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Contents

Foreword

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

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The present document is part 4 of a multi-part Technical Specification (TS) covering the New Radio (NR) User Equipment (UE) conformance specification, which is divided in the following parts:

FFS.

1 Scope

The present document specifies the measurement procedures for the conformance test of the user equipment (UE) that contain performance requirements as part of 5G-NR.

The requirements are listed in different clauses only if the corresponding parameters deviate. More generally, tests are only applicable to those mobiles that are intended to support the appropriate functionality. To indicate the circumstances in which tests apply, this is noted in the "*definition and applicability*" part of the test.

For example only Release 15 and later UE declared to support 5G-NR shall be tested for this functionality. In the event that for some tests different conditions apply for different releases, this is indicated within the text of the test itself.

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 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[3] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone"

[4] 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".

[5] 3GPP TS 38.101-4: "NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements".

[6] 3GPP TS 38.508-1: “5GS; User Equipment (UE) conformance specification; Part 1: Common test environment“

[7] 3GPP TS 38.521-1: ”NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Range 1 Standalone”

[8] 3GPP TS 38.521-2: ” NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 2: Range 2 Standalone”

[9] 3GPP TS 38.211: "NR; Physical channels and modulation".

[10] 3GPP TS 38.212: "NR; Multiplexing and channel coding".

[11] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[12] 3GPP TS 38.214: "NR; Physical layer procedures for data".

[13] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity", Stage 2.

[14] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

[15] 3GPP TR 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz".

[16] 3GPP TS 36.521-1: "E-UTRA; User Equipment (UE) conformance specification; Radio transmission and reception; Part1: conformance testing"

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in 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 TR 21.905 [1].

aggregated channel bandwidth: The RF bandwidth in which a UE transmits and receives multiple contiguously aggregated carriers.

carrier aggregation: Aggregation of two or more component carriers in order to support wider transmission bandwidths.

carrier aggregation band: A set of one or more operating bands across which multiple carriers are aggregated with a specific set of technical requirements.

carrier aggregation bandwidth class: A class defined by the aggregated transmission bandwidth configuration and maximum number of component carriers supported by a UE.

carrier aggregation configuration: A combination of CA operating band(s) and CA bandwidth class(es) supported by a UE.

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 [4, Section 5.1].

FR2: Frequency range 2 as defined in TS 38.101-3 [4, Section 5.1].

PDSCH mapping type A or B: A type of PDSCH allocation sent in the RRC message which defines the time domain allocation of PDSCH DMRS symbols. PDSCH mapping type A is slot based assignment with fixed starting OFDM symbol with variable length. PDSCH mapping type B is non-slot based assignment used for configuring min-slots.

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 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 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

TS 38.101-4 is a Single-RAT and interwork specification for NR UE, covering minimum performance requirements of both conducted and radiated requirements. Conformance is demonstrated by fulfilling the test requirements specified in the conformance specification 3GPP TS 38.521-4.

The Minimum Requirements given in TS 38.101-4 makes no allowance for measurement uncertainty. The test specification the present document defines test tolerances. These test tolerances are individually calculated for each test. The test tolerances are used to relax the minimum requirements in the present document 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 [X].

The applicability of each requirement is described under each subclauses in [5.1, 6.1, 7.1 and 8.1] of TS 38.101-4.

4.2 Applicability of minimum requirements

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

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

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

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

4.3 Specification suffix information

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

Table 4.3-1: Definition of suffixes

Clause suffix	Variant
None	Single Carrier
A	Carrier Aggregation (CA)
B	Dual-Connectivity (DC)
C	Supplement Uplink (SUL)

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

4.4 Conducted requirements

4.4.0 Introduction

The requirements are defined for the following modes:

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

4.4.1 Reference point

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

4.4.2 SNR definition

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

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

where-N_{RX} denotes the number of receiver antenna connectors and the superscript receiver antenna connector j.

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

4.4.3 Noc

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

4.4.4 Es

Editor's note: Minimum Es values and derivation procedure are TBD

4.5 Radiated requirements

4.5.0 Introduction

The requirements are defined for the following modes:

- Mode 1: conditions with external noise source
  - Wanted signal with power level Es is transmitted.
  - External white noise source with power spectral density Noc is used.
  - *Es* and *Noc* levels are selected to achieve target SNR as described in Clause 4.5.2.

- Mode 2: Noise free conditions
  - Wanted signal with power level Es is transmitted.
  - No external noise transmitted.

4.5.1 Reference point

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

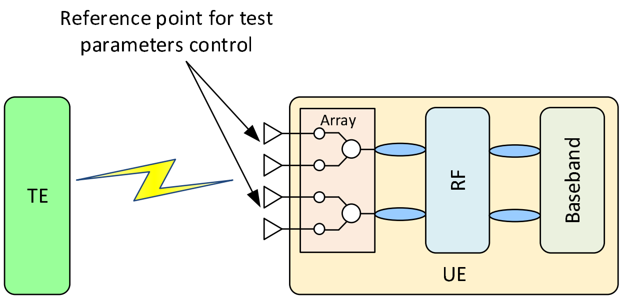

Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements

4.5.2 SNR definition

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

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

where Δ_{BB} is specified in clause 4.5.3.

The reference point SNR is defined as:

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

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

4.5.3 Noc

4.5.3.1 Introduction

For mode 1 conditions radiated testing of demodulation and CSI requirements it is not feasible in practice to use signal levels high enough to make the noise contribution of the UE negligible. Demodulation requirements are therefore specified with the applied noise higher than the UE peak EIS level in TS 38.101-2 [3] 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 Δ_{BB} =1dB.

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

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

For PC3 multi-band devices, the Noc power level (Noc_{MB}) shall increase by multi-band relaxation defined in TS 38.101-2 [3] Table 6.2.1.3-4.

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

- Noc_{SB} is the Noc defined in Table 4.5.3.2-1
- ΣMB_P values are specified in TS 38.101-2 [3].

4.5.3.3 Derivation of Noc values for NR operating bands in FR2

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

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

where:

- $REFSENS_{PC3,\ n260,\ 50MHz}$ is the REFSENS value in dBm specified for Power Class 3 UE in Band n260 for 50MHz Channel bandwidth in TS 38.101-2 [3] Table 7.3.2.3-1.
- $SCS_{REFSENS}$ is a subcarrier spacing associated with N_{RB} for 50MHz in TS 38.101-2 [3] Table 5.3.2-1, chosen as 120kHz.
- $PRB_{REFSENS}$ is N_{RB} associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-2 [3] Table 5.3.2-1 and is 32.
- 12 is the number of subcarriers in a PRB
- $SNR_{REFSSENS}$ = -1 dB is the SNR used for simulation of R EFSENS.
- $\Delta_{thermal}$ is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of Δ_{BB}. $\Delta_{thermal}$ = 6dB, giving a rise in total noise of 1dB**.**

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

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

Noc(PC_X, Band_Y) = -155 dBm/Hz + $REFSENS_{PC\_X,\ Band\_Y,\ 50MHz} - REFSENS_{PC3,\ n260,\ 50MHz}$ where REFSENS values are specified in TS 38.101-2 [3].

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 [3].

4.6 Test coverage across 5G NR architecture options

The test cases in the present document cover both Standalone (FR1, FR2) as well as Non-Standalone FR1 and FR2 (E-UTRA and 5G NR interworking) testing. Below shall be the understanding with respect to coverage across 5G NR architecture options:

1) Unless otherwise stated within the test case, it shall be understood that test requirements are agnostic of the NSA architecture option configured within the test. The test coverage across NSA options shall be considered fulfilled by execution of the NSA test case using one NSA option. Subsequently the test results can be leveraged to other NSA options.

2) Only one SA or NSA architecture option type is identified and utilized in the definition of each test case within this test specification. NSA test cases are configured using Connectivity EN-DC i.e. NSA Option 3 and Standalone (SA) test cases are configured using Connectivity NR i.e. SA Option 2, which shall be the default architecture options used for NSA and SA test execution respectively.

3) If a UE does not support NSA Option 3, any other supported NSA option can be configured to execute the test. This is accomplished by appropriately picking the generic procedure parameter from Table 4.5.1-2. The leverage rule detailed in (1) would apply.

Table 4.6-1: Generic procedure parameter summary for SA

Generic Procedure Parameter to use in Initial Conditions		**Description**	**5G NR SA Architecture Option supported by UE**
Connectivity	*NR*	NG-RAN NR Radio Access	SA Option 2
	E-UTRA	NG-RAN E-UTRA Radio Access	SA Option 5

Editor's Note: Any additional test config details needed for SA Option 5 is FFS

Table 4.6-2: Generic procedure parameter summary for NSA

Generic Procedure Parameter to use in Initial Conditions		**Description**	**5G NR NSA Architecture Option supported by UE**
Connectivity	**NSA**		
	EN-DC	E-UTRA-NR Dual Connectivity	NSA Option 3
	NGEN-DC	NG-RAN E-UTRA-NR Dual Connectivity	NSA Option 4
	NE-DC	NR-E-UTRA Dual Connectivity	NSA Option 7

Editor's Note: Any additional test config details needed for NSA Options 4 and 7 are FFS

5 Demodulation performance requirements (Conducted requirements)

5.1 General

5.1.1 Applicability of requirements

5.1.1.1 General

The minimum performance requirements are applicable to all FR1 operating bands defined in TS 38.101-1 [2].

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 7.2 of TS 38.101-1 [3]. The UE requirements applicability for UEs with different number of RX antenna ports is defined in Table 5.1.1.2-1.

Table 5.1.1.2-1: Requirements applicability

Supported RX antenna ports	Test type	Test list
UE supports only 2RX	PDSCH	All tests in Clause 5.2.2
	PDCCH	All tests in Clause 5.3.2
	PBCH	All tests in Clause 5.4.2
UE supports only 4RX or both 2RX and 4RX	PDSCH	All tests in Clause 5.2.3
	PDCCH	All tests in Clause 5.3.3
	PBCH	All tests in Clause 5.4.2 or 5.4.3[Note 1]
Note1: Requirements for PBCH with 4Rx is up to UE declaration		

5.1.1.3 Applicability of requirements for optional UE capabilities

For UE which supports optional UE capabilities the additional performance requirements from Table 5.1.1.2-1 should be applied.

Table 5.1.1.2-1: 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 scheme			Transmission scheme 1
EPRE ratio of PTRS to PDSCH		dB	N/A
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 2)	RBs	0
	Subcarrier spacing	kHz	15 or 30
DL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in TS 38.101-1 [6, Section 5.3.2] for tested channel bandwidth and subcarrier spacing
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
	First DMRS position for Type A PDSCH mapping		2
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH	Symbols	0, 1
	Number of PRBs in CORESET		Table 5.2-2 for tested channel bandwidth and subcarrier spacing
	Number of PDCCH candidates and aggregation levels		1/AL8
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
	TCI state		TCI state #1
Cross carrier scheduling			Not configured
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k_0=0 for CSI-RS resource 1,2,3,4
	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 1 and 3 l_0 = 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 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
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS		k_0 = 0
	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
	Number of CSI-RS ports (X)		Same as number of transmit antenna
	CDM Type		'FD-CDM2'
	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 Number of PRB = BWP size
	QCL info		TCI state #1
ZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS		k_0 = 4
	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
	Number of CSI-RS ports (X)		4

	CDM Type			'FD-CDM2'
	Density (ρ)			1
	CSI-RS periodicity		Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset		Slots	0
	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
PDSCH DMRS configuration	Antenna ports indexes			{1000} for Rank 1 tests {1000, 1001} for Rank 2 tests {1000-1002} for Rank 3 tests {1000-1003} for Rank 4 tests
	Number of PDSCH DMRS CDM group(s) without data			1 for Rank 1 and Rank 2 tests 2 for Rank 3 and Rank 4 tests
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
PTRS configuration				PTRS is not configured
Maximum number of code block groups for ACK/NACK feedback				1
Maximum number of HARQ transmission				4
HARQ ACK/NACK bundling				Multiplexed
Redundancy version coding sequence				{0,2,3,1}
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 transmission. Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing.				

Table 5.2-2: Number of PRBs in CORESET

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

The normative reference for this requirement is TS 38.101-4 [5] clause 5.2

5.2.1 1RX requirements (Void)

5.2.2 2RX requirements

5.2.2.1 FDD

5.2.2.1.1 2Rx FDD FR1 PDSCH mapping Type A performance

5.2.2.1.1.0 Minimum conformance requirements

The performance requirements are specified in Table 5.2.2.1.1.0-3 and Table 5.2.2.1.1.0-4, with the test parameters defined in table 5.2.2.1.1.0-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.1.0-1.

Table 5.2.2.1.1.0-1: Tests purpose

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

Table 5.2.2.1.1.0-2: Test Parameters for Testing

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Test 1-1 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
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Test 1-1 1 for other tests
	Length		Single symbol
Number of HARQ Processes			8 for Tests 1-4 4 for other tests
K1 value (PDSCH-to-HARQ-timing-indicator)			2

Table 5.2.2.1.1.0-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.1 FDD	10 / 15	QPSK, 0.30	TDLB100-400	2x2, ULA Low	70	0.8
1-2	R.PDSCH.1-1.2 FDD	10 / 15	QPSK, 0.30	TDLC300-100	2x2, ULA Low	70	0.3
1-3	R.PDSCH.1-4.1 FDD	10 / 15	256QAM, 0.82	TDLA30-10	2x2, ULA Low	70	24.6
1-4	R.PDSCH.1-2.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	30	1.1

Table 5.2.2.1.1.0-4: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-3.1 FDD	10 / 15	64QAM, 0.51	TDLA30-10	2x2, ULA Low	70	19.4
2-2	R.PDSCH.2-1.1 FDD	20 / 30	64QAM, 0.51	TDLA30-10	2x2, ULA Low	70	19.7

Table 5.2.2.1.1.0-5: Minimum performance for Rank 2 and Enhanced Type X Receiver

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

The normative reference for this requirement is TS 38.101-4 [5], clause 5.2.2.1.1.

5.2.2.1.1_1 2Rx FDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

5.2.2.1.1_1.1 Test purpose

To verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs and number of MIMO layers for a specified downlink Reference Measurement Channel (RMC) to achieve a certain throughput and as well verify the HARQ soft combining with default baseline receiver configuration, for Rank 1 and Rank 2 scenarios.

5.2.2.1.1_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.2.2.1.1_1.3 Test description

5.2.2.1.1_1.3.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D:

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and clause A.3.2.2 for UE diagram.

2. The parameter settings for the cell are set up according to Table 5.2-1, Table 5.2.2.1.1.0-2 and Table 5.2.2.1.0-3 and as appropriate.

3. Downlink signals for NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1 and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.0.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On, Test Mode* On or (EN-DC, DC bearer *MCG* and *SCG, Connected without release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1_1.3.3.

5.2.2.1.1_1.3.2 Test procedure

1. SS transmits PDSCH via PDCCH DCI format 1_1 for C_RNTI to transmit the DL RMC according to Tables 5.2.2.1.1_1.3-1. The SS sends downlink MAC padding bits on the DL RMC.
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 5.2.2.1.1_1.3-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Tables 5.2.2.1.1_1.3-1, 5.2.2.1.1_1.3-2 and 5.2.2.1.1_1.3-3 as appropriate.
4. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL during each subtest and decide pass or fail according to Table G.1.5-1 in Annex G clause G.1.5.
5. Repeat steps from 1 to 4 for each subtest in Table 5.2.2.1.1_1.3-1 as appropriate.

5.2.2.1.1_1.3.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.2.2.1.1_1.3.3_1 Message exceptions for SA

Table 5.2.2.1.1_1.3.3_1-1: *PDSCH-Config*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-100			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-Config ::= SEQUENCE {			
prb-BundlingType CHOICE {			
staticBundling SEQUENCE {			
bundleSize	n4, n2	n4 for test 1-1 n2 for other tests	
}			
}			
}			

Table 5.2.2.1.1_1.3.3_1-2: DMRS-DownlinkConfig

Derivation Path: TS 38.508-1 [6], Table 4.6.3-50			
Information Element	**Value/remark**	**Comment**	**Condition**
DMRS-DownlinkConfig ::= SEQUENCE {			
dmrs-AdditionalPosition	pos1	For all tests except test 1-1	
	pos2	For test 1-1	
}			

Table 5.2.2.1.1_1.3.3_1-3: PDSCH-ServingCellConfig

Derivation Path: TS 38.508-1 [6], Table 4.6.3-102			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-ServingCellConfig ::= SEQUENCE {			
nrofHARQ-ProcessesForPDSCH	n8, n4	n8 for Test 1-4 n4 for other tests	
}			

5.2.2.1.1_1.3.3_2 Message exceptions for NSA

Same as 5.2.2.1.1_1.3.3_1

5.2.2.1.1_1.4 Test requirement

Table 5.2.2.1.1_1.3-2 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A TBD for each throughput test shall meet or exceed the specified value in Table 5.2.2.1.1_1.4-1 and Table 5.2.2.1.1_1.4-1 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.2.1.1_1.4-1: Minimum performance for Rank 1

Test num.	Reference channel	Modulation format	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.1 FDD	QPSK, 0.30	TDLB100-400	2x2, ULA Low	70	0.1
1-2	R.PDSCH.1-1.2 FDD	QPSK, 0.30	TDLC300-100	2x2, ULA Low	70	0.11
1-3	R.PDSCH.1-4.1 FDD	256AM, 0.82	TDLA30-10	2x2, ULA Low	70	25.6
1-4	R.PDSCH.1-2.1 FDD	16QAM, 0.48	TDLC300-100	2x2, ULA Low	30	2

Table 5.2.2.1.1_1.4-2: Test Requirements for Rank 2

Test num.	**Reference channel**	**Modulation format and code rate**	**Propagation condition**	**Correlation matrix and antenna configuration**	**Reference value**	
					Fraction of maximum throughput (%)	**SNR (dB)**
2-1	R.PDSCH.1-3.1 FDD	64QAM, 0.51	TDLA30-10	2x2, ULA Low	70	20.4
2-2	R.PDSCH.2-1.1 FDD	64QAM, 0.51	TDLA30-10	2x2, ULA Low	70	20.7

5.2.2.1.1_2 2Rx FDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA

Editor's note: Same editor's note as in clause 5.2.2.1.1_1

5.2.2.1.1_2.1 Test purpose

To verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs and number of MIMO layers for a specified downlink Reference Measurement Channel (RMC) to achieve a certain throughput and as well verify the HARQ soft combining with enhanced type X receiver configuration, for Rank 2 scenarios.

5.2.2.1.1_2.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting NR enhanced receiver type X.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and NR enhanced receiver type X.

5.2.2.1.1_2.3 Test description

Same test description as in clause 5.2.2.1.1_1.3.

5.2.2.1.1_2.3.1 Initial conditions

Same initial conditions as in clause 5.2.2.1.1_1.3.1.

5.2.2.1.1_2.3.2 Test procedure

Same test procedure as in clause 5.2.2.1.1_1.3.2.

5.2.2.1.1_2.3.3 Message contents

Same message contents as in clause 5.2.2.1.1_1.3.3.

5.2.2.1.1_2.3.3_1 Message exceptions for SA

Same message exceptions for SA as in clause 5.2.2.1.1_1.3.3_1.

5.2.2.1.1_2.3.3_2 Message exceptions for NSA

Same message exceptions for NSA as in clause 5.2.2.1.1_1.3.3_2.

5.2.2.1.1_2.3.4 Test requirement

Same test requirement as in clause 5.2.2.1.1_1.3.4.

Table 5.2.2.1.1_2.3.4-1: Test Requirements for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
3-1	R.PDSCH.1-2.2 FDD	10 / 15	16QAM, 0.48	TDLA30-10	2x2, ULA Medium	70	18.6

5.2.2.1.2 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance

5.2.2.1.2.0 Minimum conformance requirements

The performance requirements are specified in Table 5.2.2.1.2.0-3, with the addition of test parameters in table 5.2.2.1.2.0-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.2.0-1.

Table 5.2.2.1.2.0-1: 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 5.2.2.1.2.0-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		1
NZP CSI-RS for CSI acquisition	OFDM symbols in the PRB used for CSI-RS		l_0 = 13
	CSI-RS periodicity		5
ZP CSI-RS for CSI acquisition	Subcarrier index in the PRB used for CSI-RS		(k_0, k_1, k_2, k_3)=(2, 4, 6, 8)
	Number of CSI-RS ports (X)		8
	CSI-RS periodicity		5
Number of HARQ Processes			4
K1 value (PDSCH-to-HARQ-timing-indicator)			2

Table 5.2.2.1.2.0-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-5.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	14. 8

The normative reference for this requirement is TS 38.101-4 [5] clause 5.2.2.1.2.

5.2.2.1.2_1 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA

5.2.2.1.2_1.1 Test purpose

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

5.2.2.1.2_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.2.2.1.2_1.3 Test description

5.2.2.1.2_1.3.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [8].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.6.2 for TE diagram and section A.3.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.2-1, Table 5.2.2.1.1.0-2 and Table 5.2.2.1.0-3 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without release On*, Test Mode *On* or (EN-DC, DC bearer *MCG* and *SCG*, *Connected without release On)*, for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.2_1.3.3.

5.2.2.1.2_1.3.2 Test procedure

1. SS transmits PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 5.2.2.1.2.0-3. The SS sends downlink MAC padding bits on the DL RMC.
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 5.2.2.1.2.0-3. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Tables 5.2.2.1.2.0-2 and 5.2.2.1.2.0-3 as appropriate.
4. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL during each subtest and decide pass or fail according to Annex G.1.4.

5.2.2.1.2_1.3.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.2.2.1.2_1.3.3_1 Message exceptions for SA

Same as for test number 1-2 in 5.2.2.1.1_1.3.3_1 with following exceptions:

Table 5.2.2.1.2_1.3.3_1-1: NZP CSI-RS-ResourceMapping for CSI Acquisition

Derivation Path: TS 38.508-1 [6], Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0001	k_0=0	
}			
firstOFDMSymbolInTimeDomain	13	l_0 = 13	
}			

Table 5.2.2.1.2_1.3.3_1-2: CSI-ResourcePeriodicityAndOffset for CSI Acquisition

Derivation Path: TS 38.508-1 [6], Table 4.6.3-43			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-ResourcePeriodicityAndOffset ::= CHOICE {			
slots5	0	Periodicity 5 slots and offset 0	
}			

Table 5.2.2.1.2_1.3.3_1-3: ZP CSI-RS-ResourceMapping for CSI Acquisition

Derivation Path: TS 38.508-1 [6], clause 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0010	k_0=2	
row1	0100	k_1=4	
row1	0110	k_2=6	
row1	0100	k_3=8	
}			
nrofPorts	P8	Eight Ports	
firstOFDMSymbolInTimeDomain	12	l_0 = 12	
cdm-Type	fd-CDM2		
density CHOICE {			
one	NULL		
}			
freqBand	CSI-FrequencyOccupation		
}			

5.2.2.1.2_1.3.3_2 Message exceptions for NSA

Same as 5.2.2.1.2_1.3.3_1

5.2.2.1.2_1.4 Test requirement

Table 5.2.2.1.2.0-2 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A for each throughput test shall meet or exceed the specified value in Table 5.2.2.1.2_1.4-1 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.2.1.2_1.4-1: Test Requirements for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-5.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	14.8+0.9

5.2.2.1.4 2Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance

5.2.2.1.4.0 Minimum conformance requirements

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 5.2.2.1.4.0-1: 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 5.2.2.1.4.0-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CRS for rate matching (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	MHz	10
	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: No MBSFN is configured on LTE carrier			

Table 5.2.2.1.4.0-3: Minimum performance for Rank 1

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

The normative reference for this requirement is TS 38.101-4 [5], clause 5.2.2.1.4.

5.2.2.1.4_1 2Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x2 MIMO with baseline receiver for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- TE diagram(4x2) is TBD

5.2.2.1.4_1.1 Test purpose

To verify the Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions with CRS rate matching configured.

5.2.2.1.4_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.2.2.1.4_1.3 Test description

5.2.2.1.4_1.3.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure TBD for TE diagram and section A.3.2.3 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.2-1, Table 5.2.2.1.4.0-2 and Table 5.2.2.1.4.0-3 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.0.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without release On*, Test Mode *On* or (EN-DC, DC bearer *MCG* and *SCG*, *Connected without release On)*, for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.4_1.3.3.

5.2.2.1.4_1.3.2 Test procedure

1. SS transmits PDSCH via PDCCH DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.2.2.1.4.0-3. The SS sends downlink MAC padding bits on the DL RMC.
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format 0_1 for C_RNTI to schedule the UL RMC according to Table 5.2.2.1.4.0-3. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Tables 5.2.2.1.4.0-2 and 5.2.2.1.4.0-3 as appropriate.
4. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL during each subtest and decide pass or fail according to Table G.1.5-1 in Annex G clause G.1.5.

5.2.2.1.4_1.3.3 Message contents

5.2.2.1.4_1.3.3_1 Message exceptions for SA

As defined in clause 5.4.2 of TS 38.508-1 [6] with the following exceptions:

Table 5.2.2.1.4_1.3.3_1.1: PDSCH-TimeDomainResourceAllocationList

Derivation Path: TS 38.508-1 [6], Table 4.6.3-103			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-TimeDomainResourceAllocationList::= SEQUENCE(SIZE(1..maxNrofDL-Allocations)) OF {	1 entry		FR1
PDSCH-TimeDomainResourceAllocation[1] SEQUENCE {			
k0	0		
mappingType	typeA		
startSymbolAndLength	94	Start symbol(S)=3, Length(L)=9 for Test 1-1	
	66	Start symbol(S)=3, Length(L)=11 for Test 1-2	
}			
}			

Table 5.2.2.1.4_1.3.3_1.5: *SearchSpace*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162 using condition USS, FR1_10MHz, Long_DCI			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
searchSpaceId	SearchSpaceId with condition USS		USS
controlResourceSetId	ControlResourceSetId		
monitoringSlotPeriodicityAndOffset CHOICE {			
sl1	NULL		
}			
duration	Not present	1 slot per default	
monitoringSymbolsWithinSlot	00100000000000		
nrofCandidates SEQUENCE {			
aggregationLevel1	n0		
aggregationLevel2	n2		FR1_5MHz OR FR1_10MHz
aggregationLevel4	n1		FR1_5MHz OR FR1_10MHz
aggregationLevel8	n0		FR1_5MHz OR FR1_10MHz
aggregationLevel16	n0		
}			
searchSpaceType CHOICE {			USS
ue-Specific SEQUENCE {			
dci-Formats	formats0-1-And-1-1		Long_DCI
}			
}			
}			

Table 5.2.2.1.4_1.3.3_1.6: ServingCellConfigCommon

Derivation Path: TS 38.508-1 [6], Table 4.6.3-168			
Information Element	**Value/remark**	**Comment**	**Condition**
ServingCellConfigCommon ::= SEQUENCE {			
lte-CRS-ToMatchAround	RateMatchPatternLTE-CRS		
}			

Table 5.2.2.1.4_1.3.3_1.7: RateMatchPatternLTE-CRS

Derivation Path: TS 38.508-1 [6], Table 4.6.3-138			
Information Element	**Value/remark**	**Comment**	**Condition**
RateMatchPatternLTE-CRS ::= SEQUENCE {			
carrierFreqDL	Same as NR carrier centre subcarrier location		
carrierBandwidthDL	n50	10MHz	
mbsfn-SubframeConfigList	Not present		
nrofCRS-Ports	n4		
v-Shift	n0		
}			

5.2.2.1.4_1.3.3_2 Message exceptions for NSA

Same as 5.2.2.1.4_1.3.3_1.

5.2.2.1.4_1.3.4 Test requirement

Table 5.2.2.1.4.0-3 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A for each throughput test shall meet or exceed the specified value in Table 5.2.2.1.4_1.3.4-1 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.2.1.4_1.3.4-1: Test requirement for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-7.1 FDD	10 / 15	QPSK, 0.30	TDLA30-10	4x2, ULA Low	70	0.0
1-2	R.PDSCH.1-7.2 FDD	10 / 15	QPSK, 0.30	TDLA30-10	4x2, ULA Low	70	0.0

5.2.2.2 TDD

5.2.2.2.1 2Rx TDD FR1 PDSCH mapping Type A performance

5.2.2.2.1.0 Minimum conformance requirements

The performance requirements are specified in Table 5.2.2.2.1.0-3 and Table 5.2.2.2.1.0-4, with the addition of test parameters in Table 5.2.2.2.1.0-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.1.0-1.

Table 5.2.2.2.1.0-1: Tests purpose

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

Table 5.2.2.2.1.0-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDCCH configuration	Number of PRBs in CORESET	PRBs	48 for Test 2-3 102 for other tests
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Tests 1-1 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
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Test 1-1 1 for other tests
	Length		1
Number of HARQ Processes			16 for Test 1-4 8 for other tests
K1 value (PDSCH-to-HARQ-timing-indicator)			Specific to each UL-DL pattern

Table 5.2.2.2.1.0-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-1.1 TDD	40 / 30	QPSK, 0.30	FR1.30-1.1	TDLB100-400	2x2, ULA Low	70	-1.1
1-2	R.PDSCH.2-1.2 TDD	40 / 30	QPSK, 0.30	FR1.30-1	TDLC300-100	2x2, ULA Low	70	0.2
1-3	R.PDSCH.2-4.1 TDD	40 / 30	256QAM, 0.82	FR1.30-1	TDLA30-10	2x2, ULA Low	70	25.3
1-4	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLC300-100	2x2, ULA Low	30	1.6
1-5	R.PDSCH.2-5.1 TDD	40 / 30	QPSK, 0.3	FR1.30-2	TDLA30-10	2x2, ULA Low	70	-0.8
1-6	R.PDSCH.2-6.1 TDD	40 / 30	QPSK, 0.30	FR1.30-3	TDLA30-10	2x2, ULA Low	70	-0.9

Table 5.2.2.2.1.0-4: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.2-3.1 TDD	40 / 30	64QAM, 0.51	FR1.30-1	TDLA30-10	2x2, ULA Low	70	19.8
2-2	R.PDSCH.2-9.1 TDD	20 / 30	64QAM, 0.51	FR1.30-1A	TDLA30-10	2x2, ULA Low	70	19.8

Table 5.2.2.2.1.0-5: Minimum performance for Rank 2 and Enhanced Type X Receiver

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

The normative reference for this requirement is TS 38.101-4 [5] clause 5.2.2.2.1.0.

5.2.2.2.1_1 2Rx TDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA

5.2.2.2.1_1.1 Test Purpose

Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs and number of MIMO layers

5.2.2.2.1_1.2 Test Applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.2.2.2.1_1.3 Test Description

5.2.2.2.1_1.3.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 of TS 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D:

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and clause A.3.2.2 for UE diagram.

2. The parameter settings for the NR cell are set up according to Table 5.2-1 and Table 5.2.2.2.1.0-2 and as appropriate.

3. Downlink signals for the NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1, and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.
4. Propagation conditions for the NR cell are set according to Annex B.0.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without release On, Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.2.1_1.4.3.

5.2.2.2.1_1.3.2 Test Procedure

1. SS transmits PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 5.2.2.2.1_1.4-1 and Table 5.2.2.2.1_1.4-2. The SS sends downlink MAC padding bits on the DL RMC.
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 5.2.2.2.1_1.3-3 and Table 5.2.2.2.1_1.3-4. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Tables 5.2.2.2.1.0-2, 5.2.2.2.1_1.4-1 and 5.2.2.2.1_1.4.4-2 as appropriate.
4. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL during each subtest and decide pass or fail according to Tables G.1.5-2 in Annex G clause G.1.5.
5. Repeat steps from 1 to 4 for each subtest in Table 5.2.2.2.1_1.4.4-1 and Table 5.2.2.2.1_1.4-2 as appropriate.

5.2.2.2.1_1.3.3 Message Contents

Message contents are according to TS 38.508-1 [6] subclause 4.6.1.

5.2.2.2.1_1.3.3_1 Message exceptions for SA

Table 5.2.2.2.1_1.3.3_1-1: Void

Table 5.2.2.2.1_1.3.3_1-2: PDSCH-TimeDomainResourceAllocationList

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-TimeDomainResourceAllocationList::= SEQUENCE(SIZE(1..maxNrofDL-Allocations)) OF {	2 entries		FR1
PDSCH-TimeDomainResourceAllocation[1] SEQUENCE {			
k0	0		
mappingType	typeA		
startSymbolAndLength	53	Start symbol(S)=2, Length(L)=12	
}			
PDSCH-TimeDomainResourceAllocation2 SEQUENCE {			
k0	0		
mappingType	typeA		
startSymbolAndLength	44	S=2, L=4	
}			
}			

Table 5.2.2.2.1_1.3.3_1-3: *PDSCH-Config*

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-Config ::= SEQUENCE {			
dmrs-DownlinkForPDSCH-MappingTypeA CHOICE {			
setup	DMRS-DownlinkConfig		
}			
mcs-Table	qam256	256qam table for test 1-3	
	Not present	64qam table for all tests except test 1-3	
prb-BundlingType CHOICE {			
staticBundling SEQUENCE {			
bundleSize	n4, n2	n4 for test 1-1 n2 for other tests	
}			
}			
}			

Table 5.2.2.2.1_1.3.3_1-4: DMRS-DownlinkConfig

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
DMRS-DownlinkConfig ::= SEQUENCE {			
dmrs-AdditionalPosition	pos1	For all tests except test 1-1	
	pos2	For test 1-1	
}			

Table 5.2.2.2.1_1.3.3_1-5: PDSCH-ServingCellConfig

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-ServingCellConfig ::= SEQUENCE {			
nrofHARQ-ProcessesForPDSCH	n16, n8	n16 for Test 1-4, [2-1] n8 for other tests	
}			

5.2.2.2.1_1.3.3_2 Message exceptions for NSA

Same as 5.2.2.2.1_1.3.3_15.2.2.2.1_1.4 Test Requirements

Table 5.2.2.2.1_1.3-2 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A.3.2.2 for each throughput test shall meet or exceed the specified value in Table 5.2.2.2.1_1.4-1 and 1 and Table 5.2.2.2.1_1.4-2 for the specified SNR including test tolerances for all throughput tests

Table 5.2.2.2.1_1.4-1: Test requirement for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-1.1 TDD	40 / 30	QPSK, 0.30	FR1.30-1.1	TDLB100-400	2x2, ULA Low	70	-0.2
1-2	R.PDSCH.2-1.2 TDD	40 / 30	QPSK, 0.30	FR1.30-1	TDLC300-100	2x2, ULA Low	70	1.1
1-3	R.PDSCH.2-4.1 TDD	40 / 30	256QAM, 0.82	FR1.30-1	TDLA30-10	2x2, ULA Low	70	26.3
1-4	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLC300-100	2x2, ULA Low	30	2.5
1-5	R.PDSCH.2-5.1 TDD	40 / 30	QPSK, 0.3	FR1.30-2	TDLA30-10	2x2, ULA Low	70	0.2
1-6	R.PDSCH.2-6.1 TDD	40 / 30	QPSK, 0.30	FR1.30-3	TDLA30-10	2x2, ULA Low	70	0.1

Table 5.2.2.2.1_1.4-2: Test requirement for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.2-3.1 TDD	40 / 30	64QAM, 0.51	FR1.30-1	TDLA30-10	2x2, ULA Low	70	20.8
2-2	R.PDSCH.2-9.1 TDD	20 / 30	64QAM, 0.51	FR1.30-1A	TDLA30-10	2x2, ULA Low	70	20.8

5.2.2.2.1_2 2Rx TDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA

5.2.2.2.1_2.1 Test Purpose

Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs and number of MIMO layers

5.2.2.2.1_2.2 Test Applicability

This test applies to all types of NR UE release 15 and forward supporting NR enhanced receiver type X.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and NR enhanced receiver type X.

5.2.2.2.1_2.3 Test Description

Same test description as in clause 5.2.2.2.1_1.4 with the following exception:

- Table 5.2.2.2.1_2.4-1 instead of 5.2.2.2.1_1.4-1

5.2.2.2.1_2.4 Test Requirements

Table 5.2.2.2.1_1.3-2 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A.3.2.2 for each throughput test shall meet or exceed the specified value in Table 5.2.2.2.1.4.4-1 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.2.2.1_2.4-1: Test requirement for Rank 2 and Enhanced Type X Receiver

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
3-1	R.PDSCH.2-2.2 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	2x2, ULA Medium	70	19.0

5.2.2.2.2 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance

5.2.2.2.2_1 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA

5.2.2.2.2_1.1 Test Purpose

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

5.2.2.2.2_1.2 Test Applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.2.2.2.2_1.3 Minimum conformance requirements

The performance requirements are specified in Table 5.2.2.2.2_1.3-3, with the addition of test parameters in table 5.2.2.2.2_1.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.2_1.3-1.

Table 5.2.2.2.2_1.3-1: Tests purpose

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

Table 5.2.2.2.2_1.3-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		1

NZP CSI-RS for CSI acquisition	OFDM symbols in the PRB used for CSI-RS		$l_0 = 13$
	CSI-RS periodicity		5
ZP CSI-RS for CSI acquisition	Subcarrier index in the PRB used for CSI-RS		(k_0, k_1, k_2, k_3)=(2, 4, 6, 8)
	Number of CSI-RS ports (X)		8
	CSI-RS periodicity		5
Number of HARQ Processes			8
K1 value (PDSCH-to-HARQ-timing-indicator)			Specific to each UL-DL pattern

Table 5.2.2.2.2_1.3-3: Minimum performance for Rank 2

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

The normative reference for this requirement is TS 38.101-4 [2] clause 5.2.2.1.2

5.2.2.2.2_1.4 Test Description

5.2.2.2.2_1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 5.1.2.1 and 5.1.2.2.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and section A.3.2.2 for UE diagram.
2. The parameter settings for the NR cell are set up according to Table 5.2-1 and Table 5.2.2.2.2_1.3-2 and as appropriate.
3. Downlink signals for the NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1, and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions for the NR cell are set according to Annex B.0.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without release On*, *Test Mode On* or EN-DC, DC bearer *MCG* and *SCG*, *Connected without release On* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.2.2_1.4.3.

5.2.2.2.2_1.4.2 Test Procedure

1. SS transmits PDSCH via PDCCH DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.2.2.2.2_1.1-3. The SS sends downlink MAC padding bits on the DL RMC.

2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to 5.2.2.2.2_1.1-3. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Tables 5.2.2.2.2_1.3-2, 5.2.2.2.2_1.3-3 and 5.2-1 as appropriate.
4. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL during each subtest and decide pass or fail according to Tables G.1.5-2 in Annex G clause G.1.5.

5.2.2.2.2_1.4.3 Message Contents

Message contents are according to TS 38.508-1 [6] subclause 4.6.1

5.2.2.2.2_1.4.3_1 Message exceptions for SA

Table 5.2.2.2.2_1.4.3_1-1: PDSCH-TimeDomainResourceAllocationList

Derivation Path: TS 38.508-1 [6], Table 4.6.3-103			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-TimeDomainResourceAllocationList::= SEQUENCE(SIZE(1..maxNrofDL-Allocations)) OF {	1 entry		FR1
PDSCH-TimeDomainResourceAllocation[1] SEQUENCE {			
startSymbolAndLength	44	Start symbol(S)=2, Length(L)=4	For Slot i, if mod(i, 10) = 7 for i from {0,…,39}
	53	Start symbol(S)=2, Length(L)=12	For Slot i, if mod(i, 10) = {0,1,2,3,4,5,}) for i from {1,…,39}
}			
}			

Table 5.2.2.2.2_1.4.3_1-2: *PDSCH-Config*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-100			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-Config ::= SEQUENCE {			
resourceAllocation	resourceAllocationType0		
prb-BundlingType CHOICE {			
staticBundling SEQUENCE {			
bundleSize	n2	PRB Bundling size of 2	
}			
}			
}			

Table 5.2.2.2.2_1.4.3_1-3: PDSCH-ServingCellConfig

Derivation Path: TS 38.508-1 [6], Table 4.6.3-102			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-ServingCellConfig ::= SEQUENCE {			
nrofHARQ-ProcessesForPDSCH	n8	8 HARQ's	
}			

Table 5.2.2.2.2_1.4.3_1-4: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
frequencyDomainResources	11111111 11111111 10000000 00000000 00000000 00000	CORESET to use the least significant 102 RBs of the BWP	
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			

Table 5.2.2.2.2_1.4.3_1-5: CSI-FrequencyOccupation for TRS

Derivation Path: TS 38.508-1 [6], Table 4.6.3-33			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-FrequencyOccupation ::= SEQUENCE {			
nrofRBs	106	40 MHz	TRS
}			

Table 5.2.2.2.2_1.4.3_1-6: NZP CSI-RS-ResourceMapping for CSI Acquisition

Derivation Path: TS 38.508-1 [6], Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0001	k_0=0	
}			
firstOFDMSymbolInTimeDomain	13	l_0 = 13	
}			

Table 5.2.2.2.2_1.4.3_1-7: CSI-ResourcePeriodicityAndOffset for CSI Acquisition

Derivation Path: TS 38.508-1 [6], Table 4.6.3-43			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-ResourcePeriodicityAndOffset ::= CHOICE {			
Slots5	0	Periodicity 5 slots and offset 0	
}			

Table 5.2.2.2.2_1.4.3_1-8: ZP CSI-RS-ResourceMapping for CSI Acquisition

Derivation Path: TS 38.508-1 [6], clause 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0010	k_0=2	
row1	0100	k_1=4	
row1	0110	k_2=6	
row1	0100	k_3=8	
}			
nrofPorts	P8	Eight Ports	
}			

5.2.2.2.2_1.4.3_2 Message exceptions for NSA

Same as 5.2.2.2.2_1.4.3_2

5.2.2.2.2_1.5 Test Requirements

Table 5.2.2.2.2_1.3-2 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A TBD for each throughput test shall meet or exceed the specified value in Table 5.2.2.2.2_1.3-3 for the specified SNR including test tolerances for all throughput tests

Table 5.2.2.2.2_1.5-1: Test requirement for Rank 2

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-7.1 TDD	16QAM, 0.48	FR1.30-1	TDLC300-100	2x2, ULA Low	70	15.7

5.2.3 4RX requirements

5.2.3.1 FDD

5.2.3.1.1 4Rx FDD FR1 PDSCH mapping Type A performance

5.2.3.1.1.0 Minimum conformance requirements

The performance requirements are specified in Table 5.2.3.1.1.0-3, Table 5.2.3.1.1.0-4, Table 5.2.3.1.1.0-5, Table 5.2.3.1.1.0-6 and Table 5.2.3.1.1.0-7, with the addition of test parameters in Table 5.2.3.1.1.0-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.1.0-1.

Table 5.2.3.1.1.0-1: Tests purpose

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

Table 5.2.3.1.1.0-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Test 1-1 WB for Test 3-1 2 for other tests
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved

Parameter		Unit	Value
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Test 1-1 1 for other tests
	Length		1
Number of HARQ Processes			8 for Test 1-4 4 for other tests
K1 value (PDSCH-to-HARQ-timing-indicator)			2

Table 5.2.3.1.1.0-3: Minimum performance for Rank 1

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

Table 5.2.3.1.1.0-4: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-3.1 FDD	10 / 15	64QAM, 0.51	TDLA30-10	2x4, ULA Low	70	13.5
2-2	R.PDSCH.2-1.1 FDD	20 / 30	64QAM, 0.51	TDLA30-10	2x4, ULA Low	70	13.7

Table 5.2.3.1.1.0-5: Minimum performance for Rank 3

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

Table 5.2.3.1.1.0-6: Minimum performance for Rank 4

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

Table 5.2.3.1.1.0-7: Minimum performance for Rank 3 and Enhanced Type X Receiver

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

The normative reference for this requirement is TS 38.101-4 [5] clause 5.2.3.1.1.

5.2.3.1.1_1 4Rx FDD FR1 PDSCH mapping Type A performance - 2x4 MIMO with baseline receiver for both SA and NSA

5.2.3.1.1_1.1 Test purpose

To verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions and with different channel models, MCSs and number of MIMO layers for a specified downlink Reference Measurement Channel (RMC) to achieve a certain throughput and as well verify the HARQ soft combining with default baseline receiver configuration, for Rank 1 and Rank 2 scenarios.

5.2.3.1.1_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and 4 Rx antenna ports.

5.2.3.1.1_1.3 Test description

5.2.3.1.1_1.3.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D.

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.4 for TE diagram and clause A.3.2.5 for UE diagram.
2. The parameter settings for the cell are set up according to Tables 5.2-1 and 5.2.3.1.1.0-2 and as appropriate.
3. Downlink signals for NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1 and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.0.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.3.1.1_1.3.3.

5.2.3.1.1_1.3.2 Test procedure

1. SS transmits PDSCH via PDCCH DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.2.3.1.1.0-2. The SS sends downlink MAC padding bits on the DL RMC.
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 5.2.3.1.1.0-2. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Tables 5.2.3.1.1_1.4-1 and 5.2.3.1.1_1.4-2 as appropriate.
4. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL during each subtest and decide pass or fail according to Table G.1.5-5 in Annex G clause G.1.5.
5. Repeat steps from 1 to 4 for each subtest in Table 5.2.3.1.1.0-1 as appropriate.

5.2.3.1.1_1.3.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1 and 5.4.2.

5.2.3.1.1_1.3.3_1 Message exceptions for SA

Table 5.2.3.1.1_1.3.3_1-1: *BWP*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-8			
Information Element	**Value/remark**	**Comment**	**Condition**
BWP ::= SEQUENCE {			
locationAndBandwidth	13750	For Test 2-2 (20MHz BW, SCS 30kHz)	
	14025	For other tests (10MHz BW, SCS 15kHz)	
}			

Table 5.2.3.1.1_1.3.3_1-2: *PDSCH-Config*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-100			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-Config ::= SEQUENCE {			
prb-BundlingType CHOICE {			
staticBundling SEQUENCE {			
bundleSize	n4	n4 for test 1-1	
	wideband	wideband for test 3-1	
	Not present	n2 for other tests	
}			
}			
}			

Table 5.2.3.1.1_1.3.3_1-3: DMRS-DownlinkConfig

Derivation Path: TS 38.508-1 [6], Table 4.6.3-50			
Information Element	**Value/remark**	**Comment**	**Condition**
DMRS-DownlinkConfig ::= SEQUENCE {			
dmrs-AdditionalPosition	pos1	pos1 for all tests except test 1-1	
	Not present	pos2 for test 1-1	
}			

Table 5.2.3.1.1_1.3.3_1-4: PDSCH-ServingCellConfig

Derivation Path: TS 38.508-1 [6], Table 4.6.3-102			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-ServingCellConfig ::= SEQUENCE {			
nrofHARQ-ProcessesForPDSCH	Not present	n8 for test 1-4	
	n4	n4 for other tests	
}			

5.2.3.1.1_1.3.3_2 Message exceptions for NSA

Same as 5.2.3.1.1_1.3.3_1

5.2.3.1.1_1.4 Test requirement

Table 5.2.3.1.1.0-3 and Table 5.2.3.1.1.0-4 define the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A.3.2.1 for each throughput test shall meet or exceed the specified value in Table 5.2.3.1.1_1.4-1 and Table 5.2.3.1.1_1.4-2 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.3.1.1_1.4-1: Test Requirement for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.1 FDD	10 / 15	QPSK, 0.30	TDLB100-400	2x4, ULA Low	70	-2.6
1-2	R.PDSCH.1-1.2 FDD	10 / 15	QPSK, 0.30	TDLC300-100	2x4, ULA Low	70	-2.0
1-3	R.PDSCH.1-4.1 FDD	10 / 15	256QAM, 0.82	TDLA30-10	2x4, ULA Low	70	22.0
1-4	R.PDSCH.1-2.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x4, ULA Low	30	-0.6

Table 5.2.3.1.1_1.4-2: Test Requirement for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-3.1 FDD	10 / 15	64QAM, 0.51	TDLA30-10	2x4, ULA Low	70	14.5
2-2	R.PDSCH.2-1.1 FDD	20 / 30	64QAM, 0.51	TDLA30-10	2x4, ULA Low	70	14.7

5.2.3.1.1_2 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with baseline receiver for both SA and NSA

5.2.3.1.1_2.1 Test purpose

To verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions and with different channel models, MCSs and number of MIMO layers for a specified downlink Reference Measurement Channel (RMC) to achieve a certain throughput and as well verify the HARQ soft combining with default baseline receiver configuration, for Rank 3 and Rank 4 scenarios.

5.2.3.1.1_2.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and 4 Rx antenna ports.

5.2.3.1.1_2.3 Test description

Same test description as in clause 5.2.3.1.1_1.3 with the following exception:

- Table 5.2.3.1.1_2.4-1 instead of 5.2.3.1.1_1.4-1
- Table 5.2.3.1.1_2.4-2 instead of 5.2.3.1.1_1.4-2
- Figure A.3.1.7.5 instead of A.3.1.7.4

5.2.3.1.1_2.4 Test requirement

Table 5.2.3.1.1.0-5 and Table 5.2.3.1.1.0-6 define the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A.3.2.1 for each throughput test shall meet or exceed the specified value in Table 5.2.3.1.1_2.4-1 and Table 5.2.3.1.1_2.4-2 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.3.1.1_2.4-1: Test Requirement for Rank 3

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
3-1	R.PDSCH.1-2.3 FDD	10 / 15	16QAM, 0.48	TDLA30-10	4x4, ULA Low	70	12.0

Table 5.2.3.1.1_2.4-2: Test Requirement for Rank 4

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
4-1	R.PDSCH.1-2.4 FDD	10 / 15	16QAM, 0.48	TDLA30-10	4x4, ULA Low	70	16.6

5.2.3.1.1_3 FFS

5.2.3.1.1_4 4Rx TDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with enhanced receiver type X for both SA and NSA

5.2.3.1.1_4.1 Test purpose

To verify the PDSCH mapping Type A enhanced performance under 4 receive antenna conditions for a specified downlink Reference Measurement Channel (RMC) to achieve a certain throughput and as well verify the HARQ soft combining with default enhanced receiver type X configuration, for Rank 3 scenario.

5.2.3.1.1_4.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports and NR enhanced receiver type X.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC, 4 Rx antenna ports and NR enhanced receiver type X.

5.2.3.1.1_4.3 Test description

Same test description as in clause 5.2.3.1.1_1.3 with the following exception:

- Figure A.3.1.7.4 instead of A.3.1.7.5

Step 3 of Test procedure as in clause 5.2.3.1.1_1.3.2 is replaced by:

3. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Table 5.2.3.1.1_4.4-1 as appropriate.

5.2.3.1.1_4.4 Test requirement

Table 5.2.3.1.1.0-7 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A.3.2.1 for each throughput test shall meet or exceed the specified value in Table 5.2.3.1.1_4.4-1 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.3.1.1_4.4-1: Test Requirement for Rank 3 and Enhanced Type X Receiver

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
5-1	R.PDSCH.1-2.3 FDD	10 / 15	16QAM, 0.48	TDLA30-10	4x4, ULA Medium A	70	23.3

5.2.3.1.4 4Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance

5.2.3.1.4.0 Minimum conformance requirements

The performance requirements are specified in Table 5.2.3.1.4-3, with the addition of test parameters in Table 5.2.3.1.4.0-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.4.0-1.

Table 5.2.3.1.4.0-1: 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 5.2.3.1.4.0-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CRS for rate matching (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	MHz	10
	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: No MBSFN is configured on LTE carrier			

Table 5.2.3.1.4.0-3: Minimum performance for Rank 1

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

The normative reference for this requirement is TS 38.101-4 [5], clause 5.2.3.1.4.

5.2.3.1.4_1 4Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x4 MIMO with baseline receiver for both SA and NSA

5.2.3.1.4_1.1 Test purpose

Same as 5.2.2.1.4_1.1.

5.2.3.1.4_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC supporting 4 Rx antenna ports.

5.2.3.1.4_1.3 Test description

5.2.3.1.4_1.3.1 Initial conditions

Same as 5.2.2.1.4_1.3.1 with the following exceptions:

- Use Figure A.3.1.7.4 for TE diagram
- Use Figure A.3.2.5 for UE diagram
- Instead of 5.2.2.1.4.x → refer 5.2.2.3.4.x

5.2.3.1.4_1.3.2 Test procedure

Same as 5.2.2.3.4_1.3.2 with the following exceptions:

- Instead of 5.2.2.1.4.x → refer 5.2.2.3.4.x

5.2.3.1.4_1.3.3 Message contents

Same as 5.2.2.1.4_1.3.3.

5.2.3.1.4_1.3.4 Test requirement

Table 5.2.3.1.4.0-3 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A for each throughput test shall meet or exceed the specified value in Table 5.2.3.1.4_1.3.4-1 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.3.1.4_1.3.4-1: Test requirement for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-7.1 FDD	10 / 15	QPSK, 0.30	TDLA30-10	4x4, ULA Low	70	-3.0
1-2	R.PDSCH.1-7.1 FDD	10 / 15	QPSK, 0.30	TDLA30-10	4x4, ULA Low	70	-3.0

5.2.3.2 TDD

5.2.3.2.1 4Rx TDD FR1 PDSCH mapping Type A performance

5.2.3.2.1.0 Minimum conformance requirements for PDSCH Mapping Type A

The performance requirements are specified in Table 5.2.3.2.1.0-3, Table 5.2.3.2.1.0-4, Table 5.2.3.2.1.0-5 and Table 5.2.3.2.1.0-6, with the test parameters defined in Table 5.2.3.2.1.0-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.1.0-1.

Table 5.2.3.2.1.0-1: Tests purpose

Purpose	Test index
[Verify the PDSCH mapping Type A normal performance under4 receive antenna conditions and with different channel models, MCSs and number of MIMO layers]	[1-1, 1-2, 1-3, 1-5, 1-6, 2-1, 2-2, 3-1, 4-1]
[Verify the PDSCH mapping Type A HARQ soft combining performance under 4 receive antenna conditions.]	[1-4]
[Verify the PDSCH mapping Type A enhanced performance requirement Type X under 4 receive antenna conditions and with 3 MIMO layers.]	[3-2]

Table 5.2.3.2.1.0-2: Test Parameters for Testing

Parameter		Unit	Value
Channel bandwidth		MHz	20 for Test 2-2 40 for other tests
Duplex mode			TDD
Active DL BWP index			1
DL BWP configuration #1	First PRB		0
	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
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for 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
PDSCH DMRS configuration	DMRS Type		Type 1
	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 5.2.3.2.1.0-3: Minimum performance for Rank 1

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-1.1 TDD	QPSK, 0.30	FR1.30-1	TDLB100-400	2x4, ULA Low	70	[-3.9]
1-2	R.PDSCH.2-1.2 TDD	QPSK, 0.30	FR1.30-1	TDLC300-100	2x4, ULA Low	70	[-2.7]
1-3	R.PDSCH.2-4.1 TDD	256QAM, 0.82	FR1.30-1	TDLA30-10	2x4, ULA Low	70	[TBD]
1-4	R.PDSCH.2-2.1 TDD	16QAM, 0.48	FR1.30-1	TDLC300-100	2x4, ULA Low	30	[-1.1]
1-5	[R.PDSCH.2-5.1 TDD]	QPSK, 0.3	FR1.30-2	TDLA30-10	2x4, ULA Low	70	[-3.9]
1-6	[R.PDSCH.2-6.1 TDD]	QPSK, 0.30	FR1.30-3	TDLA30-10	2x4, ULA Low	70	[-3.9]

Table 5.2.3.2.1.0-4: Minimum performance for Rank 2

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.2-3.1 TDD	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	[13.8]

Table 5.2.3.2.1.0-5: Minimum performance for Rank 3

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
3-1	R.PDSCH.2-2.3 TDD	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	[11.4]
3-2	R.PDSCH.2-2.3 TDD	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Medium A	70	[22.9]

Table 5.2.3.2.1.0-6: Minimum performance for Rank 4

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
4-1	R.PDSCH.2-2.4 TDD	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	[16.1]

The normative reference for this requirement is TS 38.101-4 [5] clause 5.2.3.2.1.

5.2.3.2.1_1 4Rx FDD FR1 PDSCH mapping Type A performance - 2x4 MIMO with baseline receiver for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update

-SNR is in [ ]

-Annex for measurement uncertainty and test tolerance is TBD

-Annex for DL and UL signal setup is TBD

- PDSCH and PDCCH configuration before measurement is TBD

- LTE link setup details is TBD

- Propagation condition description in Annex is TBD

- Annex for statistical tput calculation is TBD

- Test tolerance analysis is missing

- Message contents are TBD

- TCI State/QCL Info is TBD

- Connection diagram is TBD

-All TBD's coming from core requirement in 38.101-4 pertaining to this test case needs to be defined

5.2.3.2.1_1.1 Test purpose

[To verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions and with different channel models, MCSs and number of MIMO layers for a specified downlink Reference Measurement Channel (RMC) to achieve a certain throughput and as well verify the HARQ soft combining with default baseline receiver configuration, for Rank 1, Rank 2, Rank 3 & Rank 4 scenarios.]

5.2.3.2.1_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.2.3.2.1_1.3 Test description

5.2.3.2.1_1.3.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [TBD].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [TBD] clause TBD.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [TBD] clause TBD.

For EN-DC within FR1 operation, setup the LTE link according to Annex D.

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [TBD] Annex A, in Figure TBD for TE diagram and clause TBD for UE diagram.

2. The parameter settings for the cell are set up according to Table 5.2-1 and Table 5.2.3.2.1.0-2 and as appropriate.

3. Downlink signals for NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1 and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without release On)* for NSA according to TS 38.508-1 [TBD] clause 4.5. Message content are defined in clause 5.2.3.2.1_1.4.3.

5.2.3.2.1_1.3.2 Test procedure

1. SS transmits PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 5.2.3.2.1.0-3, Table 5.2.3.2.1.0-4, Table 5.2.3.2.1.0-5 and Table 5.2.3.2.1.0-6. The SS sends downlink MAC padding bits on the DL RMC.

2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 5.2.3.2.1.0-3, Table 5.2.3.2.1.0-4, Table 5.2.3.2.1.0-5 and Table 5.2.3.2.1.0-6. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.

3. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Tables 5.2.3.2.1.0-1, 5.2.3.2.1.0-2 and as appropriate.

4. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex TBD clause TBD. Count the number of NACKs, ACKs and statDTXs on the UL during each subtest and decide pass or fail according to Tables TBD in Annex TBD clause TBD.

5. Repeat steps from 1 to 3 for each subtest in Table 5.2.3.2.1.0-1 as appropriate.

5.2.3.2.1_1.3.3 Message contents

Message contents are according to TS 38.508-1 [TBD] clause 4.6.1.

5.2.3.2.1_1.3.3_1 Message exceptions for SA

Table 5.2.3.2.1_1.3.3_1: message exceptions for SA

FFS

5.2.3.2.1_1.3.3_2 Message exceptions for NSA

Table 5.2.3.2.1_1.3.3_2: message exceptions for NSA

FFS

5.2.3.2.1_1.3.4 Test requirement

Table 5.2.3.2.1.0-2 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A TBD for each throughput test shall meet or exceed the specified value in Table 5.2.3.2.1_1.3.4-1, Table 5.2.3.2.1_1.3.4-2, Table 5.2.3.2.1_1.3.4-3 and Table 5.2.3.2.1_1.3.4-4 for the specified SNR including test tolerances for all throughput tests.

Table 5.2.3.2.1_1.3.4-1: Test Requirements for Rank 1

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-1.1 TDD	QPSK, 0.30	FR1.30-1	TDLB100-400	2x4, ULA Low	70	[-3.9] + TT
1-2	R.PDSCH.2-1.2 TDD	QPSK, 0.30	FR1.30-1	TDLC300-100	2x4, ULA Low	70	[-2.7] + TT
1-3	R.PDSCH.2-4.1 TDD	256QAM, 0.82	FR1.30-1	TDLA30-10	2x4, ULA Low	70	[TBD] + TT
1-4	R.PDSCH.2-2.1 TDD	16QAM, 0.48	FR1.30-1	TDLC300-100	2x4, ULA Low	30	[-1.1] + TT
1-5	[R.PDSCH.2-5.1 TDD]	QPSK, 0.3	FR1.30-2	TDLA30-10	2x4, ULA Low	70	[-3.9] + TT
1-6	[R.PDSCH.2-6.1 TDD]	QPSK, 0.30	FR1.30-3	TDLA30-10	2x4, ULA Low	70	[-3.9] + TT

Table 5.2.3.2.1_1.3.4-2: Test Requirements for Rank 2

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.2-3.1 TDD	64QAM, 0.51	FR1.30-1	TDLA30-10	2x4, ULA Low	70	[TBD] + TT
2-2	R.PDSCH.2-3.2 TDD	64QAM, 0.51	FR1.30-1	TDLA30-10	2x4, ULA Low	70	[13.8] + TT

5.2.3.2.1_2 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with baseline receiver for both SA and NSA

Editor's note: Same editor's note as in clause 5.2.3.2.1_1

5.2.3.2.1_2.1 Test purpose

Same test purpose as in clause 5.2.3.2.1_1.1.

5.2.3.2.1_2.2 Test applicability

Same test applicability as in clause 5.2.3.2.1_1.2.

5.2.3.2.1_2.3 Test description

5.2.3.2.1_2.3.1 Initial conditions

Same initial conditions as in clause 5.2.3.2.1_1.3.1.

5.2.3.2.1_2.3.2 Test procedure

Same test procedure as in clause 5.2.3.2.1_1.3.2.

5.2.3.2.1_2.3.3 Message contents

Message contents are according to TS 38.508-1 [TBD] clause 4.6.1.

5.2.3.2.1_2.3.3_1 Message exceptions for SA

Table 5.2.3.2.1_2.3.3_1: message exceptions for SA

FFS

5.2.3.2.1_2.3.3_2 Message exceptions for NSA

Table 5.2.3.2.1_2.3.3_2: message exceptions for NSA

FFS

5.2.3.2.1_2.3.4 Test requirement

Same test requirement as in 5.2.3.2.1_1.3.4

Table 5.2.3.2.1_2.3.4-3: Test Requirements for Rank 3

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
3-1	R.PDSCH.2-2.3 TDD	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	[11.4] + TT

Table 5.2.3.2.1_2.3.4-4: Test Requirements for Rank 4

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
4-1	R.PDSCH.2-2.4 TDD	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	[16.1] + TT

5.2.3.2.1_3 FFS

5.2.3.2.1_4 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with enhanced receiver type X for both SA and NSA

Editor's note: Same editor's note as in clause 5.2.3.2.1_1

5.2.3.2.1_4.1 Test purpose

Same test purpose as in clause 5.2.3.2.1_1.1.

5.2.3.2.1_4.2 Test applicability

Same test applicability as in clause 5.2.3.2.1_1.2.

5.2.3.2.1_4.3 Test description

5.2.3.2.1_4.3.1 Initial conditions

Same initial conditions as in clause 5.2.3.2.1_1.3.1.

5.2.3.2.1_4.3.2 Test procedure

Same test procedure as in clause 5.2.3.2.1_1.3.2.

5.2.3.2.1_4.3.3 Message contents

Message contents are according to TS 38.508-1 [TBD] clause 4.6.1.

5.2.3.2.1_4.3.3_1 Message exceptions for SA

Table 5.2.3.2.1_4.3.3_1: message exceptions for SA

FFS

5.2.3.2.1_4.3.3_2 Message exceptions for NSA

Table 5.2.3.2.1_4.3.3_2: message exceptions for NSA

FFS

5.2.3.2.1_4.3.4 Test requirement

Same test requirement as in clause 5.2.3.2.1_1.3.4.

Table 5.2.3.2.1_4.3.4-3: Test Requirements for Rank 3

Test num.	Reference channel	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
3-2	R.PDSCH.2-2.3 TDD	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Medium A	70	[22.9] + TT

5.3 PDCCH demodulation requirements

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

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

Table 5.3-1: Common test Parameters

Parameter			Unit	Value
DL BWP configuration #1	Cyclic prefix			Normal
Common serving cell parameters	Physical Cell ID			0
	SSB position in burst			1
	SSB periodicity		ms	20
PDCCH configuration	Slots for PDCCH monitoring			Each slot
	Number of PDCCH candidates			1
	TCI state			TCI state #1
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k_0)			0
	First OFDM symbol in the PRB used for CSI-RS (l_0)			CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4: 8
	Number of CSI-RS ports (*X*)			1
	CDM Type			No CDM
	Density (ρ)			3
	CSI-RS periodicity		Slots	15 kHz SCS: 20 30 kHz SCS: 40
	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
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
Precoding configuration				SP Type I, Random per slot with REG bundling granularity for number of Tx larger than 1
Symbols for all unused Res				OCNG in Annex A.5

The normative reference for this requirement is TS 38.101-4 [2] clause 5.3.

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 2Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA

5.3.2.1.1.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a single-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 5.3.2.1.1.3-1. The downlink physical setup is in accordance with Annex C.3.1.

5.3.2.1.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.3.2.1.1.3 Minimum conformance requirements

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 5.3.2.1.1.3-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.2.1.1.3-1: Minimum performance for 1 Tx PDCCH with 15 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								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	8.1
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	4.4
5	10 MHz	48	2	16	R.PDCCH.1-2.6 FDD	TDLA30-10	1x2 Low	1	-2.1

The normative reference for this requirement is TS 38.101-4 [2] clause 5.3.

5.3.2.1.1.4 Test description

5.3.2.1.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D:

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A in Figure A.3.1.7.2 for TE diagram and clause A.3.2.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1 and Table 5.3.2.1.1-1 and as appropriate.
3. Downlink signals for NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1 and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On*, *Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG*, *Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1.4.3.

5.3.2.1.1.4.2 Test procedure

1. SS transmits PDCCH with DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.3.2.1.1-1. The details of PDCCH are specified in Table 5.3.1, Table 5.3.2.1-1, Table 5.3.2.1.1.3-1 respectively. The SS sends downlink MAC padding bits on the DL RMC.
2. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 5.3.2.1.1-1 as appropriate.
3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 5.3.2.1.1-1, pass the UE. Otherwise fail the UE.
4. Repeat steps from 1 to 3 for each subtest in Table 5.3.2.1.1-1 as appropriate.

5.3.2.1.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.3.2.1.1.4.3.1 Message exceptions for SA

Table 5.3.2.1.1.4.3.1-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
frequencyDomainResources	11111111 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 48 RBs of the BWP Test 3, 4, 5	
	11110000 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 24 RBs of the BWP Test 1, 2	
Duration	2	SearchSpace duration of 2 symbols Test 1, 2, 3, 5	
	1	SearchSpace duration of 1 symbol Test 4	
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			

Table 5.3.2.1.1.4.3.1-7: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
searchSpaceId	1	SearchSpaceId with condition USS	USS
controlResourceSetId	0	ControlResourceSetId	
monitoringSlotPeriodicityAndOffset CHOICE {			
sl1	NULL		
}			
monitoringSymbolsWithinSlot	11000000000000	Symbols 0 and 1	
nrofCandidates SEQUENCE {			
aggregationLevel1	n0		
aggregationLevel2	n1	AL2	Test 1, Test 2
aggregationLevel4	n1	AL4	Test 3, Test 4
aggregationLevel8	n0		
aggregationLevel16	n1	AL16	Test 5
}			
searchSpaceType CHOICE {			
common SEQUENCE {			CSS, SISS
ue-Specific SEQUENCE {			USS
dci-Formats	formats0-1-And-1-1	DCI Format 1_1	Long_DCI
}			
}			
}			

5.3.2.1.1.4.3.2 Message exceptions for NSA

Same as 5.3.2.1.1.4.3.1

5.3.2.1.1.4.4 Test requirement

Table 5.3.2.1.1.4.4-1 defines the primary level settings.

For the parameters specified in Table 5.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.2.1.1.4.4-1.

Table 5.3.2.1.1.4.4-1: Test Requirement for 1Tx PDCCH with 15 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10 MHz	24	2	2	R.PDCCH.1-2.1 FDD	TDLA30-10	1x2 Low	1	8.9
2	10 MHz	24	2	2	R.PDCCH.1-2.3 FDD	TDLC300-100	1x2 Low	1	8.9
3	10 MHz	48	2	4	R.PDCCH.1-2.4 FDD	TDLA30-10	1x2 Low	1	6.4
4	10 MHz	48	1	4	R.PDCCH.1-1.1 FDD	TDLA30-10	1x2 Low	1	5.3
5	10MHz	48	2	16	R.PDCCH.1-2.6 FDD	TDLA30-10	1x2 Low	1	-1.5

5.3.2.1.2 2Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA

5.3.2.1.2.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a two-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 5.3.2.1.2.3-1. The downlink physical setup is in accordance with Annex C.3.1.

5.3.2.1.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.3.2.1.2.3 Minimum conformance requirements

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 5.3.2.1.2.3-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.2.1.2.3-1: Minimum performance for 2 Tx PDCCH with 15 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10 MHz	24	2	4	R.PDCCH.1-2.2 FDD	TDLC300-100	2x2 Low	1	2.0
2	10 MHz	48	2	8	R.PDCCH.1-2.5 FDD	TDLC300-100	2x2 Low	1	[-1. 5]
3	10 MHz	48	1	8	R.PDCCH.1-1.3 FDD	TDLA30-10	2x2 Low	1	[-0.3]

The normative reference for this requirement is TS 38.101-4 [2] clause 5.3.

5.3.2.1.2.4 Test description

5.3.2.1.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and clause A.3.2.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1, Table 5.3.2.1-1 and Table 5.3.2.1.2.3-1 and as appropriate.
3. Downlink signals for NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1 and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On*, *Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1.4.3.

5.3.2.1.2.4.2 Test procedure

1. SS transmits PDCCH with DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 5.3.2.1.1-1. The details of PDCCH are specified in Table [ ] respectively. The SS sends downlink MAC padding bits on the DL RMC.
2. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 5.3.2.1.2.3-1 as appropriate.
3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 5.3.2.1.1-1, pass the UE. Otherwise fail the UE.
4. Repeat steps from 1 to 3 for each subtest in Table 5.3.2.1.2.3-1 as appropriate.

5.3.2.1.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.3.2.1.2.4.3.1 Message exceptions for SA

Table 5.3.2.1.1.4.3.1-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
frequencyDomainResources	11111111 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 48 RBs of the BWP Test 2, 3	
	11110000 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 24 RBs of the BWP Test 1	
Duration	2	SearchSpace duration of 2 symbols Test 1, 2	
	1	SearchSpace duration of 1 symbol Test 3	
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			

Table 5.3.2.1.1.4.3.1-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
nrofCandidates SEQUENCE {			
aggregationLevel1	n0		
aggregationLevel2	n0		
aggregationLevel4	n1	AL4	Test 1
aggregationLevel8	n1	AL8	Test 2, 3
aggregationLevel16	n0		
}			
searchSpaceType CHOICE {			
common SEQUENCE {			CSS, SISS
ue-Specific SEQUENCE {			USS
dci-Formats	formats0-1-And-1-1	DCI Format 1_1	Long_DCI
}			
}			
}			

5.3.2.1.2.4.3.2 Message exceptions for NSA

Same as 5.3.2.1.2.4.3.1

5.3.2.1.2.4.4 Test requirement

Table 5.3.2.1.2.4.4-1 defines the primary level settings.

For the parameters specified in Table 5.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.2.1.2.4.4-1.

Table 5.3.2.1.2.4.4-1: Test Requirements for 2 Tx PDCCH with 15 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10 MHz	24	2	4	R.PDCCH.1-2.2 FDD	TDLC300-100	2x2 Low	1	2.9
2	10 MHz	48	2	8	R.PDCCH.1-2.5 FDD	TDLC300-100	2x2 Low	1	-0.6
3	10 MHz	48	1	8	R.PDCCH.1-1.3 FDD	TDLA30-10	2x2 Low	1	0.7

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 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update
    - SNR in min requirements table is within square brackets.

5.3.2.2.1.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a single-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 5.3.2.2.1.3-1. The downlink physical setup is in accordance with Annex C.3.1.

5.3.2.2.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.3.2.2.1.3 Minimum conformance requirements

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 5.3.2.2.1.3-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.2.2.1.3-1: Minimum performance for PDCCH with 30 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								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]

The normative reference for this requirement is TS 38.101-4 [5] clause 5.3.2.2.

5.3.2.2.1.4 Test description

5.3.2.2.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-2 of 38.521-1 [7].

Configurations of PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D.

1. Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.2 for TE diagram and section A.3.2.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1, Table 5.3.2.2-1 and Table 5.3.2.2.1.3-1 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On*, *Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.3.2.2.1.4.3.

5.3.2.2.1.4.2 Test procedure

1. SS transmits PDCCH with DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.3.2.2.1.3-1. The details of PDCCH are specified in Table 5.3-1, Table 5.3.2.2-1 and Table 5.3.2.2.1.3-1 respectively. The SS sends downlink MAC padding bits on the DL RMC.
2. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 5.3.2.2.1.3-1 as appropriate.
3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 5.3.2.2.1.5-1, pass the UE. Otherwise fail the UE.

4. Repeat steps from 1 to 3 for each subtest in Table 5.3.2.2.1.3-1 as appropriate.

5.3.2.2.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.3.2.2.1.4.3.1 Message exceptions for SA

Table 5.3.2.2.1.4.3.1-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
controlResourceSetId	ControlResourceSetId		
frequencyDomainResources	11111111 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 48 RBs of the BWP Test 3, 4, 5	
	11110000 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 24 RBs of the BWP Test 1, 2	
Duration	2	SearchSpace duration of 2 symbols Test 1, 2, 3, 5	
	1	SearchSpace duration of 1 symbol Test 4	
cce-REG-MappingType CHOICE {			
Interleaved SEQUENCE {	Null		
reg-BundleSize	n2		1 Tx
interleaverSize	n3		TDD
}			
precoderGranularity	sameAsREG-bundle		
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			
}			

Table 5.3.2.2.1.4.3.1-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
searchSpaceId	0	SearchSpaceId with condition CSS	CSS
controlResourceSetId	0	ControlResourceSetId	
monitoringSlotPeriodicityAndOffset CHOICE {			
sl1	NULL		
}			
monitoringSymbolsWithinSlot	11000000000000	Symbols 0 and 1	
nrofCandidates SEQUENCE {			
aggregationLevel2	n1	AL2	Test 1
aggregationLevel4	n1	AL4	Test 2
aggregationLevel16	n1	AL16	Test 3
}			
searchSpaceType CHOICE {			
common SEQUENCE {			CSS, SISS
ue-Specific SEQUENCE {			USS
dci-Formats	formats0-1-And-1-1	DCI Format 1_1	Long_DCI
}			
}			
}			
}			

5.3.2.2.1.4.3.2 Message exceptions for NSA

Same as 5.3.2.2.1.4.3.1.5.3.2.2.1.5 Test requirement

Table 5.3.2.2.1.5-1 defines the primary level settings.

For the parameters specified in Table 5.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.2.2.1.5-1.

Table 5.3.2.2.1.5-1: Test Requirement for 1Tx PDCCH with 30 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40 MHz	102	1	2	R.PDCCH. 2-1.1 TDD	TDL A30-10	1x2 Low	1	[6.7]+ 0.9
2	40 MHz	102	1	4	R.PDCCH. 2-1.2 TDD	TDL C300 - 100	1x2 Low	1	[2.7]+ 0.9
3	40 MHz	48	2	16	R.PDCCH. 2-2.1 TDD	TDL C300 - 100	1x2 Low	1	[-4.4]+ 0.9

5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update

  - SNR in min requirements table is within square brackets.

5.3.2.2.2.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a two-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 5.3.2.2.2.3-1. The downlink physical setup is in accordance with Annex C.3.1.

5.3.2.2.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

5.3.2.2.2.3 Minimum conformance requirements

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 5.3.2.2.2.3-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.2.2.2.3-1: Minimum performance for PDCCH with 30 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40 MHz	[90]	1	8	R.PDCCH.2-1.3 TDD	TDLC300-100	2x2 Low	1	[-1.5]

The normative reference for this requirement is TS 38.101-4 [5] clause 5.3.2.2.

5.3.2.2.2.4 Test description

5.3.2.2.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-2 of 38.521-1 [7].

Configurations of PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause TBD.

For EN-DC within FR1 operation, setup the LTE link according to Annex D.

1. Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and section A.3.2.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1, Table 5.3.2.2-1 and Table 5.3.2.2.2.3-1 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On, Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.3.2.2.2.4.3.

5.3.2.2.2.4.2 Test procedure

1. SS transmits PDCCH with DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.3.2.2.2.3-1. The details of PDCCH are specified in Table 5.3-1, Table 5.3.2.2-1 and Table 5.3.2.2.2.3-1 respectively. The SS sends downlink MAC padding bits on the DL RMC.

2. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 5.3.2.2.2.3-1 as appropriate.

3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 5.3.2.2.2.5-1, pass the UE. Otherwise fail the UE.

5.3.2.2.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.3.2.2.2.4.3.1 Message exceptions for SA

Table 5.3.2.2.2.4.3.1-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
controlResourceSetId	ControlResourceSetId		
frequencyDomainResources	11111111 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 48 RBs of the BWP Test 3, 4, 5	
	11110000 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 24 RBs of the BWP Test 1, 2	
Duration	2	SearchSpace duration of 2 symbols Test 1, 2, 3, 5	
	1	SearchSpace duration of 1 symbol Test 4	
cce-REG-MappingType CHOICE {			
Interleaved SEQUENCE {	Null		
reg-BundleSize	n6		2 Tx
interleaverSize	n3		TDD
}			
precoderGranularity	sameAsREG-bundle		
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			
}			

Table 5.3.2.2.2.4.3.1-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
searchSpaceId	0	SearchSpaceId with condition CSS	CSS
controlResourceSetId	0	ControlResourceSetId	
monitoringSlotPeriodicityAndOffset CHOICE {			
sl1	NULL		
}			
monitoringSymbolsWithinSlot	11000000000000	Symbols 0 and 1	
nrofCandidates SEQUENCE {			
aggregationLevel8	n1	AL8	Test 1
}			
searchSpaceType CHOICE {			
common SEQUENCE {			CSS, SISS
ue-Specific SEQUENCE {			USS
dci-Formats	formats0-1-And-1-1	DCI Format 1_1	Long_DCI
}			
}			
}			
}			

5.3.2.2.2.4.3.2 Message exceptions for NSA

Same as 5.3.2.2.2.4.3.1.

5.3.2.2.2.5 Test requirement

Table 5.3.2.2.2.5-1 defines the primary level settings.

For the parameters specified in Table 5.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.2.2.2.5-1.

Table 5.3.2.2.2.5-1: Test Requirement for 2Tx PDCCH with 30 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	**SNR (dB)**
1	40 MHz	[90]	1	8	R.PDCCH.2-1.3 TDD	TDLC300-100	2x2 Low	1	[-1.5]+1.0

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 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update

  - SNR in min requirements table is within square brackets.

5.3.3.1.1.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a single-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 5.3.3.1.1.3-1. The downlink physical setup is in accordance with Annex C.3.1.

5.3.3.1.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and 4 Rx antenna ports.

5.3.3.1.1.3 Minimum conformance requirements

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 5.3.3.1.1.3-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.3.1.1.3-1: Minimum performance for PDCCH with 15 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10 MHz	24	2	2	R.PDCCH. 1-2.1 FDD	TDLA30-10	1x4 Low	1	[2.3]
2	10 MHz	24	2	2	R.PDCCH. 1-2.3 FDD	TDLC300-100	1x4 Low	1	[2.5]
3	10 MHz	48	2	4	R.PDCCH. 1-2.4 FDD	TDLA30-10	1x4 Low	1	[0.0]
4	10 MHz	48	1	4	R.PDCCH. 1-1.1 FDD	TDLA30-10	1x4 Low	1	[-0.7]

The normative reference for this requirement is TS 38.101-4 [5] clause 5.3.3.1.

5.3.3.1.1.4 Test description

5.3.3.1.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D.

1. Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.3 for TE diagram and section A.3.2.5 for UE diagram.

2. The parameter settings for the cell are set up according to Table 5.3-1, Table 5.3.3.1-1 and Table 5.3.3.1.1.3-1 as appropriate.

3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On, Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.3.3.1.1.4.3.

5.3.3.1.1.4.2 Test procedure

1. SS transmits PDCCH with DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.3.3.1.1.3-1. The details of PDCCH are specified in Table 5.3-1, Table 5.3.3.1-1 and Table 5.3.3.1.1.3-1 respectively. The SS sends downlink MAC padding bits on the DL RMC.

2. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 5.3.3.1.1.3-1 as appropriate.

3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause G.1.5. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 5.3.3.1.1.5-1, pass the UE. Otherwise fail the UE.

4. Repeat steps from 1 to 3 for each subtest in Table 5.3.3.1.1.3-1 as appropriate.

5.3.3.1.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.3.3.1.1.4.3.1 Message exceptions for SA

Table 5.3.3.1.1.4.3.1-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
controlResourceSetId	ControlResourceSetId		
frequencyDomainResources	11111111 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 48 RBs of the BWP Test 3, 4, 5	
	11110000 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 24 RBs of the BWP Test 1, 2	
Duration	2	SearchSpace duration of 2 symbols Test 1, 2, 3, 5	
	1	SearchSpace duration of 1 symbol Test 4	
precoderGranularity	sameAsREG-bundle		
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			

Table 5.3.3.1.1.4.3.1-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
searchSpaceId	0	SearchSpaceId with condition CSS	CSS
controlResourceSetId	0	ControlResourceSetId	
monitoringSlotPeriodicityAndOffset CHOICE {			
sl1	NULL		
}			
monitoringSymbolsWithinSlot	11000000000000	Symbols 0 and 1	
nrofCandidates SEQUENCE {			
aggregationLevel2	n1	AL2	Test 1, Test 2
aggregationLevel4	n1	AL4	Test 3, Test 4
}			
searchSpaceType CHOICE {			
common SEQUENCE {			CSS, SISS
ue-Specific SEQUENCE {			USS
dci-Formats	formats0-1-And-1-1	DCI Format 1_1	Long_DCI
}			
}			
}			
}			

5.3.3.1.1.4.3.2 Message exceptions for NSA

Same as 5.3.3.1.1.4.3.1.

5.3.3.1.1.5 Test requirement

Table 5.3.3.1.1.5-1 defines the primary level settings.

For the parameters specified in Table 5.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.3.1.1.5-1.

Table 5.3.3.1.1.5-1: Test Requirement for 1Tx PDCCH with 15 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10 MHz	24	2	2	R.PDCCH. 1-2.1 FDD	TDLA30-10	1x4 Low	1	[2.3]+ 0.9
2	10 MHz	24	2	2	R.PDCCH. 1-2.3 FDD	TDLC300-100	1x4 Low	1	[2.5]+ 0.9
3	10 MHz	48	2	4	R.PDCCH. 1-2.4 FDD	TDLA30-10	1x4 Low	1	[0.0]+ 0.9
4	10 MHz	48	1	4	R.PDCCH. 1-1.1 FDD	TDLA30-10	1x4 Low	1	[-0.7]+ 0.9

5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update

    - SNR in min requirements table is within square brackets.

5.3.3.1.2.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a single-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 5.3.3.1.2.3-1. The downlink physical setup is in accordance with Annex C.3.1.

5.3.3.1.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and 4 Rx antenna ports.

5.3.3.1.2.3 Minimum conformance requirements

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 5.3.3.1.2.3-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.3.1.2.3-1: Minimum performance for PDCCH with 15 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10 MHz	24	2	4	R.PDCCH. 1-2.2 FDD	TDLC300-100	2x4 Low	1	TBD
2	10 MHz	48	2	8	R.PDCCH. 1-2.5 FDD	TDLC300-100	2x4 Low	1	[-4.8]
3	10 MHz	48	1	4	R.PDCCH. 1-1.3 FDD	TDLA30-10	2x4 Low	1	TBD

The normative reference for this requirement is TS 38.101-4 [5] clause 5.3.3.1.

5.3.3.1.2.4 Test description

5.3.3.1.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D.

1. Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.4 for TE diagram and section A.3.2.5 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1, Table 5.3.3.1-1 and Table 5.3.3.1.2.3-1 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On*, *Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.3.3.1.2.4.3.

5.3.3.1.2.4.2 Test procedure

1. SS transmits PDCCH with DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.3.3.1.2.3-1. The details of PDCCH are specified in Table 5.3-1, Table 5.3.3.1-1 and Table 5.3.3.1.2.3-1 respectively. The SS sends downlink MAC padding bits on the DL RMC.
2. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 5.3.3.1.2.3-1 as appropriate.
3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause [G.1.x]. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 5.3.3.1.2.5-1, pass the UE. Otherwise fail the UE.

4. Repeat steps from 1 to 3 for each subtest in Table 5.3.3.1.2.3-1 as appropriate.

5.3.3.1.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.3.3.1.2.4.3.1 Message exceptions for SA

Table 5.3.3.1.2.4.3.1-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
controlResourceSetId	ControlResourceSetId		
frequencyDomainResources	11111111 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 48 RBs of the BWP Test 3, 4, 5	
	11110000 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 24 RBs of the BWP Test 1, 2	
Duration	2	SearchSpace duration of 2 symbols Test 1, 2, 3, 5	
	1	SearchSpace duration of 1 symbol Test 4	
precoderGranularity	sameAsREG-bundle		
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			

Table 5.3.3.1.2.4.3.1-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
searchSpaceId	0	SearchSpaceId with condition CSS	CSS
controlResourceSetId	0	ControlResourceSetId	
monitoringSlotPeriodicityAndOffset CHOICE {			
sl1	NULL		
}			
monitoringSymbolsWithinSlot	11000000000000	Symbols 0 and 1	
nrofCandidates SEQUENCE {			
aggregationLevel4	n1	AL4	Test 1, Test 3
aggregationLevel8	n1	AL8	Test 2
}			
searchSpaceType CHOICE {			
common SEQUENCE {			CSS, SISS
ue-Specific SEQUENCE {			USS
dci-Formats	formats0-1-And-1-1	DCI Format 1_1	Long_DCI
}			
}			
}			
}			

5.3.3.1.2.4.3.2 Message exceptions for NSA

Same as 5.3.3.1.2.4.3.1.

5.3.3.1.2.5 Test requirement

Table 5.3.3.1.2.5-1 defines the primary level settings.

For the parameters specified in Table 5.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.3.1.2.5-1.

Table 5.3.3.1.2.5-1: Test Requirement for 2Tx PDCCH with 15 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	**SNR (dB)**
1	10 MHz	24	2	4	R.PDCCH. 1-2.2 FDD	TDLC300-100	2x4 Low	1	TBD+ 1.0
2	10 MHz	48	2	8	R.PDCCH. 1-2.5 FDD	TDLC300-100	2x4 Low	1	[-4.8]+ 1.0
3	10 MHz	48	1	4	R.PDCCH. 1-1.3 FDD	TDLA30-10	2x4 Low	1	TBD+ 1.0

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 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update
  - SNR in minimum requirements table is TBD

5.3.3.2.1.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a single-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 5.3.3.2.1.3-1. The downlink physical setup is in accordance with Annex C.3.1.

5.3.3.2.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and 4 Rx antenna ports.

5.3.3.2.1.3 Minimum conformance requirements

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 5.3.3.2.1.3-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.3.2.1.3-1: Minimum performance for PDCCH with 30 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								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]

The normative reference for this requirement is TS 38.101-4 [5] clause 5.3.3.2.

5.3.3.2.1.4 Test description

5.3.3.2.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-2 of 38.521-1 [7].

Configurations of PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D.

1. Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.3 for TE diagram and section A.3.2.5 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1, Table 5.3.3.2-1 and Table 5.3.3.2.1.3-1 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On, Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.3.3.2.1.4.3.

5.3.3.2.1.4.2 Test procedure

1. SS transmits PDCCH with DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.3.3.2.1.3-1. The details of PDCCH are specified in Table 5.3-1, Table 5.3.3.2-1 and Table 5.3.3.2.1.3-1 respectively. The SS sends downlink MAC padding bits on the DL RMC.
2. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 5.3.3.2.1.3-1 as appropriate.
3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause [G.1.x]. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 5.3.3.2.1.5-1, pass the UE. Otherwise fail the UE.
4. Repeat steps from 1 to 3 for each subtest in Table 5.3.3.2.1.3-1 as appropriate.

5.3.3.2.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.3.3.2.1.4.3.1 Message exceptions for SA

Table 5.3.3.2.1.4.3.1-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
controlResourceSetId	ControlResourceSetId		
frequencyDomainResources	11111111 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 48 RBs of the BWP Test 3, 4, 5	
	11110000 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 24 RBs of the BWP Test 1, 2	
Duration	2	SearchSpace duration of 2 symbols Test 1, 2, 3, 5	
	1	SearchSpace duration of 1 symbol Test 4	
cce-REG-MappingType CHOICE {			
Interleaved SEQUENCE {	Null		
reg-BundleSize	n2		1 Tx
interleaverSize	n3		TDD
}			
precoderGranularity	sameAsREG-bundle		
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			
}			

Table 5.3.3.2.1.4.3.1-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
searchSpaceId	0	SearchSpaceId with condition CSS	CSS
controlResourceSetId	0	ControlResourceSetId	
monitoringSlotPeriodicityAndOffset CHOICE {			
sl1	NULL		
}			
monitoringSymbolsWithinSlot	11000000000000	Symbols 0 and 1	
nrofCandidates SEQUENCE {			
aggregationLevel2	n1	AL2	Test 1
aggregationLevel4	n1	AL4	Test 2
aggregationLevel16	n1	AL16	Test 3
}			
searchSpaceType CHOICE {			
common SEQUENCE {			CSS, SISS
ue-Specific SEQUENCE {			USS
dci-Formats	formats0-1-And-1-1	DCI Format 1_1	Long_DCI
}			
}			
}			
}			

5.3.3.2.1.4.3.2 Message exceptions for NSA

Same as 5.3.3.2.1.4.3.1.

5.3.3.2.1.5 Test requirement

Table 5.3.3.2.1.5-1 defines the primary level settings.

For the parameters specified in Table 5.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.3.2.1.5-1.

Table 5.3.3.2.1.5-1: Test Requirement for 1Tx PDCCH with 30 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40 MHz	102	1	2	R.PDCCH.2-1.1 TDD	TDLA30-10	1x4 Low	1	TBD+0.9
2	40 MHz	102	1	4	R.PDCCH.2-1.2 TDD	TDLC300-100	1x4 Low	1	TBD+0.9
3	40 MHz	48	2	16	R.PDCCH.2-2.1 TDD	TDLA30-10	1x4 Medium A	1	[-4.1]+0.9

5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update

  - RMC and SNR in min requirements table is TBD

5.3.3.2.2.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a single-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 5.3.3.2.2.3-1. The downlink physical setup is in accordance with Annex C.3.1.

5.3.3.2.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and 4 Rx antenna ports.

5.3.3.2.2.3 Minimum conformance requirements

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 5.3.3.2.2.3-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.3.2.2.3-1: Minimum performance for PDCCH with 30 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40 MHz	90	1	8	TBD	TDLC300-100	2x4 Low	1	[-4.6]

The normative reference for this requirement is TS 38.101-4 [5] clause 5.3.3.2.

5.3.3.2.2.4 Test description

5.3.3.2.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-2 of 38.521-1 [7].

Configurations of PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D.

1. Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.4 for TE diagram and section A.3.2.5 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1, Table 5.3.3.2-1 and Table 5.3.3.2.2.3-1 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without Release On, Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.3.3.2.2.4.3.

5.3.3.2.2.4.2 Test procedure

1. SS transmits PDCCH with DCI format 1_1 for C_RNTI to transmit the DL RMC according to Table 5.3.3.2.2.3-1. The details of PDCCH are specified in Table 5.3-1, Table 5.3.3.2-1 and Table 5.3.3.2.2.3-1. The SS sends downlink MAC padding bits on the DL RMC.
2. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 5.3.3.2.2.3-1 as appropriate.
3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause [G.1.x]. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 5.3.3.2.2.5-1, pass the UE. Otherwise fail the UE.
4. Repeat steps from 1 to 3 for each subtest in Table 5.3.3.2.2.3-1 as appropriate.

5.3.3.2.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

5.3.3.2.2.4.3.1 Message exceptions for SA

Table 5.3.3.2.2.4.3.1-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
controlResourceSetId	ControlResourceSetId		
frequencyDomainResources	11111111 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 48 RBs of the BWP Test 3, 4, 5	
	11110000 00000000 00000000 00000000 00000000 00000	CORESET to use the least significant 24 RBs of the BWP Test 1, 2	
Duration	2	SearchSpace duration of 2 symbols Test 1, 2, 3, 5	
	1	SearchSpace duration of 1 symbol Test 4	
cce-REG-MappingType CHOICE {			
Interleaved SEQUENCE {	Null		
reg-BundleSize	n6		2 Tx
interleaverSize	n3		TDD
}			
precoderGranularity	sameAsREG-bundle		
tci-StatesPDCCH-ToAddList {			
	0	TCI State #0	
	1	TCI State #1	
}			
}			
}			

Table 5.3.3.2.2.4.3.1-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
searchSpaceId	0	SearchSpaceId with condition CSS	CSS
controlResourceSetId	0	ControlResourceSetId	
monitoringSlotPeriodicityAndOffset CHOICE {			
sl1	NULL		
}			
monitoringSymbolsWithinSlot	11000000000000	Symbols 0 and 1	
nrofCandidates SEQUENCE {			
aggregationLevel8	n1	AL8	Test 1
}			
searchSpaceType CHOICE {			
common SEQUENCE {			CSS, SISS
ue-Specific SEQUENCE {			USS
dci-Formats	formats0-1-And-1-1	DCI Format 1_1	Long_DCI
}			
}			
}			
}			

5.3.3.2.2.4.3.2 Message exceptions for NSA

FFS

5.3.3.2.2.5 Test requirement

Table 5.3.3.2.2.5-1 defines the primary level settings.

For the parameters specified in Table 5.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.3.2.2.5-1.

Table 5.3.3.2.2.5-1: Test Requirement for 2Tx PDCCH with 30 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40 MHz	90	1	8	TBD	TDLC300-100	2x4 Low	1	[-4.6]+1.0

5.4 PBCH demodulation requirements

RAN4 will specify the PBCH performance requirements and has recommended that these requirements do not need to be tested.

5.5 Sustained downlink data rate provided by lower layers

5.5.1 FR1 Sustained downlink data rate performance for single carrier

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Test Procedure to calculate PDCP SDU success rate is FFS

5.5.1.1 Test Purpose

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

5.5.1.2 Test Applicability

This test applies to all types of NR UE release 15 and forward.

5.5.1.3 Minimum conformance requirements

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

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

The TB success rate is defined as $100\%*N_{DL\_correct\_rx} / (N_{DL\_newtx} + N_{DL\_retx})$, where N_{DL_newtx} is the number of newly transmitted DL transport blocks, N_{DL_retx} is the number of retransmitted DL transport blocks, and $N_{DL\_correct\_rx}$ is the number of correctly received DL transport blocks.

The common test parameters are specified in Table 5.5.1.3-1. The parameters specified in Table 5.5.1.3-2 are applicable for tests on FDD bands and parameters specified in Table 5.5.1.3-3 are applicable for tests on TDD bands.

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 5.5.1.3-1: Common test parameters for FDD and TDD bands

Parameter		Unit	Value
PDSCH transmission scheme			Transmission scheme 1
EPRE ratio of PTRS to PDSCH		dB	N/A
Channel bandwidth		MHz	Channel bandwidth from selected band
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
	First DMRS position for Type A PDSCH mapping		2
Cross carrier scheduling			Not configured
Active DL BWP index			1
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 2)	RBs	0
	Subcarrier spacing	kHz	15 or 30
DL BWP configuration #1	RB offset	RBs	0
	Number of contiguous PRB		Maximum transmission bandwidth configuration as specified in 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
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		Symbols #0
	Number of PRBs in CORESET		Table 5.5A-4
	Number of PDCCH candidates and aggregation levels		1/AL 1 for 30 kHz / 5 MHz 1/AL4 for 15 kHz / 5 MHz, 30 kHz / 10 MHz and 30 kHz / 15 MHz 1/AL 8 for other combinations
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
	TCI State		TCI state #1
PDSCH configuration	Mapping type		Type A
	k0		0
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		WB
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		1
	Antenna ports indexes		{1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs {1000 – 1003} for 4 Layers CCs
	Number of PDSCH DMRS CDM group(s) without data		1 for 1 layer and 2 layers CCs 2 for 4 Layers CCs
PTRS configuration			PTRS is not configured
CSI-RS for tracking	Subcarrier indexes in the PRB used for CSI-RS		k_0 = 3 for CSI-RS resource 1,2,3,4
	OFDM symbols in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 1 and 3 l_0 = 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 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
NZP CSI-RS for CSI acquisition	Subcarrier indexes in the PRB used for CSI-RS			$k_0 = 4$
	OFDM symbols in the PRB used for CSI-RS			$l_0 = 12$
	Number of CSI-RS ports (X)			Same as number of transmit antenna
	CDM Type			'FD-CDM2'
	Density (ρ)			1
	CSI-RS periodicity			15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset			0
	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Subcarrier indexes in the PRB used for CSI-RS			$k_0 = 0$
	OFDM symbols in the PRB used for CSI-RS			$l_0 = 12$
	Number of CSI-RS ports (X)			4
	CDM Type			'FD-CDM2'
	Density (ρ)			1
	CSI-RS periodicity			15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset			0
	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #1 TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
	Type 1 QCL information	SSB index		SSB #0
Maximum number of code block groups for ACK/NACK feedback				1
Maximum number of HARQ transmission				4
HARQ ACK/NACK bundling				Multiplexed
Redundancy version coding sequence				{0,2,3,1}
Precoding configuration				SP Type I, Random per slot with PRB bundling granularity
Symbols for all unused Res				OCNG Annex A.5
Propagation condition				Static propagation condition No external noise sources are applied
Antenna configuration	1 layer CCs			1x2 or 1x4
	2 layers CCs			2x2 or 2x4
	4 layers CCs			4x4
Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [2] for tested channel bandwidth and subcarrier spacing				

Table 5.5.1.3-2: Additional test parameters for FDD band

Parameter		Unit	Value
Duplex mode			FDD
PDSCH configuration	Starting symbol (S)		1
	Length (L)		13
Number of HARQ Processes			4
K1 value			2

Table 5.5.1.3-3: Additional test parameters for TDD band

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

Table 5.5.1.3-4: 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 5.5.1.3-5: 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

5.5.1.3.1 Procedure for test parameter selection

Below test parameter selection procedure is from 38.101-4 [5] by replacing CA configuration with operating band, and bandwidth instead of bandwidth combination.

The test parameters are determined by the following procedure:

- Select one operating band among all supported operating bands and set of per band UE capabilities among all supported UE capabilities that provides the largest data rate [TS 38.306 [14, Section 4.1.2]].

- Set of per band 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 bandwidths 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 channel bandwidth.

- For each operating band, use Table 5.5.1.3-5 to determine MCS based on test parameters and indicated UE capabilities

Pasting relevant portion of max data rate equation from TS 38.306 [14] section 4.1

For NR, the approximate data rate for a given number of aggregated carriers in a band or band combination is computed as follows.

$$\text{data rate (in Mbps)} = 10^{-6} \cdot \sum_{j=1}^{J} \left(v_{Layers}^{(j)} \cdot Q_m^{(j)} \cdot f^{(j)} \cdot R_{\max} \cdot \frac{N_{PRB}^{BW(j),\mu} \cdot 12}{T_s^{\mu}} \cdot \left(1 - OH^{(j)}\right) \right)$$

wherein

J is the number of aggregated component carriers in a band or band combination

R_{max} = 948/1024

For the j-th CC,

$v_{Layers}^{(j)}$ is the maximum number of supported layers given by higher layer parameter *maxNumberMIMO-LayersPDSCH* for downlink and maximum of higher layer parameters *maxNumberMIMO-LayersCB-PUSCH* and *maxNumberMIMO-LayersNonCB-PUSCH* for uplink.

$Q_m^{(j)}$ is the maximum supported modulation order given by higher layer parameter *supportedModulationOrderDL* for downlink and higher layer parameter *supportedModulationOrderUL* for uplink.

$f^{(j)}$ is the scaling factor given by higher layer parameter *scalingFactor* and can take the values 1, 0.8, 0.75, and 0.4.

μ is the numerology (as defined in TS 38.211 [6])

T_s^{μ} is the average OFDM symbol duration in a subframe for numerology μ, i.e. $T_s^{\mu} = \frac{10^{-3}}{14 \cdot 2^{\mu}}$. Note that normal cyclic prefix is assumed.

$N_{PRB}^{BW(j),\mu}$ is the maximum RB allocation in bandwidth $BW^{(j)}$ with numerology μ, as defined in 5.3 TS 38.101-1 [2] and 5.3 TS 38.101-2 [3], where $BW^{(j)}$ is the UE supported maximum bandwidth in the given band or band combination.

$OH^{(j)}$ is the overhead and takes the following values

0.14, for frequency range FR1 for DL

0.18, for frequency range FR2 for DL

0.08, for frequency range FR1 for UL

0.10, for frequency range FR2 for UL

NOTE: Only one of the UL or SUL carriers (the one with the higher data rate) is counted for a cell operating SUL.

The approximate maximum data rate can be computed as the maximum of the approximate data rates computed using the above formula for each of the supported band or band combinations.

The normative reference for this requirement is TS 38.101-4 [5], clause 5.5.1.

5.5.1.4 Test description

5.5.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 of TS 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

1. Connect the SS to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram (without fader and AWGN) and clause A.3.2.2 for UE diagram.
2. The parameter settings for the NR cell are initially set up according to Table 5.5.1.3-1 as appropriate.
3. Downlink signals for the NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1, and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.
4. Propagation conditions for the NR cell are set according to Annex B.0.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR with *Connected without release On*, according to TS 38.508-1 [6] clause 4.5.4. Message content are defined in clause 5.5.1.4.3.
6. SS shall transmit UECapabilityEnquiry message.
7. The UE shall transmit UECapabilityInformation message.
8. Using the UE capabilities advertised in the *UE-CapabilityRAT-Container* of the type *UE-NR-Capability*, and the procedure outlined in 5.5.1.3.1 determine one set of parameters that would provide the largest data rate.
9. Setup up the NR cell using these parameters for the test.
10. Configure the TBsize, DL RMC, UL RMC, PDCP size from Annex A.3.2_1 and Annex A.2.2 for UL as appropriate.

5.5.1.4.2 Test procedure

FFS

5.5.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 5.4.2 with the following exceptions

Table 5.5.1.4.3-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
frequencyDomainResources	CORESET value according to Table 5.5.1.3-4 as applicable		
}			
}			

Table 5.5.1.4.3-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
monitoringSymbolsWithinSlot	10000000000000	Symbols 0	
nrofCandidates SEQUENCE {			
aggregationLevel1	n1		5MHz 30kHz
aggregationLevel2	n0		
aggregationLevel4	n1		5MHz 15kHz, 10MHz 30kHz, 15MHz 30kHz
aggregationLevel8	n1	AL8	For all other BW/SCS cases
aggregationLevel16	n0		
}			
}			

Table 5.5.1.4.3-3: CSI-RS-ResourceMapping for TRS

Derivation Path: TS 38.508-1 [6], Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0001	k_0=0 for CSI-RS resource 1,2,3,4	TRS
}			
}			

Table 5.5.1.4.3-4: NZP CSI-RS-ResourceMapping for CSI Acquisition

Derivation Path: TS 38.508-1 [6], Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
NZP-CSI-RS-Resource ::= SEQUENCE {			
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0100	k_0=4	
}			
}			
}			

Table 5.5.1.4.3-5: ZP CSI-RS-ResourceMapping for CSI Acquisition

Derivation Path: TS 38.508-1 [6], clause 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
ZP-CSI-RS-Resource ::= SEQUENCE {			
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0001	k_0=0	
}			
}			
}			

Table 5.5.1.4.3-6: *PDSCH-Config*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-100			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-Config ::= SEQUENCE {			
prb-BundlingType CHOICE {			
staticBundling SEQUENCE {			
bundleSize	wideband	Wideband PRB Bundling	
}			
}			
}			

5.5.1.5 Test requirement

The PDCP SDU success rate of greater than 85% shall be sustained during at least 300 frames.

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 transmission scheme			**Transmission scheme 1**
EPRE ratio of PTRS to PDSCH		**dB**	
Active DL BWP index			**1**
Cyclic prefix			**Normal**
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0,1
	Number of PDCCH candidates and aggregation levels		1/[8]
	DCI format		1_1
	TCI state		TCI state #1
Cross carrier scheduling			Not configured
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		Single-symbol DM-RS
	DMRS ports indexes		{1000} for Rank1 {1000,1001} for Rank2 {1000,1001,1002} for Rank3 {1000,1001,1002,1003} for Rank4
	Number of PDSCH DMRS CDM group(s) without data		2
PTRS configuration	Frequency density (K_{PT-RS})		N/A
	Time density (L_{PT-RS})		N/A
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k_0)		[0]
	First OFDM symbol in the PRB used for CSI-RS (l_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 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
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #0

NZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
Number of HARQ Processes				4 For FDD 8 for TDD
HARQ ACK/NACK bundling				Multiplexed
Redundancy version coding sequence				{0,2,3,1}
K1 value (PDSCH-to-HARQ-timing-indicator)				2 for FDD Defined in Annex A.1.2 for TDD
Symbols for unused Res				OCNG as specified in A.5
Note 1: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL. Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission.				

6.2 Reporting of Channel Quality Indicator (CQI)

6.2.1 1RX requirements (Void)

6.2.2 2RX requirements

6.2.2.1 FDD

6.2.2.1.1 CQI reporting definition under AWGN conditions

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

6.2.2.1.1.1 2Rx FDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA

6.2.2.1.1.1.1 Test Purpose

The purpose of this test is to verify the variance of the wideband CQI reports is within the limits defined and a PDSCH BLER of 10% falls between the transport format based median CQI-1 and median CQI or the transport format based median CQI and median CQI +1.

6.2.2.1.1.1.2 Test Applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.2.2.1.1.1.3 Minimum requirement for periodic CQI reporting

For the parameters specified in Table 6.2.2.1.1.1.3-1, 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 6.2.2.1.1.1.3-1: CQI reporting definition test

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Duplex Mode			FDD			
Subcarrier spacing		kHz	15			
SNR		dB	8	9	14	15
Propagation channel			AWGN			
Antenna configuration			2×2 with static channel specified in Annex B.1			
Beamforming Model			As specified in Section Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6,-)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1			
CSI-IM configuration	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	5/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Wideband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	8			
CSI-reportingBand			1111111			
CSI-Report periodicity and offset		slot	5/1			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		010000			
	RI Restriction		N/A			
Physical channel for CSI report			PUCCH			
	CQI/RI/PMI delay	ms	8			
Maximum number of HARQ transmission			1			
Measurement channel			As specified in Table A.4-2, TBS.2-2			

The normative reference for this requirement is TS 38.101-4 [5] clause 6.2.2.1.1.1.

6.2.2.1.1.1.4 Test Description

6.2.2.1.1.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7 for TE diagram and section A.3.2.3 for UE diagram.
2. The parameter settings for the NR cell are set up according to Table 6.1.2-1 and 6.2.2.1.1.1.3-1 as appropriate.
3. Downlink signals for the NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 , and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions for the NR cell are set according to Annex B.1.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without release On, Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG, Connected without release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 6.2.2.1.1.1.4.3.

6.2.2.1.1.1.4.2 Test Procedure

1. Set the parameters of bandwidth, SCS, reference Channel, the propagation condition, antenna configuration and the SNR according to Table 6.2.2.2.1.1.3-1.
2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to CQI value 8 and keep it regardless of the wideband CQI value sent by the UE. The SS sends downlink MAC padding bits on the DL RMC. Continue transmission of the PDSCH until 2000 wideband CQI reports have been gathered. In this process the SS collects wideband CQI reports every 5 ms and also cases where UE transmits nothing in its CQI timing are also counted as wideband CQI reports.
3. Set up a relative frequency distribution for the reported wideband CQI-values, Calculate the median value (wideband Median CQI is the wideband CQI that is at or crosses 50% distribution from the lower wideband CQI side). This CQI-value is declared as wideband Median CQI value.
4. If Median CQI is not equal to 1 or 15 and [1800] or more of the wideband CQI values are in the range (Median CQI - 1) ≤ Median CQI ≤ (Median CQI + 1) then continue with step 5, otherwise go to step 8.
5. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the wideband median-CQI value and shall not react to the UE's wideband CQI reports. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH transmitted by the SS, record the associated ACK, NACK and statDTX responses. The responses are then filtered as follows: for the sequence of responses for each HARQ process, discard all the statDTX responses. Continue to gather data until the number of filtered ACK+NACK responses reaches 1000.

   For the filtered ACK and NACK responses if the ratio (NACK / ACK + NACK) ≤ 0.1 then go to step 6, otherwise go to step 7.
6. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the wideband median-CQI+1 value and shall not react to the UE's wideband CQI reports. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH, transmitted by the SS, record and filter the ACK, NACK and statDTX responses as in step 5 until 1000 filtered ACK+NACK responses are gathered.

If the ratio (NACK /ACK + NACK) > 0.1

then pass the UE for this test and go to step 9, otherwise go to step 8.

7. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the wideband median-CQI-1 value and shall not react to the UE's wideband CQI reports. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH, transmitted by the SS, record and filter the ACK, NACK and statDTX responses as in step 5 until 1000 filtered ACK+NACK responses are gathered.

   If the ratio (NACK /ACK + NACK) ≤ 0.1

   then pass the UE for this test and go to step 9, otherwise go to step 8.

8. If both SNR points of the test have not been tested, then repeat the same procedure (steps 1 to 7) for the other SNR point as appropriate. Otherwise fail the UE.

9. Repeat step 1 to 8 for Test2.

6.2.2.1.1.1.4.4 Message contents

Message contents are according to TS 38.508 [6] clause 5.4.2 with the following exceptions:

6.2.2.1.1.1.4.4_1 Message exceptions for SA

Table 6.2.2.1.1.1.4.4_1-1: CSI-ReportConfig

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-ReportConfig ::= SEQUENCE {			
reportConfigType CHOICE {		Periodic	
periodic SEQUENCE {			
reportSlotConfig	CSI-ReportPeriodicityAndOffset	5/1	
}			
}			
reportQuantity CHOICE {			
cri-RI-PMI-CQI	NULL,		
}			
reportFreqConfiguration SEQUENCE {			
cqi-FormatIndicator	widebandCQI		
pmi-FormatIndicator	widebandPMI		
csi-ReportingBand CHOICE{			
Subbands8	1111111		
}			
}			
timeRestrictionForChannelMeasurements	notConfigured		
timeRestrictionForInterferenceMeasurements	notConfigured		
codebookConfig	CodebookConfig		
dummy	Not present		
cqi-Table	table2		
subbandSize	Value8		
non-PMI-PortIndication	Not present		
}			

Table 6.2.2.1.1.1.4.4_1-2: *CodebookConfig*

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
CodebookConfig ::= SEQUENCE {			
codebookType CHOICE {			
type1 SEQUENCE {			
subType CHOICE {			
typeI-SinglePanel SEQUENCE {			
nrOfAntennaPorts CHOICE {			
Two SEQUENCE {			
twoTX-codebookSubsetRestriction	010000		
}			
},			
}			
}			
typeI-SinglePanel-ri-Restriction	notPresent		
},			
codebookMode	1		
},			

6.2.2.1.1.1.4.4_2 Message exceptions for NSA

Same as specified in 6.2.2.1.1.1.4.4_1.

6.2.2.1.1.1.5 Test Requirements

The pass fail decision is as specified in the test procedure in clause 6.2.2.1.1.1.4.2.

There are no parameters in the test setup or measurement process whose variation impacts the results so there are no applicable test tolerances for this test.

6.2.2.1.2 CQI reporting under fading conditions

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.

6.2.2.1.2.1 2Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update

    - Beamforming model is TBD in test parameter table -Minimum requirement is within square brackets

- Annex for measurement uncertainty and test tolerance is TBD

- Propagation condition description in Annex is TBD

- Minimum test time is TBD

- Test tolerance analysis is missing

- Message exceptions for NSA is FFS

6.2.2.1.2.1.1 Test purpose

To verify the variance of the wideband CQI reports is within the limits defined, that the ratio of the throughput is within the limits defined and that the average PDSCH BLER is greater than or equal to [2]% for the indicated transport format.

6.2.2.1.2.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of E-UTRA UE release 15 and forward supporting EN-DC.

6.2.2.1.2.1.3 Minimum conformance requirements

For the parameters specified in Table 6.2.2.1.2.1.3-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) 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 6.2.2.1.2.1.3-2;

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 6.2.2.1.2.1.3-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Duplex Mode			FDD			
DL BWP configuration #1	First PRB		0			
	Number of contiguous PRB		52			
	Subcarrier spacing	kHz	15			
SNR		dB	[6]	[7]	[12]	[13]
Propagation channel			TDLA30-5			
Antenna configuration			2×2			
Correlation configuration			ULA high			
Beamforming Model			As specified in Section [Annex TBD]			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6,-)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1			
CSI-IM configuration	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping ($k_{CSI\text{-}IM}$,$l_{CSI\text{-}IM}$)		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	5/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Wideband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	[8]			
Csi-ReportingBand			[1111111]			
CSI-Report periodicity and offset		slot	5/1			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		000001			
	RI Restriction		[N/A]			
Physical channel for CSI report			[PUCCH]			
CQI/RI/PMI delay		ms	8			
Maximum number of HARQ transmission			1			
Measurement channel			As specified in Table A.4-2, TBS.2-1			

Table 6.2.2.1.2.1.3-2: Minimum requirements

Parameters	Test 1	Test 2
α [%]	[20]	[20]
γ	[1.05]	[1.05]

The normative reference for this requirement is TS 38.101-4 [5] clause 6.2.2.1.2.1.

6.2.2.1.2.1.4 Test description

6.2.2.1.2.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.6.2 for TE diagram and Figure A.3.2.3.1 for UE diagram.

2. The parameter settings for the cell are set up according to Table 6.2.2.1.2.1.3-1 as appropriate.

3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with Connected without release On, Test Mode On and Test Loop Function On or EN-DC, DC bearer MCG and SCG, Connected without release On, for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 6.2.2.1.2.1.4.3.

6.2.2.1.2.1.4.2 Test procedure

1. Set the parameters of bandwidth, reference Channel, the propagation condition, antenna configuration and the SNR according to Table 6.2.2.1.2.1.5-1.

2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to CQI value 8 and keep it regardless of the wideband CQI value sent by the UE. The SS sends downlink MAC padding bits on the DL RMC. Continue transmission of the PDSCH until [2000] wideband CQI reports have been gathered. In this process the SS collects wideband CQI reports every 5 ms and also cases where UE transmits nothing in its CQI timing are also counted as wideband CQI reports.

3. Set up a relative frequency distribution for the reported wideband CQI-values, Calculate the median value (wideband Median CQI is the wideband CQI that is at or crosses 50% distribution from the lower wideband CQI side). This CQI-value is declared as Median CQI value.

4. If Median CQI value is not equal to 1 or 15 and [400 (α%)] or more of the wideband CQI values are outside the range (Median CQI - 1) $\leq$ Median CQI $\leq$ (Median CQI + 1) then continue with step 5, otherwise fail the UE.

5. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the Median CQI value from step 3 and shall not react to the UE's wideband CQI reports. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH transmitted by the SS, record the associated ACK, NACK and statDTX responses. The responses are then filtered as follows: for the sequence of responses for each HARQ process, discard all the statDTX responses. Continue to gather data until the number of filtered ACK+NACK

responses reaches [1000]. Record the BLER (NACK / ACK + NACK) for Median CQI and measure the average throughput according to Annex TBD. Declare the throughput as t_{median}.

If the recorded BLER ≥ [0.02] then continue with step 6, otherwise fail the UE.6. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the UE's reported wideband CQI value. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH transmitted by the SS, record the associated ACK, NACK and statDTX responses. The responses are then filtered as follows: for the sequence of responses for each HARQ process, discard all the statDTX responses. Continue to gather data until the number of filtered ACK+NACK responses reaches [1000]. Record the BLER (NACK / ACK + NACK) and measure the average throughput according to Annex TBD. Declare the throughput as t.

If the recorded BLER ≥ [0.02] and t / t_{median} ≥ γ then continue with step 7, otherwise fail the UE.

7. If both SNR points of the test have not been tested, then repeat the same procedure (steps 1 to 6) for the other SNR point as appropriate.

8. If both tests have not been done, then repeat the same procedure (steps 1 to 7) with test conditions according to the table 6.2.2.1.2.1.5 -1 for the other Test as appropriate.

6.2.2.1.2.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.2.2.1.2.1.4.3_1 Message exceptions for SA

Table 6.2.2.1.2.1.4.3_1-1: CSI-RS-ResourceMapping for NZP-CSI-RS

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
Row3	001000		
}			
nrofPorts	p2		
firstOFDMSymbolInTimeDomain	13		
}			

Table 6.2.2.1.2.1.4.3_1-2: CSI-RS-ResourceMapping for ZP-CSI-RS

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
Row5	000100		
}			
nrofPorts	p4		
firstOFDMSymbolInTimeDomain	9		
}			

Table 6.2.2.1.2.1.4.3_1-3: CSI-IM-Resource

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-34			
Information Element	**Value/remark**	**Comment**	**Condition**
csi-IM-ResourceElementPattern			
pattern0 SEQUENCE {			
subcarrierLocation-p0	s4		
symbolLocation-p0	9		
}			
periodicityAndOffset	CSI-ResourcePeriodicityAndOffset		

Table 6.2.2.1.2.1.4.3_1-4: *CSI-ResourcePeriodicityAndOffset*

Derivation Path: TS 38.508-1 [6], clause 4.6.2, Table 4.6.2-43			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-ResourcePeriodicityAndOffset CHOICE {			
slots5	1		
}			

Table 6.2.2.1.2.1.4.3_1-5: *CodebookConfig*

Derivation Path: TS 38.508-1 [6], clause 4.6.2, Table 4.6.3-25			
Information Element	**Value/remark**	**Comment**	**Condition**
nrOfAntennaPorts CHOICE {			
Two SEQUENCE {			
twoTX-CodebookSubsetRestriction	000001		
}			
}			
typeI-SinglePanel-ri-Restriction	[00000000]		

Table 6.2.2.1.2.1.4.3_1-6: CSI-ReportConfig

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-39			
Information Element	**Value/remark**	**Comment**	**Condition**
reportConfigType CHOICE {			
periodic SEQUENCE {			
reportSlotConfig	CSI-ReportPeriodicityAndOffset		
pucch-CSI-ResourceList	[PUCCH-CSI-Resource]		
}			
reportFreqConfiguration SEQUENCE {			
csi-ReportingBand CHOICE {			
subbands7	[1111111]		
}			
}			
subbandSize	8		
CSI-ReportPeriodicityAndOffset CHOICE {			
Slots5	4	5 slots	
}			
}			

6.2.2.1.2.1.4.3_2 Message exceptions for NSA

Table 6.2.2.1.2.1.4.3_2: Message exceptions for NSA

FFS

6.2.2.1.2.1.5 Test requirement

The pass/fail decision is as specified in the test procedure in clause 6.2.2.1.2.1.4.2.

Table 6.2.2.1.2.1.5-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Duplex Mode			FDD			
DL BWP configuration #1	First PRB		0			
	Number of contiguous PRB		52			
	Subcarrier spacing	kHz	15			
SNR		dB	[6] + TT	[7] + TT	[12] + TT	[13] + TT
Propagation channel			TDLA30-5			
Antenna configuration			2×2			
Correlation configuration			ULA high			
Beamforming Model			As specified in Section [Annex TBD]			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6,-)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1			
CSI-IM configuration	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	5/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Wideband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	[8]			
Csi-ReportingBand			[11111111]			
CSI-Report periodicity and offset		slot	5/1			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		000001			
	RI Restriction		[N/A]			
Physical channel for CSI report			[PUCCH]			
CQI/RI/PMI delay		ms	8			
Maximum number of HARQ transmission			1			
Measurement channel			As specified in Table A.4-2, TBS.2-1			
Note 1: TT = TBD						

Table 6.2.2.1.2.1.5-2: Minimum requirements

Parameters	Test 1	Test 2
α [%]	[20]	[20]
γ	[1.05]	[1.05]

6.2.2.1.2.2 2Rx FDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Annex for measurement uncertainty and test tolerance is TBD
- Some TBD in minimum conformance requirements
- Minimum test time is TBD
- Test tolerance analysis is missing

6.2.2.1.2.2.1 Test purpose

To verify the variance of the wideband CQI reports is within the limits defined, that the ratio of the throughput is within the limits defined and that the average PDSCH BLER is greater than or equal to [2]% for the indicated transport format.

6.2.2.1.2.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of E-UTRA UE release 15 and forward supporting EN-DC.

6.2.2.1.2.2.3 Minimum conformance requirements

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 6.2.2.1.2.2.3-1 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 6.2.2.1.2.2.3-2.

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 6.2.2.1.2.2.3-2.

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 6.2.2.1.2.2.3-1: Sub-band CQI reporting test under frequency-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Duplex Mode			FDD			
DL BWP configuration #1	First PRB		0			
	Number of contiguous PRB		52			
	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 τ_d=0.45μs]			
Antenna configuration			2x2			
Correlation configuration			As per Annex B.1			
Beamforming Model			As specified in Section B.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6,-)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1			
CSI-IM configuration	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	5/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Subband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	8			
CSI-Report periodicity and offset		slot	5/1			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		000001			
	RI Restriction		N/A			
Physical channel for CSI report			TBD			
	CQI/RI/PMI delay	ms	8			
Maximum number of HARQ transmission			1			
Measurement channel			TBD			

Table 6.2.2.1.2.2.3-2: Minimum requirements

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

The normative reference for this requirement is TS 38.101-4 [5] clause 6.2.2.1.2.2.

6.2.2.1.2.2.4 Test description

6.2.2.1.2.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.6.1 for TE diagram and Figure A.3.2.3.1 for UE diagram.

2. The parameter settings for the cell are set up according to Table 6.2.2.1.2.2.3-1 as appropriate.

3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with Connected without release On, Test Mode On and Test Loop Function On or EN-DC, DC bearer MCG and SCG, Connected without release On, for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 6.2.2.1.2.2.4.3.

6.2.2.1.2.2.4.2 Test procedure

1. Set the parameters of bandwidth, reference Channel, the propagation condition, antenna configuration and the SNR according to Table 6.2.2.1.2.2.3-1 as appropriate.

2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to CQI value 8 and keep it regardless of the wideband and subband CQI value sent by the UE. The SS sends downlink MAC padding bits on the DL RMC. Continue transmission of the PDSCH until [2000] wideband CQI reports and full-size subband CQI reports for each full-size subband have been gathered. In this process the SS collects sub-band CQI reports every 10 ms and also cases where UE transmits nothing in its CQI timing are also counted as subband CQI reports.

3. Set up a relative frequency distribution for the reported wideband CQI-values, Calculate the median value (wideband Median CQI is the CQI that is at or crosses 50% distribution from the lower wideband CQI side). This CQI-value is declared as wideband Median CQI value.

4. For each subband, if subband differential CQI offset level of 0 is reported, at least α% but less than β% of [2000] full-size subband CQI report, then continue to step 5, otherwise, go to step 7.

5. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC in an each available downlink transmission instance randomly selected full-size subband using the transport format according to the wideband median CQI value regardless of UE wideband or subband CQI report. Note that each

full-size subband shall be selected in the equal probability. The SS sends downlink MAC padding bits on the DL RMC. Measure the average throughput according to Annex TBD. Declare the throughput as t_{median}.

6. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the highest UE reported full-size subband CQI value in one full-size subband selected among the sub-bands in which UE report the highest full-size subband CQI. Subband differential CQI offset level is selected from {0, 1, 2, -1}. Note that the SS shall send PDSCH in the same full-size subband until next UE report is available. In case when same full-size subbands are reported subsequently as subbands with highest full-size subband CQI, the SS shall select for transmission a different subband with respect to the last selection. The SS sends downlink MAC padding bits on the DL RMC Measure the average throughput and (NACK /(ACK + NACK)) according to Annex TBD. Declare the throughput as $t_{subband}$. If the ratio ($t_{subband}$ / t_{median}) ≥ γ and (NACK /(ACK + NACK)) ≥ TBD, pass the UE and go to step 8. Otherwise, go to step 7.
7. If both SNR points of the test have not been tested, then repeat the same procedure (steps 1 to 6) for the other SNR point as appropriate. Otherwise fail the UE.
8. If both tests have not been done, then repeat the same procedure (steps 1 to 7) with test conditions according to the table 6.2.2.1.2.2.3-1 for the other test as appropriate.

6.2.2.1.2.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.2.2.1.2.2.4.3_1 Message exceptions for SA

Table 6.2.2.1.2.2.4.3_1-1: CSI-RS-ResourceMapping for NZP-CSI-RS

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
Row3	001000		
}			
nrofPorts	p2		
firstOFDMSymbolInTimeDomain	13		
}			

Table 6.2.2.1.2.2.4.3_1-2: CSI-RS-ResourceMapping for ZP-CSI-RS

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
Row5	000100		
}			
nrofPorts	p4		
firstOFDMSymbolInTimeDomain	9		
}			

Table 6.2.2.1.2.2.4.3_1-3: CSI-IM-Resource

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-34			
Information Element	**Value/remark**	**Comment**	**Condition**
csi-IM-ResourceElementPattern			
pattern0 SEQUENCE {			
subcarrierLocation-p0	s4		
symbolLocation-p0	9		
}			
periodicityAndOffset	CSI-ResourcePeriodicityAndOffset		

Table 6.2.2.1.2.2.4.3_1-4: *CSI-ResourcePeriodicityAndOffset*

Derivation Path: TS 38.508-1 [6], clause 4.6.2, Table 4.6.2-43			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-ResourcePeriodicityAndOffset CHOICE {			
slots5	1		
}			

Table 6.2.2.1.2.2.4.3_1-5: *CodebookConfig*

Derivation Path: TS 38.508-1 [6], clause 4.6.2, Table 4.6.3-25			
Information Element	**Value/remark**	**Comment**	**Condition**
nrOfAntennaPorts CHOICE {			
Two SEQUENCE {			
twoTX-CodebookSubsetRestriction	000001		
}			
}			
typeI-SinglePanel-ri-Restriction	[00000000]		

Table 6.2.2.1.2.2.4.3_1-6: CSI-ReportConfig

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-39			
Information Element	**Value/remark**	**Comment**	**Condition**
reportConfigType CHOICE {			
periodic SEQUENCE {			
reportSlotConfig	CSI-ReportPeriodicityAndOffset		
pucch-CSI-ResourceList	[PUCCH-CSI-Resource]		
}			
reportFreqConfiguration SEQUENCE {			
cqi-FormatIndicator	subbandCQI		
csi-ReportingBand CHOICE {			
subbands7	[1111111]		
}			
}			
subbandSize	8		
CSI-ReportPeriodicityAndOffset CHOICE {			
Slots8	7	8 slots	
}			
}			

6.2.2.1.2.2.4.3_2 Message exceptions for NSA

Same as in 6.2.2.1.2.2.4.3_1.

6.2.2.1.2.2.5 Test requirement

The pass/fail decision is as specified in the test procedure in clause 6.2.2.1.2.2.4.2.

Table 6.2.2.1.2.2.5 -1: Sub-band CQI reporting test under frequency-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Duplex Mode			FDD			
DL BWP configuration #1	First PRB		0			
	Number of contiguous PRB		52			
	Subcarrier spacing	kHz	15			
SNR		dB	TBD + TT	TBD + TT	TBD + TT	TBD + TT
Propagation channel			[Two tap model specified in Annex B.2.4 with *a*=1, f_D = 5Hz, and τ_d=0.45µs]			
Antenna configuration			TBD			
Correlation configuration			As per Annex B.1			
Beamforming Model			As specified in Section [Annex TBD]			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6,-)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1			
CSI-IM configuration	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	5/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Subband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	8			
CSI-Report periodicity and offset		slot	5/1			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		000001			
	RI Restriction		[N/A]			
Physical channel for CSI report			TBD			
	CQI/RI/PMI delay	ms	8			
Maximum number of HARQ transmission			1			
Measurement channel			TBD			
Note 1: TT = TBD						

Table: 6.2.2.1.2.2.5-2: 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 2Rx TDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA

6.2.2.2.1.1.1 Test Purpose

The purpose of this test is to verify the variance of the wideband CQI reports is within the limits defined and a PDSCH BLER of 10% falls between the transport format based median CQI-1 and median CQI or the transport format based median CQI and median CQI +1.

6.2.2.2.1.1.2 Test Applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.2.2.2.1.1.3 Minimum requirement for periodic CQI reporting

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

For the parameters specified in Table 6.2.2.2.1.1.3-1, 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 6.2.2.2.1.1.3-1: CQI reporting definition test

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	40			
Subcarrier spacing		kHz	30			
Duplex Mode			TDD			
TDD UL-DL pattern			FR1.30-1			
SNR		dB	8	9	14	15
Propagation channel			AWGN			
Antenna configuration			2×2 with static channel specified in Annex B.1			
Beamforming Model			As specified in Section Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6,-)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1			
CSI-IM configuration	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	10/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Wideband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	16			
CSI-reportingBand			1111111			
CSI-Report periodicity and offset		slot	10/1			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		010000			
	RI Restriction		N/A			
Physical channel for CSI report			PUCCH			
CQI/RI/PMI delay		ms	9.5			
Maximum number of HARQ transmission			1			
Measurement channel			As specified in Table A.4-2, TBS.2-4			

The normative reference for this requirement is TS 38.101-4 [5] clause 6.2.2.2.1.1.

6.2.2.2.1.1.4 Test Description

6.2.2.2.1.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7 for TE diagram and section A.3.2.3 for UE diagram.
2. The parameter settings for the NR cell are set up according to Table 6.1.2-1 and 6.2.2.2.1.1.3-1 as appropriate.
3. Downlink signals for the NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 , and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions for the NR cell are set according to Annex B.1.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 6.2.2.2.1.1.4.3.

6.2.2.2.1.1.4.2 Test Procedure

1. Set the parameters of bandwidth, SCS, reference Channel, the propagation condition, antenna configuration and the SNR according to Table 6.2.2.2.1.1.3-1.
2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to CQI value 8 and keep it regardless of the wideband CQI value sent by the UE. The SS sends downlink MAC padding bits on the DL RMC. Continue transmission of the PDSCH until 2000 wideband CQI reports have been gathered. In this process the SS collects wideband CQI reports every 5 ms and also cases where UE transmits nothing in its CQI timing are also counted as wideband CQI reports.
3. Set up a relative frequency distribution for the reported wideband CQI-values, Calculate the median value (wideband Median CQI is the wideband CQI that is at or crosses 50% distribution from the lower wideband CQI side). This CQI-value is declared as wideband Median CQI value.
4. If Median CQI is not equal to 1 or 15 and [1800] or more of the wideband CQI values are in the range (Median CQI - 1) $\leq$ Median CQI $\leq$ (Median CQI + 1) then continue with step 5, otherwise go to step 8.
5. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the wideband median-CQI value and shall not react to the UE's wideband CQI reports. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH transmitted by the SS, record the associated ACK, NACK and statDTX responses. The responses are then filtered as follows: for the sequence of responses for each HARQ process, discard all the statDTX responses. Continue to gather data until the number of filtered ACK+NACK responses reaches 1000.

   For the filtered ACK and NACK responses if the ratio (NACK / ACK + NACK) $\leq$ 0.1 then go to step 6, otherwise go to step 7.
6. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the wideband median-CQI+1 value and shall not react to the UE's wideband CQI reports. The SS sends

downlink MAC padding bits on the DL RMC. For any PDSCH, transmitted by the SS, record and filter the ACK, NACK and statDTX responses as in step 5 until 1000 filtered ACK+NACK responses are gathered.

If the ratio (NACK /ACK + NACK) > 0.1

then pass the UE for this test and go to step 9, otherwise go to step 8.

7. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the wideband median-CQI-1 value and shall not react to the UE's wideband CQI reports. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH, transmitted by the SS, record and filter the ACK, NACK and statDTX responses as in step 5 until 1000 filtered ACK+NACK responses are gathered.

   If the ratio (NACK /ACK + NACK) ≤ 0.1

   then pass the UE for this test and go to step 9, otherwise go to step 8.

8. If both SNR points of the test have not been tested, then repeat the same procedure (steps 1 to 7) for the other SNR point as appropriate. Otherwise fail the UE.

9. Repeat step 1 to 8 for Test2.

6.2.2.2.1.1.4.4 Message contents

Message contents are according to TS 38.508 [6] clause 5.4.2 with the following exceptions:

6.2.2.2.1.1.4.4_1 Message exceptions for SA

Table 6.2.2.2.1.1.4.4_1-1: CSI-ReportConfig

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-ReportConfig ::= SEQUENCE {			
reportConfigType CHOICE {		Periodic	
periodic SEQUENCE {			
reportSlotConfig	CSI-ReportPeriodicityAndOffset	10/1	
}			
}			
reportQuantity CHOICE {			
cri-RI-PMI-CQI	NULL,		
}			
reportFreqConfiguration SEQUENCE {			
cqi-FormatIndicator	widebandCQI		
pmi-FormatIndicator	widebandPMI		
csi-ReportingBand CHOICE{			
Subbands16	1111111		
}			
}			
timeRestrictionForChannelMeasurements	notConfigured		
timeRestrictionForInterferenceMeasurements	notConfigured		
codebookConfig	CodebookConfig		
dummy	Not present		
cqi-Table	table2		
subbandSize	Value16		
non-PMI-PortIndication	Not present		
}			

Table 6.2.2.2.1.1.4.4_1-2: *CodebookConfig*

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
CodebookConfig ::= SEQUENCE {			
codebookType CHOICE {			
type1 SEQUENCE {			
subType CHOICE {			
typeI-SinglePanel SEQUENCE {			
nrOfAntennaPorts CHOICE {			
Two SEQUENCE {			
twoTX-codebookSubsetRestriction	010000		
}			
},			
}			
}			
typeI-SinglePanel-ri-Restriction	notPresent		
},			
codebookMode	1		
},			

6.2.2.2.1.1.4.4_2 Message exceptions for NSA

Same as specified in 6.2.2.2.1.1.4.4_1.

6.2.2.2.1.1.5 Test Requirements

The pass fail decision is as specified in the test procedure in clause 6.2.2.2.1.1.4.2.

There are no parameters in the test setup or measurement process whose variation impacts the results so there are no applicable test tolerances for this test.

6.2.2.2.2 Wideband CQI reporting under fading conditions

6.2.2.2.2.1 2Rx TDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update

-Minimum requirement is within square brackets

- Minimum test time is TBD

- Test tolerance is missing

- Message exceptions for NSA

6.2.2.2.2.1.1 Test purpose

To verify the variance of the wideband CQI reports is within the limits defined, that the ratio of the throughput is within the limits defined and that the average PDSCH BLER is greater than or equal to [2]% for the indicated transport format.

6.2.2.2.2.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of E-UTRA UE release 15 and forward supporting EN-DC.

6.2.2.2.2.1.3 Minimum conformance requirements

For the parameters specified in Table 6.2.2.2.2.1.3-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) 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 6.2.2.2.2.1.3-2;

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 6.2.2.2.2.1.3-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to [0.02].

Table 6.2.2.2.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	40			
Subcarrier spacing		kHz	30			
Duplex Mode			TDD			
TDD UL-DL pattern			FR1.30-1			
SNR		dB	6	7	12	13
Propagation channel			TDLA30-5			
Antenna configuration			2×2			
Correlation configuration			ULA high			
Beamforming Model			As specified in AnnexB.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6,-)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1			
CSI-IM configuration	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	10/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Wideband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	16			
Csi-ReportingBand			1111111			
CSI-Report periodicity and offset		slot	10/1			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		000001			
	RI Restriction		N/A			
Physical channel for CSI report			PUCCH			
	CQI/RI/PMI delay	ms	9.5			
Maximum number of HARQ transmission			1			
Measurement channel			As specified in Table A.4-1, TBS.2-3			

Table 6.2.2.2.2.1-2: Minimum requirements

Parameters	Test 1	Test 2
α [%]	[20]	[20]
γ	[1.05]	[1.05]

The normative reference for this requirement is TS 38.101-4 [5] clause 6.2.2.2.2.1.

6.2.2.2.2.1.4 Test description

6.2.2.2.2.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.6.2 for TE diagram and section A.3.2 for UE diagram.

2. The parameter settings for the cell are set up according to Table 6.2.2.2.2.1.3-1 as appropriate.

3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with Connected without release On, Test Mode On and Test Loop Function On or EN-DC, DC bearer MCG and SCG, Connected without release On, for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 6.2.2.2.2.1.4.3.

6.2.2.2.2.1.4.2 Test procedure

1. Set the parameters of bandwidth, reference Channel, the propagation condition, antenna configuration and the SNR according to Table 6.2.2.2.2.1.5-1.

2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to CQI value 8 and keep it regardless of the wideband CQI value sent by the UE. The SS sends downlink MAC padding bits on the DL RMC. Continue transmission of the PDSCH until [2000] wideband CQI reports have been gathered. In this process the SS collects wideband CQI reports every 10 ms and also cases where UE transmits nothing in its CQI timing are also counted as wideband CQI reports.

3. Set up a relative frequency distribution for the reported wideband CQI-values, Calculate the median value (wideband Median CQI is the wideband CQI that is at or crosses 50% distribution from the lower wideband CQI side). This CQI-value is declared as Median CQI value.

4. If Median CQI value is not equal to 1 or 15 and [400 (α%)] or more of the wideband CQI values are outside the range (Median CQI - 1) ≤ Median CQI ≤ (Median CQI + 1) then continue with step 5, otherwise fail the UE.

5. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the Median CQI value from step 3 and shall not react to the UE's wideband CQI reports. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH transmitted by the SS, record the associated ACK, NACK and statDTX responses. The responses are then filtered as follows: for the sequence of responses for each HARQ process, discard all the statDTX responses. Continue to gather data until the number of filtered ACK+NACK

responses reaches [1000]. Record the BLER (NACK / ACK + NACK) for Median CQI and measure the average throughput according to Annex TBD. Declare the throughput as t_{median}.

If the recorded BLER ≥ [0.02] then continue with step 6, otherwise fail the UE.

6. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the UE's reported wideband CQI value. The SS sends downlink MAC padding bits on the DL RMC. For any PDSCH transmitted by the SS, record the associated ACK, NACK and statDTX responses. The responses are then filtered as follows: for the sequence of responses for each HARQ process, discard all the statDTX responses. Continue to gather data until the number of filtered ACK+NACK responses reaches [1000]. Record the BLER (NACK / ACK + NACK) and measure the average throughput according to Annex TBD. Declare the throughput as t.

   If the recorded BLER ≥ [0.02] and t / t_{median} ≥ γ then continue with step 7, otherwise fail the UE.

7. If both SNR points of the test have not been tested, then repeat the same procedure (steps 1 to 6) for the other SNR point as appropriate.

8. If both tests have not been done, then repeat the same procedure (steps 1 to 7) with test conditions according to the table 6.2.2.2.2.1.5 -1 for the other Test as appropriate.

6.2.2.2.2.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.2.2.2.2.1.4.3_1 Message exceptions for SA

Same as 6.2.2.1.2.1.4.3_1 with following exceptions:

Table 6.2.2.2.2.1.4.3_1-1: *CSI-ResourcePeriodicityAndOffset*

Derivation Path: TS 38.508-1 [6], clause 4.6.2, Table 4.6.2-43			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-ResourcePeriodicityAndOffset CHOICE {			
slots10	1		
}			

6.2.2.2.2.1.4.3_2 Message exceptions for NSA

FFS

6.2.2.2.2.1.5 Test requirement

The pass/fail decision is as specified in the test procedure in clause 6.2.2.2.2.1.4.2.

Table 6.2.2.2.2.1.5 -1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter	Unit	Test 1		Test 2	
SNR	dB	6+TT	7+TT	12+TT	13+TT

Table 6.2.2.2.2.1.5-2: Minimum requirements

Parameters	Test 1	Test 2
α [%]	[20]	[20]
γ	[1.05]	[1.05]

6.2.2.2.2.2 2Rx TDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Following are pending RAN4 core spec update

  -Minimum requirement is within square brackets

  - Minimum requirement for BLER is TBD

- Annex for measurement uncertainty and test tolerance is TBD

- Minimum test time is TBD

- Test tolerance analysis is missing

6.2.2.2.2.2.1 Test purpose

To verify the variance of the subband CQI reports is within the limits defined, that the ratio of the throughput is within the limits defined and that the average PDSCH BLER is greater than or equal to TBD % for the indicated transport format.

6.2.2.2.2.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of E-UTRA UE release 15 and forward supporting EN-DC.

6.2.2.2.2.2.3 Minimum conformance requirements

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 6.2.2.2.2.2.3-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A sub-band differential CQI offset level of 0 shall be reported at least α% of the time but less than β% of the time for each sub-band, where α and β are specified in Table 6.2.2.2.2.2.3-2;

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 6.2.2.2.2.2.3-2;

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 6.2.2.2.2.2.3-1: Sub-band CQI reporting test under frequency-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	40			
Subcarrier spacing		kHz	30			
Duplex Mode			TDD			
TDD UL-DL pattern			FR1.30-1			
SNR		dB	[8]	[9]	[14]	[15]
Propagation channel			Two tap model specified in Annex B.2.4 with *a*=1, f_D = 5Hz, and τ_d=0.1125μs			
Antenna configuration			2×2			
Correlation configuration			As per Annex B.1			
Beamforming Model			As specified in Section Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6,-)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1			
CSI-IM configuration	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	10/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Subband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	16			
CSI-Report periodicity and offset		slot	10/1			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		000001			
	RI Restriction		N/A			
Physical channel for CSI report			TBD			
	CQI/RI/PMI delay	ms	9.5			
Maximum number of HARQ transmission			1			
Measurement channel			TBD			

Table 6.2.2.2.2.2.3-2: Minimum requirements

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

The normative reference for this requirement is TS 38.101-4 [5] clause 6.2.2.2.2.2.

6.2.2.2.2.2.4 Test description

6.2.2.2.2.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [7].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.6.2 for TE diagram and section A.3.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 6.2.2.2.2.2.3-1 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with Connected without release On, Test Mode On and Test Loop Function On or EN-DC, DC bearer MCG and SCG, Connected without release On, for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 6.2.2.2.2.2.4.3.

6.2.2.2.2.2.4.2 Test procedure

1. Set the parameters of bandwidth, reference Channel, the propagation condition, antenna configuration and the SNR according to Table 6.2.2.2.2.2.3-1 as appropriate.
2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to CQI value 8 and keep it regardless of the wideband and subband CQI value sent by the UE. The SS sends downlink MAC padding bits on the DL RMC. Continue transmission of the PDSCH until [2000] wideband CQI reports and full-size subband CQI reports for each full-size subband have been gathered. In this process the SS collects sub-band CQI reports every 10 ms and also cases where UE transmits nothing in its CQI timing are also counted as subband CQI reports.
3. Set up a relative frequency distribution for the reported wideband CQI-values, Calculate the median value (wideband Median CQI is the CQI that is at or crosses 50% distribution from the lower wideband CQI side). This CQI-value is declared as wideband Median CQI value.
4. For each subband, if subband differential CQI offset level of 0 is reported, at least α% but less than β% of [2000] full-size subband CQI report, then continue to step 5, otherwise, go to step 7.
5. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC in an each available downlink transmission instance randomly selected full-size subband using the transport format according to the wideband median CQI value regardless of UE wideband or subband CQI report. Note that each

full-size subband shall be selected in the equal probability. The SS sends downlink MAC padding bits on the DL RMC. Measure the average throughput according to Annex TBD. Declare the throughput as t_{median}.

6. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the highest UE reported full-size subband CQI value in one full-size subband selected among the sub-bands in which UE report the highest full-size subband CQI. Subband differential CQI offset level is selected from {0, 1, 2, -1}. Note that the SS shall send PDSCH in the same full-size subband until next UE report is available. In case when same full-size subbands are reported subsequently as subbands with highest full-size subband CQI, the SS shall select for transmission a different subband with respect to the last selection. The SS sends downlink MAC padding bits on the DL RMC Measure the average throughput and (NACK /(ACK + NACK)) according to Annex TBD. Declare the throughput as $t_{subband}$. If the ratio ($t_{subband}$ / t_{median}) ≥ γ and (NACK /(ACK + NACK)) ≥ TBD, pass the UE and go to step 8. Otherwise, go to step 7.
7. If both SNR points of the test have not been tested, then repeat the same procedure (steps 1 to 6) for the other SNR point as appropriate. Otherwise fail the UE.
8. If both tests have not been done, then repeat the same procedure (steps 1 to 7) with test conditions according to the table 6.2.2.2.2.2.3-1 for the other test as appropriate.

6.2.2.2.2.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.2.2.2.2.2.4.3_1 Message exceptions for SA

Table 6.2.2.2.2.2.4.3_1-1: CSI-RS-ResourceMapping for NZP-CSI-RS

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
Row3	001000		
}			
nrofPorts	p2		
firstOFDMSymbolInTimeDomain	13		
}			

Table 6.2.2.2.2.2.4.3_1-2: CSI-RS-ResourceMapping for ZP-CSI-RS

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
Row5	000100		
}			
nrofPorts	p4		
firstOFDMSymbolInTimeDomain	9		
}			

Table 6.2.2.2.2.2.4.3_1-3: CSI-IM-Resource

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-34			
Information Element	**Value/remark**	**Comment**	**Condition**
csi-IM-ResourceElementPattern			
pattern0 SEQUENCE {			
subcarrierLocation-p0	s4		
symbolLocation-p0	9		
}			
periodicityAndOffset	CSI-ResourcePeriodicityAndOffset		

Table 6.2.2.2.2.2.4.3_1-4: *CSI-ResourcePeriodicityAndOffset*

Derivation Path: TS 38.508-1 [6], clause 4.6.2, Table 4.6.2-43			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-ResourcePeriodicityAndOffset CHOICE {			
slots10	1		
}			

Table 6.2.2.2.2.2.4.3_1-5: *CodebookConfig*

Derivation Path: TS 38.508-1 [6], clause 4.6.2, Table 4.6.3-25			
Information Element	**Value/remark**	**Comment**	**Condition**
nrOfAntennaPorts CHOICE {			
Two SEQUENCE {			
twoTX-CodebookSubsetRestriction	000001		
}			
}			
typeI-SinglePanel-ri-Restriction	[00000000]		

Table 6.2.2.2.2.2.4.3_1-6: CSI-ReportConfig

Derivation Path: TS 38.508-1 [6], clause 4.6.3, Table 4.6.3-39			
Information Element	**Value/remark**	**Comment**	**Condition**
reportConfigType CHOICE {			
periodic SEQUENCE {			
reportSlotConfig	CSI-ReportPeriodicityAndOffset		
pucch-CSI-ResourceList	TBD		
}			
}			
CSI-ReportPeriodicityAndOffset CHOICE {			
slots10	1		
}			

6.2.2.2.2.2.4.3_2 Message exceptions for NSA

Same as in 6.2.2.2.2.2.4.3_1.

6.2.2.2.2.2.5 Test requirement

The pass/fail decision is as specified in the test procedure in clause 6.2.2.2.2.2.4.2.

Table 6.2.2.2.2.2.5 -1: Subband CQI reporting test under frequency non-selective fading conditions

Parameter	Unit	Test 1		Test 2	
SNR	dB	[8]+TT	[9]+TT	[14]+TT	[15]+TT
NOTE 1: Test tolerance TT = TBD dB.					

Table 6.2.2.2.2.2.5-2: Minimum requirements

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

6.2.3 4RX requirements

6.2.3.1 FDD

6.2.3.2 TDD

6.3 Reporting of Precoding Matrix Indicator (PMI)

6.3.1 1RX requirements (Void)

6.3.2 2RX requirements

6.3.2.1 FDD

6.3.2.1.1 2Rx FDD FR1 Single PMI with 4Tx Type I

6.3.2.1.1_1 2Rx FDD FR1 Single PMI with 4Tx Type I – SinglePanel codebook for both SA and NSA

Editor's Note: This test case is incomplete. The following aspects are either missing or TBD

- Test Description is TBD since the following sections are not yet defined

- Test Procedure is TBD

-Test Requirements are TBD

6.3.2.1.1_1.1 Test purpose

The purpose of this test is to test the accuracy of the Precoding Matrix Indicator (PMI) reporting such that the system throughput is maximized based on the precoders configured according to the UE reports.

6.3.2.1.1_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.3.2.1.1_1.3 Minimum conformance requirements

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
DL BWP configuration #1	First PRB		0
	Number of contiguous PRB		52
	Subcarrier spacing	kHz	15
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 2 (N1,N2) = (2,1)
Beamforming Model			TBD
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 4, (0,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)
	CSI-RS interval and offset		5/1
CSI-IM configuration	CSI-IM RE pattern		Patten 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	5/1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
CSI-Report interval and offset		slot	5/1
aperiodicTriggeringOffset			0
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)

	CodebookSubset Restriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			MCS 13, TBD for reference channel
Note 1: For random precoder selection, the precoder shall be updated in each slot (1 ms granularity). Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#[(n-4)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+4)]. Note 3: Randomization of the principle beam direction shall be used as specified in TBD.			

Table 6.3.2.1.1-2: Minimum requirement

Parameter	Test 1
γ	[1.3]

6.3.2.1.1_1.4 Test description

6.3.2.1.1_1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and section A.3.2.2 for UE diagram.

2. The parameter settings for the cell are set up according to Table 5.3-1 and Table 5.3.2.1.1-1 and as appropriate.

3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR, Connected without release *On* for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1.4.3.

6.3.2.1.1_1.4.2 Test procedure

FFS

6.3.2.1.1_1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.3.2.1.1_1.4.3_1 Message exceptions for SA

FFS

6.3.2.1.1_1.4.3_2 Message exceptions for NSA

FFS

6.3.2.1.1_1.4.4 Test requirement

TBD

6.3.2.1.2 2Rx FDD FR1 Single PMI with 8Tx Type I – SinglePanel codebook for both SA and NSA

Editor's Note: This test case is incomplete. The following aspects are either missing or TBD

- Test Description is TBD since the following sections are not yet defined

-Test Requirements is in []

-TT is TBD

-Message exceptions are FFS

-Procedure for establish $t_{ue,follow1,follow2}$, $SNR_{follow1,follow2}$ and $t_{rnd1,rnd2}$ are TBD

6.3.2.1.2.1 Test purpose

The purpose of this test is to test the accuracy of the Precoding Matrix Indicator (PMI) reporting such that the system throughput is maximized based on the precoders configured according to the UE reports.

6.3.2.1.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.3.2.1.2.3 Minimum conformance requirements

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 6.3.2.1.2.3-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High XP 8 x 2 (N1,N2) = (4,1)
Beamforming Model			As specified in TS 38.101 Section Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		8
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 8, (4,6)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5,-)
	CSI-RS interval and offset	slot	5/1
CSI-IM configuration	CSI-IM RE pattern		Patten 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	5/1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
csi-ReportingBand			[1111111]
CSI-Report interval and offset		slot	5/1
CSI-Report interval and offset		slot	5/1
aperiodicTriggeringOffset			0
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	CodebookSubset Restriction		0x FFFF

	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.2
Note 1: For random precoder selection, the precoder shall be updated in each slot (1 ms granularity). Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#[(n-4)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+4)]. Note 3: Randomization of the principle beam direction shall be used as specified in TBD.			

Table 6.3.2.1.2-2: Minimum requirement

Parameter	Test 1
γ	[1.5]

6.3.2.1.2.4 Test description

6.3.2.1.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and section A.3.2.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1 and Table 5.3.2.1.1-1 and as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR, Connected without release *On* for SA or (EN-DC, DC bearer *MCG* and *SCG*, *Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1.4.3.

6.3.2.1.2.4.2 Test procedure

1. Set the parameters of bandwidth, the propagation condition, antenna configuration and measurement channel according to Table 6.3.2.1.2.3-1 as appropriate.
2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC with precoding matrix according to PMI report from the UE. The SS sends downlink MAC padding bits on the DL RMC. SS schedules the UL transmission to carry the PUSCH CSI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Establish $t_{ue,follow1,follow2}$ and $SNR_{follow1,follow2}$ according to Annex TBD.

3. Set SNR to $SNR_{follow1,follow2}$. The SS shall transmit PDSCH with randomly selected precoding matrix from codebook (Table 5.2.2.2.1-6 in TS 38.214 [TBD]) every slot regardless of PMI reports from the UE. Note that each precoding matrix shall be selected in equal probabilities. The SS sends downlink MAC padding bits on the DL RMC. SS schedules the UL transmission to carry the PUSCH CSI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Measure $t_{rnd1,rnd2}$ according to Annex TBD.

4. Calculate $\gamma = \frac{t_{ue,follow1,follow2}}{t_{rnd1,rnd2}}$. If the ratio ≥ γ which is specified in table 6.3.2.1.2.4.4-1, then the test is pass. Otherwise, the test is fail.

6.3.2.1.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.3.2.1.2.4.3.1 Message exceptions for SA

FFS

6.3.2.1.2.4.3.2 Message exceptions for NSA

FFS

6.3.2.1.2. 5 Test requirement

Table 6.3.2.1.2.4.4-1: Test requirement

Parameter	Test 1
γ	[1.5]

6.3.2.2 TDD

6.3.2.2.1 2Rx TDD FR1 Single PMI with 4Tx Type1 - SinglePanel codebook for both SA and NSA

Editor's Note: This test case is incomplete. The following aspects are either missing or TBD

- Test Description is TBD since the following sections are not yet defined
    - Initial Conditions are TBD
    - Test Procedure is TBD
    - Message Contents are TBD
- Test Requirements are TBD

6.3.2.2.1.1 Test Purpose

The purpose of this test is to test the accuracy of the Precoding Matrix Indicator (PMI) reporting such that the system throughput is maximized based on the precoders configured according to the UE reports.

6.3.2.2.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.3.2.2.1.3 Minimum Conformance Requirements

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 6.3.2.2.1.3-1: 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
DL BWP configuration #1	First PRB		0
	Number of contiguous PRB		106
	Subcarrier spacing	kHz	30
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 2 (N1,N2) = (2,1)
Beamforming Model			TBD
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 4, (0,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)
	CSI-RS interval and offset	slot	10/1
CSI-IM configuration	CSI-IM RE pattern		Patten 0
	CSI-IM Resource Mapping (k_{CSI-IM}, l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	10/1

Parameter		Unit	Test 1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
CSI-Report interval and offset		slot	10/1
aperiodicTriggeringOffset			0
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	CodebookSubsetRestriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			4
Measurement channel			MCS13, TBD for reference channel
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 6.3.2.2.1.3-2: Minimum requirement

Parameter	Test 1
γ	[1.3]

6.3.2.2.1.4 Test Description

TBD

6.3.2.2.1.5 Test Requirements

TBD

6.3.3 4RX requirements

6.3.3.1 FDD

6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook– SinglePanel codebook for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Test Procedure is TBD

-Procedure for establish $t_{ue,\,follow1,\,follow2}$, $SNR_{follow1,\,follow2}$ and $t_{rnd1,\,rnd2}$ are TBD

- Test requirement is in []
- TT is TBD
- Message exceptions are FFs

6.3.3.1.1.1 Test purpose

To test the accuracy of the Precoding Matrix Indicator (PMI) reporting such that the system throughput is maximized based on the precoders configured according to the UE reports.

6.3.3.1.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.3.3.1.1.3 Minimum conformance requirements

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 6.3.3.1.1.3-1: Test parameters for single layer (FDD)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 4 (N1,N2) = (2,1)
Beamforming Model			As specified in Section Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 4, (0,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)
	CSI-RS interval and offset	slot	5/1
CSI-IM configuration	CSI-IM RE pattern		Patten 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	5/1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	5/1
aperiodicTriggeringOffset			0
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	CodebookSubset Restriction		11111111

	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.1 FDD
Note 1: For random precoder selection, the precoder shall be updated in each slot (1 ms granularity). Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#[(n-3)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+3)]. Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3			

Table 6.3.3.1.1.3-2: Minimum requirement

Parameter	Test 1
γ	[1.3]

The normative reference for this requirement is TS 38.101-4 [5] clause 6.3.3.1.1.

6.3.3.1.1.4 Test description6.3.3.1.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and section A.3.2.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1 and Table 5.3.2.1.1-1 and as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR, Connected without release *On* for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1.4.3.

6.3.3.1.1.4.2 Test procedure

1. Set the parameters of bandwidth, the propagation condition, antenna configuration and measurement channel according to Table 6.3.2.2.1.3-1 as appropriate.
2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC with precoding matrix according to PMI report from the UE. The SS sends downlink MAC padding bits on the DL RMC. SS schedules the UL transmission to carry the PUSCH CQI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Establish $t_{ue,follow1,follow2}$ and $SNR_{follow1,follow2}$ according to Annex TBD.

3. Set SNR to $SNR_{follow1,follow2}$. The SS shall transmit PDSCH with randomly selected precoding matrix from codebook (Table 5.2.2.2.1-5 in TS 38.214 [12]) every slot regardless of PMI reports from the UE. Note that each precoding matrix shall be selected in equal probabilities. The SS sends downlink MAC padding bits on the DL RMC. SS schedules the UL transmission to carry the PUSCH CSI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Measure $t_{rnd1,rnd2}$ according to Annex TBD.

4. Calculate $\gamma = \frac{t_{ue,follow1,follow2}}{t_{rnd1,rnd2}}$. If the ratio ≥ γ which is specified in table 6.3.2.1.1.5-1, then the test is pass. Otherwise, the test is fail.

6.3.3.1.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.3.3.1.1.4.3.1 Message exceptions for SA

FFS

6.3.3.1.1.4.3.2 Message exceptions for NSA

FFS

6.3.3.1.1.5 Test requirement

Table 6.3.3.1.1.5-1: Test requirement

Parameter	Test 1
γ	[1.3]

6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook– SinglePanel codebook for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Test Procedure is TBD

-Procedure for establish $t_{ue,follow1,follow2}$, $SNR_{follow1,follow2}$ and $t_{rnd1,rnd2}$ are TBD

- Test requirement is in []

- TT is TBD

- Message exceptions are FFS

6.3.3.1.2.1 Test purpose

To test the accuracy of the Precoding Matrix Indicator (PMI) reporting such that the system throughput is maximized based on the precoders configured according to the UE reports.

6.3.3.1.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.3.3.1.2.3 Minimum conformance requirements

For the parameters specified in Table 6.3.3.1.2.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.2.3-2.

Table 6.3.3.1.2.3-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High XP 8 x 4 (N1,N2) = (4,1)
Beamforming Model			As specified in Section Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		8
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 8, (4,6)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5,-)
	CSI-RS interval and offset	slot	5/1
CSI-IM configuration	CSI-IM RE pattern		Patten 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	5/1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	5/1
aperiodicTriggeringOffset			0
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	CodebookSubset Restriction		0x FFFF

	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.2 FDD
Note 1: For random precoder selection, the precoder shall be updated in each slot (1 ms granularity). Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#[(n-4)], this reported PMI cannot be applied at the eNB downlink before slot#[(n+4)]. Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3			

Table 6.3.3.1.2.3-2: Minimum requirement

Parameter	Test 1
γ	[1.5]

The normative reference for this requirement is TS 38.101-4 [5] clause 6.3.3.1.2.

6.3.3.1.2.4 Test description

6.3.3.1.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and section A.3.2.2 for UE diagram.

2. The parameter settings for the cell are set up according to Table 5.3-1 and Table 5.3.2.1.1-1 and as appropriate.

3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR, Connected without release *On* for SA or (EN-DC, DC bearer *MCG* and *SCG*, *Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1.4.3.

6.3.3.1.2.4.2 Test procedure

1. Set the parameters of bandwidth, the propagation condition, antenna configuration and measurement channel according to Table 6.3.2.2.1.3-1 as appropriate.

2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC with precoding matrix according to PMI report from the UE. The SS sends downlink MAC padding bits on the DL

RMC. SS schedules the UL transmission to carry the PUSCH CQI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Establish $t_{ue,\,follow1,\,follow2}$ and $SNR_{follow1,\,follow2}$ according to Annex TBD.

3. Set SNR to $SNR_{follow1,\,follow2}$. The SS shall transmit PDSCH with randomly selected precoding matrix from codebook (Table 5.2.2.2.1-5 in TS 38.214 [12]) every slot regardless of PMI reports from the UE. Note that each precoding matrix shall be selected in equal probabilities. The SS sends downlink MAC padding bits on the DL RMC. SS schedules the UL transmission to carry the PUSCH CSI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Measure $t_{rnd1,\,rnd2}$ according to Annex TBD.

4. Calculate $\gamma = \dfrac{t_{ue,\,follow1,\,follow2}}{t_{rnd1,\,rnd2}}$. If the ratio ≥ γ which is specified in table 6.3.2.1.1.5-1, then the test is pass. Otherwise, the test is fail.

6.3.3.1.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.3.3.1.2.4.3.1 Message exceptions for SA

FFS

6.3.3.1.2.4.3.2 Message exceptions for NSA

FFS

6.3.3.1.2.5 Test requirement

Table 6.3.3.1.2.5-1: Test requirement

Parameter	Test 1
γ	[1.5]

6.3.3.2 TDD

6.3.3.2.1 4Rx TDD FR1 Single PMI with 4Tx Type1 - SinglePanel codebook for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

-Procedure for establish $t_{ue,\,follow1,\,follow2}$, $SNR_{follow1,\,follow2}$ and $t_{rnd1,\,rnd2}$ are TBD

- Test requirement is in []

- TT is TBD

- Message exceptions are FFS

6.3.3.2.1.1 Test purpose

To test the accuracy of the Precoding Matrix Indicator (PMI) reporting such that the system throughput is maximized based on the precoders configured according to the UE reports.

6.3.3.2.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.3.3.2.1.3 Minimum conformance requirements

For the parameters specified in Table 6.3.3.2.1.3-1 and using the downlink physical channels specified in Annex TBD, the minimum requirements are specified in Table 6.3.3.2.1.3-2.

Table 6.3.3.2.1.3-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configuration			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 4 (N1,N2) = (2,1)
Beamforming Model			As specified in Section Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 4, (0,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)
	CSI-RS interval and offset		10/1
CSI-IM configuration	CSI-IM RE pattern		Patten 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	10/1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	10/1
aperiodicTriggeringOffset			0
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)

	CodebookSubset Restriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.1 TDD
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 Annex B.2.3.2.3			

Table 6.3.3.2.1.3-2: Minimum requirement

Parameter	Test 1
γ	[1.3]

6.3.3.2.1.4 Test description

6.3.3.2.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and section A.3.2.2 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.3-1 and Table 5.3.2.1.1-1 and as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR, Connected without release *On* for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1.4.3.

6.3.3.2.1.4.2 Test procedure

1. Set the parameters of bandwidth, the propagation condition, antenna configuration and measurement channel according to Table 6.3.2.2.1.3-1 as appropriate.
2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC with precoding matrix according to PMI report from the UE. The SS sends downlink MAC padding bits on the DL

RMC. SS schedules the UL transmission to carry the PUSCH CQI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Establish $t_{ue,\,follow1,\,follow2}$ and $SNR_{follow1,\,follow2}$ according to Annex TBD.

3. Set SNR to $SNR_{follow1,\,follow2}$. The SS shall transmit PDSCH with randomly selected precoding matrix from codebook (Table 5.2.2.2.1-5 in TS 38.214 [12]) every slot regardless of PMI reports from the UE. Note that each precoding matrix shall be selected in equal probabilities. The SS sends downlink MAC padding bits on the DL RMC. SS schedules the UL transmission to carry the PUSCH CSI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Measure $t_{rnd1,\,rnd2}$ according to Annex TBD.

4. Calculate $\gamma = \dfrac{t_{ue,\,follow1,\,follow2}}{t_{rnd1,\,rnd2}}$. If the ratio ≥ γ which is specified in table 6.3.2.1.1.5-1, then the test is pass. Otherwise, the test is fail.

6.3.3.2.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.3.3.2.1.4.3.1 Message exceptions for SA

FFS

6.3.3.2.1.4.3.2 Message exception for NSA

FFS

6.3.3.2.1.5 Test requirement

Table 6.3.3.2.1.5-1: Test requirement

Parameter	Test 1
γ	[1.3]

6.3.3.2.2 4Rx TDD FR1 Single PMI with 8Tx Type1 - SinglePanel codebook for both SA and NSA

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

-Procedure for establish $t_{ue,\,follow1,\,follow2}$, $SNR_{follow1,\,follow2}$ and $t_{rnd1,\,rnd2}$ are TBD

- Test requirement is in []

- TT is TBD

- Message exceptions are FFS

6.3.3.2.2.1 Test purpose

To test the accuracy of the Precoding Matrix Indicator (PMI) reporting such that the system throughput is maximized based on the precoders configured according to the UE reports.

6.3.3.2.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.3.3.2.2.3 Minimum conformance requirements

For the parameters specified in Table 6.3.3.2.2.3-1, and using the downlink physical channels specified in Annex TBD, the minimum requirements are specified in Table 6.3.3.2.2.3-2.

Table 6.3.3.2.2.3-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 8 x 4 (N1,N2) = (4,1)
Beamforming Model			As specified in Section Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		8
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 8, (4,6)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5,-)
	CSI-RS interval and offset	slot	10/1
CSI-IM configuration	CSI-IM RE pattern		Patten 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	10/1
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannnelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	10/1
aperiodicTriggeringOffset			0
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)

	CodebookSubset Restriction		0x FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.2 TDD
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 Annex B.2.3.2.3			

Table 6.3.3.2.2.3-2: Minimum requirement

Parameter	Test 1
γ	[1.5]

6.3.3.2.2.4 Test description

6.3.3.2.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram and section A.3.2.2 for UE diagram.

2. The parameter settings for the cell are set up according to Table 5.3-1 and Table 5.3.2.1.1-1 and as appropriate.

3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR, Connected without release *On* for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 5.2.2.1.1.4.3.

6.3.3.2.2.4.2 Test procedure

1. Set the parameters of bandwidth, the propagation condition, antenna configuration and measurement channel according to Table 6.3.2.2.1.3-1 as appropriate.

2. The SS shall transmit PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC with precoding matrix according to PMI report from the UE. The SS sends downlink MAC padding bits on the DL

RMC. SS schedules the UL transmission to carry the PUSCH CQI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Establish $t_{ue,\, follow1,\, follow2}$ and $SNR_{follow1,\, follow2}$ according to Annex TBD.

3. Set SNR to $SNR_{follow1,\, follow2}$. The SS shall transmit PDSCH with randomly selected precoding matrix from codebook (Table 5.2.2.2.1-5 in TS 38.214 [12]) every slot regardless of PMI reports from the UE. Note that each precoding matrix shall be selected in equal probabilities. The SS sends downlink MAC padding bits on the DL RMC. SS schedules the UL transmission to carry the PUSCH CSI feedback via PDCCH DCI format [0_1] with aperiodic CSI request triggered. Measure $t_{rnd1,\, rnd2}$ according to Annex TBD.

4. Calculate $\gamma = \dfrac{t_{ue,\, follow1,\, follow2}}{t_{rnd1,\, rnd2}}$. If the ratio ≥ γ which is specified in table 6.3.2.1.1.5-1, then the test is pass. Otherwise, the test is fail.

6.3.3.2.2.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 4.6.1.

6.3.3.2.2.4.3.1 Message contents

FFS

6.3.3.2.2.4.3.2 Message contents

FFS

6.3.3.2.2.5 Test requirement

Table 6.3.3.2.2.5-1: Test requirement

Parameter	Test 1
γ	[1.5]

6.4 Reporting of Rank Indicator (RI)

6.4.1 1RX requirements (Void)

6.4.2 2RX requirements

6.4.2.1 FDD

6.4.2.2 TDD

6.4.2.2.1 2Rx TDD FR1 RI reporting for both SA and NSA

Editor's Note: This test case is incomplete. The following aspects are either missing or TBD

- SNR and gamma ratio are currently in square brackets in TS 38.101-4.

- Annex G update for measuring throughput ratio

- Message Contents are TBD

- Test Procedure updates to differentiate RRC connection reconfiguration between NSA and SA

6.4.2.2_1.1 Test Purpose

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.

6.4.2.2_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

6.4.2.2_1.3 Minimum Conformance Requirements

The minimum performance requirement in Table 6.4.2.2_1.3-2 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_1.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.4.2.2_1.3-2.

Table 6.4.2.2_1.3-1: RI Test (TDD)

Parameter		Unit	Test 1	Test 2	Test 3
Bandwidth		MHz	40	40	40
Subcarrier spacing		kHz	30	30	30
Duplex Mode			TDD	TDD	TDD
TDD Slot Configuration			FR1.30-1	FR1.30-1	FR1.30-1
SNR		dB	[0]	[20]	[20]
Propagation channel			TDLA30-5	TDLA30-5	TDLA30-5
Antenna configuration			ULA Low 2x2	ULA Low 2x2	ULA High 2x2
Beamforming Model			As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		4	4	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)	(9,-)	(9,-)
	CSI-RS periodicity and offset	slot	10/1	10/1	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		2	2	2
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	10/1	10/1
CSI-IM configuration	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	10/1	10/1	10/1
ReportConfigType			Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured	not configured	not configured
timeRestrictionForInterferenceMeasurements			not configured	not configured	not configured
cqi-FormatIndicator			Wideband	Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband	Wideband
Sub-band Size		RB	16	16	16
csi-ReportingBand			1111111	1111111	1111111
CSI-Report periodicity and offset		slot	10/1	10/1	10/1
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1	1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A	N/A	N/A
	CodebookSubsetRestriction		010000 for fixed rank 2, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank
	RI Restriction		N/A	N/A	N/A
Physical channel for CSI report			PUCCH	PUCCH	PUCCH
CQI/RI/PMI delay		ms	9.5	9.5	9.5
Maximum number of HARQ transmission			1	1	1
RI Configuration			Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI

Table 6.4.2.2_1.3-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
γ_1	N/A	TBD	TBD
γ_2	TBD	N/A	N/A

The normative reference for this requirement is TS 38.101-4 [2] clause 6.4.2.2.

6.4.2.2_1.4 Test Description

6.4.2.2_1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state. The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex D.

Test Environment: Normal as defined in TS 38.508 [6] clause 4.1.

Frequencies to be tested: Mid Range as defined in TS 38.508 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7 for TE diagram and section A.3.2.3 for UE diagram.
2. The parameter settings for the cell are set up according to Table 5.2-1, Table 5.2.2.1.1.0-2 and Table 5.2.2.1.0-3 as appropriate.
3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.
4. Propagation conditions for the NR cell are set according to Annex B.1.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR, *Connected without release On* and Test Mode ON for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without release On* for NSA according to TS 38.508-1 [TBD] clause 4.5. Message contents are defined in clause 6.4.2.2_1.4.3.

6.4.2.2_1.4.2 Test procedure

1. Set the parameters of bandwidth, reference channel, the propagation condition, antenna configuration, antenna correlation, Codebook configuration, Beamforming Model, RI configuration and SNR according to Table 6.4.2.2_1.3-1 as appropriate.
2. The SS shall send PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the UE reported CQI (wideband CQI), PMI and fixed RI as defined in Table 6.4.2.2_1.3-1. The SS sends downlink MAC padding bits on the DL RMC. The SS sends uplink scheduling information via PDCCH DCI format [1_1]. Measure the t_{fix} according to Annex TBD
3. Propagation conditions are set according to Annex B.2.
4. The SS sends uplink scheduling information via PDCCH DCI format [1_1].
5. The SS shall transmit an RRC Connection Reconfiguration message to set codebookSubsetRestriction as for UE reported RI according to Table 6.4.2.2_1.3-1.
6. The UE shall transmit RRC Connection Reconfiguration Complete message.
7. Propagation conditions are set according to Table 6.4.2.2_1.3-1.
8. The SS shall send PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the UE reported CQI (wideband CQI), PMI and RI. The SS sends downlink MAC padding bits on the DL RMC. The

SS sends uplink scheduling information via PDCCH DCI format [1_1]. Measure $t_{reported}$ according to Annex TBD

If the ratio ($t_{reported}$ / t_{fix}) satisfies the requirement in Table 6.4.2.2_1.5-1, then pass the UE for this test and go to step 9. Otherwise, declare a FAIL verdict.

9. If all tests have not been done, then repeat the same procedure (steps 1 to 8) with test conditions according to the Table 6.6.2.2_1.3-2 for the other Tests as appropriate. Otherwise, declare a PASS verdict.

6.4.2.2_1.4.3 Message Contents

TBD

6.4.2.2_1.5 Test Requirements

Table 6.4.2.2_1.5-1: Test Requirement (TDD)

	Test 1	Test 2	Test 3
γ_1	N/A	TBD	TBD
γ_2	TBD	N/A	N/A

6.4.3 4RX requirements

6.4.3.1 FDD

6.4.3.2 TDD

6.4.3.2_1 4Rx TDD FR1 RI reporting for both SA and NSA

Editor's Note: This test case is incomplete. The following aspects are either missing or incomplete:

- RAN4 dependency: There are brackets and TBDs in core requirements and test parameters.

- Message Contents are not complete

- TT analysis is missing

6.4.3.2_1.1 Test Purpose

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.

6.4.3.2_1.2 Test applicability

This test applies to all types of NR UE release 15 and forward supporting 4 Rx antenna ports.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and 4 Rx antenna ports.

6.4.3.2_1.3 Minimum Conformance Requirements

The minimum performance requirement in Table 6.4.3.2_1.3-2 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_1.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.4.3.2_1.3-2.

Table 6.4.3.2_1.3-1: RI Test (TDD)

Parameter		Unit	Test 1	Test 2	Test 3	Test 4
Bandwidth		MHz	40	40	40	40
Duplex Mode			TDD	TDD	TDD	TDD
TDD Slot Configuration			FR1.30-1	FR1.30-1	FR1.30-1	FR1.30-1
DL BWP configuration #1	First PRB		0	0	0	0
	Number of contiguous PRB		106	106	106	106
	Subcarrier spacing	kHz	30	30	30	30
SNR		dB	TBD	[16]	[16]	TBD
Propagation channel			TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna configuration			ULA Low 2x4	ULA Low 2x4	ULA High 2x4	ULA Low 4x4
Beamforming Model			As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		4	4	4	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)	Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)	(9,-)	(9,-)	(9,-)
	CSI-RS periodicity and offset	slot	10/1	10/1	10/1	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		2	2	2	2
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3 (6,-)	Row 3 (6,-)	Row 3 (6,-)	Row 4 (0,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)	(13,-)	(13,-)	(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	10/1	10/1	10/1
CSI-IM configuration	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0	Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)	(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	10/1	10/1	10/1	10/1
ReportConfigType			Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured	not configured	not configured	not configured
timeRestrictionForInterferenceMeasurements			not configured	not configured	not configured	not configured
cqi-FormatIndicator			Wideband	Wideband	Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband	Wideband	Wideband
Sub-band Size		RB	[16]	[16]	[16]	[16]
csi-ReportingBand			[1111111]	[1111111]	[1111111]	[1111111]
CSI-Report periodicity and offset		slot	10/1	10/1	10/1	10/1
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1	1	1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A	N/A	N/A	(2,1)
	CodebookSubsetRestriction		[010000 for fixed rank 2, 010011 for following rank]	[000011 for fixed rank 1, 010011 for following rank]	[000011 for fixed rank 1, 010011 for following rank]	11111111
	RI Restriction		N/A	N/A	N/A	00000010 for fixed Rank 2 and 00001111 for follow RI

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

Table 6.4.3.2_1.3-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3	Test 4
γ_1	N/A	[1.05]	[0.9]	N/A
γ_2	TBD	N/A	N/A	TBD

The normative reference for this requirement is TS 38.101-4 [2] clause 6.4.3.2.

6.4.3.2_1.4 Test Description

6.4.3.2_1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 of 38.521-1[7].

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR1 operation, setup the LTE link according to Annex D

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7 for TE diagram and section A.3.2.5 for UE diagram.

2. The parameter settings for the cell are set up according to Table 6.1.2-1 and Table 6.4.3.2_1.3-1 as appropriate.

3. Downlink signals for NR cell are initially set up according to Annex C.0, C.1, C.2, C.3.1 and uplink signals according to Annex G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR, *Connected without release On* and Test Mode ON for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without release On* for NSA according to TS 38.508-1 [6] clause 4.5. Message contents are defined in clause 6.4.3.2_1.4.3.

6.4.3.2_1.4.2 Test procedure

1. Set the parameters of bandwidth, reference channel, the propagation condition, antenna configuration, antenna correlation, Codebook configuration, Beamforming Model, RI configuration and SNR according to Table 6.4.3.2_1.3-1 as appropriate.

2. The SS shall send PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the UE reported CQI (wideband CQI), PMI and fixed RI as defined in Table 6.4.3.2_1.3-1. The SS sends downlink MAC padding bits on the DL RMC. The SS sends uplink scheduling information via PDCCH DCI format [1_1]. Measure the t_{fix} according to Annex.

3. Propagation conditions are set according to Annex B.2.

4. The SS sends uplink scheduling information via PDCCH DCI format [1_1].

5. The SS shall transmit an RRC Connection Reconfiguration message to set codebookSubsetRestriction as for UE reported RI according to Table 6.4.3.2_1.3-1.

6. The UE shall transmit RRC Connection Reconfiguration Complete message.

7. Propagation conditions are set according to Table 6.4.3.2_1.3-1.

8. The SS shall send PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to the UE reported CQI (wideband CQI), PMI and RI. The SS sends downlink MAC padding bits on the DL RMC. The SS sends uplink scheduling information via PDCCH DCI format [1_1]. Measure $t_{reported}$ according to Annex TBD

   If the ratio ($t_{reported}$ / t_{fix}) satisfies the requirement in Table 6.4.3.2_1.5-1, then pass the UE for this test and go to step 9. Otherwise, declare a FAIL verdict.

9. If all tests have not been done, then repeat the same procedure (steps 1 to 8) with test conditions according to the Table 6.4.3.2_1.3-2 for the other Tests as appropriate. Otherwise, declare a PASS verdict.

6.4.3.2_1.4.3 Message Contents

Message contents are according to TS 38.508-1 [6] clause 4.6 with the following exceptions:

TBD

6.4.3.2_1.5 Test Requirements

Table 6.4.3.2_1.5-1: Test Requirement (TDD)

	Test 1	Test 2	Test 3	Test 4
γ_1	N/A	[1.05]	[0.9]	N/A
γ_2	TBD	N/A	N/A	TBD

7 Demodulation performance requirements (Radiated requirements)

7.1 General

For conformance testing involving FR2 test cases in this specification, the UE under test shall disable UL Tx diversity schemes.

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 [3] 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 antenna ports	PDSCH	All tests in Clause 7.2.2
	PDCCH	All tests in Clause 7.3.2
	PBCH	All tests in Clause 7.4.2

7.1.1.3 Applicability of requirements for optional UE 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	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 scheme			Transmission scheme 1
PTRS *epre-Ratio*			0
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 2)	RBs	0
	Subcarrier spacing	kHz	60 or 120
DL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in TS 38.101-2 [7, Section 5.3.2] for tested channel bandwidth and subcarrier spacing
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		1
	SSB periodicity	ms	20
	First DMRS position for Type A PDSCH mapping		2
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0
	Number of PRBs in CORESET		Table 7.2-2 for tested channel bandwidth and subcarrier spacing
	Number of PDCCH candidates and aggregation levels		1/8
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
	TCI state		TCI state #1
Cross carrier scheduling			Not configured
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k_0)		0 for CSI-RS resource 1,2,3,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		6 for CSI-RS resource 1 and 3 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (*X*)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resource 1,2,3,4 120 kHz SCS: 160 for CSI-RS resource 1,2,3,4

	CSI-RS offset	Slots	60 kHz SCS: 40 for CSI-RS resource 1 and 2 41 for CSI-RS resource 3 and 4 120 kHz SCS: 80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #0
NZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k_0)		0
	First OFDM symbol in the PRB used for CSI-RS (l_0)		12
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	CSI-RS periodicity	Slots	60 kHz SCS: 80 120 kHz SCS: 160
	CSI-RS offset		0
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #1
ZP CSI-RS for CSI acquisition	First subcarrier index in the PRB used for CSI-RS (k_0)		4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		12
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	CSI-RS periodicity	Slots	60 kHz SCS: 80 120 kHz SCS: 160
	CSI-RS offset		0
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
CSI-RS for beam refinement	First subcarrier index in the PRB used for CSI-RS		k_0=0 for CSI-RS resource 1,2
	First OFDM symbol in the PRB used for CSI-RS		l_0 = 8 for CSI-RS resource 1 l_0 = 9 for CSI-RS resource 2
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2
	CDM Type		'No CDM' for CSI-RS resource 1,2
	Density (ρ)		3 for CSI-RS resource 1,2
	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resource 1,2 120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset	Slots	0 for CSI-RS resource 1,2
	QCL info		TCI state #1

PDSCH DMRS configuration	Antenna ports indexes			{1000} for Rank 1 tests {1000, 1001} for Rank 2 tests
	Number of PDSCH DMRS CDM group(s) without data			1
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
PTRS configuration	Frequency density (K_{PT-RS})			2
	Time density (L_{PT-RS})			1
Maximum number of code block groups for ACK/NACK feedback				1
Maximum number of HARQ transmission				4
HARQ ACK/NACK bundling				Multiplexed
Redundancy version coding sequence				{0,2,3,1}
Precoding configuration				SP Type I, Random per slot with PRB bundling granularity
Symbols for all unused Res				OCNG in Annex A.5
Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from 38.101-2 [7] for tested channel bandwidth and subcarrier spacing.				

Table 7.2-2: Number of PRBs in CORESET

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

7.2.1 1RX requirements (Void)

7.2.2 2RX requirements

7.2.2.1 FDD (Void)

7.2.2.2 TDD

7.2.2.2.1 2Rx TDD FR2 PDSCH mapping Type A performance

7.2.2.2.1_0 Minimum conformance requirements

For PDSCH Type-A scheduling, the requirements are specified in Table 7.2.2.2.1_0-3, 7.2.2.2.1_0-4 and 7.2.2.2.1_0-5, with the addition of the parameters in Table 7.2.2.2.1_0-2 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 7.2.2.2.1_0-1.

Table 7.2.2.2.1_0-1: Tests purpose

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

Table 7.2.2.2.1_0-2: Test Parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
CSI-RS for tracking	First OFDM symbol in the PRB used for CSI-RS (l_0)		For Test 1-1 and 1-2: 3 for CSI-RS resource 1 and 3 7 for CSI-RS resource 2 and 4
	CSI-RS offset	Slots	For Test 1-2: 82 for CSI-RS resource 1 and 2 83 for CSI-RS resource 3 and 4
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		1
	Length (L)		As defined in Annex 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 interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		Single-symbol DM-RS
	Antenna ports indexes		{1000} for Rank1 {1000,1001} for Rank2
	Number of PDSCH DMRS CDM group(s) without data		1
Number of HARQ Processes			8 for Test 1-1, 1-3, 2-2, 2-4 10 for Test 2-1, 2-3, 2-5, 2-6, 3-1 16 for Test 1-2
K1 value (PDSCH-to-HARQ-timing-indicator)			As defined in Annex A.1.3

Table 7.2.2.2.1_0-3: Minimum performance for Rank 1 (FRC)

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

Table 7.2.2.2.1_0-4: Minimum performance for Rank 2 (FRC)

Test num.	Reference channel	Bandwidth (MHz)/Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR_{BB} (dB)
2-1	R.PDSCH.5-4.1TDD	100/120	QPSK, 0.30	FR2.120-2	TDLA30-75	2x2 ULA Low	70	4.1
2-2	R.PDSCH.5-2.2TDD	100/120	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	14.4
2-3	R.PDSCH.5-5.2TDD	50/120	16QAM,0.48	FR2.120-2	TDLA30-75	2x2 ULA Low	70	14.0
2-4	R.PDSCH.5-2.3TDD	200/120	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	14.2
2-5	R.PDSCH.4-1.1TDD	50/60	16QAM, 0.48	FR2.60-1	TDLA30-75	2x2 ULA Low	70	14.3
2-6	R.PDSCH.5-6.1TDD	100/120	64QAM, 0.43	FR2.120-2	TBD	2x2 ULA Low	70	18.6

Table 7.2.2.2.1_0-5: Minimum performance for Rank 2 (FRC) for Enhanced Type X Receiver

Test num.	Reference channel	Bandwidth (MHz)/Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR_{BB} (dB)
3-1	R.PDSCH.5-5.1TDD	100/120	16QAM, 0.48	FR2.120-2	TDLA30-75	2x2 ULA Med	70	19.0

The normative reference for this requirement is TS 38.101-4 [5] clause 7.2.2.2.1.

7.2.2.2.1_1 2Rx TDD FR2 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for SA and NSA

Editor's Note: This clause is incomplete. The following aspects are either missing or not yet determined:

-Annex for measurement uncertainty and test tolerance is TBD

- Method for setting up UE in Rx beam peak direction is TBD

- Connection diagram is TBD

- Minimum test time is TBD.

- message contents are TBD

7.2.2.2.1_1.1 Test Purpose

Verify the PDSCH mapping Type A normal performance with different channel models, MCSs and number of MIMO layers

7.2.2.2.1_1.2 Test Applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

7.2.2.2.1_1.3 Test Description

7.2.2.2.1_1.3.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 of 38.521-1.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

For EN-DC within FR2 operation, setup the LTE radiated link according to Annex D:

1. Connection between SS, the faders, AWGN noise source and the UE antenna is shown in TS 38.508-1 [TBD] Annex [TBD], Figure [TBD].
2. The parameter settings for the NR cell are set up according to Table 7.2-1 and Table 7.2.2.2.1.0-2 and as appropriate.
3. Downlink signals for NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1, and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.
4. Propagation conditions for NR cell are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA with *Connected without release On*, *Test Mode On* or (EN-DC, DC bearer *MCG* and *SCG), Connected without release On) for NSA* according to TS 38.508-1 [6] clause 4.5. Message content are defined in clause 7.2.2.2.1.4.3.

7.2.2.2.1_1.3.2 Test Procedure

1. Set the UE in the Rx beam peak direction using method described in Annex [TBD].
2. Configure UE for SS-RSRB reporting.
3. Ensure channel between SS and UE is conducive for UE to start decoding a rank 2 MCS using procedure specified in stage 2 of Annex Y.
4. SS transmits PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 7.2.2.2.1_1.3-3 and 7.2.2.2.1_1.3-4. The SS sends downlink MAC padding bits on the DL RMC.
5. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 7.2.2.2.1_1.3-3 and 7.2.2.2.1_1.3-4. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
6. Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix and the SNR according to Tables 7.2.2.2.1_1.4.4-1 as appropriate.
7. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex TBD clause TBD. Count the number of NACKs, ACKs and statDTXs on the UL during each subtest and decide pass or fail according to Tables TBD and TBD in Annex TBD clause TBD.
8. Repeat steps from 1 to 7 for each subtest in Table 7.2.2.2.1_1.4.4-1 and Table 7.2.2.2.1_1.4.4-2 as appropriate.

7.2.2.2.1_1.3.3 Message Contents

Message contents are according to TS 38.508-1 [6] subclause 4.6.1 with the following exceptions:

7.2.2.2.1_1.3.3_1 Message exceptions for SA

Table 7.2.2.2.1_1.3.3_1: message exceptions for SA

FFS

7.2.2.2.1_1.3.3_2 Message exceptions for NSA

Table 7.2.2.2.1_1.3.3_2: message exceptions for NSA

FFS

7.2.2.2.1_1.4 Test Requirements

Table 7.2.2.2.1-2 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A.3.2 for each throughput test shall meet or exceed the specified value in Table 7.2.2.2.1_1.4-1 and Table 7.2.2.21_1.4-2 for the specified SNR including test tolerances for all throughput tests.

Table 7.2.2.2.1_1.4-1: Test Requirement for Rank 1 (FRC)

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

Table 7.2.2.2.1_1.4-2: Test Requirement for Rank 2 (FRC)

Test num.	Reference channel	Bandwidth (MHz)/Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR_{BB} (dB)
2-1	R.PDSCH.5-4.1TDD	100/120	QPSK, 0.30	FR2.120-2	TDLA30-75	2x2 ULA Low	70	4.1+TT
2-2	R.PDSCH.5-2.2TDD	100/120	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	14.4+TT
2-3	R.PDSCH.5-5.2TDD	50/120	16QAM,0.48	FR2.120-2	TDLA30-75	2x2 ULA Low	70	14.0+TT
2-4	R.PDSCH.5-2.3TDD	200/120	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	14.2+TT
2-5	R.PDSCH.4-1.1TDD	50/60	16QAM, 0.48	FR2.60-1	TDLA30-75	2x2 ULA Low	70	14.3+TT
2-6	R.PDSCH.5-6.1TDD	100/120	64QAM, 0.43	FR2.120-2	TBD	2x2 ULA Low	70	18.6+TT

7.2.2.2.1_2 2Rx TDD FR2 PDSCH mapping Type A performance - 2x2 MIMO with enhanced type X receiver for SA and NSA

Editor's Note: This clause is incomplete. The following aspects are either missing or not yet determined:

-Annex for measurement uncertainty and test tolerance is TBD

- Method for setting up UE in Rx beam peak direction is TBD
- Connection diagram is TBD
- Min test time is TBD

7.2.2.2.1_2.1 Test Purpose

Verify the PDSCH mapping Type A normal performance with different channel models, MCSs and number of MIMO layers

7.2.2.2.1_2.2 Test Applicability

This test applies to all types of NR UE release 15 and forward supporting NR enhanced receiver type X.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC and NR enhanced receiver type X.

7.2.2.2.1_2.3 Test Description

Same test description as in clause 7.2.2.2.1_1.4 with following exception:

- Table 7.2.2.2.1_2.5-1 instead of Table 7.2.2.2.1_1.5-1

7.2.2.2.1_2.4 Test Requirements

Table 7.2.2.2.1.0-2 defines the primary level settings.

The fraction of maximum throughput percentage for the downlink reference measurement channels specified in Annex A TBD for each throughput test shall meet or exceed the specified value in Table 7.2.2.2.1_2.4-1 for the specified SNR including test tolerances for all throughput tests.

Table 7.2.2.2.1_2.4-1: Test Requirement for Rank 2 (FRC) for Enhanced Type X Receiver

Test num.	Reference channel	Bandwidth (MHz)/Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR_{BB} (dB)
3-1	R.PDSCH.5-5.1TDD	100/120	16QAM, 0.48	FR2.120-2	TDLA30-75	2x2 ULA Med	70	19.0+TT

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 serving cell parameters	Physical Cell ID			0
	SSB position in burst			1
	SSB periodicity		ms	20
PDCCH configuration	Slots for PDCCH monitoring			Each slot
	Number of PDCCH candidates			1
	TCI state			TCI state #1
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k0)			0
	First OFDM symbol in the PRB used for CSI-RS (l0)			CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4: 8
	Number of CSI-RS ports (X)			1
	CDM Type			No CDM
	Density (ρ)			3
	CSI-RS periodicity		Slots	160
	CSI-RS offset		Slots	80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4
	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #0
NZP CSI-RS for beam management	First subcarrier index in the PRB used for CSI-RS (k0)			0
	First OFDM symbol in the PRB used for CSI-RS (l0)			CSI-RS resource 1: 8 CSI-RS resource 2: 9
	Number of CSI-RS ports (X)			1
	CDM Type			No CDM
	Density (ρ)			3
	CSI-RS periodicity		Slots	120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Repetition			ON
	QCL info			TCI state #1
Precoding configuration				SP Type I, Random per slot with REG bundling granularity for number of Tx larger than 1
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
Symbols for all unused 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

7.3.2.2.1 2Rx TDD FR2 PDCCH 1 Tx antenna performance for both SA and NSA

Editor's Note: This clause is incomplete. The following aspects are either missing or not yet determined:

-Annex for measurement uncertainty and test tolerance is TBD

-Annex for DL and UL signal setup is TBD

- PDSCH and PDCCH configuration before measurement is TBD

- Method for setting up UE in Rx beam peak direction is TBD

- Connection diagram is TBD

- Propagation condition description in Annex is TBD

- Min test time is TBD

- message contents are TBD

7.3.2.2.1.1 Test Purpose

This test verifies the demodulation performance of PDCCH for a single-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 7.3.2.2.1.3-1.

7.3.2.2.1.2 Test Applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

7.3.2.2.1.3 Minimum conformance requirements

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 7.3.2.2.1.3-1. The downlink physical setup is in accordance with Annex C.5.1.

Table 7.3.2.2.1.3-1: Test Parameters

Parameter	Unit	1 Tx Antenna	2 Tx Antenna
TDD UL-DL pattern		FR2.120-1	
CCE to REG mapping type		Interleaved	
REG bundle size		2 for test 1-1 6 for test 1-2	2
Interleaver size		3 for test 1-1 2 for test 1-2	3
Shift index		0	

Table 7.3.2.2.1.3-2: Minimum performance requirements with 120 kHz SCS for 1Tx antenna

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR_{BB} (dB)
1-1	100 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

The normative reference for this requirement is TS 38.101-4 [5] clause 7.3.2.2.1.

7.3.2.2.1.4 Test Description

7.3.2.2.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [TBD].

Configurations of PDCCH before measurement are specified in Annex TBD.

Test Environment: Normal, as defined in TS 38.508-1 [TBD] clause TBD.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [TBD] clause TBD.

For EN-DC within FR1 operation, setup the LTE link according to Annex D:

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [TBD] Annex A, in Figure TBD for TE diagram and clause TBD for UE diagram.
2. The parameter settings for the cell are set up according to Table 7.3-1 and Table 7.3.2.2.1.3-1as appropriate.
3. Downlink signals for NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1 and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.
4. Propagation conditions are set according to Annex B.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [TBD] clause 4.5. Message content are defined in clause 7.3.2.2.1.4.3.

7.3.2.2.1.4.2 Test procedure

1. Set the UE in the Rx beam peak direction using method described in Annex [TBD].
2. Configure UE for SS-RSRB reporting

3. SS transmits PDCCH with DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 7.3.2.2.1.4.4-1. The details of PDCCH are specified in Table [ ] respectively. The SS sends downlink MAC padding bits on the DL RMC.
4. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 7.3.2.2.1.4.4-1 as appropriate.
5. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex [G] clause [G.4]. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 7.3.2.2.1.4.4-1, pass the UE. Otherwise fail the UE.
6. Repeat steps from 1 to 5 for each subtest in Table 7.3.2.2.1.4.4-1 as appropriate.

7.3.2.2.1.4.3 Message contents

Message contents are according to TS 38.508-1 [TBD] clause 4.6.1.

7.3.2.2.1.4.3.1 Message exceptions for SA

Table 7.3.2.2.1.4.3.1: message exceptions for SA

FFS

7.3.2.2.1.4.3.2 Message exceptions for NSA

Table 7.3.2.2.1.4.3.2: message exceptions for NSA

FFS

7.3.2.2.1.4.4 Test requirement

Table 7.3.2.2.1.4.4-1 defines the primary level settings.

For the parameters specified in Table 7.3.2.2.1.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 7.3.2.2.1.4.4-1.

Table 7.3.2.2.1.4.4-1: Test requirements with 120 kHz SCS for 1Tx antenna

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR_{BB} (dB)
1-1	100 MHz	60	1	2 CCE	R.PDCCH.5-1.1 TDD	TDLA30-75	1x2 Low	1	6 + TT
1-2	100 MHz	60	1	4 CCE	R.PDCCH.5-1.2 TDD	TDLA30-300	1x2 Low	1	2.6 + TT

7.3.2.2.2 2Rx TDD FR2 PDCCH 2 Tx antenna performance for both SA and NSA

Editor's Note: This clause is incomplete. The following aspects are either missing or not yet determined:

-Annex for measurement uncertainty and test tolerance is TBD

-Annex for DL and UL signal setup is TBD

- PDSCH and PDCCH configuration before measurement is TBD

- Method for setting up UE in Rx beam peak direction is TBD

- Connection diagram is TBD

- Propagation condition description in Annex is TBD

- Min test time is TBD

- message contents are TBD

7.3.2.2.2.1 Test Purpose

This test verifies the demodulation performance of PDCCH for two-antenna port with a given SNR for which the average probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg), shall be below the specified value in Table 7.3.2.2.2.3-1.

7.3.2.2.2.2 Test Applicability

This test applies to all types of NR UE release 15 and forward.

This test also applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

7.3.2.2.2.3 Minimum conformance requirements

For the parameters specified in Table 7.3.2.2.2.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 7.3.2.2.2.3-1. The downlink physical setup is in accordance with Annex C.5.1.

Table 7.3.2.2.2.3-1: Test Parameters

Parameter	Unit	1 Tx Antenna	2 Tx Antenna
TDD UL-DL pattern		FR2.120-1	
CCE to REG mapping type		Interleaved	
REG bundle size		2 for test 1-1 6 for test 1-2	2
Interleaver size		3 for test 1-1 2 for test 1-2	3
Shift index		0	

Table 7.3.2.2.2.3-1: Minimum performance requirements with 120 kHz SCS for 2Tx Antenna

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR_{BB} (dB)
2-1	100 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

The normative reference for this requirement is TS 38.101-4 [TBD] clause 7.3.2.2.2.

7.3.2.2.2.4 Test Description

7.3.2.2.2.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1 and Table 5.3.6-1 of 38.521-1 [TBD].

Configurations of PDCCH before measurement are specified in Annex TBD.

Test Environment: Normal, as defined in TS 38.508-1 [TBD] clause TBD.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [TBD] clause TBD.

For EN-DC within FR1 operation, setup the LTE link according to Annex D:

1. Connect the SS, the faders and AWGN noise source to the UE antenna connectors as shown in TS 38.508-1 [TBD] Annex A, in Figure TBD for TE diagram and clause TBD for UE diagram.

2. The parameter settings for the cell are set up according to Table 7.3-1 and Table 7.3.2.2.2.3-1as appropriate.

3. Downlink signals for NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1 and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.

4. Propagation conditions are set according to Annex B.

5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity NR for SA or (EN-DC, DC bearer *MCG* and *SCG, Connected without Release On)* for NSA according to TS 38.508-1 [TBD] clause 4.5. Message content are defined in clause 7.3.2.2.1.4.3.

7.3.2.2.2.4.2 Test procedure

1. Set the UE in the Rx beam peak direction using method described in Annex [TBD].

2. Configure UE for SS-RSRB reporting

3. SS transmits PDCCH with DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 7.3.2.2.2.4.4-1. The details of PDCCH are specified in Table [ ] respectively. The SS sends downlink MAC padding bits on the DL RMC.

4. Set the parameters of the propagation condition, antenna configuration, the correlation matrix and the SNR according to Table 7.3.2.2.2.4.4-1 as appropriate.

5. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex [G] clause [G.4]. Count the number of NACKs, ACKs and statDTXs on the UL PUCCH during each subtest interval. Pm-dsg is the ratio (statDTX)/(NACK+ACK+statDTX). If Pm-dsg is less than the value specified in table 7.3.2.2.2.4.4-1, pass the UE. Otherwise fail the UE.

6. Repeat steps from 1 to 5 for each subtest in Table 7.3.2.2.2.4.4-1 as appropriate.

7.3.2.2.2.4.3 Message contents

Message contents are according to TS 38.508-1 [TBD] clause 4.6.1.

7.3.2.2.2.4.3.1 Message exceptions for SA

Table 7.3.2.2.2.4.3.1: message exceptions for SA

FFS

7.3.2.2.2.4.3.2 Message exceptions for NSA

Table 7.3.2.2.2.4.3.2: message exceptions for NSA

FFS

7.3.2.2.2.4.4 Test requirement

Table 7.3.2.2.2.4.4-1 defines the primary level settings.

For the parameters specified in Table 7.3.2.2.2.3-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 7.3.2.2.2.4.4-1.

Table 7.3.2.2.2.4.4-1: Test requirements with 120 kHz SCS

Test number	Bandwidth	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR_{BB} (dB)
2-1	100 MHz	60	1	8 CCE	R.PDCCH.5-1.3 TDD	TDLA30-75	2x2 Low	1	-0.4 + TT
2-2	100 MHz	60	2	16 CCE	R.PDCCH.5-2.1 TDD	TDLA30-75	2x2 Low	1	-3.4 + TT

7.4 PBCH demodulation requirements

RAN4 will specify the PBCH performance requirements and has recommended that these requirements do not need to be tested.

7.5 Sustained downlink data rate provided by lower layers

8 CSI reporting requirements (Radiated requirements)

8.1 General

For conformance testing involving FR2 test cases in this specification, the UE under test shall disable UL Tx diversity schemes.

8.1.1 Applicability of requirements

FFS

8.1.2 Common test parameters

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

Table 8.1.2-1: Test parameters for CSI test cases

Parameter	Unit	Value
PDSCH transmission scheme		Transmission scheme 1
Duplex Mode		TDD
PTRS *epre-Ratio*		0

Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)	RBs	0
	Subcarrier spacing	kHz	120
DL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in TS 38.101-2 [7, Section 5.3.2] for tested channel bandwidth and subcarrier spacing
Active DL BWP index			1
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0,1
	Number of PDCCH candidates and aggregation levels		1/[8]
	DCI format		1_1
	TCI state		TCI state #1
Cross carrier scheduling			Not configured
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	DMRS ports indexes		{1000} for Rank1 {1000,1001} for Rank2
	Length		Single-symbol DM-RS
	Number of PDSCH DMRS CDM group(s) without data		2
PTRS configuration	Frequency density (K_{PT-RS})		2
	Time density (L_{PT-RS})		1
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k_0)		0
	First OFDM symbol in the PRB used for CSI-RS (l_0)		4
	Number of CSI-RS ports (*X*)		1
	CDM Type		No CDM
	Density (ρ)		3
	CSI-RS periodicity	slot	120kHz SCS: 160
	CSI-RS offset	slot	120 kHz SCS: 80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #0

NZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
CSI-RS for beam refinement	First subcarrier index in the PRB used for CSI-RS			k_0=0 for CSI-RS resource 1,2
	First OFDM symbol in the PRB used for CSI-RS			l_0 = 8 for CSI-RS resource 1 l_0 = 9 for CSI-RS resource 2
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2
	CDM Type			'No CDM' for CSI-RS resource 1,2
	Density (ρ)			3 for CSI-RS resource 1,2
	CSI-RS periodicity		Slots	120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Repetition			ON
	QCL info			TCI state #1
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
Number of HARQ Processes				8
HARQ ACK/NACK bundling				Multiplexed
Redundancy version coding sequence				{0,2,3,1}
K1 value (PDSCH-to-HARQ-timing-indicator)				For FR2.120-1: 3 if mod (i.5) = 0, 6 if mod(i,5) = 2 For FR2.120-2: 11 if mod(i,8) = 0, 7]if mod(i,8) = 4, 6]if mod(i,8) = 5, where i is slot index per radio fame with values 0-79.
Symbols for unused Res				OCNG as specified in A.5
Note 1: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL. Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. Note 3: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from 38.101-2 [7] for tested channel bandwidth and subcarrier spacing.				

8.2 Reporting of Channel Quality Indicator (CQI)

8.2.1 1RX requirements

TBD

8.2.2 2RX requirements

8.2.2.1 FDD

TBD

8.2.2.2 TDD

8.3 Reporting of Precoding Matrix Indicator (PMI)

8.3.1 1RX requirements (Void)

8.3.2 2RX requirements

8.3.2.1 FDD

TBD

8.3.2.2 TDD

8.4 Reporting of Rank Indicator (RI)

8.4.1 1RX requirements

TBD

8.4.2 2RX requirements

8.4.2.1 FDD

TBD

8.4.2.2 TDD

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.

For conformance testing involving FR2 test cases in this specification, the UE under test shall disable UL Tx diversity schemes.

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.

9.2 Void

9.2A PDSCH Demodulation for CA

9.2A.1 NR CA between FR1 and FR2

FFS

9.2B PDSCH Demodulation for DC

9.2B.1 EN-DC

9.2B.1.1 EN-DC within FR1

The NR PDSCH demodulation performance requirements and test case details for this test case 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

The NR PDSCH demodulation performance requirements and test case details for this test case 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

FFS

9.3 Void

9.3A PDCCH Demodulation for CA

9.3A.1 NR CA between FR1 and FR2

FFS

9.3B PDCCH Demodulation for DC

9.3B.1 EN-DC

9.3B.1.1 EN-DC within FR1

The NR PDCCH demodulation performance requirements and test case details for this test case 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

The NR PDCCH demodulation performance requirements and test case details for this test case 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

FFS

9.4 Void

9.4A SDR test for CA

FFS

9.4B SDR test for DC

9.4B.1 EN-DC

9.4B.1.1 Sustained downlink data rate performance for EN-DC within FR1

Editor's note: This test case is incomplete. The following aspects are either missing or TBD

- Test Procedure to calculate PDCP SDU success rate is FFS

9.4B.1.1.1 Test Purpose

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

9.4B.1.1.2 Test Applicability

This test applies to all types of EUTRA UE release 15 and forward supporting EN-DC.

9.4B.1.1.3 Minimum conformance requirements

During the test, the PDSCH performance on both the NR cell(s) and LTE cell(s) shall be verified.

The TB success rate shall be higher than 85% when NR PDSCH is scheduled with MCS defined for the selected EN-DC bandwidth combination and with the downlink physical channel setup according to Annex C.3.1 and when E-UTRA PDSCH is scheduled with FRC defined for the selected EN-DC bandwidth combination and with the downlink physical channel setup according to Annex C.3.2 from TS 36.101 [X].

The TB success rate is defined as 100%*$N_{DL\_correct\_rx}$ / (N_{DL_newtx} + N_{DL_retx}), where N_{DL_newtx} is the number of newly transmitted DL transport blocks, N_{DL_retx} is the number of retransmitted DL transport blocks, and $N_{DL\_correct\_rx}$ is the number of correctly received DL transport blocks.

The common test parameters for NR cell are specified in Table 9.4B.1.1.3-1. The parameters specified in Table 9.4B.1.1.3-2 are applicable for tests on FDD NR cell and parameters specified in Table 9.4B.1.1.3-3 are applicable for tests on TDD NR cell.

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

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

Table 9.4B.1.1.3-1: Common test parameters for FDD or TDD NR band

Parameter		Unit	Value
PDSCH transmission scheme			Transmission scheme 1
EPRE ratio of PTRS to PDSCH		dB	N/A
Channel bandwidth		MHz	Channel bandwidth
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
	First DMRS position for Type A PDSCH mapping		2
Cross carrier scheduling			Not configured
Active DL BWP index			1
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 2)	RBs	0
	Subcarrier spacing	kHz	15 or 30
DL BWP configuration #1	RB offset	RBs	0
	Number of contiguous PRB		Maximum transmission bandwidth configuration as specified in 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
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		Symbols #0
	Number of PRBs in CORESET		Table 5.5A-4
	Number of PDCCH candidates and aggregation levels		1/AL 1 for 30 kHz / 5 MHz 1/AL4 for 15 kHz / 5 MHz, 30 kHz / 10 MHz and 30 kHz / 15 MHz 1/AL 8 for other combinations
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
	TCI State		TCI state #1
PDSCH configuration	Mapping type		Type A
	k0		0
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		WB
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		1
	Antenna ports indexes		{1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs {1000 – 1003} for 4 Layers CCs
	Number of PDSCH DMRS CDM group(s) without data		1 for 1 layer and 2 layers CCs 2 for 4 Layers CCs
PTRS configuration			PTRS is not configured
CSI-RS for tracking	Subcarrier indexes in the PRB used for CSI-RS		k_0 = 3 for CSI-RS resource 1,2,3,4
	OFDM symbols in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 1 and 3 l_0 = 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 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
NZP CSI-RS for CSI acquisition	Subcarrier indexes in the PRB used for CSI-RS			$k_0 = 4$
	OFDM symbols in the PRB used for CSI-RS			$l_0 = 12$
	Number of CSI-RS ports (X)			Same as number of transmit antenna
	CDM Type			'FD-CDM2'
	Density (ρ)			1
	CSI-RS periodicity			15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset			0
	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Subcarrier indexes in the PRB used for CSI-RS			$k_0 = 0$
	OFDM symbols in the PRB used for CSI-RS			$l_0 = 12$
	Number of CSI-RS ports (X)			4
	CDM Type			'FD-CDM2'
	Density (ρ)			1
	CSI-RS periodicity			15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset			0
	Frequency Occupation			Start PRB 0 Number of PRB = BWP size
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #1 TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
	Type 1 QCL information	SSB index		SSB #0
Maximum number of code block groups for ACK/NACK feedback				1
Maximum number of HARQ transmission				4
HARQ ACK/NACK bundling				Multiplexed
Redundancy version coding sequence				{0,2,3,1}
Precoding configuration				SP Type I, Random per slot with PRB bundling granularity
Symbols for all unused Res				OCNG Annex A.5
Propagation condition				Static propagation condition No external noise sources are applied
Antenna configuration	1 layer CCs			1x2 or 1x4
	2 layers CCs			2x2 or 2x4
	4 layers CCs			4x4

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

Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [2] for tested channel bandwidth and subcarrier spacing

Table 9.4B.1.1.3-2: Additional test parameters for NR FDD band

Parameter		Unit	Value
Duplex mode			FDD
PDSCH configuration	Starting symbol (S)		1
	Length (L)		13
Number of HARQ Processes			4
K1 value			2

Table 9.4B.1.1.3-3: Additional test parameters for NR TDD band

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

Table 9.4B.1.1.3-4: Number of PRBs in CORESET for NR cell

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 9.4B.1.1.3-5: MCS indexes for indicated UE capabilities for NR cell

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

Table 9.4B.1.1.3-6: Additional test setup for E-UTRA CC

Parameter	Unit	Value
Inter-TTI Distance		1
Number of OFDM symbols for PDCCH per component carrier	OFDM symbols	1
Cross carrier scheduling		Not configured
Propagation condition		Static propagation condition No external noise sources are applied
$\hat{E}_s$ at antenna port	dBm/15kHz	-85
Antenna configuration	2 layer CC	2x2 or 2x4
	4 layer CC	4x4
Codebook subset restriction	2 layer CC	10
	4 layer CC	1000
Downlink power allocation	2 layer CC	ρ_A = -3dB, ρ_B = -3dB, σ = 0dB
	4 layer CC	ρ_A = -6dB, ρ_B = -6dB, σ = 3dB

Table 9.4B.1.1.3-7: E-UTRA FRC for SDR test (FDD)

MIMO layer	Bandwidth	Reference channel		
		64QAM	256QAM	1024QAM
2 layer	5	R.PDSCH.4-1.1 FDD	R.PDSCH.4-3.1 FDD	R.PDSCH.4-5.1 FDD
	10	R.PDSCH.4-1.2 FDD	R.PDSCH.4-3.2 FDD	R.PDSCH.4-5.2 FDD
	15	R.PDSCH.4-1.3 FDD	R.PDSCH.4-3.3 FDD	R.PDSCH.4-5.3 FDD
	20	R.PDSCH.4-1.4 FDD	R.PDSCH.4-3.4 FDD	R.PDSCH.4-5.4 FDD
4 layer	5	R.PDSCH.4-2.1 FDD	R.PDSCH.4-4.1 FDD	R.PDSCH.4-6.1 FDD
	10	R.PDSCH.4-2.2 FDD	R.PDSCH.4-4.2 FDD	R.PDSCH.4-6.2 FDD
	15	R.PDSCH.4-2.3 FDD	R.PDSCH.4-4.3 FDD	R.PDSCH.4-6.3 FDD
	20	R.PDSCH.4-2.4 FDD	R.PDSCH.4-4.4 FDD	R.PDSCH.4-6.4 FDD

Table 9.4B.1.1.3-8: E-UTRA FRC for SDR test (TDD)

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

9.4B.1.1.3.1 Procedure for test parameter selection

The test parameters are determined by the following procedure:

- Select one EN-DC bandwidth combination among all supported EN-DC configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities that provides the largest data rate [TS 38.306 [14, Section 4.1.2]].
  - Set of per NR CC UE capabilities include channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor TS 38.306 [14] Section 4.1.2]].
  - Set of per E-UTRA CC UE capabilities includes channel bandwidth, number of PDSCH MIMO layers and modulation format [TS 38.306 [14] Section 4.1.2]].
  - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with same largest data rate, select one among sets with the smallest aggregated channel bandwidth.

- For each NR FR1 CC in EN-DC bandwidth combination, use Table 9.4B.1.1.3-5 to determine MCS based on test parameters and indicated UE capabilities.

- For each E-UTRA CC in EN-DC bandwidth combination, use Table 9.4B.1.1.3-7 and Table 9.4B.1.1.3-8 to determine FRC based on test parameters and indicated UE capabilities.

Pasting relevant portion of max data rate equation from TS 38.306 [14] section 4.1

For NR, the approximate data rate for a given number of aggregated carriers in a band or band combination is computed as follows.

$$\text{data rate (in Mbps)} = 10^{-6} \cdot \sum_{j=1}^{J} \left(v_{Layers}^{(j)} \cdot Q_m^{(j)} \cdot f^{(j)} \cdot R_{\max} \cdot \frac{N_{PRB}^{BW(j),\mu} \cdot 12}{T_s^{\mu}} \cdot \left(1 - OH^{(j)}\right) \right)$$

wherein

J is the number of aggregated component carriers in a band or band combination

R_{max} = 948/1024

For the j-th CC,

$v_{Layers}^{(j)}$ is the maximum number of supported layers given by higher layer parameter *maxNumberMIMO-LayersPDSCH* for downlink and maximum of higher layer parameters *maxNumberMIMO-LayersCB-PUSCH* and *maxNumberMIMO-LayersNonCB-PUSCH* for uplink.

$Q_m^{(j)}$ is the maximum supported modulation order given by higher layer parameter *supportedModulationOrderDL* for downlink and higher layer parameter *supportedModulationOrderUL* for uplink.

$f^{(j)}$ is the scaling factor given by higher layer parameter *scalingFactor* and can take the values 1, 0.8, 0.75, and 0.4.

μ is the numerology (as defined in TS 38.211 [6])

T_s^{μ} is the average OFDM symbol duration in a subframe for numerology μ, i.e. $T_s^{\mu} = \frac{10^{-3}}{14 \cdot 2^{\mu}}$. Note that normal cyclic prefix is assumed.

$N_{PRB}^{BW(j),\mu}$ is the maximum RB allocation in bandwidth $BW^{(j)}$ with numerology μ, as defined in 5.3 TS 38.101-1 [2] and 5.3 TS 38.101-2 [3], where $BW^{(j)}$ is the UE supported maximum bandwidth in the given band or band combination.

$OH^{(j)}$ is the overhead and takes the following values

0.14, for frequency range FR1 for DL

0.18, for frequency range FR2 for DL

0.08, for frequency range FR1 for UL

0.10, for frequency range FR2 for UL

NOTE: Only one of the UL or SUL carriers (the one with the higher data rate) is counted for a cell operating SUL.

For EUTRA in case of MR-DC, the approximate data rate for a given number of aggregated carriers in a band or band combination is computed as follows.

Data rate (in Mbps) = $10^{-3} \cdot \sum_{j=1}^{J} TBS_j$

wherein

J is the number of aggregated EUTRA component carriers in MR-DC band combination

TBS_j is the total maximum number of DL-SCH transport block bits received within a 1ms TTI for j-th CC, as derived from TS36.213 [22] based on the UE supported maximum MIMO layers for the j-th carrier, and based on the modulation order and number of PRBs based on the bandwidth of the j-th carrier.

The approximate maximum data rate can be computed as the maximum of the approximate data rates computed using the above formula for each of the supported band or band combinations.

For MR-DC, the approximate maximum data rate is computed as the sum of the approximate maximum data rates from NR and EUTRA

The normative reference for this requirement is TS 38.101-4 [5], clause 9.4B.1.1.

9.4B.1.1.4 Test description

9.4B.1.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR and E-UTRA operating bands specified in Table 5.3.5-1 of TS 38.521-1.

Configurations of NR PDSCH and NR PDCCH before measurement are specified in Annex C.

E-UTRA configurations before measurement are specified in Annex D.

Test Environment: Normal, as defined in TS 38.508-1 [6] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [6] clause 4.3.1.1.

1. Connect the SS to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure A.3.1.7.1 for TE diagram (without fader and AWGN) and clause A.3.2.2 for UE diagram.
2. Downlink signals for the NR cell are initially set up according to Annexes C.0, C.1, C.2, C.3.1, and uplink signals according to Annexes G.0, G.1, G.2, G.3.1.
3. Downlink signals for E-UTRA cell are initially set up according to TS 36.521-1 [16] Annex C.0 and uplink signals according to TS 36.521-1 [16] Annex H
4. Propagation conditions are set according to TS 36.521-1 [16] and TS 38.521-1 [7] Annex B.0 for E-UTRA CG and NR CG respectively.
5. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity EN-DC, DC bearer *MCG* and *SCG*, Connected without release *On,* according to TS 38.508-1 [6] clause 4.5.4. Message content are defined in clause 5.5.1.4.3.
6. SS shall transmit UECapabilityEnquiry message containing *UE-CapabilityRAT-Request* with *rat-Type* set to *eutra-nr* and *eutra*.
7. The UE shall transmit UECapabilityInformation message.
8. Using the UE capabilities advertised in the *UE-CapabilityRAT-Container* of the type *UE-MRDC-Capability and UE-EUTRA-Capability,* and the procedure outlined in 9.4B.1.1.3.1 determine one EN-DC bandwidth combination that would provide the largest aggregated data rate.
9. Setup up the NR CG and E-UTRA CG using these parameters for the test.
10. Configure the NR CG TBsize, NR CG DL RMC, NR CG UL RMC from Annex A.3.2_1 and Annex A.2.2 for UL as appropriate. Configure the E-UTRA CG TBsize, DL RMC and UL RMC from Table 9.4B.1.1.3-7, Table 9.4B.1.1.3-8 as appropriate.

9.4B.1.1.4.2 Test procedure

FFS

9.4B.1.1.4.3 Message contents

Message contents are according to TS 38.508-1 [6] clause 5.4.2 with the following exceptions

Table 9.4B.1.1.4.3-1: PDCCH-ControlResourceSet

Derivation Path: TS 38.508-1 [6], Table 4.6.3-28			
Information Element	**Value/remark**	**Comment**	**Condition**
ControlResourceSet ::= SEQUENCE {			
frequencyDomainResources	CORESET value according to Table 5.5.1.3-4 as applicable		
}			
}			

Table 9.4B.1.1.4.3-2: PDCCH *Search Space*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-162			
Information Element	**Value/remark**	**Comment**	**Condition**
SearchSpace ::= SEQUENCE {			
monitoringSymbolsWithinSlot	10000000000000	Symbols 0	
nrofCandidates SEQUENCE {			
aggregationLevel1	n1		5MHz 30kHz
aggregationLevel2	n0		
aggregationLevel4	n1		5MHz 15kHz, 10MHz 30kHz, 15MHz 30kHz
aggregationLevel8	n1	AL8	For all other BW/SCS cases
aggregationLevel16	n0		
}			
}			

Table 9.4B.1.1.4.3-3: CSI-RS-ResourceMapping for TRS

Derivation Path: TS 38.508-1 [6], Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0001	k_0=0 for CSI-RS resource 1,2,3,4	TRS
}			
}			

Table 9.4B.1.1.4.3-4: NZP CSI-RS-ResourceMapping for CSI Acquisition

Derivation Path: TS 38.508-1 [6], Table 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
NZP-CSI-RS-Resource ::= SEQUENCE {			
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0100	k_0=4	
}			
}			
}			

Table 9.4B.1.1.4.3-5: ZP CSI-RS-ResourceMapping for CSI Acquisition

Derivation Path: TS 38.508-1 [6], clause 4.6.3-45			
Information Element	**Value/remark**	**Comment**	**Condition**
ZP-CSI-RS-Resource ::= SEQUENCE {			
CSI-RS-ResourceMapping ::= SEQUENCE {			
frequencyDomainAllocation CHOICE {			
row1	0001	k_0=0	
}			
}			
}			

Table 9.4B.1.1.4.3-6: *PDSCH-Config*

Derivation Path: TS 38.508-1 [6], Table 4.6.3-100			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-Config ::= SEQUENCE {			
prb-BundlingType CHOICE {			
staticBundling SEQUENCE {			
bundleSize	wideband	Wideband PRB Bundling	
}			
}			
}			

9.4B.1.1.5 Test requirement

The PDCP SDU success rate of greater than 85% shall be sustained during at least 300 frames.

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

For conformance testing involving FR2 test cases in this specification, the UE under test shall disable UL Tx diversity schemes.

10.1.1 Applicability of requirements

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

- For UEs supporting both SA and NSA,
  - The performance requirements specified in Section 6 will be verified in SA mode only.
  - The performance requirements specified in Section 8 will be verified in SA mode only.
- The FR1 EN-DC test cases with the NR TDD DL-UL configurations which are not aligned with LTE TDD DL-UL configuration can be tested on the corresponding EN-DC band combinations where UE supports simultaneous transmission and reception.

10.2 Void

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

FFS

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

10.2B.1 EN-DC

10.2B.1.1 EN-DC within FR1

The NR CQI requirements and test case details for this test case are specified in Section 6.2.

During the test, only the CQI requirements on the NR cell shall be verified.

10.2B.1.2 EN-DC including FR2 NR carrier

The NR CQI requirements and test case details for this test case are specified in Section 8.2.

During the test, only the CQI performance on the NR cell(s) on FR2 carriers shall be verified.

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

The CSI performance requirements are verified according to section 10.2B.1.1 for EN-DC with FR1 NR carrier only and section 10.2B.1.2 for EN-DC with FR2 NR carrier only.

During the test for EN-DC with FR2 NR carriers, only the CSI performance requirements on the FR2 carriers are verified.

No CSI requirement for FR1 NR or LTE carriers is specified for EN-DC including FR2 carrier(s).

10.2B.2 NR DC between FR1 and FR2

FFS

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

FFS

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

10.3B.1 EN-DC

10.3B.1.1 EN-DC within FR1

The NR PMI requirements and test case details for this test case are specified in Section 6.3.

During the test, only the PMI requirements on the NR cell shall be verified.

10.3B.1.2 EN-DC including FR2 NR carrier

The NR PMI requirements and test case details for this test case are specified in Section 8.3.

During the test, only the PMI performance on the NR cell(s) on FR2 carriers shall be verified.

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

The PMI performance requirements are verified according to section 10.3B.1.1 for EN-DC with FR1 NR carrier only and section 10.3B.1.2 for EN-DC with FR2 NR carrier only.

During the test for EN-DC with FR2 NR carriers, only the PMI performance requirements on the FR2 carriers are verified.

No PMI requirement for FR1 NR or LTE carriers is specified for EN-DC including FR2 carrier(s).

10.3B.2 NR DC between FR1 and FR2

FFS

10.4A Reporting of Rank Indicator (RI) for CA

FFS

10.4B Reporting of Rank Indicator (RI) for DC

10.4B.1 EN-DC

10.4B.1.1 EN-DC within FR1

The NR RI requirements and test case details for this test case are specified in Section 6.4.

During the test, only the RI requirements on the NR cell shall be verified.

10.4B.1.2 EN-DC including FR2 NR carrier

The NR RI requirements and test case details for this test case are specified in Section 8.4.

During the test, only the RI performance on the NR cell(s) on FR2 carriers shall be verified.

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

The RI performance requirements are verified according to section 10.4B.1.1 for EN-DC with FR1 NR carrier only and section 10.4B.1.2 for EN-DC with FR2 NR carrier only.

During the test for EN-DC with FR2 NR carriers, only the RI performance requirements on the FR2 carriers are verified.

No RI requirement for FR1 NR or LTE carriers is specified for EN-DC including FR2 carrier(s).

10.4B.2 NR DC between FR1 and FR2

FFS

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**
			FR1.15-1
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	15
	dl-UL-TransmissionPeriodicity	ms	5
	nrofDownlinkSlots		3
	nrofDownlinkSymbols		10
	nrofUplinkSlot		1
	nrofUplinkSymbols		2
K1 value (PDSCH-to-HARQ-timing-indicator)			4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3
NOTE 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. NOTE 2: D, G, 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

Parameter		Unit	UL-DL pattern					
			FR1.30-1	FR1.30-2	FR1.30-3		FR1.30-5	FR1.30-6
TDD Slot Configuration pattern (Note 1)			7DS2U	DDDSU	DDDSUDDSUU		DDSU	DS$_1$S$_2$U
Special Slot Configuration (Note 2)			6D+4G+4U	10D+2G+2U	10D+2G+2U		10D+2G+2U	S1: 10D+2G+2U S2: 12D+2G+0U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	30	30	30		30	30
	dl-UL-TransmissionPeriodicity	ms	5	2.5	2.5		2	1
	nrofDownlinkSlots		7	3	3		2	1
	nrofDownlinkSymbols		6	10	10		10	10
	nrofUplinkSlot		2	1	1		1	0
	nrofUplinkSymbols		4	2	2		2	2
UL-DL configuration2 (*tdd-UL-DL-ConfigurationCommon2*)	*referenceSubcarrierSpacing*	kHz	N/A	N/A	30		N/A	30
	dl-UL-TransmissionPeriodicity	ms	N/A	N/A	2.5		N/A	1
	nrofDownlinkSlots		N/A	N/A	2		N/A	0
	nrofDownlinkSymbols		N/A	N/A	10		N/A	12
	nrofUplinkSlot		N/A	N/A	2		N/A	1
	nrofUplinkSymbols		N/A	N/A	2		N/A	0
K1 value (PDSCH-to-HARQ-timing-indicator)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7	4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3	4 if mod(i,10) = 0 3 if mod(i,10) = 1 2 if mod(i,10) = 2 5 if mod(i,10) = 3 3 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7		3 if mod(i,4) = 0 2 if mod(i,4) = 1 5 if mod(i,4) = 3	3 if mod(i,4) = 0 2 if mod(i,4) = 1 3 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,…,19}

Table A.1.2-2a: TDD UL-DL pattern for SCS 30 kHz for DCI-based dynamic UL/DL detection

Parameter		Unit	UL-DL pattern
			FR1.30-1.1
TDD Slot Configuration pattern (Note 1)			7DS2U
Special Slot Configuration (Note 2)			6D+4G+4U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*) (Note 4)	*referenceSubcarrierSpacing*	kHz	N/A
	dl-UL-TransmissionPeriodicity	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
UL-DL configuration2 (*tdd-UL-DL-ConfigurationCommon2*) (Note 4)	*referenceSubcarrierSpacing*	kHz	N/A
	dl-UL-TransmissionPeriodicity	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
PDCCH DCI Configuration	DCI Format		1-1 for slot indices with mod(i,10) = 0,1,2,3,4,5,6,7
	Scheduled Grant		Symbol 2-13 for slot indices with mod(i,10) = 0,1,2,3,4,5,6 and Symbol 2-5 for slot indices with mod(i,10) = 7
K1 value (PDSCH-to-HARQ-timing-indicator)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7
NOTE 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. NOTE 2: D, G and U denote DL, guard and UL symbols, respectively. The field is for information. NOTE 3: i is the slot index per frame; i = {0,…,19} NOTE 4: Do not configure TDD UL-DL pattern semi-statically using RRC configuration.			

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

Parameter		Unit	UL-DL pattern
			FR2.60-1
TDD Slot Configuration pattern (Note 1)			DDSU
Special Slot Configuration (Note 2)			11D+3G+0U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	60
	dl-UL-TransmissionPeriodicity	ms	1
	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0
K1 value (PDSCH-to-HARQ-timing-indicator)			K1 = 3 if mod(i,4) = 0 K1 = 2 if mod(i,4) = 1 K1 = 5 if mod(i,4) = 2
NOTE 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. NOTE 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. NOTE 3: i is the slot index per frame; i = {0,…,39}			

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

Parameter		Unit	UL-DL pattern	
			FR2.120-1	**FR2.120-2**
TDD Slot Configuration pattern (Note 1)			DDDSU	DDSU
Special Slot Configuration (Note 2)			10D+2G+2U	11D+3G+0U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	120	120
	dl-UL-TransmissionPeriodicity	ms	0.625	0.5
	nrofDownlinkSlots		3	2
	nrofDownlinkSymbols		10	11
	nrofUplinkSlot		1	1
	nrofUplinkSymbols		2	0
K1 value (PDSCH-to-HARQ-timing-indicator)			K1 = 4 if mod(i,5) = 0 K1 = 3 if mod(i,5) = 1 K1 = 2 if mod(i,5) = 2 K1 = 6 if mod(i,5) = 3	K1 = 3 if mod(i,4) = 0 K1 = 2 if mod(i,4) = 1 K1 = 5 if mod(i,4) = 2
NOTE 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. NOTE 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. NOTE 3: i is the slot index per frame; i = {0,…,79}				

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

Parameter		Unit	UL-DL pattern
			FR2.120-1.1
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*) (Note 4)	*referenceSubcarrierSpacing*	kHz	N/A
	dl-UL-TransmissionPeriodicity	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
UL-DL configuration2 (*tdd-UL-DL-ConfigurationCommon2*) (Note 4)	*referenceSubcarrierSpacing*	kHz	N/A
	dl-UL-TransmissionPeriodicity	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
PDCCH DCI Configuration	DCI Format		1-1 for slot indices with mod(i,5) = 0,1,2,3
	Scheduled Grant		Symbol 1-13 for slot indices with mod(i,5) = 0,1,2 and Symbol 1-9 for slot indices with mod(i,5) = 3
K1 value (PDSCH-to-HARQ-timing-indicator)			K1 = 4 if mod(i,5) = 0 K1 = 3 if mod(i,5) = 1 K1 = 2 if mod(i,5) = 2 K1 = 6 if mod(i,5) = 3
NOTE1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. NOTE 2: D, G and U denote DL, guard and UL symbols, respectively. The field is for information. NOTE 3: i is the slot index per frame; i = {0,…,79} NOTE 4: Do not configure TDD UL-DL pattern semi-statically using RRC configuration.			

A.2 UL Reference measurement channels

A.2.1 General

The measurement channels in the following subclauses are defined to test the performance requirements where PUSCH is required. The measurement channels represent example configurations of physical channels for different data rates.

A.2.2 Reference measurement channels for FDD

A.2.2.1 RMC for Sustained downlink data rate

A.2.2.1.1 CP-OFDM 64QAM

Table A.2.2.1.1-1: Reference Channels for CP-OFDM 64QAM for 15kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size	Transport block CRC	LDPC Base Graph	Number of code blocks per slot (Note 3)	Total number of bits per slot	Total modulated symbols per slot
Unit	MHz	KHz						Bits	Bits			Bits	
	5	15	25	11	64QAM	19	1/2	9992	24	1	2	19800	3300
	10	15	52	11	64QAM	19	1/2	21000	24	1	3	41184	6864
	15	15	79	11	64QAM	19	1/2	31752	24	1	4	62568	10428
	20	15	106	11	64QAM	19	1/2	42016	24	1	5	83952	13992
	25	15	133	11	64QAM	19	1/2	53288	24	1	7	105336	17556
	30	15	160	11	64QAM	19	1/2	63528	24	1	8	126720	21120
	40	15	216	11	64QAM	19	1/2	86040	24	1	11	171072	28512
	50	15	270	11	64QAM	19	1/2	108552	24	1	13	213840	35640

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [12].
Note 3: 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)

Table A.2.2.1.1-2: Reference Channels for CP-OFDM 64QAM for 30kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size	Transport block CRC	LDPC Base Graph	Number of code blocks per slot (Note 3)	Total number of bits per slot	Total modulated symbols per slot
Unit	MHz	KHz						Bits	Bits			Bits	
	5	30	11	11	64QAM	19	1/2	4352	24	1	1	8712	1452
	10	30	24	11	64QAM	19	1/2	9480	24	1	2	19008	3168
	15	30	38	11	64QAM	19	1/2	15112	24	1	2	30096	5016
	20	30	51	11	64QAM	19	1/2	20496	24	1	3	40392	6732
	25	30	65	11	64QAM	19	1/2	26120	24	1	4	51480	8580
	30	30	78	11	64QAM	19	1/2	31240	24	1	4	61776	10296
	40	30	106	11	64QAM	19	1/2	42016	24	1	5	83952	13992
	50	30	133	11	64QAM	19	1/2	53288	24	1	7	105336	17556
	60	30	162	11	64QAM	19	1/2	64552	24	1	8	128304	21384
	80	30	217	11	64QAM	19	1/2	86040	24	1	11	171864	28644
	90	30	245	11	64QAM	19	1/2	98376	24	1	12	194040	32340
	100	30	273	11	64QAM	19	1/2	108552	24	1	13	216216	36036

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [12].
Note 3: 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.2.3 Reference measurement channels for TDD

A.2.3.1 RMC for Sustained downlink data rate

A.2.3.1.1 CP-OFDM 16QAM

Table A.2.3.1.1-1: Reference Channels for CP-OFDM 16QAM for 15kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots 4 and 9	Transport block CRC
Unit	**MHz**	**KHz**						**Bits**	**Bits**
	5-50	15	1	11	16QAM	10	1/3	176	16
	5	15	13	11	16QAM	10	1/3	2280	16
	5	15	25	11	16QAM	10	1/3	4352	24
	10	15	26	11	16QAM	10	1/3	4480	24
	10	15	52	11	16QAM	10	1/3	9224	24
	15	15	40	11	16QAM	10	1/3	7040	24
	15	15	79	11	16QAM	10	1/3	13832	24
	20	15	53	11	16QAM	10	1/3	9224	24
	20	15	106	11	16QAM	10	1/3	18432	24
	25	15	67	11	16QAM	10	1/3	11784	24
	25	15	133	11	16QAM	10	1/3	23040	24
	30	15	80	11	16QAM	10	1/3	14088	24
	30	15	160	11	16QAM	10	1/3	28168	24
	40	15	108	11	16QAM	10	1/3	18960	24
	40	15	216	11	16QAM	10	1/3	37896	24
	50	15	135	11	16QAM	10	1/3	23568	24
	50	15	270	11	16QAM	10	1/3	47112	24

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that
11. DMRS is [TDM'ed] with PUSCH data.

Note 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [12].

Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (ot

Table A.2.3.1.1-2: Reference Channels for CP-OFDM 16QAM for 30kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots 8, 9, 18 and 19	Transport block CRC
Unit	MHz	KHz						Bits	Bits
	5-50	30	1	11	16QAM	10	1/3	176	16
	5	30	6	11	16QAM	10	1/3	1064	16
	5	30	11	11	16QAM	10	1/3	1928	16
	10	30	12	11	16QAM	10	1/3	2088	16
	10	30	24	11	16QAM	10	1/3	4224	24
	15	30	19	11	16QAM	10	1/3	3368	16
	15	30	38	11	16QAM	10	1/3	6656	24
	20	30	26	11	16QAM	10	1/3	4480	24
	20	30	51	11	16QAM	10	1/3	8968	24
	25	30	33	11	16QAM	10	1/3	5760	24
	25	30	65	11	16QAM	10	1/3	11272	24
	30	30	39	11	16QAM	10	1/3	6784	24
	30	30	78	11	16QAM	10	1/3	13576	24
	40	30	53	11	16QAM	10	1/3	9224	24
	40	30	106	11	16QAM	10	1/3	18432	24
	50	30	67	11	16QAM	10	1/3	11784	24
	50	30	133	11	16QAM	10	1/3	23040	24
	60	30	81	11	16QAM	10	1/3	14088	24
	60	30	162	11	16QAM	10	1/3	28168	24
	80	30	109	11	16QAM	10	1/3	18960	24
	80	30	217	11	16QAM	10	1/3	37896	24
	90	30	123	11	16QAM	10	1/3	21504	24
	90	30	245	11	16QAM	10	1/3	43032	24
	100	30	137	11	16QAM	10	1/3	24072	24
	100	30	273	11	16QAM	10	1/3	48168	24

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [12].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (ot

A.3 DL reference measurement channels

A.3.1 General

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

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

A.3.2 Reference measurement channels for PDSCH performance requirements

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

A.3.2.1 FDD

A.3.2.1.1 Reference measurement channels for SCS 15 kHz FR1

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-1.1 FDD	R.PDSCH.1-1.2 FDD	R.PDSCH.1-1.3 FDD	R.PDSCH.1-1.4 FDD	R.PDSCH.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 symbols		12	12	7	9	11
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. NOTE 2: Slot i is slot index per 2 frames.						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-2.1 FDD	R.PDSCH.1-2.2 FDD	R.PDSCH.1-2.3 FDD	R.PDSCH.1-2.4 FDD	
Channel bandwidth	MHz	10	10	10	10	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	52	52	52	52	
Number of consecutive PDSCH symbols		12	12	12	12	
Allocated slots per 2 frames	Slots	19	19	19	19	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		13	13	13	13	
Modulation		16QAM	16QAM	16QAM	16QAM	
Target Coding Rate		0.48	0.48	0.48	0.48	
Number of MIMO layers		1	2	3	4	
Number of DMRS REs		12	12	24	24	
Overhead for TBS determination		0	0	0	0	
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	13064	26120	35856	48168	
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	24	24	24	24	
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	CBs	2	4	5	6	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 10, 11	Bits	26208	52416	71136	94848	
For Slots i = 1,…, 9, 12, …, 19	Bits	27456	54912	74880	99840	
Max. Throughput averaged over 2 frames	Mbps	12.411	24.814	34.063	45.760	
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

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

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

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

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

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-5.1 FDD				
Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames	Slots	19				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS REs		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	26120				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,…, 19	CBs	4				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 5, 15	Bits	50752				
For Slots i = 10	Bits	48256				
For Slots i = 11	Bits	52416				
For Slots i = 1,…,4,6,…, 9,12,…14,16,…,19	Bits	54912				
Max. Throughput averaged over 2 frames	Mbps	24.814				
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-6.1 FDD	R.PDSCH.1-6.2 FDD			
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		64QAM	64QAM			
MCS index		13	13			
Modulation		16QAM	16QAM			
Target Coding Rate		0.48	0.48			
Number of MIMO layer		1	2			
Number of DMRS REs (Note 3)		24	24			
Overhead for TBS determination		0	0			
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A			
For CSI Slots i, if mod (i,5) =1, 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			

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.3.2.1.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-1.1 FDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	30				
Number of allocated resource blocks	PRBs	51				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames	Slots	39				
MCS table		64QAM				
MCS index		19				
Modulation		64QAM				
Target Coding Rate		0.51				
Number of MIMO layers		2				
Number of DMRS REs		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 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				
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

A.3.2.2 TDD

A.3.2.2.1 Reference measurement channels for SCS 15 kHz FR1 (Void)

A.3.2.2.2 Reference measurement channels for SCS 30 kHz FR1

Table A.3.2.2.2-1: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and FR1.30-1.1 (QPSK)

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

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

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-2.1 TDD	R.PDSCH. 2-2.2 TDD	R.PDSCH. 2-2.3 TDD	R.PDSCH. 2-2.4 TDD	
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) = {0,1,2,3,4,5,6) for i from {1,…,39}		12	12	12	12	
Allocated slots per 2 frames		31	31	31	31	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		13	13	13	13	
Modulation		16QAM	16QAM	16QAM	16QAM	
Target Coding Rate		0.48	0.48	0.48	0.48	
Number of MIMO layers		1	2	3	4	
Number of DMRS REs						
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	12	12	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}		12	12	24	24	
Overhead for TBS determination		0	0	0	0	
Information Bit Payload per Slot						
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) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	26632	53288	73776	98376	
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	24	24	24	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	24	24	24	24	
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	2	3	3	4	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) 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) = {0,1,2,3,4,5,6) 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 slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.2-3: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-3.1 TDD	R.PDSCH. 2-3.2 TDD			
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 {0,…,39}		4	4			
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) 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) = {0,1,2,3,4,5,6) 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) = {8,9} for i from {0,…,39}	Bits	N/A	N/A			
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	27144	13064			
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	83976	40976			
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			
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	24			
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	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			
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	4	2			
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	CBs	10	5			
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A			
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) = {0,1,2,3,4,5,6) 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 slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-4.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}		12				
Allocated slots per 2 frames		31				
MCS table		256QAM				
MCS index		24				
Modulation		256QAM				
Target Coding Rate		0.82				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}		12				
Overhead for TBS determination		0				
Maximum number of HARQ transmissions		4				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	29192				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	92200				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	4				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	CBs	11				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slots i = 20, 21	Bits	106848				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	35616				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,19,22,…,39}	Bits	111936				
Max. Throughput averaged over 2 frames	Mbps	130.308				
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.2-5: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-2

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

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

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-6.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}		8				
For Slot i, if mod(i, 10) = {0,1,2,5,6) for i from {1,…,39}		12				
Allocated slots per 2 frames		27				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}		12				
For Slot i, if mod(i, 10) = {0,1,2,5,6) for i from {1,…,39}		12				
Overhead for TBS determination		0				
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) = {0,1,2,5,6) for i from {1,…,39}	Bits	8456				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,5,6) for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}	CBs	1				
For Slot i, if mod(i, 10) = {0,1,2,5,6) for i from {1,…,39}	CBs	2				
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}	Bits	N/A				
For Slot i = 20, 21	Bits	26712				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}	Bits	17808				
For Slot i, if mod(i, 10) = {0,1,2,5,6) for i from {1,…,19,22,…,39}	Bits	27984				
Max. Throughput averaged over 2 frames	Mbps	10.184				
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.2-7: 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) = {0,1,2,3,4,5,6) for i from {1,…,39}		12				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS REs						
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16896				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	53288				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	3				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	CBs	7				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {0,5) for i from {1,…,19,22,…,39}	Bits	103456				
For Slots i = 20	Bits	98368				
For Slots i = 21	Bits	106848				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	35616				
For Slot i, if mod(i, 10) = {1,2,3,4,6) for i from {1,…,19,22,…,39}	Bits	111936				
Max. Throughput averaged over 2 frames	Mbps	75.318				
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-8.1 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 REs (Note 3)		24	24			
Overhead for TBS determination		0	0			
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {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			
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 (Void)

A.3.2.2.4 Reference measurement channels for SCS 60 kHz FR2

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

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

A.3.2.2.5 Reference measurement channels for SCS 120 kHz FR2

Table A.3.2.2.5-1: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 and FR2.120-1.1 (QPSK)

Parameter	Unit	Value				
Reference channel		R.PDSCH.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 {0,…, 159}		9				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}		13				
Allocated slots per 2 frames		127				
MCS table		64QAM				
MCS index		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) = {0,1,2) for i from {1,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	3624				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}	Bits	5504				
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) = {0,1,2) for i from {1,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	1				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}	CBs	1				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slots i = 80, 81	Bits	17490				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	12210				
For Slot i, if mod(i, 5) = {0,1,2) for i 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 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-2.1 TDD	R.PDSCH.5-2.2 TDD	R.PDSCH.5-2.3 TDD		
Channel bandwidth	MHz	100	100	200		
Subcarrier spacing	kHz	120	120	120		
Allocated resource blocks	PRBs	66	66	132		
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		9	9	9		
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}		13	13	13		
Allocated slots per 2 frames		127	127	127		
MCS table		64QAM	64QAM	64QAM		
MCS index		13	13	13		
Modulation		16QAM	16QAM	16QAM		
Target Coding Rate		0.48	0.48	0.48		
Number of MIMO layers		1	2	2		
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		12	12	12		
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}		12	12	12		
Overhead for TBS determination		6	6	6		
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	11272	22536	45096		
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}	Bits	17424	34816	69672		
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	24	24	24		
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}	Bits	24	24	24		
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	2	3	6		
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}	CBs	3	5	9		
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A	N/A		
For Slots i = 80, 81	Bits	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) = {0,1,2) for i from {1,…,79,82,…,159}	Bits	36564	73128	146256		
Max. Throughput averaged over 2 frames	Mbps	100.799	201.434	403.096		
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-3.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		9				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}		13				
Allocated slots per 2 frames		127				
MCS table		64QAM				
MCS index		18				
Modulation		64QAM				
Target Coding Rate		0.46				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		12				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	16136				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}	Bits	25104				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	24				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	2				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,159}	CBs	3				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slots i = 80, 81	Bits	52470				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	36630				
For Slot i, if mod(i, 5) = {0,1,2) for i from {1,…,79,82,…,159}	Bits	54846				
Max. Throughput averaged over 2 frames	Mbps	145.062				
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-4.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	6				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		10				
For Slot i, if mod(i, 4) = {0,1) for i from {1,…,159}		13				
Allocated slots per 2 frames		119				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		2				
Number of DMRS REs						
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		12				
For Slot i, if mod(i, 4) = {0,1) for i from {1,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	736				
For Slot i, if mod(i, 4) = {0,1) for i from {1,…,159}	Bits	1032				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	16				
For Slot i, if mod(i, 4) = {0,1) for i from {1,…,159}	Bits	16				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	CBs	1				
For Slot i, if mod(i, 4) = {0,1) for i from {1,…,159}	CBs	1				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i = 80, 81	Bits	3180				
For Slot i, if mod(i, 4) = 2 for i from {4,…, 159}	Bits	2496				
For Slot i, if mod(i, 4) = {0,1) for i from {1,…,79,82,…,159}	Bits	3324				
Max. Throughput averaged over 2 frames	Mbps	5.548				
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.						

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

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

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

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

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-7.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames		63				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS rEs (Note 3)		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 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) = {7,8,9} for i from {0,…,39}	CBs	N/A				
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}		2				
For Slot i = 20	CBs	N/A				
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	CBs	2				
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				
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	Bits	28776				
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	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 rEs (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 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) = {7,8,9} for i from {0,…,39}	CBs	N/A				
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}		2				
For Slot i = 20	CBs	N/A				
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	CBs	2				
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				
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	Bits	28776				
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/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_1 Reference measurement channels for Sustained downlink data rate performance requirements

A.3.2_1.1 FDD

A.3.2_1.1.1 Reference measurement channels for SCS 15 kHz FR1

Table A.3.2_1.1.1-2: Sustained Downlink Data Rate Reference Channel for FDD 15kHz SCS FR1 (64QAM)

Parameter	Channel bandwidth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Binary Channel Bits per Slot for allocated full DL slots (Note 1)	Max. Throughput averaged over 2 frames
	MHz	kHz	PRBs	Symbols						Bits	Bits	CBs	Bits	Mbps
	10	15	52	13	18	64QAM	0.46	1	1	20496	24	3	44928	17.422
	20	15	106	13	18	64QAM	0.46	1	1	42016	24	5	91584	35.714
	10	15	52	13	22	64QAM	0.65	1	1	29192	24	4	44928	24.813
	20	15	106	13	22	64QAM	0.65	1	1	59432	24	8	91584	50.517
	10	15	52	13	23	64QAM	0.7	1	1	31752	24	4	44928	26.989
	20	15	106	13	23	64QAM	0.7	1	1	64552	24	8	91584	54.869
	10	15	52	13	27	64QAM	0.89	1	1	39936	24	5	44928	33.946
	20	15	106	13	27	64QAM	0.89	1	1	81976	24	10	91584	69.68
	10	15	52	13	18	64QAM	0.46	2	1	40976	24	5	89856	34.83
	20	15	106	13	18	64QAM	0.46	2	1	83976	24	10	183168	71.38
	10	15	52	13	22	64QAM	0.65	2	1	58384	24	7	89856	49.626
	20	15	106	13	22	64QAM	0.65	2	1	118896	24	15	183168	101.062
	10	15	52	13	23	64QAM	0.7	2	1	63528	24	8	89856	53.999
	20	15	106	13	23	64QAM	0.7	2	1	129128	24	16	183168	109.759
	10	15	52	13	27	64QAM	0.89	2	1	79896	24	10	89856	67.912
	20	15	106	13	27	64QAM	0.89	2	1	163976	24	20	183168	139.38
	10	15	52	13	19	64QAM	0.5	4	1	83976	24	10	164736	71.38
	20	15	106	13	19	64QAM	0.5	4	1	167976	24	20	335808	142.78
	10	15	52	13	23	64QAM	0.7	4	1	114776	24	14	164736	97.56
	20	15	106	13	23	64QAM	0.7	4	1	237776	24	29	335808	202.11
	10	15	52	13	24	64QAM	0.75	4	1	125016	24	15	164736	106.264

	20	15	106	13	24	64QAM	0.75	4	1	254176	24	31	335808	216.05
	10	15	52	13	27	64QAM	0.89	4	1	147576	24	18	164736	125.44
	20	15	106	13	27	64QAM	0.89	4	1	295176	24	36	335808	250.9

Note 1: Allocated full DL slots are with slot index i, if i is not in {0,10,11} for i = 0,1,...,19. So total number of allocated slots per 2 frames is 17.
Note 2: MCS Index is based on MCS Table defined in TS38.214 when 256QAM is not enabled. MCS 18 and 19 are equivalent to MCS 11 and 12 in 256QAM table, respectively.
Note 3: Number of DMRS REs per RB = 12,12,24,24 for number of MIMO layers = 1,2,3,4, respectively
Note 4: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms.
Note 5: Overhead parameter for TBS determination is 0.
Note 6: 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)

Table A.3.2_1.1.1-2: Sustained Downlink Data Rate Reference Channel for FDD 15kHz SCS FR1 (256QAM)

Parameter	Channel bandwidth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Binary Channel Bits per Slot for allocated full DL slots (Note 1)	Max. Throughput averaged over 2 frames
	MHz	kHz	PRBs	Symbols						Bits	Bits	CBs	Bits	Mbps
	10	15	52	13	20	256QAM	0.67	1	1	39936	24	5	59904	33.946
	20	15	106	13	20	256QAM	0.67	1	1	81976	24	10	122112	69.68
	10	15	52	13	21	256QAM	0.69	1	1	42016	24	5	59904	35.714
	20	15	106	13	21	256QAM	0.69	1	1	83976	24	10	122112	71.38
	10	15	52	13	26	256QAM	0.9	1	1	53288	24	7	59904	45.295
	20	15	106	13	26	256QAM	0.9	1	1	108552	24	13	122112	92.269
	10	15	52	13	20	256QAM	0.67	2	1	79896	24	10	119808	67.912
	20	15	106	13	20	256QAM	0.67	2	1	163976	24	20	244224	139.38
	10	15	52	13	21	256QAM	0.69	2	1	83976	24	10	119808	71.38
	20	15	106	13	21	256QAM	0.69	2	1	167976	24	20	244224	142.78
	25	15	133	13	21	256QAM	0.69	2	1	213176	24	26	306432	181.2

	10	15	52	13	26	256QAM	0.9	2	1	106576	24	13	119808	90.59
	20	15	106	13	26	256QAM	0.9	2	1	217128	24	26	244224	184.559
	10	15	52	13	22	256QAM	0.74	4	1	159880	24	19	219648	135.898
	20	15	106	13	22	256QAM	0.74	4	1	327888	24	39	447744	278.705
	10	15	52	13	23	256QAM	0.78	4	1	172176	24	21	219648	146.35
	20	15	106	13	23	256QAM	0.78	4	1	352440	24	42	447744	299.574
	25	15	133	13	23	256QAM	0.78	4	1	434280	24	52	561792	369.138
	10	15	52	13	26	256QAM	0.9	4	1	196776	24	24	219648	167.26
	20	15	106	13	26	256QAM	0.9	4	1	401640	24	48	447744	341.394

Note 1: Allocated full DL slots are with slot index i, if i is not in {0,10,11} for i = 0,1,...,19. So total number of allocated slots per 2 frames is 17.
Note 2: MCS Index is based on MCS Table defined in TS38.214 when 256QAM is enabled.
Note 3: Number of DMRS REs per RB = 12,12,24,24 for number of MIMO layers = 1,2,3,4, respectively
Note 4: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms.
Note 5: Overhead parameter for TBS determination is 0.
Note 6: 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_1.2 TDD

A.3.2_1.2.1 Reference measurement channels for SCS 30 kHz FR1

Table A.3.2_1.2.1-1: Sustained Downlink Data Rate Reference Channel for TDD 30kHz SCS FR1 (64QAM)

Parameter	Channel bandwidth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Binary Channel Bits per Slot for allocated full DL slots (Note 1)	Max. Throughput averaged over 2 frames
	MHz	kHz	PRBs	Symbols						Bits	Bits	CBs	Bits	Mbps
	20	30	51	13	18	64QAM	0.46	1	1	19968	24	3	44064	24.96
	100	30	273	13	18	64QAM	0.46	1	1	106576	24	13	235872	133.22
	20	30	51	13	22	64QAM	0.65	1	1	28680	24	4	44064	35.85
	100	30	273	13	22	64QAM	0.65	1	1	151608	24	18	235872	189.51
	20	30	51	13	23	64QAM	0.7	1	1	30728	24	4	44064	38.41
	100	30	273	13	23	64QAM	0.7	1	1	163976	24	20	235872	204.97
	20	30	51	13	27	64QAM	0.89	1	1	38936	24	5	44064	48.67

	100	30	273	13	27	64QAM	0.89	1	1	208976	24	25	235872	261.22
	20	30	51	13	18	64QAM	0.46	2	1	39936	24	5	88128	49.92
	100	30	273	13	18	64QAM	0.46	2	1	213176	24	26	471744	266.47
	20	30	51	13	22	64QAM	0.65	2	1	57376	24	7	88128	71.72
	100	30	273	13	22	64QAM	0.65	2	1	303240	24	36	471744	379.05
	20	30	51	13	23	64QAM	0.7	2	1	61480	24	8	88128	76.85
	100	30	273	13	23	64QAM	0.7	2	1	327888	24	39	471744	409.86
	20	30	51	13	27	64QAM	0.89	2	1	77896	24	10	88128	97.37
	100	30	273	13	27	64QAM	0.89	2	1	417976	24	50	471744	522.47
	20	30	51	13	19	64QAM	0.5	4	1	81976	24	10	161568	102.47
	100	30	273	13	19	64QAM	0.5	4	1	434280	24	52	864864	542.85
	20	30	51	13	23	64QAM	0.7	4	1	112648	24	14	161568	140.81
	100	30	273	13	23	64QAM	0.7	4	1	606504	24	72	864864	758.13
	20	30	51	13	24	64QAM	0.75	4	1	120936	24	15	161568	151.17
	100	30	273	13	24	64QAM	0.75	4	1	655800	24	78	864864	819.75
	20	30	51	13	27	64QAM	0.89	4	1	143400	24	18	161568	179.25
	100	30	273	13	27	64QAM	0.89	4	1	770568	24	92	864864	963.21

Note 1: Allocated full DL slots are with slot index i, if mod(i,10) = 0,1,2,3,4,5,6 and i is not in {0,20,21} for i = 0,1,...,39. So total number of allocated slots per 2 frames is 25.
Note 2: MCS Index is based on MCS Table defined in TS38.214 when 256QAM is not enabled. MCS 18 and 19 are equivalent to MCS 11 and 12 in 256QAM table, respectively.
Note 3: Number of DMRS REs per RB = 12,12,24,24 for number of MIMO layers = 1,2,3,4, respectively
Note 4: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms.
Note 5: Overhead parameter for TBS determination is 0.
Note 6: 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)

Table A.3.2_1.2.1-2: Sustained Downlink Data Rate Reference Channel for TDD 30kHz SCS FR1(256QAM)

Parameter	Channel bandwidth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Binary Channel Bits per Slot for allocated full DL slots (Note 1)	Max. Throughput averaged over 2 frames
	MHz	kHz	PRBs	Symbols						Bits	Bits	CBs	Bits	Mbps
	20	30	51	13	20	256QAM	0.67	1	1	38936	24	5	58752	48.67

	100	30	273	13	20	256QAM	0.67	1	1	208976	24	25	314496	261.22
	20	30	51	13	21	256QAM	0.69	1	1	40976	24	5	58752	51.22
	100	30	273	13	21	256QAM	0.69	1	1	217128	24	26	314496	271.41
	20	30	51	13	26	256QAM	0.9	1	1	52224	24	7	58752	65.28
	100	30	273	13	26	256QAM	0.9	1	1	278776	24	34	314496	348.47
	20	30	51	13	20	256QAM	0.67	2	1	77896	24	10	117504	97.37
	100	30	273	13	20	256QAM	0.67	2	1	417976	24	50	628992	522.47
	20	30	51	13	21	256QAM	0.69	2	1	81976	24	10	117504	102.47
	100	30	273	13	21	256QAM	0.69	2	1	434280	24	52	628992	542.85
	20	30	51	13	26	256QAM	0.9	2	1	104496	24	13	117504	130.62
	100	30	273	13	26	256QAM	0.9	2	1	557416	24	67	628992	696.77
	20	30	51	13	22	256QAM	0.74	4	1	159880	24	19	215424	199.85
	100	30	273	13	22	256QAM	0.74	4	1	852696	24	102	1153152	1065.87
	20	30	51	13	23	256QAM	0.78	4	1	167976	24	20	215424	209.97
	100	30	273	13	23	256QAM	0.78	4	1	901344	24	107	1153152	1126.68
	20	30	51	13	26	256QAM	0.9	4	1	192624	24	23	215424	240.78
	100	30	273	13	26	256QAM	0.9	4	1	1032192	24	123	1153152	1290.24

Note 1: Allocated full DL slots are with slot index i, if mod(i,10) = 0,1,2,3,4,5,6 and i is not in {0,20,21} for i = 0,1,...,39. So total number of allocated slots per 2 frames is 25.
Note 2: MCS Index is based on MCS Table defined in TS38.214 when 256QAM is enabled.
Note 3: Number of DMRS REs per RB = 12,12,24,24 for number of MIMO layers = 1,2,3,4, respectively
Note 4: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms.
Note 5: Overhead parameter for TBS determination is 0.
Note 6: 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.3.3 Reference measurement channels for PDCCH performance requirements

A.3.3.1 FDD

A.3.3.1.1 Reference measurement channels for SCS 15 kHz FR1

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

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

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

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

A.3.3.1.2 Reference measurement channels for SCS 30 kHz FR1

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

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

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

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

A.3.3.2 TDD

A.3.3.2.1 Reference measurement channels for SCS 15 kHz FR1

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

Parameter	Unit	Value					
Reference channel		R.PDCCH.1-1.1 TDD	R.PDCCH.1-1.2 TDD	R.PDCCH.1-1.3 TDD			
Subcarrier spacing	kHz	15	15	15			
CORESET frequency domain allocation		48	48	48			
CORESET time domain allocation		1	1	1			
Aggregation level		4	4	8			
DCI Format		1_0	1_1	1_1			
Payload (without CRC)	Bits	39	51	51			

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

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

A.3.3.2.2 Reference measurement channels for SCS 30 kHz FR1

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

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

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

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

A.3.3.2.3 Reference measurement channels for SCS 60 kHz FR1 (Void)

A.3.3.2.4 Reference measurement channels for SCS 60 kHz FR2 (Void)

A.3.3.2.5 Reference measurement channels for SCS 120 kHz FR2

Table A.3.3.2.5-1: PDCCH Reference Channels (Time domain allocation 1 symbol)

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

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

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

A.4 CSI reference measurement channels

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

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

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

TBS Scheme				TBS.1-1	TBS.1-2				
MCS table				64QAM					
Number of allocated PDSCH resource blocks				66	66				
Number of consecutive PDSCH symbols				12	12				
Number of PDSCH MIMO layers				1	2				
Number of DMRS REs (Note 1)				24	24				
Overhead for TBS determination				6	6				
Available RE-s				7920	7920				
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot					
0	OOR	OOR	OOR	N/A	N/A				
1	0.1523	0	QPSK	1800	3624				
2	0.2344	0		1800	3624				
3	0.3770	2		2856	5640				
4	0.6016	4		4480	8968				
5	0.8770	6		6528	13064				
6	1.1758	8		8712	17928				
7	1.4766	11	16QAM	11016	22032				
8	1.9141	13		14343	28680				
9	2.4063	15		17928	35856				
10	2.7305	18	64QAM	20496	40976				
11	3.3223	20		25104	50184				
12	3.9023	22		29192	58384				
13	4.5234	24		33816	67584				
14	5.1152	26		38936	77896				
15	5.5547	28		42016	83976				
NOTE: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data.									

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

TBS Scheme				TBS.2-1	TBS.2-2	TBS.2-3	TBS.2-4		
MCS table				256QAM					
Number of allocated PDSCH resource blocks				52	52	106	106		
Number of consecutive PDSCH symbols				12	12	12	12		
Number of PDSCH MIMO layers				1	2	1	2		
Number of DMRS REs (Note 1)				24	24	24	24		
Overhead for TBS determination				0	0	0	0		
Available RE-s for PDSCH				7920	7920	12720	12720		
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot					
0	OOR	OOR	OOR	N/A	N/A	N/A	N/A		
1	0.1523	0	QPSK	1480	2976	2976	5896		
2	0.3770	1		2408	4744	4744	9480		
3	0.8770	3		5504	11016	11016	22536		
4	1.4766	5	16QAM	9224	18432	18960	37896		
5	1.9141	7		12040	24072	24576	49176		
6	2.4063	9		15112	30216	30728	61480		
7	2.7305	11	64QAM	16896	33816	34816	69672		
8	3.3223	13		20496	40976	42016	83976		
9	3.9023	15		24576	49176	49176	98376		
10	4.5234	17		28168	56368	57376	114776		
11	5.1152	19		31752	63528	65576	131176		
12	5.5547	21	256QAM	34816	69672	69672	139376		
13	6.2266	23		38936	77896	79896	159880		
14	6.9141	25		43032	86040	88064	176208		
15	7.4063	27		46104	92200	94248	188576		
NOTE: Number of DMRS REs includes the overhead of the DM-RS CDM groups without 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 CORESETS appointed by the search spaces in use. NOTE 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals in channel bandwidth.		

A.5.2 OCNG Patterns for TDD

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

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

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

Annex B (normative): Propagation conditions

B.1 Static propagation condition

B.1.1 UE Receiver with 2Rx

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

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

For 2 port transmission the channel matrix is defined in the frequency domain by:

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

For 4 port transmission the channel matrix is defined in the frequency domain by:

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

For 8 port transmission the channel matrix is defined in the frequency domain by:

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

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-line", 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 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 clauses B.2.1.1 and B.2.1.2 can be used as such.

Step 1: Use the original TDL model from TR38.901.

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 [15].

Step 4: Apply the quantization to the delay resolution 5 ns. This is done simply by rounding the tap delays to the nearest multiple of the delay resolution.

Step 5: If multiple taps are rounded to the same delay bin, merge them by calculating their linear power sum.

Step 6: If there are more than 12 taps in the quantized model, merge the taps as follows:

- Find the weakest tap from all taps (both merged and unmerged taps are considered)
  - If there are two or more taps having the same value and are the weakest, select the tap with the smallest delay as the weakest tap.
- When the weakest tap is the first delay tap, merge taps as follows:
  - Update the power of the first delay tap as the linear power sum of the weakest tap and the second delay tap.
  - Remove the second delay tap.
- When the weakest tap is the last delay tap, merge taps as follows:
  - Update the power of the last delay tap as the linear power sum of the second-to-last tap and the last tap.
  - Remove the second-to-last tap.
- Otherwise
  - For each side of the weakest tap, identify the neighbour tap that has the smaller delay difference to the weakest tap.

- When the delay difference between the weakest tap and the identified neighbour tap on one side equals the delay difference between the weakest tap and the identified neighbour tap on the other side.
    - Select the neighbour tap that is weaker in power for merging.
- Otherwise, select the neighbour tap that has smaller delay difference for merging.

- To merge, the power of the merged tap is the linear sum of the power of the weakest tap and the selected tap.
- When the selected tap is the first tap, the location of the merged tap is the location of the first tap. The weakest tap is removed.
- When the selected tap is the last tap, the location of the merged tap is the location of the last tap. The weakest tap is removed.
- Otherwise, the location of the merged tap is based on the average delay of the weakest tap and selected tap. If the average delay is on the sampling grid, the location of the merged tap is the average delay. Merge two parallel taps with different delays (average delay, sum power) starting from the weakest ones. Otherwise, the location of the merged tap is rounded towards the direction of the selected tap (e.g. 10 ns & 20 ns → 15 ns, 10 ns & 25 ns → 20 ns, if 25 ns had higher or equal power; 15 ns, if 10 ns had higher power). The weakest tap and the selected tap are removed.

- Repeat step 6 until the final number of taps is 12.

Step 7: Round the amplitudes of taps to one decimal (e.g. -8.78 dB → -8.8 dB)

Step 8: If the delay spread has slightly changed due to the tap merge, adjust the final delay spread by increasing or decreasing the power of the last tap so that the delay spread is corrected.

Step 9: Re-normalize tap powers such that the strongest tap is at 0dB.

NOTE 1: Some values of the delay profile created by the simplification steps may differ from the values in tables B.2.1.1-2, B.2.1.1-3, B.2.1.1-4, B.2.1.2-2, and B.2.1.1-3 for the corresponding model.

NOTE 2: For Step 5 and Step 6, the power values are expressed in the linear domain using 6 digits of precision. The operations are in the linear domain.

B.2.1.1 Delay profiles for FR1

The delay profiles for FR1 are selected to be representative of low, medium and high delay spread environment. The resulting model parameters are specified in B.2.1.1-1 and the tapped delay line models are specified in Tables B.2.1.1-2 ~ Table B.2.1.1-4.

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

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

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

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

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

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

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

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

B.2.1.2 Delay profiles for FR2

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

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 clause 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 clause B.2.3.1 apply for the antenna configuration using uniform linear array (ULA) at both gNB and UE.

B.2.3.1.1 Definition of MIMO Correlation Matrices

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

Table B.2.3.1.1-1: gNB correlation matrix

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

Table B.2.3.1.1-2 defines the correlation matrix for the UE:

Table B.2.3.1.1-2 UE correlation matrix

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

Table B.2.3.1.1-3 defines the channel spatial correlation matrix R_{spat}. The parameters, α and β in Table B.2.3.1-3 defines the spatial correlation between the antennas at the gNB and UE.

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

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

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

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

The 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 Correlation	0.3	0.9
Medium Correlation A	0.3	0.3874
High Correlation	0.9	0.9

The correlation matrices for high, medium, medium A and low correlation are defined in Tables B.2.3.1.2-2, B.2.3.1.2-3, B.2.3.1.2-4 and B.2.3.1.2-5 as below.

The values in Table B.2.3.1.2-2 have been adjusted for the 4x2 and 4x4 high correlation cases to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision. This is done using the equation:

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

Where the value "a" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 4x2 high correlation case, a=0.00010. For the 4x4 high correlation case, a=0.00012.

The same method is used to adjust the 2x4 and 4x4 medium correlation matrix in Table B.2.3.1.2-3 to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision with a = 0.00010 and a = 0.00012.

Table B.2.3.1.2-2: MIMO correlation matrices for high correlation

1x2 case	$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$
2x1 case	$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$
2x2 case	$R_{high} = \begin{pmatrix} 1 & 0.9 & 0.9 & 0.81 \\ 0.9 & 1 & 0.81 & 0.9 \\ 0.9 & 0.81 & 1 & 0.9 \\ 0.81 & 0.9 & 0.9 & 1 \end{pmatrix}$
4x2 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 & 0.8999 & 0.8099 \\ 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 & 0.8099 & 0.8999 \\ 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 \\ 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 \\ 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 \\ 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 \\ 0.8999 & 0.8099 & 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 \\ 0.8099 & 0.8999 & 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 \end{bmatrix}$
4x4 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.8999 & 0.8894 & 0.8587 & 0.8099 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.8894 & 0.8999 & 0.8894 & 0.8587 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.8587 & 0.8894 & 0.8999 & 0.8894 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8099 & 0.8587 & 0.8894 & 0.8999 \\ 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9541 & 0.9430 & 0.9105 & 0.8587 \\ 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9105 \\ 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9105 & 0.9430 & 0.9541 & 0.9430 \\ 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.9105 & 0.9430 & 0.9541 \\ 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 \\ 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 \\ 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 \\ 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 \\ 0.8999 & 0.8894 & 0.8587 & 0.8099 & 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.8894 & 0.8999 & 0.8894 & 0.8587 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.8587 & 0.8894 & 0.8999 & 0.8894 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.8099 & 0.8587 & 0.8894 & 0.8999 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{bmatrix}$

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

1x2 case	N/A
2x1 case	N/A
2x2 case	$R_{medium} = \begin{pmatrix} 1 & 0.9 & 0.3 & 0.27 \\ 0.9 & 1 & 0.27 & 0.3 \\ 0.3 & 0.27 & 1 & 0.9 \\ 0.27 & 0.3 & 0.9 & 1 \end{pmatrix}$
2x4 case	$R_{medium} = \begin{pmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.3000 & 0.2965 & 0.2862 & 0.2700 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.2965 & 0.3000 & 0.2965 & 0.2862 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.2862 & 0.2965 & 0.3000 & 0.2965 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.2700 & 0.2862 & 0.2965 & 0.3000 \\ 0.3000 & 0.2965 & 0.2862 & 0.2700 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.2965 & 0.3000 & 0.2965 & 0.2862 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.2862 & 0.2965 & 0.3000 & 0.2965 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.2700 & 0.2862 & 0.2965 & 0.3000 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{pmatrix}$
4x2 case	$R_{medium} = \begin{pmatrix} 1.0000 & 0.9000 & 0.8748 & 0.7873 & 0.5856 & 0.5271 & 0.3000 & 0.2700 \\ 0.9000 & 1.0000 & 0.7873 & 0.8748 & 0.5271 & 0.5856 & 0.2700 & 0.3000 \\ 0.8748 & 0.7873 & 1.0000 & 0.9000 & 0.8748 & 0.7873 & 0.5856 & 0.5271 \\ 0.7873 & 0.8748 & 0.9000 & 1.0000 & 0.7873 & 0.8748 & 0.5271 & 0.5856 \\ 0.5856 & 0.5271 & 0.8748 & 0.7873 & 1.0000 & 0.9000 & 0.8748 & 0.7873 \\ 0.5271 & 0.5856 & 0.7873 & 0.8748 & 0.9000 & 1.0000 & 0.7873 & 0.8748 \\ 0.3000 & 0.2700 & 0.5856 & 0.5271 & 0.8748 & 0.7873 & 1.0000 & 0.9000 \\ 0.2700 & 0.3000 & 0.5271 & 0.5856 & 0.7873 & 0.8748 & 0.9000 & 1.0000 \end{pmatrix}$
4x4 case	$R_{medium} = \begin{pmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.3000 & 0.2965 & 0.2862 & 0.2700 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.2965 & 0.3000 & 0.2965 & 0.2862 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.2862 & 0.2965 & 0.3000 & 0.2965 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.2700 & 0.2862 & 0.2965 & 0.3000 \\ 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 0.5855 & 0.5787 & 0.5588 & 0.5270 \\ 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.5787 & 0.5855 & 0.5787 & 0.5588 \\ 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.5588 & 0.5787 & 0.5855 & 0.5787 \\ 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.5270 & 0.5588 & 0.5787 & 0.5855 \\ 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 \\ 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 \\ 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 \\ 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 \\ 0.3000 & 0.2965 & 0.2862 & 0.2700 & 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.2965 & 0.3000 & 0.2965 & 0.2862 & 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.2862 & 0.2965 & 0.3000 & 0.2965 & 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.2700 & 0.2862 & 0.2965 & 0.3000 & 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{pmatrix}$

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

2x4 case	$R_{medium\ A} = \begin{pmatrix} 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.3000 & 0.2700 & 0.1968 & 0.1162 \\ 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.2700 & 0.3000 & 0.2700 & 0.1968 \\ 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.1968 & 0.2700 & 0.3000 & 0.2700 \\ 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \\ 0.1968 & 0.2700 & 0.3000 & 0.2700 & 0.6561 & 0.9000 & 1.0000 & 0.9000 \\ 0.1162 & 0.1968 & 0.2700 & 0.3000 & 0.3874 & 0.6561 & 0.9000 & 1.0000 \end{pmatrix}$
4x4 case	$R_{medium\ A} = \begin{pmatrix} 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.3000 & 0.2700 & 0.1968 & 0.1162 \\ 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.2700 & 0.3000 & 0.2700 & 0.1968 \\ 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.1968 & 0.2700 & 0.3000 & 0.2700 \\ 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 0.5856 & 0.5270 & 0.3842 & 0.2269 \\ 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.5270 & 0.5856 & 0.5270 & 0.3842 \\ 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.3842 & 0.5270 & 0.5856 & 0.5270 \\ 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.2269 & 0.3842 & 0.5270 & 0.5856 \\ 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 \\ 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 \\ 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 \\ 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \\ 0.1968 & 0.2700 & 0.3000 & 0.2700 & 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 \\ 0.1162 & 0.1968 & 0.2700 & 0.3000 & 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 \end{pmatrix}$

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

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

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

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

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

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

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

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

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

where *N* is the number of transmit antennas, *p* is the polarization group index, n_1 is the row index, and n_2 is the column index of the antenna element.

For the linear (single dimension, 1D) cross-polarized antenna, the *N* antennas are labelled following the above equations with N_2=1.

B.2.3.2.1 Definition of MIMO Correlation Matrices using cross polarized antennas

For the channel spatial correlation matrix, the following is used:

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

where

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

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

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

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

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

where

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

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

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

$$R_{gNB\_Dim,i} = 1.$$

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

$$R_{gNB\_Dim,i} = \begin{pmatrix} 1 & \alpha_i \\ \alpha_i^* & 1 \end{pmatrix}.$$

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

$$R_{gNB\_Dim,i} = \begin{pmatrix} 1 & \alpha_i^{1/4} & \alpha_i \\ \alpha_i^{1/4*} & 1 & \alpha_i^{1/4} \\ \alpha_i^* & \alpha_i^{1/4*} & 1 \end{pmatrix}.$$

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

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

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

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

$$R_{gNB} = R_{gNB\_Dim,1}$$

The spatial correlation matrices at UE side are as follows:

- For 1 antenna element with the same polarization,

$$R_{UE} = 1.$$

- F 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

Correlation Model	α_1	α_2	β	γ
Medium Correlation A	0.3	N/A	0.6	0.2
High Correlation	0.9	0.9	0.9	0.3
NOTE 1: Value of α_1 applies when more than one pair of cross-polarized antenna elements in first dimension at gNB side. NOTE 2: Value of α_2 applies when more than one pair of cross-polarized antenna elements in second dimension at gNB side. NOTE 3: Value of β applies when more than one pair of cross-polarized antenna elements at UE side.				

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

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

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

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

4x2 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.0000 & 0.9000 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.9000 & 0.0000 & 0.3000 & 0.0000 & 0.2700 \\ 0.9000 & 0.0000 & 1.0000 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.9000 & 0.0000 & 1.0000 & 0.0000 & 0.2700 & 0.0000 & 0.3000 \\ -0.3000 & 0.0000 & -0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9000 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9000 \\ -0.2700 & 0.0000 & -0.3000 & 0.0000 & 0.9000 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.9000 & 0.0000 & 1.0000 \end{bmatrix}$
8x2 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & -0.2700 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.2700 \\ 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 \\ 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 \\ 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 \\ 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 \\ 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & -0.2700 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.2700 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 \\ -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & -0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 \\ -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 \\ 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 \\ -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 \\ 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 \\ -0.2700 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 \end{bmatrix}$

B.2.3.2.3 Beam steering approach

For the 2D cross-polarized antenna array at gNB, given the channel spatial correlation matrix in clauses B.2.3.2.1 and B.2.3.2.2, the corresponding random channel matrix *H* can be calculated. The signal model for the *k*-th slot is denoted as:

$$y = HD_{\theta_{k,1},\theta_{k,2}} Wx + n$$

And the steering matrix is further expressed as following:

$$D_{\theta_{k,1},\theta_{k,2}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes \left(D_{\theta_{k,1}}(N_1) \otimes D_{\theta_{k,2}}(N_2) \right)$$

Where:

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

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

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

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

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

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

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

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

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

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

- $\theta_{k,i}$ controls the phase variation in first dimension and second dimension respectively, and the phase for k-th subframe is denoted by $\theta_{k,i} = \theta_{0,i} + \Delta\theta \cdot k$, where $\theta_{0,i}$ is the random start value with the uniform distribution, i.e. $\theta_{0,i} \in [0, 2\pi]$, $\Delta\theta$ is the step of phase variation, which is defined in Table B.2.3B.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.2.3.4-1: 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

FFS

B.4 Beamforming Model

B.4.1 Generic beamforming model

The transmission on antenna port(s) $p = p_0, p_0 + 1, \ldots, p_0 + N_p - 1$ is defined by using a precoder matrix $W(i)$ of size $N_{ANT} \times N_p$, where N_{ANT} is the number of physical transmit antenna elements configured per test , N_p is the number of ports for a reference signal or physical channel configured per test, and p_0 is the first port for that reference signal or physical channel as defined in section 7.3 and 7.4 in TS 38.211 [9]. This precoder takes as an input a block of signals for antenna port(s) $p = p_0, p_0 + 1, \ldots, p_0 + N_p - 1$, $y^{(p)}(i) = \left[y^{(p_0)}(i) \;\; y^{(p_0+1)}(i) \;\; \ldots \;\; y^{(p_0+N_p-1)}(i)\right]^T$, $i = 0,1,\ldots,M_{\text{symb}}^{\text{ap}} - 1$, 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 $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i) \;\; y_{bf}^{(1)}(i) \;\; \ldots \;\; y_{bf}^{(N_{ANT}-1)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair (k,l) as per the test configuration but transmitted on different physical antenna elements:

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

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

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

The physical antenna elements are identified by indices $j = 0,1,..., N_{ANT} - 1$, where N_{ANT} is the number of physical antenna elements configured per test.

Modulation symbols $a_{k,l}$ for CSI-RS resources which configured for tracking with one port are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}$ for CSI-RS resources which configured for beam refinement with one port are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}^{(p)}$ for NZP CSI-RS which configured for CSI acquisition with $p \in \{p_0, p_0 + 1,..., p_0 + N_{CSI} - 1\}$ are mapped to the physical antenna index $j = p - p_0$ where N_{CSI} is the number of NZP CSI-RS ports configured per test.

Annex C (normative): Downlink physical channels

C.0 Downlink signal levels

Downlink power settings to be configured for connection setup has been defined in this clause covering both FR1 and FR2.

C.0.1 FR1 Downlink Signal Levels (Conducted)

The downlink power settings in Table C.0.1-1 is used for FR1 conducted unless otherwise specified in a test case.

If the UE has more than one Rx antenna, the downlink signal is applied to each one. All UE Rx antennas shall be connected.

Table C.0.1-1: Default Downlink power levels for NR FR1

SCS (kHz)		Unit	Channel bandwidth											
			5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
15	Number of RBs		25	50	75	100	128	160	215	270	N/A	N/A	N/A	N/A
	Channel BW power	dBm	-60	-57	-55	-54	-53	-52	-51	-50	N/A	N/A	N/A	N/A
30	Number of RBs		10	24	36	50	64	75	100	128	162	216	243	270
	Channel BW power	dBm	-61	-57	-55	-54	-53	-52	-51	-50	-49	-48	-47	-47
60	Number of RBs		N/A	10	18	24	30	36	50	64	75	100	120	135
	Channel BW power	dBm	N/A	-58	-56	-54	-53	-52	-51	-50	-49	-48	-47	-47
	SSS EPRE	dBm/ 15 kHz	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85
	NOTE 1: The channel bandwidth powers are informative, based on -85dBm/15kHz SS/PBCH SSS EPRE, then scaled according to the number of RBs and rounded to the nearest integer dBm value. Full RE allocation with no boost or deboost is assumed. NOTE 2: The power level is specified at each UE Rx antenna. NOTE 3: DL level is applied for any of the Subcarrier Spacing configuration ( ) with the same power spectrum density of -85 dBm/15 kHz.													

The default signal level uncertainty is [+/-3] dB at each test port, for any level specified. If the uncertainty value is critical for the test purpose, a tighter uncertainty is specified for the related test case in [Annex F]

C.0.2 FR2 Downlink Signal Levels (Radiated)

The downlink power settings in Table C.0.2-1 is used unless otherwise specified in a test case.

Table C.0.2-1: Default Downlink power levels for NR FR2

SCS (kHz)		Unit	Channel Bandwidth			
			50 MHz	100 MHz	200 MHz	400 MHz
60	Number of RBs		66	132	264	N/A
	Channel BW power	dBm	-70	-67	-64	N/A
120	Number of RBs		32	66	132	264
	Channel BW power	dBm	-70	-67	-64	-61
	SS/PBCH SSS EPRE	dBm/60 kHz	[-99]	[-99]	[-99]	[-99]
NOTE 1: The channel bandwidth powers are informative, based on [-99] dBm/60 kHz SS/PBCH SSS EPRE, then scaled according to the number of RBs and rounded to the nearest integer dBm value. Full RE allocation with no boost or deboost is assumed. NOTE 2: The power level is specified at the centre of quiet zone. NOTE 3: DL level is applied for any of the Subcarrier Spacing configuration (μ) with the same power spectrum density of [-99]dBm/60kHz.						

The default downlink signal level uncertainty is +/- TBD dB, for any level specified. If the uncertainty value is critical for the test purpose, a tighter uncertainty is specified for the related test case in Annex F.

C.1 Setup

The following clause describes the downlink Physical Channels that are transmitted during connection setup.

C.1.1 FR1 Setup

Table C.1.1-1 describes the downlink Physical Channels that are required for FR1 connection set up.

Table C.1.1-1: Downlink Physical Channels required for FR1 connection setup

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

The following common PDSCH and PDCCH configuration parameters shall be used to bring up the connection setup for FR1 NR cell.

Table C.1.1-2: Common reference channel parameters for FR1

Parameter	Unit	Value
CORESET frequency domain allocation		Full BW,number of RB's to be in multiple of 6
CORESET time domain allocation		2 OFDM symbols at the begin of each slot
PDSCH mapping type		Type A
PDSCH start symbol index (S)		2
Number of consecutive PDSCH symbols (L)		12
PDSCH PRB bundling	PRBs	2
Dynamic PRB bundling		false
Overhead value for TBS determination		0
First DMRS position for Type A PDSCH mapping		2
DMRS type		Type 1
Number of additional DMRS		1
FDM between DMRS and PDSCH		Enable
TRS configuration		2 slots, periodicity 20 ms, offset 10
PTRS configuration		PTRS is not configured
Num of HARQ processes		8 (TDD)

Table C.1.1-3: Additional reference channels parameters for FDD

Parameter	Unit	Value
Number of HARQ Processes		4
K1 value		2 for all slots

Table C.1.1-4: TDD UL-DL pattern for SCS 15 KHz

Parameter		Unit	UL-DL pattern
			FR1.15-1
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	15
	dl-UL-TransmissionPeriodicity	ms	5
	nrofDownlinkSlots		3
	nrofDownlinkSymbols		10
	nrofUplinkSlot		1
	nrofUplinkSymbols		2
K1 value (PDSCH-to-HARQ-timing-indicator)			[4] if mod(I,5) = 0 [3] if mod(i,5) = 1 [2] if mod(i,5) = 2 [6] if mod(i,5) = 3
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, 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 C.1.1-5: TDD UL-DL pattern for SCS 30 KHz

Parameter		Unit	UL-DL Pattern
TDD Slot Configuration pattern (Note 1)			7DS2U
Special Slot Configuration (Note 2)			6D+4G+4U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	30	kHz
	dl-UL-TransmissionPeriodicity	5	
	nrofDownlinkSlots	7	
	nrofDownlinkSymbols	6	
	nrofUplinkSlot	2	
	nrofUplinkSymbols	4	
UL-DL configuration2 (*tdd-UL-DL-ConfigurationCommon2*)	*referenceSubcarrierSpacing*	N/A	
	dl-UL-TransmissionPeriodicity	N/A	
	nrofDownlinkSlots	N/A	
	nrofDownlinkSymbols	N/A	
	nrofUplinkSlot	N/A	
	nrofUplinkSymbols	N/A	
K1 value (PDSCH-to-HARQ-timing-indicator)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7
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}			

C.1.2 FR2 Setup

Table C.1.2-1 describes the downlink Physical Channels that are required for FR2 connection set up.

Table C.1.2-1: Downlink Physical Channels required for FR2 connection set-up

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

The following common PDSCH and PDCCH configuration parameters shall be used to bring up the connection setup for FR2 NR cell.

Table C.1.2-2: Common reference channel parameters for FR2

Parameter	Unit	Value
CORESET frequency domain allocation		Full BW, number of RB's to be in multiple of 6
CORESET time domain allocation		1 OFDM symbols at the begin of each slot
PDSCH mapping type		Type A
PDSCH start symbol index (S)		1
Number of consecutive PDSCH symbols (L)		13
PDSCH PRB bundling	PRBs	2
Dynamic PRB bundling		false
MCS table for TBS determination		64QAM
Overhead value for TBS determination		0
First DMRS position for Type A PDSCH mapping		2
DMRS type		Type 1
Number of additional DMRS		1
FDM between DMRS and PDSCH		Enable
TRS configuration		2 slots, periodicity 20 ms, offset 10
PTRS configuration		Single port, every other RB, every symbol (K=2, L=1)
Num of HARQ processes		8

Table C.1.2-3: Additional test parameters for TDD for SCS 60 KHz

Parameter		Unit	UL-DL pattern
TDD Slot Configuration pattern (Note 1)			DDSU
Special Slot Configuration (Note 2)			11D+3G+0U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	60
	dl-UL-TransmissionPeriodicity	ms	1
	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0
K1 value (PDSCH-to-HARQ-timing-indicator)			K1 = 3 if mod(i,4) = 0 K1 = 2 if mod(i,4) = 1 K1 = 5 if mod(i,4) = 2
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,39}			

Table C.1.2-4: Additional test parameters for TDD for SCS 120 KHz

Parameter		Unit	UL-DL pattern
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	120
	dl-UL-TransmissionPeriodicity	ms	0.625
	nrofDownlinkSlots		3
	nrofDownlinkSymbols		10
	nrofUplinkSlot		1
	nrofUplinkSymbols		2
K1 value (PDSCH-to-HARQ-timing-indicator)			K1 = [4] if mod(i,5) = 0 K1 = [3] if mod(i,5) = 1 K1 = [2] if mod(i,5) = 2 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}			

C.2 Connection

C.2.1 FR1 Measurement of Performance Characteristics

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.2.1-1: Downlink Physical Channels transmitted during a connection (FDD and TDD) for FR1

Parameter	Unit	Value
SSS transmit power	W	Test specific
EPRE ratio of PSS to SSS	dB	0
EPRE ratio of PBCH to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS	dB	0
EPRE ratio of PDCCH to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH to SSS	dB	0
EPRE ratio of PDSCH to PDSCH DMRS	dB	Test specific (Note 1)
EPRE ratio of CSI-RS to SSS	dB	0
EPRE ratio of OCNG to SSS	dB	0
NOTE 1: Value is derived from Table 4.1-1 in TS 38.214 [X] based on “Number of DM-RS CDM groups without data” and “DMRS Type” parameters specified for each test.		

C.2.2 FR2 Measurement of Performance Characteristics

Unless otherwise stated, Table C.2.2-1 is applicable for measurements on the Performance Characteristics.

Table C.2.2-1: Downlink Physical Channels transmitted during a connection (TDD) for FR2

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 (Note 1)	dB	3
EPRE ratio of PDSCH to PDSCH DMRS (Note 1)	dB	-3
EPRE ratio of CSI-RS to SSS	dB	0
EPRE ratio of PTRS to PDSCH	dB	Test specific
EPRE ratio of OCNG DMRS to SSS	dB	0
EPRE ratio of OCNG to OCNG DMRS (Note 1)	dB	0
NOTE 1: No boosting is applied to any of the channels except PDSCH DMRS. For PDSCH DMRS, 3 dB power boosting is applied assuming DMRS Type 1 configuration when DMRS and PDSCH are TDM'ed and only half of the DMRS REs are occupied. NOTE 2: Number of DMRS CDM groups without data for PDSCH DMRS configuration for OCNG is set to 1.		

Annex D (normative): E-UTRA link setup config for NSA testing

D.0 General

Below sub-clauses define the E-UTRA link setup config for NSA Demodulation and CSI tests cases unless otherwise specified within the main test case.

D.1 E-UTRA test parameters

Below are the common test parameters to be configured for E-UTRA link.

Table D.1-1: Common Test Parameters (FDD)

Parameter	Unit	Value	Comments
Inter-TTI Distance		1	
Number of HARQ processes	Processes	8	For FDD, 8 HARQ processes in the DL, as specified in TS 36.213 [10] clause 7. All 8 HARQ processes are used.
Scheduling of retransmissions			1. Retransmissions use the same Transport Block Size (TBS) as the initial transmission. 2. HARQ processes are scheduled consecutively, independent of the fact, whether retransmissions (for negatively acknowledged HARQ processes) or new transmissions (for positively acknowledged HARQ processes) occur.
Maximum number of HARQ transmission		4	It is always 4 for FDD, as specified in TS 36.213 [10] clause 8
Redundancy version coding sequence		{0,1,2,3} for QPSK	
Number of OFDM symbols for PDCCH	OFDM symbols	3 for 5 MHz bandwidths, 2 for 10 MHz, 20MHz	The PCFICH carries information about the number of OFDM symbols used for transmission of PDCCHs in a subframe, as specified in TS 36.211 [8] clause 6.7
Cyclic Prefix		Normal	CP consist of the following physical resource blocks (RBs) parameters: 12 consecutive subcarriers at a 15 kHz spacing and 7 OFDM symbols, as specified in TS 36.211 [8] clause 6.2.3
Cell ID		0 (Note 1)	The Cell ID is uniquely defined by a number in the range of 0 to 503, representing the physical-layer cell identity, as specified in TS 36.211 [8] clause 6.11.
DCI format for PDSCH	Format 2A		
DCI format for PUSCH	Format 0		

Table D.1-2: Common Test Parameters (TDD)

Parameter	Unit	Value	Comments
Uplink downlink configuration (Note 1)		1	
Special subframe configuration (Note 2)		4	
Inter-TTI Distance		1	
Number of HARQ processes	Processes	7	For TDD, 7 HARQ processes in the DL, as specified in TS 36.213 [10] clause 7. All 7 HARQ processes are used.
Scheduling of retransmissions			1. Retransmissions use the same Transport Block Size (TBS) as the initial transmission. 2. HARQ processes are scheduled consecutively, independent of the fact, whether retransmissions (for negatively acknowledged HARQ processes) or new transmissions (for positively acknowledged HARQ processes) occur. 3. In case when the initial transmission and the retransmissions are scheduled in subframes with a different N_{PRB} (in terms of TS 36.213 [10] subclause 7.1.7) $29 \le I_{MCS} \le 31$ according to TS 36.213 [10] subclause 7.1.7.2 and the appropriate modulation is used.
Maximum number of HARQ transmission		4	It is always 4 for TDD, as specified in TS 36.213 [10] clause 8
Redundancy version coding sequence		{0,1,2,3} for QPSK	
Number of OFDM symbols for PDCCH	OFDM symbols	3 for 5 MHz bandwidths, 2 for 10 MHz	The PCFICH carries information about the number of OFDM symbols used for transmission of PDCCHs in a subframe, as specified in TS 36.211 [8] clause 6.7
Cyclic Prefix		Normal	CP consist of the following physical resource blocks (RBs) parameters: 12 consecutive subcarriers at a 15 kHz spacing and 7 OFDM symbols, as specified in TS 36.211 [8] clause 6.2.3
Cell ID		0 (Note 3)	The Cell ID is uniquely defined by a number in the range of 0 to 503, representing the physical-layer cell identity, as specified in TS 36.211 [8] clause 6.11.
DCI format for PDSCH	Format 2A		
DCI format for PUSCH	Format 0		

NOTE 1: as specified in Table 4.2-2 in TS 36.211 [8].
NOTE 2: as specified in Table 4.2-1 in TS 36.211 [8].
NOTE 3: For CA tests, Cell ID = 0 applies only to P-Cell. For (n)*th* S-Cell, Cell ID = n is used.

D.2 E-UTRA configuration

This clause defines the E-UTRA link settings for the test cases defined in clauses 5 and 6. The LTE link is supposed to be a functional link. The configuration defined in this clause ensures establishment of LTE link.

Table D.2-1: E-UTRA configuration for EN-DC tests

Parameter	Value	Comments
Test Frequency during and after connection setup	Mid	As defined in TS 36.508 [TBD] for inter band test cases and as defined in TS 38.508-1 [6] clause 4.3.1 for intra band test cases, with NR SCS as per the test case for the LTE band under test
Bandwidth during and after connection setup	5 MHz (Note 1)	Supported by all LTE bands.
PDSCH transmission mode and antenna config	TM3 2x2	
OCNG pattern	OP.1 for FDD OP.1 for TDD	These physical resource blocks are assigned to an arbitrary number of virtual UE′s with one PDSCH per virtual UE; the data transmitted over the OCNG PDSCHs shall be uncorrelated pseudo random data, which is QPSK modulated.
DL RMC	R.10-2 FDD for FDD R.10 TDD for TDD	Since there is no LTE RMC defined for TDD 2Tx 5 MHz, reuse the 10MHz one and change channel BW to 5 MHz or 20 MHz as applicable.
DL RB allocation	25	Full RB allocation assuming 5 MHz ChBW. 100 RB for 20 MHz ChBW as applicable
UL Signal levels during connection setup	PUSCH Power	Attained by enabling open loop power control and setting up UL signal levels according to Annexes H.0, H.2 and H.3 of TS
TA adjustments	*TimeAlignmentTimerDedicated* IE to be set to infinity	*TimeAlignmentTimerDedicated* IE to be set to infinity to ensure UE doesn't look for TA adjustments (See Table D.2-4)
CQI reports and SRS after connection setup	Disabled (See Table D.2-2 and D.2-3)	Disable periodic and aperiodic CQI reports to ensure none of these transmissions occur on the LTE uplink.
NOTE: If none of the UE supported EN-DC band combos support 5MHz E-UTRA carrier, configure 20 MHz channel BW.		

Table D.2-2 -*CQI-ReportConfig-DEFAULT:* Additional E-UTRA Anchor Configuration

Derivation Path: TS 36.508 [7] clause 4.6.3, Table 4.6.3-2 CQI-ReportConfig-DEFAULT			
Information Element	**Value/remark**	**Comment**	**Condition**
CQI-ReportConfig-DEFAULT ::= SEQUENCE {			
cqi-ReportModeAperiodic	NOT PRESENT		
cqi-ReportPeriodic	NOT PRESENT		
}			

Table D.2-3: *PhysicalConfigDedicated-DEFAULT:* Additional E-UTRA Anchor Configuration

Derivation Path: TS 36.508 [7] clause 4.8.2, Table 4.8.2.1.6-1 PhysicalConfigDedicated-DEFAULT			
Information Element	**Value/remark**	**Comment**	**Condition**
PhysicalConfigDedicated-DEFAULT ::= SEQUENCE {			
soundingRS-UL-ConfigDedicated	Not present		RBC
}			

Table D.2-4: *MAC-MainConfig-RBC*: Additional E-UTRA Anchor Configuration

Derivation Path: TS 36.508 [7] clause 4.8.2.1.5, Table 4.8.2.1.5-1 MAC-MainConfig-RBC			
Information Element	**Value/remark**	**Comment**	**Condition**
timeAlignmentTimerDedicated	Infinity		

D.3 E-UTRA link common physical channel setup

Table D.3-1 describes the downlink Physical Channels that are required for E-UTRA connection set up.

Table D.3-1: Downlink Physical Channels required for E-UTRA connection set-up

Physical Channel	EPRE Ratio	Note
PBCH	PBCH_RA = 0 dB	
	PBCH_RB = 0 dB	
PSS	PSS_RA = 0 dB	
SSS	SSS_RA = 0 dB	
PCFICH	PCFICH_RB = 0 dB	
PDCCH	PDCCH_RA = 0 dB	
	PDCCH_RB = 0 dB	
PDSCH	PDSCH_RA = -3 dB	
	PDSCH_RB = -3 dB	
PHICH	PHICH_RA = 0 dB	
	PHICH_RB = 0 dB	
NOTE 1: $P_B = 1$. NOTE 2: PHICH group power, i.e. the total power of all active PHICH sequences within a PHICH group.		

D.4 E-UTRA power level

D.4.1 E-UTRA power level (conducted)

Table D.4.1-1: DL power level for E-UTRA (conducted)

Parameter	Value	Comments
DL signal level	RS EPRE -85.0 dBm/15 kHz	The power level is specified at each UE Rx antenna

D.4.2 E-UTRA power level (radiated)

Table D.4.2-1: Downlink power levels for E-UTRA (radiated)

Parameter	Value	Comments
DL signal level	RS EPRE -100 dBm/15 kHz	The power level is specified at each UE Rx antenna

Annex E (normative): Environmental conditions

FFS

Annex F (normative): Measurement uncertainties and test tolerances

The requirements of this clause apply to all tests in the present document.

F.1 Measurement uncertainties and test tolerances for FR1

F.1.1 Acceptable uncertainty of test system (normative)

The maximum acceptable uncertainty of the Test System is specified below for each test, where appropriate. The Test System shall enable the stimulus signals in the test case to be adjusted to within the specified range, and the equipment under test to be measured with an uncertainty not exceeding the specified values. All ranges and uncertainties are absolute values, and are valid for a confidence level of 95 %, unless otherwise stated.

A confidence level of 95 % is the measurement uncertainty tolerance interval for a specific measurement that contains 95 % of the performance of a population of test equipment.

For RF tests it should be noted that the uncertainties in clause F.1 apply to the Test System operating into a nominal 50 ohm load and do not include system effects due to mismatch between the DUT and the Test System.

The downlink signal uncertainties apply at each receiver antenna connector.

F.1.1.1 Measurement of test environments

The measurement accuracy of the UE test environments defined in TS 38.508-1 [5] subclause 4.1, Test environments shall be

- Pressure ±5 kPa.
- Temperature ±2 degrees.
- Relative Humidity ±5 %.
- DC Voltage ±1,0 %.
- AC Voltage ±1,5 %.
- Vibration 10 %.
- Vibration frequency 0,1 Hz.

The above values shall apply unless the test environment is otherwise controlled and the specification for the control of the test environment specifies the uncertainty for the parameter.

F.1.1.2 Measurement of Demod Performance requirements

This clause defines the maximum test system uncertainty for Demod Performance requirements. The maximum test system uncertainty allowed for the measurement uncertainty contributors are defined in Table F.1.1.2-1.

Table F.1.1.2-1: Maximum measurement uncertainty values for the test system for FR1 (up to 6 GHz) and Channel BW ≤ 40 MHz

MU contributor	Unit	Value	Comment
AWGN and signal flatness	dB	±2.0	Same as in LTE
Signal to noise ratio uncertainty	dB	±0.3	Same as in LTE
Signal to noise ratio variation	dB	±0.5	Same as in LTE

MU contributor	Unit	Value	Comment
Fading profile power uncertainty for 1Tx	dB	±0.5	Same as in LTE
Fading profile power uncertainty for 2Tx	dB	±0.7	Same as in LTE

The maximum test system uncertainty for test cases defined in section 5 is defined in Table F.1.1.2-2.

Table F.1.1.2-2: Maximum test system uncertainty for FR1 demodulation performance test cases

Subclause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
5.2.2.1.1_1 2Rx FDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA	± 0.9 dB for > 10Hz doppler ± 1 dB for 10Hz doppler	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2}) + SNR uncertainty due to finite test time^2 Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.7 dB for MIMO 2x2 AWGN flatness and signal flatness ±2.0 dB SNR uncertainty due to finite test time ±0.3 dB
5.2.2.1.1_2 2Rx FDD FR1 PDSCH Mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.2_1 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.3_1 2Rx FDD FR1 PDSCH mapping Type B performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.4_1 2Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.1_1 2Rx TDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.1_2 2Rx TDD FR1 PDSCH Mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.2_1 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.3_1 2Rx TDD FR1 PDSCH mapping Type B performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1

5.3.2.1.1 2Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	± 0.8 dB for >10 Hz doppler ± 0.9 dB for 10 Hz doppler	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2}+ SNR uncertainty due to finite test time^2) Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.5 dB for MIMO 2x2 AWGN flatness and signal flatness ±2.0 dB SNR uncertainty due to finite test time ±0.3 dB
5.3.2.1.2 2Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.3.2.2.1 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.1_1	Same as 5.3.2.1.1_1
5.3.3.1.1 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.3.3.2.1 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1

5.2.3.1.1_1 4Rx FDD FR1 PDSCH mapping Type A performance - 2x4 MIMO with baseline receiver for both SA and NSA	± 0.9 dB for > 10Hz doppler ± 1.0 dB for 10Hz doppler	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty 2 + Fading profile power uncertainty 2 + (0.25 x AWGN flatness and signal flatness) 2 + SNR uncertainty due to finite test time2) Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.7 dB for MIMO AWGN flatness and signal flatness ±2.0 dB SNR uncertainty due to finite test time ±0.3 dB
5.2.3.1.1_2 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.1_4 4Rx TDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with enhanced receiver type X for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.4_1 4Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1

F.1.1.3 Measurement of Channel State Information reporting

This clause defines the maximum test system uncertainty for channel state information reporting requirements. The maximum test system uncertainty allowed for the measurement uncertainty contributors are defined in Table F.1.1.3-1.

Table F.1.1.3-1: Maximum measurement uncertainty values for the test system for FR1 (up to 6 GHz) and Channel BW ≤ 40 MHz

MU contributor	Unit	Value	Comment
AWGN and signal flatness	dB	Same as in table F.1.1.2-1	
Signal to noise ratio uncertainty	dB	Same as in table F.1.1.2-1	
Signal to noise ratio variation	dB	Same as in table F.1.1.2-1	
Fading profile power uncertainty for 1Tx	dB	Same as in table F.1.1.2-1	
Fading profile power uncertainty for 2Tx	dB	Same as in table F.1.1.2-1	

The maximum test system uncertainty for test cases defined in section 6 is defined in Table F.1.1.3-2.

Table F.1.1.3-2: Maximum test system uncertainty for FR1 channel state information reporting test cases

Subclause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
6.2.2.1.2.12Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	+/- 0.8 dB	Overall system uncertainty for fading conditions comprises two quantities: 1. Signal-to-noise ratio uncertainty ±0.3 dB 2. Fading profile power uncertainty for 2Tx ±0.7 dB Items 1 and 2 are assumed to be uncorrelated so can be root sum squared: Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2}) *AWGN flatness and signal flatness ±2.0 dB not expected to have any significant effect*
6.2.2.1.2.22Rx FDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.2.2.2.2.22Rx TDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1

F.1.2 Interpretation of measurement results (normative)

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 ETR 273-1-2 clause 6.5.

The actual measurement uncertainty of the Test System for the measurement of each parameter shall be included in the test report.

The recorded value for the Test System uncertainty shall be, for each measurement, equal to or lower than the appropriate figure in clause F.1 of the present document.

If the Test System for a test is known to have a measurement uncertainty greater than that specified in clause F.1, it is still permitted to use this apparatus provided that an adjustment is made value as follows:

Any additional uncertainty in the Test System over and above that specified in clause F.1 shall be used to tighten the Test Requirement, making the test harder to pass. For some tests, for example receiver tests, this may require modification of stimulus signals. This procedure will ensure that a Test System not compliant with clause F.1does not increase the chance of passing a device under test where that device would otherwise have failed the test if a Test System compliant with clause F.1 had been used.

F.1.3 Test Tolerance and Derivation of Test Requirements (informative)

The Test Requirements in the present document have been calculated by relaxing the Minimum Requirements of the core specification using the Test Tolerances defined in this clause. When the Test Tolerance is zero, the Test Requirement will be the same as the Minimum Requirement. When the Test Tolerance is non-zero, the Test Requirements will differ from the Minimum Requirements, and the formula used for the relaxation is given in this clause.

The Test Tolerances are derived from Test System uncertainties, regulatory requirements and criticality to system performance. As a result, the Test Tolerances may sometimes be set to zero.

The test tolerances should not be modified for any reason e.g. to take account of commonly known test system errors (such as mismatch, cable loss, etc.).

The downlink Test Tolerances apply at each receiver antenna connector.

F.1.3.1 Measurement of test environments

The UE test environments are set to the values defined in TS 36.508 subclause 4.1, without any relaxation. The applied Test Tolerance is therefore zero.

F.1.3.2 Measurement of Demod Performance requirements

The derivation of the test requirements for the test cases in section 5 is defined in Table F.1.3.2-1.

Table F.1.3.2-1: Derivation of Test Requirements (FR1 demodulation performance tests)

Test	Minimum Requirement in TS 38.101-4	Test Tolerance (TT)	Test Requirement in TS 38.521-4
5.2.2.1.1_1 2Rx FDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.1_2 2Rx FDD FR1 PDSCH Mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.2_1 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.3_1 2Rx FDD FR1 PDSCH mapping Type B performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.4_1 2Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.1_1 2Rx TDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.1_2 2Rx TDD FR1 PDSCH Mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.2_1 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.3_1 2Rx TDD FR1 PDSCH mapping Type B performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.3.2.1.2 2Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.3.2.1.1 2Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.3.2.2.1 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged

5.3.3.1.1 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged
5.3.3.2.1 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.1.1_1 4Rx FDD FR1 PDSCH mapping Type A performance - 2x4 MIMO baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.1_2 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.1_4 4Rx TDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with enhanced receiver type X for both SA and NSA	SNRs as specified	0.9 dB for > 10Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.4_1 4Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged

F.1.3.3 Measurement of Channel State Information reporting

The derivation of the test requirements for the test cases in section 6 is defined in Table F.1.3.3-1.

Table F.1.3.3-1: Derivation of Test Requirements (FR1 channel state information reporting tests)

Test	Minimum Requirement in TS 38.101-4	Test Tolerance (TT)	Test Requirement in TS 38.521-4
6.2.2.1.2.12Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α [20%] γ [1.05] BLER [0.02]	SNR TBD dB α TBD γ *TBD* BLER TBD	SNR TBD α limit TBD γ1limit TBD BLER limit TBD
6.2.2.1.2.22Rx FDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α TBD β TBD γ *TBD* BLER TBD	SNR TBD dB α TBD β TBD γ *TBD* BLER TBD	SNR TBD α limit TBD β limit TBD γ1limit TBD BLER limit TBD
6.2.2.2.2.22Rx TDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α [2%] β [55%] γ [1.05] BLER TBD	SNR TBD dB α TBD β TBD γ *TBD* BLER TBD	SNR TBD α limit TBD β limit TBD γ1limit TBD BLER limit TBD

Annex G (normative): Statistical Testing

G.1 Statistical testing of Performance Requirements with throughput

G.1.1 General

The test of receiver performance characteristics is twofold.

1. A signal or a combination of signals is offered to the RX port(s) of the receiver.
2. The ability of the receiver to demodulate /decode this signal is verified by measuring the throughput.

In (2) is the statistical aspect of the test and is treated here.

The minimum requirement for all receiver performance tests is either 70 % or 30 % of the maximum throughput.

All receiver performance tests are performed in fading conditions. In addition to the statistical considerations, this requires the definition of a minimum test time.

G.1.2 Mapping throughput to error ratio

a) The measured information bit throughput R is defined as the sum (in kilobits) of the information bit payloads successfully received during the test interval, divided by the duration of the test interval (in seconds).

b) In measurement practice the UE indicates successfully received information bit payload by signalling an ACK to the SS.
If payload is received, but damaged and cannot be decoded, the UE signals a NACK.

c) Only the ACK and NACK signals, not the data bits received, are accessible to the SS.
The number of bits is known in the SS from knowledge of what payload was sent.

d) For the reference measurement channel, applied for testing, the number of bits is different in different subframes, however in a radio frame it is fixed during one test.

e) The time in the measurement interval is composed of successfully received subframes (ACK), unsuccessfully received subframes (NACK) and no reception at all (DTX-subframes).

f) DTX-subframes may occur regularly according the applicable reference measurement channel (regDTX).
In real live networks this is the time when other UEs are served. In TDD these are the UL and special subframes.
regDTX vary from test to test but are fixed within the test.

g) Additional DTX-subframes occur statistically when the UE is not responding ACK or NACK where it should. (statDTX)
This may happen when the UE was not expecting data or decided that the data were not intended for it.

The pass / fail decision is done by observing the:

- number of NACKs
- number of ACKs and
- number of statDTXs (regDTX is implicitly known to the SS)

The ratio `(NACK + statDTX)/(NACK+ statDTX + ACK)`is the Error Ratio (ER). Taking into account the time consumed by the ACK, NACK, and DTX-TTIs (regular and statistical), ER can be mapped unambiguously to throughput for any single reference measurement channel test.

G.1.3 Design of the test

The test is defined by the following design principles (see clause G.2, Theory):

1. The standard concept is applied. (not the early decision concept)
2. A second limit is introduced: The second limit is different, whether 30 % or 70 % throughput is tested.
3. To decide the test pass:

   Supplier risk is applied based on the Bad DUT quality

   To decide the test fail:

   Customer Risk is applied based on the specified DUT quality

The test is defined by the following parameters:

1a) Limit Error Ratio = 0.3 (in case 70 % Throughput is tested) or

1b) Limit Throughput = 0.3 (in case 30 % Throughput is tested)

2a) Bad DUT factor M=1.378 (selectivity)

2b) Bad DUT factor m=0.692 (selectivity)

justification see: TS 34.121 Clause F.6.3.3

3) Confidence level CL = 95 % (for specified DUT and Bad DUT-quality)

G.1.4 Pass Fail limit

Testing Throughput = 30 %, then the test limit is

Number of successes (ACK) / number of samples ≥ 59 / 233

Testing Throughput = 70 % then the test limit is

Number of fails (NACK and statDTX) / number of samples ≤ 66 / 184

There are 3 distinct cases:

a) The duration for the number of samples (233 or 184) is greater than the minimum test time:

Then the number of samples (233 or 184) is predefined and the decision is done according to the number of events (59 successes or 66 fails)

b) Since subframe 0 and 5 contain less bits than the remaining subframes, it is allowed to predefine a number of samples contained in an integer number of frames. In this case test-limit-ratio applies.

c) The minimum test time is greater than the duration for the number of samples:

The minimum test time is predefined and the decision is done comparing the measured ratio at that instant against the test-limit-ratio.

NOTE: The test time for most of the tests is governed by the Minimum Test Time.

G.1.5 Minimum Test time

Editor's Note: Simulation method to derive minimum test time for FR2 needs to be evaluated.

If a pass fail decision in clause G.1.4 can be achieved earlier than the minimum test time, then the test shall not be decided, but continued until the minimum test time is elapsed.

The tables below contain the minimum number of slots for FDD and TDD.

By simulations the minimum number of active subframes (carrying DL payload) was derived (MNAS), then adding inactive subframes to the active ones. For TDD additional subframes contain no DL payload) then rounding up to full thousand and then adding a bias of 1000 (BMNSF).

Simulation method to derive minimum test time:

With a level, corresponding a throughput at the test limit (here 30 % or 70 % of the max. throughput) the preliminary throughput versus time converges towards the final throughput. The allowance of ± 0.2 dB around the above mentioned level is predefined by RAN5 to find the minimum test time. The allowance of ±0.2 dB maps through the function "final throughput versus level" into a throughput corridor. The minimum test time is achieved when the preliminary throughput escapes the corridor the last time. The two functions "final throughput versus level" and "preliminary throughput versus time" are simulation results, which are done individual for each demodulation scenario.

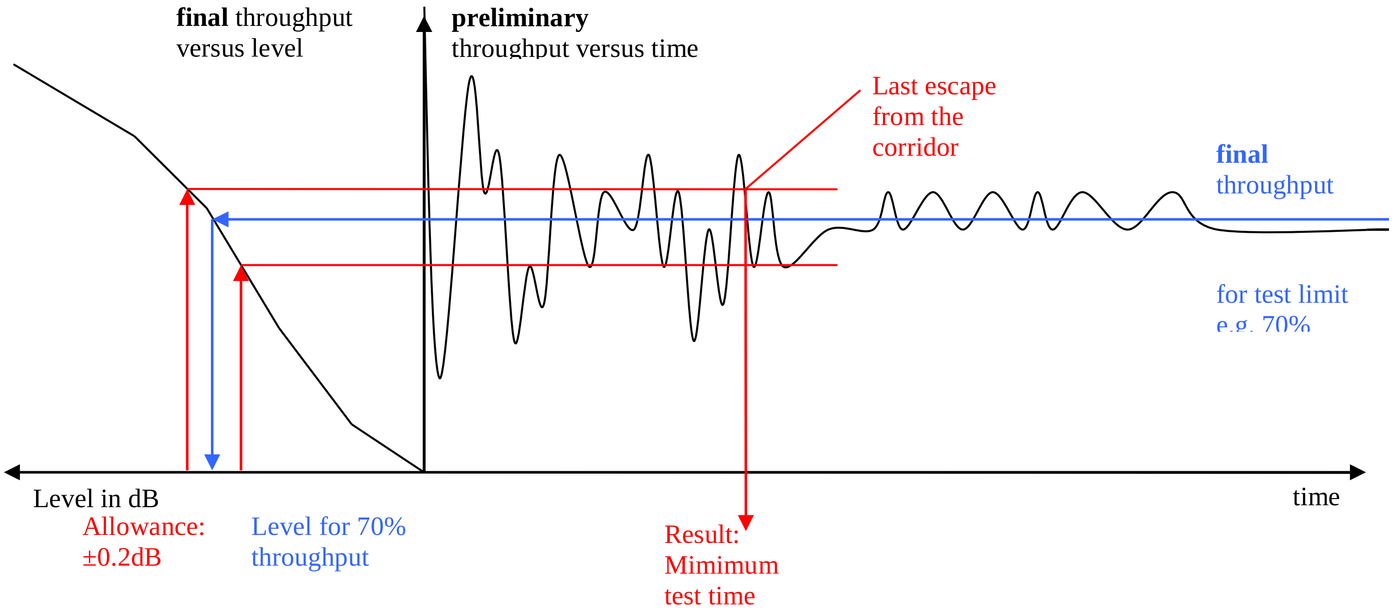

Figure G.1.5-1: Simulation method to derive minimum test time

Table G.1.5-1: Minimum Test time for 2Rx FDD FR1 PDSCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulations)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1-1	R.PDSCH.1-1.1 FDD 10MHz ChBW/15kHz SCS, QPSK, 0.30, 2x2, ULA Low TDLB100ns-400Hz	10	10000	10526	11000
1-2	R.PDSCH.1-1.2 FDD 10MHz ChBW/15kHz SCS, QPSK, 0.30, 2x2, ULA Low TDLC300ns-100Hz	20	20000	21052	22000
1-3	R.PDSCH.1-4.1 FDD 10MHz ChBW/15kHz SCS, 256QAM, 0.82, 2x2, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
1-4	R.PDSCH.1-2.1 FDD 10MHz ChBW/15kHz SCS, 16QAM, 0.48, 2x2, ULA Low TDLC300ns-100Hz	20	20000	21052	22000
2-1	R.PDSCH.1-3.1 FDD 10MHz ChBW/15kHz SCS, 64QAM, 0.51, 2x2, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
2-2	R.PDSCH.2-1.1 FDD 20MHz ChBW/15kHz SCS, 64QAM, 0.51, 2x2, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
3-1	R.PDSCH.1-2.2 FDD 10MHz ChBW/15kHz SCS, 16QAM, 0.48, 2x2, ULA Medium TDLA30ns-10Hz	75	75000	78947	79000

Table G.1.5-2: Minimum Test time for 2Rx TDD FR1 PDSCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1-1	R.PDSCH.2-1.1 TDD 40MHz ChBW/30kHz SCS, QPSK, 0.30, FR1.30-1, 2x2, ULA Low TDLB100ns-400Hz	10	10000	14285	15000
1-2	R.PDSCH.2-1.2 TDD 40MHz ChBW/30kHz SCS, QPSK, 0.30, FR1.30-1, 2x2, ULA Low TDLC300ns-100Hz	20	20000	28570	29000
1-3	R.PDSCH.2-4.1 TDD 40MHz ChBW/30kHz SCS, 256QAM, 0.82, FR1.30-1, 2x2, ULA Low TDLA30ns-10Hz	75	75000	107143	108000
1-4	R.PDSCH.2-2.1 TDD 40MHz ChBW/30kHz SCS, 16QAM, 0.48, FR1.30-1, 2x2, ULA Low TDLC300ns-100Hz	20	20000	28570	29000
1-5	[R.PDSCH.2-5.1 TDD] 40MHz ChBW/30kHz SCS, QPSK, 0.30, FR1.30-2, 2x2, ULA Low TDLA30ns-10Hz	75	75000	125000	125000
1-6	[R.PDSCH.2-6.1 TDD] 40MHz ChBW/30kHz SCS, QPSK, 0.30, FR1.30-2, 2x2, ULA Low TDLA30ns-10Hz	75	75000	125000	125000
2-1	R.PDSCH.2-3.1 TDD 40MHz ChBW/30kHz SCS, 64QAM, 0.51, FR1.30-1, 2x2, ULA Low TDLA30ns-10Hz	75	75000	107143	108000
2-2	R.PDSCH.2-9.1 TDD 20MHz ChBW/30kHz SCS, 64QAM, 0.51, FR1.30-1A, 2x2, ULA Low TDLA30ns-10Hz	75	75000	107143	108000
3-1	R.PDSCH.2-2.2 TDD 40MHz ChBW/30kHz SCS, 16QAM, 0.48, FR1.30-1, 2x2, ULA Medium TDLA30ns-10Hz	75	75000	107143	108000

Editor's note: The min test time specified in the table above to be used unless more simulation data suggests changing the test time.

Table G.1.5-3: Minimum Test time for 2Rx 2Tx FDD FR1 PDCCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1	R.PDCCH.1-2.2 FDD 10MHz ChBW/15kHz SCS, 2x2, ULA Low TDLA300ns-100Hz	20	20000	21052	22000
2	R.PDCCH.1-2.5 FDD 10MHz ChBW/15kHz SCS, 2x2, ULA Low TDLC300ns-100Hz	20	20000	21052	22000
3	R.PDCCH.1-1.3 FDD 10MHz ChBW/15kHz SCS 2x2, ULA Low TDLA30ns-10Hz	75	75000	78947	79000

Table G.1.5-4: Minimum Test time for 2Rx 1Tx FDD FR1 PDCCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1	R.PDCCH.1-2.1 FDD 10MHz ChBW/15kHz SCS, 2x2, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
2	R.PDCCH.1-2.3 FDD 10MHz ChBW/15kHz SCS, 2x2, ULA Low TDLC300ns-100Hz	20	20000	21052	22000
3	R.PDCCH.1-2.4 FDD 10MHz ChBW/15kHz SCS 2x2, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
4	R.PDCCH.1-1.1 FDD 10MHz ChBW/15kHz SCS, 2x2, ULA Low TDLC30ns-10Hz	75	75000	78947	79000
5	[R.PDCCH.1-2.6 FDD] 10MHz ChBW/15kHz SCS, 2x2, ULA Low TDLA30ns-10Hz	75	75000	78947	79000

Table G.1.5-5: Minimum Test time for 2Rx TDD FR1 PDSCH Type A and CSI-RS overlapped performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulations)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1-1	R.PDSCH.2-7.1 TDD 40MHz ChBW/30kHz SCS, 16QAM, 0.48, FR1.30-1 2x2, ULA Low TDLC300ns-100Hz	20	20000	28571	29000

Table G.1.5-6: Minimum Test time for 2Rx 1Tx TDD FR1 PDCCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1	R.PDCCH. 2-1.1 TDD 40MHz ChBW/30kHz SCS, 1x2, ULA Low TDLA30ns-10Hz	100	100000	142857	143000
2	R.PDCCH. 2-1.2 TDD 40MHz ChBW/30kHz SCS, 1x2, ULA Low TDLC300ns-100Hz	100	100000	142857	143000
3	R.PDCCH. 2-2.1 TDD 40MHz ChBW/30kHz SCS 1x2, ULA Low TDLC300ns-100Hz	100	100000	142857	143000

Table G.1.5-7: Minimum Test time for 2Rx 2Tx TDD FR1 PDCCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1	R.PDCCH. 2-1.3 TDD 40MHz ChBW/30kHz SCS, 2x2, ULA Low TDLC300ns-100Hz	100	100000	142857	143000

Table G.1.5-8: Minimum Test time for 4Rx 1Tx FDD FR1 PDCCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1	R.PDCCH. 1-2.1 FDD 10MHz ChBW/15kHz SCS, 1x4, ULA Low TDLA30ns-10Hz	100	100000	105263	106000
2	R.PDCCH. 1-2.3 FDD 10MHz ChBW/15kHz SCS, 1x4, ULA Low TDLC300ns-100Hz	100	100000	105263	106000
3	R.PDCCH. 1-2.4 FDD 10MHz ChBW/15kHz SCS, 1x4, ULA Low TDLA30ns-10Hz	100	100000	105263	106000
4	R.PDCCH. 1-1.1 FDD 10MHz ChBW/15kHz SCS, 1x4, ULA Low TDLA30ns-10Hz	100	100000	105263	106000

Table G.1.5-9: Minimum Test time for 4Rx 2Tx FDD FR1 PDCCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1	R.PDCCH. 1-2.2 FDD 10MHz ChBW/15kHz SCS, 2x4, ULA Low TDLC300ns-100Hz	100	100000	105263	106000
2	R.PDCCH. 1-2.5 FDD 10MHz ChBW/15kHz SCS, 2x4, ULA Low TDLC300ns-100Hz	100	100000	105263	106000
3	R.PDCCH. 1-1.3 FDD 10MHz ChBW/15kHz SCS, 2x4, ULA Low TDLA30ns-10Hz	100	100000	105263	106000

Table G.1.5-10: Minimum Test time for 4Rx 1Tx TDD FR1 PDCCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1	R.PDCCH. 2-1.1 TDD 40MHz ChBW/30kHz SCS, 1x4, ULA Low TDLA30ns-10Hz	100	100000	142857	143000
2	R.PDCCH. 2-1.2 TDD 40MHz ChBW/30kHz SCS, 1x4, ULA Low TDLC300ns-100Hz	100	100000	142857	143000
3	R.PDCCH. 2-2.1 TDD 40MHz ChBW/30kHz SCS, 1x4, ULA Medium A TDLA30ns-10Hz	100	100000	142857	143000

Table G.1.5-11: Minimum Test time for 4Rx 2Tx TDD FR1 PDCCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1	[TBD] 40MHz ChBW/30kHz SCS, 2x4, ULA Low TDLC300ns-100Hz	100	100000	142857	143000

Table G.1.5-12: Minimum Test time for 4Rx FDD FR1 PDSCH Type A performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulations	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1-1	R.PDSCH.1-1.1 FDD 10MHz ChBW/15kHz SCS, QPSK, 0.30, 2x4, ULA Low TDLB100ns-400Hz	10	10000	10526	11000
1-2	R.PDSCH.1-1.2 FDD 10MHz ChBW/15kHz SCS, QPSK, 0.30, 2x4, ULA Low TDLC300ns-100Hz	20	20000	21052	22000
1-3	R.PDSCH.1-4.1 FDD 10MHz ChBW/15kHz SCS, 256QAM, 0.82, 2x4, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
1-4	R.PDSCH.1-2.1 FDD 10MHz ChBW/15kHz SCS, 16QAM, 0.48, 2x2, ULA Low TDLC300ns-100Hz	20	20000	21052	22000
2-1	R.PDSCH.1-3.1 FDD 10MHz ChBW/15kHz SCS, 64QAM, 0.51, 2x4, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
2-2	R.PDSCH.2-1.1 FDD 20MHz ChBW/30kHz SCS, 64QAM, 0.51, 2x4, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
3-1	R.PDSCH.1-2.3 FDD 10MHz ChBW/15kHz SCS, 16QAM, 0.48, 4x4, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
4-1	R.PDSCH.1-2.4 FDD 10MHz ChBW/15kHz SCS, 16QAM, 0.48, 4x4, ULA Low TDLA30ns-10Hz	75	75000	78947	79000
5-1	R.PDSCH.1-2.3 FDD 10MHz ChBW/15kHz SCS, 16QAM, 0.48, 4x4, ULA Medium A TDLA30ns-10Hz	75	75000	78947	79000

Table G.1.5-13: Minimum Test time for 2Rx FDD FR1 PDSCH Type A performance for LTE-NR coexistence scenario

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulations)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1-1	R.PDSCH.1-7.1 FDD 10MHz ChBW/15kHz SCS, QPSK, 0.30, 4x2, ULA Low TDLA30ns-10Hz	75	75000	93750	94000
1-2	R.PDSCH.1-7.2 FDD 10MHz ChBW/15kHz SCS, QPSK, 0.30, 4x2, ULA Low TDLC30ns-10Hz	75	75000	93750	94000

Table G.1.5-14: Minimum Test time for 4Rx FDD FR1 PDSCH Type A performance for LTE-NR coexistence scenario

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulations)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1-1	R.PDSCH.1-7.1 FDD 10MHz ChBW/15kHz SCS, QPSK, 0.30, 4x4, ULA Low TDLA30ns-10Hz	75	75000	93750	94000
1-2	R.PDSCH.1-7.2 FDD 10MHz ChBW/15kHz SCS, QPSK, 0.30, 4x4, ULA Low TDLC30ns-10Hz	75	75000	93750	94000

Table G.1.5-15: Minimum Test time for 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance

Test No	Demodulation scenario (info only)	Minimum Test Time (seconds) (Based on simulation)	Minimum number of subframes (MNS = active and inactive subframes)	Minimum number of active subframes (MNAS) (Information only)	Minimum Number of Active Subframes (MNAS) after rounding up to nearest thousand MNAS= $1000 * \left\lceil \frac{MNAS}{1000} \right\rceil$ (mandatory)
1-1	R.PDSCH.1-5.1 FDD 10MHz ChBW/15kHz SCS, 16QAM, 0.48, FR1.30-1, 2x2, ULA Low TDLC300ns-100Hz	20	20000	28570	29000

Table G.1.5-16: Minimum Test time for 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance

FFS

G.2 Theory to derive the numbers for statistical testing (informative)

Editor's note: This clause of the Annex G is for information only and it described the background theory and information for statistical testing.

G.2.1 Error Ratio (ER)

The Error Ratio (ER) is defined as the ratio of number of errors (ne) to all results, number of samples (ns).

(1-ER is the success ratio).

G.2.2 Test Design

A statistical test is characterized by:

Test-time, Selectivity and Confidence level.

G.2.3 Confidence level

The outcome of a statistical test is a decision. This decision may be correct or in-correct. The Confidence Level CL describes the probability that the decision is a correct one. The complement is the wrong decision probability (risk) D = 1-CL.

G.2.4 Introduction: Supplier Risk versus Customer Risk

There are two targets of decision:

(a) A measurement on the pass-limit shows, that the DUT has the specified quality or is better with probability CL (CL e.g.95 %). This shall lead to a "pass decision".

The pass-limit is on the good side of the specified DUT-quality. A more stringent CL (CL e.g.99 %) shifts the pass-limit farer into the good direction. Given the quality of the DUTs is distributed, a greater CL passes less and better DUTs.

A measurement on the bad side of the pass-limit is simply "not pass" (undecided or artificial fail).

(aa) Complementary:

A measurement on the fail-limit shows, that the DUT is worse than the specified quality with probability CL.

The fail-limit is on the bad side of the specified DUT-quality. A more stringent CL shifts the fail-limit farer into the bad direction. Given the quality of the DUTs is distributed, a greater CL fails less and worse DUTs.

A measurement on the good side of the fail-limit is simply "not fail".

(b) A DUT, known to have the specified quality, shall be measured and decided pass with probability CL. This leads to the test limit.

For CL e.g. 95 %, the test limit is on the bad side of the specified DUT-quality. CL e.g.99 % shifts the pass-limit farer into the bad direction. Given the DUT-quality is distributed, a greater CL passes more and worse DUTs.

(bb) A DUT, known to be an (ε→0) beyond the specified quality, shall be measured and decided fail with probability CL.

For CL e.g.95 %, the test limit is on the good side of the specified DUT-quality.

NOTE 1: The different sense for CL in (a), (aa) versus (b), (bb).

NOTE 2: For constant CL in all 4 bullets (a) is equivalent to (bb) and (aa) is equivalent to (b).

G.2.5 Supplier Risk versus Customer Risk

The table below summarizes the different targets of decision.

Table G.2.5-1: Equivalent statements

	Equivalent statements, using different cause-to-effect-directions, and assuming CL = constant >1/2	
cause-to-effect-directions	Known measurement result → estimation of the DUT's quality	Known DUT's quality → estimation of the measurement's outcome
Supplier Risk	A measurement on the pass-limit shows, that the DUT has the specified quality or is better (a)	A DUT, known to have an (ε→0) beyond the specified DUT-quality, shall be measured and decided fail (bb)
Customer Risk	A measurement on the fail-limit shall shows, that the DUT is worse than the specified quality (aa)	A DUT, known to have the specified quality, shall be measured and decided pass (b)

The shaded area shown the direct interpretation of Supplier Risk and Customer Risk.

The same statements can be based on other DUT-quality-definitions.

G.2.6 Introduction: Standard test versus early decision concept

In standard statistical tests, a certain number of results (ns) is predefined in advance to the test. After ns results the number of bad results (ne) is counted and the error ratio (ER) is calculated by ne/ns.

Applying statistical theory, a decision limit can be designed, against which the calculated ER is compared to derive the decision. Such a limit is one decision point and is characterized by:

- D: the wrong decision probability (a predefined parameter)

- ns: the number of results (a fixed predefined parameter)
- ne: the number of bad results (the limit based on just ns)

In the formula for the limit, D and ns can be understood as variable parameter and variable. However the standard test execution requires fixed ns and D. The property of such a test is: It discriminates between two states only, depending on the test design:

- pass (with CL) / undecided (undecided in the sense: finally undecided)
- fail (with CL) / undecided (undecided in the sense: finally undecided)
- pass(with CL) / fail (with CL) (however against two limits).

In contrast to the standard statistical tests, the early decision concept predefines a set of (ne,ns) co-ordinates, representing the limit-curve for decision. After each result a preliminary ER is calculated and compared against the limit-curve. After each result one may make the decision or not (undecided for later decision). The parameters and variables in the limit-curve for the early decision concept have a similar but not equal meaning:

- D: the wrong decision probability (a predefined parameter)
- ns: the number of results (a variable parameter)
- ne: the number of bad results (the limit. It varies together with ns)

To avoid a "final undecided" in the standard test, a second limit shall be introduced and the single decision co-ordinate (ne,ns) needs a high ne, leading to a fixed (high) test time. In the early decision concept, having the same selectivity and the same confidence level an "undecided" need not to be avoided, as it can be decided later. A perfect DUT will hit the decision coordinate (ne,ns) with ne=0. This test time is short.

G.2.7 Standard test versus early decision concept

For Supplier Risk:

The wrong decision probability D in the standard test is the probability, to decide a DUT in-correct in the single decision point. In the early decision concept there is a probability of in-correct decisions d at each point of the limit-curve. The sum of all those wrong decision probabilities accumulate to D. Hence d<D.

For Customer Risk:

The correct decision probability CL in the standard test is the probability, to decide a DUT correct in the single decision point. In the early decision concept there is a probability of correct decisions cl at each point of the limit-curve. The sum of all those correct decision probabilities accumulate to CL. Hence cl<CL or d>D.

G.2.8 Selectivity

There is no statistical test which can discriminate between a limit DUT and a DUT which is an ($\varepsilon \rightarrow 0$) apart from the limit in finite time and high confidence level CL. Either the test discriminates against one limit with the results pass (with CL)/undecided or fail (with CL)/undecided, or the test ends in a result pass (with CL)/fail (with CL) but this requires a second limit.

For CL>1/2, a (measurement-result = specified-DUT-quality), generates undecided in test "supplier risk against pass limit" (a, from above) and also in the test "customer risk against the fail limit " (aa)

For CL>1/2, a DUT, known to be on the limit, will be decided pass for the test "customer risk against pass limit" (b) and also "supplier risk against fail limit" (bb).

This overlap or undecided area is not a fault or a contradiction, however it can be avoided by introducing a Bad or a Good DUT quality according to:

- Bad DUT quality: specified DUT-quality * M (M>1)
- Good DUT quality: specified DUT-quality * m (m<1)

Using e.g. M>1 and CL=95 % the test for different DUT qualities yield different pass probabilities:

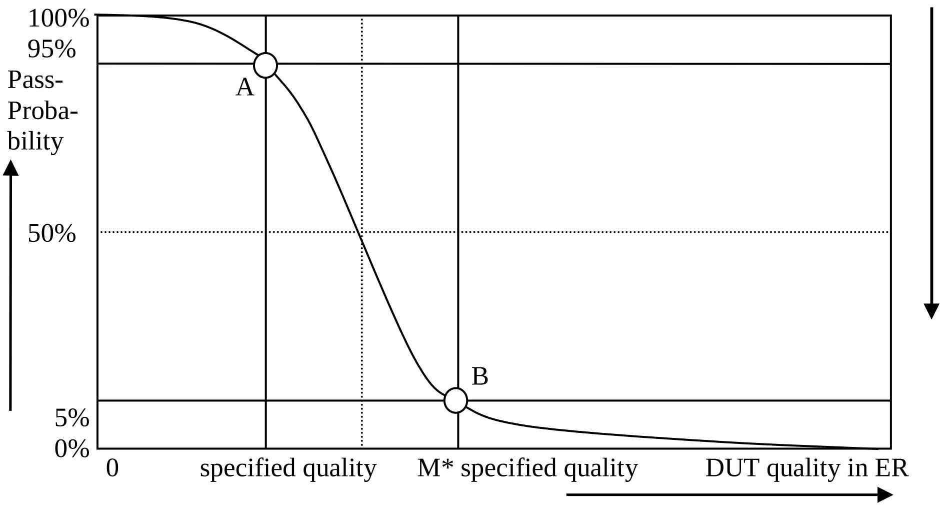

Figure G.2.8-1: Pass probability versus DUT quality

G.2.9 Design of the test

The receiver characteristic test are defined by the following design principles:

1. The early decision concept is applied.
2. A second limit is introduced: Bad DUT factor M>1
3. To decide the test pass:

    Supplier risk is applied based on the Bad DUT quality

    To decide the test fail

    Customer Risk is applied based on the specified DUT quality

The receiver characteristic test are defined by the following parameters:

1. Limit ER = 0.05
2. Bad DUT factor M=1.5 (selectivity)
3. Confidence level CL = 95 % (for specified DUT and Bad DUT-quality)

This has the following consequences:

1. A measurement on the fail limit is connected with 2 equivalent statements:

A measurement on the fail-limit shows, that the DUT is worse than the specified DUT-quality	A DUT, known have the specified quality, shall be measured and decided pass

2. A measurement on the pass limit is connected with the complementary statements:

A measurement on the pass limit shows, that the DUT is better than the Bad DUT-quality.	A DUT, known to have the Bad DUT quality, shall be measured and decided fail

The left column is used to decide the measurement.

The right column is used to verify the design of the test by simulation.

The simulation is based on the two fulcrums A and B only in Figure G.2.8-1

3. Test time

   The minimum and maximum test time is fixed.

   The average test time is a function of the DUT's quality.

   The individual test time is not predictable.

4. The number of decision co-ordinates (ne,ns) in the early decision concept is responsible for the selectivity of the test and the maximum test time. Having fixed the number of decision co-ordinates there is still freedom to select the individual decision co-ordinates in many combinations, all leading to the same confidence level.

G.2.10 Simulation to derive the pass fail limits

There is freedom to design the decision co-ordinates (ne,ns).

The binomial distribution and its inverse is used to design the pass and fail limits. Note that this method is not unique and that other methods exist.

$$\mathrm{fail}(ne, d_f) := \frac{ne}{(ne + \mathrm{qnbinom}(d_f, ne, ER))}$$

$$\mathrm{pass}(ne, cl_p, M) := \frac{ne}{(ne + \mathrm{qnbinom}(cl_p, ne, ER \cdot M))}$$

Where

- fail(..) is the error ratio for the fail limit
- pass(..) is the error ratio for the pass limit
- ER is the specified error ratio 0.05
- ne is the number of bad results. This is the variable in both equations
- M is the Bad DUT factor M=1.5
- d_f is the wrong decision probability of a single (ne,ns) co-ordinate for the fail limit.
  It is found by simulation to be $d_f = 0.004$
- cl_p is the confidence level of a single (ne,ns) co-ordinate for the pass limit.
  It is found by simulation to be $cl_p = 0.9975$
- qnbinom(..): The inverse cumulative function of the negative binomial distribution

The simulation works as follows:

- A large population of limit DUTs with true ER = 0.05 is decided against the pass and fail limits.
- cl_p and d_f are tuned such that CL (95 %) of the population passes and D (5 %) of the population fails.
- A population of Bad DUTs with true ER = M*0.05 is decided against the same pass and fail limits.
- cl_p and d_f are tuned such that CL (95 %) of the population fails and D (5 %) of the population passes.

- This procedure and the relationship to the measurement is justified in clause G.2.9. The number of DUTs decrease during the simulation, as the decided DUTs leave the population. That number decreases with an approximately exponential characteristics. After 169 bad results all DUTs of the population are decided.

NOTE: The exponential decrease of the population is an optimal design goal for the decision co-ordinates (ne,ns), which can be achieved with other formulas or methods as well.

Annex H (informative): Test Procedure for FR2 Demod Testing

This annex specifies the common test procedure for FR2 demodulation performance testing.

FR2 demodulation testing can be split into following 3 stages:

- Stage1: Selecting the best UE beam during initial call setup.
- Stage2: Before the actual test measurement starts, ensure the channel is conducive for UE to start decoding a given MCS as required by the RAN4 requirement.
- Stage 3: Actual test with RAN4 defined test parameters starts.

Following test function is defined to accomplish stage1 and stage2:

1 DUT position in the test zone.

- If known, align the DUT to the best {X,Y,Z} location in the test zone:
  - Where {X,Y,Z} are the co-ordinate points for aligning DUT Antenna Panel, such that the panel is:
    - Center Aligned of the Test zone (Quiet Zone); and/or
    - Center Aligned to the boresight of the TRxP
- Else:
  - Align the geometric center of the DUT to the center of the quiet zone.

2. Determine the best DUT position for stage3:

- Maximize various metricsRank, RSRP Per branch (RSRPB).
- Maximize any other metrics (FFS) based on configured measurements.
- Best {Azimuth, Elevation} position in a sweep list of N {$Azimuth_{1..n}$, $Elevation_{1..n}$}:
  - Where {$Azimuth_{1..n}$, $Elevation_{1..n}$} are distinct Azimuth & Elevation points
- DUT positioner is swept through these distinct points using a measurement grid FFS.

3. Additional Procedure (Optional):

- Identify the actual Pathloss for run time compensation in the testcase:
  - Define the use of the pathloss in the test
  - Use of ***[Expected Pathloss - Actual Pathloss]*** in the test
- Optionally identify the best TRxP, if applicable:
  - Store data in a calibration file for further use.
- Define the procedure for controlling the positioner:
  - SCPI based definitions

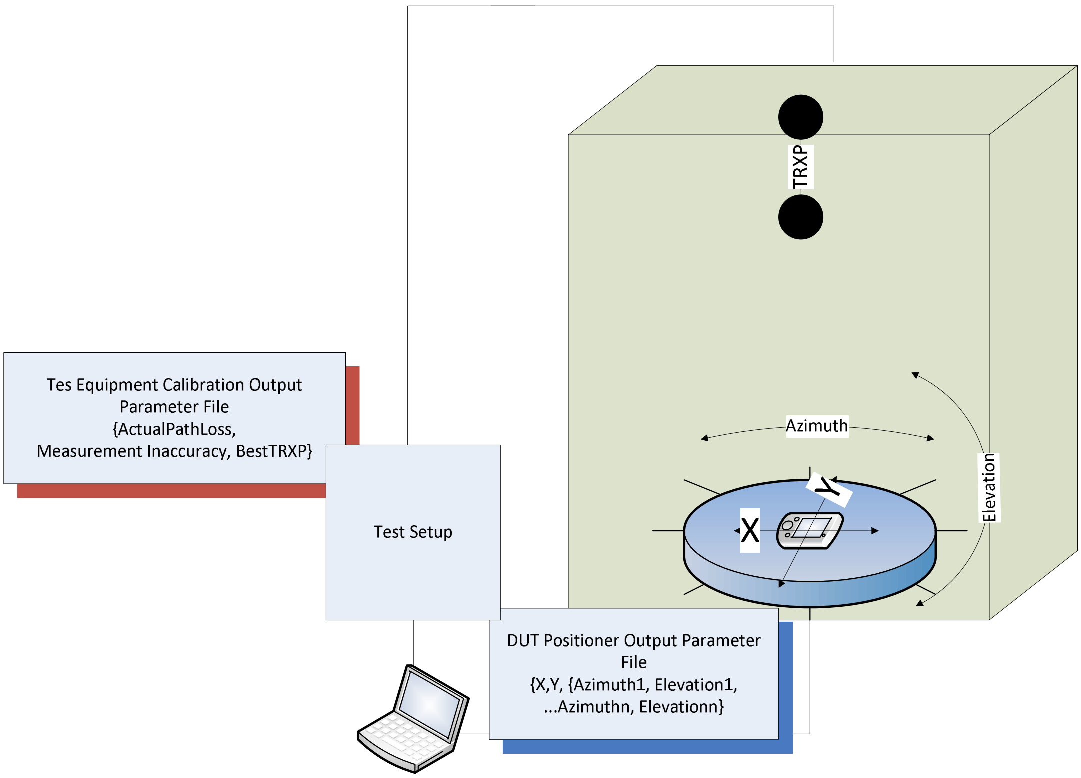

Figure Y-1: Test Function Usage in Demod/RRM (and optionally Signalling)

Stage1 & Stage2 in NSA Mode:

The below flow chart details the steps for Stage 1 and Stage 2 in NSA Mode for demodulation testing and possibly applicable to RRM scenarios.

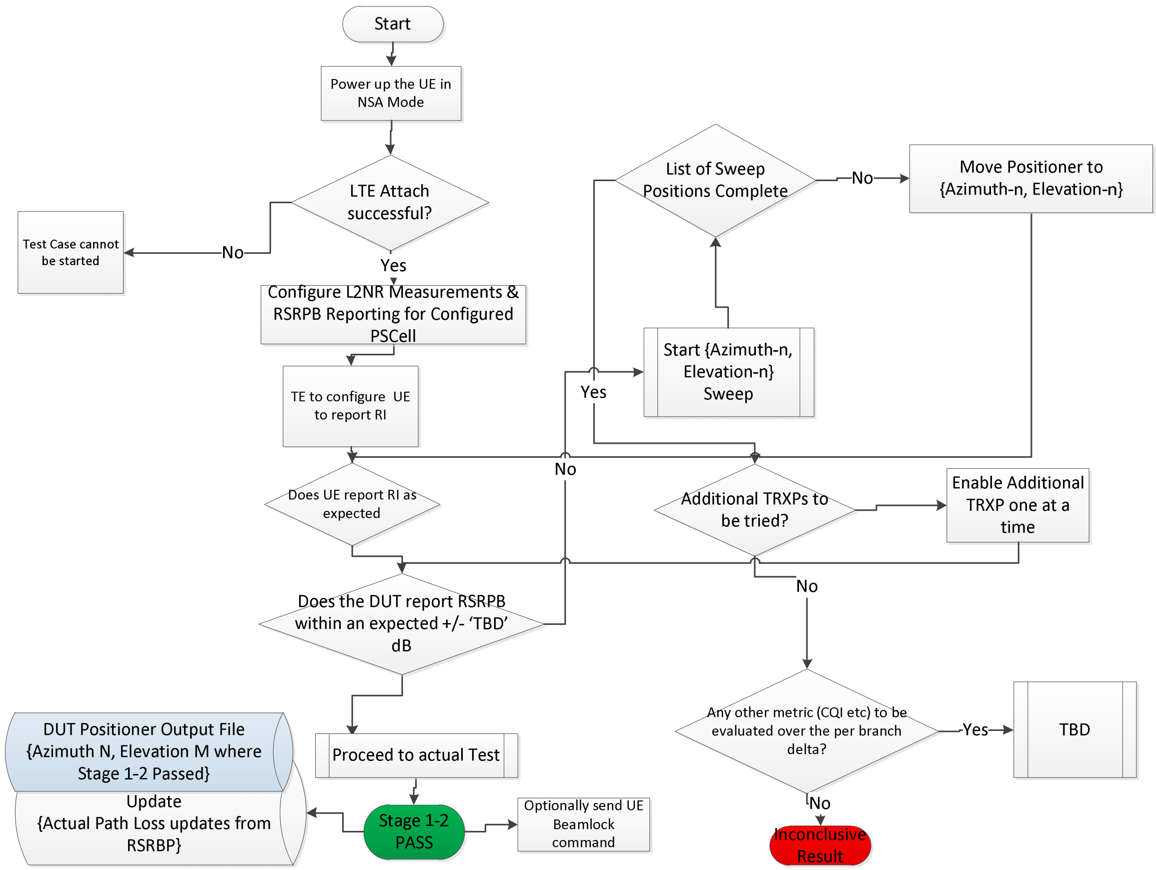

Figure Y-2: Flow Chart depicting Test Steps for Stage 1 & 2 in NSA Mode for Demod/RRM

Steps

1) Power-up the UE in NSA Mode, and let the LTE ATTACH go through.

2) TE now configures the DUT to report RSRPB for the configured NR PSCell.

3) TE also configures UE to report RI.

4) Check if RI is as expected and DUT reports RSRPB within an expected pre-defined tolerance limit +/- "x" dB.

5) If the reported RSRPB is not within this pre-defined tolerance limit or RI is not as expected, sweep the Azimuth and Elevation points {Azimuth, Elevation}, with the help of UE Positioner.

6) Stop the sweep once the DUT reports RSRPB within pre-defined tolerance limits and RI is as expected.

7) Stage 1 and Stage 2 have passed in NSA Mode, and Test can proceed to Stage 3, which is the actual Demod Test.

8) If list of sweep positions completed without the criteria for RSRPB or RI report being met, optionally use additional TRxP to do step 2 to 7.

9) Any other metric to check is FFS.

10) Optionally the best DUT position along with the Azimuth and Elevation, and the RSRPB or any other metrics is stored in an output file, and the calibration file is also updated.

Stage 1 in SA Mode:

The below flow chart details the steps for Stage 1 in SA Mode for Demod Tests, and possibly applicable to RRM.

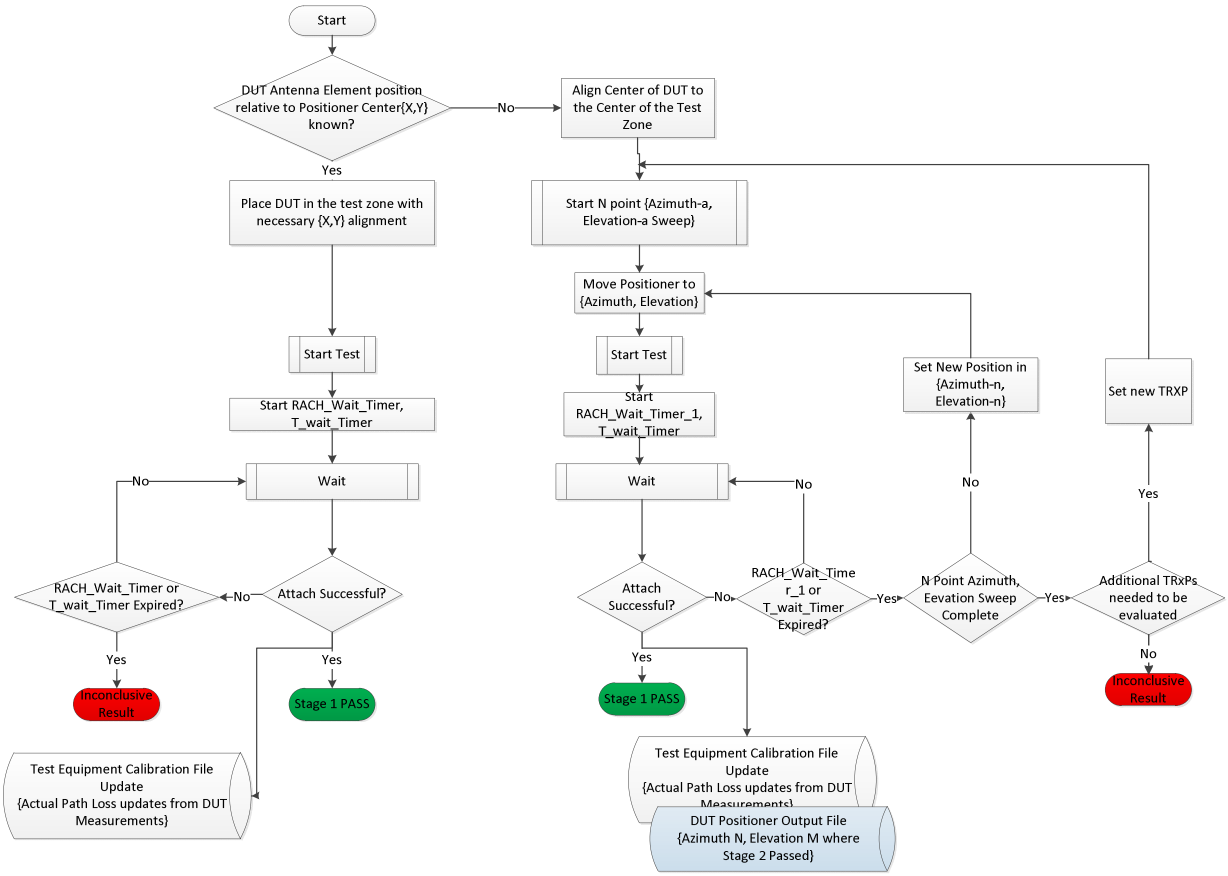

Figure Y-3: Flow Chart depicting Test Steps for Stage1 in SA Mode for Demod/RRM

Steps

1) If the DUT Antenna Panel exact position is known, then place it in the center of Test Zone/Quiet Zone in a perfect alignment forming a boresight with the active TRxP.

2) Else, align the geometric center of the DUT to the center of the quiet zone.

3) If this position is not known, iteratively sweep the Azimuth and Elevation points {Azimuth, Elevation}, with the help of UE Positioner.

4) For each Azimuth and Elevation point, TE waits for the DUT to RACH, indicating the DUT has found the best beam to RACH on to followed by ATTACH procedure, indicating Stage 1 has passed.

5) The wait for RACH and eventual ATTACH is tried until a certain timer expires.

6) If the timer expires and ATTACH is unsuccessful,

   a) Go to next Azimuth and Elevation and repeat the steps 3-4.

   b) Else optionally evaluate using additional TRxP.

   c) If ATTACH still not completed, declare the test inconclusive.

7) If the Test Passes, optionally the Test Equipment Calibration File is updated with the Azimuth and Elevation values where the DUT successfully ATTACHED, and the path loss is also updated, if known.

Stage 2 in SA Mode

The below flow chart details the steps for Stage 2 in SA Mode for demodulation tests, and possibly applicable to RRM.

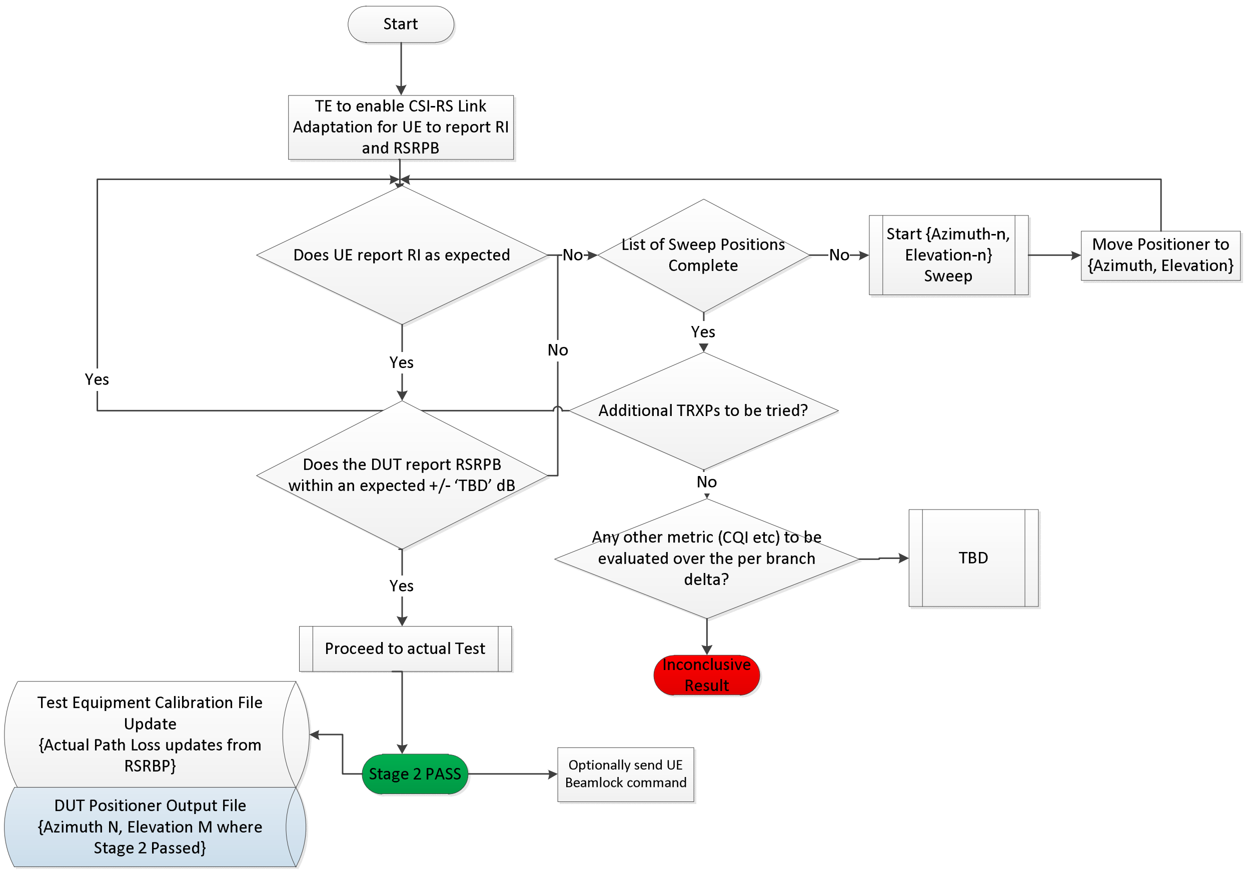

Figure Y-4: Flow Chart depicting Test Steps for Stage 2 in SA Mode for Demod/RRM

Steps

1) Keeping the DUT in the same position in which it passed the Stage 1,

2) TE configures the DUT to report RI and RSRPB.

3) Check if RI reported is as expected and the DUT reports RSRPB within a pre-defined tolerance limit of +/- "x" dB.

4) If the reported RSRPB is not within this pre-defined tolerance limit or RI is not as expected, sweep the Azimuth and Elevation points {Azimuth, Elevation}, with the help of UE Positioner.

5) Stop the sweep once the DUT reports RSRPB within pre-defined tolerance limits and RI is as expected.

6) Stage 2 has now passed and test can proceed to Stage 3, which is the actual Demod Test.

7) If list of sweep positions completed without RSRPB or RI report as expected, optionally use additional TRxP to do step 2 to 5.

8) Any other metric to check is FFS.

9) Optionally the best DUT position along with the Azimuth and Elevation, and the RSRPB or any other metric is stored in an output file, and the calibration file is also updated.

Annex I (informative): Change history

Change history							
Date	**Meeting**	**Tdoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2018-01		R5-180064				Skeleton for NR Demod spec	0.0.1
2018-04-13		R5-182036				Added the test procedure for FR2 Demod testing in Annex	0.1.0
2018-10-12		R5-185903				Added the demod spec test case section titles to be in line with RAN4 approved skeleton for 38.101-4	0.1.1
2018-11-20	RAN5 #81	R5-188006				new TC for PDSCH FR1 demod	0.2.0
2018-11-20	RAN5 #81	R5-188008				new TC for PDSCH FR2 demod	0.2.0
2018-11-20	RAN5 #81	R5-187573				section 3 of 38.521-4 spec	0.2.0
2018-11-20	RAN5 #81	R5-187845				section 4 of 38.521-4 spec	0.2.0
2018-11-20	RAN5 #81	R5-188009				pCR for new TC addition for FR1 FDD PDSCH Demod	0.2.0
2018-11-20	RAN5 #81	R5-188010				pCR for new TC addition for FR1 FDD PDCCH Demod	0.2.0
2019-01-25	RAN5 5G-NR AH#4	R5-190054				update to 2Rx TDD FR1 PDSCH mapping Type A performance test case	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190926				pCR for new TC addition for FR1 4Rx FDD PDSCH Demodulation performance (2x4)	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190927				pCR for new TC addition for FR1 4Rx FDD PDSCH Demodulation performance (4x4)	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190928				pCR for new TC addition for FR1 4Rx FDD PDSCH Demodulation performance with enhanced receiver type X (4x4)	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190291				Updated to Annex A Measurement Channels for Performance tests	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190292				Updated to Annex B Propagation conditions for Performance tests	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190458				update to 2Rx TDD FR2 PDSCH mapping Type A performance test case	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190461				2Rx TDD FR2 PDCCH performance test case	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190929				LTE link setup details for demod test cases	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190930				Annex for statistical tput calculation for demod test cases	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190931				pCR for TC addition of FR1 TDD 4Rx PDSCH	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190932				pCR for modification of FDD 2Rx FR1 PDSCH Demod	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190933				Annex for DL and UL Signal Setup	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190934				pCR for modification of FDD FR1 PDCCH Demod	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190935				PDSCH and PDCCH Config before measurement	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190986				38.521-4 Common Section updates to clarify leverage across architecture options	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190552				Addition of 2Rx TDD FR1 Single PMI tests for both SA and NSA	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190553				Addition of 2Rx TDD FR1 RI reporting for both SA and NSA	0.3.0
2019-03-01	RAN5 #82	R5-191183				Adding relevant references to 38.521-4	0.4.0
2019-03-01	RAN5 #82	R5-192461				Adding of test case 6.2.2.1.2.1.2, Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192672				Introduction of New test case 5.3.2.2.1 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192463				Introduction of New test case 5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192462				Introduction of New test case 5.3.3.1.1 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192464				Introduction of New test case 5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192465				Introduction of New test case 5.3.3.2.1 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192465				Introduction of New test case 5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192474				Introduction of TS 38.521-4 test case 6.3.2.1.1	0.4.0
2019-03-01	RAN5 #82	R5-192475				Introduction of TS 38.521-4 test case 6.3.2.1.2	0.4.0
2019-03-01	RAN5 #82	R5-192467				Introduction of test case 5.2.2.1.2_1, 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192840				Demod spec section 4 update	0.4.0

2019-03-01	RAN5 #82	R5-192673				Update to TDD FR1 2Rx PDSCH Type A test case	0.4.0
2019-03-01	RAN5 #82	R5-192103				addition of 2Rx TDD FR1 periodic CQI reporting test case	0.4.0
2019-03-01	RAN5 #82	R5-192468				pCR for addition of 2Rx TDD FR1 TypeA and CSI-RS overlapped TC	0.4.0
2019-03-01	RAN5 #82	R5-192866				pCR for modification of PDSCH and PDCCH Config before measurement	0.4.0
2019-03-01	RAN5 #82	R5-192470				pCR for modification of FDD FR1 PDCCH Demod	0.4.0
2019-03-01	RAN5 #82	R5-192471				pCR for modification of FDD 2Rx FR1 PDSCH Demod	0.4.0
2019-03-01	RAN5 #82	R5-192472				Update to 2Rx TDD FR1 RI reporting for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192460				Minimum test time update for FR1 Demod test case	0.4.0
2019-03-01	RAN5 #82	R5-192473				Addition of Annex F for Demod spec	0.4.0
2019-03	RAN#83	RP-190222	-	-	-	Presented to the RAN#83 plenary for 1-step approval	1.0.0
2019-03	RAN#83	-	-	-	-	raised to v15.0.0 with editorial changes only	15.0.0
2019-06	RAN5#83	R5-193544	0030	-	F	Updates to test case 6.2.2.1.2.1, 2Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-193943	0035	-	F	Adding test case 6.2.2.2.2.2, 2Rx TDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194159	0048	-	F	Alignment of Annex C with core specification	15.1.0
2019-06	RAN5#83	R5-194466	0056	-	F	Introduction of FR1 CQI test case 6.2.2.2.2.1	15.1.0
2019-06	RAN5#83	R5-194622	0057	-	F	Corrections TDD UL-DL configurations	15.1.0
2019-06	RAN5#83	R5-194680	0066	-	F	Demod section 5 general update	15.1.0
2019-06	RAN5#83	R5-194689	0073	-	F	Addition of text for FR1 PBCH demodulation test case	15.1.0
2019-06	RAN5#83	R5-194690	0074	-	F	Update to 2Rx TDD FR2 PDSCH Type A test case	15.1.0
2019-06	RAN5#83	R5-194691	0075	-	F	Update to FR2 PDCCH config param	15.1.0
2019-06	RAN5#83	R5-194692	0076	-	F	Addition of text for FR2 PBCH demodulation test case	15.1.0
2019-06	RAN5#83	R5-194693	0077	-	F	Update to section 8 CSI reporting	15.1.0
2019-06	RAN5#83	R5-194979	0063	1	F	Further updates to 2Rx TDD FR1 PDSCH mapping Type A test case	15.1.0
2019-06	RAN5#83	R5-194980	0032	1	F	Introduction of TC 6.4.3.2_1 4Rx TDD FR1 RI reporting for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194981	0034	1	F	Adding test case 6.2.2.1.2.2, 2Rx FDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194982	0053	1	F	Update to 4Rx FDD FR1 PDSCH mapping Type A performance 4x4 MIMO with baseline Rx	15.1.0
2019-06	RAN5#83	R5-194983	0054	1	F	Update to 4Rx FDD FR1 PDSCH mapping Type A performance 4x4 MIMO with enhanced Rx	15.1.0
2019-06	RAN5#83	R5-194984	0037	1	F	Editorial changes to TS 38.521-4 test case 6.3.2.1.2	15.1.0
2019-06	RAN5#83	R5-194985	0038	1	F	Introduction to TS 38.521-4 test case 6.3.3.1.1	15.1.0
2019-06	RAN5#83	R5-194986	0039	1	F	Introduction to TS 38.521-4 test case 6.3.3.1.2	15.1.0
2019-06	RAN5#83	R5-194987	0040	1	F	Introduction to TS 38.521-4 test case 6.3.3.2.1	15.1.0
2019-06	RAN5#83	R5-194988	0041	1	F	Introduction to TS 38.521-4 test case 6.3.3.2.2	15.1.0
2019-06	RAN5#83	R5-194989	0059	1	F	Modification of 2Rx FDD FR1 PDSCH mapping Type A performance - enhanced Rx	15.1.0
2019-06	RAN5#83	R5-194990	0060	1	F	Modification of 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - baseline Rx	15.1.0
2019-06	RAN5#83	R5-194991	0061	1	F	Modification of 2Rx FDD FR1 PDCCH 1 Tx	15.1.0
2019-06	RAN5#83	R5-194992	0062	1	F	Modification of 2Rx FDD FR1 PDCCH 2 Tx	15.1.0
2019-06	RAN5#83	R5-194993	0042	1	F	Update to test case 5.3.2.2.1 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194994	0043	1	F	Update to test case 5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194995	0044	1	F	Update to test case 5.3.3.1.1 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194996	0045	1	F	Update to test case 5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194997	0046	1	F	Update to test case 5.3.3.2.1 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194998	0047	1	F	Update to test case 5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194999	0055	1	F	Update to FR1 demod test case 5.2.2.1.2_1	15.1.0
2019-06	RAN5#83	R5-195000	0078	1	F	Update to RI Reporting Accuracy test	15.1.0
2019-06	RAN5#83	R5-195001	0049	1	F	Updated to Annexes for performance tests	15.1.0
2019-06	RAN5#83	R5-195002	0068	1	F	Demod section 2-4 update	15.1.0
2019-06	RAN5#83	R5-195003	0058	1	F	Modification of 2Rx FDD FR1 PDSCH mapping Type A performance - baseline Rx	15.1.0
2019-06	RAN5#83	R5-195088	0029	1	F	Editorial Aligning CSI common test parameters with core specification	15.1.0
2019-06	RAN5#83	R5-195089	0031	1	F	Updating of E-UTRA test frequency for DEMOD test cases	15.1.0
2019-06	RAN5#83	R5-195098	0079	-	F	Performance implementation of FR2 UL demod OTA tests using single pol Rx TE	15.1.0

2019-06	RAN5#83	R5-195170	0052	1	F	Update to 4Rx FDD FR1 PDSCH mapping Type A performance 2x4 MIMO with baseline Rx	15.1.0
2019-06	RAN5#83	R5-195171	0033	1	F	Introducing MU and TT clauses in annex F for Channel State Information reporting test cases	15.1.0
2019-06	RAN5#83	R5-195172	0069	1	F	Annex update for PDSCH PDCCH minimum test time	15.1.0
2019-06	RAN5#83	R5-195413	0067	1	F	Update to section 9 and 10 of Demod spec	15.1.0
2019-06	RAN5#83	R5-195438	0050	2	F	Introducing 5.2.2.1.4_1 2Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance	15.1.0
2019-06	RAN5#83	R5-195439	0051	2	F	Introducing 5.2.3.1.4_1 4Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance	15.1.0
2019-06	RAN5#83	R5-195440	0064	1	F	Addition of new test case for 2Rx FDD FR1 periodic CQI reporting under AWGN	15.1.0
2019-06	RAN5#83	R5-195441	0065	1	F	Update to 2Rx TDD FR1 periodic CQI reporting under AWGN	15.1.0
2019-06	RAN5#83	R5-195442	0070	1	F	Addition of SDR test case for single carrier in SA mode	15.1.0
2019-06	RAN5#83	R5-195443	0072	1	F	Addition of FR1 SDR test case for CA in NSA mode	15.1.0

History

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