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Foreword

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1 Scope

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

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.
- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
 [2] 3GPP TS 38.521-4: "NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements".
 [3] Recommendation ITU-R M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications-2000".
- [4] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".
- [5] 3GPP TR 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz".
- [6] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".
- [7] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".
- [8] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".
- [9] 3GPP TS 38.211: "NR; Physical channels and modulation".
- [10] 3GPP TS 38.212: "NR; Multiplexing and channel coding".
- [11] 3GPP TS 38.213: "NR; Physical layer procedures for control".
- [12] 3GPP TS 38.214: "NR; Physical layer procedures for data".
- [13] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity", Stage 2.
- [14] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".
- [15] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation".

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].

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

Section 4.4.3 for conducted requirements and Section 4.5.3 for radiated requirements

3.3 Abbreviations

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

CA Carrier Aggregation
CC Component Carrier
CCE Control Channel Element
CORESET Control Resource Set

CP Cyclic Prefix

CSI Channel-State Information
CSI-IM CSI Interference Measurement

CSI-RS CSI Reference Signal

CW Codeword

CQI Channel Quality Indicator
CRC Cyclic Redundancy Check
CRI CSI-RS Resource Indicator

DC Dual Connectivity

DCI Downlink Control Information

DL Downlink

DMRS Demodulation Reference Signal EPRE Energy Per Resource Element EN-DC E-UTRA-NR Dual Connectivity

FR Frequency Range

FRC Fixed Reference Channel

HARQ Hybrid Automatic Repeat Request

LI Layer Indicator

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

NR New Radio

NSA Non-Standalone Operation Mode OCNG OFDMA Channel Noise Generator

OFDM Orthogonal Frequency Division Multiplexing
OFDMA Orthogonal Frequency Division Multiple Access

PBCH Physical Broadcast Channel

Pcell Primary Cell

PDCCH Physical Downlink Control Channel PDSCH Physical Downlink Shared Channel

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

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

RI Rank Indicator

RRC Radio Resource Control SA Standalone operation mode

SCS Subcarrier Spacing

SINR Signal-to-Interference-and-Noise Ratio

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

TDM Time division multiplexing
TTI Transmission Time Interval

UL Uplink

VRB Virtual Resource Block

4 General

4.1 Relationship between minimum requirements and test requirements

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

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

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

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

The applicability of each requirement is described under each sub-clause in 5.1, 6.1, 7.1, 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 interwork minimum requirement specified in this specification shall be met in all applicable scenarios for NR interworking operation.

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

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

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

4.3 Specification suffix information

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

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 subclause (suffix A, B, C) in clauses 5, 6, 7, 8, 9, 10.

4.4 Conducted requirements

4.4.0 Introduction

The requirements are defined for the following modes:

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

4.4.1 Reference point

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

4.4.2 SNR definition

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

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

Where

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

4.4.3 Noc

4.4.3.1 Introduction

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

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

4.4.3.2 Noc for NR operating bands in FR1

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

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

4.4.3.2.1 Derivation of Noc values for NR operating bands in FR1

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

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

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. $\Delta_{\text{thermal}} = 16 \text{dB}$, 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.

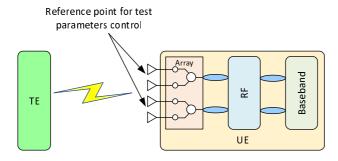


Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements

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

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:

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 arrive in the UE Rx beam peak direction as defined in TS 38.101-2 [7].

4.5.5 Es

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

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

5 Demodulation performance requirements (Conducted requirements)

5.1 General

5.1.1 Applicability of requirements

5.1.1.1 General

The minimum performance requirements are applicable to all FR1 operating bands defined in TS 38.101-1[6].

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

5.1.1.2 Applicability of requirements for different number of RX antenna ports

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

The UE shall support 2 or 4 RX antenna ports for different RF operating bands. The operating bands, where 4 RX antenna ports shall be the baseline, are defined in Clause 7.2 of TS 38.101-1 [6]. The UE requirements applicability for UEs with different number of RX antenna ports is defined in Table 5.1.1.2-1.

Table 5.1.1.2-1: Requirements applicability

Supported RX antenna ports	Test type	Test list
UE supports only	PDSCH	All tests in Clause 5.2.2
2RX	PDCCH	All tests in Clause 5.3.2
	PBCH	All tests in Clause 5.4.2
UE supports only	PDSCH	All tests in Clause 5.2.3
4RX or both 2RX	PDCCH	All tests in Clause 5.3.3
and 4RX	PBCH	All tests in Clause 5.4.2 or 5.4.3 (Note)
Note: Requirements for PBCH with 4Rx is up to UE declaration		

5.1.1.3 Applicability of requirements for optional UE features

For UE which supports optional UE features the additional performance requirements from Table 5.1.1.3-1 should be applied.

Table 5.1.1.3-1: Requirements applicability for optional UE features

UE feature/capability [14]	Test	type	Test list	Applicability notes
Enhanced Type X receiver	FR1 FDD	PDSCH	5.2.2.1.1 Minimum requirements for PDSCH Mapping Type A (Test 3-1)	
			5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A (Test 5-1)	
	FR1 TDD	PDSCH	5.2.2.2.1 Minimum requirements for PDSCH Mapping Type A (Test 3-1)	
			5.2.3.2.1 Minimum requirements for PDSCH Mapping Type A (Test 5-1)	
Alternative additional DMRS position for co-existence with LTE CRS (additionalDMRS-DL-Alt)	FR1 FDD	PDSCH	5.2.2.1.4 Minimum requirements for PDSCH Mapping Type A and LTE- NR coexistence (Test 1-2)	
			5.2.3.1.4 Minimum requirements for PDSCH Mapping Type A and LTE- NR coexistence (Test 1-2)	

5.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

For UE which supports mandatory UE features with capability signalling the additional performance requirements from Table 5.1.1.4-1 should be applied.

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

UE feature/capability [14]	Test type		Test list	Applicability notes
	FR1 FDD	PDSCH	5.2.2.1.1 Minimum requirements for PDSCH Mapping Type A (Test 1-3)	
256QAM modulation scheme for PDSCH for FR1 (pdsch-			5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A (Test 1-3)	
256QAM-FR1)	FR1 TDD	PDSCH	5.2.2.2.1 Minimum requirements for PDSCH Mapping Type A (Test 1-3)	
			5.2.3.2.1 Minimum requirements for PDSCH Mapping Type A (Test 1-3)	
	FR1 FDD	PDSCH	5.2.2.1.3 Minimum requirements for PDSCH Mapping Type B	
PDSCH mapping type B			5.2.3.1.3 Minimum requirements for PDSCH Mapping Type B	
(pdsch-MappingTypeB)	FR1 TDD	PDSCH	5.2.2.2.3 Minimum requirements for PDSCH Mapping Type B	
			5.2.3.2.3 Minimum requirements for PDSCH Mapping Type B	
Rate-matching around LTE	FR1 FDD	PDSCH	5.2.2.1.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence	
CRS (rateMatchingLTE-CRS)	FR1 FDD	PDSCH	5.2.3.1.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence	
PDSCH MIMO layers (maxNumberMIMO-	FR1 FDD	PDSCH	5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A (Test 2-1, 2- 2, 3-1, 4-1)	
LayersPDSCH)	FR1 TDD	PDSCH	5.2.3.2.1 Minimum requirements for PDSCH Mapping Type A (Test 2-1, 2-2, 3-1, 4-1)	

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		Parameter	Unit	Value
Usable subcarrier on this carrier (Note 2) Nes	PDSCH transmission			
Subcarrier spacing			RBs	0
RB offset	configuration		kHz	15 or 30
DL BWP Configuration #1 Number of contiguous PRB PRBs Assimitant transmission bandwidth and subcarrier spacing cell parameters Physical Cell ID 0 SSB position in burst SSB position		Cyclic prefix		Normal
Number of contiguous PRB		RB offset	RBs	0
SSB position in burst SSB pictodicity ms 20		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
SSB periodicity		Physical Cell ID		0
SSB periodicity	Common serving			First SSB in Slot #0
PDCH			ms	20
PDCCH	con parameters	mapping		
Number of PRBs in CORESET		Slots for PDCCH monitoring		
PDCCH		Symbols with PDCCH	Symbols	- ,
Number of PDCCH candidates and aggregation levels CCE-to-REG mapping type Non-interfeaved	PDCCH			
DCI format		aggregation levels		
TCl state TCl state #1				Non-interleaved
Cross carrier scheduling				
First subcarrier index in the PRB used for CSI-RS resource 1,2,3,4				
CSI-RS First OFDM symbol in the PRB used for CSI-RS First OFDM symbol in the PRB used for CSI-RS First OFDM symbol in the PRB used for CSI-RS First OFDM symbol in the PRB used for CSI-RS First OFDM symbol in the PRB used for CSI-RS First OFDM CSI-RS First off of CSI-RS First off of CSI-RS First off of CSI-RS CSI-	Cross carrier schedu			Not configured
CSI-RS Io = 10 for CSI-RS resource 2 and 4		CSI-RS		
CDM Type CDM Type CDM for CSI-RS resource 1,2,3,4 3 for CSI-RS resource 1,2,3,4 15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 30 kHz SCS: 40 for CSI-RS resource 1,2,3,4 15 kHz SCS: 40 for CSI-RS resource 1,2,3,4 15 kHz SCS: 10 for CSI-RS resource 1,2,3,4 15 kHz SCS: 10 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 1 and 2 21 for CSI-RS resource 3 and 4 Start PRB 0 Number of PRB = BWP size DCI-RS for CSI-RS for CSI-RS for CSI-RS ports (X) Same as number of transmit antenna CDI-RS for CSI-RS ports (X) Same as number of transmit antenna CDI-RS for CSI-RS offset Slots DCI-RS offset Slots Start PRB offset Slots Slots Start PRB offset Slots		CSI-RS		
Density (p)		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
CSI-RS periodicity Slots Slots 15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 15 kHz SCS: 40 for CSI-RS resource 1,2,3,4 15 kHz SCS: 10 for CSI-RS resource 1,2,3,4 15 kHz SCS: 10 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 Slots Slot		CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
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 1,2,3,4 15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4 12 for CSI-RS resource 3 and 4 12 for CSI-RS resource 3 and 4 13 for CSI-RS resource 3 and 4 14 for CSI-RS resource 3 and 4 15 for CSI-RS 16 for CSI-RS resource 3 and 4 15 for CSI-RS resource 3 and 4 15 for CSI-RS 16 for CSI-RS resource 3 and 4 16 for CSI-R		Density (ρ)		
CSI-RS offset	CSI-RS for tracking	CSI-RS periodicity	Slots	1,2,3,4 30 kHz SCS: 40 for CSI-RS resource 1,2,3,4
		CSI-RS offset	Slots	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
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		Frequency Occupation		
$NZP \ CSI-RS \ for \ CSI-RS \ first subcarrier index in the PRB used for \ CSI-RS \ first OFDM symbol in the PRB used for \ CSI-RS \ Number of CSI-RS ports (X) \ Same as number of transmit antenna \ CDM Type \ Density (p) \ CSI-RS periodicity \ Slots \ Slots \ Slots \ Start PRB 0 \ Number of PRB = BWP size \ QCL info \ SI-RS subcarrier index in the PRB used for \ CSI-RS for CSI-RS \ acquisition \ ZP CSI-RS for CSI \ acquisition \ First subcarrier index in the PRB used for \ CSI-RS \ Number of CSI-RS ports (X) \ Number of CSI-RS ports (X) \ A \ A \ A \ A \ A \ A \ A \ A \ A \ $, ,		
NZP CSI-RS for CSI acquisition		First subcarrier index in the PRB used for		
$\begin{tabular}{lll} NZP CSI-RS for CSI acquisition & Number of CSI-RS ports (X) & Same as number of transmit antenna & `FD-CDM2' & `FD-CDM2' & 1 & 1 & 15 kHz SCS: 20 & 30 kHz SCS: 20 & 30 kHz SCS: 40 & 30 kHz SCS: 40 & Slots & 0 & Start PRB 0 & Start $		First OFDM symbol in the PRB used for		I ₀ = 12
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		Number of CSI-RS ports (X)		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$				1
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	CSI acquisition		Slots	
		CSI-RS offset	Slots	
		QCL info		
acquisition CSI-RS Number of CSI-RS ports (X) 4		First subcarrier index in the PRB used for		
Number of CSI-RS ports (X) 4		CSI-RS		I ₀ = 12
CDM Type 'FD-CDM2'				•
		CDM Type		'FD-CDM2'

	Density (ρ)			1		
	CSI-RS periodic	city	Slots	15 kHz SCS: 20 30 kHz SCS: 40		
	CSI-RS offset		Slots	0		
	Eroguanay Oca	unation		Start PRB 0		
	Frequency Occ	upation		Number of PRB = BWP size		
				{1000} for Rank 1 tests		
	Antenna ports i	ndeves		{1000, 1001} for Rank 2 tests		
PDSCH DMRS	Antenna porto i	ndexes		{1000-1002} for Rank 3 tests		
configuration				{1000-1003} for Rank 4 tests		
		SCH DMRS CDM group(s)		1 for Rank 1 and Rank 2 tests		
	without data			2 for Rank 3 and Rank 4 tests		
	Type 1 QCL	SSB index		SSB #0		
TCI state #0	information	QCL Type		Type C		
TOI State #0	Type 2 QCL	SSB index		N/A		
	information	QCL Type		N/A		
	Type 1 QCL	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for		
	information	CSI-RS resource		tracking' configuration		
TCI state #1	IIIIOIIIIalioii	QCL Type		Type A		
	Type 2 QCL	CSI-RS resource		N/A		
	information	QCL Type		N/A		
PT-RS configuration				PT-RS is not configured		
Maximum number of	code block group	os 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}		
				SP Type I, Random per slot with PRB		
Precoding configuration				bundling granularity		
Symbols for all unused REs				OCNG Annex A.5		
		tate for the PDSCH is identic	al to the TC	I 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)	5MHz	10MHz	15MHz	20 MHz	25 MHz	30 MHz	40 MHz	50MHz	60 MHz	80 MHz	100 MHz
15	24	48	78	102	132	156	216	270	N/A	N/A	N/A
30	6	24	36	48	60	78	102	132	162	216	270

1RX requirements 5.2.1

(Void)

5.2.2 2RX requirements

5.2.2.1 **FDD**

5.2.2.1.1 Minimum requirements for PDSCH Mapping Type A

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

The test purposes are specified in Table 5.2.2.1.1-1.

Table 5.2.2.1.1-1: Tests purpose

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

Table 5.2.2.1.1-2: Test parameters

	Parameter	Unit	Value
Duplex mode			FDD
Active DL BWP index			1
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	PRB bundling size		4 for Test 1-1 2 for other tests
	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		2 for Tests 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.
			Other tests: Table 5.2-1.
CSI-RS for tracking	CSI-RS offset	Slots	Test 1-5: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4.
			Other tests: Table 5.2-1.
Number of HARQ Pro	Number of HARQ Processes		8 for Test 1-4 4 for other tests
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.1-3: 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	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	[6.5]	

Table 5.2.2.1.1-4: Minimum performance for Rank 2

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

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

		Bandwidth			Correlation	Reference value		
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)	
3-1	R.PDSCH.1-2.2 FDD	10 / 15	16QAM, 0.48	TDLA30-10	2x2, ULA Medium	70	17.6	

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

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

The test purposes are specified in Table 5.2.2.1.2-1.

Table 5.2.2.1.2-1: Tests purpose

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

Table 5.2.2.1.2-2: Test parameters

	Parameter	Unit	Value
Duplex mode			FDD
Active DL BWP index	(1
	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		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		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 Pr	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.1-1.4 FDD	10 / 15	QPSK, 0.30	TDLA30-10	2x2, ULA Low	70	-0.9

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

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

The test purposes are specified in Table 5.2.2.1.4-1.

Table 5.2.2.1.4-1: Tests purpose

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

Table 5.2.2.1.4-2: Test parameters

Parameter			Value
Duplex mode			FDD
Active DL BWP index	X		1
	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
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
CRS for rate	LTE carrier BW	MHz	10
matching (Note 1)	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: No MBSF	N is configured on LTE carrier		

Table 5.2.2.1.4-3: Minimum performance for Rank 1

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

5.2.2.2 TDD

5.2.2.2.1 Minimum requirements for PDSCH Mapping Type A

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

The test purposes are specified in Table 5.2.2.2.1-1.

Table 5.2.2.2.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance	1-1, 1-2, 1-3, 1-5, 1-6, 1-7, 1-8, 1-9, 2-1, 2-2
under 2 receive antenna conditions and with different	
channel models, MCSs and number of MIMO layers	
Verify the PDSCH mapping Type A HARQ soft combining	1-4
performance under 2 receive antenna conditions.	
Verify the PDSCH mapping Type A enhanced	3-1
performance requirement Type X under 2 receive	
antenna conditions and with 2 MIMO layers.	

Table 5.2.2.2.1-2: 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
	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		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
PDSCH DMRS configuration	Number of additional DMRS		2 for Tests 1-1, 1-7, 1-8, 1-9 1 for other tests
Comgulation	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.
Number of HARQ Processes			16 for Test 1-4 10 for Test 1-9 8 for other tests
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.2.2.1-3: Minimum performance for Rank 1

		Bandwidth				Correlation	Reference v	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	-0.8
1-6	R.PDSCH.2- 6.1 TDD	40 / 30	QPSK, 0.30	FR1.30-3	TDLA30-10	2x2, ULA Low	70	-0.9
1-7	R.PDSCH.2- 10.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	[HST-1000]	1x2	70	[6.6]
1-8	R.PDSCH.2- 11.1 TDD	40 / 30	QPSK, 0.30	FR1.30-5	TDLB100- 400	2x2, ULA Low	70	[- 1.0]
1-9	R.PDSCH.2- 12.1 TDD	40 / 30	QPSK, 0.30	FR1.30-6	TDLB100- 400	2x2, ULA Low	70	[- 1.1]

Table 5.2.2.2.1-4: Minimum performance for Rank 2

		Bandwidth				Correlation	Reference value	
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	L Propagation	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 Type X Receiver

		Bandwidth	Mandadatian	TDD III		Correlation	Reference	value
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
3-1	R.PDSCH.2- 2.2 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	2x2, ULA Medium	70	18.0

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

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

The test purposes are specified in Table 5.2.2.2.1.

Table 5.2.2.2-1: Tests purpose

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

Table 5.2.2.2-2: Test parameters

Parameter			Value
Duplex mode			TDD
Active DL BWP index	(1
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle		N/A
	size		•
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		I ₀ = 13
CSI acquisition	CSI-RS periodicity		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		5
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 5.2.2.2-3: Minimum performance for Rank 2

		Bandwidth	Madulatian	TDD		Correlation	Reference v	/alue
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2- 7.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLC300- 100	2x2, ULA Low	70	14.8

5.2.2.2.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.2.2.3-1.

Table 5.2.2.2.3-1: Tests purpose

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

Table 5.2.2.3-2: Test parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP inde	X		1
	Mapping type		Type B
	k0		0
	Starting symbol (S)		5
	Length (L)		7
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Pr	rocesses		8
The number of slots ACK information	between PDSCH and corresponding HARQ-		Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.2.3-3: 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- 1.3 TDD	40 / 30	QPSK, 0.30	FR1.30- 1	TDLA30-10	2x2, ULA Low	70	-0.9

5.2.3 4RX requirements

5.2.3.1 FDD

5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A

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

The test purposes are specified in Table 5.2.3.1.1-1.

Table 5.2.3.1.1-1: Tests purpose

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

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 configuration	PRB bundling size		4 for Test 1-1 WB for Test 3-1 2 for other tests
	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		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. Other tests: Table 5.2-1.
CSI-RS for tracking	CSI-RS offset	Slots	Test 1-5: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4. Other tests: Table 5.2-1.
Number of HARQ Pro	Number of HARQ Processes		8 for Test 1-4, 2-1 4 for other tests
The number of slots I ACK information	petween PDSCH and corresponding HARQ-		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	[3.5]

Table 5.2.3.1.1-4: Minimum performance for Rank 2

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

Table 5.2.3.1.1-5: Minimum performance for Rank 3

	Reference channel (M Subo spa	Bandwidth	Madulation	Madulation .		Reference value	
Test num.		(MHz) / Subcarrier spacing (kHz)	rrier format and ng code rate	Propagation condition	Correlation 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		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)
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 Type X Receiver

	Bandwidth		Correlation	Reference value			
Tes		(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
5-	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	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 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
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		I ₀ = 13
CSI acquisition	CSI-RS periodicity		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		5
Number of HARQ Processes			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	Propagation condition	Correlation matrix and antenna configuration	Reference va	llue
num.	channel	(kHz)	code rate			Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-5.1 FDD	10 / 15	16QAM, 0.48	TDLC300- 100	4x4, ULA Low	70	9.1

5.2.3.1.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.3.1.3-1.

Table 5.2.3.1.3-1: Tests purpose

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

Table 5.2.3.1.3-2: Test parameters

	Parameter	Unit	Value
Duplex mode			FDD
Active DL BWP index			1
	Mapping type		Type B
	k0		0
	Starting symbol (S)		5
	Length (L)		7
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Pr	ocesses		4
The number of slots ACK information	between PDSCH and corresponding HARQ-		2

Table 5.2.3.1.3-3: Minimum performance for Rank 1

		Bandwidth			Correlation	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.1-1.4 FDD	10 / 15	QPSK, 0.30	TDLA30-10	4x4, ULA Low	70	-3.8

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

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

The test purposes are specified in Table 5.2.3.1.4-1.

Table 5.2.3.1.4-1: Tests purpose

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

Table 5.2.3.1.4-2: Test parameters

	Parameter	Unit	Value
Duplex mode			FDD
Active DL BWP index			1
	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
DDOOLI	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	Length		1
0001	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
CRS for rate	LTE carrier BW	MHz	10
matching (Note 1)	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: No MBSF	N is configured on LTE carrier	•	

Table 5.2.3.1.4-3: Minimum performance for Rank 1

		Bandwidth (MHz) /	Madalatian		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 enhanced	5-1
performance requirement Type X under 4 receive	
antenna conditions and with 3 MIMO layers.	

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			4 for Tests 1-1, 1-8, 1-9
configuration	PRB bundling size		WB for Test 3-1
			2 for other tests
	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		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.

Number of HARQ Processes	16 for Test 1-4 8 for other tests
The number of slots between PDSCH and corresponding HARQ-ACK information	Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.3.2.1-3: 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	-3.6
1-6	R.PDSCH.2- 6.1 TDD	40 / 30	QPSK, 0.30	FR1.30- 3	TDLA30-10	2x4, ULA Low	70	-3.8
1-7	R.PDSCH.2- 10.1 TDD	40 / 30	16QAM, 0.48	FR1.30- 1	[HST-1000]	1x4	70	[3.6]
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

		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)
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	Madalatian			Correlation	Reference value		
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)	
3-1	R.PDSCH.2- 2.3 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	11.1	

Table 5.2.3.2.1-6: Minimum performance for Rank 4

		Bandwidth		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 Type X Receiver

		Bandwidth	Mandadatian	TDD III		Correlation	Reference	value
Test num.	Reference channel	(MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL- DL pattern	Propagation condition	matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
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
22201	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	PRB bundling size		2
configuration	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
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		l ₀ = 13
CSI acquisition	CSI-RS periodicity		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		5
Number of HARQ Pr	ocesses		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 5.2.3.2.2-3: Minimum performance for Rank 2

	Bandwidth (MHz) / Modulation TDD UL-			Correlation	Reference v	/alue		
Test num.	Reference channel	Subcarrier spacing (kHz)	format and code rate	DL DL pattern	Propagation condition	matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2- 7.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLC300- 100	4x4, ULA Low	70	9.0

5.2.3.2.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.3.2.3-1.

Table 5.2.3.2.3-1: Tests purpose

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

Table 5.2.3.2.3-2: Test parameters

	Parameter	Unit	Value	
Duplex mode			TDD	
Active DL BWP inde	ex		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			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 (MHz)/	Modulation	TDD UL-	Correlation Reference va		alue	
Test num.	Reference channel	Subcarrier spacing (kHz)	format and code rate	DL pattern	Propagation condition	matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH,2- 1.3 TDD	40 / 30	QPSK, 0.30	FR1.30- 1	TDLA30-10	2x4, ULA Low	70	-3.9

5.3 PDCCH demodulation requirements

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

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

Table 5.3-1: Common test Parameters

	Paramete	er	Unit	Value
DL BWP configuration #1	Cyclic prefix			Normal
Common	Physical Cel	l ID		0
serving cell	SSB position			1
parameters	SSB periodic	city	ms	20
DDOOLL	Slots for PD	CCH monitoring		Each slot
PDCCH		DCCH candidates		1
configuration	TCI state			TCI state #1
	First subcarrused for CS	ier index in the PRB $-RS(k_0)$		0
	First OFDM used for CS	symbol in the PRB -RS (<i>l</i> ₀)		CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4:
	Number of C	SI-RS ports (X)		1
	CDM Type	or No ports (A)		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
	Frequency C	Occupation		resource 3 and 4 Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
	Type 1	SSB index		SSB #0
TOI state #0	QCL information	QCL Type		Type C
TCI state #0	Type 2	SSB index		SSB #0
	QCL information	QCL Type		Type D
	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
TCI state #1		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
Precoding config	guration			SP Type I, Random per slot with REG bundling granularity for number of Tx larger than 1
Symbols for all u	nused RFs			OCNG in Annex A.5
Symbolo for all a			-	23113 117 11110 171.0

5.3.1 1RX requirements

(Void)

5.3.2 2RX requirements

5.3.2.1 FDD

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

Table 5.3.2.1-1: Test Parameters

Parameter	Unit	1 Tx Antenna	2 Tx Antenna	
CCE to REG mapping type	nonInter	leaved		
REG bundle size		6		
Shift index		0		

5.3.2.1.1 1 Tx Antenna performances

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

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

			CORES				Antenna	Reference	e value
Test numbe r	Bandw idth (MHz)	CORE SET RB	ET duratio n	Aggregati on level	Reference Channel	Propagation Condition	configurat ion and correlatio n Matrix	Pm-dsg (%)	SNR (dB)
1	10	24	2	2	R.PDCCH. 1-2.1 FDD	TDLA30-10	1x2 Low	1	8.1
2	10	24	2	2	R.PDCCH. 1-2.3 FDD	TDLC300- 100	1x2 Low	1	8.2
3	10	48	2	4	R.PDCCH. 1-2.4 FDD	TDLA30-10	1x2 Low	1	5.5
4	10	48	1	4	R.PDCCH. 1-1.1 FDD	TDLA30-10	1x2 Low	1	4.4
5	10	48	2	16	R.PDCCH. 1-2.6 FDD	TDLA30-10	1x2 Low	1	-2.1

5.3.2.1.2 2 Tx Antenna performances

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

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

			CORES				Antenna	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		FR1.30-1				
CCE to REG mapping type		interleaved				
Interleaver size		3				
REG bundle size		2	6			
Shift Index	Shift Index					

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. 2-1.1 TDD	TDLA30-10	1x2 Low	1	7.0
2	40	102	1	4	R.PDCCH. 2-1.2 TDD	TDLC300- 100	1x2 Low	1	3.0
3	40	48	2	16	R.PDCCH. 2-2.1 TDD	TDLC300- 100	1x2 Low	1	-3.8

5.3.2.2.2 2 Tx Antenna performances

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

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

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

5.3.3 4RX requirements

5.3.3.1 FDD

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

Table 5.3.3.1-1: Test Parameters

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

5.3.3.1.1 1 Tx Antenna performances

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

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

			CORES				Antenna	Reference	value
Test numbe r	Bandw idth (MHz)	CORE SET RB	ET duratio n	Aggregati on level	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	1x4 Low	1	2.2
2	10	24	2	2	R.PDCCH. 1-2.3 FDD	TDLC300- 100	1x4 Low	1	2.7
3	10	48	2	4	R.PDCCH. 1-2.4 FDD	TDLA30-10	1x4 Low	1	0.2
4	10	48	1	4	R.PDCCH. 1-1.1 FDD	TDLA30-10	1x4 Low	1	-0.4
5	10	48	2	16	R.PDCCH. 1-2.6 FDD	TDLA30-10	1x4 Medium A	1	-3.2

5.3.3.1.2 2 Tx Antenna performances

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

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

			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
					1-1.3 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		interleaved				
Interleaver size		3				
REG bundle size		2	6			
Shift Index		0				

5.3.3.2.1 1 Tx Antenna performances

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

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

			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	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	Refer val	
	(kHz)				Pm- bch (%)	SNR (dB)
1	10 / 15	R.PBCH.1	TDLC300-100	1 x 2 Low	1	-6.7

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

Test Bandwidth (MHz) /		Reference	Propagation	Antenna configuration	Referen	ce value
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)
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	Refer val	
	(kHz)				Pm- bch (%)	SNR (dB)
1	40 / 30	R.PBCH.2	TDLA30-10	1 x 4 Low	1	-8.6

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

Test number	Bandwidth (MHz) / Subcarrier spacing	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		Oint	Transmission scheme 1
EPRE ratio of PTRS		dB	N/A
		MHz	Channel bandwidth from selected CA
Channel bandwidth	Channel bandwidth		bandwidth combination
	Physical Cell ID		0
Common conting	SSB position in burst		First SSB in Slot #0
Common serving cell parameters	SSB periodicity	ms	20
Cell parameters	First DMRS position for Type A PDSCH		2
	mapping		_
Cross carrier schedu			Not configured
Active DL BWP index			1
Actual carrier	Offset between Point A and the lowest	RBs	0
configuration	usable subcarrier on this carrier (Note 2)	Id I=	45 07 20
	Subcarrier spacing RB offset	kHz RBs	15 or 30
	RB offset	RBS	0 Maximum transmission bandwidth
			configuration as specified in clause
DL BWP	Number of contiguous PRB		5.3.2 of TS 38.101-1 [6] for tested
configuration #1			channel bandwidth and subcarrier spacing
	Subcarrier spacing	kHz	15 or 30
	Cyclic prefix	KI IZ	Normal
	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		Symbols #0
	Symbols with FDCCH		Symbols #0
	Number of PRBs in CORESET		Table 5.5A-4
PDCCH			1/AL 1 for 30 kHz / 5 MHz
configuration	Number of PDCCH candidates and		1/AL4 for 15 kHz / 5 MHz, 30 kHz / 10
	aggregation levels		MHz and 30 kHz / 15 MHz
	CCE to DEC manning type		1/AL 8 for other combinations Non-interleaved
	CCE-to-REG mapping type DCI format		1 1
	TCI State		TCI state #1
	Mapping type		Type A
	k0		0
	PDSCH aggregation factor		1
	PRB bundling type		Static
PDSCH	PRB bundling size		WB
configuration	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle		
	size		N/A
	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		1
PDSCH DMRS configuration	Antenna ports indexes		{1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs
	Number of PDSCH DMRS CDM group(s)	1	{1000 – 1003} for 4 Layers CCs 1 for 1 layer and 2 layers CCs
	without data		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
	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
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
CSI-RS for tracking	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
Joi No for tracking	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	20.1011/ (P/		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

				45 M I= 000
	CSI-RS offset		Slots	15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4
	CSI-RS Offset		Olots	30 kHz SCS: 20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
	Frequency Oc	ccupation		Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
	Subcarrier ind CSI-RS	lexes in the PRB used for		k ₀ = 4
	RS	ols in the PRB used for CSI-		I ₀ = 12
		SI-RS ports (X)		Same as number of transmit antenna
NZP CSI-RS for	CDM Type Density (ρ)			'FD-CDM2'
CSI acquisition				15 kHz SCS: 20
	CSI-RS period	dicity		30 kHz SCS: 40
	CSI-RS offset			0
	Frequency Od	ccupation		Start PRB 0
	QCL info	·		Number of PRB = BWP size TCI state #1
		lexes in the PRB used for		
	CSI-RS			$k_0 = 0$
	OFDM symbo	els in the PRB used for CSI-		I ₀ = 12
		SI-RS ports (X)		4
ZP CSI-RS for CSI	CDM Type			'FD-CDM2'
acquisition	Density (ρ)			1 15 kHz SCS: 20
	CSI-RS period	dicity		15 KHZ SCS: 20 30 kHz SCS: 40
	CSI-RS offset			0
	Frequency Oc			Start PRB 0 Number of PRB = BWP size
	Type 1 QCL	SSB index		SSB #0
TCI state #0	information	QCL Type		Type C
TCI state #0	Type 2 QCL	SSB index		N/A
	information	QCL Type		N/A
	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
TCI state #1		QCL Type		Type A
TCI state #0	Type 2 QCL	CSI-RS resource		N/A
	information Type 1 QCL information	SSB index		SSB #0
		ups for ACK/NACK feedback		1
Maximum number of		ssion		4
HARQ ACK/NACK bundling				Multiplexed
Redundancy version coding sequence				{0,2,3,1}
Precoding configuration				SP Type I, Random per slot with PRB bundling granularity
Symbols for all unused Res			OCNG Annex A.5	
Propagation condition				Static propagation condition No external noise sources are applied
Antenna	1 layer CCs		+	1x2 or 1x4
configuration	2 layers CCs			2x2 or 2x4
	4 layers CCs	etate for the BDSCU is identi-	al to the T	4x4
transmissi Note 2: Point A co	on incides with mir			CI state applied for the PDCCH 5.3.3-1 from TS 38.101-1 [6] for tested

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 Pro	Number of HARQ Processes		4
K1 value			2

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

	Parameter	Unit	Value
Duplex mode			TDD
PDSCH	Starting symbol (S)		1
configuration	Length (L)		13
Number of HARQ Processes			8
K1 value			Specific to each UL-DL pattern
TDD UL-DL pattern			15 kHz SCS: FR1.15-1
			30 kHz SCS: FR1.30-1
Note 1: PDSCI	H is scheduled only on full DL slots		

Table 5.5A-4: Number of PRBs in CORESET

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

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

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

6 CSI reporting requirements (Conducted requirements)

6.1 General

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

6.1.1 Applicability of requirements

6.1.1.1 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.

6.1.1.2 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.

Test list Supported RX Test type antenna ports UE supports only CQI All tests in Clause 6.2.2 2RX PMI All tests in Clause 6.3.2 RΙ All tests in Clause 6.4.2 All tests in Clause 6.2.3 UE supports only CQI 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

For UE which supports mandatory UE features with capability signalling the additional performance requirements from Table 6.1.1.4-1 should be applied.

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
PDSCH MIMO layers	FR1 FDD	PDSCH	6.2.3.1.1 .1 Minimum requirement for CQI periodic reporting 6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook 6.4.3.1 (Test 1 - 4)	
(maxNumberMIMO- LayersPDSCH)	FR1 TDD	PDSCH	6.2.3.2.1.1 Minimum requirement for CQI periodic reporting 6.3.3.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook 6.4.3.2 (Test 1 - 4)	

6.1.2 Common test parameters

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

Table 6.1.2-1: Test parameters for CSI test cases

	Parameter	Unit	Value
		Onic	Transmission
PDSCH transmis	sion scheme		scheme 1
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)	RBs	0
Ŭ	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 First CCB in Clat #0
serving cell parameters	SSB position in burst	m	First SSB in Slot #0
parameters	SSB periodicity	ms	20
	Slots for PDCCH monitoring		Each slot 0,1
PDCCH	Symbols with PDCCH Number of PDCCH candidates		0,1
configuration	and aggregation levels		1/AL8
	DCI format		1_1
	TCI state		TCI state #1
Cross carrier sch			Not configured
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
PDSCH	PDSCH aggregation factor		1
configuration	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		type 0 Non-interleaved
	VRB-to-PRB mapping type		Non-interieaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
PDSCH DMRS configuration			{1000} for Rank1 {1000,1001} for Rank2
	DMRS ports indexes		{1000,1001,1002} for Rank3 {1000,1001,1002,100
	Number of PDSCH DMRS CDM		3} for Rank4 2
PTRS	group(s) without data		N/A
configuration	Frequency density (<i>K</i> _{PT-RS}) Time density (<i>L</i> _{PT-RS})		N/A N/A
corniguration	First subcarrier index in the PRB		0 for CSI-RS
	used for CSI-RS (k ₀)		resource 1,2,3,4
CSI-RS for tracking	First OFDM symbol in the PRB used for CSI-RS (<i>lo</i>)		4 for CSI-RS resource 1 and 3 8 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS
	· ·		resource 1,2,3,4

	Density (ρ)			3 for CSI-RS			
				resource 1,2,3,4 15 kHz SCS: 20 for			
				CSI-RS resource			
	CSI-RS perio	dicity	slot	1,2,3,4			
		a.o.ty	0.01	30 kHz SCS: 40 for			
				CSI-RS resource			
				15 kHz SCS:			
				10 for CSI-RS			
				resource 1 and 2 11 for CSI-RS			
				resource 3 and 4			
	CSI-RS offset	1	slot	1000dio0 o dila 1			
				30 kHz SCS:			
				20 for CSI-RS			
				resource 1 and 2			
				21 for CSI-RS			
				resource 3 and 4 Start PRB 0			
	Frequency Od	ccupation		Number of PRB =			
				BWP size			
	QCL info			TCI state #0			
				Start PRB 0			
NZP CSI-RS for	Frequency O	ccupation		Number of PRB =			
CSI acquisition	QCL info			BWP size TCI state #1			
	QCL IIIIO			Start PRB 0			
ZP CSI-RS for	Frequency Od	ccupation		Number of PRB =			
CSI acquisition				BWP size			
	Type 1 QCL	SSB index		SSB #0			
	information	QCL Type		Type C			
TCI state #0	Type 2 QCL	SSB index		N/A			
	information	QCL Type		N/A			
				CSI-RS resource 1			
	Type 1 QCL	CSI-RS resource		from 'CSI-RS for			
	information			tracking'			
TCI state #1				configuration			
	T: ::: 0 001	QCL Type		Type A			
	Type 2 QCL information	CSI-RS resource		N/A			
	IIIIOIIIIalioii	QCL Type		N/A			
Number of HARC) Processes			4 For FDD			
				8 for TDD			
HARQ ACK/NAC Redundancy vers		uence		Multiplexed {0,2,3,1}			
Reduitdancy vers	sion county sequ	uence		2 for FDD			
				For FR1.30-1:			
				8 if $mod(i,10) = 0$			
				6 if $mod(i,10) = 2$			
K1 value				5 if $mod(i,10) = 3$			
(PDSCH-to-HAR	Q-timing-indicat	or)		5 if mod(i,10) = 4 4 if mod(i,10) = 5			
				3 if mod(i,10) = 5			
			Where i is slot index				
			per radio frame with				
	0~19						
Symbols for unus			OCNG as specified in A.5				
Note 1: PDSC DL.							
Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state							
applied for the PDCCH transmission. Note 3: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from							
		minimum guard band sted channel bandwid					
10 30.	. J [O] IOI IO	c.ca chamio banawa					

6.2 Reporting of Channel Quality Indicator (CQI)

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

6.2.1 1RX requirements

(Void)

6.2.2 2RX requirements

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

6.2.2.1 FDD

6.2.2.1.1 CQI reporting definition under AWGN conditions

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

6.2.2.1.1.1 Minimum requirement for periodic CQI reporting

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

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

Table 6.2.2.1.1.1-1: CQI reporting definition test

Parameter			Te	est 1	Te	st 2
Bandwidth		MHz		10)	
Duplex Mode				FD	D	
Subcarrier spacing	g	kHz		15	5	
SNR		dB	8	9	14	15
Propagation chan	nel			AWO		•
Antenna configura	ation		2×2 wi	th static cha Annex		ecified in
Beamforming Mod	del		As	specified in		3.4.1
	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			D	<i>-</i> 1	
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	slot		5/	1	
	periodicity and offset	SIOL		5/	ı	
	CSI-RS resource Type			Perio	odic	
	Number of CSI-RS ports (X)			2		
	CDM Type			FD-CI	DM2	
NZD OOL DO 6- "	Density (ρ)			1		
NZP CSI-RS for	First subcarrier index in the PRB		Row 3,(6,-)			
CSI acquisition	used for CSI-RS (k ₀ , k ₁)					
	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	3/1			
	CSI-IM RE pattern			0		
CSI-IM	CSI-IM Resource Mapping		(4, 9)			
configuration	(Ксзі-ім,Ісзі-ім)		(4, 9)			
Comigaration	CSI-IM timeConfig	slot	5/1			
	periodicity and offset	0.01				
ReportConfigType	9			Perio		
CQI-table				Tabl		
reportQuantity			cri-RI-PMI-CQI			
	rChannelMeasurements			Not conf		
	rInterferenceMeasurements			Not con		
cqi-FormatIndicate				Widek		
pmi-FormatIndicat	tor			Widek		
Sub-band Size		RB		8		
Csi-ReportingBan				1111		
CSI-Report period		slot		5/		
aperiodicTriggerin				Not conf		
	Codebook Type			typel-Sing	glePanel	
	Codebook Mode			1		
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)			Not conf	figured	
J. 2	CodebookSubsetRestriction		1	0100	000	
	RI Restriction		1	N//		
Physical channel for CSI report				PUC		
CQI/RI/PMI delay		ms	1	8		
	of HARQ transmission	1113	+	1		
waxiiiluiii iluiiibei	OF FICH CHAINSTINGSTOFF		As sno	cified in Tal	مام ۵ مار	TRS 2.
Measurement cha		As spe	2		, 100.2-	

6.2.2.1.2 CQI reporting under fading conditions

6.2.2.1.2.1 Minimum requirement for wideband CQI reporting

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

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

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

- a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α % of the time where α % is specified in Table 6.2.2.1.2.1-2;
- b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, 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	Unit	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	uration		ULA high	
Beamforming Mod			As specified in Anne	x B.4.1
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CDM2	
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB		Row 5,4	
oogu.ao	used for CSI-RS (k ₀)		1.00 0, 1	
	First OFDM symbol in the PRB used		9	
	for CSI-RS (I ₀)		,	
	CSI-RS	slot	5/1	
	periodicity and offset		B : I	
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-CDM2	
NZP CSI-RS for	Density (ρ) First subcarrier index in the PRB		1	
CSI acquisition			Row 3,(6,-)	
	used for CSI-RS (k ₀ , k ₁) 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 RE pattern		0	
	CSI-IM Resource Mapping			
CSI-IM	(Kcsi-im, Icsi-im)		(4, 9)	
configuration	(*-oor im, -oor im)		(1, 2)	
J	CSI-IM timeConfig	alat	F /4	
	periodicity and offset	slot	5/1	
ReportConfigType)		Periodic	
CQI-table			Table 2	
reportQuantity			cri-RI-PMI-CQ	l
	rChannelMeasurements		Not configured	
timeRestrictionFo	rInterferenceMeasurements		Not configured	l
cqi-FormatIndicate	or		Wideband	
pmi-FormatIndicat	tor		Wideband	
Sub-band Size		RB	8	
Csi-ReportingBan			1111111	
CSI-Report period		slot	5/1	
aperiodicTriggerin			Not configured	
	Codebook Type		typel-SinglePan	el
	Codebook Mode		1	
Codebook	(CodebookConfig-		Not configured	I
configuration	N1,CodebookConfig-N2)		,	
	CodebookSubsetRestriction		000001	
RI Restriction			N/A	
Physical channel for CSI report			PUCCH	
CQI/RI/PMI delay		ms	8	
Maximum number	of HARQ transmission		1	
Measurement cha	nnel		As specified in Table A.4	l-2, TBS.2-

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.

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 channel			Two tap model specified in Annex B.2.4 with $a=1$, $f_D=5$ Hz, and $\tau_d=0.45$ µs	
Antenna configura	ation		2×2	
Correlation config			As per Annex B.1	
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	
70.001.00	Density (ρ)		1	
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	slot	5/1	
	periodicity and offset		Aporiodio	
	CSI-RS resource Type		Aperiodic	
	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	5/1	
	CSI-IM RE pattern		0	
CSI-IM	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4, 9)	
configuration	CSI-IM timeConfig	slot	5/1	
D (0 " T	periodicity and offset		B : "	
ReportConfigType	9		Periodic	
CQI-table			Table 2	
reportQuantity			cri-RI-PMI-CQI	
	rChannelMeasurements		Not configured	
	rInterferenceMeasurements		Not configured	
cqi-FormatIndicat			Subband	
pmi-FormatIndica	tor		Wideband	
Sub-band Size		RB	8	
csi-ReportingBan			1111111	
CSI-Report interv		slot	5/1	
aperiodicTriggerin			0	
Codebook configuration	Codebook Type		typel-SinglePanel	
	Codebook Mode		1	
	(CodebookConfig- N1,CodebookConfig-N2)		Not configured	
	CodebookSubsetRestriction		000001	
	RI Restriction		N/A	
Physical channel for CSI report			PUSCH	
CQI/RI/PMI delay		ms	8	
Maximum number of HARQ transmission		-	1	
			As specified in Table A.4-2, TBS.2-	
Measurement channel			5	

Table 6.2.2.1.2.2-2: Minimum requirements

Parameters	Test 1	Test 2
α [%]	2	2
β [%]	55	55
γ	1.05	1.05

6.2.2.2 TDD

6.2.2.2.1 CQI reporting definition under AWGN conditions

6.2.2.2.1.1 Minimum requirement for periodic CQI reporting

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [12]. The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median.

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

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

Table 6.2.2.2.1.1-1: CQI reporting definition test

Parameter		Unit	Test 1	Test 2
Bandwidth		MHz	40	
Subcarrier spacing	g	kHz	30	
Duplex Mode			TDD	
TDD UL-DL patter	TDD UL-DL pattern		FR1.30-1	
SNR		dB	8 9 14 15	
Propagation chan	nel		AW	
Antenna configura	Antenna configuration		2x2 with static channel specified in Annex B.1	
Beamforming Mod			As specified in Annex B.4.1	
	CSI-RS resource Type		Perio	odic
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CDM2	
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB used for CSI-RS (k 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		Perio	odic
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-C	DM2
	Density (p)		1	
NZP CSI-RS for 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 RE pattern		0	
001.114	CSI-IM Resource Mapping		,, ,	
CSI-IM configuration	(kcsi-im,lcsi-im)		(4,	9)
	CSI-IM timeConfig periodicity and offset	slot	10/1	
ReportConfigType)		Perio	
CQI-table			Tabl	
reportQuantity			cri-RI-P	
	rChannelMeasurements		Not con	
timeRestrictionFo	rInterferenceMeasurements		Not con	
cqi-FormatIndicate			Widel	
pmi-FormatIndicat	tor		Widel	
Sub-band Size		RB	16	
Csi-ReportingBan			1111	
CSI-Report periodicity and offset		slot	10	
aperiodicTriggerin			Not con	
	Codebook Type		typel-Sing	glePanel
	Codebook Mode		1	
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not configured	
	CodebookSubsetRestriction	ļ	010000	
	RI Restriction		N/A	
Physical channel for CSI report			PUC	
CQI/RI/PMI delay		ms	9.	5
Maximum number of HARQ transmission			1	
Measurement channel			As specified in Tal	

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.

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 ≥ γ, where γ is specified in Table 6.2.2.2.2.1-2;
- c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

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

	Parameter	Unit	Test 1	Test 2
Bandwidth		MHz	40	
Subcarrier spacin	g	kHz	30	
Duplex Mode			TDD	
TDD UL-DL patter	rn		FR1.30-1	
SNR		dB	6 7	12 13
Propagation chan	nel		TDLA	30-5
Antenna configura			2×	2
Correlation config	uration		ULA	high
Beamforming Mod	del		As specified in	Annex B.4.1
	CSI-RS resource Type		Perio	odic
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-C	DM2
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB		Row	5 A
Corniguration	used for CSI-RS (k ₀)		Kow	5,4
	First OFDM symbol in the PRB used		9	
	for CSI-RS (I ₀)		9	
	CSI-RS	slot	10.	/1
	periodicity and offset	SIOL	10,	
	CSI-RS resource Type		Perio	odic
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-C	DM2
NZP CSI-RS for	Density (ρ)		1	
CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 3	5,(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		1:	3
	NZP CSI-RS-timeConfig	slot	10.	
	periodicity and offset	0.01		
	CSI-IM RE pattern		0	
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,	9)
comiguration	CSI-IM timeConfig periodicity and offset	slot	10.	/1
ReportConfigType	9		Perio	odic
CQI-table			Tabl	e 2
reportQuantity			cri-RI-P	MI-CQI
timeRestrictionFo	rChannelMeasurements		Not con	figured
timeRestrictionFo	rInterferenceMeasurements		Not con	figured
cqi-FormatIndicat	or		Widel	oand
pmi-FormatIndica	tor		Widel	oand
Sub-band Size		RB	16	6
Csi-ReportingBan			1111	
CSI-Report period		slot	10	
aperiodicTriggerin			Not con	
	Codebook Type		typel-Sing	glePanel
	Codebook Mode		1	
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not con	figured
	CodebookSubsetRestriction		0000	001
	RI Restriction		N/	
Physical channel			PUC	
CQI/RI/PMI delay		ms	9.	
	r of HARQ transmission		1	
			As specified in Tal	ole A.4-2, TBS.2-
Measurement cha	uniei		3	

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.

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

Bandwidth Subcarrier spacing Duplex Mode TDD UL-DL pattern SNR Propagation channel Antenna configuration	MHz kHz	$\begin{array}{c c} 40 \\ 30 \\ \hline TDD \\ \hline FR1.30-1 \\ 8 & 9 & 14 & 15 \\ \hline Two tap model specified in Annex \\ B.2.4 with a=1, f_D=5Hz, and \tau_d=0.1125\mu s 2\times 2$
Duplex Mode TDD UL-DL pattern SNR Propagation channel Antenna configuration		TDD FR1.30-1 8 9 14 15 Two tap model specified in Annex B.2.4 with $a=1$, $f_D=5$ Hz, and $\tau_d=0.1125\mu$ s 2×2
TDD UL-DL pattern SNR Propagation channel Antenna configuration	dB	FR1.30-1 8 9 14 15 Two tap model specified in Annex B.2.4 with $a=1$, $f_D=5$ Hz, and $\tau_d=0.1125\mu$ s 2×2
SNR Propagation channel Antenna configuration	dB	8 9 14 15 Two tap model specified in Annex B.2.4 with a =1, f _D = 5Hz, and $τ$ _d =0.1125 $μ$ s 2×2
Propagation channel Antenna configuration	dB	Two tap model specified in Annex B.2.4 with $a=1$, $f_D=5$ Hz, and $\tau_d=0.1125\mu s$ 2×2
Antenna configuration		B.2.4 with $a=1$, $f_D = 5$ Hz, and $t_d=0.1125\mu s$ 2×2
		2×2
Correlation configuration		As per Annex B.1
Beamforming Model		As specified in Annex B.4.1
CSI-RS resource Type		Periodic
Number of CSI-RS ports	s (X)	4
CDM Type		FD-CDM2
Dencity (a)		1
ZP CSI-RS configuration First subcarrier index in used for CSI-RS (k ₀)	the PRB	Row 5,4
First OFDM symbol in the for CSI-RS (I ₀)	e PRB used	9
CSI-RS	slot	10/1
periodicity and offset CSI-RS resource Type		Doriodio
Number of CSI-RS ports	· (M	Periodic 2
CDM Type	S (A)	FD-CDM2
Density (ρ)		1
NZP CSI-RS 101 First subcarrior index in	the PPR	•
used for CSI-RS (k ₀ , k ₁		Row 3,(6,-)
First OFDM symbol in the for CSI-RS (I ₀)		13
NZP CSI-RS-timeConfig periodicity and offset	slot	10/1
CSI-IM RE pattern		0
CSI-IM Resource Mapp (kcsi-im,lcsi-im) configuration	ng	(4, 9)
CSI-IM timeConfig periodicity and offset	slot	10/1
ReportConfigType		Aperiodic
CQI-table		Table 2
reportQuantity		cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements		Not configured
timeRestrictionForInterferenceMeasuremen	ts	Not configured
cqi-FormatIndicator		Subband
pmi-FormatIndicator		Wideband
Sub-band Size	RB	16
csi-ReportingBand		111111
CSI-Report interval and offset	slot	10/1
aperiodicTriggeringOffset		0
Codebook Type		typel-SinglePanel
Codebook Mode		1
Codebook (CodebookConfig- configuration N1,CodebookConfig-N	2)	Not configured
CodebookSubsetRestr		000001
RI Restriction		N/A
Physical channel for CSI report		PUSCH
CQI/RI/PMI delay	ms	9.5
Maximum number of HARQ transmission		1
Measurement channel		As specified in Table A.4-2, TBS.2-6

Table 6.2.2.2.2-2: 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.

6.2.3.1.1.1 Minimum requirement for period CQI reporting

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

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

Table 6.2.2.1.1.1-1: CQI reporting definition test

	Parameter	Unit	Test 1	Test 2
Bandwidth		MHz	10	
Subcarrier spacing	g	kHz	15	
Duplex Mode			FDD	
SNR		dB	5 6	11 12
Propagation chan	nel		AWGN	
Antenna configura	ation		2x4 with static channel Annex B.	
Beamforming Mod	del		As specified in An	
_	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CDM:	2
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		=/4	
	periodicity and offset	slot	5/1	
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-CDM2	2
NZP CSI-RS for	Density (ρ)		1	
CSI acquisition	First subcarrier index in the PRB		Day 2 (6	\
Coi 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			
	periodicity and offset	slot	5/1	
	CSI-IM RE pattern		0	
	CSI-IM Resource Mapping			
CSI-IM configuration	(Kcsi-im,Icsi-im)		(4, 9)	
Ŭ	CSI-IM timeConfig periodicity and offset	slot	5/1	
ReportConfigType			Periodic	
CQI-table			Table 2	
reportQuantity			cri-RI-PMI-0	
	rChannelMeasurements		Not configu	red
timeRestrictionFo	rInterferenceMeasurements		Not configu	red
cqi-FormatIndicate	or		Wideban	d
pmi-FormatIndicat	tor		Wideban	d
Sub-band Size		RB	8	
csi-ReportingBand	d		1111111	
CSI-Report period		slot	5/1	
aperiodicTriggerin	ngOffset		Not configu	
	Codebook Type		typel-SingleF	Panel
	Codebook Mode		1	
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not configu	red
	CodebookSubsetRestriction		010000	
	RI Restriction		N/A	
Physical channel	Physical channel for CSI report		PUCCH	
CQI/RI/PMI delay		ms	8	
	r of HARQ transmission		1	
Measurement cha			As specified in Table 2	A.4-2, TBS.2-

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.

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	10	
Subcarrier spacing	g	kHz	15	
Duplex Mode			FDD	
SNR		dB	3 4	9 10
Propagation chan	nel		TDLA30	-5
Antenna configura			2×4	
Correlation config	uration		XP Higl	
Beamforming Mod			As specified in A	
	CSI-RS resource Type		Periodi	C
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-CDN	12
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB		Row 5,	4
garano	used for CSI-RS (k ₀)		11000 0,	•
	First OFDM symbol in the PRB used		9	
	for CSI-RS (I ₀)			
	CSI-RS	slot	5/1	
	periodicity and offset		D : 1	
	CSI-RS resource Type		Periodi	C
	Number of CSI-RS ports (X)		2	10
	CDM Type		FD-CDM	12
NZP CSI-RS for	Density (ρ) First subcarrier index in the PRB		1	
CSI acquisition			Row 3,(6	,-)
	used for CSI-RS (k ₀ , k ₁) 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 RE pattern		0	
	CSI-IM Resource Mapping			
CSI-IM	(Kcsi-im, Icsi-im)		(4, 9)	
configuration	(*-oor im, oor im)		(1, 1)	
J	CSI-IM timeConfig	alat	E/1	
	periodicity and offset	slot	5/1	
ReportConfigType)		Periodi	C
CQI-table			Table 2	
reportQuantity			cri-RI-PMI-	CQI
	rChannelMeasurements		Not configu	
timeRestrictionFor	rInterferenceMeasurements		Not configu	
cqi-FormatIndicate	or		Widebar	nd
pmi-FormatIndicat	tor		Widebar	nd
Sub-band Size		RB	8	
csi-ReportingBand			111111	1
CSI-Report period		slot	5/1	
aperiodicTriggerin			Not config	
	Codebook Type		typel-Single	Panel
	Codebook Mode		1	
Codebook	(CodebookConfig-		Not config	ıred
configuration	N1,CodebookConfig-N2)		Ţ.	
	CodebookSubsetRestriction		000001	
	RI Restriction		N/A	
Physical channel f	for CSI report		PUCCH	1
CQI/RI/PMI delay		ms	8	
Maximum number	of HARQ transmission		1	
Measurement cha	nnel		As specified in Table 1	A.4-2, TBS.2-

Table 6.2.3.1.2.1-2: Minimum requirements

Parameters	Test 1	Test 2
<i>α</i> [%]	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.

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 spacin	g	kHz	15
Duplex Mode			FDD
SNR		dB	5 6 11 12
Propagation chan	nel		Two tap model specified in Annex B.2.4 with a =1, f D = 5Hz, and t d=0.45 μ s
Antenna configura	ation		2×4
Correlation config			As per Annex B.1
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
70.001.00	Density (ρ)		1
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	slot	5/1
	periodicity and offset		Periodic
	CSI-RS resource Type		
	Number of CSI-RS ports (X)		2 FD-CDM2
	CDM Type		FD-CDIVIZ
NZP CSI-RS for	Density (ρ) First subcarrier index in the PRB		l l
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 periodicity and offset	slot	5/1
	CSI-IM RE pattern		0
CSI-IM configuration	CSI-IM Resource Mapping (k _{CSI-IM} ,l _{CSI-IM})		(4, 9)
Comiguration	CSI-IM timeConfig periodicity and offset	slot	5/1
ReportConfigType	9		Aperiodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionFo	rChannelMeasurements		Not configured
timeRestrictionFo	rInterferenceMeasurements		Not configured
cqi-FormatIndicat	or		Subband
pmi-FormatIndica	tor		Wideband
Sub-band Size		RB	8
csi-ReportingBan	d		1111111
CSI-Report interv	al and offset	slot	5/1
aperiodicTriggerin			0
	Codebook Type		typel-SinglePanel
	Codebook Mode		1
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction		N/A
Physical channel			PUSCH
CQI/RI/PMI delay		ms	8
	r of HARQ transmission	-	1
			As specified in Table A.4-2, TBS.2-
Measurement cha	annei		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.

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

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

Table 6.2.3.2.1.1-1: CQI reporting definition test

	Parameter	Unit	Test 1	Test 2
Bandwidth		MHz	40	
Subcarrier spacing	g	kHz	30	
Duplex Mode			TDD	
TDD UL-DL patter	rn		FR1.	30-1
SNR		dB	5 6	11 12
Propagation chan	nel		AW	-
Antenna configura	ation		2x4 with static cha	
Beamforming Mod			As specified in	Annex B.4.1
	CSI-RS resource Type		Perio	odic
	Number of CSI-RS ports (X)		4	
	CDM Type		FD-C	DM2
ZP CSI-RS	Density (ρ)		1	
configuration	First subcarrier index in the PRB 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	1	Perio	odic
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-C	
	Density (ρ)		1	51112
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 3	3,(6,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		10	3
	NZP CSI-RS-timeConfig periodicity and offset	slot	10.	/1
	CSI-IM RE pattern		0	
	CSI-IM Resource Mapping			
CSI-IM configuration	(kcsi-im,lcsi-im)		(4,	9)
	CSI-IM timeConfig periodicity and offset	slot	10	/1
ReportConfigType)		Perio	odic
CQI-table			Tabl	e 2
reportQuantity			cri-RI-P	
	rChannelMeasurements		Not con	
timeRestrictionFo	rInterferenceMeasurements		Not con	
cqi-FormatIndicate			Widel	
pmi-FormatIndicat	tor		Widel	
Sub-band Size		RB	16	
csi-ReportingBand			1111	
CSI-Report period	•	slot	10.	
aperiodicTriggerin			Not con	
	Codebook Type		typel-Sing	glePanel
	Codebook Mode		1	
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not con	0
	CodebookSubsetRestriction		0100	
	RI Restriction		N/	
Physical channel	for CSI report		PUC	
CQI/RI/PMI delay		ms	9.	5
Maximum number	of HARQ transmission		1	
Measurement cha	nnel		As specified in Tal	

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.

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 spacing	9	kHz	30
Duplex Mode			TDD
TDD UL-DL patter	n		FR1.30-1
SNR		dB	3 4 9 10
Propagation chan	nel		TDLA30-5
Antenna configura			2×4
Correlation config			XP 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
ZP CSI-RS	Density (ρ)		1
configuration	First subcarrier index in the PRB		Row 5,4
garano	used for CSI-RS (k ₀)		11011 0, 1
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		9
	CSI-RS	slot	10/1
	periodicity and offset	0.01	
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
NZP CSI-RS for	Density (ρ)		1
CSI acquisition	First subcarrier index in the PRB		Row 3,(6,-)
•	used for CSI-RS (k ₀ , k ₁)		X ,
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		13
	NZP CSI-RS-timeConfig	slot	10/1
	periodicity and offset CSI-IM RE pattern		0
	CSI-IM Resource Mapping		0
CSI-IM configuration	(kcsi-im,lcsi-im)		(4, 9)
comiguration	CSI-IM timeConfig periodicity and offset	slot	10/1
ReportConfigType			Periodic
CQI-table	,		Table 2
reportQuantity			cri-RI-PMI-CQI
	ChannelMeasurements		Not configured
	InterferenceMeasurements		Not configured
cgi-FormatIndicate	or		Wideband
pmi-FormatIndicat	or		Wideband
Sub-band Size		RB	16
csi-ReportingBand	1		1111111
CSI-Report period	licity and offset	slot	10/1
aperiodicTriggerin			Not configured
	Codebook Type		typel-SinglePanel
	Codebook Mode		1
Codebook configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction		N/A
Physical channel t	for CSI report		PUCCH
CQI/RI/PMI delay		ms	9.5
Maximum number	of HARQ transmission		1
Measurement cha	nnel		As specified in Table A.4-2, TBS.2-3

Table 6.2.3.2.2.1-2: Minimum requirements

Parameters	Test 1	Test 2
<i>α</i> [%]	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.

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 Te	est 2
Bandwidth		MHz	40	
Subcarrier spacing	Subcarrier spacing		30	
Duplex Mode			TDD	
TDD UL-DL patter	'n		FR1.30-1	
SNR		dB	5 6 11	12
			Two tap model specified i	
Propagation chan	nel		B.2.4 with $a=1$, $f_D = 5H$	z, and
			τ _d =0.1125μs	
Antenna configura			2×4	
Correlation config			As per Annex B.1	
Beamforming Mod			As specified in Annex	B.4.1
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X) CDM Type		4 FD-CDM2	
	Density (ρ)		1	
ZP CSI-RS	First subcarrier index in the PRB		<u>'</u>	
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	10/1	
	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		Row 3,(6,-)	
COI acquisition	used for CSI-RS (k ₀ , k ₁)		Kow 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 RE pattern		0	
	CSI-IM Resource Mapping			
CSI-IM configuration	(Ксы-ім,Ісы-ім)		(4, 9)	
	CSI-IM timeConfig	slot	10/1	
	periodicity and offset	3101		
ReportConfigType	9		Aperiodic	
CQI-table			Table 2	
reportQuantity	Ol INA		cri-RI-PMI-CQI	
	rChannelMeasurements		Not configured	
cgi-FormatIndicate	rInterferenceMeasurements		Not configured Subband	
pmi-FormatIndicat			Wideband	
Sub-band Size	loi	RB	16	
csi-ReportingBand	1	IND.	1111111	
CSI-ReportingBand CSI-Report interval and offset		slot	10/1	
aperiodicTriggeringOffset		3101	0	
aponodio miggerini	Codebook Type		typel-SinglePane	
	Codebook Mode		1	
Codebook	(CodebookConfig-		·	
configuration	N1,CodebookConfig-N2)		Not configured	
	CodebookSubsetRestriction		000001	
	RI Restriction		N/A	
Physical channel for CSI report			PUSCH	
CQI/RI/PMI delay		ms	9.5	
Maximum number of HARQ transmission			1	
Measurement channel			As specified in Table A.4-2	2, TBS.2-

Table 6.2.2.1.2.2-2: Minimum requirements

Parameters	Test 1	Test 2
a [%]	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 reports compared to the case when the transmitter is using random precoding, respectively. When the transmitter uses random precoding, for each PDSCH allocation a precoder is randomly generated and applied to the PDSCH. A fixed transport format (FRC) is configured for all requirements.

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

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

In the definition of γ , for 4TX and 8TX PMI requirements, $t_{follow1,follow2}$ is 90 % of the maximum throughput obtained at $SNR_{follow1,follow2}$ using the precoders configured according to the UE reports, and $t_{rnd1,rnd2}$ is the throughput measured at $SNR_{follow1,follow2}$ with random precoding.

6.3.1 1RX requirements

(Void)

6.3.2 2RX requirements

6.3.2.1 FDD

6.3.2.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.2.1.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth	Bandwidth		10
	Subcarrier spacing		15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configu	ıration		High XP 4 x 2
			(N1,N2) = (2,1)
Beamforming M			As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI-		
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
7D 001 D0	First subcarrier		
ZP CSI-RS	index in the PRB		Dow F (4.)
configuration	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(9,-)
	used for CSI-RS		(-,)
	(l ₀ , l ₁) CSI-RS		
	interval and offset	slot	5/1
	CSI-RS resource		
	Type		Aperiodic
	Number of CSI-		
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
NZP CSI-RS	First subcarrier		
for CSI	index in the PRB		Row 4, (0,-)
acquisition	used for CSI-RS		10W 4, (0,-)
	(k_0, k_1)		
	First OFDM		
	symbol in the PRB used for CSI-RS		(13,-)
			, , ,
	(l ₀ , l ₁) CSI-RS		
	interval and offset		5/1
	CSI-IM RE pattern		Patten 0
	CSI-IM Resource		. unon e
CSI-IM	Mapping		(4,9)
configuration	(k _{CSI-IM} ,I _{CSI-IM})		, ,
	CSI-IM timeConfig	slot	5/1
	interval and offset	3101	5/ 1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity	To #Ole a to := = 18.4		cri-RI-PMI-CQI
timeRestrictionI ments	ForChannelMeasure		Not configured
timeRestrictionForInterferenceMeas			
	urements		Not configured
cqi-FormatIndic	ator		Wideband
pmi-FormatIndio			Wideband
	Sub-band Size		8
csi-ReportingBa	and	RB	1111111
CSI-Report inte		slot	5/1
aperiodicTriggeringOffset			0
Codebook Type			typel-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig-		
configuration	N1,CodebookConf		(2,1)
Johnguration	ig-N2)		
	CodebookSubset		1111111
	Restriction		

	RI Restriction		0000001
Physical channel for CSI report			PUSCH
CQI/RI/P	MI delay	ms	6
Maximum	n number of HARQ		4
transmiss	sion		4
Measurer	ment channel		R.PDSCH.1-6.1 FDD
Note 1: For random precoder selection		ction, the p	recoder shall be updated in each
	slot (1 ms granularity).		
Note 2: If the UE reports in an available uplink report			
based on PMI estimation at a downlink slot not later than slot#(n-3),			nk slot not later than slot#(n-3),
this reported PMI cannot be applied at the eNB downlink before			at the eNB downlink before
	slot#(n+3).		
Note 3: Randomization of the principle beam direction shall be used as		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			10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation cha	annel		TDLA30-5
Antenna configu	uration		High XP 8 x 2
Beamforming M			(N1,N2) = (4,1) As specified in Annex B.4.1
Dearmonning iv	CSI-RS resource		
	Type		Aperiodic
	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,-)
l comiganism	used for CSI-RS		, (. , ,
	(k ₀ , k ₁)		
	First OFDM symbol in the PRB		
	used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS		
	interval and offset	slot	5/1
	CSI-RS resource		A marria di a
	Type		Aperiodic
	Number of CSI-		8
	RS ports (X)		
	CDM Type		CDM4 (FD2, TD2)
1170 001 00	Density (ρ)		1
NZP CSI-RS	First subcarrier		
for CSI acquisition	index in the PRB used for CSI-RS		Row 8, (4,6)
acquisition	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		<i>(</i> -)
	used for CSI-RS		(5,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	5/1
	interval and offset	3101	
	CSI-IM RE pattern		Pattern 0
001.114	CSI-IM Resource		(1.5)
CSI-IM	Mapping		(4,9)
configuration	(k _{CSI-IM} , l _{CSI-IM})		
	CSI-IM timeConfig interval and offset	slot	5/1
ReportConfigTy			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
	orChannelMeasure		
ments	ments		Not configured
timeRestrictionForInterferenceMeas			Not configured
urements			-
cqi-FormatIndic			Wideband
	pmi-FormatIndicator		Wideband
Sub-band Size	va al	RB	8
csi-ReportingBa		clo+	1111111 5/1
CSI-Report interval and offset aperiodicTriggeringOffset		slot	0
Codebook Type			typel-SinglePanel
	Codebook Type Codebook Mode		typer-onigier and
	(CodebookConfig-		1
Codebook	N1,CodebookConf		(4,1)
configuration	ig-N2)		(', ',
	CodebookSubset		۵۷ ۵۲۵
	Restriction	<u> </u>	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.1-6.2
Note 1:	 For random precoder selection, the precoder shall be updated in each slot (1 ms granularity). 		
Note 2:	2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the eNB downlink before slot#(n+4).		
Note 3:	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 6.3.2.1.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

6.3.2.2 TDD

6.3.2.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.2.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth	Bandwidth		40
Subcarrier space	cing	kHz	30
Duplex Mode	Duplex Mode		TDD
TDD DL-UL cor	TDD DL-UL configuration		FR1.30-1 as specified in Annex A
Propagation cha	annel		TDLA30-5
Antenna configu	uration		High XP 4 x 2 (N1,N2) = (2,1)
Beamforming M	lodel		As specified in Annex B.4.1
	CSI-RS resource		Aperiodic
	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,-)
Jgu	used for CSI-RS		11011 0, (1,)
	(k ₀ , k ₁)		
	First OFDM symbol in the PRB		
	used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS	_	
	interval and offset	slot	10/1
	CSI-RS resource		Aperiodic
	Туре		Aperiodic
	Number of CSI-		4
	RS ports (X) CDM Type		FD-CDM2
	Density (ρ)		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
NZP CSI-RS	First subcarrier		<u>'</u>
for CSI	index in the PRB		
acquisition	used for CSI-RS		Row 4, (0,-)
,	(k_0, k_1)		
	First OFDM		
	symbol in the PRB		(13,-)
	used for CSI-RS		(10,)
	(l ₀ , l ₁)		
	CSI-RS	slot	10/1
	interval and offset CSI-IM RE pattern		Pattern 0
	CSI-IM Resource		T attern 0
CSI-IM	Mapping		(4,9)
configuration	(kcsi-im,lcsi-im)		(1,0)
	CSI-IM timeConfig	slot	10/1
	interval and offset	5101	
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity	Tou Channal Manager		cri-RI-PMI-CQI
timeRestrictionForChannelMeasure ments			Not configured
timeRestrictionForInterferenceMeas urements			Not configured
	cqi-FormatIndicator		Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand		,,,,	1111111
CSI-Report interval and offset		slot	10/1
aperiodicTriggeringOffset			0
	Codebook Type		typel-SinglePanel
Codebook	Codebook Mode		1
Codebook - configuration	(CodebookConfig-		
	N1,CodebookConf		(2,1)
	ig-N2)		

	CodebookSubset Restriction		11111111
	RI Restriction		0000001
Physical channel for CSI report			PUSCH
CQI/RI/P	MI delay	ms	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.1 TDD
Note 1: For random precoder select slot (0.5 ms granularity).		ction, the p	recoder shall be updated in each
Note 2: If the UE reports in an available uplink reporting instance at slot #n based on PMI estimation at a downlink slot not later than slot#(n-4) this reported PMI cannot be applied at the eNB downlink before slot#(n+4).		nk slot not later than slot#(n-4),	
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 6.3.2.2.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.2.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.2.2.2-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.2-2.

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

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier space	cing	kHz	30
Duplex Mode	Duplex Mode		TDD
TDD DL-UL cor	TDD DL-UL configurations		FR1.30-1 as specified in Annex A
Propagation cha	annel		TDLA30-5
Antenna configu	uration		High XP 8 x 2 (N1,N2) = (4,1)
Beamforming M	lodel		As specified in Annex B.4.1
	CSI-RS resource		Aperiodic
	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,-)
3	used for CSI-RS		, , , ,
	(k ₀ , k ₁) First OFDM		
	symbol in the PRB		
	used for CSI-RS		(9,-)
	(I_0, I_1)		
	CSI-RS	slot	10/1
	interval and offset	0.00	10/1
	CSI-RS resource Type		Aperiodic
	Number of CSI-		
	RS ports (X)		8
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
NZP CSI-RS	First subcarrier		
for CSI	index in the PRB		Row 8, (4,6)
acquisition	used for CSI-RS (k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(5,-)
	used for CSI-RS		(5,-)
	(l ₀ , l ₁)		
	CSI-RS interval and offset	slot	10/1
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource		1 ditom 0
CSI-IM	Mapping		(4,9)
configuration	(kcsi-im,lcsi-im)		
	CSI-IM timeConfig	slot	10/1
ReportConfigTy	interval and offset		Aperiodic
CQI-table	pe		Table 1
reportQuantity			cri-RI-PMI-CQI
	ForlChannelMeasur		
ements			Not configured
timeRestrictionForInterferenceMeas			Not configured
urements cqi-FormatIndicator			
pmi-FormatIndicator			Wideband Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	10/1
aperiodicTriggeringOffset			0
	Codebook Type		typel-SinglePanel
Codebook	Codebook Mode		1
configuration	(CodebookConfig- N1,CodebookConf		(4,1)
	ig-N2)		(', ')

	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010
Physical	channel for CSI report		PUSCH
CQI/RI/P	MI delay	ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.2 TDD
Note 1: For random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity).			recoder shall be updated in each
Note 2:	If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the eNB downlink before slot#(n+6).		

Table 6.3.2.2.2: Minimum requirement

Randomization of the principle beam direction shall be used as

Parameter	Test 1
γ	1.5

6.3.3 4RX requirements

6.3.3.1 FDD

6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook

specified in Annex B.2.3.2.3.

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

Table 6.3.3.1.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation cha	annel		TDLA30-5
Antenna configu	Antenna configuration		High XP 4 x 4
			(N1,N2) = (2,1)
Beamforming M			As specified in Annex B.4.1
	CSI-RS resource		Aperiodic
	Type Number of CSI-		
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
7D 001 D0	First subcarrier		
ZP CSI-RS configuration	index in the PRB		Dow 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		
	(l ₀ , l ₁) CSI-RS		
	interval and offset	slot	5/1
	CSI-RS resource		
	Type		Aperiodic
	Number of CSI-		
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
NZP CSI-RS	First subcarrier		
for CSI	index in the PRB		Row 4, (0,-)
acquisition	used for CSI-RS		1, (0,)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB used for CSI-RS		(13,-)
	(l ₀ , l ₁)		
	CSI-RS		
	interval and offset	slot	5/1
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource		
CSI-IM	Mapping		(4,9)
configuration	(kcsi-im,lcsi-im)		
	CSI-IM timeConfig	slot	5/1
D (0 " T	interval and offset	0.01	
ReportConfigTy	pe		Aperiodic
CQI-table			Table 1 cri-RI-PMI-CQI
reportQuantity timeRestrictionForChannelMeasure			
ments			Not configured
ments timeRestrictionForInterferenceMeas			
urements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	5/1
aperiodicTriggeringOffset			0
Codebook Type			typeI-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig-		(2.4)
configuration	N1,CodebookConf		(2,1)
	ig-N2) CodebookSubset		
	Restriction		11111111
	I NESHIGHUH	<u> </u>	

RI Restriction			0000001		
Physical channel for CSI report			PUSCH		
CQI/RI/P	MI delay	ms	6		
Maximun	n number of HARQ		4		
transmiss	transmission		4		
Measure	ment channel		R.PDSCH.1-6.1 FDD		
Note 1:	For random precoder selection, the precoder shall be updated in each				
	slot (1 ms granularity).				
Note 2:	e 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),			nk slot not later than slot#(n-3),		
this reported PMI cannot be applied at the eNB downlink before			at the eNB downlink before		
	slot#(n+3).				
Note 3:	3: Randomization of the principle beam direction shall be used as				
specified in Annex B.2.3.2.3.					

Table 6.3.3.1.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation cha	annel		TDLA30-5
Antenna configuration			High XP 8 x 4 (N1,N2) = (4,1)
Beamforming M			As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI-		4
	RS ports (X)		ED CDM3
	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		
	used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS		
	interval and offset	slot	5/1
	CSI-RS resource		
	Туре		Aperiodic
	Number of CSI-		
	RS ports (X)		8
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
NZP CSI-RS	First subcarrier		
for CSI	index in the PRB		Row 8, (4,6)
acquisition	used for CSI-RS		Kow 8, (4,0)
	(k_0, k_1)		
	First OFDM		
	symbol in the PRB		(5,-)
	used for CSI-RS		(-,)
	(l ₀ , l ₁)		
	CSI-RS interval and offset	slot	5/1
	CSI-IM RE pattern		Pattern 0
			Pattern 0
CSI-IM	CSI-IM Resource		(4,9)
configuration	Mapping (kcsі-ім,lcsі-ім)		(4,9)
Comigaration	CSI-IM timeConfig		
	interval and offset	slot	5/1
ReportConfigTy			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure			
ments			Not configured
timeRestrictionForInterferenceMeas			Not configured
urements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	5/1
aperiodicTriggeringOffset			0
Codebook Type			typel-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig-		
configuration	N1,CodebookConf		(4,1)
3	ig-N2)		
	CodebookSubset		0x FFFF
	Restriction		<u> </u>

	R	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.1-6.2 FDD
Note 1:	For random precoder selection, the precoder shall be updated in each			
	slot (1 ms granularity).			
Note 2:	If the UE reports in an available uplink reporting instance at slot#n			
	based on PMI estimation at a downlink slot not later than slot#(n-4),			
	this reported PMI cannot be applied at the eNB downlink before			
	slot#(n+4).			
Note 3:	Randomization of the principle beam direction shall be used as			
	specified in Annex B.2.3.2.3.			

Table 6.3.3.1.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

6.3.3.2 TDD

6.3.3.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

For the parameters specified in Table 6.3.3.2.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.1-2.

Table 6.3.3.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth			40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configuration			FR1.30-1 as specified in Annex A
Propagation cha	annel		TDLA30-5
Antenna configu	uration		High XP 4 x 4 (N1,N2) = (2,1)
Beamforming M			As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI-		4
	RS ports (X)		·
	CDM Type Density (ρ)		FD-CDM2
	First subcarrier		I I
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		(0.)
	used for CSI-RS		(9,-)
	(I_0, I_1)		
	CSI-RS	slot	10/1
	interval and offset	3101	10/1
	CSI-RS resource		Aperiodic
	Type Number of CSI-		·
	RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
NZP CSI-RS	First subcarrier		
for CSI	index in the PRB		Row 4, (0,-)
acquisition	used for CSI-RS		1, (0,)
	(k ₀ , k ₁)		
	First OFDM symbol in the PRB		
	used for CSI-RS		(13,-)
	(l ₀ , l ₁)		
	CSI-RS		10/1
	interval and offset		10/1
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource		
CSI-IM	Mapping		(4,9)
configuration	(kcsi-im,lcsi-im)		
	CSI-IM timeConfig interval and offset	slot	10/1
ReportConfigTy			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure ments			Not configured
timeRestrictionForInterferenceMeas			Not configured
urements			
cqi-FormatIndic			Wideband
pmi-FormatIndio	CalUI	RB	Wideband 16
csi-ReportingBand		מא	1111111
CSI-Report interval and offset		slot	10/1
aperiodicTriggeringOffset		5,51	0
Sportodiorriggo	Codebook Type		typel-SinglePanel
Codelina	Codebook Mode		1
Codebook	(CodebookConfig-		
configuration	N1,CodebookConf		(2,1)
	ig-N2)		

	CodebookSubset Restriction		11111111
	RI Restriction		0000001
Physical	channel for CSI report		PUSCH
CQI/RI/P	MI delay	ms	5.5
Maximum number of HARQ transmission			4
Measure	Measurement channel		R.PDSCH.2-8.1 TDD
Note 1:	For random precoder selection slot (0.5 ms granularity).	ction, the p	recoder shall be updated in each
Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the eNB downlink before slot#(n+4).			nk slot not later than 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	Test 1
Bandwidth		MHz	40
Subcarrier space	cing	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 (N1,N2) = (4,1)
Beamforming M			As specified in Annex B.4.1
	CSI-RS resource Type		Aperiodic
	Number of CSI-		4
	RS ports (X) CDM Type		FD-CDM2
	Density (ρ)		1 D-05/W2
70.001.00	First subcarrier		·
ZP CSI-RS	index in the PRB		Daw 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		(0,)
	(l ₀ , l ₁)		
	CSI-RS	slot	10/1
	interval and offset CSI-RS resource		
	Type		Aperiodic
	Number of CSI-		8
	RS ports (X)		
	CDM Type		CDM4 (FD2, TD2)
NZP CSI-RS	Density (ρ)		1
for CSI	First subcarrier index in the PRB		
acquisition	used for CSI-RS		Row 8, (4,6)
aoquioition	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(5.)
	used for CSI-RS		(5,-)
	(I_0, I_1)		
	CSI-RS	slot	10/1
	interval and offset		
	CSI-IM RE pattern		Pattern 0
CSI-IM	CSI-IM Resource Mapping		(4,9)
configuration	(ксынм,Ісынм)		(4,9)
oomigaration	CSI-IM timeConfig		
	interval and offset	slot	10/1
ReportConfigTy	pe		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionF ements	ForChannnelMeasur		Not configured
	timeRestrictionForInterferenceMeas		Not configured
urements			
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand		clo+	1111111
CSI-Report interval and offset aperiodicTriggeringOffset		slot	10/1
apenouicingge	Codebook Type		typel-SinglePanel
	Codebook Type Codebook Mode		1 1
Codebook	(CodebookConfig-		· ·
configuration	N1,CodebookConf		(4,1)
	ig-N2)		

	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010
Physical	channel for CSI report		PUSCH
CQI/RI/P	MI delay	ms	6.5
	Maximum number of HARQ transmission		4
Measure	ment channel		R.PDSCH.2-8.2 TDD
Note 1: For random precoder selection, the precoder shall be updated slot (0.5 ms granularity).			recoder shall be updated in each
Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the eNB downlink before slot#(n+6).			nk slot not later than slot#(n-6),
Note 3: Randomization of the principle beam direction shall be used as			

Table 6.3.3.2.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

6.4 Reporting of Rank Indicator (RI)

specified in Annex B.2.3.2.3.

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 of	hannel		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
Dearmonning			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
70 001 00	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 used for CSI-RS (I ₀ , I ₁)		(9,-)	(9,-)	(9,-)
	CSI-RS periodicity and offset	slot	5/1	5/1	5/1
	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		2	2	2
NZP CSI-	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
RS for CSI	Density (ρ) First subcarrier index in the		1	1	1
acquisition	PRB used for CSI-RS (k ₀ , k ₁)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
	First OFDM symbol in the PRB used for CSI-RS (l ₀ , l ₁)		(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	5/1	5/1
001.04	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0
CSI-IM configuratio	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)	(4,9)	(4,9)
n	CSI-IM timeConfig periodicity and offset	slot	5/1	5/1	5/1
ReportConfig	Гуре		Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2
reportQuantity	/		cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestrictio	nForChannelMeasurements		not configured	not configured	not configured
	nForInterferenceMeasurements		not configured	not configured	not configured
cqi-FormatInd			Wideband	Wideband	Wideband
pmi-Formating		DD	Wideband	Wideband	Wideband
Sub-band Size csi-Reporting		RB	8 1111111	8 1111111	8 1111111
	eriodicity and offset	slot	5/1	5/1	5/1
OOI-IVEPOIL PO	Codebook Type	3101	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	000011 for	000011 for
			fixed rank 2,	fixed rank 1,	fixed rank 1,
			010011 for	010011 for	010011 for
			following rank	following rank	following rank
	RI Restriction		N/A	N/A	N/A
Physical channel for CSI report			PUCCH	PUCCH	PUCCH
CQI/RI/PMI de		ms	8	8	8
Maximum nur	nber of HARQ transmission		1	1	1
RI Configurati	on		Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI

Table 6.4.2.1-2: Minimum requirement (FDD)

	Test 1	Test 2	Test 3
24	N/A	1.05	0.9
γ2	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		Test 1	Test 2	Test 3
Bandwidth		MHz	40	40	40
Subcarrier spa	acing	kHz	30	30	30
Duplex Mode			TDD	TDD	TDD
TDD Slot Con	figuration		FR1.30-1	FR1.30-1	FR1.30-1
SNR		dB	0	20	20
Propagation of			TDLA30-5	TDLA30-5	TDLA30-5
Antenna confi	guration		ULA Low 2x2	ULA Low 2x2	ULA High 2x2
Beamforming	Model		As defined in	As defined in	As defined in
Beamlionning			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		(0.)	(0.)	(0.)
	used for CSI-RS (I ₀ , I ₁)		(9,-)	(9,-)	(9,-)
	CSI-RS	slot	10/1	10/1	10/1
	periodicity and offset 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 D-CDIVIZ	1 D-CDIVIZ
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,-)
	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	10/1	10/1
	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0
CSI-IM	CSI-IM Resource Mapping				
configuratio	(Kcsi-im,Icsi-im)		(4,9)	(4,9)	(4,9)
n	CSI-IM timeConfig periodicity and offset	slot	10/1	10/1	10/1
ReportConfig			Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2
reportQuantity	1		cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestrictio	nForChannelMeasurements		not configured	not configured	not configured
timeRestrictio	nForInterferenceMeasurements		not configured	not configured	not configured
cqi-FormatInd	licator		Wideband	Wideband	Wideband
pmi-FormatIn			Wideband	Wideband	Wideband
Sub-band Siz		RB	16	16	16
csi-Reportingl			1111111	1111111	1111111
CSI-Report pe	eriodicity and offset	slot	10/1	10/1	10/1
	Codebook Type		typel- SinglePanel	typel- SinglePanel	typel- SinglePanel
	Codebook Mode		1	1	1
	(CodebookConfig-				
Codebook	N1,CodebookConfig-N2)		N/A	N/A	N/A
configuration	CodebookSubsetRestriction		010000 for	000011 for	000011 for
			fixed rank 2,	fixed rank 1,	fixed rank 1,
			010011 for	010011 for	010011 for
			following rank	following rank	following rank
	RI Restriction		N/A	N/A	N/A
	nel for CSI report		PUCCH	PUCCH	PUCCH
CQI/RI/PMI de		ms	9.5	9.5	9.5
Maximum nur	nber of HARQ transmission		1	1	1
RI Configurati	on		Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI

Table 6.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
71	N/A	1.05	0.9
72	1.0	N/A	N/A

6.4.3 4RX requirements

6.4.3.1 FDD

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

- a) The ratio of the throughput obtained when transmitting based on UE reported RI and that obtained when transmitting with fixed rank 1 shall be $\geq \gamma_1$;
- b) The ratio of the throughput obtained when transmitting based on UE reported RI and that obtained when transmitting with fixed rank 2 shall be $\geq \gamma_2$;

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

Table 6.4.3.1-1: RI Test (FDD)

	Parameter	Unit	Test 1	Test 2	Test 3	Test 4
Bandwidth	i arameter	MHz	10	10	10	10
Subcarrier spa	acina	kHz	15	15	15	15
Duplex Mode	ionig	IXI IZ	FDD	FDD	FDD	FDD
SNR		dB	-2	16	16	22
Propagation cl	hannel	-	TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna config			ULA Low 2x4	ULA Low 2x4	ULA High 2x4	ULA Low 4x4
Beamforming	Madal		As defined in	As defined in	As defined in	As defined in
beamlonning i			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 used for CSI-RS (I ₀ , I ₁)		(9,-)	(9,-)	(9,-)	(9,-)
	CSI-RS periodicity and offset	slot	5/1	5/1	5/1	5/1
<u> </u>	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
<u> </u>	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 (l ₀ , l ₁)		(13,-)	(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	5/1	5/1	5/1
	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
ReportConfigT	- ype		Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestriction	nForChannelMeasurements		not configured	not configured	not configured	not configured
	nForInterferenceMeasurements		not configured	not configured	not configured	not configured
cqi-FormatIndi			Wideband	Wideband	Wideband	Wideband
pmi-Formating		רב	Wideband	Wideband	Wideband	Wideband
Sub-band Size		RB	8 1111111	8 1111111	8 1111111	8 1111111
csi-ReportingE	riodicity and offset	slot	5/1	5/1	5/1	5/1
Joi Report pe	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,	11111111
configuration			010011 for	010011 for	010011 for	
	DI De atriation		following rank	following rank	following rank	000000101
	RI Restriction					00000010 for fixed Rank 2
			N/A	N/A	N/A	and
			19/7	14/7	1 1/7	00001111 for
						follow RI
Physical chan	Physical channel for CSI report		PUCCH	PUCCH	PUCCH	PUCCH
CQI/RI/PMI de	elay	ms	8	8	8	8
Maximum num	nber of HARQ transmission		1	1	1	1
RI Configuration	on		Fixed RI = 2	Fixed RI = 1	Fixed RI = 1	Fixed RI = 2
Joinigaran			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
γı	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 spa	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 c			TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna confi	guration		ULA Low 2x4	ULA Low 2x4	ULA High 2x4	ULA Low 4x4
Beamforming	Model		As defined in	As defined in	As defined in	As defined in
			Annex B.4.1	Annex B.4.1	Annex B.4.1	Annex B.4.1
}	CSI-RS resource Type Number of CSI-RS ports (X)		Periodic 4	Periodic 4	Periodic 4	Periodic 4
}	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				·	
n	PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
	used for CSI-RS (I ₀ , I ₁)		(9,-)	(9,-)	(9,-)	(9,-)
	CSI-RS periodicity and offset	slot	10/1	10/1	10/1	10/1
	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		2	2	2	2
[CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
NZP CSI-	Density (ρ)		1	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,-)	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 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	10/1	10/1	10/1	10/1
ReportConfig			Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantity	1		cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestriction	nForChannelMeasurements		not configured	not configured	not configured	not configured
timeRestrictio	nForInterferenceMeasurements		not configured	not configured	not configured	not configured
cqi-FormatInd	icator		Wideband	Wideband	Wideband	Wideband
pmi-FormatInd			Wideband	Wideband	Wideband	Wideband
Sub-band Size	e	RB	16	16	16	16
csi-Reporting			1111111	1111111	1111111	1111111
CSI-Report pe	eriodicity and offset	slot	10/1	10/1	10/1	10/1
	Codebook Type		typel- SinglePanel	typel- SinglePanel	typel- SinglePanel	typel- SinglePanel
	Codebook Mode		1	1	1	1
	(CodebookConfig-		N/A	N/A	N/A	(2,1)
	N1,CodebookConfig-N2)					ν—, · ,
Codebook configuration	CodebookSubsetRestriction		010000 for fixed rank 2, 010011 for	000011 for fixed rank 1, 010011 for	000011 for fixed rank 1, 010011 for	11111111
	DI Destricti		following rank	following rank	following rank	000000101
	RI Restriction		N/A	N/A	N/A	00000010 for fixed Rank 2 and 00001111 for
<u> </u>	11.001		D. 10 0 : :	Di i con i	D/ 10 0 1 1	follow RI
	nel for CSI report		PUCCH	PUCCH	PUCCH	PUCCH
CQI/RI/PMI de		ms	9.5	9.5	9.5	9.5
i iviaximum nun	nber of HARQ transmission	l	1	1	1	1

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

Table 6.4.3.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3	Test 4
71	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.

7.1.1.2 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

For UE which supports optional UE features the additional performance requirements from Table 7.1.1.3-1 should be applied.

Table 7.1.1.3-1: Requirements applicability for optional UE features

UE feature/capability [14]	Test	type	Test list	Applicability notes
Enhanced Type X receiver	FR2 TDD	PDSCH	7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A (Test 3- 1)	

7.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

For UE which supports mandatory UE features with capability signalling the additional performance requirements from Table 7.1.1.4-1 should be applied.

Table 7.1.1.4-1: Requirements applicability for mandatory features with UE capability signalling

UE feature/capability [14]	Test type		Test list	Applicability notes
PDSCH MIMO layers (maxNumberMIMO- LayersPDSCH)	FR2 TDD	PDSCH	7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A (Test 2-1 to 2-6)	
Support of 1 port PTRS (onePortsPTRS)	FR2 TDD	PDSCH	All test cases	

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 transmis	ssion scheme		Transmission
			scheme 1
PTRS epre-Ratio Offset between Point A and the			0
Actual carrier configuration	lowest usable subcarrier on this carrier (Note 2)	RBs	0
	Subcarrier spacing	kHz	60 or 120
	Cyclic prefix		Normal
	RB offset	RBs	0
DL BWP configuration #1	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing
	Physical Cell ID		0
Common	SSB position in burst		1
serving cell	SSB periodicity	ms	20
parameters	First DMRS position for Type A PDSCH mapping		2
	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0
PDCCH	Number of PRBs in CORESET		Table 7.2-2 for tested channel bandwidth and subcarrier spacing
configuration	Number of PDCCH candidates and aggregation levels		1/AL8
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
	TCI state		TCI state #1
Cross carrier sch			Not configured
	First subcarrier index in the PRB		0 for CSI-RS
	used for CSI-RS (k ₀)		resource 1,2,3,4
	First OFDM symbol in the PRB used for CSI-RS (<i>l</i> ₀)		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
CSI-RS for tracking	CDM Type		'No CDM' for CSI- RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resource 1,2,3,4 120 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
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #0
	First subcarrier index in the PRB used for CSI-RS (k_0) First OFDM symbol in the PRB used		0
	for CSI-RS (lo)		12
	Number of CSI-RS ports (X)		2 FD CDM2
NZP CSI-RS	CDM Type	1	FD-CDM2
for CSI	Density (ρ)	1	1 60 kHz SCS: 80
acquisition	CSI-RS periodicity	Slots	120 kHz SCS: 160
	CSI-RS offset		0
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #1
	First subcarrier index in the PRB used for CSI-RS (k ₀)		4
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		12
	Number of CSI-RS ports (X)		4 FD 0DM0
ZP CSI-RS for	CDM Type		FD-CDM2
CSI acquisition	Density (ρ)		1 60 kHz SCS: 80
	CSI-RS periodicity	Slots	120 kHz SCS: 160
	CSI-RS offset		0
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	First subcarrier index in the PRB used for CSI-RS		k ₀ =0 for CSI-RS resource 1,2
	First OFDM symbol in the PRB used for CSI-RS		l ₀ = 8 for CSI-RS resource 1 l ₀ = 9 for CSI-RS resource 2
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2
CSI-RS for	CDM Type		'No CDM' for CSI- RS resource 1,2
beam refinement	Density (ρ)		3 for CSI-RS resource 1,2
	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resource 1,2 120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset	Slots	0 for CSI-RS resource 1,2
	QCL info		TCI state #1
-	•		

PDSCH DMRS configuration	Antenna por	{1000} for Rank 1 tests {1000, 1001} for Rank 2 tests	
	Number of P group(s) with	PDSCH DMRS CDM nout data	1
	Type 1	SSB index	SSB #0
TOI -1-1- #0	QCL information	QCL Type	Type C
TCI state #0	Type 2	SSB index	SSB #0
	QCL information	QCL Type	Type D
	Type 1 QCL information	CSI-RS resource	CSI-RS resource 1 from 'CSI-RS for tracking' configuration
TCI state #1		QCL Type	Type A
TOT State #1	Type 2 QCL information	CSI-RS resource	CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type	Type D
PTRS		lensity (K _{PT-RS})	2
configuration	Time density		1
Maximum number feedback	er of code bloc	ck groups for ACK/NACK	1
Maximum numb		ansmission	4
HARQ ACK/NACK bundling			Multiplexed
Redundancy version coding sequence			{0,2,3,1}
Precoding configuration			SP Type I, Random per slot with PRB bundling granularity
Symbols for all u	inused Res		OCNG in Annex A.5
Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state			

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 38.101-2 [7] for tested channel bandwidth and subcarrier spacing.

Table 7.2-2: Number of PRBs in CORESET

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

7.2.1 1RX requirements

(Void)

7.2.2 2RX requirements

7.2.2.1 FDD

(Void)

7.2.2.2 TDD

7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A

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

The test purposes are specified in Table 7.2.2.1.1-1.

Table 7.2.2.1.1-1: Tests purpose

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

Table 7.2.2.1-2: 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
	kO		0
	Starting symbol (S)		1
	Length (L)		Specific to each Reference channel as defined in A.3.2.2
	PDSCH aggregation factor		1
PDSCH configuration	PRB bundling type		Static
	PRB bundling size		WB for Test 1-1, 2 for other tests
	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 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 be HARQ-ACK information	tween PDSCH and corresponding		As defined in Annex A.1.3

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

						Correlation	Reference value	
Test num	Referenc e channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulatio n and code rate	TDD UL- DL pattern	Propagatio n condition	matrix and antenna configuratio n	Fraction of maximum throughpu t (%)	SNR _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-A	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)	Modulatio n and code rate	TDD UL-DL pattern	Propagatio n condition	matrix and antenna configuratio n	Fraction of maximum throughp ut (%)	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 Type X Receiver

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
DL BWP configuration #1	Cyclic prefix			Normal
Common	Physical Cell I			0
serving cell	SSB position i			1
parameters	SSB periodicit		ms	20
PDCCH	Slots for PDC			Each slot
configuration		CCH candidates		1
	TCI state			TCI state #1
	used for CSI-F	er index in the PRB RS (k0)		0
				CSI-RS resource 1:
	Firet OFDM ev	mbol in the PRB		CSI-RS resource 2:
	used for CSI-F			CSI-RS resource 3:
				4 CSI-RS resource 4:
001 00 6	Number of CS	U DC porto (V)		8 1
CSI-RS for	CDM Type	11-K3 ports (A)		No CDM
tracking	Density (ρ)			3
	CSI-RS period	Hicity	Slots	160
	OOI NO period	lioity	Oloto	80 for CSI-RS
	CSI-RS offset		Slots	resource 1 and 2 81 for CSI-RS resource 3 and 4
	Frequency Oc	cupation		Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
	First subcarrie	er index in the PRB		0
		mbol in the PRB		CSI-RS resource 1: 8 CSI-RS resource 2:
	Number of CC	U.D.C. norto (V)		9
NZP CSI-RS	Number of CS CDM Type	11-K3 ports (A)		No CDM
for beam	Density (ρ)			3
management	Density (p)			120 kHz SCS: 160
	CSI-RS period	dicity	Slots	for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS
				resource 1,2
	Repetition QCL info			ON TCI state #1
	WOL IIIIO			SP Type I, Random
				per slot with REG
Precoding config	guration			bundling granularity
]	-			for number of Tx
				larger than 1
	Type 1 QCL	SSB index		SSB #0
TCI state #0	information	QCL Type		Type C
	Type 2 QCL	SSB index		SSB #0
	information	QCL Type		Type D
	Tum = 4 001	CCL DC		CSI-RS resource 1 from 'CSI-RS for
	Type 1 QCL	CSI-RS resource		tracking'
	information			configuration
TCI state #1		QCL Type		Type A
. C. State #1	Type 2 QCL	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking'
	information		<u> </u>	configuration
		QCL Type		Type D

Symbols for all unused REs	OCNG in Annex A.5
Oyinbols for all unused INES	OONO III AIIIIGA A.S

7.3.1 1RX requirements

(Void)

7.3.2 2RX requirements

7.3.2.1 FDD

(Void)

7.3.2.2 TDD

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

Table 7.3.2.2-1: Test Parameters

Parameter	Unit	1 Tx Antenna	2 Tx Antenna
TDD UL-DL pattern		FR2.1:	20-1
CCE to REG mapping type		Interlea	aved
REG bundle size		2 for test 1-1 6 for test 1-2	2
Interleaver size		3 for test 1-1 2 for test 1-2	3
Shift index		0	

7.3.2.2.1 1 Tx Antenna performances

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

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

Test	Bandwidth	CORES	CORESET	Aggregation	Reference	Propagation	Antenna configuration	_	erence value
num ber	(MHz)	ET RB	duration	level	Channel	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	Bandwidth	CORESE	CORESET	Aggragation	Poforonoo	Proposition	Antenna configuration	_	erence alue
num ber	(MHz)	TRB	duration	Aggregation level	Reference 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

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

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).

7.4.1 1RX requirements

(Void)

7.4.2 2RX requirements

7.4.2.1 FDD

(Void)

7.4.2.2 TDD

Table 7.4.2.2-1: Test parameters for PBCH

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

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

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

Test	Bandwidth (MHz) /	Reference	Propagation	Antenna configuration	Referer	nce value
number	Subcarrier spacing (kHz)	channel	condition	and correlation matrix	Pm- bch (%)	SNR _{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	channel	condition	and correlation matrix	Pm-	PBCH
	(kHz)				bch	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: 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.

$$DataRate = 10^{-3} \sum_{j=1}^{J} TBS_{j} \mu_{j}$$

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 within 10 ms.

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
PDCCH	Number of PRBs in CORESET		Table 7.5A.1-2
configuration	Number of PDCCH candidates and aggregation levels		1/8
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1-1
	TCI State		TCI state #1
	Mapping type		Type A
	k0 PDSCH aggregation factor		0
	PRB bundling type		Static
	PRB bundling size		WB
PDSCH	Resource allocation type		Type 0
configuration	RBG size		Config2
comigaration	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
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 (Kpt-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		$l_0 = 6$ 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
CSI-RS for tracking	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 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
	ı	1	

	CSI-RS offset		Slots	60 kHz SCS: 40 for CSI-RS resource 1 and 2 41 for CSI-RS resource 3 and 4
			2.0.0	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			TCI state #0
		in the PRB used for		
	CSI-RS	th - DDD 1 for 001		k ₀ = 4
	RS	the PRB used for CSI-		I 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
	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
	QCL info			TCI state #1
	Subcarrier indexes in the PRB used for CSI-RS			$k_0 = 0$
		the PRB used for CSI-		I ₀ = 12
ZP CSI-RS for CSI	Number of CSI-RS	ports (X)		4
	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			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
	First OFDM symbo	ol in the PRB used for		I ₀ = 8 for CSI-RS resource 1 I ₀ = 9 for CSI-RS resource 2
	Number of CSI-RS	ports (X)		1 for CSI-RS resource 1,2
	CDM Type			'No CDM' for CSI-RS resource 1,2
CSI-RS for beam	Density (ρ)			3 for CSI-RS resource 1,2
refinement				60 kHz SCS: 80 for CSI-RS resource
	CSI-RS periodicity		Slots	1,2 120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Repetition			ON
	QCL info			TCI state #1
	Tyoe 1 QCL	SSB index		SSB #0
TCI state #0	information	QCL Type		Type C
	Tyoe 2 QCL information	SSB index QCL Type		SSB #0 Type D
				CSI-RS resource 1 from 'CSI-RS for
	Tyoe 1 QCL information	CSI-RS resource		tracking' configuration
TCI state #1	ioiiiatioii	QCL Type		Type A
	Tyoe 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
Maximum number of	Maximum number of code block groups for ACK/NACK			Type D
feedback				1
Number of HARQ Pr	ocesses			10 for FR2.60-1 and 8 for FR2.120-1
K1 value	SUADO trans			Specific to each UL-DL pattern
Maximum number of HARQ ACK/NACK b				4 Multiplexed
				{0,2,3,1}
Redundancy version	coging sequence	Į.		

TDD UL-DL pattern		60 kHz SCS: FR2.60-1 120 kHz SCS: FR2.120-1	
Precoding configuration		SP Type I, Random per slot with PRB bundling granularity	
Symbols for all unused Res		OCNG Annex A.5	
Propagation condition		Static propagation condition No external noise sources are applied	
Antenna	1 layer CCs	1x2 or 1x4	
configuration	2 layers CCs	2x2 or 2x4	
Note 1: PDSCH is scheduled only on full DL slots not containing SSB or TRS.			

Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH

transmission.

Note 3: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-2 [7] for tested

channel bandwidth and subcarrier spacing.

Table 7.5A.1-2: Number of PRBs in CORESET

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

Table 7.5A.1-3: MCS indexes for indicated UE capabilities

Maximum number of PDSCH MIMO layers	Maximum modulation format	Scaling factor	MCS
1	6	1	27
1	6	0.8	23
1	6	0.75	22
1	6	0.4	14
1	4	1	16
1	4	0.8	16
1	4	0.75	16
1	4	0.4	10
1	2	1	9
1	2	0.8	9
1	2	0.75	9
1	2	0.4	4
2	6	1	27
2	6	0.8	23
2	6	0.75	22
2	6	0.4	14
2	4	1	16
2	4	0.8	16
2	4	0.75	16
2	4	0.4	10
2	2	1	9
2	2	0.8	9
2	2	0.75	9
2	2	0.4	4

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

MCS Index (Note 1)	SNR _{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 section 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.

8.1.1.2 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

For UE which supports mandatory UE features with capability signalling the additional performance requirements from Table 8.1.1.4-1 should be applied.

Table 8.1.1.4-1: Requirements applicability for mandatory features with UE capability signalling

UE feature/capability [14]	Test t	уре	Test list	Applicability notes
PDSCH MIMO layers (maxNumberMIMO- LayersPDSCH)	FR2 TDD	PDSCH	8.2.2.2.1.1 Minimum requirement for periodic CQI reporting	
			8.4.2.2 (Test 1 – 3)	
Support of 1 port PTRS (onePortsPTRS)	FR2 TDD	PDSCH	All test cases	

8.1.2 Common test parameters

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

Table 8.1.2-1: Test parameters for CSI test cases

	Parameter	Unit	Value
PDSCH transmission scheme			Transmission
			scheme 1
Duplex Mode			TDD
PTRS epre-Ratio			0
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)	RBs	0
	Subcarrier spacing	kHz	120
	Cyclic prefix		Normal
	RB offset	RBs	0
DL BWP configuration #1	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing
Active DL BWP in			1
Common	Physical Cell ID SSB position in burst		0 First SSB in Slot #0
serving cell parameters	SSB periodicity	me	20
parameters	Slots for PDCCH monitoring	ms	Each slot
	Symbols with PDCCH		0,1
PDCCH	Number of PDCCH candidates		·
configuration	and aggregation levels		1/AL8
Comigaration	DCI format		1 1
	TCI state		TCI state #1
Cross carrier sch			Not configured
	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 size		N/A
	DMRS Type		Type 1
	Number of additional DMRS		1 (4000) (D 14
PDSCH DMRS	DMRS ports indexes		{1000} for Rank1 {1000,1001} for Rank2
configuration	Maximum number of OFDM symbols for DL front loaded DMRS		1
	Number of PDSCH DMRS CDM group(s) without data		2
PTRS	Frequency density (K _{PT-RS})		2
configuration	Time density (L _{PT-RS})		1
	First subcarrier index in the PRB		0 for CSI-RS
	used for CSI-RS (k ₀)		resource 1,2,3,4
			4 for CSI-RS
001.507	First OFDM symbol in the PRB used for CSI-RS (<i>l</i> ₀)		resource 1 and 3
CSI-RS for			8 for CSI-RS
tracking			resource 2 and 4 1 for CSI-RS
	Number of CSI-RS ports (X)		
			resource 1,2,3,4 No CDM for CSI-RS
	CDM Type		resource 1,2,3,4
<u> </u>	<u>I</u>	1	10000100 1,2,0,7

	1		1	3 for CSI-RS
	Density (ρ)			resource 1,2,3,4
				120kHz SCS: 160 for
	CCI De porio	diaity	slot	CSI-RS resource
	CSI-RS perio	dicity	SIOL	
				1,2,3,4 120 kHz SCS:
	CSI-RS offse		slot	80 for CSI-RS
	CSI-RS Offse	E	SIOL	resource 1 and 2
				81 for CSI-RS
				resource 3 and 4
				Start PRB 0
	Frequency O	ccupation		Number of PRB =
	OCL info			BWP size
	QCL info			TCI state #0
NZP CSI-RS				Start PRB 0
for CSI	Frequency O	ccupation		Number of PRB =
acquisition	001 : (BWP size
	QCL info			TCI state #1
ZP CSI-RS for	-			Start PRB 0
CSI acquisition	Frequency O	ccupation		Number of PRB =
				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
	used for CSI-RS			$I_0 = 9$ for CSI-RS
				resource 2
	Number of CSI-RS ports (X)			1 for CSI-RS
				resource 1,2
CSI-RS for	CDM Type			'No CDM' for CSI-RS
beam				resource 1,2
refinement	Density (ρ)			3 for CSI-RS
				resource 1,2
			Slots	120 kHz SCS: 160
	CSI-RS perio	odicity		for CSI-RS resource
				1,2
	CSI-RS offse	et	Slots	0 for CSI-RS
				resource 1,2
	Repetition			ON
	QCL info	T = = =		TCI state #1
	Type 1	SSB index		SSB #0
	QCL	QCL Type		Type C
TCI state #0	information			
	Type 2 QCL	SSB index		SSB #0
	information	QCL Type		Type D
	oadoi1			CSI-RS resource 1
	Type 1	001.00		from 'CSI-RS for
	QCL	CSI-RS resource		tracking'
	information			configuration
TOL -1 . "1		QCL Type		Type A
TCI state #1		71		CSI-RS resource 1
	Type 2	CCI DC *		from 'CSI-RS for
	QCL	CSI-RS resource		tracking'
	information			configuration
		QCL Type		Type D
Number of HARO	8			
HARQ ACK/NAC				Multiplexed
Redundancy vers		quence		{0,2,3,1}
			1	(-, ,-,-,

		For FR2.120-1:		
		3 if mod $(i.5) = 0$,		
		6 if $mod(i,5) = 2$		
		For FR2.120-2:		
K1 value		11 if $mod(i,8) = 0$,		
(PDSCH-	to-HARQ-timing-indicator)	7]if $mod(i,8) = 4$,		
		6]if $mod(i,8) = 5$,		
		where i is slot index		
		per radio fame with		
		values 0-79.		
Cymbolo	for unused Dog	OCNG as specified		
Symbols	for unused Res	in A.5		
Note 1:	PDSCH is not scheduled on slots containing	ng CSI-RS or slots which are not		
	full DL.			
Note 2:	Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state			
applied for the PDCCH transmission.				

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	Bandwidth		100
Subcarrier spa	acing	kHz	120
Duplex Mode			TDD
TDD Slot Con	figuration		FR2.120-2 Annex A.1.3
SNR _{BB}		dB	8 9 14 15
Propagation of	channel		AWGN
Antenna confi	iguration		2x2 with static channel specified in Annex B.1
Beamforming	Model		As specified in Annex B.4.1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
ZP CSI-RS	Density (ρ)		1
configuratio	First subcarrier index in the		_
n	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	8/1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		fd-CDM2
NZP CSI-	Density (ρ)		1
RS for CSI	First subcarrier index in the		_
acquisition	PRB used for CSI-RS (k ₀ , k ₁)		6
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		13
	NZP CSI-RS-timeConfig periodicity and offset	slot	8/1
	CSI-IM RE pattern		1
CSI-IM	CSI-IM Resource Mapping		(2 (2)
configuratio	(k _{CSI-IM} ,l _{CSI-IM})		(8, 13)
n	CSI-IM timeConfig periodicity and offset	slot	8/1
ReportConfig			Periodic
CQI-table	-71		Table 1
reportQuantity	V		cri-RI-PMI-CQI
	nForChannelMeasurements		Not configured
	nForInterferenceMeasurements		Not configured
cqi-FormatInd			Wideband
pmi-FormatIn			Wideband
Sub-band Siz		RB	8
csi-Reporting			111111111
	eriodicity and offset	slot	8/1
aperiodicTrigg			Not configured
	Codebook Type		typel-SinglePanel
	Codebook Mode		1
Codebook	(CodebookConfig-		N
configuration	N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		010000
	RI Restriction		N/A
Physical chan	nnel for CSI report		PUCCH
,	CQI/RI/PMI delay	ms	8.375
Maximum nur	mber of HARQ transmission		1
Measurement			As specified in Table A.4-1, TBS.1-2
L		1	/\.\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

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 8.2.2.2.1-2;
- 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	Unit	Test 1	Test 2
Bandwidth		MHz	100	
Subcarrier spa	acing	kHz	12	20
Duplex Mode			TE	
TDD Slot Con	figuration			-2 Annex
			A.	
SNR _{BB}		dB	6 7	12 13
Propagation of	channel			30-35
Antenna confi	guration		2x ULA	
Beamforming	Model			d in Annex
	CSI-RS resource Type		Apei	riodic
	Number of CSI-RS ports (X)			1
	CDM Type			DM2
ZP CSI-RS	Density (ρ)			
configuratio	First subcarrier index in the		,	3
n	PRB used for CSI-RS (k ₀ , k ₁)		`	
	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		1	3
	CSI-RS interval and offset	slot	8/	/1
	CSI-RS resource Type		Ana	riodic
	Number of CSI-RS ports (X))
	CDM Type		fd-C	
NZP CSI-	Density (ρ)		14-0	
RS for CSI	First subcarrier index in the			<u> </u>
acquisition	PRB used for CSI-RS (k ₀ , k ₁)		(6
1	First OFDM symbol in the PRB		4	
	used for CSI-RS (l ₀ , l ₁)		1	3
	NZP CSI-RS-timeConfig	slot	8/	/1
	interval and offset	SIUL	O/	ı
	CSI-IM RE pattern		•	
CSI-IM	CSI-IM Resource Mapping		(8,	13)
configuratio	(KCSI-IM, ICSI-IM)		(-,	- ,
n	CSI-IM timeConfig	slot	8/1	
D (O fi	interval and offset		A	i a ali a
ReportConfig	туре			riodic
CQI-table			Tab	PMI-CQI
reportQuantity	/nForChannelMeasurements			nfigured
	nForInterferenceMeasurements			nfigured
cqi-FormatInd				band
pmi-Formatine				band band
Sub-band Siz		RB		3
csi-Reporting		IND	1111	
	eriodicity and offset	slot	8/	
aperiodicTrigg		3101		nfigured
aponodiorngs	Codebook Type			glePanel
	Codebook Mode		19701 0111	J
Codebook	(CodebookConfig-			
configuration	N1,CodebookConfig-N2)		Not cor	nfigured
	CodebookSubsetRestriction		000	001
	RI Restriction		N,	
Physical chan	inel for CSI report		PUS	
•	CQI/RI/PMI delay	ms		375
Maximum nur	nber of HARQ transmission		,	
Measurement			As specifie A.4-1, 7	ed in Table TBS.1-1

Table 8.2.2.2.1-2 Minimum requirements

	Test 1	Test 2
α[%]	2	2
γ	1.05	1.05

8.3 Reporting of Precoding Matrix Indicator (PMI)

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

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

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

In the definition of 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 spacia	ng	kHz	120	120
			FR2.120-2 as	FR2.120-1 as
TDD DL-UL conf	iguration		specified in	specified in
			Annex A.1.3	Annex A.1.3
Propagation char			TDLA30-35	TDLA30-35
Antenna configui	ration		2 x 2 ULA Low	2 x 2 ULA Low
Beamforming Mo	odel		As specified in	As specified in
	CSI-RS resource		Annex B.4.1	Annex B.4.1
	Type		Aperiodic	Aperiodic
	Number of CSI-RS		4	4
	ports (X) CDM Type		FD-CDM2	FD-CDM2
	Density (ρ)		1 1	1
ZP CSI-RS	First subcarrier		1	ı ı
configuration	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
NIZD 001 D0	Density (ρ)		1	1
NZP CSI-RS for CSI	First subcarrier			·
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 (lo, l1)		(13,-)	(13,-)
	CSI-RS interval and offset	slot	8/1	5/1
	CSI-IM RE pattern		Pattern 1	Pattern 1
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(8,13)	(8,13)
	CSI-IM timeConfig interval and offset	slot	8/1	5/1
ReportConfigTyp	e		Aperiodic	Aperiodic
CQI-table			Table 1	Table 1
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionFo	orChannelMeasureme		Not configured	Not configured
timeRestrictionFo	orInterferenceMeasur		Not configured	Not configured
cqi-FormatIndica	tor		Wideband	Wideband
pmi-FormatIndica			Wideband	Wideband
Sub-band Size		RB	8	8
csi-ReportingBar	nd		111111111	111111111
CSI-Report interv	val and offset	slot	8/1	5/1
aperiodicTriggeri	ngOffset		0	0

	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 dela	у	ms	1.375	1.75		
Maximum numb transmission	er of HARQ		4	4		
Measurement channel			R.PDSCH.5-8.1 TDD	R.PDSCH.5- 7.1 TDD		
Note 1: For ra	Note 1: For random precoder selection, the precoder shall be undated in each slot					

- Note 1: For random precoder selection, the precoder shall be updated in each slot (0.125 ms granularity).
- Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4)], this reported PMI cannot be applied at the eNB downlink before slot#(n+4)].
- Note 3: Randomization of the principle beam direction shall be used as specified in 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 spa	acing	kHz	120	120	120
Duplex Mode			TDD	TDD	TDD
TDD Slot Con	figuration		FR1.120-2	FR1.120-2	FR1.120-2
SNR		dB	0	16	16
Propagation c			TDLA30-35	TDLA30-35	TDLA30-35
Antenna confi	guration		ULA Low 2x2	ULA Low 2x2	XP 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 Number of CSI-RS ports (X)		Aperiodic 4	Aperiodic 4	Aperiodic
	CDM Type		FD-CDM2	FD-CDM2	4 FD-CDM2
ZP CSI-RS	Density (p)		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		(40.)	(40.)	(40.)
	used for CSI-RS (I ₀ , I ₁)		(13,-)	(13,-)	(13,-)
	CSI-RS	slot	8/1	8/1	8/1
	interval and offset	SIOL			
	CSI-RS resource Type		Aperiodic	Aperiodic	Aperiodic
	Number of CSI-RS ports (X)		2	2	2
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
NZP CSI-	Density (p)		1	1	1
RS for CSI	First subcarrier index in the		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
acquisition	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				
	interval and offset	slot	8/1	8/1	8/1
	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	slot	8/1	8/1	8/1
	interval and offset	3101			
ReportConfigT	^Т уре		Aperiodic	Aperiodic	Aperiodic
CQI-table			Table 1	Table 1	Table 1
reportQuantity	•		cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
				not	not
timeRestriction	nForChannelMeasurements		not configured	configured	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-ReportingE	Band		111111111	111111111]	111111111
	erval and offset	slot	8/1	8/1	8/1
aperiodicTrigg			0	0	0
	Codebook Type		typel-	typel-	typel-
	Codobook Mada		SinglePanel	SinglePanel	SinglePanel
	Codebook Mode (CodebookConfig-		1	1	I
	N1,CodebookConfig-N2)		N/A	N/A	N/A
Codebook	CodebookSubsetRestriction				
configuration			010000 for	000011 for	000011 for
			fixed rank 2,	fixed rank 1,	fixed rank 1,
			010011 for	010011 for following rank	010011 for
			following rank	_	following rank
	RI Restriction		N/A	N/A	N/A
	nel for CSI report		PUSCH	PUSCH	PUSCH
CQI/RI/PMI de	elay	ms	1.375	1.375	1.375
Maximum num	nber of HARQ transmission		1	1	1
RI Configuration	on		Fixed RI = 2	Fixed RI = 1	Fixed RI = 1
		<u> </u>	and follow RI	and follow RI	and follow RI

Table 8.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
21	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 Section 5 will be verified only for SA except for the sustained downlink data rate test specified in Section 5.5 and 5.5A.
 - The performance requirements specified in Section 7 will be verified only for SA except for the sustained downlink data rate test specified in Section 7.5 and 7.5A.
 - The sustained downlink data rate tests specified in Sections 5.5, 5.5A and 7.5, 7.5A for SA and in Section 9.4B for NSA are verified separately.
- The FR1 EN-DC test cases with the NR TDD DL-UL configurations which are not aligned with LTE's can be tested on the corresponding EN-DC band combinations where UE supports simultaneous transmission and reception.
- For UEs supporting NR FR1 CA and NR CA including FR1 and FR2, the sustained downlink data rate requirements are specified in 7.5A.
- For UEs supporting EN-DC including FR2 and EN-DC including FR1 and FR2, the sustained downlink data rate requirements are specified in 9.4B.1.2.

9.1.1.1 Applicability of requirements for optional UE features

For UE which supports optional UE features the additional performance requirements from Table 9.1.1.1-1 should be applied.

Table 9.1.1.1-1: Requirements applicability for optional UE features

UE feature/capability [14]	Test	type	Test list	Applicability notes
DDCCU MIMO Invers	FR1 FDD	PDSCH	5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A (Test 2-1, 2-2, 3-1, 4-1)	EN-DC
PDSCH MIMO layers (maxNumberMIMO- LayersPDSCH)	FR1 TDD	PDSCH	5.2.3.2.1 Minimum requirements for PDSCH Mapping Type A (Test 2-1, 2-2, 3-1, 4-1)	EN-DC
	FR2 TDD	PDSCH	7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A (Test 2-1 to 2-6)	EN-DC

9.1.1.2 Applicability of requirements for mandatory UE features with capability signalling

9.1.2 LTE Pcell setup

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

9.1.2.1 FDD

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

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

Unit Value **Parameter** Cyclic prefix Normal Physical Cell ID 0 Number of PDCCH 1 symbols symbols PHICH Ng (Note 1) PHICH duration Normal Number of HARQ R processes per Processes 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 3 Transmission time difference between LTE μs 0 cell and NR cell(s) Antenna configuration 2x2 Codebook subset 10 restriction Symbols for all unused OCNG in Annex A.5 Res

Table 9.1.2.1-1: Common Test Parameters (FDD)

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

Test setup	Bandwidth (MHz)	Downlink power allocation (dB)		
•	, ,	$ ho_{\scriptscriptstyle A}$	$ ho_{\scriptscriptstyle B}$	σ
1	5	-3	-3	0
2	10	-3	-3	0
3	15	-3	-3	0
4	20	-3	-3	0

9.1.2.2 TDD

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

The measurement channels in Table 9.1.2.2-2 and OCNG pattern OP.1 TDD are specified in TS 36.101 [4]. The physical channel setup with downlink power allocation is according to Annex C.3.2 of TS 36.101 [4].

Table 9.1.2.2-1: Common Test Parameters (TDD)

Parameter	Unit	Value
UL DL configuration		2 (Note1)
Special subframe		7
configuration		'
Number of PDCCH	symbols	1
symbols	Зуппооіз	'
PHICH Ng (Note 3)		1
PHICH duration		Normal
Cyclic prefix		Normal
Cell ID		0
Maximum number of		4
HARQ transmission		<u> </u>
Redundancy version		{0,0,1,2} for 64QAM
coding sequence		1 1 1 1
Propagation condition		Static propagation condition
		No external noise sources are applied
Transmission mode		3
Transmission time		
difference between LTE	μs	0
cell and NR cell(s)		
Antenna configuration		2x2
Codebook subset		10
restriction		10
Symbols for all unused		OCNG in Annex A.5
Res		OCING III AIIIIEX A.5

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

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

Test	Bandwidth		nlink p cation	
setup	(MHz)	$ ho_{\scriptscriptstyle A}$	$ ho_{\scriptscriptstyle B}$	σ
1	10	-3	-3	0
2	15	-3	-3	0
3	20	-3	-3	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 Section 9.1.2. The NR PDSCH demodulation performance requirements for NR are specified in Section 5.2. During the test, only the PDSCH performance on the NR cell(s) shall be verified.

- 9.2B.1.2 EN-DC including FR2 NR carrier only
- 9.2B.1.2.1 PDSCH

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

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

(Void)

- 9.2B.2 NR DC between FR1 and FR2
- 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 Section 9.1.2. The NR PDCCH demodulation performance requirements for NR are specified in Section 5.3. During the test, only the PDCCH performance on the single NR cell shall be verified.

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

9.3B.1.2.1 PDCCH

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

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

(Void)

9.3B.2 NR DC between FR1 and FR2

9.4 Void

9.4A SDR test for CA

9.4A.1 NR CA between FR1 and FR2

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 Section 5.5A. The NR FR2 SDR tests setup is specified in Section 7.5A. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers is verified and only NR FR1 PCell is activated from all FR1 CCs for the tested CA bandwidth combination.

The TB success rate shall be higher than 85% when NR FR2 PDSCH is scheduled with MCS defined for the selected CA bandwidth combination and with the downlink physical channel setup according to Annex C.3.1.

9.4B SDR test for DC

9.4B.1 EN-DC

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

9.4B.1.1 EN-DC within FR1

9.4B.1.1.1 SDR test

The Sustained Data Rate (SDR) requirements in this clause are applicable to the EN-DC within FR1.

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

The test parameters are determined by the following procedure:

- Select one EN-DC bandwidth combination among all supported EN-DC configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities that provides the largest data rate [in accordance with clause 4.1.2 of TS 38.306 [14]].
 - Set of per NR CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor in accordance with clause 4.1.2 of TS 38.306 [14].
 - Set of per E-UTRA CC UE capabilities includes channel bandwidth, number of PDSCH MIMO layers and modulation format in accordance with clause 4.1.2 of TS 38.306 [14].
 - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with same largest data rate, select one among sets with the smallest aggregated channel bandwidth.
- For each NR FR1 CC in EN-DC bandwidth combination, use Table 5.5A-5 in Section 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 Section 9.1.2 and Table 9.4B.1.1.1-1. The NR SDR tests setup is specified in Section 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].

Parameter Unit Value Inter-TTI Distance Number of OFDM symbols for PDCCH per OFDM symbols component carrier Cross carrier scheduling Not configured Static propagation condition Propagation condition No external noise sources are applied dBm/15kHz at antenna port -85 2 layer CC 2x2 or 2x4 Antenna configuration 4 layer CC 4x4 Codebook subset 2 layer CC 10 restriction 4 layer CC 1000 2 layer CC $\rho_A = -3dB$, $\rho_B = -3dB$, $\sigma = 0dB$ Downlink power allocation 4 layer CC $\rho_A = -6 \text{dB}, \ \rho_B = -6 \text{dB}, \ \sigma = 3 \text{dB}$

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)

MIMO layer	Bandwidth	Reference channel				
Willivio layer	Danuwium	64QAM	256QAM	1024QAM		
	5	R.PDSCH.4-1.1 FDD	R.PDSCH.4-3.1 FDD	R.PDSCH.4-5.1 FDD		
2 lover	10	R.PDSCH.4-1.2 FDD	R.PDSCH.4-3.2 FDD	R.PDSCH.4-5.2 FDD		
2 layer	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 lover	10	R.PDSCH.4-2.2 FDD	R.PDSCH.4-4.2 FDD	R.PDSCH.4-6.2 FDD		
4 layer	15	R.PDSCH.4-2.3 FDD	R.PDSCH.4-4.3 FDD	R.PDSCH.4-6.3 FDD		
	20	R.PDSCH.4-2.4 FDD	R.PDSCH.4-4.4 FDD	R.PDSCH.4-6.4 FDD		

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

MIMO lavor	Bandwidth		Reference channel	
MIMO layer	Danuwiuin	64QAM	256QAM	1024QAM
	10	R.PDSCH.6-1.1 TDD	R.PDSCH.6-3.1 TDD	R.PDSCH.6-5.1 TDD
2 layer	15	R.PDSCH.6-1.2 TDD	R.PDSCH.6-3.2 TDD	R.PDSCH.6-5.2 TDD
	20	R.PDSCH.6-1.3 TDD	R.PDSCH.6-3.3 TDD	R.PDSCH.6-5.3 TDD
	10	R.PDSCH.6-2.1 TDD	R.PDSCH.6-4.1 TDD	R.PDSCH.6-6.1 TDD
4 layer	15	R.PDSCH.6-2.2 TDD	R.PDSCH.6-4.2 TDD	R.PDSCH.6-6.2 TDD
	20	R.PDSCH.6-2.3 TDD	R.PDSCH.6-4.3 TDD	R.PDSCH.6-6.3 TDD

9.4B.1.2 EN-DC including FR2 NR carrier

9.4B.1.2.1 SDR test

The Sustained Data Rate (SDR) requirements in this clause are applicable to the EN-DC including FR2 NR carrier.

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

The test parameters are determined by the following procedure:

- Step 1: Calculate the NR FR2 data rate for EN-DC bandwidth combinations, using a procedure from Clause 7.5A, for all supported EN-DC configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:

- Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 2: Calculate the E-UTRA data rate for EN-DC bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported EN-DC configurations and set of per E-UTRA component carrier (CC) UE capabilities among all supported UE capabilities:
 - Set of per E-UTRA CC UE capabilities includes a channel bandwidth, number of PDSCH MIMO layers and modulation format as defined in clause 4.1.2 of TS 38.306 [14].
- Step 3: Select the EN-DC bandwidth combination among all supported EN-DC configurations that achieves maximum total data rate in steps 1 and 2 among all UE capabilities:
 - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with the same largest data rate, select a single set with the smallest aggregated channel bandwidth.
- Step 4: For each NR FR2 CC in the selected EN-DC bandwidth combination, use MCS determined in step 1 for that EN-DC bandwidth combination based on test parameters and indicated UE capabilities.

The test setup for E-UTRA Pcell is specified in Section 9.1.2 and Table 9.4B.1.1.1-1. The NR PDSCH SDR tests setup is specified in Section 7.5A. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers is verified.

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

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

The Sustained Data Rate (SDR) requirements in this clause are applicable to the EN-DC including both FR1 and FR2 NR carriers.

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

The test parameters are determined by the following procedure:

- Step 1: Calculate the NR FR1 data rate for EN-DC bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported EN-DC configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
 - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 2: Calculate the NR FR2 data rate for EN-DC bandwidth combinations, using a procedure from Clause 7.5A, for all supported EN-DC configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
 - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 3: Calculate the E-UTRA data rate for EN-DC bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported EN-DC configurations and set of per E-UTRA component carrier (CC) UE capabilities among all supported UE capabilities:
 - Set of per E-UTRA CC UE capabilities includes a channel bandwidth, number of PDSCH MIMO layers and modulation format as defined in clause 4.1.2 of TS 38.306 [14].
- Step 4: Select the EN-DC bandwidth combination among all supported EN-DC configurations that achieves the maximum total data rate in steps 1, 2 and 3 among all UE capabilities:
 - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with the same largest data rate, select a single set among sets with the smallest aggregated channel bandwidth.

- Step 5: For each NR FR2 CC in the selected EN-DC bandwidth combination, use MCS determined in step 2 for that EN-DC bandwidth combination based on test parameters and indicated UE capabilities.

The test setup for E-UTRA Pcell is specified in Section 9.1.2 and Table 9.4B.1.1.1-1. The NR FR2 PDSCH SDR tests setup is specified in Section 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

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.

10.1.1.1 Applicability of requirements for optional UE features

For UE which supports optional UE features the additional performance requirements from Table 10.1.1.1-1 should be applied.

Table 10.1.1.1-1: Requirements applicability for optional UE features

UE feature/capability [14]	Test	type	Test list	Applicability notes
PDSCH MIMO layers (maxNumberMIMO- LayersPDSCH)	FR1 FDD	PDSCH	6.2.3.1.1 .1 Minimum requirement for CQI periodic reporting 6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook 6.4.3.1 (Test 1 - 4)	EN-DC
Layersrusorij	FR1 TDD	PDSCH	6.2.3.2.1.1 Minimum requirement for CQI periodic reporting 6.3.3.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook	EN-DC

		6.4.3.2 (Test 1 - 4)	
FR2 TDD	PDSCH	8.2.2.2.1.1 Minimum requirement for periodic CQI reporting	EN-DC
		8.4.2.2 (Test 1 – 3)	

- 10.1.1.2 Applicability of requirements for mandatory UE features with capability signalling
- 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

(Void)

- 10.2B.2 NR DC between FR1 and FR2
- 10.3 Reporting of Precoding Matrix Indicator (PMI)
- 10.3A Reporting of Precoding Matrix Indicator (PMI) for CA

(Void)

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

10.3B.1 EN-DC

10.3B.1.1 EN-DC within FR1

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PMI reporting requirements are specified in Clause 6.3. During the test, only the performance based on NR requirements on the NR cell(s) shall be verified.

10.3B.1.2 EN-DC including NR FR2 carrier

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PMI reporting requirements are specified in Clause 8.3. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

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

(Void)

10.3B.2 NR DC between FR1 and FR2

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

(Void)

10.4B.2 NR DC between FR1 and FR2

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 Configuration p	pattern (Note 1)		DDDSU
Special Slot Configuratio	n (Note 2)		10D+2G+2U
referenceSubcarrierSpace	cing	kHz	15
UL-DL configuration	dl-UL-TransmissionPeriodicity	ms	5
(tdd-UL-DL-	nrofDownlinkSlots		3
ConfigurationCommon)	nrofDownlinkSymbols		10
	nrofUplinkSlot		1
	nrofUplinkSymbols		2
The number of slots betv	veen PDSCH and corresponding		4 if $mod(i,5) = 0$
HARQ-ACK information		3 if $mod(i,5) = 1$	
			2 if $mod(i,5) = 2$
			6 if $mod(i,5) = 3$

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

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

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

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

		1	UL-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	DS ₁ S ₂ U
Special Slot Configuration (Note 2)			6D+4G+4U	10D+2G+2U	10D+2G+2U	6D+4G+4U	12D+2G	\$1: 10D+2G+2U \$2: 12D+2G+0U
referenceSubcarrierSpacing		kHz	30	30	30	30	30	30
pattern1								
	dl-UL- TransmissionPeriodicity	ms	5	2.5	2.5	3	2	1
	nrofDownlinkSlots		7	3	3	3	1	1
	nrofDownlinkSymbols		6	10	10	6	12	10
	nrofUplinkSlot		2	1	1	2	2	0
	nrofUplinkSymbols		4	2	2	4	0	2
patterb2	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

Dove		Unit	UL-DL pattern	
Paran	leter	Unit	FR1.30-1A	
TDD Slot Configuration pattern	(Note 1)		7DS2U	
Special Slot Configuration (Note	2)		6D+4G+4U	
referenceSubcarrierSpacing		kHz	N/A	
pattern (Note 4)				
. , ,	dl-UL-	ms	NI/A	
	TransmissionPeriodicity		N/A	
	nrofDownlinkSlots		N/A	
	nrofDownlinkSymbols		N/A	
	nrofUplinkSlot		N/A	
	nrofUplinkSymbols		N/A	
Pattern2 (Note 4)				
	dl-UL-	ms	NI/A	
	TransmissionPeriodicity		N/A	
	nrofDownlinkSlots		N/A	
	nrofDownlinkSymbols		N/A	
	nrofUplinkSlot		N/A	
	nrofUplinkSymbols		N/A	
PDCCH DCI Configuration	DCI Format		1-1 for slot	
			indices with	
			mod(i,10) =	
			0,1,2,3,4,5,6,7	
	Scheduled Grant		Symbol 2-13 for	
			slot indices with	
			mod(i,10) =	
			0,1,2,3,4,5,6 and	
			Symbol 2-5 for	
			slot indices with	
			mod(i,10) = 7	
The number of slots between Pl			8 if $mod(i,10) = 0$	
HARQ-ACK information (Note 3			7 if $mod(i,10) = 1$	
(PDSCH-to-HARQ-timing-indication)	itor)		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 $mod(i,10) = 6$	
Note 1: D denotes a slot with	all DL aymbola: C danatas a si	ot with -	2 if mod(i,10) = 7	
and the contract of the contra				
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.	E, gadia dila OE symbols, lesp	Convery.		
Note 3: i is the slot index per	frame: i = {019}			
	UL-DL-semi-statically using RF	RC confi	guration.	

A.1.3 TDD UL-DL configuration 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

Pa	Parameter		UL-DL pattern
Faranietei		Unit	FR2.60-1
TDD Slot Configuration patt	ern (Note 1)		DDSU
Special Slot Configuration (Note 2)		11D+3G+0U
referenceSubcarrierSpacing	9	kHz	60
pattern1	dl-UL-	ms	1
	TransmissionPeriodicity		1
	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0
The number of slots between PDSCH and corresponding			3 if $mod(i,4) = 0$
HARQ-ACK information (No	ote 3)		2 if $mod(i,4) = 1$
			5] if $mod(i,4) = 2$

Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U

denotes a slot with all UL symbols. The field is for information.

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

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

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

	Parameter	Unit	UL-DL pattern		
raiailletei		Onit	FR2.120-1	FR2.120-2	
TDD Slot Configuration	pattern (Note 1)		DDDSU	DDSU	
Special Slot Configuration	on (Note 2)		10D+2G+2U	11D+3G+0U	
referenceSubcarrierSpa	cing	kHz	120	120	
pattern1	dl-UL-	ms	0.625	0.5	
	TransmissionPeriodicity		0.025	0.5	
	nrofDownlinkSlots		3	2	
	nrofDownlinkSymbols		10	11	
	nrofUplinkSlot		1	1	
	nrofUplinkSymbols		2	0	
The number of slots between PDSCH and corresponding			4 if $mod(i,5) = 0$	3 if $mod(i,4) = 0$	
HARQ-ACK information(Note 3)			3 if $mod(i,5) = 1$	2 if $mod(i,4) = 1$	
	•		2 if $mod(i,5) = 2$	5 if $mod(i,4) = 2$	
			6 if $mod(i,5) = 3$		

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

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

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

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

Parameter		Unit	UL-DL pattern	
		Offic	FR2.120-1A	
TDD Slot Configuration pattern (N	Note 1)		DDDSU	
Special Slot Configuration (Note:	2)		10D+2G+2U	
referenceSubcarrierSpacing	referenceSubcarrierSpacing			
pattern1 (Note 4)	dI-UL-	ms	N/A	
	TransmissionPeriodicity		IN/A	
	nrofDownlinkSlots		N/A	
	nrofDownlinkSymbols		N/A	
	nrofUplinkSlot		N/A	
	nrofUplinkSymbols		N/A	
Pattern2 (Note 4)				
	dI-UL-	ms	N/A	
	TransmissionPeriodicity		-	
	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 $mod(i,5) = 2$	
No. 1	"5"		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.				
Note 3: i is the slot index per fr	ramo: i = (0 70)			
	ame, r = {0,, <i>r</i> 9} nfigurationCommon semi-static	ally neir	na RRC	
configuration.	ingaration Common semi-static	any usii	ig ixixo	
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.

Reference measurement channels for PDSCH performance A.3.2 requirements

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

A.3.2.1 FDD

A.3.2.1.1 Reference measurement channels for SCS 15 kHz FR1

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

Parameter	Unit	Value					
Reference channel		R.PDSCH.1- 1.1 FDD	R.PDSCH.1- 1.2 FDD	R.PDSCH.1- 1.3 FDD			
Channel bandwidth	MHz	1.1 FDD	1.2 FDD	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 transmi		t #0 with period	icity 20 ms				

Note 2: Slot i is slot index per 2 frames

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

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

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

Note 2:

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				
Defended should		R.PDSCH.1-				
Reference channel		4.1 FDD				
Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames	Slots	19				
MCS table		256QAM				
MCS index		24				
Modulation		256QAM				
Target Coding Rate		0.82				
Number of MIMO layers		1				
Number of DMRS rEs		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,, 19	Bits	45096				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,, 19	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,, 19	CBs	6				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 10, 11	Bits	52416				
For Slots i = 1,, 9, 12,, 19	Bits	54912				
Max. Throughput averaged over 2 frames Note 1: SS/PBCH block is transmitted.	Mbps	42.841				

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

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

Parameter	Unit	Value				
Deference showned		R.PDSCH.1-				
Reference channel		5.1 FDD				
Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH		12				
symbols		12				
Allocated slots per 2 frames	Slots	19				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS rEs		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,, 19	Bits	26120				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,, 19	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,, 19	CBs	4				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 5, 15	Bits	50752				
For Slots i = 10	Bits	48256				
For Slots i = 11	Bits	52416				
For Slots $i = 1,,4,6,,$	Bits	54912				
9,12,14,16,,19	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	
Reference channel		R.PDSCH.1-	R.PDSCH.1-		
Reference channel		6.1 FDD	6.2 FDD		
Channel bandwidth	MHz	10	10		
Subcarrier spacing	kHz	15	15		
Number of allocated resource blocks	PRBs	52	52		
Number of consecutive PDSCH		12	10		
symbols		12	12		
Allocated slots per 2 frames	Slots	15	15		
MCS table		64QAM	64QAM		
MCS index		13	13		
Modulation		16QAM	16QAM		
Target Coding Rate		0.48	0.48		
Number of MIMO layer		1	2		
Number of DMRS rEs (Note 3)		24	24		
Overhead for TBS determination		0	0		
Information Bit Payload per Slot					
For Slot i = 0	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,		NI/A	NI/A		
i={0,,19}		N/A	N/A		
For Non CSI-RS Slot i, if mod (i,5)	Bits	12040	24072		
={0,2,3,4}, i={1,19}	DIIS	12040	24072		
Transport block CRC per Slot					
For Slot $i = 0$	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,		N/A	N/A		
i={0,,19}		IN/A	IN/A		
For Non CSI-RS Slot i, if mod (i,5)	Bits	24	24		
={0,2,3,4}, i={1,19}	Dito	24	24		
Number of Code Blocks per Slot					
For Slot i = 0	CBs	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,		N/A	N/A		
i={0,,19}		14/71	14/7 (
For Non CSI-RS Slot i, if mod (i,5)	CBs	2	3		
={0,2,3,4}, i={1,,19}	<u> </u>		Ŭ		
Binary Channel Bits Per Slot					
For Slot i = 0	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,		N/A	N/A		
i={0,,19}					
For Slots i = 10	Bits	23712	47424		
For Non CSI-RS Slot i, if mod (i,5)	Bits	24960	49920		
={0,2,3,4}, i={1,9,11,,19}			.5525		
Max. Throughput averaged over 2	Mbps	9.030	18.054		
Note 1: SS/DBCH block is transmitt	·				

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

Note 2:

Slot i is slot index per 2 frames

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

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-	R.PDSCH.1-			
		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	19	19			
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 channel		8.1 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		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	Mbps	11.924	
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

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 channel		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,, 30	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 transmitte	ed in slot	#0 with periodici	ity 20 ms

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

A.3.2.1.3 Reference measurement channels for SCS 60 kHz FR1

A.3.2.1.4 Reference measurement channels for E-UTRA

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

Parameter	Unit		Va	lue	
Reference channel		R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-	R.PDSCH.4-
		1.1 FDD	1.2 FDD	1.3 FDD	1.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		9	10	10	10
Modulation		64QAM	64QAM	64QAM	64QAM
Coding Rate					
For Sub-Frames 1,2,3,4,6,7,8,9,		0.85	0.85	0.85	0.88
For Sub-Frame 5		N/A	0.89	0.91	0.87
For Sub-Frame 0		0.83	0.90	0.88	0.90
Information Bit Payload (Note 3)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	18336	36696	55056	75376
For Sub-Frame 5	Bits	N/A	35160	52752	71112
For Sub-Frame 0	Bits	15840	36696	55056	75376
Number of Code Blocks					
(Notes 3 and 4)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	3	6	9	13
For Sub-Frame 5	Bits	N/A	6	9	12
For Sub-Frame 0	Bits	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	17.837	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	Bits	6	11	16	21		
For Sub-Frame 5	Bits	N/A	10	15	21		
For Sub-Frame 0	Bits	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	Bits	4	8	13	16	
For Sub-Frames 1,2,6,7	Bits	4	7	11	14	
For Sub-Frame 5	Bits	4	7	11	14	
For Sub-Frame 0	Bits	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	Bits	7	14	21	28	
For Sub-Frames 1,2,6,7	Bits	7	14	21	28	
For Sub-Frame 5	Bits	7	14	21	27	
For Sub-Frame 0	Bits	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	Bits	5	9	14	18	
For Sub-Frames 1,2,6,7	Bits	5	9	14	18	
For Sub-Frame 5	Bits	5	9	13	18	
For Sub-Frame 0	Bits	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	Bits	9	18	27	36	
For Sub-Frames 1,2,6,7	Bits	9	18	27	36	
For Sub-Frame 5	Bits	8	17	26	35	
For Sub-Frame 0	Bits	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
- A.3.2.2.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit			Value	
Reference channel		R.PDSCH.2- 1.1 TDD	R.PDSCH.2- 1.2 TDD	R.PDSCH.2- 1.3 TDD	
Channel bandwidth	MHz	40	40	40	
Subcarrier spacing	kHz	30	30	30	
Allocated resource blocks	PRBs	106	6	106	
Number of consecutive PDSCH	TILDO	100	,	100	
symbols					
For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}		4	4	N/A	
For Slot i, if mod(i, 10) =		12	12	7	
{0,1,2,3,4,5,6} for i from {1,,39}		0.4		2=	
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		6	6	N/A	
{0,,39}		0	U	TN//A	
For Slot i, if mod(i, 10) =		18	12	12	
{0,1,2,3,4,5,6})for i from {1,,39}		10	12		
Overhead for TBS determination		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	
{8,9} for i from {0,,39}	DIIS	IN/A	IN/A	IN/A	
For Slot i, if mod(i, 10) = 7 for i from	Bits	2664	144	NI/A	
{0,,39}	Bits	2664	144	N/A	
For Slot i, if mod(i, 10) =	Dito	9064	400	4600	
{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) =	D:to	NI/A	NI/A	NI/A	
{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	D:to	4.0	4.0	NI/A	
{0,,39}	Bits	16	16	N/A	
For Slot i, if mod(i, 10) =	D:4-	0.4	40	0.4	
{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) =	OD-	NI/A	NI/A	NI/A	
{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	0.0	4	4	N1/0	
{0,,39}	CBs	1	1	N/A	
For Slot i, if mod(i, 10) =	OD-	4	4	4	
{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) =	5	21/2	.	21/2	
{8,9} for i from {0,,39}	Bits	N/A	N/A	N/A	
For Slots i = 20, 21	Bits	25440	1512	13992	
For Slot i, if $mod(i, 10) = 7$ for i from					
{0,,39}	Bits	8904	504	N/A	
For Slot i, if mod(i, 10) =					
{0,1,2,3,4,5,6} for i from	Bits	26712	1584	15264	
{1,,19,22,,39}					
Max. Throughput averaged over 2		44.440	0.6==	0.004	
frames	Mbps	11.419	0.677	6.221	
Note 1: SS/PBCH block is transmitte	d in slot #0) with periodicity	/ 20 ms		

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

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

Parameter	Unit			Value	
Reference channel		R.PDSCH.2-	R.PDSCH.2-	R.PDSCH.2-	R.PDSCH.2-
	N 41 1-	2.1 TDD	2.2 TDD	2.3 TDD	2.4 TDD
Channel bandwidth	MHz	40	40	40	40
Subcarrier spacing Allocated resource blocks	kHz	30 106	30	30	30 106
	PRBs	106	106	106	106
Number of consecutive PDSCH symbols					
For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}		4	4	4	4
For Slot i, if mod(i, 10) =		12	12	12	12
{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 $\{0,,39\}$		6	6	12	12
For Slot i, if mod(i, 10) =					
{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		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	N/A
For Slot i, if $mod(i, 10) = 7$ for i from					
{0,,39}	Bits	8456	16896	22032	29192
For Slot i, if mod(i, 10) =	D:4	00000	50000	70770	00070
{0,1,2,3,4,5,6} for i from {1,,39}	Bits	26632	53288	73776	98376
Transport block CRC per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	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	24	24	24	24
{0,,39}	Dito	27	24	24	27
For Slot i, if $mod(i, 10) =$	Bits	24	24	24	24
{0,1,2,3,4,5,6}for i from {1,,39}					
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if $mod(i, 10) =$	CBs	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	CBs	2	3	3	4
{0,,39} For Slot i, if mod(i, 10) =					
	CBs	4	7	9	12
{0,1,2,3,4,5,6} for i from {1,,39} Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 10) =					
$\{8,9\}$ for i from $\{0,,39\}$	Bits	N/A	N/A	N/A	N/A
For Slots i = 20, 21	Bits	53424	106848	144008	193344
For Slot i, if $mod(i, 10) = 7$ for i from					
{0,,39}	Bits	17808	35616	45792	61056
For Slot i, if mod(i, 10) =					
{0,1,2,3,4,5,6} for i from	Bits	55968	111936	152640	203520
{1,,19,22,,39}					
Max. Throughput averaged over 2	Mbps	37.644	75 210	104 710	138.646
frames			75.318	104.719	130.040
Note 1: SS/PBCH block is transmitted		#0 with periodic	city 20 ms		
Note 2: Slot i is slot index per 2 fram	es				

.

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 rÉs				
For Slot i, if mod(i, 10) = 7 for i from		0		
{0,,39}		6		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		10		
for i from {1,,39}		12		
Overhead for TBS determination		0		
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A		
{8,9} for i from {0,,39}	DIIS	IV/A		
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	27144		
{0,,39}	Dito	2/177		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	Bits	83976		
for i from {1,,39}	Dito	00070		
Transport block CRC per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A		
{8,9} for i from {0,,39}				
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	Bits	24		
For Slot i, if mod(i, 10) =				_
{0,1,2,3,4,5,6}for i from {1,,39}	Bits	24		
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 10) =				
{8,9} for i from {0,,39}	CBs	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from		_		
{0,,39}	CBs	4		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	0.0	4.0		
for i from {1,,39}	CBs	10		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	D:+-	NI/A		
{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		110 ====		
frames	Mbps	118.796		
Note 1: SS/PBCH block is transmitted i	n slot #0 w	vith periodicity 20	0 ms	
Note 2: Slot i is slot index per 2 frames		. ,		

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

Parameter	Unit			Value		
Reference channel		R.PDSCH.2-				
		4.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30			 	
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 10) = 7 for i from					+	
$\{0,,39\}$		4				
For Slot i, if mod(i, 10) =			-			
{0,1,2,3,4,5,6}for i from {1,,39}		12				
Allocated slots per 2 frames		31				
MCS table		256QAM				
MCS index		24				
Modulation		256QAM				
Target Coding Rate		0.82				
Number of MIMO layers		1				
Number of DMRS rEs						
For Slot i, if $mod(i, 10) = 7$ for i from		6				
{0,,39}		Ů				
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		12				
for i from {1,,39}					 	
Overhead for TBS determination		0				
Maximum number of HARQ		4				
transmissions 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) =	5.4	22222				
{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) =	Bits	N/A				
{8,9} for i from {0,,39}	DIIS	IN/A				
For Slot i, if mod(i, 10) = 7 for i from	Bits	24				
{0,,39}	Dito	21				
For Slot i, if mod(i, 10) =	Bits	24				
{0,1,2,3,4,5,6}for i from {1,,39}					 	
Number of Code Blocks per Slot For Slots 0 and Slot i, if mod(i, 10) =						
$\{8,9\}$ for i from $\{0,,39\}$	CBs	N/A				
For Slot i, if $mod(i, 10) = 7$ for i from						
$\{0,,39\}$	CBs	4				
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$			+			
for i from {1,,39}	CBs	11				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) =	D:4-	NI/A				
{8,9} for i from {0,,39}	Bits	N/A			<u> </u>	<u> </u>
For Slots i = 20, 21	Bits	106848				
For Slot i, if mod(i, 10) = 7 for i from	Bits	35616				
{0,,39}	סונס	33010				
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$ for i from $\{1,,19,22,,39\}$	Bits	111936				
Max. Throughput averaged over 2 frames	Mbps	130.308				
Note 1: SS/PBCH block is transmitted	n slot #0 v	vith periodicity 20			1	1
Note 2: Slot i is slot index per 2 frames	5.5t #U V	politicality 20				

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

Parameter	Unit		Value	
Reference channel		R.PDSCH.2-		
		5.1 TDD		
Channel bandwidth	MHz	40		
Subcarrier spacing	kHz	30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH				
symbols				
For Slot i, if $mod(i, 5) = 3$ for i from		8		
{0,,39}				
For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i		12		
from {1,,39} Allocated slots per 2 frames		31		-
MCS table		64QAM		
MCS table MCS index		4		-
Modulation		QPSK		-
Target Coding Rate		0.30		-
Number of MIMO layers		1		
Number of DMRS rEs		'		
For Slot i, if mod(i, 5) = 3 for i from				-
		12		
$\{0,,39\}$ For Slot i, if mod(i, 5) = $\{0,1,\}$) for i from				
$\{1,,39\}$		12		
Overhead for TBS determination		0		
Information Bit Payload per Slot		0		
For Slot 0 and Slot i, if $mod(i, 5) = 4$ for				
i from {0,,39}	Bits	N/A		
For Slot i, if $mod(i, 5) = 3$ for i from				
{0,,39}	Bits	5376		
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i	D.,	0.450		
from {1,,39}	Bits	8456		
Transport block CRC per Slot				
For Slot 0 and Slot i, if mod(i, 5) = 4 for	Dito	N/A		
i from {0,,39}	Bits	IN/A		
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	24		
{0,,39}	DIIS	24		
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	Bits	24		
from {1,,39}	Dito	27		
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}		1471		
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	CBs	2		
from {1,,39}				
Binary Channel Bits Per Slot				
For Slot 0 and Slot i, if $mod(i, 5) = 4$ for	Bits	N/A		
i from {0,,39}	Bits	26712		
For Slot $i = 20, 21$ For Slot i, if mod(i, 5) = 3 for i from	DIIS	20/12		
	Bits	17808		
$\{0,,39\}$ For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i		1		
For Slot 1, if find(1, 5) = $\{0, 1, 2\}$ for 1 from $\{1,, 19, 22,, 39\}$	Bits	27984		
Max. Throughput averaged over 2		1		
frames	Mbps	11.875		
Note 1: SS/PBCH block is transmitted in	n slot #0 w	ith periodicity 20) ms	<u> </u>
Note 2: Slot i is slot index per 2 frames	. 5.50 W	poliodioley 20		

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

Parameter	Unit		Valu	ıe	
		R.PDSCH.2-			
Reference channel		6.1 TDD			
Channel bandwidth	MHz	40			
Subcarrier spacing	kHz	30			
Allocated resource blocks	PRBs	106			
Number of consecutive PDSCH	1100	100			
symbols					
For Slot i, if $mod(i, 10) = \{3,7\}$ for i from					
		8			
$\{0,,39\}$ For Slot i, if mod(i, 10) = $\{0,1,2,5,6\}$ for					
		12			
i from {1,,39}		07			
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		12			
{0,,39}		12			
For Slot i, if $mod(i, 10) = \{0,1,2,5,6\}$ for		12			
i from {1,,39}		12			
Overhead for TBS determination		0			
Maximum number of HARQ		4			
transmissions		4			
Information Bit Payload per Slot					
For Slot 0 and Slot i, if mod(i, 10) =	D.:				
{4,8,9} for i from {0,,39}	Bits	N/A			
For Slot i, if $mod(i, 10) = \{3,7\}$ for i from					
{0,,39}	Bits	5376			
For Slot i, if $mod(i, 10) = \{0,1,2,5,6\}$ for					
i from {1,,39}	Bits	8456			
Transport block CRC per Slot					
For Slot 0 and Slot i, if mod(i, 10) =					
{4,8,9} for i from {0,,39}	Bits	N/A			
For Slot i, if mod(i, 10) = $\{3,7\}$ for i from					
$\{0,,39\}$	Bits	24			
For Slot i, if mod(i, 10) = $\{0,1,2,5,6\}$ for					
	Bits	24			
i from {1,,39} Number of Code Blocks per Slot					
For Slot 0 and Slot i, if mod(i, 10) =	CBs	N/A			
{4,8,9} for i from {0,,39}					
For Slot i, if $mod(i, 10) = \{3,7\}$ for i from	CBs	1			
{0,,39}					
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) =	Bits	N/A			
{4,8,9} for i from {0,,39}					
For Slot i = 20, 21	Bits	26712			
For Slot i, if $mod(i, 10) = \{3,7\}$ for i from	Bits	17808			
{0,,39}	טונט	17000			
For Slot i, if $mod(i, 10) = \{0,1,2,5,6\}$ for	Bits	27984			
i from {1,,19,22,,39}	טונס	21304			
Max. Throughput averaged over 2	Mbps	10.184			
frames					
Note 1: SS/PBCH block is transmitted i	n slot #0 v	vith periodicity 20	ე ms		
Note 2: Slot i is slot index per 2 frames		•			

Table A.3.2.2.7: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and CSI-RS overlapped with PDSCH

Parameter	Unit		Value	
Reference channel		R.PDSCH.2-		
Reference charmer		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 i from $\{1,,39\}$		12		
Overhead for TBS determination		0		
Information Bit Payload per Slot		ŭ		
For Slots 0 and Slot i, if mod(i, 10) =	D:4-	N1/A		
{8,9} for i from {0,,39}	Bits	N/A		
For Slot i, if mod(i, 10) = 7 for i from	Bits	16896		
{0,,39}	Dito	10030		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$	Bits	53288		
for i from {1,,39}		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 $mod(i, 10) = \{0,1,2,3,4,5,6\}$	D.,			
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}	ODS	IN/A		
For Slot i, if $mod(i, 10) = 7$ for i from	CBs	3		
{0,,39}				
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$ for i from $\{1,,39\}$	CBs	7		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) =				
{8,9} for i from {0,,39}	Bits	N/A		
For Slot i, if $mod(i, 10) = \{0,5\}$ for i from	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}		223.0		
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	ith periodicity 20) ms	
Note 2: Slot i is slot index per 2 frames		portodiony 20		

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

Parameter	Unit			Value
Deference channel		R.PDSCH.2-	R.PDSCH.2-	
Reference channel		8.1 TDD	8.2 TDD	
Channel bandwidth	MHz	40	40	
Subcarrier spacing	kHz	30	30	
Allocated resource blocks	PRBs	106	106	
Number of consecutive PDSCH		12	12	
symbols		12	12	
Allocated slots per 2 frames		23	23	
MCS table		64QAM	64QAM	
MCS index		13	13	
Modulation		16QAM	16QAM	
Target Coding Rate		0.48	0.48	
Number of MIMO layers		1	2	
Number of DMRS rEs (Note 3)		24	24	
Overhead for TBS determination		0	0	
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	D:4-	N1/A	NI/A	
{7,8,9} for i from {0,,39}	Bits	N/A	N/A	
For CSI-RS Slot i, if mod(i,10) =1 for i	D:4-	NI/A	NI/A	
from {0,,39}	Bits	N/A	N/A	
For Slot i = 20	Bits	24576	49176	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$		24576	40476	
for i from {1,,19,22,,39}		24576	49176	
Transport block CRC per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	NI/A	N/A	
{7,8,9} for i from {0,,39}	DIIS	N/A	IN/A	
For CSI-RS Slot i, if mod(i,10) =1 for i		N/A	N/A	
from {0,,39}		IN/A	IN/A	
For Slot i = 20	Bits	24	24	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	Bits	24	24	
for i from {1,,19,22,,39}	Dita	24	24	
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	CBs	N/A	N/A	
{7,8,9} for i from {0,,39}	CD3	IN/A	IN/A	
For CSI-RS Slot i, if mod(i,10) =1 for i		N/A	N/A	
from {0,,39}			·	
For Slot i = 20	CBs	3	6	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	CBs	3	6	
for i from {1,,19,22,,39}	ODS	3	U	
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	N/A	
{7,8,9} for i from {0,,39}	טונט	1 1/ / \	14/73	
For CSI-RS Slot i, if mod(i,10) =1 for i	Bits	N/A	N/A	
from {0,,39}				
For Slot i = 20	Bits	48336	96672	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	Bits	50880	101760	
for i from {1,,19,22,,39}	Dito	00000	101700	
Max. Throughput averaged over 2	Mbps	28.2624	56.5524	
frames Note 1: SS/PBCH block is transmitted	-			

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.3.2.2.2-9: 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) = {4,5} for i from {0,,39}	Bits	N/A		
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 frames	Mbps	57.930		
Note 1: SS/PBCH block is transmitted i	n slot #0 w	ith periodicity 20) ms	1
Note 2: Slot i is slot index per 2 frames	310 <i>t #</i> 0 W	nur portoutotty 20	, mo	

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

Parameter	Unit		Value	
Reference channel		R.PDSCH.2-		
Reference charmer		10.1 TDD		
Channel bandwidth	MHz	40		
Subcarrier spacing	kHz	30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH				
symbols				
For Slot i, if mod(i, 10) = 7 for i from		4		
{0,,39}		4		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		12		
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 rÉs				
For Slot i, if mod(i, 10) = 7 for i from		_		
{0,,39}		6		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,6\}$		4.0		
for i from {1,,39}		18		
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 $mod(i, 10) = \{0,1,2,3,4,5,6\}$				
for i from {1,,39}	Bits	25608		
Transport block CRC per Slot				
For Slots 0 and Slot i, if mod(i, 10) =				
{8,9} for i from {0,,39}	Bits	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from				
{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	65	_		
{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) =	F.			
{8,9} for i from {0,,39}	Bits	N/A		
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	h	00.000		
frames	Mbps	36.262		
Note 1: SS/PBCH block is transmitted i	n slot #0 w	ith periodicity 2	0 ms	I .
Note 2: Slot i is slot index per 2 frames	5.5.775 11	500010107 2		

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			
		12	
$\{1,,39\}$ 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		18	
{1,,39}		10	
For Slot i, if $mod(i, 4) = 1$ for i from		18	
{0,,39}		_	
Overhead for TBS determination		0	
Information Bit Payload per Slot			
For Slot 0 and Slot i, if $mod(i, 4) = \{2,3\}$	Bits	N/A	
for i from {0,,39}			
For Slot i, if $mod(i, 4) = 0$ for i from	Bits	8064	
$\{1,,39\}$ For Slot i, if mod(i, 4) = 1 for i from			
{0,,39}	Bits	6528	
Transport block CRC per Slot			
For Slot 0 and Slot i, if $mod(i, 4) = \{2,3\}$			
for i from {0,,39}	Bits	N/A	
For Slot i, if $mod(i, 4) = 0$ for i from	D::	0.4	
{1,,39}	Bits	24	
For Slot i, if mod(i, 4) = 1 for i from	Bits	24	
{0,,39}	DIG	24	
Number of Code Blocks per Slot			
For Slot 0 and Slot i, if $mod(i, 4) = \{2,3\}$	CBs	N/A	
for i from {0,,39}		1471	
For Slot i, if $mod(i, 4) = 0$ for i from	CBs	1	
$\{1,,39\}$ For Slot i, if mod(i, 4) = 1 for i from			
	CBs	1	
{0,,39} 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	Dito	24624	
{0,,19,22,,39}	Bits	21624	
Max. Throughput averaged over 2	Mbps	6.893	
frames	•		
Note 1: SS/PBCH block is transmitted i Note 2: Slot i is slot index per 2 frames	n slot #0 v	vith periodicity 20	0 ms

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

Parameter	Unit		Value		
Reference channel	-	R.PDSCH.2-			
	MHz	12.1 TDD			
Channel bandwidth Subcarrier spacing	kHz	40 30			
Allocated resource blocks	PRBs	106			
Number of consecutive PDSCH					
symbols					
For Slot i, if $mod(i, 4) = 0$ for i from		12			
$\{1,,39\}$ For Slot i, if mod(i, 4) = 1 for i from					
{0,,39}		8			
For Slot i, if $mod(i, 4) = 2$ for i from		10			
{0,,39} Allocated slots per 2 frames		31			
MCS table		64QAM			
MCS index		4			
Modulation		QPSK			
Target Coding Rate		0.30			
Number of MIMO layers		1			
Number of DMRS rEs For Slot i, if mod(i, 4) = 0 for i from				+	
$\{1,,39\}$		18			
For Slot i, if $mod(i, 4) = 1$ for i from		18			
{0,39}		10			
For Slot i, if $mod(i, 4) = 2$ for i from		18			
{0,,39} Overhead for TBS determination		0			
Information Bit Payload per Slot					
For Slot 0 and Slot i, if $mod(i, 4) = 3$ for	Bits	N/A			
i from {0,,39}	DIIS	IN/A			
For Slot i, if $mod(i, 4) = 0$ for i from	Bits	8064			
$\{1,,39\}$ For Slot i, if mod(i, 4) = 1 for i from					
{0,,39}	Bits	4992			
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	6528			
{0,,39}	Dito	0020			
Transport block CRC per Slot For Slot 0 and Slot i, if mod(i, 4) = 3 for					
i from $\{0,,39\}$	Bits	N/A			
For Slot i, if $mod(i, 4) = 0$ for i from	Bits	24			
{1,,39}	סונס	24			
For Slot i, if $mod(i, 4) = 1$ for i from	Bits	24			
$\{0,,39\}$ For Slot i, if mod(i, 4) = 2 for i from					
{0,,39}	Bits	24			
Number of Code Blocks per Slot					
For Slot 0 and Slot i, if $mod(i, 4) = 3$ for	CBs	N/A			
i from $\{0,,39\}$ For Slot i, if mod(i, 4) = 0 for i from					
{1,,39}	CBs	1			
For Slot i, if $mod(i, 4) = 1$ for i from	CDa	4			
{0,,39}	CBs	1			
For Slot i, if $mod(i, 4) = 2$ for i from	CBs	1			
{0,,39} Binary Channel Bits Per Slot				+	
For Slot 0 and Slot i, if $mod(i, 4) = 3$ for	F::	.			
i from {0,,39}	Bits	N/A			
For Slot i = 20	Bits	25440			
For Slot i = 21	Bits	15264			
For Slot i, if $mod(i, 4) = 0$ for i from $\{1,,19,22,,39\}$	Bits	26712			
For Slot i, if $mod(i, 4) = 1$ for i from	D:1-c	40500			
{1,,19,22,,39}	Bits	16536			
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	21624			
{0,,39}					

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Max. Thro	oughput averaged over 2	Mbps	9.389					
Note 1:	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		Val	ue	
Potoronos channel		R.PDSCH.4-			
Reference channel		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					
For Slot 1, if $\text{mod}(1, 4) = 2 \text{ for 1 from}$ $\{1,, 79\}$		10			
For Slot i, if mod(i, 4) = $\{0,1\}$ for i from					
{1,,79}		13			
Allocated slots per 2 frames		59			
MCS table		64QAM			
MCS index		13			
Modulation		16QAM			
Target Coding Rate		0.48			
Number of MIMO layers		2			
Number of DMRS rEs					
For Slot i, if $mod(i, 4) = 2$ for i from		12			
{1,, 79}					
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from		12			
{1,,79} Overhead for TBS determination		6			
Information Bit Payload per Slot		0			
For Slots 0 and Slot i, if $mod(i, 4) = 3$					
	Bits	N/A			
for i from $\{0,,79\}$ For Slot i, if mod(i, 4) = 2 for i from	D:4-	05000			
{1,, 79}	Bits	25608			
For Slot i, if $mod(i, 4) = \{0,\}$) for i from	Bits	34816			
{1,,79}	Dito	34010			
Transport block CRC per Slot					
For Slots 0 and Slot i, if $mod(i, 4) = 3$	Bits	N/A			
for i from $\{0,,79\}$ For Slot i, if mod(i, 4) = 2 for i from					
$\{1,,79\}$	Bits	24			
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from					
{1,,79}	Bits	24			
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if mod(i, 4) = 3	CBs	N/A			
for i from {0,,79}	CDS	IN/A			
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	CBs	5			
{1,,79} 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	Bits	73128			
{1,,39,42,,79}	טונס	70120			
Max. Throughput averaged over 2	Mbps	93.499			
frames			0		
Note 1: SS/PBCH block is transmitted Note 2: Slot i is slot index per 2 frames		viiii periodicity 2	J 1110		

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:4-	NI/A	
for i from {0,,159}	Bits	N/A	
For Slot i, if $mod(i, 5) = 3$ for i from	Dita	4.0	
{0,, 159}	Bits	16	
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	Dito	24	
from {1,,159}	Bits	24	
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if mod(i, 5) = 4	CBs	N/A	
for i from {0,,159}	CDS	IN/A	
For Slot i, if $mod(i, 5) = 3$ for i from	CBs	1	
{0,, 159}	CDS	1	
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	CBs	1	
from {1,,159}	CDS	'	
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 w	vith periodicity 20	0 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- 2.1 TDD	R.PDSCH.5- 2.2 TDD	R.PDSCH.5- 2.3 TDD	
Channel bandwidth	MHz	100	100	200	
Subcarrier spacing	kHz	120	120	120	
Allocated resource blocks	PRBs	66	66	132	
Number of consecutive PDSCH					
symbols					
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$		9	9	9	
For Slot i, if $mod(i, 5) = \{0,1,2\}$ 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 $\{0,, 159\}$		12	12	12	
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i from $\{1,,159\}$		12	12	12	
Overhead for TBS determination		6	6	6	
Information Bit Payload per Slot					
For Slots 0 and Slot i, if $mod(i, 5) = 4$	Bits	N/A	N/A	N/A	
For Slot i, if mod(i, 5) = 3 for i from $\{0,, 159\}$	Bits	11272	22536	45096	
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from $\{1,,159\}$	Bits	17424	34816	69672	
Transport block CRC per Slot					
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	Bits	N/A	N/A	N/A	
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$	Bits	24	24	24	
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from $\{1,,159\}$	Bits	24	24	24	
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	CBs	N/A	N/A	N/A	
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$	CBs	2	3	6	
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i from $\{1,,159\}$	CBs	3	5	9	
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	Bits	N/A	N/A	N/A	
For Slots i = 80, 81	Bits	36564	69960	139920	
For Slots i = 82, 83	Bits	34980	73128	146256	
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$	Bits	24420	48840	97680	
For Slot i, if mod(i, 5) = $\{0,1,2\}$ for i from $\{1,,79,84,,159\}$	Bits	36564	73128	146256	
Max. Throughput averaged over 2 frames	Mbps	100.799	201.434	403.096	
Note 1: SS/PBCH block is transmitted Note 2: Slot i is slot index per 2 frame) with periodicity	/ 20 ms	<u> </u>	I

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

Parameter	Unit		Valu	ie	
Reference channel		R.PDSCH.5-			
		3.1 TDD			
Channel bandwidth	MHz	100			
Subcarrier spacing	kHz	120			
Allocated resource blocks	PRBs	66			
Number of consecutive PDSCH					
symbols For Slot i, if mod(i, 5) = 3 for i from					
$\{0,, 159\}$		9			
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i					
from {1,,159}		13			
Allocated slots per 2 frames		127			
MCS table		64QAM			
MCS index		18			
Modulation		64QAM			
Target Coding Rate		0.46			
Number of MIMO layers		1			
Number of DMRS rEs					
For Slot i, if $mod(i, 5) = 3$ for i from		12			
{0,, 159}		12			
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i		12			
from {1,,159}					
Overhead for TBS determination		6			
Information Bit Payload per Slot					
For Slots 0 and Slot i, if $mod(i, 5) = 4$	Bits	N/A			
for i from {0,,159}	Bito				
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	16136			
{0,, 159}					
For Slot i, if $mod(i, 5) = \{0, 1, 2\}$ for i	Bits	25104			
from {1,,159} Transport block CRC per Slot					
For Slots 0 and Slot i, if $mod(i, 5) = 4$		N/A			
for i from {0,,159}	Bits	IN/A			
For Slot i, if $mod(i, 5) = 3$ for i from					
{0,, 159}	Bits	24			
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	D::	0.4			
from {1,,159}	Bits	24			
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if mod(i, 5) = 4	CBs	N/A			
for i from {0,,159}	CDS	IN/A			
For Slot i, if mod(i, 5) = 3 for i from	CBs	2			
{0,, 159}	ODS				
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i	CBs	3			
from {1,,159}					
Binary Channel Bits Per Slot		21/2			
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 Slots $i = 80, 81$ For Slot i, if mod(i, 5) = 3 for i from	DIIS		 		
{0,, 159}	Bits	36630			
For Slot i, if $mod(i, 5) = \{0,1,2\}$ for i		 		 	+
from {1,,79,82,,159}	Bits	54846			
Max. Throughput averaged over 2		145.062			
frames	Mbps				
Note 1: SS/PBCH block is transmitted		vith periodicity 2	0 ms		
Note 2: Slot i is slot index per 2 frames		•			

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

Parameter	Unit		Value	
Reference channel		R.PDSCH.5-		
		4.1 TDD		
Channel bandwidth	MHz	100		
Subcarrier spacing	kHz	120		
Allocated resource blocks	PRBs	6		
Number of consecutive PDSCH				
symbols				
For Slot i, if $mod(i, 4) = 2$ for i from		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		4		
Modulation Date		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		12		
{1,, 159}				
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from		12		
{1,,159} Overhead for TBS determination		6		
Information Bit Payload per Slot		0		
For Slots 0 and Slot i, if $mod(i, 4) = 3$				
for i from $\{0,,159\}$	Bits	N/A		
For Slot i, if $mod(i, 4) = 2$ for i from				
{1,, 159}	Bits	736		
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from				
{1,,159}	Bits	1032		
Transport block CRC per Slot				
For Slots 0 and Slot i, if $mod(i, 4) = 3$				
for i from {0,,159}	Bits	N/A		
For Slot i, if $mod(i, 4) = 2$ for i from	D.,	4.0		
{1,, 159}	Bits	16		
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	D:1-	40		
{1,,159}	Bits	16		
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	1		
{1,, 159}	CDS	'		
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	CBs	1		
{1,,159}	CD3	'		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if $mod(i, 4) = 3$	Bits	N/A		
for i from {0,,159}				
For Slot i = 80, 81	Bits	3180		
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	2496		
{4,, 159}		00		
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	Bits	3324		
{1,,79,82,,159}				
Max. Throughput averaged over 2	Mbps	5.548		
frames	·		<u> </u>	1
Note 1: SS/PBCH block is transmitted in		ntn periodicity 20	Ums	
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		110	110	+		
MCS table		119 64QAM	119 64QAM	+		
MCS index		13	13			
Modulation		16QAM	16QAM			
Target Coding Rate		0.48	0.48			
Number of MIMO layers		2	2			
Number of DMRS rEs						
For Slot i, if $mod(i, 4) = 2$ for i from						
{1,, 159}		12	12			
For Slot i, if mod(i, 4) = $\{0,1\}$ for i from				+		
{1,,159}		12	12			
Overhead for TBS determination		6	6			
Information Bit Payload per Slot		0				
For Slots 0 and Slot i, if $mod(i, 4) = 3$				+		
for i from {0,,159}	Bits	N/A	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	5	0.404.0	40000			
{1,,159}	Bits	34816	16896			
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3	Dita	NI/A	NI/A			
for i from {0,,159}	Bits	N/A	N/A			
For Slot i, if $mod(i, 4) = 2$ for i from	Bits	24	24			
{1,, 159}	DIIS	24	24			
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	Bits	24	24			
{1,,159}	Dita	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}	000	14// (14/7			
For Slot i, if $mod(i, 4) = 2$ for i from	CBs	4	2			
{1,, 159}		-	_			
For Slot i, if $mod(i, 4) = \{0, 1\}$ for i from	CBs	5	3			
{1,,159}		_	_			
Binary Channel Bits Per Slot						
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	+		
For Slot i, if mod(i, 4) = 2 for i from $\{4,, 159\}$	Bits	54912	26624			
For Slot i, if mod(i, 4) = $\{0,1\}$ for i from				† †		
$\{1,,79,82,,159\}$	Bits	73128	35456			
Max. Throughput averaged over 2	1			†		
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		. ,				

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		0	
For Slots 0 and Slot i, if $mod(i, 4) = 3$			
for i from $\{0,,159\}$	Bits	N/A	
For Slot i, if $mod(i, 4) = 2$ for i from			
{1,, 159}	Bits	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	CDo	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}	ODS	0	
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}		52555	
For Slot i, if $mod(i, 4) = \{0,1\}$ for i from	Bits	109692	
{1,,79,82,,159}		1.5500_	
Max. Throughput averaged over 2	Mbps	255.724	
frames	•		00.000
Note 1: SS/PBCH block is transmitted i		ntn periodicity 2	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-	
Reference charmer		7.1 TDD	
Channel bandwidth	MHz	100	
Subcarrier spacing	kHz	120	
Allocated resource blocks	PRBs	66	
Number of consecutive PDSCH symbols		12	
Allocated slots per 2 frames		63	
MCS table		64QAM	
MCS index		13	
Modulation		16QAM	
Target Coding Rate		0.48	
Number of MIMO layers		1	
Number of DMRS rEs (Note 3)		6	
Overhead for TBS determination		4	
Information Bit Payload per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	Bits	NI/A	
{7,8,9} for i from {0,,39}	Bits	N/A	
For CSI-RS Slot i, if mod(i,10) =1 for i	Dito	14344	
from {0,,39}	Bits	14344	
For Slot i = 20	Bits	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$		14344	
for i from {1,,19,22,,39}		14344	
Transport block CRC per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	
{7,8,9} for i from {0,,39}	סום	IN/A	
For CSI-RS Slot i, if mod(i,10) =1 for i		24	
from {0,,39}			
For Slot i = 20	Bits	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	Bits	24	
for i from {1,,19,22,,39}	Dita	27	
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	CBs	N/A	
{7,8,9} for i from {0,,39}	ODS	IN/A	
For CSI-RS Slot i, if mod(i,10) =1 for i		2	
from {0,,39}		_	
For Slot i = 20	CBs	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	CBs	2	
for i from {1,,19,22,,39}		_	
Binary Channel Bits Per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	
{7,8,9} for i from {0,,39}			
For CSI-RS Slot i, if mod(i,10) =1 for i	Bits	28776	
from {0,,39}			
For Slot i = 20	Bits	N/A	
For Slot i, if mod(i, 10) =	Bits	30360	
{0,2,3,4,5,6}for i from {1,,19,22,,39}			
Max. Throughput averaged over 2	Mbps	45.1836	
frames			

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-	
Neierence chainer		8.1 TDD	
Channel bandwidth	MHz	100	
Subcarrier spacing	kHz	120	
Allocated resource blocks	PRBs	66	
Number of consecutive PDSCH symbols		12	
Allocated slots per 2 frames		59	
MCS table		64QAM	
MCS index		13	
Modulation		16QAM	
Target Coding Rate		0.48	
Number of MIMO layers		1	
Number of DMRS rEs (Note 3)		6	
Overhead for TBS determination		4	
Information Bit Payload per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	D:4-	NI/A	
{7,8,9} for i from {0,,39}	Bits	N/A	
For CSI-RS Slot i, if mod(i,10) =1 for i	Dito	14344	
from {0,,39}	Bits	14344	
For Slot i = 20	Bits	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$		14344	
for i from {1,,19,22,,39}		14344	
Transport block CRC per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	
{7,8,9} for i from {0,,39}	DIIS	IN/A	
For CSI-RS Slot i, if mod(i,10) =1 for i		24	
from {0,,39}		24	
For Slot i = 20	Bits	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	Bits	24	
for i from {1,,19,22,,39}	טונס	24	
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	CBs	N/A	
{7,8,9} for i from {0,,39}	CD3	IN/A	
For CSI-RS Slot i, if mod(i,10) =1 for i		2	
from {0,,39}		_	
For Slot i = 20	CBs	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$	CBs	2	
for i from {1,,19,22,,39}	<u> </u>		
Binary Channel Bits Per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	Bits	N/A	
{7,8,9} for i from {0,,39}	2110	14//1	
For CSI-RS Slot i, if mod(i,10) =1 for i	Bits	28776	
from {0,,39}			
For Slot i = 20	Bits	N/A	
For Slot i, if $mod(i, 10) =$	Bits	30360	
{0,2,3,4,5,6}for i from {1,,19,22,,39}	210	20000	
Max. Throughput averaged over 2	Mbps	42.3148	
frames	•		
Note 1: CC/DDCH block is transmitted in	1-+ 40	.: 41	

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	Value				
Reference channel		R.PDSCH.6-	R.PDSCH.6-	R.PDSCH.6-		
		1.1 TDD	1.2 TDD	1.3 TDD		
Channel bandwidth	MHz	10	15	20		
Allocated resource blocks		Note 7	Note 8	Note 9		
Uplink-Downlink Configuration (Note 3)		2	2	2		
Number of HARQ Processes per component		10	10	10		
carrier						
Allocated subframes per Radio Frame (D+S)		6	6	6		
Modulation		64QAM	64QAM	64QAM		
Coding Rate						
For Sub-Frames 1,2,6,7		N/A	N/A	N/A		
For Sub-Frames 3,4,8,9		0.85	0.85	0.88		
For Sub-Frame 5		0.88	0.87	0.87		
For Sub-Frame 0		0.90	0.88	0.90		
Information Bit Payload (Note 4)						
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A		
For Sub-Frames 3,4,8,9	Bits	36696	55056	75376		
For Sub-Frame 5	Bits	35160	52752	71112		
For Sub-Frame 0	Bits	36696	55056	75376		
Number of Code Blocks						
(Notes 4 and 5)						
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A		
For Sub-Frames 3,4,8,9	Bits	6	9	13		
For Sub-Frame 5	Bits	6	9	12		
For Sub-Frame 0	Bits	6	9	13		
Binary Channel Bits (Note 4)						
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A		
For Sub-Frames 3,4,8,9	Bits	43200	64800	86400		
For Sub-Frame 5	Bits	40176	60912	82512		
For Sub-Frame 0	Bits	41184	62784	84384		
Number of layers		2	2	2		
Max. Throughput averaged over 1 frame (Note 4)	Mbps	21.864	32.803	44.799		

- Note 1: 1 symbol allocated to PDCCH for all tests.
- Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
- Note 3: As per Table 4.2-2 in TS 36.211 [15].
- Note 4: Given per component carrier per codeword.
- Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
- Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
- Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
- Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
- Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0.3,4.8,9.

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.6-	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		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		0.78	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	Bits	N/A	N/A	N/A		
For Sub-Frames 3,4,8,9	Bits	11	16	21		
For Sub-Frame 5	Bits	10	15	21		
For Sub-Frame 0	Bits	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	Bits	N/A	N/A	N/A		
For Sub-Frames 3,4	Bits	7	11	14		
For Sub-Frames 8,9	Bits	8	13	16		
For Sub-Frame 5	Bits	7	11	14		
For Sub-Frame 0	Bits	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	Bits	N/A	N/A	N/A		
For Sub-Frames 3,4	Bits	14	21	28		
For Sub-Frames 8,9	Bits	14	21	28		
For Sub-Frame 5	Bits	14	21	27		
For Sub-Frame 0	Bits	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		Valu	e	
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	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	9	14	18	
For Sub-Frames 8,9	Bits	9	14	18	
For Sub-Frame 5	Bits	9	13	18	
For Sub-Frame 0	Bits	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	20.928	32.2232	43.5936	

- 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		Valu	e	
Reference channel		R.PDSCH.6-	R.PDSCH.6-	R.PDSCH.6-	
		6.1 TDD	6.2 TDD	6.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component		10	10	10	
carrier					
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		1024QAM	1024QAM	1024QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.81	0.79	0.81	
For Sub-Frames 8,9		0.81	0.79	0.81	
For Sub-Frame 5		0.81	0.82	0.82	
For Sub-Frame 0		0.85	0.82	0.83	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	110136	161760	220296	
For Sub-Frames 8,9	Bits	110136	161760	220296	
For Sub-Frame 5	Bits	101840	157432	211936	
For Sub-Frame 0	Bits	110136	161760	220296	
Number of Code Blocks					
(Notes 4 and 5)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	18	27	36	
For Sub-Frames 8,9	Bits	18	27	36	
For Sub-Frame 5	Bits	17	26	35	
For Sub-Frame 0	Bits	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	43.2248	64.2712	87.2824	

- 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	512	52	52	39

A.3.3.1.2 Reference measurement channels for SCS 30 kHz FR1

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

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

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

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

A.3.3.2 TDD

A.3.3.2.1 Reference measurement channels for SCS 15 kHz FR1

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

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

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

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

A.3.4 Reference measurement channels for PBCH demodulation requirements

A.3.4.1 Reference measurement channels for FR1

Table A.3.4.1-1: PBCH Reference Channel

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

A.3.4.2 Reference measurement channels for FR2

Table A.3.4.2-1: PBCH Reference Channel

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

A.4 CSI reference measurement channels

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

Tables in this section specifies the mapping of CQI index to Information Bit payload, which complies with the CQI definition specified in 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	е			TBS.1-1	TBS.1-2				
MCS table						640	QAM	•	
Number of a	allocated PDS	CH resource	blocks	66	66				
Number of consecutive PDSCH symbols			12	12					
Number of F	PDSCH MIMO	layers		1	2				
Number of E	DMRS rEs (No	ote 1)		24	24				
Overhead for	r TBS determ	ination		6	6				
Available R	E-s			7920	7920				
CQI index	Spectral	MCS	Modulatio		Infor	mation Bit	Payload p	er Slot	
	efficiency	index	n						
0	OOR	OOR	OOR	N/A	N/A				
1	0.1523	0		1800	3624				
2	0.2344	0	QPSK	1800	3624				
3	0.3770	2		2856	5640				
4	0.6016	4		4480	8968				
5	0.8770	6		6528	13064				
6	1.1758	8		8712	17928				
7	1.4766	11		11016	22032				
8	1.9141	13	16QAM	14343	28680				
9	2.4063	15		17928	35856				
10	2.7305	18		20496	40976				
11	3.3223	20		25104	50184				
12	3.9023	22	64QAM	29192	58384				
13	4.5234	24	04QAW	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 Schem	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	Illocated PDS	CH resource l	olocks	52	52	106	106	8	16
Number of c	Number of consecutive PDSCH symbols			12	12	12	12	12	12
Number of F	DSCH MIMO	layers		1	2	1	2	1	1
Number of D	OMRS rEs (No	te 1)		24	24	24	24	24	24
Overhead for	r TBS determ	ination		0	0	0	0	0	0
Available RE	E-s for PDSCH	1		6240	6240	12720	12720	960	1920
CQI index	Spectral	MCS	Modulatio		Infor	mation Bit F	Payload per	r Slot	
	efficiency	index	n						
0	OOR	OOR	OOR	N/A	N/A	N/A	N/A	N/A	N/A
1	0.1523	0		1480	2976	2976	5896	224	456
2	0.3770	1	QPSK	2408	4744	4744	9480	368	736
3	0.8770	3		5504	11016	11016	22536	848	1736
4	1.4766	5		9224	18432	18960	37896	1416	2856
5	1.9141	7	16QAM	12040	24072	24576	49176	1864	3752
6	2.4063	9		15112	30216	30728	61480	2408	4608
7	2.7305	11		16896	33816	34816	69672	2600	5248
8	3.3223	13		20496	40976	42016	83976	3240	6400
9	3.9023	15	64QAM	24576	49176	49176	98376	3752	7424
10	4.5234	17		28168	56368	57376	114776	4352	8712
11	5.1152	19		31752	63528	65576	131176	4864	9736
12	5.5547	21		34816	69672	69672	139376	5248	10760
13	6.2266	23	256QAM	38936	77896	79896	159880	6016	12040
14	6.9141	25	ZOOQAW	43032	86040	88064	176208	6656	13320
15	15 7.4063 27 46104 92200 94248 188576 7040 14088						14088		
Note 1: Number of DMRS rEs includes the overhead of the DM-RS CDM groups without data									
Note 2: P	DSCH is not s	scheduled on	slots containir	ng CSI-RS	or slots whi	ch are not f	ull DL		
Note 3: P	DSCH is not s	scheduled on	slots containir	ng PBCH, i.	e. slot#0 pe	er 20ms pei	riodicity		

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

A.5.1 **OCNG Patterns for FDD**

OCNG FDD pattern 1: Generic OCNG FDD Pattern for all unused rEs

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

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

synchronization signals or reference signals in channel bandwidth.

A.5.2 OCNG Patterns for TDD

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

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

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

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

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

Annex B (normative): Propagation conditions

B.1 Static propagation condition

B.1.1 UE Receiver with 2Rx

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

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

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 subclause 7.7.3 in TR 38.901 [5].
- Step 4: Apply the quantization to the delay resolution 5 ns. This is done simply by rounding the tap delays to the nearest multiple of the delay resolution.
- Step 5: If multiple taps are rounded to the same delay bin, merge them by calculating their linear power sum.
- Step 6: If there are more than 12 taps in the quantized model, merge the taps as follows
- Find the weakest tap from all taps (both merged and unmerged taps are considered)
 - If there are two or more taps having the same value and are the weakest, select the tap with the smallest delay as the weakest tap.
- When the weakest tap is the first delay tap, merge taps as follows
 - Update the power of the first delay tap as the linear power sum of the weakest tap and the second delay tap.
 - Remove the second delay tap.
- When the weakest tap is the last delay tap, merge taps as follows
 - Update the power of the last delay tap as the linear power sum of the second-to-last tap and the last tap.
 - Remove the second-to-last tap.
- Otherwise
 - For each side of the weakest tap, identify the neighbour tap that has the smaller delay difference to the weakest tap.

- When the delay difference between the weakest tap and the identified neighbour tap on one side equals the delay difference between the weakest tap and the identified neighbour tap on the other side.
 - Select the neighbour tap that is weaker in power for merging.
- Otherwise, select the neighbour tap that has smaller delay difference for merging.
- To merge, the power of the merged tap is the linear sum of the power of the weakest tap and the selected tap.
- When the selected tap is the first tap, the location of the merged tap is the location of the first tap. The weakest tap is removed.
- When the selected tap is the last tap, the location of the merged tap is the location of the last tap. The weakest tap is removed.
- Otherwise, the location of the merged tap is based on the average delay of the weakest tap and selected tap. If the average delay is on the sampling grid, the location of the merged tap is the average delay. Merge two parallel taps with different delays (average delay, sum power) starting from the weakest ones. Otherwise, the location of the merged tap is rounded towards the direction of the selected tap (e.g. 10 ns & 20 ns → 15 ns, 10 ns & 25 ns → 20 ns, if 25 ns had higher or equal power; 15 ns, if 10 ns had higher power). The weakest tap and the selected tap are removed.
- Repeat step 6 until the final number of taps is 12.
- Step 7: Round the amplitudes of taps to one decimal (e.g. -8.78 dB \rightarrow -8.8 dB)
- Step 8: If the delay spread has slightly changed due to the tap merge, adjust the final delay spread by increasing or decreasing the power of the last tap so that the delay spread is corrected.
- Step 9: Re-normalize tap powers such that the strongest tap is at 0dB.
- Note: Some values of the delay profile created by the simplification steps may differ from the values in tables B.2.1.1-2, B.2.1.1-3, B.2.1.1-4, B.2.1.2-2, and B.2.1.1-3 for the corresponding model.
- Note: For Step 5 and Step 6, the power values are expressed in the linear domain using 6 digits of precision. The operations are in the linear domain.

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

Table B.2.3.1.1-3 defines the channel spatial correlation matrix R_{spat} . The parameters, 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	$R_{spat} = R_{gNB} = egin{bmatrix} 1 & lpha \ lpha^* & 1 \end{bmatrix}$
2x2 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \end{bmatrix} = \begin{bmatrix} 1 & \beta & \alpha & \alpha\beta \\ \beta^* & 1 & \alpha\beta^* & \alpha \\ \alpha^* & \alpha^*\beta & 1 & \beta \\ \alpha^*\beta^* & \alpha^* & \beta^* & 1 \end{bmatrix}$
2x4 case	$R_{spat} = R_{gNB} \otimes R_{UE} = egin{bmatrix} 1 & lpha \ lpha^* & 1 \end{bmatrix} \otimes egin{bmatrix} 1 & eta^{1\!\!/_{\!\!9}} & eta^{4\!\!/_{\!\!9}} & eta \ eta^{1\!\!/_{\!\!9}*} & 1 & eta^{1\!\!/_{\!\!9}} & eta^{4\!\!/_{\!\!9}} \ eta^{4\!\!/_{\!\!9}*} & eta^{1\!\!/_{\!\!9}*} & 1 & eta^{1\!\!/_{\!\!9}*} \ eta^{4\!\!/_{\!\!9}*} & eta^{1\!\!/_{\!\!9}*} & eta^{1\!\!/_{\!\!9}*} & 1 \end{bmatrix}$
4x1 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^{*} & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^{*} & 1 \end{bmatrix} = \begin{bmatrix} 1 & \beta & \alpha & \alpha\beta \\ \beta^{*} & 1 & \alpha\beta^{*} & \alpha \\ \alpha^{*} & \alpha^{*}\beta & 1 & \beta \\ \alpha^{*}\beta^{*} & \alpha^{*} & \beta^{*} & 1 \end{bmatrix}$ $R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^{*} & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta^{1/9} & \beta^{1/9} & \beta \\ \beta^{1/9*} & 1 & \beta^{1/9} & \beta^{1/9} \\ \beta^{*}\beta^{1/9*} & \beta^{1/9*} & 1 & \beta^{1/9} \\ \beta^{*} & \beta^{1/9*} & \beta^{1/9*} & 1 \end{bmatrix}$ $R_{spat} = R_{gNB} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9} & \alpha^{1/9} & \alpha^{1/9} & 1 & \alpha^{1/9} \\ \alpha^{*} & \alpha^{1/9} & \alpha^{1/9} & \alpha^{1/9} \end{bmatrix}$ $R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{1/9} & \alpha^{1/9} & 1 & \alpha^{1/9} \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^{*} & 1 \end{bmatrix}$ $\alpha^{*} = \alpha^{1/9} & \alpha^{1/9} & \alpha^{1/9} & 1$ $\alpha^{*} = \alpha^{1/9} & \alpha^{1/9} & 1 & \alpha^{1/9} \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^{*} & 1 \end{bmatrix}$
4x2 case	$R_{spat} = R_{gNB} \otimes R_{UE} = egin{bmatrix} 1 & lpha^{1/9} & lpha^{4/9} & lpha \ lpha^{1/9} & 1 & lpha^{1/9} & lpha^{4/9} \ lpha^{4/9} & lpha^{1/9} & 1 & lpha^{1/9} \ lpha^* & lpha^{4/9} & lpha^{1/9} & 1 \end{bmatrix} egin{bmatrix} 1 & eta \ eta^* & 1 \end{bmatrix}$
4x4 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9} & \alpha^{1/9} & 1 & \alpha^{1/9} \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9*} & \beta^{1/9*} & 1 & \beta^{1/9} \\ \beta^{8} & \beta^{4/9*} & \beta^{1/9*} & 1 \end{bmatrix}$

For cases with more antennas at either gNB or UE or both, the channel spatial correlation matrix can still be expressed as the Kronecker product of R_{gNB} and R_{UE} according to $R_{spat} = R_{gNB} \otimes R_{UE}$.

B.2.3.1.2 MIMO Correlation Matrices at High, Medium and Low Level

The 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	$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$										
2x1 case	$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$										
2x2 case	$R_{high} = \begin{pmatrix} 1 & 0.9 & 0.9 & 0.81 \\ 0.9 & 1 & 0.81 & 0.9 \\ 0.9 & 0.81 & 1 & 0.9 \\ 0.81 & 0.9 & 0.9 & 1 \end{pmatrix}$										
4x2 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 & 0.8999 & 0.8099 \\ 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 & 0.8099 & 0.8999 \\ 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 \\ 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 \\ 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 \\ 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 \\ 0.8999 & 0.8099 & 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 \\ 0.8099 & 0.8999 & 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 \end{bmatrix}$										
4x4 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9541 & 0.9430 & 0.9105 & 0.8887 & 0.8999 & 0.8894 & 0.8889 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.8894 & 0.8999 & 0.8894 & 0.8899 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.8587 & 0.8894 & 0.8899 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8099 & 0.8587 & 0.8894 \\ 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9541 \\ 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9430 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9882 & 0.9767 & 0.9882 & 0.9767 & 0.9882 & 0.9767 & 0.9882 & 0.9767 & 0.9882 & 0.9767 & 0.9882 & 0.9767 & 0.9882 & 0.9767 & 0.9430$	394 0.8587 399 0.8894 394 0.8999 305 0.8587 330 0.9105 541 0.9430 430 0.9541 430 0.8894 767 0.9430 382 0.9767 767 0.9882 541 0.8999 382 0.9541 300 0.9882									

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	1.0000 0.9882 0.9541 0.8999 0.8747 0.8645 0.8347 0.7872 0.5855 0.5787 0.5588 0.5270 0.3000 0.2965 0.2862 0.2700											

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

					,												
					1.0000	0.90	000 0	.6561	0.3874	0.300	00 0.2	2700	0.1968	0.1162	2)		
					0.9000	1.00	000 0	.9000	0.6561	0.270	0.3	8000	0.2700	0.196	3		
					0.656	0.90	000 1.	0000	0.9000	0.196	68 0.2	2700	0.3000	0.2700)		
2x4					0.3874	1 0.65	561 0	.9000	1.0000	0.116	52 0.1	968	0.2700	0.3000)		
case			R_{med}	$_{lium A} =$	0.3000			.1968	0.1162				0.6561	0.3874			
					0.270	0.30	000 0	.2700	0.1968	0.900)0 1.0	0000	0.9000	0.656	1		
					0.196	3 0.27	700 0	.3000	0.2700	0.65	51 0.9	9000	1.0000	0.9000)		
					0.1162	2 0.19	968 0	.2700	0.3000	0.38	74 0.0	6561	0.9000	1.0000	0)		
		1.0000	0.9000	0.6561	0.3874	0.8748	0.7873	0.5739	0.3389	0.5856	0.5270	0.3842	2 0.2269	0.3000	0.2700	0.1968	0.1162
		0.9000	1.0000	0.9000	0.6561	0.7873	0.8748	0.7873	0.5739	0.5270	0.5856	0.5270	0.3842	0.2700	0.3000	0.2700	0.1968
		0.6561	0.9000	1.0000	0.9000	0.5739	0.7873	0.8748	0.7873	0.3842	0.5270	0.5856	0.5270	0.1968	0.2700	0.3000	0.2700
		0.3874	0.6561	0.9000	1.0000	0.3389	0.5739	0.7873	0.8748	0.2269	0.3842	0.5270	0.5856	0.1162	0.1968	0.2700	0.3000
		0.8748	0.7873	0.5739	0.3389	1.0000	0.9000	0.6561	0.3874	0.8748	0.7873	0.5739	0.3389	0.5856	0.5270	0.3842	0.2269
		0.7873	0.8748	0.7873	0.5739	0.9000	1.0000	0.9000	0.6561	0.7873	0.8748	0.7873	0.5739	0.5270	0.5856	0.5270	0.3842
		0.5739	0.7873	0.8748	0.7873	0.6561	0.9000	1.0000	0.9000	0.5739	0.7873	0.8748	0.7873	0.3842	0.5270	0.5856	0.5270
4x4	D	0.3389	0.5739	0.7873	0.8748	0.3874	0.6561	0.9000	1.0000	0.3389	0.5739	0.7873	0.8748	0.2269	0.3842	0.5270	0.5856
case	$R_{medium\ A} =$	0.5856	0.5270	0.3842	0.2269	0.8748	0.7873	0.5739	0.3389	1.0000	0.9000	0.6561	0.3874	0.8748	0.7873	0.5739	0.3389
		0.5270	0.5856	0.5270	0.3842	0.7873	0.8748	0.7873	0.5739	0.9000	1.0000	0.9000	0.6561	0.7873	0.8748	0.7873	0.5739
		0.3842	0.5270	0.5856	0.5270	0.5739	0.7873	0.8748	0.7873	0.6561	0.9000	1.0000	0.9000	0.5739	0.7873	0.8748	0.7873
		0.2269	0.3842	0.5270	0.5856	0.3389	0.5739	0.7873	0.8748	0.3874	0.6561	0.9000	1.0000	0.3389	0.5739	0.7873	0.8748
		0.3000	0.2700	0.1968	0.1162	0.5856	0.5270	0.3842	0.2269	0.8748	0.7873	0.5739	0.3389	1.0000	0.9000	0.6561	0.3874
		0.2700	0.3000	0.2700	0.1968	0.5270	0.5856	0.5270	0.3842	0.7873	0.8748	0.7873	0.5739	0.9000	1.0000	0.9000	0.6561
		0.1968	0.2700	0.3000	0.2700	0.3842	0.5270	0.5856	0.5270	0.5739	0.7873	0.8748	0.7873	0.6561	0.9000	1.0000	0.9000
	,	0.1162	0.1968	0.2700	0.3000	0.2269	0.3842	0.5270	0.5856	0.3389	0.5739	0.7873	0.8748	0.3874	0.6561	0.9000	1.0000
	,	0.1162	0.1968	0.2700	0.3000	0.2269	0.3842	0.5270	0.5856	0.3389	0.5739	0.7873	0.8748	0.3874	0.6561	0.9000	1.0000)

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

1x2 case	R_{low} = \mathbf{I}_2
1x4 case	$R_{low} = \mathbf{I}_4$
2x1 case	$R_{low} = \mathbf{I}_2$
2x2 case	$R_{low} = \mathbf{I}_4$
2x4 case	$R_{low} = \mathbf{I}_8$
4x1 case	$R_{low} = \mathbf{I}_4$
4x2 case	$R_{low} = \mathbf{I}_8$
4x4 case	$R_{low} = \mathbf{I}_{16}$

In Table B.2.3.1.2-5, \mathbf{I}_d is the $d \times d$ identity matrix.

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

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

For the 2D cross-polarized antenna array at eNodeB, the N antennas are indexed by (N_1, N_2, P) , and total number of antennas is $N = P \cdot N_1 \cdot N_2$, where

- N_1 is the number of antenna elements in first dimension with same polarization,
- N_2 is the number of antenna elements in second dimension with same polarization, and
- P is the number of polarization groups.

For the 2D cross-polarized antennas at gNB, the N antennas are labelled such that antennas shall be in increasing order of the second dimension firstly, then the first dimension, and finally the polarization group. For a specific antenna element at p-th polarization, n_1 -th row, and n_2 -th column within the 2D antenna array, the following index number is used for antenna labelling:

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

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:

$$R_{gNB} = R_{gNB_Dim,1} \otimes R_{gNB_Dim,2}$$

where

- - $R_{eNB\ Diml}$ 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,

$$R_{ONB-Dim i} = 1$$
.

- 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,

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

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

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

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

For the 1D cross-polarized antenna array at gNB, the matrix of R_{gNB} is determined by follow the equations for 2D cross-polarized antenna array and letting $R_{gNB_Dim2} = 1$, i.e.,

$$R_{gNB} = R_{gNB_Dim,1}$$

The spatial correlation matrices at UE side are as follows:

- For 1 antenna element with the same polarization,

$$R_{UF}=1$$
.

- 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 , 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	0⁄2	β	γ
Mediu	m Correlation A	0.3	N/A	0.6	0.2
High Correlation 0.9 0.9 0.9					0.3
 Note 1: Value of α₁ applies when more than one pair of cross-polarized antenna elements in first dimension at gNB side. Note 2: Value of α₂ applies when more than one pair of cross-polarized 					
antenna elements in second dimension at gNB side. Note 3: Value of β applies when more than one pair of cross-polarized antenna elements at UE side.					

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

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

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

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

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

				_											_		
				1.00	000	0.0000	0.90	000	0.0000	-0.30	000 0	0.0000	-0.27	00 0	.0000		
				0.0	000	1.0000	0.00	000	0.9000	0.00	000 0	0.3000	0.00	000 0	.2700		
				0.9	000	0.0000	1.00	000	0.0000	-0.27	00 0	0.0000	-0.30	000 0	.0000		
				0.0	000	0.9000	0.00	000	1.0000	0.00	000	0.2700	0.00	00 0	0.3000		
4x2 case	$R_{high} =$		$R_{high} =$														
Case			-0.5		0.0000	-0.2	/00 (0.0000	1.000		0.0000	0.90		0.0000			
				0.0	000	0.3000	0.0	000	0.2700	0.00	00 1.	.0000	0.00	00 0	0.9000		
				-0.2	700 (0.0000	-0.30	000	0.0000	0.90	00 0.	.0000	1.00	00 00	.0000		
				0.0	000	0.2700	0.0	000	0.3000	0.00	00 0	.9000	0.00	00 1	.0000		
		1.0000	0.0000	0.9883	0.0000	0.9542	0.0000	0.8999	0.0000	-0.3000	0.0000	-0.2965	0.0000	-0.2862	0.0000	-0.2700	0.0000
		0.0000	1.0000	0.0000	0.9883	0.0000	0.9542	0.0000	0.8999	0.0000	0.3000	0.0000	0.2965	0.0000	0.2862	0.0000	0.2700
		0.9883	0.0000	1.0000	0.0000	0.9883	0.0000	0.9542	2 0.0000	-0.2965	0.0000	-0.3000	0.0000	-0.2965	0.0000	-0.2862	0.0000
		0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.0000	0.9542	0.0000	0.2965	0.0000	0.3000	0.0000	0.2965	0.0000	0.2862
		0.9542	0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.0000	-0.2862	0.0000	-0.2965	0.0000	-0.3000	0.0000	-0.2965	0.0000
		0.0000	0.9542	0.0000	0.9883	0.0000	1.0000	0.000	0.9883	0.0000	0.2862	0.0000	0.2965	0.0000	0.3000	0.0000	0.2965
		0.8999	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000	0.0000	-0.2700	0.0000	-0.2862	0.0000	-0.2965	0.0000	-0.3000	0.0000
8x2	D	0.0000	0.8999	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000	0.0000	0.2700	0.0000	0.2862	0.0000	0.2965	0.0000	0.3000
case	$R_{high} =$	-0.3000	0.0000	-0.2965	0.0000	-0.2862	0.0000	-0.2700	0.0000	1.0000	0.0000	0.9883	0.0000	0.9542	0.0000	0.8999	0.0000
		0.0000	0.3000	0.0000	0.2965	0.0000	0.2862	0.000	0.2700	0.0000	1.0000	0.0000	0.9883	0.0000	0.9542	0.0000	0.8999
		-0.2965	0.0000	-0.3000	0.0000	-0.2965	0.0000	-0.2862	2 0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.0000	0.9542	0.0000
		0.0000	0.2965	0.0000	0.3000	0.0000	0.2965	0.000	0.2862	0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.0000	0.9542
		-0.2862	0.0000	-0.2965	0.0000	-0.3000	0.0000	-0.2965	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.0000
		0.0000	0.2862	0.0000	0.2965	0.0000	0.3000	0.000	0.2965	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000	0.0000	0.9883
		-0.2700	0.0000	-0.2862	0.0000	-0.2965	0.0000	-0.3000	0.0000	0.8999	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000	0.0000
		0.0000	0.2700	0.0000	0.2862	0.0000	0.2965	0.0000	0.3000	0.0000	0.8999	0.0000	0.9542	0.0000	0.9883	0.0000	1.0000

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,
- $D_{\theta_{-1}}(N_1)$ is the steering matrix in first dimension with same polarization,
- $D_{\theta_{0,2}}(N_2)$ is the steering matrix in second dimension with same polarization,
- N_1 is the number of antenna elements in first dimension with same polarization,
- N_2 is the number of antenna elements in second dimension with same polarization,
- For antenna array with only one direction, number of antenna element in second direction N_2 equals 1.

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

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

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

$$D_{\theta_{k,i}}(2) = \begin{bmatrix} 1 & 0 \\ 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

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

$$D_{\theta_{k,i}}(3) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & e^{j1.5\theta_{k,i}} & 0 \\ 0 & 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

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

$$D_{\theta_{k,i}}(4) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\theta_{k,i}} & 0 & 0 \\ 0 & 0 & e^{j2\theta_{k,i}} & 0 \\ 0 & 0 & 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

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

- $\theta_{k,i}$ controls the phase variation in first dimension and second dimension respectively, and the phase for k-th subframe is denoted by $\theta_{k,i} = \theta_{0,i} + \Delta\theta \cdot k$, where $\theta_{0,i}$ is the random start value with the uniform distribution, i.e., $\theta_{0,i} \in [0,2\pi]$, $\Delta\theta$ is the step of phase variation, which is defined in Table B.2.3B.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:

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

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)

$$\cos\theta(t) = \cos\theta(t \mod(2D_s/v)), \ t > 2D_s/v \tag{B.3.1.4}$$

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.

Parameter	Value						
Parameter	HST-750	HST-1000					
D_s	300 m	300 m					
D_{\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					

Table B.3.1-1: High speed train scenario

NOTE 1: Parameters for HST conditions in table B.3.1-1 including f_d and Doppler shift trajectories presented on figure B.3.1-1 for 750 Hz for 15 kHz SCS and figure B.3.1-2 for 1000 Hz for 30 kHz SCS are applied for performance verification in all frequency bands.

NOTE 2: The propagation conditions used for the performance requirements under high speed train condition are indicated as a combination of "HST", subcarrier spacing and Doppler shift f_d , i.e. HST-<Doppler shift>, where '<Doppler shift>'indicates the maximum Doppler shift (Hz) .

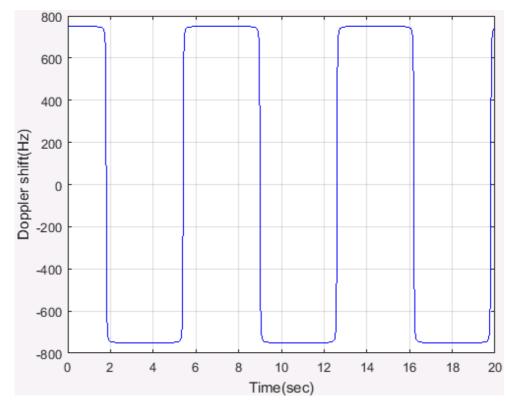


Figure B.3.1-1: Doppler shift trajectory (f_d = 750 Hz)

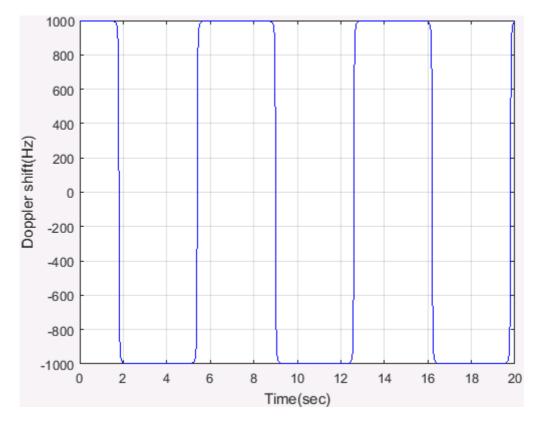


Figure B.3.1-2: Doppler shift trajectory ($f_{\scriptscriptstyle d}$ = 1000 Hz)

For 1x2 antenna configuration, the same $h(t,\tau)$ is used to describe the channel between every pair of Tx and Rx. For 1x4 antenna configuration, the same $h(t,\tau)$ is used to describe the channel between every pair of Tx and Rx.

B.4 Beamforming Model

B.4.1 Generic beamforming model

The transmission on antenna port(s) $p = p_0, p_0 + 1, ..., p_0 + N_p - 1$ is defined by using a precoder matrix W(i) of size $N_{ANT} \times N_p$, where N_{ANT} is the number of physical transmit antenna elements configured per test, N_p is the number of ports for a reference signal or physical channel configured per test, and p_0 is the first port for that reference signal or physical channel as defined in clauses 7.3 and 7.4 in TS 38.211 [9]. This precoder takes as an input a block of signals for antenna port(s) $p = p_0, p_0 + 1, ..., p_0 + N_p - 1, y^{(p)}(i) = \left[y^{(p_0)}(i) \ y^{(p_0+1)}(i) \ ... \ y^{(p_0+N_p-1)}(i)\right]^T,$ $i = 0,1,...,M_{\text{symb}}^{\text{ap}} - 1$, 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 $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i) \ y_{bf}^{(1)}(i) \ ... \ y_{bf}^{(N_ANT-1)}(i)\right]^T$ 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:

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

The precoder matrix W(i) is specific to the test case configuration.

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 $a_{k,l}$ 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

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

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

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

Parameter	Unit	Value				
SSS transmit power	W	Test specific				
EPRE ratio of PSS to SSS	dB	0				
EPRE ratio of PBCH 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	0				
EPRE ratio of OCNG to SSS	dB	0				
Note 1: Value is derived from Table 4.1.1 in TS 29.214 [12] based on "Number of DM PS CDM						

Note 1: Value is derived from Table 4.1-1 in TS 38.214 [12] based on "Number of DM-RS CDM groups without data" and "DMRS Type" parameters specified for each test

C.4 Setup (Radiated)

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

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

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

C.5 Connection (Radiated)

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

C.5.1 Measurement of Receiver Characteristics

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

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

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

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

Annex D (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

< Editor's note: Further check whether extreme temperature conditions should be considered.>

The UE shall fulfil all the requirements in the temperature range defined in Table E.2.1-1.

Table E.2.1-1: Temperature conditions

+15°C to +35°C	For normal conditions (with relative humidity of 25 % to 75 %)
----------------	--

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 of TS 38.101-1 [6] for extreme operation.

E.2.2 Voltage

< Editor's note: Further check whether extreme voltage conditions should be considered.>

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, Section 6.2] for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

E.2.3 Vibration

The UE shall fulfil all the requirements when vibrated at the following frequency/amplitudes.

Table E.2.3-1: Vibration conditions

Frequency	ASD (Acceleration Spectral Density) random vibration
5 Hz to 20 Hz	$0.96 \text{ m}^2/\text{s}^3$
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.

Further check whether extreme voltage conditions should be considered.>

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

2018-07 A 2018-08 R	RAN4 AH18-07 RAN4#88 RAN4#88 bis	R4- 1809554 R4- 1811357 R4- 1814237	CR R	ev Ca	Draft skeleton Skeleton update Approved Text Proposal in RAN4#88bis: 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 section 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" R4-1814059, "TP for 38.101-4 section 8.3 FR2 PMI test cases" R4-1814061, "Draft TP on FR2 Rank Indication Reporting	New version
2018-08 R	AH18-07 RAN4#88 RAN4#88	1809554 R4- 1811357 R4-			Skeleton update Approved Text Proposal in RAN4#88bis: 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 section 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" R4-1814059, "TP for 38.101-4 section 8.3 FR2 PMI test cases" R4-1814061, "Draft TP on FR2 Rank Indication Reporting	0.0.2
2018-08 R	RAN4#88 RAN4#88	R4- 1811357 R4-			Approved Text Proposal in RAN4#88bis: 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 section 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	
2018-10 R		R4-			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 section 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	0.1.0
	bis	1814237			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 section 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	
					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 section 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	
					requirements (5.2)" R4-1813924, "TP for introducing FR1 PDCCH requirements in TS 38.101-4 section 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	
					R4-1813924, "TP for introducing FR1 PDCCH requirements in TS 38.101-4 section 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	
					38.101-4 section 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	
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					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	
					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	
					requirements" R4-1814059, "TP for 38.101-4 section 8.3 FR2 PMI test cases" R4-1814061, "Draft TP on FR2 Rank Indication Reporting	
					R4-1814059, "TP for 38.101-4 section 8.3 FR2 PMI test cases" R4-1814061, "Draft TP on FR2 Rank Indication Reporting	
					R4-1814061, "Draft TP on FR2 Rank Indication Reporting	
					Performance Requirements"	
			1		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	
2018-11 R	RAN4#89	R4-			conditions" Approved Text Proposal in RAN4#89:	0.2.0
2010-11	XAIN4#09	1816559			R4-1814053, "TP on performance specification 38.101-4 Chapter 4	0.2.0
					general part"	
					R4-1814487, "TP for TS38.101-4 section 2 (Reference)"	
					R4-1814488, "TP for TS38.101-4 section 3 (Definitions, symbols and abbreviations)"	
					R4-1814579, "TP to TS 38.101-4: Annex A Measurement channels –	
					PDSCH"	
					R4-1814580, "TP to TS 38.101-4: Annex A Measurement channels - DL Control"	
					R4-1814581, "TP to TS 38.101-4: Annex A Measurement channels –	
					CSI" P4.1946205 "FP2 damad. No. Bond groups and Bot point. TD for	
					R4-1816395, "FR2 demod: Noc, Band groups and Ref point - TP for TS 38.101-4"	
					R4-1816692, "TP to TS 38.101-4: Requirements applicability"	
					R4-1816693, "TP for performance requirements for interworking (9)" R4-1816694, "TP to TS 38.101-4: FR1 PDSCH demodulation	
					requirements (5.2)"	
					R4-1816695, "Draft TP on FR2 PDSCH Demodulation Performance	
					Requirements" R4-1816697, "TP for updating FR1 PDCCH requirements in TS	
					38.101-4 section 5.3"	
					R4-1816699, "TP to TS 38.101-4: 5.4 FR1 PBCH demodulation	
					requirements"	
					R4-1816700, "TP to TS 38.101-4: 7.4 FR2 PBCH demodulation requirements"	
					R4-1816701, "TP of introduction of FR1 CQI requirement (6.2)"	
					R4-1816702, "TP to TS 38.101-4: FR2 CQI requirements (8.2)"	
					R4-1816703, "Draft TP on FR1 Rank Indication Reporting Performance Requirements"	
					R4-1816704, "Draft TP on FR2 Rank Indication Reporting	
					Performance Requirements"	
					R4-1816705, "TP for TS 38.101-4 FR1 PMI test requirement" R4-1816706, "TP to TS 38.101-4 FR2 PMI requirements"	
					R4-1816712, "TP to TS 38.101-4: FR1 SDR requirements (5.5)"	
					R4-1816713, "TP to TS38.101-4 Section 7.3: PDCCH demodulation	
					requirements" R4-1816714, "TP for propagation conditions in TS 38.104-4(Annex	
					B)"	
		RP-182408			V1.0.0 is submitted to RAN for 1-step approval	1.0.0
	RAN#82 RAN#82	RP-182704			V1.0.1 with editorial changes Approved by plenary – Rel-15 spec under change control	1.0.1 15.0.0

2019-03	RAN#83	RP-190403	0001	В	CR on UE demodulation and CSI requirements for 38.101-4	15.1.0
					This CR comboines all the endorsed draft CRs as list below: General sections	
					R4-1902427, Draft CR on NR UE demodulation requirements	
					applicability (Intel Corporation)	
					R4-1902576, Draft CR on General Applicability of Requirements (Qualcomm Incorporated)	
					R4-1902412, Editorial cleanup of FR2 Radiated Requirements	
					General section (ANRITSU)	
					PDSCH	
					R4-1902414, Draft CR on FR1 normal PDSCH demodulation requirements (Intel Corporation)	
					R4-1902415, Draft CR on FR2 PDSCH Requirements (Qualcomm	
					Incorporated)	
					R4-1902411, Draft CR on FR1 SDR requirements (Intel Corporation)	
					PDCCH	
					R4-1902416 Draft CR for updating FR1 PDCCH performance requirements in TS38.101-4Huawei, HiSilicon	
					R4-1902423 Draft CR for updating FR2 PDCCH performance	
					requirements in TS38.101-4 section 7.3 CATT	
					PBCH PA 1002420 Droft CB on 2By PBCH demodulation requirement for	
					R4-1902420, Draft CR on 2Rx PBCH demodulation requirement for FR1 (CMCC)	
					R4-1902421, Draft CR on 4Rx PBCH demodulation requirements for	
					FR1 (CMCC)	
					R4-1902422, Draft CR on 2Rx PBCH demodulation requirement for	
					FR2 (CMCC) CSI	
					R4-1902418, Draft CR on FR2 CSI Reporting Tests (Qualcomm	
					Incorporated)	
					R4-1902419, Draft CR on FR1 CSI Reporting Tests (Qualcomm	
					Incorporated) R4-1900105, Draft CR on NR CSI reporting (Intel Corporation)	
					R4-1902058, Draft CR for update of FR1 CQI reporting test (Huawei,	
					HiSilicon)	
					R4-1902059, Draft CR for update of FR2 CQI reporting test (Intel)	
					R4-1902426, Draft CR for PMI test cases: 6.2, 8.2, A.3.2.2.2, A.3.2.2.5 (Samsung)	
					R4-1902425, Draft CR for FR1 and FR2 RI test cases (Qualcomm)	
					Annex	
					R4-1900369, Draft CR on PDSCH FRC (Intel Corporation)	
					R4-1900370, Draft CR on PDCCH FRC (Intel Corporation) R4-1902424, Corrections to 38.101-4 subclause B.2.1 Delay profile	
					calculation (Huawei, HiSilicon)	
					R4-1902575, Draft CR on Beamforming Model (Qualcomm)	
					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.	

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 R4-1904750, draft(CR on RMC for demod requirement for 38.101-4 R4-1904750, draft(CR on RMC for demod requirement for 38.101-4 R4-1904750, Draft CR on RMC for demod requirement for 38.101-4 R4-1904756, Draft CR on FR1 normal PDSCH demodulation requirements R4-1904756, Draft CR on FR1 normal PDSCH demodulation requirements R4-1904758, Draft CR on FR2 PDSCH Demodulation Performance Tests R4-1904758, Draft CR on EN-DC SDR requirements R4-1904758, Draft CR on FR2 PDCCH demodulation requirements R4-1904766, draft(CR: Updates to FR1 PDCCH demodulation requirements R4-1904766, Draft CR on FR2 PDCCH demodulation requirements R4-1904766, Draft CR on FR2 PDCCH demodulation requirements R4-1904767, Draft CR for Beamforming model: Annex B.4.1 R4-1904767, Draft CR on FR1 SDR requirements R4-1904776, Draft CR on FR2 SDR Requirements R4-1904778, Draft CR on FR3 SDR Requirements R4-1904778, Draft CR to TS38.101-4: Correction to FR1 CS1 test cases R4-1904780, Draft CR to TS38.101-4: Correction to FR2 CS1 test cases R4-1904780, Draft CR to TS38.101-4: Or SNR, Es and Noc setup endorsed draft CRs from RAM491 R4-1906980, Draft CR to TS38.101-4 on applicable SNR level for FR2 R4-1906980, Draft CR to TS38.101-4 on applicable SNR level for FR2 R4-1906980, Draft CR to TS38.101-4 on Applicable SNR level for FR2 R4-1906980, Draft CR to TS38.101-4 on Applicable SNR level for FR2 R4-190799, Draft CR to TS38.101-4 on Applicable SNR level for FR2 R4-190799, Draft CR to TS38.101-4 on Applicable SNR level for FR2 R4-190799, Draft CR to TS38.101-4 on Applicable SNR level for FR2 R4-190799, Draft CR to SR8.101-4 on Applicable SNR level for Intervorking R4-190799, Draft CR to SR8.101-4 on Applicability of requirements for intervorking R4-190730,	2019-06	RAN#84	RP-191240	0002	В	CR to TS 38.101-4: Implementation of endorsed draft CRs from RAN4#90bis and RAN4#91	15.2.0
R4-1902885, Draft CR on DL power allocation for TS 38.101-4 R4-1903377, Draft CR on PBCH requirements 6, 8, 10 R4-1903471, Draft CR on PBCH requirements R4-1904750, draft CR on RMC for demod requirement for 38.101-4 R4-1904750, Draft CR on RMC for demod requirement for 38.101-4 R4-1904756, Draft CR on FR1 normal PDSCH demodulation requirements R4-1904756, Draft CR on FR1 normal PDSCH demodulation requirements R4-1904756, Draft CR on FR2 PDSCH Demodulation Performance Tests R4-1904758, Draft CR on EN-DC SDR requirements R4-1904758, Draft CR on EN-DC SDR requirements R4-1904758, Draft CR on FR2 PDSCH demodulation requirements R4-1904766, draft CR on FR2 PDSCH demodulation requirements R4-1904766, Draft CR on FR2 PDSCH demodulation requirements R4-1904766, Draft CR on FR2 PDSCH demodulation requirements R4-1904767, Draft CR on FR2 PDSCH demodulation requirements R4-1904767, Draft CR on FR2 SDR requirements R4-1904776, Draft CR on FR2 SDR requirements R4-1904776, Draft CR on FR2 SDR requirements R4-1904776, Draft CR on FR2 SDR requirements R4-1904778, Draft CR on FR2 SDR requirements R4-1904778, Draft CR on FR2 SDR requirements R4-1904778, Draft CR on TS38.101-4 on applicable SNR level for FR2 R4-1904833, Draft CR to TS38.101-4 on applicable SNR level for FR2 R4-1904833, Draft CR to TS38.101-4 on applicable SNR level for FR2 R4-1904833, Draft CR to TS38.101-4 on applicable SNR level for FR2 R4-1904833, Draft CR to TS38.101-4 on applicable SNR level for FR2 R4-1906980, Draft CR to RBA1678, Draft CR to						TOTAL	
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						R4-1907315, Draft CR on SDR requirements for NR CA between	
FR1 and FR2							

History

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