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NR;
User Equipment (UE) radio transmission and reception;
Part 4: Performance requirements
(Release 15)





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Foreword

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

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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".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

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

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

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

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

3.2 Symbols

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

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

 N_{oc} The power spectral density of a white noise source with average power per RE normalized to the

subcarrier spacing as defined in Section 4.4.3 for conducted requirements and Section 4.5.3 for

radiated requirements

3.3 Abbreviations

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

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

CP Cyclic Prefix

CSI Channel-State Information
CSI-IM CSI Interference Measurement

CSI-RS CSI Reference Signal

CW Codeword

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

DC Dual Connectivity

DCI Downlink Control Information

DL Downlink

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

FR Frequency Range

FRC Fixed Reference Channel

HARQ Hybrid Automatic Repeat Request

LI Layer Indicator

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

NR New Radio

NSA Non-Standalone Operation Mode OCNG OFDMA Channel Noise Generator

OFDM Orthogonal Frequency Division Multiplexing
OFDMA Orthogonal Frequency Division Multiple Access

PBCH Physical Broadcast Channel

Pcell Primary Cell

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

QCL Quasi Co-location

RB Resource Block

RBG Resource Block Group

RE Resource Element

REG Resource Element Group

RI Rank Indicator

RRC Radio Resource Control SA Standalone operation mode

SCS Subcarrier Spacing

SINR Signal-to-Interference-and-Noise Ratio

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

TDM Time division multiplexing TTI Transmission Time Interval

UL Uplink

VRB Virtual Resource Block

4 General

4.1 Relationship between minimum requirements and test requirements

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

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

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

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

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

4.2 Applicability of minimum requirements

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

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

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

4.3 Specification suffix information

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

Table 4.3-1: Definition of suffixes

Clause suffix Variant	
None	Single Carrier
Α	Carrier Aggregation (CA)
В	Dual-Connectivity (DC)
С	Supplement Uplink (SUL)

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

4.4 Conducted requirements

4.4.1 Conducted requirement reference point

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

4.4.2 SNR definition

UE demodulation and CSI requirements define the SNR as:

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

 N_{RX} denotes the number of receiver 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.

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

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

 N_{oc} denotes the power spectral density of a white noise source, with average power per RE normalized to the subcarrier spacing.

4.4.3 Noc

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

4.5 Radiated requirements

4.5.1 Radiated requirement reference point

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

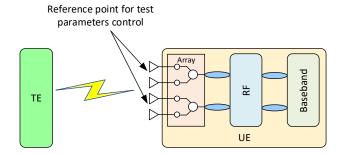


Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements

Radiated performance requirements are specified at the Reference point, with signal-to-noise ratio (SNR) $SNR_{RP} = SNR_{BB} + \Delta_{BB}$

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

4.5.2 SNR definition

UE demodulation and CSI requirements define the SNR as:

$$SNR_{\langle signal \rangle} = \frac{\sum_{j=1}^{N_{RX}} \hat{E}_{\langle signal \rangle}^{(j)}}{\sum_{j=1}^{N_{RX}} N_{oc}^{(j)}}$$

 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.

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

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

 N_{oc} denotes the power spectral density of a white noise source, with average power per RE normalized to the subcarrier spacing.

4.5.3 Noc

4.5.3.1 Introduction

For radiated testing of demodulation and CSI requirements it is not feasible in practice to use signal levels high enough to make the noise contribution of the UE negligible. Demodulation requirements are therefore specified with the applied noise higher than the UE peak EIS level in TS 38.101-2 [7] by a defined amount, so that the impact of UE noise floor is limited to no greater than a value 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 Pow		
	1	2	3	4
n257	-166.8	-163.8	-157.6	-166.3
n258	-166.8	-163.8	-157.6	-166.3
n260	-163.8		-155.0	-164.3
n261	-166.8	-163.8	-157.6	-166.3
Note 1: Noc levels are specified in dBm/Hz				

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

4.5.3.3 Derivation of Noc values for NR operating bands in FR2

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

Spectral density of Noc = Refsens_{PC3, n260, 50MHz} - $10Log_{10}(SCS_{Refsens} \times PRB_{Refsens} \times 12) - SNR_{Refsens} + \Delta_{thermal}$

where:

Refsens $_{PC3,\,n260,\,50MHz}$ is the Refsens value in dBm specified for Power Class 3 in Band n260 for 50MHz Channel bandwidth in TS 38.101-2 [7, Table 7.3.2.3-1].

 $SCS_{Refsens}$ is a subcarrier spacing associated with N_{RB} for 50MHz in TS 38.101-2 [7, Table 5.3.2-1], chosen as 120 kHz.

PRB_{Refsens} is N_{RB} associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-2 [7, Table 5.3.2-1] and is 32.

12 is the number of subcarriers in a PRB

SNR_{Refsens} is the SNR used for simulation of Refsens, and is -1dB

 $\Delta_{thermal}$ is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of Δ_{BB} . $\Delta_{thermal}$ is chosen as 6dB, giving a rise in total noise of 1dB.

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

The following methodology to define the Noc level for power class X (PC_X) and operating band Y (Band_Y) is used for the single carrier case:

 $Noc(PC_X, Band_Y) = -155 dBm/Hz + Refsens_{PC_X, Band_Y, 50MHz} - Refsens_{PC3, n260, 50MHz} + \Sigma MB_P + Refsens_{PC3, n260, 50MHz} + Refsens_{PC3, n260, 50MHz}$

where Refsens and ΣMB_P 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].

Demodulation performance requirements (Conducted requirements)

5.1 General

5.1.1 Applicability of requirements

5.1.1.1 General

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

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

5.1.1.2 Applicability of requirements for different number of RX antenna ports

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

The UE shall support 2 or 4 RX antenna ports for different RF operating bands. The operating bands, where 4 RX antenna ports shall be the baseline, are defined in Clause 7.4 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 5.4.3

5.1.1.3 Applicability of requirements for optional UE capabilities

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

Table 5.1.1.3-1: Requirements applicability for optional UE capabilities

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

5.2 PDSCH demodulation requirements

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

Table 5.2-1: Common test parameters

	Parameter	Unit	Value
PDSCH transmission			Transmission scheme 1
EPRE ratio of PTRS	to PDSCH	dB	N/A
DL BWP configuration #1	Cyclic prefix		Normal
Cornigulation #1	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
Common serving	SSB periodicity	ms	20
cell parameters	First DMRS position for Type A PDSCH	1110	
	mapping		2
	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH	Symbols	0, 1
PDCCH	Number of PDCCH candidates and		1/[AL8]
configuration	aggregation levels		1/[ALO]
	DCI format		1_1
	TCI state		TCI state #1
Cross carrier schedu			Not configured
	First subcarrier index in the PRB used for CSI-RS		k₀=0 for CSI-RS resource 1,2,3,4
	First OFDM symbol in the PRB used for		$I_0 = 6$ for CSI-RS resource 1 and 3
	CSI-RS		l ₀ = 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
			15 kHz SCS: 20 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	30 kHz SCS: 40 for CSI-RS resource
CSI-RS for tracking			1,2,3,4
our no for tracking			15 kHz SCS:
			10 for CSI-RS resource 1 and 2
	CSI-RS offset		11 for CSI-RS resource 3 and 4
		Slots	
			30 kHz SCS:
			20 for CSI-RS resource 1 and 2
			21 for CSI-RS resource 3 and 4
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #0
	First subcarrier index in the PRB used for		
	CSI-RS		$k_0 = 0$
	First OFDM symbol in the PRB used for CSI-RS		l ₀ = 12
	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
oor acquicition	CSI-RS periodicity	Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset	Slots	0
	Frequency Occupation		Start PRB 0
	QCL info		Number of PRB = BWP size TCl 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		l ₀ = 12
	Number of CSI-RS ports (X)		4
ZP CSI-RS for CSI	CDM Type		'FD-CDM2'
acquisition	Density (ρ)		1
	CSI-RS periodicity	Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset	Slots	0
	Frequency Occupation		Start PRB 0
PDSCH DMRS			Number of PRB = BWP size {1000} for Rank 1 tests
configuration	Antenna ports indexes		{1000, 1001} for Rank 2 tests

			{1000-1002} for Rank 3 tests {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	
TOT 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 tracking' configuration	
TCI state #1	information	QCL Type	Type A	
	Type 2 QCL	CSI-RS resource	N/A	
	information	QCL Type	N/A	
PTRS configuration			PTRS is not configured	
Maximum number of	of code block group	os for ACK/NACK feedback	1	
Maximum number of	of HARQ transmiss	sion	4	
HARQ ACK/NACK I	bundling		Multiplexed	
Redundancy version coding sequence			{0,2,3,1}	
Precoding configuration			SP Type I, Random per slot with PRB bundling granularity	
Symbols for all unused REs			OCNG Annex A.5	
Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH				
transmiss	sion.			

5.2.1 1RX requirements

(Void)

5.2.2 2RX requirements

5.2.2.1 FDD

5.2.2.1.1 Minimum requirements for PDSCH Mapping Type A

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

The test purposes are specified in Table 5.2.2.1.1-1.

Table 5.2.2.1.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance	1-1, 1-2, 1-3, 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 performance	3-1
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
Channel bandwidth		MHz	20 for Test 2-3
		IVII IZ	10 for other tests
Duplex mode			FDD
Active DL BWP ind			1
	First PRB		0
DL BWP	Number of contiguous PRB	PRBs	51 for Test 2-3 52 for other tests
configuration #1	Subcarrier spacing	kHz	30 for Test 2-3 15 for other tests
PDCCH configuration	Number of PRBs in CORESET	PRBs	48
	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
	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 Test 1-1 1 for other tests
Length			Single symbol
Number of HARQ F	Processes		8 for Tests 1-4, [2-1] 4 for other tests
K1 value (PDSCH-to-HARQ-	timing-indicator)		2

Table 5.2.2.1.1-3: Minimum performance for Rank 1

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

Table 5.2.2.1.1-4: Minimum performance for Rank 2

Toot		Modulation	Dramanation	Modulation Brancastics	Correlation matrix	Reference val	ue
Test num.	Reference channel	format and code rate	Propagation condition	and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)	
2-1	R.PDSCH.1-3.1 FDD	64QAM, 0.51	TDLA30-10	2x2, ULA Low	70	TBD	
2-2	R.PDSCH.2-1.1 FDD	64QAM, 0.51	TDLA30-10	2x2, ULA Low	70	[19.7]	

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

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

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

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

The test purposes are specified in Table 5.2.2.1.2-1.

Table 5.2.2.1.2-1: Tests purpose

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

Table 5.2.2.1.2-2: Test parameters

Parameter			Value
Channel bandwidth		MHz	10
Duplex mode			FDD
Active DL BWP index	(1
DL BWP	First PRB		0
configuration #1	Number of contiguous PRB	PRBs	52
configuration #1	Subcarrier spacing	kHz	15
PDCCH configuration	Number of PRBs in CORESET	PRBs	48
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
PDSCH	PDSCH aggregation factor		1
configuration	PRB bundling type		Static
Comiguration	PRB bundling size		2
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS	DMRS Type		Type 1
	Number of additional DMRS		1
configuration	Length		1
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		$I_0 = 13$
CSI acquisition CSI-RS periodicity			5
	Subcarrier index in the PRB used for CSI-		$(k_0, k_1, k_2, k_3)=(2, 4, 6, 8)$
ZP CSI-RS for CSI	RS		$(R_0, R_1, R_2, R_3) = (2, 4, 0, 0)$
acquisition	Number of CSI-RS ports (X)		8
CSI-RS periodicity			5
Number of HARQ Pro	ocesses		4
K1 value (PDSCH-to-HARQ-tir	ning-indicator)		2

Table 5.2.2.1.2-3: Minimum performance for Rank 2

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

5.2.2.1.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.2.1.3-1.

Table 5.2.2.1.3-1: Tests purpose

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

Table 5.2.2.1.3-2: Test parameters

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

Table 5.2.2.1.3-3: Minimum performance for Rank 1

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

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

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

The test purposes are specified in Table 5.2.2.1.4-1.

Table 5.2.2.1.4-1: Tests purpose

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

Table 5.2.2.1.4-2: Test parameters

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

Table 5.2.2.1.4-3: Minimum performance for Rank 1

Toot Peference		onco Modulation Bron		Correlation matrix	Reference value		
Test num.	Reference channel	format and code rate Propagation condition		and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)	
1-1	R.PDSCH.1-1.4 FDD	QPSK, 0.30	TDLA30-10	4x2, ULA Low	70	[-1.0]	
1-2	R.PDSCH.1-1.5 FDD	QPSK, 0.30	TDLA30-10	4x2, ULA Low	70	[-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 5.2.2.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance	1-1, 1-2, 1-3, 1-5, 1-6, 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 performance	3-1
requirement Type X under 2 receive antenna conditions	
and with 2 MIMO layers.	

Table 5.2.2.1-2: Test parameters

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

Table 5.2.2.2.1-3: Minimum performance for Rank 1

		M. I. I. d	Correlation Reference valu		alue		
Test num.	Reference channel	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	QPSK, 0.30	FR1.30-1	TDLB100-400	2x2, ULA Low	70	[-1.1]
1-2	R.PDSCH.2- 1.2 TDD	QPSK, 0.30	FR1.30-1	TDLC300-100	2x2, ULA Low	70	[0.3]
1-3	R.PDSCH.2- 4.1 TDD	256QAM, 0.82	FR1.30-1	TDLA30-10	2x2, ULA Low	70	[25.3]
1-4	R.PDSCH.2- 2.1 TDD	16QAM, 0.48	FR1.30-1	TDLC300-100	2x2, ULA Low	30	[1.6]
1-5	R.PDSCH.2- 5.1 TDD	QPSK, 0.3	FR1.30-2	TDLA30-10	2x2, ULA Low	70	[-0.8]
1-6	R.PDSCH.2- 6.1 TDD	QPSK, 0.30	FR1.30-3	TDLA30-10	2x2, ULA Low	70	[-0.9]

Table 5.2.2.2.1-4: Minimum performance for Rank 2

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

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

		Madulation		Correlation	Reference value		
Test num.	Reference channel	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	16QAM, 0.48	FR1.30-1	TDLA30-10	2x2, ULA Medium	70	[18.1]

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

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

The test purposes are specified in Table 5.2.2.2.1.

Table 5.2.2.2.1: Tests purpose

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

Table 5.2.2.2-2: Test parameters

	Parameter	Unit	Value
Channel bandwidth		MHz	40
Duplex mode			TDD
Active DL BWP index	(1
DL BWP	First PRB		0
configuration #1	Number of contiguous PRB	PRBs	106
comiguration #1	Subcarrier spacing	kHz	30
PDCCH configuration	Number of PRBs in CORESET	PRBs	102
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
PDSCH	PDSCH aggregation factor		1
configuration	PRB bundling type		Static
Comiguration	PRB bundling size		2
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
DD00U DMD0	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Length		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 Pro			8
K1 value (PDSCH-to-HARQ-tir			Specific to each UL-DL pattern

Table 5.2.2.2.3: Minimum performance for Rank 2

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

5.2.2.2.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.2.2.3-1.

Table 5.2.2.2.3-1: Tests purpose

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

Table 5.2.2.3-2: Test parameters

	Parameter	Unit	Value
Channel bandwidth		MHz	40
Duplex mode			TDD
Active DL BWP inde	X		1
DL BWP	First PRB		0
configuration #1	Number of contiguous PRB	PRBs	106
configuration #1	Subcarrier spacing	kHz	30
PDCCH configuration	Number of PRBs in CORESET	PRBs	102
	Mapping type		Type B
	k0		0
	Starting symbol (S)		5
	Length (L)		7
PDSCH	PDSCH aggregation factor		1
configuration	PRB bundling type		Static
corniguration	PRB bundling size		2
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
DD00H DMD0	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Length		1
Number of HARQ Processes			4
K1 value (PDSCH-to-HARQ-ti	ming-indicator)		Specific to each UL-DL pattern

Table 5.2.2.2.3-3: Minimum performance for Rank 1

Toot	Deference	Modulation			Reference val	ue	
Test num.	Reference channel	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	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, 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 performance	5-1
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
Chanal handuidth		MHz	20 for Test 2-2
Channel bandwidth		IVIHZ	10 for other tests
Duplex mode			FDD
Active DL BWP ind	ex		1
	First PRB		0
DL BWP	Number of continuous DDD	PRBs	51 for Test 2-2
configuration #1	Number of contiguous PRB	PRDS	52 for other tests
corniguration #1	Subcarrier spacing	kHz	30 for Test 2-2
	Subcarrier spacing	KI IZ	15 for other tests
PDCCH	Number of PRBs in CORESET	PRBs	51 for Test 2-2
configuration	Number of FRBS III CORESET	FNDS	52 for other tests
	Mapping type		Туре А
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration			4 for Test 1-1
comiguration	PRB bundling size		WB for Test 3-1
			2 for other tests
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle		N/A
	size		IV/A
	DMRS Type		Type 1
PDSCH DMRS configuration	Number of additional DMRS		2 for Test 1-1
	Number of additional Divino		1 for other tests
	Length		1
Number of HARQ F	Processes		8 for Test 1-4, [2-1]
	1000000		4 for other tests
K1 value			2
(PDSCH-to-HARQ-	timing-indicator)		

Table 5.2.3.1.1-3: Minimum performance for Rank 1

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

Table 5.2.3.1.1-4: Minimum performance for Rank 2

T = =1		Modulation	Doggodian	Correlation matrix	Reference value	
Test num.	Reference channel	format and code rate	Propagation condition	and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-3.1 FDD	64QAM, 0.51	TDLA30-10	2x4, ULA Low	70	[TBD]
2-2	R.PDSCH.2-1.1 FDD	64QAM, 0.51	TDLA30-10	2x4, ULA Low	70	[13.7]

Table 5.2.3.1.1-5: Minimum performance for Rank 3

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

Table 5.2.3.1.1-6: Minimum performance for Rank 4

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

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

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

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

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

The test purposes are specified in Table 5.2.3.1.2-1.

Table 5.2.3.1.2-1: Tests purpose

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

Table 5.2.3.1.2-2: Test parameters

Parameter			Value
Channel bandwidth		MHz	10
Duplex mode			FDD
Active DL BWP index	(1
DL BWP	First PRB		0
configuration #1	Number of contiguous PRB	PRBs	52
Corniguration #1	Subcarrier spacing	kHz	15
PDCCH configuration	Number of PRBs in CORESET	PRBs	48
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
PDSCH	PDSCH aggregation factor		1
configuration	PRB bundling type		Static
Comiguration	PRB bundling size		2
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
DD00H DMD0	DMRS Type		Type 1
PDSCH DMRS	Number of additional DMRS		1
configuration	Length		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 Pro			4
K1 value (PDSCH-to-HARQ-tir	ming-indicator)		2

Table 5.2.3.1.2-3: Minimum performance for Rank 2

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

5.2.3.1.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.3.1.3-1.

Table 5.2.3.1.3-1: Tests purpose

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

Table 5.2.3.1.3-2: Test parameters

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

Table 5.2.3.1.3-3: Minimum performance for Rank 1

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

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

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

The test purposes are specified in Table 5.2.3.1.4-1.

Table 5.2.3.1.4-1: 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
Channel bandwidth			10
Duplex mode			FDD
Active DL BWP index	X		1
DL BWP	First PRB		0
configuration #1	Number of contiguous PRB	PRBs	52
configuration #1	Subcarrier spacing	kHz	15
PDCCH configuration	Number of PRBs in CORESET	PRBs	48
	Mapping type		0
	k0		52
	Starting symbol (S)		15
	Length (L)		48
	PDSCH aggregation factor		Type A
PDSCH	PRB bundling type		0
configuration	PRB bundling size		3
	Resource allocation type		9 for Test 1-1 11 for Test 1-2
	VRB-to-PRB mapping type		1
	VRB-to-PRB mapping interleaver bundle size		Static
DD00H DMD0	DMRS Type		2
PDSCH DMRS	Number of additional DMRS		Type 0
configuration	Length		Non-interleaved
000 (LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
CRS for rate matching	LTE carrier BW	MHz	10
	Number of antenna ports		4
	v-shift		0
Number of HARQ Pr	ocesses		4
K1 value (PDSCH-to-HARQ-ti	ming-indicator)		2

Table 5.2.3.1.4-3: Minimum performance for Rank 1

Toot		Modulation		Modulation Propagation Corr		Correlation matrix		
Test num. Reference channel	Reference channel	format and code rate	condition	and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)		
1-1	R.PDSCH.1-1.4 FDD	QPSK, 0.30	TDLA30-10	4x4, ULA Low	70	[-4.0]		
1-2	R.PDSCH.1-1.5 FDD	QPSK, 0.30	TDLA30-10	4x4, ULA Low	70	[-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, 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 performance	5-1
requirement Type X under 4 receive antenna conditions	
and with 3 MIMO layers.	

Table 5.2.3.2.1-2: Test parameters

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

Table 5.2.3.2.1-3: Minimum performance for Rank 1

					Correlation	Reference value	
Test num.	Reference channel	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	QPSK, 0.30	FR1.30-1	TDLB100-400	2x4, ULA Low	70	[-4.1]
1-2	R.PDSCH.2- 1.2 TDD	QPSK, 0.30	FR1.30-1	TDLC300-100	2x4, ULA Low	70	[-2.6]
1-3	R.PDSCH.2- 4.1 TDD	256QAM, 0.82	FR1.30-1	TDLA30-10	2x4, ULA Low	70	[21.6]
1-4	R.PDSCH.2- 2.1 TDD	16QAM, 0.48	FR1.30-1	TDLC300-100	2x4, ULA Low	30	[-1.0]
1-5	[R.PDSCH.2- 5.1 TDD]	QPSK, 0.3	FR1.30-2	TDLA30-10	2x4, ULA Low	70	[-3.6]
1-6	[R.PDSCH.2- 6.1 TDD]	QPSK, 0.30	FR1.30-3	TDLA30-10	2x4, ULA Low	70	[-3.8]

Table 5.2.3.2.1-4: Minimum performance for Rank 2

		Madulatian			Correlation	Reference value	
Test num.	Reference channel	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	64QAM, 0.51	FR1.30-1	TDLA30-10	2x4, ULA Low	70	TBD
2-2	R.PDSCH.2- 3.2 TDD	64QAM, 0.51	FR1.30-1	TDLA30-10	2x4, ULA Low	70	[13.7]

Table 5.2.3.2.1-5: Minimum performance for Rank 3

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

Table 5.2.3.2.1-6: Minimum performance for Rank 4

		Madulation			Correlation	Reference value	
Test num.	Reference channel	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	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	[15.7]

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

					Correlation	Reference v	alue
Test num.	Reference channel	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	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			Value
Channel bandwidth			40
Duplex mode			TDD
Active DL BWP index	(1
DL BWP configuration #1	First PRB		0
	Number of contiguous PRB	PRBs	106
	Subcarrier spacing	kHz	30
PDCCH configuration	Number of PRBs in CORESET	PRBs	102
	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
PDSCH	PDSCH aggregation factor		1
configuration	PRB bundling type		Static
Comigaration	PRB bundling size		2
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS	DMRS Type		Type 1
	Number of additional DMRS		1
configuration	Length		1
NZP CSI-RS for	OFDM symbols in the PRB used for CSI-RS		$I_0 = 13$
CSI acquisition	CSI-RS periodicity		5
	Subcarrier index in the PRB used for CSI-		$(k_0, k_1, k_2, k_3)=(2, 4, 6, 8)$
ZP CSI-RS for CSI	RS		(NO, N1, N2, N3)=(2, 4, 0, 0)
acquisition	Number of CSI-RS ports (X)		8
	CSI-RS periodicity		5
Number of HARQ Processes			8
K1 value (PDSCH-to-HARQ-timing-indicator)			Specific to each UL-DL pattern

Table 5.2.3.2.2-3: Minimum performance for Rank 2

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

5.2.3.2.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.3.2.3-1.

Table 5.2.3.2.3-1: Tests purpose

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

Table 5.2.3.2.3-2: Test parameters

	Parameter	Unit	Value	
Channel bandwidth		MHz	40	
Duplex mode			TDD	
Active DL BWP inde	ex		1	
DL BWP	First PRB		0	
	Number of contiguous PRB	PRBs	106	
configuration #1	Subcarrier spacing	kHz	30	
PDCCH configuration	Number of PRBs in CORESET	PRBs	102	
<u> </u>	Mapping type		Type B	
	k0		0	
	Starting symbol (S)		5	
	Length (L)		7	
PDSCH	PDSCH aggregation factor		1	
configuration	PRB bundling type		Static	
Corniguration	PRB bundling size		2	
	Resource allocation type		Type 0	
	VRB-to-PRB mapping type		Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size		N/A	
DD00H DMD0	DMRS Type		Type 1	
PDSCH DMRS configuration	Number of additional DMRS		1	
	Length		1	
Number of HARQ Processes			8	
K1 value (PDSCH-to-HARQ-timing-indicator)			Specific to each UL-DL pattern	

Table 5.2.3.2.3-3: Minimum performance for Rank 1

Toot	Deference	Modulation	TDD III DI	Dranagation	Correlation	Reference value	
Test Reference num. channel	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	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	I ID		0
serving cell	SSB position			1
parameters	SSB periodic		ms	20
PDCCH		CCH monitoring		Each slot
configuration	Number of F	PDCCH candidates		1
configuration	TCI state			TCI state #1
	First subcarr used for CSI	rier index in the PRB I-RS (k_0)		0
	First OFDM used for CSI	symbol in the PRB I-RS (<i>l₀</i>)		CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4: 8
	Number of C	CSI-RS ports (X)		1
	CDM Type			No CDM
	Density (p)			3
CSI-RS for tracking	CSI-RS peri	odicity	Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offse	et	Slots	15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4
				30 kHz SCS: 20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
	Frequency C	Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
	Type 1	SSB index		SSB #0
TCI state #0	QCL information	QCL Type		Type C
TOT 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
TOI State #1	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
Precoding configu	uration			SP Type I, Random per slot with REG bundling granularity for number of Tx
Symbols for all ur	nused RFs			larger than 1 OCNG in Annex A.5
Symbols for all ur	IUSEU IVES			CONG III AIII EX A.5

5.3.1 1RX requirements

(Void)

5.3.2 2RX requirements

5.3.2.1 FDD

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

Table 5.3.2.1-1: Test Parameters

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

5.3.2.1.1 1 Tx Antenna performances

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

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

			CORES				Antenna	Reference	e value
Test numbe r	Bandw idth	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 MHz	24	2	2	R.PDCCH. 1-2.1 FDD	TDLA30-10	1x2 Low	1	[8.0]
2	10 MHz	24	2	2	R.PDCCH. 1-2.3 FDD	TDLC300- 100	1x2 Low	1	[8.0]
3	10 MHz	48	2	4	R.PDCCH. 1-2.4 FDD	TDLA30-10	1x2 Low	1	[5.5]
4	10 MHz	48	1	4	R.PDCCH. 1-1.1 FDD	TDLA30-10	1x2 Low	1	[4.3]
5	10MHz	48	2	16	R.PDCCH. 1-2.6 FDD	TDLA30-10	1x2 Low	1	[-2.1]

5.3.2.1.2 2 Tx Antenna performances

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

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

			CORES				Antenna	Reference value	
Test numbe r	Bandw idth	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 MHz	24	2	4	R.PDCCH.	TDLC300-	2x2 Low	1	TBD
					1-2.2 FDD	100			
2	10 MHz	48	2	8	R.PDCCH.	TDLC300-	2x2 Low	1	[-1.5]
					1-2.5 FDD	100			
3	10 MHz	48	1	8	R.PDCCH.	TDLA30-10	2x2 Low	1	[-0.3]
					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		0			

5.3.2.2.1 1 Tx Antenna performances

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

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

			CORES				Antenna	Reference value	
Test numbe r	Bandw idth	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 MHz	102	1	2	R.PDCCH. 2-1.1 TDD	TDLA30-10	1x2 Low	1	[6.7]
2	40 MHz	102	1	4	R.PDCCH. 2-1.2 TDD	TDLC300- 100	1x2 Low	1	[2.7]
3	40 MHz	48	2	16	R.PDCCH. 2-2.1 TDD	TDLC300- 100	1x2 Low	1	[-4.4]

5.3.2.2.2 2 Tx Antenna performances

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

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

			CORES				Antenna	Reference	e value
Test numbe r	Bandw idth	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 MHz	[90]	1	8	R.PDCCH. 2-1.3 TDD	TDLC300- 100	2x2 Low	1	[-1.5]

5.3.3 4RX requirements

5.3.3.1 FDD

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

Table 5.3.3.1-1: Test Parameters

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

5.3.3.1.1 1 Tx Antenna performances

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

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

			CORES				Antenna	Reference value	
Test numbe r	Bandw idth	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 MHz	24	2	2	R.PDCCH.	TDLA30-10	1x4 Low	1	[2.3]
					1-2.1 FDD				
2	10 MHz	24	2	2	R.PDCCH.	TDLC300-	1x4 Low	1	[2.5]
					1-2.3 FDD	100			
3	10 MHz	48	2	4	R.PDCCH.	TDLA30-10	1x4 Low	1	[0.0]
					1-2.4 FDD				
4	10 MHz	48	1	4	R.PDCCH.	TDLA30-10	1x4 Low	1	[-0.7]
					1-1.1 FDD				_

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	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 MHz	24	2	4	R.PDCCH.	TDLC300-	2x4 Low	1	TBD
					1-2.2 FDD	100			
2	10 MHz	48	2	8	R.PDCCH.	TDLC300-	2x4 Low	1	[-4.8]
					1-2.5 FDD	100			
3	10 MHz	48	1	4	R.PDCCH.	TDLA30-10	2x4 Low	1	TBD
					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	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 MHz	102	1	2	R.PDCCH. 2-1.1 TDD	TDLA30-10	1x4 Low	1	TBD
2	40 MHz	102	1	4	R.PDCCH. 2-1.2 TDD	TDLC300- 100	1x4 Low	1	TBD
3	40 MHz	48	2	16	R.PDCCH. 2-2.1 TDD	TDLA30-10	1x4 Medium A	1	[-4.1]

5.3.3.2.2 2 Tx Antenna performances

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

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

			CORES				Antenna	Reference	e value
Test numbe r	Bandw idth	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 MHz	90	1	8	TBD	TDLC300- 100	2x4 Low	1	[-4.6]

5.4 PBCH demodulation requirements

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

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

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

5.4.1 1RX requirements

(Void)

5.4.2 2RX requirements

5.4.2.1 FDD

Table 5.4.2.1-1: Test parameters for PBCH

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

For the parameters specified in Table 5.4.2.1-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.2.1-2 in case SS/PBCH block index is not known and below the specifies values

in Table.5.4.2.1-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

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

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

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

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

5.4.2.2 TDD

Table 5.4.2.2-1: Test parameters for PBCH

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

For the parameters specified in Table 5.4.2.2-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.2.2-2 in case SS/PBCH block index is not known 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	Bandwidth	Reference	Propagation	Antenna configuration and	Reference	e value
number		channel	condition	correlation matrix	Pm-bch	SNR
					(%)	(dB)
1	40 MHz	R.PBCH.2	TDLA30-10	1 x 2 Low	1	[-5]

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

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

5.4.3 4RX requirements

5.4.3.1 FDD

Table 5.4.3.1-1: Test parameters for PBCH

Parameter	Unit	Single antenna port
Physical Cell ID		0
Cyclic prefix		Normal
Number of SS/PBCH blocks within an SS burst set periodicity		1
SS/PBCH block index Note1		0
SS/PBCH block periodicity	ms	20
Note 1: as specified in clause 4.1 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	Bandwidth	Reference	Propagation	Antenna configuration and	Reference	ce value
number		channel	condition	correlation matrix	Pm-bch	SNR
					(%)	(dB)
1	10 MHz	R.PBCH.1	TDLC300-100	1 x 4 Low	1	[-9.1]

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

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

5.4.3.2 TDD

Table 5.4.3.2-1: Test parameters for PBCH

Parameter	Unit	Single antenna port
Physical Cell ID		0
Cyclic prefix		Normal
Number of SS/PBCH blocks within an SS burst set periodicity		1
SS/PBCH block index Note1		0
SS/PBCH block periodicity	ms	20
TDD UL-DL pattern		FR1.30-1
Note 1: as specified in 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	Bandwidth	Reference	Propagation	Antenna configuration and	Reference	e value
number		channel	condition	correlation matrix	Pm-bch	SNR
					(%)	(dB)
1	40 MHz	R.PBCH.2	TDLA30-10	1 x 4 Low	1	[-8.5]

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

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

5.5 Sustained downlink data rate provided by lower layers

5.5.1 FR1 single carrier requirements

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

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

5.5A Sustained downlink data rate provided by lower layers

5.5A.1 FR1 CA requirements

< Editor's note: Open issues to be resolved:

Sustained rate minimum duration

Whether same requirements apply for FR1 DC>

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

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

The test parameters are determined by the following procedure:

- Select one CA bandwidth combination among all supported CA configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities that provides the largest data rate [TS 38.306 [14, Section 4.1.2]].
 - Set of per CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor [TS 38.306 [14, Section 4.1.2]].
 - When there are multiple sets of CA bandwidth combinations and UE capabilities (channel bandwidth, subcarrier spacing, number of MIMO layer, modulation format, scaling factor) with same largest data rate, select one among sets with the smallest aggregated channel bandwidth.
- For each CC in CA bandwidth combination, use Table 5.5A-5 to determine MCS based on test parameters and indicated UE capabilities.

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

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

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

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

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

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

	Parameter	Unit	Value
PDSCH transmission		31110	Transmission scheme 1
EPRE ratio of PTRS		dB	N/A
			Channel bandwidth from selected CA
Channel bandwidth		MHz	bandwidth combination
	Physical Cell ID		0
0	SSB position in burst		First SSB in Slot #0
Common serving	SSB periodicity	ms	20
cell parameters	First DMRS position for Type A PDSCH		2
	mapping		2
Cross carrier schedul			Not configured
Active DL BWP index			1
	First PRB		0
DL BWP configuration #1	Number of contiguous PRB		Maximum transmission bandwidth configuration as specified in TS 38.101-1 [6, Section 5.3.2] for tested channel bandwidth and subcarrier spacing
	Subcarrier spacing	kHz	[15 or 30]
	Cyclic prefix		Normal
	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		Symbols #0
PDCCH	Number of PRBs in CORESET		Table 5.5A-4
configuration	Number of PDCCH candidates and aggregation levels		1/[AL 8]
	DCI format		1_1
	TCI State		TCI state #1
	Mapping type		Type A
	k0		0
	PDSCH aggregation factor		1
PDSCH	PRB bundling type		Static
configuration	PRB bundling size		WB
comigaration	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 {1000 – 1003} for 4 Layers CCs
	Number of PDSCH DMRS CDM group(s)		1 for 1 layer and 2 layers CCs
DTD0 " :	without data		2 for 4 Layers CCs
PTRS configuration	Out comic indexes in the BBB 17, 001		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
	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 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	15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4 30 kHz SCS:
			20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
	Frequency Occupation		Start PRB 0

			Number of PRB = BWP size
	QCL info		TCI state #0
		dexes in the PRB used for CSI-	k ₀ = 4
	OFDM symbo	ols in the PRB used for CSI-RS	l ₀ = 12
		SI-RS ports (X)	Same as number of transmit antenna
	CDM Type	· · · · · · · · · · · · · · · · · · ·	'FD-CDM2'
NZP CSI-RS for	Density (ρ)		1
CSI acquisition	CSI-RS perio	dicity	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset	i	0
	Frequency O	ccupation	Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #1
	Subcarrier inc	dexes in the PRB used for CSI-	k ₀ = 0
		ols in the PRB used for CSI-RS	l ₀ = 12
		SI-RS ports (X)	4
ZP CSI-RS for CSI	CDM Type		'FD-CDM2'
acquisition	Density (ρ)		1
acquisition	CSI-RS perio	dicity	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset		0
	Frequency O	ccupation	Start PRB 0 Number of PRB = BWP size
	Type 1 QCL	SSB index	SSB #0
TO!	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 #1	Type 2 QCL	CSI-RS resource	N/A
TOI State #0	information Type 1 QCL information	SSB index	SSB #0
Maximum number of		ips for ACK/NACK feedback	1
Maximum number of			4
HARQ ACK/NACK bu			Multiplexed
Redundancy version		ce	{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
	1 layer CCs		[1x2 or 1x4]
Antenna	2 layers CCs		[2x2 or 2x4]
configuration	4 layers CCs		[4x4]
Note 1: UE assum transmissi	es that the TCI	state for the PDSCH is identical to the	

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

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

Table 5.5A-4: Number of PRBs in CORESET

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

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

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

6 CSI reporting requirements (Conducted requirements)

6.1 General

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

6.1.1 Applicability of requirements

6.1.2 Common test parameters

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

Table 6.1.2-1: Test parameters for CSI test cases

	Parameter	Unit	Value
PDSCH transmiss	sion scheme		Transmission scheme
EPRE ratio of PT	RS to PDSCH	dB	!
Active DL BWP in			1
Cyclic prefix			Normal
Common	Physical Cell ID		0
serving cell	SSB position in burst		First SSB in Slot #0
parameters	SSB periodicity	ms	20
	Slots for PDCCH monitoring		Each slot
DDCCH	Symbols with PDCCH Number of PDCCH candidates		0,1
PDCCH configuration	and aggregation levels		1/[8]
Comigaration	DCI format		1 1
	TCI state		TCI state #1
Cross carrier sch			Not configured
	Mapping type		Type A
	kO		0
	Starting symbol (S)		2
	Length (L)		12
PDSCH	PDSCH aggregation factor		1
configuration	PRB bundling type		Static
	PRB bundling size Resource allocation 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		Single-symbol DM-RS
PDSCH DMRS configuration	DMRS ports indexes		{1000} for Rank1 {1000,1001} for Rank2 {1000,1001,1002} for Rank3 {1000,1001,1002,100
	Number of PDSCH DMRS CDM		3} for Rank4 2
	group(s) without data		
PTRS	Frequency density (KPT-RS)		N/A
configuration	Time density (L _{PT-RS})		N/A
	First subcarrier index in the PRB used for CSI-RS (<i>k</i> ₀)		[0]
	First OFDM symbol in the PRB used for CSI-RS (<i>l</i> ₀)		[4]
	Number of CSI-RS ports (X)		1
	CDM Type		No CDM
	Density (ρ)		3
	CSI-RS periodicity	slot	15 kHz SCS: 20 30 kHz SCS: 40
CSI-RS for tracking	CSI-RS offset	slot	15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4 30 kHz SCS:
			20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4 Start PRB 0
	Frequency Occupation		Number of PRB = BWP size
	QCL info		TCI state #0

			Start PRB 0			
NZP CSI-RS for	Frequency Occupation		Number of PRB =			
CSI acquisition	, ,	·	BWP size			
	QCL info		TCI state #1			
ZP CSI-RS for			Start PRB 0			
	Frequency Oc	ccupation	Number of PRB =			
CSI acquisition			BWP size			
	Type 1 QCL	SSB index	SSB #0			
TOI -1-1- #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 1			
		CSI-RS resource	from 'CSI-RS for			
			tracking' configuration			
TCI state #1		QCL Type	Type A			
	Type 2 QCL	CSI-RS resource	N/A			
	information	QCL Type	N/A			
Number of HARQ	Drocosoo		4 For FDD			
Number of HARQ	Flocesses		8 for TDD			
HARQ ACK/NAC	K bundling		Multiplexed			
Redundancy vers	ion coding sequ	{0,2,3,1}				
K1 value		2 for FDD				
(PDSCH-to-HARQ-timing-indicator)			Defined in Annex			
(FD3CIT-to-HARQ-tilling-indicator)			A.1.2 for TDD			
Symbols for unused Res			OCNG as specified in			
			A.5			
	H is not schedul	ed on slots containing CSI-F	RS or slots which are not full			
DL.			DL.			

UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission.

6.2 Reporting of Channel Quality Indicator (CQI)

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

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

6.2.1 1RX requirements

(Void)

6.2.2 2RX requirements

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

6.2.2.1 **FDD**

6.2.2.1.1 CQI reporting definition under AWGN conditions

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

Minimum requirement for periodic CQI reporting 6.2.2.1.1.1

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			Test 1 Test 2
Bandwidth			MHz	10
Duplex Mode				FDD
DL BWP configura	ation	First PRB		0
#1	allon	Number of contiguous PRB		52
		Subcarrier spacing	kHz	15
SNR			dB	[8] [9] [14] [15]
Propagation chan	nel			AWGN
Antenna configura	ation			2x2 with static channel specified in Annex B.1
Beamforming Mod	del			As specified in Section [Annex TBD]
	CSI-R	RS resource Type		Periodic
	Numb	per of CSI-RS ports (X)		4
	CDM	Туре		FD-CDM2
ZP CSI-RS	Densi	ty (ρ)		1
configuration	First s	subcarrier index in the PRB		Dow F 4
	used	for CSI-RS (k ₀)		Row 5,4
		OFDM symbol in the PRB used BI-RS (I ₀)		9
	CSI-R		slot	5/1
		RS resource Type		Periodic
		per of CSI-RS ports (X)		2
	CDM Type			FD-CDM2
	Densi			1
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)			Row 3,(6,-)
1	First OFDM symbol in the PRB used for CSI-RS (I ₀)			13
	NZP (CSI-RS-timeConfig dicity and offset	slot	5/1
		M RE pattern		0
CSI-IM	CSI-II	M Resource Mapping		<u> </u>
configuration		м,lcsi-iм)		(4, 9)
	CSI-IM timeConfig periodicity and offset		slot	5/1
ReportConfigType				Periodic
CQI-table				Table 2
reportQuantity				cri-RI-PMI-CQI
timeRestrictionFo	rChann	elMeasurements		Not configured
timeRestrictionFo	rInterfer	renceMeasurements		Not configured
cqi-FormatIndicat				Wideband
pmi-FormatIndica				Wideband
Sub-band Size			RB	N/A
CSI-Report period	dicity an	d offset	slot	5/1
aperiodicTriggerin				Not configured
		ebook Type		typel-SinglePanel
Codebook		ebook Mode		1
configuration	(CodebookConfig- N1,CodebookConfig-N2) CodebookSubsetRestriction			Not configured
				[010000]
RI Restriction			[N/A]	
Physical channel				[PUCCH]
yoroa. oriariilor	COI/F	RI/PMI delay	ms	8
Maximum number			5	1
				As specified in Table A.4-1, TBS.2-
Measurement cha	annel			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
Duplex Mode			FDD
DL BWP configura	First PRB		0
#1	Number of configuous PRB		52
	Subcarrier spacing	kHz	15
SNR		dB	[6] [7] [12] [13]
Propagation chan			TDLA30-5
Antenna configura			2×2
Correlation config	uration		ULA high
Beamforming Mod			As specified in Section [Annex TBD]
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
ZP CSI-RS	Density (ρ)		1
configuration	First subcarrier index in the PRB used for CSI-RS (k ₀)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		9
	CSI-RS periodicity and offset	slot	5/1
	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
	Density (ρ)		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	5/1
	CSI-IM RE pattern		0
CSI-IM configuration	CSI-IM Resource Mapping (Kcsi-im,lcsi-im)		(4, 9)
	CSI-IM timeConfig periodicity and offset	slot	5/1
ReportConfigType			Periodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionFor	rChannelMeasurements		Not configured
	rInterferenceMeasurements		Not configured
cqi-FormatIndicato			Wideband
pmi-FormatIndicat	tor		Wideband
Sub-band Size		RB	[8]
Csi-ReportingBan			[111111]
CSI-Report period		slot	5/1
aperiodicTriggerin			Not configured
Codebook	Codebook Type		typel-SinglePanel
configuration	Codebook Mode (CodebookConfig-		1
oomigurauon	N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
Dharat 1 1 1 1 11	RI Restriction		[N/A]
Physical channel f			[PUCCH]
Mandana	CQI/RI/PMI delay	ms	8
ıvıaxımum number	of HARQ transmission		1
Measurement cha	nnel		As specified in Table A.4-1, 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 α % of the time but less than β % of the time for each sub-band, where α and β are specified in Table 6.2.2.1.2.2-2;
- b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be $\geq \gamma$, 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 TBD.

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

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

Parameter		Unit	Test 1	Test 2	
Bandwidth			MHz	10)
Duplex Mode				FD	D
DL BWP configura	ation	First PRB		0	
#1	ation	Number of contiguous PRB		52	2
		Subcarrier spacing	kHz	15	
SNR			dB	TBD TBD	TBD TBD
Propagation channel			[Two tap model specified in Annex B.2.4 with a =1, f _D = 5Hz, and t _d =0.45 μ s]		
Antenna configura	ation			TB	
Correlation config				As per Ar	nnex B.1
	Beamforming Model			As specified in S	Section [Annex
			TB		
		RS resource Type		Perio	
		ber of CSI-RS ports (X)		4	
70.001.00		Type		FD-C	
ZP CSI-RS		sity (p)		1	
configuration		subcarrier index in the PRB		Row	5,4
	used	for CSI-RS (k ₀)		1.50	-,:
		OFDM symbol in the PRB used SI-RS (I ₀)		9	1
	CSI-I	RS	slot	5/	1
periodicity and offset			3101		
		RS resource Type		Perio	
		ber of CSI-RS ports (X)		2	,
	CDM Type			FD-CDM2	
NZP CSI-RS for CSI acquisition		sity (ρ)		1	
	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)			Row 3	3,(6,-)
oor doquionion	First OFDM symbol in the PRB used for CSI-RS (I ₀)			13	
	NZP	CSI-RS-timeConfig dicity and offset	slot	5/	1
		M RE pattern		0	
CSI-IM		M Resource Mapping			<u>'</u>
configuration		im,lcsi-im)		(4,	9)
	perio	M timeConfig dicity and offset	slot	5/	1
ReportConfigType)			Perio	
CQI-table				Tabl	
reportQuantity				cri-RI-P	
timeRestrictionFo				Not con	
		renceMeasurements		Not con	
cqi-FormatIndicate				Subb	
pmi-FormatIndicat	tor			Widel	oand
Sub-band Size			RB	8	
CSI-Report period			slot	5/	
aperiodicTriggerin	aperiodicTriggeringOffset			Not con	figured
	Coc	lebook Type		typel-Sing	glePanel
Codebook		lebook Mode		1	
configuration	(Co	debookConfig- CodebookConfig-N2)		Not con	figured
		lebookSubsetRestriction		0000	201
		Restriction		[N/	
Dhysical shape at					
Physical channel t				TB	
Massinarus		RI/PMI delay	ms	8	
Maximum number		Kų transmission		1	
Measurement cha	ınneı			ТВ	ט

Table 6.2.2.1.2.2-2: Minimum requirements

Parameters	Test 1	Test 2
α [%]	TBD	TBD
β [%]	TBD	TBD
γ	TBD	TBD

6.2.2.2 TDD

6.2.2.2.1 CQI reporting definition under AWGN conditions

6.2.2.2.1.1 Minimum requirement for periodic CQI reporting

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

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

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

Table 6.2.2.2.1.1-1: CQI reporting definition test

Parameter			Unit	Test 1 Test 2			st 2
Bandwidth			MHz		4(
Duplex Mode				TDD			
TDD UL-DL patter	rn				FR1.		
DL BWP configura	ation	First PRB			0		
#1		Number of contiguous PRB			10		
CND		Subcarrier spacing	kHz	[0]	30		[4.5]
SNR Propagation chan	nol		dB	[8]	[9] AW	[14]	[15]
				2×2 with	static cha		ecified in
Antenna configuration			ZAZ WIG	Anne		Joined III	
Beamforming Mod	del			As sp	ecified in S TBI		Annex
		RS resource Type			Perio		
		per of CSI-RS ports (X)			4		
		Туре			FD-C		
ZP CSI-RS		ity (ρ)			1		
configuration	used	subcarrier index in the PRB for CSI-RS (k ₀)			Row	5,4	
		OFDM symbol in the PRB used SI-RS (I ₀)			9		
	CSI-F		-1-4		40	/4	
	perio	dicity and offset	slot		10		
	CSI-F	RS resource Type per of CSI-RS ports (X)			Perio		
		Type			2		
		ity (ρ)		FD-CDM2			
NZP CSI-RS for	First subcarrier index in the PRB				-		
CSI acquisition	I	for CSI-RS (k ₀ , k ₁)			Row 3	,(6,-)	
·	First	OFDM symbol in the PRB used SI-RS (I ₀)		13			
NZ		CSI-RS-timeConfig	slot	10/1			
		dicity and offset	3101	10/1			
001.114		M RE pattern			0		
CSI-IM configuration		M Resource Mapping м,lсsı-ıм)			(4,	9)	
		M timeConfig dicity and offset	slot	10/1			
ReportConfigType		alony and oneon		Periodic			
CQI-table				Table 2			
reportQuantity					cri-RI-PI	MI-CQI	
timeRestrictionFo					Not con		
		renceMeasurements			Not con		
cqi-FormatIndicate					Widel		
pmi-FormatIndica	tor		55		Widel		
Sub-band Size	1:-:4	al affact	RB	N/A			
	CSI-Report periodicity and offset		slot	10/1 Not configured			
apenouic mggenii	aperiodicTriggeringOffset Codebook Type				typel-Sing		
Codebook		ebook Type ebook Mode			<u>typer-ont</u> 1		
configuration	(Cod	debookConfig-			Not con		
		CodebookConfig-N2)					
		ebookSubsetRestriction			[0100		
Dharias		Restriction			[N/.		
Physical channel				-	[PUC		
Maximum number		RI/PMI delay	ms	-	[9. .	ol	
		Ng transmission		As speci	ified in Tal	ole A 4-1	. TBS 2-
Measurement cha	ınnel			, to opoo	4		, 120.2

6.2.2.2.2 Wideband CQI reporting under fading conditions

6.2.2.2.2.1 Minimum requirement for wideband CQI reporting

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

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

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

- a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α % of the time where α % is specified in Table 6.2.2.2.1-2;
- b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, where γ is specified in Table 6.2.2.2.2.1-2;
- c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to [0.02].

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

	Unit	Test 1 Test 2			
Bandwidth		MHz	4	.0	
Duplex Mode				DD	
TDD UL-DL pattern				.30-1	
DL BWP configuration	n First PRB)	
#1	Number of Configuous PRB	1.11=		06	
	Subcarrier spacing	kHz	3	0	
SNR		dB	6 7	12 13	
Propagation channel			[TDLA30-5]		
Antenna configuration	า			k 2	
Correlation configurat	tion			high	
Beamforming Model			As specified in TE	Section [Annex	
I C	SI-RS resource Type			odic	
	umber of CSI-RS ports (X)			1	
	DM Type			DM2	
				1	
	irst subcarrier index in the PRB		Dou	, F 1	
	sed for CSI-RS (k ₀)		Row	7 5,4	
	irst OFDM symbol in the PRB used			9	
	or CSI-RS (I ₀)		`		
	SI-RS eriodicity and offset	slot	10)/1	
	SI-RS resource Type		Peri	odic	
	umber of CSI-RS ports (X)			2	
	DM Type			DM2	
	ensity (ρ)			1	
NZP CSI-RS for Fi	irst subcarrier index in the PRB		Pow '	2 (6)	
	sed for CSI-RS (k ₀ , k ₁)		ROW .	3,(6,-)	
fo	irst OFDM symbol in the PRB used or CSI-RS (I ₀)		1	3	
	ZP CSI-RS-timeConfig eriodicity and offset	slot	10/1		
	SI-IM RE pattern		()	
	SI-IM Resource Mapping			-	
	CCSI-IM, ICSI-IM)		(4,	9)	
C	SI-IM timeConfig	-1-4	4.0	2/4	
	eriodicity and offset	slot	10	0/1	
ReportConfigType			Periodic		
CQI-table				le 2	
reportQuantity			cri-RI-P		
timeRestrictionForCh	anneimeasurements erferenceMeasurements		Not cor	nfigured	
cgi-FormatIndicator	enerenceweasurements				
pmi-FormatIndicator			Wideband Wideband		
Sub-band Size		RB	[1		
Csi-ReportingBand				<u> </u>	
CSI-Report periodicity	y and offset	slot	10		
aperiodicTriggeringO			Not cor	nfigured	
(Codebook Type		typel-Sin	glePanel	
	Codebook Mode		,	1	
	(CodebookConfig-		Not cor	nfigured	
	N1,CodebookConfig-N2) CodebookSubsetRestriction				
	SI Restriction		000	/A]	
Physical channel for 0				CCH]	
	QI/RI/PMI delay	ms		.5]	
Maximum number of		5	,	·-, 1	
			As specified in Ta	able A.4-1, TBS.2-	
Measurement channe	51		· · · · · · · · · · · · · · · · · · ·	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 6.2.2.2.2.2-1 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 6.2.2.2.2.2.2;
- c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to TBD.

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

Table 6.2.2.2.2-1: Sub-band CQI reporting test under frequency-selective fading conditions

	Pa	arameter	Unit	Test 1		Tes	st 2
Bandwidth			MHz		40		
Duplex Mode					TD	D	
TDD UL-DL patter	rn				FR1.3		
•		First PRB			0		
DL BWP configura	ation	Number of contiguous PRB		106			
#1		Subcarrier spacing	kHz	30			
SNR			dB	TBD -	ΓBD	TBD	TBD
Propagation chan	nel			[Two tap model specified in Anne B.2.4 with $a=1$, $f_D=5$ Hz, and			
					$T_d = 0.11$		•
Antenna configura	ation				TB		
Correlation config				As	per Ar	nex B.1	
Beamforming Mod	del			As speci	fied in S TBI		Annex
	CSI-F	RS resource Type			Perio		
		per of CSI-RS ports (X)			4		
		Type			FD-CI	DM2	
ZP CSI-RS		ity (ρ)			1		
configuration		subcarrier index in the PRB for CSI-RS (k ₀)			Row	5,4	
	First	OFDM symbol in the PRB used SI-RS (I ₀)			9		
	CSI-F	RS	slot		10/	/1	
		dicity and offset			Daria	al: a	
		RS resource Type			Perio		
		Number of CSI-RS ports (X) CDM Type		2			
	Density (p)			FD-CDM2			
NIZD COL DO (3 (1)		1			
NZP CSI-RS for CSI acquisition	used	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)			Row 3	,(6,-)	
		OFDM symbol in the PRB used SI-RS (I ₀)		13			
		CSI-RS-timeConfig dicity and offset	slot	10/1			
	CSI-I	M RE pattern			0		
CSI-IM configuration		M Resource Mapping м,lcsнм)		(4, 9)			
		M timeConfig dicity and offset	slot	10/1			
ReportConfigType		•		Periodic			
CQI-table				Table 2			
reportQuantity				С	ri-RI-PI		
timeRestrictionFor	rChann	elMeasurements			lot conf		
timeRestrictionFor	rInterfe	renceMeasurements			lot conf		
cqi-FormatIndicate	or				Subb	and	
pmi-FormatIndicat				Wideband			
Sub-band Size			RB		16		
CSI-Report period	licity ar	nd offset	slot		10/		
aperiodicTriggeringOffset			١	lot conf	figured		
		ebook Type				glePanel	
Codebook	Cod	ebook Mode			1		
configuration		debookConfig- CodebookConfig-N2)		N	Not conf	figured	
		ebookSubsetRestriction		000001			
		estriction			[N//		
Physical channel t					TB		
,		RI/PMI delay	ms		[9.		
Maximum number					1		
Measurement cha					TB		
				1			

Table 6.2.2.2.2-2: Minimum requirements

Parameters	Test 1	Test 2
α [%]	TBD	TBD
β [%]	TBD	TBD
γ	TBD	TBD

6.2.3 4RX requirements

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

6.2.3.1 FDD

6.2.3.1.1 CQI reporting definition under AWGN conditions

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

6.2.3.1.1.1 Minimum requirement for period CQI reporting

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

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

Table 6.2.2.1.1.1-1: CQI reporting definition test

	Parameter	Unit	Test 1	Test 2
Bandwidth		MHz	10	
Duplex Mode			FDD	
DL BWP configura	First PRB		0	
#1	Number of contiguous PRB		52	
	Subcarrier spacing	kHz	15	
SNR		dB	[5] [6] [11] [
Propagation chan	nel		AWGN	1 '6' 1'
Antenna configura	ation		2x4 with static channel specified in Annex B.1	
Beamforming Model			As specified in Sec TBD]	
	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (X)		4	
75 001 50	CDM Type		FD-CDM2	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 periodicity and offset	slot	5/1	
CSI-RS resource Type			Periodic	
	Number of CSI-RS ports (X)		2	
	CDM Type		FD-CDM2	2
	Density (ρ)		1	
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 3,(6,	-)
oor adquidition	First OFDM symbol in the PRB used for CSI-RS (I ₀)		13	
	NZP CSI-RS-timeConfig	slot	5/1	
	periodicity and offset CSI-IM RE pattern		0	
CSI-IM	CSI-IM Resource Mapping		0	
configuration	(ксы-ім, Ісы-ім)		(4, 9)	
	CSI-IM timeConfig periodicity and offset	slot	5/1	
ReportConfigType			Periodic	
CQI-table			Table 2	
reportQuantity			cri-RI-PMI-0	CQI
timeRestrictionFo	rChannelMeasurements		Not configu	red
timeRestrictionFo	rInterferenceMeasurements		Not configu	red
cqi-FormatIndicate	or		Wideban	d
pmi-FormatIndica	tor		Wideban	d
Sub-band Size		RB	N/A	
CSI-Report period		slot	5/1	
aperiodicTriggerin	gOffset		Not configu	red
	Codebook Type		typel-SingleF	anel
Codebook	Codebook Mode		1	
configuration	(CodebookConfig- N1,CodebookConfig-N2)		Not configu	red
	CodebookSubsetRestriction		[010000]	
	RI Restriction		[N/A]	
Physical channel	for CSI report		[PUCCH]
	CQI/RI/PMI delay	ms	8	
Maximum number	r of HARQ transmission		1	
Measurement cha	nnel	_	As specified in Table 2	A.4-1, TBS.2-
l				

6.2.3.1.2 Wideband CQI reporting under fading conditions

6.2.3.1.2.1 Minimum requirement for wideband CQI reporting

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

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

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

- a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α % of the time where α % is specified in Table 6.2.3.1.2.1-2;
- b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, 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		
Duplex Mode			FDD		
DL BWP configura	First PRB		0		
#1	Number of contiguous PRB		52		
#1	Subcarrier spacing	kHz	15		
SNR		dB	[3] [4] [9] [10]	
Propagation chan			TDLA30-5		
Antenna configura			2×4		
Correlation config	uration		XP High		
Beamforming Model			As specified in Sect TBD]	ion [Annex	
	CSI-RS resource Type		Periodic		
	Number of CSI-RS ports (X)		4		
	CDM Type		FD-CDM2	2	
ZP CSI-RS	Density (ρ)		1		
configuration	First subcarrier index in the PRB		Row 5,4		
	used for CSI-RS (k ₀)		NOW 5,4		
	First OFDM symbol in the PRB used for CSI-RS (I ₀)		9		
	CSI-RS	slot	5/1		
	periodicity and offset	SIUL			
CSI-RS resource Type			Periodic		
	Number of CSI-RS ports (X)		2		
	CDM Type		FD-CDM2	2	
	Density (ρ)		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	5/1		
	CSI-IM RE pattern		0		
CSI-IM	CSI-IM Resource Mapping				
configuration	(KCSI-IM, ICSI-IM)		(4, 9)		
	CSI-IM timeConfig periodicity and offset	slot	5/1		
ReportConfigType			Periodic		
CQI-table			Table 2		
reportQuantity			cri-RI-PMI-C	COL	
	rChannelMeasurements		Not configur		
	rInterferenceMeasurements		Not configur		
cgi-FormatIndicate			Wideband		
pmi-FormatIndica			Wideband		
Sub-band Size		RB	[8]	-	
csi-ReportingBand	d		[1111111]	1	
CSI-Report period		slot	5/1		
aperiodicTriggerin		Siot	Not configur	ed	
aponodio rriggerii	Codebook Type		typel-SingleP		
Codebook	Codebook Mode		1		
configuration	(CodebookConfig-		Not configur	·ed	
	N1,CodebookConfig-N2)			Cu	
	CodebookSubsetRestriction		000001		
	RI Restriction		[N/A]		
Physical channel			[PUCCH]		
	CQI/RI/PMI delay	ms	8		
Maximum number	r of HARQ transmission		1		
Maggiramont cha	unnel		As specified in Table A	4.4-1, TBS.2-	
Measurement channel			1		

Table 6.2.3.1.2.1-2: Minimum requirements

Parameters	Test 1	Test 2
α[%]	[5]	[5]
γ	[1.05]	[1.05]

6.2.3.1.2.2 Minimum requirement for sub-band CQI reporting

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

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

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

- a) A sub-band differential CQI offset level of 0 shall be reported at least α % of the time but less than β % of the time for each sub-band, where α and β are specified in Table 6.2.3.1.2.2-2;
- b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be $\geq \gamma$, 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 TBD.

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

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

Parameter		Unit	Test 1	Test 2	
Bandwidth			MHz	10)
Duplex Mode				FD	D
DL BWP configura	ation	First PRB		0	
#1	allon	Number of contiguous PRB		52	2
		Subcarrier spacing	kHz	15	
SNR			dB	TBD TBD	TBD TBD
Propagation channel			[Two tap model sp B.2.4 with a=1, Td=0.4	$f_D = 5Hz$, and	
Antenna configura	ation			TB	
Correlation config				As per Ar	nnex B.1
Beamforming Model			As specified in S		
	CSI-	RS resource Type		Perio	odic
		ber of CSI-RS ports (X)		4	
	CDM	Type		FD-C	DM2
ZP CSI-RS		sity (ρ)		1	
configuration		subcarrier index in the PRB			- A
J		for CSI-RS (k ₀)		Row	5,4
	First	OFDM symbol in the PRB used SI-RS (I ₀)		9	
	CSI-		slot	5/	1
		RS resource Type		Perio	odic
		ber of CSI-RS ports (X)		2	
	CDM Type			FD-CDM2	
NZP CSI-RS for	Density (ρ)			1	DIVIE
		subcarrier index in the PRB			
CSI acquisition		for CSI-RS (k ₀ , k ₁)		Row 3	3,(6,-)
·	First OFDM symbol in the PRB used for CSI-RS (I ₀)			13	
		CSI-RS-timeConfig dicity and offset	slot	5/	1
		M RE pattern		0	1
CSI-IM configuration		M Resource Mapping ıм,lcsı-ıм)		(4,	9)
		M timeConfig dicity and offset	slot	5/	1
ReportConfigType				Perio	odic
CQI-table				Tabl	e 2
reportQuantity				cri-RI-P	MI-CQI
timeRestrictionFo	rChanr	nelMeasurements		Not con	figured
timeRestrictionFo	rInterfe	renceMeasurements		Not con	figured
cqi-FormatIndicate	or			Subb	
pmi-FormatIndicat	tor			Widel	oand
Sub-band Size			RB	8	
CSI-Report period	licity a	nd offset	slot	5/	1
	aperiodicTriggeringOffset			Not con	figured
. 55		lebook Type		typel-Sing	
Codebook		lebook Mode		1	-
configuration	(Co	debookConfig- CodebookConfig-N2)		Not con	figured
		lebookSubsetRestriction		0000	001
		Restriction		[N/	
Physical channel				TB	
, 5.54. 5.14.11101		RI/PMI delay	ms	8	
Maximum number			1110	1	
Measurement cha				TB	
addi official offic			1	1 10	_

Table 6.2.3.1.2.2-2: Minimum requirements

Parameters	Test 1	Test 2
a [%]	TBD	TBD
β [%]	TBD	TBD
γ	TBD	TBD

6.2.3.2 TDD

6.2.3.2.1 CQI reporting definition under AWGN

6.2.3.2.1.1 Minimum requirement for CQI periodic reporting

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

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

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

Table 6.2.3.2.1.1-1: CQI reporting definition test

Bandwidth	Parameter			Unit	Test 1	Test 2
DL Butp configuration	Bandwidth			MHz	40	
DL BWP configuration					TDD	
Number of contiguous PRB 106					FR1.30-1	
Multiple of Uconing Use PRB Subcarrier spacing SNR	DL BWP configura					
Subcarner spacing	_	Number of configuous PRB				
Propagation channel	Subcarrier spacing			· · · · · · · · · · · · · · · · · · ·		
Antenna configuration				dB		
Beamforming Model	Propagation chan	nel				
CSI-RS resource Type	Antenna configuration				Annex B.1	
Number of CSI-RS ports (X)	Beamforming Model				•	
CDM Type					Periodic	
Density (p)					=	
First subcarrier index in the PRB ged for CSI-RS (ks) First OFDM symbol in the PRB used for CSI-RS (ls) SIot 10/1					FD-CDM2	
Used for CSI-RS (k ₀)					1	
Tor CSI-RS (lo) Solot So	configuration	used for CSI-RS (k ₀)			Row 5,4	
CSI-RS periodicity and offset Solt 10/1					9	
CSI-RS resource Type		CSI-RS		slot	10/1	
Number of CSI-RS ports (X) 2					Perio	ndic
CDM Type						
Density (p)					_	
NZP CSI-RS for CSI acquisition First subcarrier index in the PRB used for CSI-RS (ko, kr)						
Used for CSI-RS (k ₀ , k ₁)	NZP CSI-RS for				·	
First OFDM symbol in the PRB used for CSI-RS (Io) NZP CSI-RS (Io) NZP CSI-RS (Io) 10/1 10/					Row 3	,(6,-)
NZP CSI-RS-timeConfig periodicity and offset CSI-IM Resource Mapping Configuration CSI-IM Resource Mapping (kcsi-IM, Icsi-IM) CSI-IM timeConfig periodicity and offset CSI-IM timeConfig periodicity and offset ReportConfigType Periodic CQI-table Table 2 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements timeRestrictionForInterferenceMeasurements videband pmi-FormatIndicator pmi-FormatIndicator pmi-FormatIndicator Sub-band Size RB N/A CSI-Report periodicity and offset aperiodicTriggeringOffset Codebook Codebook Type Codebook Type Codebook Mode Codebook Configuration RI Restriction RI Restriction RI Restriction RI Restriction [O10000] RI Restriction RI Restriction [PUCCH] CQI/RI/PMI delay Maximum number of HARQ transmission 1 Measurement channel		First OFDM symbol in the PRB used			13	3
Deriodicity and offset Siot 10/1				_		
CSI-IM RE pattern				slot	10/1	
CSI-IM configuration CSI-IM Resource Mapping (kcsi-im,lcsi-im) CSI-IM timeConfig periodicity and offset ReportConfigType CQI-table reportQuantity reportQuantity reportConfierType ReportConfigType ReportConfigType Periodic Table 2 reportQuantity reportQuanti					0	
CSI-IM timeConfig periodicity and offset slot 10/1 ReportConfigType Periodic CQI-table Table 2 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured timeRestrictionForInterferenceMeasurements Not configured wideband pmi-FormatIndicator Wideband Size RB N/A CSI-Report periodicity and offset slot 10/1 aperiodicTriggeringOffset Slot 10/1 aperiodicTriggeringOffset Not configured typel-SinglePanel Codebook configuration CodebookConfig-N1,CodebookConfig-N1,CodebookConfig-N2) CodebookSubsetRestriction [010000] RI Restriction Periodicaty Slot 10/1 Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel	CSI-IM					
ReportConfigType	configuration				(4,	9)
ReportConfigType Periodic CQI-table Table 2 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured timeRestrictionForInterferenceMeasurements Not configured cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB N/A CSI-Report periodicity and offset slot 10/1 aperiodicTriggeringOffset Not configured Codebook Codebook Type typel-SinglePanel Codebook 1 (Codebook Type-SinglePanel Codebook Mode 1 Not configured Codebook Config-N12 Not configured Not configured Not configured Not configured Not configured In Codebook Config-N12 In Codebook Config-N2 Codebook SubsetRestriction [010000] RI Restriction [NA] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms Maximum number of HARQ transmission 1 As specified in Tab				slot	10/1	
CQI-table Table 2 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured timeRestrictionForInterferenceMeasurements Not configured cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB N/A CSI-Report periodicity and offset slot 10/1 aperiodicTriggeringOffset Not configured Codebook Codebook Type typel-SinglePanel Codebook 1 Codebook Mode 1 configuration (CodebookConfig-N2) Not configured Not configured Not configured <td colspan="3"></td> <td></td> <td colspan="2">Periodic</td>					Periodic	
reportQuantity cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured timeRestrictionForInterferenceMeasurements Not configured cqi-FormatIndicator Wideband pmi-FormatIndicator RB N/A Sub-band Size RB N/A CSI-Report periodicity and offset slot 10/1 aperiodicTriggeringOffset Not configured Codebook Type typel-SinglePanel Codebook 1 Codebook Mode 1 (CodebookConfig-N2) Not configured N1,CodebookConfig-N2) Not configured RI Restriction [010000] RI Restriction [N/A] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-						
timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size CSI-Report periodicity and offset aperiodicTriggeringOffset Codebook configuration Codebook configuration RI Restriction Physical channel for CSI report CQI/RI/PMI delay Mot configured Mot configured Slot 10/1 Not configured 10/1 Not configured 10/1 Not configured Not configured 10/1 Not configured Not configured 10/1 Not configured 10/1 Not configured 10/1 Not configured Not configured Not configured 10/1 Not configured Not configured Not configured 10/1 Not configured Not configured Not configured Not configured Not configured 10/1 Not configured Not configured Not configured Not configured 10/1 Not configured 10/1 Not configured Not configured 10/1 Not configured Not configured Not configured 10/1 Not configured Not configured 10/1 Not configured 10/1 Not configured Not configured 10/1						
timeRestrictionForInterferenceMeasurements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size CSI-Report periodicity and offset aperiodicTriggeringOffset Codebook configuration Codebook Config- N1,CodebookConfig- N1,CodebookConfig- N1,CodebookSubsetRestriction RI Restriction Physical channel for CSI report CQI/RI/PMI delay Measurement channel Twice deband Wideband Wideband Not configured 10/1 Not configured 10/2 Not configured 10/3 Not configured 10/4 Not configured 10/4 Not configured 10/4 Not configured Not configured 10/4 Not configured 10/4 Not configured Not configured 10/4 Not configured Not configured 10/4 Not configured Not configured Not configured 10/4 Not configured Not configured Not configured 10/4 Not configured Not configured Not configured Not configured Not configured Not configured 10/4 Not configured Not configured Not configured Not configured 10/4 Not configured Not configured Not configured Not configured 10/4 Not configured Not configured Not configured 10/4 Not configured Not configured Not configured 10/1 Not configured Not configured Not configured 10/1 Not configured 10/1 Not configured Not configured 10/1 Not configured Not configured 10/1 Not configured Not configur						
cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB N/A CSI-Report periodicity and offset slot 10/1 aperiodicTriggeringOffset Not configured Codebook Type typeI-SinglePanel Codebook Mode 1 (Codebook Mode 1 (CodebookConfig-N2) Not configured N1,CodebookConfig-N2) [010000] RI Restriction [010000] RI Restriction [N/A] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-						
pmi-FormatIndicator Wideband Sub-band Size RB N/A CSI-Report periodicity and offset slot 10/1 aperiodicTriggeringOffset Not configured Codebook Type typeI-SinglePanel Codebook Mode 1 (Codebook Config-N2) Not configured N1,CodebookConfig-N2) Not configured Codebook SubsetRestriction [010000] RI Restriction [N/A] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-						
Sub-band Size RB N/A CSI-Report periodicity and offset slot 10/1 aperiodicTriggeringOffset Not configured Codebook typeI-SinglePanel Codebook 1 Codebook Mode 1 (CodebookConfig-N2) Not configured N1,CodebookConfig-N2) [010000] CodebookSubsetRestriction [010000] RI Restriction [N/A] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-						
CSI-Report periodicity and offset slot 10/1 aperiodicTriggeringOffset Not configured Codebook typel-SinglePanel Codebook 1 Codebook Mode 1 (CodebookConfig-N2) Not configured N1,CodebookConfig-N2) [010000] CodebookSubsetRestriction [010000] RI Restriction [N/A] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-	,			RB		
aperiodicTriggeringOffset Not configured Codebook Codebook Mode 1 configuration (CodebookConfig- N1,CodebookConfig-N2) Not configured CodebookSubsetRestriction [010000] RI Restriction [N/A] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-						
Codebook Type						
Codebook configuration Codebook Mode (CodebookConfig-N1, CodebookConfig-N2) 1 CodebookSubsetRestriction RI Restriction [010000] RI Restriction [N/A] Physical channel for CSI report CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-						
N1,CodebookConfig-N2)		Codebook Mode			1	
CodebookSubsetRestriction [010000] RI Restriction [N/A] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-					Not conf	igured
RI Restriction [N/A] Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-					[0100	000]
Physical channel for CSI report [PUCCH] CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-						
CQI/RI/PMI delay ms [9.5] Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-	Physical channel	Physical channel for CSI report				
Maximum number of HARQ transmission 1 Measurement channel As specified in Table A.4-1, TBS.2-				ms	•	•
Measurement Channel	Maximum number				1	
	Measurement cha	nnel			-	

6.2.3.2.2 Wideband CQI reporting under fading conditions

6.2.3.2.2.1 Minimum requirement for wideband CQI reporting

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

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

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

- a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α % of the time where α % is specified in Table 6.2.3.2.2.1-2;
- b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, 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	Те	st 1	Tes	st 2
Bandwidth			MHz		40)	
Duplex Mode					TD	D	
TDD UL-DL patter	rn				FR1.3	30-1	
DL BWP configura	ation	First PRB			0		
#1	20011	Number of contiguous PRB		106			
	Subcarrier spacing		kHz	1	30)	1
SNR			dB	[2]	[4]	[0]	[40]
Propagation chan	nel			[3]	[4] [TDLA	[9] 30-51	[10]
Antenna configura					2×		
Correlation config					XP H		
				As sp	ecified in S		Annex
Beamforming Mod					TBI		
		RS resource Type			Perio		
		ber of CSI-RS ports (X)			4		
70.001.00		Type			FD-CI	DM2	
ZP CSI-RS		sity (ρ) subcarrier index in the PRB			1		
configuration		for CSI-RS (k ₀)			Row	5,4	
		OFDM symbol in the PRB used					
		SI-RS (I ₀)			9		
	CSI-I		alat		40	/4	
		dicity and offset	slot		10/		
		RS resource Type			Perio		
		ber of CSI-RS ports (X)			2		
		Type			FD-CI	DM2	
NZD OOL DO 4	Density (ρ)				1		
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)				Row 3	,(6,-)	
COI acquisition		OFDM symbol in the PRB used					
		SI-RS (I ₀)		13			
	NZP CSI-RS-timeConfig		slot		10/	/4	
		dicity and offset	SIOL				
		M RE pattern			0		
CSI-IM		M Resource Mapping				۵)	
configuration	(KCSI-	ім,Ісзі-ім)			(4,	9)	
	CSI-I	M timeConfig					
		dicity and offset	slot	10/1			
ReportConfigType					Perio	odic	
CQI-table					Tabl	e 2	
reportQuantity					cri-RI-PI		
timeRestrictionFo					Not con		
		renceMeasurements			Not con		
cqi-FormatIndicate					Widek		
pmi-FormatIndicat	tor		RB		Widek		
Sub-band Size csi-ReportingBand	1		KD		[16] [1111]		
CSI-ReportingBand		nd offset	slot		10/		
aperiodicTriggerin			3101		Not con		
Sp 55 dio i riggorii		lebook Type			typel-Sing		
Codebook		lebook Mode			1	,	
configuration	(Co	debookConfig-			Not con	figurod	
		CodebookConfig-N2)					
		lebookSubsetRestriction			0000		
<u> </u>		Restriction			[N/.		
Physical channel for CSI report					[PUC		
CQI/RI/PMI delay			ms		[9.	o]	
iviaximum number	Maximum number of HARQ transmission			Ac cocc	1 cified in Tal		TRCO
Measurement cha	nnel			As spec	inea in Tai 3		100.2-
				1			

Table 6.2.3.2.2.1-2: Minimum requirements

Parameters	Test 1	Test 2
α[%]	[5]	[5]
γ	[1.05]	[1.05]

6.2.3.2.2.2 Minimum requirement for sub-band CQI reporting

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

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

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;
- 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 TBD.

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

Table 6.2.3.2.2.1: Sub-band CQI reporting test under frequency-selective fading conditions

	Pa	arameter	Unit	Te	est 1	Te	st 2
Bandwidth			MHz		4		
Duplex Mode					TE		
TDD UL-DL patter	rn	<u></u>			FR1.	30-1	
DL BWP configura	ation	First PRB			(
#1 Number of Configuous PRB				10)6		
		Subcarrier spacing	kHz	30			
SNR			dB	TBD	TBD	TBD	TBD
Duana action show					ap model s		
Propagation chan	nei			D.2.	4 with <i>a</i> =1		, and
Antonno configura	4:				T _d =0.1		
Antenna configura				TBD As per Annex B.1			
Correlation config	uration			Λο οι	pecified in		\nnov
Beamforming Mod	del			AS S	pecilied in TB		Aillex
	CSI-F	RS resource Type			Peri	odic	
		per of CSI-RS ports (X)			4	1	
		Type			FD-C	DM2	
ZP CSI-RS		ity (ρ)			1		
configuration	First	subcarrier index in the PRB			D		
-	used	for CSI-RS (k ₀)			Row	0,4	
		OFDM symbol in the PRB used					
		SI-RS (lo)			ξ)	
	CSI-F	RS	alat		4.0	./4	
	perio	dicity and offset	slot		10	// I	
	CSI-F	RS resource Type			Peri	odic	
	Number of CSI-RS ports (X)			2			
	CDM Type				FD-C	DM2	
	Dens	ity (ρ)			1		
NZP CSI-RS for	1	subcarrier index in the PRB		Row 3,(6,-)		3,(6,-)	
CSI acquisition	First	for CSI-RS (k ₀ , k ₁) OFDM symbol in the PRB used			1	2	
		SI-RS (I ₀) CSI-RS-timeConfig					
		dicity and offset	slot	10/1			
	CSI-I	M RE pattern			()	
CSI-IM	CSI-I	M Resource Mapping					
configuration	(kcsı-ı	м,lcsi-iм)			(4,	9)	
		M timeConfig	slot		10	1/1	
		dicity and offset	3101				
ReportConfigType)				Peri		
CQI-table					Tab		
reportQuantity					cri-RI-P		
timeRestrictionFo					Not cor		
		renceMeasurements			Not cor		
cqi-FormatIndicate				1	Subl		
pmi-FormatIndicat	tor				Wide		
Sub-band Size			RB		1		
CSI-Report periodicity and offset		slot		10			
aperiodicTriggeringOffset				Not cor			
		ebook Type			typel-Sin		
Codebook		ebook Mode			1		
configuration		debookConfig-			Not cor	ifigured	
		CodebookConfig-N2)		+	000		
CodebookSubsetRestriction				+	000 [N		
RI Restriction				+			
Physical channel for CSI report			me	+	TE		
CQI/RI/PMI delay Maximum number of HARQ transmission			ms	+	[9.		
		NG HAHSHIISSIOH		1	TE	•	
Measurement channel			1	1	IE	טט	

Table 6.2.2.1.2.2-2: Minimum requirements

Parameters	Test 1	Test 2
a [%]	TBD	TBD
β [%]	TBD	TBD
γ	TBD	TBD

6.3 Reporting of Precoding Matrix Indicator (PMI)

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

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

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

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

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 Typel-SinglePanel Codebook

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

Table 6.3.2.1.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Duplex Mode			FDD
	First PRB		0
DL BWP	Number of		52
configuration	contiguous PRB		
#1	Subcarrier	kHz	15
Dranagation abo	spacing		TDI 420 F
Propagation cha			TDLA30-5 High XP 4 x 2
Antenna configu	ıration		(N1,N2) = (2,1)
Beamforming M	odel		TBD
	CSI-RS resource		Aperiodic
	Туре		лрепосіо
	Number of CSI-		4
	RS ports (X)		ED CDMO
	CDM Type Density (ρ)		FD-CDM2 1
ZP CSI-RS	First subcarrier		ı
configuration	index in the PRB		
oormgaranon	used for CSI-RS		Row 5, (4,-)
	(k_0, k_1)		
	First OFDM		
	symbol in the PRB		(9,-)
	used for CSI-RS		(3,-)
	(I_0, I_1)		
	CSI-RS	slot	5/1
	interval and offset CSI-RS resource		
	Type		Aperiodic
	Number of CSI-		
	RS ports (X)		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		, (, ,
	(k ₀ , k ₁) First OFDM		
	symbol in the PRB		(12.)
	used for CSI-RS		(13,-)
	(I_0, I_1)		
	CSI-RS		5/1
	interval and offset		
	CSI-IM RE pattern		Patten 0
	CSI-IM Resource		
CSI-IM	Mapping (kcsі-ім,lcsі-ім)		(4,9)
configuration	(NCSI-IM,ICSI-IM)		
3	CSI-IM timeConfig	-1.6	- I
	interval and offset	slot	5/1
	ReportConfigType		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure ments			Not configured
timeRestrictionForInterferenceMeas			
urements			Not configured
cqi-FormatIndic	ator		Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	[8]
csi-ReportingBand			[111111]
CSI-Report interval and offset aperiodicTriggeringOffset		slot	5/1
aperiodic i rigge			0 typel-SinglePanel
	Codebook Type		typel-SinglePanel

Codeboo	k	Codebook Mode		1	
configura	tion	(CodebookConfig-			
		N1,CodebookConf		(2,1)	
		ig-N2)			
		CodebookSubset		1111111	
		Restriction		11111111	
		RI Restriction		0000001	
Physical	channe	el for CSI report		PUSCH	
CQI/RI/P	CQI/RI/PMI delay			6	
Maximum number of HARQ			4		
transmiss	transmission			4	
Measure	ment c	hannel		R.PDSCH.1-6.1 FDD	
Note 1:	For ra	andom precoder selec	ction, the p	recoder shall be updated in each	
	slot (1 ms granularity).			
Note 2:				k reporting instance at slot#n	
based on PMI estimation a				k slot not later than slot#[(n-3)],	
this reported PMI cannot be			e applied a	at the eNB downlink before	
	slot#[(n+3)].				
Note 3: Randomization of the princ			ciple beam	direction shall be used as	
	specified in TBD.				

Table 6.3.2.1.1-2: Minimum requirement

Parameter	Test 1
γ	[1.3]

6.3.2.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Duplex Mode			FDD
	First PRB		0
DL BWP	Number of		52
configuration	contiguous PRB		32
#1	Subcarrier	kHz	15
	spacing	KI IZ	15
Propagation cha	annel		TDLA30-5
Antenna configu	ıration		High XP 8 x 2
			(N1,N2) = (4,1)
Beamforming M			TBD
	CSI-RS resource		Aperiodic
	Type		
	Number of CSI-		4
	RS ports (X)		FD-CDM2
	CDM Type Density (ρ)		1 1
ZP CSI-RS	First subcarrier		ı ı
configuration	index in the PRB		
Comigaration	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		
	used for CSI-RS		(9,-)
	(I_0, I_1)		
	CSI-RS		-11
	interval and offset	slot	5/1
	CSI-RS resource		Ai di
	Type		Aperiodic
	Number of CSI-		8
	RS ports (X)		
	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		110W 0, (4,0)
aoquionion	(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		Patten 0
	CSI-IM Resource		Patterio
	Mapping		
CSI-IM	(kcsi-im,lcsi-im)		(4,9)
configuration	(NCSI-IM,ICSI-IM)		
garaner.	CSI-IM timeConfig		
	interval and offset	slot	5/1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure			Not configured
ments			Not configured
timeRestrictionForInterferenceMeas			Not configured
urements			-
cqi-FormatIndic			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	[8]
csi-ReportingBa			[111111]
CSI-Report inte		slot	5/1
aperiodicTrigge			0
	Codebook Type		typel-SinglePanel

Codebook	Codebook Mode		1		
configuration	(CodebookConfig-				
	N1,CodebookConf		(4,1)		
	ig-N2)				
	CodebookSubset		0x FFFF		
	Restriction		0.21111		
	RI Restriction		0000010		
Physical chann	Physical channel for CSI report		PUSCH		
CQI/RI/PMI delay		ms	8		
Maximum number of HARQ			4		
transmission			4		
Measurement	channel		R.PDSCH.1-6.2		
Note 1: For	random precoder selec	ction, the p	recoder shall be updated in each		
slot	(1 ms granularity).				
Note 2: If th	e UE reports in an ava	ilable uplinl	k reporting instance at slot#n		
bas	ed on PMI estimation a	at a downlin	k slot not later than slot#[(n-4)],		
this	reported PMI cannot b	e applied a	t the eNB downlink before		
slot	slot#[(n+4)].				
Note 3: Randomization of the principle beam direction shall be used					
spe	cified in TBD.				

Table 6.3.2.1.2-2: Minimum requirement

Parameter	Test 1
γ	[1.5]

6.3.2.2 TDD

6.3.2.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.2.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Duplex Mode			TDD
TDD DL-UL con	TDD DL-UL configuration		FR1.30-1 as specified in Annex A
	First PRB		0
DL BWP configuration	Number of contiguous PRB		106
#1	Subcarrier spacing	kHz	30
Propagation cha			TDLA30-5
Antenna configu	ıration		High XP 4 x 2 (N1,N2) = (2,1)
Beamforming M			TBD
	CSI-RS resource		Aperiodic
	Type Number of CSI-		· · · · · · · · · · · · · · · · · · ·
	RS ports (X)		4
	CDM Type		FD-CDM2
70 001 00	Density (ρ)		1
ZP CSI-RS	First subcarrier		
configuration	index in the PRB used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(0.)
	used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS	slot	10/1
	interval and offset CSI-RS resource		
	Type		Aperiodic
	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 4, (0,-)
	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(13,-)
	CSI-RS interval and offset	slot	10/1
	CSI-IM RE pattern		Patten 0
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)
oogu.ao	CSI-IM timeConfig interval and offset	slot	10/1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure ments			Not configured
timeRestrictionF urements	timeRestrictionForInterferenceMeas urements		Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	[16]
csi-ReportingBa			[111111]
CSI-Report inte	rvai and offset	slot	10/1

aperiodicTriggeringOffset			0
	Codebook Type		typel-SinglePanel
Codebook	Codebook Mode		1
configuration	(CodebookConfig- N1,CodebookConfig-N2)		(2,1)
	CodebookSubset Restriction		11111111
	RI Restriction		0000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	5.5
Maximum number of HARQ transmission			4
Measurement c	hannel		R.PDSCH.2-8.1 TDD

Note 1: For random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity).

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

slot#[(n+4)].
Randomization of the principle beam direction shall be used as

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

Table 6.3.2.2.1-2: Minimum requirement

Parameter	Test 1
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 TBD, the minimum requirements are specified in Table 6.3.2.2.2-2.

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

Parameter		Unit	Test 1
Bandwidth		MHz	40
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
	First PRB		0
DL BWP	Number of		106
configuration	contiguous PRB		100
#1	Subcarrier	kHz	30
Propagation cha	spacing		TDLA30-5
			High XP 8 x 2
Antenna configu	ıratıon		(N1,N2) = (4,1)
Beamforming M			TBD
	CSI-RS resource		Aperiodic
	Туре		, (periodio
	Number of CSI-		4
	RS ports (X)		ED ODMO
	CDM Type		FD-CDM2
ZP CSI-RS	Density (ρ)		1
configuration	First subcarrier index in the PRB		
Configuration	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		4
	used for CSI-RS		(9,-)
	(l ₀ , l ₁)		
	CSI-RS	alat	40/4
	interval and offset	slot	10/1
	CSI-RS resource		Aperiodic
	Туре		Apendalc
	Number of CSI-		8
	RS ports (X)		
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
NZP CSI-RS	First subcarrier index in the PRB		
for CSI	used for CSI-RS		Row 8, (4,6)
acquisition	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(5.)
	used for CSI-RS		(5,-)
	(I_0, I_1)		
	CSI-RS	slot	10/1
	interval and offset	SIUL	10/1
	CSI-IM RE pattern		Patten 0
	CSI-IM Resource		
CCLIM	Mapping		(4,9)
CSI-IM configuration	(kcsi-im,lcsi-im)		(,-/
Comiguration	CCI IM time Confirm		
	CSI-IM timeConfig interval and offset	slot	10/1
ReportConfigTy	ReportConfigType		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForlChannelMeasur			
ements			Not configured
	timeRestrictionForInterferenceMeas		Not configured
urements			
cqi-FormatIndicator			Wideband
pmi-FormatIndio	2a10f	DD	Wideband
Sub-band Size	and	RB	[16]
csi-ReportingBa		slot	[1111111] 10/1
CSI-Report interval and offset		5101	10/1

aperiodicTriggeringOffset			0
	Codebook Type		typel-SinglePanel
Codebook	Codebook Mode		1
configuration	(CodebookConfig- N1,CodebookConfig-N2)		(4,1)
	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ			4
transmission			4
Measurement channel			R.PDSCH.2-8.2 TDD

Note 1: For random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity).

Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#[(n-6)], this reported PMI cannot be applied at the eNB downlink before

this reported PMI cannot be applied at the eNB downlink before slot#[(n+6)].

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

Table 6.3.2.2.2: Minimum requirement

Parameter	Test 1
γ	[1.5]

6.3.3 4RX requirements

6.3.3.1 FDD

6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.3.1.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Duplex Mode			FDD
	First PRB		0
DL BWP	Number of		52
configuration	contiguous PRB		52
#1	Subcarrier	kHz	15
	spacing	NI IZ	13
Propagation cha	annel		TDLA30-5
Antenna configu	ıration		High XP 4 x 4
			(N1,N2) = (2,1)
Beamforming M			TBD
	CSI-RS resource		Aperiodic
	Type		'
	Number of CSI-		4
	RS ports (X)		FD-CDM2
	CDM Type		1 1
ZP CSI-RS	Density (ρ) First subcarrier		l l
configuration	index in the PRB		
Cornigulation	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		(2.)
	used for CSI-RS		(9,-)
	(I_0, I_1)		
	CSI-RS	alat	E/4
	interval and offset	slot	5/1
	CSI-RS resource		Aperiodic
	Type		Aperiodic
	Number of CSI-		4
	RS ports (X)		·
	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		
	(k ₀ , k ₁) First OFDM		
	symbol in the PRB		
	used for CSI-RS		(13,-)
	(I_0, I_1)		
	CSI-RS		
	interval and offset	slot	5/1
	CSI-IM RE pattern		Patten 0
	CSI-IM Resource		
	Mapping		(4.0)
CSI-IM	(kcsi-im,lcsi-im)		(4,9)
configuration			
	CSI-IM timeConfig	slot	5/1
	interval and offset	ગાળા	
ReportConfigTy	pe		Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure			Not configured
ments			3
timeRestrictionForInterferenceMeas			Not configured
urements			
cqi-FormatIndicator			Wideband Wideband
pmi-FormatIndicator		RB	
	Sub-band Size		[8]
csi-ReportingBand CSI-Report interval and offset		slot	[1111111] 5/1
aperiodicTrigge		SIUL	0
apenduic myge	Codebook Type		typel-SinglePanel
	Codebook Type		typer-omgleranei

Codeboo	k	Codebook Mode		1
configura	tion	(CodebookConfig-		
		N1,CodebookConf		(2,1)
		ig-N2)		
		CodebookSubset		1111111
		Restriction		'''''
		RI Restriction		0000001
Physical	Physical channel for CSI report			PUSCH
CQI/RI/P	CQI/RI/PMI delay		ms	6
Maximum number of HARQ			4	
transmission			4	
Measurement channel			R.PDSCH.1-6.1 FDD	
Note 1:	Note 1: For random precoder select		ction, the p	recoder shall be updated in each
	slot (1 ms granularity).		
Note 2:	` •			k reporting instance at slot#n
based on PMI estimation at a downlink slot not later than slo			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#	slot#[(n+3)].		
Note 3: Randomization of the principle beam direction shall be used			direction shall be used as	
	specified in TBD.			

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
Duplex Mode			FDD
	First PRB		0
DL BWP	Number of		52
configuration	contiguous PRB		52
#1	Subcarrier	kHz	15
	spacing	KI IZ	
Propagation cha	annel		TDLA30-5
Antenna configu	uration		High XP 8 x 4
			(N1,N2) = (4,1)
Beamforming M			TBD
	CSI-RS resource		Aperiodic
	Type		·
	Number of CSI-		4
	RS ports (X)		FD-CDM2
	CDM Type		1 1
ZP CSI-RS	Density (ρ) First subcarrier		l l
configuration	index in the PRB		
Comigaration	used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁)		
	First OFDM		
	symbol in the PRB		
	used for CSI-RS		(9,-)
	(I_0, I_1)		
	CSI-RS		-/4
	interval and offset	slot	5/1
	CSI-RS resource		Aidi
	Туре		Aperiodic
	Number of CSI-		8
	RS ports (X)		
	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		110W 0, (4,0)
acquiottion	(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		Patten 0
	CSI-IM Resource		rallen 0
	Mapping		
CSI-IM	(kcsi-im,lcsi-im)		(4,9)
configuration	(NOSI-IIVI, IOSI-IIVI)		
	CSI-IM timeConfig		
	interval and offset	slot	5/1
ReportConfigTy			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasure			Not configured
ments			Not configured
timeRestrictionForInterferenceMeas			Not configured
urements			
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	[8]
csi-ReportingBand			[111111]
CSI-Report interval and offset		slot	5/1
aperiodicTrigge			0
	Codebook Type		typel-SinglePanel

Codebook	Codebook Mode		1
configuration	(CodebookConfig-		
	N1,CodebookConf		(4,1)
	ig-N2)		
	CodebookSubset		0x FFFF
	Restriction		0.21111
	RI Restriction		0000010
Physical cha	nnel for CSI report		PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ			4
transmission			4
Measurement channel			R.PDSCH.1-6.2 FDD
Note 1: For random precoder select		ction, the p	recoder shall be updated in each
sl	slot (1 ms granularity).		
Note 2: If	Note 2: If the UE reports in an available uplink reporting instance at slot#n		
ba	based on PMI estimation at a downlink slot not later than slot#[(n-4)],		
th	this reported PMI cannot be applied at the eNB downlink before		
sl	slot#[(n+4)].		
Note 3: R	Note 3: Randomization of the principle beam direction shall be used as		
sp	ecified in TBD.		

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 TBD, the minimum requirements are specified in Table 6.3.3.2.1-2.

Table 6.3.3.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Duplex Mode			TDD
TDD DL-UL configuration			FR1.30-1 as specified in Annex A
	First PRB		0
DL BWP configuration	Number of contiguous PRB		106
#1	Subcarrier spacing	kHz	30
Propagation cha	annel		TDLA30-5
Antenna configu			High XP 4 x 4 (N1,N2) = (2,1)
Beamforming M			TBD
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
ZP CSI-RS configuration	First subcarrier index in the PRB used for CSI-RS		Row 5, (4,-)
	(k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS		(9,-)
	(I ₀ , I ₁) CSI-RS interval and offset	slot	10/1
	CSI-RS resource Type		Aperiodic
	Number of CSI- RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 4, (0,-)
	First OFDM symbol in the PRB used for CSI-RS (lo, l1)		(13,-)
	CSI-RS interval and offset		10/1
	CSI-IM RE pattern		Patten 0
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)
	CSI-IM timeConfig interval and offset	slot	10/1
ReportConfigType			Aperiodic
CQI-table CQI-table			Table 1
reportQuantity timeRestrictionForChannelMeasure			cri-RI-PMI-CQI Not configured
timeRestrictionF	ments timeRestrictionForInterferenceMeas		Not configured
	urements		-
cqi-FormatIndicator			Wideband Wideband
pmi-FormatIndicator Sub-band Size		RB	vvideband [16]
	csi-ReportingBand		[111111]
CSI-Report interval and offset		slot	10/1

aperiodicTriggeringOffset			0
	Codebook Type		typel-SinglePanel
Codebook	Codebook Mode		1
configuration	(CodebookConfig- N1,CodebookConfig-N2)		(2,1)
	CodebookSubset Restriction		11111111
	RI Restriction		0000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.1 TDD

Note 1: For random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity).

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

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

Table 6.3.3.2.1-2: Minimum requirement

Parameter	Test 1	
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 TBD, the minimum requirements are specified in Table 6.3.3.2.2-2.

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

Bandwidth	Parameter		Unit	Test 1
TDD DL-UL configurations	Bandwidth		MHz	40
First PRB	Duplex Mode			
DL BWP configuration	TDD DL-UL con			I
configuration #1 contiguous PRB 106 #1 Subcarrier spacing kHz 30 Propagation channel TDLA30-5 High XP 8 x 4 (N1,N2) = (4,1) Antenna configuration CSI-RS resource Type Aperiodic Local RS ports (X) Aperiodic Aperiodic Local RS ports (X) 4 RS ports (X) 4 CDM Type Density (p) 1 1 Local RS ports (X) Density (p) 1 1 Local RS ports (X) RS ports (X) RS ports (X) 4 RS ports (X) 8				0
Propagation channel	configuration	contiguous PRB		106
Antenna configuration	#1 		kHz	30
Beamforming Model	Propagation cha	annel		
CSI-RS resource Type	Antenna configu	ıration		
Type	Beamforming M			TBD
RS ports (X)		Туре		Aperiodic
CDM Type				4
First subcarrier index in the PRB used for CSI-RS (lo, l₁)				FD-CDM2
configuration index in the PRB used for CSI-RS (k ₀ , k ₁) Row 5, (4,-) Name of the properties of time Restriction For Cnal report Quantity index in the PRB used for CSI-RS (k ₀ , k ₁) (9,-) NZP CSI-RS (b, l, l) CSI-RS resource Type Aperiodic NZP CSI-RS for CSI acquisition RS ports (X) 8 NZP CSI-RS for CSI acquisition RS ports (X) 1 NZP CSI-RS for CSI acquisition RS ports (X) Row 8, (4,6) NZP CSI-RS for CSI acquisition Row 8, (4,6) Row 8, (4,6) NZP CSI-RS for CSI acquisition Row 8, (4,6) Row 8, (4,6) NZP CSI-RS for CSI acquisition Row 8, (4,6) Row 8, (4,6) NZP CSI-RS for CSI acquisition Row 8, (4,6) Row 8, (4,6) NZP CSI-RS for CSI acquisition Row 8, (4,6) Row 8, (4,6) NZP CSI-RS for CSI acquisition Row 8, (4,6) Row 8, (4,6) NZP CSI-RS for CSI acquisition Row 8, (4,6) Row 8, (4,6) NZP CSI-RS for CSI acquisition Row 8, (4,6) Row 8, (4,6) Name of CSI-RS (ko, k1) Row 8, (4,6) Row 8, (4,6) Name of CSI-RS (ko, k1) Row 8, (1
First OFDM symbol in the PRB used for CSI-RS (lo, l₁) CSI-RS interval and offset Slot 10/1		index in the PRB used for CSI-RS		Row 5, (4,-)
CSI-RS interval and offset slot 10/1		First OFDM symbol in the PRB used for CSI-RS		(9,-)
CSI-RS resource Type Number of CSI- RS ports (X) CDM Type Density (p) Density (p) Tirst subcarrier index in the PRB used for CSI-RS (ko, k1) First OFDM symbol in the PRB used for CSI-RS (lo, l1) CSI-RS interval and offset CSI-IM RE pattern CSI-IM Resource Mapping (kcsI-IM, IcSI-IM) CSI-IM timeConfig interval and offset Table 1 ReportConfigType CSI-IM reportQuantity TimeRestrictionForChannelMeasur ements TimeRestrictionForChannelMeasur ements TimeRestrictionForChannelMeasur ements TimeRestrictionForInterferenceMeas urements TimeRestrictionForInterferenceMeas urements Cgi-FormatIndicator Wideband Dis-FornatIndicator Wideband Sub-band Size RB [16] CSI-RS Row 8, (4,6) Row 8, (4,6) Row 8, (4,6) Slot TimeRestriction To/l To/l To/l Tori-RI-PMI-CQI TimeRestrictionForChannelMeasur Wideband Wideband Sub-band Size RB [16] Table 1 Tori-RI-PMI-CQI TimeRestrictionForInterferenceMeas Usi-band Size RB [16] TimeRestrictionForChannelMeasur Wideband TimeRestrictionBand TimeRestrictionForUsion Wideband TimeRestrictionBand TimeRestrictionForUsion Wideband TimeRestrictionForInterferenceMeas Usi-band Size RB [16]		CSI-RS	slot	10/1
Number of CSI-RS ports (X) CDM Type Density (p) First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS (l ₀ , l ₁) CSI-RS interval and offset CSI-IM RE pattern CSI-IM Resource Mapping (kcsi-IM, lcsi-IM) COSI-IM timeConfig interval and offset ReportConfigType CSI-IM timeConfig interval and offset CQI-table ReportQuantity timeRestrictionForChannnelMeasur ements timeRestrictionForInterferenceMeas urements cqi-FormatIndicator Sub-band Size RB [16] CSD-M4 (FD2, TD2) Row 8, (4,6) 10 (5,-) (5,-) (5,-) (4,9) (4,9) CSI-IM timeConfig interval and offset Table 1 reportQuantity timeRestrictionForChannnelMeasur ements Not configured Wideband Mideband Sub-band Size RB [16] csi-ReportingBand		CSI-RS resource		Aperiodic
NZP CSI-RS for CSI acquisition First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS (l ₀ , l ₁)		Number of CSI-		8
NZP CSI-RS for CSI acquisition First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS (l ₀ , l ₁) CSI-RS interval and offset CSI-IM RE pattern CSI-IM Resource Mapping (k ₀ SI-IM, l ₀ SI-IM) (k ₀ SI-IM) (k ₀ SI-IM, l ₀ SI-IM) (k ₀ SI-IM, l ₀ SI-IM) (k ₀ SI-IM) (k ₀ SI-IM, l ₀ SI-IM) (k ₀ SI-IM, l ₀ SI-IM) (k ₀ SI				CDM4 (FD2, TD2)
for CSI-RS for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS (l ₀ , l ₁) CSI-RS interval and offset CSI-IM Resource Mapping (Kcsi-iii, lcsi-iii) CSI-IM timeConfig interval and offset CQI-table ReportConfigType CQI-table ReportQuantity Table 1 reportQuantity timeRestrictionForChannnelMeasur ements timeRestrictionForInterferenceMeas urements cqi-FormatIndicator Sub-band Size Report(Interpress of the pressure o				· .
First OFDM symbol in the PRB used for CSI-RS (lo, l₁) CSI-RS interval and offset CSI-IM RE pattern CSI-IM Resource Mapping (kcsI-IM, lcsI-IM) CSI-IM timeConfig interval and offset CSI-IM timeConfig interval and offset CSI-IM timeConfig interval and offset ReportConfigType CQI-table Table 1 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannnelMeasur ements timeRestrictionForInterferenceMeas urements cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB [16] csi-ReportingBand [11111111]	for CSI	index in the PRB used for CSI-RS		Row 8, (4,6)
interval and offset CSI-IM RE pattern CSI-IM Resource Mapping (kcsi-iM,lcsi-iM) CSI-IM timeConfig interval and offset ReportConfigType CQI-table reportQuantity timeRestrictionForChannnelMeasur ements timeRestrictionForInterferenceMeas urements cqi-FormatIndicator Sub-band Size CSI-IM timeConfig slot 10/1 Aperiodic Table 1 Table 1 Teri-RI-PMI-CQI Not configured Not configured Wideband Wideband Sub-band Size RB [16] Csi-ReportingBand [1111111]		First OFDM symbol in the PRB used for CSI-RS		(5,-)
CSI-IM dapping (kcsi-iM, lcsi-iM) (4,9) CSI-IM timeConfig interval and offset slot 10/1 ReportConfigType Aperiodic CQI-table Table 1 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannnelMeasur ements Not configured timeRestrictionForInterferenceMeas urements Not configured cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB [16] csi-ReportingBand [1111111]			slot	10/1
CSI-IM configuration CSI-IM timeConfig interval and offset Slot 10/1				Patten 0
CSI-IM timeConfig interval and offset slot 10/1 ReportConfigType Aperiodic CQI-table Table 1 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannnelMeasur ements timeRestrictionForInterferenceMeas urements Cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB [16] csi-ReportingBand [1111111]		Mapping		(4,9)
CQI-table Table 1 reportQuantity cri-RI-PMI-CQI timeRestrictionForChannnelMeasur ements Not configured timeRestrictionForInterferenceMeas urements Not configured verification Wideband pmi-FormatIndicator Wideband Sub-band Size RB [16] csi-ReportingBand [1111111]	-		slot	10/1
reportQuantity cri-RI-PMI-CQI timeRestrictionForChannnelMeasur ements Not configured timeRestrictionForInterferenceMeas urements Not configured urements Wideband pmi-FormatIndicator Wideband Sub-band Size RB [16] csi-ReportingBand [1111111]				
timeRestrictionForChannnelMeasur ements timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-ReportingBand Not configured Not configured Wideband Wideband Figure 1 Wideband Wideband Wideband Wideband The configured Wideband Wideband Wideband The configured Wideband Wideband Wideband The configured The configured The configured Wideband The configured				
timeRestrictionForInterferenceMeas urements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-ReportingBand timeRestrictionForInterferenceMeas Not configured Wideband Wideband Wideband The properties of the properties	timeRestrictionF	ForChannnelMeasur		
cqi-FormatIndicator Wideband pmi-FormatIndicator Wideband Sub-band Size RB [16] csi-ReportingBand [1111111]	timeRestrictionForInterferenceMeas			-
pmi-FormatIndicatorWidebandSub-band SizeRB[16]csi-ReportingBand[1111111]				-
Sub-band Size RB [16] csi-ReportingBand [111111]				
csi-ReportingBand [1111111]		oaiUl	RR	
CSI-Report interval and offset slot 10/1		ind		
	CSI-Report inte	rval and offset	slot	

aperiodicTrigge	aperiodicTriggeringOffset		0
	Codebook Type		typel-SinglePanel
Codebook	Codebook Mode		1
configuration	(CodebookConfig- N1,CodebookConfig-N2)		
	CodebookSubset Restriction		0x FFFF
	RI Restriction		0000010
Physical channe	el for CSI report		PUSCH
CQI/RI/PMI dela	CQI/RI/PMI delay		6.5
Maximum number of HARQ			4
transmission			4
Measurement c	hannel		R.PDSCH.2-8.2 TDD

Note 1: For random precoder selection, the precoder shall be updated in each

slot (0.5 ms granularity).

Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#[(n-6)], this reported PMI cannot be applied at the eNB downlink before

slot#[(n+6)].

Note 3: Randomization of the principle beam direction shall be used as

specified in TBD.

Table 6.3.3.2.2-2: Minimum requirement

Parameter	Test 1	
γ	[1.5]	

6.4 Reporting of Rank Indicator (RI)

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

6.4.1 1RX requirements

(Void)

6.4.2 2RX requirements

6.4.2.1 FDD

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

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

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

Table 6.4.2.1-1: RI Test (FDD)

Bandwidth	Parameter		Unit	Test 1	Test 2	Test 3	
DL BWP Configuration #1 Enter PRB D.				MHz	10	10	
DL BWP configuration #1 Number of contiguous PRB Subcarrier spacing kHz 15 15 15 15 15 15 15 1	Duplex Mode				FDD	FDD	FDD
PRB Subarrier spacing Subarrier spacin					0	0	0
SNR	configuration #1 PRB			52	52	52	
Propagation channel	-		Subcarrier spacing				
Beamlorming Model				dB			
Beamforming Model							
CSI-RS resource Type	Antenna confi	igura	tion				
Number of CSI-RS ports (X)	Beamforming	Mod	el				
CDM Type		CSI	-RS resource Type		Periodic	Periodic	Periodic
Density (p) First subcarrier index in the PRB used for CSI-RS (kg, k1) First OFDM symbol in the PRB used for CSI-RS (kg, k1) First OFDM symbol in the PRB used for CSI-RS (kg, k1) CSI-RS periodicity and offset Slot S/1		Nur	mber of CSI-RS ports (X)				
Configuration Configurati	7D CSL-DS				FD-CDM2	FD-CDM2	FD-CDM2
PIRS used for CiSI+RS (ko, k s) Row 5, (4,-)					1	1	1
First OFDM symbol in the PRB (9,-) (9,-) (9,-) (9,-)	_				Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
Periodicity and offset					(9,-)	(9,-)	(9,-)
CSI-IM configuration CSI-IM timeConfig periodicity and offset CSI-IM timeRestrictionForChannelMeasurements CSI-IM timeRestrictionForChannelMeasurements CI-IM configured configured configured configured configured configuration CSI-Report periodicity and offset Restriction CSI-Report periodicity and offset Codebook Configuration CSI-Report periodicity and offset COdebook Config-N2) Codebook Config-N2) Codebook Config-N2) Codebook SubsetRestriction COdebook Config-N2) CODE				slot	5/1	5/1	5/1
NZP CSI-RS for CSI		CSI	-RS resource Type		Periodic	Periodic	Periodic
NZP CSI-RS for CSI acquisition First subcarrier index in the PRB used for CSI-RS (ko, kr) First OFDM symbol in the PRB used for CSI-RS (ko, kr) NZP CSI-RS-timeConflig periodicity and offset Slot S/1 S/					2	2	
RS for CSI acquisition		CD	М Туре		FD-CDM2	FD-CDM2	FD-CDM2
Acquisition		Der	nsity (ρ)		1	1	1
First OFDM symbol in the PRB used for CSI-RS (lo, l1)					Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
NZP CSI-RS-timeConfig periodicity and offset Slot S/1		Firs	t OFDM symbol in the PRB		(13,-)	(13,-)	(13,-)
CSI-IM CSI-IM Resource Mapping (CSI-IM Resource Mapping (KcsI-IM, IcSI-IM) CSI-IM Resource Mapping (KcsI-IM, IcSI-IM) (4,9)		NZI	CSI-RS-timeConfig	slot	5/1	5/1	5/1
CSI-IM CSI-IM Resource Mapping (KcSI-IM, IcSI-IM) (4,9)					Pattern 0	Pattern 0	Pattern 0
CSI-IM timeConfig periodicity and offset ReportConfigType CQI-table reportQuantity Cri-RI-PMI-CQI timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements cqi-FormatIndicator pmi-FormatIndicator Sub-band Size CSI-Report periodic CSI-Report periodic COQI TOCQI Tocqi	configuratio	CSI	-IM Resource Mapping		(4,9)	(4,9)	(4,9)
ReportConfigType Periodic CQI-table Periodic Table 2 Cri-RI-PMI-CQI CCI-RI-PMI-CQI COI+RI-PMI-CQI COI+RI-PMI-CQI COIHA-PMI-CQI COIHA-PMI-CQI COIHA-PMI-CQI Table 2 cri-RI-PMI-CQI COIHA-PMI-CQI not configured configured configured configured Configured Wideband Wideband Wideband Wideband Wideband Wideband Wideband Sigle Pane [8] E8 [8] [8] Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">				slot	5/1	5/1	5/1
CQI-table Table 2 Cri-RI-PMI-CQI Cri-RI-PMI-CQI CORI-PMI-CQI CORI-PMI-CQI CORI-PMI-CQI CORI-PMI-CQI CORI-PMI-CQI CORI-PMI-CQI CORI-PMI-CQI not configured Wideband Sigle Pane [8] [8] Colspan="2">Codebook Confige-N2) SinglePanel SinglePanel SinglePanel SinglePanel SinglePanel <	ReportConfig		edicity and eneet		Periodic	Periodic	Periodic
reportQuantity cri-RI-PMI-CQI cri-RI-PMI-CQI cql not configured configured timeRestrictionForInterferenceMeasurements not configured cqi-FormatIndicator Wideband Wideband Wideband Sub-band Size RB [8] [8] [8] [8] csi-ReportingBand [1111111] [1111111] [1111111] CSI-Report periodicity and offset slot 5/1 5/1 5/1 5/1 5/1 5/1 5/1 5/1 5/1 5/1		. , po					
timeRestrictionForChannelMeasurements timeRestrictionForInterferenceMeasurements not configured timeRestrictionForInterferenceMeasurements not configured not configured conf		/				cri-RI-PMI-	cri-RI-PMI-
timeRestrictionForInterferenceMeasurements not configured cqi-FormatIndicator pmi-FormatIndicator Sub-band Size csi-ReportingBand CSI-Report periodicity and offset Codebook configured Wideband Wid	timeRestrictio	nFor	ChannelMeasurements		not configured	not	not
cqi-FormatIndicator Wideband Wideband Wideband pmi-FormatIndicator RB [8] [8] [8] Sub-band Size RB [8] [8] [8] csi-ReportingBand [1111111] [1111111] [1111111] CSI-Report periodicity and offset slot 5/1 5/1 5/1 Codebook Type typel-SinglePanel SinglePanel SinglePanel SinglePanel Codebook Mode 1 1 1 1 (CodebookConfig-N1) N/A N/A N/A N/A N1,CodebookConfig-N2) [010000 for fixed rank 2, 010011 for fixed rank 1, 010011 for following rank] [000011 for following rank] [010001 for following rank] [01000 for following rank]	timeRestrictio	nFor	InterferenceMeasurements		not configured	not	not
pmi-FormatIndicator Wideband Wideband Wideband Sub-band Size RB [8] [8] [8] csi-ReportingBand [1111111] [1111111] [1111111] [1111111] CSI-Report periodicity and offset slot 5/1 5/1 5/1 5/1 Codebook Type typel- SinglePanel typel- SinglePanel SinglePanel SinglePanel SinglePanel Codebook Mode 1 1 1 1 1 (CodebookConfig- N1, CodebookConfig-N2) N/A N/A N/A N/A CodebookSubsetRestriction [010000 for fixed rank 2, 010011 for fixed rank 1, 010011 for following rank] [000011 for fixed rank 1, 010011 for following rank] [010011 for following	cgi-FormatIng	licato	r		Wideband		
Sub-band Size							
Csi-ReportingBand [1111111] [111111] [111111] [111111] CSI-Report periodicity and offset slot 5/1 5/1 5/1 Codebook Codebook Type typel-SinglePanel typel-SinglePanel SinglePanel Codebook Mode 1 1 1 1 (CodebookConfig-N2) N/A N/A N/A N/A CodebookSubsetRestriction [010000 for fixed rank 2, 010011 for fixed rank 1, 010011 for following rank] [000011 for fixed rank 1, 010011 for following rank] [010001 for following rank] RI Restriction N/A N/A N/A Physical channel for CSI report PUCCH PUCCH PUCCH			-	RB			
CSI-Report periodicity and offset slot 5/1 5/1 5/1 Codebook Configuration Codebook Configuration Codebook Mode SinglePanel Codebook Mode SinglePanel Codebook Config-N2) 1					_		
Codebook Type Codebook Type Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) CodebookSubsetRestriction RI Restriction Codebook Type SinglePanel 1 1 1 1 1 1 1 1 1 1 1 0 N/A N/A N/A N/A N/A N/A I 000011 for fixed rank 1, 010011 for following rank] RI Restriction RI Restriction Codebook Type SinglePanel 1 1 1 1 0 1 0 N/A N/A N/A N/A N/A N/A N/A N/	CSI-Report pe	eriodi	city and offset	slot			
Codebook configuration Codebook Mode (CodebookConfig-N1, CodebookConfig-N1, CodebookConfig-N2) N/A PUCCH PUCCH PUCCH PUCCH PUCCH							
Configuration Codebook Mode (CodebookConfig- N1,CodebookConfig-N2) 1 1 1 CodebookConfig- N1,CodebookConfig-N2) N/A N/A N/A CodebookSubsetRestriction [010000 for fixed rank 2, 010011 for following rank] [000011 for fixed rank 1, 010011 for following rank] [010011 for following rank] RI Restriction N/A N/A N/A Physical channel for CSI report PUCCH PUCCH PUCCH	Codebook		21				
(CodebookConfig-N1, CodebookConfig-N2) N/A N/A N/A N/A CodebookSubsetRestriction [010000 for fixed rank 2, 010011 for following rank] [000011 for fixed rank 1, 010011 for following rank] [010011 for foll		Co	debook Mode			1	
CodebookSubsetRestriction [010000 for fixed rank 2, 010011 for following rank] RI Restriction [010000 for fixed rank 1, 010011 for following rank] RI Restriction N/A Physical channel for CSI report [000011 for fixed rank 1, 010011 for following rank] N/A PUCCH [000011 for fixed rank 1, 010011 for following rank] N/A PUCCH PUCCH PUCCH		(Co	odebookConfig-		N/A	N/A	N/A
RI Restriction Pucch Pucch Fixed rank 1, 010011 for following rank] Fixed rank 1, 010011 for following rank 1,					1040000 1	[000011 for	[000011 for
RI Restriction Pucch Puc							
RI Restriction Pucch Puc							
Physical channel for CSI report PUCCH PUCCH PUCCH					rollowing rank]		
Physical channel for CSI report PUCCH PUCCH PUCCH		RI	Restriction		N/A	N/A	N/A
	Physical char				PUCCH	PUCCH	PUCCH
				ms	8	8	

Maximum number of HARQ transmission	1	1	1
DI Configuration	Fixed RI = 2	Fixed RI = 1	Fixed RI = 1
RI Configuration	and follow RI	and follow RI	and follow RI

Table 6.4.2.1-2: Minimum requirement (FDD)

	Test 1	Test 2	Test 3
<i>y</i> 1	N/A	[1.05]	[0.9]
<i>γ</i> 2	[1.0]	N/A	N/A

6.4.2.2 TDD

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

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

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

Table 6.4.2.2-1: RI Test (TDD)

Danielo del del	F	arameter	Unit	Test 1	Test 2	Test 3
Bandwidth			MHz	40	40 TDD	40 TDD
Duplex Mode TDD Slot Cor		ation		TDD FR1.30-1	TDD FR1.30-1	TDD FR1.30-1
100 3101 001	iliguia	First PRB		0	0	0
DL BWP configuration	#1	Number of contiguous PRB		106	106	106
Configuration	# 1	Subcarrier spacing	kHz	30	30	30
SNR		Subsumer spacing	dB	[0]	[20]	[20]
Propagation of	chann	el		TDLA30-5	TDLA30-5	TDLA30-5
Antenna conf	igurat	ion		ULA Low 2x2	ULA Low 2x2	ULA High 2x2
Beamforming	Mode	el		As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
	CSI	-RS resource Type		Periodic	Periodic	Periodic
		nber of CSI-RS ports (X)		4	4	4
7D CCL DC		M Type		FD-CDM2	FD-CDM2	FD-CDM2
ZP CSI-RS configuratio		sity (ρ)		1	1	1
n		t subcarrier index in the 3 used for CSI-RS (k ₀ , k ₁)		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
	use	t OFDM symbol in the PRB d for CSI-RS (lo, l1)		(9,-)	(9,-)	(9,-)
	CSI	-RS odicity and offset	slot	10/1	10/1	10/1
		-RS resource Type		Periodic	Periodic	Periodic
		nber of CSI-RS ports (X)		2	2	2
		И Туре		FD-CDM2	FD-CDM2	FD-CDM2
NZP CSI-		ısity (ρ)		1	1	1
RS for CSI acquisition	PRE	t subcarrier index in the 3 used for CSI-RS (k ₀ , k ₁)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
		t OFDM symbol in the PRB d for CSI-RS (I ₀ , I ₁)		(13,-)	(13,-)	(13,-)
		CSI-RS-timeConfig odicity and offset	slot	10/1	10/1	10/1
	CSI	-IM RE pattern		Pattern 0	Pattern 0	Pattern 0
CSI-IM configuratio n		-IM Resource Mapping I-IM,IcsI-IM)		(4,9)	(4,9)	(4,9)
		-IM timeConfig odicity and offset	slot	10/1	10/1	10/1
ReportConfig				Periodic	Periodic	Periodic
CQI-table				Table 2	Table 2	Table 2
reportQuantit	у			cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestrictio	nFor(ChannelMeasurements		not configured	not configured	not configured
timeRestriction	nForl	nterferenceMeasurements		not configured	not configured	not configured
cqi-FormatInd				Wideband	Wideband	Wideband
pmi-FormatIn		or		Wideband	Wideband	Wideband
Sub-band Siz			RB	[16]	[16]	[16]
csi-Reporting				[1111111]	[1111111]	[1111111]
CSI-Report p		city and offset	slot	10/1	10/1	10/1
Codebook		debook Type		typel- SinglePanel	typel- SinglePanel	typel- SinglePanel
configuration		debook Mode		1	1	1
		odebookConfig- ,CodebookConfig-N2)		N/A	N/A	N/A
		debookSubsetRestriction		[010000 for	[000011 for	[000011 for
				[010000 for fixed rank 2,	fixed rank 1,	fixed rank 1,
				010011 for	010011 for	010011 for
				following rank]	following	following
	Di	Destriction			rank]	rank]
Dhysical share		Restriction		N/A PUCCH	N/A	N/A
Physical char	mei fo	л сы героп		PUCCH	PUCCH	PUCCH

CQI/RI/PMI delay	ms	9.5	9.5	9.5
Maximum number of HARQ transmission		1	1	1
RI Configuration		Fixed RI = 2	Fixed RI = 1	Fixed RI = 1
10 Configuration		and follow RI	and follow RI	and follow RI

Table 6.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
<i>γ</i> 1	N/A	[1.05]	[0.9]
γ2	[1.0]	N/A	N/A

6.4.3 4RX requirements

6.4.3.1 FDD

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

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

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

Table 6.4.3.1-1: RI Test (FDD)

	Parameter	Unit	Test 1	Test 2	Test 3	Test 4
Bandwidth		MHz	10	10	10	10
Duplex Mode			FDD	FDD	FDD	FDD
	First PRB		0	0	0	0
DL BWP configuration	Number of contiguous #1 PRB		52	52	52	52
	Subcarrier spacing	kHz	15	15	15	15
SNR		dB	TBD	[16]	[16]	TBD
Propagation of	channel		TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna conf	iguration		ULA Low 2x4	ULA Low 2x4	ULA High 2x4	ULA Low 4x4
Beamforming	Model		As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		4	4	4	4
7D CCL DC	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
	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		2	2	2	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
NZP CSI-	Density (ρ)		1	1	1	1
RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)	Row 4 (0,-)
	First OFDM symbol in the PRB used for CSI-RS (I ₀ , I ₁)		(13,-)	(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	5/1	5/1	5/1
	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0	Pattern 0
CSI-IM configuration	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)	(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	5/1	5/1	5/1	5/1
ReportConfig			Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantity	у		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			Wideband	Wideband	Wideband	Wideband
pmi-FormatIn			Wideband	Wideband	Wideband	Wideband
Sub-band Siz	е	RB	[8]	[8]	[8]	[8]
csi-Reporting	Band		[1111111]	[1111111]	[1111111]	[1111111]
CSI-Report p	eriodicity and offset	slot	5/1	5/1	5/1	5/1
Codobook	Codebook Type		typel-	typel-	typel-	typel-
Codebook configuration	Codebook Mode		SinglePanel 1	SinglePanel 1	SinglePanel	SinglePanel 1
Corniguration			1	1	1	1
	(CodebookConfig- N1,CodebookConfig-N2)		N/A	N/A	N/A	(2,1)
	CodebookSubsetRestriction		[010000 for fixed rank 2, 010011 for following rank]	[000011 for fixed rank 1, 010011 for following rank]	[000011 for fixed rank 1, 010011 for following rank]	11111111
	RI Restriction		N/A	N/A	N/A	00000010 for fixed Rank 2 and

					00001111 for follow RI
Physical channel for CSI report		PUCCH	PUCCH	PUCCH	PUCCH
CQI/RI/PMI delay	ms	8	8	8	8
Maximum number of HARQ transmission		1	1	1	1
RI Configuration		Fixed RI = 2	Fixed RI = 1	Fixed RI = 1	Fixed RI = 2
1 Configuration		and follow RI	and follow RI	and follow RI	and follow RI

Table 6.4.3.1-2: Minimum requirement (FDD)

	Test 1	Test 2	Test 3	Test 4
2/1	N/A	[1.05]	[0.9]	N/A
γ2	TBD	N/A	N/A	TBD

6.4.3.2 TDD

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

- a) The ratio of the throughput obtained when transmitting based on UE reported RI and that obtained when transmitting with fixed rank 1 shall be $\geq \gamma_1$;
- 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 TBD, the minimum requirements are specified in Table 6.4.3.2-2.

Table 6.4.3.2-1: RI Test (TDD)

D 1 : 10	Parameter	Unit	Test 1	Test 2	Test 3	Test 4
Bandwidth		MHz	40	40	40	40 TDD
Duplex Mode TDD Slot Cor	figuration		TDD FR1.30-1	TDD FR1.30-1	TDD FR1.30-1	TDD FR1.30-1
100 300 001	First PRB		0	0	0	0
DL BWP	Number of contiguous		106	106	106	106
configuration	#1 PRB Subcarrier spacing	kHz	30	30	30	30
SNR		dB	TBD	[16]	[16]	TBD
Propagation of	channel	4.5	TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna conf			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
Bearmonning			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 FD-CDM2	4 FD-CDM2	4 FD-CDM2	4 FD-CDM2
ZP CSI-RS	CDM Type Density (ρ)		1 1	1	1 1	1
configuratio	First subcarrier index in the			·	·	-
n	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	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,-)
acquisition	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 n	CSI-IM Resource Mapping (kcsi-im,lcsi-im)		(4,9)	(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	10/1	10/1	10/1	10/1
ReportConfig			Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantit	У		cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestriction	nForChannelMeasurements		not configured	not configured	not configured	not configured
timeRestriction	nForInterferenceMeasurements		not configured	not configured	not configured	not configured
cqi-FormatInd	licator	<u> </u>	Wideband	Wideband	Wideband	Wideband
pmi-FormatIn			Wideband	Wideband	Wideband	Wideband
Sub-band Siz		RB	[16]	[16]	[16]	[16]
csi-Reporting			[1111111]	[1111111]	[1111111]	[1111111]
CSI-Report p	eriodicity and offset	slot	10/1	10/1	10/1	10/1
Codebook	Codebook Type		typel- SinglePanel	typel- SinglePanel	typel- SinglePanel	typel- SinglePanel
configuration	Codebook Mode		1	1	1	1
	(CodebookConfig- N1,CodebookConfig-N2)		N/A	N/A	N/A	(2,1)
	CodebookSubsetRestriction		[010000 for fixed rank 2, 010011 for following rank]	[000011 for fixed rank 1, 010011 for following rank]	[000011 for fixed rank 1, 010011 for following rank]	11111111
	RI Restriction		N/A	N/A	N/A	00000010 for fixed Rank 2

					and 00001111 for follow RI
Physical channel for CSI report		PUCCH	PUCCH	PUCCH	PUCCH
CQI/RI/PMI delay	ms	9.5	9.5	9.5	9.5
Maximum number of HARQ transmission		1	1	1	1
RI Configuration		Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 2 and follow RI

Table 6.4.3.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3	Test 4
<i>γ</i> 1	N/A	[1.05]	[0.9]	N/A
<i>γ</i> 2	TBD	N/A	N/A	TBD

7 Demodulation performance requirements (Radiated requirements)

7.1 General

7.1.1 Applicability of requirements

7.1.1.1 General

The minimum performance requirements are applicable to the FR2 operating bands defined in TS 38.101-2 [7] with 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 capabilities

For UE which supports optional UE capabilities 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 capabilities

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

7.2 PDSCH demodulation requirements

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

Table 7.2-1: Common Test Parameters

	Parameter	Unit	Value
PDSCH transmission	on scheme		Transmission scheme
EPRE ratio of PTRS	S to PDSCH	dB	0
DL BWP	Cyclic prefix		Normal
configuration #1	Physical Cell ID		0
Common coming	SSB position in burst		1
Common serving cell parameters	SSB periodicity	ms	20
Con parameters	First DMRS position for Type A PDSCH		2
	mapping Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0
PDCCH	Number of PDCCH candidates and		•
configuration	aggregation levels		1/[8]
	DCI format		1_1
Cross carrier sched	TCI state		TCI state #1 Not configured
Closs carrier scree	First subcarrier index in the PRB used for		_
	CSI-RS (<i>k</i> ₀)		0
	First OFDM symbol in the PRB used for CSI-RS (<i>I</i> ₀)		CSI-RS resource 1: 6 CSI-RS resource 2: 10 CSI-RS resource 3: 6 CSI-RS resource 4: 10
	Number of CSI-RS ports (X)		1
CSI-RS for	CDM Type		No CDM
tracking	Density (p) CSI-RS periodicity	Slots	3 160
lacking	OCI NO periodicity	01013	80 for CSI-RS
	CSI-RS offset	Slots	resource 1 and 2
	Ser ite sheet	0.0.0	81 for CSI-RS resource 3 and 4
			Start PRB 0
	Frequency Occupation		Number of PRB =
			BWP size
	QCL info First subcarrier index in the PRB used for		TCI state #0
	CSI-RS (k_0)		0
	First OFDM symbol in the PRB used for		12
	CSI-RS (I ₀) Number of CSI-RS ports (X)		2
NZP CSI-RS for	CDM Type		FD-CDM2
CSI acquisition	Density (p)		1
	CSI-RS periodicity CSI-RS offset	Slots	160
	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>l</i> ₀)		12
	Number of CSI-RS ports (X)		4
ZP CSI-RS for	CDM Type		FD-CDM2
CSI acquisition	Density (p)	Slots	1
	CSI-RS periodicity CSI-RS offset	Sidis	160
			Start PRB 0
	Frequency Occupation		Number of PRB = BWP size
	First subcarrier index in the PRB used for CSI-RS		k ₀ =0 for CSI-RS resource 1,2
CSI-RS for beam	First OFDM symbol in the PRB used for CSI-RS		I ₀ = 8 for CSI-RS resource 1 I ₀ = 9 for CSI-RS
refinement	Number of CSI-RS ports (X)		resource 2 1 for CSI-RS resource 1,2
	CDM Type		'No CDM' for CSI-RS resource 1,2
	Density (ρ)		3 for CSI-RS resource
	* " *		

				1,2
				120 kHz SCS: 160 for
	CSI-RS perio	odicity	Slots	CSI-RS resource 1,2
	CSI-RS offse	et	Slots	0 for CSI-RS resource 1,2
PDSCH DMRS configuration	Antenna por	ts indexes		{1000} for Rank 1 tests {1000, 1001} for Rank 2 tests
Configuration Number of PDSCH DMRS CE without data Type 1 QCL information TCI state #0 Type 2 QCL information Type 1 QCL Type Type 1 QCL Type Type 1 QCL Type Type 2 QCL information QCL Type Time density (<i>L_{PT-RS}</i>) Maximum number of code block groups for ACK/N/feedback Maximum number of HARQ transmission HARQ ACK/NACK bundling Redundancy version coding sequence Precoding configuration	DSCH DMRS CDM group(s)		1	
	Type 1	SSB index		SSB #0
		QCL Type		Type C
TCI state #0	Type 2	SSB index		SSB #0
	QCL	QCL Type		Type D
	QCL	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
TCI atata #1		QCL Type		Type A
TCI state #1	QCL	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
				2
				1
	of code block g	roups for ACK/NACK		1
Maximum number of	of HARQ transi	mission		4
HARQ ACK/NACK	bundling			Multiplexed
<u> </u>				{0,2,3,1}
Precoding configura	ation			SP Type I, Random per slot with PRB bundling granularity
Symbols for all unu	sed Res			OCNG in Annex A.5
		ne TCI state for the PDSCH	is identica	al to the TCI state

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

applied for the PDCCH transmission.

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	[1-2]
combining 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 7.2.2.2.1-2: Test Parameters

	Parameter	Unit	Value
Duplex mode			TDD
Active DL BWP index			1
	First PRB		0
	THOUT IND		Maximum
			transmission
			bandwidth
			configuration as
DL BWP configuration			specified in
#1	Number of contiguous PRB		subclause 5.3.2 of
			TS 38.101-2 [7] for
			tested channel
			bandwidth and
			subcarrier spacing
550011 # #	N	555	As defined in Table
PDCCH configuration	Number of PRBs in CORESET	PRBs	7.2-2
	Mapping type		Type A
	kO		0
	Starting symbol (S)		1
	Length (L)		As defined in Annex
PDSCH configuration			A.1.3
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		WB for 1-1,
			2 for other tests
	Resource allocation type		Type 1
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping		N/A
	interleaver bundle size		-
	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		Single-symbol DM-
PDSCH DMRS	Longar		RS
configuration			{1000} for Rank1
garanon.	Antenna ports indexes		{1000,1001} for
			Rank2
	Number of PDSCH DMRS CDM		1
	group(s) without data		
			8 for Test 1-1, 1-3,
			2-4
Number of HARQ Proce	esses		10 for Test 2-1, 2-3,
			2-5, 2-6, 3-1 16 for Test 1-2
K1 value			TBD for Test 2-2 As defined in Annex
	og indicator)		
(PDSCH-to-HARQ-timir	ig-indicator)		A.1.3

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

Test num.	Reference channel	Bandwidth/Subcarrier spacing	Modulation and code rate	TDD UL- DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference Fraction of maximum throughput	SNR _{BB} (dB)
						Comiguration	(%)	(4.2)
1-1	R.PDSCH. 5-1.1_TDD	100MHz/120kHz	QPSK, 0.30	FR2.120- 1	TDLC60-300	2x2 ULA Low	70	[-0.4]
1-2	R.PDSCH. 5-2.1_TDD	100MHz/120kHz	16QAM, 0.48	FR2.120- 1	TDLA30-300	2x2 ULA Low	30	[1.7]
1-3	R.PDSCH. 5-3.1_TDD	100MHz/120kHz	64QAM, 0.45	FR2.120- 1	TDLA30-300	2x2 XPL Med- A	70	[12.4]

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

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

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

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

7.3 PDCCH demodulation requirements

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

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

Table 7.3-1: Common test Parameters

	Parameter		Unit	Value
DL BWP configuration #1	Cyclic prefix			Normal
Common	Physical Cell I	D		0
serving cell	SSB position i			1
parameters	SSB periodicit		ms	20
PDCCH	Slots for PDC0			Each slot
configuration		CCH candidates		1
ooringaration	TCI state			TCI state #1
	First subcarrie used for CSI-F	r index in the PRB RS (k0)		0
	First OFDM sy used for CSI-F	rmbol in the PRB RS (I0)		CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4: 8
	Number of CS	I-RS ports (X)		1
	CDM Type			No CDM
CSI-RS for	Density (ρ)			3
tracking	CSI-RS period	licity	Slots	160
	CSI-RS offset		Slots	80 for CSI-RS 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
Precoding configu	uration			SP Type I, Random per slot with REG 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
	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
Symbols for all ur	nused REs			OCNG in Annex A.5

7.3.1 1RX requirements

(Void)

7.3.2 2RX requirements

7.3.2.1 FDD

(Void)

7.3.2.2 TDD

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

Table 7.3.2.2-1: Test Parameters

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

7.3.2.2.1 1 Tx Antenna performances

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

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

Test		CORES	CORESET	Aggragation	Reference	Propagation	Antenna configuration		erence alue
num ber	Bandwidth	ET RB	duration	Aggregation level	Channel	Propagation Condition	and correlation Matrix	Pm- dsg (%)	SNR _{BB} (dB)
1-1	100 MHz	60	1	2 CCE	R.PDCCH. 5-1.1 TDD	TDLA30-75	1x2 Low	1	[6.0]
1-2	100 MHz	60	1	4 CCE	R.PDCCH. 5-1.2 TDD	TDLA30-300	1x2 Low	1	[2.6]

7.3.2.2.2 2 Tx Antenna performances

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

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

Test		CORESE	CORESET	Aggragation	Reference	Propagation	Antenna configuration	_	erence alue
num ber	Bandwidth	TRB	duration	Aggregation level	Channel	Propagation Condition	and correlation Matrix	Pm- dsg (%)	SNR _{BB} (dB)
2-1	100 MHz	60	1	8 CCE	R.PDCCH. 5-1.3 TDD	TDLA30-75	2x2 Low	1	[-0.4]
2-2	100 MHz	60	2	16 CCE	R.PDCCH. 5-2.1 TDD	TDLA30-75	2x2 Low	1	[-3.4]

7.4 PBCH demodulation requirements

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

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

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

7.4.1 1RX requirements

(Void)

7.4.2 2RX requirements

7.4.2.1 FDD

(Void)

7.4.2.2 TDD

Table 7.4.2.2-1: Test parameters for PBCH

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

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

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

Test	Bandwidth	Reference	Propagation	Antenna configuration and	Referen	ce value
number		channel	condition	correlation matrix	Pm- bch (%)	SNR _{BB} (dB)
1	100 MHz	R.PBCH.5	[TDLA30-300]	1 x 2 Low	1	[-6.1]
2	100 MHz	R.PBCH.6	[TDLA30-75]	1 x 2 Low	1	TBD

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

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

7.5 Sustained downlink data rate provided by lower layers

<TBA>

8 CSI reporting requirements (Radiated requirements)

8.1 General

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

8.1.1 Applicability of requirements

<TBA>

8.1.2 Common test parameters

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

Table 8.1.2-1: Test parameters for CSI test cases

	Parameter	Unit	Value
DD00114		O i iii	Transmission
PDSCH transmiss	sion scheme		scheme 1
Duplex Mode			TDD
EPRE ratio of PT		dB	[0]
Active DL BWP in	ndex		1
Cyclic prefix			Normal
Common	Physical Cell ID		0
serving cell	SSB position in burst		First SSB in Slot #0
parameters	SSB periodicity	ms	20
	Slots for PDCCH monitoring		Each slot
DDOOLI	Symbols with PDCCH		0,1
PDCCH configuration	Number of PDCCH candidates and aggregation levels		1/[8]
Comiguration	DCI format		1 1
	TCI state		TCI state #1
Cross carrier sch			Not configured
Oroco carrier con	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
DDCCH	PDSCH aggregation factor		1
PDSCH configuration	PRB bundling type		Static
Configuration	PRB bundling size		2
	Resource allocation type		0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver		N/A
	bundle size		
	DMRS Type		Type 1
	Number of additional DMRS		1 {1000} for Rank1
	DMRS ports indexes		{1000} for Rank1 {1000,1001} for
PDSCH DMRS	Diving ports indexes		Rank2
configuration			Single-symbol DM-
	Length		RS
	Number of PDSCH DMRS CDM		2
	group(s) without data		
PTRS	Frequency density (KpT-RS)		2
configuration	Time density (L _{PT-RS})		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		[0]
	First OFDM symbol in the PRB		
	used for CSI-RS (Io)		[4]
	Number of CSI-RS ports (X)		1
	CDM Type		No CDM
	Density (p)		3
CSI-RS for	CSI-RS periodicity	slot	120kHz SCS: 160
tracking			120 kHz SCS:
3	001 00 11 1		80 for CSI-RS
	CSI-RS offset	slot	resource 1 and 2
			81 for CSI-RS resource 3 and 4
			Start PRB 0
	Frequency Occupation		Number of PRB =
			BWP size
	QCL info		TCI state #0
			Start PRB 0
NZP CSI-RS for	Frequency Occupation		Number of PRB =
CSI acquisition			BWP size
	QCL info		TCI state #1
ZP CSI-RS for	Fraguency Occurs of the		Start PRB 0
CSI acquisition	Frequency Occupation		Number of PRB = BWP size
CSI-RS for	First subcarrier index in the PRB		k ₀ =0 for CSI-RS
001-100 101	i natauboaniei inuex iii the FND	1	NU-0 101 031-N3

beam	used for CSI-	RS		resource 1,2
refinement				I ₀ = 8 for CSI-RS
	First OFDM s	ymbol in the PRB		resource 1
	used for CSI-			$I_0 = 9$ for CSI-RS
				resource 2
		0.00		1 for CSI-RS
	Number of C	SI-RS ports (X)		resource 1,2
				'No CDM' for CSI-RS
	CDM Type			resource 1,2
				3 for CSI-RS
	Density (ρ)			resource 1,2
				120 kHz SCS: 160 for
	CSI-RS perio	dicity	Slots	CSI-RS resource 1,2
				0 for CSI-RS
	CSI-RS offse	t	Slots	resource 1,2
	Repetition			ON
	Type 1 QCL	SSB index		SSB #0
	information			
	Intomation	QCL Type		Type C
TCI state #0	Type 2 QCL	SSB index		SSB #0
	information	QCL Type		Type D
		QQ) PQ		= -
	T 4.00			CSI-RS resource 1
	Type 1 QCL	CSI-RS resource		from 'CSI-RS for
	information			tracking'
		001 -		configuration
TCI state #1		QCL Type		Type A
				CSI-RS resource 1
	Type 2 QCL	CSI-RS resource		from 'CSI-RS for
	information			tracking'
		001 -		configuration
	<u> </u>	QCL Type		Type D
Number of HARO				8
HARQ ACK/NAC				Multiplexed
Redundancy vers	sion coding seq	uence		{0,2,3,1}
				For FR2.120-1:
				[3] if mod $(i.5) = 0$,
				[6] if $mod(i,5) = 2$
				For FR2.120-2:
K1 value (PDSCH-to-HARQ-timing-indicator)				[11] if $mod(i,8) = 0$,
				[7] if $mod(i,8) = 4$,
,	· ·	,		[6] if $mod(i,8) = 5$,
				where i is slot index
				per radio fame with
				values 0-79.
OCNG as specified				OCNG as specified in
Symbols for unused Res A.5				
Note 1: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full				
DL.			,	
Note O. UE as		TOL state for the DDC		al to the TCI state

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

8.2 Reporting of Channel Quality Indicator (CQI)

8.2.1 1RX requirements

(Void)

8.2.2 2RX requirements

8.2.2.1 FDD

(Void)

8.2.2.2 TDD

8.2.2.2.1 CQI reporting under AWGN conditions

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

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

8.2.2.2.1.1 Minimum requirement for periodic CQI reporting

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

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

Table 8.2.2.2.1.1-1 Test parameters

Bandwidth MHz		P	arameter	Unit	Test 1	Test 2	
TDD Slot Configuration	Bandwidth			MHz			
Discription	Duplex Mode						
DL BWP Configuration #1 First PRB 0 0 0 0 0	TDD Slot Cor	figura	ation		-	_	
DL BWP Configuration #1 Surbarrier spacing SNRas Subcarrier spacing SNRas Subcarrier spacing SNRas Subcarrier spacing SNRas Subcarrier spacing SNRas	122 0101 001	gaic					
PRB Subcarrier spacing SHZ 120					0	0	
Subcarrier spacing		4			66	66	
SNRe	configuration	#1			100	100	
Propagation channel	CNID		Subcarrier spacing			-	
Antenna configuration		hann	ما	иь			
Specified in [Annex Specified in [Annex Shed]	Fiopagation	лапп	ei				
Beamforming Model	Antenna conf	igurat	ion		specified in [Annex	specified in [Annex	
CSI-RS resource Type	Beamforming	Mode	 el		As specified in Section	As specified in Section	
Number of CSI-RS ports (X)					[Annex IBD]	[Annex IRD]	
Number of CSI-RS ports (X)		CSI	PS resource Type		Pariadia	Poriodio	
CDM Type							
Density (p)			. ,		·	=	
First subcarrier index in the PRB used for CSI-RS (k ₀ , k ₁) First OFDM symbol in the PRB used for CSI-RS (l ₀ , l ₁) CSI-RS symbol in the PRB used for CSI-RS (l ₀ , l ₁) SI SI SI SI SI SI SI S							
First OFDM symbol in the PRB used for CSI-RS (lo, l₁) 13	-	Firs	t subcarrier index in the		-	-	
CSI-RS resource Type		Firs	t OFDM symbol in the PRB		13	13	
CSI-RS resource Type Periodic Periodic		CSI	-RS	slot	8/1	8/1	
Number of CSI-RS ports (X) 2 2 2 2 CDM Type fd-CDM2 fd-CDM2 fd-CDM2 Density (p) 1 1 1 1 1 1 1 1 1			· ·		Periodic	Periodic	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$					2		
RS for CSI acquisition					fd-CDM2	fd-CDM2	
RS for CSI acquisition	NZD CCI	Den	ısity (ρ)		1	1	
First OFDM symbol in the PRB used for CSI-RS (lo, l₁)	RS for CSI				6	6	
Deriodicity and offset	acquisition	use	d for CSI-RS (I ₀ , I ₁)		13	13	
CSI-IM configuratio n CSI-IM timeConfig periodicity and offset slot 8/1 8/1 ReportConfigType Periodic Periodic Periodic CQI-table reportQuantity Table 1 Table 1 Table 1 reportConfigType Periodic Periodic Periodic CQI-table reportQuantity Table 1 Table 1 Table 1 reportQuantity cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured Not configured Not configured cqi-FormatIndicator Wideband Wideband Wideband gub-band Size RB [8] [8] csi-ReportingBand [111111111] [11111111] [111111111] CSI-Report periodicity and offset slot 8/1 8/1 aperiodicTriggeringOffset Not configured Not configured Codebook Todebook Type typel-SinglePanel typel-SinglePanel Codebook Mode Todebook Type Not configured Not configured Not configured				slot	8/1	8/1	
configuratio n CSI-IM timeConfig periodicity and offset ReportConfigType					1	1	
Periodicity and offset	configuratio	(k _{CS}	I-IM,ICSI-IM)		(8, 13)	(8, 13)	
CQI-table Table 1 Table 1 reportQuantity cri-RI-PMI-CQI cri-RI-PMI-CQI timeRestrictionForChannelMeasurements Not configured Not configured timeRestrictionForInterferenceMeasurements Not configured Not configured cqi-FormatIndicator Wideband Wideband pmi-FormatIndicator Wideband Wideband Sub-band Size RB [8] [8] csi-ReportingBand [11111111] [11111111] CSI-Report periodicity and offset slot 8/1 8/1 aperiodicTriggeringOffset Not configured Not configured Codebook Codebook Type typel-SinglePanel typel-SinglePanel Codebook Config-N1,CodebookConfig-N1,CodebookConfig-N2) CodebookSubsetRestriction [010000] [010000] RI Restriction [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission				slot	8/1	8/1	
reportQuantity cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI cri-RI-PMI-CQI Not configured Not configured <th< td=""><td></td><td>Туре</td><td></td><td></td><td></td><td></td></th<>		Туре					
timeRestrictionForChannelMeasurementsNot configuredNot configuredtimeRestrictionForInterferenceMeasurementsNot configuredNot configuredcqi-FormatIndicatorWidebandWidebandpmi-FormatIndicatorRB[8][8]sub-band SizeRB[8][8]csi-ReportingBand[1111111111][111111111]CSI-Report periodicity and offsetslot8/18/1aperiodicTriggeringOffsetNot configuredNot configuredCodebook Typetypel-SinglePaneltypel-SinglePanelCodebook Config-N1, CodebookConfig-N1, CodebookConfig-N1, CodebookConfig-N2)Not configuredNot configuredCodebookSubsetRestriction[010000][010000]RI Restriction[N/A][N/A]Physical channel for CSI report[PUCCH][PUCCH]CQI/RI/PMI delayms[8.375][8.375]Maximum number of HARQ transmission11							
timeRestrictionForInterferenceMeasurements Cqi-FormatIndicator pmi-FormatIndicator Sub-band Size Csi-ReportingBand CSI-Report periodicity and offset aperiodicTriggeringOffset Codebook configuration CodebookConfig-N1, CodebookConfig-N2) CodebookSubsetRestriction RI Restriction Physical channel for CSI report CQI/RI/PMI delay Mideband Wideband Not configured Not co							
cqi-FormatIndicator Wideband Wideband pmi-FormatIndicator RB [8] [8] Sub-band Size RB [8] [8] csi-ReportingBand [111111111] [111111111] [111111111] CSI-Report periodicity and offset slot 8/1 8/1 aperiodicTriggeringOffset Not configured Not configured Codebook Type typel-SinglePanel typel-SinglePanel Codebook Mode 1 1 configuration (CodebookConfig-N2) Not configured Not configured Not configured N1,CodebookConfig-N2) Not configured CodebookSubsetRestriction [010000] [010000] RI Restriction [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1							
pmi-FormatIndicator Wideband Wideband Sub-band Size RB [8] [8] csi-ReportingBand [111111111] [111111111] CSI-Report periodicity and offset slot 8/1 8/1 aperiodicTriggeringOffset Not configured Not configured Codebook Type typel-SinglePanel typel-SinglePanel Codebook Mode 1 1 configuration (CodebookConfig-N2) Not configured N1,CodebookConfig-N2) Not configured CodebookSubsetRestriction [010000] [010000] RI Restriction [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1							
Sub-band Size RB [8] [8] csi-ReportingBand [111111111] [111111111] CSI-Report periodicity and offset slot 8/1 8/1 aperiodicTriggeringOffset Not configured Not configured Codebook Type typeI-SinglePanel typeI-SinglePanel Codebook Mode 1 1 configuration (CodebookConfig-N2) Not configured Not configured Not configured N1,CodebookConfig-N2) [010000] [010000] RI Restriction [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1							
Csi-ReportingBand [11111111] [11111111] CSI-Report periodicity and offset slot 8/1 8/1 aperiodicTriggeringOffset Not configured Not configured Codebook Codebook Type typeI-SinglePanel typeI-SinglePanel Codebook Codebook Mode 1 1 configuration (CodebookConfig-N2) Not configured Not configured N1,CodebookConfig-N2) [010000] [010000] [010000] RI Restriction [N/A] [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1)r	חר			
CSI-Report periodicity and offset slot 8/1 8/1 aperiodicTriggeringOffset Not configured Not configured Codebook Codebook Type typeI-SinglePanel typeI-SinglePanel Codebook Codebook Mode 1 1 configuration (CodebookConfig-N2) Not configured Not configured N1,CodebookConfig-N2) [010000] [010000] RI Restriction [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1				KR			
aperiodicTriggeringOffset Not configured Not configured Codebook Type typel-SinglePanel typel-SinglePanel Codebook Mode 1 1 configuration (CodebookConfig-N2) Not configured Not configured Not configured Not configu			city and offset	olo4			
Codebook Configuration Codebook Mode Codebook Mode Codebook Configuration typel-SinglePanel typel-SinglePanel Not configured 1 1 Not configured Not configured ENJONAL [010000] [010000] [010000] [010000] [010000] [010000] [010000] [010000] [010000] [010000] [010000] <				SIUI			
Codebook configuration Codebook Mode (CodebookConfig-N1,CodebookConfig-N2) 1 1 CodebookSubsetRestriction RI Restriction [010000] [010000] [010000] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] Maximum number of HARQ transmission 1 1	apenouic mg						
Configuration (CodebookConfig-N1,CodebookConfig-N2) Not configured Not configured CodebookSubsetRestriction [010000] [010000] RI Restriction [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1	Codebook				1	1	
N1,CodebookConfig-N2)						· · · · · ·	
CodebookSubsetRestriction [010000] [010000] RI Restriction [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1	9				Not configured	Not configured	
RI Restriction [N/A] [N/A] Physical channel for CSI report [PUCCH] [PUCCH] CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1					[010000]	[010000]	
Physical channel for CSI report[PUCCH][PUCCH]CQI/RI/PMI delayms[8.375][8.375]Maximum number of HARQ transmission11							
CQI/RI/PMI delay ms [8.375] [8.375] Maximum number of HARQ transmission 1 1	Physical char						
Maximum number of HARQ transmission 1 1	-			ms			
	Maximum nur				•	1	
	Measuremen	char	nnel		As specified in Table	As specified in Table	

	A.4-1, TBS.1-2	A.4-1, TBS.1-2
	A.4-1, TBS.1-2	A.4-1, IBS.1-2

8.2.2.2.2 CQI reporting under fading conditions

8.2.2.2.2.1 Minimum requirement for wideband CQI reporting

< Editor's note: Open issues to be resolved:

- SNR levels
- Test parameters
- Requirements values (BLER, α, γ)>

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

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

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

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

Table 8.2.2.2.1-1 Test parameters

Parameter		Unit	Test 1	Test 2	
Bandwidth			MHz	100	100
Duplex Mode				TDD	TDD
TDD Slot Con	fiaura	ation		FR2.120-2 [Annex	FR2.120-2 [Annex
				A.1.3]	A.1.3]
DI DWD		First PRB		0	0
DL BWP	#1	Number of contiguous		66	66
configuration	# I	PRB Subscript appains	I/LI-	120	120
SNR _{BB}		Subcarrier spacing	kHz dB	120	12 13
Propagation c	hann	<u>el</u>	ub	[TDLA30-35]	[TDLA30-35]
				2x2	2x2
Antenna confi	gurat	ion		[ULA High]	[ULA High]
D (i	N 4I -	-1		As specified in Section	As specified in Section
Beamforming	Mode	91		[Annex TBD]	[Annex TBD]
		-RS resource Type		Aperiodic	Aperiodic
		nber of CSI-RS ports (X)		4	4
ZP CSI-RS		И Туре		FD-CDM2	FD-CDM2
configuratio		sity (ρ)		1	1
n		t subcarrier index in the		8	8
	PRE	B used for CSI-RS (k ₀ , k ₁)			
		t OFDM symbol in the PRB		13	13
-	CSI	d for CSI-RS (I ₀ , I ₁)			
		rval and offset	slot	[8/1]	[8/1]
		-RS resource Type		Aperiodic	Aperiodic
		nber of CSI-RS ports (X)		2	2
		М Туре		fd-CDM2	fd-CDM2
		sity (ρ)		1	1
NZP CSI-		t subcarrier index in the			
RS for CSI		B used for CSI-RS (k ₀ , k ₁)		6	6
acquisition	Firs	t OFDM symbol in the PRB		13	13
	use	d for CSI-RS (I ₀ , I ₁)		13	13
		CSI-RS-timeConfig	slot	[8/1]	[8/1]
		rval and offset	0.01		
001.114	CSI	-IM RE pattern		1	1
CSI-IM configuratio		-IM Resource Mapping		(0.12)	(0.12)
n	(KCS	ı-ıм, І сsı-ıм)		(8, 13)	(8, 13)
''	CSI	-IM timeConfig	_		
		rval and offset	slot	[8/1]	[8/1]
ReportConfig				Aperiodic	Aperiodic
CQI-table				Table 1	Table 1
reportQuantity				cri-RI-PMI-CQI	cri-RI-PMI-CQI
		ChannelMeasurements		Not configured	Not configured
		nterferenceMeasurements		Not configured	Not configured
cqi-FormatInd				Wideband	Wideband
pmi-FormatIng		or		Wideband	Wideband
Sub-band Size			RB	[8]	[8]
csi-Reporting		oity and offert	cla ⁴	[11111111]	[11111111]
CSI-Report periodicity and offset aperiodicTriggeringOffset		slot	8/1	8/1	
apenodic i rigg				Not configured	Not configured
Codebook		debook Type debook Mode		typel-SinglePanel	typel-SinglePanel
configuration		odebook Config-		I I	I
Jonnigaradori		,CodebookConfig-N2)		Not configured	Not configured
		debookSubsetRestriction		[000001]	[000001]
		Restriction		[N/A]	[N/A]
Physical chan				[PUSCH]	[PUSCH]
		/RI/PMI delay	ms	[1.375]	[1.375]
Maximum nun		of HARQ transmission		1	1
Measurement				As specified in Table	As specified in Table
MOGSGISTICITE	orial			A.4-1, TBS.1-1	A.4-1, TBS.1-1

Table 8.2.2.2.1-2 Minimum requirements

	Test 1	Test 2
α[%]	[2]	[2]
γ	[1.05]	[1.05]

8.3 Reporting of Precoding Matrix Indicator (PMI)

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

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

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

In the definition of 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
			FR2.120-2 as	FR2.120-2 as
TDD DL-UL conf	figuration		specified in	specified in
			Annex A	Annex A
DL BWP	First PRB		0	0
configuration	Number of		66	66
#1	contiguous PRB Subcarrier spacing	kHz	120	120
Propagation cha		11112	[TDLA30-35]	120
Antenna configu			2 x 2 [ULA Low]	2 x 2 [ULA Low]
Beamforming Mo			TBD	
9	CSI-RS resource		Aperiodic	Aporiodio
	Туре		Aperiodic	Aperiodic
	Number of CSI-RS		4	4
	ports (X) CDM Type		FD-CDM2	FD-CDM2
	Density (ρ)		1	1 1 1
ZP CSI-RS	First subcarrier		1	ı
configuration	index in the PRB		_ , ,,	
	used for CSI-RS		Row 4, (8,-)	Row 4, (8,-)
	(k_0, k_1)			
	First OFDM symbol		(40.)	(40.)
	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		Aperiodic	Aperiodic
	Type		7 (20110010	Aponodio
	Number of CSI-RS ports (X)		2	2
	CDM Type		FD-CDM2	FD-CDM2
	Density (ρ)		1	1
NZP CSI-RS	First subcarrier			
for CSI	index in the PRB		Row 3, (6,-)	Row 3, (6,-)
acquisition	used for CSI-RS		1.000 3, (0,-)	10W 3, (0,-)
	(k ₀ , k ₁) First OFDM symbol			
	in the PRB used for		(13,-)	(13,-)
	CSI-RS (I ₀ , I ₁)		(13,-)	(13,-)
	CSI-RS	slot	8/1	8/1
	interval and offset	5101	0/ 1	6/ 1
	CSI-IM RE pattern		_	_
			Patten 0	Patten 0
CSI-IM	OOL IM December			
configuration	CSI-IM Resource Mapping			
	(kcsi-im,lcsi-im)			
	, , , , ,		(8,13)	(8,13)
	CSI-IM timeConfig	slot	8/1	5/1
PoportConficT:	interval and offset			
ReportConfigType CQI-table			Aperiodic Table 1	Aperiodic Table 1
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI
	orChannelMeasureme			
nts			Not configured	Not configured
	orInterferenceMeasur		Not configured	Not configured
ements	stor		_	-
cqi-FormatIndica			Wideband	Wideband
pmi-FormatIndic	aı∪I		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	ingOffset		0	0		
Codebook	Codebook Type		typel- SinglePanel	typel- SinglePanel		
configuration	Codebook Mode		1	1		
	(CodebookConfig- N1,CodebookConfi g-N2)		N/A	N/A		
	CodebookSubsetR estriction		001111	001111		
	RI Restriction		N/A	N/A		
Physical channel	for CSI report		PUSCH	PUSCH		
CQI/RI/PMI delay	CQI/RI/PMI delay		1.375	1.75		
Maximum number of HARQ transmission			4	4		
Measurement ch	annel		R.PDSCH.5-8.1 TDD	R.PDSCH.5- 7.1 TDD		
Note 1: For 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 TBD.

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
Duplex Mode TDD Slot Con	figur	ation		TDD FR1.120-2	TDD FR1.120-2	TDD FR1.120-2
100 300 000	iliguia	First PRB		0	0	0
DL BWP configuration	#1	Number of contiguous PRB		66	66	66
Corniguration	# I	Subcarrier spacing	kHz	120	120	120
SNR		Cascamor spacing	dB	[0]	[20]	[20]
Propagation of	hann	el		[TDLA30-35]	[TDLA30-35]	[TDLA30-35]
Antenna confi	gurat	ion		ULA Low 2x2	ULA Low 2x2	XP High 2x2
Beamforming	Mode	7		As defined in	As defined in	As defined in
Boarmonning				Annex B.4.1	Annex B.4.1	Annex B.4.1
		-RS resource Type		Aperiodic	Aperiodic	Aperiodic
		nber of CSI-RS ports (X)		4 FD-CDM2	4 FD-CDM2	4 FD-CDM2
ZP CSI-RS		M Type sity (ρ)		1 1	1	1 1
configuratio		t subcarrier index in the				
n	PRE	B used for CSI-RS (k ₀ , k ₁)		Row 4, (8,-)	Row 4, (8,-)	Row 4, (8,-)
	use	t OFDM symbol in the PRB d for CSI-RS (l ₀ , l ₁)		(13,-)	(13,-)	(13,-)
		rval and offset	slot	8/1	8/1	8/1
		-RS resource Type		Aperiodic	Aperiodic	Aperiodic
		nber of CSI-RS ports (X)		2	2	2
1170 001		M Type		FD-CDM2	FD-CDM2	FD-CDM2
NZP CSI- RS for CSI		sity (ρ) t subcarrier index in the		1	1	1
acquisition	PRE	B used for CSI-RS (k ₀ , k ₁)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
	use	t OFDM symbol in the PRB d for CSI-RS (l₀, l₁)		(13,-)	(13,-)	(13,-)
		CSI-RS-timeConfig	slot	8/1	8/1	8/1
		-IM RE pattern		Pattern 1	Pattern 1	Pattern 1
CSI-IM configuratio n		-IM Resource Mapping I-IM,IcsI-IM)		(8,13)	(8,13)	(8,13)
		-IM timeConfig rval and offset	slot	8/1	8/1	8/1
ReportConfig				Aperiodic	Aperiodic	Aperiodic
CQI-table	7.			Table 1	Table 1	Table 1
reportQuantity	/			cri-RI-PMI-CQI	cri-RI-PMI- CQI	cri-RI-PMI- CQI
timeRestrictio	nFor(ChannelMeasurements		not configured	not configured	not configured
timeRestrictio	nForl	nterferenceMeasurements		not configured	not configured	not configured
cqi-FormatInd				Wideband	Wideband	Wideband
pmi-FormatIn		or		Wideband	Wideband	Wideband
Sub-band Siz			RB	[8]	[8]	[8]
	csi-ReportingBand		-1.1	[111111111]	[111111111]	[111111111]
	CSI-Report interval and offset aperiodicTriggeringOffset		slot	8/1 0	8/1 0	8/1 0
apenouic mgg		debook Type		typel-	typel-	typel-
Codebook		aosoon Type		SinglePanel	SinglePanel	SinglePanel
configuration	Со	debook Mode		1	1	1
	(Co	odebookConfig- ,CodebookConfig-N2)		N/A	N/A	N/A
		debookSubsetRestriction			[000011 for	[000011 for
		22230043331100011		[010000 for fixed rank 2, 010011 for	fixed rank 1, 010011 for following	fixed rank 1, 010011 for following
	<u> </u>			following rank]	rank]	rank]
	RI	Restriction		N/A	N/A	N/A

Physical channel for CSI report		PUSCH	PUSCH	PUSCH
CQI/RI/PMI delay	ms	1.375	1.375	1.375
Maximum number of HARQ transmission		1	1	1
RI Configuration		Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI

Table 8.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
2/1	N/A	[1.05]	[1.05]
<i>γ</i> 2	[1.0]	N/A	N/A

9 Demodulation performance requirements for interworking

9.1 General

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

9.1.1 Applicability of requirements

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

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

9.1.2 LTE Pcell setup

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

9.1.2.1 FDD

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

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

Table 9.1.2.1-1: Common Test Parameters (FDD)

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

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

Test	Bandwidth		Downlink p allocation		
setup	(MHz)	$ ho_{\scriptscriptstyle A}$	$ ho_{\scriptscriptstyle B}$	٩	
1	5	-3	-3	0	
2	10	-3	-3	0	
3	15	-3	-3	0	
4	20	-3	-3	0	

9.1.2.2 TDD

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

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

Table 9.1.2.2-1: Common Test Parameters (TDD)

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

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

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

Test	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 Void
- 9.2A PDSCH demodulation for CA
- 9.2A.1 NR CA between FR1 and FR2
- 9.2B PDSCH demodulation for DC
- 9.2B.1 EN-DC

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

9.2B.1.1 EN-DC within FR1

9.2B.1.1.1 PDSCH

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

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

9.2B.1.2.1 PDSCH

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

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

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

9.2B.2 NR DC between FR1 and FR2

9.3 Void

9.3A PDCCH demodulation for CA

9.3A.1 NR CA between FR1 and FR2

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

9.3B PDCCH demodulation for DC

9.3B.1 EN-DC

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

9.3B.1.1 EN-DC within FR1

9.3B.1.1.1 PDCCH

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

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

9.3B.1.2.1 PDCCH

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

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

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

9.3B.2 NR DC between FR1 and FR2

9.4 Void

9.4A SDR test for CA

9.4A.1 NR CA between FR1 and FR2

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

9.4B SDR test for DC

9.4B.1 EN-DC

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

9.4B.1.1 EN-DC within FR1

9.4B.1.1.1 SDR test

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

9.4B.1.2 EN-DC including FR2 NR carrier

9.4B.1.2.1 SDR test

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

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

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

9.4B.2 NR DC between FR1 and FR2

10 CSI reporting requirements for interworking

10.1 General

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

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

10.1.1 Applicability of requirements

<TBA>

10.2 Void

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

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

10.2B.1 EN-DC

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

10.2B.1.1 EN-DC within FR1

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

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

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

10.2B.1.2 EN-DC including FR2 NR carrier

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

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

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

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

10.3 Void

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

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

10.3B.1 EN-DC

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

10.3B.1.1 EN-DC within FR1

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

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

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

10.3B.1.2 EN-DC including NR FR2 carrier

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

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

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

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

10.4 Void

10.4A Reporting of Rank Indicator (RI) for CA

10.4B Reporting of Rank Indicator (RI) for DC

10.4B.1 EN-DC

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

10.4B.1.1 EN-DC within FR1

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

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

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

10.4B.1.2 EN-DC including NR FR2 carrier

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

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

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

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

Annex A (normative): Measurement channels

A.1 General

A.1.1 Throughput definition

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

A.1.2 TDD UL-DL patterns for FR1

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

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

	Parameter	Unit	UL-DL pattern	
	- ar arrieter	Onit	FR1.15-1	
TDD Slot Configuration p	TDD Slot Configuration pattern (Note 1)			
Special Slot Configuration	n (Note 2)		10D+2G+2U	
UL-DL configuration	kHz	15		
(tdd-UL-DL-	dl-UL-TransmissionPeriodicity	ms	5	
ConfigurationCommon)	ConfigurationCommon) nrofDownlinkSlots		3	
	nrofDownlinkSymbols		10	
	nrofUplinkSlot		1	
	nrofUplinkSymbols		2	
K1 value			[4] if $mod(1,5) = 0$	
(PDSCH-to-HARQ-timing	g-indicator)		[3] if $mod(i,5) = 1$	
			[2] if $mod(i,5) = 2$	
			[6] if $mod(i,5) = 3$	

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

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

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

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

В		I Incia			UL-DL	pattern		
	arameter	Unit	FR1.30-1	FR1.30-2	FR1.30-3	FR1.30-4	FR1.30-5	FR1.30-6
TDD Slot Configuration pa	attern (Note 1)		7DS2U	DDDSU	DDDSUDDSUU	SU	DDSU	DS ₁ S ₂ U
			6D+4G+4U	10D+2G+2U	10D+2G+2U	12D+2G+0U	10D+2G+2U	S1:
Special Slot Configuration	(Note 2)							10D+2G+2U
Special Slot Corlingulation	(Note 2)							S2:
								12D+2G+0U
UL-DL configuration	referenceSubcarrierSpacing	kHz	30	30	30	30	30	30
(tdd-UL-DL-	dl-UL-TransmissionPeriodicity	ms	5	2.5	2.5	1	2	1
ConfigurationCommon)	nrofDownlinkSlots		7	3	3	0	2	1
	nrofDownlinkSymbols		6	10	10	12	10	10
	nrofUplinkSlot		2	1	1	1	1	0
	nrofUplinkSymbols		4	2	2	0	2	2
UL-DL configuration2	referenceSubcarrierSpacing	kHz	N/A	N/A	30	N/A	N/A	30
(tdd-UL-DL-	dl-UL-TransmissionPeriodicity	ms	N/A	N/A	2.5	N/A	N/A	1
ConfigurationCommon2)	nrofDownlinkSlots		N/A	N/A	2	N/A	N/A	0
	nrofDownlinkSymbols		N/A	N/A	10	N/A	N/A	12
	nrofUplinkSlot		N/A	N/A	2	N/A	N/A	1
	nrofUplinkSymbols		N/A	N/A	2	N/A	N/A	0
K1 value			[7] if mod(i,10)	[4] if $mod(i,5) =$	[4] if mod(i,10)	[3] if $mod(i,2) =$	[3] if $mod(i,4) =$	[3] if $mod(i,4) =$
(PDSCH-to-HARQ-timing-	-indicator)		= 0	0	= 0	0	0	0
			[6] if mod(i,10)	[3] if $mod(i,5) =$	[3] if mod(i,10)		[2] if $mod(i,4) =$	[2] if $mod(i,4) =$
			= 1	1	= 1		1	1
			[5] if mod(i,10)	[2] if $mod(i,5) =$	[2] if mod(i,10)		[5] if $mod(i,4) =$	[3] if $mod(i,4) =$
			= 2	2	= 2		3	3
			[5] if mod(i,10)	[6] if $mod(i,5) =$	[5] if mod(i,10)			
			= 3	3	= 3			
			[4] if mod(i,10)		[3] if mod(i,10)			
			= 4		= 5			
			[3] if mod(i,10) = 5		[3] if mod(i,10) = 6			
			= 5 [3] if mod(i,10)		= 6 [2] if mod(i,10)			
			= 6		= 7			
			= 6 [2] if mod(i,10)		= 1			
			= 7					

Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,...,19}

A.1.3 TDD UL-DL patterns for FR2

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

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

В	arameter	Unit	UL-DL pattern
	raiailletei		FR2.60-1
TDD Slot Configuration p	attern (Note 1)		DDSU
Special Slot Configuration	n (Note 2)		11D+3G+0U
UL-DL configuration	referenceSubcarrierSpacing	kHz	60
(tdd-UL-DL-	dl-UL-TransmissionPeriodicity	ms	1
ConfigurationCommon)	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0
K1 value			K1 = [3] if mod(i,4) = 0
(PDSCH-to-HARQ-timing-indicator)			K1 = [2] if mod(i,4) = 1
			K1 = [5] if mod(i,4) = 3

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

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

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

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

	Parameter		UL-DL	pattern
raiailletei		Unit	FR2.120-1	FR2.120-2
TDD Slot Configuration p	pattern (Note 1)		DDDSU	DDSU
Special Slot Configuration	n (Note 2)		10D+2G+2U	11D+3G+0U
UL-DL configuration	referenceSubcarrierSpacing	kHz	120	120
(tdd-UL-DL-	dl-UL-TransmissionPeriodicity	ms	0.625	0.5
ConfigurationCommon)	nrofDownlinkSlots		3	2
	nrofDownlinkSymbols		10	11
	nrofUplinkSlot		1	1
	nrofUplinkSymbols		2	0
K1 value			K1 = [4] if mod(i,5) = 0	K1 = [3] if mod(i,4) = 0
(PDSCH-to-HARQ-timing-indicator)			K1 = [3] if mod(i,5) = 1	K1 = [2] if mod(i,4) = 1
			K1 = [2] if mod(i,5) = 2	K1 = [5] if mod(i,4) = 3
			K1 = [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; $i = \{0,...,79\}$

A.2 Void

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

A.3 DL reference measurement channels

A.3.1 General

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

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

A.3.2 Reference measurement channels for PDSCH performance requirements

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

A.3.2.1 FDD

A.3.2.1.1 Reference measurement channels for SCS 15 kHz FR1

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

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

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

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

Parameter	Unit			Value		
Reference channel		R.PDSCH.	R.PDSCH.	R.PDSCH.	R.PDSCH.	
Reference channel		1-2.1 FDD	1-2.2 FDD	1-2.3 FDD	1-2.4 FDD	
Channel bandwidth	MHz	10	10	10	10	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	52	52	52	52	
Number of consecutive PDSCH		12	12	12	12	
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 1:

Note 2:

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

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

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

Note 2:

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

Parameter	Unit		Value
Defended about		R.PDSCH.	
Reference channel		1-4.1 FDD	
Channel bandwidth	MHz	10	
Subcarrier spacing	kHz	15	
Number of allocated resource blocks	PRBs	52	
Number of consecutive PDSCH		12	
symbols		12	
Allocated slots per 2 frames	Slots	19	
MCS table		256QAM	
MCS index		24	
Modulation		256QAM	
Target Coding Rate		0.82	
Number of MIMO layers		1	
Number of DMRS rEs		12	
Overhead for TBS determination		0	
Information Bit Payload per Slot			
For Slot i = 0	Bits	N/A	
For Slots i = 1,, 19	Bits	45096	
Transport block CRC per Slot			
For Slot $i = 0$	Bits	N/A	
For Slots i = 1,, 19	Bits	24	
Number of Code Blocks per Slot			
For Slot $i = 0$	CBs	N/A	
For Slots i = 1,, 19	CBs	6	
Binary Channel Bits Per Slot			
For Slot i = 0	Bits	N/A	
For Slots i = 10, 11	Bits	52416	
For Slots i = 1,, 9, 12,, 19	Bits	54912	
Max. Throughput averaged over 2	Mbps	42.841	
frames Note 1: SS/PRCH block is transmitted		Luith pariadiaits	. 20

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

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

Parameter	Unit		Value
Defended about		R.PDSCH.	
Reference channel		1-5.1 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	04812	
Max. Throughput averaged over 2	Mbps	24.814	
frames	Minho	24.014	

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

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

Parameter	Unit			Value	
Reference channel		R.PDSCH.	R.PDSCH.		
		1-6.1 FDD	1-6.2 FDD		
Channel bandwidth	MHz	10	10		
Subcarrier spacing	kHz	15	15		
Number of allocated resource blocks	PRBs	52	52		
Number of consecutive PDSCH symbols		12	12		
Allocated slots per 2 frames	Slots	15	15		
MCS table	Cioto	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		U	U		
For Slot i = 0	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1,	DIIS	IN/A	IN/A		
i={0,,19}		N/A	N/A		
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,19}	Bits	12040	24072		
Transport block CRC per Slot					
For Slot i = 0	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1, $i=\{0,,19\}$		N/A	N/A		
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,19}	Bits	24	24		
Number of Code Blocks per Slot					
For Slot $i = 0$	CBs	N/A	N/A		
For CSI Slots i, if mod (i,5) =1, $i=\{0,,19\}$		N/A	N/A		
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,,19}	CBs	2	3		
Binary Channel Bits Per Slot					
For Slot i = 0	Bits	N/A	N/A		
For CSI Slots i, if mod (i,5) =1, $i=\{0,,19\}$		N/A	N/A		
For Slots i = 10	Bits	23712	47424		
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,9,11,,19}	Bits	24960	49920		
Max. Throughput averaged over 2 frames	Mbps	9.030	18.054		

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.3.2.1.2 Reference measurement channels for SCS 30 kHz FR1

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

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

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

Note 2:

A.3.2.2 TDD

A.3.2.2.1 Reference measurement channels for SCS 15 kHz FR1

Reference measurement channels for SCS 30 kHz FR1 A.3.2.2.2

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

Parameter	Unit			Value	
Deference channel		R.PDSCH.	R.PDSCH.	R.PDSCH.	
Reference channel		2-1.1 TDD	2-1.2 TDD	2-1.3 TDD	
Channel bandwidth	MHz	40	40	40	
Subcarrier spacing	kHz	30	30	30	
Allocated resource blocks	PRBs	106	6	106	
Number of consecutive PDSCH symbols					
For Slot i, if mod(i, 10) = 7 for i from				N1/A	
{0,,39}		4	4	N/A	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}$		4.0	4.0	_	
for i from {1,,39}		12	12	7	
Allocated slots per 2 frames		31	31	27	
MCS table		64QAM	64QAM	64QAM	
MCS index		4	4	4	
Modulation		QPSK	QPSK	QPSK	
Target Coding Rate		0.30	0.30	0.30	
Number of MIMO layers		1	1	1	
Number of DMRS rEs					
For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}		6	6	N/A	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$					
for i from $\{1,,39\}$		18	12	12	
Overhead for TBS determination		0	0	0	
Information Bit Payload per Slot		0	0	0	
For Slots 0 and Slot i, if mod(i, 10) =					
	Bits	N/A	N/A	N/A	
{8,9} for i from $\{0,,39\}$ For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}	Bits	2664	144	N/A	
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,\}$					
for i from $\{1,,39\}$	Bits	8064	480	4608	
Transport block CRC per Slot					
For Slots 0 and Slot i, if mod(i, 10) =					
{8,9} for i from {0,,39}	Bits	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from					
$\{0,,39\}$	Bits	16	16	N/A	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$					
for i from $\{1,,39\}$	Bits	24	16	24	
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if mod(i, 10) =					
For Slots 0 and Slot 1, if $\text{Flod}(1, 10) = \{8,9\}$ for i from $\{0,,39\}$	CBs	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from					
$\{0,,39\}$	CBs	1	1	N/A	
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,\}$					
for i from $\{1,,39\}$	CBs	1	1	1	
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 10) =					
{8,9} for i from {0,,39}	Bits	N/A	N/A	N/A	
For Slots i = 20, 21	Bits	25440	1512	13992	
For Slots 1 = 20, 21 For Slot i, if mod(i, 10) = 7 for i from					
$\{0,,39\}$	Bits	8904	504	N/A	
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,\}$					
For Slot 1, if flod(1, 10) = $\{0, 1, 2, 3, 4, 5, \}$) for i from $\{1,, 19, 22,, 39\}$	Bits	26712	1584	15264	
Max. Throughput averaged over 2 frames	Mbps	11.419	0.677	6.221	
Note 1: SS/PBCH block is transmitted in				0.221	
Note 2: Slot i is slot index per 2 frames	SIUL #U WILI	i periodicity 20	J 1113		

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

Parameter	Unit			Value		
Deference channel		R.PDSCH.	R.PDSCH.	R.PDSCH.	R.PDSCH.	
Reference channel		2-2.1 TDD	2-2.2 TDD	2-2.3 TDD	2-2.4 TDD	
Channel bandwidth	MHz	40	40	40	40	
Subcarrier spacing	kHz	30	30	30	30	
Allocated resource blocks	PRBs	106	106	106	106	
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 10) = 7 for i from						
{0,,39}		4	4	4	4	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$		4.0	4.0	4.0	40	
for i from {1,,39}		12	12	12	12	
Allocated slots per 2 frames		31	31	31	31	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		13	13	13	13	
Modulation		16QAM	16QAM	16QAM	16QAM	
Target Coding Rate		0.48	0.48	0.48	0.48	
Number of MIMO layers		1	2	3	4	
Number of DMRS rEs			_			
For Slot i, if $mod(i, 10) = 7$ for i from						
{0,,39}		6	6	12	12	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$						_
for i from {1,,39}		12	12	24	24	
Overhead for TBS determination		0	0	0	0	
Information Bit Payload per Slot			Ŭ			
For Slots 0 and Slot i, if mod(i, 10) =						
{8,9} for i from {0,,39}	Bits	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from						
{0,,39}	Bits	8456	16896	22032	29192	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$						_
for i from {1,,39}	Bits	26632	53288	73776	98376	
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) =						
{8,9} for i from {0,,39}	Bits	N/A	N/A	N/A	N/A	
For Slot i, if $mod(i, 10) = 7$ for i from						_
{0,,39}	Bits	24	24	24	24	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$						_
for i from {1,,39}	Bits	24	24	24	24	
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) =						_
{8,9} for i from {0,,39}	CBs	N/A	N/A	N/A	N/A	
For Slot i, if $mod(i, 10) = 7$ for i from						_
{0,,39}	CBs	2	3	3	4	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$						_
for i from $\{1,,39\}$	CBs	4	7	9	12	
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) =						_
{8,9} for i from {0,,39}	Bits	N/A	N/A	N/A	N/A	
For Slots i = 20, 21	Bits	53424	106848	144008	193344	
For Slot i, if $mod(i, 10) = 7$ for i from						
{0,,39}	Bits	17808	35616	45792	61056	
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$						
for i from {1,,19,22,,39}	Bits	55968	111936	152640	203520	
Max. Throughput averaged over 2 frames	Mbps	37.644	75.318	104.719	138.646	
Note 1: SS/PBCH block is transmitted in				101.710	100.040	
Note 2: Slot i is slot index per 2 frames	SIGE #O WILL	· portodicity 20	. 1110			

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.	R.PDSCH.		
Reference charmer		2-3.1 TDD	2-3.2 TDD		
Channel bandwidth	MHz	40	20		
Subcarrier spacing	kHz	30	30		
Allocated resource blocks	PRBs	106	51		
Number of consecutive PDSCH symbols					
For Slot i, if mod(i, 10) = 7 for i from		4	4		
{0,,39}		4	4		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}$		40	40		
for i from {1,,39}		12	12		
Allocated slots per 2 frames		31	31		
MCS table		64QAM	64QAM		
MCS index		19	19		
Modulation		64QAM	64QAM		
Target Coding Rate		0.51	0.51		
Number of MIMO layers		2	2		
Number of DMRS rEs					
For Slot i, if mod(i, 10) = 7 for i from			_		
{0,,39}		6	6		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$					
for i from $\{1,,39\}$		12	12		
Overhead for TBS determination		0	0		
Information Bit Payload per Slot					
For Slots 0 and Slot i, if mod(i, 10) =					1
{8,9} for i from {0,,39}	Bits	N/A	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from					1
{0,,39}	Bits	27144	13064		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$					
for i from {1,,39}	Bits	83976	40976		
Transport block CRC per Slot					
For Slots 0 and Slot i, if mod(i, 10) =			3.77		
{8,9} for i from {0,,39}	Bits	N/A	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from	5.4	0.4	0.4		
{0,,39}	Bits	24	24		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}$	5	0.4	0.4		
for i from {1,,39}	Bits	24	24		
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	0.0	N1/A	N1/0		
{8,9} for i from {0,,39}	CBs	N/A	N/A		
For Slot i, if mod(i, 10) = 7 for i from	0.0				
{0,,39}	CBs	4	2		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}$	0.0	40	_		
for i from {1,,39}	CBs	10	5		
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	D.,	N1/A	N1/0		
{8,9} for i from {0,,39}	Bits	N/A	N/A		
For Slots i = 20, 21	Bits	160272	77112		
For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}	Bits	53424	25704		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}$	D:to	167004	90794		
for i from {1,,19,22,,39}	Bits	167904	80784		
Max. Throughput averaged over 2 frames	Mbps	118.796	57.930		
Note 1: SS/PBCH block is transmitted in					
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		
Deference showned		R.PDSCH.			
Reference channel		2-4.1 TDD			
Channel bandwidth	MHz	40			
Subcarrier spacing	kHz	30			
Allocated resource blocks	PRBs	106			
Number of consecutive PDSCH symbols					
For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}		4			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$					
for i from $\{1,,39\}$		12			
Allocated slots per 2 frames		31			
MCS table		256QAM			
MCS index		24			
Modulation		256QAM			
		0.82			
Target Coding Rate Number of MIMO layers		0.02			
Number of DMRS rEs		l l			
For Slot i, if $mod(i, 10) = 7$ for i from		6			
{0,,39}					
For Slot i, if mod(i, 10) = $\{0,1,2,3,4,5,\}$		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) =	Bits	N/A			
{8,9} for i from {0,,39}	5.10	14// 1			
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	29192			
{0,,39}	5.10	20102			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\})$	Bits	92200			
for i from {1,,39}	5.10	02200			
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}	Dito	14// (
For Slot i, if $mod(i, 10) = 7$ for i from	Bits	24			
{0,,39}	Dito	2-7			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\})$	Bits	24			
for i from {1,,39}	Dito	27			
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}	CDS	IN/A			
For Slot i, if $mod(i, 10) = 7$ for i from	CBs	4			
{0,,39}	CDS	4			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}$	CBs	11			
for i from {1,,39}	CDS	11			
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 10) =	Dito	NI/A			
{8,9} for i from {0,,39}	Bits	N/A			
For Slots i = 20, 21	Bits	106848			
For Slot i, if mod(i, 10) = 7 for i from					
{0,,39}	Bits	35616			
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\})$	D.,	444600			
for i from {1,,19,22,,39}	Bits	111936			
Max. Throughput averaged over 2 frames	Mbps	130.308			
Note 1: SS/PBCH block is transmitted in			ns	<u>I</u>	1
Note 2: Slot i is slot index per 2 frames		,, _0 1	-		

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

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

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

Parameter	Unit		Value		
		R.PDSCH.			
Reference channel		2-6.1 TDD			
Channel bandwidth	MHz	40			
Subcarrier spacing	kHz	30			
Allocated resource blocks	PRBs	106			
Number of consecutive PDSCH symbols					
For Slot i, if $mod(i, 10) = \{3,7\}$ for i from					
{0,,39}		8			
For Slot i, if $mod(i, 10) = \{0,1,2,5,\}$) for i					
from {1,,39}		12			
Allocated slots per 2 frames		27			
MCS table		64QAM			
MCS index		4			
Modulation		QPSK			
Target Coding Rate		0.30			
Number of MIMO layers		1			
Number of DMRS rEs					
For Slot i, if $mod(i, 10) = \{3,7\}$ for i from					
{0,,39}		12			
For Slot i, if $mod(i, 10) = \{0,1,2,5,\}\)$ for i					
from {1,,39}		12			
Overhead for TBS determination		0			
Maximum number of HARQ					
transmissions		4			
Information Bit Payload per Slot					
For Slot 0 and Slot i, if mod(i, 10) =					
{4,8,9} for i from {0,,39}	Bits	N/A			
For Slot i, if mod(i, 10) = $\{3,7\}$ for i from					
$\{0,,39\}$	Bits	5376			
For Slot i, if $mod(i, 10) = \{0,1,2,5,\}\)$ for i					
from {1,,39}	Bits	8456			
Transport block CRC per Slot					
For Slot 0 and Slot i, if mod(i, 10) =					
{4,8,9} for i from {0,,39}	Bits	N/A			
For Slot i, if mod(i, 10) = $\{3,7\}$ for i from					
{0,,39}	Bits	24			
For Slot i, if $mod(i, 10) = \{0,1,2,5,\}\)$ for i					
from {1,,39}	Bits	24			
Number of Code Blocks per Slot					
For Slot 0 and Slot i, if mod(i, 10) =					
{4,8,9} for i from {0,,39}	CBs	N/A			
For Slot i, if mod(i, 10) = $\{3,7\}$ for i from					
{0,,39}	CBs	1			
For Slot i, if $mod(i, 10) = \{0,1,2,5,\}\)$ for i					
from {1,,39}	CBs	2			
Binary Channel Bits Per Slot					
For Slot 0 and Slot i, if mod(i, 10) =					
{4,8,9} for i from {0,,39}	Bits	N/A			
For Slot i = 20, 21	Bits	26712			
For Slot i, if mod(i, 10) = $\{3,7\}$ for i from					
{0,,39}	Bits	17808			
For Slot i, if $mod(i, 10) = \{0,1,2,5,\}\)$ for i					
from {1,,19,22,,39}	Bits	27984			
Max. Throughput averaged over 2 frames	Mbps	10.184			
Note 1: SS/PBCH block is transmitted in) ms	<u> </u>	1
Note 2: Slot i is slot index per 2 frames	J. J. 77 WILL	. politionly 20			
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Table A.3.2.2.7: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and CSI-RS overlapped with PDSCH

Parameter	Unit		Value	
Reference channel		R.PDSCH. 2-7.1 TDD		
Channel bandwidth	MHz	40		
Subcarrier spacing	kHz	30		
Allocated resource blocks	PRBs	106		
Number of consecutive PDSCH symbols				
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$		4		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$ for i from $\{1,,39\}$		12		
Allocated slots per 2 frames		31		
MCS table		64QAM		
MCS index		13		
Modulation		16QAM		
Target Coding Rate		0.48		
Number of MIMO layers		2		
Number of DMRS rEs				
For Slot i, if mod(i, 10) = 7 for i from		6		
{0,,39}		0		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$ for i from $\{1,,39\}$		12		
Overhead for TBS determination		0		
Information Bit Payload per Slot				
For Slots 0 and Slot i, if $mod(i, 10) = \{8,9\}$ for i from $\{0,,39\}$	Bits	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	Bits	16896		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$ for i from $\{1,,39\}$	Bits	53288		
Transport block CRC per Slot				
For Slots 0 and Slot i, if $mod(i, 10) = \{8,9\}$ for i from $\{0,,39\}$	Bits	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	Bits	24		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$ for i from $\{1,,39\}$	Bits	24		
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 10) =	OD -	N1/A		
{8,9} for i from {0,,39}	CBs	N/A		
For Slot i, if $mod(i, 10) = 7$ for i from $\{0,,39\}$	CBs	3		
For Slot i, if $mod(i, 10) = \{0,1,2,3,4,5,\}\}$ for i from $\{1,,39\}$	CBs	7		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,,39}	Bits	N/A		
For Slot i, if mod(i, 10) = $\{0,\}$) for i from $\{1,,19,22,,39\}$	Bits	103456		
For Slots i = 20	Bits	98368		
For Slots i = 21	Bits	106848		
For Slot i, if mod(i, 10) = 7 for i from {0,,39}	Bits	35616		
For Slot i, if mod(i, 10) = $\{1,2,3,4,\}$) for i from $\{1,,19,22,,39\}$	Bits	111936		
Max. Throughput averaged over 2 frames	Mbps	75.318		
Note 1: SS/PBCH block is transmitted in) ms	 1
Note 2: Slot i is slot index per 2 frames	SIOL #U WILI	i politication 20	, iiio	

Table A.3.2.2.8: PDSCH Reference Channel for TDD PMI reporting requirements with UL-DL pattern FR1.30-1 (16QAM)

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

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

Note 2: Slot i is slot index per 2 frames

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

A.3.2.2.3 Reference measurement channels for SCS 60 kHz FR1

A.3.2.2.4 Reference measurement channels for SCS 60 kHz FR2

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

Parameter	Unit		Value
Reference channel		R.PDSCH.	
Channel bandwidth	MHz	4-1.1 TDD 50	
Subcarrier spacing	kHz	60	
Allocated resource blocks	PRBs	66	
Number of consecutive PDSCH symbols	LIVD9	00	
For Slot i, if mod(i, 4) = 2 for i from			
{1,, 79}		10	
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,79\}$		13	
Allocated slots per 2 frames		59	
MCS table		64QAM	
MCS index		13	
Modulation		16QAM	
Target Coding Rate		0.48	
Number of MIMO layers		2	
Number of DMRS rEs		_	
For Slot i, if mod(i, 4) = 2 for i from {1,, 79}		12	
For Slot i, if mod(i, 4) = $\{0,\}$) for i from $\{1,,79\}$		12	
Overhead for TBS determination		6	
Information Bit Payload per Slot		0	
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for			
i from {0,,79}	Bits	N/A	
For Slot i, if $mod(i, 4) = 2$ for i from $\{1,, 79\}$	Bits	25608	
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,79\}$	Bits	34816	
Transport block CRC per Slot			
For Slots 0 and Slot i, if mod(i, 4) = 3 for	Bits	N/A	
i from {0,,79}	Dito	IV/A	
For Slot i, if $mod(i, 4) = 2$ for i from $\{1,, 79\}$	Bits	24	
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,79\}$	Bits	24	
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for		21/4	
i from {0,,79}	CBs	N/A	
For Slot i, if mod(i, 4) = 2 for i from {1,, 79}	CBs	4	
For Slot i, if $mod(i, 4) = \{0,\}$) for i from	CBs	5	
{1,,79}	CDS	3	
Binary Channel Bits Per Slot			
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,79\}$	Bits	N/A	
For Slot i = 40, 41	Bits	69960	
For Slot i, if $mod(i, 4) = 2$ for i from			
{4,, 79}	Bits	54912	
For Slot i, if mod(i, 4) = $\{0,\}$) for i from $\{1,,39,42,,79\}$	Bits	73128	
Max. Throughput averaged over 2 frames	Mbps	93.499	
Note 1: SS/PBCH block is transmitted in	slot #0 wit	h periodicity 20	ms

A.3.2.2.5 Reference measurement channels for SCS 120 kHz FR2

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

Parameter	Unit		Value	
Reference channel		R.PDSCH.		
Reference channel		5-1.1 TDD		
Channel bandwidth	MHz	100		
Subcarrier spacing	kHz	120		
Allocated resource blocks	PRBs	66		
Number of consecutive PDSCH symbols				
For Slot i, if $mod(i, 5) = 3$ for i from		9		
{0,, 159}		ŭ		
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from $\{1,,159\}$		13		
Allocated slots per 2 frames		127		
MCS table		64QAM		
MCS index		4		
Modulation		QPSK		
Target Coding Rate		0.30		
Number of MIMO layers		1		
Number of DMRS rEs				
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$		12		
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from				
{1,,159}		12		
Overhead for TBS determination		6		
Information Bit Payload per Slot		-		
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for	D''	N1/0		
i from {0,,159}	Bits	N/A		
For Slot i, if mod(i, 5) = 3 for i from $\{0,, 159\}$	Bits	3624		
For Slot i, if $mod(i, 5) = \{0,1,\})$ for i from	Bits	5504		
{1,,159}				
Transport block CRC per Slot				
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	Bits	N/A		
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$	Bits	16		
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from $\{1,,159\}$	Bits	24		
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 5) = 4 for	CBs	N/A		
i from $\{0,,159\}$ For Slot i, if mod(i, 5) = 3 for i from				
{0,, 159}	CBs	1		
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from $\{1,,159\}$	CBs	1		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	Bits	N/A		
For Slots i = 80, 81	Bits	17490		+
For Slot i, if mod(i, 5) = 3 for i from	Bits	12210		
$\{0,, 159\}$ For Slot i, if mod(i, 5) = $\{0,1,\}$) for i from				
{1,,79,82,,159}	Bits	18282		
Max. Throughput averaged over 2 frames	Mbps	31.942		
Note 1: SS/PBCH block is transmitted in	slot #0 wit	h periodicity 20) ms	1
Note 2: Slot i is slot index per 2 frames	2.01.70 1111			

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

Parameter	Unit			Value			
		R.PDSCH.	R.PDSCH.	R.PDSCH.			
Reference channel		5-2.1 TDD	5-2.2 TDD	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		9	9	9			
{0,, 159}		9	9	9			
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from $\{1,,159\}$		13	13	13			
Allocated slots per 2 frames		127	127	127			
MCS table		64QAM	64QAM	64QAM			
MCS index		13	13	13			
Modulation		16QAM	16QAM	16QAM			
Target Coding Rate		0.48	0.48	0.48			
Number of MIMO layers		1	2	2			
Number of DMRS rEs							
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$		12	12	12			
For Slot i, if mod(i, 5) = $\{0,1,\}$) for i from		40	40	40			
{1,,159}		12	12	12			
Overhead for TBS determination		6	6	6			
Information Bit Payload per Slot							
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	Bits	N/A	N/A	N/A			
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$	Bits	11272	22536	45096			
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from $\{1,,159\}$	Bits	17424	34816	69672			
Transport block CRC per Slot							
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	Bits	N/A	N/A	N/A			
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	24	24	24			
$\{0,, 159\}$ For Slot i, if mod(i, 5) = $\{0,1,\}$) for i from							
{1,,159}	Bits	24	24	24			
Number of Code Blocks per Slot							
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	CBs	N/A	N/A	N/A			
For Slot i, if $mod(i, 5) = 3$ for i from $\{0,, 159\}$	CBs	2	3	6			
For Slot i, if $mod(i, 5) = \{0,1,\}\)$ for i from $\{1,,159\}$	CBs	3	5	9			
Binary Channel Bits Per Slot							
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for i from $\{0,,159\}$	Bits	N/A	N/A	N/A			
For Slots i = 80, 81	Bits	34980	69960	139920			
For Slot i, if mod(i, 5) = 3 for i from {0,, 159}	Bits	24420	48840	97680			
For Slot i, if mod(i, 5) = $\{0,1,\}$) for i from $\{1,,79,82,,159\}$	Bits	36564	73128	146256			
Max. Throughput averaged over 2		400 700	004 101	100.000			
frames	Mbps	100.799	201.434	403.096			
Note 1: SS/PBCH block is transmitted in	n slot #0 w	ith periodicity 2	0 ms				
Note 2: Slot i is slot index per 2 frames							

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

Parameter	Unit		Value	
		R.PDSCH.		
Reference channel		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		9		
{0,, 159}		9		
For Slot i, if $mod(i, 5) = \{0,1,\}$) for i from		13		
{1,,159}				
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}				
For Slot i, if $mod(i, 5) = \{0,1,\}$) for i from		12		
{1,,159}				
Overhead for TBS determination		6		
Information Bit Payload per Slot				
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for	Bits	N/A		
i from {0,,159}				
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	16136		
{0,, 159}				
For Slot i, if mod(i, 5) = $\{0,1,\}$) for i from	Bits	25104		
{1,,159} Transport block CRC per Slot				+
For Slots 0 and Slot i, if $mod(i, 5) = 4$ for		N/A		+ + +
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) = $\{0,1,\}$) for i from				+ + + + + + + + + + + + + + + + + + + +
{1,,159}	Bits	24		
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 5) = 4 for	0.5	21/2		
i from {0,,159}	CBs	N/A		
For Slot i, if $mod(i, 5) = 3$ for i from	OD-	0		
{0,, 159}	CBs	2		
For Slot i, if $mod(i, 5) = \{0,1,\}$) for i from	CDo	2		
{1,,159}	CBs	3		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 5) = 4 for	Bits	N/A		
i from {0,,159}				
For Slots i = 80, 81	Bits	52470		
For Slot i, if $mod(i, 5) = 3$ for i from	Bits	36630		
{0,, 159}	Dito	00000		
For Slot i, if $mod(i, 5) = \{0,1,\}$) for i from	Bits	54846		
{1,,79,82,,159}				
Max. Throughput averaged over 2	Mbps	145.062		
frames	-			
Note 1: SS/PBCH block is transmitted in	i siot #U wit	n periodicity 20	ms	

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.		
Reference channel		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}		10		
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,159\}$		13		
Allocated slots per 2 frames		119		
MCS table		64QAM		
MCS index		4		
Modulation		QPSK		
Target Coding Rate		0.30		
Number of MIMO layers		2		
Number of DMRS rEs				
For Slot i, if $mod(i, 4) = 2$ for i from $\{1,, 159\}$		12		
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,159\}$		12		
Overhead for TBS determination		6		
Information Bit Payload per Slot				
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	Bits	N/A		
For Slot i, if mod(i, 4) = 2 for i from {1,, 159}	Bits	736		
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,159\}$	Bits	1032		
Transport block CRC per Slot				
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	Bits	N/A		
For Slot i, if mod(i, 4) = 2 for i from {1,, 159}	Bits	16		
For Slot i, if mod(i, 4) = $\{0,\}$) for i from $\{1,,159\}$	Bits	16		
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	CBs	N/A		
For Slot i, if mod(i, 4) = 2 for i from {1,, 159}	CBs	1		
For Slot i, if mod(i, 4) = $\{0,\}$) for i from $\{1,,159\}$	CBs	1		
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	Bits	N/A		-
For Slot i = 80, 81	Bits	3180		
For Slot i, if mod(i, 4) = 2 for i from {4,, 159}	Bits	2496		
For Slot i, if $mod(i, 4) = \{0,\}$ for i from $\{1,,79,82,,159\}$	Bits	3324		
Max. Throughput averaged over 2 frames	Mbps	5.548		
Note 1: SS/PBCH block is transmitted in	slot #0 wit	h periodicity 20	ms	\dashv
N + 0 Ol + :: 1 + : 1		,		

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

Parameter	Unit	Value				
Deference channel		R.PDSCH.	R.PDSCH.			
Reference channel		5-5.1 TDD	5-5.2 TDD			
Channel bandwidth	MHz	100	50			
Subcarrier spacing	kHz	120	120			
Allocated resource blocks	PRBs	66	32			
Number of consecutive PDSCH symbols						
For Slot i, if $mod(i, 4) = 2$ for i from		10	10			
{1,, 159}		10	10			
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,159\}$		13	13			
Allocated slots per 2 frames		119	119			
MCS table		64QAM	64QAM			
MCS index		13	13			
Modulation		16QAM	16QAM			
Target Coding Rate		0.48	0.48			
Number of MIMO layers		2	2			
Number of DMRS rEs						
For Slot i, if $mod(i, 4) = 2$ for i from $\{1,, 159\}$		12	12			
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,159\}$		12	12			
Overhead for TBS determination		6	6			
Information Bit Payload per Slot						
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	Bits	N/A	N/A			
For Slot i, if mod(i, 4) = 2 for i from {1,, 159}	Bits	25608	12552			
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,159\}$	Bits	34816	16896			
Transport block CRC per Slot						
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	Bits	N/A	N/A			
For Slot i, if $mod(i, 4) = 2$ for i from $\{1,, 159\}$	Bits	24	24			
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,159\}$	Bits	24	24			
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	CBs	N/A	N/A			
For Slot i, if mod(i, 4) = 2 for i from {1,, 159}	CBs	4	2			
For Slot i, if $mod(i, 4) = \{0,\}$) for i from $\{1,,159\}$	CBs	5	3			
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if $mod(i, 4) = 3$ for i from $\{0,,159\}$	Bits	N/A	N/A			
For Slot i = 80, 81	Bits	69960	33920			
For Slot i, if $mod(i, 4) = 2$ for i from $\{4,, 159\}$	Bits	54912	26624			
For Slot i, if $mod(i, 4) = \{0,\}$ for i from $\{1,,79,82,,159\}$	Bits	73128	35456			
Max. Throughput averaged over 2 frames	Mbps	188.739	91.843			
Note 1: SS/PBCH block is transmitted in	slot #0 wit	h periodicity 20	ms		_1	<u>.I.</u>
N · O O · · · · · · · · · · · · · · · ·			-			

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

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

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

Parameter	Unit		Value
Reference channel		R.PDSCH. 5-7.1 TDD	
Channel bandwidth	MHz	100	
Subcarrier spacing	kHz	120	
Allocated resource blocks	PRBs	66	
Number of consecutive PDSCH symbols		12	
Allocated slots per 2 frames		63	
MCS table		64QAM	
MCS index		13	
Modulation		16QAM	
Target Coding Rate		0.48	
Number of MIMO layers		1	
Number of DMRS rÉs (Note 3)		6	
Overhead for TBS determination		4	
Information Bit Payload per Slot			
For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,,39}	Bits	N/A	
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,,39}	Bits	14344	
For Slot i = 20	Bits	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$ for	Dito		
i from {1,,19,22,,39}		14344	
Transport block CRC per Slot			
For Slots 0 and Slot i, if mod(i, 10) =			
{7,8,9} for i from {0,,39}	Bits	N/A	
For CSI-RS Slot i, if mod(i,10) =1 for i			
from {0,,39}		24	
For Slot i = 20	Bits	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$ for			
i from {1,,19,22,,39}	Bits	24	
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if mod(i, 10) =	CBs	NI/A	
{7,8,9} for i from {0,,39}	CBS	N/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 $mod(i, 10) = \{0,2,3,4,5,6\}$ for	CBs	2	
i from {1,,19,22,,39}	CD3	2	
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}	Dito	14// (
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) = $\{0,2,3,4,5,6\}$ for i	Bits	30360	
from {1,,19,22,,39}			
Max. Throughput averaged over 2 frames Note 1: SS/PBCH block is transmitted in	Mbps	45.1836	

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

Note 2: Slot i is slot index per 2 frames

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

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

Parameter	Unit		Value
Reference channel		R.PDSCH. 5-8.1 TDD	
Channel bandwidth	MHz	100	
Subcarrier spacing	kHz	120	
Allocated resource blocks	PRBs	66	
Number of consecutive PDSCH symbols		12	
Allocated slots per 2 frames		59	
MCS table		64QAM	
MCS index		13	
Modulation		16QAM	
Target Coding Rate		0.48	
Number of MIMO layers		1	
Number of DMRS rÉs (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	D:4-	44044	
from {0,,39}	Bits	14344	
For Slot i = 20	Bits	N/A	
For Slot i, if $mod(i, 10) = \{0,2,3,4,5,6\}$ for		4.40.44	
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 $mod(i, 10) = \{0,2,3,4,5,6\}$ for	Bits	24	
i from {1,,19,22,,39}	Dito	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 $mod(i, 10) = \{0,2,3,4,5,6\}$ for	CBs	2	
i from {1,,19,22,,39}			
Binary Channel Bits Per Slot		1	
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 $mod(i, 10) = \{0,2,3,4,5,6\}$ for i from $\{1,,19,22,,39\}$	Bits	30360	
Max. Throughput averaged over 2 frames	Mbps	42.3148	
Note 1: SS/DBCH block is transmitted in			

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

Note 2: Slot i is slot index per 2 frames

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

A.3.3 Reference measurement channels for PDCCH performance requirements

A.3.3.1 FDD

A.3.3.1.1 Reference measurement channels for SCS 15 kHz FR1

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

Parameter	Unit			Val	lue	
Reference		R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-		
channel		1.1 FDD	1.2 FDD	1.3 FDD		
Subcarrier spacing	kHz	15	15	15		
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 channel		R.PDCCH.	R.PDCCH.	R.PDCCH.	R.PDCCH.	R.PDCCH.	R.PDCCH.
		1-2.1 FDD	1-2.2 FDD	1-2.3 FDD	1-2.4 FDD	1-2.5 FDD	1-2.6 FDD
Subcarrier spacing	kHz	15	15	15	15	15	15
CORESET		24	24	24	48	48	48
frequency domain							
allocation							
CORESET time		2	2	2	2	2	2
domain allocation							
Aggregation level		2	4	2	4	8	16
DCI Format		1_0	1_0	1_1	1_1	1_1	1_0
Payload (without	Bits	39	39	512	52	52	39
CRC)							

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 spacing	kHz	30	30	30						
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 CRC)	Bits	41	53	53						

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

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

A.3.3.2 TDD

A.3.3.2.1 Reference measurement channels for SCS 15 kHz FR1

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

Parameter	Unit	Value							
Reference		R.PDCCH.1-	R.PDCCH.1-	R.PDCCH.1-					
channel		1.1 TDD	1.2 TDD	1.3 TDD					
Subcarrier spacing	kHz	15	15	15					
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 CRC)	Bits	39	52	52					

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

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

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

Parameter	Unit		Valu	ıe	
Reference		R.PDCCH.			
channel		2-2.1 TDD			
Subcarrier spacing	kHz	30			
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.	R.PDCCH.	R.PDCCH.				
channel		5-1.1 TDD	5-1.2 TDD	5-1.3 TDD				
Subcarrier spacing	kHz	120	120	120				
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.			
channel		5-2.1 TDD			
Subcarrier spacing	kHz	120			
CORESET		60			
frequency domain					
allocation					
CORESET time		2			
domain allocation					
Aggregation level		16			
DCI Format		1_0			
Payload (without	Bits	40			
CRC)					

A.3.4 Reference measurement channels for PBCH demodulation requirements

A.3.4.1 Reference measurement channels for FR1

Table A.3.4.1-1: PBCH Reference Channel

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

A.3.4.2 Reference measurement channels for FR2

Table A.3.4.2-1: PBCH Reference Channel

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

A.4 CSI reference measurement channels

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

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

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

TBS Scheme	е			TBS.1-1	TBS.1-2				
MCS table	MCS table					640	QAM		
Number of allocated PDSCH resource blocks			66	66					
Number of c	onsecutive PD	SCH symbols	}	12	12				
Number of P	DSCH MIMO	layers		1	2				
Number of D	MRS rEs (No	te 1)		24	24				
Overhead fo	r TBS determi	ination		6	6				
Available RE	-s			7920	7920				
CQI index	Spectral	MCS index	Modulation		Infor	mation Bit	Payload pe	er Slot	
	efficiency								
0	OOR	OOR	OOR	N/A	N/A				
1	0.1523	0		1800	3624				
2	0.2344	0		1800	3624				
3	0.3770	2	QPSK	2856	5640				
4	0.6016	4	QFSK	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: N	umber of DMF	RS rEs include	s the overhea	d of the DM	-RS CDM g	roups with	out data		-

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

TBS Scheme	Э			TBS.2-1	TBS.2-2	TBS.2-3	TBS.2-4		
MCS table					2560	QAM			
Number of a	llocated PDS0	CH resource b	locks	52	52	106	106		
Number of c	onsecutive PD	SCH symbols	3	12	12	12	12		
Number of F	DSCH MIMO	layers		1	2	1	2		
Number of D	MRS rEs (No	te 1)		24	24	24	24		
Overhead fo	r TBS determi	nation		0	0	0	0		
Available RE	-s for PDSCH	1		7920	7920	12720	12720		
CQI index	Spectral efficiency	MCS index	Modulation		Infor	mation Bit F	Payload per	Slot	
0	OOR	OOR	OOR	N/A	N/A	N/A	N/A		
1	0.1523	0		1480	2976	2976	5896		
2	0.3770	1	QPSK	2408	4744	4744	9480		
3	0.8770	3		5504	11016	11016	22536		
4	1.4766	5		9224	18432	18960	37896		
5	1.9141	7	16QAM	12040	24072	24576	49176		
6	2.4063	9		15112	30216	30728	61480		
7	2.7305	11		16896	33816	34816	69672		
8	3.3223	13		20496	40976	42016	83976		
9	3.9023	15	64QAM	24576	49176	49176	98376		
10	4.5234	17		28168	56368	57376	114776		
11	5.1152	19		31752	63528	65576	131176		
12	5.5547	21		34816	69672	69672	139376		
13	6.2266	23	256QAM	38936	77896	79896	159880		
14	6.9141	25	ZOUGAIVI	43032	86040	88064	176208		
15	7.4063	27		46104	92200	94248	188576		
Note 1: N	umber of DMF	RS rEs include	s the overhea	d of the DM	-RS CDM g	roups withou	out data		

A.5 OFDMA Channel Noise Generator (OCNG)

A.5.1 OCNG Patterns for FDD

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

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

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

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

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.

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. $-8.78 \text{ dB} \rightarrow -8.8 \text{ dB}$)
- Step 8: If the delay spread has slightly changed due to the tap merge, adjust the final delay spread by increasing or decreasing the power of the last tap so that the delay spread is corrected.
- Step 9: Re-normalize tap powers such that the strongest tap is at 0dB.

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

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

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}	a = 0	1 0.9 0.9 1 0.9 0.81 .81 0.9	1 (0.9						
4x2 case			R_{high} =	0.8999 0.9883 0.8894	0.899 1.000 0.889 0.988 0.858 0.954 0.809	0 0.88 4 1.00 3 0.89 7 0.98 2 0.88 9 0.93	894 (000 (000) (00	0.8894 0.9883 0.8999 1.0000 0.8894 0.9883 0.8587	0.85 0.98 0.88 1.00 0.89 0.98	87 0 83 0 94 0 00 0 99 1 883 0		0.809 0.954 0.858 0.988 0.889	42 0.8 87 0.9 83 0.8 94 0.9 90 0.8	8999 8587 9542 8894 9883 8999		
4x4 case	$R_{high} =$	0.9882 0.9541 0.8999 0.9882 0.9767 0.9430 0.8894 0.9541 0.9430 0.9105 0.8587 0.8999 0.8894	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		0.9767 0.9430 0.8894 1.0000 0.9882 0.9541 0.8999 0.9882 0.9767 0.9430 0.8894 0.9541 0.9430 0.9105	0.9882 0.9767 0.9430 0.9882 1.0000 0.9882 0.9541 0.9767 0.9882 0.9767 0.9430 0.9430 0.9541 0.9541	0.9767 0.9882 0.9767 0.9541 0.9882 1.0000 0.9882 0.9430 0.9767 0.9882 0.9767 0.9105 0.9430 0.9541	0.9430 0.9767 0.9882 0.8999 0.9541 0.9882 1.0000 0.8894 0.9430 0.9767 0.9882 0.8587 0.9105 0.9430	0.9430 0.9105 0.8587 0.9882 0.9767 0.9430 0.8894 1.0000 0.9882 0.9541 0.8999 0.9882 0.9767 0.9430	0.9541 0.9430 0.9105 0.9767 0.9882 0.9767 0.9430 0.9882 1.0000 0.9882 0.9541 0.9767 0.9882 0.9767	0.9430 0.9541 0.9430 0.9430 0.9767 0.9882 0.9767 0.9541 0.9882 1.0000 0.9882 0.9430 0.9767 0.9882	0.9105 0.9430 0.9541 0.8894 0.9430 0.9767 0.9882 0.8999 0.9541 0.9882 1.0000 0.8894 0.9430 0.9767	0.8894 0.8587 0.8099 0.9541 0.9430 0.9105 0.8587 0.9882 0.9767 0.9430 0.8894 1.0000 0.9882 0.9541	0.8999 0.8894 0.8587 0.9430 0.9541 0.9430 0.9105 0.9767 0.9882 0.9767 0.9430 0.9882 1.0000 0.9882	0.8894 0.8999 0.8894 0.9105 0.9430 0.9541 0.9430 0.9767 0.9882 0.9767 0.9541 0.9882 1.0000	0.8587 0.8894 0.8999 0.8587 0.9105 0.9430 0.9541 0.8894 0.9430 0.9767 0.9882 0.8999 0.9541 0.9882

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

1x2 case									N/A								
2x1									N/A								
2x2 case			R_{mea}	_{dium} =	0.9882 0.9541 0.8999 0.3000	0 0.98 2 1.00 0.98 0 0.95 0 0.29	382 (0 00 0 82 1. 41 0 65 0	0.9541 .9882 .0000 .9882	0.9 1 0.3 0.27 0.8999 0.9541 0.9882 1.0000 0.2700	0.9 0.30 0.296 0.286 0.270 1.000	0.3 0.9 1 00 0.55 0.355 0.352 0.00 0.00 0.00 0.00	3000 0 2965 0 2862 0 9882 0	0.2965 0.3000 0.2965 0.9541	0.286 0.296 0.300 0.899	52 55 00 09		
					0.2862	0.29	65 0	.3000	0.2862 0.2965 0.3000	0.95	41 0.9	9882 1	.0000	0.988	32		
4x2 case			R_{medium}	, =	1.0000 0.9000 0.8748 0.7873 0.5856 0.5271 0.3000 0.2700	1.00 0.78 0.87 0.52 0.58 0.27	00 (073 148 (071 (071 (071 (071 (071 (071 (071 (071	0.8748 0.7873 1.0000 0.9000 0.8748 0.7873 0.5856 0.5271	0.874 0.900 1.000 0.787 0.874 0.527	8 0.5 0 0.8 0 0.7 3 1.0 8 0.9	271 2748 2873 000 0000 3748	0.5271 0.5856 0.7873 0.8748 0.9000 1.0000 0.7873 0.8748	0.27 0.58 0.52 0.87 0.78 1.00	00 0.56 0 71 0.48 0.73 0.00 0.00	.2700 .3000 .5271 .5856 .7873 .8748 .9000		
4x4 case	R _{medium} =	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	0.9882 1.0000 0.9882 0.9541 0.8645 0.8747 0.8645 0.8347 0.5787 0.5855 0.5787 0.5588 0.2965 0.3000 0.2965 0.2862	0.9541 0.9882 1.0000 0.9882 0.8347 0.8645 0.8747 0.8645 0.5787 0.5855 0.5787 0.2862 0.2965 0.3000 0.2965	0.9541 0.9882 1.0000 0.7872 0.8347 0.8645 0.8747 0.5270 0.5588 0.5787 0.5855 0.2700 0.2862 0.2965	0.8645 0.8347 0.7872 1.0000 0.9882 0.9541 0.8999 0.8747 0.8645 0.8347 0.7872 0.5855 0.5787	0.8645 0.8747 0.8645 0.8347 0.9882 1.0000 0.9882 0.9541 0.8645 0.8747 0.5787 0.5787 0.5585	0.8347 0.8645 0.8747 0.8645 0.9541 0.9882 1.0000 0.9882 0.8347 0.8645 0.8747 0.8645 0.5588 0.5787	0.7872 0.8347 0.8645 0.8747 0.8999 0.9541 0.9882 1.0000 0.7872 0.8347 0.8645 0.8747 0.5270 0.5588 0.5787	0.5855 0.5787 0.5588 0.5270 0.8747 0.8645 0.8347 0.7872 1.0000 0.9882 0.9541 0.8999 0.8747 0.8645 0.8347	0.5787 0.5855 0.5787 0.5588 0.8645 0.8747 0.8645 0.9882 1.0000 0.9882 0.9541 0.8645 0.8747 0.8645	0.5588 0.5787 0.5855 0.5787 0.8347 0.8645 0.8747 0.8645 0.9541 0.9882 1.0000 0.9882 0.8347 0.8645 0.8747	0.5270 0.5588 0.5787 0.5855 0.7872 0.8347 0.8645 0.8747 0.9882 1.0000 0.7872 0.8347 0.8645 0.8747	0.3000 0.2965 0.2862 0.2700 0.5855 0.5787 0.5588 0.5270 0.8747 0.8645 0.8347 0.7872 1.0000 0.9882 0.9541 0.8999	0.2965 0.3000 0.2965 0.2862 0.5787 0.5855 0.5787 0.5588 0.8645 0.8747 0.8645 0.8347 0.9882 1.0000 0.9882	0.2862 0.2965 0.3000 0.2965 0.5588 0.5787 0.5855 0.5787 0.8645 0.8747 0.8645 0.9541 0.9882 1.0000 0.9882	0.2700 0.2862 0.2965 0.3000 0.5270 0.5588 0.5787 0.5855 0.7872 0.8347 0.8645 0.8747 0.8999 0.9541 0.9882

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

$R_{mediumA} = \begin{pmatrix} 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.3000 & 0.2700 & 0.1968 & 0.1162 \\ 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.2700 & 0.3000 & 0.2700 & 0.1968 \\ 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.1968 & 0.2700 & 0.3000 & 0.2700 \\ 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \\ 0.1968 & 0.2700 & 0.3000 & 0.2700 & 0.6561 & 0.9000 & 1.0000 & 0.9000 \end{pmatrix}$	
$R_{mediumA} = \begin{bmatrix} 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.1968 & 0.2700 & 0.3000 & 0.2700 \\ 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \\ \end{bmatrix}$	
$R_{medium A} = \begin{bmatrix} 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \end{bmatrix}$	
case $R_{mediumA} = \begin{bmatrix} 0.3000 & 0.2700 & 0.1968 & 0.1162 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \end{bmatrix}$	
case $R_{mediumA} = \begin{bmatrix} 0.3000 & 0.2700 & 0.1968 & 0.1162 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \end{bmatrix}$	
0.3000 0.2700 0.1968 0.1162 1.0000 0.9000 0.6361 0.3874 0.2700 0.3000 0.2700 0.1968 0.9000 1.0000 0.9000 0.6561	
0.1968 0.2700 0.3000 0.2700 0.6561 0.9000 1.0000 0.9000	1
0.1162 0.1968 0.2700 0.3000 0.3874 0.6561 0.9000 1.0000	
(1.0000 0.9000 0.6561 0.3874 0.8748 0.7873 0.5739 0.3389 0.5856 0.5270 0.3842 0.2269 0.3000 0.2700 0.1968 0.	1162)
0.9000 1.0000 0.9000 0.6561 0.7873 0.8748 0.7873 0.5739 0.5270 0.5856 0.5270 0.3842 0.2700 0.3000 0.2700 0.3	
0.6561 0.9000 1.0000 0.5739 0.7873 0.8748 0.7873 0.3842 0.5270 0.5856 0.5270 0.1968 0.2700 0.3000 0.3	
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 0.3	
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 0.2700 0.3830 0.1102 0.1908 0.2700 0.	
0.8748 0.7873 0.5739 0.5389 1.0000 0.9000 0.0301 0.3874 0.8748 0.7873 0.5739 0.5389 0.5270 0.5856 0.5270 0.3842 0.3	-
0.7873 0.8748 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 0.5	
0.0000 0.5770 0.0777 0.0774 0.0774 0.0000 1.0000 0.0772 0.0774 0.0740 0.0740 0.0777	
$ \begin{vmatrix} \mathbf{4x4} \\ \mathbf{case} \end{vmatrix} R_{medium A} = \begin{vmatrix} 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.5270 & 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 $	
0.3630 0.3270 0.3642 0.2209 0.8746 0.7673 0.3739 0.3389 1.0000 0.9000 0.0301 0.3874 0.8746 0.7873 0.3739 0.3	1
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 0.5	
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 0.7	
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 0.8	
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 0.3	
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 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.000000	
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 0.9	
(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 1.0	000 /

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

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

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

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

The MIMO channel correlation matrices defined in B.2.3.2 apply for the antenna configuration using cross polarized (XP/X-pol) antennas at both gNB and UE. The cross-polarized antenna elements with ± 1.45 degrees polarization slant angles are deployed at gNB and cross-polarized antenna elements with ± 1.45 degrees polarization slant angles are deployed at UE.

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

- N_1 is the number of antenna elements in first dimension with same polarization,

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

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

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

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:

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

where

- R_{UE} is the spatial correlation matrix at the UE with same polarization,
- R_{eNB} 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

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

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

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

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

where

- - $R_{gNB_Dim,1}$ is the correlation matrix of antenna elements in first dimension with same polarization, and
- - $R_{gNB_Dim,2}$ is the correlation matrix of antenna elements in second dimension with same polarization.

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

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

$$R_{oNB Dim.i} = 1$$
.

- 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,

$$R_{gNB_Dim,i} = \begin{pmatrix} 1 & \alpha_i^{\frac{1}{9}} & \alpha_i^{\frac{4}{9}} & \alpha_i \\ \alpha_i^{\frac{1}{9}*} & 1 & \alpha_i^{\frac{1}{9}} & \alpha_i^{\frac{4}{9}} \\ \alpha_i^{\frac{4}{9}*} & \alpha_i^{\frac{1}{9}*} & 1 & \alpha_i^{\frac{1}{9}} \\ \alpha_i^* & \alpha_i^{\frac{4}{9}*} & \alpha_i^{\frac{1}{9}*} & 1 \end{pmatrix}.$$

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

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

$$R_{ONR} = R_{ONR Dim 1}$$

The spatial correlation matrices at UE side are as follows:

- For 1 antenna element with the same polarization,

$$R_{UE}=1$$
.

- For 2 antenna elements with the same polarization,

$$R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & 1 \end{pmatrix}.$$

B.2.3.2.2 MIMO Correlation Matrices using cross polarized antennas

The values for parameters α , 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	lpha1	02	β	γ
Mediu	m Correlation A	0.3	N/A	0.6	0.2
Higl	h Correlation	0.9	0.9	0.9	0.3
Note 1: Note 2: Note 3:	Value of α_1 applies antenna elements in Value of α_2 applies antenna elements in Value of β applies the elements at UE sides.	n first dimension when more the necond dimental when more the	on at gNB side an one pair of ension at gNB	e. cross-polarize side.	ed

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

				1.0	000	0.0000	0.90	000	0.0000	-0.30	000	0.0000	-0.27	700	0.0000]		
				0.0	000	1.0000	0.00	000	0.9000	0.00	000	0.3000	0.0	000	0.2700			
				0.9	000	0.0000	1.00	000	0.0000	-0.27	700 (0.0000	-0.30	000	0.0000			
4x2				0.0	000	0.9000	0.00	000	1.0000	0.00	000 (0.2700	0.00	00	0.3000			
case			$R_{high} =$	-03	000	0.0000			0.0000	1.00		0.0000	0.90	00	0.0000			
						0.3000			0.2700	0.00		.0000	0.00		0.9000			
						0.0000			0.0000	0.90		.0000	1.00		0.0000			
				0.0	000	0.2700	0.0	000	0.3000	0.00	00 0	0.9000	0.00	000 1	1.0000			
		1.0000	0.0000	0.9883	0.0000		0.0000	0.8999		-0.3000		-0.2965			2 0.0000	-0.2700	0.0000	
		0.0000	1.0000	0.0000	0.9883	0.0000	0.9542	0.000	0 0.8999	0.0000	0.3000		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	5 0.0000	-0.2862	0.0000	
		0.0000	0.9883	0.0000	1.0000	0.0000	0.9883	0.000	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	0.988	3 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	1.000	0.0000	-0.2700	0.0000	-0.2862	0.0000	-0.296	5 0.0000	-0.3000	0.0000	
8x2	R -	0.0000	0.8999	0.0000	0.9542	0.0000	0.9883	0.000	0 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	-0.270	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 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	-0.296	5 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	0.000	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,
- $D_{\theta_{k,1}}(N_1)$ is the steering matrix in first dimension with same polarization,
- $D_{\theta_{k,2}}(N_2)$ is the steering matrix in second dimension with same polarization,
- N_1 is the number of antenna elements in first dimension with same polarization,
- N_2 is the number of antenna elements in second dimension with same polarization,
- For antenna array with only one direction, number of antenna element in second direction N_2 equals 1.

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

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

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)
$\Delta \theta$	1.2566×10 ⁻³

B.2.4 Two-tap propagation conditions for CQI tests

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

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

in continuous time (t, τ) representation, with τ_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.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.

Annex C (normative): Downlink physical channels

C.1 General

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

C.2 Setup (Conducted)

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

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

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

C.3 Connection (Conducted)

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

C.3.1 Measurement of Performance requirements

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

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

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

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

C.4 Setup (Radiated)

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

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

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

C.5 Connection (Radiated)

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

C.5.1 Measurement of Receiver Characteristics

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

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

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

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

Annex D (informative): Void

Annex E (normative): Environmental conditions

E.1 General

This annex specifies the environmental requirements of the UE. Within these limits the requirements of the present documents shall be fulfilled.

E.2 Environmental (Conducted)

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

E.2.1 Temperature

The UE shall fulfil all the requirements in the full temperature range of:

Table E.2.1-1 Temperature conditions

+15°C to +35°C	For normal conditions (with relative humidity of 25 % to 75 %)
-10°C to +55°C	For extreme conditions (see IEC publications 68-2-1 and 68-2-2)

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

E.2.2 Voltage

The UE shall fulfil all the requirements in the full voltage range, i.e. the voltage range between the extreme voltages.

The manufacturer shall declare the lower and higher extreme voltages and the approximate shutdown voltage. For the equipment that can be operated from one or more of the power sources listed below, the lower extreme voltage shall not be higher, and the higher extreme voltage shall not be lower than that specified below.

Table E.2.2-1 Voltage conditions

Power source	Lower extreme	Higher extreme	Normal conditions	
	voltage	voltage	voltage	
AC mains	0,9 * nominal	1,1 * nominal	nominal	
Regulated lead acid battery	0,9 * nominal	1,3 * nominal	1,1 * nominal	
Non regulated batteries:				
Leclanché	0,85 * nominal	Nominal	Nominal	
Lithium	0,95 * nominal	1,1 * Nominal	1,1 * Nominal	
Mercury/nickel & cadmium	0,90 * nominal		Nominal	

Outside this voltage range the UE if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 38.101-1[6, Section 6.2] for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

E.2.3 Vibration

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

Table E.2.3-1 Vibration conditions

Frequency	ASD (Acceleration Spectral Density) random vibration		
5 Hz to 20 Hz	$0.96 \text{ m}^2/\text{s}^3$		
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%
-10°C to +55°C	For extreme conditions

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS38.101-2 [7, Section 6.2] for extreme operation.

E.3.2 Voltage

E.3.3 Void

Annex G (informative): Void

Annex H (informative): Void

Annex I (informative): Void

Annex J (informative): Void

Annex K (informative): Void

Annex L (informative): Change history

D /	Ta	l. D	10-		.	Change history	
Date	Meeting	tDoc	CR	Rev	Cat	Subject/Comment	New version
2018-07	RAN4 AH18-07	R4-1809554				Draft skeleton	0.0.1
2018-08	RAN4#88	R4-1811357				Skeleton update	0.0.2
2018-10	RAN4#88	R4-1814237				Approved Text Proposal in RAN4#88bis:	0.1.0
	bis					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	
						Performance Requirements"	
						R4-1813925, "TP for introducing demodulation performance	
						requirements for interworking TS 38.101-4 section 9"	
						R4-1814052, "TP for 38.101-4 section 10 CSI test cases of	
						interworking" R4-1814066, "TP on channel models for TS38.101-4"	
						R4-1814023, "TP to TS38.101-4 Annex C: Downlink physical	
						channels"	
						R4-1814024, "TP to TS38.101-4 Annex E: Environmental conditions"	
2018-11	RAN4#89	R4-1816559				Approved Text Proposal in RAN4#89:	0.2.0
2010 11	10 41 17700	111 101000				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 – ICSI"	
						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)"	
				1		R4-1816713, "TP to TS38.101-4 Section 7.3: PDCCH demodulation	

					requirements"	
					R4-1816714, "TP for propagation conditions in TS 38.104-4(Annex	
					B)"	
2018-12	RAN#82	RP-182408			V1.0.0 is submitted to RAN for 1-step approval	1.0.0
2018-12	RAN#82	RP-182704			V1.0.1 with editorial changes	1.0.1
2018-12	RAN#82				Approved by plenary – Rel-15 spec under change control	15.0.0
2019-03	RAN#83	RP-190403	000	В	CR on UE demodulation and CSI requirements for 38.101-4	15.1.0
			1		This OD south since all the endouged don't ODs as list below	
					This CR comboines all the endorsed draft CRs as list below: General sections	
					R4-1902427, Draft CR on NR UE demodulation requirements	
					applicability (Intel Corporation)	
					R4-1902576, Draft CR on General Applicability of Requirements	
					(Qualcomm Incorporated)	
					R4-1902412, Editorial cleanup of FR2 Radiated Requirements	
					General section (ANRITSU)	
					PDSCH	
					R4-1902414, Draft CR on FR1 normal PDSCH demodulation	
					requirements (Intel Corporation)	
					R4-1902415, Draft CR on FR2 PDSCH Requirements (Qualcomm	
					Incorporated) R4-1902411, Draft CR on FR1 SDR requirements (Intel Corporation)	
					PDCCH	
					R4-1902416 Draft CR for updating FR1 PDCCH performance	
					requirements in TS38.101-4Huawei, HiSilicon	
					R4-1902423 Draft CR for updating FR2 PDCCH performance	
					requirements in TS38.101-4 section 7.3 CATT	
					PBCH	
					R4-1902420, Draft CR on 2Rx PBCH demodulation requirement for	
					FR1 (CMCC) R4-1902421, Draft CR on 4Rx PBCH demodulation requirements for	
					FR1 (CMCC)	
					R4-1902422, Draft CR on 2Rx PBCH demodulation requirement for	
					FR2 (CMCC)	
					CSI	
					R4-1902418, Draft CR on FR2 CSI Reporting Tests (Qualcomm	
					Incorporated)	
					R4-1902419, Draft CR on FR1 CSI Reporting Tests (Qualcomm	
					Incorporated) R4-1900105, Draft CR on NR CSI reporting (Intel Corporation)	
					R4-1902058, Draft CR for update of FR1 CQI reporting test (Huawei,	
					HiSilicon)	
					R4-1902059, Draft CR for update of FR2 CQI reporting test (Intel)	
					R4-1902426, Draft CR for PMI test cases: 6.2, 8.2, A.3.2.2.2,	
					A.3.2.2.5 (Samsung)	
					R4-1902425, Draft CR for FR1 and FR2 RI test cases (Qualcomm)	
					Annex	
					R4-1900369, Draft CR on PDSCH FRC (Intel Corporation)	
					R4-1900370, Draft CR on PDCCH FRC (Intel Corporation) R4-1902424, Corrections to 38.101-4 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	
					Come minor editorial chariges	
					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.	