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Contents

Foreword

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z the third digit is incremented when editorial only changes have been incorporated in the document.

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*.

Editor's note: intended to capture more references

[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”

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.

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.

3.2 Symbols

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

Editor's note: intended to capture symbols to be used in this spec

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].

Editor's note: intended to capture abbreviations to be used in this spec.

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.

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

4.4.1 Conducted requirement reference point

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

4.4.2 SNR definition

UE demodulation and CSI requirements define the SNR as:

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

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

The above SNR definition assumes that the REs are not precoded, and does not account for any gain which can be associated to the precoding operation.

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

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

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

4.4.3 Noc

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

4.5 Radiated requirements

4.5.1 Radiated requirement reference point

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

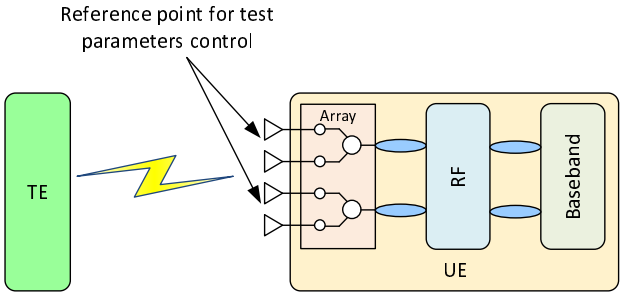

Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements

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

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

4.5.2 SNR definition

UE demodulation and CSI requirements define the SNR as:

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

N_{RX} denotes the number of receiver reference points, and the super script receiver reference point j.

The above SNR definition assumes that the REs are not precoded, and does not account for any gain which can be associated to the precoding operation.

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

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

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

4.5.3 Noc

4.5.3.1 Introduction

For radiated testing of demodulation and CSI requirements it is not feasible in practice to use signal levels high enough to make the noise contribution of the UE negligible. Demodulation requirements are therefore specified with the applied noise higher than the UE peak EIS level in TS 38.101-2 [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				

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

4.5.3.3 Derivation of Noc values for NR operating bands in FR2

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

$$\text{Spectral density of Noc} = \text{Refsens}_{\text{PC3, n260, 50MHz}} - 10\text{Log}_{10}(\text{SCS}_{\text{Refsens}} \times \text{PRB}_{\text{Refsens}} \times 12) - \text{SNR}_{\text{Refsens}} + \Delta_{\text{thermal}}$$

where:

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

$\text{SCS}_{\text{Refsens}}$ is a subcarrier spacing associated with N_{RB} for 50MHz in TS 38.101-2 [3, Table 5.3.2-1], chosen as 120kHz.

$\text{PRBs}_{\text{Refsens}}$ 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

$\text{SNR}_{\text{Refsens}}$ is the SNR used for simulation of Refsens, and is -1dB

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

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

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

$$\text{Noc(PC\_X, Band\_Y)} = -155 \text{ dBm/Hz} + \text{Refsens}_{\text{PC\_X, Band\_Y, 50MHz}} - \text{Refsens}_{\text{PC3, n260, 50MHz}} + \Sigma MB_P$$

where Refsens and $+ \Sigma MB_P$ 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

5.2 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
DL BWP configuration #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
	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 PDCCH candidates and aggregation levels		TBD
	DCI format		TBD
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
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
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
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
PTRS configuration			PTRS is not configured
Maximum number of code block groups for ACK/NACK feedback			1
Maximum number of HARQ transmission			4
Redundancy version coding sequence			{0,2,3,1}
Precoding configuration			SP Type I, Random per slot with PRB bundling granularity

Parameter	Unit	Value
Symbols for all unused Res		OCNG Annex A.5

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, 2-3]
[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.]	[2-2]

Table 5.2.2.1.1.0-2: Test Parameters for Testing

Parameter		Unit	Value
Channel bandwidth		**MHz**	**20 for Test 2-3 10 for other tests**
Duplex mode			**FDD**
Active DL BWP index			**1**
DL BWP configuration #1	First PRB		0
	Number of contiguous PRB	PRBs	51 for Test 2-3 52 for other tests
	Subcarrier spacing	kHz	30 for Test 2-3 15 for other tests
PDCCH configuration	Number of PRBs in CORESET	PRBs	48
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, [2-1] [4 for other tests]
K1 value (PDSCH-to-HARQ-timing-indicator)			TBD

Table 5.2.2.1.1.0-3: Minimum performance for Rank 1

Test num.	Reference channel	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	QPSK, 0.30	TDLB100-400	2x2, ULA Low	70	[-0.9]
1-2	R.PDSCH.1-1.2 FDD	QPSK, 0.30	TDLC300-100	2x2, ULA Low	70	[0.5]
1-3	R.PDSCH.1-4.1 FDD	256QAM, 0.82	TDLA30-10	2x2, ULA Low	70	[24.5]
1-4	R.PDSCH.1-2.1 FDD	16QAM, 0.48	TDLC300-100	2x2, ULA Low	30	[1.3]

Table 5.2.2.1.1.0-4: Minimum performance 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	TBD
2-2	R.PDSCH.1-2.2 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Medium	70	[17.5]
2-3	R.PDSCH.2-1.1 FDD	64QAM, 0.51	TDLA30-10	2x2, ULA Low	70	TBD

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

- Following are pending RAN4 core spec update

-SNR in [].

- 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 contents are TBD
- TCI State/QCL Info is TBD
- Connection diagram is 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 [TBD].

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 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, 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 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_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 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 5.2.2.1.1_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 xx: message exceptions for SA

FFS

5.2.2.1.1_1.3.3_2 Message exceptions for NSA

Table yy: message exceptions for NSA

FFS

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	[-0.9]+TT
1-2	R.PDSCH.1-1.2 FDD	QPSK, 0.30	TDLC300-100	2x2, ULA Low	70	[0.5]+TT
1-3	R.PDSCH.1-4.1 FDD	256AM, 0.82	TDLA30-10	2x2, ULA Low	70	[24.5]+TT
1-4	R.PDSCH.1-2.1 FDD	16QAM, 0.48	TDLC300-100	2x2, ULA Low	30	[1.3]+TT

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	[TBD] + TT
2-3	R.PDSCH.2-1.1 FDD	64QAM, 0.51	TDLA30-10	2x2, ULA Low	70	[TBD] + TT

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 1 and 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	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
2-2	R.PDSCH.1-2.2 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Medium	70	[17.5] + TT

5.2.2.2 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
Channel bandwidth		MHz	10
Duplex mode			FDD
Active DL BWP index			1
DL BWP configuration #1	First PRB		0
	Number of contiguous PRB	PRBs	52
	Subcarrier spacing	kHz	15
PDCCH configuration	Number of PRBs in CORESET	PRBs	48
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)			TBD

Table 5.2.2.1.2.0-3: Minimum performance 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)
1-1	R.PDSCH.1-5.1 FDD	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	[14.7]

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

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

- Following are pending RAN4 core spec update
  - -HARQ timing is TBD in test parameters table
  - -SNR in min requirements table is within brackets.
- Annex for measurement uncertainty and test tolerance is TBD
- Minimum test time is TBD
- Test tolerance analysis is missing
- Message contents are TBD
- TCI State/QCL Info is TBD
- Connection diagram is TBD

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 TBD.

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 source to the UE antenna connectors as shown in TS 38.508-1 [6] Annex A, in Figure TBD for TE diagram and section TBD 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 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.

5.2.2.1.2_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

Table xx: message exceptions for SA

FFS

5.2.2.1.2_1.3.3_2 Message exceptions for NSA

Table yy: message exceptions for NSA

FFS

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	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	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	[14.7]+TT

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, 2-1]
[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.]	[2-2]

Table 5.2.2.2.1.0-2: Test parameters

Parameter		Unit	Value
Channel bandwidth		MHz	20 for Test 2-3 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 2-3 106 for other tests
	Subcarrier spacing	kHz	30
PDCCH configuration	Number of PRBs in CORESET	PRBs	48 for Test 2-3 102 for other tests
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, [2-1] 8 for other tests
K1 value (PDSCH-to-HARQ-timing-indicator)			Specific to each UL-DL pattern

Table 5.2.2.2.1.0-3: 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	2x2, ULA Low	70	[-0.9]
1-2	R.PDSCH.2-1.2 TDD	QPSK, 0.30	FR1.30-1	TDLC300-100	2x2, ULA Low	70	[0.3]
1-3	R.PDSCH.2-4.1 TDD	256QAM, 0.82	FR1.30-1	TDLA30-10	2x2, ULA Low	70	TBD
1-4	R.PDSCH.2-2.1 TDD	16QAM, 0.48	FR1.30-1	TDLC300-100	2x2, ULA Low	30	[1.5]
1-5	[R.PDSCH.2-5.1 TDD]	QPSK, 0.3	FR1.30-2	TDLA30-10	2x2, ULA Low	70	[-0.9]
1-6	[R.PDSCH.2-6.1 TDD]	QPSK, 0.30	FR1.30-3	TDLA30-10	2x2, ULA Low	70	[-0.9]

Table 5.2.2.2.1.0-4: 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	2x2, ULA Low	70	TBD
2-2	R.PDSCH.2-2.2 TDD	16QAM, 0.48	FR1.30-1	TDLA30-10	2x2, ULA Medium	70	[18.0]
2-3	R.PDSCH.2-3.2 TDD	64QAM, 0.51	FR1.30-1	TDLA30-10	2x2, ULA Low	70	[19.2]

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

Editor's Note: This clause is incomplete. The following aspects are either missing or not yet determined:

- Following are pending RAN4 core spec update

  -SNR requirements table is TBD for few test id and in [] for rest of the test id.

- minimum test time is in [].

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: ServingCellConfigCommon

Derivation Path: TS 38.331 [6], clause 6.3.2		
Information Element	**Value/remark**	**Comment**
ServingCellConfigCommon ::= SEQUENCE {		
ssb-PositionsInBurst CHOICE {		
shortBitmap	0100	
}		
}		

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	72	S=2, L=6	
}			
}			

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 {			
dataScramblingIdentityPDSCH	0		
dmrs-DownlinkForPDSCH-MappingTypeA CHOICE {			
setup	DMRS-DownlinkConfig		
}			
vrb-ToPRB-Interleaver	Not present		
resourceAllocation	resourceAllocationType0		
pdsch-AggregationFactor	Not present		
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	
}			
}			
zp-CSI-RS-ResourceToAddModList			
zp-CSI-RS-ResourceToReleaseList			
aperiodic-ZP-CSI-RS-ResourceSetsToAddModList			
aperiodic-ZP-CSI-RS-ResourceSetsToReleaseList			
sp-ZP-CSI-RS-ResourceSetsToAddModList			
sp-ZP-CSI-RS-ResourceSetsToReleaseList			
p-ZP-CSI-RS-ResourceSet			
}			

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-Type	Not present		
dmrs-AdditionalPosition	pos1	For all tests except test 1-1	
	pos2	For test 1-1	
maxLength	len1		
phaseTrackingRS	Not present		
}			

Table 5.2.2.2.1_1.3.3_1-4: 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

Table 5.2.2.2.1_1.3.3_2-1: ServingCellConfigCommon

Derivation Path: TS 38.331 [6], clause 6.3.2		
Information Element	**Value/remark**	**Comment**
ServingCellConfigCommon ::= SEQUENCE {		
ssb-PositionsInBurst CHOICE {		
shortBitmap	0100	
}		
}		

Table 5.2.2.2.1_1.3.3_2-2: 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	72	S=2, L=6	
}			
}			

Table 5.2.2.2.1_1.3.3_2-3: *PDSCH-Config*

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
PDSCH-Config ::= SEQUENCE {			
dataScramblingIdentityPDSCH	0		
dmrs-DownlinkForPDSCH-MappingTypeA CHOICE {			
setup	DMRS-DownlinkConfig		
}			
vrb-ToPRB-Interleaver	Not present		
resourceAllocation	resourceAllocationType0		
pdsch-AggregationFactor	Not present		
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	
}			
}			
zp-CSI-RS-ResourceToAddModList			
zp-CSI-RS-ResourceToReleaseList			
aperiodic-ZP-CSI-RS-ResourceSetsToAddModList			
aperiodic-ZP-CSI-RS-ResourceSetsToReleaseList			
sp-ZP-CSI-RS-ResourceSetsToAddModList			
sp-ZP-CSI-RS-ResourceSetsToReleaseList			
p-ZP-CSI-RS-ResourceSet			
}			

Table 5.2.2.2.1_1.3.3_2-4: DMRS-DownlinkConfig

Derivation Path: TS 38.331 [6], clause 6.3.2			
Information Element	**Value/remark**	**Comment**	**Condition**
DMRS-DownlinkConfig ::= SEQUENCE {			
dmrs-Type	Not present		
dmrs-AdditionalPosition	pos1	For all tests except test 1-1	
	pos2	For test 1-1	
maxLength	len1		
phaseTrackingRS	Not present		
}			

Table 5.2.2.2.1_1.3.3_2-4: 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_1.4 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	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	2x2, ULA Low	70	[-0.9] + TT
1-2	R.PDSCH.2-1.2 TDD	QPSK, 0.30	FR1.30-1	TDLC300-100	2x2, ULA Low	70	[0.3] + TT
1-3	R.PDSCH.2-4.1 TDD	256QAM, 0.82	FR1.30-1	TDLA30-10	2x2, ULA Low	70	TBD + TT
1-4	R.PDSCH.2-2.1 TDD	16QAM, 0.48	FR1.30-1	TDLC300-100	2x2, ULA Low	30	[1.5] + TT
1-5	[R.PDSCH.2-5.1 TDD]	QPSK, 0.3	FR1.30-2	TDLA30-10	2x2, ULA Low	70	[-0.9] + TT
1-6	[R.PDSCH.2-6.1 TDD]	QPSK, 0.30	FR1.30-3	TDLA30-10	2x2, ULA Low	70	[-0.9] + TT

Table 5.2.2.2.1_1.4-2: 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)
2-1	R.PDSCH.2-3.1 TDD	64QAM, 0.51	FR1.30-1	TDLA30-10	2x2, ULA Low	70	TBD + TT
2-3	R.PDSCH.2-3.2 TDD	64QAM, 0.51	FR1.30-1	TDLA30-10	2x2, ULA Low	70	[19.2] + TT

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

Editor's Note: This clause is incomplete. The following aspects are either missing or not yet determined:

- Following are pending RAN4 core spec update

  -SNR requirements are in []

- Minimum test time is in [].

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

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)
2-2	R.PDSCH.2-2.2 TDD	16QAM, 0.48	FR1.30-1	TDLA30-10	2x2, ULA Medium	70	[18.0] + TT

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

Editor's Note: This clause is incomplete. The following aspects are either missing or not yet determined:

-SNR requirements is TBD

-Annex for measurement uncertainty and test tolerance is TBD

-Connection diagram is TBD

-Propagation condition description in Annex is TBD

-Minimum test time is TBD

-Message contents are TBD

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
Channel bandwidth		MHz	40
Duplex mode			TDD
Active DL BWP index			1
DL BWP configuration #1	First PRB		0
	Number of contiguous PRB	PRBs	106
	Subcarrier spacing	kHz	30
PDCCH configuration	Number of PRBs in CORESET	PRBs	102
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	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	TBD

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 TBD for TE diagram and section TBD 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 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.

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 xx: message exceptions for SA

FFS

5.2.2.2.2_1.4.3_2 Message exceptions for NSA

Table yy: message exceptions for NSA

FFS

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	TBD + TT

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 and Table 5.2.3.1.1.0-6, 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.]	[3-2]

Table 5.2.3.1.1.0-2: Test parameters

Parameter		Unit	Value
Channel bandwidth		MHz	20 for Test 2-2 10 for other tests
Duplex mode			FDD
Active DL BWP index			1
DL BWP configuration #1	First PRB		0
	Number of contiguous PRB	PRBs	51 for Test 2-2 52 for other tests
	Subcarrier spacing	kHz	30 for Test 2-2 15 for other tests
PDCCH configuration	Number of PRBs in CORESET	PRBs	51 for Test 2-2 52 for other tests
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
	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, [2-1] 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	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	QPSK, 0.30	TDLB100-400	2x4, ULA Low	70	[-3.7]
1-2	R.PDSCH.1-1.2 FDD	QPSK, 0.30	TDLC300-100	2x4, ULA Low	70	[-2.7]
1-3	R.PDSCH.1-4.1 FDD	256QAM, 0.82	TDLA30-10	2x4, ULA Low	70	[21.0]
1-4	R.PDSCH.1-2.1 FDD	16QAM, 0.48	TDLC300-100	2x4, ULA Low	30	[-1.5]

Table 5.2.3.1.1.0-4: Minimum performance 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	2x4, ULA Low	70	[TBD]
2-2	R.PDSCH.2-1.1 FDD	64QAM, 0.51	TDLA30-10	2x4, ULA Low	70	TBD

Table 5.2.3.1.1.0-5: Minimum performance for Rank 3

Test num.	Reference channel	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	16QAM, 0.48	TDLA30-10	4x4, ULA Low	70	[10.9]
3-2	R.PDSCH.1-2.3 FDD	16QAM, 0.48	TDLA30-10	4x4, ULA Medium A	70	[22.2]

Table 5.2.3.1.1.0-6: Minimum performance for Rank 4

Test num.	Reference channel	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	16QAM, 0.48	TDLA30-10	4x4, ULA Low	70	[15.5]

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 baseline receiver for both SA and NSA

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

- Following are pending RAN4 core spec update
  - SNR requirements is TBD for few test id
  - 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
- Propagation condition description in Annex is TBD
- Message contents are TBD
- Minimum test time is TBD
- Connection diagram is TBD

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 [TBD].

Configurations of PDSCH and 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 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 [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 Tables 5.2-1 and 5.2.3.1.1.0-2 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 [TBD] 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 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 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 [TBD] clause 4.6.1.

5.2.3.1.1_1.3.3_1 Message exceptions for SA

FFS

5.2.3.1.1_1.3.3_2 Message exceptions for NSA

FFS

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 TBD 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	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	QPSK, 0.30	TDLB100-400	2x4, ULA Low	70	[-3.7]+TT
1-2	R.PDSCH.1-1.2 FDD	QPSK, 0.30	TDLC300-100	2x4, ULA Low	70	[-2.7]+TT
1-3	R.PDSCH.1-4.1 FDD	256QAM, 0.82	TDLA30-10	2x4, ULA Low	70	[21.0]+TT
1-4	R.PDSCH.1-2.1 FDD	16QAM, 0.48	TDLC300-100	2x4, ULA Low	30	[-1.5]+TT

Table 5.2.3.1.1_1.4-2: Test Requirement 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	2x4, ULA Low	70	[TBD]+TT
2-2	R.PDSCH.2-1.1 FDD	64QAM, 0.51	TDLA30-10	2x4, ULA Low	70	[TBD]+TT

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

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

- Following are pending RAN4 core spec update
  - SNR requirements are 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
- Propagation condition description in Annex is TBD
- Message contents are TBD
- Minimum test time is TBD
- Connection diagram is TBD

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

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 TBD 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	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	16QAM, 0.48	TDLA30-10	4x4, ULA Low	70	[10.9]+TT

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

Test num.	Reference channel	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	16QAM, 0.48	TDLA30-10	4x4, ULA Low	70	[15.5]+TT

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

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

- Following are pending RAN4 core spec update
  - SNR requirement 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
- Propagation condition description in Annex is TBD
- Message contents are TBD

- Minimum test time is TBD

- Connection diagram is TBD

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:

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 5.2.3.1.1.0-5 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 5.2.3.1.1_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

Test num.	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
3-2	R.PDSCH.1-2.3 FDD	16QAM, 0.48	TDLA30-10	4x4, ULA Medium A	70	[22.2]+TT

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 xx: message exceptions for SA

FFS

5.2.3.2.1_1.3.3_2 Message exceptions for NSA

Table yy: 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 xx: message exceptions for SA

FFS

5.2.3.2.1_2.3.3_2 Message exceptions for NSA

Table yy: 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 xx: message exceptions for SA

FFS

5.2.3.2.1_4.3.3_2 Message exceptions for NSA

Table yy: 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		TBD
	Number of PDCCH candidates		TBD
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
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

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

- Following are pending RAN4 core spec update

  -Many parameter TBD in test parameters table

  -Modulation format and SNR in min requirements table is TBD.

- Annex for measurement uncertainty and test tolerance 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

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	[8.2]
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	[5.7]
4	10 MHz	48	1	4	R.PDCCH.1-1.1 FDD	TDLA30-10	1x2 Low	1	[4.6]
5	10MHz	48	2	16	R.PDCCH.1-2.6 FDD	TDLA30-10	1x2 Low	1	TBD

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 [TBD].

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 TBD for TE diagram and clause TBD 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 [ ] 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.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 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 xx: message exceptions for SA

FFS

5.3.2.1.1.4.3.2 Message exceptions for NSA

Table yy: message exceptions for NSA

FFS

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	[8.2] + TT
2	10 MHz	24	2	2	R.PDCCH.1-2.3 FDD	TDLC300-100	1x2 Low	1	[8.1] + TT
3	10 MHz	48	2	4	R.PDCCH.1-2.4 FDD	TDLA30-10	1x2 Low	1	[5.7] + TT
4	10 MHz	48	1	4	R.PDCCH.1-1.1 FDD	TDLA30-10	1x2 Low	1	[4.6] + TT
5	10MHz	48	2	16	R.PDCCH.1-2.6 FDD	TDLA30-10	1x2 Low	1	TBD + TT

5.3.2.1.2 2Rx 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

-Many parameter TBD in test parameters table

-Test purpose table is missing the mapping between test purpose and test index.

- SNR in min requirements table is TBD.

- Annex for measurement uncertainty and test tolerance 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

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	[1.6]
2	10 MHz	48	2	8	R.PDCCH.1-2.5 FDD	TDLC300-100	2x2 Low	1	[-1.6]
3	10 MHz	48	1	8	R.PDCCH.1-1.3 FDD	TDLA30-10	2x2 Low	1	TBD

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 [TBD].

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 TBD for TE diagram and clause TBD 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 [TBD] 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.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 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 xx: message exceptions for SA

FFS

5.3.2.1.2.4.3.2 Message exceptions for NSA

Table yy: message exceptions for NSA

FFS

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	[1.6] + TT
2	10 MHz	48	2	8	R.PDCCH.1-2.5 FDD	TDLC300-100	2x2 Low	1	[-1.6] + TT
3	10 MHz	48	1	8	R.PDCCH.1-1.3 FDD	TDLA30-10	2x2 Low	1	[TBD] + TT

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 TBD.
- Annex for measurement uncertainty and test tolerance is TBD

- Annex for statistical tput calculation is TBD

- Message contents are TBD

- TCI State/QCL Info is TBD

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	[7.0]
2	40 MHz	102	1	4	R.PDCCH.2-1.2 TDD	TDLC300-100	1x2 Low	1	[3.2]
3	40 MHz	48	2	16	R.PDCCH.2-2.1 TDD	TDLC300-100	1x2 Low	1	[-4.5]

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 [TBD].

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.3.1.6.1 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 5.3.2.2.1.3-1 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 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 A.3.3.2.2-1 and Table A.3.3.2.2-2. 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.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 5.3.2.2.1.5-1, 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

FFS

5.3.2.2.1.4.3.2 Message exceptions for NSA

FFS

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	TDLA30-10	1x2 Low	1	[7.0]+TT
2	40 MHz	102	1	4	R.PDCCH. 2-1.2 TDD	TDLC300 - 100	1x2 Low	1	[3.2]+TT
3	40 MHz	48	2	16	R.PDCCH. 2-2.1 TDD	TDLC300 - 100	1x2 Low	1	[-4.5]+TT

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 TBD.
- Annex for measurement uncertainty and test tolerance is TBD
- Annex for statistical tput calculation is TBD
- Message contents are TBD
- TCI State/QCL Info is TBD

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	TBD

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 [TBD].

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 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 A.3.3.2.2-1. 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 5.3.2.2.2.3-1 as appropriate.

3. Measure the Pm-dsg for a duration sufficient to achieve statistical significance according to Annex G clause [G.1.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 5.3.2.2.2.5-1, 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

FFS

5.3.2.2.2.4.3.2 Message exceptions for NSA

FFS

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	TBD+TT

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 TBD.
- Annex for measurement uncertainty and test tolerance is TBD
- Annex for statistical tput calculation is TBD
- Message contents are TBD
- TCI State/QCL Info is TBD
- Connection diagram is TBD

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	[2.1]
2	10 MHz	24	2	2	R.PDCCH.1-2.3 FDD	TDLC300-100	1x4 Low	1	[2.3]
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	TBD

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 [TBD].

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 TBD for TE diagram and section TBD 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 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 A.3.3.1.1-1 and Table A.3.3.1.1-2. 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.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 5.3.3.1.1.5-1, 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

FFS

5.3.3.1.1.4.3.2 Message exceptions for NSA

FFS

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	[2.1]+TT
2	10 MHz	24	2	2	R.PDCCH.1-2.3 FDD	TDLC300-100	1x4 Low	1	[2.3]+TT
3	10 MHz	48	2	4	R.PDCCH.1-2.4 FDD	TDLA30-10	1x4 Low	1	[0.0]+TT
4	10 MHz	48	1	4	R.PDCCH.1-1.1 FDD	TDLA30-10	1x4 Low	1	TBD+TT

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 TBD.
- Annex for measurement uncertainty and test tolerance is TBD
- Annex for statistical tput calculation is TBD
- Message contents are TBD
- TCI State/QCL Info is TBD
- Connection diagram is TBD

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	[-4.9]
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 [TBD].

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 TBD for TE diagram and section TBD 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 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 A.3.3.1.1-1 and Table A.3.3.1.1-2. 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

FFS

5.3.3.1.2.4.3.2 Message exceptions for NSA

FFS

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+TT
2	10 MHz	48	2	8	R.PDCCH.1-2.5 FDD	TDLC300-100	2x4 Low	1	[-4.9]+TT
3	10 MHz	48	1	4	R.PDCCH.1-1.3 FDD	TDLA30-10	2x4 Low	1	TBD+TT

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
  - Many parameter TBD in test parameters table
  - Minimum requirements table is TBD
  - PDCCH table is TBD
- Annex for measurement uncertainty and test tolerance is TBD
- Annex for statistical tput calculation is TBD
- Message contents are TBD
- TCI State/QCL Info is TBD
- Connection diagram 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)

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 [TBD].

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 TBD for TE diagram and section TBD 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 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 [A.3.3.2.2-]. 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

FFS

5.3.3.2.1.4.3.2 Message exceptions for NSA

FFS

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)

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
  - PDCCH table is TBD
- Annex for measurement uncertainty and test tolerance is TBD
- Annex for statistical tput calculation is TBD
- Message contents are TBD
- TCI State/QCL Info is TBD
- Connection diagram 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	TBD

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 [TBD].

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 TBD for TE diagram and section TBD 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 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 [A.3.3.2.2-]. 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

FFS

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	TBD+TT

5.4 PBCH demodulation requirements

5.4.1 1RX requirements (Void)

5.4.2 2RX requirements

5.4.2.1 FDD

5.4.2.2 TDD

5.5 Sustained downlink data rate provided by lower layers

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		TBD
	DCI format		TBD
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		TBD
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
Number of HARQ Processes			4 For FDD 8 for TDD
HARQ ACK/NACK bundling			TBD
Redundancy version coding sequence			{0,2,3,1}

K1 value (PDSCH-to-HARQ-timing-indicator)		2 for FDD TBD for TDD
Symbols for unused Res		OCNG as specified in A.5

6.2 Reporting of Channel Quality Indicator (CQI)

6.2.1 1RX requirements (Void)

6.2.2 2RX requirements

6.2.2.1 FDD

6.2.2.1.2 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

  -Many parameter TBD in test parameters 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 contents are TBD

- TCI State/QCL Info is TBD

- Connection diagram is TBD

- Test procedure is FFS

- Test requirement 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 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				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	N/A	
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				TBD	

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 TBD for TE diagram and section TBD 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

FFS

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 xx: message exceptions for SA

FFS

6.2.2.1.2.1.4.3_2 Message exceptions for NSA

Table yy: Message exceptions for NSA

FFS

6.2.2.1.2.1.5 Test requirement

FFS

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

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

- Minimum requirement for median CQI reporting is in []
- SNR for testing this requirement is in []
- Few parameters are also in []
- Message contents are FFS.
- Test procedure is FFS

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	
Duplex Mode				TDD	
TDD UL-DL pattern				FR1.30-1	
DL BWP configuration #1		First PRB		0	
		Number of contiguous PRB		106	
		Subcarrier spacing	kHz	30	
SNR			dB	[8] [9]	[14] [15]
Propagation channel				AWGN	
Antenna configuration				2×2 with static channel specified in Annex B.1	
Beamforming Model				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	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	N/A	
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				TBD	

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 [5] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 38.508-1 [5] 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 [5] 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 [5] 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

FFS

6.2.2.2.1.1.4.4 Message contents

Message contents are according to TS 38.508 [X] clause 4.6 with the following exceptions:

6.2.2.2.1.1.4.4_1 Message exceptions for SA

FFS

Table 6.2.2.2.1.1.4.4_1-1: Message exceptions for NSA

FFS

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.

6.2.3 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 TypeI

6.3.2.1.1_1 2Rx FDD FR1 Single PMI with 4Tx TypeI – 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 TypeI

6.3.2.1.2_1 2Rx FDD FR1 Single PMI with 8Tx TypeI – 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

6.3.2.1.2_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.

6.3.2.1.2_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.

6.3.2.1.2_1.3 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 6.3.2.1.2-1: Test parameters (dual-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 8 x 2 (N1,N2) = (4,1)
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*)		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-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			MCS13, 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 6.3.2.1.2-2: Minimum requirement

Parameter	Test 1
γ	TBD

6.3.2.1.2_1.4 Test description

6.3.2.1.2_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.

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_1.4.2 Test procedure

FFS

6.3.2.1.2_1.4.3 Message contents

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

6.3.2.1.2_1.4.3_1 Message exceptions for SA

FFS

6.3.2.1.2_1.4.3_2 Message exceptions for NSA

FFS

6.3.2.1.2_1.4.4 Test requirement

TBD

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

Parameter		Unit	Test 1
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
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

Parameter	Unit	Test 1
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

6.3.3.2 TDD

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

- Below items are TBD in RAN4 spec:
  - SNR and gamma ratio are currently TBD.
  - CodebookSubsetRestriction parameter setting is
- Annex G update for measuring throughput ratio

- Connection Diagram reference is FFS

- Message Contents are TBD

- Test Procedure needs to be refined further

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
Duplex Mode			TDD	TDD	TDD
TDD Slot Configuration			FR1.30-1	FR1.30-1	FR1.30-1
DL BWP configuration #1	First PRB		0	0	0
	Number of contiguous PRB		106	106	106
	Subcarrier spacing	kHz	30	30	30
SNR		dB	TBD	TBD	TBD
Propagation channel			TDLA30-5	TDLA30-5	TDLA30-5
Antenna configuration			ULA Low 2x2	ULA Low 2x2	ULA High 2x2
Beamforming Model			TBD	TBD	TBD
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
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		TBD	TBD	TBD
	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 [TBD] clause TBD.

Frequencies to be tested: Mid Range as defined in TS 38.508 [TBD] 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 [TBD] Annex A, in Figure TBD for TE diagram and section TBD 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, *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

7 Demodulation performance requirements (Radiated requirements)

7.1 General

7.2 PDSCH demodulation requirements

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
TBD	TBD

Table 7.2.2.2.1_0-2: Test Parameters

Parameter		Unit	Value
Channel bandwidth		MHz	50 for 2-3 and 2-5, 200 for 2-4, 100 for other tests
Duplex mode			TDD
Active DL BWP index			1
DL BWP configuration #1	First PRB		0
	Number of contiguous PRB		32 for 2-3, 132 for 2-4, 66 for other tests
	Subcarrier spacing	kHz	120
PDCCH configuration	Number of PRBs in CORESET	PRBs	66
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		TBD
	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, 2-4 10 for Test 2-1, 2-3, 2-5, 2-6, 3-1 16 for Test 1-2 TBD for Test 2-2
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	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	TBD	QPSK, 0.30	FR2.120-1	TDLC60-300	2x2 ULA Low	70	[-0.5]
1-2	TBD	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	30	[1.6]
1-3	TBD	64QAM, 0.45	FR2.120-1	TDLA30-300	2x2 XPL Med-A	70	[TBD]

Table 7.2.2.2.1_0-4: Minimum performance for Rank 2 (FRC)

Test num.	Reference channel	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	TBD	QPSK, 0.30	FR2.120-2	TDLA30-75	2x2 ULA Low	70	[TBD]
2-2	TBD	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	[TBD]
2-3	TBD	16QAM,0.48	FR2.120-2	TDLA30-75	2x2 ULA Low	70	[13.9]
2-4	TBD	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	[TBD]
2-5	TBD	16QAM, 0.48	FR2.60-1	TDLA30-75	2x2 ULA Low	70	[14.3]
2-6	TBD	64QAM, 0.43	FR2.120-2	TBD	2x2 ULA Low	70	[TBD]

Table 7.2.2.2.1_0-5: Minimum performance for Rank 2 (FRC) for Enhanced Type X Receiver

Test num.	Reference channel	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	TBD	16QAM, 0.48	FR2.120-2	TDLA30-75	2x2 ULA Med	70	[19.5]

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:

- Following are pending RAN4 core spec update
  - -Few parameter TBD in test parameters table
  - -Test purpose table is missing the mapping between test purpose and test index.
  - -SNR in min requirements table is TBD for few test id.
  - -RMC definitions is TBD
  - -Annex for measurement uncertainty and test tolerance is TBD
  - -Annex for DL and UL signal setup 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
- 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 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 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 or (EN-DC, DC bearer *MCG* and *SCG), Connected without release On) for NSA* according to TS 38.508-1 [5] 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 xx: message exceptions for SA

FFS

7.2.2.2.1_1.3.3_2 Message exceptions for NSA

Table yy: 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 TBD 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	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	TBD	QPSK, 0.30	FR2.120-1	TDLC60-300	2x2 ULA Low	70	[-0.5] + TT
1-2	TBD	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	30	[1.6] + TT
1-3	TBD	64QAM, 0.45	FR2.120-1	TDLA30-300	2x2 XPL Med-A	70	[TBD] + TT

Table 7.2.2.2.1_1.4-2: Test Requirement for Rank 2 (FRC)

Test num.	Reference channel	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	TBD	QPSK, 0.30	FR2.120-2	TDLA30-75	2x2 ULA Low	70	[TBD] + TT
2-2	TBD	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	[TBD] +TT
2-3	TBD	16QAM,0.48	FR2.120-2	TDLA30-75	2x2 ULA Low	70	[13.9] + TT
2-4	TBD	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	[TBD] + TT
2-5	TBD	16QAM, 0.48	FR2.60-1	TDLA30-75	2x2 ULA Low	70	[14.3] + TT
2-6	TBD	64QAM, 0.43	FR2.120-2	TBD	2x2 ULA Low	70	[TBD] + 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:

- Following are pending RAN4 core spec update

-Few parameter TBD in test parameters table

-Test purpose table is missing the mapping between test purpose and test index.

-SNR in min requirements table is in []

-RMC definitions is TBD

-Annex for measurement uncertainty and test tolerance is TBD

-Annex for DL and UL signal setup 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

7.2.2.2.1_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	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	TBD	16QAM, 0.48	FR2.120-2	TDLA30-75	2x2 ULA Med	70	[19.5]

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		TBD
	Number of PDCCH candidates		TBD
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
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

7.3.1 1RX requirements

TBD

7.3.2 2RX requirements

7.3.2.1 FDD

TBD

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:

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

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	TBD
1-2	100 MHz	60	1	4 CCE	R.PDCCH. 5-1.2 TDD	TDLA30-300	1x2 Low	1	TBD

The normative reference for this requirement is TS 38.101-4 [TBD] 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 xx: message exceptions for SA

FFS

7.3.2.2.1.4.3.2 Message exceptions for NSA

Table yy: 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

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	TBD + TT
1-2	100 MHz	60	1	4 CCE	R.PDCCH. 5-1.2 TDD	TDLA30-300	1x2 Low	1	TBD + 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:

- 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

- 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

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	[-0.3]
2-2	100 MHz	60	2	16 CCE	R.PDCCH. 5-2.1 TDD	TDLA30-75	2x2 Low	1	[-3.6]

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 xx: message exceptions for SA

FFS

7.3.2.2.2.4.3.2 Message exceptions for NSA

Table yy: 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	[-0.3] + TT
2-2	100 MHz	60	2	16 CCE	R.PDCCH. 5-2.1 TDD	TDLA30-75	2x2 Low	1	[-3.6] + TT

7.4 PBCH demodulation requirements

7.4.1 1RX requirements (Void)

7.4.2 2RX requirements

7.4.2.1 FDD (Void)

7.4.2.2 TDD

7.5 Sustained downlink data rate provided by lower layers

8 CSI reporting requirements (Radiated requirements)

8.1 General

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

10 CSI reporting requirements for interworking

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**	**FR1.30-4**	**FR1.30-5**	**FR1.30-6**
TDD Slot Configuration pattern (Note 1)			7DS2U	DDDSU	DDDSUDDSUU	SU	DDSU	DS_1S_2U
Special Slot Configuration (Note 2)			6D+4G+4U	10D+2G+2U	10D+2G+2U	12D+2G+0U	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	30
	dl-UL-TransmissionPeriodicity	ms	5	2.5	2.5	1	2	1
	nrofDownlinkSlots		7	3	3	0	2	1
	nrofDownlinkSymbols		6	10	10	12	10	10
	nrofUplinkSlot		2	1	1	1	1	0
	nrofUplinkSymbols		4	2	2	0	2	2
UL-DL configuration2 (*tdd-UL-DL-ConfigurationCommon2*)	*referenceSubcarrierSpacing*	kHz	N/A	N/A	30	N/A	N/A	30
	dl-UL-TransmissionPeriodicity	ms	N/A	N/A	2.5	N/A	N/A	1
	nrofDownlinkSlots		N/A	N/A	2	N/A	N/A	0
	nrofDownlinkSymbols		N/A	N/A	10	N/A	N/A	12
	nrofUplinkSlot		N/A	N/A	2	N/A	N/A	1
	nrofUplinkSymbols		N/A	N/A	2	N/A	N/A	0
K1 value (PDSCH-to-HARQ-timing-indicator)			[7] if mod(i,10) = 0 [6] if mod(i,10) = 1 [5] if mod(i,10) = 2 [5] if mod(i,10) = 3 [4] if mod(i,10) = 4 [3] 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,2) = 0	[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}

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) = 3
NOTE 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. NOTE 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. NOTE 3: i is the slot index per frame; i = {0,…,39}			

Table A.3.1-2: 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) = 3
NOTE 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. NOTE 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. NOTE 3: i is the slot index per frame; i = {0,…,79}				

A.2 Void

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

A.3 DL reference measurement channels

A.3.1 General

The transport block size (TBS) determination procedure is described in Clause 5.1.3.2 of [TS 38.214].

[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	
Channel bandwidth	MHz	10	10	10	10	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	52	6	52	52	
Number of consecutive PDSCH symbols		12	12	7	[9]	
Allocated slots per 2 frames	Slots	19	19	19	19	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		4	4	4	4	
Modulation		QPSK	QPSK	QPSK	QPSK	
Target Coding Rate		0.30	0.30	0.30	0.30	
Number of MIMO layers		1	1	1	1	
Number of DMRS REs		18	12	12	12	
Overhead for TBS determination		0	0	0	18	
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	3904	480	2280	[2472]	
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	16	16	16	
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	1	1	1	1	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 10, 11	Bits	12480	1512	6864	[7760]	
For Slots i = 3,…, 9, 12, …, 19	Bits	13104	1584	7488	[8384]	
Max. Throughput averaged over 2 frames	Mbps	3.709	0.456	2.166	[2.348]	
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 (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	2	1	2		
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	1	2	3	4	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	CBs	4	7	10	13	
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	3	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	3				
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	2				
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		21	21			
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,5) =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) 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,5) =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) 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,5) =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) 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,5) =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) for i from {1,…,19,22,…,39}	Bits	50880	101760			
Max. Throughput averaged over 2 frames	Mbps	25.8048	51.6348			
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 (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	3				
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 FR2.120-2 (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-7.1 TDD	R.PDSCH.5-7.2 TDD			
Channel bandwidth	MHz	100	100			
Subcarrier spacing	kHz	120	120			
Allocated resource blocks	PRBs	66	66			
Number of consecutive PDSCH symbols		12	12			
Allocated slots per 2 frames		59	59			
MCS table		64QAM	64QAM			
MCS index		13	4			
Modulation		16QAM	QPSK			
Target Coding Rate		0.48	0.30			
Number of MIMO layers		1	1			
Number of DMRS REs (Note 3)		24	24			
Overhead for TBS determination		6	6			
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A	N/A			
For Slot i = 80	Bits	14344	4480			
For CSI-RS Slot i, if mod(i, 8) = 1 for i from {0,…, 159}	Bits	N/A	N/A			
For Slot i, if mod(i, 8) = {0,4,5) for i from {1,…,79,82,…,159}		14344	4480			
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A	N/A			
For Slot i = 80	Bits	24	24			
For CSI-RS Slot i, if mod(i, 8) = 1 for i from {0,…, 159}		N/A	N/A			
For Slot i, if mod(i, 8) = {0,4,5) for i from {1,…,79,82,…,159}	Bits	24	24			
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	CBs	N/A	N/A			
For Slot i = 80	CBs	2	1			
For CSI-RS Slot i, if mod(i, 8) = 1 for i from {0,…, 159}	CBs	N/A	N/A			
For Slot i, if mod(i, 8) = {0,4,5) for i from {1,…,79,82,…,159}		2	1			
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A	N/A			
For Slot i = 80	Bits	28776	14388			
For CSI-RS Slot i, if mod(i, 8) = 1 for i from {0,…, 159}	Bits	N/A	N/A			
For Slot i, if mod(i, 8) = {0,4,5) for i from {1,…,79,82,…,159}	Bits	30360	15180			
Max. Throughput averaged over 2 frames	Mbps	42.3148	13.2160			
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames. NOTE 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data.						

A.3.3 Reference measurement channels for PDCCH performance requirements

A.3.3.1 FDD

A.3.3.1.1 Reference measurement channels for SCS 15 kHz FR1

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

Parameter	Unit	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	[51]	[51]			

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	[51]	[51]	[51]	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]	[51]	[51]	[51]	[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	41	[52]	[52]			

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 [TBD] and with MCS definition specified in Clause 5.1.3 of TS 38.214 [TBD]

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 clause 7.7.3 in TR 38.901.

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:

- Keep first tap as such, and the last tap delay as such.
- Merge two parallel taps with different delays (average delay, sum power) starting from the weakest ones. If the average delay is not in the sampling grid, round up/down it towards the direction of the higher power original 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)
- Continue as long as 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

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*×*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 1/(μ+1) 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, $\Delta f = 2^{\mu} \cdot 15$[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

FFS

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)			[7] if mod(i,10) = 0 [6] if mod(i,10) = 1 [5] if mod(i,10) = 2 [5] if mod(i,10) = 3 [4] if mod(i,10) = 4 [3] 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) = 3
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,39}			

Table 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

Unless otherwise stated, Table C.3_1.1-1 is applicable for measurements on the Performance Characteristics.

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 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.		

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 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	Overall system uncertainty for fading conditions comprises three quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness Items 1, 2 and 3 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}) 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
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 - 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_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

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	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	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	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	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 - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB	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	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	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	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	Formula: SNR + TT T-put limit unchanged

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.x, 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 $\geq$ 59 / 233

Testing Throughput = 70 % then the test limit is

Number of fails (NACK and statDTX) / number of samples $\leq$ 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.

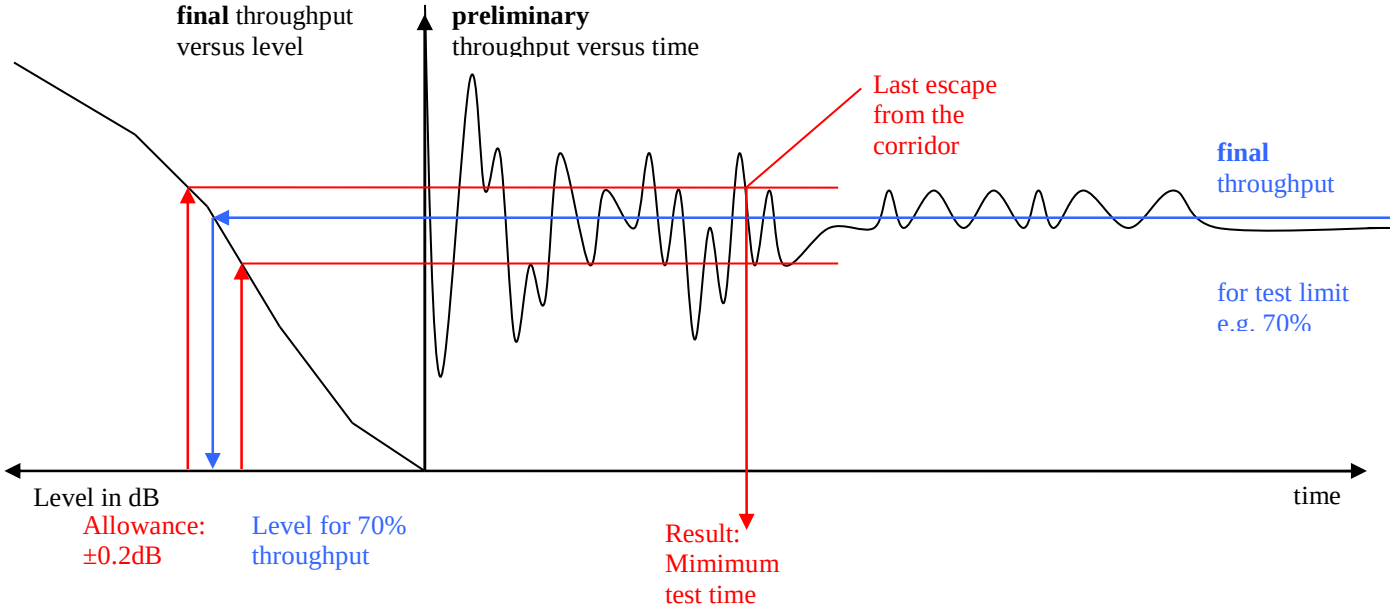

Figure G.1.5-1: Simulation method to derive minimum test time

Table G.1.5-1: Minimum Test time for 2Rx FDD FR1 PDSCH Type A performance

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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)
1-1	R.PDSCH.2-1.1 TDD 40MHz ChBW/30kHz SCS, QPSK, 0.30, FR1.30-1, 2x2, ULA Low TDLB100ns-400Hz	[10]
1-2	R.PDSCH.2-1.2 TDD 40MHz ChBW/30kHz SCS, QPSK, 0.30, FR1.30-1, 2x2, ULA Low TDLC300ns-100Hz	[20]
1-3	R.PDSCH.2-4.1 TDD 40MHz ChBW/30kHz SCS, 256QAM, 0.82, FR1.30-1, 2x2, ULA Low TDLA30ns-10Hz	[45]
1-4	R.PDSCH.2-2.1 TDD 40MHz ChBW/30kHz SCS, 16QAM, 0.48, FR1.30-1, 2x2, ULA Low TDLC300ns-100Hz	[20]
1-5	[R.PDSCH.2-5.1 TDD] 40MHz ChBW/30kHz SCS, QPSK, 0.30, FR1.30-2, 2x2, ULA Low TDLA30ns-10Hz	[45]
1-6	[R.PDSCH.2-6.1 TDD] 40MHz ChBW/30kHz SCS, QPSK, 0.30, FR1.30-2, 2x2, ULA Low TDLA30ns-10Hz	[45]
2-1	R.PDSCH.2-3.1 TDD 40MHz ChBW/30kHz SCS, 64QAM, 0.51, FR1.30-1, 2x2, ULA Low TDLA30ns-10Hz	[45]
2-2	R.PDSCH.2-2.2 TDD 40MHz ChBW/30kHz SCS, 16QAM, 0.48, FR1.30-1, 2x2, ULA Medium TDLA30ns-10Hz	[45]
2-3	R.PDSCH.2-3.2 TDD 20MHz ChBW/30kHz SCS, 64QAM, 0.51, FR1.30-1, 2x2, ULA Low TDLA30ns-10Hz	[45]

Editor's note: The min test time specified in the table above to be used unless more simulation data suggests changing the test time.

G.X 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.X.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.X.2 Test Design

A statistical test is characterized by:

Test-time, Selectivity and Confidence level.

G.X.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.X.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 ($\varepsilon \rightarrow 0$) 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.X.5 Supplier Risk versus Customer Risk

The table below summarizes the different targets of decision.

Table G.X.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.X.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.X.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.X.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:

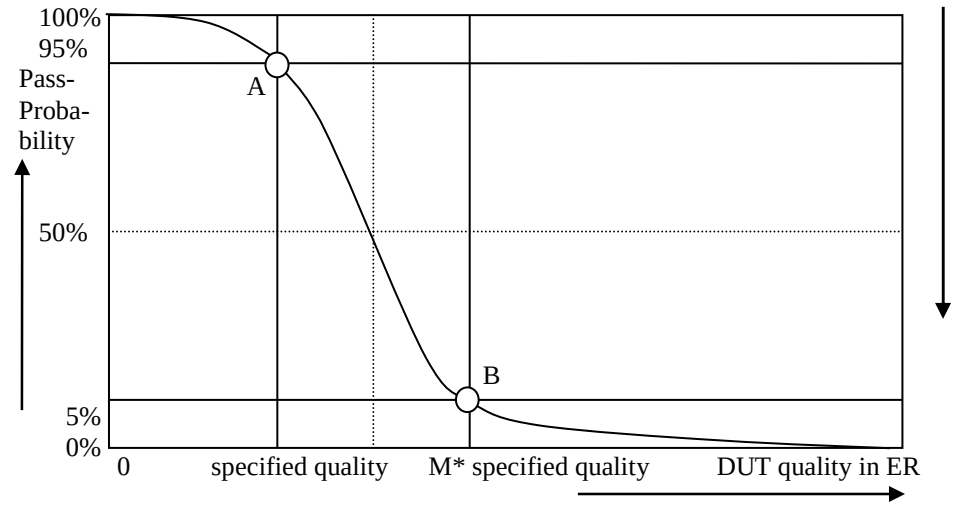

Figure G.X.8-1: Pass probability versus DUT quality

G.X.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.x.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.X.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.

$$fail(ne, d_f) := \frac{ne}{(ne + qnbinom(d_f, ne, ER))}$$

$$pass(ne, cl_p, M) := \frac{ne}{(ne + qnbinom(cl_p, ne, ER \cdot M))}$$

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.x.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 {$\text{Azimuth}_{1..n}$, $\text{Elevation}_{1..n}$}:
  - Where {$\text{Azimuth}_{1..n}$, $\text{Elevation}_{1..n}$} 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

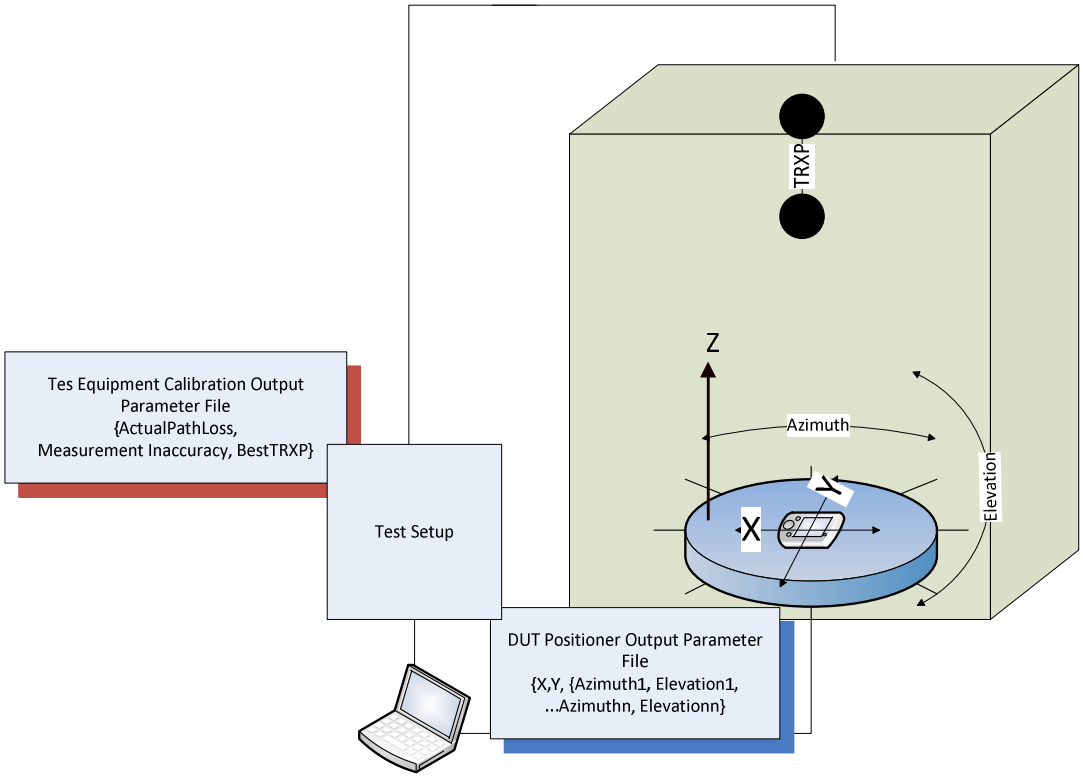

Figure Y-1: Test Function Usage in Demod/RRM (and optionally Signalling)

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.

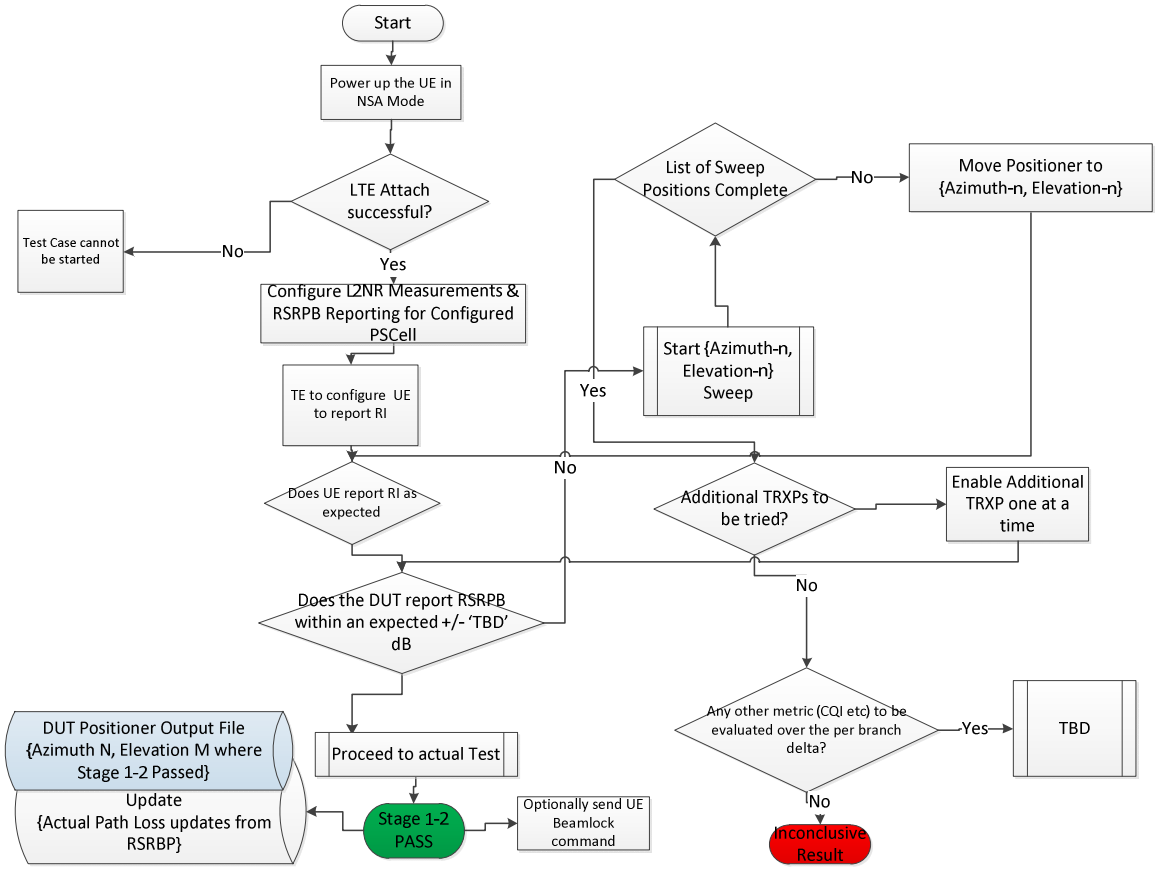

Figure Y-2: Flow Chart depicting Test Steps for Stage 1 & 2 in NSA Mode for Demod/RRM

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.

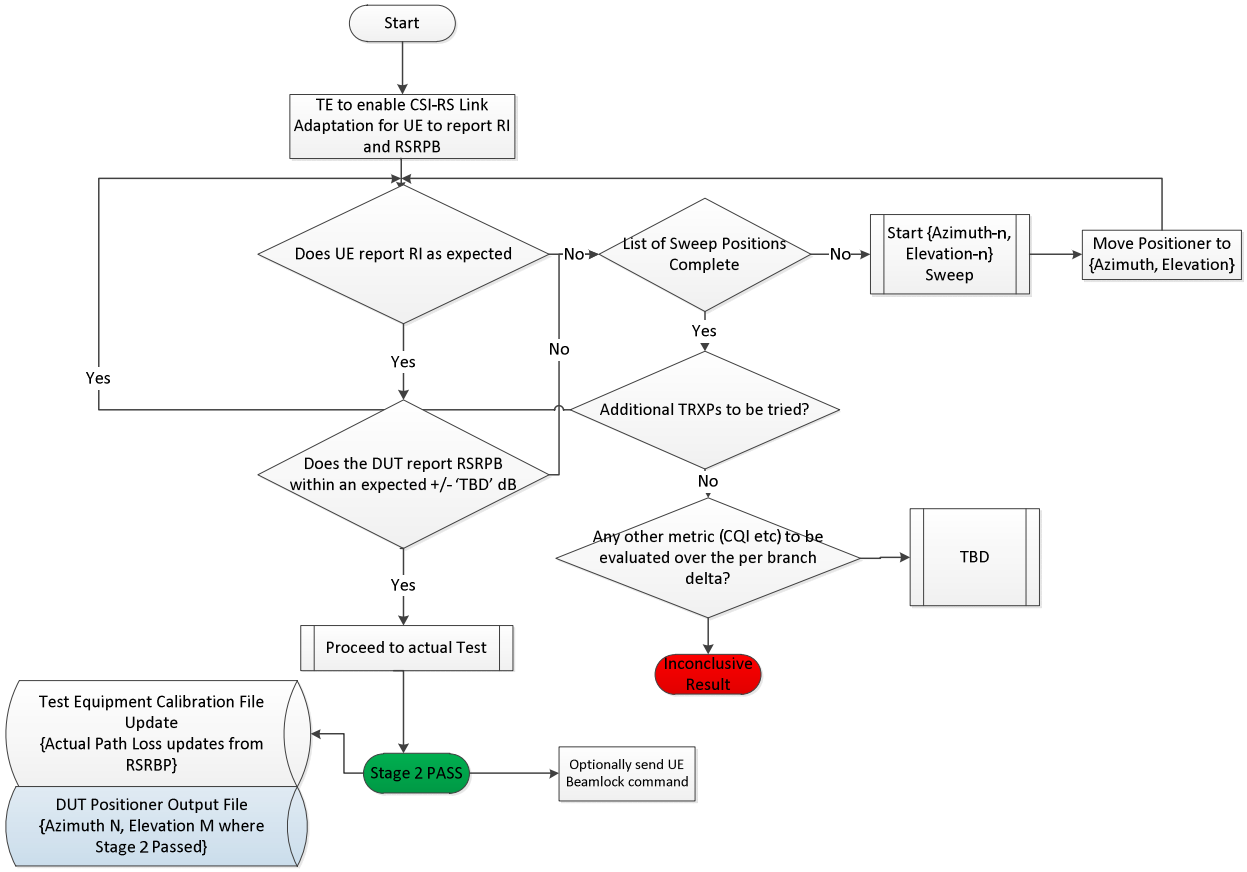

Figure Y-4: Flow Chart depicting Test Steps for Stage 2 in SA Mode for Demod/RRM

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

History

Document history		
V15.0.0	May 2019	Publication