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- 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_s The averaged received energy per Hz of the wanted signal during the useful part of the symbol, i.e. excluding the cyclic prefix, at the UE antenna connector; average power is computed within a set

of REs used for the transmission of physical, divided transmission bandwidth within the set

μ 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 2nd 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:

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

Where

- N_{RX} denotes the number of receiver antenna connectors and the superscript receiver antenna connector j.
- The above SNR definition assumes that the REs are not precoded, and does not account for any gain which can be associated to the precoding operation.
- Unless otherwise stated, the SNR refers to the SSS wanted signal.
- The downlink SSS transmit power is defined as the linear average over the power contributions in [W] of all resource elements that carry the SSS within the operating system bandwidth.
- The power ratio of other wanted signals to the SSS is defined in clause C.3.1.

4.4.3 Noc

4.4.3.1 Introduction

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

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

4.4.3.2 Noc for NR operating bands in FR1

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

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

4.4.3.2.1 Derivation of Noc values for NR operating bands in FR1

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

 $Noc_{Band_X,\ SCS_Y,\ CBW_Z} = REFSENS_{Band_X,\ SCS_Y,\ CBW_Z} - 10*log10(12*SCS_Y*nPRB) + D - SNR_{REFSENS} + \Delta_{thermal} +$

where

- REFSENS_{Band_X, SCS_Y, CBW_Z} is the REFSENS value in dBm for Band X, SCS Y and CBW Z specified in Table 7.3.2-1 of TS 38.101-1 [6]
- 12 is the number of subcarriers in a PRB
- SCS Y is the subcarrier spacing associated with the REFSENS value
- nPRB is the maximum number of PRB for SCS Y and CBW Z associated with the REFSENS value, and is specified in Table 5.3.2-1 of TS 38.101-1 [6]
- D is diversity gain equal to 3 dB

- SNR_{REFSENS} = -1 dB is the SNR used for simulation of REFSENS
- Δ_{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_{Band_X, SCS_Y, CBW_Z} is the REFSENS value in dBm for Band X, SCS Y and CBW Z specified in Table 7.3.2-1 of TS 38.101-1 [6]
- 12 is the number of subcarriers in a PRB
- SCS Y is the subcarrier spacing associated with the REFSENS value
- nPRB is the maximum number of PRB for SCS Y and CBW Z associated with the REFSENS value, and is specified in Table 5.3.2-1 of TS 38.101-1 [6]
- D is diversity gain equal to 3 dB
- SNR_{REFSENS} = -1 dB is the SNR used for simulation of REFSENS
- dB_{EVM} is the SNR of the applied signal due to EVM impairment on the wanted Es. An allowed EVM of 3% gives a dB_{EVM} of 30.5dB, derived as 20*log10(1/0.03).
- $\Delta_{thermal}$ is the amount of dB that the impairment due to EVM on the wanted Es is set above UE thermal noise, giving a defined rise in total impairment. $\Delta_{thermal} = 7.6$ 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.

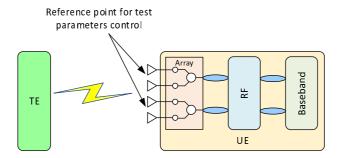


Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements

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_{BB}. The SNR at the reference point is defined as

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

where Δ_{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_{BB} at the specified Noc level. As UEs have EIS levels that are dependent on operating band and power class. Noc level is dependent on operating band and power class.

4.5.3.2 Noc for NR operating bands in FR2

Values for Noc according to operating band and power class for single carrier requirements are specified in Table 4.5.3.2-1 for $\Delta_{BB} = 1$ 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_{SB} is the Noc defined in Table 4.5.3.2-1
- Σ MB_P values are specified in TS 38.101-2 [7].

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

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

- Noc_{SC} is derived by assuming UE supports single carrier.
- ΔR_{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_{REFSENS} is a subcarrier spacing associated with N_{RB} for 50MHz in Table 5.3.2-1 of TS 38.101-2 [7], chosen as 120 kHz.
- PRB_{REFSENS} is N_{RB} associated with subcarrier spacing 120 kHz for 50MHz in Table 5.3.2-1 of TS 38.101-2 [7] and is 32.
- 12 is the number of subcarriers in a PRB

- SNR_{REFSENS} = -1 dB is the SNR used for simulation of REFSENS
- Δ_{thermal} is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of Δ_{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_{PC} X, Band Y, 50MHz - REFSENS_{PC}3, n260, 50MHz

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 (Note 2)
4RX or both 2RX	PDCCH	All tests in Clause 5.3.3 (Note 2)
and 4RX	PBCH	All tests in Clause 5.4.2 or 5.4.3 (Note)
Note 2: 'maxMIMO)-Layers-r16' is not con	is up to UE declaration figured during the performance requirements a 16 per-BWP MIMO layer adaptation.

5.1.1.3 Applicability of requirements for optional UE features

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

Table 5.1.1.3-1: Requirements applicability for optional UE features

UE feature/capability [14]	Test 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)	
	FR1 TDD	PDSCH	Clause 5.2.2.2.4 (Test 1-2)	
			Clause 5.2.3.2.4 (Test 1-2)	
Basic DL NR-NR CA operation (supportedBandCombinationList)	NR CA	SDR	Clause 5.5A.1	1)Up to 16 DL carriers 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	type	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	
Rate-matching around LTE CRS (rateMatchingLTE-CRS)	FR1 FDD	PDSCH	Clause 5.2.2.1.4 Clause 5.2.3.1.4	For UEs supporting "Alternative additional DMRS position for co- existence with LTE CRS", if Test 1-2 is tested, the test coverage can be considered fulfilled without executing Test 1-1. Otherwise, only Test 1-1 is tested.
	FR1 TDD	PDSCH	Clause 5.2.2.2.4 Clause 5.2.3.2.4	
Supported maximum number of ports across all configured NZP-CSI-RS resources per CC (maxConfigNumberPortsAcros sNZP-CSI-RS-PerCC)	FR1 FDD	PDSCH	Clause 5.2.2.1.4 (Tests 1-1, 1-2) Clause 5.2.3.1.1 (Tests 3-1, 4-1, 5-1) Clause 5.2.3.1.4 (Tests 1-1, 1-2)	The requirements apply only in case the number of NZP-CSI-RS ports in the test case satisfies UE capability on
	FR1 TDD	PDSCH	Clause 5.2.3.2.1 (Test 3-1, 4-1, 5-1)	maximum number of NZP-CSI-RS ports
Supported maximum number of PDSCH MIMO layers (maxNumberMIMO-LayersPDSCH)	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Tests 2-1, 2-2, 3-1) Clause 5.2.2.1.2 Clause 5.2.3.1.1 (Tests 2-1, 2-2, 3-1, 4-1, 5-1) Clause 5.2.3.1.2	The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers
	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Tests 2-1, 2-2, 3-1) Clause 5.2.2.2.2 Clause 5.2.3.2.1 (Tests 2-1, 2-2, 3-1, 4-1, 5-1) Clause 5.2.3.2.2	capability

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 SSB periodicity SSB periodicity SSB periodicity Single 5.2c per tested channel bandwidth and subcarrier spacing 1/AL8 Single Panel Type I, Random per slow with equal probability of each applicable i1, i2 combination, and with applicable i1, i2 combin
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 ₁ , i ₂ combination, and with applicable i ₁ , i ₂ 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 ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination, and with equal probability of each applicable i ₁ , i ₂ combination equal probability of each applicable i ₁ , i ₂ combination equal probability in the equal probability is equal probability of each applicable i ₁ , i ₂ combination equal probability is equal probability in the equal probability is equal probability
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 ₁ , i ₂ combination, and with applicable i ₂ combination i ₁ applicable i ₂ combination i ₂ combination i ₁ applicable i ₂ combination i ₂ combination i ₂ combination i ₃ combination i ₄ 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 ₁ , i ₂ combination, and with applicable i ₁ , i ₂ combination, and applicable i ₁
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 ₁ , i ₂ combination, and with applicable i ₁ , i ₂ combination, and with aggregation levels Non-interleaved Single Panel Type I, Random per slow with equal probability of each applicable i ₁ , i ₂ combination, and with aggregation levels Non-interleaved
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 ₁ , i ₂ combination, and with applicable i ₁ , i ₂ combination, and with applicable i ₁ , i ₂ combination, and with applicable i ₂ , i ₃ combination, and with applicable i ₄ , i ₄ combination, and with applicable i ₄ , i ₅ combination i ₆ 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 ₁ , i ₂ 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 ₁ , i ₂ combination, and with
PDCCH & PDCCH DMRS Precoding configuration Single Panel Type I, Random per slo with equal probability of each applicable i ₁ , i ₂ 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 subservior	index in the PRB used for		
	CSI-RS	index in the PRB used for		$k_0 = 4$
	First OFDM syr	mbol in the PRB used for		I ₀ = 12
	Number of CSI	-RS ports (X)		4
ZP CSI-RS for CSI	CDM Type			'FD-CDM2'
acquisition	Density (p)			1
	CSI-RS periodi	city	Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset		Slots	0
			Cioto	Start PRB 0
	Frequency Occ	upation		Number of PRB = BWP size
PDSCH DMRS	Antenna ports i	ndexes		{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
	Number of PDS	SCH DMRS CDM group(s)		1 for Rank 1 and Rank 2 tests
	without data	CCD in day		2 for Rank 3 and Rank 4 tests SSB #0
	Type 1 QCL information	SSB index QCL Type		Type C
TCI state #0	Type 2 QCL	SSB index		N/A
	information	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
PT-RS configuration	•			PT-RS is not configured
		os for ACK/NACK feedback		1
Maximum number of				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 ₁ , i ₂ combination, and with PRB bundling granularity
Symbols for all unus	ed RFs			OCNG Annex A.5
Physical signals, cha		nd precoding		As specified in Annex B.4.1
i riyalcai algilala, Cila	anieis mapping a	na precounty		no openieu ili Alliex D.4. I

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 5.2-2: 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			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 bundling sine		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
	NDO SIZE		Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
			2 for Tests 1-1, 1-5
PDSCH DMRS	Number of additional DMRS		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:
3			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 UADO Processes			8 for Test 1-4
·	Number of HARQ Processes		4 for other tests
The number of slots I ACK information	petween PDSCH and corresponding HARQ-		2

Table 5.2.2.1.1-3: 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	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					Reference value	
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation 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	
Tes nun		(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
	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		IN/A
	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 ₀ = 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			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

			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 P	Number of HARQ Processes		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	-0.9

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

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

The test purposes are specified in Table 5.2.2.1.4-1.

Table 5.2.2.1.4-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance	1-1, 1-2
under 2 receive antenna conditions with CRS rate	
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
	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
			3
. 200 2	Mapping type k0 Starting symbol (S) Length (L) PDSCH aggregation factor PRB bundling type PRB bundling size Resource allocation type RBG size VRB-to-PRB mapping type VRB-to-PRB mapping interleaver bundle size DMRS Type Position of the first DM-RS for downlink Number of additional DMRS Maximum number of OFDM symbols for DL front loaded DMRS LTE carrier BW Number of antenna ports v-shift		1
configuration			1
	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
PRB bundling size Resource allocation type RBG size VRB-to-PRB mapping type VRB-to-PRB mapping interleaver bundle size DMRS Type Position of the first DM-RS for downlink Number of additional DMRS Maximum number of OFDM symbols for DL front loaded DMRS LTE carrier centre subcarrier location LTE carrier BW Number of antenna ports v-shift Number of HARQ Processes	MHz	10	
	Number of antenna ports		4
			0
Number of HARQ Pro	ocesses		4
	The number of slots between PDSCH and corresponding HARQ-		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 ma condition a	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 Pro	ocesses		16 for Test 1-4 10 for Test 1-9 8 for other tests
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 5.2.2.2.1-3: Minimum performance for Rank 1

		Bandwidth				Correlation	Reference v	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	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

	Reference	Bandwidth (MHz) / Subcarrier spacing (kHz)				Correlation	Reference value	
Test num.			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	Subcarrior	Modulation TDD UL- format and DL code rate 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		I ₀ = 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 Pro	ocesses		8
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 5.2.2.2-3: Minimum performance for Rank 2

	Test num.		Bandwidth		TDD		Correlation	Reference v	/alue
		Reference channel	(MHz) / Modulation Subcarrier format and spacing (kHz)	format and	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	Duplex mode		TDD		
Active DL BWP inde	Active DL BWP index		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 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 5.2.2.3-3: Minimum performance for Rank 1

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

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

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

The test purposes are specified in Table 5.2.2.2.4-1.

Table 5.2.2.2.4-1: Tests purpose

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

Table 5.2.2.4-2: Test parameters

Parameter			Value		
Duplex mode			TDD		
Active DL BWP index	(1		
NR UL transmission with a 7.5 kHz shift to the LTE raster			true		
	Mapping type		Type A		
	k0		0		
	Starting symbol (S)		3		
	Length (L)		9 for Test 1-1 11 for Test 1-2		
DD0011	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		
DD00H DMD0	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		
CDC for rate	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location		
CRS for rate matching (Note 1)	LTE carrier BW	MHz	10		
	Number of antenna ports		4		
	v-shift		0		
Number of HARQ Processes			8		
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2		
	N is configured on LTE carrier	1	and do domina in Amina A A A A		

Table 5.2.2.2.4-3: Minimum performance for Rank 1

	Reference channel	Subcarrier f			Propagation condition	Correlation matrix and antenna configuration	Reference value	
Test num.			Modulation format and code rate	TDD UL- DL pattern			Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1- 1.1 TDD	10 / 15	QPSK, 0.30	FR1.15-1	TDLA30-10	4x2, ULA Low	70	-0.8
1-2	R.PDSCH.1- 1.2 TDD	10 / 15	QPSK, 0.30	FR1.15-1	TDLA30-10	4x2, ULA Low	70	-0.8

5.2.3 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	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
PDSCH	PRB bundling size		4 for Test 1-1 WB for Test 3-1 2 for other tests
configuration	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.
Number of HARQ Processes			Other tests: Table 5.2-1. 8 for Test 1-4, 2-1 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 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	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 Correlati		Correlation	Correlation Reference valu			
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 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)	
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 ₀ = 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			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 format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference va	ılue
num.	channel	(kHz)				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 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 Pi	rocesses		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	Madulation		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	2x4, ULA Low	70	-3.8

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

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

The test purposes are specified in Table 5.2.3.1.4-1.

Table 5.2.3.1.4-1: Tests purpose

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

Table 5.2.3.1.4-2: Test parameters

Duplex mode		Parameter	Unit	Value
NR UL transmission with a 7.5 kHz shift to the LTE raster	Duplex mode			FDD
PDCCH configuration	Active DL BWP index	(1
Mapping type	NR UL transmission	with a 7.5 kHz shift to the LTE raster		true
PDSCH configuration		Symbols with PDCCH		Symbol# 2
PDSCH configuration CRS for rate matching (Note 1) Starting symbol (S) 3 9 for Test 1-1 11 for Test 1-2	_	Mapping type		Type A
Length (L)		k0		0
PDSCH configuration		Starting symbol (S)		
PDSCH configuration 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 Position of the first DM-RS for downlink 3 Number of additional DMRS 1 Maximum number of OFDM symbols for DL front loaded DMRS 1 CRS for rate matching (Note 1) LTE carrier centre subcarrier location Same as NR carrier centre subcarrier location LTE carrier BW MHz 10 Number of ABRQ Processes 4 The number of slots between PDSCH and corresponding HARQ-ACK information 2		Length (L)		
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 Position of the first DM-RS for downlink 3 Number of additional DMRS 1 Maximum number of OFDM symbols for DL front loaded DMRS 1 CRS for rate matching (Note 1) LTE carrier centre subcarrier location Same as NR carrier centre subcarrier location LTE carrier BW MHz 10 Number of HARQ Processes 4 The number of slots between PDSCH and corresponding HARQ-ACK information 2	DDCCH	PDSCH aggregation factor		1
PRB bundling size				Static
RBG size	Configuration	PRB bundling size		2
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 Number of additional DMRS 1 Maximum number of OFDM symbols for DL front loaded DMRS 1 CRS for rate matching (Note 1) LTE carrier centre subcarrier location Same as NR carrier centre subcarrier location LTE carrier BW MHz 10 Number of antenna ports v-shift 4 Number of slots between PDSCH and corresponding HARQ-ACK information 2		Resource allocation type		Type 0
VRB-to-PRB mapping interleaver bundle size N/A PDSCH DMRS configuration DMRS Type Type 1 Position of the first DM-RS for downlink configuration 3 Number of additional DMRS 1 Maximum number of OFDM symbols for DL front loaded DMRS 1 CRS for rate matching (Note 1) LTE carrier centre subcarrier location Same as NR carrier centre subcarrier location LTE carrier BW MHz 10 Number of antenna ports v-shift 4 Number of HARQ Processes 4 The number of slots between PDSCH and corresponding HARQ-ACK information 2		RBG size		Config2
PDSCH DMRS configuration		VRB-to-PRB mapping type		Non-interleaved
DMRS Type Type 1		VRB-to-PRB mapping interleaver bundle		NI/Δ
PDSCH DMRS configuration Position of the first DM-RS for downlink Number of additional DMRS Maximum number of OFDM symbols for DL front loaded DMRS LTE carrier centre subcarrier location LTE carrier BW Number of antenna ports V-shift Number of HARQ Processes The number of slots between PDSCH and corresponding HARQ-ACK information Position of the first DM-RS for downlink 3 Numbers of additional DMRS 1 Same as NR carrier centre subcarrier location MHz 10 NHz 0				·
Number of additional DMRS Configuration Number of additional DMRS Maximum number of OFDM symbols for DL front loaded DMRS LTE carrier centre subcarrier location LTE carrier BW Number of antenna ports V-shift Number of HARQ Processes The number of slots between PDSCH and corresponding HARQ-ACK information Number of additional DMRS 1 Same as NR carrier centre subcarrier location MHz 10 NHz 0 2				Type 1
CRS for rate matching (Note 1) Number of additional DMRS Maximum number of OFDM symbols for DL front loaded DMRS LTE carrier centre subcarrier location LTE carrier BW Number of antenna ports V-shift Number of HARQ Processes The number of slots between PDSCH and corresponding HARQ-ACK information	PDSCH DMRS	Position of the first DM-RS for downlink		3
Maximum number of OFDM symbols for DL front loaded DMRS 1 1				1
CRS for rate matching (Note 1) LTE carrier subcarrier location location LTE carrier BW MHz 10 Number of antenna ports 4 v-shift 0 Number of HARQ Processes 4 The number of slots between PDSCH and corresponding HARQ-ACK information 2	configuration			1
matching (Note 1) LTE carrier BW MHZ 10 Number of antenna ports 4 v-shift 0 Number of HARQ Processes 4 The number of slots between PDSCH and corresponding HARQ-ACK information 2	0001	LTE carrier centre subcarrier location		
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		LTE carrier BW	MHz	10
v-shift0Number of HARQ Processes4The number of slots between PDSCH and corresponding HARQ-ACK information2	matching (Note 1)	Number of antenna ports		4
The number of slots between PDSCH and corresponding HARQ-ACK information				0
ACK information	Number of HARQ Pr	ocesses		4
Note 1: No MBSFN is configured on LTE carrier	The number of slots between PDSCH and corresponding HARQ-			2
	Note 1: No MBSF	N is configured on LTE carrier		

Table 5.2.3.1.4-3: Minimum performance for Rank 1

		Bandwidth (MHz) /	lz) /		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
configuration	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 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 (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.2- 3.1 TDD	40 / 30	64QAM, 0.50	FR1.30- 1	TDLA30-10	2x4, ULA Low	70	13.6
2-2	R.PDSCH.2- 9.1 TDD	20 / 30	64QAM, 0.50	FR1.30- 4	TDLA30-10	2x4, ULA Low	70	13.7

Table 5.2.3.2.1-5: Minimum performance for Rank 3

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

Table 5.2.3.2.2-2: Test parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP index	X		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		IN/A
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for		1
	DL front loaded DMRS		*
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		I ₀ = 13
CSI acquisition	CSI-RS periodicity	Slots	5
	Subcarrier index in the PRB used for CSI-		(1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
ZP CSI-RS 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	Number of HARQ Processes		8
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 5.2.3.2.2-3: Minimum performance for Rank 2

		Bandwidth (MUS) / Madulation TDD III					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	2x4, ULA Low	70	9.0	

5.2.3.2.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.3.2.3-1.

Table 5.2.3.2.3-1: Tests purpose

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

Table 5.2.3.2.3-2: Test parameters

	Parameter	Unit	Value	
Duplex mode			TDD	
Active DL BWP index			1	
	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 P	Number of HARQ Processes		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 TDD III			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- 1.3 TDD	40 / 30	QPSK, 0.30	FR1.30- 1	TDLA30-10	2x4, ULA Low	70	-3.9

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

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

The test purposes are specified in Table 5.2.3.2.4-1.

Table 5.2.3.2.4-1: Tests purpose

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

Table 5.2.3.2.4-2: Test parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP index			1
NR UL transmission with a 7.5 kHz shift to the LTE raster			true
	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
	PDSCH aggregation factor		1
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
DD00H DMD0	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
CRS for rate	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
matching (Note 1)	LTE carrier BW	MHz	10
matching (Note 1)	Number of antenna ports		4
v-shift			0
Number of HARQ Pro			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: No MBSFI	N is configured on LTE carrier	•	

Table 5.2.3.2.4-3: Minimum performance for Rank 1

		Bandwidth (MHz) / Madulation TRD III				Correlation	Reference	value
Test num.	Reference channel	Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	DL condition antenna	matrix and	Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1- 1.1 TDD	10 / 15	QPSK, 0.30	FR1.15-1	TDLA30-10	4x4, ULA Low	70	-3.6
1-2	R.PDSCH.1- 1.2 TDD	10 / 15	QPSK, 0.30	FR1.15-1	TDLA30-10	4x4, ULA Low	70	-3.5

5.3 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		le subcarrier on this		
DL BWP	carrier (Note Cyclic prefix			Normal
configuration #1	RB offset		RBs	0
Common	Physical Ce	II ID	1120	0
serving cell	SSB position			1
parameters	SSB periodi		ms	20
		CCH monitoring		Each slot
PDCCH	Number of F	PDCCH candidates		1
configuration		domain resource r CORESET		Start from RB = 0 with contiguous RB allocation
	TCI state			TCI state #1
	First subcar used for CS	rier index in the PRB I-RS (k_0)		0
				CSI-RS resource 1:
	First OFDM	symbol in the PRB		CSI-RS resource 2:
	used for CS	I-RS (I ₀)		CSI-RS resource 3:
				CSI-RS resource 4:
		CSI-RS ports (X)		1
	CDM Type			No CDM
	Density (ρ)			3
CSI-RS for	CSI-RS peri	odicity	Slots	15 kHz SCS: 20 30 kHz SCS: 40
tracking	CSI-RS offs	et	Slots	15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4 30 kHz SCS:
				20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
	Frequency (Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
	Type 1	SSB index		SSB #0
TCI state #0	QCL information	QCL Type		Туре С
1 OI SIAIG #U	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
TCI etete #4		QCL Type		Type A
TCI state #1	Type 2 QCL	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking'
	information			configuration
		QCL Type		Type D

PDCCH & PDCCH DMRS Precoding configuration	Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i ₁ , i ₂ combination with REG bundling granularity for number of Tx larger than 1			
Physical signals, channels mapping and precoding	As specified in Annex B.4.1			
Symbols for all unused REs	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.

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 Ante		
CCE to REG mapping type		nonInterleaved		
REG bundle size		6		
Shift index		0		

5.3.2.1.1 1 Tx Antenna performances

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

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

			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	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	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	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	TDD UL-DL pattern			
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		C		

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	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		nonInter	leaved
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	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.	TDLA30-10	1x4 Low	1	2.2
					1-2.1 FDD				
2	10	24	2	2	R.PDCCH.	TDLC300-	1x4 Low	1	2.7
					1-2.3 FDD	100			
3	10	48	2	4	R.PDCCH.	TDLA30-10	1x4 Low	1	0.2
					1-2.4 FDD				
4	10	48	1	4	R.PDCCH.	TDLA30-10	1x4 Low	1	-0.4
					1-1.1 FDD				
5	10	48	2	16	R.PDCCH.	TDLA30-10	1x4	1	-3.2
					1-2.6 FDD		Medium A		

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

			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	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	;
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

			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. 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	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.	TDLC300-	2x4 Low	1	-4.3
					2-1.3 TDD	100			

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

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

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		Reference value		
number	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	Reference value	
	(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	Reference value	
		(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 $100\%*N_{DL_correct_rx}/(N_{DL_newtx} + N_{DL_retx})$, where N_{DL_newtx} is the number of newly transmitted DL transport blocks, N_{DL_retx} is the number of retransmitted DL transport blocks, and $N_{DL_correct_rx}$ is the number of correctly received DL transport blocks.

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

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

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

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

	Parameter	Unit	Value
PDSCH transmission	scheme		Transmission scheme 1
EPRE ratio of PTRS to PDSCH			N/A
Channel bandwidth			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 ₀ = 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 To		T	INO COMI for COLDO recessor 4.0.0.4
	CDM Type		+	'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		+	3 for CSI-RS resource 1,2,3,4 15 kHz SCS: 20 for CSI-RS resource
	00:55	P. M		15 kHz SCS: 20 for CSI-RS resource 1,2,3,4
	CSI-RS period	aicity	Slots	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 1 and 2 11 for CSI-RS resource 3 and 4
	CSI-RS offset	V	Slots	
	CSI-RS offset			30 kHz SCS:
				20 for CSI-RS resource 1 and 2
			1	21 for CSI-RS resource 3 and 4
	Frequency Oc	ccupation		Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
		dexes in the PRB used for		k ₀ = 4
		ols in the PRB used for CSI-		1
	RS			I ₀ = 12
	Number of CS	SI-RS ports (X)		Same as number of transmit antenna
NZP CSI-RS for	CDM Type		<u> </u>	'FD-CDM2'
CSI acquisition	Density (ρ)		-	1
	CSI-RS period	dicity		15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset		1	30 KHZ SCS: 40 0
				Start PRB 0
	Frequency Oc	сираноп		Number of PRB = BWP size
	QCL info			TCI state #1
	CSI-RS	dexes in the PRB used for		k ₀ = 0
	OFDM symbo	ols in the PRB used for CSI-		I ₀ = 12
	Number of CS	SI-RS ports (X)		4
ZP CSI-RS for CSI	CDM Type			'FD-CDM2'
acquisition	Density (ρ)		<u> </u>	1
	CSI-RS period	dicity		15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset	<u> </u>	<u> </u>	0
	Frequency Oc			Start PRB 0
	1	SSB index	+	Number of PRB = BWP size SSB #0
	Type 1 QCL information	QCL Type		SSB #0 Type C
TCI state #0	Type 2 QCL	SSB index		N/A
	information	QCL Type	1	N/A
		CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for
To:	Type 1 QCL information			tracking' configuration
TCI state #1		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource	1	N/A
		QCL Type		N/A
		ups for ACK/NACK feedback		1
Maximum number of	HARQ transmis		<u></u>	4
HARQ ACK/NACK bu		20	1	Multiplexed
Redundancy version	coung sequent	<u>∪</u> -	+	{0,2,3,1} Single Panel Type I, Random precoder
PDSCH & PDSCH DMRS Precoding configuration			selection updated per slot, with equal probability of each applicable i ₁ , i ₂	
-2 41 000110	. 200 a. 200 2 rosodnig domigaration			combination with PRB bundling granularity
Symbols for all unuse	ed REs			OCNG Annex A.5
Propagation condition				Static propagation condition No external noise sources are applied
A m.t =	1 layer CCs		1	1x2 or 1x4
Antenna	2 layers CCs			2x2 or 2x4
configuration	4 layers CCs			4x4
Physical signals, cha	Physical signals, channels mapping and precoding			As specified in Annex B.4.1

Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH

transmission

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	Duplex mode		TDD
PDSCH	Starting symbol (S)		1
configuration	Length (L)		13
Number of HARQ	Number of HARQ Processes		8
K1 value	K1 value		Specific to each UL-DL pattern
TDD III DI nettern			15 kHz SCS: FR1.15-1
TDD UL-DL pattern			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	0.73	4
4	8	1	26
4	8	0.8	23
4	8	0.75	22
4	8	0.75	12
4	6	1	27
4	6		24
4	6	0.8	
•		0.75	23
4	6 4	0.4 1	14
	4		16
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	type	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 6.4.2.2	
Supported maximum number of	FR1 FDD	PMI	Clause 6.3.2.1.1	The requirements
ports across all configured	11(1100	' '''	Clause 6.3.2.1.2	apply only in case
NZP-CSI-RS resources per CC			Clause 6.3.2.1.3	the number of NZP-
(maxConfigNumberPortsAcros			Clause 6.3.2.1.4	CSI-RS ports in the
sNZP-CSI-RS-PerCC)			Clause 6.3.3.1.1	test case satisfies UE
			Clause 6.3.3.1.2	capability on
			Clause 6.3.3.1.3	maximum number of
			Clause 6.3.3.1.4	NZP-CSI-RS ports
		RI	Clause 6.4.3.1 (Test 4)	
	FR1 TDD	PMI	Clause 6.3.2.2.1	
			Clause 6.3.2.2.2	
			Clause 6.3.2.2.3	
			Clause 6.3.2.2.4	
			Clause 6.3.3.2.1	
			Clause 6.3.3.2.2	
			Clause 6.3.3.2.3	
		DI	Clause 6.3.3.2.4	
		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 configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)	RBs	0
	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	1	First SSB in Slot #0
parameters	SSB periodicity	ms	20
	Slots for PDCCH monitoring		Each slot
DD C C : :	Symbols with PDCCH		0,1
PDCCH configuration	Number of PDCCH candidates and aggregation levels		1/AL8
	DCI format		1_1
	TCI state		TCI state #1
Cross carrier sch			Not configured
	Mapping type		Type A
	kO		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH 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:
PDSCH DMRS configuration	DMRS Type Number of additional DMRS Maximum number of OFDM		Single Panel Type I, Random precoder chosen from precoder index 0 an 2, selection updated per slot Type 1 1
g:	symbols for DL front loaded DMRS		1

	DMRS ports i	ndexes		{1000} for Rank1 {1000,1001} for Rank2 {1000,1001,1002} for Rank3 {1000,1001,1002,100
		DSCH DMRS CDM		3} for Rank4 2
DTDO	group(s) with			NI/A
PTRS configuration	Frequency de Time density			N/A N/A
Corniguration		er index in the PRB		0 for CSI-RS
	used for CSI-			resource 1,2,3,4
	First OFDM s used for CSI-	ymbol in the PRB RS (<i>l</i> ₀)		4 for CSI-RS resource 1 and 3 8 for CSI-RS resource 2 and 4
	Number of CS	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
	Danaita (a)			3 for CSI-RS
	Density (ρ)			resource 1,2,3,4
				15 kHz SCS: 20 for
	CCL DC maria	-li -:4	alat	CSI-RS resource
CSI-RS for	CSI-RS perio	aicity	slot	1,2,3,4 30 kHz SCS: 40 for
tracking				CSI-RS resource
3				15 kHz SCS:
				10 for CSI-RS
				resource 1 and 2
				11 for CSI-RS resource 3 and 4
	CSI-RS offset	•	slot	resource 3 and 4
	OOI NO OIISCI	•	3101	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 CSI acquisition	Frequency O	ccupation		Number of PRB = BWP size
CSI acquisition	QCL info			TCI state #1
7D 001 D0 (QGE IIIIO			Start PRB 0
ZP CSI-RS for CSI acquisition	Frequency O	ccupation		Number of PRB =
Ooi acquisition				BWP size
	Type 1 QCL	SSB index		SSB #0
TCI state #0	information	QCL Type		Type C
101 State #0	Type 2 QCL	SSB index		N/A
	information	QCL Type		N/A
	T 4 001			CSI-RS resource 1
	Type 1 QCL information	CSI-RS resource		from 'CSI-RS for tracking'
TOI " -	"" o' madon			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
				8 for TDD
HARQ ACK/NACK bundling				Multiplexed

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	
Physical	signals, channels mapping and precoding		As specified in Annex B.4.1	
Note 1:	PDSCH is not scheduled on slots containing DL.	CSI-RS or	slots which are not full	
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: 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 ± 1 of the reported median more than 90% of the time.
- b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.2.1.1.1-1: CQI reporting definition test

	Parameter	Unit	Test 1 Test 2		
Bandwidth		MHz	10		
Duplex Mode			FDD)	
Subcarrier spacing	g	kHz	15		
SNR		dB	8 9	14 15	
Propagation chan	nel		AWG		
Antenna configura	ation		2x2 with static channel specified in Annex B.1		
Beamforming Mod	del		As specified in		
	CSI-RS resource Type		Period		
	Number of CSI-RS ports (X)		4		
	CDM Type		FD-CD	M2	
7D 001 D0	Density (p)		1		
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k ₀)		Row 5	5,4	
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		9		
	CSI-RS				
	periodicity and offset	slot	5/1		
	CSI-RS resource Type		Period	dic	
	Number of CSI-RS ports (X)		2		
	CDM Type		FD-CD	M2	
	Density (p)		1		
NZP CSI-RS for	First subcarrier index in the PRB		Б 0	(0.)	
CSI acquisition	used for CSI-RS (k ₀ , k ₁)		Row 3,	(6,-)	
	First OFDM symbol in the PRB used		40		
	for CSI-RS (I ₀)		13		
	NZP CSI-RS-timeConfig	slot	5/1		
	periodicity and offset	SIOL	3/1		
	CSI-IM resource Type		Period	dic	
	CSI-IM RE pattern		0		
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4, 9))	
J	CSI-IM timeConfig				
	periodicity and offset	slot	5/1		
ReportConfigType			Period	dic	
CQI-table			Table	2	
reportQuantity			cri-RI-PM		
	rChannelMeasurements		Not confi	gured	
timeRestrictionFo	rInterferenceMeasurements		Not confi		
cqi-FormatIndicate			Wideba	and	
pmi-FormatIndicat	tor		Wideba	and	
Sub-band Size		RB	8		
Csi-ReportingBan	d		11111	11	
CSI-Report period		slot	5/0		
aperiodicTriggerin	gOffset		Not confi	gured	
	Codebook Type		typel-Singl	lePanel	
	Codebook Mode		1		
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not confi	gured	
J	CodebookSubsetRestriction		01000	00	
	RI Restriction		N/A		
Physical channel for CSI report			PUCC		
CQI/RI/PMI delay		ms	8		
	of HARQ transmission		1		
Measurement cha			As specified in Tab 2	le A.4-2, TBS.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 α % of the time where α % is specified in Table 6.2.2.1.2.1-2;
- b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, 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		Test 1 Test 2
Bandwidth		MHz	10
Subcarrier spacing	g	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 54
configuration	used for CSI-RS (k ₀)		Row 5,4
	First OFDM symbol in the PRB used		0
	for CSI-RS (I ₀)		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 COLDO for	Density (p)		1
NZP CSI-RS for	First subcarrier index in the PRB		Day: 2 (C.)
CSI acquisition	used for CSI-RS (k ₀ , k ₁)		Row 3,(6,-)
	First OFDM symbol in the PRB used		13
	for CSI-RS (I ₀)		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
aperiodicTriggerin			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	tor CSI report		PUCCH
CQI/RI/PMI delay		ms	8
Maximum number	of HARQ transmission		1
Measurement cha	innel		As specified in Table A.4-2, TBS.2-
		L	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 α and β are specified in Table 6.2.2.1.2.2-2;
- b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be $\geq \gamma$, where γ is specified in Table 6.2.2.1.2.2-2;
- c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to 0.02.

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

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

Parameter		Unit	Test 1	Test 2
Bandwidth		MHz	10	
Subcarrier spacing		kHz	15	
Duplex Mode			FDD)
SNR		dB	8 9	14 15
Propagation chan			Two tap model specified in Anne B.2.4 with $a=1$, $f_D=5$ Hz, and $\tau_d=0.45\mu s$	
Antenna configura	ation		2×2)
Correlation config			As per Anı	
Beamforming Mod			As specified in	
	CSI-RS resource Type		Perio	dic
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CD	M2
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB used for CSI-RS (k ₀)		Row	5,4
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		9	
	CSI-RS periodicity and offset	slot	5/1	
	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 ₀ , k ₁)		Row 3,	(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		13	
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	
	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	5/1	
ReportConfigType)		Aperio	dic
CQI-table			Table	2
reportQuantity			cri-RI-PM	
	rChannelMeasurements		Not confi	
	rInterferenceMeasurements		Not confi	
cqi-FormatIndicate			Subba	
pmi-FormatIndicat	tor		Wideb	and
Sub-band Size		RB	8	
csi-ReportingBand			11111	
CSI-Report interva		slot	Not confi	gured
Aperiodic Report S	Slot Offset		1 in slots i, where	
·			otherwise it is	equal to 0
reportTriggerSize			One State with one	Associated
CSI-AperiodicTriggerStateList			Report Configuration Associated Report	on
			contains pointers and CS	to NZP CSI-RS
aperiodicTriggerin	gOffset		Not confi	
	Codebook Type		typel-Sing	lePanel
	Codebook Mode		1	
Codebook	(CodebookConfig-		Not confi	gured
configuration	N1,CodebookConfig-N2)		Not confi	
	CodebookSubsetRestriction		000001	
	RI Restriction		N/A	
Physical channel to	or CSI report		PUSC	H
CQI/RI/PMI delay		ms	8	

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

Table 6.2.2.1.2.2-2: Minimum requirements

Parameters	Test 1	Test 2
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. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

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

- a) The reported CQI value according to the reference channel shall be in the range of ± 1 of the reported median more than 90% of the time.
- b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.2.2.1.1-1: CQI reporting definition test

Parameter		Unit	Test 1 Test 2	
Bandwidth	ndwidth MHz 40)	
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		AWO	GN .
Antenna configura			2x2 with static cha	annel specified in
Beamforming Mod	del		As specified in	
•	CSI-RS resource Type		Perio	odic
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CI	DM2
ZP CSI-RS	Density (ρ)		1	
	First subcarrier index in the PRB		David	F 4
configuration	used for CSI-RS (k ₀)		Row	5,4
	First OFDM symbol in the PRB used		0	
	for CSI-RS (I ₀)		9	
	CSI-RS	alat	10/	/4
	periodicity and offset	slot	10/	1
	CSI-RS resource Type		Perio	odic
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-CI	DM2
NZP CSI-RS for	Density (ρ)		1	
	First subcarrier index in the PRB		D 0	(0.)
CSI acquisition	used for CSI-RS (k ₀ , k ₁)		Row 3	,(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		13	
	NZP CSI-RS-timeConfig	slot	10/	/1
	periodicity and offset	3101		
	CSI-IM resource Type		Perio	odic
	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	odic
CQI-table			Tabl	e 2
reportQuantity			cri-RI-PI	MI-CQI
timeRestrictionFo	rChannelMeasurements		Not con	figured
timeRestrictionFo	rInterferenceMeasurements		Not con	figured
cqi-FormatIndicat			Widek	pand
pmi-FormatIndica	tor		Widek	
Sub-band Size		RB	16	6
Csi-ReportingBan	d		1111	
CSI-Report period		slot	10/	/9
aperiodicTriggerin			Not con	
	Codebook Type		typel-Sing	
	Codebook Mode		1	-
Codebook	(CodebookConfig-		A1 .	
configuration	N1,CodebookConfig-N2)		Not con	iigurea
	CodebookSubsetRestriction		0100	000
	RI Restriction		N/.	
Physical channel			PUC	
CQI/RI/PMI delay		ms	9.9	
	r of HARQ transmission	11.0	1	-
			As specified in Tal	ole A.4-2, TBS.2-
Measurement 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 α % of the time where α % 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 $\geq \gamma$, 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

Bandwidth	Parameter		Unit	Test 1 Test 2		st 2	
Duplex Mode	Bandwidth			40			
TDD UL-DL pattern							
SNR				TDD			
Propagation channel	TDD UL-DL patter	rn			FR1.	30-1	ı
Antenia configuration	SNR		dB	6	7	12	13
Correlation configuration							
Beamforming Model							
CSI-RS resource Type							
Number of CSI-RS ports (X)	Beamforming Mod			As			.4.1
CDM Type							
Density (p)						•	
First subcarrier index in the PRB used for CSI-RS (k ₀) First OFDM symbol in the PRB used for CSI-RS (k ₀) CSI-RS periodicity and offset Periodicity and offset SIot CSI-RS resource Type Number of CSI-RS (x ₀) CDM Type Density (p) Density (p) NZP CSI-RS for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS resource Type Number of CSI-RS ports (X) CDM Type Density (p) Density (p) Density (p) Tirst OFDM symbol in the PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS (k ₀ , k ₁) NZP CSI-RS-timeConfig periodicity and offset CSI-IM resource Type CSI-IM resource Type CSI-IM Resource Mapping (KCSI-IM, ICSI-IM) CSI-IM meconfig periodicity and offset CSI-IM resource Mapping (KCSI-IM, ICSI-IM) CSI-IM timeConfig periodicity and offset Slot 10/1 ReportConfigType CSI-IM Resource Mapping (KCSI-IM, ICSI-IM) CSI-IM timeConfig periodicity and offset Table 2 cri-RI-PMI-CQI timeRestrictionForthannelMeasurements Not configured timeRestrictionForthanferenceMeasurements Not configured cqi-FormatIndicator Wideband mini-FormatIndicator Wideband mini-FormatIndicator Wideband Till1111 CSI-Report periodicity and offset Sub-band Size RB 16 CSI-ReportingBand CSI-Report periodicity and offset Not configured Not configured Codebook Codebook Mode 1 Codebook Config-N2) Codebook Config-N2) Not configured Not configure					7D-C	DIVIZ	
Used for CSI-RS (ko)							
For CSI-RS (Io) 9 10/1	configuration	used for CSI-RS (k ₀)			Row	5,4	
Periodicity and offset		for CSI-RS (I ₀)			9)	
Number of CSI-RS ports (X) 2 CDM Type		periodicity and offset	slot				
NZP CSI-RS for CSI acquisition NZP CSI-RS for CSI acquisition First subcarrier index in the PRB used for CSI-RS (ko, kt) First subcarrier index in the PRB used for CSI-RS (ko, kt)							
Density (p)							
First subcarrier index in the PRB used for CSI-RS (ko, kr)							
used for CSI-RS (k ₀ , k ₁) Row 3,(6,-7) First OFDM symbol in the PRB used for CSI-RS (l ₀) 13 NZP CSI-RS-timeConfig periodicity and offset slot 10/1 CSI-IM resource Type Periodic CSI-IM Resource Mapping (kcsI-IM, IcsI-IM) (4, 9) CSI-IM Resource Mapping (kcsI-IM, IcsI-IM) (4, 9) CSI-IM timeConfig periodicity and offset slot 10/1 ReportConfigType Periodic CQI-table Table 2 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured videband timeRestrictionForInterferenceMeasurements Not configured videband cqi-FormatIndicator Wideband Wideband pmi-FormatIndicator RB 16 CSi-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Not configured Codebook Mode 1 Codebook Mode 1 Codebook Mode 1 Codebook SubsetRestriction 000001 RI Restriction N/A	NZP CSI-RS for				1		
For CSI-RS (Io) NZP CSI-RS-timeConfig periodicity and offset Slot 10/1	CSI acquisition	used for CSI-RS (k ₀ , k ₁)		Row 3,(6,-)			
Deriodicity and offset		for CSI-RS (I ₀)		13			
CSI-IM resource Type			slot		10	/1	
CSI-IM configuration CSI-IM Resource Mapping (kcsi-im, lcsi-im) CSI-IM timeConfig periodicity and offset ReportConfigType CQI-table Table 2 reportQuantity timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements Cqi-FormatIndicator pmi-FormatIndicator pmi-FormatIndicator pmi-FormatIndicator pmi-FormatIndicator Sub-band Size RB 16 CSi-ReportingBand CSi-ReportingBand Sub-band Size RB 16 CSi-ReportingBand T111111 CSI-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Not configured Codebook Type Codebook Mode Codebook Configuration RI Restriction RI Restriction Physical channel for CSI report Massurement channel CSI-Report Public Results					Perio	odic	
CSI-IM timeConfig periodicity and offset ReportConfigType CQI-table reportQuantity timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements cqi-FormatIndicator mi-FormatIndicator Sub-band Size RB 16 Csi-Report periodicity and offset aperiodicTriggeringOffset Codebook configured Codebook configured Codebook configured Table 2 reportQuantity cri-RI-PMI-CQI mot configured timeRestrictionForChannelMeasurements Not configured Wideband Wideband Sub-band Size RB 16 Csi-Report periodicity and offset aperiodicTriggeringOffset Not configured typel-SinglePanel Codebook Mode 1 Codebook configuration N1,CodebookConfig- N1					0)	
ReportConfigType Periodic CQI-table Table 2 reportQuantity Cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured timeRestrictionForInterferenceMeasurements Not configured cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB 16 Csi-ReportingBand 1111111 CSI-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Slot 10/9 aperiodicTriggeringOffset Not configured Codebook Configured Codebook Configured Codebook Configured RI Restriction Not configured N1,CodebookConfig-N2) CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel				(4, 9)			
ReportConfigType Periodic CQI-table Table 2 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured timeRestrictionForInterferenceMeasurements Not configured cqi-FormatIndicator Wideband Sub-band Size RB 16 Csi-ReportingBand 1111111 CSI-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Not configured Codebook Type typel-SinglePanel Codebook Mode 1 Codebook Config- configuration Not configured N1, CodebookConfig- N1, CodebookSubsetRestriction Not configured RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-			slot	10/1			
CQI-table	ReportConfigType				Perio	odic	
timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size CSi-ReportingBand CSI-Report periodicity and offset aperiodicTriggeringOffset Codebook Configuration Codebook configuration All Restriction RI Restriction Measurement channel Not configured Not configured Slot 10/9 1111111 Not configured 10/9 10	CQI-table				Tab	le 2	
timeRestrictionForInterferenceMeasurements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size Csi-ReportingBand CSI-Report periodicity and offset aperiodicTriggeringOffset Codebook Configuration Codebook Configuration CodebookSubsetRestriction RI Restriction RI Restriction Measurement channel Cqi-FormatIndicator Wideband Wideband Wideband Wideband Sub-band Size RB 16 Codebook Slot 10/9 Not configured Vypel-SinglePanel Typel-SinglePanel Not configured Not configur					cri-RI-P	MI-CQI	
cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB 16 Csi-ReportingBand 1111111 CSI-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Not configured Codebook Type typel-SinglePanel Codebook Mode 1 Codebook Mode 1 Codebook Config-N2) Not configured N1,CodebookConfig-N2) Not configured CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-							
pmi-FormatIndicator Wideband Sub-band Size RB 16 Csi-ReportingBand 1111111 CSI-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Not configured Codebook Type typel-SinglePanel Codebook Mode 1 Codebook Config-N2) Not configured N1,CodebookConfig-N2) Not configured CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-							
Sub-band Size RB 16 Csi-ReportingBand 1111111 CSI-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Not configured Codebook Type typel-SinglePanel Codebook Mode 1 Codebook Config-N2) Not configured CodebookConfig-N2) Not configured CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 As specified in Table A.4-2, TBS.2-							
Csi-ReportingBand 1111111 CSI-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Not configured Codebook Type typel-SinglePanel Codebook Mode 1 Codebook Config-N2) Not configured N1,CodebookConfig-N2) Not configured CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-		tor					
CSI-Report periodicity and offset slot 10/9 aperiodicTriggeringOffset Not configured Codebook Type typel-SinglePanel Codebook Mode 1 Codebook Config- configuration Not configured N1,CodebookConfig-N2) Not configured CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-			KR	1			
aperiodicTriggeringOffset Not configured Codebook Type typel-SinglePanel Codebook Mode 1 Codebook Config- configuration Not configured N1,CodebookConfig- N1,CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-			olo+	1			
Codebook Type typel-SinglePanel Codebook Mode 1 Codebook Config- N1, CodebookConfig-N2) Not configured CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-			SIOL				
Codebook Configuration Codebook Config-N2) Not configured CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-	apenduic mygem						
Codebook configuration (CodebookConfig-N1, CodebookConfig-N2) Not configured CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-		Codebook Mode					
CodebookSubsetRestriction 000001 RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-		(CodebookConfig-		·			
RI Restriction N/A Physical channel for CSI report PUCCH CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-	Johnguration	CodebookSubsetRestriction			nnn	001	
Physical channel for CSI report CQI/RI/PMI delay Maximum number of HARQ transmission Measurement channel PUCCH ms 9.5 As specified in Table A.4-2, TBS.2-							
CQI/RI/PMI delay ms 9.5 Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-	Physical channel			1			
Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-2, TBS.2-		P	ms				
Measurement channel As specified in Table A.4-2, TBS.2-		of HARQ transmission	_				
				As spe			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 α and β 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 γ 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			40
Subcarrier spacin	carrier spacing kHz 30		30
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 $\tau_d=0.1125$ µs
Antenna configura	ation		2×2
Correlation config			As per Annex B.1
Beamforming Mo	del		As specified in Annex B.4.1
<u> </u>	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
ZD COLDO	Density (ρ)		1
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k ₀)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		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 ₀ , k ₁)		Row 3,(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		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	e		Aperiodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
	rChannelMeasurements		Not configured
timeRestrictionFo	rInterferenceMeasurements		Not configured
cqi-FormatIndicat	or		Subband
pmi-FormatIndica	tor		Wideband
Sub-band Size		RB	16
csi-ReportingBan			1111111
CSI-Report interv		slot	Not configured
Aperiodic Report	Slot Offset		9 1 in slots i, where mod(i, 10) = 1,
CSI request			otherwise it is equal to 0
reportTriggerSize			One State with one Associated
CSI-AperiodicTriggerStateList			Report Configuration Associated Report Configuration
			contains pointers to NZP CSI-RS and CSI-IM
aperiodicTriggerir	ngOffset		Not configured
, 33,,	Codebook Type		typel-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig-		N. C
configuration	N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction	-	N/A
D: : :	for CSI report		PUSCH

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

Table 6.2.2.2.2-2: 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 ± 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			1	0
Subcarrier spacing	carrier spacing kHz 15		5	
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 ₀)		Row	5,4
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		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 ₀ , k ₁)		NOW	5,(0,-)
	First OFDM symbol in the PRB used		13	
	for CSI-RS (I ₀)			
	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 α % of the time where α % is specified in Table 6.2.3.1.2.1-2;
- b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, 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			15	
Duplex Mode			FDD	
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 ₀)		Row	7 5,4
	First OFDM symbol in the PRB used			`
	for CSI-RS (I ₀)		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 ₀ , k ₁)		Row	5,(6,-)
	First OFDM symbol in the PRB used		1	2
	for CSI-RS (I ₀)		13	
	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			
			000001	
Dhysical shares 14	RI Restriction		N/A PUCCH	
Physical channel f	ог Сы героп			
CQI/RI/PMI delay	of LIADO transmissis	ms	8	
iviaximum number	of HARQ transmission		As an acifical in To	
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 α and β are specified in Table 6.2.3.1.2.2-2;
- b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be $\geq \gamma$, where γ is specified in Table 6.2.3.1.2.2-2;
- c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to 0.02.

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

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

Parameter		Unit	Test 1	Test 2
Bandwidth		MHz	10	
Subcarrier spacing	g	kHz	15	
Duplex Mode			FDI	
SNR		dB	5 6	11 12
Propagation chan			Two tap model sp B.2.4 with a=1, td=0.4	f _D = 5Hz, and 5μs
Antenna configura	ation		2×4	4
Correlation config			As per An	
Beamforming Mod			As specified in	
	CSI-RS resource Type		Perio	dic
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CI	DM2
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB used for CSI-RS (k ₀)		Row	5,4
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		9	
	CSI-RS periodicity and offset	slot	5/1	
	CSI-RS resource Type		Perio	dic
	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 ₀ , k ₁)		Row 3	(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		13	
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	
	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	5/1	
ReportConfigType)		Aperio	odic
CQI-table			Table	e 2
reportQuantity			cri-RI-PN	
	rChannelMeasurements		Not conf	
	rInterferenceMeasurements		Not conf	
cqi-FormatIndicate			Subba	
pmi-FormatIndicat	tor		Wideb	and
Sub-band Size		RB	8	
csi-ReportingBand			11111	
CSI-Report interva		slot	Not conf	igured
Aperiodic Report S	Slot Offset		1 in slots i, where	
·			otherwise it is	equal to 0
reportTriggerSize			One State with one	Associated
CSI-AperiodicTrig	gerStateList		Report Configuration Associated Report	on
-	Col-Aperiodic Higger StateList		contains pointers and CS	to NZP CSI-RS
aperiodicTriggerin	gOffset		Not conf	
	Codebook Type		typel-Sing	lePanel
	Codebook Mode		1	
Codebook	(CodebookConfig-		Not conf	igured
configuration	N1,CodebookConfig-N2)		Not conf	
	CodebookSubsetRestriction		0000	
	RI Restriction		N/A	
Physical channel to	or CSI report		PUS	JH
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
α [%]	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 ± 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	Bandwidth		40	
Subcarrier spacin	g	kHz	30	
Duplex 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 cha Annex	
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 Λ
configuration	used for CSI-RS (k ₀)		Row	5,4
	First OFDM symbol in the PRB used		0	
	for CSI-RS (I ₀)		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	Definity (b)			
CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 3	,(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		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			PUC	CH
CQI/RI/PMI delay	·	ms	9.5	
	r of HARQ transmission	-	1	
Measurement cha			As specified in Tab	ole A.4-2, TBS.2-
<u> </u>			· ·	

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 α % of the time where α % is specified in Table 6.2.3.2.2.1-2;
- b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, where γ is specified in Table 6.2.3.2.2.1-2;
- c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

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

	Parameter	Unit	Test 1	Test 2
Bandwidth		MHz 40		
Subcarrier spacin	g	kHz	30	
Duplex Mode			TDD	
TDD UL-DL patte	rn		FR1.3	60-1
SNR		dB	3 4	9 10
Propagation chan			TDLA	
Antenna configura			2×4	
Correlation config			XP H	
Beamforming Mod			As specified in	
	CSI-RS resource Type		Perio 4	aic
	Number of CSI-RS ports (X) CDM Type		FD-CI	NAO.
	Density (p)		1	JIVIZ
ZP CSI-RS	First subcarrier index in the PRB			
configuration	used for CSI-RS (k ₀)		Row	5,4
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		9	
	CSI-RS periodicity and offset	slot	10/	
	CSI-RS resource Type		Perio	dic
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-CI	DM2
NZP CSI-RS for	Density (p)		1	
CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 3	(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		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 conf	
	rInterferenceMeasurements		Not conf	
cqi-FormatIndicate			Wideb	
pmi-FormatIndica	tor	D.C.	Wideb	
Sub-band Size		RB	16	
csi-ReportingBand		olo+	11111	
CSI-Report period aperiodicTriggering		slot	10/ Not conf	
apenouic mggenr	Codebook Type		typel-Sing	
	Codebook Type Codebook Mode		typei-Sing	ioi ai ioi
Codebook	(Codebook Mode (CodebookConfig-		•	
configuration	N1,CodebookConfig-N2)		Not conf	igured
223	CodebookSubsetRestriction		0000	01
	RI Restriction		N/A	
Physical channel			PUC	
CQI/RI/PMI delay	•	ms	9.5	
	r of HARQ transmission		1	
Measurement cha	nnel		As specified in Tab	le 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 α and β are specified in Table 6.2.3.2.2.2-2;
- b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be $\geq \gamma$, where γ is specified in Table 6.2.3.2.2.2-2;
- c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to 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	Bandwidth		40	
Subcarrier spacin			30	
Duplex Mode				
TDD UL-DL patte	rn		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 _d =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 ₀) First OFDM symbol in the PRB used			
	for CSI-RS (I ₀)		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 ₀ , k ₁)		Row 3,(6,-)	
	First OFDM symbol in the PRB used			
	for CSI-RS (I ₀)		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	,		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	
aperiodicTriggerin			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	ioi coi report	<u> </u>	L POSCH	

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 [%]	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 i₁ and i₂ combination and applied to the PDSCH. A fixed transport format (FRC) is configured for all requirements.

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

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

In the definition of γ , for 4TX, 8TX, 16TX, and 32TX 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	10
Subcarrier spaci	ing	kHz	15
Duplex Mode	nnal		FDD TDL A20 F
Propagation cha	innei		TDLA30-5 High XP 4 x 2
Antenna configu	ration		(N1,N2) = (2,1)
Beamforming Me	odel		As specified in Annex B.4.1
Boarmonning with	CSI-RS resource		•
	Type		Periodic
	Number of CSI-RS		4
	ports (X)		-
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS	First subcarrier index in the PRB		
configuration	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(0.)
	used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	5/1
	interval and offset		5, .
	CSI-RS resource Type		Aperiodic
	Number of CSI-RS		
	ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier		
NZP CSI-RS	index in the PRB		Row 4, (0,-)
for CSI	used for CSI-RS		, (5,)
acquisition	(k ₀ , k ₁) First OFDM		
	symbol in the PRB		
	used for CSI-RS		(13,-)
	(l ₀ , l ₁)		
	CSI-RS		Not configured
	interval and offset		rvot connigured
	aperiodicTriggering		0
	Offset 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	slot	Not configured
ReportConfigTyp	interval and offset		Aperiodic
CQI-table	V-C		Table 1
reportQuantity			cri-RI-PMI-CQI
	orChannelMeasure		
ments			Not configured
timeRestrictionForInterferenceMeasu			Not configured
rements			Wideband
cqi-FormatIndica			Wideband
Sub-band Size	ator	RB	Wideballd 8
csi-ReportingBa	nd		111111
CSI-Report inter		slot	Not configured
Aperiodic Repor		,	4
CSI request			1 in slots i, where $mod(i, 5) = 1$,
·	_		otherwise it is equal to 0
reportTriggerSiz	е		1

CSI-AperiodicTr	iggerStateList		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,CodebookConfi g-N2)		(2,1)
configuration	(CodebookConfig- O1,CodebookConfi g-O2)		(4,1)
	CodebookSubsetR estriction		11111111
	RI Restriction		0000001
Physical channe	I 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: 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 i₁, i₂ 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.

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spac	ing	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-RS		
	ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1 D-0DIW2
	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		(3,-)
	(l ₀ , l ₁)		
	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		
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		(0,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	Not configured
	interval and offset		
	aperiodicTriggerin gOffset		0
	CSI-IM resource		
	Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		
configuration	Mapping		(4,9)
	(k _{CSI-IM} , l _{CSI-IM})		
	CSI-IM timeConfig	slot	Not configured
	interval and offset	3101	-
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	8 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

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
	(CodebookConfig-		
	N1,CodebookConf		(4,1)
Codebook	ig-N2)		
configuration	(CodebookConfig-		
Comiguration	O1,CodebookConf		(4,1)
	ig-O2)		
	CodebookSubsetR		0x FFFF
	estriction		0.000
	RI Restriction		0000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ			4
transmission			4
Measurement channel			R.PDSCH.1-6.2
Note 1: When Throughput is managined using random procedur cologies, 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 i₁, i₂ 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	

6.3.2.1.3 Single PMI with 16TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier space	ing	kHz	15
Duplex Mode			FDD
Propagation ch	annel		TDLC300-5
Antenna configuration			High XP 16 x 2 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		4
ZP CSI-RS	CDM Type		FD-CDM2
configuration	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)

	T =:	ı	
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
NZP CSI-RS for CSI	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁ , k ₂ , k ₃)		Row 12, (2, 4, 6, 8)
acquisition	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggerin gOffset		0
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM configuration	CSI-IM Resource Mapping		(4,9)
	(kcsi-im,lcsi-im) CSI-IM timeConfig	slot	Not configured
interval and offset			-
ReportConfigType CQI-table			Aperiodic Table 1
reportQuantity			cri-RI-PMI-CQI
	ForChannelMeasure		
ments	ForInterferenceMeas		Not configured
urements			Not configured
cqi-FormatIndic			Wideband
pmi-FormatIndi	cator	DD	Subband
Sub-band Size csi-ReportingBa	and	RB	8 1111111
		alat	
CSI-Report inte		slot	Not configured 5
CSI request	Aperiodic Report Slot Offset CSI request		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typel-SinglePanel
	Codebook Mode		1
	(CodebookConfig- N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig- O1,CodebookCon fig-O2)		(4,4)
	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010

Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ			4
transmiss	sion		'
Measure	ment channel		R.PDSCH.1-6.3
Note 1: Note 2:	Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i ₁ , i ₂ combination. 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 3:	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 6.3.2.1.3-2: Minimum requirement

Parameter	Test 1
γ	TBD

6.3.2.1.4 Single PMI with 32TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth	Bandwidth		10
Subcarrier space	cing	kHz	15
Duplex Mode			FDD
Propagation cha	annel		TDLA30-5
Antenna configu	uration		High XP 32 x 2 (N1,N2) = (4,4)
Beamforming M	lodel		As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		32
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁ , k ₂ , k ₃)		Row 17, (2, 4, 6, 8)

	_		_
	First OFDM symbol in the PRB		
	used for CSI-RS		(5, 12)
	(l ₀ , l ₁)		
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggerin gOffset		0
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		1 attern o
configuration	Mapping		(4,9)
oormgara	(ксы-ім,Ісы-ім)		(4,5)
	CSI-IM timeConfig	_	
	interval and offset	slot	Not configured
ReportConfigTy	pe		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionF ments	ForChannelMeasure		Not configured
timeRestrictionForInterferenceMeas urements			Not configured
cqi-FormatIndic	ator		Wideband
pmi-FormatIndio			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
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
	(CodebookConfig-		
On dalah sada	N1,CodebookConf ig-N2)		(4,4)
Codebook configuration	(CodebookConfig- O1,CodebookCon fig-O2)		(4,4)
	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
			R.PDSCH.1-6.3
Measurement channel		L	K.FD3CH.1-0.3

Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i₁, i₂ 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 6.3.2.1.4-2: Minimum requirement

Parameter	Test 1
γ	TBD

6.3.2.2 TDD

6.3.2.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.2.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configuration			FR1.30-1 as specified in Annex A
Propaga	ation channel		TDLA30-5
Antenna	configuration		High XP 4 x 2
			(N1,N2) = (2,1)
Beamfo	rming Model CSI-RS resource		As specified in Annex B.4.1
	Type		Periodic
	Number of CSI-		,
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS	First subcarrier index in the PRB		
configuration	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(0.)
	used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	10/1
	interval and offset	0.01	10,1
	CSI-RS resource Type		Aperiodic
	Number of CSI-		,
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
NIZD OOL DO	First subcarrier		
NZP CSI-RS for CSI	index in the PRB		Row 4, (0,-)
acquisition	used for CSI-RS (k ₀ , k ₁)		
acquisition	First OFDM		
	symbol in the PRB		(40.)
	used for CSI-RS		(13,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	Not configured
	interval and offset aperiodicTriggerin		3
	gOffset		0
	CSI-IM resource		Apariadia
	Туре		Aperiodic
001114	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		(4.0)
configuration	Mapping		(4,9)
	(kcsi-im,lcsi-im) CSI-IM timeConfig		
	interval and offset	slot	Not configured
ReportConfigTy	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		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0

reportTriggerSiz	ze		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
Codobook	(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	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.1 TDD
		in each slo	random precoder selection, the ot (0.5 ms granularity) with equal mbination.
Note 2: If the			

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
Subcar	rier spacing	kHz	30
Dup	lex Mode		TDD
TDD DL-UI	_ configurations		FR1.30-1 as specified in Annex A
Propaga	ation 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,-)
Corniguration	used for CSI-RS		1(0W 5, (4,-)
	(k_0, k_1)		
	First OFDM		
	symbol in the PRB		(0.)
	used for CSI-RS		(9,-)
	(I ₀ , I ₁)		
	CSI-RS		40/4
	interval and offset	slot	10/1
	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		
for CSI	used for CSI-RS		Row 8, (4,6)
acquisition	(k ₀ , k ₁)		
aoquioition	First OFDM		
	symbol in the PRB		
	used for CSI-RS		(5,-)
	(I ₀ , I ₁) CSI-RS		
	interval and offset	slot	Not configured
	mitor ran arra orraot		
	aperiodicTriggerin		0
	gOffset CSI-IM resource		
			Aperiodic
	Type		Dettern 0
CCLIM	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		(4.0)
configuration	Mapping		(4,9)
	(kcsi-im,lcsi-im)		
	CSI-IM timeConfig	slot	Not configured
ReportConfigTy	interval and offset		Apariodic
	ρ ο		Aperiodic Table 1
CQI-table			cri-RI-PMI-CQI
reportQuantity timeRestrictionForlChannelMeasur			CII-KI-PIVII-UQI
ements			Not configured
timeRestrictionForInterferenceMeas			Nat
urements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
			111111
	csi-ReportingBand		Not configured
CSI-Report interval and offset Aperiodic Report Slot Offset		slot	Not configured 8
	IL OIUL OIISEL		1 in slots i, where mod(i, 10) =
CSI request			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
		in each slo	random precoder selection, the ot (0.5 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-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 6.3.2.2.2: Minimum requirement

Parameter	Test 1
γ	1.5

6.3.2.2.3 Single PMI with 16TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Dup	lex Mode		TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propaga	ation channel		TDLC300-5
Antenna configuration			High XP 16 x 2 (N1,N2) = (4,2)
Beamfo	rming Model		As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
ZP CSI-RS configuration	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1

	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁ , k ₂ , k ₃)		Row 12, (2, 4, 6, 8)
acquisition	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggerin gOffset		0
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM configuration	CSI-IM Resource Mapping		(4,9)
	(kcsi-im,lcsi-im) CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigTy			Aperiodic
CQI-table	μ		Table 1
reportQuantity			cri-RI-PMI-CQI
ements	ForlChannelMeasur		Not configured
timeRestrictionF urements	ForInterferenceMeas		Not configured
cqi-FormatIndic			Wideband
pmi-FormatIndio	cator		Subband
Sub-band Size		RB	16
csi-ReportingBa			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset CSI request			1 in slots i, where mod(i, 10) =
reportTriggerSize			1, otherwise it is equal to 0
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)		(4,2)
Ŭ	(CodebookConfig- O1,CodebookCon fig-O2)		(4,4)

	CodebookSubset		
	Restriction		0x FFFF
	RI Restriction		0000010
Physical channel for CSI report			PUSCH
CQI/RI/P	MI delay	ms	6.5
Maximun transmiss	n number of HARQ sion		4
Measurement channel			R.PDSCH.2-8.3 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 economorphic probability of each applicable i ₁ , i ₂ combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6 this reported PMI cannot be applied at the gNB downlink before slot#(n+6).		mbination. k reporting instance at slot#n ik slot not later than slot#(n-6),	
Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			direction shall be used as

Table 6.3.2.2.3-2: Minimum requirement

Parameter	Test 1
γ	TBD

6.3.2.2.4 Single PMI with 32TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcar	rier spacing	kHz	30
Dupl	lex Mode		TDD
TDD DL-UI	_ configurations		FR1.30-1 as specified in Annex A
Propaga	ation channel		TDLA30-5
Antenna	configuration		High XP 32 x 2 (N1,N2) = (4,4)
Beamfo	rming Model		As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		32

	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier		·
	index in the PRB		-
	used for CSI-RS		Row 17, (2, 4, 6, 8)
	(k_0, k_1, k_2, k_3)		
	First OFDM		
	symbol in the PRB		(5.40)
	used for CSI-RS		(5, 12)
	(l ₀ , l ₁)		
	CSI-RS		
	interval and offset	slot	Not configured
	aperiodicTriggerin		0
	gOffset		0
	CSI-IM resource		A
	Туре		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		
configuration	Mapping		(4,9)
	(kcsi-im,lcsi-im)		
	CSI-IM timeConfig	-1-4	Not configured
	interval and offset	slot	Not configured
ReportConfigTy	rpe		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestriction	ForlChannelMeasur		Not configured
ements			Hot cormgared
	ForInterferenceMeas		Not configured
urements			
cqi-FormatIndic			Wideband
pmi-FormatIndio	cator		Wideband
Sub-band Size	d	RB	16
csi-ReportingBa		-1-4	1111111
CSI-Report inte		slot	Not configured
Aperiodic Repo	rt Slot Oliset		8
CSI request			1 in slots i, where mod(i, 10) =
reportTriggerSiz	70		1, otherwise it is equal to 0
report riggersiz	26		One State with one Associated
			Report Configuration
CSI-AperiodicT	rinnarStatal ist		Associated Report
OOI-Aperiodic I	nggerotateList		Configuration contains pointers
			to NZP CSI-RS and CSI-IM
	Codebook Type		typel-SinglePanel
	Codebook Mode		1
	(CodebookConfig-		
Codebook configuration	N1,CodebookConf		(4,4)
	ig-N2)		(', ',
	(CodebookConfig-		
	O1,CodebookCon		(4,4)
	fig-O2)		
	CodebookSubset		0., 5555
	Restriction		0x FFFF
	RI Restriction		0000010

Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ			4
transmiss	sion		4
Measure	ment channel		R.PDSCH.2-8.3 TDD
Note 1:	When Throughput is measured using random precoder selection, the		
Note 2:	precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1 , i_2 combination.		
Note 3:	,		

Table 6.3.2.2.4-2: Minimum requirement

Parameter	Test 1	
γ	TBD	

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)

Subcarrier spacing KHz 15	Parameter		Unit	Test 1
Duplex Mode	Bandwidth		MHz	10
Propagation channel			KHZ	
Antenna configuration				
Beamforming Mode				
Seamforming Model	Antenna configu	uration		
Type	Beamforming M	lodel		
				Periodic
RS ports (X)				. 5.15 4.15
CDM Type				4
Density (p)				FD-CDM2
First subcarrier index in the PRB used for CSI-RS (ko, kr)				1
Index in the PRB used for CSI-RS (k₀, k₁)	7D CSI DS			
Used Iot CSI-RS				Row 5 (4 -)
First OFDM symbol in the PRB used for CSI-RS (lo, lr)	garanon			1.6.1.6, (1,)
Symbol in the PRB used for CSI-RS ([0, 1:))				
Used for CSI-RS				
CSI-RS slot slot slot slot S/1				(9,-)
Interval and offset		(I_0, I_1)		
Interval and offset			slot	5/1
Type			3101	3/1
Number of CSI-RS ports (X)				Aperiodic
RS ports (X)				
CDM Type				4
Density (p)				FD-CDM2
Index in the PRB used for CSI-RS (ko, k1)				1
Second content of the content of t				
acquisition Color Color				Row 4, (0,-)
First OFDM symbol in the PRB used for CSI-RS (lo, l1) CSI-RS interval and offset aperiodicTriggerin gOffset CSI-IM resource Type Aperiodic CSI-IM RE pattern Pattern Pattern 0 CSI-IM Resource Mapping (kcsi-im,lcsi-im) CSI-IM timeConfig interval and offset aperiodic Table 1 ReportConfigType Aperiodic CQI-table Table 1 reportQuantity Cri-RI-PMI-CQI timeRestrictionForChannelMeasure ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator Wideband Sub-band Size RB 8 csi-Report interval and offset slot Not configured Aperiodic Report Slot Offset Aperiodic Report in slot in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				
symbol in the PRB used for CSI-RS (lo, l₁) CSI-RS interval and offset aperiodicTriggerin gOffset CSI-IM resource Type CSI-IM RE pattern CSI-IM Resource Mapping (kcsi-M,lcsi-IM) CSI-IM timeConfig interval and offset ReportConfigType Aperiodic CQI-table Table 1 reportQuantity cri-Ri-PMI-CQI timeRestrictionForChannelMeasure ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator Wideband Sub-band Size RB 8 csi-Report interval and offset slot Not configured Aperiodic Report Slot Offset Slot Not configured Table 1 RB 8 CSI-Report interval and offset Slot Not configured Table 1 Tabl	acquisition			
used for CSI-RS (lo, l1) CSI-RS interval and offset aperiodicTriggerin gOffset CSI-IM resource Type CSI-IM RE pattern CSI-IM Resource Mapping (kcsi-im,lcsi-im) CSI-IM timeConfig interval and offset ReportConfigType CQI-table reportQuantity timeRestrictionForChannelMeasure ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-Report Slot Offset CSI request Not configured				(40.)
CSI-RS interval and offset aperiodic Triggerin gOffset CSI-IM resource Type				(13,-)
interval and offset aperiodicTriggerin gOffset CSI-IM resource Type CSI-IM RE pattern CSI-IM Resource Mapping (kcsi-im,lcsi-im) CSI-IM timeConfig interval and offset ReportConfigType CQI-table reportQuantity timeRestrictionForChannelMeasure ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator pmi-FormatIndicator sub-band Size csi-ReportingBand CSI request Interval and offset Slot Not configured Not configured Not configured Not configured Not configured Not configured Table 1 Table 1 Table 1 Table 1 Toti-Reportingured Not configured Not configured Not configured Not configured Not configured Not configured Viideband Not configured Not configured Not configured Viideband Not configured				
CSI-IM resource Type			slot	Not configured
CSI-IM resource Type CSI-IM RE pattern Pattern 0				_
CSI-IM resource Type CSI-IM RE pattern CSI-IM Resource Mapping (kcsi-IM, lcsi-IM) CSI-IM timeConfig interval and offset ReportConfigType CQI-table reportQuantity timeRestrictionForChannelMeasure ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator sub-band Size csi-Report Slot Offset CSI request CSI-IM Resource Pattern 0 (4,9) (4,9) Not configured Not configured Not configured Not configured Wideband Wideband Sub-band Size Si-Report interval and offset Aperiodic Report Slot Offset 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				0
CSI-IM RE pattern CSI-IM Resource Mapping (KCSI-IM,IcSI-IM) CSI-IM timeConfig interval and offset ReportConfigType Aperiodic CQI-table Table 1 Table 1 TeportQuantity Cri-RI-PMI-CQI timeRestrictionForChannelMeasure ments Not configured timeRestrictionForInterferenceMeas urements ReportConfigured ReportConfigured Table 1 Table 1 TeportQuantity TimeRestrictionForChannelMeasure ments RestrictionForInterferenceMeas urements Rot configured Table 1 TeportQuantity TimeRestrictionForInterferenceMeas Urements RestrictionForInterferenceMeas Urements ReportInterferenceMeas Urements TimeRestrictionForInterferenceMeas Urements ReportInterferenceMeas Urements ReportInterferenc				Anaviadia
CSI-IM Resource Mapping (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 ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator Wideband Sub-band Size RB 8 csi-ReportingBand 1111111 CSI-Report interval and offset Aperiodic Report Slot Offset 4 CSI request 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				Арепосіс
configuration Mapping (kcsl-IM, lcsl-IM) CSI-IM timeConfig interval and offset ReportConfigType Aperiodic CQI-table Table 1 reportQuantity timeRestrictionForChannelMeasure ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator Wideband Sub-band Size RB 8 csi-Report interval and offset Aperiodic Slot Offset CSI request Mapping (4,9) (4,9) (4,9) Not configured Not configured Not configured Wideband Wideband 1111111 CSI-Report interval and offset Slot Not configured 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				Pattern 0
CSI-IM timeConfig interval and offset Slot Not configured				(4.3)
CSI-IM timeConfig interval and offset slot Not configured ReportConfigType Aperiodic CQI-table Table 1 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasure ments Not configured timeRestrictionForInterferenceMeas urements Wideband cqi-Formatlndicator Wideband pmi-Formatlndicator Wideband Sub-band Size RB 8 csi-ReportingBand 1111111 CSI-Report interval and offset slot Not configured Aperiodic Report Slot Offset 4 CSI request 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0	configuration			(4,9)
Interval and offset Slot Not configured				
CQI-table Table 1 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasure ments Not configured timeRestrictionForInterferenceMeas urements Not configured cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB 8 csi-ReportingBand 1111111 CSI-Report interval and offset slot Not configured Aperiodic Report Slot Offset 4 CSI request 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0			slot	Not configured
reportQuantity timeRestrictionForChannelMeasure ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-ReportingBand CSI-Report interval and offset Aperiodic Report Slot Offset CSI request RIST Cri-RI-PMI-CQI Not configured Not configured Wideband Wideband RB 8 8 1111111 Not configured Aperiodic Report Slot Offset 4 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0	ReportConfigType			Aperiodic
timeRestrictionForChannelMeasure ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size Csi-Report interval and offset Aperiodic Report Slot Offset CSI request Not configured Wideband Wideband Wideband 1111111 Not configured 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				
ments timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-ReportingBand CSI-Report interval and offset Aperiodic Report Slot Offset CSI request Not configured Wideband Wideband 1111111 Not configured Not configured 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				cri-RI-PMI-CQI
timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size CSI-Report interval and offset CSI request Not configured Wideband Wideband Not configured Wideband Sub-band Size RB 8 1111111 Not configured A lin slots i, where mod(i, 5) = 1, otherwise it is equal to 0				Not configured
urements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size Csi-ReportingBand CSI-Report interval and offset Aperiodic Report Slot Offset CSI request Not configured Wideband Wideband 1111111 Not configured A l in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				
cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB 8 csi-ReportingBand 1111111 CSI-Report interval and offset slot Not configured Aperiodic Report Slot Offset 4 CSI request 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				Not configured
Sub-band Size CSi-ReportingBand CSI-Report interval and offset Aperiodic Report Slot Offset CSI request RB 8 1111111 Not configured 4 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0				Wideband
csi-ReportingBand 1111111 CSI-Report interval and offset slot Not configured Aperiodic Report Slot Offset 4 CSI request 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0		cator		-
CSI-Report interval and offset slot Not configured Aperiodic Report Slot Offset 4 CSI request 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0			RB	_
Aperiodic Report Slot Offset CSI request 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0			0104	
CSI request 1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0			SIOT	
otherwise it is equal to 0	•			-
	CSI request			
	reportTriggerSiz	ze		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 chann	el for CSI report		PUSCH
CQI/RI/PMI delay		ms	6
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.1 FDD
• .		in each slo	random precoder selection, the ot (1 ms granularity) with equal

probability of each applicable i₁, i₂ 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

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.

	2-1: Test parameters	Unit	Test 1
(dual-layer) Parameter		MHz	10
	Bandwidth Subsection angling		10 15
Subcarrier spacing Duplex Mode		kHz	FDD
Propagation cha	annel		TDLA30-5
			High XP 8 x 4
Antenna configu	ıratıon		(N1,N2) = (4,1)
Beamforming M	odel		As specified in Annex B.4.1
_	CSI-RS resource		Periodic
	Type		r enouic
	Number of CSI-		4
	RS ports (X)		
	CDM Type		FD-CDM2
	Density (ρ) First subcarrier		1
ZP CSI-RS	index in the PRB		
configuration	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(9,-)
	used for CSI-RS		(3,-)
	(I_0, I_1)		
	CSI-RS	slot	5/1
	interval and offset CSI-RS resource		
	Type		Aperiodic
	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		, (, , , , ,
acquisition	(k ₀ , k ₁) First OFDM		
	symbol in the PRB		
	used for CSI-RS		(5,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	Not configured
	interval and offset	3101	140t configured
	aperiodicTriggerin		0
	gOffset CSI-IM resource		-
	Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		1 auditi 0
configuration	Mapping		(4,9)
	(kcsi-im,lcsi-im)		,
	CSI-IM timeConfig	slot	Not configured
interval and offset		3.01	
ReportConfigType			Aperiodic
CQI-table			Table 1 cri-RI-PMI-CQI
reportQuantity timeRestrictionForChannelMeasure			
ments			Not configured
timeRestrictionForInterferenceMeas			N. C.
urements	urements		Not configured
cqi-FormatIndic	ator	-	Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			5 1 in slots i, where mod(i, 5) = 1,
CSI request	CSI request		otherwise it is equal to 0

reportTrig	gerSiz	e		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
Codobool	l.	(CodebookConfig- N1,CodebookConfig-N2)		(4,1)
Codebook configuration		(CodebookConfig- O1,CodebookCon fig-O2)		(4,1)
		CodebookSubset Restriction		0x FFFF
	RI Restriction			0000010
Physical of	Physical channel for CSI report			PUSCH
CQI/RI/PI	MI dela	ay	ms	8
Maximum transmiss		er of HARQ		4
Measurer	nent c	hannel		R.PDSCH.1-6.2 FDD
Note 1:	Whe	n Throughput is meas	ured using	random precoder selection, the
precoder shall be updated in each slot (1 ms granular probability of each applicable i1, i2 combination.			mbination.	
Note 2: If the UE reports in an available uplink reporting instance at slot#r 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).		nk slot not later than slot#(n-4), at the gNB downlink before		
Note 3:	te 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			direction shall be used as

Table 6.3.3.1.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

6.3.3.1.3 Single PMI with 16TX TypeI-SinglePanel Codebook

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

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

Pai	rameter	Unit	Test 1
Bandwidth	Bandwidth		10
Subcarrier space	ing	kHz	15
Duplex Mode			FDD
Propagation cha	annel		TDLC300-5
Antenna configu	ıration		High XP 16 x 4
Antenna comigi	uration		(N1,N2) = (4,2)
Beamforming M	lodel		As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
ZP CSI-RS configuration	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1

		1	
	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁ , k ₂ , k ₃)		Row 12, (2, 4, 6, 8)
acquisition	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggerin gOffset		0
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigTy	/pe		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestriction	ForChannelMeasure		Not configured
	ments timeRestrictionForInterferenceMeas		Not configured
cqi-FormatIndic	rator		Wideband
pmi-FormatIndio			Subband
Sub-band Size	cator	RB	8
		KD	-
	csi-ReportingBand CSI-Report interval and offset		1111111
	Aperiodic Report Slot Offset		Not configured 5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSiz	ze		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)		(4,2)
	(CodebookConfig- O1,CodebookCon fig-O2)		(4,4)

	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010
Physical channel for CSI report			PUSCH
CQI/RI/P	MI delay	ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3 FDD
Note 1: When Throughput is measured using random pre precoder shall be updated in each slot (1 ms gran probability of each applicable i ₁ , i ₂ combination. Note 2: If the UE reports in an available uplink reporting ir based on PMI estimation at a downlink slot not lat this reported PMI cannot be applied at the gNB do slot#(n+4).		ot (1 ms granularity) with equal mbination. k reporting instance at slot#n k slot not later than slot#(n-4),	
Note 3:	,		

Table 6.3.3.1.3-2: Minimum requirement

Parameter	Test 1
γ	TBD

6.3.3.1.4 Single PMI with 32TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier space	cing	kHz	15
Duplex Mode			FDD
Propagation cha	annel		TDLA30-5
Antenna configuration			High XP 32 x 4 (N1,N2) = (4,4)
Beamforming M	lodel		As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)
Ü	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		32
acquisition	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1

		,	
	First subcarrier index in the PRB used for CSI-RS		Row 17, (2, 4, 6, 8)
	(k ₀ , k ₁ , k ₂ , k ₃) First OFDM symbol in the PRB used for CSI-RS		(5, 12)
	(I ₀ , I ₁) CSI-RS interval and offset	slot	Not configured
	aperiodicTriggerin gOffset		0
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigTy	pe		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure ments			Not configured
timeRestrictionF urements	timeRestrictionForInterferenceMeas		Not configured
cgi-FormatIndic	cqi-FormatIndicator		Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand		IND.	1111111
CSI-Report interval and offset		olot	
		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
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 (CodebookConfig- N1,CodebookConfig- ig-N2)		1 (4,4)
Codebook configuration	(CodebookConfig- O1,CodebookCon fig-O2)		(4,4)
	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 c	hannel		R.PDSCH.1-6.3 FDD
Note 1: When Throughput is most			

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 i₁, i₂ combination.

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

Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.

Table 6.3.3.1.4-2: Minimum requirement

Parameter	Test 1
γ	TBD

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)

Pai	rameter	Unit	Test 1
Bandwidth		MHz	10
Subcarrier spac	ing	kHz	15
Duplex Mode			FDD
Propagation cha	annel		TDLA30-5
Antenna configu	ıration		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-0DIVIZ
	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		(0.)
	used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	5/1
	interval and offset	0.01	G, .
	CSI-RS resource		Aperiodic
	Type Number of CSI-RS		·
			8
	ports (X) CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier		I I
NZP CSI-RS	index in the PRB		
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 ₀ , l ₁)		
	CSI-RS	slot	Not configured
	interval and offset	0.01	. tot cogarca
	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)
Comigaration	(k _{CSI-IM} ,l _{CSI-IM})		(4,0)
	CSI-IM timeConfig		
	interval and offset	slot	Not configured
ReportConfigTy			Aperiodic
CQI-table			Table 1
reportQuantity	reportQuantity		cri-RI-PMI-CQI
timeRestrictionForChannelMeasure			Not configured
ments			. ist somigatod
timeRestrictionForInterferenceMeas			Not configured
urements			-
cqi-FormatIndicator			Wideband
pmi-FormatIndicator		DD	Wideband
Sub-band Size		RB	8 1111111
	csi-Report interval and offset		Not configured
CSI-Report interval and offset Aperiodic Report Slot Offset		slot	5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSiz	'Δ		1
reportriiggersize		<u> </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 configuration	(CodebookConfig- N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig- O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetR estriction		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 FDD

When Throughput is measured using random precoder selection, the Note 1: precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i₁, i₂ combination.

If the UE reports in an available uplink reporting instance at slot#n

Note 2: 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). Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.

Note 3:

In Annex B.2.3.2.3.			
Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spac	ing	kHz	30
Duplex Mode			TDD
TDD DL-UL con	figuration		FR1.30-1 as specified in Annex A
Propagation cha	annel		TDLA30-5
Antenna configu	ıration		High XP 4 x 4 (N1,N2) = (2,1)
Beamforming M	odel		As specified in Annex B.4.1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(9,-)
	CSI-RS interval and offset	slot	10/1
	CSI-RS resource Type		Aperiodic
NZP CSI-RS for CSI	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
acquisition	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 4, (0,-)

	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(13,-)
	CSI-RS interval and offset		Not configured
	aperiodicTriggerin gOffset		0
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigTy	pe		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionF ments	orChannelMeasure		Not configured
timeRestrictionF urements	ForInterferenceMeas		Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSiz	:e		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,CodebookConfig-O2)		(4,1)
	CodebookSubsetR estriction		11111111
	RI Restriction		0000001
Physical channe	el 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 measu			

Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i₁, i₂ combination.

probability of each applicable i₁, i₂ combination.

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

Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.

Table 6.3.3.2.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.3.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.2.2-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.2-2.

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

Parameter		Unit MHz	Test 1
Bandwidth			40
Subcarrier space	eing	kHz	30
Duplex Mode			TDD
TDD DL-UL cor	nfigurations		FR1.30-1 as specified in Annex A
Propagation cha	annel		TDLA30-5
Antenna configu	uration		High XP 8 x 4
Beamforming M			(N1,N2) = (4,1) As specified in Annex B.4.1
Bearmonning iv	CSI-RS resource		
	Туре		Periodic
	Number of CSI-		4
	RS ports (X) CDM Type		FD-CDM2
	Density (ρ)		1 1
7D 001 D0	First subcarrier		·
ZP CSI-RS configuration	index in the PRB		Pow 5 (4)
Configuration	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS	alat	10/1
	interval and offset	slot	10/1
	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		Row 8, (4,6)
for CSI acquisition	used for CSI-RS (k ₀ , k ₁)		
acquisition	First OFDM		
	symbol in the PRB		(5.)
	used for CSI-RS		(5,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	Not configured
	interval and offset aperiodicTriggerin		
	gOffset		0
	CSI-IM resource		Aperiodic
	Type		· ·
CSI-IM	CSI-IM RE pattern CSI-IM Resource		Pattern 0
configuration	Mapping		(4,9)
3	(kcsi-im,lcsi-im)		(1,0)
	CSI-IM timeConfig	slot	Not configured
D 10 " T	interval and offset	Olot	-
ReportConfigTy CQI-table	/pe		Aperiodic Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannnelMeasur			
ements			Not configured
timeRestrictionForInterferenceMeas			Not configured
urements			
cqi-FormatIndicator			Wideband Wideband
pmi-FormatIndicator Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Repo	rt Slot Offset		8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0

Note 3:

reportTrigge	rSize		1
CSI-Aperiod	cTriggerStateList		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 cha	nnel for CSI report		PUSCH
CQI/RI/PMI	delay	ms	6.5
	Maximum number of HARQ transmission		4
Measuremer	nt channel		R.PDSCH.2-8.2 TDD
Note 1: When Throughput is measured using random precoder selection, t precoder shall be updated in each slot (0.5 ms granularity) with equiprobability of each applicable i ₁ , i ₂ combination.		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) this reported PMI cannot be applied at the gNB downlink before slot#(n+6)		k reporting instance at slot#n nk slot not later than slot#(n-6),	

Table 6.3.3.2.2-2: Minimum requirement

Randomization of the principle beam direction shall be used as

Parameter	Test 1
γ	1.5

6.3.3.2.3 Single PMI with 16TX TypeI-SinglePanel Codebook

specified in Annex B.2.3.2.3.

For the parameters specified in Table 6.3.3.2.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.3-2.

Table 6.3.3.2.3-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier space	cing	kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation cha	annel		TDLC300-5
Antenna configuration			High XP 16 x 4 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
_	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		4
ZP CSI-RS	CDM Type		FD-CDM2
configuration	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)

	T		
	First OFDM symbol in the PRB used for CSI-RS (l ₀ , l ₁)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
NZP CSI-RS for CSI	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁ , k ₂ , k ₃)		Row 12, (2, 4, 6, 8)
acquisition	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggerin gOffset		0
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		
configuration	Mapping (kcsi-ім,lcsi-ім)		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigTy	/pe		Aperiodic
CQI-table			Table 1
reportQuantity	reportQuantity		cri-RI-PMI-CQI
timeRestrictionI ements	ForChannnelMeasur		Not configured
timeRestrictionI urements	ForInterferenceMeas		Not configured
cqi-FormatIndic	ator		Wideband
pmi-FormatIndi	cator		Subband
Sub-band Size		RB	16
csi-ReportingBa			1111111
CSI-Report inte		slot	Not configured
Aperiodic Repo	rt Slot Offset		8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSiz	ze		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- ig-N2)		(4,2)
	(CodebookConfig- O1,CodebookCon fig-O2)		(4,4)
	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010

Physical	channel for CSI report		PUSCH
CQI/RI/P	CQI/RI/PMI delay		6.5
Maximum	n number of HARQ		4
transmiss	sion		4
Measure	ment channel		R.PDSCH.2-8.3 TDD
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal			ot (0.5 ms granularity) with equal
Note 2:	probability of each applicable i ₁ , i ₂ combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before		
Note 3:	slot#(n+6). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.		

Table 6.3.3.2.3-2: Minimum requirement

Parameter	Test 1
γ	TBD

6.3.3.2.4 Single PMI with 32TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.2.4-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.4-2.

Table 6.3.3.2.4-1: Test parameters (dual-layer)

Pai	rameter	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	uration		High XP 32 x 4 (N1,N2) = (4,4)
Beamforming M	lodel		As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS	CSI-RS resource Type		Aperiodic
for CSI	Number of CSI- RS ports (X)		32
acquisition	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1

	I		
	First subcarrier		
	index in the PRB		Row 17, (2, 4, 6, 8)
	used for CSI-RS		
	(k ₀ , k ₁ , k ₂ , k ₃) First OFDM		
	symbol in the PRB		
	used for CSI-RS		(5, 12)
	(I ₀ , I ₁) CSI-RS		
	interval and offset	slot	Not configured
	aperiodicTriggerin		
	gOffset		0
	CSI-IM resource		
	Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource		i duo c
configuration	Mapping		(4,9)
3	(kcsi-im,lcsi-im)		(1,5)
	CSI-IM timeConfig		
	interval and offset	slot	Not configured
ReportConfigTy			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
	orChannnelMeasur		
ements			Not configured
timeRestrictionF	ForInterferenceMeas		N
urements			Not configured
cqi-FormatIndic	ator		Wideband
pmi-FormatIndicator			Wideband
pini-i omiamian	-		
Sub-band Size		RB	16
Sub-band Size		RB	
	and	RB slot	16
Sub-band Size csi-ReportingBa	and rval and offset		16 1111111 Not configured 8
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo	and rval and offset		16 1111111 Not configured
Sub-band Size csi-ReportingBa CSI-Report inte	and rval and offset		16 1111111 Not configured 8
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo	and rval and offset rt Slot Offset		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) =
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request	and rval and offset rt Slot Offset		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) =
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request	and rval and offset rt Slot Offset		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request	and rval and offset rt Slot Offset		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSize	and rval and offset rt Slot Offset		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSize	rval and offset rt Slot Offset ze riggerStateList		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSize	rval and offset rt Slot Offset ze riggerStateList Codebook Type		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSize	rval and offset rt Slot Offset re riggerStateList Codebook Type Codebook Mode		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSize	rval and offset rt Slot Offset re riggerStateList Codebook Type Codebook Mode (CodebookConfig-		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typeI-SinglePanel 1
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSize	rval and offset rt Slot Offset re riggerStateList Codebook Type Codebook Mode (CodebookConfig- N1,CodebookConf		16 1111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz	rval and offset rt Slot Offset re riggerStateList Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2)		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typeI-SinglePanel 1
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT	riggerStateList Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) (CodebookConfig-N2)		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4)
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz	riggerStateList Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) (CodebookConfig-O1,		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typeI-SinglePanel 1
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT	riggerStateList Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) (CodebookConfig-O1,CodebookConfig-O1,CodebookConfig-O2)		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4)
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT	ryal and offset rt Slot Offset regerStateList Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) (CodebookConfig-O1,CodebookConfig-O2) CodebookSubset		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4)
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT	riggerStateList Codebook Type CodebookConfig-N1,CodebookConfig-N2) (CodebookConfig-O1,CodebookConfig-O2) CodebookSubset Restriction		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4) (4,4)
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT	riggerStateList Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) (CodebookConfig-O1,CodebookConfig-O2) CodebookSubset Restriction RI Restriction		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4) (4,4) 0x FFFF 000000010
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT Codebook configuration	rval and offset rt Slot Offset re riggerStateList Codebook Type CodebookConfig- N1,CodebookConfig- N2) (CodebookConfig- O1,CodebookConfig- O1,CodebookConfig- O2) CodebookSubset Restriction RI Restriction	slot	16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4) (4,4) 0x FFFF 00000010 PUSCH
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT Codebook configuration Physical channe CQI/RI/PMI dela	rval and offset rt Slot Offset re riggerStateList Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) (CodebookConfig-O1,CodebookConfig-O2) CodebookSubset Restriction RI Restriction el for CSI report		16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4) (4,4) 0x FFFF 000000010
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT Codebook configuration Physical channe CQI/RI/PMI dela Maximum numb	rval and offset rt Slot Offset re riggerStateList Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) (CodebookConfig-O1,CodebookConfig-O2) CodebookSubset Restriction RI Restriction el for CSI report	slot	16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4) (4,4) 0x FFFF 00000010 PUSCH
Sub-band Size csi-ReportingBa CSI-Report inte Aperiodic Repo CSI request reportTriggerSiz CSI-AperiodicT Codebook configuration Physical channe CQI/RI/PMI dela	rval and offset rt Slot Offset ze riggerStateList Codebook Type Codebook Mode (CodebookConfig- N1,CodebookConfig- O1,CodebookConfig- O1,CodebookConfig- O1,CodebookSubset Restriction RI Restriction el for CSI report ay per of HARQ	slot	16 111111 Not configured 8 1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0 1 One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM typel-SinglePanel 1 (4,4) (4,4) 0x FFFF 000000010 PUSCH 6.5

Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i₁, i₂ 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-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 6.3.3.2.4-2: Minimum requirement

Parameter	Test 1
γ	TBD

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 spa	acing	kHz	15	15	15
Duplex Mode			FDD	FDD	FDD
SNR		dB	0	20	20
Propagation c			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
			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 1	FD-CDM2	FD-CDM2
configuratio	First subcarrier index in the		1	1	1
n	PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
''	First OFDM symbol in the PRB				
	used for CSI-RS (I ₀ , I ₁)		(9,-)	(9,-)	(9,-)
	CSI-RS				-11
	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
NZD OOL	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
NZP CSI- RS for CSI	Density (ρ)		1	1	1
acquisition	First subcarrier index in the		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
	PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB		- (-,)	- (-, /	- (-,)
	used for CSI-RS (I ₀ , I ₁)		(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig				
	periodicity and offset	slot	5/1	5/1	5/1
	CSI-IM resource Type		Periodic	Periodic	Periodic
001.184	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0
CSI-IM configuratio	CSI-IM Resource Mapping		(4.0)	(4.0)	
n	(kcsi-im,lcsi-im)		(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	5/1	5/1	5/1
ReportConfig			Periodic	Periodic	Periodic
CQI-table	. , , , ,		Table 2	Table 2	Table 2
	_			cri-RI-PMI-	cri-RI-PMI-
reportQuantity	1		cri-RI-PMI-CQI	CQI	CQI
timeRestrictio	nForChannelMeasurements		not configured	not configured	not configured
				not	not
timeRestriction	nForInterferenceMeasurements		not configured	configured	configured
cqi-FormatInd	icator		Wideband	Wideband	Wideband
pmi-FormatInd			Wideband	Wideband	Wideband
Sub-band Size		RB	8	8	8
csi-ReportingI	Band		1111111	1111111	1111111
CSI-Report pe	eriodicity and offset	slot	5/0	5/0	5/0
	Codebook Type		typel-	typel-	typel-
			SinglePanel	SinglePanel	SinglePanel
	Codebook Mode		1	1	1
0-4-1	(CodebookConfig-		N/A	N/A	N/A
Codebook	N1,CodebookConfig-N2)			000011 for	
configuration	CodebookSubsetRestriction		010000 for fixed rank 2,	fixed rank 1,	000011 for fixed rank 1,
			010011 for	010011 for	010011 for
			following rank	following rank	following rank
	RI Restriction		N/A	N/A	N/A
Physical chan	nel for CSI report		PUCCH	PUCCH	PUCCH
CQI/RI/PMI de		ms	8	8	8
	nber of HARQ transmission		1	1	1
RI Configurati			Fixed RI = 2	Fixed RI = 1	Fixed RI = 1
1XI Comigurati	OII		and follow RI	and follow RI	and follow RI

Table 6.4.2.1-2: Minimum requirement (FDD)

	Test 1	Test 2	Test 3
24	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)

	Parameter	Unit	Test 1	Test 2	Test 3
Bandwidth	1 diameter	MHz	40	40	40
Subcarrier sp	acing	kHz	30	30	30
Duplex Mode			TDD	TDD	TDD
TDD Slot Cor			FR1.30-1	FR1.30-1	FR1.30-1
SNR		dB	0	20	20
Propagation of	channel		TDLA30-5	TDLA30-5	TDLA30-5
Antenna conf	iguration		ULA Low 2x2	ULA Low 2x2	ULA High 2x2
Doomforming	Madal		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 n	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
	First OFDM symbol in the PRB		(2.)	(5.)	(2.)
	used for CSI-RS (I ₀ , I ₁)		(9,-)	(9,-)	(9,-)
	CSI-RS	-1-4	40/4	40/4	40/4
	periodicity and offset	slot	10/1	10/1	10/1
	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		2	2	2
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
NZP CSI-	Density (ρ)		1	1	1
RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
acquioinon	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	10/1	10/1
	CSI-IM resource Type		Periodic	Periodic	Periodic
	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0
CSI-IM configuratio	CSI-IM Resource Mapping		(4,9)	(4,9)	(4,9)
n	(kcsi-im,lcsi-im) CSI-IM timeConfig				
	periodicity and offset	slot	10/1	10/1	10/1
ReportConfig			Periodic	Periodic	Periodic
CQI-table	71		Table 2	Table 2	Table 2
ranartOuantity	,		ori DI DMI COL	cri-RI-PMI-	cri-RI-PMI-
reportQuantity	y		cri-RI-PMI-CQI	CQI	CQI
timeRestrictio	nForChannelMeasurements		not configured	not configured	not configured
timePestrictio	nForInterferenceMeasurements		not configured	not	not
umercestrictio	The office reference we as a rements		•	configured	configured
cqi-FormatInd			Wideband	Wideband	Wideband
pmi-FormatIn			Wideband	Wideband	Wideband
Sub-band Siz		RB	16	16	16
csi-Reporting			1111111	1111111	1111111
CSI-Report pe	eriodicity and offset	slot	10/9	10/9	10/9
	Codebook Type		typel-	typel-	typel-
	Codebook Mode		SinglePanel 1	SinglePanel	SinglePanel 1
	(CodebookConfig-		N/A	N/A	N/A
Codebook	N1,CodebookConfig-N2)				
configuration	CodebookSubsetRestriction		010000 for	000011 for	000011 for
			fixed rank 2,	fixed rank 1,	fixed rank 1,
			010011 for	010011 for	010011 for
	RI Restriction		following rank N/A	following rank	following rank N/A
Dhysical char	nnel for CSI report		PUCCH	N/A PUCCH	PUCCH
CQI/RI/PMI d		ms	9.5	9.5	9.5
	nber of HARQ transmission	1115	9.5	9.5	9.5 1
			Fixed RI = 2	Fixed RI = 1	Fixed RI = 1
RI Configurati	ion		and follow RI	and follow RI	and follow RI
-			•	•	

Table 6.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
21	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 sp	acing	kHz	15	15	15	15
Duplex Mode			FDD	FDD	FDD	FDD
SNR		dB	-2	16	16	22
Propagation of	channel		TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna conf	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
Beamlonning			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 n	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
"	First OFDM symbol in the PRB		(9,-)	(9,-)	(9,-)	(9,-)
	used for CSI-RS (l ₀ , l ₁) CSI-RS		(9,-)	(9,-)	(9,-)	(9,-)
	periodicity and offset	slot	5/1	5/1	5/1	5/1
	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 PRB used for CSI-RS (k ₀ , k ₁)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)	Row 4 (0,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(13,-)	(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	5/1	5/1	5/1
	CSI-IM resource Type		Periodic	Periodic	Periodic	Periodic
001.114	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0	Pattern 0
CSI-IM configuratio	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)	(4,9)	(4,9)	(4,9)
n	CSI-IM timeConfig periodicity and offset	slot	5/1	5/1	5/1	5/1
ReportConfig			Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantit	у		cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestriction	onForChannelMeasurements		not configured	not	not configured	not
timeRestrictio	onForInterferenceMeasurements		not configured	configured not	not	configured not
				configured	configured	configured
cqi-FormatInd			Wideband	Wideband	Wideband	Wideband
pmi-FormatIn Sub-band Siz		RB	Wideband	Wideband	Wideband	Wideband
csi-Reporting		ND.	8 1111111	8 1111111	8 1111111	8 1111111
	eriodicity and offset	slot	5/0	5/0	5/0	5/0
ooi-ixepoit p	Codebook Type	3101	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,	444444
configuration			010011 for following rank	010011 for following rank	010011 for following rank	11111111
	RI Restriction		10.10 Willing Turin	.o.oming rank	.o.ownig raint	00000010 for
						fixed Rank 2
			N/A	N/A	N/A	and
		l	1			00001111 for
Physical char	onel for CSI report		DIICCH	DIICCH	DIICCL	follow RI
Physical char	nnel for CSI report	ms	PUCCH 8	PUCCH 8	PUCCH 8	

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		Unit	Test 1	Test 2	Test 3	Test 4
Bandwidth		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 ₀ , k ₁)		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
n	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(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 ₀ , k ₁)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)	Row 4 (0,-)
·	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(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 configuratio n	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
Physical channel for CSI report		 	DUOQU	DUCCU	PUCCH	PUCCH
Physical char	nnel for CSI report		PUCCH	PULLA	1 100.00	700.00
Physical char CQI/RI/PMI de		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>γ</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.

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Table 7.1.1.4-1: 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-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
	FR2 TDD	PDSCH	Clause 7.2	
Support of PT-RS with one antenna port for DL reception (onePortsPTRS)		SDR	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
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 ₁ , i ₂ 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 CSIRS (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

				Start PRB 0
	Frequency Occ	unation		Number of PRB = BWP
	1 requeries cos	apation		size
	QCL info			TCI state #0
		index in the PRB used for CSI-		
	RS (<i>k</i> ₀)			0
	First OFDM syn	nbol in the PRB used for CSI-RS		12
	(<i>I</i> ₀)			
	Number of CSI-	RS ports (X)		2
	CDM Type			FD-CDM2
NZP CSI-RS for	Density (ρ)			1
CSI acquisition	CSI-RS periodic	city	Slots	60 kHz SCS: 80
	•	,		120 kHz SCS: 160
	CSI-RS offset			O Ctort DDD 0
	F			Start PRB 0
	Frequency Occ	upation		Number of PRB = BWP
	QCL info			size TCI state #1
		index in the PRB used for CSI-		TCI state #1
	RS (k ₀)	index in the FKB used for CSI-		4
		nbol in the PRB used for CSI-RS		
	(I_0)	ibor in the FRB used for GOFRE		12
	Number of CSI-	RS ports (X)		4
	CDM Type	(**)		FD-CDM2
ZP CSI-RS for CSI	Density (ρ)			1
acquisition	, W		Clata	60 kHz SCS: 80
	CSI-RS periodic	жу	Slots	120 kHz SCS: 160
	CSI-RS offset			0
				Start PRB 0
	Frequency Occupation			Number of PRB = BWP
				size
	First subcarrier index in the PRB used for CSI-			k ₀ =0 for CSI-RS
	RS			resource 1,2
	First OFDM symbol in the PRB used for CSI-RS			I ₀ = 8 for CSI-RS resource 1
				l ₀ = 9 for CSI-RS
				resource 2
				1 for CSI-RS resource
	Number of CSI-	RS ports (X)		1,2
	ODM Torre			'No CDM' for CSI-RS
CSI-RS for beam	CDM Type			resource 1,2
refinement	Density (ρ)			3 for CSI-RS resource
	Definity (p)			1,2
				60 kHz SCS: 80 for CSI-
	CSI-RS periodic	citv	Slots	RS resource 1,2
		Col-10 periodicity		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
	QOLIIIIO			
				{1000} for Rank 1 tests
	Antenna ports in	ndexes		{1000, 1001} for Rank 2
	/ into into in			tests
PDSCH DMRS				
configuration	D = = 141 = = 4 41 = 4	inst DMDO to a DDOOLL or and in a		
		irst DMRS for PDSCH mapping		2
	type A			
		CH DMRS CDM group(s) without		1
	data	OOD in day		
	Type 1 QCL information	SSB index		SSB #0
TCI state #0	miormation	QCL Type		Type C
		SSB index		SSB #0
<u> </u>	I.			

	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
TCI 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		2
PTRS configuration	Time density (L		1
	Resource Elem	ı	2
		s for ACK/NACK feedback	1
Maximum number of	HARQ transmiss	ion	4
HARQ ACK/NACK bundling			Multiplexed
Redundancy version	coding sequence		{0,2,3,1}
			Single Panel Type I, Random precoder selection updated per
PDSCH & PDSCH DMRS Precoding configuration			slot, with equal probability of each applicable i ₁ , i ₂ combination, andwith Wideband granularity
Symbols for all unused REs			OCNG in Annex A.5
Physical signals, channels mapping and precoding		As specified in Annex B.4.1	
transmissio	on.	ate for the PDSCH is identical to the num guard band as specified in Table	• •

tested channel bandwidth and subcarrier spacing.

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

Table 7.2-2: Number of PRBs in CORESET

1RX requirements 7.2.1

(Void)

2RX requirements 7.2.2

7.2.2.1 **FDD**

(Void)

7.2.2.2 **TDD**

7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A

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

The test purposes are specified in Table 7.2.2.1.1-1.

Table 7.2.2.1.1-1: Tests purpose

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

Table 7.2.2.2.1-2: Test Parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP index			1
CSI-RS for tracking	First OFDM symbol in the PRB used for CSI-RS (<i>l</i> ₀)		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 _{RBs} = 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)

		Randwidth				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 _B _B (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	Referenc	e value
Test num	Reference channel	(MHz) / Subcarrier spacing (kHz)	r nand UL-DL i		Propagatio n condition	n antenna condition configuratio n		SNR _{BB} (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

Test num	Reference channel	Bandwidt h (MHz) / Subcarrier spacing (kHz)	Modulatio n and code rate	TDD UL- DL pattern	Propagatio n condition	Correlation matrix and antenna configuratio n	Reference Fraction of maximum throughpu t (%)	SNR _B B (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	!	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
	4554.5.55.			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		applicable i ₁ , i ₂ 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				
Symbols for all un	used REs	OCNG in Annex A.5					
Note 1: Point A coincides with minimum guard band as specified in Table 5.3.3-1							

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.

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.

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

0

Table 7.3.2.2-1: Test Parameters

7.3.2.2.1 1 Tx Antenna performances

Shift index

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	CORESET	Aggregation	Deference	Dranagation	Antenna configuration	_	erence alue
num ber	(MHz)	ET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	and correlation Matrix	Pm- dsg (%)	SNR _{BB} (dB)
1-1	100	60	1	2	R.PDCCH. 5-1.1 TDD	TDLA30-75	1x2 Low	1	6.4
1-2	100	60	1	4	R.PDCCH. 5-1.2 TDD	TDLA30-300	1x2 Low	1	3.0

7.3.2.2.2 2 Tx Antenna performances

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

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

Test	Dan duridéh	CORESE	CORESET	Aggregation	RESET Aggregation	on Reference Propa		Reference	Dranagation	Antenna configuration	-	erence alue
num ber	Bandwidth (MHz)	CORESE T RB	CORESET duration	level	Channel	Propagation Condition	and correlation Matrix	Pm- dsg (%)	SNR _{BB} (dB)			
2-1	100	60	1	8	R.PDCCH. 5-1.3 TDD	TDLA30-75	2x2 Low	1	0.1			
2-2	100	60	2	16	R.PDCCH. 5-2.1 TDD	TDLA30-75	2x2 Low	1	-3.0			

7.4 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	Reference valu	
number	Subcarrier spacing (kHz)	channel	condition	and correlation matrix	Pm- bch (%)	SNR _{BB} (dB)
1	100 / 120	R.PBCH.5	TDLA30-300	1 x 2 Low	1	-6.3
2	100 / 240	R.PBCH.6	TDLA30-75	1 x 2 Low	1	-6.1

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

Test	Bandwidth (MHz) /	Reference	Propagation	Antenna configuration	Refere	nce value
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_j is the total number of DL-SCH transport block bits calculated based on methodology in Clause 5.1.3.2 of TS 38.214 [12] and using parameters from Table 7.5A.1-1

μ_i 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
Comigaration	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
Comgulation	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 _{PT-RS})		2
configuration	Time density (L _{PT-RS})	-	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		I ₀ = 6 for CSI-RS resource 1 and 3 I ₀ = 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)		5 101 001-100 1630u106 1,2,3,4

	_			
				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	
				120 kHz SCS:
				80 for CSI-RS resource 1 and 2
				81 for CSI-RS resource 3 and 4
	Frequency Occupa	ation		Start PRB 0
				Number of PRB = BWP size
	QCL info	in the PRB used for		TCI state #0
	CSI-RS	III the PKD used for		$k_0 = 4$
		the PRB used for CSI-		
	RS			l ₀ = 13
	Number of CSI-RS	ports (X)		Same as number of transmit antenna
NZP CSI-RS for	CDM Type			'FD-CDM2'
CSI acquisition	Density (ρ)			1
Coracquionion	CSI-RS periodicity		Slots	60 kHz SCS: 80
				120 kHz SCS: 160
	CSI-RS offset			0 Start PRB 0
	Frequency Occupa	ation		Number of PRB = BWP size
	QCL info			TCI state #1
		in the PRB used for		
	CSI-RS	111 1110 1 1110 4004 101		$k_0 = 0$
	OFDM symbols in RS	the PRB used for CSI-		l ₀ = 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
	Frequency Occupa	ation		Start PRB 0
				Number of PRB = BWP size
	CSI-RS	ex in the PRB used for		k ₀ =0 for CSI-RS resource 1,2
		I in the PRB used for		l ₀ = 8 for CSI-RS resource 1
	CSI-RS Number of CSI-RS	norto (V)		l ₀ = 9 for CSI-RS resource 2 1 for CSI-RS resource 1,2
	CDM Type	ports (A)		'No CDM' for CSI-RS resource 1,2
CSI-RS for beam	Density (ρ)			3 for CSI-RS resource 1,2
refinement	Boriotty (p)			60 kHz SCS: 80 for CSI-RS resource
	CCL DC poriodicity		Slots	1,2
	CSI-RS periodicity		31015	120 kHz SCS: 160 for CSI-RS
	001.50 (/			resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Repetition			ON
	QCL info Tyoe 1 QCL	SSB index		TCI state #1 SSB #0
	information	QCL Type		Type C
TCI state #0	Tyoe 2 QCL	SSB index		SSB #0
	information	QCL Type		Type D
		CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for
	Tyoe 1 QCL information			tracking' configuration
TCI state #1		QCL Type		Type A
. 5. 5.5.5.77	Tyoe 2 QCL	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for
	information	QCL Type		tracking' configuration Type D
Maximum number of	i f code block arouns f			
feedback				1
Number of HARQ P	rocesses			10 for FR2.60-1 and 8 for FR2.120-1
K1 value				Specific to each UL-DL pattern

Maximum number of HARQ transmission	4	
HARQ ACK/NACK bundling	Multiplexed	
Redundancy version coding sequence	{0,2,3,1}	
TDD UL-DL pattern	60 kHz SCS: FR2.60-1 120 kHz SCS: FR2.120-1	
PDSCH & PDSCH DMRS Precoding configuration	Single Panel Type I, Precoder index 0 per slot with Wideband granularity for Rank 2	
Symbols for all unused REs	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 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 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 _{BB} (dB) for maximum number of PDSCH MIMO Layers = 1	SNR _{BB} (dB) for maximum number of PDSCH MIMO Layers = 2
13	6.2	9.0
	-	
14	7.2	9.9
15	8.2	10.9
16	8.7	11.6
17	10.1	13.2
18	10.7	13.7
19	11.7	14.7
20	12.7	15.6
21	13.6	16.5
22	14.8	17.6
23	15.6	18.6
24	16.9	19.7
25	18.3	21.2
26	19.3	22.3
27	20.5	23.3

Note 1: MCS Index is based on MCS 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 type		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		
(Offer Orisi 1113)		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
	SION SCHEME		scheme 1
Duplex Mode			TDD
PTRS epre-Ratio	Offset between Point A and the		0
Actual carrier configuration	ctual carrier lowest usable subcarrier on this carrier (Note 3)		0
	Subcarrier spacing	kHz	120
	Cyclic prefix	55	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 in			1
Common serving cell	Physical Cell ID SSB position in burst		0 First SSB in Slot #0
parameters	SSB position in burst SSB periodicity	me	
parameters	Slots for PDCCH monitoring	ms	20 Each slot
	Symbols with PDCCH		0,1
	Number of PDCCH candidates		,
	and aggregation levels		1/AL8
	DCI format		1_1
	TCI state		TCI state #1
PDCCH 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 and 2, selection updated per slot
Cross carrier sch			Not configured
	Mapping type		Type A
	Starting symbol (S)		0 2
	Starting symbol (S) Length (L)		12
	PDSCH aggregation factor		12
PDSCH	PRB bundling type		Static
configuration	PRB bundling size		2
J	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
	Number of Pl group(s) with			2
PTRS	Frequency de			2
configuration	Time density			1
	Resource Ele			2
		er index in the PRB		0 for CSI-RS
	used for CSI-	·RS (K0)		resource 1,2,3,4
	First OFDM s used for CSI-	symbol in the PRB RS (<i>l</i> ₀)		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 No CDM for CSI-RS
	CDM Type			resource 1,2,3,4
				3 for CSI-RS
CSI-RS for	Density (ρ)			resource 1,2,3,4
tracking				120kHz SCS: 160 for
a doming	CSI-RS perio	dicity	slot	CSI-RS resource
	Ooi No pene	raioity	3101	1,2,3,4
				120 kHz SCS:
	CSI-RS offset			80 for CSI-RS
			slot	resource 1 and 2
				81 for CSI-RS
				resource 3 and 4
				Start PRB 0
	Frequency Occupation			Number of PRB =
	' '	•		BWP size
	QCL info			TCI state #0
NZP CSI-RS				Start PRB 0
for CSI	Frequency O	ccupation		Number of PRB =
acquisition				BWP size
acquisition	QCL info			TCI state #1
ZP CSI-RS for				Start PRB 0
CSI acquisition	Frequency O	ccupation		Number of PRB =
COT GOOGLIGHT				BWP size
		er index in the PRB		k ₀ =0 for CSI-RS
	used for CSI-	RS		resource 1,2
				$I_0 = 8$ for CSI-RS
		symbol in the PRB		resource 1 l ₀ = 9 for CSI-RS
	used for CSI-RS			resource 2
				1 for CSI-RS
	Number of CSI-RS ports (X)			resource 1,2
CSI-RS for				'No CDM' for CSI-RS
beam	CDM Type			resource 1,2
refinement	Day =tr. ()			3 for CSI-RS
	Density (ρ)			resource 1,2
				120 kHz SCS: 160
	CSI-RS perio	dicity	Slots	for CSI-RS resource
	Co. rec pomousing			1,2
	CSI-RS offse	t	Slots	0 for CSI-RS
	CSI-RS offse	t	Slots	resource 1,2
	Repetition	t	Slots	resource 1,2 ON
	Repetition QCL info		Slots	resource 1,2 ON TCI state #1
	Repetition QCL info Type 1	t SSB index	Slots	resource 1,2 ON
	Repetition QCL info Type 1 QCL	SSB index	Slots	resource 1,2 ON TCI state #1 SSB #0
TCI state #0	Repetition QCL info Type 1 QCL information	SSB index QCL Type	Slots	resource 1,2 ON TCI state #1 SSB #0 Type C
TCI state #0	Repetition QCL info Type 1 QCL information Type 2	SSB index	Slots	resource 1,2 ON TCI state #1 SSB #0
TCI state #0	Repetition QCL info Type 1 QCL information	SSB index QCL Type	Slots	resource 1,2 ON TCI state #1 SSB #0 Type C

Type 1 QCL informatio		CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
TOL -1-1- //4		QCL Type		Type A
TCI state #1	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
Number of HAR	Q Processes			8
HARQ ACK/NA				Multiplexed
Redundancy ve	rsion coding sed	quence		{0,2,3,1}
K1 value (PDSCH-to-HARQ-timing-indicator)			For FR2.120-1: 3 if mod (i.5) = 0, 6 if mod(i,5) = 2 For FR2.120-2: 11 if mod(i,8) = 0, 7]if mod(i,8) = 4, 6]if mod(i,8) = 5, where i is slot index per radio fame with values 0-79.	
Symbols for unused REs			OCNG as specified in A.5	
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.				

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

Note 3:

(Void)

8.2.2 2RX requirements

8.2.2.1 FDD

(Void)

8.2.2.2 TDD

8.2.2.2.1 CQI reporting under AWGN conditions

The reporting accuracy of the channel quality indicator (CQI) under frequency non-selective conditions is determined by the reporting variance and the BLER performance using the transport format indicated by the reported CQI median. The purpose is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [12]. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

8.2.2.2.1.1 Minimum requirement for periodic CQI reporting

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

- a) the reported CQI value shall be in the range of ± 1 of the reported median more than 90% of the time;
- b) if the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, the BLER using the transport format indicated by the (median CQI + 1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, the BLER using transport format indicated by (median CQI 1) shall be less than or equal to 0.1.

Table 8.2.2.2.1.1-1 Test parameters

	Parameter	Unit	Test 1	Test 2
Bandwidth				00
Subcarrier sp		kHz	120	
Duplex Mode				DD
TDD Slot Cor	nfiguration			Annex A.1.3
SNR _{BB}		dB	8 9	14 15
Propagation of	channel			VGN
Antenna conf	iguration			tatic channel n Annex B.1
Beamforming	Model			ed in Annex .4.1
	CSI-RS resource Type		Pei	riodic
	Number of CSI-RS ports (X)			4
	CDM Type		FD-	CDM2
ZP CSI-RS	Density (ρ)			1
configuratio n	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)			8
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)			13
	CSI-RS periodicity and offset	slot	8	3/1
	CSI-RS resource Type		Pei	riodic
	Number of CSI-RS ports (X)			2
	CDM Type		fd-C	CDM2
NZP CSI-	Density (ρ)			1
RS for CSI	First subcarrier index in the			
acquisition	PRB used for CSI-RS (k ₀ , k ₁)			6
acquiomen.	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)			13
	NZP CSI-RS-timeConfig	slot	,	3/1
	periodicity and offset	3101		
	CSI-IM resource Type		Pei	riodic
CSI-IM	CSI-IM RE pattern			1
configuratio	CSI-IM Resource Mapping		(8.	, 13)
n	(KCSI-IM, ICSI-IM)		(0,	,
	CSI-IM timeConfig	slot	8	3/1
	periodicity and offset			
ReportConfig	Туре			riodic
CQI-table				ble 1
reportQuantity				PMI-CQI
	onForChannelMeasurements			nfigured
	nForInterferenceMeasurements			nfigured
cqi-FormatInd				eband
pmi-FormatIn			Wid	eband
Sub-band Siz		RB		8
csi-Reporting				11111
	eriodicity and offset	slot		3/3
aperiodicTrigg				nfigured
	Codebook Type		typel-Si	nglePanel
	Codebook Mode			1
Codebook	(CodebookConfig-	1	Not co	nfigured
configuration	N1,CodebookConfig-N2)	1		•
	CodebookSubsetRestriction			0000
<u></u>	RI Restriction			J/A
Physical char	nnel for CSI report	1		CCH
ļ.,	CQI/RI/PMI delay	ms	8.	375
Maximum nur	mber of HARQ transmission			1
Measurement	t channel			ed in Table TBS.1-2

8.2.2.2.2 CQI reporting under fading conditions

8.2.2.2.2.1 Minimum requirement for wideband CQI reporting

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

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI. To account for sensitivity of the input SNR the CQI reporting under frequency non-selective fading conditions is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

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

- a) a CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α % of the time, where α % is specified in Table 8.2.2.2.2.1-2;
- b) the ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ γ, where γ is specified in Table 8.2.2.2.2.1-2;
- c) when transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater or equal to 0.01.

Table 8.2.2.2.1-1 Test parameters

	Parameter			Test 2
Bandwidth		MHz		00
Subcarrier sp Duplex Mode		kHz	12 TE	<u>20</u>
				-2 Annex
TDD Slot Cor	nfiguration			1.3
SNR _{BB}		dB	6 7	12 13
Propagation of	channel			30-35
Antenna conf	iguration		2x ULA	
Beamforming	Model			d in Annex
	CSI-RS resource Type			iodic
	Number of CSI-RS ports (X)			1
	CDM Type			DM2
ZP CSI-RS	Density (p)			1
configuratio n	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		8	3
11	First OFDM symbol in the PRB			
	used for CSI-RS (I ₀ , I ₁)		1	3
	CSI-RS interval and offset	slot	8,	/1
	CSI-RS resource Type		Anei	riodic
	Number of CSI-RS ports (X)			2
	CDM Type		fd-C	DM2
NZP CSI-	Density (ρ)		•	1
RS for CSI	First subcarrier index in the			3
acquisition	PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB			
	used for CSI-RS (I ₀ , I ₁)		1	3
	NZP CSI-RS-timeConfig interval and offset	slot	Not cor	nfigured
	aperiodicTriggeringOffset		()
	CSI-IM resource Type		Aper	iodic
CSI-IM	CSI-IM RE pattern		•	1
configuratio	CSI-IM Resource Mapping (Kcsi-im, Icsi-im)		(8,	13)
n	CSI-IM timeConfig	slot	Not cor	nfigured
	interval and offset	3101		
ReportConfig CQI-table	Туре		Apei Tab	riodic
reportQuantit	V			PMI-CQI
	onForChannelMeasurements			nfigured
	onForInterferenceMeasurements			nfigured
cqi-FormatInd	dicator			band
pmi-FormatIn			Wide	band
Sub-band Siz		RB		3
csi-Reporting		alat	11111	
	eriodicity and offset port Slot Offset	slot	NOT COR	nfigured
Aperiodic Ne	port Siot Offset		1 in slots	i, where
CSI request			mod(i,	8) = 1, t is equal to
			Otherwise i	
reportTrigger	Size		,	i
			One State v	
			Associated	
CSI-Aperiodic	cTriggerStateList		Configuration	ed Report
Cor-Aperiodic	CriiggerStateList			on contains
				NZP CSI-
			RS and	CSI-IM
	Codebook Type		typeI-Sin	glePanel
Codebook	Codebook Mode			
configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not cor	nfigured
	L	<u> </u>		

	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
<i>α</i> [%]	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 γ , 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
Drangation sho	anal		Annex A.1.3 TDLA30-35	Annex A.1.3 TDLA30-35
Propagation char				
Antenna configui	ation		2 x 2 ULA Low As specified in	2 x 2 ULA Low As specified in
Beamforming Mo			As specified in 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 ₀ , k ₁)		Row 4, (8,-)	Row 4, (8,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(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 (p)		1	1
NZD COLDO	First subcarrier		•	'
NZP CSI-RS for CSI acquisition	index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 3, (6,-)	Row 3, (6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(13,-)	(13,-)
	CSI-RS interval and offset	slot	Not configured	Not configured
	aperiodicTriggering Offset		0	0
	CSI-IM resource Type		Aperiodic	Aperiodic
CSI-IM configuration	CSI-IM RE pattern		Pattern 1	Pattern 1
	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
timeRestrictionFo	timeRestrictionForInterferenceMeasur ements		Not configured	Not configured
cqi-FormatIndica	tor		Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband

Sub-band Size		RB	8	8
csi-ReportingBand			111111111	111111111
CSI-Report interval and offset		slot	Not configured	Not configured
Aperiodic Report	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	Э		1	1
CSI-AperiodicTri	ggerStateList		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 channe	I for CSI report		PUSCH	PUSCH
CQI/RI/PMI delay		ms	1.375	1.75
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 sp	acing	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 ₀ , k ₁)		Row 4, (8,-)	Row 4, (8,-)	Row 4, (8,-)
	First OFDM symbol in the PRB		4)	4)	4
	used for CSI-RS (I ₀ , I ₁)		(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 ₀ , k ₁)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
acquisition	First OFDM symbol in the PRB				
	used for CSI-RS (I ₀ , I ₁)		(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-FormatIndicator		Wideband	Wideband	Wideband
Sub-band Size		RB	8	8	8
	csi-ReportingBand		111111111	111111111	111111111
<u> </u>				Not	Not
CSI-Report in	iterval and offset	slot	Not configured	configured	configured
Aperiodic Res	port Slot Offset		7	7	7
Aponodic INE	Jon Giot 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
reportingger	OILU .	I	<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 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	on		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
71	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

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].

Parameter Unit Value 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)

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.

OCNG in Annex A.5

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 configuration		7
Number of PDCCH symbols	symbols	1
PHICH Ng (Note 3)		1
PHICH duration		Normal
Cyclic prefix		Normal
Cell ID		0
Maximum number of HARQ transmission		4
Redundancy version coding sequence		{0,0,1,2} for 64QAM
Propagation condition		Static propagation condition No external noise sources are applied
Transmission mode		1
Transmission time difference between E- UTRA cell and NR cell(s)	μs	0
Antenna configuration		All NR cells are in FR1: 1x2 Any NR cell is in FR2: 1 Tx ^{Note 2}
Codebook subset restriction		10
Symbols for all unused REs		OCNG in Annex A.5

NOTE 1: The start of transmission of LTE frame is delayed by 2 LTE subframes with respect to the start of transmission of NR frame when TDD-TDD EN-DC configuration is configured during the test.

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.

restriction

Downlink power allocation

- 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.

Parameter Unit 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

1000

 $\rho_A = -3dB$, $\rho_B = -3dB$, $\sigma = 0dB$

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

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)

4 layer CC

2 layer CC

4 layer CC

MIMO layer	Bandwidth	Reference channel					
	Danuwium	64QAM	256QAM	1024QAM			
	5	R.PDSCH.4-1.1 FDD	R.PDSCH.4-3.1 FDD	R.PDSCH.4-5.1 FDD			
2 layer	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			
	5	R.PDSCH.4-2.1 FDD	R.PDSCH.4-4.1 FDD	R.PDSCH.4-6.1 FDD			
4 layer	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			

R.PDSCH.6-6.3 TDD

20

Reference channel **MIMO** layer **Bandwidth** 64QAM 256QAM 1024QAM 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 2 layer R.PDSCH.6-1.3 TDD R.PDSCH.6-5.3 TDD 20 R.PDSCH.6-3.3 TDD 10 R.PDSCH.6-2.1 TDD R.PDSCH.6-4.1 TDD R.PDSCH.6-6.1 TDD R.PDSCH.6-2.2 TDD R.PDSCH.6-2.3 TDD 4 layer 15 R.PDSCH.6-4.2 TDD R.PDSCH.6-6.2 TDD

R.PDSCH.6-4.3 TDD

Table 9.4B.1.1.1-3: E-UTRA FRC for SDR test (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.

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

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

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	Unit	UL-DL pattern
	Parameter	Unit	FR1.15-1
TDD Slot Configurat	ion pattern (Note 1)		DDDSU
Special Slot Configu	ration (Note 2)		10D+2G+2U
referenceSubcarrier	Spacing	kHz	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	tion (Note 3)		3 if $mod(i,5) = 1$
			2 if $mod(i,5) = 2$
			6 if $mod(i,5) = 3$

guard symbols; U 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

		1				JL-DL pattern		
Param	neter	Unit	FR1.30-1	FR1.30-2	FR1.30-3	FR1.30-4	FR1.30-5	FR1.30-6
TDD Slot Configuration pattern	(Note 1)		7DS2U	DDDSU	DDDSUDDSUU	DDDSUUDDDD	DSUU	DS₁S₂U
,	Special Slot Configuration (Note 2)		6D+4G+4U	10D+2G+2U	10D+2G+2U	6D+4G+4U	12D+2G	S1: 10D+2G+2U S2: 12D+2G+0U
referenceSubcarrierSpacing		kHz	30	30	30	30	30	30
pattern1								
	dl-UL- TransmissionPeriodicity	ms	5	2.5	2.5	3	2	1
	nrofDownlinkSlots		7	3	3	3	1	1
	nrofDownlinkSymbols		6	10	10	6	12	10
	nrofUplinkSlot		2	1	1	2	2	0
_	nrofUplinkSymbols		4	2	2	4	0	2
pattern2	dl-UL- TransmissionPeriodicity	ms	N/A	N/A	2.5	2	N/A	1
	nrofDownlinkSlots		N/A	N/A	2	4	N/A	0
	nrofDownlinkSymbols		N/A	N/A	10	0	N/A	12
	nrofUplinkSlot		N/A	N/A	2	0	N/A	1
	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						
information.	guard symbols; U denotes a slot with all UL symbols. The field is for					
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

Poro	Parameter		UL-DL pattern
Fala	neter	Unit	FR2.60-1
TDD Slot Configuration pattern	(Note 1)		DDSU
Special Slot Configuration (No	te 2)		11D+3G+0U
referenceSubcarrierSpacing		kHz	60
pattern1 dl-UL-		ms	1
	TransmissionPeriodicity		I
	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0
The number of slots between I	PDSCH and corresponding		3 if $mod(i,4) = 0$
HARQ-ACK information (Note	3)		2 if $mod(i,4) = 1$
			5 if $mod(i,4) = 2$

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 1:

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

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

Poro	Parameter		UL-DL pattern		
Farameter		Unit	FR2.120-1	FR2.120-2	
TDD Slot Configuration pattern	n (Note 1)		DDDSU	DDSU	
Special Slot Configuration (No	te 2)		10D+2G+2U	11D+3G+0U	
referenceSubcarrierSpacing		kHz	120	120	
pattern1	dl-UL- TransmissionPeriodicity		0.625	0.5	
	nrofDownlinkSlots		3	2	
	nrofDownlinkSymbols		10	11	
	nrofUplinkSlot		1	1	
	nrofUplinkSymbols		2	0	
The number of slots between I		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 $mod(i,5) = 3$		

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 1:

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

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

Table A.1.3-2a: TDD UL-DL configuration for SCS 120 kHz for DCI-based dynamic UL/DL detection

Param	Unit	UL-DL pattern				
Faiaiii	Offic	FR2.120-1A				
TDD Slot Configuration pattern (TDD Slot Configuration pattern (Note 1)					
Special Slot Configuration (Note		10D+2G+2U				
referenceSubcarrierSpacing		kHz	N/A			
pattern1 (Note 4)	dl-UL-	ms	N/A			
	TransmissionPeriodicity		IN/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 PD	SCH 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 $mod(i,5) = 3$			
	all DL symbols; S denotes a slo					
	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.						
	JL-DL-ConfigurationCommon เ	ısina R	RC 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					

Note 2: Slot i is slot index per 2 frames

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

Parameter	Unit			Value		
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

Note 2: Slot i is slot index per 2 frames

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

Parameter	Unit		Value
Reference channel		R.PDSCH.1-	
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	Mbps	39.915	
frames Note 1: SS/PBCH block is transmitt			

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

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

Parameter	Unit		Value
Reference channel		R.PDSCH.1-	
Reference channel		4.1 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		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	Mhnc	42.841	
frames	Mbps	42.041	

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 channel		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	DIIS	34812	
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	
Deference channel		R.PDSCH.1-	R.PDSCH.1-	R.PDSCH.1-	
Reference channel		6.1 FDD	6.2 FDD	6.3 FDD	
Channel bandwidth	MHz	10	10	10	
Subcarrier spacing	kHz	15	15	15	
Number of allocated resource	555	50	50		
blocks	PRBs	52	52	52	
Number of consecutive PDSCH		40	40	40	
symbols		12	12	12	
Allocated slots per 2 frames	Slots	15	15	15	
MCS table		64QAM	64QAM	64QAM	
MCS index		13	13	20	
Modulation		16QAM	16QAM	64QAM	
Target Coding Rate		0.48	0.48	0.55	
Number of MIMO layer		1	2	2	
Number of DMRS REs (Note 3)		24	24	24	
Overhead for TBS determination		0	0	0	
Information Bit Payload per Slot		-	-	-	
For Slot i = 0	Bits	N/A	N/A	N/A	
For CSI Slots i, if mod (i,5) =1,					
i={0,,19}		N/A	N/A	N/A	
For Non CSI-RS Slot i, if mod (i,5)	5	10010	0.4070	10070	
={0,2,3,4}, i={1,19}	Bits	12040	24072	40976	
Transport block CRC per Slot					
For Slot i = 0	Bits	N/A	N/A	N/A	
For CSI Slots i, if mod (i,5) =1,		NI/A	N1/A	N1/A	
i={0,,19}		N/A	N/A	N/A	
For Non CSI-RS Slot i, if mod (i,5)	D:4-	24	24	24	
={0,2,3,4}, i={1,19}	Bits	24	24	24	
Number of Code Blocks per Slot					
For Slot i = 0	CBs	N/A	N/A	N/A	
For CSI Slots i, if mod (i,5) =1,		N/A	N/A	N/A	
i={0,,19}		IN/A	IN/A	IN/A	
For Non CSI-RS Slot i, if mod (i,5)	CBs	2	3	5	
={0,2,3,4}, i={1,,19}	CDS	2	3	5	
Binary Channel Bits Per Slot					
For Slot i = 0	Bits	N/A	N/A	N/A	
For CSI Slots i, if mod (i,5) =1,		N/A	N/A	N/A	
i={0,,19}					
For Slots i = 10	Bits	23712	47424	71136	
For Non CSI-RS Slot i, if mod (i,5)	Bits	24960	49920	74880	
={0,2,3,4}, i={1,9,11,,19}	סונס	24300	43320	14000	
Max. Throughput averaged over 2	Mbps	9.030	18.054	30.732	
frames	·			30.732	

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

Note 2: Note 3: Slot i is slot index per 2 frames Number of DMRS REs includes the overhead of the DM-RS CDM groups without data

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

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

Note 2: Slot i is slot index per 2 frames

A.3.2.1.3 Reference measurement channels for SCS 60 kHz FR1

A.3.2.1.4 Reference measurement channels for E-UTRA

Table A.3.2.1.4-1: PDSCH Reference Channel for sustained data-rate test (64QAM, 2 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.

Note 6: Resource blocks $n_{PRB} = 0..24$ in sub-frames 0,1,2,3,4,6,7,8,9.

Note 7: Resource blocks $n_{PRB} = 3..49$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..49$ in sub-frames 0,1,2,3,4,6,7,8,9.

Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.

Note 9: Resource blocks $n_{PRB} = 4..99$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..99$ in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-2: PDSCH Reference Channel for sustained data-rate test (64QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 6: Resource blocks $n_{PRB} = 0..24$ in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 7: Resource blocks $n_{PRB} = 3..49$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..49$ in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-3: PDSCH Reference Channel for sustained data-rate test (256QAM, 2 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 6: Resource blocks $n_{PRB} = 2..24$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..24$ in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-4: PDSCH Reference Channel for sustained data-rate test (256QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 6: Resource blocks $n_{PRB} = 2..24$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..24$ in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-5: 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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 6: Resource blocks $n_{PRB} = 2..24$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..24$ in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-6: PDSCH Reference Channel for sustained data-rate test (1024QAM, 4 MIMO layers)

Parameter	Unit	Value					
Reference channel		R.PDSCH.4-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 6: Resource blocks n_{PRB} = 2..24 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
- Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

A.3.2.2 TDD

A.3.2.2.1 Reference measurement channels for SCS 15 kHz FR1

Table A.3.2.2.1-1: PDSCH Reference Channel for TDD UL-DL pattern FR1.15-1 and LTE-NR coexistence scenario

Parameter	Unit			Value	
Reference channel		R.PDSCH.1-	R.PDSCH.1-		
	N 41 1-	1.1 TDD	1.2 TDD		
Channel bandwidth	MHz	10	10		
Subcarrier spacing	kHz	15	15		
Allocated resource blocks Number of consecutive PDSCH	PRBs	52	52		
symbols					
For Slot i, if mod(i, 5) = 3 for i from					
{0,,19}		N/A	N/A		
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i		_	4.4		
from {1,,19}		9	11		
Allocated slots per 2 frames		7	7		
MCS table		64QAM	64QAM		
MCS index		4	4		
Modulation		QPSK	QPSK		
Target Coding Rate		0.30	0.30		
Number of MIMO layers		1	1		
Number of DMRS REs					
For Slot i, if $mod(i, 5) = 3$ for i from		N/A	N/A		
{0,,19}		IN/A	IN/A		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		12	12		
from {1,,19}					
Overhead for TBS determination		18	18		
Information Bit Payload per Slot					
For Slot 0 and Slot i, if mod(i, 5) =	Bits	N/A	N/A		
{2,3,4} for i from {0,,19}			,		
For Slot i, if $mod(i, 5) = \{0,1\}$ for i from	Bits	2472	3240		
{1,,19}					
Transport block CRC per Slot					
For Slot 0 and Slot i, if mod(i, 5) =	Bits	N/A	N/A		
$\{2,3,4\}$ for i from $\{0,,19\}$ For Slot i, if mod(i, 5) = $\{0,1\}$ for i from					
$\{1,,19\}$	Bits	16	16		
Number of Code Blocks per Slot					
For Slot 0 and Slot i, if mod(i, 5) =					
{2,3,4} for i from {0,,19}	CBs	N/A	N/A		
For Slot i, if $mod(i, 5) = \{0,1\}$ for i from			,		
{1,,19}	CBs	1	1		
Binary Channel Bits Per Slot					
For Slot 0 and Slot i, if mod(i, 5) =	Bits	N/A	N/A		
{2,3,4} for i from {0,,19}	DIIS				
For Slots i = 10, 11	Bits	7760	10256		
For Slot i, if $mod(i, 5) = \{0,1\}$ for i from	Bits	8384	10880		
{1,,9,12,,19}	טונס	0304	10000		
Max. Throughput averaged over 2	Mbps	0.865	1.134		
frames					

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: No user data is scheduled on slots with LTE PBCH/PSS/SSS

A.3.2.2.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit			Value	
		R.PDSCH.2-	R.PDSCH.2-	R.PDSCH.2-	
Reference channel		1.1 TDD	1.2 TDD	1.3 TDD	
Channel bandwidth	MHz	40	40	40	
Subcarrier spacing	kHz	30	30	30	
Allocated resource blocks	PRBs	106	6	106	
Number of consecutive PDSCH				100	
symbols					
For Slot i, if mod(i, 10) = 7 for i from				21/2	
{039}		4	4	N/A	
For Slot 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	
MCS index		4	4	4	
Modulation		QPSK	QPSK	QPSK	
Target Coding Rate		0.30	0.30	0.30	
Number of MIMO layers		1	1	1	
Number of DMRS REs		'	'	'	
For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}		6	6	N/A	
For Slot i, if mod(i, 10) =					
{0,1,2,3,4,5,6} for i from {1,,39}		18	12	12	
Overhead for TBS determination		0	0	0	
Information Bit Payload per Slot		U	U	0	
For Slots 0 and Slot i, if mod(i, 10) =					
$\{8,9\}$ for i from $\{0,,39\}$	Bits	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from					
$\{0,,39\}$	Bits	2664	144	N/A	
For Slot i, if mod(i, 10) =					
$\{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	Bits	8064	480	4608	
Transport block CRC per Slot					
For Slots 0 and Slot i, if mod(i, 10) =					
	Bits	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	16	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					
For Slots 0 and Slot i, if mod(i, 10) =					
{8,9} for i from {0,,39}	CBs	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}	CBs	1	1	N/A	
For Slot i, if mod(i, 10) =					
$\{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	CBs	1	1	1	
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 10) =					
$\{8,9\}$ for i from $\{0,,39\}$	Bits	N/A	N/A	N/A	
For Slots i = 20, 21	Bits	25440	1512	13992	
For Slots i = 20, 21 For Slot i, if mod(i, 10) = 7 for i from		20 11 0	1012		
{0,,39}	Bits	8904	504	N/A	
For Slot i, if mod(i, 10) =					
{0,1,2,3,4,5,6} for i from	Bits	26712	1584	15264	
{1,,19,22,,39}	סונס	20/12	1004	10204	
Max. Throughput averaged over 2					
frames	Mbps	11.419	0.677	6.221	
Note 1: SS/PBCH block is transmitted	l in slot #0) with periodicity	/ 20 ms	<u> </u>	

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-
		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					·
For Slot i, if mod(i, 10) = 7 for i from		_	_		1.2
{0,,39}		6	6	12	12
For Slot i, if $mod(i, 10) =$		40	40	0.4	24
{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}	DIIS	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	0400	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}			00200		333.3
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	Bits	24	24	24	24
{0,,39} For Slot i, if mod(i, 10) =					
{0,1,2,3,4,5,6}for i from {1,,39}	Bits	24	24	24	24
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if mod(i, 10) =					
{8,9} for i from {0,,39}	CBs	N/A	N/A	N/A	N/A
For Slot i, if $mod(i, 10) = 7$ for i from	OD-	0	0	0	4
{0,,39}	CBs	2	3	3	4
For Slot i, if mod(i, 10) =	CPo	1	7	0	12
{0,1,2,3,4,5,6} for i from {1,,39}	CBs	4	1	9	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}	2110	1, 500	00010	10702	0.000
For Slot i, if mod(i, 10) =	D.:	FF6.00	444000	450040	000500
{0,1,2,3,4,5,6} for i from	Bits	55968	111936	152640	203520
{1,,19,22,,39}					
Max. Throughput averaged over 2	Mbps	37.644	75.318	104.004	138.646
frames Note 1: SS/PBCH block is transmitted.					
Note 2: Slot i is slot index per 2 fram		#0 with periodic	ary 20 IIIS		
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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 $\{0,,39\}$		6		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$		12		
Overhead for TBS determination		0		
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}	Bits	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	Bits	27144		
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	Bits	83976		
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}	DIIS	24		
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}	CBs	N/A		
For Slot i, if mod(i, 10) = 7 for i from $\{0,,39\}$	CBs	4		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	CBs	10		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}	Bits	N/A		
For Slots i = 20, 21	Bits	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	Mbps	118.796		
frames Note 1: SS/PBCH block is transmitted i		vith poriodicity 20) mc	
Note 1: SS/PBCH block is transmitted i Note 2: Slot i is slot index per 2 frames	11 2101 #U V	viiri periodicity 20	סווו כ	

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

Parameter	Unit		Valu	ie	
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 $\{0,,39\}$		6			
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$		12			
Overhead for TBS determination		0			
Information Bit Payload per Slot					
For Slots 0 and Slot i, if $mod(i, 10) = \{8,9\}$ for i from $\{0,,39\}$	Bits	N/A			
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	Bits	29192			
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	Bits	92200			
Transport block CRC per Slot					
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}	Bits	N/A			
For Slot i, if mod(i, 10) = 7 for i from $\{0,,39\}$	Bits	24			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	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 $\{0,,39\}$	CBs	4			
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	CBs	11			
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}	Bits	N/A			
For Slots i = 20, 21	Bits	106848			
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	Bits	35616			
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$ for i from $\{1,,19,22,,39\}$	Bits	111936			
Max. Throughput averaged over 2	Mbps	130.308			
frames Note 1: SS/PBCH block is transmitted i) mc		
Note 1: SS/PBCH block is transmitted i Note 2: Slot i is slot index per 2 frames	11 210t #U V	vitir periodicity 20	6 III 6		

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 $\{0,,39\}$		8		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i from $\{1,,39\}$		12		
Allocated slots per 2 frames		31		
MCS table		64QAM		
MCS index		4		
Modulation		QPSK		
Target Coding Rate		0.30		
Number of MIMO layers		1		
Number of DMRS REs				
For Slot i, if $mod(i, 5) = 3$ for i from		4.0		
{0,,39}		12		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		40		
from {1,,39}		12		
Overhead for TBS determination		0		
Information Bit Payload per Slot				
For Slot 0 and Slot i, if mod(i, 5) = 4 for	Dito	NI/A		
i from {0,,39}	Bits	N/A		
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	5276		
{0,,39}	DIIS	5376		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	Bits	8456		
from {1,,39}	Dita	0430		
Transport block CRC per Slot				
For Slot 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,39\}$	Bits	N/A		
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,,39\}$	Bits	24		
For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i from $\{1,,39\}$	Bits	24		
Number of Code Blocks per Slot			 	
For Slot 0 and Slot i, if mod(i, 5) = 4 for	CBs	N/A		
i from $\{0,,39\}$ For Slot i, if mod(i, 5) = 3 for i from	CBs	1		
$\{0,,39\}$ For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i				
from {1,,39}	CBs	2		
Binary Channel Bits Per Slot				
For Slot 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,39\}$	Bits	N/A		
For Slot i = 20, 21	Bits	26712		
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,,39\}$	Bits	17808		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i from $\{1,,19,22,,39\}$	Bits	27984		
Max. Throughput averaged over 2 frames	Mbps	11.875		
Note 1: SS/PBCH block is transmitted i	n slot #0 u	ith periodicity 20	0 ms	-
Note 2: Slot i is slot index per 2 frames	ii siul #U W	vian periodicity 20	o mo	

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

Parameter	Unit		Value	
Reference channel		R.PDSCH.2- 6.1 TDD		
Channel bandwidth	MHz	40		
Subcarrier spacing	kHz	30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH				
symbols				
For Slot i, if mod(i, 10) = $\{3,7\}$ for i from $\{0,,39\}$		8		
For Slot i, if $mod(i, 10) = \{0,1,2,5,6\}$ 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 i from $\{1,,39\}$		12		
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				
{0,,39}	Bits	5376		
For Slot i, if $mod(i, 10) = \{0,1,2,5,6\}$ for	Bits	8456		
i from {1,,39}				
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	CBs	2		
i from {1,,39} 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 i	n slot #0 w	vith periodicity 20) ms	
Note 2: Slot i is slot index per 2 frames		portodiony 20		

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-		
Reference channel		7.1 TDD		
Channel bandwidth	MHz	40		
Subcarrier spacing	kHz	30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH				
symbols For Slot i, if mod(i, 10) = 7 for i from				
{0,,39}		4		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$				
for i from $\{1,,39\}$		12		
Allocated slots per 2 frames		31		
MCS table		64QAM		
MCS index		13		
Modulation		16QAM		
Target Coding Rate		0.48		
Number of MIMO layers		2		
Number of DMRS REs				
For Slot i, if $mod(i, 10) = 7$ for i from		6		
$\{0,,39\}$ For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$				
For Slot 1, if find(i, $10) = \{0, 1, 2, 3, 4, 5, 6\}$ for i from $\{1,, 39\}$		12		
Overhead for TBS determination		0		
Information Bit Payload per Slot		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}	DIIS	10090		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	Bits	53288		
for i from {1,,39}	Dito	00200		
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				
{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) =	CBs	N/A		
{8,9} for i from {0,,39}	CBS	IN/A		
For Slot i, if $mod(i, 10) = 7$ for i from	CBs	3		
{0,,39}				
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) =	_	<u> </u>		
{8,9} for i from {0,,39}	Bits	N/A		
For Slot i, if $mod(i, 10) = \{0,5\}$ for i from	D::	400450		
{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}	2.0	555.0		
For Slot i, if mod(i, 10) = $\{1,2,3,4,6\}$ for	Bits	111936		
i from {1,,19,22,,39}				
Max. Throughput averaged over 2 frames	Mbps	75.318		
Note 1: SS/PBCH block is transmitted i	n slot #0 w	vith periodicity 20) ms	
Note 2: Slot i is slot index per 2 frames	5.5t #0 W	portodioity 20	,	

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

Parameter	Unit			Value	
Reference channel		R.PDSCH.2- 8.1 TDD	R.PDSCH.2- 8.2 TDD	R.PDSCH.2- 8.3 TDD	
Channel bandwidth	MHz	40	40	40	
Subcarrier spacing	kHz	30	30	30	
Allocated resource blocks	PRBs	106	106	106	
Number of consecutive PDSCH symbols		12	12	12	
Allocated slots per 2 frames		23	23	23	
MCS table		64QAM	64QAM	64QAM	
MCS index		13	13	20	
Modulation		16QAM	16QAM	64QAM	
Target Coding Rate		0.48	0.48	0.55	
Number of MIMO layers		1	2	2	
Number of DMRS REs (Note 3)		24	24	24	
Overhead for TBS determination		0	0	0	
Information Bit Payload per Slot		<u>, </u>			
For Slots 0 and Slot i, if $mod(i, 10) = \{7,8,9\}$ for i from $\{0,,39\}$	Bits	N/A	N/A	N/A	
For CSI-RS Slot i, if $mod(i,10) = 1$ for i from $\{0,,39\}$	Bits	N/A	N/A	N/A	
For Slot i = 20	Bits	24576	49176	83976	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$ for i from $\{1,,19,22,,39\}$	Bits	24576	49176	83976	
Transport block CRC per Slot For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,,39} For CSI-RS Slot i, if mod(i,10) =1 for i	Bits	N/A	N/A	N/A	
from {0,,39}	Bits	N/A	N/A	N/A	
For Slot i = 20	Bits	24	24	24	
For Slot i, if mod(i, 10) = $\{0,2,3,4,5,6\}$ for i from $\{1,,19,22,,39\}$	Bits	24	24	24	
Number of Code Blocks per Slot For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,,39}	CBs	N/A	N/A	N/A	
For CSI-RS Slot i, if $mod(i,10) = 1$ for i from $\{0,,39\}$	CBs	N/A	N/A	N/A	
For Slot i = 20	CBs	3	6	10	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$ for i from $\{1,,19,22,,39\}$	CBs	3	6	10	
Binary Channel Bits Per Slot For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,,39}	Bits	N/A	N/A	N/A	
For CSI-RS Slot i, if $mod(i,10) = 1$ for i from $\{0,,39\}$	Bits	N/A	N/A	N/A	
For Slot i = 20	Bits	48336	96672	145008	
For Slot i, if mod(i, 10) = $\{0,2,3,4,5,6\}$ for i from $\{1,,19,22,,39\}$	Bits	50880	101760	152640	
Max. Throughput averaged over 2 frames	Mbps	28.2624	56.5524	96.5724	

Note 1: 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 $\{0,,39\}$		6		
For Slot i, if mod(i, 10) = $\{0,1,2,6,7,8,9\}$ for i from $\{1,,39\}$		12		
Overhead for TBS determination		0		
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,,39}	Bits	N/A		
For Slot i, if mod(i, 10) = 3 for i from $\{0,,39\}$	Bits	13064		
For Slot i, if mod(i, 10) = $\{0,1,2,6,7,8,9\}$ for i from $\{1,,39\}$	Bits	40976		
Transport block CRC per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A		
$\{4,5\}$ for i from $\{0,,39\}$ For Slot i, if mod(i, 10) = 3 for i from	Bits	24		
$\{0,,39\}$ For Slot i, if mod(i, 10) = $\{0,1,2,6,7,8,9\}$	Bits	24		
for i from {1,,39}				
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,,39}	CBs	N/A		
For Slot i, if $mod(i, 10) = 3$ for i from $\{0,,39\}$	CBs	2		
For Slot i, if $mod(i, 10) = \{0,1,2,6,7,8,9\}$ for i from $\{1,,39\}$	CBs	5		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,,39}	Bits	N/A		
For Slots i = 20, 21	Bits	77112		
For Slot i, if mod(i, 10) = 3 for i from $\{0,,39\}$	Bits	25704		
For Slot i, if mod(i, 10) = $\{0,1,2,6,7,8,9\}$ for i from $\{1,,19,22,,39\}$	Bits	80784		
Max. Throughput averaged over 2	Mbps	57.930		
frames Note 1: SS/PBCH block is transmitted i		vith periodicity 20	0 ms	
Note 1: SS/PBCH block is transmitted in Note 2: Slot i is slot index per 2 frames	11 SIUL #U V	viiri periodicity 20	OIII O	

Table A.3.2.2.2-10: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST scenario

Parameter	Unit		Value	
Reference channel		R.PDSCH.2- 10.1 TDD		
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		13		
Modulation		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 $\{0,,39\}$		6		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		18		
for i from {1,,39}		0		
Overhead for TBS determination		0		
Information Bit Payload per Slot For Slots 0 and Slot i, if mod(i, 10) =				
{8,9} for i from {0,,39}	Bits	N/A		
For Slot i, if mod(i, 10) = 7 for i from				
{0,,39}	Bits	8456		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	Bits	25608		
for i from {1,,39}	2.10			
Transport block CRC per Slot				
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}	Bits	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	Bits	24		
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	Bits	24		
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 10) =				
{8,9} for i from {0,,39}	CBs	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	CBs	2		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	CBs	4		
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 $\{0,,39\}$	Bits	17808		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$ for i from $\{3,,20,23,,39\}$	Bits	53424		
Max. Throughput averaged over 2 frames	Mbps	36.262		
Note 1: SS/PBCH block is transmitted i	n slot #0 w	vith periodicity 20	1	
Note 2: Slot i is slot index per 2 frames		porrodionly 20	· · · · ·	

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					
For Slot 0 and Slot i, if $mod(i, 4) = \{2,3\}$ for i from $\{0,,39\}$	Bits	N/A			
For Slot i, if $mod(i, 4) = 0$ for i from $\{1,,39\}$	Bits	8064			
For Slot i, if $mod(i, 4) = 1$ for i from $\{0,,39\}$	Bits	6528			
Transport block CRC per Slot					
For Slot 0 and Slot i, if $mod(i, 4) = \{2,3\}$	D:4-	N1/A			
for i from {0,,39}	Bits	N/A			
For Slot i, if $mod(i, 4) = 0$ for i from $\{1,,39\}$	Bits	24			
For Slot i, if $mod(i, 4) = 1$ for i from $\{0,,39\}$	Bits	24			
Number of Code Blocks per Slot					
For Slot 0 and Slot i, if $mod(i, 4) = \{2,3\}$ for i from $\{0,,39\}$	CBs	N/A			
For Slot i, if $mod(i, 4) = 0$ for i from $\{1,,39\}$	CBs	1			
For Slot i, if mod(i, 4) = 1 for i from $\{0,,39\}$	CBs	1			
Binary Channel Bits Per Slot					
For Slot 0 and Slot i, if $mod(i, 4) = \{2,3\}$	_				
for i from {0,,39}	Bits	N/A			
For Slot i = 20	Bits	25440			
For Slot i = 21	Bits	20352			
For Slot i, if mod(i, 4) = 0 for i from $\{1,,19,22,,39\}$	Bits	26712			
For Slot i, if $mod(i, 4) = 1$ for i from $\{0,,19,22,,39\}$	Bits	21624			
Max. Throughput averaged over 2 frames	Mbps	6.893			
Note 1: SS/PBCH block is transmitted i	n slot #0 w	vith periodicity 20) ms		
Note 2: Slot i is slot index per 2 frames					

Table A.3.2.2.2-12: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-6

Parameter	Unit		Value		
Reference channel		R.PDSCH.2-			
Channel bandwidth	MHz	12.1 TDD 40			
Subcarrier spacing	kHz	30			
Allocated resource blocks	PRBs	106			
Number of consecutive PDSCH		,,,,,			
symbols			<u> </u>		
For Slot i, if mod(i, 4) = 0 for i from		12			
{1,,39}		12			
For Slot i, if $mod(i, 4) = 1$ for i from		8			
$\{0,,39\}$ For Slot i, if mod(i, 4) = 2 for i from				1	
$\{0,,39\}$		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				1	
For Slot i, if $mod(i, 4) = 0$ for i from		18			
{0,,39}		18			
For Slot i, if $mod(i, 4) = 2$ for i from					
{0,,39}		18			
Overhead for TBS determination		0			
Information Bit Payload per Slot					
For Slot 0 and Slot i, if $mod(i, 4) = 3$ for	Bits	N/A			
i from {0,,39}	Dito	1471			
For Slot i, if $mod(i, 4) = 0$ for i from	Bits	8064			
$\frac{\{1,,39\}}{\text{For Slot i, if mod(i, 4)} = 1 \text{ for i from}}$					
{0,,39}	Bits	4992			
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	0500			
{0,,39}	DIIS	6528			
Transport block CRC per Slot					
For Slot 0 and Slot i, if $mod(i, 4) = 3$ for	Bits	N/A			
i from $\{0,,39\}$ For Slot i, if mod(i, 4) = 0 for i from					
{1,,39}	Bits	24			
For Slot i, if $mod(i, 4) = 1$ for i from					
{0,,39}	Bits	24			
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	24			
{0,,39}	טוט	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	
{1,,39}	CBs	1			
For Slot i, if $mod(i, 4) = 1$ for i from	0.0	4			
{0,,39}	CBs	1			
For Slot i, if $mod(i, 4) = 2$ for i from	CBs	1			
{0,,39}	555	<u>'</u>			
Binary Channel Bits Per Slot					
For Slot 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,39\}$	Bits	N/A			
For Slot i = 20	Bits	25440		1	
For Slot i = 21	Bits	15264		1	
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	Bits	16536			
{1,,19,22,,39}	2,10	10000			
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	21624			
{0,,39}					

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Max. Thre	oughput averaged over 2	Mbps	9.389				
Note 1:	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
Reference channel		R.PDSCH.4-	
Reference charmer		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		10	
{1,, 79}			
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from		13	
{1,,79}		50	
Allocated slots per 2 frames		59	
MCS table		64QAM	
MCS index		13	
Modulation		16QAM	
Target Coding Rate Number of MIMO layers		0.48	
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	5.4	05000	
{1,, 79}	Bits	25608	
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	D:4-	0.404.0	
{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}	Dita	IN/A	
For Slot i, if mod(i, 4) = 2 for i from	Bits	24	
{1,, 79}	Dito	2-7	
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	Bits	24	
{1,,79}	2.10		
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if $mod(i, 4) = 3$	CBs	N/A	
for i from {0,,79}			
For Slot i, if $mod(i, 4) = 2$ for i from	CBs	4	
$\{1,, 79\}$ 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	D:+=	72400	
{1,,39,42,,79}	Bits	73128	
Max. Throughput averaged over 2	Mbps	93.499	
frames	•		
Note 1: SS/PBCH block is transmitted		vith periodicity 2	0 ms
Note 2: Slot i is slot index per 2 frames			

A.3.2.2.5 Reference measurement channels for SCS 120 kHz FR2

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

Parameter	Unit		Value				
Deference channel		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		0					
{0,, 159}		9					
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		40					
from {1,,159}		13					
Allocated slots per 2 frames		127					
MCS table		64QAM					
MCS index		4					
Modulation		QPSK					
Target Coding Rate		0.30					
Number of MIMO layers		1					
Number of DMRS REs							
For Slot i, if $mod(i, 5) = 3$ for i from		4.0					
{0,, 159}		12					
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		4.0					
from {1,,159}		12					
Overhead for TBS determination		6					
Information Bit Payload per Slot							
For Slots 0 and Slot i, if $mod(i, 5) = 4$	5	21/2					
for i from {0,,159}	Bits	N/A					
For Slot i, if mod(i, 5) = 3 for i from	5	2224					
{0,, 159}	Bits	3624					
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i	D::	5504					
from {1,,159}	Bits	5504					
Transport block CRC per Slot							
For Slots 0 and Slot i, if mod(i, 5) = 4	D::	N1/A					
for i from {0,,159}	Bits	N/A					
For Slot i, if $mod(i, 5) = 3$ for i from	D:4-	40					
{0,, 159}	Bits	16					
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	Dita	0.4					
from {1,,159}	Bits	24					
Number of Code Blocks per Slot							
For Slots 0 and Slot i, if mod(i, 5) = 4	CDa	NI/A					
for i from {0,,159}	CBs	N/A					
For Slot i, if mod(i, 5) = 3 for i from	CBs	1					
{0,, 159}	CDS	<u> </u>					
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	CBs	1					
from {1,,159}	CDS	ı					
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	17490					
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	12210					
{0,, 159}	סונס	12210					
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	Bits	18282					
from {1,,79,82,,159}	טונס	10202					
Max. Throughput averaged over 2	Mbps	31.942					
frames	·						
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					
Reference channel		R.PDSCH.5-	R.PDSCH.5-	R.PDSCH.5-		
		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 $\{0,, 159\}$		9	9	9		
For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i						
from $\{1,,159\}$		13	13	13		
Allocated slots per 2 frames		127	127	127		
MCS table		64QAM	64QAM	64QAM		
MCS index		13	13	13		
Modulation		16QAM	16QAM	16QAM		
Target Coding Rate		0.48	0.48	0.48		
Number of MIMO layers		1	2	2		
Number of DMRS REs						
For Slot i, if $mod(i, 5) = 3$ for i from		10	10	10		
{0,, 159}		12	12	12		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		12	12	12		
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 $mod(i, 5) = 4$	Bits	N/A	N/A	N/A		
for i from {0,,159}	Dito	14/7	1471	1471		
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} Transport block CRC per Slot						
For Slots 0 and Slot i, if $mod(i, 5) = 4$						
for i from $\{0,,159\}$	Bits	N/A	N/A	N/A		
For Slot i, if $mod(i, 5) = 3$ for i from						
{0,, 159}	Bits	24	24	24		
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i	D::	0.4	0.4	0.4		
from {1,,159}	Bits	24	24	24		
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4	CBs	N/A	N/A	N/A		
for i from {0,,159}	CDS	IN/A	IN/A	IN/A		
For Slot i, if mod(i, 5) = 3 for i from	CBs	2	3	6		
{0,, 159}	OD3		3	0		
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 $mod(i, 5) = 4$	Bits	N/A	N/A	N/A		
for i from {0,,159}						
For Slots i = 80, 81 For Slots i = 82, 83	Bits Bits	36564 34980	69960 73128	139920		
For Slots $i = 82, 83$ For Slot i, if mod(i, 5) = 3 for i from	DIIS	34900	13120	146256		
$\{0,, 159\}$	Bits	24420	48840	97680		
For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i				+		
from {1,,79,84,,159}	Bits	36564	73128	146256		
Max. Throughput averaged over 2	.	100	004 :5:	400 555		
frames	Mbps	100.799	201.434	403.096		
Note 1: SS/PBCH block is transmitted	d in slot #0	with periodicity	/ 20 ms	<u>. </u>		
Note 2: Slot i is slot index per 2 frames						

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

Parameter	Unit		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 $\{1,, 159\}$		10				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from $\{1,,159\}$		13				
Allocated slots per 2 frames		119				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		2				
Number of DMRS REs						
For 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	Dita	NI/A				
for i from {0,,159}	Bits	N/A				
For Slot i, if $mod(i, 4) = 2$ for i from $\{1,, 159\}$	Bits	736				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from $\{1,,159\}$	Bits	1032				
Transport block CRC per Slot						
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,, 159}	Bits	16				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	Bits	16				
{1,,159}						
Number of Code Blocks per Slot For Slots 0 and Slot i, if mod(i, 4) = 3	CBs	N/A				
for i from $\{0,,159\}$ For Slot i, if mod(i, 4) = 2 for i from	CBs	1				
$\{1,, 159\}$ For Slot i, if mod(i, 4) = $\{0,1\}$ for i from						
{1,,159} Binary Channel Bits Per Slot	CBs	1				
For Slots 0 and Slot i, if mod(i, 4) = 3						
for i from {0,,159}	Bits	N/A				
For Slot i = 80, 81	Bits	3180				
For Slot i, if mod(i, 4) = 2 for i from $\{4,, 159\}$	Bits	2496				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from $\{1,,79,82,,159\}$	Bits	3324				
Max. Throughput averaged over 2 frames	Mbps	5.548				
Note 1: SS/PBCH block is transmitted	in slot #0 w	ith periodicity 20	1			
Note 2: Slot i is slot index per 2 frames						

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

Parameter	Unit			Value		
Reference channel		R.PDSCH.5-	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		10				
{1,, 159}						
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from		13				
{1,,159}		440				
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		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		O				
For Slots 0 and Slot i, if $mod(i, 4) = 3$						
for i from $\{0,,159\}$	Bits	N/A				
For Slot i, if $mod(i, 4) = 2$ for i from						
{1,, 159}	Bits	34816				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from						
{1,,159}	Bits	47112				
Transport block CRC per Slot						
For Slots 0 and Slot i, if $mod(i, 4) = 3$						
for i from {0,,159}	Bits	N/A				
For Slot i, if $mod(i, 4) = 2$ for i from	D.,	0.4				
{1,, 159}	Bits	24				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	D:1-	0.4				
{1,,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3	CD-	NI/A				
for i from {0,,159}	CBs	N/A				
For Slot i, if $mod(i, 4) = 2$ for i from	CBs	5				
{1,, 159}	CD3	3				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	CBs	6				
{1,,159}	CD3	U				
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	114940				
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	82368				
{4,, 159}		32000				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	Bits	109692				
{1,,79,82,,159}						
Max. Throughput averaged over 2	Mbps	255.724				
frames	•		00			
Note 1: SS/PBCH block is transmitted i		ntn periodicity 20	zu 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-				
Channel bandwidth	MHz	7.1 TDD 100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols	FKD5	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				
		6				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if $mod(i, 5) = {3,4}$ for i from ${0,,159}$	Bits	N/A				
For CSI-RS Slot i, if $mod(i,5) = 1$ for i from $\{0,,159\}$	Bits	N/A				
For Slot i = 80	Bits	14344				
For Slot i, if $mod(i, 5) = \{0,2\}$ for i from						
{1,,79,82,,159}	Bits	14344				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) =	D:	N1/A				
{3,4} for i from {0,,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i,5) =1 for i	D:4-	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	Bits	24				
{1,,79,82,,159}	טונס	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) =	CBs	N/A				
{3,4} for i from {0,,159}	D ₂	IN/A				
For CSI-RS Slot i, if mod(i,5) =1 for i	CBs	N/A				
from {0,,159}						
For Slot i = 80	CBs	2				
For Slot i, if $mod(i, 5) = \{0,2\}$ for i from	CBs	2				
{1,,79,82,,159}		_				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if $mod(i, 5) = {3,4}$ for i from ${0,,159}$	Bits	N/A				
For CSI-RS Slot i, if $mod(i,5) = 1$ for i from $\{0,,159\}$	Bits	N/A				
For Slot i = 80	Bits	28776				
For Slot i, if $mod(i, 5) = \{0,2\}$ for i from						
{1,,79,82,,159}	Bits	30360				
Max. Throughput averaged over 2 frames	Mbps	45.1836				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms						

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

Parameter	Unit		Value
Reference channel		R.PDSCH.5- 8.1 TDD	
Channel bandwidth	MHz	100	
Subcarrier spacing	kHz	120	
Allocated resource blocks	PRBs	66	
Number of consecutive PDSCH symbols		12	
Allocated slots per 2 frames		59	
MCS table		64QAM	
MCS index		13	
Modulation		16QAM	
Target Coding Rate		0.48	
Number of MIMO layers		1	
Number of DMRS REs (Note 3)		24	
Overhead for TBS determination		6	
Information Bit Payload per Slot			
For Slots 0 and Slot i, if $mod(i, 4) = \{2,3\}$ for i from $\{0,,159\}$	Bits	N/A	
For CSI-RS Slot i, if mod(i,8) =1 for i from {0,,159}	Bits	N/A	
For Slot i = 80	Bits	14344	
For Slot i, if $mod(i, 8) = \{0,4,5\}$ for i from $\{1,,79,82,,159\}$	Bits	14344	
Transport block CRC per Slot			
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,,159}	Bits	N/A	
For CSI-RS Slot i, if $mod(i,8) = 1$ for i from $\{0,,159\}$	Bits	N/A	
For Slot i = 80	Bits	24	
For Slot i, if $mod(i, 8) = \{0,4,5\}$ for i from $\{1,,79,82,,159\}$	Bits	24	
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if $mod(i, 4) = \{2,3\}$ for i from $\{0,,159\}$	CBs	N/A	
For CSI-RS Slot i, if $mod(i,8) = 1$ for i from $\{0,,159\}$	CBs	N/A	
For Slot i = 80	CBs	2	
For Slot i, if $mod(i, 8) = \{0,4,5\}$ for i from $\{1,,79,82,,159\}$	CBs	2	
Binary Channel Bits Per Slot			
For Slots 0 and Slot i, if $mod(i, 4) = \{2,3\}$ for i from $\{0,,159\}$	Bits	N/A	
For CSI-RS Slot i, if mod(i,8) =1 for i from {0,,159}	Bits	N/A	
For Slot i = 80	Bits	28776	
For Slot i, if $mod(i, 8) = \{0,4,5\}$ for i from $\{1,,79,82,,159\}$	Bits	30360	
Max. Throughput averaged over 2 frames Note 1: SS/PBCH block is transmitted in	Mbps	42.3148	

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:

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		Valu	е	
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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0.3,4,8,9.

Table A.3.2.2.6-2: PDSCH Reference Channel for sustained data-rate test (64QAM, 4 MIMO layers)

Parameter	Unit		Valu	е	
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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-3: PDSCH Reference Channel for sustained data-rate test (256QAM, 2 MIMO layers)

Parameter	Unit	Value				
Reference channel		R.PDSCH.6-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks $n_{PRB} = 3..49$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..49$ in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks $n_{PRB} = 4..99$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..99$ in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-4: PDSCH Reference Channel for sustained data-rate test (256QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks $n_{PRB} = 3..49$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..49$ in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks $n_{PRB} = 4..99$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..99$ in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-5: PDSCH Reference Channel for sustained data-rate test (1024QAM, 2 MIMO layers)

Parameter	Unit	Value				
Reference channel		R.PDSCH.6-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks $n_{PRB} = 4..99$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..99$ in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-6: PDSCH Reference Channel for sustained data-rate test (1024QAM, 4 MIMO layers)

Parameter	Unit	Value				
Reference channel		R.PDSCH.6-	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_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks $n_{PRB} = 3..49$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..49$ in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks $n_{PRB} = 4..99$ are allocated for the user data in sub-frame 5, and resource blocks $n_{PRB} = 0..99$ in sub-frames 0,3,4,8,9.

A.3.3 Reference measurement channels for PDCCH performance requirements

A.3.3.1 FDD

A.3.3.1.1 Reference measurement channels for SCS 15 kHz FR1

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

Parameter	Unit		Value							
Reference		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			Va	lue		
Reference		R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-
channel		2.1 FDD	2.2 FDD	2.3 FDD	2.4 FDD	2.5 FDD	2.6 FDD
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.3.3.1.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit		Value						
Reference		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		Val	ue	
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	Bits	39	39	52	52	52	39
CRC)							

A.3.3.2.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit		Value							
Reference		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		Value							
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		Value					
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	Va	lue
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	Va	lue
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	e			TBS.1-1	TBS.1-2				
MCS table	64QAM					•			
Number of a	66	66							
Number of c	12	12							
Number of F	Number of PDSCH MIMO layers								
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	- QPSK	1800	3624				
2	0.2344	0		1800	3624				
3	0.3770	2		2856	5640				
4	0.6016	4		4480	8968				
5	0.8770	6		6528	13064				
6	1.1758	8		8712	17928				
7	1.4766	11		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: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data									

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 Scheme			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	DSCH symbol	ls	12	12	12	12	12	12
Number of F	DSCH MIMO	layers		1	2	1	2	1	1
Number of D	MRS REs (N	ote 1)		24	24	24	24	24	24
Overhead for	r TBS determ	ination		0	0	0	0	0	0
Available RE	-s for PDSC	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	ZOOQAW	43032	86040	88064	176208	6656	13320
15	7.4063	27		46104	92200	94248	188576	7040	14088
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									

A.5 OFDMA Channel Noise Generator (OCNG)

A.5.1 OCNG Patterns for FDD

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

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

OCNG Appliance	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 RFs in the active C	ORESETS appointed by the search	ch snaces in use

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

A.5.2 OCNG Patterns for TDD

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

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

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

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

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

Annex B (normative): Propagation conditions

B.1 Static propagation condition

B.1.1 UE Receiver with 2Rx

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

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

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 ~ Table B.2.1.1-4.

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

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

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

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

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

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

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

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

B.2.1.2 Delay profiles for FR2

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

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

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

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

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

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

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

B.2.2 Combinations of channel model parameters

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

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

Table B.2.2-1 Channel model parameters for FR1

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

Table B.2.2-2 Channel model parameters for FR2

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

B.2.3 MIMO Channel Correlation Matrices

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

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

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

B.2.3.1.1 Definition of MIMO Correlation Matrices

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

Table B.2.3.1.1-1 gNB correlation matrix

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

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, α and β in Table B.2.3.1-3 defines the spatial correlation between the antennas at the gNB and UE.

Table B.2.3.1.1-3: R_{spat} correlation matrices

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

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 α and β for different correlation types are given in Table B.2.3.1.2-1.

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

Correlation Model	α	β
Low correlation	0	0
Medium	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	$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$	$R \dots = $							
2x1 case	$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$	R=							
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	$R_{high} = \begin{pmatrix} 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 \\ 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 \\ 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 \\ 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 \\ 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 \\ 0.8999 & 0.8099 & 0.9542 & 0.8587 & 0.9883 \end{pmatrix}$	0.8587 0.8999 0.8099 0.9542 0.8099 0.8999 0.8894 0.9542 0.8587 0.9883 0.8587 0.9542 0.8999 0.9883 0.8894 1.0000 0.8894 0.9883 0.8894 1.0000 0.8999 0.9883 0.8999 1.0000							
4x4 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9541 & 0.9482 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 \\ 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9105 & 0.944 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.91 \\ 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.976 \\ 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.988 \\ 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.976 \\ 0.9541 & 0.9430 & 0.9165 & 0.8587 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.988 \\ 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.000 \\ 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.980 \\ 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.954 \\ 0.8894 & 0.8999 & 0.8894 & 0.8587 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.9882 & 0.9767 \\ 0.8894 & 0.8999 & 0.8894 & 0.8587 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9430 & 0.9430 & 0.9767 \\ 0.8894 & 0.8999 & 0.8894 & 0.8587 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9430 & 0.9430 & 0.9767 \\ 0.8897 & 0.8894 & 0.8899 & 0.8894 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9430 & 0.9767 \\ 0.8099 & 0.8587 & 0.8894 & 0.8999 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 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 $	41 0.9430 0.9105 0.8894 0.8999 0.8894 0.8587 30 0.9541 0.9430 0.8587 0.8894 0.8999 0.8894 0.8999 0.8894 0.5 0.9430 0.9541 0.8099 0.8587 0.8894 0.8999 67 0.9430 0.8894 0.9541 0.9430 0.9105 0.8587 0.8894 0.9767 0.9430 0.9430 0.9541 0.9430 0.9105 0.9882 0.9767 0.9105 0.9430 0.9541 0.9430 0.9541 0.9430 0.9541 0.9430 0.9767 0.9882 0.8587 0.9105 0.9430 0.9541 0.9430 0.9541 0.8999 0.9882 0.9767 0.9430 0.8894 0.9541 0.8999 0.9882 0.9767 0.9882 0.9767 0.9430 0.8894 0.9430 0.9882 1.0000 0.9882 0.9767 0.9882 0.9767 0.9882 0.9767 0.9430 0.8894 0.9430 0.9767 0.9882 0.9767 0.9430 0.8894 0.9430 0.9767 0.9882 0.9767 0.9430 0.8894 1.0000 0.9882 0.9541 0.8999 0.9882 0.9767 0.9430 0.9882 1.0000 0.9882 0.9541 0.9882 0.9767 0.9430 0.9882 1.0000 0.9882 0.9541 0.9882 0.9767 0.9430 0.9882 1.0000 0.9882 0.9541 0.9882 0.9767 0.9430 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 1.0000 0.9882 0.9541 0.9882 0.9767 0.9882 0.9767 0.9882 1.0000 0.9882 0.9541							

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 _{mediui}	nA -	1 0.9000 0.6561 0.3874	0.9000 1 0.9000 0.6561	0.90) 1	00 0.6 0.9	3874 _] 5561 9000 1					
2x4 case	$R_{medium A} =$ (1.0000 0.9000 0.656)			1.0000 0.9000 0.6561 0.3874 0.3000 0.2700 0.1968 0.1162	00 1.0000 0.9000 0 61 0.9000 1.0000 0 74 0.6561 0.9000 1 00 0.2700 0.1968 0 00 0.3000 0.2700 0 68 0.2700 0.3000 0		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 ± 1.45 degrees polarization slant angles are deployed at gNB and cross-polarized antenna elements with ± 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,
- Γ is a polarization correlation matrix, and
- $(\bullet)^T$ denotes transpose.

The matrix Γ 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:

$$R_{gNB} = R_{gNB \ Dim1} \otimes R_{gNB \ Dim2}$$

where

- - R_{gNB_Diml} 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,

$$R_{gNB_Dim,i} = \begin{pmatrix} 1 & \alpha_i^{\frac{1}{4}} & \alpha_i \\ \alpha_i^{\frac{1}{4}*} & 1 & \alpha_i^{\frac{1}{4}} \\ \alpha_i^* & \alpha_i^{\frac{1}{4}*} & 1 \end{pmatrix}.$$

- 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 α_1 , α_2 , β and γ for the cross polarized antenna models are given in Table B.2.3.2.2-1.

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

Corr	elation Model	α_1	02	β	γ			
Medi	um Correlation	0.3	0.3	0.6	0.2			
	h Correlation	0.9	0.9	0.9	0.3			
Note 1:	Note 1: Value of α_1 applies when more than one pair of cross-polarized							
	antenna elements in first dimension at gNB side.							
Note 2:	Value of α2 applies	when more th	an one pair of	cross-polarize	ed			
	antenna elements in second dimension at gNB side.							
Note 3:	Note 3: Value of β applies when more than one pair of cross-polarized antenna							
	elements at UE side.							

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

For the 2D cross polarized antenna array at gNB side, the correlation matrices for high spatial correlation are defined in Table B.2.3.2.2-4 as below.

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

$$R_{high} = [R_{spat} + aI_n]/(1+a)$$
 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 $8(4,1,2)x^2$ high spatial correlation case, a=0.00010. For the $16(4,2,2)x^2$ high spatial correlation case, a=0.00012.

The same method is used to adjust the 16(4,2,2)x4, 32(4,4,2)x2 and 32(4,4,2)x4 high correlation matrix to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision with a =0.00012, a =0.00022, and a=0.00022 resoectively.

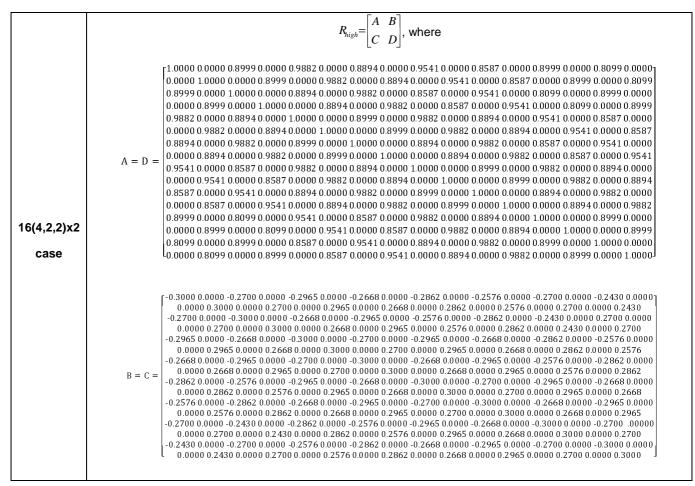
Table B.2.3.2.2-2: MIMO correlation matrices for high spatial correlation (1D cross polarized antenna array at gNB side)

				Г 1	0000	0.0000	0.00	200 (0000	0.20	000 0	0000	0.25	700 0	0000	1	
						0.0000	0.90		0.0000	-0.30		0.0000	-0.27		.0000		
				0.	0000	1.0000	0.00		0.9000	0.00		0.3000	0.00		0.2700		
				0.	9000	0.0000	1.00	000	0.0000	-0.27	700 C	.0000	-0.30	000 0	.0000		
4(2,1,2)x2			D _	0.	0000	0.9000	0.0	000	1.0000	0.00	000	.2700	0.00	00 0	.3000		
case			$R_{high} =$	-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	00 1	.0000	0.00	00 0	.9000		
						0.0000			0.0000	0.90		.0000	1.00		.0000		
						0.2700			0.3000	0.00		.9000	0.00		.0000		
					0000	0.9000			0.0000	-0.30		0.2700	0.000		0000		
				0.9	9000	1.0000	0.0	000	0.0000	-0.27	'00 -	0.3000	0.000	00 0.	0000		
				0.0	0000	0.0000	0 1.0	000	0.9000	0.00	000 0	.0000	0.300	0 0.2	2700		
2(1,1,2)x4			n	0.0	0000	0.0000	0.9	000	1.0000	0.00	00 0	.0000	0.270	0 0.3	000		
case			R_{high}	= -0.	3000	-0.270	0.0	000	0.0000	1.00	00 0	.9000	0.000	0.0	000		
				-0.	2700	-0.300	0.0	000	0.0000	0.90	000 1	.0000	0.000	0.0	000		
				0.0	0000	0.0000	0.3	000	0.2700	0.00	000 0	.0000	1.000	0 0.9	000		
					0000	0.0000		700	0.3000			.0000	0.900		000		
		1.0000	0.9000	0.0000		0.9000	0.8100	0.0000		-0.3000	-0.2700	0.0000	0.0000	-0.2700	-0.2430	0.0000	0.0000
		0.9000		0.0000	0.0000	0.8100	0.9000	0.0000	0.0000	-0.2700	-0.3000	0.0000	0.0000	-0.2430	-0.2700	0.0000	0.0000
		0.0000		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		0.9000	1.0000	0.0000 1.0000	0.0000	0.8100	0.9000 0.0000	0.0000 -0.2700	0.0000 -0.2430	0.2700 0.0000	0.3000	0.0000 -0.3000	0.0000 -0.2700	0.2430 0.0000	0.2700 0.0000
		0.8100		0.0000	0.0000	0.9000	1.0000	0.0000	0.0000	-0.2430	-0.2430	0.0000	0.0000	-0.2700	-0.3000	0.0000	0.0000
		0.0000	0.0000	0.9000	0.8100	0.0000	0.0000	1.0000	0.9000	0.0000	0.0000	0.2700	0.2430	0.0000	0.0000	0.3000	0.2700
4(2,1,2)x4	$R_{ m high}$ $=$	0.0000		0.8100	0.9000	0.0000	0.0000	0.9000	1.0000	0.0000	0.0000	0.2430	0.2700	0.0000	0.0000	0.2700	0.3000
case				0.0000	0.0000	-0.2700 -0.2430	-0.2430 -0.2700	0.0000	0.0000	1.0000 0.9000	0.9000 1.0000	0.0000	0.0000	0.9000 0.8100	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	0.3000	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	-0.3000 -0.2700	-0.2700 -0.3000	0.0000	0.0000	0.9000 0.8100	0.8100	0.0000	0.0000	1.0000 0.9000	0.9000 1.0000	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	0.988	0.000	0.9542	0.0000				0.0000	-0.2965	0.0000	-0.2862		-0.2700	0.0000
		0.0000			0.988		0.9542		0.8999					0.0000		0.0000	
		0.9883				0 0.9883											
		0.0000				0.0000										0.0000	
		0.9542				0 1.0000 3 0.0000											
		0.8999				0.0000											
9/4 1 2)v2		0.0000				2 0.0000											
8(4,1,2)x2 case	$R_{high} =$	-0.3000				0 -0.2862											
		0.0000				5 0.0000											
		-0.2965	0.0000	-0.300	0.000	0 -0.2965	0.0000	-0.2862	0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.0000	0.9542	0.0000
		0.0000	0.2965	0.000	0.300	0.0000	0.2965	0.0000	0.2862	0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.0000	0.9542
		-0.2862	0.0000	-0.296	5 0.000	0 -0.3000	0.0000	-0.2965	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.0000
		0.0000	0.2862	0.000	0.296	5 0.0000	0.3000	0.0000	0.2965	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000	0.0000	0.9883
		-0.2700				0 -0.2965						0.9542		0.9883	0.0000		
		0.0000	0.2700	0.0000	0.286	2 0.0000	0.2965	0.0000	0.3000	0.0000	0.8999	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000

Table B.2.3.2.2-3: MIMO correlation matrices for medium spatial correlation (1D cross polarized antenna array at gNB side)

	[1.000	0	0.0000	-0.2000	0.0000	
2(1,1,2)x2	$_{ m D}$ $_{ m D}$ $_{ m D}$ 0.00	00	1.0000	0.0000	0.2000	
case	$\frac{\kappa_{medium} 0.20}{\kappa_{medium}}$	00	0.0000	1.0000	0.0000	
	0,00	00	0.2000	0.0000	1.0000	

Table 1 B.2.3.2.2-4: MIMO correlation matices for high spatial correlation (2D cross polarized antenna array at gNB side)



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,
- $N_{\rm l}$ 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,

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

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.
- μ 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 ⁻³

B.2.4 Two-tap propagation conditions for CQI tests

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

$$h(t,\tau) = \delta(\tau) + a\exp(-i2\pi f_D t)\delta(\tau - \tau_d)$$

in continuous time (t, τ) 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.

Table B.3.1-1: High speed train scenario

Doromotor	Value			
Parameter	HST-750	HST-1000		
D_s	300 m	300 m		
$D_{ m min}$	2 m	2 m		
ν	300 km/h	300 km/h		
f_d	750 Hz for 15 kHz SCS test	1000 Hz for 30 kHz SCS test		

NOTE 1: Parameters for HST conditions in table B.3.1-1 including f_d and Doppler shift trajectories presented on 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) .

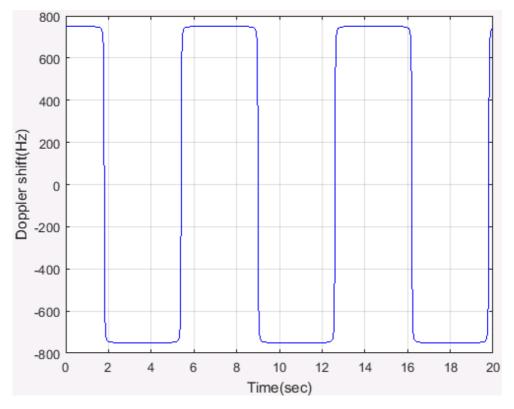


Figure B.3.1-1: Doppler shift trajectory ($f_{\scriptscriptstyle d}$ = 750 Hz)

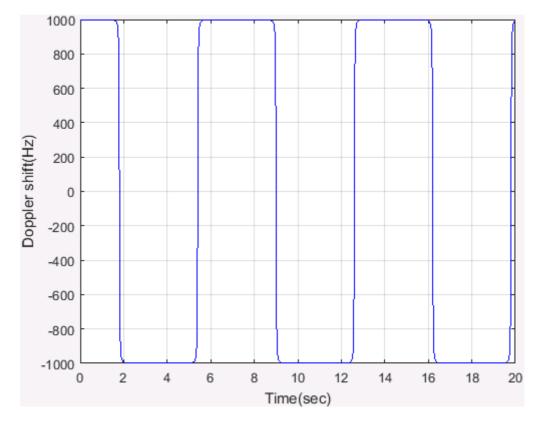


Figure B.3.1-2: Doppler shift trajectory (f_d = 1000 Hz)

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) $p = p_0, p_0 + 1, \dots, p_0 + N_p - 1$ 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) $p = p_0, p_0 + 1, \dots, p_0 + N_p - 1, y^{(p)}(i) = \left[y^{(p_0)}(i) \ y^{(p_0+1)}(i) \ \dots \ y^{(p_0+N_p-1)}(i)\right]^T$, $i = 0,1,\dots,M_{\text{symb}}^{\text{ap}} - 1$, with $M_{\text{symb}}^{\text{ap}}$ being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i) \ y_{bf}^{(1)}(i) \ \dots \ y_{bf}^{(N_{ANT}-1)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair (k,l) as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = W(i)y^{(p)}(i)$$

For Clause 6 and 8, the transmission of PDCCH and PDCCH DMRS on antenna port $p = p_0$ is defined by using a precoder matrix W(i) of size 2x1. This precoder takes as an input a block of signals for antenna port(s) $p = p_0$,

 $y^{(p)}(i) = y^{(p_0)}(i)$ and generates a block of signals $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i) \ y_{bf}^{\left(\frac{N_{ANT}}{2}\right)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair (k,l) as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = W(i)y^{(p)}(i)$$

The precoder matrix W(i) is specific to the test case configuration. W(i) is defined in Clause 5.2.2.2 of TS 38.214 [12].

The transimison on PT-RS antenna port is associated (using same precoder) with the lowest indexed DM-RS antenna port among the DM-RS antenna ports assigned for the PDSCH.

The physical antenna elements are identified by indices $j = 0,1,...,N_{ANT}-1$, 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		0
EPRE ratio of PBCH to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS		0
EPRE ratio of PDCCH to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH to SSS	dB	0
EPRE ratio of PDSCH to PDSCH DMRS	dB	Test specific (Note 1)
EPRE ratio of CSI-RS to SSS	dB	-10*log10(L) (Note 3)
EPRE ratio of OCNG to SSS	dB	0
EPRE ratio of PDCCH OCNG to SSS		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.

C.4 Setup (Radiated)

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

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

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

C.5 Connection (Radiated)

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

C.5.1 Measurement of Receiver Characteristics

Table C.5.1-1 is applicable for measurements in which uniform RS-to-EPRE boosting for all downlink physical channels, unless otherwise stated.

Table C.5.1-1: Downlink Physical Channels transmitted during a connection (TDD)

Parameter	Unit	Value (Note 2)
SSS transmit power	W	Test specific
EPRE ratio of PSS to SSS	dB	0
EPRE ratio of PBCH to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS	dB	0
EPRE ratio of PDCCH to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH to SSS	dB	0
EPRE ratio of PDSCH to PDSCH DMRS	dB	Test specific (Note 1)
EPRE ratio of CSI-RS to SSS	dB	-10*log10(L) (Note 3)
EPRE ratio of PTRS to PDSCH	dB	Test specific
EPRE ratio of OCNG to SSS	dB	0
EPRE ratio of PDCCH OCNG to SSS	dB	0
EPRE ratio of PDCCH OCNG to SSS	dB	0 3 38.214 [12] based on "Number of DM-RS

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 %)
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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 ² /s ³ at 20 Hz, thereafter –3 dB/Octave

Outside the specified frequency range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 38.101-1[6] for extreme operation.

E.3 Environmental (Radiated)

The requirements in this clause apply to all types of UE(s).

E.3.1 Temperature

All requirements for UEs operating in FR2 are defined over the air and can only be tested in an OTA chamber.

The UE shall fulfil all the requirements in the temperature range defined in Table E.3.1-1.

Table E.3.1-1: Temperature conditions

+ 25 °C ± 10 °C	For normal (room temperature) conditions with relative
	humidity of 25% to 75%

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 of TS 38.101-2 [7] for extreme operation.

E.3.2 Voltage

< Editor's note: This requirement is incomplete. The following aspects are either missing or not yet determined:

Methodology to control the voltage in a case which a power cable is not connected to DUT is FFS since it is not agreed whether we can connect the power cable to DUT at the OTA measurement situation yet.

>

The UE shall fulfil all the requirements in the voltage range defined in Table E.3.2-1.

Table E.3.2-1: Voltage conditions

Power source	Normal conditions voltage
AC mains	nominal
Regulated lead acid battery	1,1 * nominal
Non regulated batteries:	
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

Data	Maatina	4D	CD	Davi	0-4	Change history	Nous
Date	Meeting	tDoc	CR	Rev	Cat	Subject/Comment	New version
2018-07	RAN4	R4-				Draft skeleton	0.0.1
0010.00	AH18-07	1809554					0.00
2018-08	RAN4#88	R4- 1811357				Skeleton update	0.0.2
2018-10	RAN4#88	R4-				Approved Text Proposal in RAN4#88bis:	0.1.0
	bis 1814237	1814237				R4-1814053, "TP on performance specification 38.101-4 Chapter 4 general part"	
						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-				Approved Text Proposal in RAN4#89:	0.2.0
		1816559				R4-1814053, "TP on performance specification 38.101-4 Chapter 4 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"	
				1		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)"	
				1		R4-1816703, "Draft TP on FR1 Rank Indication Reporting"	
						Performance Requirements" R4-1816704, "Draft TP on FR2 Rank Indication Reporting	
						Performance Requirements"	
				1		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) "	
				1		R4-1816713, "TP to TS38.101-4 Section 7.3: PDCCH demodulation	
						requirements" P4-1816714 "TP for propagation conditions in TS 38 104-4(Appex	
						R4-1816714, "TP for propagation conditions in TS 38.104-4(Annex B)"	
2018-12	RAN#82	RP-182408				V1.0.0 is submitted to RAN for 1-step approval	1.0.0
2018-12	RAN#82	RP-182704				V1.0.1 with editorial changes	1.0.1
2018-12	RAN#82					Approved by plenary – Rel-15 spec under change control	15.0.0

2019-03	RAN#83	RP-190403	0001	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)	
					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 P4.4003448 Proft CB on FB3 CSI Reporting Tests (Qualcomm	
					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)	
					R4-1900370, 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	B 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	
				R4-1904777, 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	
				R4-1907304, Editorial corrections for 36.101-4 FDCCH tables R4-1907307, draftCR: updates to FR1 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) P4 1007315 Draft CP on SDP requirements for NP CA between	
				R4-1907315, Draft CR on SDR requirements for NR CA between FR1 and FR2	
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2019-09	RAN#85	RP-192022	0008		F	CR to TS 38.101-4: Implementation of endorsed draft CRs from	15.3.0
2019-09	KAN#03	KF-192022	0008		ı	RAN4#92 (Rel-15)	13.3.0
						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 2019-12	RAN#86	RP-192998	0010		F B	CR to TS 38.101-4: Editorial corrections for PDSCH RMC (R15) CR to TS 38.101-4: Introduction of NE-DC and NR-DC SDR	15.4.0
	RAN#86	RP-192998	0011		Ь	requirements (R15)	15.4.0
2019-12 2019-12	RAN#86 RAN#86	RP-192998 RP-192998	0014 0015	1	F	CR on corrections for MIMO Correlation Matrices CR on corrections for FR1 PDSCH demodulation performance tests	15.4.0 15.4.0
2019-12	RAN#86	RP-192998	0016	1	F	CR on corrections for FR2 PDSCH demodulation performance tests	15.4.0
2019-12	RAN#86	RP-192998	0017	1	F	CR on corrections for FR1 CSI Reporting performance tests	15.4.0
2019-12 2019-12	RAN#86	RP-192998	0018	1	F	CR on corrections for FR2 CSI Reporting performance tests	15.4.0 15.4.0
2019-12	RAN#86 RAN#86	RP-192998 RP-192998	0019 0021	1	F	Editorial change on reference PDCCH payload size Editorial CR to correct PMI test cases	15.4.0
2019-12	RAN#86	RP-192998	0023	1	F	CR for TS38.101-4: Angle of arrival for radiated UE demodulation	15.4.0
2019-12	RAN#86	RP-192998	0024		F	testing CR on demodulation performance requirements for EN-DC including FR1 and FR2 CCs	15.4.0
2019-12	RAN#86	RP-192998	0025		F	CR: Correction on NR PDCCH demodulation performance requirements	15.4.0
2019-12	RAN#86	RP-192998	0026		F	CR on CSI reporting requirements for EN-DC including FR1 and FR2 CCs	15.4.0
2019-12	RAN#86	RP-192998	0027	1	В	CR on NE-DC and NGEN-DC performance requirements	15.4.0
2019-12 2019-12	RAN#86 RAN#86	RP-192998 RP-192998	0028 0029	1	B F	CR on NR-DC performance requirements CR: Updates to NR RMC for UE performance requirements	15.4.0 15.4.0
2019-12	RAN#86	RP-192998	0030	1	F	CR: Updates to NR EN-DC SDR tests	15.4.0
2020-03	RAN#87	RP-200397	0031	1	F	Clarification of Random PMI when testing	15.5.0
2020-03	RAN#87	RP-200397	0032	1	F	Correction to 5.3.3 4Rx PDCCH Demod Requirements	15.5.0
2020-03	RAN#87	RP-200397	0033	1	F	CR on corrections for FR1 PDSCH demodulation performance tests	15.5.0
2020-03 2020-03	RAN#87 RAN#87	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	RAN#87	RP-200397	0038		F	CR: Updates to NR PDSCH test parameters (Rel-15)	15.5.0

2020-03	RAN#87	RP-200379	0035		В	CR to TS 38.101-4: LTE-NR coexistence requirements for TDD mode (R16)	16.0.0
2020-06	RAN#88	RP-200985	0040		Α	CR to Aperiodic Report Slot Offset for CQI report	16.1.0
2020-06	RAN#88	RP-200985	0044		Α	CR to TS 38.101-4: Beamforming clarification (R16)	16.1.0
2020-06	RAN#88	RP-201043	0045		F	CR to TS 38.101-4: CR on TDD LTE-NR coexistence requirements finalization	16.1.0
2020-06	RAN#88	RP-200985	0047		Α	CR to TS 38.101-4: MIMO correlation matrices definition (R16)	16.1.0
2020-06	RAN#88	RP-200985	0054		Α	CR for correction of Angle of Arrival for Radiated Requirements in section 4	16.1.0
2020-06	RAN#88	RP-200985	0055		Α	CR: updates to NR CSI test	16.1.0
2020-06	RAN#88	RP-201048	0042	1	F	CR on max MIMO layer assumption in TS38.101-4	16.1.0
2020-06	RAN#88	RP-200985	0056		Α	Update of DL physical channels definitions	16.1.0
2020-06	RAN#88	RP-200985	0057		Α	CR: clarification on EPRE ratio definition	16.1.0
2020-09	RAN#89	RP-201512	0059		Α	CR to ZP-CSI-RS configuration	16.2.0
2020-09	RAN#89	RP-201512	0061		Α	CR to 2Rx PDSCH mapping type B	16.2.0
2020-09	RAN#89	RP-201499	0074		В	CR for TS 38.101-4: Applicability for NR PMI requirements with Tx ports larger than 8 and up to 32	16.2.0
2020-09	RAN#89	RP-201499	0075		В	Addition of Rel-16 SP Type I PMI tests, FRCs, and spatial correlation matrices	16.2.0
2020-09	RAN#89	RP-201512	0078		Α	CR on Corrections in 38.101-4	16.2.0

History

Document history						
V16.1.0	July 2020	Publication				
V16.2.0	November 2020	Publication				