16QAM | 16QAM | |
| Target Coding Rate | | 0.33 | 0.33 | 0.33 | 0.33 | |
| Number of MIMO layers | | 2 | 2 | 2 | 2 | |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | | 12 | 12 | 12 | 12 | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | | 12 | 12 | 12 | 12 | |
| Overhead for TBS determination | | 6 | 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 | N/A | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 7680 | 15880 | 31752 | 63528 | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | Bits | 11784 | 24072 | 48168 | 96264 | |
| 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 | N/A | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 24 | 24 | 24 | 24 | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | Bits | 24 | 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 | N/A | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | CBs | 1 | 2 | 4 | 8 | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | CBs | 2 | 3 | 6 | 12 | |
| 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 | N/A | |
| For Slots i = 80, 81 | Bits | 33920 | 69960 | 139920 | 279840 | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 23680 | 48840 | 97680 | 195360 | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,84,…,159} | Bits | 35456 | 73128 | 146256 | 292512 | |
| Max. Throughput averaged over 2 frames | Mbps | 68.262 | 139.750 | 279.601 | 558.899 | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.5-10: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 (256QAM)**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.5-10.1 TDD | | | | |
| Channel bandwidth | MHz | 50 | | | | |
| Subcarrier spacing | kHz | 120 | | | | |
| Allocated resource blocks | PRBs | 32 | | | | |
| 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) = {0,1,2} for i from {1,…,159} | | 13 | | | | |
| Allocated slots per 2 frames | | 127 | | | | |
| MCS table | | 256QAM | | | | |
| MCS index | | 20 | | | | |
| Modulation | | 256QAM | | | | |
| Target Coding Rate | | 0.67 | | | | |
| 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) = {0,1,2} 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 | 15368 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} | Bits | 23568 | | | | |
| 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) = {0,1,2} 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) = {0,1,2} 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 | 33920 | | | | |
| For Slot i, if mod(i, 5) = 3 for i from {0,…, 159} | Bits | 23680 | | | | |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,82,…,159} | Bits | 35456 | | | | |
| Max. Throughput averaged over 2 frames | Mbps | 136.537 | | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames | | | | | | |

**Table A.3.2.2.5-11: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2**

| Parameter | Unit | Value | | | | |
|---|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.5-11.1 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) = {0,1} for i from {2,…,159} | | 13 | | | | |
| Allocated slots per 2 frames | | 78 | | | | |
| MCS table | | 64QAMLowSE | | | | |
| MCS index | | 16 | | | | |
| Modulation | | 16QAM | | | | |
| Target Coding Rate | | 0.37 | | | | |
| Number of MIMO layers | | 1 | | | | |
| Number of DMRS REs | | | | | | |
| For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159} | | 12 | | | | |
| Overhead for TBS determination | | 6 | | | | |
| Information Bit Payload per Slot | | | | | | |
| For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159} | Bits | 13320 | | | | |
| Transport block CRC per Slot | | | | | | |
| For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159} | Bits | 24 | | | | |
| Number of Code Blocks per Slot | | | | | | |
| For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159} | CBs | N/A | | | | |
| For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159} | CBs | 2 | | | | |
| Binary Channel Bits Per Slot | | | | | | |
| For Slots 0,1 and Slot i, if mod(i, 4) = {2, 3} for i from {0,…,159} | Bits | N/A | | | | |
| For Slot i = 80, 81 | Bits | 34980 | | | | |
| For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159} | Bits | 36564 | | | | |
| Max. Throughput averaged over 2 frames | Mbps | 25.974 (Note 3) | | | | |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms<br>Note 2: Slot i is slot index per 2 frames<br>Note 3: Throughput is calculated under assumption of aggregation factor 2. | | | | | | |

### A.3.2.2.6 Reference measurement channels for E-UTRA

**Table A.3.2.2.6-1: PDSCH Reference Channel for sustained data-rate test (64QAM, 2 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.6-1.1 TDD | R.PDSCH.6-1.2 TDD | R.PDSCH.6-1.3 TDD | |
| Channel bandwidth | MHz | 10 | 15 | 20 | |
| Allocated resource blocks | | Note 7 | Note 8 | Note 9 | |
| Uplink-Downlink Configuration (Note 3) | | 2 | 2 | 2 | |
| Number of HARQ Processes per component carrier | | 10 | 10 | 10 | |
| Allocated subframes per Radio Frame (D+S) | | 6 | 6 | 6 | |
| Modulation | | 64QAM | 64QAM | 64QAM | |
| Coding Rate | | | | | |
| For Sub-Frames 1,2,6,7 | | N/A | N/A | N/A | |
| For Sub-Frames 3,4,8,9 | | 0.85 | 0.85 | 0.88 | |
| For Sub-Frame 5 | | 0.88 | 0.87 | 0.87 | |
| For Sub-Frame 0 | | 0.90 | 0.88 | 0.90 | |
| Information Bit Payload (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4,8,9 | Bits | 36696 | 55056 | 75376 | |
| For Sub-Frame 5 | Bits | 35160 | 52752 | 71112 | |
| For Sub-Frame 0 | Bits | 36696 | 55056 | 75376 | |
| Number of Code Blocks (Notes 4 and 5) | | | | | |
| For Sub-Frames 1,2,6,7 | CBs | N/A | N/A | N/A | |
| For Sub-Frames 3,4,8,9 | CBs | 6 | 9 | 13 | |
| For Sub-Frame 5 | CBs | 6 | 9 | 12 | |
| For Sub-Frame 0 | CBs | 6 | 9 | 13 | |
| Binary Channel Bits (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4,8,9 | Bits | 43200 | 64800 | 86400 | |
| For Sub-Frame 5 | Bits | 40176 | 60912 | 82512 | |
| For Sub-Frame 0 | Bits | 41184 | 62784 | 84384 | |
| Number of layers | | 2 | 2 | 2 | |
| Max. Throughput averaged over 1 frame (Note 4) | Mbps | 21.864 | 32.803 | 44.799 | |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: 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).
Note 6: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks $n_{PRB}$ = 4..74 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,3,4,8,9.

**Table A.3.2.2.6-2: PDSCH Reference Channel for sustained data-rate test (64QAM, 4 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.6-2.1 TDD | R.PDSCH.6-2.2 TDD | R.PDSCH.6-2.3 TDD | |
| Channel bandwidth | MHz | 10 | 15 | 20 | |
| Allocated resource blocks | | Note 7 | Note 8 | Note 9 | |
| Uplink-Downlink Configuration (Note 3) | | 2 | 2 | 2 | |
| Number of HARQ Processes per component carrier | | 10 | 10 | 10 | |
| Allocated subframes per Radio Frame (D+S) | | 6 | 6 | 6 | |
| Modulation | | 64QAM | 64QAM | 64QAM | |
| Coding Rate | | | | | |
| For Sub-Frames 1,2,6,7 | | N/A | N/A | N/A | |
| For Sub-Frames 3,4,8,9 | | 0.78 | 0.77 | 0.79 | |
| For Sub-Frame 5 | | 0.79 | 0.79 | 0.80 | |
| For Sub-Frame 0 | | 0.82 | 0.79 | 0.81 | |
| Information Bit Payload (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4,8,9 | Bits | 63776 | 93800 | 128496 | |
| For Sub-Frame 5 | Bits | 59256 | 90816 | 124464 | |
| For Sub-Frame 0 | Bits | 63776 | 93800 | 128496 | |
| Number of Code Blocks (Notes 4 and 5) | | | | | |
| For Sub-Frames 1,2,6,7 | CBs | N/A | N/A | N/A | |
| For Sub-Frames 3,4,8,9 | CBs | 11 | 16 | 21 | |
| For Sub-Frame 5 | CBs | 10 | 15 | 21 | |
| For Sub-Frame 0 | CBs | 11 | 16 | 21 | |
| Binary Channel Bits (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4,8,9 | Bits | 81600 | 122400 | 163200 | |
| For Sub-Frame 5 | Bits | 75840 | 115008 | 155808 | |
| For Sub-Frame 0 | Bits | 77856 | 118656 | 159456 | |
| Number of layers | | 4 | 4 | 4 | |
| Max. Throughput averaged over 1 frame (Note 4) | Mbps | 37.813 | 55.981 | 76.694 | |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: 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).
Note 6: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks $n_{PRB}$ = 4..74 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,3,4,8,9.

**Table A.3.2.2.6-3: PDSCH Reference Channel for sustained data-rate test (256QAM, 2 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.6-3.1 TDD | R.PDSCH.6-3.2 TDD | R.PDSCH.6-3.3 TDD | |
| Channel bandwidth | MHz | 10 | 15 | 20 | |
| Allocated resource blocks | | Note 7 | Note 8 | Note 9 | |
| Uplink-Downlink Configuration (Note 3) | | 2 | 2 | 2 | |
| Number of HARQ Processes per component carrier | | 10 | 10 | 10 | |
| Allocated subframes per Radio Frame (D+S) | | 6 | 6 | 6 | |
| Modulation | | 256QAM | 256QAM | 256QAM | |
| Coding Rate | | | | | |
| For Sub-Frames 1,2,6,7 | | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | | 0.74 | 0.79 | 0.74 | |
| For Sub-Frames 8,9 | | 0.85 | 0.88 | 0.85 | |
| For Sub-Frame 5 | | 0.76 | 0.76 | 0.74 | |
| For Sub-Frame 0 | | 0.78 | 0.77 | 0.76 | |
| Information Bit Payload (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | Bits | 42368 | 63776 | 84760 | |
| For Sub-Frames 8,9 | Bits | 48936 | 75376 | 97896 | |
| For Sub-Frame 5 | Bits | 40576 | 61664 | 81176 | |
| For Sub-Frame 0 | Bits | 42368 | 63776 | 84760 | |
| Number of Code Blocks (Notes 4 and 5) | | | | | |
| For Sub-Frames 1,2,6,7 | CBs | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | CBs | 7 | 11 | 14 | |
| For Sub-Frames 8,9 | CBs | 8 | 13 | 16 | |
| For Sub-Frame 5 | CBs | 7 | 11 | 14 | |
| For Sub-Frame 0 | CBs | 7 | 11 | 14 | |
| Binary Channel Bits (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | Bits | 57600 | 86400 | 115200 | |
| For Sub-Frames 8,9 | Bits | 57600 | 86400 | 115200 | |
| For Sub-Frame 5 | Bits | 53568 | 81216 | 110016 | |
| For Sub-Frame 0 | Bits | 54912 | 83712 | 112512 | |
| Number of layers | | 2 | 2 | 2 | |
| Max. Throughput averaged over 1 frame (Note 4) | Mbps | 26.555 | 40.374 | 53.125 | |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: 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).
Note 6: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks $n_{PRB}$ = 4..74 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,3,4,8,9.

**Table A.3.2.2.6-4: PDSCH Reference Channel for sustained data-rate test (256QAM, 4 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.6-4.1 TDD | R.PDSCH.6-4.2 TDD | R.PDSCH.6-4.3 TDD | |
| Channel bandwidth | MHz | 10 | 15 | 20 | |
| Allocated resource blocks | | Note 7 | Note 8 | Note 9 | |
| Uplink-Downlink Configuration (Note 3) | | 2 | 2 | 2 | |
| Number of HARQ Processes per component carrier | | 10 | 10 | 10 | |
| Allocated subframes per Radio Frame (D+S) | | 6 | 6 | 6 | |
| Modulation | | 256QAM | 256QAM | 256QAM | |
| Coding Rate | | | | | |
| For Sub-Frames 1,2,6,7 | | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | | 0.78 | 0.79 | 0.78 | |
| For Sub-Frames 8,9 | | 0.78 | 0.79 | 0.78 | |
| For Sub-Frame 5 | | 0.81 | 0.82 | 0.78 | |
| For Sub-Frame 0 | | 0.82 | 0.82 | 0.80 | |
| Information Bit Payload (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | Bits | 84760 | 128496 | 169544 | |
| For Sub-Frames 8,9 | Bits | 84760 | 128496 | 169544 | |
| For Sub-Frame 5 | Bits | 81176 | 124464 | 161760 | |
| For Sub-Frame 0 | Bits | 84760 | 128496 | 169544 | |
| Number of Code Blocks (Notes 4 and 5) | | | | | |
| For Sub-Frames 1,2,6,7 | CBs | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | CBs | 14 | 21 | 28 | |
| For Sub-Frames 8,9 | CBs | 14 | 21 | 28 | |
| For Sub-Frame 5 | CBs | 14 | 21 | 27 | |
| For Sub-Frame 0 | CBs | 14 | 21 | 28 | |
| Binary Channel Bits (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | Bits | 108800 | 163200 | 217600 | |
| For Sub-Frames 8,9 | Bits | 108800 | 163200 | 217600 | |
| For Sub-Frame 5 | Bits | 101120 | 153344 | 207744 | |
| For Sub-Frame 0 | Bits | 103808 | 158208 | 212608 | |
| Number of layers | | 4 | 4 | 4 | |
| Max. Throughput averaged over 1 frame (Note 4) | Mbps | 50.498 | 76.694 | 100.948 | |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: 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).
Note 6: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks $n_{PRB}$ = 4..74 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,3,4,8,9.

**Table A.3.2.2.6-5: PDSCH Reference Channel for sustained data-rate test (1024QAM, 2 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.6-5.1 TDD | R.PDSCH.6-5.2 TDD | R.PDSCH.6-5.3 TDD | |
| Channel bandwidth | MHz | 10 | 15 | 20 | |
| Allocated resource blocks | | Note 7 | Note 8 | Note 9 | |
| Uplink-Downlink Configuration (Note 3) | | 2 | 2 | 2 | |
| Number of HARQ Processes per component carrier | | 10 | 10 | 10 | |
| Allocated subframes per Radio Frame (D+S) | | 6 | 6 | 6 | |
| Modulation | | 1024QAM | 1024QAM | 1024QAM | |
| Coding Rate | | | | | |
| For Sub-Frames 1,2,6,7 | | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | | 0.76 | 0.75 | 0.76 | |
| For Sub-Frames 8,9 | | 0.76 | 0.75 | 0.76 | |
| For Sub-Frame 5 | | 0.76 | 0.78 | 0.77 | |
| For Sub-Frame 0 | | 0.80 | 0.78 | 0.78 | |
| Information Bit Payload (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | Bits | 55056 | 81176 | 110136 | |
| For Sub-Frames 8,9 | Bits | 55056 | 81176 | 110136 | |
| For Sub-Frame 5 | Bits | 51024 | 78704 | 105528 | |
| For Sub-Frame 0 | Bits | 55056 | 81176 | 110136 | |
| Number of Code Blocks (Notes 4 and 5) | | | | | |
| For Sub-Frames 1,2,6,7 | CBs | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | CBs | 9 | 14 | 18 | |
| For Sub-Frames 8,9 | CBs | 9 | 14 | 18 | |
| For Sub-Frame 5 | CBs | 9 | 13 | 18 | |
| For Sub-Frame 0 | CBs | 9 | 14 | 18 | |
| Binary Channel Bits (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | Bits | 72000 | 108000 | 144000 | |
| For Sub-Frames 8,9 | Bits | 72000 | 108000 | 144000 | |
| For Sub-Frame 5 | Bits | 66960 | 101520 | 137520 | |
| For Sub-Frame 0 | Bits | 68640 | 104640 | 140640 | |
| Number of layers | | 2 | 2 | 2 | |
| Max. Throughput averaged over 1 frame (Note 4) | Mbps | 32.630 | 48.458 | 65.621 | |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: 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).
Note 6: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks $n_{PRB}$ = 4..74 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,3,4,8,9.

**Table A.3.2.2.6-6: PDSCH Reference Channel for sustained data-rate test (1024QAM, 4 MIMO layers)**

| Parameter | Unit | Value | | | |
|---|---|---|---|---|---|
| Reference channel | | R.PDSCH.6-6.1 TDD | R.PDSCH.6-6.2 TDD | R.PDSCH.6-6.3 TDD | |
| Channel bandwidth | MHz | 10 | 15 | 20 | |
| Allocated resource blocks | | Note 7 | Note 8 | Note 9 | |
| Uplink-Downlink Configuration (Note 3) | | 2 | 2 | 2 | |
| Number of HARQ Processes per component carrier | | 10 | 10 | 10 | |
| Allocated subframes per Radio Frame (D+S) | | 6 | 6 | 6 | |
| Modulation | | 1024QAM | 1024QAM | 1024QAM | |
| Coding Rate | | | | | |
| For Sub-Frames 1,2,6,7 | | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | | 0.81 | 0.79 | 0.81 | |
| For Sub-Frames 8,9 | | 0.81 | 0.79 | 0.81 | |
| For Sub-Frame 5 | | 0.81 | 0.82 | 0.82 | |
| For Sub-Frame 0 | | 0.85 | 0.82 | 0.83 | |
| Information Bit Payload (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | Bits | 110136 | 161760 | 220296 | |
| For Sub-Frames 8,9 | Bits | 110136 | 161760 | 220296 | |
| For Sub-Frame 5 | Bits | 101840 | 157432 | 211936 | |
| For Sub-Frame 0 | Bits | 110136 | 161760 | 220296 | |
| Number of Code Blocks (Notes 4 and 5) | | | | | |
| For Sub-Frames 1,2,6,7 | CBs | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | CBs | 18 | 27 | 36 | |
| For Sub-Frames 8,9 | CBs | 18 | 27 | 36 | |
| For Sub-Frame 5 | CBs | 17 | 26 | 35 | |
| For Sub-Frame 0 | CBs | 18 | 27 | 36 | |
| Binary Channel Bits (Note 4) | | | | | |
| For Sub-Frames 1,2,6,7 | Bits | N/A | N/A | N/A | |
| For Sub-Frames 3,4 | Bits | 136000 | 204000 | 272000 | |
| For Sub-Frames 8,9 | Bits | 136000 | 204000 | 272000 | |
| For Sub-Frame 5 | Bits | 126400 | 191680 | 259680 | |
| For Sub-Frame 0 | Bits | 129760 | 197760 | 265760 | |
| Number of layers | | 2 | 2 | 2 | |
| Max. Throughput averaged over 1 frame (Note 4) | Mbps | 65.252 | 96.623 | 131.342 | |

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: 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).
Note 6: Resource blocks $n_{PRB}$ = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks $n_{PRB}$ = 3..49 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks $n_{PRB}$ = 4..74 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks $n_{PRB}$ = 4..99 are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB}$ = 0..99 in sub-frames 0,3,4,8,9.

# 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 | R.PDCCH.1-2.7 FDD |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| CORESET frequency domain allocation | | 24 | 24 | 24 | 48 | 48 | 48 | 48 |
| CORESET time domain allocation | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Aggregation level | | 2 | 4 | 2 | 4 | 8 | 16 | 8 |
| DCI Format | | 1_0 | 1_0 | 1_1 | 1_1 | 1_1 | 1_0 | 2_6 |
| Payload (without CRC) | Bits | 39 | 39 | 52 | 52 | 52 | 39 | 12 |

#### 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 | R.PDCCH.2-1.4 TDD | | |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | | |
| CORESET frequency domain allocation | | 102 | 102 | 90 | 102 | | |
| CORESET time domain allocation | | 1 | 1 | 1 | 1 | | |
| Aggregation level | | 2 | 4 | 8 | 8 | | |
| DCI Format | | 1_0 | 1_1 | 1_1 | 2_6 | | |
| Payload (without CRC) | Bits | 41 | 53 | 53 | 12 | | |

**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 | R.PDCCH.5-1.4 TDD | | |
| Subcarrier spacing | kHz | 120 | 120 | 120 | 120 | | |
| CORESET frequency domain allocation | | 60 | 60 | 60 | 60 | | |
| CORESET time domain allocation | | 1 | 1 | 1 | 1 | | |
| Aggregation level | | 2 | 4 | 8 | 8 | | |
| DCI Format | | 1_0 | 1_1 | 1_1 | 2_6 | | |
| Payload (without CRC) | Bits | 40 | 56 | 56 | 12 | | |

**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 clause defines the DL signal applicable to the reporting of channel state information (Clauses 6 and 8).

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

**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 | | | | 7590 | 7590 | | | | |
| CQI index | Spectral efficiency | MCS index | Modulation | Information Bit Payload per Slot | | | | | |
| 0 | OOR | OOR | OOR | N/A | N/A | | | | |
| 1 | 0.2344 | 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<br>Note 2: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL<br>Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity<br>Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-1 of TS 38.214 [12] | | | | | | | | | |

**Table A.4-2: Mapping of CQI Index to Information Bit payload (CQI table 2, Rank 1 and Rank 2)**

| TBS Scheme | | | | TBS.2-1 | TBS.2-2 | TBS.2-3 | TBS.2-4 | TBS.2-5 | TBS.2-6 | TBS.2-7 | TBS.2-8 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MCS table | | | | 256QAM | | | | | | | |
| Number of allocated PDSCH resource blocks | | | | 52 | 52 | 106 | 106 | 8 | 16 | 32 | 51 |
| Number of consecutive PDSCH symbols | | | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Number of PDSCH MIMO layers | | | | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 2 |
| Number of DMRS REs (Note 1) | | | | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Overhead for TBS determination | | | | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| Available RE-s for PDSCH | | | | 6240 | 6240 | 12720 | 12720 | 960 | 1920 | 3680 | 6120 |
| CQI index | Spectral efficiency | MCS index | Modulation | Information Bit Payload per Slot | | | | | | | |
| 0 | OOR | OOR | OOR | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1 | 0.2344 | 0 | QPSK | 1480 | 2976 | 2976 | 5896 | 224 | 456 | 848 | 1864 |
| 2 | 0.3770 | 1 | | 2408 | 4744 | 4744 | 9480 | 368 | 736 | 1416 | 4616 |
| 3 | 0.8770 | 3 | | 5504 | 11016 | 11016 | 22536 | 848 | 1736 | 3240 | 10760 |
| 4 | 1.4766 | 5 | 16QAM | 9224 | 18432 | 18960 | 37896 | 1416 | 2856 | 5376 | 17928 |
| 5 | 1.9141 | 7 | | 12040 | 24072 | 24576 | 49176 | 1864 | 3752 | 6912 | 23568 |
| 6 | 2.4063 | 9 | | 15112 | 30216 | 30728 | 61480 | 2408 | 4608 | 8712 | 29192 |
| 7 | 2.7305 | 11 | 64QAM | 16896 | 33816 | 34816 | 69672 | 2600 | 5248 | 9992 | 33816 |
| 8 | 3.3223 | 13 | | 20496 | 40976 | 42016 | 83976 | 3240 | 6400 | 12040 | 40976 |
| 9 | 3.9023 | 15 | | 24576 | 49176 | 49176 | 98376 | 3752 | 7424 | 14344 | 48168 |
| 10 | 4.5234 | 17 | | 28168 | 56368 | 57376 | 114776 | 4352 | 8712 | 16392 | 55304 |
| 11 | 5.1152 | 19 | | 31752 | 63528 | 65576 | 131176 | 4864 | 9736 | 18432 | 62504 |
| 12 | 5.5547 | 21 | 256QAM | 34816 | 69672 | 69672 | 139376 | 5248 | 10760 | 20496 | 67584 |
| 13 | 6.2266 | 23 | | 38936 | 77896 | 79896 | 159880 | 6016 | 12040 | 22536 | 75792 |
| 14 | 6.9141 | 25 | | 43032 | 86040 | 88064 | 176208 | 6656 | 13320 | 25104 | 83976 |
| 15 | 7.4063 | 27 | | 46104 | 92200 | 94248 | 188576 | 7040 | 14088 | 27144 | 90176 |

Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data
Note 2: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL
Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity
Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-2 of TS 38.214 [12]

**Table A.4-3: Mapping of CQI Index to Information Bit payload (CQI table 2, Rank 3 and Rank 4)**

| TBS Scheme | | | | TBS.3-1 | TBS.3-2 | TBS.3-3 | TBS.3-4 | | |
|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | 3 | 4 | 3 | 4 | | |
| Number of DMRS REs (Note 1) | | | | 24 | 24 | 24 | 24 | | |
| Overhead for TBS determination | | | | 0 | 0 | 0 | 0 | | |
| Available RE-s for PDSCH | | | | 6240 | 6240 | 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 | 0.2344 | 0 | QPSK | 4360 | 5896 | 8976 | 11784 | | |
| 2 | 0.3770 | 1 | | 7048 | 9480 | 14344 | 18976 | | |
| 3 | 0.8770 | 3 | | 16392 | 22032 | 33816 | 45096 | | |
| 4 | 1.4766 | 5 | 16QAM | 27656 | 36896 | 56368 | 75792 | | |
| 5 | 1.9141 | 7 | | 35856 | 48168 | 73776 | 98376 | | |
| 6 | 2.4063 | 9 | | 45096 | 60456 | 92200 | 122976 | | |
| 7 | 2.7305 | 11 | 64QAM | 51216 | 67584 | 104496 | 139376 | | |
| 8 | 3.3223 | 13 | | 62504 | 81976 | 127080 | 167976 | | |
| 9 | 3.9023 | 15 | | 73776 | 98376 | 147576 | 196776 | | |
| 10 | 4.5234 | 17 | | 83976 | 112648 | 172176 | 229576 | | |
| 11 | 5.1152 | 19 | | 96264 | 127080 | 196776 | 262376 | | |
| 12 | 5.5547 | 21 | 256QAM | 104496 | 139376 | 213176 | 278776 | | |
| 13 | 6.2266 | 23 | | 116792 | 155776 | 237776 | 319784 | | |
| 14 | 6.9141 | 25 | | 129128 | 172176 | 262376 | 352440 | | |
| 15 | 7.4063 | 27 | | 139376 | 184424 | 278776 | 376896 | | |
| Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data<br>Note 2: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL<br>Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity<br>Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-2 of TS 38.214 [12] | | | | | | | | | |

**Table A.4-4: Mapping of CQI Index to Information Bit payload (CQI table 3)**

| TBS Scheme | | | | TBS.4-1 | TBS.4-2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MCS table | | | | 64QAMLowSE | | | | | |
| Number of allocated PDSCH resource blocks | | | | 52 | 106 | | | | |
| Number of consecutive PDSCH symbols | | | | 12 | 12 | | | | |
| Number of PDSCH MIMO layers | | | | 1 | 1 | | | | |
| Number of DMRS REs (Note 1) | | | | 24 | 24 | | | | |
| Overhead for TBS determination | | | | 0 | 0 | | | | |
| Available RE-s for PDSCH | | | | 6240 | 12720 | | | | |
| CQI index | Spectral efficiency | MCS index | Modulation | Information Bit Payload per Slot | | | | | |
| 0 | OOR | OOR | OOR | N/A | N/A | | | | |
| 1 | 0.0586 | 0 | QPSK | 368 | 768 | | | | |
| 2 | 0.0977 | 2 | | 608 | 1256 | | | | |
| 3 | 0.1523 | 4 | | 984 | 2024 | | | | |
| 4 | 0.2344 | 6 | | 1480 | 2976 | | | | |
| 5 | 0.3770 | 8 | | 2408 | 4744 | | | | |
| 6 | 0.6016 | 10 | | 3752 | 7680 | | | | |
| 7 | 0.8770 | 12 | | 5504 | 11016 | | | | |
| 8 | 1.1758 | 14 | | 7296 | 14856 | | | | |
| 9 | 1.4766 | 16 | 16QAM | 9224 | 18960 | | | | |
| 10 | 1.9141 | 18 | | 12040 | 24576 | | | | |
| 11 | 2.4063 | 20 | | 15112 | 30728 | | | | |
| 12 | 2.7305 | 22 | 64QAM | 16896 | 34816 | | | | |
| 13 | 3.3223 | 24 | | 20496 | 42016 | | | | |
| 14 | 3.9023 | 26 | | 24576 | 49176 | | | | |
| 15 | 4.5234 | 28 | | 28168 | 57376 | | | | |
| Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data<br>Note 2: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL<br>Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity | | | | | | | | | |

# 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.<br>Note 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals, and excluding REs in all the available PDSCH DMRS CDM groups, 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.<br>Note 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals, and excluding REs in all the available PDSCH DMRS CDM groups, in channel bandwidth. | | |

# A.6 SL reference measurement channels

## A.6.1 General

The transport block size (TBS) determination procedure is described in clause 8.1.3 of TS 38.214 [12].

## A.6.2 Reference measurement channels for PSSCH performance requirements

### A.6.2.1 Reference measurement channels for SCS 15 kHz FR1

### A.6.2.2 Reference measurement channels for SCS 30 kHz FR1

**Table A.6.2.2-1: PSSCH Reference Channel**

| Parameter | | Unit | Value | | | | |
|---|---|---|---|---|---|---|---|
| Reference channel | | | R.PSSCH. 2-1.1 | R.PSSCH. 2-1.2 | R.PSSCH. 2-1.3 | R.PSSCH. 2-1.4 | R.PSSCH. 2-1.5 |
| Channel bandwidth | | MHz | 20 | 20 | 20 | 20 | 20 |
| Subcarrier spacing | | kHz | 30 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | | RB | 20 | 20 | 10 | 10 | 10 |
| CP-OFDM symbols for slot with PSFCH(Note 1) | | | 9 | 9 | 9 | 9 | 9 |
| CP-OFDM symbols for slot without PSFCH | | | 12 | 12 | 12 | 12 | - |
| Modulation order | | | QPSK | 16QAM | 64QAM | QPSK | 64QAM |
| MCS index | | | 4 | 11 | 17 | 4 | 27 |
| Number of MIMO layers | | | 1 | 1 | 1 | 1 | 1 |
| Number of DMRS REs | | | 21 | 15 | 12 | 15 | 12 |
| Number of REs for SCI format 1-A | | | 240 | 240 | 240 | 240 | 240 |
| 2nd stage SCI format 2-A configuraion | Payloads | Bits | 35 | 35 | 35 | 35 | 35 |
| | $\alpha$ | | 1 | 1 | 1 | 1 | 1 |
| | $\beta_{offset}$ | | 3.5 | 5 | 5 | 3.5 | 2.5 |
| Overhaed for TBS determination | | | 0 | 0 | 0 | 0 | 0 |
| Transport Block Size for slot with PSFCH | | Bits | 704 | 1800 | 984 | 208 | 3496 |
| Transport Block Size for slot without PSFCH | | Bits | 1128 | 2856 | 1928 | 432 | - |
| Transport block CRC | | Bits | 24 | 24 | 24 | 24 | 16 |
| Maximum number of HARQ transmissions | | | 1 | 1 | 1 | 1 | 2 |
| Binary Channel Bits for slots with PSFCH | | | 2304 | 4848 | 2232 | 744 | 3816 |
| Binary Channel Bits for slots without PSFCH | | Bits | 3744 | 7728 | 4392 | 1464 | - |
| Note 1: OFDM symbols is for PSCCH/PSSCH transmission not including first symbol (AGC), PSFCH symbols, and guard symbols. | | | | | | | |

## A.6.3 Reference measurement channels for PSCCH performance requirements

### A.6.3.1 Reference measurement channels for SCS 15 kHz FR1

### A.6.3.2 Reference measurement channels for SCS 30 kHz FR1

**Table A.6.3.2-1: PSCCH Reference Channel**

| Parameter | Unit | Value |
|---|---|---|
| Reference channel | | R.PSCCH.2-1.1 |
| Allocated resource blocks | | 10 |
| OFDM Symbols per slot (Note 2) | | 2 |
| Modulation | | QPSK |
| Payload (without CRC) | Bits | 26 |
| CRC | Bits | 24 |
| SCI Format | | 1-A |
| Binary Channel Bits | Bits | 180 |
| NOTE 1: The first OFDM symbol of a PSSCH and its associated PSCCH is duplicated as described in clauses 8.3.1.5 and 8.3.2.3 of TS 38.211. This symbol is used for AGC and not used for demodulation.<br>NOTE 2: First OFDM symbol is not included. | | |

## A.6.4 Reference measurement for PSBCH performance requirements

### A.6.4.1 Reference measurement channels for SCS 15 kHz FR1

### A.6.4.2 Reference measurement channels for SCS 30 kHz FR1

**Table A.6.4.2-1: PSBCH Reference Channel**

| Parameter | Unit | Value |
|---|---|---|
| Reference channel | | R.PSBCH.2-1 |
| Channel bandwidth | MHz | 20 |
| Allocated resource blocks | | 11 |
| CP-OFDM Symbols per slot (see Note 1) | | 8 |
| Modulation | | QPSK |
| Transport Block Size (without CRC) | Bits | 32 |
| Transport block CRC | Bits | 24 |
| Binary Channel Bits | Bits | 1782 |
| Note 1: PSBCH transmissions are rate-matched for 9 CP-OFDM symbols per slot. The first symbol is used for AGC and the last symbol is gap and shall not be used for PSBCH transmission as per TS 38.211. | | |

# 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

$$\mathbf{H} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}.$$

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

$$\mathbf{H} = \begin{pmatrix} 1 & j \\ 1 & -j \end{pmatrix}.$$

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

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & j & j \\ 1 & 1 & -j & -j \end{bmatrix}$$

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

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & 1 & 1 & j & j & j & j \\ 1 & 1 & 1 & 1 & -j & -j & -j & -j \end{bmatrix}$$

### B.1.2 UE Receiver with 4Rx

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

$$\mathbf{H} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}.$$

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

$$\mathbf{H} = \begin{bmatrix} 1 & j \\ 1 & -j \\ 1 & j \\ 1 & -j \end{bmatrix}.$$

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

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & j & j \\ 1 & 1 & -j & -j \\ 1 & -1 & j & -j \\ 1 & -1 & -j & j \end{bmatrix}.$$

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

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & 1 & 1 & j & j & j & j \\ 1 & 1 & 1 & 1 & -j & -j & -j & -j \\ 1 & 1 & -1 & -1 & j & j & -j & -j \\ 1 & 1 & -1 & -1 & -j & -j & j & j \end{bmatrix}$$

# 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).

Initial channel matrix for LOS component of TDL-D channel model is equal to channel matrix of Static propagation conditions in Clause B.1.

## 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 clause 7.7.3 in TR 38.901 [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.

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

Note: Delay profile for TDLD30 is generated under assumption that Steps 1-8 are applied for taps with Rayleigh distribution.

## 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 |
| TDLD30 | 10 | 30 ns | 375 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 |

**Table B.2.1.2-4 TDLD30 (DS = 30 ns)**

| Tap # | Delay [ns] | Power [dB] | Fading distribution |
|---|---|---|---|
| 1 | 0 | -0.2 | LOS path |
| | 0 | -12.4 | Rayleigh |
| 2 | 20 | -21 | Rayleigh |
| 3 | 40 | -16.7 | Rayleigh |
| 4 | 55 | -18.3 | Rayleigh |
| 5 | 80 | -21.9 | Rayleigh |
| 6 | 120 | -27.8 | Rayleigh |
| 7 | 240 | -23.6 | Rayleigh |
| 8 | 285 | -24.8 | Rayleigh |
| 9 | 290 | -30.0 | Rayleigh |
| 10 | 375 | -27.6 | Rayleigh |
| Note 1: Tap #1 follows a Ricean distribution. | | | |

# 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 |
| TDLC300-600 | TDLC300 | 600 Hz |
| TDLC300-1200 | TDLC300 | 1200 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 |
| TDLD30-75 | TDLD30 | 75 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 | $R_{gNB} = 1$ | $R_{gNB} = \begin{pmatrix} 1 & \alpha \\ \alpha^* & 1 \end{pmatrix}$ | $R_{gNB} = \begin{pmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{pmatrix}$ |

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 | $R_{UE}=1$ | $R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & \mathbf{1} \end{pmatrix}$ | $R_{UE} = \begin{pmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{pmatrix}$ |

Table B.2.3.1.1-3 defines the channel spatial correlation matrix $R_{spat}$. The parameters, $\alpha$ and $\beta$ 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: $R_{spat}$ correlation matrices**

| | |
|---|---|
| **1x2 case** | $R_{spat} = R_{UE} = \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix}$ |
| **1x4 case** | $R_{spat} = R_{UE} = \begin{pmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{pmatrix}$ |
| **2x1 case** | $R_{spat} = R_{gNB} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix}$ |
| **2x2 case** | $R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix} = \begin{bmatrix} 1 & \beta & \alpha & \alpha\beta \\ \beta^* & 1 & \alpha\beta^* & \alpha \\ \alpha^* & \alpha^*\beta & 1 & \beta \\ \alpha^*\beta^* & \alpha^* & \beta^* & 1 \end{bmatrix}$ |
| **2x4 case** | $R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{bmatrix}$ |
| **4x1 case** | $R_{spat} = R_{gNB} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{bmatrix}$ |
| **4x2 case** | $R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix}$ |
| **4x4 case** | $R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{bmatrix} \otimes \begin{pmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{pmatrix}$ |

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 $R_{gNB}$ and $R_{UE}$ according to $R_{spat} = R_{gNB} \otimes R_{UE}$.

### B.2.3.1.2 MIMO Correlation Matrices at High, Medium and Low Level

The $\alpha$ and $\beta$ 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 | $\alpha$ | $\beta$ |
|---|---|---|
| **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:

$$R_{high} = [R_{spat} + aI_n]/(1+a)$$

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** | $R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$ |
| **2x1 case** | $R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$ |
| **2x2 case** | $R_{high} = \begin{pmatrix} 1 & 0.9 & 0.9 & 0.81 \\ 0.9 & 1 & 0.81 & 0.9 \\ 0.9 & 0.81 & 1 & 0.9 \\ 0.81 & 0.9 & 0.9 & 1 \end{pmatrix}$ |
| **4x2 case** | $R_{high} = \left[\begin{array}{cccccccc} 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 & 0.8999 & 0.8099 \\ 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 & 0.8099 & 0.8999 \\ 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 \\ 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 \\ 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 \\ 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 \\ 0.8999 & 0.8099 & 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 \\ 0.8099 & 0.8999 & 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 \end{array}\right]$ |
| **4x4 case** | $R_{high} = \left[\begin{array}{cccccccccccccccc} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.8999 & 0.8894 & 0.8587 & 0.8099 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.8894 & 0.8999 & 0.8894 & 0.8587 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.8587 & 0.8894 & 0.8999 & 0.8894 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8099 & 0.8587 & 0.8894 & 0.8999 \\ 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9541 & 0.9430 & 0.9105 & 0.8587 \\ 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9105 \\ 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9105 & 0.9430 & 0.9541 & 0.9430 \\ 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.9105 & 0.9430 & 0.9541 \\ 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 \\ 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 \\ 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 \\ 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 \\ 0.8999 & 0.8894 & 0.8587 & 0.8099 & 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.8894 & 0.8999 & 0.8894 & 0.8587 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.8587 & 0.8894 & 0.8999 & 0.8894 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.8099 & 0.8587 & 0.8894 & 0.8999 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{array}\right]$ |

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

| | |
|---|---|
| **1x2 case** | N/A |
| **2x1 case** | N/A |
| **2x2 case** | $R_{medium} = \begin{pmatrix} 1 & 0.9 & 0.3 & 0.27 \\ 0.9 & 1 & 0.27 & 0.3 \\ 0.3 & 0.27 & 1 & 0.9 \\ 0.27 & 0.3 & 0.9 & 1 \end{pmatrix}$ |
| **2x4 case** | $R_{medium} = \begin{pmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.3000 & 0.2965 & 0.2862 & 0.2700 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.2965 & 0.3000 & 0.2965 & 0.2862 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.2862 & 0.2965 & 0.3000 & 0.2965 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.2700 & 0.2862 & 0.2965 & 0.3000 \\ 0.3000 & 0.2965 & 0.2862 & 0.2700 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.2965 & 0.3000 & 0.2965 & 0.2862 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.2862 & 0.2965 & 0.3000 & 0.2965 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.2700 & 0.2862 & 0.2965 & 0.3000 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{pmatrix}$ |
| **4x2 case** | $R_{medium} = \begin{pmatrix} 1.0000 & 0.9000 & 0.8748 & 0.7873 & 0.5856 & 0.5271 & 0.3000 & 0.2700 \\ 0.9000 & 1.0000 & 0.7873 & 0.8748 & 0.5271 & 0.5856 & 0.2700 & 0.3000 \\ 0.8748 & 0.7873 & 1.0000 & 0.9000 & 0.8748 & 0.7873 & 0.5856 & 0.5271 \\ 0.7873 & 0.8748 & 0.9000 & 1.0000 & 0.7873 & 0.8748 & 0.5271 & 0.5856 \\ 0.5856 & 0.5271 & 0.8748 & 0.7873 & 1.0000 & 0.9000 & 0.8748 & 0.7873 \\ 0.5271 & 0.5856 & 0.7873 & 0.8748 & 0.9000 & 1.0000 & 0.7873 & 0.8748 \\ 0.3000 & 0.2700 & 0.5856 & 0.5271 & 0.8748 & 0.7873 & 1.0000 & 0.9000 \\ 0.2700 & 0.3000 & 0.5271 & 0.5856 & 0.7873 & 0.8748 & 0.9000 & 1.0000 \end{pmatrix}$ |
| **4x4 case** | $R_{medium} = \begin{pmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.3000 & 0.2965 & 0.2862 & 0.2700 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.2965 & 0.3000 & 0.2965 & 0.2862 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.2862 & 0.2965 & 0.3000 & 0.2965 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.2700 & 0.2862 & 0.2965 & 0.3000 \\ 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 0.5855 & 0.5787 & 0.5588 & 0.5270 \\ 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.5787 & 0.5855 & 0.5787 & 0.5588 \\ 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.5588 & 0.5787 & 0.5855 & 0.5787 \\ 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.5270 & 0.5588 & 0.5787 & 0.5855 \\ 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 \\ 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 \\ 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 \\ 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 \\ 0.3000 & 0.2965 & 0.2862 & 0.2700 & 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.2965 & 0.3000 & 0.2965 & 0.2862 & 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.2862 & 0.2965 & 0.3000 & 0.2965 & 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.2700 & 0.2862 & 0.2965 & 0.3000 & 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{pmatrix}$ |

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

| | |
|---|---|
| **1x4 case** | $R_{medium\ A} = \begin{bmatrix} 1 & 0.9000 & 0.6561 & 0.3874 \\ 0.9000 & 1 & 0.9000 & 0.6561 \\ 0.6561 & 0.9000 & 1 & 0.9000 \\ 0.3874 & 0.6561 & 0.9000 & 1 \end{bmatrix}$ |
| **2x4 case** | $R_{medium\ A} = \begin{pmatrix} 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.3000 & 0.2700 & 0.1968 & 0.1162 \\ 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.2700 & 0.3000 & 0.2700 & 0.1968 \\ 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.1968 & 0.2700 & 0.3000 & 0.2700 \\ 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \\ 0.1968 & 0.2700 & 0.3000 & 0.2700 & 0.6561 & 0.9000 & 1.0000 & 0.9000 \\ 0.1162 & 0.1968 & 0.2700 & 0.3000 & 0.3874 & 0.6561 & 0.9000 & 1.0000 \end{pmatrix}$ |
| **4x4 case** | $R_{medium\ A} = \begin{pmatrix} 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.3000 & 0.2700 & 0.1968 & 0.1162 \\ 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.2700 & 0.3000 & 0.2700 & 0.1968 \\ 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.1968 & 0.2700 & 0.3000 & 0.2700 \\ 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 0.5856 & 0.5270 & 0.3842 & 0.2269 \\ 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.5270 & 0.5856 & 0.5270 & 0.3842 \\ 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.3842 & 0.5270 & 0.5856 & 0.5270 \\ 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.2269 & 0.3842 & 0.5270 & 0.5856 \\ 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 \\ 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 \\ 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 \\ 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \\ 0.1968 & 0.2700 & 0.3000 & 0.2700 & 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 \\ 0.1162 & 0.1968 & 0.2700 & 0.3000 & 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 \end{pmatrix}$ |

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

| | |
|---|---|
| **1x2 case** | $R_{low}=\mathbf{I}_2$ |
| **1x4 case** | $R_{low}=\mathbf{I}_4$ |
| **2x1 case** | $R_{low}=\mathbf{I}_2$ |
| **2x2 case** | $R_{low}=\mathbf{I}_4$ |
| **2x4 case** | $R_{low}=\mathbf{I}_8$ |
| **4x1 case** | $R_{low}=\mathbf{I}_4$ |
| **4x2 case** | $R_{low}=\mathbf{I}_8$ |
| **4x4 case** | $R_{low}=\mathbf{I}_{16}$ |

In Table B.2.3.1.2-5, $\mathbf{I}_d$ is the $d \times d$ 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 $(N_1, N_2, P)$, and total number of antennas is $N = P \cdot N_1 \cdot N_2$, where

- $N_1$ is the number of antenna elements in first dimension with same polarization,
- $N_2$ is the number of antenna elements in second dimension with same polarization, and
- $P$ 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:

$$Index(p, n_1, n_2) = p \cdot N_1 \cdot N_2 + n_1 \cdot N_2 + n_2 + 1; \qquad p = 0,1; \; n_1 = 0, \cdots, N_1 - 1; \; n_2 = 0, \cdots, N_2 - 1.$$

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:

$$R_{spat} = P\left(R_{gNB} \otimes \Gamma \otimes R_{UE}\right)P^T$$

where

- $R_{UE}$ is the spatial correlation matrix at the UE with same polarization,
- $R_{gNB}$ is the spatial correlation matrix at the gNB with same polarization,
- $\Gamma$ is a polarization correlation matrix, and
- $(\bullet)^T$ denotes transpose.

The matrix $\Gamma$ is defined as

$$\Gamma = \begin{bmatrix} 1 & 0 & -\gamma & 0 \\ 0 & 1 & 0 & \gamma \\ -\gamma & 0 & 1 & 0 \\ 0 & \gamma & 0 & 1 \end{bmatrix}$$

A permutation matrix P elements are defined as

$$P(a,b) = \begin{cases} 1 & for \quad a = (j-1)Nr + i \quad and \quad b = 2(j-1)Nr + i, \qquad i = 1, \cdots, Nr, \; j = 1, \cdots Nt/2 \\ 1 & for \quad a = (j-1)Nr + i \quad and \quad b = 2(j - Nt/2)Nr - Nr + i, \quad i = 1, \cdots, Nr, \; j = Nt/2 + 1, \cdots, Nt \cdot \\ 0 & otherwise \end{cases}$$

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:

$$R_{gNB} = R_{gNB\_Dim,1} \otimes R_{gNB\_Dim,2}$$

where

- - $R_{gNB\_Dim,1}$ is the correlation matrix of antenna elements in first dimension with same polarization, and
- - $R_{gNB\_Dim,2}$ 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,

$$R_{gNB\_Dim,i} = 1.$$

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

$$R_{gNB\_Dim,i} = \begin{pmatrix} 1 & \alpha_i \\ \alpha_i^* & 1 \end{pmatrix}.$$

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

$$R_{gNB\_Dim,i} = \begin{pmatrix} 1 & \alpha_i^{1/4} & \alpha_i \\ \alpha_i^{1/4*} & 1 & \alpha_i^{1/4} \\ \alpha_i^* & \alpha_i^{1/4*} & 1 \end{pmatrix}.$$

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

$$R_{gNB\_Dim,i} = \begin{pmatrix} 1 & \alpha_i^{1/9} & \alpha_i^{4/9} & \alpha_i \\ \alpha_i^{1/9*} & 1 & \alpha_i^{1/9} & \alpha_i^{4/9} \\ \alpha_i^{4/9*} & \alpha_i^{1/9*} & 1 & \alpha_i^{1/9} \\ \alpha_i^* & \alpha_i^{4/9*} & \alpha_i^{1/9*} & 1 \end{pmatrix}.$$

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 of $R_{gNB}$ is determined by follow the equations for 2D cross-polarized antenna array and letting $R_{gNB\_Dim,2} = 1$, i.e.,

$$R_{gNB} = R_{gNB\_Dim,1}$$

The spatial correlation matrices at UE side are as follows:

- For 1 antenna element with the same polarization,

$$R_{UE} = 1.$$

- For 2 antenna elements with the same polarization,

$$R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & 1 \end{pmatrix}.$$

### B.2.3.2.2 MIMO Correlation Matrices using cross polarized antennas

The values for parameters $\alpha_1$, $\alpha_2$, $\beta$ and $\gamma$ 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 | $\alpha_1$ | $\alpha_2$ | $\beta$ | $\gamma$ |
|---|---|---|---|---|
| **Medium Correlation** | 0.3 | 0.3 | 0.6 | 0.2 |
| **High Correlation** | 0.9 | 0.9 | 0.9 | 0.3 |
| Note 1: Value of $\alpha_1$ applies when more than one pair of cross-polarized antenna elements in first dimension at gNB side.<br>Note 2: Value of $\alpha_2$ applies when more than one pair of cross-polarized antenna elements in second dimension at gNB side.<br>Note 3: Value of $\beta$ 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 are defined in Table B.2.3.2.2-2 and Table B.2.3.2.2-3 as below.

For the 2D cross polarized antenna array at gNB side, the correlation matrices for high spatial correlation are defined in Table B.2.3.2.2-4 as below.

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

$$R_{high} = [R_{spat} + aI_n]/(1+a) \text{ or } R_{medium} = [R_{spat} + aI_n]/(1+a)$$

Where the value "*a*" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 8(4,1,2)x2 high spatial correlation case, *a*=0.00010. For the 16 (4,2,2)x2 high spatial correlation case, a=0.00012.

The same method is used to adjust the the 16(4,2,2)x4, 32(4,4,2)x2 and 32(4,4,2)x4 high correlation matrix to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision with a =0.00012, a =0.00022, and a=0.00022 resoectively.

**Table B.2.3.2.2-2: MIMO correlation matrices for high spatial correlation (1D cross polarized antenna array at gNB side)**

| | |
|---|---|
| **4(2,1,2)x2 case** | $R_{high} = \begin{bmatrix} 1.0000 & 0.0000 & 0.9000 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.9000 & 0.0000 & 0.3000 & 0.0000 & 0.2700 \\ 0.9000 & 0.0000 & 1.0000 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.9000 & 0.0000 & 1.0000 & 0.0000 & 0.2700 & 0.0000 & 0.3000 \\ -0.3000 & 0.0000 & -0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9000 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9000 \\ -0.2700 & 0.0000 & -0.3000 & 0.0000 & 0.9000 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.9000 & 0.0000 & 1.0000 \end{bmatrix}$ |
| **2(1,1,2)x4 case** | $R_{high} = \begin{bmatrix} 1.0000 & 0.9000 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 \\ 0.9000 & 1.0000 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.3000 & 0.2700 \\ 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.2700 & 0.3000 \\ -0.3000 & -0.2700 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 \\ -0.2700 & -0.3000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 1.0000 & 0.9000 \\ 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 \end{bmatrix}$ |
| **4(2,1,2)x4 case** | $R_{high} = \begin{bmatrix} 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 & -0.2700 & -0.2430 & 0.0000 & 0.0000 \\ 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 & -0.2430 & -0.2700 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 0.2700 & 0.2430 \\ 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.2430 & 0.2700 \\ 0.9000 & 0.8100 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & -0.2700 & -0.2430 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 \\ 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & -0.2430 & -0.2700 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.2700 & 0.2430 & 0.0000 & 0.0000 & 0.3000 & 0.2700 \\ 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.2430 & 0.2700 & 0.0000 & 0.0000 & 0.2700 & 0.3000 \\ -0.3000 & -0.2700 & 0.0000 & 0.0000 & -0.2700 & -0.2430 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 \\ -0.2700 & -0.3000 & 0.0000 & 0.0000 & -0.2430 & -0.2700 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 0.2700 & 0.2430 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 0.8100 \\ 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.2430 & 0.2700 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 \\ -0.2700 & -0.2430 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 \\ -0.2430 & -0.2700 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.2700 & 0.2430 & 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & 1.0000 & 0.9000 \\ 0.0000 & 0.0000 & 0.2430 & 0.2700 & 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 \end{bmatrix}$ |
| **8(4,1,2)x2 case** | $R_{high} = \begin{bmatrix} 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & -0.2700 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.2700 \\ 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 \\ 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 \\ 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 \\ 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 \\ 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & -0.2700 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.2700 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 \\ -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & -0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 \\ -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 \\ 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 \\ -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 \\ 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 \\ -0.2700 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 \end{bmatrix}$ |

**Table B.2.3.2.2-3: MIMO correlation matrices for medium spatial correlation (1D cross polarized antenna array at gNB side)**

| | |
|---|---|
| **2(1,1,2)x2 case** | $R_{medium} = \begin{bmatrix} 1.0000 & 0.0000 & -0.2000 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.2000 \\ -0.2000 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2000 & 0.0000 & 1.0000 \end{bmatrix}$ |

**Table 1 B.2.3.2.2-4: MIMO correlation matices for high spatial correlation (2D cross polarized antenna array at gNB side)**

| | |
|---|---|
| **16(4,2,2)x2 case** | $R_{high} = \begin{bmatrix} A & B \\ C & D \end{bmatrix}$, where<br>$\mathrm{A} = \mathrm{D} = \left[\begin{array}{cccccccccccccccc} 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.8999 & 0.0000 & 0.8099 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.8999 & 0.0000 & 0.8099 \\ 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8099 & 0.0000 & 0.8999 & 0.0000 \\ 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8099 & 0.0000 & 0.8999 \\ 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 \\ 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 0.9541 & 0.0000 & 0.8587 \\ 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 \\ 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8587 & 0.0000 & 0.9541 \\ 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 \\ 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 \\ 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 \\ 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 \\ 0.8999 & 0.0000 & 0.8099 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 \\ 0.0000 & 0.8999 & 0.0000 & 0.8099 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 \\ 0.8099 & 0.0000 & 0.8999 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.8099 & 0.0000 & 0.8999 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 \end{array}\right]$<br>$\mathrm{B} = \mathrm{C} = \left[\begin{array}{cccccccccccccccc} -0.3000 & 0.0000 & -0.2700 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.2862 & 0.0000 & -0.2576 & 0.0000 & -0.2700 & 0.0000 & -0.2430 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.2862 & 0.0000 & 0.2576 & 0.0000 & 0.2700 & 0.0000 & 0.2430 \\ -0.2700 & 0.0000 & -0.3000 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2576 & 0.0000 & -0.2862 & 0.0000 & -0.2430 & 0.0000 & 0.2700 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2576 & 0.0000 & 0.2862 & 0.0000 & 0.2430 & 0.0000 & 0.2700 \\ -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.2862 & 0.0000 & -0.2576 & 0.0000 \\ 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.2862 & 0.0000 & 0.2576 \\ -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2576 & 0.0000 & -0.2862 & 0.0000 \\ 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2576 & 0.0000 & 0.2862 \\ -0.2862 & 0.0000 & -0.2576 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 \\ 0.0000 & 0.2862 & 0.0000 & 0.2576 & 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 0.2965 & 0.0000 & 0.2668 \\ -0.2576 & 0.0000 & -0.2862 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 \\ 0.0000 & 0.2576 & 0.0000 & 0.2862 & 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.2668 & 0.0000 & 0.2965 \\ -0.2700 & 0.0000 & -0.2430 & 0.0000 & -0.2862 & 0.0000 & -0.2576 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & .00000 \\ 0.0000 & 0.2700 & 0.0000 & 0.2430 & 0.0000 & 0.2862 & 0.0000 & 0.2576 & 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.3000 & 0.0000 & 0.2700 \\ -0.2430 & 0.0000 & -0.2700 & 0.0000 & -0.2576 & 0.0000 & -0.2862 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.2430 & 0.0000 & 0.2700 & 0.0000 & 0.2576 & 0.0000 & 0.2862 & 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2700 & 0.0000 & 0.3000 \end{array}\right]$ |

## 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

$$y = HD_{\theta_{k,1},\theta_{k,2}}Wx + n$$

And the steering matrix is further expressed as following:

$$D_{\theta_{k,1},\theta_{k,2}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes \left( D_{\theta_{k,1}}(N_1) \otimes D_{\theta_{k,2}}(N_2) \right)$$

where

- $H$ is the $Nr \times Nt$ channel matrix per subcarrier.
- $D_{\theta_{k,1},\theta_{k,2}}$ is the steering matrix,

- $D_{\theta_{k,1}}(N_1)$ is the steering matrix in first dimension with same polarization,
- $D_{\theta_{k,2}}(N_2)$ is the steering matrix in second dimension with same polarization,
- $N_1$ is the number of antenna elements in first dimension with same polarization,
- $N_2$ 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 $N_2$ equals 1.

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

$$D_{\theta_{k,i}}(1) = 1.$$

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

$$D_{\theta_{k,i}}(2) = \begin{bmatrix} 1 & 0 \\ 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

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

$$D_{\theta_{k,i}}(3) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & e^{j1.5\theta_{k,i}} & 0 \\ 0 & 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

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

$$D_{\theta_{k,i}}(4) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\theta_{k,i}} & 0 & 0 \\ 0 & 0 & e^{j2\theta_{k,i}} & 0 \\ 0 & 0 & 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

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

- $\theta_{k,i}$ controls the phase variation in first dimension and second dimension respectively, and the phase for k-th subframe is denoted by $\theta_{k,i} = \theta_{0,i} + \Delta\theta \cdot k$, where $\theta_{0,i}$ is the random start value with the uniform distribution, i.e., $\theta_{0,i} \in [0, 2\pi]$, $\Delta\theta$ is the step of phase variation, which is defined in Table B.2.3.2.3-1, and k is the linear increment of $2^{-\mu}$ for every slot throughout the simulation, the index $i = 1,2$ stands for first dimension and second dimension respectively.
- $W$ is the precoding matrix for Nt transmission antennas,
- *y* is the received signal, *x* is the transmitted signal, and *n* is AWGN.
- $\mu$ corresponds to subcarrier spacing configuration, $\Delta f = 2^{\mu} \cdot 15[\text{kHz}]$

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.,

$$D_{\theta_{k,1}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes D_{\theta_{k,1}}(N_1)$$

**Table B.2.3.2.3-1: The step of phase variation**

| Variation Step | Value (rad/ms) |
|---|---|
| $\Delta\theta$ | $1.2566\times10^{-3}$ |

### B.2.3.2.3A Beam steering approach with dual cluster beams

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

$$y=\left[\sqrt{\frac{1}{1+p^2}}H_m D^{(m)}_{\theta_{k,1},\theta_{k,2}}+\sqrt{\frac{p^2}{1+p^2}}H_s D^{(s)}_{\theta_{k,1},\theta_{k,2}}\right]Wx+n$$

And the steering matrix is further expressed as following:

$$D_{\theta_{k,1},\theta_{k,2}}=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\otimes\left(D_{\theta_{k,1}}(N_1)\otimes D_{\theta_{k,2}}(N_2)\right)$$

where

- $H_m$, $H_s$ are independent channels for the first beam and second beam with the Nr xNt channel matrix per subcarrier.
- $D^{(m)}_{\theta_{k,1},\theta_{k,2}}$, $D^{(s)}_{\theta_{k,1},\theta_{k,2}}$ are the steering matrix for first beam and second beam
- $D_{\theta_{k,1}}(N_1)$ is the steering matrix in first dimension with same polarization,
- $D_{\theta_{k,2}}(N_2)$ is the steering matrix in second dimension with same polarization,
- $N_1$ is the number of antenna elements infirst dimension with same polarization,
- $N_2$ 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 $N_2$ equals 1，
- $p$ is the relative power ratio of the second beam to the first beam, the value of $p$ is specific to a test case,

For 1 antenna element of the same polarization in one direction, $D_{\theta_{k,i}}(1)=1$.

For 2 antenna elements of the same polarization in one direction, $D_{\theta_{k,i}}(2)=\begin{bmatrix}1 & 0\\ 0 & e^{j3\theta_{k,i}}\end{bmatrix}$.

For 3 antenna elements of the same polarization in one direction, $D_{\theta_{k,i}}(3)=\begin{bmatrix}1 & 0 & 0\\ 0 & e^{j1.5\theta_{k,i}} & 0\\ 0 & 0 & e^{j3\theta_{k,i}}\end{bmatrix}$.

For 4 antenna elements of the same polarization in one direction, $D_{\theta_{k,i}}(4)=\begin{bmatrix}1 & 0 & 0 & 0\\ 0 & e^{j\theta_{k,i}} & 0 & 0\\ 0 & 0 & e^{j2\theta_{k,i}} & 0\\ 0 & 0 & 0 & e^{j3\theta_{k,i}}\end{bmatrix}$.

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

- $\theta_{k,i}$ controls the phase variation in first dimension and second dimension respectively, and the phase for k-th subframe is denoted by $\theta_{k,i} = \theta_{0,i} + \Delta\theta \cdot k$, where $\theta_{0,i}$ is the random start value with the uniform distribution, i.e., $\theta_{0,i} \in [0, 2\pi]$, $\Delta\theta$ is the step of phase variation, which is defined in Table B.2.3.2.3A-1, and k is the linear increment of $2^{-\mu}$ for every slot throughout the simulation, the index $i = 1,2$ stands for first dimension and second dimension respectively.
- $W$ is the precoding matrix for Nt transmission antennas,
- *y* is the received signal, *x* is the transmitted signal, and *n* is AWGN.
- $\mu$ corresponds to subcarrier spacing configuration, $\Delta f = 2^{\mu} \cdot 15[\text{kHz}]$

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.,

$$D_{\theta_{k,1}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes D_{\theta_{k,1}}(N_1)$$

**Table B.2.3.2.3A-1: The step of phase variation**

| Variation Step | Value (rad/subframe) |
|---|---|
| $\Delta\theta^{(m)}$ | $1.2566\times10^{-3}$ |
| $\Delta\theta^{(s)}$ | $2.5132\times10^{-3}$ |

## B.2.4 Two-tap propagation conditions for CQI tests

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

$$h(t,\tau) = \delta(\tau) + a\exp(-i2\pi f_D t)\delta(\tau - \tau_d)$$

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

# B.3 High Speed Train Scenario

## B.3.1 Single Tap Channel Profile

The high speed train condition for the test of the baseband performance is a non fading propagation channel with one tap. Doppler shift is given by

$$f_s(t) = f_d \cos\theta(t) \qquad \text{(B.3.1.1)}$$

where $f_s(t)$ is the Doppler shift and $f_d$ is the maximum Doppler frequency. The cosine of angle $\theta(t)$ is given by

$$\cos\theta(t) = \frac{D_s/2 - vt}{\sqrt{D_{\min}^2 + (D_s/2 - vt)^2}},\ 0 \le t \le D_s/v \qquad \text{(B.3.1.2)}$$

$$\cos\theta(t) = \frac{-1.5D_s + vt}{\sqrt{D_{\min}^{2} + (-1.5D_s + vt)^2}}, \quad D_s/v < t \le 2D_s/v \qquad \text{(B.3.1.3)}$$

$$\cos\theta(t) = \cos\theta(t \mod (2D_s/v)), \quad t > 2D_s/v \qquad \text{(B.3.1.4)}$$

where $D_s/2$ is the initial distance of the train from gNB, and $D_{\min}$ is gNB Railway track distance, both in meters; $v$ is the velocity of the train in m/s, $t$ is time in seconds.

Doppler shift and cosine angle are given by equation B.3.1.1 and B.3.1.2-B.3.1.4 respectively, where the required input parameters listed in Table B.3.1-1 and the resulting Doppler shift shown in Figures B.3.1-1, B.3.1-2, B.3.1-3, B.3.1-4 are applied for all frequency bands.

**Table B.3.1-1: High speed train scenario**

| Parameter | Value | | | |
|---|---|---|---|---|
| | HST-750 | HST-972 | HST-1000 | HST-1667 |
| $D_s$ | 300 m | 300 m | 300 m | 300 m |
| $D_{\min}$ | 2 m | 2 m | 2 m | 2 m |
| $v$ | 300 km/h | 500 km/h | 300 km/h | 500 km/h |
| $f_d$ | 750 Hz for 15 kHz SCS test | 972 Hz for 15 kHz SCS test | 1000 Hz for 30 kHz SCS test | 1667 Hz for 30 kHz SCS test |

Note 1: Parameters for HST conditions in Table B.3.1-1 including $f_d$ and Doppler shift trajectories presented on figures B.3.1-1 for 750 Hz and B.3.1-3 for 972 Hz for 15 kHz SCS and figures B.3.1-2 for 1000 Hz and B.3.1-4 for 1667 Hz for 30 kHz SCS are applied for performance verification in all frequency bands.

Note 2: The propagation conditions used for the performance requirements under high speed train condition are indicated as a combination of "HST" and Doppler shift $f_d$ , i.e. HST-<Doppler shift>, where '<Dopper shift>' indicates the maximum Doppler shift (Hz) .

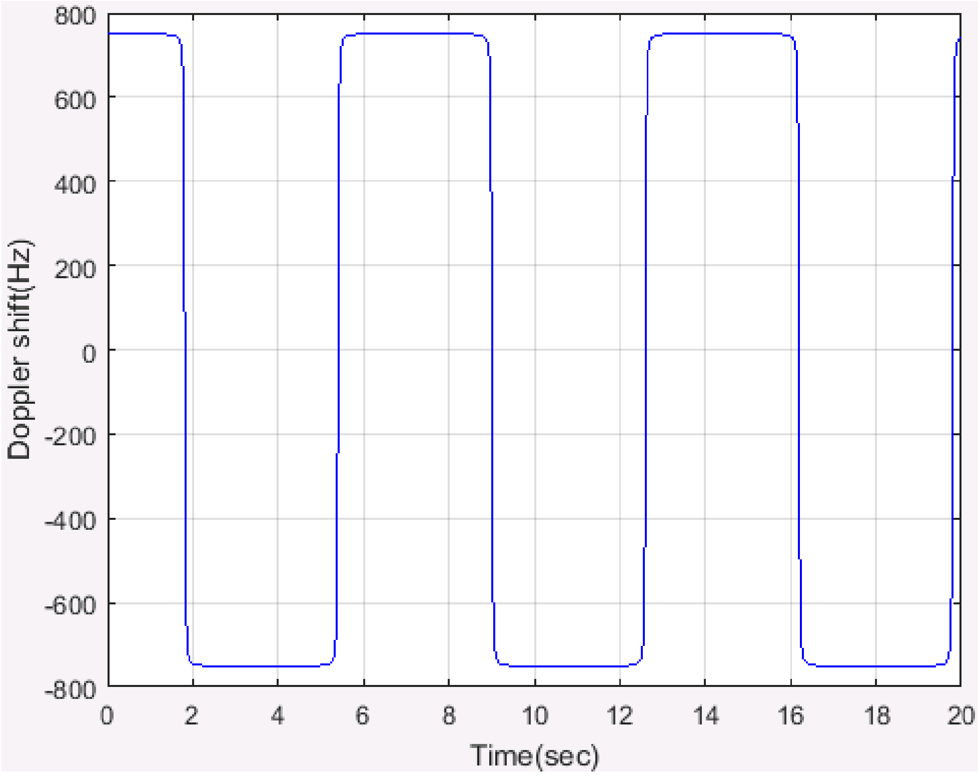



**Figure B.3.1-1: Doppler shift trajectory ( $f_d$ = 750 Hz)**

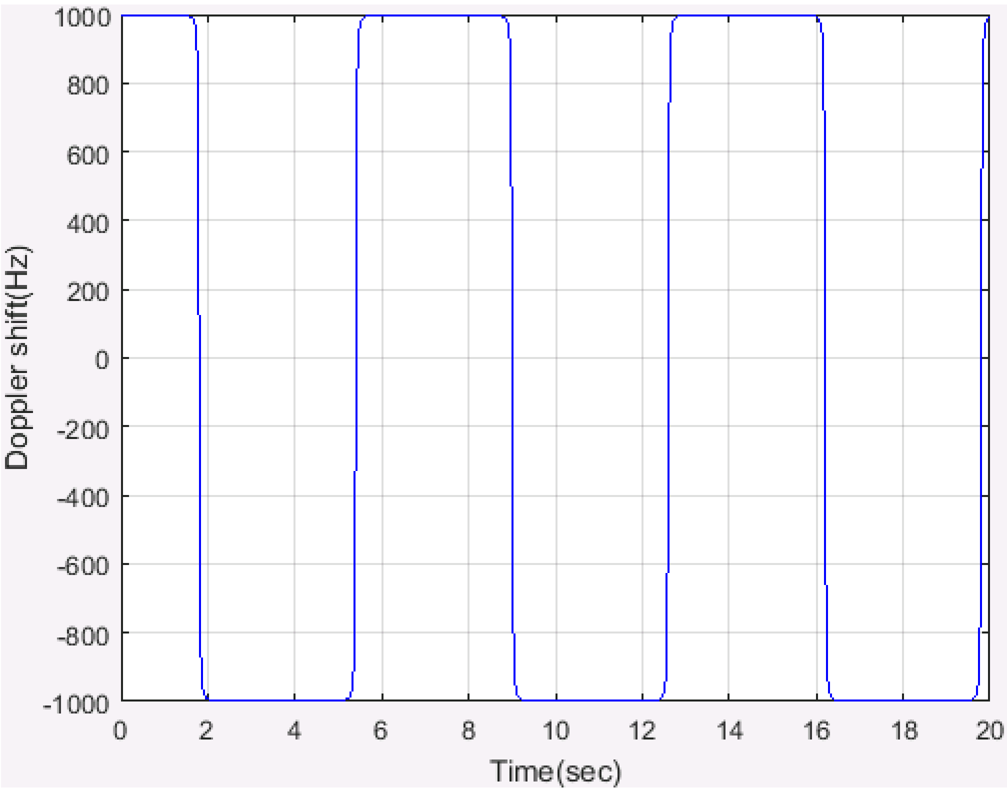



**Figure B.3.1-2: Doppler shift trajectory ( $f_d$ = 1000 Hz)**

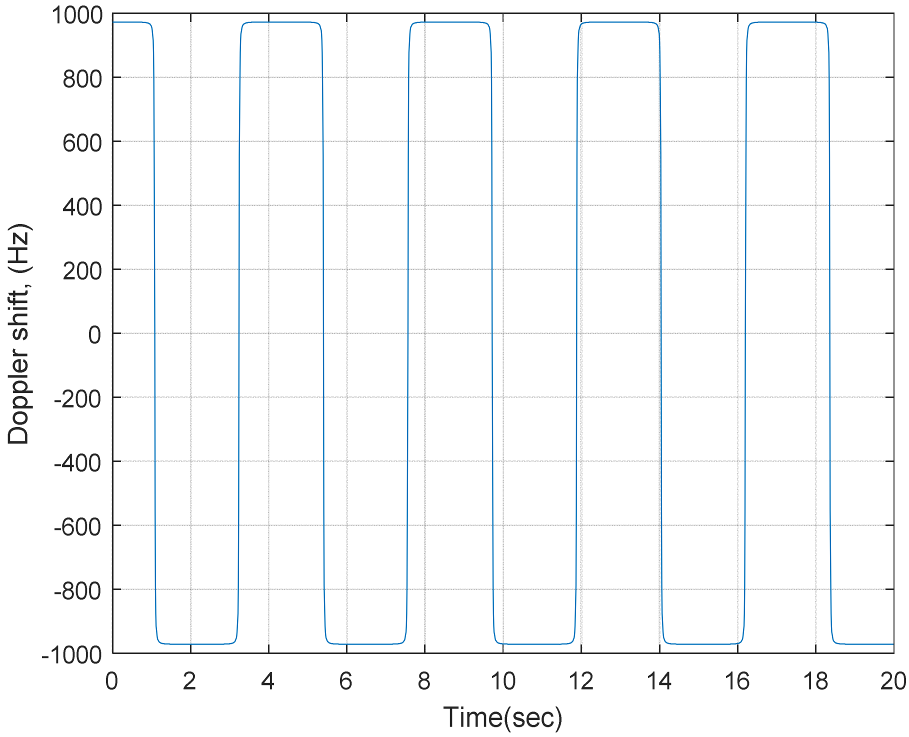



**Figure B.3.1-3: Doppler shift trajectory ( $f_d$ = 972 Hz)**

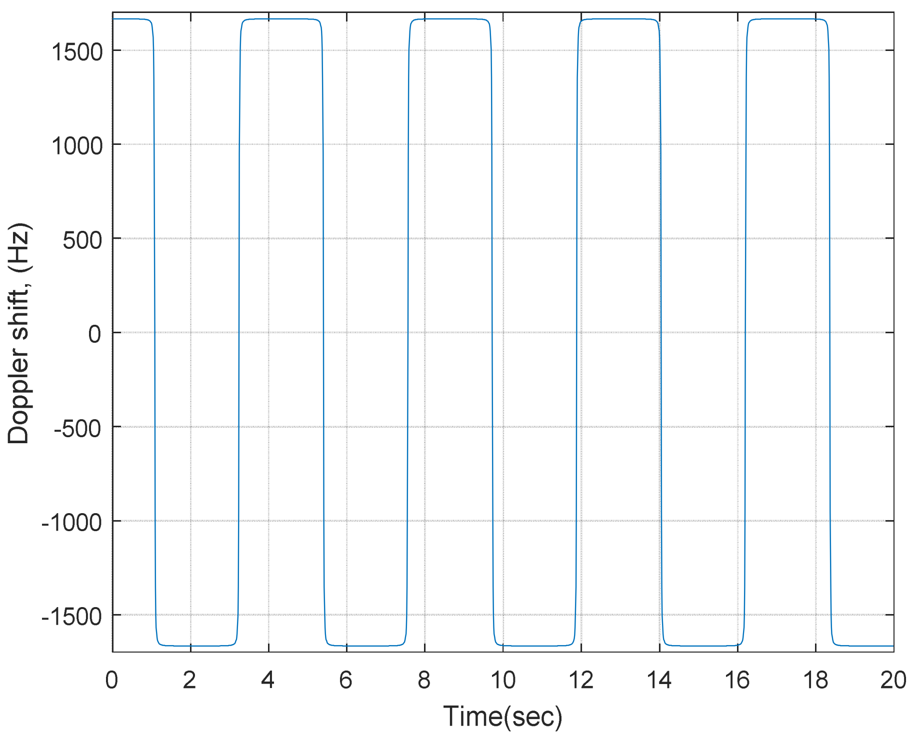



**Figure B.3.1-4: Doppler shift trajectory ( $f_d$ = 1667 Hz)**

For 1x2 antenna configuration, the same $h(t,\tau)$ is used to describe the channel between every pair of Tx and Rx.

For 1x4 antenna configuration, the same $h(t,\tau)$ is used to describe the channel between every pair of Tx and Rx.

Static channel matrix will be used as defined in Annex B.1.

## B.3.2 HST-SFN Channel Profile

There is an infinite number of RRHs distributed equidistantly along the track with the same Cell ID as depicted in figure B.3.2-1.

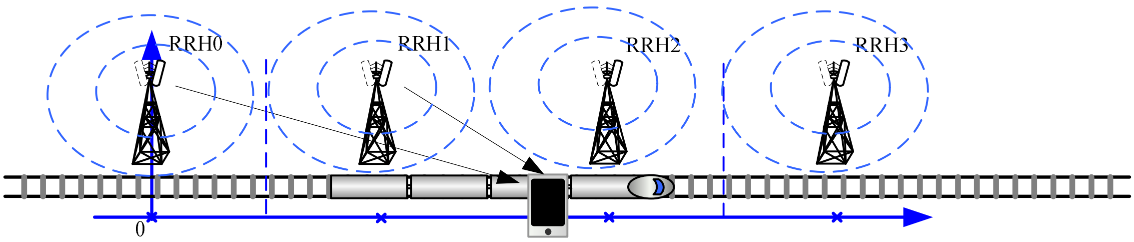



**Figure B.3.2-1: Deployment of HST-SFN**

The location of RRH $k$ is given as:

$$x_k = k * D_s + j * D_{\min} \qquad \text{(B.3.2.1)}$$

where: $k \in [-\infty, \infty]$, $j = sqrt(-1)$ and $D_{\min}$ is the distance between the RRHs and railway track, while $D_s$ is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = a + j * 0 \qquad \text{(B.3.2.2)}$$

where: $a \in [0, \infty]$ and $a$ means distance in meters, which means the train is right on the track.

The HST-SFN scenario for the test of the baseband performance is a non fading propagation channel with four taps, namely the four nearest RRHs. Thus, RRH $k$ is visible for the train only in the range:

$$k * D_s - 2 * D_s \le a < k * D_s + 2 * D_s \qquad \text{(B.3.2.3)}$$

Power level $P_k$ (dB) for the signal from $k^{\text{th}}$ RRH, normalized to the total power received from all visible RRHs, is given by:

$$P_k = -20\lg\left(\left|y - x_k\right|\right) - 10\lg\left(\sum_{i \in \{i | i*D_S - 2*D_S \le a < i*D_S + 2*D_S\}} \frac{1}{\left|y - x_i\right|^2}\right) \text{ for } k * D_s - 2 * D_s \le a < k * D_s + 2 * D_s$$

(B.3.2.4)

Doppler shift $F_{D,k}$ (Hz) from $k^{\text{th}}$ RRH is given by:

$$F_{D,k} = f_C \times real\left[ -v \times \frac{y - x_k}{|y - x_k| \times C} \right] \text{ for } k*D_s - 2*D_s \le a < k*D_s + 2*D_s \qquad \text{(B.3.2.5)}$$

The relative delay $T_k$ (s) for the signal from $k^{th}$ RRH can be derived as:

$$T_k = \frac{|y - x_k|}{C} \text{ for } k*D_s - 2*D_s \le a < k*D_s + 2*D_s \qquad \text{(B.3.2.6)}$$

In the above $v$ (m/s) is the moving speed of the train, $f_C$ (Hz) is the center frequency, and $C$ (m/s) is the velocity of light.

Power level, Doppler shift and relative delay are given by equations B.3.2.4 ~ B.3.2.6 respectively, where the required input parameters listed in table B.3.2-1 and the resulting Doppler shift shown in Figures B.3.2-3 and B.3.2-4 are applied for all requency bands.

**Table B.3.2-1: HST-SFN scenario**

| Parameter | Value |
|---|---|
| $D_s$ | 700 m |
| $D_{\min}$ | 150 m |
| $v$ | 500 km/h |
| $f_d$ | 870 Hz for 15 kHz SCS test;<br>1667 Hz for 30 kHz SCS test |

NOTE 1: The trajectories of ralative power, Doppler shifts and absolute delays presented in Figures B.3.2-2, B.3.2-3, B.3.2-4 and B.3.2-5 are derived from the equations B.3.2.4 ~ B.3.2.6 respectively.

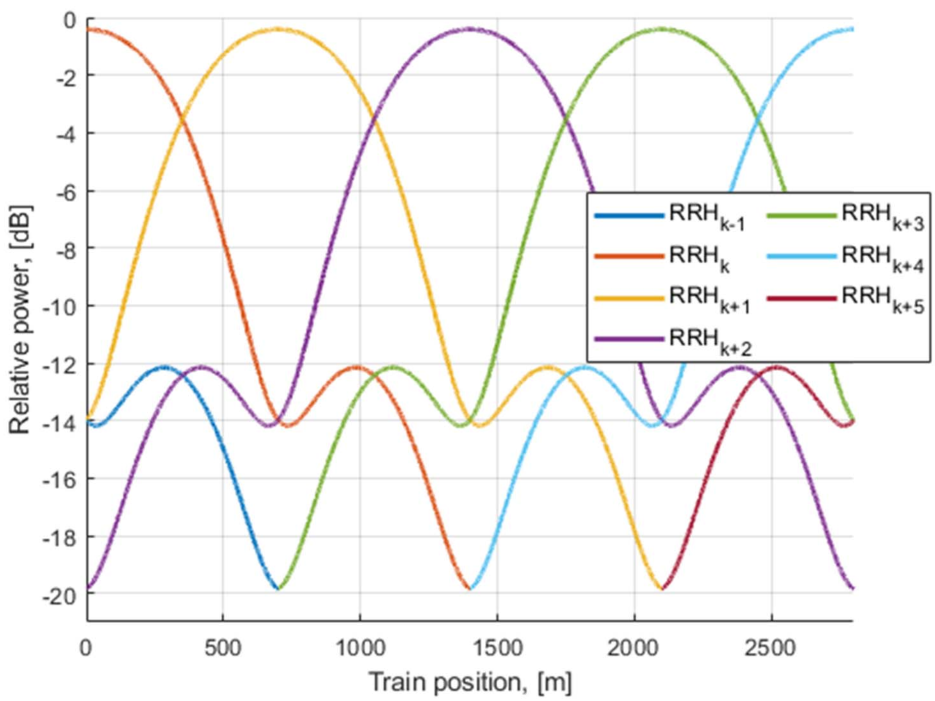



**Figure B.3.2-2 Relative power level trajectories**

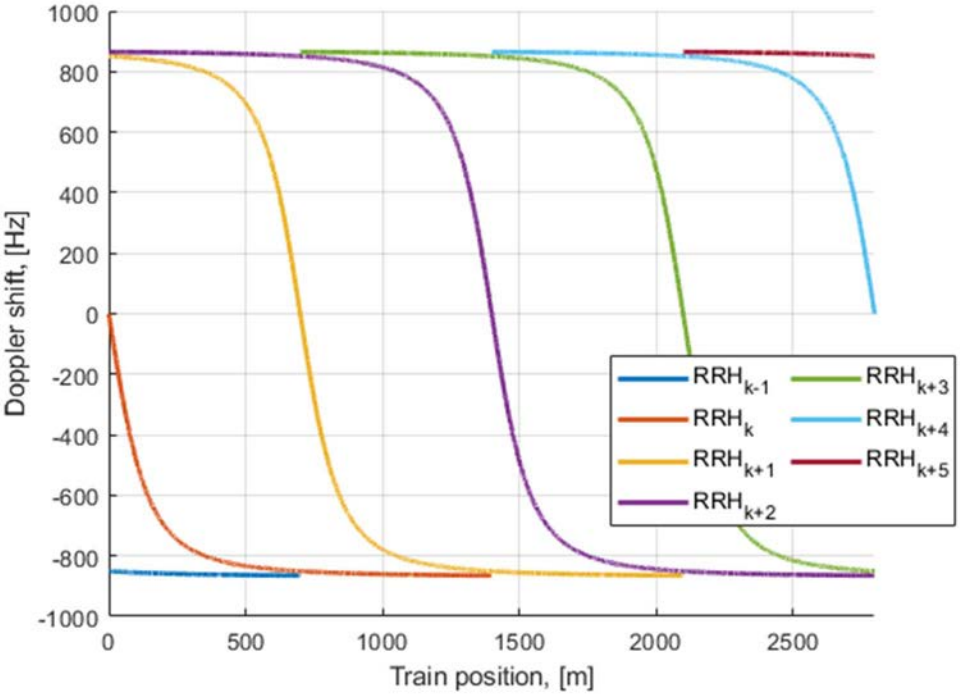



**Figure B.3.2-3 Doppler shift trajectories ( $f_d$ = 870 Hz)**

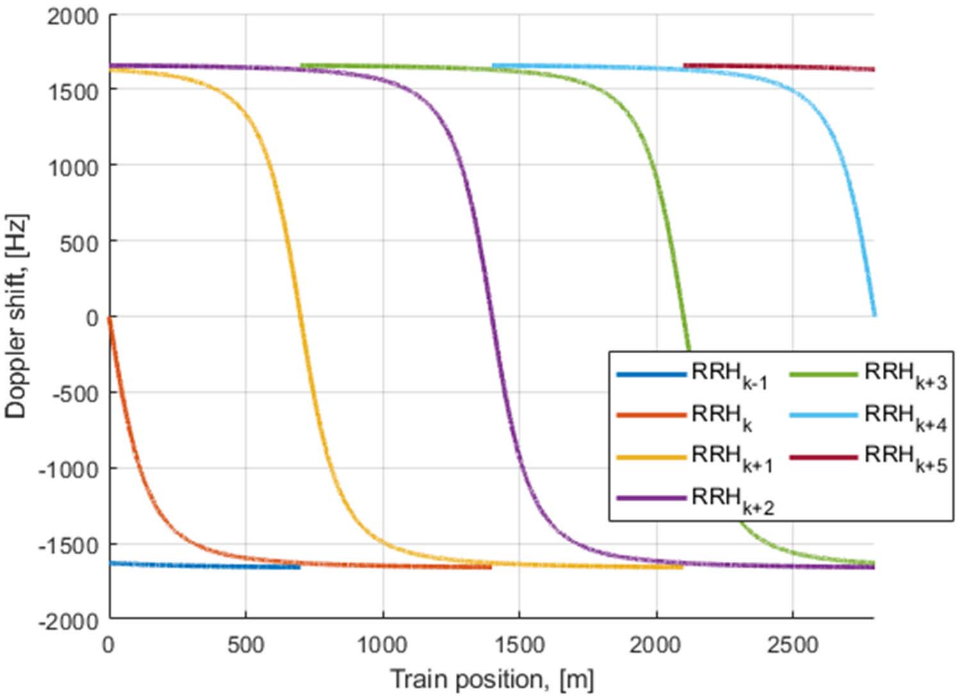



**Figure B.3.2-4 Doppler shift trajectories ( $f_d$ = 1667 Hz)**

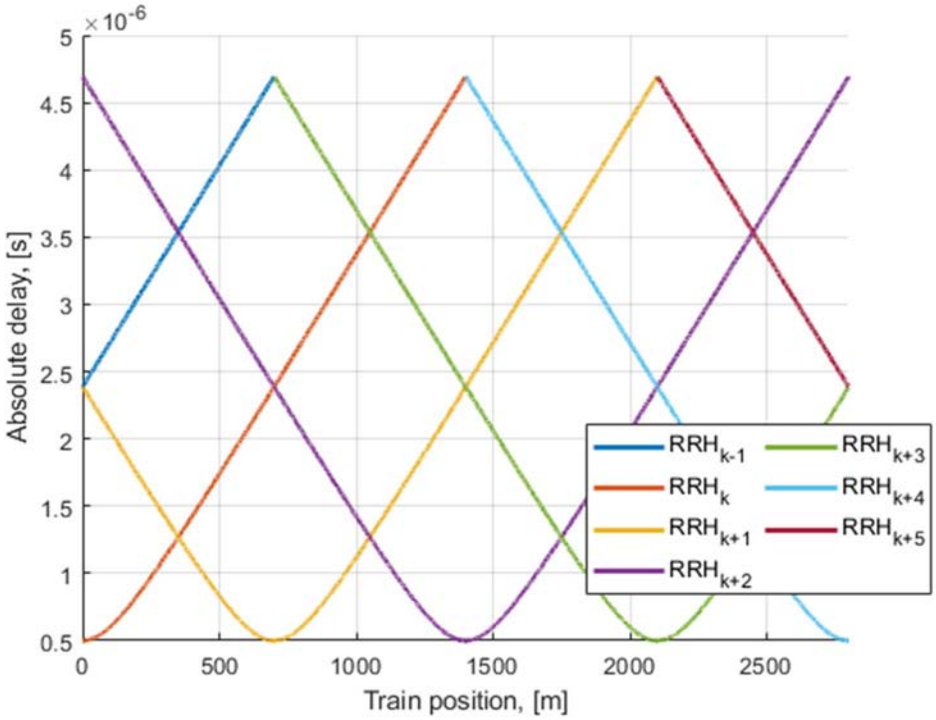



**Figure B.3.2-5 Absolute delay trajectories**

Static channel matrix will be used as defined in Annex B.1.

# B.3.3 HST-DPS Channel Profile

There is an infinite number of RRHs distributed equidistantly along the railway track with the same Cell ID as illustrated in Figure B.3.3-1.

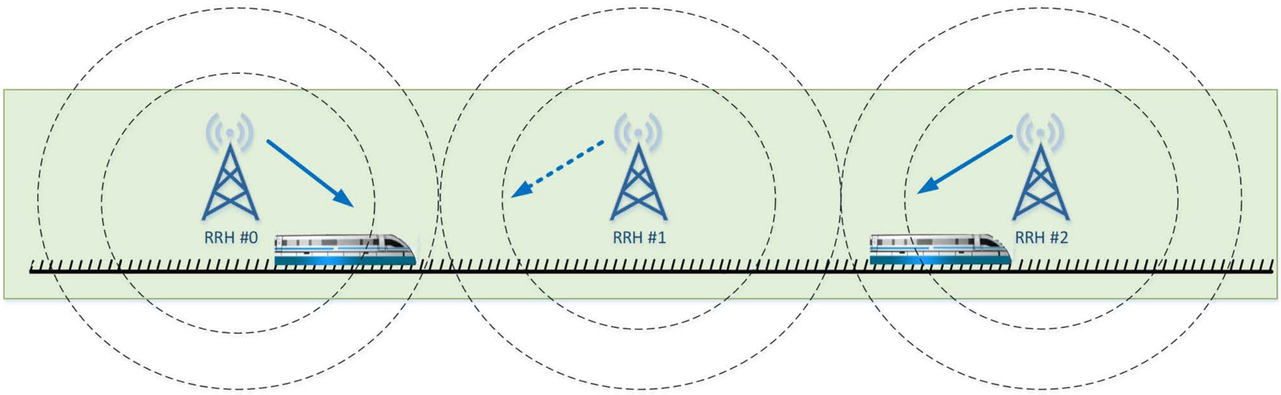



**Figure B.3.3-1: Deployment of HST-DPS**

The location of RRH *k* is given as:

$$x_k = k * D_s + j * D_{\min} \qquad \text{(B.3.3.1)}$$

where: $k \in [-\infty, \infty]$, $j = sqrt(-1)$ and $D_{\min}$ is the distance between the RRHs and railway track, while $D_s$ is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = a + j * 0 \qquad \text{(B.3.3.2)}$$

where: $a \in [0, \infty]$ and *a* means distance in meters, which means the train is right on the track.

The HST DPS multi-RRH scenario for the test of the baseband performance is a single tap propagation channel at each time with switching of transmission point in the middle point between two RRHs. RRH *k* is visible for the train only in the range:

$$k * D_s - \frac{D_s}{2} \leq a < k * D_s + \frac{D_s}{2} \qquad \text{(B.3.3.3)}$$

However, RRH k is considered for PDSCH and PDCCH signal transmission only in the range:

$$k * D_s - \frac{D_s}{2} \leq a < k * D_s + \frac{D_s}{2} \qquad \text{(B.3.3.4)}$$

Propagation delay difference are not considered between signals from different RRHs.

Power level $P_k$ (dB) for the signal from each RRH equals to 0. Doppler shift $F_{D,k}$ (Hz) from $k^{th}$ RRH is given by:

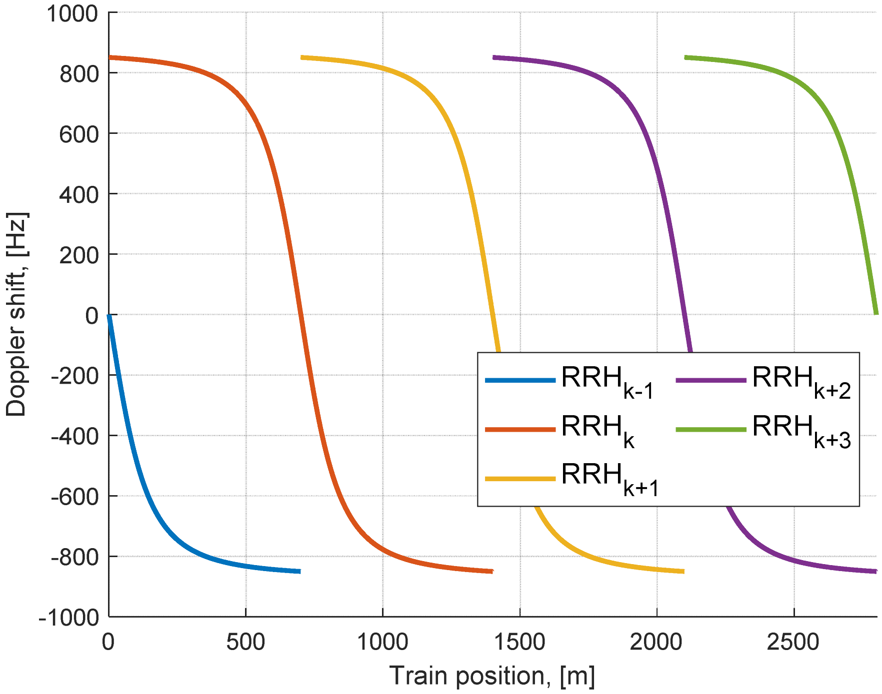
$$F_{D,k} = f_C \times real\left[ -v \times \frac{y - x_k}{|y - x_k| \times C} \right] \text{ for } k * D_s - \frac{D_s}{2} \leq a < k * D_s + \frac{D_s}{2} \qquad \text{(B.3.3. 5)}$$

In the above v (m/s) is the moving speed of the train, $f_C$ (Hz) is the centre frequency, and C (m/s) is the velocity of light.

Doppler shift is given by equation B.3.3.4, where the required input parameters listed in table B.3.3-1 and the resulting Doppler shift shown in Figures B.3.3-2 and B.3.3-3 are applied for all requency bands.

**Table B.3.2-1: HST-DPS scenario**

| Parameter | Value |
|---|---|
| $D_s$ | 700 m |
| $D_{\text{min}}$ | 150 m |
| $v$ | 500 km/h |
| $f_d$ | 870 Hz for 15 kHz SCS test;<br>1667 Hz for 30 kHz SCS test |



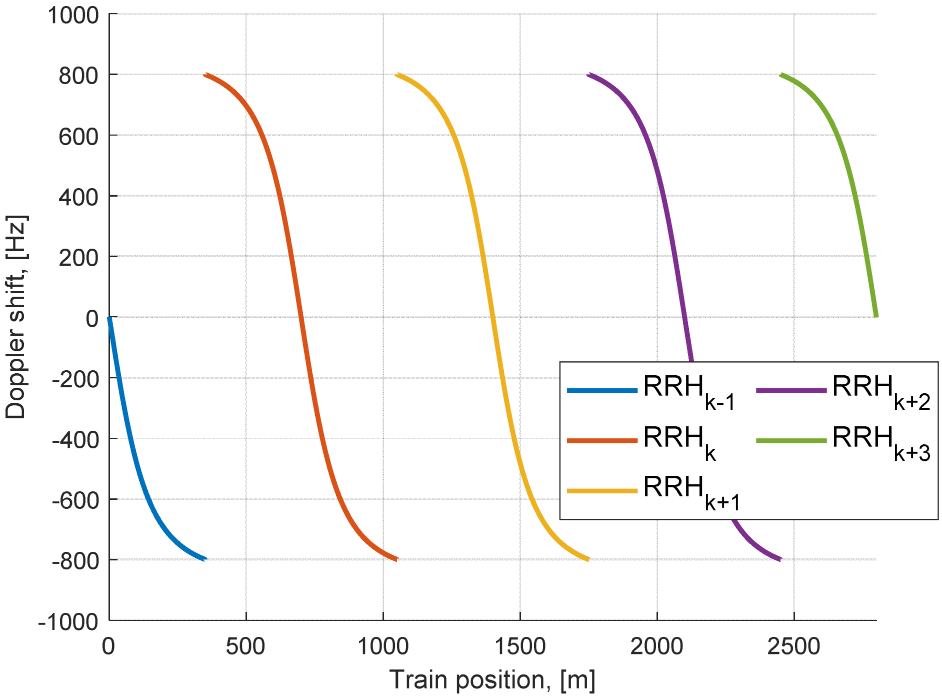




**Figure B.3.3-2 Doppler shift trajectory ( $f_d$ = 870 Hz)**

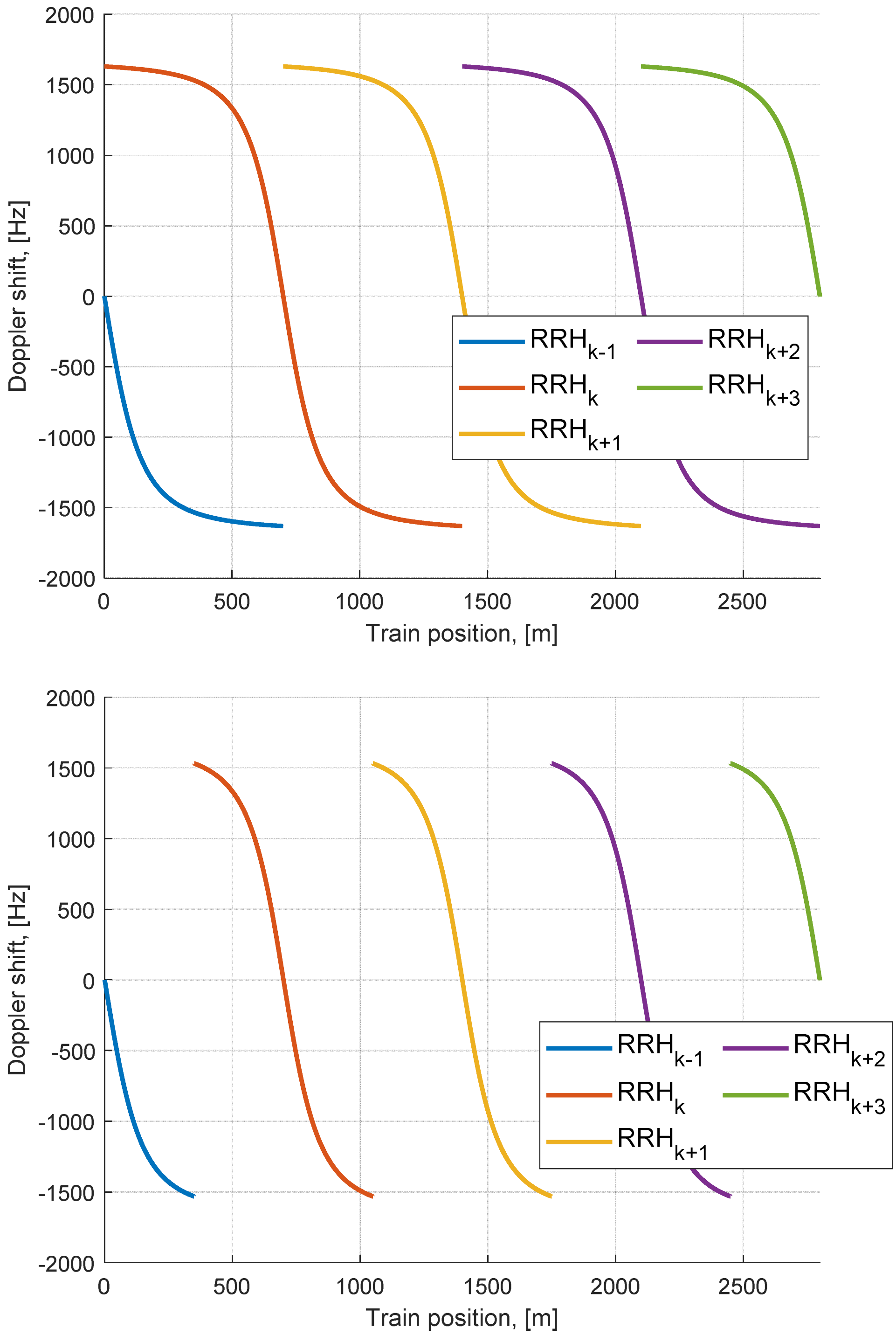



**Figure B.3.3-3 Doppler shift trajectory ( $f_d$ = 1667 Hz)**

Static channel matrix will be used as defined in Annex B.1.

# B.4 Physical signals, channels mapping and precoding

## B.4.1 General

Unless otherwise stated, the transmission on antenna port(s) $p = p_0, p_0 + 1, \ldots, p_0 + N_p - 1$ is defined by using a precoder matrix $W(i)$ of size $N_{ANT} \times N_p$, where $N_{ANT}$ is the number of physical transmit antenna elements configured per test , $N_p$ is the number of ports for a reference signal or physical channel configured per test, and $p_0$ is the first port for that reference signal or physical channel as defined in clauses 7.3 and 7.4 in TS 38.211 [9]. This precoder takes as an input a block of signals for antenna port(s) $p = p_0, p_0 + 1, \ldots, p_0 + N_p - 1$, $y^{(p)}(i) = \left[y^{(p_0)}(i)\ \ y^{(p_0+1)}(i)\ \ \ldots\ \ y^{(p_0+N_p-1)}(i)\right]^T$, $i = 0,1,\ldots,M_{\mathrm{symb}}^{\mathrm{ap}} - 1$, with $M_{\mathrm{symb}}^{\mathrm{ap}}$ being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i)\ \ y_{bf}^{(1)}(i)\ \ \ldots\ \ y_{bf}^{(N_{ANT}-1)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair $(k,l)$ as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = W(i)y^{(p)}(i)$$

For Clause 6 and 8, the transmission of PDCCH and PDCCH DMRS on antenna port $p = p_0$ is defined by using a precoder matrix $W(i)$ of size 2x1. This precoder takes as an input a block of signals for antenna port(s) $p = p_0$, $y^{(p)}(i) = y^{(p_0)}(i)$ and generates a block of signals $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i)\ \ y_{bf}^{\left(\frac{N_{ANT}}{2}\right)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair $(k,l)$ as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = W(i)y^{(p)}(i)$$

The precoder matrix $W(i)$ is specific to the test case configuration. $W(i)$ is defined in Clause 5.2.2.2 of TS 38.214 [12].

The transimison on PT-RS antenna port is associated (using same precoder) with the lowest indexed DM-RS antenna port among the DM-RS antenna ports assigned for the PDSCH.

The physical antenna elements are identified by indices $j = 0,1,\ldots,N_{ANT} - 1$, where $N_{ANT}$ is the number of physical antenna elements configured per test.

Modulation symbols $y^{(p)}(i)$ with $p \in \{4000\}$ (i.e. PSS, SSS, PBCH and DM-RS for PBCH) are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}$ for CSI-RS resources which configured for tracking with one port are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}$ for CSI-RS resources which configured for beam refinement with one port are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}^{(p)}$ for NZP CSI-RS which configured for CSI acquisition with $p \in \{p_0, p_0 + 1, \ldots, p_0 + N_{CSI} - 1\}$ are mapped to the physical antenna index $j = p - p_0$ where $N_{CSI}$ is the number of NZP CSI-RS ports configured per test.

# Annex C (normative): Downlink physical channels

# B.5 Downlink Transmission Model for requirements on bands with shared spectrum access

This clause provides a description of the Downlink Transmission Model to be used in PDSCH Demodulation and CQI reporting performance tests on bands with shared spectrum access.

The model as designed in the following applies to both configurations for *channelAccessMode*=’semiStatic’ or ‘dynamic’.

## B.5.1 Downlink Transmission Model for bands with shared spectrum access

The Downlink Period for performance tests on bands with shared spectrum access is defined as the duration included in the Test Configuration Parameters.

For tests configured with the RRC Parameter *channelAccessMode*=’semiStatic’, the duration of the Fixed Frame Period (FFP) equals the duration of the Downlink Period.

For each Downlink Period, the downlink signal to be transmitted is allocated according to the steps listed below:

1. Select the Downlink Transmission Duration in number of slots, randomly and with equally distributed probability, from the set of possible Downlink Transmission Duration values as included in the Test Configuration Parameters;
   a. This duration includes occupied OFDM symbols and non-occupied OFDM symbols within the Downlink Transmission;
2. Depending on the Downlink Transmission Duration chosen in the previous step:
   b. If the Downlink Transmission Duration equals 2 slots, all the OFDM symbols in both slots are fully allocated to downlink transmission, else;
   c. If the Downlink Transmission Duration is larger than 2 slots, the configuration of occupied symbols in the last slot included in the downlink duration is selected in number of symbols, randomly and with equally distributed probability, from the set of possible ‘Occupied OFDM symbols in the last slot of the downlink duration’ as included in the Test Configuration Parameters;

For each Downlink Period, the last Slot is not scheduled for downlink transmission. This is to comply with the Idle period requirement in case of *channelAccessMode*=’semiStatic’, and to align the test setup. In the case of *channelAccessMode*=’semiStatic’, it can be assumed that the Channel Occupancy Time (COT) covers the entire duration of the Downlink Period except for the last slot.

For each Downlink Period, a uniform random variable from [0, 1] is generated. If the random variable is less than the $p_{LBT}$ value included in the Test Configuration Parameters, the entire Downlink Period duration is muted across the entire bandwidth. This applies to all the signals that were scheduled for transmission, including but not limited to PDSCH, PDCCH, SSB, TRS, CSI-RS, etc.

# 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

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 (Note 2) |
|---|---|---|
| SSS transmit power | W | Test specific |
| EPRE ratio of PSS to SSS | dB | 0 |
| EPRE ratio of PBCH to SSS | dB | 0 |
| EPRE ratio of PBCH to PBCH DMRS | dB | 0 |
| EPRE ratio of PDCCH to SSS | dB | 0 |
| EPRE ratio of PDCCH to PDCCH DMRS | dB | 0 |
| EPRE ratio of PDSCH to SSS | dB | 0 |
| EPRE ratio of PDSCH to PDSCH DMRS | dB | Test specific (Note 1) |
| EPRE ratio of CSI-RS to SSS | dB | -10*log10(L) (Note 3) |
| EPRE ratio of OCNG to SSS | dB | 0 |
| EPRE ratio of PDCCH OCNG to SSS | dB | 0 |
| EPRE ratio of LTE CRS to NR SSS | dB | 0 (Note 4) |
| Note 1: Value is derived from Table 4.1-1 in TS 38.214 [12] based on "Number of DM-RS CDM groups without data" and "DMRS Type" parameters specified for each test.<br>Note 2: The value is the energy of per RE for a single antenna port before pre-coding.<br>Note 3: $L \in \{1,2,4,8\}$ is the CDM group size of NZP CSI-RS specified for each test.<br>Note 4: It is only applicable to LTE-NR coexistence tests. | | |

# 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

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 (Note 2) |
|---|---|---|
| SSS transmit power | W | Test specific |
| EPRE ratio of PSS to SSS | dB | 0 |
| EPRE ratio of PBCH to SSS | dB | 0 |
| EPRE ratio of PBCH to PBCH DMRS | dB | 0 |
| EPRE ratio of PDCCH to SSS | dB | 0 |
| EPRE ratio of PDCCH to PDCCH DMRS | dB | 0 |
| EPRE ratio of PDSCH to SSS | dB | 0 |
| EPRE ratio of PDSCH to PDSCH DMRS | dB | Test specific (Note 1) |
| EPRE ratio of CSI-RS to SSS | dB | -10*log10(L) (Note 3) |
| EPRE ratio of PTRS to PDSCH | dB | Test specific |
| EPRE ratio of OCNG to SSS | dB | 0 |
| EPRE ratio of PDCCH OCNG to SSS | dB | 0 |
| Note 1: Value is derived from Table 4.1-1 in TS 38.214 [12] based on "Number of DM-RS CDM groups without data" and "DMRS Type" parameters specified for each test.<br>Note 2: The value is the energy of per RE for a single antenna port before pre-coding.<br>Note 3: $L \in \{1,2,4,8\}$ is the CDM group size of NZP CSI-RS specified for each test.<br>Note 4: Value is derived from Table 4.1-2 in TS 38.214 [12] based on “The number of PDSCH layers” and “*epre-Ratio*” parameters specified for each test. | | |

# Annex D (informative): 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 temperature range defined in Table E.2.1-1.

**Table E.2.1-1: Temperature conditions**

| | |
|---|---|
| +15°C to +35°C | For normal conditions (with relative humidity of 25 % to 75 %) |

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 clause 6.2 of TS 38.101-1 [6] for extreme operation.

## E.2.2 Voltage

The UE shall fulfil all the requirements in the voltage range defined in Table E.2.2-1.

**Table E.2.2-1: Voltage conditions**

| Power source | Normal conditions voltage |
|---|---|
| AC mains | nominal |
| Regulated lead acid battery | 1,1 * nominal |
| Non regulated batteries:<br>Leclanché<br>Lithium<br>Mercury/nickel & cadmium | <br>Nominal<br>1,1 * Nominal<br>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, Clause 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 $m^2/s^3$ |
| 20 Hz to 500 Hz | 0,96 $m^2/s^3$ 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% |

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 clause 6.2 of TS 38.101-2 [7] for extreme operation.

### E.3.2 Voltage

*<Editor's note: This requirement is incomplete. The following aspects are either missing or not yet determined:*

*Methodology to control the voltage in a case which a power cable is not connected to DUT is FFS since it is not agreed whether we can connect the power cable to DUT at the OTA measurement situation yet.*

>

The UE shall fulfil all the requirements in the voltage range defined in Table E.3.2-1.

**Table E.3.2-1: Voltage conditions**

| Power source | Normal conditions voltage |
|---|---|
| AC mains | nominal |
| Regulated lead acid battery | 1,1 * nominal |
| Non regulated batteries:<br>Leclanché<br>Lithium<br>Mercury/nickel & cadmium | <br>Nominal<br>1,1 * Nominal<br>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 clause 6.2 of TS 38.101-2 [7] 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.3.3 Void

# Annex G (informative): Void

# Annex H (informative): Void

# Annex I (informative): Void

# Annex J (informative): Void

# Annex K (informative): Void

# Annex L (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 |
| 2018-08 | RAN4#88 | R4-1811357 | | | | Skeleton update | 0.0.2 |
| 2018-10 | RAN4#88 bis | R4-1814237 | | | | Approved Text Proposal in RAN4#88bis:<br>R4-1814053, "TP on performance specification 38.101-4 Chapter 4 general part"<br>R4-1814054, "TP to TS 38.101-4: FR1 PDSCH demodulation requirements (5.2)"<br>R4-1813924, "TP for introducing FR1 PDCCH requirements in TS 38.101-4 clause 5.3"<br>R4-1814058, "TP for 38.101-4 section 6.3 FR1 PMI test cases"<br>R4-1814060, "Draft TP on FR1 Rank Indication Reporting Performance Requirements"<br>R4-1814055, "Draft TP on FR2 PDSCH Demodulation Performance Requirements"<br>R4-1814022, "TP to TS38.101-4 Section 7.3: PDCCH demodulation requirements"<br>R4-1814059, "TP for 38.101-4 section 8.3 FR2 PMI test cases"<br>R4-1814061, "Draft TP on FR2 Rank Indication Reporting Performance Requirements"<br>R4-1813925, "TP for introducing demodulation performance requirements for interworking TS 38.101-4 section 9"<br>R4-1814052, "TP for 38.101-4 section 10 CSI test cases of interworking"<br>R4-1814066, "TP on channel models for TS38.101-4"<br>R4-1814023, "TP to TS38.101-4 Annex C: Downlink physical channels"<br>R4-1814024, "TP to TS38.101-4 Annex E: Environmental conditions" | 0.1.0 |
| 2018-11 | RAN4#89 | R4-1816559 | | | | Approved Text Proposal in RAN4#89:<br>R4-1814053, "TP on performance specification 38.101-4 Chapter 4 general part"<br>R4-1814487, "TP for TS38.101-4 section 2 (Reference)"<br>R4-1814488, "TP for TS38.101-4 section 3 (Definitions, symbols and abbreviations)"<br>R4-1814579, "TP to TS 38.101-4: Annex A Measurement channels – PDSCH"<br>R4-1814580, "TP to TS 38.101-4: Annex A Measurement channels - DL Control"<br>R4-1814581, "TP to TS 38.101-4: Annex A Measurement channels – CSI"<br>R4-1816395, "FR2 demod: Noc, Band groups and Ref point - TP for TS 38.101-4"<br>R4-1816692, "TP to TS 38.101-4: Requirements applicability"<br>R4-1816693, "TP for performance requirements for interworking (9)"<br>R4-1816694, "TP to TS 38.101-4: FR1 PDSCH demodulation requirements (5.2)"<br>R4-1816695, "Draft TP on FR2 PDSCH Demodulation Performance Requirements"<br>R4-1816697, "TP for updating FR1 PDCCH requirements in TS 38.101-4 section 5.3"<br>R4-1816699, "TP to TS 38.101-4: 5.4 FR1 PBCH demodulation requirements"<br>R4-1816700, "TP to TS 38.101-4: 7.4 FR2 PBCH demodulation requirements"<br>R4-1816701, "TP of introduction of FR1 CQI requirement (6.2)"<br>R4-1816702, "TP to TS 38.101-4: FR2 CQI requirements (8.2)"<br>R4-1816703, "Draft TP on FR1 Rank Indication Reporting Performance Requirements"<br>R4-1816704, "Draft TP on FR2 Rank Indication Reporting Performance Requirements"<br>R4-1816705, "TP for TS 38.101-4 FR1 PMI test requirement"<br>R4-1816706, "TP to TS 38.101-4 FR2 PMI requirements"<br>R4-1816712, "TP to TS 38.101-4: FR1 SDR requirements (5.5) "<br>R4-1816713, "TP to TS38.101-4 Section 7.3: PDCCH demodulation requirements"<br>R4-1816714, "TP for propagation conditions in TS 38.104-4(Annex B)" | 0.2.0 |
| 2018-12 | RAN#82 | RP-182408 | | | | V1.0.0 is submitted to RAN for 1-step approval | 1.0.0 |
| 2018-12 | RAN#82 | RP-182704 | | | | V1.0.1 with editorial changes | 1.0.1 |
| 2018-12 | RAN#82 | | | | | Approved by plenary – Rel-15 spec under change control | 15.0.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2019-03 | RAN#83 | RP-190403 | 0001 | | B | CR on UE demodulation and CSI requirements for 38.101-4<br><br>This CR comboines all the endorsed draft CRs as list below:<br>General sections<br>R4-1902427, Draft CR on NR UE demodulation requirements applicability (Intel Corporation)<br>R4-1902576, Draft CR on General Applicability of Requirements (Qualcomm Incorporated)<br>R4-1902412, Editorial cleanup of FR2 Radiated Requirements General section (ANRITSU)<br>PDSCH<br>R4-1902414, Draft CR on FR1 normal PDSCH demodulation requirements (Intel Corporation)<br>R4-1902415, Draft CR on FR2 PDSCH Requirements (Qualcomm Incorporated)<br>R4-1902411, Draft CR on FR1 SDR requirements (Intel Corporation)<br>PDCCH<br>R4-1902416 Draft CR for updating FR1 PDCCH performance requirements in TS38.101-4Huawei, HiSilicon<br>R4-1902423 Draft CR for updating FR2 PDCCH performance requirements in TS38.101-4 section 7.3 CATT<br>PBCH<br>R4-1902420, Draft CR on 2Rx PBCH demodulation requirement for FR1 (CMCC)<br>R4-1902421, Draft CR on 4Rx PBCH demodulation requirements for FR1 (CMCC)<br>R4-1902422, Draft CR on 2Rx PBCH demodulation requirement for FR2 (CMCC)<br>CSI<br>R4-1902418, Draft CR on FR2 CSI Reporting Tests (Qualcomm Incorporated)<br>R4-1902419, Draft CR on FR1 CSI Reporting Tests (Qualcomm Incorporated)<br>R4-1900105, Draft CR on NR CSI reporting (Intel Corporation)<br>R4-1902058, Draft CR for update of FR1 CQI reporting test (Huawei, HiSilicon)<br>R4-1902059, Draft CR for update of FR2 CQI reporting test (Intel)<br>R4-1902426, Draft CR for PMI test cases: 6.2, 8.2, A.3.2.2.2, A.3.2.2.5 (Samsung)<br>R4-1902425, Draft CR for FR1 and FR2 RI test cases (Qualcomm)<br>Annex<br>R4-1900369, Draft CR on PDSCH FRC (Intel Corporation)<br>R4-1900370, Draft CR on PDCCH FRC (Intel Corporation)<br>R4-1902424, Corrections to 38.101-4 clause B.2.1 Delay profile calculation (Huawei, HiSilicon)<br>R4-1902575, Draft CR on Beamforming Model (Qualcomm)<br><br>Additional modifications:<br>- Compared to endorsed CR R4-1902414, requirements for several FR1 PDSCH test cases were modified to correct stat error<br>- Correct the format for Annex A.x<br>- Correct table number under PDSCH section 5.2.3.1.3<br>- Some minor editorial changes<br><br>Editorial changes after RAN#83<br>To align the annex numbering with other specifications (TS 38.101-x series), annexes J and K were added and Change history was numbered as annex L. | 15.1.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2019-06 | RAN#84 | RP-191240 | 0002 | | B | CR to TS 38.101-4: Implementation of endorsed draft CRs from RAN4#90bis and RAN4#91<br><br>endorsed draft CRs from RAN4#90bis<br>R4-1902885, Draft CR on DL power allocation for TS 38.101-4<br>R4-1903387, Draft CR for adding applicable rules on CSI test cases: 6, 8, 10<br>R4-1903471, Draft CR on PBCH requirements<br>R4-1904750, draftCR on RMC for demod requirement for 38.101-4<br>R4-1904751, Clarification on step 5 and step 6 for delay profiles calculation in B.2.1<br>R4-1904756, Draft CR on FR1 normal PDSCH demodulation requirements<br>R4-1904757, Draft CR on FR2 PDSCH Demodulation Performance Tests<br>R4-1904758, Draft CR on EN-DC SDR requirements<br>R4-1904759, Addition of alternative TDD configuration for UE demodulation requirements<br>R4-1904765, Draft CR on FR2 PDCCH demodulation requirements<br>R4-1904766, draftCR: Updates to FR1 PDCCH demodulation requirements<br>R4-1904767, Draft CR for Beamforming model: Annex B.4.1<br>R4-1904768, Draft CR for modification on CSI test cases: 6, 8, 10<br>R4-1904776, Draft CR on FR1 SDR requirements<br>R4-1904777, Draft CR on FR2 SDR Requirements<br>R4-1904778, Draft CR on PDSCH DL RMC<br>R4-1904779, Draft CR to TS38.101-4: Correction to FR1 CSI test cases<br>R4-1904780, Draft CR to TS38.101-4: Correction to FR2 CSI test cases<br>R4-1904796, Draft CR to 38.101-4 on applicable SNR level for FR2<br>R4-1904833, Draft CR to TS 38.101-4 on SNR, Es and Noc setup<br><br>endorsed draft CRs from RAN4#91<br>R4-1906069, Draft CR on PBCH requirements<br>R4-1906706, Editorial corrections for 38.101-4 PBCH tables<br>R4-1907194, Draft CR on Noc and Es setup<br>R4-1907293, Draft CR to TS38.101-4 for FR2 SDR test cases<br>R4-1907294, draftCR: Introduce single-tap HST channel model in TS 38.101-4<br>R4-1907295, draftCR: updates to FR2 PDSCH test parameters<br>R4-1907296, draftCR: updates to FRC for demodulation performance<br>R4-1907297, draftCR: updates to FR1 CQI reporting test cases in section 6.2<br>R4-1907298, Draft CR to 38.101-4 on Applicability of requirements<br>R4-1907299, Draft CR to 38.101-4 on Demodulation requirements for interworking<br>R4-1907300, Draft CR to 38.101-4 on CSI requirements for interworking<br>R4-1907301, Draft CR on FR1 normal PDSCH demodulation requirements<br>R4-1907302, Draft CR on PDSCH FRC<br>R4-1907303, Draft CR on FR2 CSI Reporting tests<br>R4-1907304, Editorial corrections for 38.101-4 PDCCH tables<br>R4-1907307, draftCR: updates to FR1 PDSCH test parameters<br>R4-1907308, Draft CR on EN-DC SDR requirements<br>R4-1907309, Draft CR to TS38.101-4 on adding FRC for sub-band CQI test cases<br>R4-1907310, Draft CR to TS38.101-4: Environmental conditions (Annex E)<br>R4-1907315, Draft CR on SDR requirements for NR CA between FR1 and FR2 | 15.2.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2019-09 | RAN#85 | RP-192022 | 0008 | | F | CR to TS 38.101-4: Implementation of endorsed draft CRs from RAN4#92 (Rel-15)<br><br>R4-1907978, Update of Noc values for Power class 2 demodulation test<br>R4-1908202, Draft CR to TS 38.101-4: Environmental conditions<br>R4-1908215, Draft CR to TS 38.101-4: Clarification of PTRS configuration for FR2 tests<br>R4-1908217, Draft CR to TS 38.101-4: DL power configuration in radiated tests<br>R4-1908517, Draft CR to TS 38.101-4: Corrections of FRC for FR2 PMI tests<br>R4-1909250, Editorial change to correct TDD measurement channels<br>R4-1909252, Editorial correction to PBCH requirements<br>R4-1909253, Editorial correction to PDSCH reference channels<br>R4-1909862, draft CR: updates to FR2 PDSCH test parameters<br>R4-1909864, draftCR: Introduce single-tap HST channel model in TS 38.101-4<br>R4-1910020, Antenna configuration for LTE cell in EN-DC<br>R4-1910021, DraftCR to 38.101-4 : Corrections to Interworking requirements<br>R4-1910023, Draft CR to TS 38.101-4: Enhanced SU-MIMO receiver definition<br>R4-1910024, draftCR: addition of test applicability for features with UE capability<br>R4-1910053, Draft CR on corrections and missing parameters for PDSCH demodulation performance tests<br>R4-1910054, Draft CR to TS 38.101-4: NR FR1 PDSCH requirements finalization<br>R4-1910055, Draft CR to TS 38.101-4: Corrections for SDR requirements<br>R4-1910056, Editorial correction to formatting on SDR table<br>R4-1910057, draft CR: updates to FR1 PDSCH test parameters<br>R4-1910058, Draft CR on corrections for PDCCH demodulation performance tests<br>R4-1910060, Draft CR on corrections for CSI Reporting performance tests<br>R4-1910061, Draft CR on updates to FR1 CSI reporting test<br>R4-1910062, Draft CR on updates to FR2 CSI reporting test<br>R4-1910129, Draft CR to TS 38.101-4: Applicability of minimum requirements<br>R4-1910563, Updates to NR PDCCH test parameters | 15.3.0 |
| 2019-12 | RAN#86 | RP-192998 | 0009 | 2 | F | CR to TS 38.101-4: Corrections for applicability rules (R15) | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0010 | | F | CR to TS 38.101-4: Editorial corrections for PDSCH RMC (R15) | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0011 | | B | CR to TS 38.101-4: Introduction of NE-DC and NR-DC SDR requirements (R15) | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0014 | 1 | F | CR on corrections for MIMO Correlation Matrices | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0015 | 1 | F | CR on corrections for FR1 PDSCH demodulation performance tests | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0016 | 1 | F | CR on corrections for FR2 PDSCH demodulation performance tests | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0017 | 1 | F | CR on corrections for FR1 CSI Reporting performance tests | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0018 | 1 | F | CR on corrections for FR2 CSI Reporting performance tests | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0019 | | F | Editorial change on reference PDCCH payload size | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0021 | 1 | F | Editorial CR to correct PMI test cases | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0023 | 1 | F | CR for TS38.101-4: Angle of arrival for radiated UE demodulation testing | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0024 | | F | CR on demodulation performance requirements for EN-DC including FR1 and FR2 CCs | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0025 | | F | CR: Correction on NR PDCCH demodulation performance requirements | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0026 | | F | CR on CSI reporting requirements for EN-DC including FR1 and FR2 CCs | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0027 | 1 | B | CR on NE-DC and NGEN-DC performance requirements | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0028 | 1 | B | CR on NR-DC performance requirements | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0029 | | F | CR: Updates to NR RMC for UE performance requirements | 15.4.0 |
| 2019-12 | RAN#86 | RP-192998 | 0030 | 1 | F | CR: Updates to NR EN-DC SDR tests | 15.4.0 |
| 2020-03 | RAN#87 | RP-200397 | 0031 | 1 | F | Clarification of Random PMI when testing | 15.5.0 |
| 2020-03 | RAN#87 | RP-200397 | 0032 | 1 | F | Correction to 5.3.3 4Rx PDCCH Demod Requirements | 15.5.0 |
| 2020-03 | RAN#87 | RP-200397 | 0033 | 1 | F | CR on corrections for FR1 PDSCH demodulation performance tests | 15.5.0 |
| 2020-03 | RAN#87 | RP-200397 | 0034 | 1 | F | CR to TS 38.101-4: Editorial corrections (R15) | 15.5.0 |
| 2020-03 | RAN#87 | RP-200397 | 0037 | | F | CR on number of NZP CSI-RS ports for RI reporting test in a TDD 4Rx test case | 15.5.0 |
| 2020-03 | RAN#87 | RP-200397 | 0038 | | F | CR: Updates to NR PDSCH test parameters (Rel-15) | 15.5.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2020-03 | RAN#87 | RP-200379 | 0035 | | B | CR to TS 38.101-4: LTE-NR coexistence requirements for TDD mode (R16) | 16.0.0 |
| 2020-06 | RAN#88 | RP-200985 | 0040 | | A | CR to Aperiodic Report Slot Offset for CQI report | 16.1.0 |
| 2020-06 | RAN#88 | RP-200985 | 0044 | | A | CR to TS 38.101-4: Beamforming clarification (R16) | 16.1.0 |
| 2020-06 | RAN#88 | RP-201043 | 0045 | | F | CR to TS 38.101-4: CR on TDD LTE-NR coexistence requirements finalization | 16.1.0 |
| 2020-06 | RAN#88 | RP-200985 | 0047 | | A | CR to TS 38.101-4: MIMO correlation matrices definition (R16) | 16.1.0 |
| 2020-06 | RAN#88 | RP-200985 | 0054 | | A | CR for correction of Angle of Arrival for Radiated Requirements in section 4 | 16.1.0 |
| 2020-06 | RAN#88 | RP-200985 | 0055 | | A | CR: updates to NR CSI test | 16.1.0 |
| 2020-06 | RAN#88 | RP-201048 | 0042 | 1 | F | CR on max MIMO layer assumption in TS38.101-4 | 16.1.0 |
| 2020-06 | RAN#88 | RP-200985 | 0056 | | A | Update of DL physical channels definitions | 16.1.0 |
| 2020-06 | RAN#88 | RP-200985 | 0057 | | A | CR: clarification on EPRE ratio definition | 16.1.0 |
| 2020-09 | RAN#89 | RP-201512 | 0059 | | A | CR to ZP-CSI-RS configuration | 16.2.0 |
| 2020-09 | RAN#89 | RP-201512 | 0061 | | A | CR to 2Rx PDSCH mapping type B | 16.2.0 |
| 2020-09 | RAN#89 | RP-201499 | 0074 | | B | CR for TS 38.101-4: Applicability for NR PMI requirements with Tx ports larger than 8 and up to 32 | 16.2.0 |
| 2020-09 | RAN#89 | RP-201499 | 0075 | | B | Addition of Rel-16 SP Type I PMI tests, FRCs, and spatial correlation matrices | 16.2.0 |
| 2020-09 | RAN#89 | RP-201512 | 0078 | | A | CR on Corrections in 38.101-4 | 16.2.0 |
| 2020-12 | RAN#90 | RP-202489 | 0080 | | A | Update of Noc for NR operating bands in FR2 | 16.3.0 |
| 2020-12 | RAN#90 | RP-202489 | 0082 | | A | Correction to FR1 Aperiodic CSI Reporting | 16.3.0 |
| 2020-12 | RAN#90 | RP-202489 | 0084 | | A | Correction to FR2 PMI Aperiodic CSI Reporting | 16.3.0 |
| 2020-12 | RAN#90 | RP-202416 | 0085 | 1 | B | CR on requirements with slot aggregation in FR2 | 16.3.0 |
| 2020-12 | RAN#90 | RP-202423 | 0088 | | B | Draft CR on FRC for Normal NR CA demodulation requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202422 | 0090 | 1 | B | CR to TS 38.101-4: HST-SFN FDD performance requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202422 | 0091 | 1 | B | CR to TS 38.101-4: Propagation conditions for HST scenarios | 16.3.0 |
| 2020-12 | RAN#90 | RP-202422 | 0092 | 1 | B | CR on HST-SFN requirements for TDD | 16.3.0 |
| 2020-12 | RAN#90 | RP-202423 | 0093 | 1 | B | Introduction of NR PDSCH FR1 CA 2Rx performance requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202423 | 0094 | 1 | B | CR: FR1 EN-DC power imbalance requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202422 | 0097 | 1 | B | CR on HST DPS requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202422 | 0098 | 1 | B | CR on HST single-tap and HST multi-path fading requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202422 | 0099 | 1 | B | CR on applicability rules for HST scenarios | 16.3.0 |
| 2020-12 | RAN#90 | RP-202416 | 0100 | 1 | B | CR to TS 38.101-4: Addition of UE performance requirements for FR1 URLLC PDSCH repetitions over multiple slots | 16.3.0 |
| 2020-12 | RAN#90 | RP-202416 | 0102 | 1 | B | CR to TS 38.101-4: Applicability rules for URLLC UE demodulation requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202423 | 0103 | 1 | B | CR: Introduction of performance requirements for NR FR1 PDSCH CA with 4Rx | 16.3.0 |
| 2020-12 | RAN#90 | RP-202423 | 0105 | 1 | B | CR: Addition of power imbalance requirements for intra-band contiguous CA and intra-band EN-DC | 16.3.0 |
| 2020-12 | RAN#90 | RP-202423 | 0108 | 1 | B | CR on Applicability rules for Normal NR CA demodulation requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202416 | 0109 | | B | CR on FRC for UE Ultra-low BLER requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202416 | 0110 | 1 | B | CR on FRC for UE Higher BLER requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202416 | 0111 | 1 | B | CR to TS 38.101-4: Performance requirements for URLLC High BLER feature tests | 16.3.0 |
| 2020-12 | RAN#90 | RP-202416 | 0112 | 1 | B | CR to TS 38.101-4: Performance requirements for URLLC PDSCH 0.001% BLER | 16.3.0 |
| 2020-12 | RAN#90 | RP-202422 | 0113 | 1 | B | CR to TS38.101-4: Addition of Rel-16 HST FRCs | 16.3.0 |
| 2020-12 | RAN#90 | RP-202489 | 0117 | | A | CR: Updates OCNG pattern reference (Rel-16) | 16.3.0 |
| 2020-12 | RAN#90 | RP-202489 | 0119 | 1 | A | CR: Correction on OCNG pattern | 16.3.0 |
| 2020-12 | RAN#90 | RP-202422 | 0120 | 2 | B | CR on FDD HST Single-Tap and Multipath Fading Requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202416 | 0121 | 2 | B | CR on FR1 PDSCH Mapping Type B and Processing Capability 2 Requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202423 | 0122 | | B | CR on FR2 PDSCH CA Requirements | 16.3.0 |
| 2020-12 | RAN#90 | RP-202423 | 0123 | | F | CR to TS 38.101-4: on gamma values for SP Type I PMI requirements | 16.3.0 |
| 2021-03 | RAN#91 | RP-210078 | 0124 | 1 | F | CR on FDD HST Single-Tap and Multipath Fading Requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0126 | 1 | B | CR to 38-101-4 on CQI reporting requirements for URLLC | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0127 | 1 | F | CR to 38.101-4 on requirements with slot aggreagation in FR2 | 16.4.0 |
| 2021-03 | RAN#91 | RP-210064 | 0128 | 1 | B | CR to 38.101-4 for eMIMO demod requirements - General and Applicability rule | 16.4.0 |
| 2021-03 | RAN#91 | RP-210066 | 0129 | 1 | B | CR for TS38.101-4, test for FR2 PDCCH DCI format 2_6 demodulation | 16.4.0 |
| 2021-03 | RAN#91 | RP-210065 | 0130 | | F | CR for NR PDSCH FR1 CA 2Rx performance requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210066 | 0131 | 1 | B | CR for TS38.101-4, test for FR1 TDD PDCCH DCI format 2_6 demodulation | 16.4.0 |
| 2021-03 | RAN#91 | RP-210067 | 0133 | 1 | B | CR on adding applicability, requirements and measurement channel for FR2 DL 256QAM CQI reporting test under fading condition | 16.4.0 |
| 2021-03 | RAN#91 | RP-210065 | 0134 | | B | CR: Adding applicability and requirements for FR1 and FR2 CA CQI reporting test | 16.4.0 |
| 2021-03 | RAN#91 | RP-210064 | 0135 | 2 | B | Introduction of PMI test cases with Rel-16 eType II codebook | 16.4.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2021-03 | RAN#91 | RP-210065 | 0136 | 2 | B | Introduction of PMI test cases with Rel-15 Type II codebook | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0137 | | F | CR to 38.101-4 on FRC table update for URLLC ultra low BLER requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210067 | 0138 | 1 | F | CR on demodulation performance requirements for DL 256QAM for FR2 | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0139 | 1 | B | CR on FRC for URLLC UE Higher BLER requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210067 | 0140 | 1 | B | CR on simplified TDL-D channel model for FR2 DL 256QAM demodulation requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210067 | 0141 | 1 | B | CR on applicability rules and FRC for FR2 DL 256QAM CQI requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210065 | 0142 | 1 | B | CR on applicability rules for Normal NR CA requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210064 | 0143 | 1 | B | CR to TS 38.101-4: Performance requirements single-DCI based multi-TRP Repetition Tx schemes | 16.4.0 |
| 2021-03 | RAN#91 | RP-210067 | 0144 | | B | CR on applicability and FRC for PDSCH normal demodulation for DL 256QAM for FR2 | 16.4.0 |
| 2021-03 | RAN#91 | RP-210067 | 0145 | 1 | B | CR on SDR requirements for DL 256QAM for FR2 | 16.4.0 |
| 2021-03 | RAN#91 | RP-210078 | 0146 | | F | CR on update TRS and CSI-RS transmission for HST DPS requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210064 | 0147 | 1 | B | CR for 38.101-4 Introduction of PDSCH requirement with Single-DCI based SDM scheme | 16.4.0 |
| 2021-03 | RAN#91 | RP-210064 | 0148 | 2 | B | CR for 38.101-4 Introduction of PDSCH requirement with Multi-DCI based multi-TRP transmission schemes | 16.4.0 |
| 2021-03 | RAN#91 | RP-210065 | 0149 | 1 | B | CR for 38.101-4 Applicablity of PMI reporting test with Tx ports larger than 8 and up to 32 | 16.4.0 |
| 2021-03 | RAN#91 | RP-210065 | 0150 | 1 | B | CR for 38.101-4 Applicablity of PMI reporting test of eType II codebook | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0151 | 1 | F | CR to TS 38.101-4 Correction of UE performance requirements for FR1 URLLC PDSCH repetitions over multiple slots. | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0152 | 1 | B | CR to TS38.101-4 Applicability rules for URLLC CSI requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210065 | 0153 | | F | CR: Updates to power imbalance for CA | 16.4.0 |
| 2021-03 | RAN#91 | RP-210066 | 0154 | 1 | F | CR on Fixed reference channel for power saving performance | 16.4.0 |
| 2021-03 | RAN#91 | RP-210065 | 0156 | | F | Correction of title on 16Tx port subband PMI reporting | 16.4.0 |
| 2021-03 | RAN#91 | RP-210116 | 0158 | | A | Correction of CQI test parameters and FRC for UE demodulation test | 16.4.0 |
| 2021-03 | RAN#91 | RP-210064 | 0159 | 1 | B | CR: FRC for eMIMO sDCI/mDCI-based PDSCH transmission | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0160 | 1 | B | CR on FRC for Ultra low BLER UE CQI requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210116 | 0162 | | A | CR on FRC for NR RI requirements (Rel-16) | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0164 | 1 | F | CR to TS 38.101-4: Performance requirements for URLLC PDSCH 0.001% BLER | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0165 | 1 | F | CR to TS 38.101-4: Performance requirements for URLLC High BLER feature tests | 16.4.0 |
| 2021-03 | RAN#91 | RP-210068 | 0166 | 1 | F | CR on FR1 PDSCH Mapping Type B and Processing Capability 2 Requirements | 16.4.0 |
| 2021-03 | RAN#91 | RP-210116 | 0168 | | A | CR on corrections for LTE-NR Co-existence tests and OCNG pattern | 16.4.0 |
| 2021-03 | RAN#91 | RP-210116 | 0170 | | A | CR to 38.101-4 on update to CSI reporting test parameters for Aperiodic reporting (R16) | 16.4.0 |
| 2021-03 | RAN#91 | RP-210066 | 0171 | | F | CR for TS38.101-4, test for FR1 FDD PDCCH DCI format 2_6 demodulation | 16.4.0 |
| 2021-03 | RAN#91 | RP-210065 | 0172 | | F | CR: Update on test applicability rule for EN-DC power imbalance | 16.4.0 |
| 2021-06 | RAN#92e | RP-211084 | 0178 | | A | CR to the definition of explicitly HARQ feedback timing in DCI format 1_0 for PDCCH demodulation tests | 16.5.0 |
| 2021-06 | RAN#92e | RP-211084 | 0181 | | A | Noc levels for FR2 demodulation test cases | 16.5.0 |
| 2021-06 | RAN#92e | RP-211086 | 0187 | | A | CR on NR UE demodulation performance requirements maintenance (R16) | 16.5.0 |
| 2021-06 | RAN#92e | RP-211103 | 0189 | 1 | F | CR to TS 38.101-4: Performance requirements for single-DCI based multi-TRP Repetition Tx schemes (R16) | 16.5.0 |
| 2021-06 | RAN#92e | RP-211104 | 0191 | 1 | F | CR to TS 38.101-4: HST-DPS channel model clarification | 16.5.0 |
| 2021-06 | RAN#92e | RP-211102 | 0193 | 1 | F | Corrections to align the description of PMI test cases with TS 38.214 | 16.5.0 |
| 2021-06 | RAN#92e | RP-211104 | 0201 | | F | CR to 38.101-4 on URLLC requirements for PDSCH slot aggregation in FR2 - R16 | 16.5.0 |
| 2021-06 | RAN#92e | RP-211104 | 0203 | | F | CR to 38.101-4 on CQI Reporting requirements with Table3 - R16 | 16.5.0 |
| 2021-06 | RAN#92e | RP-211104 | 0205 | 1 | F | CR to 38.101-4 on TRS config update for HST-DPS test cases- R16 | 16.5.0 |
| 2021-06 | RAN#92e | RP-211104 | 0208 | | F | CR on HST-SFN requirements for TDD | 16.5.0 |
| 2021-06 | RAN#92e | RP-211101 | 0210 | | B | Big CR: Introduction of Rel-16 NR V2X demodulation performance requirements | 16.5.0 |
| 2021-06 | RAN#92e | RP-211105 | 0213 | | F | Clear up CR for Rel-16 eMIMO PMI test cases | 16.5.0 |
| 2021-06 | RAN#92e | RP-211103 | 0215 | 1 | F | Correction on PMI test cases with Rel-15 Type I, TypeII codebook | 16.5.0 |
| 2021-06 | RAN#92e | RP-211106 | 0217 | | F | CR on corrections of PDCCH-WUS requirements | 16.5.0 |
| 2021-06 | RAN#92e | RP-211088 | 0220 | | A | CR: Updates to PDSCH requirements and CSI requirements (Rel-16) | 16.5.0 |
| 2021-06 | RAN#92e | RP-211107 | 0224 | | F | CR on correction of FRC for HST (Rel-16) | 16.5.0 |
| 2021-06 | RAN#92e | RP-211108 | 0226 | | F | CR on removal of square brackets for HST requirements | 16.5.0 |
| 2021-06 | RAN#92e | RP-211100 | 0229 | | F | CR on correction of FRC for DL 256QAM (Rel-16) | 16.5.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2021-06 | RAN#92e | RP-211100 | 0231 | | F | CR on correction of FR2 256QAM CQI applicability rules (Rel-16) | 16.5.0 |
| 2021-06 | RAN#92e | RP-211104 | 0233 | 1 | F | CR to TS 38.101-4: Cleanup of UE performance requirements for FR1 URLLC PDSCH repetitions over multiple slots | 16.5.0 |
| 2021-06 | RAN#92e | RP-211103 | 0235 | 1 | F | CR for 38.101-4: Updates on PDSCH requirement with Single-DCI based SDM scheme | 16.5.0 |
| 2021-06 | RAN#92e | RP-211103 | 0236 | 1 | F | CR for 38.101-4: Updates on PDSCH requirement with Multi-DCI based transmission scheme | 16.5.0 |
| 2021-06 | RAN#92e | RP-211088 | 0240 | | A | Correction of variable name for PMI test metric | 16.5.0 |
| 2021-06 | RAN#92e | RP-211109 | 0242 | | F | CR: Correction of the applicability of requirements | 16.5.0 |
| 2021-06 | RAN#92e | RP-211103 | 0245 | 1 | F | Finalization of URLLC pre-emption and mapping type B requirements | 16.5.0 |
| 2021-06 | RAN#92 | RP-211103 | 0249 | 1 | F | CR for TS38.101-4, Editorial correction to UE performance requirements for FR1 pre-emption and FR2 PDSCH mapping Type B R16<br>NOTE: The CR is was not implementable because it conflicted with another CR | 16.5.0 |
| 2021-06 | RAN#92e | RP-211110 | 0251 | 1 | F | CR on Applicability Rule for TDD LTE-NR Coexistence Tests | 16.5.0 |
| 2021-06 | RAN#92e | RP-211100 | 0252 | 1 | F | CR on clarification of TDL-D channel model (R16) | 16.5.0 |
| 2021-06 | RAN#92e | RP-211091 | 0259 | | A | CR to TS 38.101-4: Editorial corrections (R16) | 16.5.0 |
| 2021-06 | RAN#92e | RP-211102 | 0262 | 2 | F | CR to TS 38.101-4: FRC index update and Editorial corrections (R16) | 16.5.0 |
| 2021-06 | RAN#92e | RP-211100 | 0264 | | F | CR on finalization on the FR2 256QAM CQI report test case | 16.5.0 |
| 2021-06 | RAN#92e | RP-211094 | 0265 | | B | Big CR for the Introduction of NR-U UE Demodulation Requirements (PDSCH and CQI) | 16.5.0 |
| 2021-09 | RAN#93e | RP-211924 | 0271 | | F | Big CR for TS 38.101-4 Maintenance (Rel-16, CAT F) | 16.6.0 |

# History

| Document history | | |
|---|---|---|
| V16.1.0 | July 2020 | Publication |
| V16.2.0 | November 2020 | Publication |
| V16.3.0 | January 2021 | Publication |
| V16.4.0 | May 2021 | Publication |
| V16.5.0 | September 2021 | Publication |
| V16.6.0 | October 2021 | Publication |