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#### **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

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#### **Foreword**

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

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

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

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

shall indicates a mandatory requirement to do somethingshall 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 possiblecannot 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*.
- 3GPP TR 21.905: "Vocabulary for 3GPP Specifications". [1] [2] 3GPP TS 38.521-4: "NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements". Recommendation ITU-R M.1545: "Measurement uncertainty as it applies to test limits for the [3] 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". 3GPP TR 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz". [5] [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". 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 [8] 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"

## 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<sub>s</sub> 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 EPRE Energy Per Resource Element EN-DC E-UTRA-NR Dual Connectivity

FR Frequency Range

FRC Fixed Reference Channel

HARQ Hybrid Automatic Repeat Request

LI Layer Indicator

MAC Medium Access Control
MCS Modulation and Coding Scheme
MIB Master Information Block

NR New Radio

NSA Non-Standalone Operation Mode OCNG OFDMA Channel Noise Generator

OFDM Orthogonal Frequency Division Multiplexing
OFDMA Orthogonal Frequency Division Multiple Access

PBCH Physical Broadcast Channel

Pcell Primary Cell

PDCCH Physical Downlink Control Channel PDSCH Physical Downlink Shared Channel

PMI Precoding Matrix Indicator
PRB Physical Resource Block
PRG Physical resource block group
PSS Primary Synchronization Signal
PTRS Phase Tracking Reference Signal
PUCCH Physical Uplink Control Channel
PUSCH Physical Uplink Shared Channel

QCL Quasi Co-location
RB Resource Block
RBG Resource Block Group
RE Resource Element
REG Resource Element Group

RI Rank Indicator

RRC Radio Resource Control SA Standalone operation mode

SCS Subcarrier Spacing

SINR Signal-to-Interference-and-Noise Ratio

SNR Signal-to-Noise Ratio
SS Synchronization Signal
SSB Synchronization Signal Block
SSS Secondary Synchronization Signal
TCI Transmission Configuration Indicator

TDM Time division multiplexing TTI Transmission Time Interval

UL Uplink

VRB Virtual Resource Block

## 4 General

## 4.1 Relationship between minimum requirements and test requirements

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

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

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

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

The applicability of each requirement is described under each sub-clause in 5.1, 6.1, 7.1, 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<sup>nd</sup> level clause, shown in table 4.3-1.

Clause suffix

None
Single Carrier

A
Carrier Aggregation (CA)

B
Dual-Connectivity (DC)

C
Supplement Uplink (SUL)

Table 4.3-1: Definition of suffixes

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<sub>RX</sub> 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<sub>Band\_X, SCS\_Y, CBW\_Z</sub> 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<sub>REFSENS</sub> = -1 dB is the SNR used for simulation of REFSENS
- $\Delta_{\text{thermal}}$  is the amount of dB that the wanted noise is set above UE thermal noise, giving a defined rise in total noise.  $\Delta_{\text{thermal}} = 16$ dB, 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<sub>Band\_X, SCS\_Y, CBW\_Z</sub> 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<sub>REFSENS</sub> = -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.  $\Delta_{thermal} = 7.6$ dB, 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.

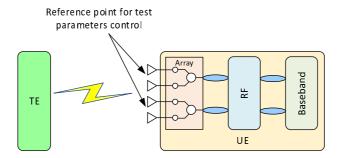


Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements

#### 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<sub>BB</sub>. 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 Δ<sub>BB</sub> 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  $\Delta_{BB} = 1$ dB.

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

Operating band		UE Pov	ver class	
	1	2	3	4
n257	-166.8	-161.3	-157.6	-166.3
n258	-166.8	-161.3	-157.6	-166.3
n260	-163.8		-155.0	-164.3
n261	-166.8	-161.3	-157.6	-166.3
Note 1: Noc leve	els 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]:

$$Noc_{MB} = Noc_{SB} + \Sigma MB_P$$

- Noc<sub>SB</sub> is the Noc defined in Table 4.5.3.2-1
- $\Sigma$ MB<sub>P</sub> values are specified in TS 38.101-2 [7].

For CA case, the Noc power level (Noc<sub>CA</sub>) 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<sub>SC</sub> 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 and on the UE Power class, and taking a baseline of UE Power class 3 in Band n260.

$$Noc = REFSENS_{PC3, \, n260, \, 50MHz} - 10Log_{10}(SCS_{REFSENS} \, x \, PRB_{REFSENS} \, x \, 12) - SNR_{REFSENS} + \Delta_{thermal} +$$

#### where:

- REFSENS $_{PC3,\,n260,\,50MHz}$  is the REFSENS value in dBm specified for Power Class 3 UE in Band n260 for 50MHz Channel bandwidth in Table 7.3.2.3-1 of TS 38.101-2 [7].
- SCS<sub>REFSENS</sub> is a subcarrier spacing associated with N<sub>RB</sub> for 50MHz in Table 5.3.2-1 of TS 38.101-2 [7], chosen as 120 kHz.
- PRB<sub>REFSENS</sub> is N<sub>RB</sub> associated with subcarrier spacing 120 kHz for 50MHz in Table 5.3.2-1 of TS 38.101-2 [7] and is 32.
- 12 is the number of subcarriers in a PRB

- SNR<sub>REFSENS</sub> = -1 dB is the SNR used for simulation of REFSENS
- $\Delta_{\text{thermal}}$  is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of  $\Delta_{\text{BB}}$ .  $\Delta_{\text{thermal}} = 6 \text{dB}$ , giving a rise in total noise of 1 dB.

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

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

Noc(PC\_X, Band\_Y) = -155 dBm/Hz + REFSENS<sub>PC X, Band Y, 50MHz</sub> - REFSENS<sub>PC3, n260, 50MHz</sub>

where REFSENS values are specified in TS 38.101-2 [7].

#### 4.5.4 Angle of arrival

Unless otherwise stated, the downlink signal and noise are aligned to 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.

#### 5.1.1.2 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	PDSCH	All tests in Clause 5.2.2
2RX	PDCCH	All tests in Clause 5.3.2
	PBCH	All tests in Clause 5.4.2
UE supports only	PDSCH	All tests in Clause 5.2.3
4RX or both 2RX	PDCCH	All tests in Clause 5.3.3
and 4RX	PBCH	All tests in Clause 5.4.2 or 5.4.3 (Note)
Note: Requireme	ents for PBCH with 4Rx	is up to UE declaration

#### 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 ty	/pe	Test list	Applicability notes
SU-MIMO Interference Mitigation advanced receiver	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 3-1)	
			Clause 5.2.3.1.1 (Test 5-1)	
	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 3-1)	
			Clause 5.2.3.2.1 (Test 5-1)	
Alternative additional DMRS position for co-existence with LTE CRS (additionalDMRS-DL-	FR1 FDD	PDSCH	Clause 5.2.2.1.4 (Test 1-2)	
Alt)			Clause 5.2.3.1.4 (Test 1-2)	
Basic DL NR-NR CA operation (supportedBandCombinationList)	NR CA	SDR	Clause 5.5A.1	1)Up to 16 DL carriers 2)Same numerology across carrier for data/control channel at a given time

## 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 t	уре	Test list	Applicability notes
256QAM modulation scheme	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-3)	
for PDSCH for FR1 (pdsch-			Clause 5.2.3.1.1 (Test 1-3)	
256QAM-FR1)	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 1-3)	
			Clause 5.2.3.2.1 (Test 1-3)	
PDSCH mapping type B	FR1 FDD	PDSCH	Clause 5.2.2.1.3	
(pdsch-MappingTypeB)			Clause 5.2.3.1.3	
	FR1 TDD	PDSCH	Clause 5.2.2.2.3	
			Clause 5.2.3.2.3	
	FR1 FDD	PDSCH	Clause 5.2.2.1.4	For UEs supporting
			Clause 5.2.3.1.4	"Alternative
				additional DMRS
				position for co-
				existence with LTE
Rate-matching around LTE				CRS", if Test 1-2 is
CRS (rateMatchingLTE-CRS)				tested, the test
erro (raternaterning=r= erro)				coverage can be
				considered fulfilled
				without executing
				Test 1-1. Otherwise,
				only Test 1-1 is
	ED4 EDD	DD 0011	OI 50044/T + 44	tested.
Supported maximum number of	FR1 FDD	PDSCH	Clause 5.2.2.1.4 (Tests 1-1,	The requirements
ports across all configured			1-2)	apply only in case the number of NZP-
NZP-CSI-RS resources per CC (maxConfigNumberPortsAcros			Clause 5.2.3.1.1 (Tests 3-1, 4-1, 5-1)	CSI-RS ports in the
sNZP-CSI-RS-PerCC)			Clause 5.2.3.1.4 (Tests 1-1,	test case satisfies UE
31/27-031-13-76100)			1-2)	capability on
	FR1 TDD	PDSCH	Clause 5.2.3.2.1 (Test 3-1,	maximum number of
	TRITOD	I Doci i	4-1, 5-1)	NZP-CSI-RS ports
Supported maximum number of	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Tests 2-1,	The requirements
PDSCH MIMO layers	TRITOD	1 00011	2-2, 3-1)	apply only in case
(maxNumberMIMO-			Clause 5.2.2.1.2	the PDSCH MIMO
LayersPDSCH)			Clause 5.2.3.1.1 (Tests 2-1,	rank in the test case
			2-2, 3-1, 4-1, 5-1)	does not exceed UE
			Clause 5.2.3.1.2	PDSCH MIMO layers
	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Tests 2-1,	capability
			2-2, 3-1)	
			Clause 5.2.2.2	
			Clause 5.2.3.2.1 (Tests 2-1,	
			2-2, 3-1, 4-1, 5-1)	
			Clause 5.2.3.2.2	

## 5.2 PDSCH demodulation requirements

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

Table 5.2-1: Common test parameters

PDSCH transmission scheme
Usable subcarrier on this carrier (Note 2)   RBS   U
Subcarrier spacing   Subcarrier spacing   Cyclic prefix   RB offset   RBs   O
DL BWP configuration #1  Number of contiguous PRB  PRBs  PRBs  Description = 1
DL BWP configuration #1  Number of contiguous PRB  PRBs  Aximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing  Physical Cell ID  SB position in burst  SB periodicity  SB periodicity  SB periodicity  SB periodicity  SB periodicity  SIots for PDCCH monitoring  Symbols with PDCCH  Number of PRBs in CORESET  Number of PDCCH candidates and aggregation levels  PDCCH  configuration  PDCCH aggregation levels  PDCCH & PDCCH DMRS Precoding  Configuration  Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing  Raymont Table 5.2-2 for tested channel bandwidth and subcarrier spacing  1/AL8  CCE-to-REG mapping type  Non-interleaved  DCI format  TCI state  TCI state #1  Single Panel Type I, Random per slow with equal probability of each applicable i1, i2 combination, and with applicable i
Number of contiguous PRB   PRBs   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  SSB position in burst SSB periodicity SSB position in burst SSB periodicity SSB periodicity SSB periodicity SpB periodicity Symbols O, 1  Table 5.2-2 for tested channel bandwidth and subcarrier spacing  1/AL8 Single parameters Single Panel Type I, Random per slow with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with
cell parameters  SSB periodicity  Sab II Slot #0  20  Table 5.2-2 for tested channel bandwidth and subcarrier spacing  1/AL8  PDCCH candidates and aggregation levels  CCE-to-REG mapping type  CCE-to-REG mapping type  DCI format  TCI state  Single Panel Type I, Random per slot with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with
SSB periodicity  Slots for PDCCH monitoring Symbols with PDCCH Symbols  Number of PRBs in CORESET  Number of PDCCH candidates and aggregation levels  PDCCH configuration  PDCCH aggregation to the configuration  PDCCH by the configuration  SSB periodicity Each slot Symbols  O, 1  Table 5.2-2 for tested channel bandwidth and subcarrier spacing  1/AL8  Non-interleaved CCE-to-REG mapping type Non-interleaved TCI state  TCI state #1  Single Panel Type I, Random per slot with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination equal probability equal
Symbols with PDCCH Number of PRBs in CORESET  Number of PDCCH candidates and aggregation levels  PDCCH configuration  Symbols  O, 1  Table 5.2-2 for tested channel bandwidth and subcarrier spacing  1/AL8  Non-interleaved  DCI format  TCI state  PDCCH & PDCCH DMRS Precoding configuration  Symbols  O, 1  Table 5.2-2 for tested channel bandwidth and subcarrier spacing  Non-interleaved  TCI state #1  Single Panel Type I, Random per slow with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>2</sub> combination i <sub>1</sub> applicable i <sub>2</sub> combination i <sub>2</sub> combination i <sub>1</sub> applicable i <sub>2</sub> combination i <sub>2</sub> combination i <sub>2</sub> combination i <sub>3</sub> combination i <sub>4</sub> co
Number of PRBs in CORESET  Number of PDCCH candidates and aggregation levels  PDCCH  configuration  Number of PDCCH candidates and aggregation levels  CCE-to-REG mapping type  DCI format  TCI state  PDCCH & PDCCH DMRS Precoding  configuration  Table 5.2-2 for tested channel bandwidth and subcarrier spacing  Non-interleaved  TCI state #1  Single Panel Type I, Random per slow with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and applicable i <sub>1</sub>
PDCCH CCE-to-REG mapping type  configuration  Number of PDCCH candidates and aggregation levels  CCE-to-REG mapping type  DCI format  TCI state  PDCCH & PDCCH DMRS Precoding  configuration  Non-interleaved  1_1  TCI state #1  Single Panel Type I, Random per slow with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with aggregation levels  Non-interleaved  Single Panel Type I, Random per slow with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with aggregation levels  Non-interleaved  1/AL8
PDCCH configuration  CCE-to-REG mapping type  DCI format  TCI state  PDCCH & PDCCH DMRS Precoding  configuration  CCE-to-REG mapping type  Non-interleaved  1_1  TCI state #1  Single Panel Type I, Random per slow with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>1</sub> , i <sub>2</sub> combination, and with applicable i <sub>2</sub> , i <sub>3</sub> combination, and with applicable i <sub>4</sub> , i <sub>4</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination, and with applicable i <sub>4</sub> , i <sub>5</sub> combination i <sub>6</sub> co
configuration  DCI format TCI state TCI state  TCI state #1 Single Panel Type I, Random per slow with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with a configuration and with a combination and with a combina
TCI state #1  Single Panel Type I, Random per slow with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with
PDCCH & PDCCH DMRS Precoding  configuration  Single Panel Type I, Random per slo with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with
of Tx larger than 1
Cross carrier scheduling Not configured
First subcarrier index in the PRB used for CSI-RS resource 1,2,3,4
First OFDM symbol in the PRB used for $I_0 = 6$ for CSI-RS resource 1 and 3 $I_0 = 10$ 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,
CDM Type 'No CDM' for CSI-RS resource 1,2,3, Density (ρ) 3 for CSI-RS resource 1,2,3,4
15 kHz SCS: 20 for CSI-RS resource
CSI-RS periodicity  Slots  1,2,3,4 30 kHz SCS: 40 for CSI-RS resource 1,2,3,4
15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4 CSI-RS offset Slots
30 kHz SCS: 20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
Frequency Occupation  Start PRB 0  Number of PRB = BWP size
QCL info TCl state #0
First subcarrier index in the PRB used for CSI-RS $k_0 = 0$
First OFDM symbol in the PRB used for CSI-RS
Number of CSI-RS ports (X)  Same as number of transmit antenna
NZP CSI-RS for CSI acquisition CDM Type 'No CDM' for 1 transmit antenna 'FD-CDM2' for 2 and 4 transmit antenna
CSI acquisition Density (ρ)
CSI-RS periodicity Slots 15 kHz SCS: 20 30 kHz SCS: 40
CSI-RS offset Slots 0
Frequency Occupation  Start PRB 0  Number of PRB = BWP size
QCL info TCl state #1

	First subcarrier CSI-RS	index in the PRB used for		k <sub>0</sub> = 4
		mbol in the PRB used for		I <sub>0</sub> = 12
	Number of CSI	-RS ports (X)		4
ZP CSI-RS for CSI	CDM Type			'FD-CDM2'
acquisition	Density (ρ)			1
	CSI-RS periodi	city	Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset		Slots	0
	Frequency Occ	cupation		Start PRB 0 Number of PRB = BWP size
Antenna ports indexes PDSCH DMRS				{1000} for Rank 1 tests {1000, 1001} for Rank 2 tests {1000-1002} for Rank 3 tests {1000-1003} for Rank 4 tests
configuration	Position of the mapping type A	first DMRS for PDSCH		2
		SCH DMRS CDM group(s)		1 for Rank 1 and Rank 2 tests 2 for Rank 3 and Rank 4 tests
	Type 1 QCL	SSB index		SSB #0
TCI state #0	information	QCL Type		Type C
TOT State #0	Type 2 QCL	SSB index		N/A
	information	QCL Type		N/A
	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
TCI state #1	IIIIOIIIIalioii	QCL Type		Type A
	Type 2 QCL	CSI-RS resource		N/A
	information	QCL Type		N/A
PT-RS configuration				PT-RS is not configured
		os for ACK/NACK feedback		1
Maximum number of		sion		4
HARQ ACK/NACK b				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 <sub>1</sub> , i <sub>2</sub> combination, and with PRB bundling granularity
Symbols for all unus	ed REs			OCNG Annex A.5
Physical signals, cha		nd precoding		As specified in Annex B.4.1

Note 1: UE assumes that the TCl state for the PDSCH is identical to the TCl state applied for the PDCCH transmission.

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	1-1, 1-2, 1-3, 1-5, 2-1, 2-2
under 2 receive antenna conditions and with different	
channel models, MCSs and number of MIMO layers	
Verify the PDSCH mapping Type A HARQ soft combining	1-4
performance under 2 receive antenna conditions.	
Verify the PDSCH mapping Type A performance	3-1
requirements for Enhanced Receiver Type 1 under 2	
receive antenna conditions.	

Table 5.2.2.1.1-2: Test parameters

	Parameter	Unit	Value
Duplex mode			FDD
Active DL BWP index			1
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	DDD hundling size		4 for Test 1-1
PDSCH	PRB bundling size		2 for other tests
configuration			Test 1-2: Type 1 with start RB = 23,
	Resource allocation type		$L_{RBs} = 6$
			Other tests: Type 0
	RBG size		Test 1-2: N/A
			Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		2 for Tests 1-1, 1-5
configuration	Number of additional DIVIRS		1 for other tests
Configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
			Test 1-5:
	CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
			Other tests: Table 5.2-1.
CSI-RS for tracking			Test 1-5:
			1 for CSI-RS resource 1 and 2
	CSI-RS offset	Slots	2 for CSI-RS resource 3 and 4.
			Other tests: Table 5.2-1.
Number of HARO Pro	Number of HARQ Processes		8 for Test 1-4
			4 for other tests
The number of slots I ACK information	between PDSCH and corresponding HARQ-		2

Table 5.2.2.1.1-3: Minimum performance for Rank 1

		Bandwidth	Mandadatian		Correlation	Reference value	
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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

Table 5.2.2.1.1-4: Minimum performance for Rank 2

		Bandwidth			Correlation	Reference value	
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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

		Bandwidth			Correlation	Reference value		
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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
7 touvo BE BVVI mido.	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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		N/A
	size		•
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		l <sub>0</sub> = 13
CSI acquisition	CSI-RS periodicity	Slots	5
ZP CSI-RS for CSI	Subcarrier index in the PRB used for CSI-RS		$(k_0, k_1, k_2, k_3)=(2, 4, 6, 8)$
acquisition	Number of CSI-RS ports (X)		8
1	CSI-RS periodicity	Slots	5
Number of HARQ Pr			4
The number of slots ACK information	between PDSCH and corresponding HARQ-		2

Table 5.2.2.1.2-3: Minimum performance for Rank 2

Ī			Bandwidth			Correlation	Reference value	
	Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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	1-1
receive antenna conditions	

Table 5.2.2.1.3-2: Test parameters

	Parameter	Unit	Value
Duplex mode			FDD
Active DL BWP inde	X		1
	Mapping type		Type B
	k0		0
	Starting symbol (S)		5
	Length (L)		7
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Pr	ocesses		4
The number of slots ACK information	between PDSCH and corresponding HARQ-		2

Table 5.2.2.1.3-3: Minimum performance for Rank 1

		Bandwidth			Correlation	Reference value	
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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	1-1

#### 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	1-1, 1-2
matching configured	

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
<u> </u>	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
DDCCH	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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
	DMRS Type		Type 1
	Position of the first DM-RS for downlink		3
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
CRS for rate	LTE carrier BW	MHz	10
matching (Note 1)	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 MBSFI	N is configured on LTE carrier		

Table 5.2.2.1.4-3: Minimum performance for Rank 1

		Bandwidth			Correlation	Reference value		
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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	

#### 5.2.2.2 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	1-1, 1-2, 1-3, 1-5, 1-6, 1-7, 1-8, 1-9, 2-1, 2-2
under 2 receive antenna conditions and with different	
channel models, MCSs and number of MIMO layers	
Verify the PDSCH mapping Type A HARQ soft combining	1-4
performance under 2 receive antenna conditions.	
Verify the PDSCH mapping Type A performance	3-1
requirements for Enhanced Receiver Type 1 under 2	
receive antenna conditions.	

Table 5.2.2.2.1-2: Test parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP index	X		1
	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
PDSCH configuration	PRB bundling size		4 for Tests 1-1, 1-8, 1-9 2 for other tests
	Resource allocation type		Test 1-2: Type 1 with start RB = 50, $L_{RBs} = 6$ Other tests: Type 0
	RBG size		Test 1-2: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		2 for Tests 1-1, 1-7, 1-8, 1-9 1 for other tests
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
	First OFDM symbol in the PRB used for CSI-RS		Tests 1-8, 1-9: $l_0 = 4$ for CSI-RS resource 1 and 3 $l_0 = 8$ for CSI-RS resource 2 and 4
			Other tests; Table 5.2-1.
	CSI-RS periodicity	Slots	Test 1-7: 20 for CSI-RS resource 1,2,3,4.
			Other tests: Table 5.2-1.
CSI-RS for tracking	CSI-RS offset	Slots	Test 1-7: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4.
			Other tests: Table 5.2-1.
	Frequency Occupation		Test 1-7: Start PRB 0 Number of PRB = 52
			Other tests: Table 5.2-1.
Number of HARQ Processes			16 for Test 1-4 10 for Test 1-9 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

		Bandwidth				Correlation	Reference v	/alue
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	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

Table 5.2.2.2.1-4: Minimum performance for Rank 2

		Bandwidth				Correlation	Reference value	
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	matrix and antenna configuration	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

		Bandwidth	Mandadatian	TDD III		Correlation	Reference	value
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	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 5.2.2.2.1.

#### Table 5.2.2.2-1: 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: Test parameters

Parameter			Value
Duplex mode			TDD
Active DL BWP index	(		1
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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		N/A
	size		·
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		l <sub>0</sub> = 13
CSI acquisition	CSI-RS periodicity	Slots	5
ZP CSI-RS for CSI	Subcarrier index in the PRB used for CSI-RS		$(k_0, k_1, k_2, k_3)=(2, 4, 6, 8)$
acquisition	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 5.2.2.2-3: Minimum performance for Rank 2

		Bandwidth	Madulatian	TDD		Correlation	Reference v	/alue
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	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	1-1
receive antenna conditions	

#### Table 5.2.2.3-2: Test parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP index			1
	Mapping type		Туре В
	k0		0
	Starting symbol (S)		5
	Length (L)		7
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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
	DMRS Type		Type 1
PDSCH DMRS configuration	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Pr	ocesses		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 5.2.2.3-3: Minimum performance for Rank 1

	Bandwidth		Correlation	Reference value				
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	matrix and antenna configuration	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

## 5.2.3 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	1-1, 1-2, 1-3, 1-5, 2-1, 2-2, 3-1, 4-1
under 4 receive antenna conditions and with different	
channel models, MCSs and number of MIMO layers	
Verify the PDSCH mapping Type A HARQ soft combining	1-4
performance under 4 receive antenna conditions.	
Verify the PDSCH mapping Type A performance	5-1
requirements for Enhanced Receiver Type 1 under 4	
receive antenna conditions.	

Table 5.2.3.1.1-2: Test parameters

Parameter			Value
Duplex mode			FDD
Active DL BWP index			1
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
PDSCH configuration	PRB bundling size		4 for Test 1-1 WB for Test 3-1 2 for other tests
	Resource allocation type		Test 1-2: Type 1 with start RB = 23, $L_{RBs} = 6$ Other test: Type 0
	RBG size		Test 1-2: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		2 for Test 1-1, 1-5 1 for other tests
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
	CSI-RS periodicity	Slots	Test 1-5: 10 for CSI-RS resource 1,2,3,4.
CSI-RS for tracking	CSI-RS offset	Slots	Other tests: Table 5.2-1.  Test 1-5: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4.  Other tests: Table 5.2-1.
Number of HARQ Processes			8 for Test 1-4 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

		Bandwidth			Correlation	Reference va	alue
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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

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

		Bandwidth	Mandadatian		Correlation	Reference	value
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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

		Bandwidth (MHz) /	Modulation		Correlation	Reference	value
Test num.	Reference channel	Subcarrier spacing (kHz)	format and code rate	Propagation condition	matrix and antenna configuration	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

		Bandwidth	Mandadatian		Correlation	Reference va	alue
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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

		Bandwidth	Mandadatian		Correlation	Reference	value
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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		N/A
	size		·
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		l <sub>0</sub> = 13
CSI acquisition	CSI-RS periodicity	Slots	5
ZP CSI-RS for CSI	Subcarrier index in the PRB used for CSI-RS		$(k_0, k_1, k_2, k_3)=(2, 4, 6, 8)$
acquisition	Number of CSI-RS ports (X)		8
	CSI-RS periodicity	Slots	5
Number of HARQ Pr	ocesses		4
The number of slots ACK information	between PDSCH and corresponding HARQ-		2

Table 5.2.3.1.2-3: Minimum performance for Rank 2

Test	Reference	Bandwidth (MHz) / Subcarrier spacing	Modulation	Propagation condition	Correlation matrix and antenna configuration	Reference va	ılue
num.	channel	(kHz)	format and code rate			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	1-1
antenna conditions	

Table 5.2.3.1.3-2: Test parameters

	Parameter	Unit	Value
Duplex mode			FDD
Active DL BWP index	x		1
	Mapping type		Type B
	k0		0
	Starting symbol (S)		5
	Length (L)		7
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Pr	ocesses		4
The number of slots ACK information	between PDSCH and corresponding HARQ-		2

Table 5.2.3.1.3-3: Minimum performance for Rank 1

		Bandwidth	Mandadatian		Correlation	Reference va	lue
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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	1-1

#### 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	1-1, 1-2
under 4 receive antenna conditions with CRS rate	
matching configured	

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
•	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
PDSCH	PDSCH aggregation factor		1
configuration	PRB bundling type		Static
Corniguration	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
	DMRS Type		Type 1
DD0011 D14D0	Position of the first DM-RS for downlink		3
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
0001	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
CRS for rate	LTE carrier BW	MHz	10
matching (Note 1)	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	N is configured on LTE carrier		

Table 5.2.3.1.4-3: Minimum performance for Rank 1

		Bandwidth (MHz) / Madulation			Correlation	Reference value	
Test num.	Reference channel	Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	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

#### 5.2.3.2 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	1-1, 1-2, 1-3, 1-5, 1-6, 1-7, 1-8, 1-9, 2-1, 2-2, 3-1, 4-1
under4 receive antenna conditions and with different	
channel models, MCSs and number of MIMO layers	
Verify the PDSCH mapping Type A HARQ soft combining	1-4
performance under 4 receive antenna conditions.	
Verify the PDSCH mapping Type A performance	5-1
requirements for Enhanced Receiver Type 1 under 4	
receive antenna conditions.	

Table 5.2.3.2.1-2: Test parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP index	(		1
	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
PDSCH configuration	PRB bundling size		4 for Tests 1-1, 1-8, 1-9 WB for Test 3-1 2 for other tests
Comiguration	Resource allocation type		Test 1-2: Type 1 with start RB = 50, L <sub>RBs</sub> = 6 Other tests: Type 0
	RBG size		Test 1-2: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		2 for Tests 1-1, 1-7, 1-8, 1-9 1 for other tests
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
	First OFDM symbol in the PRB used for CSI-RS		Tests 1-8, 1-9: $l_0$ = 4 for CSI-RS resource 1 and 3 $l_0$ = 8 for CSI-RS resource 2 and 4 Other tests; Table 5.2-1.
CSI-RS for tracking	CSI-RS periodicity	Slots	Test 1-7: 20 for CSI-RS resource 1,2,3,4. Other tests: Table 5.2-1.
	CSI-RS offset	Slots	Test 1-7: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4. Other tests: Table 5.2-1.

Frequency Occupation	Test 1-7: Start PRB 0 Number of PRB = 52
	Other tests: Table 5.2-1.
	16 for Test 1-4
Number of HARQ Processes	10 for Test 1-9
	8 for other tests
The number of slots between PDSCH and corresponding HARQ-	Specific to each TDD UL-DL pattern
ACK information	and as defined in Annex A.1.2

Table 5.2.3.2.1-3: Minimum performance for Rank 1

		Bandwidth		TDD		Correlation	Reference	value
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	matrix and antenna configuration	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

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

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna	Reference Fraction of maximum	SNR
		(kHz)	couc rate	pattern		configuration	throughput (%)	(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

		Bandwidth				Correlation	Reference	value
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	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

		Bandwidth		<b>TDD</b>		Correlation	Reference	value
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	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

		Bandwidth		TDD		Correlation	Reference	/alue
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	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	1-1
under 4 receive antenna conditions and CSI-RS	
overlapped with PDSCH	

Table 5.2.3.2.2-2: Test parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP index	(		1
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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		N/A
	size	ze	
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		l <sub>0</sub> = 13
CSI acquisition	CSI-RS periodicity	Slots	5
ZP CSI-RS for CSI	Subcarrier index in the PRB used for CSI-RS		$(k_0, k_1, k_2, k_3)=(2, 4, 6, 8)$
acquisition	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

		Bandwidth	Madulation	TDD UL-		Correlation	Reference value	
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	DL DL pattern	Propagation condition	matrix and antenna configuration	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 inde	ex		1
	Mapping type		Type B
PDSCH configuration	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
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ P	rocesses		8
The number of slots ACK information	between PDSCH and corresponding HARQ-		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

		Bandwidth (MHz)/	Madulation	TDD UL-		Correlation	Reference v	alue
Test num.	Reference channel	Subcarrier spacing (kHz)	Modulation format and code rate	DL pattern	Propagation condition	matrix and antenna configuration	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

# 5.3 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** 

	Paramete	er	Unit	Value
Carrier		een Point A and the		0
configuration	lowest usab	le subcarrier on this		
	carrier (Note	e 1)		
DL BWP	Cyclic prefix			Normal
configuration #1	RB offset		RBs	0
Common	Physical Ce			0
serving cell	SSB position			1
parameters	SSB periodi		ms	20
		CCH monitoring PDCCH candidates		Each slot
PDCCH	Number of F	DCCH candidates		Start from RB = 0
configuration		domain resource		with contiguous RB
oomigaration	allocation fo	r CORESET		allocation
	TCI state			TCI state #1
		rier index in the PRB		
	used for CS	I-RS ( <i>k</i> ₀)		0
				CSI-RS resource 1:
				4
	First OFDM	average at in the DDD		CSI-RS resource 2:
	used for CS	symbol in the PRB		8 CSI-RS resource 3:
	used for CS	1-13 (10)		4
				CSI-RS resource 4:
				8
	Number of 0	CSI-RS ports (X)		1
	CDM Type			No CDM
	Density $(\rho)$			3
001 00 (	CSI-RS peri	odicity	Slots	15 kHz SCS: 20
CSI-RS for			0.010	30 kHz SCS: 40
tracking				15 kHz SCS: 10 for CSI-RS
				resource 1 and 2
				11 for CSI-RS
				resource 3 and 4
	CSI-RS offs	et	Slots	
				30 kHz SCS:
				20 for CSI-RS
				resource 1 and 2
				21 for CSI-RS resource 3 and 4
				Start PRB 0
	Frequency (	Occupation		Number of PRB =
	1,111,11	· · ·		BWP size
	QCL info			TCI state #0
	Type 1	SSB index		SSB #0
	QCL	QCL Type		Type C
TCI state #0	information			
	Type 2 QCL	SSB index		SSB #0
	information	QCL Type		Type D
				CSI-RS resource 1
	Type 1	CSI-RS resource		from 'CSI-RS for
	QCL	OOI NO TOSOUTOC		tracking'
	information	OOL Torre		configuration
TCI state #1		QCL Type		Type A
	Type 2			CSI-RS resource 1 from 'CSI-RS for
	QCL	CSI-RS resource		tracking'
	information			configuration
		QCL Type		Type D

PDCCH Precoding configuration	Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination with REG bundling granularity for number of Tx larger					
Symbols for all unused REs	than 1 OCNG in Annex A.5					
Physical signals, channels mapping and precoding	As specified in Annex B.4.1					
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)

#### 2RX requirements 5.3.2

#### 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		nonInter	leaved
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

			CORES				Antenna	Reference	e value
Test numbe r	Bandw idth (MHz)	CORE SET RB	ET duratio n	Aggregati on level	Reference Channel	Propagation Condition	configurat ion and correlatio n Matrix	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

			CORES		Antenna				value
Test numbe r	Bandw idth (MHz)	CORE SET RB	ET duratio n	Aggregati on level	Reference Channel	Propagation Condition	configurat ion and correlatio n Matrix	Pm-dsg (%)	SNR (dB)
1	10	24	2	4	R.PDCCH.	TDLC300-	2x2 Low	1	2.0
					1-2.2 FDD	100			
2	10	48	2	8	R.PDCCH.	TDLC300-	2x2 Low	1	-1.3
					1-2.5 FDD	100			
3	10	48	1	8	R.PDCCH.	TDLA30-10	2x2 Low	1	-0.2
					1-1.3 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 Other tests: interleaved	interleaved
Interleaver size		3	}
REG bundle size		Test 3: 6 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

			CORES				Antenna	Reference	value
Test numbe r	Bandw idth (MHz)	CORE SET RB	ET duratio n	Aggregati on level	Reference Channel	Propagation Condition	configurat ion and correlatio n Matrix	Pm-dsg (%)	SNR (dB)
1	40	102	1	2	R.PDCCH.	TDLA30-10	1x2 Low	1	7.0
					2-1.1 TDD				
2	40	102	1	4	R.PDCCH.	TDLC300-	1x2 Low	1	3.0
					2-1.2 TDD	100			3.0
3	40	48	2	16	R.PDCCH.	TDLC300-	1x2 Low	1	-3.8
3	40	40		10	2-2.1 TDD	100	IXZ LOW	ı	-3.6

#### 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

			CORES				Antenna	Reference	e value
Test numbe r	Bandw idth (MHz)	CORE SET RB	ET duratio n	Aggregati on level	Reference Channel	Propagation Condition	configurat ion and correlatio n Matrix	Pm-dsg (%)	SNR (dB)
1	40	90	1	8	R.PDCCH. 2-1.3 TDD	TDLC300- 100	2x2 Low	1	-1.2

# 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

			CORES				Antenna	Reference	value
Test numbe r	Bandw idth (MHz)	CORE SET RB	ET duratio n	Aggregati on level	Channel Condition	Propagation Condition	configurat ion and correlatio n Matrix	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

		CORE SET RB	CORES ET duratio n	Aggregati on level			Antenna	Reference value	
Test numbe r	Bandw idth (MHz)				Reference Channel	Propagation Condition	configurat ion and correlatio n Matrix	Pm-dsg (%)	SNR (dB)
1	10	24	2	4	R.PDCCH.	TDLC300-	2x4 Low	1	-1.9
					1-2.2 FDD	100			
2	10	48	2	8	R.PDCCH.	TDLC300-	2x4 Low	1	-4.5
					1-2.5 FDD	100			
3	10	48	1	4	R.PDCCH.	TDLA30-10	2x4 Low	1	-1.0
					1-1.2 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 Other tests: interleaved	interleaved
Interleaver size		3	<b>;</b>
REG bundle size		Test 3: 6 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

		CORE SET RB	CORES				Antenna	Reference value	
Test numbe r	Bandw idth (MHz)		. El	Aggregati on level	Reference Channel	Propagation Condition	configurat ion and correlatio n Matrix	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

			CORES				Antenna	Reference	e value
Test numbe r	Bandw idth (MHz)	CORE SET RB	ET duratio n	Aggregati on level	Reference Channel	Propagation Condition	configurat ion and correlatio n Matrix	Pm-dsg (%)	SNR (dB)
1	40	90	1	8	R.PDCCH. 2-1.3 TDD	TDLC300- 100	2x4 Low	1	-4.3

# 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

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

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	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
	(kHz)				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	Bandwidth (MHz) /	Reference	Propagation	Antenna configuration	Referen	ce value
numbe	Subcarrier spacing (kHz)	channel	condition	and correlation matrix	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]		
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	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Refer val	
	(kHz)				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	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Refer val	
		(kHz)				Pm- bch (%)	SNR (dB)
I	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	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
	(kHz)				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	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
	(kHz)				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]		
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	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
	(kHz)				Pm-	SNR
					bch	(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	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
	(kHz)				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%\*NDL\_correct\_rx/ (NDL\_newtx + NDL\_retx), where NDL\_newtx is the number of newly transmitted DL transport blocks, NDL\_retx is the number of retransmitted DL transport blocks, and NDL\_correct\_rx is the number of correctly received DL transport blocks.

The 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
	Physical Cell ID		0
Common serving	SSB position in burst		First SSB in Slot #0
cell parameters	SSB periodicity First DMRS position for Type A PDSCH	ms	20
	mapping		2
Cross carrier schedu	ů .		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
- comigaration	Subcarrier spacing	kHz	15 or 30
	RB offset	RBs	0
DL BWP configuration #1	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
	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 1/AL4 for 15 kHz / 5 MHz, 30 kHz / 10 MHz and 30 kHz / 15 MHz 1/AL 8 for other combinations
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
PDCCH	TCI State		TCI state #1
configuration	PDCCH & PDCCH DMRS Precoding configuration		For 2Tx: Single Panel Type I, Random precoder chosen from precoder index 0 and 2, selection updated per slot  For 4Tx: 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
	Mapping type		Type A
	k0		0
	PDSCH aggregation factor	+	1
PDSCH	PRB bundling type		Static WB
configuration	PRB bundling size Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle		N/A
	size DMRS Type		Type 1
	Number of additional DMRS		1 1 1
	Length		1
PDSCH DMRS configuration	Antenna ports indexes		{1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs {1000 – 1003} for 4 Layers CCs
	Number of PDSCH DMRS CDM group(s) without data		1 for 1 layer and 2 layers CCs 2 for 4 Layers CCs
PTRS configuration			PTRS is not configured
	Subcarrier indexes in the PRB used for CSI-RS		k <sub>0</sub> = 3 for CSI-RS resource 1,2,3,4
CSI-RS for tracking	OFDM symbols in the PRB used for CSI-RS		$l_0 = 6$ for CSI-RS resource 1 and 3 $l_0 = 10$ 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		
	= =::::: (P)			15 kHz SCS: 20 for CSI-RS resource		
	CCL DC maria	al: a.i.e	Slots	1,2,3,4		
	CSI-RS period	uicity	Siois	30 kHz SCS: 40 for CSI-RS resource		
				1,2,3,4		
				15 kHz SCS:		
				10 for CSI-RS resource 1 and 2		
	CSI-RS offset		Slots	11 for CSI-RS resource 3 and 4		
	CSI-NS Olisei		31013	30 kHz SCS:		
				20 for CSI-RS resource 1 and 2		
				21 for CSI-RS resource 3 and 4		
	Fraguenay Or	acunation		Start PRB 0		
	Frequency Od	ccupation		Number of PRB = BWP size		
	QCL info			TCI state #0		
		lexes in the PRB used for		$k_0 = 4$		
	CSI-RS	1 : 4				
		ls in the PRB used for CSI-		l <sub>0</sub> = 12		
	RS Number of CS	SI-RS ports (X)		Same as number of transmit antenna		
	CDM Type	BI-RS ports (A)		'FD-CDM2'		
NZP CSI-RS for	Density (p)			1 D-GDIM2		
CSI acquisition	- 11	P		15 kHz SCS: 20		
	CSI-RS period	dicity		30 kHz SCS: 40		
	CSI-RS offset			0		
	Fraguenay O	acupation		Start PRB 0		
	Frequency Od	ccupation		Number of PRB = BWP size		
	QCL info			TCI state #1		
		lexes in the PRB used for		$k_0 = 0$		
	CSI-RS	In the DDD was differed ON				
		ls in the PRB used for CSI-		l <sub>0</sub> = 12		
	RS Number of CS	SI-RS ports (X)		4		
ZP CSI-RS for CSI	CDM Type	BI-NO PORTS (A)		'FD-CDM2'		
acquisition	Density (ρ)			1		
	•,	-1: -:		15 kHz SCS: 20		
	CSI-RS period	dicity		30 kHz SCS: 40		
	CSI-RS offset			0		
	Frequency Od	ecupation		Start PRB 0		
		•		Number of PRB = BWP size		
	Type 1 QCL			SSB #0		
TCI state #0	information	QCL Type		Type C N/A		
	Type 2 QCL information	SSB index QCL Type		N/A		
		• •		CSI-RS resource 1 from 'CSI-RS for		
	Type 1 QCL	CSI-RS resource		tracking configuration		
TCI state #1	information	QCL Type		Type A		
	Type 2 QCL	CSI-RS resource		N/A		
	information	QCL Type		N/A		
				IV/A		
		ups for ACK/NACK feedback		1		
Maximum number of		ssion		4		
HARQ ACK/NACK bundling Redundancy version coding sequence				Multiplexed		
Redundancy version	couing sequent	J <del>C</del>		{0,2,3,1} Single Panel Type I, Random precoder		
				selection updated per slot, with equal		
PDSCH & PDSCH D	MRS Precoding	configuration		probability of each applicable i <sub>1</sub> , i <sub>2</sub>		
		,		combination with PRB bundling		
				granularity		
Symbols for all unused REs				OCNG Annex A.5		
Propagation condition				Static propagation condition		
				No external noise sources are applied		
Antenna	1 layer CCs			1x2 or 1x4		
configuration	2 layers CCs			2x2 or 2x4		
Corniguration				$\Lambda \vee \Lambda$		
Physical signals, cha	4 layers CCs	and precoding		4x4 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

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	Starting symbol (S)		1
configuration	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	Starting symbol (S)		1			
configuration	Length (L)		13			
Number of HARQ	Processes		8			
K1 value			Specific to each UL-DL pattern			
TDD UL-DL patter	in.		15 kHz SCS: FR1.15-1			
TOD OL-DL patter	П		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]

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].

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.

#### 6.1.1.2 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.

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

Table 6.1.1.2-1: Requirements applicability

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

# 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 t	:уре	Test list	Applicability notes
	FR1 FDD	CQI	Clause 6.2.3.1.1.1	The requirements
		PMI	Clause 6.3.3.1.2	apply only in case
		RI	Clause 6.4.2.1	the PDSCH MIMO
			Clause 6.4.3.1	rank in the test case
Supported maximum number of PDSCH MIMO layers (maxNumberMIMO-	FR1 TDD	CQI	Clause 6.2.3.2.1.1	does not exceed UE PDSCH MIMO layers capability
LayersPDSCH)		PMI	Clause 6.3.3.2.2	
		RI	Clause 6.4.2.2 Clause 6.4.3.2	
Supported maximum number of	FR1 FDD	PMI	Clause 6.3.2.1.1	The requirements
ports across all configured			Clause 6.3.2.1.2	apply only in case
NZP-CSI-RS resources per CC			Clause 6.3.3.1.1	the number of NZP-
(maxConfigNumberPortsAcros			Clause 6.3.3.1.2	CSI-RS ports in the
sNZP-CSI-RS-PerCC)		RI	Clause 6.4.3.1 (Test 4)	test case satisfies UE
	FR1 TDD	PMI	Clause 6.3.2.2.1	capability on
			Clause 6.3.2.2.2	maximum number of
			Clause 6.3.3.2.1	NZP-CSI-RS ports
			Clause 6.3.3.2.2	
		RI	Clause 6.4.3.2 (Test 4)	

# 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 transmis	sion scheme		Transmission scheme 1
Actual carrier	Actual carrier configuration Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)		0
Comiguration	Subcarrier spacing	kHz	15 or 30
	Cyclic prefix		Normal
	RB offset	RBs	0
DL BWP configuration #1	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
Active DL BWP in			1
Common	Physical Cell ID		0
serving cell	SSB position in burst		First SSB in Slot #0
parameters	SSB periodicity	ms	20
	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH Number of PDCCH candidates		0,1
	and aggregation levels		1/AL8
	DCI format		1_1
	TCI state		TCI state #1
PDCCH configuration	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  Static propagation conditions: Single Panel Type I, Random precoder chosen from precoder index 0 an 2, selection updated per slot  Not configured
Cross carrier scri	Mapping type		Type A
	k0	1	0
	Starting symbol (S)		2
	Length (L)		12
PDSCH configuration	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
	DMRS Type		Type 1
DD00::	Number of additional DMRS		1
PDSCH DMRS configuration	Maximum number of OFDM		
20garadori	symbols for DL front loaded DMRS		1

				{1000} for Rank1
				{1000,1001} for
	DMRS ports i	ndexes		Rank2 {1000,1001,1002} for
				Rank3 {1000,1001,1002,100
				3} for Rank4
	Number of PE group(s) with	DSCH DMRS CDM		2
PTRS	Frequency de			N/A
configuration	Time density			N/A
		er index in the PRB		0 for CSI-RS
	used for CSI-	RS ( <i>k</i> <sub>0</sub> )		resource 1,2,3,4
	First OFDM o	umbal in the DDD		4 for CSI-RS
	used for CSI-	ymbol in the PRB		resource 1 and 3 8 for CSI-RS
	usea 101 CO1-	100 (10)		resource 2 and 4
	Number of Co	CLDC norte (V		1 for CSI-RS
	Number of Ca	SI-RS ports (X)		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
				15 kHz SCS: 20 for
				CSI-RS resource
	CSI-RS perio	dicity	slot	1,2,3,4
CSI-RS for				30 kHz SCS: 40 for
tracking				CSI-RS resource
				15 kHz SCS: 10 for CSI-RS
				resource 1 and 2
				11 for CSI-RS
				resource 3 and 4
	CSI-RS offset	t	slot	
				30 kHz SCS:
				20 for CSI-RS resource 1 and 2
				21 for CSI-RS
				resource 3 and 4
				Start PRB 0
	Frequency O	ccupation		Number of PRB =
				BWP size
	QCL info			TCI state #0 Start PRB 0
NZP CSI-RS for	Frequency O	ccupation		Number of PRB =
CSI acquisition	i roquonoy ox	occupation		BWP size
	QCL info			TCI state #1
ZP CSI-RS for				Start PRB 0
CSI acquisition	Frequency O	ccupation		Number of PRB =
	Type 1 QCL	SSB index		BWP size SSB #0
	information	QCL Type		Type C
TCI state #0	Type 2 QCL	SSB index		N/A
	information			
		QCL Type		N/A
	Type 1 QCL			CSI-RS resource 1 from 'CSI-RS for
	information	CSI-RS resource		tracking'
TCI state #4				configuration
TCI state #1		QCL Type		Type A
	Type 2 QCL	CSI-RS resource		N/A
	information	QCL Type		N/A
Number of HARC	Processes			4 For FDD
HARQ ACK/NAC	K hundling			8 for TDD Multiplexed
LIVING VOLVINAC	r bunuling		<u> </u>	Manupiezea

Redunda	ncy version coding sequence		{0,2,3,1}		
K1 value (PDSCH-to-HARQ-timing-indicator)		2 for FDD For FR1.30-1: 8 if mod(i,10) = 0 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 Where i is slot index per radio frame with 0~19			
Symbols	for unused REs		OCNG as specified in A.5		
Physica	al 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 f DL.					
Note 2:	Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission.				
Note 3:	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.				

# 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  $\pm 1$  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	To	est 1	Te	st 2
Bandwidth		MHz	10			
Duplex Mode			FDD			
Subcarrier spacing	kHz		1:	5		
SNR		dB	8	9	14	15
Propagation chan	nel			AW	GN	•
Antenna configura	ation		2×2 wi	2x2 with static channel specified in Annex B.1		
Beamforming Mod	101		As	As specified in Annex B.4.1		
	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		4			
	CDM Type		FD-CDM2			
7D 001 D0	Density (ρ)			1		
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> )			Row 5,4		
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )			9	)	
	CSI-RS					
	periodicity and offset	slot		5/	1	
	CSI-RS resource Type			Perio	odic	
	Number of CSI-RS ports (X)			2		
	CDM Type			FD-C	DM2	
N7D 001 D0 (	Density (p)			1		
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB			D 1	) (C )	
CSI acquisition	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )			Row 3	3,(6,-)	
	First OFDM symbol in the PRB used		13			
	for CSI-RS (I <sub>0</sub> )					
	NZP CSI-RS-timeConfig	slot		5/	1	
	periodicity and offset			Dorie	adia	
	CSI-IM resource Type			Perio		
CSI-IM	CSI-IM RE pattern CSI-IM Resource Mapping			0		
configuration	(Kcsi-im,Icsi-im)			(4,	9)	
	CSI-IM timeConfig	alat		<b>-</b> /	4	
	periodicity and offset	slot		5/	1	
ReportConfigType	)			Perio	odic	
CQI-table				Tabl	le 2	
reportQuantity				cri-RI-P	MI-CQI	
	rChannelMeasurements			Not con		
	rInterferenceMeasurements			Not con		
cqi-FormatIndicate	or			Widel	band	
pmi-FormatIndica	tor			Widel		
Sub-band Size		RB		8		
Csi-ReportingBan				1111		
CSI-Report period		slot		5/		
aperiodicTriggerin				Not con		
Codebook	Codebook Type			typel-Sing	gieranel	
	Codebook Mode (CodebookConfig-			1		
configuration	N1,CodebookConfig-N2)			Not con		
	CodebookSubsetRestriction			0100		
	RI Restriction		N/A			
Physical channel for CSI report			1	PUC		
CQI/RI/PMI delay		ms		8	<b>S</b>	
Maximum number of HARQ transmission			1	1		TD0 -
Measurement channel			As spe	cified in Tal 2		2, 1BS.2-

#### 6.2.2.1.2 CQI reporting under fading conditions

#### 6.2.2.1.2.1 Minimum requirement for wideband CQI reporting

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

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI. To account for sensitivity of the input SNR the 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 ≥ γ, where γ is specified in Table 6.2.2.1.2.1-2;
- c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

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

	Parameter	Unit	Test 1 Test 2
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
SNR		dB	6 7 12 13
Propagation chan	nel		TDLA30-5
Antenna configura			2×2
Correlation config			ULA high
Beamforming Mod			As specified in Annex B.4.1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
7D CCL DC	Density (ρ)		1
ZP CSI-RS	First subcarrier index in the PRB		D 5. 4
configuration	used for CSI-RS (k <sub>0</sub> )		Row 5,4
	First OFDM symbol in the PRB used		0
	for CSI-RS (I <sub>0</sub> )		9
	CSI-RS	alat	F/4
	periodicity and offset	slot	5/1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
NZD COLDC for	Density (ρ)		1
NZP CSI-RS for	First subcarrier index in the PRB		Day: 2 (C.)
CSI acquisition	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3,(6,-)
	First OFDM symbol in the PRB used		13
	for CSI-RS (I <sub>0</sub> )		13
	NZP CSI-RS-timeConfig	slot	5/1
	periodicity and offset	SIOL	5/1
	CSI-IM resource Type		Periodic
	CSI-IM RE pattern		0
CSI-IM	CSI-IM Resource Mapping		
configuration	(Ксы-ім,Ісы-ім)		(4, 9)
garano			
	CSI-IM timeConfig	slot	5/1
	periodicity and offset		
ReportConfigType	)		Periodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
	rChannelMeasurements		Not configured
	rInterferenceMeasurements		Not configured
cqi-FormatIndicate			Wideband
pmi-FormatIndica	tor		Wideband
Sub-band Size		RB	8
Csi-ReportingBan			1111111
CSI-Report period		slot	5/0
aperiodicTriggeringOffset			Not configured
	Codebook Type		typel-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig-		Not configured
configuration	N1,CodebookConfig-N2)		
	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	
α[%]	20	20	
γ	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	Ö
Subcarrier spacing		kHz	15	
Duplex Mode			FDD	
SNR	SNR		8 9	14 15
	Propagation channel		Two tap model specified in Anne B.2.4 with $a=1$ , $f_D=5$ Hz, and $t_d=0.45\mu$ s	
Antenna configura	ation		2×2	
Correlation config			As per Annex B.1	
Beamforming Mod			As specified in	
	CSI-RS resource Type		Perio	
	Number of CSI-RS ports (X)		4	
	CDM Type Density (ρ)		FD-C	
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> )		1 Row 5,4	
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		9	
	CSI-RS periodicity and offset	slot	5/	1
	CSI-RS resource Type		Perio	odic
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-C	DM2
NZP CSI-RS for	Density (ρ)		1	
CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3	3,(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		1;	3
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/	
	CSI-IM resource Type		Perio	
	CSI-IM RE pattern		C	
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,	9)
	CSI-IM timeConfig periodicity and offset	slot	5/	
ReportConfigType	)		Aperi	
CQI-table			Tab	
reportQuantity			cri-RI-P	
	rChannelMeasurements		Not con	
cgi-FormatIndicate	rInterferenceMeasurements		Not con Subb	
pmi-FormatIndicat			Widel	
Sub-band Size	toi	RB	vvidei 8	
csi-ReportingBand	1	112	1111	
CSI-Report interva		slot	Not con	
Aperiodic Report			5	
CSI request			1 in slots i, wher otherwise it i	
reportTriggerSize		-	1	
CSI-AperiodicTriggerStateList			One State with on Report Configurat Associated Report Contains pointers	ion ort Configuration
aperiodicTriggeringOffset			and C	SI-IM
apenduic i figgetti	Codebook Type		typel-Sin	
	Codebook Type  Codebook Mode	typei-Single		gior arioi
Codebook	(CodebookConfig-			
configuration	N1,CodebookConfig-N2)		Not con	tigured
	CodebookSubsetRestriction		0000	
RI Restriction			N/	
Physical channel	tor CSI report	ms	PUS	
CQI/RI/PMI delay	CQI/RI/PMI delay		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
α [%]	2	2
β [%]	55	55
γ	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.

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  $\pm 1$  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	4(	
Subcarrier spacin	g	kHz	30	
Duplex Mode			TDD	
TDD UL-DL patte	rn		FR1.30-1	
SNR		dB	8 9	14   15
Propagation chan	nel		AW	
Antenna configura	ation		2x2 with static cha	x B.1
Beamforming Mod			As specified in	
	CSI-RS resource Type		Perio	
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-C	DM2
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB		Row	5,4
	used for CSI-RS (k <sub>0</sub> ) First OFDM symbol in the PRB used			
	for CSI-RS (I <sub>0</sub> )		9	l
	CSI-RS	slot	10.	/1
	periodicity and offset	3101		
	CSI-RS resource Type		Perio	
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-C	DM2
NZP CSI-RS for	Density (ρ)		1	
CSI acquisition	First subcarrier index in the PRB		Row 3	3,(6,-)
-	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )			
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		13	3
	NZP CSI-RS-timeConfig	slot	10	/1
	periodicity and offset CSI-IM resource Type		Perio	odio
	CSI-IM RE pattern		Pend	
	CSI-IM Resource Mapping			·
CSI-IM configuration	(Ксы-ім,Ісы-ім)		(4,	9)
	CSI-IM timeConfig	slot	10.	/1
	periodicity and offset	SIUL	10.	/ 1
ReportConfigType	9		Perio	
CQI-table			Tabl	
reportQuantity			cri-RI-P	
	rChannelMeasurements		Not con	
	rInterferenceMeasurements		Not con	
cqi-FormatIndicat			Widel	
pmi-FormatIndica	lUI	רח	Widel	
Sub-band Size	d	RB	1111	
Csi-ReportingBan		slot	1111	
aperiodicTriggerin		SIUL	Not con	
apendale i riggerii	Codebook Type		typel-Sing	
	Codebook Mode		1	gior arioi
Codebook	(CodebookConfig-		<u> </u>	. ,
configuration	N1,CodebookConfig-N2)		Not con	tigured
g:	CodebookSubsetRestriction		0100	000
	RI Restriction		N/	
Physical channel			PUC	
CQI/RI/PMI delay		ms	9.	5
Maximum number	r of HARQ transmission	-	1	
Measurement cha	annel		As specified in Ta	
Woodlement Channel			4	•

#### 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 6.2.2.2.1-2;
- b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ γ, where γ is specified in Table 6.2.2.2.2.1-2;
- c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

Table 6.2.2.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1	Test 2	
Bandwidth			40		
Subcarrier spacin	g	kHz	30		
Duplex Mode			TDD		
TDD UL-DL patte	rn		FR1.30-1		
SNR		dB	6 7	12 13	
Propagation chan			TDLA3		
Antenna configura			2x2		
Correlation config			ULA h		
Beamforming Mod			As specified in		
	CSI-RS resource Type		Perio	dic	
	Number of CSI-RS ports (X)		4 FD 0F	NAO	
	CDM Type Density (ρ)		FD-CD	JIVIZ	
ZP CSI-RS	First subcarrier index in the PRB		1		
configuration	used for CSI-RS (k <sub>0</sub> )		Row	5,4	
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		9		
	CSI-RS periodicity and offset	slot	10/		
	CSI-RS resource Type		Perio	dic	
	Number of CSI-RS ports (X)		2		
	CDM Type		FD-CD	M2	
NZP CSI-RS for	Density (ρ)		1		
CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3,(6,-)		
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		13		
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/	1	
	CSI-IM resource Type		Perio	dic	
	CSI-IM RE pattern		0		
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4, 9	9)	
	CSI-IM timeConfig periodicity and offset	slot	10/	1	
ReportConfigType			Perio	dic	
CQI-table			Table		
reportQuantity			cri-RI-PN		
	rChannelMeasurements		Not confi		
	rInterferenceMeasurements		Not confi		
cqi-FormatIndicate			Wideb		
pmi-FormatIndica	tor	55	Wideb	and	
Sub-band Size		RB	16	4.4	
Csi-ReportingBan	U lighty and offset	ole+	11111		
CSI-Report period aperiodicTriggering		slot	10/9 Not confi		
apenouic mggenr	Codebook Type		typel-Sing		
	Codebook Type Codebook Mode		typer-sing 1	וכו מווטו	
Codebook	(Codebook Mode (CodebookConfig-		·		
configuration	N1,CodebookConfig-N2)		Not confi	gured	
]	CodebookSubsetRestriction		0000	01	
	RI Restriction		N/A		
Physical channel			PUC		
CQI/RI/PMI delay		ms	9.5		
Maximum number	r of HARQ transmission		1		
Measurement cha	nnel		As specified in Tab	le A.4-2, TBS.2-	

Table 6.2.2.2.1-2: Minimum requirements

Parameters	Test 1	Test 2
α[%]	20	20
γ	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 6.2.2.2.2-1 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 6.2.2.2.2.2;
- 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;
- 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 6.2.2.2.2-1: Sub-band CQI reporting test under frequency-selective fading conditions

Parameter		Unit	Test 1 Test 2	
Bandwidth		MHz	40	
Subcarrier spacin				
Duplex Mode			TDD	
TDD UL-DL patte	rn		FR1.30-1	
SNR		dB	8 9 14 15	
Propagation chan	nnel		Two tap model specified in Annex B.2.4 with $a=1$ , $f_D = 5$ Hz, and	
			т <sub>d</sub> =0.1125µs	
Antenna configura			2x2	
Correlation config			As per Annex B.1	
Beamforming Mo			As specified in Annex B.4.1	
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CDM2	
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> )		Row 5,4	
	First OFDM symbol in the PRB used			
	for CSI-RS (I <sub>0</sub> )		9	
	CSI-RS	-1-4	40/4	
	periodicity and offset	slot	10/1	
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-CDM2	
NZD COLDC for	Density (ρ)		1	
NZP CSI-RS for	First subcarrier index in the PRB		D0 (0 )	
CSI acquisition	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3,(6,-)	
	First OFDM symbol in the PRB used		42	
	for CSI-RS (I <sub>0</sub> )		13	
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	
	CSI-IM resource Type		Periodic	
	CSI-IM RE pattern		0	
	CSI-IM Resource Mapping		1	
CSI-IM configuration	(ксы-ім, Іся-ім)		(4, 9)	
	CSI-IM timeConfig periodicity and offset	slot	10/1	
ReportConfigType			Aperiodic	
CQI-table	<del>5</del>		Table 2	
reportQuantity			cri-RI-PMI-CQI	
	rChannelMeasurements		Not configured	
	orInterferenceMeasurements		Not configured	
cqi-FormatIndicat			Subband	
pmi-FormatIndica			Wideband	
Sub-band Size		RB	16	
csi-ReportingBan	d	N.D	111111	
CSI-Report interv		slot	Not configured	
Aperiodic Report		3101	q	
CSI request	GIOT GIISCT		1 in slots i, where $mod(i, 10) = 1$ ,	
reportTriggerSize			otherwise it is equal to 0	
report riggeraize			One State with one Associated	
			Report Configuration	
CSI-AperiodicTric	ggerStateList			
CSI-AperiodicTrig	ggerStateList		Associated Report Configuration	
CSI-AperiodicTrig	ggerStateList		Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM	
CSI-AperiodicTrig			Associated Report Configuration contains pointers to NZP CSI-RS	
			Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM	
	ngOffset		Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM  Not configured	
	ngOffset Codebook Type Codebook Mode		Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM  Not configured typel-SinglePanel  1	
aperiodicTriggerin	ngOffset Codebook Type Codebook Mode (CodebookConfig-		Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM  Not configured	
aperiodicTriggerin	ngOffset Codebook Type Codebook Mode		Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM  Not configured typel-SinglePanel	
aperiodicTriggerin	ngOffset  Codebook Type Codebook Mode (CodebookConfig- N1,CodebookConfig-N2)		Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM  Not configured typeI-SinglePanel  1  Not configured	

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: Minimum requirements

Parameters	Test 1	Test 2
α [%]	2	2
β [%]	55	55
γ	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  $\pm 1$  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	
Subcarrier spacing	g	kHz	15	
Duplex Mode			FDD	
SNR		dB	5 6	11 12
Propagation chan	nel		AW	
Antenna configura	ation		2x4 with static ch Anne	
Beamforming Mod	101		As specified in	
Boarmonning woo	CSI-RS resource Type		Peri	
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-C	DM2
7D CCL DC	Density (ρ)		1	
ZP CSI-RS configuration	First subcarrier index in the PRB		Dou	. 5. 4
Corniguration	used for CSI-RS (k <sub>0</sub> )		Row	5,4
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		Ş	)
	CSI-RS		_	
	periodicity and offset	slot	5/	1
	CSI-RS resource Type		Peri	odic
	Number of CSI-RS ports (X)		2	)
	CDM Type		FD-C	DM2
NZP CSI-RS for	Density (ρ)		1	
CSI acquisition	First subcarrier index in the PRB		Row	3 (6 -)
OOI acquisition	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		NOW	5,(0,-)
	First OFDM symbol in the PRB used		1	3
	for CSI-RS (I <sub>0</sub> )			
	NZP CSI-RS-timeConfig	slot	5/1	
	periodicity and offset CSI-IM resource Type		Peri	odio
	CSI-IM RE pattern		reii (	
	CSI-IM Resource Mapping			)
CSI-IM configuration	(ксы-ім,Ісы-ім)		(4,	9)
	CSI-IM timeConfig periodicity and offset	slot	5/	′1
ReportConfigType	9		Peri	
CQI-table			Tab	
reportQuantity			cri-RI-P	
	rChannelMeasurements		Not con	
	rInterferenceMeasurements		Not con	
cqi-Formatindicate			Wide	
pmi-FormatIndicate Sub-band Size	tor	RB	Wide 8	
csi-ReportingBand	4	KD	1111	
CSI-Report period		slot	5/	
aperiodicTriggerin		3101	Not cor	
apendalerriggenin	Codebook Type		typel-Sin	
	Codebook Mode		1	g
Codebook	(CodebookConfig-		***	<i>t</i> :
configuration	N1,CodebookConfig-N2)		Not con	ingurea
_	CodebookSubsetRestriction		010	
	RI Restriction		N/	
Physical channel	for CSI report		PUC	CCH
CQI/RI/PMI delay		ms	8	3
Maximum number	of HARQ transmission		1	,
Measurement cha	nnel		As specified in Ta	

#### 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 ≥ γ, where γ is specified in Table 6.2.3.1.2.1-2;
- c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

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

Parameter		Unit	Test 1	Test 2
Bandwidth		MHz	1	0
Subcarrier spacing	g	kHz	15	
Duplex Mode			FC	DD
SNR		dB	3 4	9 10
Propagation chan	nel		TDLA	\30-5
Antenna configura			2>	
Correlation configu			XP I	
Beamforming Mod			As specified in	
· ·	CSI-RS resource Type		Peri	
	Number of CSI-RS ports (X)		4	1
	CDM Type		FD-C	DM2
ZP CSI-RS	Density (ρ)		1	
	First subcarrier index in the PRB		D	. 5. 4
configuration	used for CSI-RS (k <sub>0</sub> )		Row	7 5,4
	First OFDM symbol in the PRB used			`
	for CSI-RS (I <sub>0</sub> )		9	1
	CSI-RS	slot	5/	/1
	periodicity and offset	SIOL	3/	1
	CSI-RS resource Type		Peri	odic
	Number of CSI-RS ports (X)		2	2
	CDM Type		FD-C	DM2
NZP CSI-RS for	Density (ρ)		1	
CSI acquisition	First subcarrier index in the PRB		Dow (	2 (6 )
CSI acquisition	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row	5,(6,-)
	First OFDM symbol in the PRB used		1	2
	for CSI-RS (I <sub>0</sub> )		Ī	3
	NZP CSI-RS-timeConfig	slot	5/1	
	periodicity and offset	SIOL		
	CSI-IM resource Type		Peri	odic
	CSI-IM RE pattern		(	)
CSI-IM	CSI-IM Resource Mapping			
configuration	(Ксы-ім,Ісы-ім)		(4,	9)
garaner.				
	CSI-IM timeConfig	slot	5/	/1
D (0 (" T	periodicity and offset		5	P
ReportConfigType	)		Peri	
CQI-table			Tab	
reportQuantity	Ol IM		cri-RI-P	
	ChannelMeasurements		Not con	
	InterferenceMeasurements		Not con	
cqi-FormatIndicato			Wide	
pmi-FormatIndicat	or	DD	Wide	
Sub-band Size		RB	3	
csi-ReportingBand			1111	
CSI-Report period		slot	5/	
aperiodicTriggerin				nfigured
	Codebook Type		typel-Sin	
Cadabast	Codebook Mode		1	l
Codebook	(CodebookConfig-		Not con	nfigured
configuration	N1,CodebookConfig-N2) CodebookSubsetRestriction			
			000 N/	
Dhysical shares 14	RI Restriction			
Physical channel f	ог Сы героп		PUC	
CQI/RI/PMI delay	of LIADO transmissis	ms	8	
iviaximum number	of HARQ transmission		As an acifical in Ta	
Measurement cha	nnel		As specified in Ta	
		l	1	l

Table 6.2.3.1.2.1-2: Minimum requirements

Parameters	Test 1	Test 2
α[%]	5	5
γ	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  $\alpha\%$  of the time but less than  $\beta\%$  of the time for each sub-band, where  $\alpha$  and  $\beta$  are specified in Table 6.2.3.1.2.2-2;
- 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  $\geq \gamma$ , 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	Bandwidth		10
Subcarrier spacing		MHz kHz	15
Duplex Mode		IN IZ	FDD
SNR		dB	5 6 11 12
ONIX		ub ub	Two tap model specified in Annex
Propagation chan	nel		B.2.4 with $a=1$ , $f_D = 5Hz$ , and
i Topagation chan			τ <sub>d</sub> =0.45μs
Antenna configura	ation		2×4
Correlation config			As per Annex B.1
Beamforming Mod			As specified in Annex B.4.1
Dearmorning Woo	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	. ,		· ·
	CDM Type		FD-CDM2
ZP CSI-RS	Density (p) First subcarrier index in the PRB		l
configuration			Row 5,4
	used for CSI-RS (k <sub>0</sub> )		·
	First OFDM symbol in the PRB used		9
	for CSI-RS (I <sub>0</sub> )		-
	CSI-RS	slot	5/1
	periodicity and offset		
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
NZP CSI-RS for	Density (ρ)		1
CSI acquisition	First subcarrier index in the PRB		Row 3,(6,-)
OOI acquisition	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		1.0W 3,(0,-)
	First OFDM symbol in the PRB used		13
	for CSI-RS (I <sub>0</sub> )		13
	NZP CSI-RS-timeConfig	slot	5/1
	periodicity and offset	SIOL	5/1
	CSI-IM resource Type		Periodic
	CSI-IM RE pattern		0
CSI-IM	CSI-IM Resource Mapping		
	(kcsi-im,lcsi-im)		(4, 9)
configuration			
	CSI-IM timeConfig	alat	E /1
	periodicity and offset	slot	5/1
ReportConfigType	)		Aperiodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
	rChannelMeasurements		Not configured
	InterferenceMeasurements		Not configured
cqi-FormatIndicate			Subband
pmi-FormatIndica			Wideband
Sub-band Size		RB	8
csi-ReportingBand	1		111111
CSI-Report interva		slot	Not configured
Aperiodic Report		3101	5
	S.C. Shoot		1 in slots i, where $mod(i, 5) = 1$ ,
CSI request			otherwise it is equal to $0$
reportTriggerSize			otherwise it is equal to 0
report ringger Size			One State with one Associated
CSI AppriediaTaia	gorStateList		Report Configuration
CSI-AperiodicTrig	geroratelist		Associated Report Configuration
			contains pointers to NZP CSI-RS and CSI-IM
aperiodicTriggeringOffset			
apenouiciriggerin			Not configured
	Codebook Type		typel-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig-		Not configured
configuration	N1,CodebookConfig-N2)		<u> </u>
	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
a [%]	2	2
β [%]	55	55
γ	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  $\pm 1$  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		30	
Duplex Mode	Ouplex Mode		TD	D
TDD UL-DL patte	rn		FR1.3	30-1
SNR		dB	5 6	11 12
Propagation chan	nel		AWC	SN .
Antenna configura	ation		2x4 with static channel specified i Annex B.1	
Beamforming Mod	del		As specified in	
G	CSI-RS resource Type		Perio	
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CI	DM2
ZP CSI-RS	Density (ρ)		1	
	First subcarrier index in the PRB		Daw	Γ <b>Λ</b>
configuration	used for CSI-RS (k <sub>0</sub> )		Row	5,4
	First OFDM symbol in the PRB used		0	
	for CSI-RS (I <sub>0</sub> )		9	
	CSI-RS		404	4
	periodicity and offset	slot	10/	1
	CSI-RS resource Type		Perio	dic
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-CI	DM2
	Density (ρ)		1	
NZP CSI-RS for	Denoity (b)			
CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3	,(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		13	}
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/	1
	CSI-IM resource Type		Perio	dic
	CSI-IM RE pattern		0	
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,	9)
	CSI-IM timeConfig periodicity and offset	slot	10/	1
ReportConfigType	9		Perio	dic
CQI-table			Table	e 2
reportQuantity			cri-RI-PI	/II-CQI
timeRestrictionFo	rChannelMeasurements		Not conf	igured
timeRestrictionFo	rInterferenceMeasurements		Not conf	igured
cqi-FormatIndicate	or		Wideb	
pmi-FormatIndica	tor		Wideb	and
Sub-band Size		RB	16	
csi-ReportingBand	d		1111	111
CSI-Report period		slot	10/	
aperiodicTriggerin			Not conf	
1 335	Codebook Type		typel-Sing	
	Codebook Mode		1	
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not conf	igured
·	CodebookSubsetRestriction		0100	
	RI Restriction		N/A	<i>H</i>
Physical channel for CSI report			PUC	CH
CQI/RI/PMI delay		ms	9.5	
	Maximum number of HARQ transmission		1	
Measurement cha			As specified in Tab	ole A.4-2, TBS.2-
			· ·	

#### 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 patte	rn		FR1.30-1
SNR		dB	3 4 9 10
Propagation chan			TDLA30-5
Antenna configura			2×4
Correlation config			XP High
Beamforming Mo			As specified in Annex B.4.1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
ZP CSI-RS	Density (p) First subcarrier index in the PRB		1
configuration	used for CSI-RS (k <sub>0</sub> )		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		9
	CSI-RS periodicity and offset	slot	10/1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
NZP CSI-RS for	Density (ρ)		1
CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3,(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> )		13
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1
	CSI-IM resource Type		Periodic
	CSI-IM RE pattern		0
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4, 9)
	CSI-IM timeConfig periodicity and offset	slot	10/1
ReportConfigType			Periodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionFo	rChannelMeasurements		Not configured
	rInterferenceMeasurements		Not configured
cqi-FormatIndicat			Wideband
pmi-FormatIndica	tor		Wideband
Sub-band Size		RB	16
csi-ReportingBan		1.4	1111111
CSI-Report period		slot	10/9
aperiodicTriggerin			Not configured
	Codebook Type Codebook Mode		typel-SinglePanel 1
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not configured
-	CodebookSubsetRestriction		000001
RI Restriction			N/A
Physical channel			PUCCH
CQI/RI/PMI delay		ms	9.5
Maximum numbe	r of HARQ transmission		1
Measurement cha	annel		As specified in Table A.4-2, TBS.2-

Table 6.2.3.2.2.1-2: Minimum requirements

Parameters	Test 1	Test 2
α[%]	5	5
γ	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  $\alpha\%$  of the time but less than  $\beta\%$  of the time for each sub-band, where  $\alpha$  and  $\beta$  are specified in Table 6.2.3.2.2.2-2;
- 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 6.2.3.2.2.1: Sub-band CQI reporting test under frequency-selective fading conditions

	Parameter	Unit	Test 1	Test 2
Bandwidth			40	
Subcarrier spacing		kHz	30	
Duplex Mode	_		TDD	
TDD UL-DL patte	TDD UL-DL pattern		FR1.30-1	
SNR		dB	5 6 11	
			Two tap model specifie	
Propagation chan	nel		B.2.4 with $a=1$ , $f_D = 5$	
			т <sub>d</sub> =0.1125µs	
Antenna configura			2x4	
Correlation config			As per Annex E	
Beamforming Mod			As specified in Anne	x B.4.1
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		4 FD 0DM0	
	CDM Type		FD-CDM2	
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB		Row 5,4	
	used for CSI-RS (k <sub>0</sub> ) First OFDM symbol in the PRB used			
	for CSI-RS (I <sub>0</sub> )		9	
	CSI-RS			
	periodicity and offset	slot	10/1	
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-CDM2	
	Density (ρ)		1 0 00 1	
NZP CSI-RS for	First subcarrier index in the PRB			
CSI acquisition	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3,(6,-)	
	First OFDM symbol in the PRB used			
	for CSI-RS (I <sub>0</sub> )		13	
	NZP CSI-RS-timeConfig	-1-4	40/4	
	periodicity and offset	slot	10/1	
	CSI-IM resource Type		Periodic	
	CSI-IM RE pattern		0	
CSI-IM	CSI-IM Resource Mapping			
configuration	(kcsi-im,lcsi-im)		(4, 9)	
oomigaration				
	CSI-IM timeConfig	slot	10/1	
Donort ConfigTune	periodicity and offset		Appriodia	
ReportConfigType CQI-table	<del>,</del>		Aperiodic Table 2	
reportQuantity			cri-RI-PMI-CC	NI.
	rChannelMeasurements		Not configured	
	rInterferenceMeasurements		Not configured	
cgi-FormatIndicate			Subband	<u></u>
pmi-FormatIndica			Wideband	
Sub-band Size		RB	16	
csi-ReportingBane	d	112	1111111	
CSI-Report interv		slot	Not configure	d
Aperiodic Report		5.01	9	
'			1 in slots i, where mode	(i, 10) = 1.
CSI request			otherwise it is equa	
reportTriggerSize			1	
			One State with one Asso	ociated
			Report Configuration	
CSI-AperiodicTrig	gerStateList		Associated Report Cor	
			contains pointers to NZ	P CSI-RS
			and CSI-IM	
aperiodicTriggeringOffset			0	
	Codebook Type		typel-SinglePar	nel
	Codebook Mode		1	
Codebook	(CodebookConfig-		Not configured	d
configuration	N1,CodebookConfig-N2)		_	
	CodebookSubsetRestriction RI Restriction		000001 N/A	
Dhysical channel			PUSCH	
Physical channel for CSI report		<u> </u>	L LOSCH	

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
α <b>[%]</b>	2	2
β [%]	55	55
γ	1.05	1.05

# 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<sub>1</sub> and i<sub>2</sub> combination and applied to the PDSCH. A fixed transport format (FRC) is configured for all requirements.

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

$$\gamma = \frac{t_{ue, follow 1, follow 2}}{t_{rnd1, rnd2}}$$

In the definition of  $\gamma$ , for 4TX and 8TX PMI requirements,  $t_{follow1,follow2}$  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 kHz	10
Subcarrier space	Subcarrier spacing		15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configu	ıration		High XP 4 x 2
			(N1,N2) = (2,1)
Beamforming M			As specified in Annex B.4.1
	CSI-RS resource		Periodic
	Type Number of CSI-		
			4
	RS ports (X) CDM Type		FD-CDM2
	Density (ρ)		1 D-05W2
	First subcarrier		'
ZP CSI-RS	index in the PRB		5 5 (4 )
configuration	used for CSI-RS		Row 5, (4,-)
	$(k_0, k_1)$		
	First OFDM		
	symbol in the PRB		(9,-)
	used for CSI-RS		(9,-)
	(l <sub>0</sub> , l <sub>1</sub> )		
	CSI-RS	slot	5/1
	interval and offset		
	CSI-RS resource		Aperiodic
	Type Number of CSI-		·
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1 D-05/W2
	First subcarrier		'
NZP CSI-RS	index in the PRB		
for CSI	used for CSI-RS		Row 4, (0,-)
acquisition	$(k_0, k_1)$		
	First OFDM		
	symbol in the PRB		(13,-)
	used for CSI-RS		(13,-)
	(l <sub>0</sub> , l <sub>1</sub> )		
	CSI-RS		Not configured
	interval and offset		
	aperiodicTriggerin		0
	gOffset CSI-IM resource		
	Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		1 attern 0
configuration	Mapping		(4,9)
garamen.	(k <sub>CSI-IM</sub> ,l <sub>CSI-IM</sub> )		(1,0)
	CSI-IM timeConfig	-1-4	Niet een Groone d
	interval and offset	slot	Not configured
ReportConfigTy	pe		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
	timeRestrictionForChannelMeasure		Not configured
ments			. ist somigatod
	timeRestrictionForInterferenceMeas		Not configured
urements			
cqi-FormatIndicator			Wideband
pmi-FormatIndicator Sub-band Size		RB	Wideband 8
		מא	1111111
csi-ReportingBand CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset		3101	4
CSI request			1 in slots i, where $mod(i, 5) = 1$ ,
-			otherwise it is equal to 0
reportTriggerSiz	<u>re</u>		1

CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM	
	Codebook Type		typel-SinglePanel	
	Codebook Mode		1	
Codebook	(CodebookConfig- N1,CodebookConfig-N2)		(2,1)	
configuration	(CodebookConfig- O1,CodebookCon fig-O2)		(4,1)	
	CodebookSubset Restriction		11111111	
	RI Restriction		0000001	
Physical channe	Physical channel for CSI report		PUSCH	
CQI/RI/PMI delay		ms	6	
Maximum number of HARQ transmission			4	
Measurement channel			R.PDSCH.1-6.1 FDD	
Note 1: Who	Note 1: When Throughput is measured using random precoder selection, the			

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<sub>1</sub>, i<sub>2</sub> 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-3), this reported PMI cannot be applied at the gNB downlink before slot#(n+3)

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
γ	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.

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

Pai	rameter	Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation cha	annel		TDLA30-5
Antenna configu	Antenna configuration		High XP 8 x 2
			(N1,N2) = (4,1)
Beamforming M			As specified in Annex B.4.1
	CSI-RS resource		Periodic
	Type		
	Number of CSI-		4
	RS ports (X)		ED CDM2
	CDM Type		FD-CDM2
	Density (ρ) First subcarrier		l l
ZP CSI-RS	index in the PRB		
configuration	used for CSI-RS		Row 5, (4,-)
	(k <sub>0</sub> , k <sub>1</sub> )		
	First OFDM		
	symbol in the PRB		4- >
	used for CSI-RS		(9,-)
	(l <sub>0</sub> , l <sub>1</sub> )		
	CSI-RS	-1-4	F/A
	interval and offset	slot	5/1
	CSI-RS resource		Aperiodic
	Type		Apendaic
	Number of CSI-		8
	RS ports (X)		
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
NIZD OOL DO	First subcarrier		
NZP CSI-RS	index in the PRB		Row 8, (4,6)
for CSI	used for CSI-RS		
acquisition	(k <sub>0</sub> , k <sub>1</sub> ) First OFDM		
	symbol in the PRB		
	used for CSI-RS		(5,-)
	(l <sub>0</sub> , l <sub>1</sub> )		
	CSI-RS		
	interval and offset	slot	Not configured
	aperiodicTriggerin		
	gOffset		0
	CSI-IM resource		Aporiodio
	Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		
configuration	Mapping		(4,9)
	(k <sub>CSI-IM</sub> , l <sub>CSI-IM</sub> )		
	CSI-IM timeConfig	slot	Not configured
D 10 " T	interval and offset		•
ReportConfigTy	pe		Aperiodic
CQI-table			Table 1
reportQuantity	ForChannolMeasure		cri-RI-PMI-CQI
ments	timeRestrictionForChannelMeasure		Not configured
	orInterferenceMeas		
urements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			111111
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
reportTriggerSiz	ze		1
		1	

CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
	Codebook Type		typel-SinglePanel
	Codebook Mode		1
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig- O1,CodebookCon fig-O2)		(4,1)
	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010
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
Nets 4. When Theorem is an account of the second of the se			

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<sub>1</sub>, i<sub>2</sub> 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 6.3.2.1.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

#### 6.3.2.2 TDD

#### 6.3.2.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.2.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing Duplex Mode		kHz	30 TDD
TDD DL-UL configuration			FR1.30-1 as specified in Annex
Propagation channel			A TDLA30-5
Antenna configuration			High XP 4 x 2
Beamfo	rming Model		(N1,N2) = (2,1) As specified in Annex B.4.1
2000	CSI-RS resource		Periodic
	Туре		1 enouic
	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS	First subcarrier		
configuration	index in the PRB		Row 5, (4,-)
	used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		
	First OFDM		
	symbol in the PRB		(0.)
	used for CSI-RS		(9,-)
	(l <sub>0</sub> , l <sub>1</sub> )		
	CSI-RS	slot	10/1
	interval and offset CSI-RS resource		
	Type		Aperiodic
	Number of CSI-		4
	RS ports (X)		
	CDM Type		FD-CDM2
	Density (ρ)		1
NZP CSI-RS	First subcarrier index in the PRB		
for CSI	used for CSI-RS		Row 4, (0,-)
acquisition	(k <sub>0</sub> , k <sub>1</sub> )		
	First OFDM		
	symbol in the PRB		(13,-)
	used for CSI-RS		(10, )
	(l <sub>0</sub> , l <sub>1</sub> ) CSI-RS		
	interval and offset	slot	Not configured
	aperiodicTriggerin		0
	gOffset		Ů.
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		-
configuration	Mapping		(4,9)
	(kcsi-im,lcsi-im)		
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure			Not configured
ments timeRestrictionForInterferenceMeas			-
urements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset Aperiodic Report Slot Offset		slot	Not configured 8
	IL SIUL OHSEL		1 in slots i, where mod(i, 10) =
CSI request			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 Type		typel-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig- N1,CodebookConfig-N2)		(2,1)
configuration	(CodebookConfig- O1,CodebookCon fig-O2)		(4,1)
	CodebookSubset Restriction		11111111
	RI Restriction		0000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.1 TDD
Note 1: When Throughput is meas		ured using	random precoder selection, the
precoder shall be updated in each slot (0.5 ms granularity) with probability of each applicable $i_1$ , $i_2$ combination.		mbination.	
	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)		

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 6.3.2.2.1-2: Minimum requirement

Parameter	Test 1
γ	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 (N1,N2) = (4,1)	
Beamfo	rming Model		As specified in Annex B.4.1	
	CSI-RS resource		Periodic	
	Type Number of CSI-			
	RS ports (X)		4	
	CDM Type		FD-CDM2	
	Density (ρ)		1	
ZP CSI-RS	First subcarrier			
configuration	index in the PRB		Row 5, (4,-)	
	used for CSI-RS		, , , ,	
	(k <sub>0</sub> , k <sub>1</sub> )			
	First OFDM			
	symbol in the PRB		(9,-)	
	used for CSI-RS		(-,,)	
	(l <sub>0</sub> , l <sub>1</sub> )			
	CSI-RS	slot	10/1	
	interval and offset CSI-RS resource			
	Type		Aperiodic	
	Number of CSI-		0	
	RS ports (X)		8	
	CDM Type		CDM4 (FD2, TD2)	
	Density (ρ)		1	
	First subcarrier			
NZP CSI-RS	index in the PRB		Row 8, (4,6)	
for CSI	used for CSI-RS		1.0w 0, (4,0)	
acquisition	$(k_0, k_1)$			
	First OFDM			
	symbol in the PRB		(5,-)	
	used for CSI-RS			
	(l <sub>0</sub> , l <sub>1</sub> ) CSI-RS			
	interval and offset	slot	Not configured	
	aperiodicTriggerin			
	gOffset		0	
	CSI-IM resource		Aperiodic	
	Type		•	
	CSI-IM RE pattern		Pattern 0	
CSI-IM	CSI-IM Resource			
configuration	Mapping		(4,9)	
	(kcsi-im,lcsi-im)			
	CSI-IM timeConfig interval and offset	slot	Not configured	
ReportConfigType			Aperiodic	
CQI-table			Table 1	
reportQuantity			cri-RI-PMI-CQI	
timeRestrictionForlChannelMeasur				
ements			Not configured	
timeRestrictionForInterferenceMeas			Not configured	
urements			-	
cqi-FormatIndicator			Wideband	
pmi-FormatIndicator			Wideband	
Sub-band Size		RB	16	
csi-ReportingBand		ماء د	1111111	
CSI-Report interval and offset		slot	Not configured 8	
Aperiodic Report Slot Offset			1 in slots i, where mod(i, 10) =	
CSI request			1, otherwise it is equal to 0	
1, other meetic 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 Type			typel-SinglePanel
	Codebook Mode		1
Cadabaak	(CodebookConfig- N1,CodebookConfig-N2)		(4,1)
Codebook configuration	(CodebookConfig- O1,CodebookCon fig-O2)		(4,1)
	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010
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
		in each slo	random precoder selection, the of (0.5 ms granularity) with equal mbination.
		ilable uplink reporting instance at slot#n	

- 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
- 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: Minimum requirement

Parameter	Test 1
γ	1.5

## 6.3.3 4RX requirements

#### 6.3.3.1 FDD

#### 6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.3.1.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 4
<u>-</u>			(N1,N2) = (2,1)
Beamforming M			As specified in Annex B.4.1
	CSI-RS resource		Periodic
	Type Number of CSI-		
			4
	RS ports (X) CDM Type		FD-CDM2
	Density (p)		1 D-6DIVIZ
	First subcarrier		'
ZP CSI-RS	index in the PRB		<b>5 -</b> (1)
configuration	used for CSI-RS		Row 5, (4,-)
	$(k_0, k_1)$		
	First OFDM		
	symbol in the PRB		(9,-)
	used for CSI-RS		(9,-)
	(l <sub>0</sub> , l <sub>1</sub> )		
	CSI-RS	slot	5/1
	interval and offset		
	CSI-RS resource		Aperiodic
	Type Number of CSI-		·
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1 D-05/W2
	First subcarrier		'
NZP CSI-RS	index in the PRB		D 4 (0 )
for CSI	used for CSI-RS		Row 4, (0,-)
acquisition	$(k_0, k_1)$		
	First OFDM		
	symbol in the PRB		(13,-)
	used for CSI-RS		(13,-)
	(l <sub>0</sub> , l <sub>1</sub> )		
	CSI-RS	slot	Not configured
	interval and offset		3
	aperiodicTriggerin		0
	gOffset CSI-IM resource		
	Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		1 ditoil 0
configuration	Mapping		(4,9)
J	(kcsi-im,lcsi-im)		(1,5)
	CSI-IM timeConfig	alat	Not configured
	interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure			Not configured
ments timeRestrictionForInterferenceMeas			3.5.5
			Not configured
urements cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	Widebarid 8
csi-ReportingBand		1,0	1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset		5,51	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 Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM	
	Codebook Type		typel-SinglePanel	
	Codebook Mode		1	
Cadabaak	(CodebookConfig- N1,CodebookConfig-N2)		(2,1)	
Codebook configuration	(CodebookConfig- O1,CodebookCon fig-O2)		(4,1)	
	CodebookSubset Restriction		11111111	
	RI Restriction		0000001	
Physical channe	el for CSI report		PUSCH	
CQI/RI/PMI dela	ay	ms	6	
Maximum number of HARQ transmission			4	
Measurement channel			R.PDSCH.1-6.1 FDD	
		in each slo	random precoder selection, the of (1 ms granularity) with equal mbination.	

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).

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
γ	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 cha	annel		TDLA30-5	
Antenna configuration			High XP 8 x 4	
			(N1,N2) = (4,1)	
Beamforming M			As specified in Annex B.4.1	
	CSI-RS resource		Periodic	
	Type Number of CSI-			
	RS ports (X)		4	
	CDM Type		FD-CDM2	
	Density (ρ)		1 D-05/N2	
	First subcarrier			
ZP CSI-RS	index in the PRB		5 5 (4 )	
configuration	used for CSI-RS		Row 5, (4,-)	
	$(k_0, k_1)$			
	First OFDM			
	symbol in the PRB		(9,-)	
	used for CSI-RS		(9,-)	
	(l <sub>0</sub> , l <sub>1</sub> )			
	CSI-RS	slot	5/1	
	interval and offset			
	CSI-RS resource		Aperiodic	
	Type Number of CSI-		·	
	RS ports (X)		8	
	CDM Type		CDM4 (FD2, TD2)	
	Density (ρ)		1	
	First subcarrier			
NZP CSI-RS	index in the PRB		D 0 (4.0)	
for CSI	used for CSI-RS		Row 8, (4,6)	
acquisition	$(k_0, k_1)$			
	First OFDM			
	symbol in the PRB		(5,-)	
	used for CSI-RS		(5,-)	
	(l <sub>0</sub> , l <sub>1</sub> )			
	CSI-RS	slot	Not configured	
	interval and offset			
	aperiodicTriggerin gOffset		0	
	CSI-IM resource			
	Туре		Aperiodic	
	CSI-IM RE pattern		Pattern 0	
CSI-IM	CSI-IM Resource		. anom o	
configuration	Mapping		(4,9)	
	(k <sub>CSI-IM</sub> , l <sub>CSI-IM</sub> )			
	CSI-IM timeConfig	slot	Not configured	
	interval and offset	3101	Ţ.	
ReportConfigTy	pe		Aperiodic	
CQI-table			Table 1	
reportQuantity			cri-RI-PMI-CQI	
timeRestrictionForChannelMeasure			Not configured	
ments timeRestrictionForInterferenceMeas				
urements			Not configured	
cqi-FormatIndicator			Wideband	
pmi-FormatIndicator			Wideband	
Sub-band Size		RB	Wideballd 8	
csi-ReportingBand		,,,,	1111111	
CSI-Report interval and offset		slot	Not configured	
Aperiodic Report Slot Offset		2.21	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 Type		typel-SinglePanel	
	Codebook Mode		1	
Codebook	(CodebookConfig- N1,CodebookConfig-N2)		(4,1)	
configuration	(CodebookConfig- O1,CodebookCon fig-O2)		(4,1)	
	CodebookSubset Restriction		0x FFFF	
	RI Restriction		0000010	
Physical channe	el for CSI report		PUSCH	
CQI/RI/PMI dela	ay	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 selectic precoder shall be updated in each slot (1 ms granularity) with e				
probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination.			mbination.	

probability of each applicable i<sub>1</sub>, i<sub>2</sub> 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

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
γ	1.5

#### 6.3.3.2 **TDD**

#### 6.3.3.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.2.1-1, and using the downlink physical channels specified in Annex 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	40		
Subcarrier spacing		kHz	30		
Duplex Mode	Duplex Mode		TDD		
TDD DL-UL con	TDD DL-UL configuration		FR1.30-1 as specified in Annex A		
Propagation cha	annel		TDLA30-5		
Antenna configu	uration		High XP 4 x 4 (N1,N2) = (2,1)		
Beamforming M	lodel		As specified in Annex B.4.1		
	CSI-RS resource		Periodic		
	Type		. 5.15 4.15		
	Number of CSI- RS ports (X)		4		
	CDM Type		FD-CDM2		
	Density (ρ)		1		
ZP CSI-RS	First subcarrier				
configuration	index in the PRB		Dow 5 (4 )		
Corniguration	used for CSI-RS		Row 5, (4,-)		
	$(k_0, k_1)$				
	First OFDM				
	symbol in the PRB		(9,-)		
	used for CSI-RS		(0, )		
	(l <sub>0</sub> , l <sub>1</sub> )				
	CSI-RS	slot	10/1		
	interval and offset		1.67.1		
	CSI-RS resource		Aperiodic		
	Type		- ф		
	Number of CSI-		4		
	RS ports (X)		ED ODMO		
	CDM Type		FD-CDM2		
	Density (ρ)		1		
NZP CSI-RS	First subcarrier				
for CSI	index in the PRB used for CSI-RS		Row 4, (0,-)		
acquisition	(k <sub>0</sub> , k <sub>1</sub> )				
aoquioition	First OFDM				
	symbol in the PRB				
	used for CSI-RS		(13,-)		
	(l <sub>0</sub> , l <sub>1</sub> )				
	CSI-RS		Not a set some d		
	interval and offset		Not configured		
	aperiodicTriggerin		0		
	gOffset		0		
	CSI-IM resource		Aperiodic		
	Туре		·		
	CSI-IM RE pattern		Pattern 0		
CSI-IM	CSI-IM Resource		(4.5)		
configuration	Mapping		(4,9)		
	(kcsi-im,lcsi-im)				
	CSI-IM timeConfig interval and offset	slot	Not configured		
ReportConfigTy			Aperiodic		
CQI-table			Table 1		
reportQuantity			cri-RI-PMI-CQI		
timeRestrictionForChannelMeasure			Not configured		
ments timeRestrictionForInterferenceMeas					
urements			Not configured		
cqi-FormatIndicator			Wideband		
pmi-FormatIndicator			Wideband		
Sub-band Size		RB	16		
csi-ReportingBand			111111		
CSI-Report interval and offset		slot	Not configured		
Aperiodic Report Slot Offset			8		
			1 in slots i, where mod(i, 10) =		
CSI request			1, otherwise it is equal to 0		

reportTriggerS	Size		1		
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM		
	Codebook Type		typel-SinglePanel		
	Codebook Mode		1		
Codebook	(CodebookConfig- N1,CodebookConf ig-N2)		(2,1)		
configuration	(CodebookConfig- O1,CodebookCon fig-O2)		(4,1)		
	CodebookSubset Restriction		11111111		
	RI Restriction		0000001		
Physical chan	nel for CSI report		PUSCH		
CQI/RI/PMI de	elay	ms	5.5		
	nber of HARQ		4		
transmission			·		
Measurement channel			R.PDSCH.2-8.1 TDD		
			random precoder selection, the		
precoder shall be updated in each slot (0.5 ms granularity) with equiprobability of each applicable i <sub>1</sub> , i <sub>2</sub> combination.			mbination.		
		ilable 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	
γ	1.3	

#### Single PMI with 8TX TypeI-SinglePanel Codebook 6.3.3.2.2

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 cha	annel		TDLA30-5	
Antenna configu	ıration		High XP 8 x 4	
•			(N1,N2) = (4,1)	
Beamforming M	CSI-RS resource		As specified in Annex B.4.1	
	Type		Periodic	
	Number of CSI-		4	
	RS ports (X)			
	CDM Type Density (ρ)		FD-CDM2	
	First subcarrier		'	
ZP CSI-RS	index in the PRB		5 5 (1)	
configuration	used for CSI-RS		Row 5, (4,-)	
	$(k_0, k_1)$			
	First OFDM			
	symbol in the PRB used for CSI-RS		(9,-)	
	(l <sub>0</sub> , l <sub>1</sub> )			
	CSI-RS		10/1	
	interval and offset	slot	10/1	
	CSI-RS resource		Aperiodic	
	Type		7 (201100110	
	Number of CSI- RS ports (X)		8	
	CDM Type		CDM4 (FD2, TD2)	
	Density (ρ)		1	
	First subcarrier			
NZP CSI-RS	index in the PRB		Row 8, (4,6)	
for CSI	used for CSI-RS		1.0.0 0, (1,0)	
acquisition	(k <sub>0</sub> , k <sub>1</sub> ) First OFDM			
	symbol in the PRB		<b>/-</b> \	
	used for CSI-RS		(5,-)	
	(l <sub>0</sub> , l <sub>1</sub> )			
	CSI-RS	slot	Not configured	
	interval and offset aperiodicTriggerin			
	gOffset		0	
	CSI-IM resource		Aperiodic	
	Туре		·	
CCLIM	CSI-IM RE pattern		Pattern 0	
CSI-IM configuration	CSI-IM Resource Mapping		(4,9)	
Comiguration	(kcsi-im,lcsi-im)		(4,9)	
	CSI-IM timeConfig	slot	Not configured	
	interval and offset	SIOL	Not configured	
ReportConfigTy	pe		Aperiodic	
CQI-table			Table 1 cri-RI-PMI-CQI	
reportQuantity timeRestrictionForChannnelMeasur				
ements			Not configured	
timeRestrictionForInterferenceMeas			Not configured	
urements				
cqi-FormatIndicator			Wideband	
pmi-FormatIndicator		DD	Wideband	
Sub-band Size		RB	16 1111111	
csi-ReportingBand CSI-Report interval and offset		slot	Not configured	
Aperiodic Report Slot Offset		0.00	8	
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0	

reportTrigge	erSize		1		
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM		
	Codebook Type		typel-SinglePanel		
	Codebook Mode		1		
Codebook	(CodebookConfig- N1,CodebookConfig-N2)		(4,1)		
configuration	fig-O2)		(4,1)		
	CodebookSubset Restriction		0x FFFF		
	RI Restriction		0000010		
Physical cha	annel for CSI report		PUSCH		
CQI/RI/PMI	delay	ms	6.5		
Maximum number of HARQ transmission			4		
Measurement channel			R.PDSCH.2-8.2 TDD		
Note 1: When Throughput is measured us precoder shall be updated in each probability of each applicable i <sub>1</sub> , i <sub>2</sub>		in each slo	ot (0.5 ms granularity) with equal		
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),			k reporting instance at slot#n		

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).

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
γ	1.5

## 6.4 Reporting of Rank Indicator (RI)

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

## 6.4.1 1RX requirements

(Void)

## 6.4.2 2RX requirements

### 6.4.2.1 FDD

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

- a) The ratio of the throughput obtained when transmitting based on UE reported RI and that obtained when transmitting with fixed rank 1 shall be  $\geq \gamma_1$ ;
- 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 6.4.2.1-1, 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 of			TDLA30-5	TDLA30-5	TDLA30-5
Antenna confi	guration		ULA Low 2x2	ULA Low 2x2	ULA High 2x2
Beamforming	Model		As defined in	As defined in	As defined in
200			Annex B.4.1	Annex B.4.1	Annex B.4.1
	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		4	4	4
ZP CSI-RS	CDM Type Density (p)		FD-CDM2	FD-CDM2	FD-CDM2
	First subcarrier index in the		1	1	1
configuratio n	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
	First OFDM symbol in the PRB				
	used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(9,-)	(9,-)	(9,-)
	CSI-RS		E /4	E /4	- /4
	periodicity and offset	slot	5/1	5/1	5/1
	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		2	2	2
NZP CSI-	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
RS for CSI	Density (ρ)		1	1	1
acquisition	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	5/1	5/1
	CSI-IM resource Type		Periodic	Periodic	Periodic
CSI-IM	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0
configuratio	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	5/1	5/1	5/1
ReportConfigType			Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2
reportQuantity	/		cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestrictio	nForChannelMeasurements		not configured	not configured	not configured
timeRestrictio	nForInterferenceMeasurements		not configured	not configured	not configured
cqi-FormatInd			Wideband	Wideband	Wideband
pmi-FormatIn			Wideband	Wideband	Wideband
Sub-band Siz		RB	8	8	8
csi-Reporting	Band eriodicity and offset	clot	1111111	1111111	1111111
Col-Report pe	Codebook Type	slot	5/0 typel-	5/0 typel-	5/0 typel-
	Codebook Type		SinglePanel	SinglePanel	SinglePanel
	Codebook Mode		1	1	1
	(CodebookConfig-		N1/A	N1/A	N1/A
Codebook configuration	N1,CodebookConfig-N2)		N/A	N/A	N/A
	CodebookSubsetRestriction		010000 for fixed rank 2,	000011 for fixed rank 1,	000011 for fixed rank 1,
			010011 for	010011 for	010011 for
			following rank	following rank	following rank
<u> </u>	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 Fixed RI = 2	1 Fixed RI = 1	1 Fixed RI = 1
RI Configuration			and follow RI	and follow RI	and follow RI

Table 6.4.2.1-2: Minimum requirement (FDD)

	Test 1	Test 2	Test 3
71	N/A	1.05	0.9
72	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)

Bandwidth		Parameter	Unit	Test 1	Test 2	Test 3
Duplex Mode	Bandwidth		MHz	40	40	40
TDD SIGN Configuration	Subcarrier spa	acing	kHz	30	30	30
SNR					TDD	TDD
Propagation channel		figuration		FR1.30-1	FR1.30-1	
Beamforming Model			dB	_		
Beamforming Model						
CSI-RS resource Type	Antenna confi	guration				
CSI-RS resource Type	Beamforming	Model				
Number of CSI-RS ports (X)						
CDM Type						
A						
First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   First OFDM symbol in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   Periodic Pe	7D CCL DC					
PRB used for CSI-RS (ko, k1)				·		
First OFDM symbol in the PRB   (9,-) (9,-) (9,-) (9,-)	•			Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
Used for CSI-RS (lo, ls)						
CSI-RS resource Type				(9,-)	(9,-)	(9,-)
Periodicity and offset				10/1	10/1	10/1
CSI-RS resource Type		periodicity and offset	SIOT	10/1	10/1	10/1
NZP CSI-RS for CSI   First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   Row 3 (6,-)   Row 3 (6,-) Row 3 (6,-)   Row 3 (6,-) Row 3 (6,-) Row 3 (6,-) Row 3 (6,-) Row 3 (6,-) Row 3 (6,-) Row		CSI-RS resource Type		Periodic	Periodic	Periodic
NZP CSI-RS for CSI acquisition   First subcarrier index in the PRB used for CSI-RS (ko, k; )   First Subcarrier index in the PRB used for CSI-RS (ko, k; )   First OFDM symbol in the PRB used for CSI-RS (ko, k; )   NZP CSI-RS-timeConflig periodicity and offset   Slot   10/1		. , ,		_	_	_
RS for CSI acquisition				FD-CDM2	FD-CDM2	FD-CDM2
Row 3 (b, -)   First OFDM symbol in the PRB used for CSI-RS (b, l, l)   NZP CSI-RS-timeConfig periodicity and offset   slot   10/1				1	1	1
First OFDM symbol in the PRB used for CSI-RS (lo, lt)   NZP CSI-RS-timeConflig periodicity and offset   Siot   10/1   1				Row 3 (6 -)	Row 3 (6 -)	Row 3 (6 -)
Used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )   (13,-)   (13,-)   (13,-)     NZP CSI-RS-timeConfig periodicity and offset   slot   10/1   10/1   10/1     CSI-IM resource Type   Periodic   Periodic   Periodic   Periodic   Periodic   Periodic   CSI-IM Resource Mapping   (4,9)   (4,9)   (4,9)   (4,9)     CSI-IM Resource Mapping (KCSI-IM, IcSI-IM)   CSI-IM timeConfig periodicity and offset   Slot   10/1   10/1   10/1     ReportConfigType   Periodic   Peri	acquisition			11011 0 (0, )	11011 0 (0, )	11011 0 (0, )
NZP CSI-RS-timeConfig periodicity and offset   Slot   10/1   10				(13,-)	(13,-)	(13,-)
CSI-IM resource Type				, , ,	, ,,	, , ,
CSI-IM   COSI-IM REsource Type   Periodic   Periodic   Periodic   CSI-IM REs pattern   Pattern 0   P			slot	10/1	10/1	10/1
CSI-IM configuration of CSI-IM Resource Mapping (CSI-IM Resource Mapping (Importance Mapping (Importanc				Periodic	Periodic	Periodic
CSI-IM						
CSI-IM timeConfig periodicity and offset   Silot   10/1						
CSI-IM timeConfig periodicity and offset	_			(4,9)	(4,9)	(4,9)
Periodic   Periodic   Periodic   Periodic   CQI-table   Table 2	n		alat	10/1	10/1	10/1
Table 2   Tabl		periodicity and offset	SIOT	10/1	10/1	10/1
Tripper   Cri-RI-PMI-CQI   Cri-RI-PMI-CQI   CQI   CQI   CQI		Туре				
TeportQuantity   CRI-PMI-CQI   CQI   CQI   CQI   timeRestrictionForChannelMeasurements   not configured   not configured   not configured   config	CQI-table			Table 2		
timeRestrictionForChannelMeasurements         not configured         configured configured         Coll configured configured configured         Configured configured configured         Configured configured configured         not configured configured         not configured configured         not configured	reportQuantity	/		cri-RI-PMI-CQI		
timeRestrictionForInterferenceMeasurements  timeRestrictionForInterferenceMeasurements  cqi-FormatIndicator  pmi-FormatIndicator  Sub-band Size  RB  16  16  16  16  16  26  26-ReportingBand  Codebook Type  Codebook Mode  Codebook Mode  Codebook Configured  Codebook Configured  Codebook Configured  Codebook Configured  Codebook Configured  N/A  N/A  N/A  N/A  PUCCH  Physical channel for CSI report  CQI/RI/PMI delay  Tode Configured  Tode Configured  Nideband  Nideband  Wideband  Videband  Videband  Videband  Videband  Videband  Videband  Nideband  Nid	-,	,				
timeRestrictionForInterferenceMeasurements	timeRestrictio	nForChannelMeasurements		not configured		
timeRestrictionForInterferenceMeasurements         not configured         configured         configured           cqi-FormatIndicator         Wideband         Wideband         Wideband           Sub-band Size         RB         16         16         16           csi-ReportingBand         11111111         1111111         1111111         1111111           CSI-Report periodicity and offset         slot         10/9         10/9         10/9           Codebook Type         typel-SinglePanel         SinglePanel         SinglePanel         SinglePanel           Codebook Mode         1         1         1         1           Codebook Node configuration         N/A         N/A         N/A         N/A           VA, CodebookConfig-N2)         O10000 for fixed rank 2, 010011 for fixed rank 1, 010011 for following rank         010001 for following rank         010001 for following rank         010001 for following rank         N/A         N/A         N/A           Physical channel for CSI report         PUCCH         PUC				-		
cqi-FormatIndicator         Wideband         Wideband         Wideband           pmi-FormatIndicator         RB         16         16         16           Sub-band Size         RB         16         16         16           csi-ReportingBand         1111111         1111111         1111111         1111111           CSI-Report periodicity and offset         slot         10/9         10/9         10/9           Codebook Type         typel- SinglePanel         SinglePanel         SinglePanel         SinglePanel           Codebook Mode (CodebookConfig- N1, CodebookConfig-N2)         N/A         N/A         N/A         N/A           Codebook SubsetRestriction         010000 for fixed rank 2, 010011 for following rank         000011 for following rank         000011 for following rank         010011 for following rank         010001 for following rank	timeRestrictio	nForInterferenceMeasurements		not configured		
Dmi-FormatIndicator	cgi-FormatInd	licator		Wideband		
Sub-band Size         RB         16         16         16           csi-ReportingBand         11111111         1111111         1111111         1111111           CSI-Report periodicity and offset         slot         10/9         10/9         10/9           Codebook Type         typel-SinglePanel         SinglePanel         SinglePanel         SinglePanel           Codebook Mode         1         1         1         1           Codebook Config-N2)         N/A         N/A         N/A         N/A           CodebookSubsetRestriction         010000 for fixed rank 2, 010011 for following rank         0100011 for following rank         0100011 for following rank         0100011 for following rank         0100011 for following rank         N/A						
CSI-ReportingBand         1111111         1111111         1111111         1111111           CSI-Report periodicity and offset         slot         10/9         10/9         10/9           Codebook Type         typel-SinglePanel         typel-SinglePanel         SinglePanel         SinglePanel           Codebook Mode         1         1         1         1           Codebook Config-N2)         N/A         N/A         N/A         N/A           Codebook SubsetRestriction         010000 for fixed rank 2, 010011 for fixed rank 1, 010011 for following rank         010011 for fixed rank 1, 010011 for following rank         010011 for following rank         N/A         N/A           Physical channel for CSI report         PUCCH         PUCCH         PUCCH         PUCCH           CQI/RI/PMI delay         ms         9.5         9.5         9.5           Maximum number of HARQ transmission         1         1         1         1           RI Configuration         Fixed RI = 2         Fixed RI = 1         Fixed RI = 1			RB			
Codebook Type						
Codebook Type		eriodicity and offset	slot			
Codebook Mode						
Codebook configuration         (CodebookConfig-N2)         N/A         N/A         N/A         N/A           CodebookSubsetRestriction         010000 for fixed rank 2, 010011 for fixed rank 2, 010011 for following rank         010001 for fixed rank 1, 010011 for following rank         01001				SinglePanel	SinglePanel	SinglePanel
Codebook configuration         N1,CodebookConfig-N2)         N/A				1	1	1
Codebook configuration         N1,CodebookConfig-N2)         010000 for fixed rank 2, 010011 for fixed rank 1, 010011 for following rank         000011 for fixed rank 1, 010011 for following rank         010011 for following rank         010011 for following rank         N/A         N/A         N/A           Physical channel for CSI report         PUCCH         PUCCH         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         Fixed RI = 1         Fixed RI = 1				N/A	N/A	N/A
fixed rank 2, 010011 for following rank   010011 for following rank   010011 for following rank   N/A   N/A   N/A						
BL Configuration         010011 for following rank         010011 for following rank         010011 for following rank         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         1           RI Configuration         Fixed RI = 2         Fixed RI = 1         Fixed RI = 1	configuration	CodebookSubsetRestriction				
RI Restriction         N/A         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         1           RI Configuration         Fixed RI = 2         Fixed RI = 1         Fixed RI = 1						
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         1           RI Configuration         Fixed RI = 2         Fixed RI = 1         Fixed RI = 1						
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         1           RI Configuration         Fixed RI = 2         Fixed RI = 1         Fixed RI = 1		RI Restriction				
CQI/RI/PMI delay         ms         9.5         9.5           Maximum number of HARQ transmission         1         1         1           RI Configuration         Fixed RI = 2         Fixed RI = 1         Fixed RI = 1	Physical chan					
Maximum number of HARQ transmission  1 1 1  RI Configuration  Fixed RI = 2 Fixed RI = 1 Fixed RI = 1			ms			
RI Configuration Fixed RI = 2 Fixed RI = 1 Fixed RI = 1				1	1	1
RUCONTIGUESTION				Fixed RI = 2	Fixed RI = 1	Fixed RI = 1
	Ki Configurati	UII		and follow RI	and follow RI	and follow RI

Table 6.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
71	N/A	1.05	0.9
72	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 spa	acing	kHz	15	15	15	15
Duplex Mode			FDD	FDD	FDD	FDD
SNR		dB	-2	16	16	22
Propagation c			TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna confi	guration		ULA Low 2x4	ULA Low 2x4	ULA High 2x4	ULA Low 4x4
Beamforming	Model		As defined in	As defined in	As defined in	As defined in
Deamlonning			Annex B.4.1	Annex B.4.1	Annex B.4.1	Annex B.4.1
	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
ZP CSI-RS	Density (ρ)		1	1	1	1
configuratio	First subcarrier index in the		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
n	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		10W 3, (+,-)	110W 3, (+,-)	110W 3, (+,-)	110W 3, (+,-)
	First OFDM symbol in the PRB		(9,-)	(9,-)	(9,-)	(9,-)
ļ	used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(0, )	(0, )	(0, )	(0, )
	CSI-RS	slot	5/1	5/1	5/1	5/1
	periodicity and offset	0.01				- '
-	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		2	2	2	4
NZP CSI-	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
RS for CSI	Density (ρ)		1	1	1	1
acquisition	First subcarrier index in the		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)	Row 4 (0,-)
aoquiomon	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		11011 0 (0, )	11011 0 (0, )	11011 0 (0, )	11011 1 (0, )
	First OFDM symbol in the PRB		(13,-)	(13,-)	(13,-)	(13,-)
-	used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(.0, )	(, /	(10, )	(10, )
	NZP CSI-RS-timeConfig	slot	5/1	5/1	5/1	5/1
	periodicity and offset					
	CSI-IM resource Type		Periodic	Periodic	Periodic	Periodic
CSI-IM	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0	Pattern 0
configuratio	CSI-IM Resource Mapping		(4,9)	(4,9)	(4,9)	(4,9)
n Š	(KCSI-IM, ICSI-IM)		( , ,	( , ,	( , ,	. , ,
	CSI-IM timeConfig	slot	5/1	5/1	5/1	5/1
DanartCartin	periodicity and offset		Daviadia	Periodic	Daviadia	Daviadia
ReportConfig	туре		Periodic		Periodic	Periodic
CQI-table			Table 2	Table 2 cri-RI-PMI-	Table 2 cri-RI-PMI-	Table 2 cri-RI-PMI-
reportQuantity	<i>'</i>		cri-RI-PMI-CQI	CQI	CII-RI-PIVII- CQI	CII-RI-PIVII- CQI
				not	not	not
timeRestriction	nForChannelMeasurements		not configured	configured	configured	configured
				not	not	not
timeRestriction	nForInterferenceMeasurements		not configured	configured	configured	configured
cqi-FormatInd	icator		Wideband	Wideband	Wideband	Wideband
pmi-FormatIng			Wideband	Wideband	Wideband	Wideband
Sub-band Size		RB	8	8	8	8
csi-Reporting			1111111	1111111	1111111	1111111
	eriodicity and offset	slot	5/0	5/0	5/0	5/0
23. Hoport pe	Codebook Type	3.00	typel-	typel-	typel-	typel-
			SinglePanel	SinglePanel	SinglePanel	SinglePanel
	Codebook Mode		1	1	1	1
	(CodebookConfig-					· · · · · · · · · · · · · · · · · · ·
	N1,CodebookConfig-N2)		N/A	N/A	N/A	(2,1)
	CodebookSubsetRestriction		010000 for	000011 for	000011 for	
Codebook			fixed rank 2,	fixed rank 1,	fixed rank 1,	1111111
configuration			010011 for	010011 for	010011 for	11111111
		<u></u>	following rank	following rank	following rank	
	RI Restriction					00000010 for
						fixed Rank 2
			N/A	N/A	N/A	and
						00001111 for
					_,,	follow RI
	nel for CSI report		PUCCH	PUCCH	PUCCH	PUCCH
CQI/RI/PMI de		ms	8	8	8	8
Maximum nun	nber of HARQ transmission		1	1	1	1

DI Configuration	Fixed RI = 2	Fixed RI = 1	Fixed RI = 1	Fixed RI = 2
RI Configuration	and follow RI	and follow RI	and follow RI	and follow RI

Table 6.4.3.1-2: Minimum requirement (FDD)

	Test 1	Test 2	Test 3	Test 4
<i>7</i> 1	N/A	1.05	0.9	N/A
72	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		Test 1	Test 2	Test 3	Test 4
Bandwidth		Unit MHz	40	40	40	40
Subcarrier sp	acing	kHz	30	30	30	30
Duplex Mode			TDD	TDD	TDD	TDD
TDD Slot Con	figuration		FR1.30-1	FR1.30-1	FR1.30-1	FR1.30-1
SNR		dB	-2	16	16	22
Propagation of			TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna confi	iguration		ULA Low 2x4	ULA Low 2x4	ULA High 2x4	ULA Low 4x4
Beamforming	Model		As defined in	As defined in	As defined in	As defined in
Doarmorning			Annex B.4.1	Annex B.4.1	Annex B.4.1	Annex B.4.1
-	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
-	Number of CSI-RS ports (X)		4	4	4	4
70.001.00	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
ZP CSI-RS	Density (p)		1	1	1	1
configuratio	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
n	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(9,-)	(9,-)	(9,-)	(9,-)
	CSI-RS	slot	10/1	10/1	10/1	10/1
	periodicity and offset 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
NZP CSI-	Density (ρ)		1	1	1	1
RS for CSI	First subcarrier index in the					
acquisition	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)	Row 4 (0,-)
·	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(13,-)	(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	10/1	10/1	10/1
	CSI-IM resource Type		Periodic	Periodic	Periodic	Periodic
001.1114	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0	Pattern 0
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)	(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	10/1	10/1	10/1	10/1
ReportConfig	Туре		Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantity	y		cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestrictio	nForChannelMeasurements		not configured	not configured	not configured	not configured
timeRestrictio	nForInterferenceMeasurements		not configured	not configured	not configured	not configured
cqi-FormatInd			Wideband	Wideband	Wideband	Wideband
pmi-FormatIn			Wideband	Wideband	Wideband	Wideband
Sub-band Siz		RB	16	16	16	16
csi-Reporting			1111111	1111111	1111111	1111111
CSI-Report pe	eriodicity and offset	slot	10/9	10/9	10/9	10/9
	Codebook Type		typel-	typel-	typel-	typel-
	Codebook Mode		SinglePanel	SinglePanel	SinglePanel	SinglePanel
	(CodebookConfig-			1	l l	I
	N1,CodebookConfig-N2)		N/A	N/A	N/A	(2,1)
	CodebookSubsetRestriction		010000 for	000011 for	000011 for	
Codebook			fixed rank 2,	fixed rank 1,	fixed rank 1,	1111111
configuration			010011 for	010011 for	010011 for	11111111
-			following rank	following rank	following rank	
	RI Restriction					00000010 for
						fixed Rank 2
			N/A	N/A	N/A	and 00001111 for follow RI
	1	<b> </b>	DUOQU	DUCCU	PUCCH	PUCCH
Physical char	nnel for CSI report		PUCCH	PULLA	1 100.00	PU
Physical char CQI/RI/PMI de	nnel for CSI report elav	ms	PUCCH 9.5	PUCCH 9.5	9.5	9.5

DI Configuration	Fixed RI = 2	Fixed RI = 1	Fixed RI = 1	Fixed RI = 2
RI Configuration	and follow RI	and follow RI	and follow RI	and follow RI

Table 6.4.3.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3	Test 4
<i>7</i> 1	N/A	1.05	0.9	N/A
72	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.

### 7.1.1.2 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	PDSCH	All tests in Clause 7.2.2
antenna ports	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	FR2	PDSCH	Clause 7.2.2.2.1 (Test 3-	
advanced receiver	TDD		1)	
Basic DL NR-NR CA operation	NR CA	SDR	Clause 7.5A.1	Up to 16 DL carriers
(supportedBandCombinationList)				Same numerology across
				carrier for data/control
				channel at a given time

# 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 7.5.1 Clause 7.5A.1	
PCell operation on FR2 ( <i>pCell-FR2</i> )	FR2 TDD	SDR	Clause 7.5A.1	

## 7.2 PDSCH demodulation requirements

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

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

	Parameter	Unit	Value
PDSCH transmission	scheme		Transmission scheme 1
PTRS epre-Ratio	T		0
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 2)	RBs	0
corniguration	Subcarrier spacing	kHz	60 or 120
	Cyclic prefix	55	Normal
DL BWP configuration #1	RB offset  Number of contiguous PRB	RBs PRBs	0 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 conting	Physical Cell ID		0
Common serving cell parameters	SSB position in burst		1
cell parameters	SSB periodicity	ms	20
	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
DDCCL	CCE-to-REG mapping type		Non-interleaved
PDCCH	DCI format		1_1 TOL 1 # #4
configuration	TCI state		TCI state #1 Single Panel Type I,
	PDCCH & PDCCH DMRS Precoding configuration		Random per slot with equal probability of each applicable i <sub>1</sub> , i <sub>2</sub> combination, and with REG bundling granularity for number of Tx larger than 1
Cross carrier schedul			Not configured
	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 ( <i>lo</i> )		6 for CSI-RS resource 1 and 3 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	СDМ Туре		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
CSI-RS for tracking	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resource 1,2,3,4 120 kHz SCS: 160 for CSI-RS resource 1,2,3,4
	CSI-RS offset	Slots	60 kHz SCS: 40 for CSI-RS resource 1 and 2 41 for CSI-RS resource 3 and 4  120 kHz SCS: 80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4

	1			1
	Frequency Occ	eupation		Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
	First subcarrier RS (k <sub>0</sub> )	index in the PRB used for CSI-		0
	(10)	mbol in the PRB used for CSI-RS		12
	Number of CSI	-RS ports (X)		2
	CDM Type			FD-CDM2
NZP CSI-RS for CSI acquisition	Density (ρ)			1
CSI acquisition	CSI-RS periodi	city	Slots	60 kHz SCS: 80 120 kHz SCS: 160
	CSI-RS offset			0 Start PRB 0
	Frequency Occ	cupation		Number of PRB = BWP size
	QCL info			TCI state #1
	First subcarrier RS (k <sub>0</sub> )	index in the PRB used for CSI-		4
		mbol in the PRB used for CSI-RS		12
	Number of CSI	-RS ports (X)		4
ZP CSI-RS for CSI	CDM Type			FD-CDM2
acquisition	Density (ρ)			1
aoquiomon	CSI-RS periodi	city	Slots	60 kHz SCS: 80 120 kHz SCS: 160
	CSI-RS offset			0
	Frequency Occ	cupation		Start PRB 0 Number of PRB = BWP size
	First subcarrier	index in the PRB used for CSI-		k <sub>0</sub> =0 for CSI-RS resource 1,2
		mbol in the PRB used for CSI-RS		I <sub>0</sub> = 8 for CSI-RS resource 1 I <sub>0</sub> = 9 for CSI-RS resource 2
	Number of CSI	-RS ports (X)		1 for CSI-RS resource
CSI-RS for beam	CDM Type			'No CDM' for CSI-RS resource 1,2
refinement	Density (ρ)			3 for CSI-RS resource 1,2
	CSI-RS periodi	city	Slots	60 kHz SCS: 80 for CSI- RS resource 1,2 120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Repetition			ON
	QCL info			TCI state #1
	Antenna ports indexes			{1000} for Rank 1 tests {1000, 1001} for Rank 2 tests
PDSCH DMRS configuration	Position of the type A	first DMRS for PDSCH mapping		2
	Number of PDS	SCH DMRS CDM group(s) without		1
	Type 1 QCL	SSB index		SSB #0
TCI state #0	information	QCL Type		Type C
TOI SIGIE #U		·		
	1	SSB index		SSB #0

	Type 2 QCL information	QCL Type	Type D
	Type 1 QCL information	CSI-RS resource	CSI-RS resource 1 from 'CSI-RS for tracking' configuration
TCI state #1		QCL Type	Type A
TOI state #1	Type 2 QCL information	CSI-RS resource	CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type	Type D
	Frequency den	sity (K <sub>PT-RS</sub> )	2
PTRS configuration	Time density (L		1
	Resource Elem		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 <sub>1</sub> , i <sub>2</sub> combination, andwith Wideband granularity	
Symbols for all unuse	ed REs		OCNG in Annex A.5
Physical signals, channels mapping and precoding		As specified in Annex B.4.1	
transmissi	on.	ate for the PDSCH is identical to the	• •

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

#### 1RX requirements 7.2.1

(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

tested channel bandwidth and subcarrier spacing.

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	1-1, 1-3, 2-1, 2-2, 2-3, 2-4, 2-5, 2-6
under 2 receive antenna conditions and with different	
channel models, MCSs and number of MIMO layers	
Verify the PDSCH mapping Type A HARQ soft combining	1-2
performance under 2 receive antenna conditions.	
Verify the PDSCH mapping Type A performance	3-1
requirements for Enhanced Receiver Type 1 under 2	
receive antenna conditions.	

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 ( <i>l</i> <sub>0</sub> )		For Test 1-1 and 1-2: 3 for CSI-RS resource 1 and 3 7 for CSI-RS resource 2 and 4
	CSI-RS offset	Slots	For Test 1-2: 82 for CSI-RS resource 1 and 2 83 for CSI-RS resource 3 and 4
PDCCH configuration	Number of PDCCH candidates and aggregation levels		1/AL4 for Test 2-3 1/AL8 for other tests
	Mapping type		Type A
	k0 Starting symbol (S)		0
	Length (L)		Specific to each Reference channel as defined in A.3.2.2
	PDSCH aggregation factor		1
	PRB bundling type		Static
PDSCH configuration	PRB bundling size		WB for Test 1-1, 2 for other tests
	Resource allocation type		Test 2-1: Type 1 with start  RB = 30, L <sub>RBs</sub> = 6  Other tests: Type 0
	RBG size		Test 2-1: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Process	ses		8 for Test 1-1, 1-3, 2-2, 2-4 10 for Test 2-1, 2-3, 2-5, 2-6, 3-1 16 for Test 1-2
The number of slots between information	een PDSCH and corresponding HARQ-ACK		As defined in Annex A.1.3

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

						Correlation Reference value		
Test num	Referenc e channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulatio n and code rate	TDD UL- DL pattern	Propagatio n condition	matrix and antenna configuratio n	Fraction of maximum throughpu t (%)	SNR <sub>B</sub> <sub>B</sub> (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

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

		Bandwidth				Correlation	Reference value	
Test num	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulatio n and code rate	TDD UL-DL pattern	Propagatio n condition	matrix and antenna configuratio n	Fraction of maximum throughp ut (%)	SNR <sub>BB</sub> (dB)
2-1	R.PDSCH. 5-4.1 TDD	100 / 120	QPSK, 0.30	FR2.12 0-2	TDLA30-75	2x2 ULA Low	70	4.1
2-2	R.PDSCH. 5-2.2 TDD	100 / 120	16QAM, 0.48	FR2.12 0-1	TDLA30- 300	2x2 ULA Low	70	14.4
2-3	R.PDSCH. 5-5.2 TDD	50 / 120	16QAM,0.4 8	FR2.12 0-2	TDLA30-75	2x2 ULA Low	70	14.0
2-4	R.PDSCH. 5-2.3 TDD	200 / 120	16QAM, 0.48	FR2.12 0-1	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	FR2.12 0-2	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

		Bandwidt				Correlation	Reference value	
Test num	Reference channel	h (MHz) / Subcarrier spacing (kHz)	Modulatio n and code rate	TDD UL- DL pattern	Propagatio n condition	matrix and antenna configuratio n	Fraction of maximum throughpu t (%)	SNR <sub>B</sub> <sub>B</sub> (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

## 7.3 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		en Point A and the		0
configuration	lowest usable carrier (Note	subcarrier on this		
DL BWP	,	1)		Name
configuration #1	Cyclic prefix			Normal
Common	Physical Cell			0
serving cell parameters	SSB position SSB periodici		ms	20
parameters		CH monitoring	1113	Each slot
		OCCH candidates		1
PDCCH	Frequency do	main resource		Start from RB = 0
configuration	allocation for			with contiguous RB allocation
	TCI state			TCI state #1
		er index in the PRB		0
	used for CSI-	RS (k0)		
				CSI-RS resource 1:
				CSI-RS resource 2:
		ymbol in the PRB		8
	used for CSI-	RS (10)		CSI-RS resource 3:
				CSI-RS resource 4:
				8
CSI-RS for		SI-RS ports (X)		1
tracking	CDM Type Density (ρ)			No CDM 3
	CSI-RS perio	dicity	Slots	160
	COLITIC POLICE	aronty	0.0.0	80 for CSI-RS
	CSI-RS offset	<del>!</del>	Slots	resource 1 and 2
	OCI ITO CIIDO	•	0.010	81 for CSI-RS
				resource 3 and 4 Start PRB 0
	Frequency Od	ccupation		Number of PRB =
	-	·		BWP size
	QCL info	er index in the PRB		TCI state #0
	used for CSI-			0
	4334.3.33			CSI-RS resource 1:
		ymbol in the PRB		8
	used for CSI-	RS (10)		CSI-RS resource 2:
	Number of CS	SI-RS ports (X)		1
NZP CSI-RS for	CDM Type	- 1 ( )		No CDM
beam management	Density (ρ)			3
la.iagee.ii	CSI-RS perio	dicity	Slots	120 kHz SCS: 160 for CSI-RS resource
	CSI-RS perior	uicity	31018	1,2
	CSI-RS offset		Slots	0 for CSI-RS
			31018	resource 1,2
	Repetition QCL info		-	ON TCI state #1
	QCL INIO			Single Panel Type I,
				Random per slot
				with equal
				probability of each
PDCCH & PDCCH	H DMRS Preco	ding configuration		applicable i <sub>1</sub> , i <sub>2</sub> combination, and
				with REG bundling
				granularity for
				number of Tx larger
	Type 1 QCL	SSB index	1	than 1 SSB #0
TOL -1-1 "0	information	QCL Type		Type C
TCI state #0	Type 2 QCL	SSB index		SSB #0
	information	QCL Type		Type D

	Type 1 QCL information	CSI-RS resource	CSI-RS resource 1 from 'CSI-RS for tracking' configuration	
TCI state #1		QCL Type	Type A	
TOI State #1	Type 2 QCL information	CSI-RS resource	CSI-RS resource 1 from 'CSI-RS for tracking' configuration	
		QCL Type	Type D	
Physical signals, channels mapping and precoding			As specified in Annex B.4.1	
Symbols for all unused REs			OCNG in Annex A.5	
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	Parameter Unit		2 Tx Antenna
TDD UL-DL pattern		FR2.120-1	
CCE to REG mapping type		Interleaved	
REG bundle size		2 for test 1-1	2
REG buildle size		6 for test 1-2	2
Interleaver size		3 for test 1-1	2
inteneaver size		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	Bandwidth	CORES ET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
num ber	(MHz)							Pm- dsg (%)	SNR <sub>BB</sub> (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	Bandwidth (MHz)	CORESE T RB	CORESET duration	Aggregation level	Reference Channel	Dronogotion	Antenna configuration and correlation Matrix	Reference value	
num ber						Propagation Condition		Pm- dsg (%)	SNR <sub>BB</sub> (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

## 7.4 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

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

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).

### 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]						
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 Bandwidth (MHz) /		Reference	Propagation	Antenna configuration	Referer	nce value
number	Subcarrier spacing (kHz)	channel	condition	and correlation matrix	Pm- bch (%)	SNR <sub>BB</sub> (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 Bandwidth (MHz) /		Reference	Propagation	Propagation Antenna configuration			
number	Subcarrier spacing (kHz)	channel	condition	and correlation matrix	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<sub>j</sub> 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

μ<sub>i</sub> 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%\*NDL\_correct\_rx/ (NDL\_newtx + NDL\_retx), where NDL\_newtx is the number of newly transmitted DL transport blocks, NDL\_retx is the number of retransmitted DL transport blocks, and NDL\_correct\_rx is the number of correctly received DL transport blocks.

The 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	n scheme		Transmission scheme 1
PTRS epre-Ratio			0
Channel bandwidth		MHz	Channel bandwidth from selected CA bandwidth combination
	Physical Cell ID		0
Common serving	SSB position in burst		First SSB in Slot #0
cell parameters	SSB periodicity	ms	20
	First DMRS position for Type A PDSCH mapping		2
Cross carrier schedu			Not configured
Active DL BWP inde			1
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)	RBs	0
Configuration	Subcarrier spacing	kHz	60 or 120
	RB Offset		0
DL BWP configuration #1	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
	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
PDCCH	CCE-to-REG mapping type		Non-interleaved
configuration	DCI format		1-1
Comiguration	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
	Mapping type		Type A
	k0		0
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		WB
PDSCH	Resource allocation type		Type 0
configuration	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
	DMRS Type		Type 1
	Number of additional DMRS		1 .
PDSCH DMRS	Length		1 (4000) ( 41 20
configuration	Antenna ports indexes		{1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs
	Number of PDSCH DMRS CDM group(s) without data		1
PTRS	Frequency density (K <sub>PT-RS</sub> )	-	2
configuration	Time density (L <sub>PT-RS</sub> )		1
	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 <sub>0</sub> = 6 for CSI-RS resource 1 and 3 l <sub>0</sub> = 10 for CSI-RS resource 2 and 4
CSI-RS for tracking	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	Donoity (p)		3 101 001 NO 16300106 1,2,0,4

	•			
				60 kHz SCS: 80 for CSI-RS resource
	CSI-RS periodicity		Slots	1,2,3,4
				120 kHz SCS: 160 for CSI-RS
				resource 1,2,3,4 60 kHz SCS:
				40 for CSI-RS resource 1 and 2
				41 for CSI-RS resource 3 and 4
	CSI-RS offset		Slots	41 for COLING resource 5 and 4
			0.010	120 kHz SCS:
				80 for CSI-RS resource 1 and 2
				81 for CSI-RS resource 3 and 4
	Frequency Occupa	tion		Start PRB 0
	Frequency Occupa	lion		Number of PRB = BWP size
	QCL info			TCI state #0
		in the PRB used for		$k_0 = 4$
	CSI-RS	b - DDD		
	RS	he PRB used for CSI-		$I_0 = 13$
	Number of CSI-RS	norte (V)		Same as number of transmit antenna
	CDM Type	ports (X)		'FD-CDM2'
NZP CSI-RS for	Density (ρ)			1 D-CDIVIZ
CSI acquisition				60 kHz SCS: 80
	CSI-RS periodicity		Slots	120 kHz SCS: 160
	CSI-RS offset			0
				Start PRB 0
	Frequency Occupa	tion		Number of PRB = BWP size
	QCL info			TCI state #1
	Subcarrier indexes	in the PRB used for		$k_0 = 0$
	CSI-RS			K <sub>0</sub> = U
	OFDM symbols in the PRB used for CSI-			lo = 12
	RS			10 - 12
	Number of CSI-RS ports (X)			4
ZP CSI-RS for CSI	CDM Type			'FD-CDM2'
acquisition	Density (ρ)			1
	CSI-RS periodicity		Slots	60 kHz SCS: 80 120 kHz SCS: 160
	CSI-RS offset			0
				Start PRB 0
	Frequency Occupation			Number of PRB = BWP size
	First subcarrier inde	ex in the PRB used for		
	CSI-RS			k <sub>0</sub> =0 for CSI-RS resource 1,2
		I in the PRB used for		l <sub>0</sub> = 8 for CSI-RS resource 1
	CSI-RS			l <sub>0</sub> = 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
CSI-RS for beam	Density (ρ)			3 for CSI-RS resource 1,2
refinement				60 kHz SCS: 80 for CSI-RS resource
	CSI-RS periodicity		Slots	1,2 120 kHz SCS: 160 for CSI-RS
				resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Repetition		01013	ON
	QCL info			TCI state #1
	Tyoe 1 QCL	SSB index		SSB #0
TOL -4: 4 #2	information	QCL Type		Type C
TCI state #0	Tyoe 2 QCL	SSB index		SSB #0
	information	QCL Type		Type D
	Tyoe 1 QCL	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for
	information			tracking' configuration
TCI state #1		QCL Type		Type A
. 51 51415 // 1	Tyoe 2 QCL	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for
	information			tracking' configuration
Maximum number = -	Maximum number of code block groups for ACK/NACK			Type D
Maximum number of   feedback	code block groups to		1	
Number of HARQ Pr	ocesses			10 for FR2.60-1 and 8 for FR2.120-1
K1 value				Specific to each UL-DL pattern
K1 value				Spoomo to oddi of De pattolli

Maximum number of	f HARQ transmission	4	
HARQ ACK/NACK b	oundling	Multiplexed	
Redundancy version	n coding sequence	{0,2,3,1}	
TDD UL-DL pattern		60 kHz SCS: FR2.60-1 120 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 unus	ed REs	OCNG Annex A.5	
Propagation condition		Static propagation condition No external noise sources are applied	
Antenna	1 layer CCs	1x2 or 1x4	
configuration 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.			

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.

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	Maximum	Scaling	MCS
PDSCH MIMO layers	modulation format	factor	
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

Table 7.5A.1-4: SNR required to achieve 85% of peak throughput under AWGN conditions

MCS Index (Note 1)	SNR <sub>BB</sub> (dB) for maximum number of PDSCH MIMO Layers = 1	SNR <sub>BB</sub> (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 Table defined in clause 5.1.3 of TS 38.214 [12] when 256QAM is not enabled.

## 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.

#### 8.1.1.2 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	CQI	All tests in Clause 8.2.2
antenna	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

## 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 t	уре	Test list	Applicability notes
Supported maximum number of PDSCH MIMO layers (maxNumberMIMO-	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
LayersPDSCH)		RI	Clause 8.4.2.2	PDSCH MIMO layers capability
Support of 1 port DTDS	FR2 TDD	CQI	Clause 8.2	
Support of 1 port PTRS (onePortsPTRS)		PMI	Clause 8.3	
(OHEFORSFINS)		RI	Clause 8.4	

### 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 transmis	esion schama		Transmission
	SSION SCHEME		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
	Cyclic prefix		Normal
	RB offset	RBs	0
DL BWP configuration #1	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 i			1
Common	Physical Cell ID		0
serving cell	SSB position in burst		First SSB in Slot #0
parameters	SSB periodicity	ms	20
	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH Number of PDCCH candidates		0,1
			1/AL8
	and aggregation levels  DCI format		1 1
	TCI state		TCI state #1
	TOTState		Multi-path fading
PDCCH configuration	PDCCH & PDCCH DMRS Precoding configuration		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 Static propagation
Cuana agrejar agl			conditions: Single Panel Type I, Random precoder chosen from precoder index 0 and 2, selection updated per slot
Cross carrier sch			Not configured
	Mapping type k0		Type A 0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	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	DMRS Type		Type 1
configuration	Number of additional DMRS		1

	DMRS ports	indexes		{1000} for Rank1 {1000,1001} for Rank2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
		DSCH DMRS CDM		2
		ensity ( $K_{PT-RS}$ )		2
PTRS	Time density			1
configuration	Resource Element Offset			2
	First subcarriused for CSI	er index in the PRB RS $(k_0)$		0 for CSI-RS resource 1,2,3,4
	First OFDM s used for CSI	symbol in the PRB -RS ( <i>l</i> <sub>0</sub> )		4 for CSI-RS resource 1 and 3 8 for CSI-RS resource 2 and 4
	Number of C	SI-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
CSI-RS for	Density (p)			resource 1,2,3,4
tracking	CSI-RS perio	odicity	slot	120kHz SCS: 160 for CSI-RS resource 1,2,3,4
	CSI-RS offset		slot	120 kHz SCS: 80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4
	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
NZP CSI-RS for CSI	Frequency O	ccupation		Start PRB 0 Number of PRB = BWP size
acquisition	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
	First subcarriused for CSI	er index in the PRB -RS		k <sub>0</sub> =0 for CSI-RS resource 1,2
	First OFDM symbol in the PRB used for CSI-RS			l <sub>0</sub> = 8 for CSI-RS resource 1 l <sub>0</sub> = 9 for CSI-RS
	Number of CSI-RS ports (X)			resource 2 1 for CSI-RS resource 1,2
CSI-RS for beam	CDM Type			'No CDM' for CSI-RS resource 1,2
refinement	Density (ρ)			3 for CSI-RS resource 1,2
	CSI-RS periodicity		Slots	120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Repetition			ON
	QCL info			TCI state #1
	Type 1	SSB index		SSB #0
TCI etete #0	QCL information	QCL Type		Type C
TCI state #0	Type 2	SSB index		SSB #0
	QCL information	QCL Type		Type D

	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
TOL -1-1- //4		QCL Type		Type A
TCI state #1				CSI-RS resource 1
	Type 2	CSI-RS resource		from 'CSI-RS for
	QCL	CSI-RS lesouice		tracking'
	information			configuration
		QCL Type		Type D
Number of H	ARQ Processes			8
HARQ ACK/	NACK bundling			Multiplexed
Redundancy	version coding sec	quence		{0,2,3,1}
				For FR2.120-1:
				3 if mod $(i.5) = 0$ ,
				6 if $mod(i,5) = 2$
				For FR2.120-2:
K1 value				11 if $mod(i,8) = 0$ ,
(PDSCH-to-F	IARQ-timing-indica	ator)		7]if $mod(i,8) = 4$ ,
				6]if $mod(i,8) = 5$ ,
				where i is slot index
				per radio fame with
				values 0-79.
Symbols for a	unused REs			OCNG as specified
				in A.5
Physical sign	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.				cal to the TCI state

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.

## 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  $\pm 1$  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 sp		kHz	120
Duplex Mode			TDD
TDD Slot Cor	nfiguration	-ID	FR2.120-2 Annex A.1.3
SNR <sub>BB</sub> Propagation of	hannal	dB	8 9 14 15 AWGN
Propagation C	channel		2x2 with static channel
Antenna conf	iguration		specified in Annex B.1
D f i	Mandal		As specified in Annex
Beamforming	Model		B.4.1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
ZP CSI-RS	Density (ρ)		1
configuratio	First subcarrier index in the		8
n	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		13
	CSI-RS		
	periodicity and offset	slot	8/1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		fd-CDM2
NZP CSI-	Density (ρ)		1
RS for CSI	First subcarrier index in the		6
acquisition	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		в
	First OFDM symbol in the PRB		13
	used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		10
	NZP CSI-RS-timeConfig	slot	8/1
	periodicity and offset		Davis dia
	CSI-IM RE patters		Periodic 1
CSI-IM	CSI-IM RE pattern CSI-IM Resource Mapping		1
configuratio	(kcsi-im,lcsi-im)		(8, 13)
n	CSI-IM timeConfig	_	
	periodicity and offset	slot	8/1
ReportConfig			Periodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictio	nForChannelMeasurements		Not configured
	nForInterferenceMeasurements		Not configured
cqi-FormatInd			Wideband
pmi-Formatin			Wideband
Sub-band Siz		RB	8
csi-Reporting	eriodicity and offset	olo+	111111111 8/3
aperiodicTrigg		slot	Not configured
apendulcing	Codebook Type	-	typel-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig-		•
configuration	N1,CodebookConfig-N2)	1	Not configured
	CodebookSubsetRestriction		010000
	RI Restriction		N/A
Physical char	nnel for CSI report		PUCCH
	CQI/RI/PMI delay	ms	8.375
Maximum nur	mber of HARQ transmission		1
Measurement	t channel		As specified in Table
		l	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  $\alpha$  % of the time, where  $\alpha$ % 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 8.2.2.2.1-1 Test parameters

Bandwidth		Parameter	Unit	Test 1 Test 2
Duplex Mode	Bandwidth			
TDD Slot Configuration		acing		
SNRes	Duplex Mode			
Propagation channel	TDD Slot Cor	nfiguration		
Antenna configuration  Beamforming Model  CSI-RS resource Type Number of CSI-RS ports (X) CDM Type Density (p) First subcarrier index in the PRB used for CSI-RS (ko, k1) First OFDM symbol in the PRB used for CSI-RS (ko, k1)  NZP CSI-RS interval and offset CSI-RS resource Type Density (p)  NZP CSI-RS (ko, k1)  First OFDM symbol in the PRB used for CSI-RS (ko, k1)  NAP CSI-RS (ko, k1)  First Subcarrier index in the PRB used for CSI-RS (ko, k1)  PRB used for CSI-RS (ko, k1)  NAP CSI-RS (ko, k1)  NAP CSI-RS (ko, k1)  NAP CSI-RS (ko, k1)  NAP CSI-RS-timeConfig interval and offset aperiodic TriggeringOffset CSI-IM Resource Mapping (kosi-Msi-Lssi-Ms) CSI-IM resource Mapping (kosi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Msi-Lssi-Ms		channel	dB	1 1
Beamforming Model    CSI-RS resource Type   Periodic				2×2
CSI-RS resource Type   Periodic   Number of CSI-RS ports (X)		-		As specified in Annex
Number of CSI-RS ports (X)				
ZP CSI-RS configuratio n  PRB used for CSI-RS (ko, kt) First Subcarrier index in the PRB used for CSI-RS (ko, kt) First OFDM symbol in the PRB used for CSI-RS (ko, kt) CSI-RS interval and offset SIOT (SI-RS (ko, kt))  NZP CSI-RS RS for CSI acquisition  NZP CSI-RS RS R				
Density (p)   Tirst subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   First oFDM symbol in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   First oFDM symbol in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   First oFDM symbol in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   PRB used for CSI-RS ports (X)   2   CSI-RS resource Type   Number of CSI-RS ports (X)   2   CDM Type   Density (p)   1   First oFDM symbol in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   6   PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   First oFDM symbol in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   First oFDM symbol in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   NZP CSI-RS-timeConfig interval and offset aperiodic TriggeringOffset   O   CSI-IM resource Type   Aperiodic   CSI-IM resource Type   Aperiodic   CSI-IM Resource Mapping (k <sub>CSI-IM-ICSI-IM</sub> )   (R <sub>CSI-IM-ICSI-IM</sub> )   CSI-IM timeConfig interval and offset   Slot   Not configured   ReportConfigType   Aperiodic   CSI-IM resource Mapping   (R <sub>CSI-IM-ICSI-IM</sub> )   CSI-IM timeConfig   Slot   Not configured   Table 1   Table				
configuration n	7P CSI-RS	Density (o)		
PRB used for CSI-RS (k₀, k1)		First subcarrier index in the		·
used for CSI-RS (lo, lr) CSI-RS interval and offset  CSI-RS resource Type Number of CSI-RS ports (X) CDM Type Density (p) First subcarrier index in the PRB used for CSI-RS (ko, k1) First OFDM symbol in the PRB used for CSI-RS (lo, lr) NZP CSI-RS-timeConfig interval and offset aperiodicTriggeringOffset CSI-IM configuratio n CSI-IM RE pattern CSI-IM Resource Type CSI-IM Resource Mapping (KCSI-IM, ICSI-IM) CSI-IM timeConfig interval and offset slot Not configured (RCSI-IM, ICSI-IM) CSI-IM fire Config interval and offset speriodicTriggeringOffset CQI-table ReportConfigType CQI-table ReportConfigType CQI-table ReportConfigType CQI-table ReportConfigType CQI-table ReportConfigType CRI-RS-(IM, ICSI-IM) Table 1 Table	_	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		8
interval and offset		used for CSI-RS (l <sub>0</sub> , l <sub>1</sub> )		13
NZP CSI-RS for CSI acquisition  NZP CSI-RS for CSI acquisition  NZP CSI-RS for CSI acquisition  NZP CSI-RS (For CSI acquisition)  NZP CSI-RS (For CSI-RS) (For CS			slot	8/1
Number of CSI-RS ports (X)   2   CDM Type   Incomplete		CSI-RS resource Type		Aperiodic
Density (p)   1   First subcarrier index in the PRB used for CSI-RS (ko, k1)   6   First subcarrier index in the PRB used for CSI-RS (ko, k1)   First OFDM symbol in the PRB used for CSI-RS (lo, l1)   NZP CSI-RS-timeConfig interval and offset aperiodicTriggeringOffset		Number of CSI-RS ports (X)		l <u>=</u>
RS for CSI acquisition   First Subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   First OFDM symbol in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )   NZP CSI-RS-timeConfig interval and offset aperiodic TriggeringOffset   O   CSI-IM resource Type   Aperiodic CSI-IM resource Type   Aperiodic CSI-IM Resource Mapping (k <sub>CSI-IM-LCSI-IM</sub> )   CSI-IM Resource Mapping (k <sub>CSI-IM-LCSI-IM</sub> )   (SSI-IM timeConfig interval and offset   Aperiodic CQI-table   Table 1				fd-CDM2
RS for CSI acquisition    PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )	NZP CSI-			1
First OF-DM symbol in the PRB used for CSI-RS (lo, l₁)     NZP CSI-RS-timeConfig interval and offset aperiodic TriggeringOffset	RS for CSI	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		6
NZP CSI-RS-timeConfig interval and offset aperiodicTriggeringOffset	acquisition			13
aperiodicTriggeringOffset 0 CSI-IM resource Type Aperiodic CSI-IM RE pattern 1 CSI-IM Resource Mapping (8, 13) CSI-IM Resource Mapping (8, 13) CSI-IM MimeConfig 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 Sci-ReportingBand 111111111 CSI-Report periodicity and offset slot Not configured Aperiodic Report Slot Offset 5 CSI request Slot Offset 1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0 reportTriggerSize 1 CSI-AperiodicTriggerStateList Associated Report Configuration Configuration Codebook Configuration Codebook Codebook Mode 1 Codebook Configuration Codebook Configuration CSI-IM Aperiodic Vype State Codebook Configuration Aperiodic Vype State Codebook Configuration Alteroafiguration Aperiodic Vype State Codebook Configuration Aperiodic Codebook Codebook Configuration Aperiodic Codebook Cod			slot	Not configured
CSI-IM configuration n  CSI-IM Resource Type				0
CSI-IM Resource Mapping (RCSI-IM Resource Mapping (RCSI-IM ImeConfigured)  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 111111111  CSI-Report periodicity and offset slot Not configured Aperiodic Report Slot Offset 6  CSI request Slot Offset 1 in slots i, where mod(i, 8) = 1, otherwise it is equal to  reportTriggerSize 1 1  CSI-AperiodicTriggerStateList Associated Report Configuration  CSI-AperiodicTriggerStateList Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM COdebook Configuration (CodebookConfig-				Aperiodic
configuration N	CSI-IM			1
ReportConfigType ReportConfigUred ReportConfigUred ReportConfigUred ReportConfigUred ReportConfigUred ReportConfigUred ReportInterferenceMeasurements Repo	configuratio			(8, 13)
ReportConfigType	n	CSI-IM timeConfig	slot	Not configured
CQI-table reportQuantity timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-ReportingBand CSI-Report periodicity and offset Aperiodic Report Slot Offset  CSI request  CSI request  CSI-AperiodicTriggerStateList  Codebook Configuration  Codebook Configuration  Codebook Configuration  Codebook Codebook Configuration  Codebook Codebook Configuration Codebook Codebook Configuration Codebook Codebook CodebookConfig-  Not configured Not configured And configured And configured And configured Codebook CodebookConfig-  Not configured  Not configured  Associated Report Configuration Associated Report Configuration Codebook Type Codebook CodebookConfig-	ReportConfig			Aperiodic
reportQuantity timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-ReportingBand CSI-Report periodicity and offset Aperiodic Report Slot Offset  CSI request  CSI request  CSI-AperiodicTriggerStateList  CSI-AperiodicTriggerStateList  Codebook configuration  Codebook Configuration  Codebook Configuration  Cir.RI-PMI-CQI Not configured Not configured  Not configured  Not configured  Not configured  Not configured  Not configured  Not configuration  Cone State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI- RS and CSI-IM  Not configured  Not configured	CQI-table	-71		
timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements  cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-ReportingBand CSI-Report periodicity and offset Aperiodic Report Slot Offset  CSI request  CSI request  CSI-AperiodicTriggerStateList  Codebook configuration  Codebook Configuration  timeRestrictionForChannelMeasurements Not configured Wideband Wideband Saba RB 8 1111111111 CINAMINE REPORT Slot Offset Slot Not configured Not configured  Not configured  One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI- RS and CSI-IM  typeI-SinglePanel Codebook Configuration  Not configured  Not configured		У		
cqi-FormatIndicator       Wideband         pmi-FormatIndicator       RB         Sub-band Size       RB         csi-ReportingBand       111111111         CSI-Report periodicity and offset       Slot         Aperiodic Report Slot Offset       6         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         CSI-AperiodicTriggerStateList       Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM         Codebook Type       typeI-SinglePanel         Codebook Mode configuration       1         Not configured	timeRestriction	nForChannelMeasurements		Not configured
pmi-FormatIndicator Sub-band Size Csi-ReportingBand CSI-Report periodicity and offset Aperiodic Report Slot Offset  CSI request  CSI request  CSI request  CSI-AperiodicTriggerStateList  CSI-AperiodicTriggerStateList  Codebook Configuration  Codebook Configuration  Codebook Configuration  CSI-AperiodicTriggerStateList  Codebook Configuration  Codebook Configuration  CSI-Substanting Report Configuration  Codebook Codebook Mode Codebook Configuration  CSI-Substanting Report Configuration  Codebook Codebook Configuration  Codebook Codebook Codebook Codebook Codebook Codebook Code	timeRestriction	nForInterferenceMeasurements		
Sub-band Size  csi-ReportingBand  CSI-Report periodicity and offset  Aperiodic Report Slot Offset  CSI request  CSI request  reportTriggerSize  CSI-AperiodicTriggerStateList  CSI-AperiodicTriggerStateList  Codebook				
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         One State with one Associated Report Configuration         CSI-AperiodicTriggerStateList       Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM         Codebook Type       typeI-SinglePanel         Codebook Configuration       Codebook Mode         Codebook Configuration       1	_			
CSI-Report periodicity and offset  Aperiodic Report Slot Offset  CSI request  CSI request  CSI request  CSI request  Totherwise it is equal to 0  TeportTriggerSize  Tone State with one Associated Report Configuration  CSI-AperiodicTriggerStateList  Codebook Type  Codebook Configuration  CSI-SinglePanel  Codebook Configuration  CodebookConfig-  CSI-Not configured  Configuration  CodebookConfig-  CodebookConfig-  Not configured			RB	
Aperiodic Report Slot Offset  CSI request  CSI request  reportTriggerSize  1  One State with one Associated Report Configuration  CSI-AperiodicTriggerStateList  Codebook Type  Codebook Configuration  Codebook Configuration  CSI-Siguration  Codebook Type  Codebook Configuration  Codebook Configuration  Codebook Configuration  Codebook Configuration  Codebook Mode  Codebook Configuration				
CSI request  1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0  reportTriggerSize  1 One State with one Associated Report Configuration CSI-AperiodicTriggerStateList  Codebook Type Codebook Configuration  Codebook CodebookConfig-  Not configured			SIOT	•
configuration  configuration  configuration  configuration  configuration  configuration  configuration  configuration  configuration contains  pointers to NZP CSI-  RS and CSI-IM  configuration  configuration  configuration  configuration  configuration  configuration  configuration  configuration  codebook  configuration  codebook  configuration  codebookConfig-	Aperiodic Rep	DORT SIDT OTISET		1 in slots i, where
reportTriggerSize  1 One State with one Associated Report Configuration Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI- RS and CSI-IM Codebook Codebook Mode Codebook Configuration  CodebookConfig-	CSI request			otherwise it is equal to
CSI-AperiodicTriggerStateList  CSI-AperiodicTriggerStateList  Configuration  Associated Report  Configuration  Associated Report  Configuration contains  pointers to NZP CSI-  RS and CSI-IM  typeI-SinglePanel  Codebook  Codebook Mode  CodebookConfig-  Not configured	rone wT.:	Cino.		0
Associated Report Configuration Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI- RS and CSI-IM Codebook Type Codebook Configuration CodebookConfig-  Not configured	reportirigger	OIZE	1	One State with and
CSI-AperiodicTriggerStateList  Configuration Associated Report Configuration contains pointers to NZP CSI- RS and CSI-IM Codebook Type Codebook Codebook Mode configuration  CodebookConfig-  Not configured				
CSI-AperiodicTriggerStateList  Associated Report Configuration contains pointers to NZP CSI- RS and CSI-IM typel-SinglePanel Codebook Codebook Mode configuration (CodebookConfig-				
Configuration contains pointers to NZP CSI- RS and CSI-IM  Codebook Type typel-SinglePanel  Codebook Codebook Mode 1  Codebook Configuration (CodebookConfig-	CSI-Aperiodic	cTriggerStateList		
pointers to NZP CSI- RS and CSI-IM  Codebook Type typeI-SinglePanel  Codebook Codebook Mode 1  configuration (CodebookConfig-	oo, Aponoaid	711199010tate=10t		
RS and CSI-IM				
Codebook Type typel-SinglePanel Codebook Configuration (CodebookConfig-				
Codebook Codebook Mode 1  configuration (CodebookConfig-		Codebook Type		
	Codebook			
N1,CodebookConfig-N2)	configuration			Not configured
		N1,CodebookConfig-N2)		rvot comigured

	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

Table 8.2.2.2.1-2 Minimum requirements

	Test 1	Test 2
α[%]	2	2
γ	1.05	1.05

## 8.3 Reporting of Precoding Matrix Indicator (PMI)

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

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

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

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 Typel-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)

Pa	rameter	Unit	Test 1	Test 2
Bandwidth		MHz	100	100
Subcarrier spacing	ng	kHz	120	120
			FR2.120-2 as	FR2.120-1 as
TDD DL-UL conf	TDD DL-UL configuration		specified in	specified in
Propagation char	nnel		Annex A.1.3 TDLA30-35	Annex A.1.3 TDLA30-35
Antenna configur			2 x 2 ULA Low	2 x 2 ULA Low
Ţ.			As specified in	As specified in
Beamforming Mo			Annex B.4.1	Annex B.4.1
	CSI-RS resource Type		Periodic	Periodic
	Number of CSI-RS ports (X)		4	4
	CDM Type		FD-CDM2	FD-CDM2
	Density (ρ)		1	1
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 4, (8,-)	Row 4, (8,-)
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(13,-)	(13,-)
	CSI-RS interval and offset	slot	8/1	5/1
	CSI-RS resource Type		Aperiodic	Aperiodic
	Number of CSI-RS ports (X)		2	2
	CDM Type		FD-CDM2	FD-CDM2
	Density (ρ)		1	1
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3, (6,-)	Row 3, (6,-)
	First OFDM symbol in the PRB used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(13,-)	(13,-)
	CSI-RS interval and offset	slot	Not configured	Not configured
	aperiodicTriggering Offset		0	0
	CSI-IM resource Type		Aperiodic	Aperiodic
	CSI-IM RE pattern		Pattern 1	Pattern 1
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(8,13)	(8,13)
	CSI-IM timeConfig interval 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
nts	orChannelMeasureme		Not configured	Not configured
ements	orInterferenceMeasur		Not configured	Not configured
cqi-FormatIndica			Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband

Sub-band Size		RB	8	8
csi-ReportingBar	nd		111111111	111111111
CSI-Report inter	val and offset	slot	Not configured	Not configured
Aperiodic Report	t Slot Offset		7	9
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	9		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 Type		typel- SinglePanel	typel- SinglePanel
	Codebook Mode		1	1
Codebook configuration	(CodebookConfig- N1,CodebookConfi g-N2)		N/A	N/A
	CodebookSubsetR estriction		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 transmission	Maximum number of HARQ transmission		4	4
Measurement ch	annel		R.PDSCH.5-8.1 TDD	R.PDSCH.5- 7.1 TDD

Note 1: For random precoder selection, the precoder shall be updated in each slot (0.125 ms granularity).

Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4)], this reported PMI cannot be applied at the 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 8.3.2.2.1-2: Minimum requirement

Parameter	Test 1	Test 2
γ	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 Cor			FR1.120-2	FR1.120-2	FR1.120-2
SNR	3	dB	0	16	16
Propagation of	channel		TDLA30-35	TDLA30-35	TDLA30-35
Antenna conf			ULA Low 2x2	ULA Low 2x2	XP High 2x2
			As defined in	As defined in	As defined in
Beamforming	Model		Annex B.4.1	Annex B.4.1	Annex B.4.1
	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		4	4	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
ZP CSI-RS	Density (ρ)		1	1	1
configuratio	First subcarrier index in the				
n	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 4, (8,-)	Row 4, (8,-)	Row 4, (8,-)
	First OFDM symbol in the PRB		4 )	4 \	4
	used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(13,-)	(13,-)	(13,-)
	CSI-RS	_	8/1	8/1	8/1
	interval and offset	slot	0,1	<i>37</i> 1	G/ 1
	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
NZP CSI-	First subcarrier index in the			·	·
RS for CSI	PRB used for CSI-RS (k <sub>0</sub> , k <sub>1</sub> )		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
acquisition	First OFDM symbol in the PRB				
	used for CSI-RS (I <sub>0</sub> , I <sub>1</sub> )		(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig		Not configured	Not	Not
	interval and offset	slot	140t configured	configured	configured
	aperiodicTriggeringOffset		0	0	0
	CSI-IM resource Type		Periodic	Periodic	Periodic
	CSI-IM RE pattern		Pattern 1	Pattern 1	Pattern 1
CSI-IM	CSI-IM Resource Mapping				
configuratio	(kcsi-im,lcsi-im)		(8,13)	(8,13)	(8,13)
n	CSI-IM timeConfig		Not configured	Not	Not
	interval and offset	slot	110t oormgaroa	configured	configured
ReportConfig			Aperiodic	Aperiodic	Aperiodic
CQI-table	.,,,,		Table 1	Table 1	Table 1
				cri-RI-PMI-	cri-RI-PMI-
reportQuantit	У		cri-RI-PMI-CQI	CQI	CQI
				not	not
timeRestriction	nForChannelMeasurements		not configured	configured	configured
				not	not
timeRestriction	nForInterferenceMeasurements		not configured	configured	configured
cqi-FormatInd	dicator		Wideband	Wideband	Wideband
pmi-FormatIn			Wideband	Wideband	Wideband
Sub-band Size		RB	8	8	8
csi-Reporting			111111111	111111111	111111111
		slot		Not	Not
CSI-Report in	CSI-Report interval and offset		Not configured	configured	configured
Aperiodic Res	port Slot Offset		7	7	7
Aponodic INE	Jon Glot Gridet		1 in slots i,	1 in slots i,	1 in slots i,
			where mod(i,	where mod(i,	where mod(i,
CSI request			8) = 1,	8) = 1,	8) = 1,
OSITEQUEST			otherwise it is	otherwise it is	otherwise it is
			equal to 0	equal to 0	equal to 0
reportTrigger	Siza		1	1	1
reportTriggerSize			<u> </u>	l I	<u>'</u>

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 Type		typel- SinglePanel	typel- SinglePanel	typel- SinglePanel
	Codebook Mode		1	1	1
Codebook	(CodebookConfig- N1,CodebookConfig-N2)		N/A	N/A	N/A
configuration	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 chan	Physical channel for CSI report		PUSCH	PUSCH	PUSCH
CQI/RI/PMI delay		ms	1.375	1.375	1.375
Maximum number of HARQ transmission			1	1	1
RI Configuration			Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI

Table 8.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
<i>γ</i> 1	N/A	1.05	1.05
72	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.

#### 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

Parameter

Symbols for all unused

**REs** 

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].

Unit

Cyclic prefix Normal Physical Cell ID 0 Number of PDCCH 1 symbols symbols PHICH Ng (Note 1) Normal PHICH duration Number of HARQ processes per **Processes** 8 component carrier Maximum number of 4 HARQ transmission Redundancy version {0,0,1,2} for 64QAM coding sequence Static propagation condition Propagation condition No external noise sources are applied Transmission mode Transmission time difference between Eμs 0 UTRA cell and NR cell(s) All NR cells are in FR1: 1x2 Antenna configuration Any NR cell is in FR2: 1 TxNote 1 Codebook subset 10 restriction

Table 9.1.2.1-1: Common Test Parameters (FDD)

Value

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)		ownlir power cation	•
-	,	$ ho_{\scriptscriptstyle A}$	$ ho_{\scriptscriptstyle 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		7
configuration		·
Number of PDCCH	symbols	1
symbols		·
PHICH Ng (Note 3)		1
PHICH duration		Normal
Cyclic prefix		Normal
Cell ID		0
Maximum number of		4
HARQ transmission		Ţ
Redundancy version		{0,0,1,2} for 64QAM
coding sequence		(0,0,1,2) 101 0+QAIVI
Propagation condition		Static propagation condition
1 Topagation condition		No external noise sources are applied
Transmission mode		1
Transmission time		
difference between E-	μs	0
UTRA cell and NR	μο	0
cell(s)		
Antenna configuration		All NR cells are in FR1: 1x2
Antenna configuration		Any NR cell is in FR2: 1 Tx <sup>Note 2</sup>
Codebook subset		10
restriction		10
Symbols for all unused		OCNG in Annex A.5
REs		OONG III AIIIIEX A.3

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.

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	Bandwidth	Downlink power allocation (dB)			
setup	(MHz)	$ ho_{\scriptscriptstyle A}$	$ ho_{\scriptscriptstyle 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.

Unit **Parameter** Value Inter-TTI Distance Number of OFDM symbols for PDCCH per OFDM symbols 1 component carrier Cross carrier scheduling Not configured Static propagation condition Propagation condition No external noise sources are applied dBm/15kHz at antenna port 2 layer CC 2x2 or 2x4 Antenna configuration 4 layer CC 4x4 Codebook subset 2 layer CC 10 restriction 4 layer CC 1000 2 layer CC  $\rho_A = -3dB$ ,  $\rho_B = -3dB$ ,  $\sigma = 0dB$ Downlink power allocation 4 layer CC

Table 9.4B.1.1.1-1: Additional test setup for E-UTRA CC

Table 9.4B.1.1.1-2: E-UTRA FRC for SDR test (FDD)

 $\rho_A = -6 \text{dB}, \ \rho_B = -6 \text{dB}, \ \sigma = 3 \text{dB}$ 

MIMO layer	Bandwidth	Reference channel				
	Danawiath	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				
	Danuwium	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.

## 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.

# 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		UL-DL pattern	
	raiailletei	Unit	FR1.15-1	
TDD Slot Configuration pattern (Note 1)			DDDSU	
Special Slot Configuration (Note 2)			10D+2G+2U	
referenceSubcarrierSpacing			15	
pattern1	dl-UL-TransmissionPeriodicity	ms	5	
	nrofDownlinkSlots		3	
	nrofDownlinkSymbols		10	
	nrofUplinkSlot		1	
	nrofUplinkSymbols		2	
The number of slots between PDSCH and corresponding			4 if $mod(i,5) = 0$	
HARQ-ACK information (Note 3)			3 if $mod(i,5) = 1$	
			2 if $mod(i,5) = 2$	
			6 if $mod(i,5) = 3$	
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and				

Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information.

Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.

Note 3: i is the slot index per frame;  $i = \{0,...,9\}$ .

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

Parameter  TDD Slot Configuration pattern (Note 1)		1	UL-DL pattern					
		Unit	FR1.30-1					FR1.30-6
			7DS2U	DDDSU	DDDSUDDSUU	DDDSUUDDDD	DSUU	DS <sub>1</sub> S <sub>2</sub> U
Special Slot Configuration (Note 2)			6D+4G+4U	10D+2G+2U	10D+2G+2U	6D+4G+4U	12D+2G	\$1: 10D+2G+2U \$2: 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
	nrofÚplinkSymbols		N/A	N/A	2	0	N/A	0
The number of slots between P HARQ-ACK information (Note 3			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7	4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3	4 if $mod(i,10) = 0$ 3 if $mod(i,10) = 1$ 2 if $mod(i,10) = 2$ 5 if $mod(i,10) = 3$ 3 if $mod(i,10) = 5$ 3 if $mod(i,10) = 6$ 2 if $mod(i,10) = 7$	5 if mod(i,10) = 0 4 if mod(i,10) = 1 3 if mod(i,10) = 2 2 if mod(i,10) = 6 7 if mod(i,10) = 7 6 if mod(i,10) = 8 5 if mod(i,10) = 9	3 if mod(i,4) = 0 2 if mod(i,4) = 1	3 if mod(i,4) = 0 2 if mod(i,4) = 1 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			
		Oilit	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			
T			mod(i,10) = 7			
The number of slots between PD	SCH and corresponding		8 if $mod(i,10) = 0$			
HARQ-ACK information (Note 3)			7 if $mod(i,10) = 1$			
(PDSCH-to-HARQ-timing-indicate	or)		6 if $mod(i,10) = 2$			
			5 if $mod(i,10) = 3$			
			5 if mod(i,10) = 4 4 if mod(i,10) = 5			
			3 if $mod(i, 10) = 6$			
			2 if $mod(i, 10) = 0$			
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 and U denote DL, guard and UL symbols, respectively. The field is for						
information.	, , ,	,				
Note 3: i is the slot index per fr	rame; $i = \{0,, 19\}$					
Note 4: Do not configure tdd-L	/L-DL-ConfigurationCommon ເ	using RF	RC configuration			

# 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

D <sub>c</sub>	Parameter		UL-DL pattern
Fa	iranietei	Unit	FR2.60-1
TDD Slot Configuration patt	ern (Note 1)		DDSU
Special Slot Configuration (	Note 2)		11D+3G+0U
referenceSubcarrierSpacing	g	kHz	60
pattern1	dl-UL-	ms	1
TransmissionPeriodicity			'
	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0
The number of slots between	en PDSCH and corresponding		3 if $mod(i,4) = 0$
HARQ-ACK information (No	ote 3)		2 if $mod(i,4) = 1$
			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.

Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.

Note 3: i is the slot index per frame;  $i = \{0,...,39\}$ 

Table A.1.3-2: TDD UL-DL configuration for SCS 120 kHz

	Parameter	Unit	UL-DL pattern		
Parameter		Ollit	FR2.120-1	FR2.120-2	
TDD Slot Configuration	pattern (Note 1)		DDDSU	DDSU	
Special Slot Configuration	on (Note 2)		10D+2G+2U	11D+3G+0U	
referenceSubcarrierSpa	acing	kHz	120	120	
pattern1	dl-UL-	ms	0.625	0.5	
	TransmissionPeriodicity		0.625	0.5	
	nrofDownlinkSlots		3	2	
	nrofDownlinkSymbols		10	11	
	nrofUplinkSlot		1	1	
	nrofUplinkSymbols		2	0	
The number of slots between PDSCH and corresponding			4 if $mod(i,5) = 0$	3  if mod(i,4) = 0	
HARQ-ACK information(Note 3)			3 if $mod(i,5) = 1$	2  if mod(i,4) = 1	
			2 if $mod(i,5) = 2$	5 if $mod(i,4) = 2$	
			6 if $mod(i.5) = 3$		

Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information.

Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information.

Note 3: i is the slot index per frame;  $i = \{0, ..., 79\}$ 

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		
F.	raianietei				
TDD Slot Configuration patt		DDDSU			
Special Slot Configuration (	Special Slot Configuration (Note 2)				
referenceSubcarrierSpacing	g	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 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3		
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information.					
Note 2: D, G and U denote DL, guard and UL symbols, respectively. The field is for information.					
	i is the slot index per frame; i = {0,,79} Do not configure <i>tdd-UL-DL-ConfigurationCommon</i> 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	
Deference channel		R.PDSCH.1-	R.PDSCH.1-	R.PDSCH.1-	
Reference channel		1.1 FDD	1.2 FDD	1.3 FDD	
Channel bandwidth	MHz	10	10	10	
Subcarrier spacing	kHz	15	15	15	
Number of allocated resource blocks	PRBs	52	6	52	
Number of consecutive PDSCH symbols		12	12	7	
Allocated slots per 2 frames	Slots	19	19	19	
MCS table		64QAM	64QAM	64QAM	
MCS index		4	4	4	
Modulation		QPSK	QPSK	QPSK	
Target Coding Rate		0.30	0.30	0.30	
Number of MIMO layers		1	1	1	
Number of DMRS REs		18	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 Slots i = 1,, 19	Bits	3904	480	2280	
Transport block CRC per Slot					
For Slot i = 0	Bits	N/A	N/A	N/A	
For Slots i = 1,, 19	Bits	24	16	16	
Number of Code Blocks per Slot					
For Slot i = 0	CBs	N/A	N/A	N/A	
For Slots i = 1,, 19	CBs	1	1	1	
Binary Channel Bits Per Slot					
For Slot i = 0	Bits	N/A	N/A	N/A	
For Slots i = 10, 11	Bits	12480	1512	6864	
For Slots i =1,, 9, 12,, 19	Bits	13104	1584	7488	
Max. Throughput averaged over 2 frames	Mbps	3.709	0.456	2.166	
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms					

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

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

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms

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

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

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames

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

Parameter	Unit		Value
Defended should		R.PDSCH.1-	
Reference channel		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  Note 1: SS/PBCH block is transmitted.	Mbps	42.841	

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames

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

Parameter	Unit		Value
Deference showned		R.PDSCH.1-	
Reference channel		5.1 FDD	
Channel bandwidth	MHz	10	
Subcarrier spacing	kHz	15	
Number of allocated resource blocks	PRBs	52	
Number of consecutive PDSCH		12	
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 $i = 1,,4,6,,$	Bits	54912	
9,12,14,16,,19	טונס	J4312	
Max. Throughput averaged over 2	Mbps	24.814	
frames			

SS/PBCH block is transmitted in slot #0 with periodicity 20 ms 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-	R.PDSCH.1-		
Reference channel		6.1 FDD	6.2 FDD		
Channel bandwidth	MHz	10	10		
Subcarrier spacing	kHz	15	15		
Number of allocated resource blocks	PRBs	52	52		
Number of consecutive PDSCH		12	12		
symbols		12	12		
Allocated slots per 2 frames	Slots	15	15		
MCS table		64QAM	64QAM		
MCS index		13	13		
Modulation		16QAM	16QAM		
Target Coding Rate		0.48	0.48		
Number of MIMO layer		1	2		
Number of DMRS REs (Note 3)		24	24		
Overhead for TBS determination		0	0		
Information Bit Payload per Slot					
For Slot i = 0	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,		N/A	N/A		
i={0,,19}		IN/A	IN/A		
For Non CSI-RS Slot i, if mod (i,5)	Bits	12040	24072		
={0,2,3,4}, i={1,19}	Dita	12040	24072		
Transport block CRC per Slot					
For Slot i = 0	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,		N/A	N/A		
i={0,,19}		IN//A	IN//A		
For Non CSI-RS Slot i, if mod (i,5)	Bits	24	24		
={0,2,3,4}, i={1,19}	Dito	2-7	2-7		
Number of Code Blocks per Slot					
For Slot i = 0	CBs	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,		N/A	N/A		
i={0,,19}		14/71	14/71		
For Non CSI-RS Slot i, if mod (i,5)	CBs	2	3		
={0,2,3,4}, i={1,,19}		_	, and the second		
Binary Channel Bits Per Slot	L				
For Slot i = 0	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,		N/A	N/A		
i={0,,19}	D::				
For Slots i = 10	Bits	23712	47424		
For Non CSI-RS Slot i, if mod (i,5)	Bits	24960	49920		
={0,2,3,4}, i={1,9,11,,19}	<b></b>		12320		
Max. Throughput averaged over 2	Mbps	9.030	18.054		
Note 1: SS/DBCH block is transmitt	·	#0 :d : I:	: 00		

SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 1:

Note 2:

Slot i is slot index per 2 frames

Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 3:

Table A.3.2.1.1-7: PDSCH Reference Channel for FDD LTE-NR coexistence scenario

Parameter	Unit			Value	
Reference channel		R.PDSCH.1-	R.PDSCH.1-		
Reference charmer		7.1 FDD	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		

SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 1:

Note 2:

Slot i is slot index per 2 frames
No user data is scheduled on slots with LTE PBCH/PSS/SSS Note 3:

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	
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		1	
Number of DMRS REs		18	
Overhead for TBS determination		0	
Information Bit Payload per Slot			
For Slot i = 0	Bits	N/A	
For Slots i = 1,, 19	Bits	12552	
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	2	
Binary Channel Bits Per Slot			
For Slot i = 0	Bits	N/A	
For Slots i = 1,2,11,12	Bits	24960	
For Slots i = 3,, 10, 13,, 19	Bits	26208	
Max. Throughput averaged over 2 frames	Mbps	11.924	

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames

## A.3.2.1.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit		Value
Deference showned		R.PDSCH.2-	
Reference channel		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	ed in slot	#0 with periodici	ity 20 ms

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms

#### 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		Va	lue	
Reference channel		R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-
		1.1 FDD	1.2 FDD	1.3 FDD	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<sub>PRB</sub> = 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		Va	Value		
Reference channel		R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-	
		2.1 FDD	2.2 FDD	2.3 FDD	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<sub>PRB</sub> = 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<sub>PRB</sub> = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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-	R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-	
		3.1 FDD	3.2 FDD	3.3 FDD	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<sub>PRB</sub> = 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<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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<sub>PRB</sub> = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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-	R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-	
		4.1 FDD	4.2 FDD	4.3 FDD	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.
- 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<sub>PRB</sub> = 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<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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<sub>PRB</sub> = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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-	R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-	
		5.1 FDD	5.2 FDD	5.3 FDD	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<sub>PRB</sub> = 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<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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<sub>PRB</sub> = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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-	R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-	
		6.1 FDD	6.2 FDD	6.3 FDD	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<sub>PRB</sub> = 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<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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<sub>PRB</sub> = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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
- 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)

Reference channel	Parameter	Unit			Value	
Channel bandwidth	Reference channel					
Subcarrier spacing         kHz         30         30         30           Allocated resource blocks         PRBs         106         6         106           Number of consecutive PDSCH symbols         106         6         106           For Siot i, if mod(i, 10) = 7 for i from (0,39)         4         4         N/A           For Siot i, if mod(i, 10) = (0,1,2,3,4,5,6) for i from (1,39)         12         12         7           Allocated slots per 2 frames         31         31         27           MCS table         64QAM         64QAM         64QAM           McStable         4         4         4           McStable         0,30         0,30         0,30           Number of MIMO layers         1         1         1           Number of MIMO layers         1         1         1           Number of DMRS REs         1         1         1           For Siot i, if mod(i, 10) = 7 for i from (0,9)         6         6         N/A           For Siot i, if mod(i, 10) = 7 for i from (1,39)         18         12         12           Voerhead of TBS determination         0         0         0         0           For Siot i, if mod(i, 10) = 7 for i from (0,39)         8<	Channel bandwidth	MHz				
Allocated resource blocks   PRBs   106   6   106						
Number of consecutive PDSCH symbols   For Slot i, if mod(i, 10) = 7 for i from (0,99)   12   12   7   7   7   7   7   7   7   7   7						
Symbols		TINDO	100	,	100	
For Slot i, if mod(i, 10) = 7 for i from (0,39)						
10,39   12   12   7   7   7   7   7   7   7   7   7						
For Slot i, if mod(i, 10) =   12			4	4	N/A	
10,1,2,3,4,5,6  for i from (1,,39)	For Slot i, if mod(i, 10) =				_	
Allocated slots per 2 frames			12	12	7	
MCS table         64QAM         64QAM         64QAM           MCS index         4         4         4           MCS index         QPSK         QPSK         QPSK           Modulation         QPSK         QPSK           Target Coding Rate         0.30         0.30         0.30           Number of MIMO layers         1         1         1           Number of DMRS REs         1         1         1           For Slot i, if modif, 10) = 7         6         6         N/A           (0,39)         For Slot i, if modif, 10) = 7         18         12         12           (0,1,2,3,4,56) for if rom (1,,39)         Bits         N/A         N/A         N/A           For Slot i, if modif, 10) = 7         For Slot i, if modif, 10) = 8         Bits         2664         144         N/A           (0,1,2,3,4,56) for if rom (1,,39)         Bits         8064         480         4608         4608           (0,1,2,3,4,56) for if rom (1,,39)         Bits         N/A         N/A         N/A           For Slot i, if modif, 10) = 7         Bits         N/A         N/A         N/A           (8,9) for i from (1,,39)         Bits         8064         480         4608			31	31	27	
MCS index         4         4         4         4         Modulation         QPSK						
Modulation						
Target Coding Rate			QPSK	QPSK	QPSK	
Number of MIMO layers						
Number of DMRS REs					1	
For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = (0,1,2,3,4,5,6) for i from (1,,39) Overhead for TBS determination Information Bit Payload per Slot For Slots 0 and Slot i, if mod(i, 10) = (8,9) for i from (0,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 7 for i from (1,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = 7 for i from (1,,39) For Slot i, if mod(i, 10) = 7 for i from (1,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 7 for i from (1,,39) Binary Channel Bits Per Slot For Slots o and Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 7 for i from (1,,39) For Slot i, if mod(i, 10) = 7 for i from (1,,39) Binary Channel Bits Per Slot For Slots o and Slot i, if mod(i, 10) = 8 lits For Slot i, if mod(i, 10) = 7 for i from (1,,39) For Slot i, if mod(i, 10) = 7 for i from (1,,39) Binary Channel Bits Per Slot For Slots i, if mod(i, 10) = 7 for i from (1,,39) Binary Channel Bits Per Slot For Slots i, if mod(i, 10) = 7 for i from (1,,39) Binary Channel Bits Per Slot For Slot i, if mod(i, 10) = 7 for i from (1,,39) Bits Slot i, if mod(i, 10) = 7 for i from (1,,39) Bits Slot i, if mod(i, 10) = 7 for i from (1,,39) Bits Slot i, if mod(i, 10) = 7 for i from (1,,39) Bits						
(0,39)   18   12   12   (0,1,2,3,4,5,6) for i from (1,,39)   18   18   12   12   (0,1,2,3,4,5,6) for i from (1,,39)   18   18   18   18   19   19   19   19			_	_		
For Slot i, if mod(i, 10) =			6	6	N/A	
10,1,2,3,4,5,6} for i from {1,,39}						
Overhead for TBS determination			18	12	12	
Information Bit Payload per Slot   For Slots 0 and Slot i, if mod(i, 10) = (8.9) for i from (0,,39)   For Slot i, if mod(i, 10) = 7 for i from (0,,39)   Bits   2664   144   N/A   (0,,39)   For Slot i, if mod(i, 10) = (0,1,2,3,4,5.6) for i from (1,,39)   Bits   8064   480   4608   4608   (0,1,2,3,4,5.6) for i from (1,,39)   Bits   8064   480   4608   (0,1,2,3,4,5.6) for i from (1,,39)   Bits   N/A			0	0	0	
For Slots 0 and Slot i, if mod(i, 10) = (8,9) for i from (0,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = (0,1,2,3,4,5,6) for i from (1,,39) Transport block CRC per Slot For Slots 0 and Slot i, if mod(i, 10) = (8,9) for i from (0,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = 7 for i from (0,,39) For Slot i, if mod(i, 10) = 8 lits 16 16 N/A  N/A  N/A  N/A  N/A  N/A  N/A  N/A					-	
(8,9) for i from (0,,39)   Bits   N/A						
For Slot i, if mod(i, 10) = 7 for i from {0,,39} For Slot i, if mod(i, 10) = 8 {0,1,2,3,4,5,6} for i from {1,,39} Bits 8064 480 4608  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39} For Slots 0 and Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {0,,39} For Slot i, if mod(i, 10) = 7 for i from {0,,39} For Slot i, if mod(i, 10) = 8 {0,1,2,3,4,5,6} for i from {1,,39} Bits 24 16 24  (0,1,2,3,4,5,6) for i from {1,,39} Number of Code Blocks per Slot For Slots 0 and Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {0,,39} For Slot i, if mod(i, 10) = 7 for i from {0,,39} For Slot i, if mod(i, 10) = 7 for i from {0,,39} For Slot i, if mod(i, 10) = 7 for i from {0,1,2,3,4,5,6} for i from {1,,39} Binary Channel Bits Per Slot For Slots 0 and Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39} Binary Channel Bits Per Slot For Slots 0 and Slot i, if mod(i, 10) = 8 {0,1,2,3,4,5,6} for i from {1,,39} Bits N/A N/A N/A For Slot i, if mod(i, 10) = 7 for i from 8 {0,,39} For Slot i, if mod(i, 10) = 7 for i from 8 {0,,39} For Slot i, if mod(i, 10) = 7 for i from 8 {0,,39} Bits 8904 504 N/A  Max. Throughput averaged over 2 Mbps 11.419 0.677 6.221		Bits	N/A	N/A	N/A	
(0,39)	For Slot i, if $mod(i, 10) = 7$ for i from					
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  Transport block CRC per Slot  For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  Number of Code Blocks per Slot  For Slot 0, and Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  Number of Code Blocks per Slot  For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {1,,39}  For Slot i, if mod(i, 10) = 7 for i from {1,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  For Slot i, if mod(i, 10) = 8		Bits	2664	144	N/A	
{0,1,2,3,4,5,6} for i from {1,,39}	For Slot i, if mod(i, 10) =	5.4	2224	400	4000	
Transport block CRC per Slot         For Slots 0 and Slot i, if mod(i, 10) = {8.9} for i from {0,,39}         Bits         N/A         N/A         N/A           For Slot i, if mod(i, 10) = {0,,39}         Bits         16         16         N/A           For Slot i, if mod(i, 10) = {0,,39}         Bits         24         16         24           Number of Code Blocks per Slot         Bits         24         16         24           For Slots 0 and Slot i, if mod(i, 10) = {8.9} for i from {0,,39}         CBs         N/A         N/A         N/A           For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}         CBs         1         1         N/A           For Slots 0 and Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}         Bits         N/A         N/A         N/A           Binary Channel Bits Per Slot         Bits         N/A         N/A         N/A         N/A           For Slots 0 and Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {0,,39}         Bits         25440         1512         13992           For Slots i, if mod(i, 10) = 7 for i from {0,,39}         Bits         26712         1584         15264           For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {0,,39}         Bits         26712         1584         15264           For Slot		Bits	8064	480	4608	
For Slots 0 and Slot i, if mod(i, 10) = (8,9) for i from (0,,39)						
{8,9} for i from {0,,39}         Bits         N/A         N/A           For Slot i, if mod(i, 10) = 7 for i from {0,,39}         Bits         16         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           Number of Code Blocks per Slot         Bits         24         N/A         N/A         N/A           For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}         CBs         1         1         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         1           Binary Channel Bits Per Slot         For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}         Bits         N/A         N/A         N/A           For Slots i = 20, 21         Bits         25440         1512         13992           For Slot i, if mod(i, 10) = {0,,39}         Bits         8904         504         N/A           For Slot i, if mod(i, 10) = {0,,39}         Bits         26712         1584         15264           For Slot i, if mod(i, 10) = {0,,39}         Bits         26712         1584         15264           For Slot i, if mod(i, 10) = {0,,39,,39}         Bits         26712         1584         15		D:4-	NI/A	NI/A	N1/A	
For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  Number of Code Blocks per Slot  For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  Binary Channel Bits Per Slot  For Slots 0 and Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {0,,39}  For Slots i = 20, 21  For Slots i = 20, 21  For Slots i, if mod(i, 10) = 7 for i from {0,,39}  For Slots i, if mod(i, 10) = 7 for i from {0,,39}  For Slots i, if mod(i, 10) = 7 for i from {0,,39}  For Slots i, if mod(i, 10) = 7 for i from {0,,39}  For Slots i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 8 lits 25440  For Slot i, if mod(i, 10) = 8 lits 26440  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712  For Slot i, if mod(i, 10) = 8 lits 26712		Bits	IN/A	IN/A	N/A	
Companies   Comp		D:4-	4.0	4.0	NI/A	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  Number of Code Blocks per Slot  For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = CBs  {0,1,2,3,4,5,6} for i from {1,,39}  Binary Channel Bits Per Slot  For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slots i = 20, 21  For Slots i, if mod(i, 10) = 7 for i from {1,,39}  Bits  Bits  N/A  N/A  N/A  N/A  N/A  N/A  N/A  N/	{0,,39}	Bits	16	16	IN/A	
\{\( \)\{\( \)\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\)\}\{\}\{	For Slot i, if mod(i, 10) =	Dito	24	16	24	
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  Binary Channel Bits Per Slot  For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slots i = 20, 21  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 8 lits 8904  {0,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {0,1,2,3,4,5,6} for i from {0,1,2,3,4,5,6} for i from {1,1,2,2,,39}  Max. Throughput averaged over 2 frames	{0,1,2,3,4,5,6} for i from {1,,39}	DIIS	24	10	24	
{8,9} for i from {0,,39}       CBS       IN/A       IN/A       IN/A         For Slot i, if mod(i, 10) = {0,,39}       CBS       1       1       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         Binary Channel Bits Per Slot       Image: Bits of the content of	Number of Code Blocks per Slot					
Result   For Slot	For Slots 0 and Slot i, if mod(i, 10) =	CBc	NI/A	NI/A	NI/A	
	{8,9} for i from {0,,39}	CDS	IN/A	IN/A	IN/A	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,39}  Binary Channel Bits Per Slot  For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slots i = 20, 21  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 8 fits	For Slot i, if $mod(i, 10) = 7$ for i from	CBc	1	1	NI/A	
{0,1,2,3,4,5,6} for i from {1,,39}       CBS       1       1         Binary Channel Bits Per Slot       504       N/A       N/A         For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}       Bits       N/A       N/A       N/A         For Slots i = 20, 21       Bits       25440       1512       13992         For Slot i, if mod(i, 10) = 7 for i from {0,,39}       Bits       8904       504       N/A         For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,19,22,,39}       Bits       26712       1584       15264         {1,,19,22,,39}       Max. Throughput averaged over 2 frames       Mbps       11.419       0.677       6.221		CDS	ı	1	IN/A	
Binary Channel Bits Per Slot  For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slots i = 20, 21  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 8 fits		CBs	1	1	1	
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}  For Slots i = 20, 21  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {0,1,2,3,4,5,6} for i from {1,,19,22,,39}  Max. Throughput averaged over 2 frames		ODS	'		'	
{8,9} for i from {0,,39}     Bits     N/A     N/A       For Slots i = 20, 21     Bits     25440     1512     13992       For Slot i, if mod(i, 10) = 7 for i from {0,,39}     Bits     8904     504     N/A       For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,19,22,,39}     Bits     26712     1584     15264       {1,,19,22,,39}     Max. Throughput averaged over 2 frames     Mbps     11.419     0.677     6.221						
For Slots i = 20, 21  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = {0,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,19,22,,39}  Max. Throughput averaged over 2 frames  Mbps 11.419  0.677  6.221	, , ,	Rits	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,,39}  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,19,22,,39}  Max. Throughput averaged over 2 frames  Bits 8904 504 N/A  15264  15264  15264						
{0,,39}     Bits     6904     504     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       Max. Throughput averaged over 2 frames     Mbps     11.419     0.677     6.221		Bits	25440	1512	13992	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,,19,22,,39}  Max. Throughput averaged over 2 frames  Mbps 11.419 0.677 6.221		Bits	8904	504	N/A	
{0,1,2,3,4,5,6} for i from {1,,19,22,,39}     Bits     26712     1584     15264       Max. Throughput averaged over 2 frames     Mbps     11.419     0.677     6.221	{0,,39}	2.0	5551	55 1	14/1	
\[ \lambda(1,,19,22,,39\) \\ Max. Throughput averaged over 2 \\ frames \\ \end{array}  \text{Mbps}  \text{11.419}  \text{0.677}  \text{6.221} \]						
Max. Throughput averaged over 2 frames 11.419 0.677 6.221		Bits	26712	1584	15264	
frames   MIDPS   11.419   0.677   6.221						
rrames '   '	- · · · · · · · · · · · · · · · · · · ·	Mbps	11.419	0.677	6,221	
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms						

SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Slot i is slot index per 2 frames

Note 1: Note 2:

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-	R.PDSCH.2-	R.PDSCH.2-	R.PDSCH.2-
Reference channel		2.1 TDD	2.2 TDD	2.3 TDD	2.4 TDD
Channel bandwidth	MHz	40	40	40	40
Subcarrier spacing	kHz	30	30	30	30
Allocated resource blocks	PRBs	106	106	106	106
Number of consecutive PDSCH					
symbols					
For Slot i, if $mod(i, 10) = 7$ for i from		4	4	4	4
{0,,39}					
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		13	13	13	13
Modulation		16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48
Number of MIMO layers		1	2	3	4
Number of DMRS REs			_	- J	
For Slot i, if $mod(i, 10) = 7$ for i from				4.5	10
{0,,39}		6	6	12	12
For Slot i, if mod(i, 10) =		40	40	0.4	0.4
{0,1,2,3,4,5,6} for i from {1,,39}		12	12	24	24
Overhead for TBS determination		0	0	0	0
Information Bit Payload per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	N/A	N/A	N/A
{8,9} for i from {0,,39}	Dita	IN/A	IN//A	IN/A	IN/A
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	8456	16896	22032	29192
{0,,39}	Dito	0.100	10000	22002	20102
For Slot i, if $mod(i, 10) =$	Bits	26632	53288	73776	98376
{0,1,2,3,4,5,6} for i from {1,,39}					
Transport block CRC per Slot					
For Slots 0 and Slot i, if $mod(i, 10) =$	Bits	N/A	N/A	N/A	N/A
{8,9} for i from $\{0,,39\}$ 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) =	OD-	N1/A	N1/A	N1/A	N1/A
{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	CBs	2	3	3	4
{0,,39}	CDS	2	3	3	4
For Slot i, if mod(i, 10) =	CBs	4	7	9	12
{0,1,2,3,4,5,6} for i from {1,,39}	ODS	-	,	3	12
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	N/A	N/A	N/A
{8,9} for i from {0,,39}					
For Slots i = 20, 21	Bits	53424	106848	144008	193344
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	17808	35616	45792	61056
{0,,39}					
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from	Bits	55968	111936	152640	203520
{0,1,2,3,4,3,6} for Filoni {1,,19,22,,39}	סווט	33300	111930	132040	203020
Max. Throughput averaged over 2					
frames	Mbps	37.644	75.318	104.004	138.646
Note 1: SS/PBCH block is transmitte	ed in slot	#0 with periodic	city 20 ms	ı	<u> </u>
Note 2: Slot i is slot index per 2 fram			,		

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		
Channel bandwidth	MHz	40		
Subcarrier spacing	kHz	30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH				
symbols				
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$		4		
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$ 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 Slot i, if mod(i, 10) = 7 for i from		0		
{0,,39}		6		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		10		
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) =	Bits	N/A		
{8,9} for i from {0,,39}	DIIS	IV/A		
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	27144		
{0,,39}	Dita	27144		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	Bits	83976		
for i from {1,,39}	Dito	00070		
Transport block CRC per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A		
{8,9} for i from {0,,39}		-		
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	24		
{0,,39}				
For Slot i, if mod(i, 10) =	Bits	24		
{0,1,2,3,4,5,6}for i from {1,,39} 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	10		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	5			
{8,9} for i from {0,,39}	Bits	N/A		
For Slots i = 20, 21	Bits	160272		
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	Bits	53424		
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$ for i from $\{1,,19,22,,39\}$	Bits	167904		
Max. Throughput averaged over 2	_		<del>                                     </del>	
frames	Mbps	118.796		
Note 1: SS/PBCH block is transmitted	n slot #0 w	vith periodicity 20	) ms	
Note 2: Slot i is slot index per 2 frames				

Table A.3.2.2.4: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (256QAM)

Parameter	Unit		Value	
Reference channel		R.PDSCH.2- 4.1 TDD		
Channel bandwidth	MHz	40		
Subcarrier spacing	kHz	30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH				
symbols				
For Slot i, if mod(i, 10) = 7 for i from $\{0,,39\}$		4		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$ 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 Slot i, if $mod(i, 10) = 7$ for i from		6		
{0,,39}		O		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		12		
for i from {1,,39}				
Overhead for TBS determination		0		
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A		
{8,9} for i from {0,,39}	Dito	11/73		
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	29192		
{0,,39}	Dito	20102		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	Bits	92200		
for i from {1,,39}		02200		
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	OD-	4		
{0,,39}	CBs	4		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	CD-	4.4		
for i from {1,,39}	CBs	11		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A		
{8,9} for i from {0,,39}				
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	Mbps	130.308		
frames   Note 1: SS/PBCH block is transmitted i			) ms	
Note 1: SS/PBCH block is transmitted i Note 2: Slot i is slot index per 2 frames		nun penodicity 20	פווו ע	

Table A.3.2.2.5: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-2

Parameter	Unit		Value	
Reference channel		R.PDSCH.2-		
		5.1 TDD		
Channel bandwidth	MHz	40		
Subcarrier spacing	kHz	30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH				
symbols				
For Slot i, if $mod(i, 5) = 3$ for i from		8		
{0,,39}				
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		12		
from {1,,39}		0.4		
Allocated slots per 2 frames		31		
MCS table		64QAM		
MCS index		4		
Modulation Date		QPSK		
Target Coding Rate		0.30		
Number of MIMO layers		1		
Number of DMRS REs				
For Slot i, if $mod(i, 5) = 3$ for i from		12		
{0,,39}				
For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i		12		
from {1,,39} Overhead for TBS determination		0		
Information Bit Payload per Slot		0		
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	D.,	0.4		
{0,,39}	Bits	24		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	D:4-	0.4		
from {1,,39}	Bits	24		
Number of Code Blocks per Slot				
For Slot 0 and Slot i, if mod(i, 5) = 4 for	CD-	NI/A		
i from {0,,39}	CBs	N/A		
For Slot i, if $mod(i, 5) = 3$ for i from	CBs	1		
{0,,39}	CDS	1		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	CBs	2		
from {1,,39}	ODS			
Binary Channel Bits Per Slot				
For Slot 0 and Slot i, if $mod(i, 5) = 4$ for	Bits	N/A		
i from {0,,39}				
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		1	+ + + +	
For Slot 1, if flod(1, 5) = $\{0, 1, 2\}$ for 1 from $\{1,, 19, 22,, 39\}$	Bits	27984		
Max. Throughput averaged over 2		1	<del>                                     </del>	
frames	Mbps	11.875		
Note 1: SS/PBCH block is transmitted	n slot #0 w	ith periodicity 20	20 ms	
Note 2: Slot i is slot index per 2 frames				

Table A.3.2.2.6: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-3

Parameter	Unit		Value			
Reference channel		R.PDSCH.2- 6.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH						
symbols						
For Slot i, if mod(i, 10) = $\{3,7\}$ for i from $\{0,,39\}$		8				
For Slot i, if $mod(i, 10) = \{0,1,2,5,6\}$ 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 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		12				
i from {1,,39} Overhead for TBS determination		0				
Information Bit Payload per Slot		U				
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	Bits	5376				
$\{0,,39\}$ 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						
Note 2: Slot i is slot index per 2 frames						

Table A.3.2.2.7: 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 Allocated resource blocks	kHz PRBs	30 106			
Number of consecutive PDSCH	FKD5	106			
symbols					
For Slot i, if mod(i, 10) = 7 for i from		4			
{0,,39}		4			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		12			
for i from {1,,39}					
Allocated slots per 2 frames MCS table		31			
MCS table MCS index		64QAM 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		6			
{0,,39}		-			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		12			
for i from {1,,39}  Overhead for TBS determination		0			
Information Bit Payload per Slot		0			
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	Bits	16896			
{0,,39}	Dito	10090			
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$	Bits	53288			
for i from {1,,39}  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	Bits	24			
{0,,39}	DIIS	24			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	Bits	24			
for i from {1,,39}					
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	0.0				
{0,,39}	CBs	3			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	CBs	7			
for i from {1,,39}		•			
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	5	100:			
{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	Bits	35616			
{0,,39}					
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					
Note 2: Slot i is slot index per 2 frames					

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

Parameter	Unit			Value
Reference channel		R.PDSCH.2-	R.PDSCH.2-	
Reference charmer		8.1 TDD	8.2 TDD	
Channel bandwidth	MHz	40	40	
Subcarrier spacing	kHz	30	30	
Allocated resource blocks	PRBs	106	106	
Number of consecutive PDSCH		12	12	
symbols				
Allocated slots per 2 frames		23	23	
MCS table		64QAM	64QAM	
MCS index		13	13	
Modulation		16QAM	16QAM	
Target Coding Rate		0.48	0.48	
Number of MIMO layers		1	2	
Number of DMRS REs (Note 3)		24	24	
Overhead for TBS determination		0	0	
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	N/A	
{7,8,9} for i from {0,,39}	טונס	1 11/7	19/7	
For CSI-RS Slot i, if mod(i,10) =1 for i	Bits	N/A	N/A	
from {0,,39}		IN//A		
For Slot i = 20	Bits	24576	49176	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	Bits	24576	49176	
for i from {1,,19,22,,39}	Dito	24070	43170	
Transport block CRC per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	N/A	
{7,8,9} for i from {0,,39}	Ditto	14//	14/7	
For CSI-RS Slot i, if mod(i,10) =1 for i	Bits	N/A	N/A	
from {0,,39}				
For Slot i = 20	Bits	24	24	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	Bits	24	24	
for i from {1,,19,22,,39}	Ditto			
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	CBs	N/A	N/A	
{7,8,9} for i from {0,,39}			,	
For CSI-RS Slot i, if mod(i,10) =1 for i	CBs	N/A	N/A	
from {0,,39}				
For Slot i = 20	CBs	3	6	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	CBs	3	6	
for i from {1,,19,22,,39}				
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	N/A	
{7,8,9} for i from {0,,39}				<del>                                     </del>
For CSI-RS Slot i, if mod(i,10) =1 for i	Bits	N/A	N/A	
from {0,,39} For Slot i = 20	D:40	40006	96672	
	Bits	48336	90072	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	Bits	50880	101760	
for i from {1,,19,22,,39}	-			
Max. Throughput averaged over 2 frames	Mbps	28.2624	56.5524	
Note 1: SS/PBCH block is transmitted	in plat #0 :	uith pariadiaitu	1 20 ma	

Note 1:

Note 2:

SS/PBCH block is transmitted in slot #0 with periodicity 20 ms
Slot i is slot index per 2 frames
Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 3:

Table A.3.2.2.9: 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 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 Slot i, if $mod(i, 10) = 3$ for i from		6			
{0,,39}		Ŭ.			
For Slot i, if $mod(i, 10) = \{0,1,2,6,7,8,9\}$		12			
for i from {1,,39}					
Overhead for TBS determination		0			
Information Bit Payload per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A			
{4,5} for i from {0,,39}			<del>                                     </del>		
For Slot i, if $mod(i, 10) = 3$ for i from	Bits	13064			
$\{0,,39\}$ 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 $mod(i, 10) = \{0,1,2,6,7,8,9\}$	<u> </u>	0.4			
for i from {1,,39}	Bits	24			
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	CBs	N/A			
{4,5} for i from {0,,39}	5	IN/A			
For Slot i, if $mod(i, 10) = 3$ for i from $\{0,,39\}$	CBs	2			
For Slot i, if $mod(i, 10) = \{0,1,2,6,7,8,9\}$	CD	-			
for i from {1,,39}	CBs	5			
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	Dito	NI/A			
{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	N All	F7 000			
frames	Mbps	57.930			
Note 1: SS/PBCH block is transmitted i	n slot #0 w	ith periodicity 20	0 ms		
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-				
Reference charmer		10.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH						
symbols						
For Slot i, if $mod(i, 10) = 7$ for i from		4				
{0,,39}		-				
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$		12				
for i from {1,,39}		0.4				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		13				
Modulation Taylor Continue Date		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if $mod(i, 10) = 7$ for i from		6				
{0,,39}						
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$		18				
Overhead for TBS determination		0		+		
Information Bit Payload per Slot		U		+		
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	8456				
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$						
for i from $\{1,,39\}$	Bits	25608				
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	n:	0.4				
{0,,39}	Bits	24				
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	D:1-	0.4				
for i from {1,,39}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) =	CD.	NI/A				
{8,9} for i from {0,,39}	CBs	N/A				
For Slot i, if mod(i, 10) = 7 for i from	CBs	2				
{0,,39}	CD3	2				
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	CBs	4				
for i from {1,,39}	000	7				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A				
{8,9} for i from {0,,39}						
For Slots i = 1,2,21,22	Bits	52176				
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	17808				
{0,,39}		1.550				
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	Bits	53424				
for i from {3,,20,23,,39}						
Max. Throughput averaged over 2	Mbps	36.262				
frames			0			
Note 1: SS/PBCH block is transmitted i	ri siot #U W	ntn periodicity 20	UITIS			
Note 2: Slot i is slot index per 2 frames						

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 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 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		Ŭ		
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	Bits	8064		
$\{1,,39\}$ For Slot i, if mod(i, 4) = 1 for i from	Bits	6528		
{0,,39}	2.10	0020		
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	Mbps	6.893		
frames  Note 1: SS/DBCH block is transmitted in	-		0 mg	L
Note 1: SS/PBCH block is transmitted i	n Siot #U W	nur periodicity 20	U IIIS	

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-		
	MHz	12.1 TDD		
Channel bandwidth Subcarrier spacing	kHz	40 30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH				
symbols				
For Slot i, if $mod(i, 4) = 0$ for i from		12		
$\{1,,39\}$ 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		10		
{0,,39} Allocated slots per 2 frames		31		
MCS table		64QAM		
MCS index		4		
Modulation		QPSK		
Target Coding Rate		0.30		
Number of MIMO layers		1		
Number of DMRS REs  For Slot i, if mod(i, 4) = 0 for i from				
$\{1,,39\}$		18		
For Slot i, if $mod(i, 4) = 1$ for i from		18		
{0,,39}		10		
For Slot i, if $mod(i, 4) = 2$ for i from		18		
{0,,39} Overhead for TBS determination		0		
Information Bit Payload per Slot				
For Slot 0 and Slot i, if $mod(i, 4) = 3$ for	Bits	N/A		
i from {0,,39}	DIIS	IN/A		
For Slot i, if $mod(i, 4) = 0$ for i from	Bits	8064		
$\{1,,39\}$ 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	Bits	6528		
{0,,39}	Dito	0020		
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	Bits	24		
{1,,39}	סונס	24		
For Slot i, if $mod(i, 4) = 1$ for i from	Bits	24		
$\{0,,39\}$ 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	CBs	N/A		
i from $\{0,,39\}$ 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	CDa	4		
{0,,39}	CBs	1		
For Slot i, if $mod(i, 4) = 2$ for i from	CBs	1		
{0,,39} Binary Channel Bits Per Slot				
For Slot 0 and Slot i, if $mod(i, 4) = 3$ for	F::	<b>.</b>		
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	D:r-	40500		
{1,,19,22,,39}	Bits	16536		
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	21624		
{0,,39}				

Max. Thro	oughput averaged over 2	Mbps	9.389				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms							
Note 2:	Slot i is slot index per 2 frames						

#### A.3.2.2.3 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	e	
Reference channel		R.PDSCH.4- 1.1 TDD			
Channel bandwidth	MHz	50			
Subcarrier spacing	kHz	60			
Allocated resource blocks	PRBs	66			
Number of consecutive PDSCH					
symbols					
For Slot i, if mod(i, 4) = 2 for i from $\{1,, 79\}$		10			
For Slot i, if $mod(i, 4) = \{0,1\}$ 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 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	Bits	N/A			
for i from $\{0,,79\}$ 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 v	vith periodicity 20	) ms	1	1
Note 2: Slot i is slot index per 2 frames		portodioity 20			

#### 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			
Deference sharped		R.PDSCH.5-				
Reference channel		1.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH						
symbols						
For Slot i, if mod(i, 5) = 3 for i from		9				
{0,, 159}		9				
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		13				
from {1,,159}						
Allocated slots per 2 frames		127				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if $mod(i, 5) = 3$ for i from		12				
{0,, 159}		12				
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		12				
from {1,,159}						
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if $mod(i, 5) = 4$	Bits	N/A				
for i from {0,,159}	Bito	1471				
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	3624				
{0,, 159}	2.10					
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	Bits	5504				
from {1,,159}						
Transport block CRC per Slot						
For Slots 0 and Slot i, if $mod(i, 5) = 4$	Bits	N/A				
for i from {0,,159}			<del>                                     </del>			
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	16				
{0,, 159}			<del>                                     </del>			
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i	Bits	24				
from {1,,159} Number of Code Blocks per Slot			+ + + + + + + + + + + + + + + + + + + +			
For Slots 0 and Slot i, if $mod(i, 5) = 4$			+ + + + + + + + + + + + + + + + + + + +			
for i from $\{0,,159\}$	CBs	N/A				
For Slot i, if $mod(i, 5) = 3$ for i from						
{0,, 159}	CBs	1				
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i						
from {1,,159}	CBs	1				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if $mod(i, 5) = 4$	_		<del>                                     </del>			
for i from {0,,159}	Bits	N/A				
For Slots i = 80, 81	Bits	17490				
For Slot i, if $mod(i, 5) = 3$ for i from						
{0,, 159}	Bits	12210				
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i	5	40000				
from {1,,79,82,,159}	Bits	18282				
Max. Throughput averaged over 2		04.040				
frames	Mbps	31.942				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms						

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

Parameter	Unit			Value	1
Deference channel		R.PDSCH.5-	R.PDSCH.5-	R.PDSCH.5-	
Reference channel		2.1 TDD	2.2 TDD	2.3 TDD	
Channel bandwidth	MHz	100	100	200	
Subcarrier spacing	kHz	120	120	120	
Allocated resource blocks	PRBs	66	66	132	
Number of consecutive PDSCH					
symbols					
For Slot i, if mod(i, 5) = 3 for i from		9	9	9	
$\{0,, 159\}$ 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 Slot i, if mod(i, 5) = 3 for i from		12	12	12	
$\{0,, 159\}$ 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	D:4-	N1/A	N1/A	N1/A	
for i from {0,,159}	Bits	N/A	N/A	N/A	
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	11272	22536	45096	
$\{0,, 159\}$ For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i	Bits	17424	34816	69672	
from {1,,159}	DIIS	17424	34010	09072	
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	Bits	24	24	24	
{0,, 159}	2.10				
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	CBs	2	3	6	
{0,, 159}		_	-	-	
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	CBs	3	5	9	
from {1,,159}					
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, 83	Bits	34980	73128	146256	
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	24420	48840	97680	
{0,, 159}		_			
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	Mhna	100 700	201 424	402.006	
frames	Mbps	100.799	201.434	403.096	
Note 1: SS/PBCH block is transmitted		with periodicity	/ 20 ms		
Note 2: Slot i is slot index per 2 frame	S				

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

Parameter	Unit		Vi	alue	
Reference channel		R.PDSCH.5-			
Reference charmer		3.1 TDD			
Channel bandwidth	MHz	100			
Subcarrier spacing	kHz	120			
Allocated resource blocks	PRBs	66			
Number of consecutive PDSCH					
symbols					
For Slot i, if $mod(i, 5) = 3$ for i from		9			
{0,, 159}		_			
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i		13			
from {1,,159}		107			
Allocated slots per 2 frames MCS table		127 64QAM			
MCS index		18			
Modulation		64QAM			
Target Coding Rate		0.46			
Number of MIMO layers		1			
Number of DMRS REs		'			
For Slot i, if mod(i, 5) = 3 for i from					
{0,, 159}		12			
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ 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	Dita	N/A			
for i from {0,,159}	Bits				
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	16136			
{0,, 159}	DIIS	10130			
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	Bits	25104			
from {1,,159}	Dito	20104			
Transport block CRC per Slot					
For Slots 0 and Slot i, if $mod(i, 5) = 4$	Bits	N/A			
for i from {0,,159}					
For Slot i, if mod(i, 5) = 3 for i from $(0, 150)$	Bits	24			
$\{0,, 159\}$ 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	OD-	0			
from {1,,159}	CBs	3			
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 5) = 4	Bits	N/A			
for i from {0,,159}					
For Slots i = 80, 81	Bits	52470			
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	36630			
$\{0,, 159\}$ For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i		1			
from $\{1,,79,82,,159\}$	Bits	54846			
Max. Throughput averaged over 2		145.062			
frames	Mbps	1 10.002			
Note 1: SS/PBCH block is transmitted	in slot #0 w	vith periodicity 20	0 ms	I	1
Note 2: Slot i is slot index per 2 frames		1	-		

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

Parameter	Unit		Value
Reference channel		R.PDSCH.5-	
		4.1 TDD	
Channel bandwidth	MHz	100	
Subcarrier spacing	kHz	120	
Allocated resource blocks	PRBs	6	
Number of consecutive PDSCH			
symbols			
For Slot i, if $mod(i, 4) = 2$ for i from		10	
{1,, 159}			
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from		13	
{1,,159}		110	
Allocated slots per 2 frames		119	<del>                                     </del>
MCS table		64QAM	
MCS index		4	
Modulation Date		QPSK	<del>                                     </del>
Target Coding Rate		0.30	<del>                                     </del>
Number of MIMO layers		2	
Number of DMRS REs			<del>                                     </del>
For Slot i, if $mod(i, 4) = 2$ for i from		12	
{1,, 159}			
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from		12	
{1,,159} Overhead for TBS determination		6	
Information Bit Payload per Slot		0	
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 $mod(i, 4) = 3$	D.,	21/2	
for i from {0,,159}	Bits	N/A	
For Slot i, if $mod(i, 4) = 2$ for i from	D::	40	
{1,, 159}	Bits	16	
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	Dito	16	
{1,,159}	Bits	16	
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if mod(i, 4) = 3	CBs	N/A	
for i from {0,,159}	CDS	IN/A	
For Slot i, if $mod(i, 4) = 2$ for i from	CBs	1	
{1,, 159}	ODS	'	
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	CBs	1	
{1,,159}	OBO		
Binary Channel Bits Per Slot			
For Slots 0 and Slot i, if $mod(i, 4) = 3$	Bits	N/A	
for i from {0,,159}			
For Slot i = 80, 81	Bits	3180	
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	2496	
{4,, 159}		1	
For Slot i, if mod(i, 4) = $\{0,1\}$ for i from	Bits	3324	
{1,,79,82,,159}			<del>                                     </del>
Max. Throughput averaged over 2	Mbps	5.548	
frames   Note 1: SS/PBCH block is transmitted	·	ith poriodicity Of	20 mg
Note 1: SS/PBCH block is transmitted in Note 2: Slot i is slot index per 2 frames		nur periodicity 20	201110
Trote 2. Sign is sign index per 2 maines			

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-	R.PDSCH.5-			
Reference charmer		5.1 TDD	5.2 TDD			
Channel bandwidth	MHz	100	50			
Subcarrier spacing	kHz	120	120			
Allocated resource blocks	PRBs	66	32			
Number of consecutive PDSCH						
symbols						
For Slot i, if $mod(i, 4) = 2$ for i from		10	10			
{1,, 159}						
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from		13	13			
{1,,159}				+		
Allocated slots per 2 frames		119	119			
MCS table		64QAM	64QAM			
MCS index		13	13			
Modulation		16QAM	16QAM			
Target Coding Rate		0.48	0.48	+		
Number of MIMO layers		2	2	+		
Number of DMRS REs				+	-	
For Slot i, if $mod(i, 4) = 2$ for i from		12	12			
$\{1,, 159\}$ For Slot i, if mod(i, 4) = $\{0,1\}$ for i from				+	+	
		12	12			
{1,,159} Overhead for TBS determination		6	6	+		
Information Bit Payload per Slot		0	0	+		
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 $mod(i, 4) = 3$	D.,	21/2	21/0			
for i from {0,,159}	Bits	N/A	N/A			
For Slot i, if $mod(i, 4) = 2$ for i from	Dita	0.4	24			
{1,, 159}	Bits	24	24			
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	Dito	24	24			
{1,,159}	Bits	24	24			
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if $mod(i, 4) = 3$	CBs	N/A	N/A			
for i from {0,,159}	CDS	IN/A	IN/A			
For Slot i, if mod(i, 4) = 2 for i from	CBs	4	2			
{1,, 159}	020	'	_			
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	CBs	5	3			
{1,,159}	050	Ŭ	Ŭ			
Binary Channel Bits Per Slot				1		
For Slots 0 and Slot i, if $mod(i, 4) = 3$	Bits	N/A	N/A			
for i from {0,,159}				+		
For Slot i = 80, 81	Bits	69960	33920	1		
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	54912	26624			
$\{4,, 159\}$ For Slot i, if mod(i, 4) = $\{0,1\}$ for i from	-			+		
	Bits	73128	35456			
{1,,79,82,,159} 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	1		
Note 2: Slot i is slot index per 2 frames		portodioity /				

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

Parameter	Unit		Value					
Reference channel		R.PDSCH.5- 6.1 TDD						
Channel bandwidth	MHz	100						
Subcarrier spacing	kHz	120						
Allocated resource blocks	PRBs	66						
Number of consecutive PDSCH								
symbols								
For Slot i, if mod(i, 4) = 2 for i from $\{1,, 159\}$		10						
For Slot i, if $mod(i, 4) = \{0,1\}$ 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 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	Bits	34816						
$\{1,, 159\}$ For Slot i, if mod(i, 4) = $\{0,1\}$ for i from	Bits	47112						
{1,,159}								
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	Mbps	255.724						
frames	-		0 mg					
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames								

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

Parameter	Unit		Value
Reference channel		R.PDSCH.5-	
Reference channel		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) =	D:4-	NI/A	
{3,4} for i from {0,,159}	Bits	N/A	
For CSI-RS Slot i, if mod(i,5) =1 for i	D:4a	NI/A	
from {0,,159}	Bits	N/A	
For Slot i = 80	Bits	14344	
For Slot i, if $mod(i, 5) = \{0,2\}$ for i from	D:4-	44044	
{1,,79,82,,159}	Bits	14344	
Transport block CRC per Slot			
For Slots 0 and Slot i, if mod(i, 5) =	Dito	NI/A	
{3,4} for i from {0,,159}	Bits	N/A	
For CSI-RS Slot i, if mod(i,5) =1 for i	Dito	NI/A	
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		İ	
{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	n slot #0 w	vith periodicity 20	1 me

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms

Note 2: Slot i is slot index per 2 frames

Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data

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

Parameter	Unit		Value
Reference channel		R.PDSCH.5-	
Reference charmer		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) =	D:4-	NI/A	
{2,3} for i from {0,,159}	Bits	N/A	
For CSI-RS Slot i, if mod(i,8) =1 for i	Dito	NI/A	
from {0,,159}	Bits	N/A	
For Slot i = 80	Bits	14344	
For Slot i, if $mod(i, 8) = \{0,4,5\}$ for i	Bits	14344	
from {1,,79,82,,159}	סווס	14344	
Transport block CRC per Slot			
For Slots 0 and Slot i, if mod(i, 4) =	Bits	N/A	
{2,3} for i from {0,,159}	סונס	IN/A	
For CSI-RS Slot i, if mod(i,8) =1 for i	Bits	N/A	
from {0,,159}	סונס	IN/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		İ	
from {1,,79,82,,159}	CBs	2	
Binary Channel Bits Per Slot			
For Slots 0 and Slot i, if mod(i, 4) =	D:to	NI/A	
{2,3} for i from {0,,159}	Bits	N/A	
For CSI-RS Slot i, if mod(i,8) =1 for i	D:to	NI/A	
from {0,,159}	Bits	N/A	
For Slot i = 80	Bits	28776	
For Slot i, if $mod(i, 8) = \{0,4,5\}$ for i	D:to	20260	
from {1,,79,82,,159}	Bits	30360	
Max. Throughput averaged over 2	Mbss	12 21 10	
frames	Mbps	42.3148	
Note 1: SS/PBCH block is transmitted in	slot #0 w	ith periodicity 20	0 ms

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms

Note 2: Slot i is slot index per 2 frames

Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data

#### A.3.2.2.6 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-	R.PDSCH.6-	R.PDSCH.6-		
		1.1 TDD	1.2 TDD	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		10	10	10		
carrier						
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<sub>PRB</sub> = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n<sub>PRB</sub> = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks n<sub>PRB</sub> = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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-	R.PDSCH.6-	R.PDSCH.6-		
		2.1 TDD	2.2 TDD	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<sub>PRB</sub> = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n<sub>PRB</sub> = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks n<sub>PRB</sub> = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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-	R.PDSCH.6-	R.PDSCH.6-		
		3.1 TDD	3.2 TDD	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		10	10	10		
carrier						
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<sub>PRB</sub> = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n<sub>PRB</sub> = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks n<sub>PRB</sub> = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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-	R.PDSCH.6-	R.PDSCH.6-		
		4.1 TDD	4.2 TDD	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		10	10	10		
carrier						
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<sub>PRB</sub> = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n<sub>PRB</sub> = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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-	R.PDSCH.6-	R.PDSCH.6-		
		5.1 TDD	5.2 TDD	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		10	10	10		
carrier						
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<sub>PRB</sub> = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n<sub>PRB</sub> = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n<sub>PRB</sub> = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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		Valu	e	
Reference channel		R.PDSCH.6-	R.PDSCH.6-	R.PDSCH.6-	
		6.1 TDD	6.2 TDD	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		10	10	10	
carrier					
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<sub>PRB</sub> = 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<sub>PRB</sub> = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n<sub>PRB</sub> = 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		R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-			
channel		1.1 FDD	1.2 FDD	1.3 FDD			
Subcarrier	kHz	15	15	15			
spacing							
CORESET		48	48	48			
frequency domain							
allocation							
CORESET time		1	1	1			
domain allocation							
Aggregation level		4	4	8			
DCI Format		1_0	1_1	1_1			
Payload (without	Bits	39	52	52			
CRC)							

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

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

### A.3.3.1.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit			Valu	ıe	
Reference		R.PDCCH.2-	R.PDCCH.2-	R.PDCCH.2-		
channel		1.1 FDD	1.2 FDD	1.3 FDD		
Subcarrier	kHz	30	30	30		
spacing						
CORESET		102	102	90		
frequency domain						
allocation						
CORESET time		1	1	1		
domain allocation						
Aggregation level		2	4	8		
DCI Format		1_0	1_1	1_1		
Payload (without	Bits	41	53	53		
CRC)						

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

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

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

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

Parameter	Unit			Va	lue		
Reference		R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-
channel		2.1 TDD	2.2 TDD	2.3 TDD	2.4 TDD	2.5 TDD	2.6 TDD
Subcarrier	kHz	15	15	15	15	15	15
spacing							
CORESET		24	24	24	48	48	48
frequency							
domain							
allocation							
CORESET time		2	2	2	2	2	2
domain							
allocation							
Aggregation		2	4	2	4	8	16
level							
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			Valu	ıe	
Reference		R.PDCCH.2-	R.PDCCH.2-	R.PDCCH.2-		
channel		1.1 TDD	1.2 TDD	1.3 TDD		
Subcarrier	kHz	30	30	30		
spacing						
CORESET		102	102	90		
frequency domain						
allocation						
CORESET time		1	1	1		
domain allocation						
Aggregation level		2	4	8		
DCI Format		1_0	1_1	1_1		
Payload (without	Bits	41	53	53		
CRC)						

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

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

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

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

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

# 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 status information (Clause X).

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 Schem	Scheme		TBS.1-1	TBS.1-2					
MCS table						640	QAM		
Number of allocated PDSCH resource blocks		66	66						
Number of c	onsecutive PI	DSCH symbo	s	12	12				
Number of F	PDSCH MIMO	layers		1	2				
Number of D	OMRS REs (N	ote 1)		24	24				
Overhead for	r TBS determ	ination		6	6				
Available RE	E-s			7920	7920				
CQI index	Spectral	MCS	Modulatio	_	Infor	mation Bit	Payload p	er Slot	
	efficiency	index	n						
0	OOR	OOR	OOR	N/A	N/A				
1	0.1523	0		1800	3624				
2	0.2344	0	QPSK	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		11016	22032				
8	1.9141	13	16QAM	14343	28680				
9	2.4063	15		17928	35856				
10	2.7305	18		20496	40976				
11	3.3223	20		25104	50184				
12	3.9023	22	64001	29192	58384				
13	4.5234	24	64QAM	33816	67584				
14	5.1152	26		38936	77896				
15	5.5547	28		42016	83976				
Note 1: N									

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

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

TBS Schem	е			TBS.2-1	TBS.2-2	TBS.2-3	TBS.2-4	TBS.2-5	TBS.2-6
MCS table						2560	QAM		
Number of a	Number of allocated PDSCH resource blocks			52	52	106	106	8	16
Number of c	onsecutive PI	OSCH symbo	ls	12	12	12	12	12	12
Number of F	PDSCH MIMO	layers		1	2	1	2	1	1
Number of E	OMRS REs (N	ote 1)		24	24	24	24	24	24
Overhead for	r TBS determ	ination		0	0	0	0	0	0
Available RE	E-s for PDSCH	1		6240	6240	12720	12720	960	1920
CQI index	Spectral	MCS	Modulatio		Infor	mation Bit F	Payload per	r Slot	
	efficiency	index	n						
0	OOR	OOR	OOR	N/A	N/A	N/A	N/A	N/A	N/A
1	0.1523	0		1480	2976	2976	5896	224	456
2	0.3770	1	QPSK	2408	4744	4744	9480	368	736
3	0.8770	3		5504	11016	11016	22536	848	1736
4	1.4766	5		9224	18432	18960	37896	1416	2856
5	1.9141	7	16QAM	12040	24072	24576	49176	1864	3752
6	2.4063	9		15112	30216	30728	61480	2408	4608
7	2.7305	11		16896	33816	34816	69672	2600	5248
8	3.3223	13		20496	40976	42016	83976	3240	6400
9	3.9023	15	64QAM	24576	49176	49176	98376	3752	7424
10	4.5234	17		28168	56368	57376	114776	4352	8712
11	5.1152	19		31752	63528	65576	131176	4864	9736
12	5.5547	21		34816	69672	69672	139376	5248	10760
13	6.2266	23	256QAM	38936	77896	79896	159880	6016	12040
14	6.9141	25	ZOUQAW	43032	86040	88064	176208	6656	13320
15	7.4063	27		46104	92200	94248	188576	7040	14088
			des the overhe slots containi						

PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity

#### OFDMA Channel Noise Generator (OCNG) **A.5**

#### 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	Control Region	Data Region
OCNG Parameters	(CORESET)	-
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 DEs in the active C	ODECETS appointed by the ager	ah anagga in uga

Note 1: All unused REs in the active CORESETS appointed by the search spaces in use.

Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, Note 2: synchronization signals or reference signals in channel bandwidth.

### A.5.2 OCNG Patterns for TDD

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

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

OCNG Appliance OCNG Parameters	Control Region (CORESET)	Data Region
Resources allocated	All unused REs (Note 1)	All unused REs (Note 2)
Structure	PDCCH	PDSCH
Content	Uncorrelated pseudo random QPSK modulated data	Uncorrelated pseudo random QPSK modulated data
Transmission scheme for multiple antennas ports transmission	Single Tx port transmission	Spatial multiplexing using any precoding matrix with dimensions same as the precoding matrix for PDSCH
Subcarrier Spacing	Same as for RMC PDCCH in the active BWP	Same as for RMC PDSCH in the active BWP
Power Level	Same as for RMC PDCCH	Same as for RMC PDSCH

Note 1: All unused REs in the active CORESETS appointed by the search spaces in use.

Note 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals in channel bandwidth.

# Annex B (normative): Propagation conditions

# B.1 Static propagation condition

### B.1.1 UE Receiver with 2Rx

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

$$\mathbf{H} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$$
.

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

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & 1 & 1 & j & j & j \\ 1 & 1 & 1 & 1 - j - j - j - j \end{bmatrix}$$

### 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).

# 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.  $-8.78 \text{ dB} \rightarrow -8.8 \text{ dB}$ )
- 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.

# 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  $\sim$  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
TDI C300	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	Ravleigh

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

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

### B.2.1.2 Delay profiles for FR2

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

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

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

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

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

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

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

# B.2.2 Combinations of channel model parameters

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

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

Table B.2.2-1 Channel model parameters for FR1

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

Table B.2.2-2 Channel model parameters for FR2

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

### B.2.3 MIMO Channel Correlation Matrices

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

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

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

### B.2.3.1.1 Definition of MIMO Correlation Matrices

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

Table B.2.3.1.1-1 gNB correlation matrix

	One antenna	Two antennas	Four antennas
gNB Correlation	$R_{gNB} = 1$	$R_{gNB} = \begin{pmatrix} 1 & \alpha \\ \alpha^* & 1 \end{pmatrix}$	$R_{gNB} = \begin{pmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9*} & \alpha^{1/9*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9*} & \alpha^{1/9*} & 1 \end{pmatrix}$

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	$R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & 1 \end{pmatrix}$	$R_{UE} = \begin{pmatrix} 1 & \beta^{\frac{1}{9}} & \beta^{\frac{4}{9}} & \beta \\ \beta^{\frac{1}{9}^*} & 1 & \beta^{\frac{1}{9}} & \beta^{\frac{4}{9}} \\ \beta^{\frac{4}{9}^*} & \beta^{\frac{1}{9}^*} & 1 & \beta^{\frac{1}{9}} \\ \beta^* & \beta^{\frac{4}{9}^*} & \beta^{\frac{1}{9}^*} & 1 \end{pmatrix}$

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	$R_{spat} = R_{UE} = \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix}$ $R_{spat} = R_{UE} = \begin{bmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9} & \beta^{1/9} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9} & \beta^{1/9} & 1 \end{bmatrix}$ $R_{spat} = R_{gNB} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix}$
2x1 case	$R_{spat} = R_{gNB} = \begin{bmatrix} 1 & \alpha \\ lpha^* & 1 \end{bmatrix}$
2x2 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \end{bmatrix} = \begin{bmatrix} 1 & \beta & \alpha & \alpha\beta \\ \beta^* & 1 & \alpha\beta^* & \alpha \\ \alpha^* & \alpha^*\beta & 1 & \beta \\ \alpha^*\beta^* & \alpha^* & \beta^* & 1 \end{bmatrix}$
2x4 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta^{\frac{1}{9}} & \beta^{\frac{4}{9}} & \beta \\ \beta^{\frac{1}{9}*} & 1 & \beta^{\frac{1}{9}} & \beta^{\frac{4}{9}} \\ \beta^{\frac{4}{9}*} & \beta^{\frac{1}{9}*} & 1 & \beta^{\frac{1}{9}} \\ \beta^* & \beta^{\frac{4}{9}*} & \beta^{\frac{1}{9}*} & 1 \end{bmatrix}$
4x1 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix} = \begin{bmatrix} 1 & \beta & \alpha & \alpha\beta \\ \beta^* & 1 & \alpha\beta^* & \alpha \\ \alpha^* & \alpha^*\beta & 1 & \beta \\ \alpha^*\beta^* & \alpha^* & \beta^* & 1 \end{bmatrix}$ $R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta^{1/9} & \beta^{1/9} & \beta \\ \beta^{1/9*} & 1 & \beta^{1/9} & \beta^{1/9} \\ \beta^{4/9*} & \beta^{1/9*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9*} & \beta^{1/9*} & 1 \end{bmatrix}$ $R_{spat} = R_{gNB} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9} & \alpha^{1/9} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9} & \alpha^{1/9} & 1 \end{bmatrix}$ $\begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{4/9} & \alpha^{4/9} & \alpha \end{bmatrix}$
4x2 case	$R_{spat} = R_{gNB} \otimes R_{UE} = egin{bmatrix} lpha^{1/9} & 1 & lpha^{1/9} & lpha^{4/9} \ lpha^{4/9} & lpha^{4/9} & 1 & lpha^{4/9} \end{bmatrix} \otimes egin{bmatrix} 1 & eta \ eta^* & lpha^{4/9} & lpha^{4/9} & 1 \end{bmatrix}$
4x4 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9} & \alpha^{1/9} & 1 & \alpha^{1/9} \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9*} & \beta^{1/9*} & 1 & \beta^{1/9} \\ \beta^{8} & \beta^{4/9*} & \beta^{1/9*} & 1 \end{bmatrix}$

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  $\alpha$  and  $\beta$  parameters for ULA MIMO correlation matrices

Correlation Model	α	β
Low correlation	0	0
Medium	0.3	0.9
Correlation		
Medium	0.3	0.3874
Correlation A		
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	$R_{high} = \begin{bmatrix} 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 & 0.8999 & 0.8099 \\ 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 & 0.8099 & 0.8999 \\ 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 \\ 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 \\ 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 \\ 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 \\ 0.8999 & 0.8099 & 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 \\ 0.8099 & 0.8999 & 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 \end{bmatrix}$
4x4 case	$R_{high} = \begin{bmatrix} 1.0000 \ 0.9882 \ 0.9541 \ 0.8999 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.8894 \ 0.9541 \ 0.9430 \ 0.9105 \ 0.8587 \ 0.8999 \ 0.8894 \ 0.8587 \ 0.8099 \\ 0.9882 \ 1.0000 \ 0.9882 \ 0.9541 \ 0.9767 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.8587 \ 0.8899 \ 0.8894 \ 0.8587 \\ 0.9541 \ 0.9882 \ 1.0000 \ 0.9882 \ 0.9767 \ 0.9882 \ 0.9767 \ 0.9105 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.8099 \ 0.8587 \ 0.8894 \ 0.8999 \ 0.8894 \ 0.8999 \ 0.8894 \ 0.8999 \ 0.8894 \ 0.8999 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9430 \ 0.9541 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.9767 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.9541 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.9882 \ 0.9767 \ 0.9430 \ 0.9882 \ 0.9767 \ 0.9430$

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

1x2 case	N/A													
2x1	N/A													
case														
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	$R_{medium} = \left( \begin{array}{cccccccccccccccccccccccccccccccccccc$													
4x4 case	Note													

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

1x4 case						R <sub>mediui</sub>	nA -	1 0.9000 0.6561 0.3874	0.9000 1 0.9000 0.6561	0.90 ) 1	00 0.6 0.9	3874 <sub>]</sub> 5561 9000 1					
2x4 case			1.0000 0.9000 0.6561 0.3874 0.3000 0.2700 0.1968 0.1162	1.00 1 0.90 1 0.65 1 0.65 1 0.27 2 0.19	000 0 000 1 561 0 700 0 700 0 700 0	.9000 .0000 .9000 .1968 .2700 .3000 .2700	0.3874 0.6561 0.9000 1.0000 0.1162 0.1968 0.2700 0.3000	0.196 0.116 1.000 0.900 0.656 0.387	00 0.3 68 0.2 62 0.1 60 0.9 60 1.0 61 0.9 74 0.0	3000 2700 968 9000 9000 9000 5561	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 0.656 0.9000 1.0000	3 0 0 4 1 1 0				
4x4 case	$R_{medium\ A}=$	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	1.0000 0.9000 0.6561 0.7873 0.8748 0.7873 0.5270 0.5856 0.5270 0.3842 0.2700 0.3000 0.2700	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	0.6561 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	0.7873 0.5739 0.3389 1.0000 0.9000 0.6561 0.3874 0.7873 0.5739 0.3389 0.5856 0.5270 0.3842	0.8748 0.7873 0.5739 0.9000 1.0000 0.9000 0.6561 0.7873 0.5739 0.5270 0.5856 0.5270	0.7873 0.8748 0.7873 0.6561 0.9000 1.0000 0.9000 3 0.5739 3 0.7873 3 0.8748 9 0.7873 0 0.3842 5 0.5270 0 0.5856	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	0.5270 0.3842 0.2269 0.8748 0.7873 0.5739 0.3389 1.0000 0.9000 0.6561 0.3874 0.8748 0.7873	0.5856 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	0.5270 0.5856 0.5270 0.5739 0.7873 0.8748 0.7873 0.6560 0.9000 0.9000 0.5733 0.8748	2 0.2269 0 0.3842 6 0.5270 0 0.5856 0 0.3389 6 0.5739 8 0.8748 1 0.3874 0 0.6561 0 0.9000 0 1.0000 9 0.3389 3 0.5739 8 0.7873 3 0.8748	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	0.3000 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	0.2700 0.3000 0.2700 0.3842 0.5270 0.5856 0.5270 0.5739 0.7873 0.8748 0.7873 0.6561 0.9000	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

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  $\pm 1.45$  degrees polarization slant angles are deployed at gNB and cross-polarized antenna elements with  $\pm 1.45$  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:

$$Inde(p, n_1, n_2) = p \cdot N_1 \cdot N_2 + n_1 \cdot N_2 + n_2 + 1;$$
  $p = 0,1; n_1 = 0, \dots, N_1 - 1; n_2 = 0, \dots, N_2 - 1.$ 

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:

$$R_{spat} = P(R_{gNB} \otimes \Gamma \otimes R_{UE})P^{T}$$

where

- $R_{\!\scriptscriptstyle U\!E}$  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

$$P(a,b) = \begin{cases} 1 & \text{for } a = (j-1)Nr + i \text{ and } b = 2(j-1)Nr + i, & i = 1, \dots, Nr, j = 1, \dots Nt/2 \\ 1 & \text{for } a = (j-1)Nr + i \text{ and } b = 2(j-Nt/2)Nr - Nr + i, & i = 1, \dots, Nr, j = Nt/2 + 1, \dots, Nt + i, \\ 0 & \text{otherwise} \end{cases}$$

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

- -  $R_{gNB\_Dim1}$  is the correlation matrix of antenna elements in first dimension with same polarization, and
- -  $R_{gNB\ Dim2}$  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,

$$R_{gNB\_Dim,i} = egin{pmatrix} 1 & lpha_i^{1/9} & lpha_i^{4/9} & lpha_i \ lpha_i^{1/9^*} & 1 & lpha_i^{1/9} & lpha_i^{4/9} \ lpha_i^{4/9^*} & lpha_i^{1/9^*} & 1 & lpha_i^{1/9} \ lpha_i^* & lpha_i^{4/9^*} & lpha_i^{1/9^*} & 1 \end{pmatrix}.$$

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  $R_{gNB,Dim2} = 1$ , 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  $\alpha$  and  $\beta$  parameters for cross-polarized MIMO correlation matrices

Corr	relation Model	$\alpha_1$	02	β	γ
Medi	um Correlation	0.3	0.3	0.6	0.2
Hig	h Correlation	0.9	0.9	0.9	0.3
Note 1:	Value of $\alpha_1$ applies antenna elements Value of $\alpha_2$ applies	in first dimensi	on at gNB side	).	
Note 3:	antenna elements Value of β applies elements at UE sid	in second dime when more tha	ension at gNB	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.

The values in Table B.2.3.2.2-2 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:

$$R_{high} = [R_{spat} + aI_n]/(1+a)$$
 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.

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

				Γ 1.	0000	0.0000	0.90	000 (	0.0000	-0.30	000 0	0.0000	-0.27	700 0	.0000	]	
						1.0000	0.00		0.9000	0.00		0.3000	0.00		.2700		
						0.0000	1.00		0.0000	-0.27		0.0000	-0.30		.0000		
4(2,1,2)x2 case																	
			$R_{high} =$	:		0.9000			1.0000	0.00		0.2700	0.00		0.3000		
			mgn	-0.	3000	0.0000	-0.2	700 (	0.0000	1.00	00 0	.0000	0.90	00 0	.0000		
				0.	0000	0.3000	0.0	0000	0.2700	0.00	000 1	.0000	0.00	00 0	.9000		
				- 0.	2700	0.0000	-0.3	000	0.0000	0.90	00 0	.0000	1.00	00 0	.0000		
				0.	0000	0.2700	0.0	0000	0.3000	0.00	00 0	.9000	0.00	000 1.	.0000		
				1.0	0000	0.9000	0.0	000	0.0000	-0.30	000 -	0.2700	0.00	00 0.	0000		
				0.9	9000	1.0000	0.0	000	0.0000	-0.27	700 -	0.3000	0.00		0000		
				0.0	0000	0.0000		000	0.9000			.0000	0.300		2700		
0/4 4 0\ 4					0000	0.0000		000	1.0000			.0000	0.270		000		
2(1,1,2)x4 case			$R_{high}$	=	3000	-0.270		000	0.0000			.9000	0.000		000		
0000						-0.300											
					2700			000	0.0000			.0000	0.000		0000		
					0000	0.0000		000	0.2700			.0000	1.000		000		
				_ 0.0	0000	0.0000	0.2	700	0.3000	0.00	000 0	.0000	0.900	00 1.0	000		
		1.0000		0.0000	0.0000	0.9000 0.8100	0.8100 0.9000	0.0000	0.0000	-0.3000 -0.2700	-0.2700 -0.3000	0.0000	0.0000	-0.2700 -0.2430	-0.2430 -0.2700	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		0.9000	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		0.0000	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		0.0000	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
4(2,1,2)x4		0.0000		0.9000 0.8100	0.8100 0.9000	0.0000	0.0000	1.0000 0.9000	0.9000 1.0000	0.0000	0.0000	0.2700 0.2430	0.2430 0.2700	0.0000	0.0000	0.3000 0.2700	0.2700 0.3000
case	$R_{ m high} =$			0.0000	0.0000		-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		0.3000	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 -0.2700		0.2700	0.3000	0.0000	0.0000 -0.2700	0.2430 0.0000	0.2700 0.0000	0.0000 0.9000	0.0000 0.8100	0.9000 0.0000	1.0000 0.0000	0.0000 1.0000	0.0000 0.9000	0.8100	0.9000
				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
		1.0000					0.0000				0.0000		0.0000	-0.2862		-0.2700	0.0000
		0.0000			0.988		0.9542		0.8999			0.0000		0.0000		0.0000	
		0.9883				0.9883											
		0.0000				0.0000											
		0.9542				1.0000											
		0.0000				3 0.0000											
		0.8999				0.9883			0.0000								
8(4,1,2)x2 case	$R_{high} =$	0.0000 -0.3000				2 0.0000 0 -0.2862											
Cusc		0.0000				5 0.0000											
		-0.2965				0.0000							0.0000			0.9542	
		0.0000				0.0000										0.0000	
		-0.2862				0.3000							0.0000	1.0000		0.9883	
		0.0000				5 0.0000								0.0000	1.0000	0.0000	
		-0.2700				0 -0.2965							0.0000		0.0000	1.0000	
						2 0.0000											
	ı																

Table B.2.3.2.2-3: MIMO correlation matrices for medium spatial correlation

	[1	.0000	0.0000	-0.2000	0.0000	
2(1,1,2)x2		0.0000	1.0000	0.0000	0.2000	
case	R <sub>medium</sub> (	0.2000	0.0000	1.0000	0.0000	
		0.0000	0.2000	0.0000	1.0000	

### 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,

$$D_{\theta_{i}}(1) = 1$$
.

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

Variation Step	Value (rad/ms)
$\Delta  heta$	1.2566×10 <sup>-3</sup>

### 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  $\mathcal{T}_d$  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

$$f_s(t) = f_d \cos \theta(t) \tag{B.3.1.1}$$

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

$$\cos\theta(t) = \frac{D_s/2 - vt}{\sqrt{D_{\min}^2 + (D_s/2 - vt)^2}}, \ 0 \le t \le D_s/v$$
(B.3.1.2)

$$\cos \theta(t) = \frac{-1.5D_s + vt}{\sqrt{D_{\min}^2 + (-1.5D_s + vt)^2}}, \ D_s/v < t \le 2D_s/v$$
(B.3.1.3)

$$\cos\theta(t) = \cos\theta(t \mod (2D_s/v)), t > 2D_s/v$$
(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 Figure B.3.1-1 are applied for all frequency bands.

Value **Parameter** HST-1000 HST-750  $D_{\mathfrak{s}}$ 300 m 300 m  $D_{\min}$ 2 m 2 m  $\nu$ 300 km/h 300 km/h  $f_d$ 750 Hz for 15 kHz SCS test 1000 Hz for 30 kHz SCS test

Table B.3.1-1: High speed train scenario

NOTE 1: Parameters for HST conditions in table B.3.1-1 including  $f_d$  and Doppler shift trajectories presented on figure B.3.1-1 for 750 Hz for 15 kHz SCS and figure B.3.1-2 for 1000 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 '<Doppler shift>' indicates the maximum Doppler shift (Hz) .

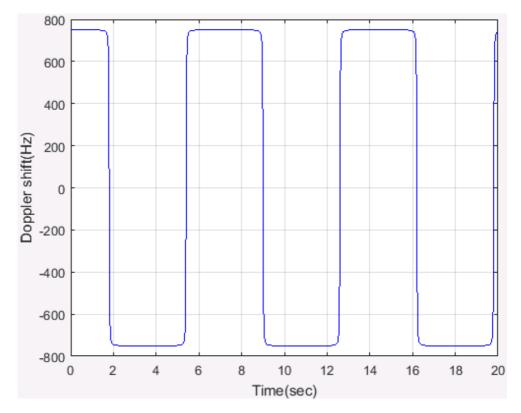


Figure B.3.1-1: Doppler shift trajectory (  $f_{\scriptscriptstyle d}$  = 750 Hz)

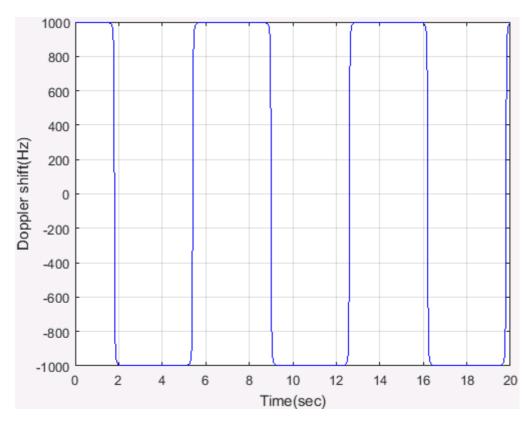


Figure B.3.1-2: Doppler shift trajectory (  $f_{\scriptscriptstyle d}$  = 1000 Hz)

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.4 Physical signals, channels mapping and precoding

#### B.4.1 General

Unless otherwise stated, the transmission on antenna port(s)  $p = p_0, p_0 + 1, ..., p_0 + N_p - 1$  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)  $p = p_0, p_0 + 1, ..., p_0 + N_p - 1, y^{(p)}(i) = \frac{1}{2} \sum_{i=1}^{n} \frac{1}$ 

 $\begin{bmatrix} y^{(p_0)}(i) \ y^{(p_0+1)}(i) \ \dots \ y^{(p_0+N_p-1)}(i) \end{bmatrix}^T, \ i=0,1,\dots, M_{\text{symb}}^{\text{ap}}-1, \ \text{with} \ M_{\text{symb}}^{\text{ap}} \ \text{being the number of modulation}$  symbols per antenna port including the reference signal symbols, and generates a block of signals  $y_{bf}^{(q)}(i)=\begin{bmatrix} y_{bf}^{(0)}(i) \ y_{bf}^{(1)}(i) \ \dots \ y_{bf}^{(N_{ANT}-1)}(i) \end{bmatrix}^T$  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  $j = 0,1,...,N_{ANT}-1$ , 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  $p \in \{p_0, p_0 + 1, ..., p_0 + N_{CSI} - 1\}$  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

### 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 NZP CSI-RS to SSS	dB	-10*log10(L) (Note 3)			
EPRE ratio of PDSCH OCNG to SSS		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					

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

Note 2: The value is the energy of per RE for a single antenna port before pre-coding.

Note 3:  $L \in \{1,2,4,8\}$  is the CDM group size of NZP CSI-RS specified for each test.

## 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 NZP CSI-RS to SSS	dB	-10*log10(L) (Note 3)			
EPRE ratio of PTRS to PDSCH	dB	Test specific (Note 4)			
EPRE ratio of PDSCH 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					
Note 2: The value is the energy of per RE for a single antenna port before pre-coding.					
Note 3: $L \in \{1,2,4,8\}$ is the CDM group size of NZP CSI-RS specified for each test.					
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:	
Leclanché	Nominal
Lithium	1,1 * Nominal
Mercury/nickel & cadmium	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	$0.96 \text{ m}^2/\text{s}^3$
20 Hz to 500 Hz	0,96 m <sup>2</sup> /s <sup>3</sup> 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:	
Leclanché	Nominal
Lithium	1,1 * Nominal
Mercury/nickel & cadmium	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

Date	Meeting	tDoc	CR	Rev	Cat	Change history Subject/Comment	New
Date	Meeting	iboc	OIX	itev	Oat	oubject/outment	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: R4-1814053, "TP on performance specification 38.101-4 Chapter 4 general part"	0.1.0
					R4-1814054, "TP to TS 38.101-4: FR1 PDSCH demodulation requirements (5.2)" R4-1813924, "TP for introducing FR1 PDCCH requirements in TS 38.101-4 clause 5.3" R4-1814058, "TP for 38.101-4 section 6.3 FR1 PMI test cases" R4-1814060, "Draft TP on FR1 Rank Indication Reporting		
						Performance Requirements" R4-1814055, "Draft TP on FR2 PDSCH Demodulation Performance Requirements" R4-1814022, "TP to TS38.101-4 Section 7.3: PDCCH demodulation	
						requirements" R4-1814059, "TP for 38.101-4 section 8.3 FR2 PMI test cases" R4-1814061, "Draft TP on FR2 Rank Indication Reporting Performance Requirements" R4-1813925, "TP for introducing demodulation performance	
						requirements for interworking TS 38.101-4 section 9" R4-1814052, "TP for 38.101-4 section 10 CSI test cases of interworking" R4-1814066, "TP on channel models for TS38.101-4"	
						R4-1814023, "TP to TS38.101-4 Annex C: Downlink physical channels" R4-1814024, "TP to TS38.101-4 Annex E: Environmental conditions"	
2018-11	RAN4#89	R4- 1816559				Approved Text Proposal in RAN4#89: R4-1814053, "TP on performance specification 38.101-4 Chapter 4	0.2.0
					general part" R4-1814487, "TP for TS38.101-4 section 2 (Reference)" R4-1814488, "TP for TS38.101-4 section 3 (Definitions, symbols and abbreviations)" R4-1814579, "TP to TS 38.101-4: Annex A Measurement channels – PDSCH" R4-1814580, "TP to TS 38.101-4: Annex A Measurement channels -		
						DL Control" R4-1814581, "TP to TS 38.101-4: Annex A Measurement channels – CSI" R4-1816395, "FR2 demod: Noc, Band groups and Ref point - TP for	
						TS 38.101-4" R4-1816692, "TP to TS 38.101-4: Requirements applicability" R4-1816693, "TP for performance requirements for interworking (9)" R4-1816694, "TP to TS 38.101-4: FR1 PDSCH demodulation	
						requirements (5.2)" R4-1816695, "Draft TP on FR2 PDSCH Demodulation Performance Requirements" R4-1816697, "TP for updating FR1 PDCCH requirements in TS	
						38.101-4 section 5.3" R4-1816699, "TP to TS 38.101-4: 5.4 FR1 PBCH demodulation requirements" R4-1816700, "TP to TS 38.101-4: 7.4 FR2 PBCH demodulation	
						requirements" R4-1816701, "TP of introduction of FR1 CQI requirement (6.2)" R4-1816702, "TP to TS 38.101-4: FR2 CQI requirements (8.2)" R4-1816703, "Draft TP on FR1 Rank Indication Reporting	
						Performance Requirements" R4-1816704, "Draft TP on FR2 Rank Indication Reporting Performance Requirements" R4-1816705, "TP for TS 38.101-4 FR1 PMI test requirement"	
						R4-1816706, "TP to TS 38.101-4 FR2 PMI requirements" R4-1816712, "TP to TS 38.101-4: FR1 SDR requirements (5.5) " R4-1816713, "TP to TS38.101-4 Section 7.3: PDCCH demodulation requirements"	
						R4-1816714, "TP for propagation conditions in TS 38.104-4(Annex B)"	
2018-12	RAN#82	RP-182408	ļ			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  Approved by plenary – Rel-15 spec under change control	1.0.1 15.0.0

2019-03	RAN#83	RP-190403	0001	В	CR on UE demodulation and CSI requirements for 38.101-4	15.1.0
					This CR comboines all the endorsed draft CRs as list below:	
					General sections	
					R4-1902427, Draft CR on NR UE demodulation requirements	
					applicability (Intel Corporation) R4-1902576, Draft CR on General Applicability of Requirements	
					(Qualcomm Incorporated)	
					R4-1902412, Editorial cleanup of FR2 Radiated Requirements	
					General section (ANRITSU)	
					PDSCH	
					R4-1902414, Draft CR on FR1 normal PDSCH demodulation	
					requirements (Intel Corporation)	
					R4-1902415, Draft CR on FR2 PDSCH Requirements (Qualcomm	
					Incorporated) R4-1902411, Draft CR on FR1 SDR requirements (Intel Corporation)	
					PDCCH	
					R4-1902416 Draft CR for updating FR1 PDCCH performance	
					requirements in TS38.101-4Huawei, HiSilicon	
					R4-1902423 Draft CR for updating FR2 PDCCH performance	
					requirements in TS38.101-4 section 7.3 CATT	
					PBCH	
					R4-1902420, Draft CR on 2Rx PBCH demodulation requirement for FR1 (CMCC)	
					R4-1902421, Draft CR on 4Rx PBCH demodulation requirements for	
					FR1 (CMCC)	
					R4-1902422, Draft CR on 2Rx PBCH demodulation requirement for	
					FR2 (CMCC)	
					CSI	
					R4-1902418, Draft CR on FR2 CSI Reporting Tests (Qualcomm	
					Incorporated)	
					R4-1902419, Draft CR on FR1 CSI Reporting Tests (Qualcomm Incorporated)	
					R4-1900105, Draft CR on NR CSI reporting (Intel Corporation)	
					R4-1902058, Draft CR for update of FR1 CQI reporting test (Huawei,	
					HiSilicon)	
					R4-1902059, Draft CR for update of FR2 CQI reporting test (Intel)	
					R4-1902426, Draft CR for PMI test cases: 6.2, 8.2, A.3.2.2.2,	
					A.3.2.2.5 (Samsung) R4-1902425, Draft CR for FR1 and FR2 RI test cases (Qualcomm)	
					Annex	
					R4-1900369, Draft CR on PDSCH FRC (Intel Corporation)	
					R4-1900370, Draft CR on PDCCH FRC (Intel Corporation)	
					R4-1902424, Corrections to 38.101-4 clause B.2.1 Delay profile	
					calculation (Huawei, HiSilicon)	
					R4-1902575, Draft CR on Beamforming Model (Qualcomm)	
					Additional modifications:	
					- Compared to endorsed CR R4-1902414, requirements for several	
					FR1 PDSCH test cases were modified to correct stat error	
					- Correct the format for Annex A.x	
					- Correct table number under PDSCH section 5.2.3.1.3	
					- Some minor editorial changes	
					Editorial changes after RAN#83	
					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.	

2019-06	RAN#84	RP-191240	0002	В	CR to TS 38.101-4: Implementation of endorsed draft CRs from RAN4#90bis and RAN4#91	15.2.0
					endorsed draft CRs from RAN4#90bis R4-1902885, Draft CR on DL power allocation for TS 38.101-4	
					R4-1903387, Draft CR for adding applicable rules on CSI test cases:	
					6, 8, 10	
					R4-1903471, Draft CR on PBCH requirements	
					R4-1904750, draftCR on RMC for demod requirement for 38.101-4	
					R4-1904751, Clarification on step 5 and step 6 for delay profiles	
					calculation in B.2.1	
					R4-1904756, Draft CR on FR1 normal PDSCH demodulation	
					requirements	
					R4-1904757, Draft CR on FR2 PDSCH Demodulation Performance	
					Tests	
					R4-1904758, Draft CR on EN-DC SDR requirements R4-1904759, Addition of alternative TDD configuration for UE	
					demodulation requirements	
					R4-1904765, Draft CR on FR2 PDCCH demodulation requirements	
					R4-1904766, draftCR: Updates to FR1 PDCCH demodulation	
					requirements	
					R4-1904767, Draft CR for Beamforming model: Annex B.4.1	
					R4-1904768, Draft CR for modification on CSI test cases: 6, 8, 10	
					R4-1904776, Draft CR on FR1 SDR requirements	
					R4-1904777, Draft CR on FR2 SDR Requirements	
					R4-1904778, Draft CR on PDSCH DL RMC R4-1904779, Draft CR to TS38.101-4: Correction to FR1 CSI test	
					cases	
					R4-1904780, Draft CR to TS38.101-4: Correction to FR2 CSI test	
					Cases	
					R4-1904796, Draft CR to 38.101-4 on applicable SNR level for FR2 R4-1904833, Draft CR to TS 38.101-4 on SNR, Es and Noc setup	
					endorsed draft CRs from RAN4#91	
					R4-1906069, Draft CR on PBCH requirements R4-1906706, Editorial corrections for 38.101-4 PBCH tables	
					R4-1907194, Draft CR on Noc and Es setup	
					R4-1907293, Draft CR to TS38.101-4 for FR2 SDR test cases	
					R4-1907294, draftCR: Introduce single-tap HST channel model in	
					TS 38.101-4	
					R4-1907295, draftCR: updates to FR2 PDSCH test parameters	
					R4-1907296, draftCR: updates to FRC for demodulation	
					performance	
					R4-1907297, draftCR: updates to FR1 CQI reporting test cases in	
					section 6.2 R4-1907298, Draft CR to 38.101-4 on Applicability of requirements	
					R4-1907299, Draft CR to 38.101-4 on Demodulation requirements	
					for interworking	
					R4-1907300, Draft CR to 38.101-4 on CSI requirements for	
					interworking	
					R4-1907301, Draft CR on FR1 normal PDSCH demodulation	
					requirements	
					R4-1907302, Draft CR on PDSCH FRC	
					R4-1907303, Draft CR on FR2 CSI Reporting tests	
					R4-1907304, Editorial corrections for 38.101-4 PDCCH tables R4-1907307, draftCR: updates to FR1 PDSCH test parameters	
					R4-1907307, draffick: updates to FRT PDSCH test parameters R4-1907308, Draft CR on EN-DC SDR requirements	
					R4-1907309, Draft CR to TS38.101-4 on adding FRC for sub-band	
					CQI test cases	
					R4-1907310, Draft CR to TS38.101-4: Environmental conditions	
					(Annex E)	
					R4-1907315, Draft CR on SDR requirements for NR CA between	
					FR1 and FR2	

2010.00	D V VIAOE	DD 400000	0000	1	F	CD to TC 20 101 1. Implementation of andersed draft CDs from	15.2.0
2019-09	RAN#85	RP-192022	8000		F	CR to TS 38.101-4: Implementation of endorsed draft CRs from RAN4#92 (Rel-15)	15.3.0
						R4-1907978, Update of Noc values for Power class 2 demodulation test	
						R4-1908202, Draft CR to TS 38.101-4: Environmental conditions	
						R4-1908215, Draft CR to TS 38.101-4: Clarification of PTRS	
						configuration for FR2 tests R4-1908217, Draft CR to TS 38.101-4: DL power configuration in	
						radiated tests	
						R4-1908517, Draft CR to TS 38.101-4: Corrections of FRC for FR2 PMI tests	
						R4-1909250, Editorial change to correct TDD measurement	
						channels R4-1909252, Editorial correction to PBCH requirements	
						R4-1909253, Editorial correction to PDSCH reference channels	
						R4-1909862, draft CR: updates to FR2 PDSCH test parameters	
						R4-1909864, draftCR: Introduce single-tap HST channel model in TS 38.101-4	
						R4-1910020, Antenna configuration for LTE cell in EN-DC	
						R4-1910021, DraftCR to 38.101-4: Corrections to Interworking requirements	
						R4-1910023, Draft CR to TS 38.101-4: Enhanced SU-MIMO receiver definition	
						R4-1910024, draftCR: addition of test applicability for features with UE capability	
						R4-1910053, Draft CR on corrections and missing parameters for	
						PDSCH demodulation performance tests	
						R4-1910054, Draft CR to TS 38.101-4: NR FR1 PDSCH requirements finalization	
						R4-1910055, Draft CR to TS 38.101-4: Corrections for SDR	
						requirements R4-1910056, Editorial correction to formatting on SDR table	
						R4-1910057, draft CR: updates to FR1 PDSCH test parameters	
						R4-1910058, Draft CR on corrections for PDCCH demodulation performance tests	
						R4-1910060, Draft CR on corrections for CSI Reporting performance	
						tests	
						R4-1910061, Draft CR on updates to FR1 CSI reporting test R4-1910062, Draft CR on updates to FR2 CSI reporting test	
						R4-1910129, Draft CR to TS 38.101-4: Applicability of minimum	
						requirements R4-1910563, Updates to NR PDCCH test parameters	
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		0010		F	CR to TS 38.101-4: Editorial corrections for PDSCH RMC (R15)	15.4.0
2019-12	RAN#86	RP-192998	0011		В	CR to TS 38.101-4: Introduction of NE-DC and NR-DC SDR requirements (R15)	15.4.0
		RP-192998		1	F	CR on corrections for MIMO Correlation Matrices	15.4.0
2019-12 2019-12	RAN#86 RAN#86	RP-192998 RP-192998	0015 0016	1	F	CR on corrections for FR1 PDSCH demodulation performance tests CR on corrections for FR2 PDSCH demodulation performance tests	15.4.0 15.4.0
2019-12	RAN#86	RP-192998	0016	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	4	F	Editorial change on reference PDCCH payload size	15.4.0
2019-12	RAN#86 RAN#86	RP-192998 RP-192998	0021 0023	1	F	Editorial CR to correct PMI test cases CR for TS38.101-4: Angle of arrival for radiated UE demodulation	15.4.0 15.4.0
						testing	
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	15.4.0
2019-12	RAN#86	RP-192998	0026		F	requirements  CR on CSI reporting requirements for EN-DC including FR1 and FR2	15.4.0
2019-12	RAN#86	RP-192998	0027	1	В	CCs CR on NE-DC and NGEN-DC performance requirements	15.4.0
2019-12	RAN#86	RP-192998	0028	1	В	CR on NR-DC performance requirements	15.4.0
2019-12 2019-12	RAN#86 RAN#86	RP-192998 RP-192998	0029 0030	1	F	CR: Updates to NR RMC for UE performance requirements CR: Updates to NR EN-DC SDR tests	15.4.0 15.4.0
2019-12	RAN#87	RP-192996 RP-200397	0030	1	F	Clarification of Random PMI when testing	15.4.0
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 2020-03		RP-200397 RP-200397	0034 0037	1	F	CR to TS 38.101-4: Editorial corrections (R15) CR on number of NZP CSI-RS ports for RI reporting test in a TDD	15.5.0 15.5.0
						4Rx test case	
2020-03 2020-06	RAN#87 RAN#88	RP-200397 RP-200985	0038		F	CR: Updates to NR PDSCH test parameters (Rel-15) CR to Aperiodic Report Slot Offset for CQI report	15.5.0 15.6.0
2020-00	IV4IN#00	117-200900	0039	l	Г	Total to Apellogic Meport 3101 Offiser for Odi Teport	13.0.0

2020-06	RAN#88	RP-200985	0048		F	CR for correction of Angle of Arrival for Radiated Requirements in section 4	15.6.0
2020-06	RAN#88	RP-200985	0050		F	CR: updates to NR CSI test	15.6.0
2020-06	RAN#88	RP-200985	0043	1	F	CR to TS 38.101-4: Beamforming clarification (R15)	15.6.0
2020-06	RAN#88	RP-200985	0049	1	F	Update of DL physical channels definitions	15.6.0
2020-06	RAN#88	RP-200985	0051	1	F	CR: clarification on EPRE ratio definition	15.6.0
2020-06	RAN#88	RP-200985	0046	1	F	CR to TS 38.101-4: MIMO correlation matrices definition (R15)	15.6.0
2020-09	RAN#89	RP-201512	0060		F	CR to 2Rx PDSCH mapping type B	15.7.0
2020-09	RAN#89	RP-201512	0077	1	F	CR on Corrections in 38.101-4	15.7.0
2020-09	RAN#89	RP-201512	0058	1	F	CR to ZP-CSI-RS configuration	15.7.0

# History

Document history						
V15.0.0	April 2019	Publication				
V15.1.0	May 2019	Publication				
V15.2.0	July 2019	Publication				
V15.3.0	October 2019	Publication				
V15.4.0	January 2020	Publication				
V15.5.0	April 2020	Publication				
V15.6.0	July 2020	Publication				
V15.7.0	November 2020	Publication				