ETSI TS 138 101-4 V17.14.0 (2024-11)

5G;
NR;
User Equipment (UE) radio transmission and reception;
Part 4: Performance requirements
(3GPP TS 38.101-4 version 17.14.0 Release 17)

Reference
RTS/TSGR-0438101-4vhe0

Keywords
5G

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Legal Notice

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

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between 3GPP and ETSI identities can be found under https://webapp.etsi.org/key/queryform.asp.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Contents

Foreword

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

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

shall indicates a mandatory requirement to do something

shall not indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

should indicates a recommendation to do something

should not indicates a recommendation not to do something

may indicates permission to do something

need not indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

can indicates that something is possible

cannot indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

will indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

will not indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

might indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

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

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.521-4: "NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 4: Performance requirements".

[3] Recommendation ITU-R M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications-2000".

[4] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[5] 3GPP TR 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz".

[6] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[7] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[8] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

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

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

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

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

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

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

[15] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation".

[16] Void.

[17] 3GPP TS 38.331: “Radio Resource Control (RRC) protocol specification”.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

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

Enhanced Receiver Type 1: SU-MIMO interference mitigation advanced receiver [14]

- R-ML (reduced complexity ML) receiver with enhanced inter-stream interference suppression for SU-MIMO transmissions with rank 2 with 2 RX antennas
- R-ML (reduced complexity ML) receiver with enhanced inter-stream interference suppression for SU-MIMO transmissions with rank 2, 3, and 4 with 4 RX antennas

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

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

RedCap: A UE with reduced capabilities as defined in clause 4.2 in TS 38.306 [14].

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

3.2 Symbols

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

E_s	The averaged received energy per Hz of the wanted signal during the useful part of the symbol, i.e. excluding the cyclic prefix, at the UE antenna connector; average power is computed within a set of REs used for the transmission of physical, divided transmission bandwidth within the set
μ	Subcarrier spacing configuration as defined in clause 4.2 of TS 38.211 [9]
N_{oc}	The power spectral density of a white noise source with average power per Hz as defined in Clause 4.4.3 for conducted requirements and Clause 4.5.3 for radiated requirements

3.3 Abbreviations

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

AGC	Automatic Gain Control
CA	Carrier Aggregation
CC	Component Carrier
CCE	Control Channel Element
CORESET	Control Resource Set
CP	Cyclic Prefix
CSI	Channel-State Information
CSI-IM	CSI Interference Measurement
CSI-RS	CSI Reference Signal
CW	Codeword
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check

CRI	CSI-RS Resource Indicator
CRS	Cell-specific Reference Signal
CRS-IM	CRS-Interference Mitigation
DC	Dual Connectivity
DCI	Downlink Control Information
DL	Downlink
DMRS	Demodulation Reference Signal
DPS	Dynamic Point Selection
EPRE	Energy Per Resource Element
EN-DC	E-UTRA-NR Dual Connectivity
FR	Frequency Range
FRC	Fixed Reference Channel
GNSS	Global Navigation Satellite System
HARQ	Hybrid Automatic Repeat Request
HD-FDD	Half-duplex Frequency Division Duplex
HST	High Speed Train
HST-SFN	High Speed Train Single Frequency Network
LI	Layer Indicator
MAC	Medium Access Control
MCS	Modulation and Coding Scheme
MIB	Master Information Block
NR	New Radio
NSA	Non-Standalone Operation Mode
OCC	Orthogonal Cover Code
OCNG	OFDMA Channel Noise Generator
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
PBCH	Physical Broadcast Channel
Pcell	Primary Cell
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PMI	Precoding Matrix Indicator
PRB	Physical Resource Block
PRG	Physical resource block group
PSBCH	Physical Sidelink Broadcast Channel
PSCCH	Physical Sidelink Control Channel
PSFCH	Physical Sidelink Feedback Channel
PSS	Primary Synchronization Signal
PSSCH	Physical Sidelink Shared Channel
PTRS	Phase Tracking Reference Signal
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel
QCL	Quasi Co-location
RB	Resource Block
RBG	Resource Block Group
RE	Resource Element
REG	Resource Element Group
RI	Rank Indicator
RRC	Radio Resource Control
SA	Standalone operation mode
SCI	Sidelink Control Information
SCS	Subcarrier Spacing
SINR	Signal-to-Interference-and-Noise Ratio
SL	Sidelink
SLSS	Sidelink Synchronization Signal
SNR	Signal-to-Noise Ratio
SS	Synchronization Signal
SSB	Synchronization Signal Block
SSS	Secondary Synchronization Signal
TCI	Transmission Configuration Indicator
TDM	Time division multiplexing
TRxP	Transmission and Reception Point

TTI	Transmission Time Interval
UL	Uplink
V2X	Vehicle to Everything
VRB	Virtual Resource Block

4 General

4.1 Relationship between minimum requirements and test requirements

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

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

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

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

The applicability of each requirement is described under each sub-clause in 5.1, 6.1, 7.1, 8.1, 9.1 and 10.1.

4.2 Applicability of minimum requirements

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

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

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

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

4.3 Specification suffix information

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

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

4.4 Conducted requirements

4.4.0 Introduction

The requirements are defined for the following modes:

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

4.4.1 Reference point

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

4.4.2 SNR definition

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

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

Where

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

4.4.3 Noc

4.4.3.1 Introduction

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

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

4.4.3.2 Noc for NR operating bands in FR1

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

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

4.4.3.2.1 Derivation of Noc values for NR operating bands in FR1

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

$$Noc_{Band\_X,\ SCS\_Y,\ CBW\_Z} = REFSENS_{Band\_X,\ SCS\_Y,\ CBW\_Z} - 10*\log10(12*SCS\_Y*nPRB) + D - SNR_{REFSENS} + \Delta_{thermal}$$

where

- $REFSENS_{Band\_X,\ SCS\_Y,\ CBW\_Z}$ is the REFSENS value in dBm for Band X, SCS Y and CBW Z specified in Table 7.3.2-1 of TS 38.101-1 [6]
- 12 is the number of subcarriers in a PRB
- SCS Y is the subcarrier spacing associated with the REFSENS value
- nPRB is the maximum number of PRB for SCS Y and CBW Z associated with the REFSENS value, and is specified in Table 5.3.2-1 of TS 38.101-1 [6]
- D is diversity gain equal to 3 dB
- $SNR_{REFSENS}$ = -1 dB is the SNR used for simulation of REFSENS
- $\Delta_{thermal}$ is the amount of dB that the wanted noise is set above UE thermal noise, giving a defined rise in total noise. $\Delta_{thermal}$ = 16dB, giving a rise in total noise of 0.1dB, regarded as insignificant.

The calculated Noc value for the baseline of Band n12, 15 kHz SCS, 15 MHz CBW is -135.5 dBm/Hz.

An allowance of 1.5dB is made for CA and for future bands, giving an Noc power level of -134 dBm/Hz.

4.4.4 Es

4.4.4.1 Introduction

This clause describes the Es power level for Mode 2 conditions conducted testing of demodulation and CSI requirements.

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

4.4.4.2 Es for NR operating bands in FR1

The Es power spectrum density shall be larger or equal to the minimum Es power level for each operating band supported by the UE as defined in Clause 4.4.4.2.1.

Unless otherwise stated, a fixed Es power level of -112 dBm/Hz shall be used for all operating bands.

4.4.4.2.1 Derivation of Es values for NR operating bands in FR1

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

$$Es_{Band\_X,\ SCS\_Y,\ CBW\_Z} = REFSENS_{Band\_X,\ SCS\_Y,\ CBW\_Z} - 10*\log10(12*SCS\_Y*nPRB) + D - SNR_{REFSENS} + dB_{EVM} + \Delta_{thermal}$$

where:

- $REFSENS_{Band\_X,\ SCS\_Y,\ CBW\_Z}$ is the REFSENS value in dBm for Band X, SCS Y and CBW Z specified in Table 7.3.2-1 of TS 38.101-1 [6]
- 12 is the number of subcarriers in a PRB
- SCS Y is the subcarrier spacing associated with the REFSENS value

- nPRB is the maximum number of PRB for SCS Y and CBW Z associated with the REFSENS value, and is specified in Table 5.3.2-1 of TS 38.101-1 [6]
- D is diversity gain equal to 3 dB
- $SNR_{REFSENS}$ = -1 dB is the SNR used for simulation of REFSENS
- dB_{EVM} is the SNR of the applied signal due to EVM impairment on the wanted Es. An allowed EVM of 3% gives a dB_{EVM} of 30.5dB, derived as 20*log10(1/0.03)**.** An allowed EVM of 2.5% gives a dB_{EVM} of 32dB, derived as 20*log10(1/0.025).
- $\Delta_{thermal}$ is the amount of dB that the impairment due to EVM on the wanted Es is set above UE thermal noise, giving a defined rise in total impairment. $\Delta_{thermal}$ = 7.6dB, giving a rise in total impairment of 0.7dB, regarded as acceptable**.**

For an allowed EVM of 3%, the calculated Es value for the baseline of Band n12, 15kHz SCS, 15MHz CBW is -113.5 dBm/Hz.

For an allowed EVM of 2.5%, the calculated Es value for the baseline of Band n12, 15kHz SCS, 15MHz CBW is -112 dBm/Hz.

An allowance of 1.5dB is made for CA and for future bands, giving an Es power level of -112 dBm/Hz for EVM of 3%, and -110.5 dBm/Hz for EVM of 2.5%.

4.4.5 SINR definition

$$SINR = \frac{\sum_{j=1}^{N_{RX}} E_s^{(j)}}{\sum_{j=1}^{N_{RX}} N'^{(j)}_{oc}}$$

Where $E_s^{(j)}$ is the averaged received energy per Hz of the wanted signal during the useful part of the symbol, i.e. excluding the cyclic prefix, at the j-th UE receiver antenna connector; average power is computed within a set of REs used for the transmission of physical, divided transmission bandwidth within the set.

And $N_{oc}^{\prime(j)}$ is the power spectral density (average power per RE normalised to the subcarrier spacing) of the summation of the received power spectral densities of the strongest interfering cells explicitly defined in a test procedure plus $N_{oc}^{(j)}$, as measured at the j-th UE receiver antenna connector. The respective power spectral density of each interfering cell relative to $N_{oc}^{(j)}$ is defined by its associated Es/Noc value.

4.5 Radiated requirements

4.5.0 Introduction

The requirements are defined for the following modes:

- Mode 1: conditions with external noise source
  - Wanted signal with power level Es is transmitted.
  - External white noise source with power spectral density Noc is used.
  - Es and Noc levels are selected to achieve target SNR as described in Clause 4.5.2.
- Mode 2: Noise free conditions
  - Wanted signal with power level Es is transmitted.
  - No external noise transmitted.

4.5.1 Reference point

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

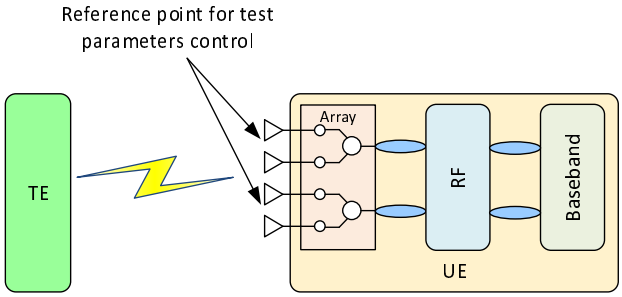

Figure 4.5.1-1: Reference point for radiated Demodulation and CSI requirements

4.5.2 SNR definition

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

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

where Δ_{BB} is specified in clause 4.5.3.

The reference point SNR is defined as:

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

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

4.5.3 Noc

4.5.3.1 Introduction

For Mode 1 conditions radiated testing of demodulation and CSI requirements it is not feasible in practice to use signal levels high enough to make the noise contribution of the UE negligible. Demodulation requirements are therefore specified with the applied noise higher than the UE peak EIS level in TS 38.101-2 [7] by a defined amount, so that the impact of UE noise floor is limited to no greater than a value Δ_{BB} at the specified Noc level. As UEs have EIS levels that are dependent on operating band and power class, Noc level is dependent on operating band and power class.

4.5.3.2 Noc for NR operating bands in FR2

Values for Noc according to operating band and power class for single carrier requirements are specified in Table 4.5.3.2-1 for 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	5	6	7
n257	-167.3	-161.8	-158.1	-166.8	-162.4	-162.4	-155.1
n258	-167.3	-161.8	-158.1	-166.8	-162.6	-162.6	-155.1
n259			-154.5		-159.5		
n260	-164.3		-155.5	-164.8			
n261	-167.3	-161.8	-158.1	-166.8		-162.4	-155.1
n262	-162.3	-156.6	-152.6	-160.8			
Note 1: Noc levels are specified in dBm/Hz							

For PC3 multi-band devices, the Noc power level (Noc_{MB}) shall increase by multi-band relaxation defined in Table 6.2.1.3-4 of TS 38.101-2 [7]:

$$Noc_{MB} = Noc_{SB} + \Delta MB_{P,n}$$

- Noc_{SB} is the Noc defined in Table 4.5.3.2-1
- $\Delta MB_{P,n}$ values are specified in TS 38.101-2 [7].

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

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

- Noc_{SC} is derived by assuming UE supports single carrier.
- ΔR_{IB} values are specified in TS 38.101-2 [7].

4.5.3.3 Derivation of Noc values for NR operating bands in FR2

The Noc values in Table 4.5.3.2-1 are based on REFSENS for the operating band X and on the UE Power class P, derived based on the following equation:

$$Noc_{PC\_P,\ Band\_X} = REFSENS_{PC\_P,\ Band\_X,\ 50MHz} - 10Log_{10}(12 \times 120kHz \times PRB_{REFSENS}) - SNR_{REFSENS} + \Delta_{thermal}$$

where:

- $REFSENS_{PC\_P,\ Band\_X,\ 50MHz}$ is the REFSENS value in dBm specified for the Power Class P of UE in Band X for 50MHz Channel bandwidth in clause 7.3.2 of TS 38.101-2 [7].
- 12 is the number of subcarriers in a PRB
- 120 kHz is chosen as a subcarrier spacing to select $PRB_{REFSENS}$.
- $PRB_{REFSENS}$ is N_{RB} associated with subcarrier spacing 120 kHz for 50MHz in Table 5.3.2-1 of TS 38.101-2 [7] and is 32.
- $SNR_{REFSENS}$ = -1 dB is the SNR used for simulation of REFSENS
- $\Delta_{thermal}$ is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of Δ_{BB}. $\Delta_{thermal} = -10Log_{10}(10^{\wedge}(\Delta_{BB}/10)-1) = 5.87dB$, giving a rise in total noise Δ_{BB} of 1 dB.

For example, the calculated Noc value UE Power class 3 in Band n260 to -155.5 dBm/Hz, rounded to 0.1dB.

4.5.4 Angle of arrival

Unless otherwise stated, the downlink signal and noise are aligned to the direction with the following criteria:

- Select the known Rx beam peak direction reused from RF testing if available, as far as it satisfies the minimum isolation requirement defined in TS 38.521-4 [2] and rank number in TS 38.521-4 [2] corresponding to the test cases

- Otherwise select one direction which satisfies the REFSENS defined in TS 38.101-2 [7], minimum isolation requirement defined in TS 38.521-4 [2] and rank number in TS 38.521-4 [2] corresponding to the test cases.

4.5.5 Es

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

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

5 Demodulation performance requirements (Conducted requirements)

5.1 General

5.1.1 Applicability of requirements

5.1.1.1 General

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

The minimum performance requirements in Clause 5 are mandatory for UE supporting NR operation, unless otherwise specified in the other subclauses of Clause 5.1.1.

If same test is listed for different UE features/capabilities in Clauses 5.1.1.3 and 5.1.1.4, then this test shall apply for UEs which support all corresponding UE features/capabilities.

5.1.1.2 Applicability of requirements for different number of RX antenna ports

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

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

Table 5.1.1.2-1: Requirements applicability

Supported RX antenna ports	Test type	Test list
UE supports only 2RX	PDSCH	All tests in Clause 5.2.2
	PDCCH	All tests in Clause 5.3.2
	PBCH	All tests in Clause 5.4.2
UE supports only 4RX or both 2RX and 4RX	PDSCH	All tests in Clause 5.2.3 (Note 2)
	PDCCH	All tests in Clause 5.3.3 (Note 2)
	PBCH	All tests in Clause 5.4.2 or 5.4.3 (Note)
Note 1: Requirements for PBCH with 4Rx is up to UE declaration Note 2: '*maxMIMO-Layers-r16*' is not configured during the performance requirements testing for UE supporting Release 16 per-BWP MIMO layer adaptation.		

5.1.1.3 Applicability of requirements for optional UE features

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

Table 5.1.1.3-1: Requirements applicability for optional UE features

UE feature/capability [14]	Test type		Test list	Applicability notes
SU-MIMO Interference Mitigation advanced receiver	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 3-1) Clause 5.2.3.1.1 (Test 5-1)	
	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 3-1) Clause 5.2.3.2.1 (Test 5-1)	
Alternative additional DMRS position for co-existence with LTE CRS *(additionalDMRS-DL-Alt)*	FR1 FDD	PDSCH	Clause 5.2.2.1.4 (Test 1-2) Clause 5.2.3.1.4 (Test 1-2)	
	FR1 TDD	PDSCH	Clause 5.2.2.2.4 (Test 1-2) Clause 5.2.3.2.4 (Test 1-2)	
Basic DL NR-NR CA operation (*supportedBandCombinationList*)	NR CA	SDR	Clause 5.5A.1	1)Up to 16 DL carriers 2)Same numerology across carrier for data/control channel at a given time
Enhanced demodulation processing for HST-SFN joint transmission scheme with velocity up to 500km/h	FR1 FDD	PDSCH	Clause 5.2.2.1.9 (Test 1-1) Clause 5.2.3.1.9 (Test 1-1)	
	FR1 TDD	PDSCH	Clause 5.2.2.2.9 (Test 1-1) Clause 5.2.3.2.9 (Test 1-1)	
Alternative 64QAM MCS table for PDSCHNew 64QAM MCS table for PDSCH (*dl-64QAM-MCS-TableAlt*)	FR1 FDD	PDSCH	Clause 5.2.2.1.5 Clause 5.2.3.1.5 Clause 5.2.2.1.6 Clause 5.2.3.1.6	
	FR1 TDD	PDSCH	Clause 5.2.2.2.5 Clause 5.2.3.2.5 Clause 5.2.2.2.6 Clause 5.2.3.2.6	
CQI table with target BLER of 10^-5New CQI table (cqi-TableAlt)	FR1 FDD	PDSCH	Clause 5.2.2.1.5 Clause 5.2.3.1.5	
	FR1 TDD	PDSCH	Clause 5.2.2.2.5 Clause 5.2.3.2.5	
PDSCH repetitions over multiple slots *(pdsch-RepetitionMultiSlots)*	FR1 FDD	PDSCH	Clause 5.2.2.1.6 Clause 5.2.3.1.6	
	FR1 TDD	PDSCH	Clause 5.2.2.2.6 Clause 5.2.3.2.6	
UE PDSCH processing capability #2 *(pdsch-ProcessingType2)*	FR1 FDD	PDSCH	Clause 5.2.2.1.7 Clause 5.2.3.1.7	
	FR1 TDD	PDSCH	Clause 5.2.2.2.7 Clause 5.2.3.2.7	
Pre-emption indication for DL *(pre-EmptIndication-DL)*	FR1 FDD	PDSCH	Clause 5.2.2.1.8 Clause 5.2.3.1.8	
	FR1 TDD	PDSCH	Clause 5.2.2.2.8 Clause 5.2.3.2.8	
Single DCI based SDM transmission for multi-TRxP (singleDCI-SDM-scheme-r16)	FR1 FDD	PDSCH	Clause 5.2.2.1.11 Clause 5.2.3.1.11	
	FR1 TDD	PDSCH	Clause 5.2.2.2.11 Clause 5.2.3.2.11	
Multi DCI based multi-TRxP support (multiDCI-MultiTRP-r16)	FR1 FDD	PDSCH	Clause 5.2.2.1.12 Clause 5.2.3.1.12	
	FR1 TDD	PDSCH	Clause 5.2.2.2.12 Clause 5.2.3.2.12	
Single DCI based FDM Scheme-A for multi-TRxP(supportFDM-SchemeA-r16)	FR1 FDD	PDSCH	Clause 5.2.2.1.13 Clause 5.2.3.1.13	
	FR1 TDD	PDSCH	Clause 5.2.2.2.13	

			Clause 5.2.3.2.13	
Single DCI based inter-slot TDM for multi-TRxP (supportInter-slotTDM-r16)	FR1 FDD	PDSCH	Clause 5.2.2.1.14 Clause 5.2.3.1.14	
	FR1 TDD	PDSCH	Clause 5.2.2.2.14 Clause 5.2.3.2.14	
Maximum number of TCI states in Single-DCI based inter-slot TDM (maxNumberTCI-states-r16)	FR1 FDD	PDSCH	Clause 5.2.2.1.14 Clause 5.2.3.1.14	The requirements apply only when maxNumberTCI-states-r16 = 2.
	FR1 TDD	PDSCH	Clause 5.2.2.2.14 Clause 5.2.3.2.14	
DRX Adaptation (*drx-Adaptation-r16*)	FR1 FDD	PDCCH	Clause 5.3.2.1.3	If the Test 1 in Clause 5.3.2.1.3 is passed, the test coverage can be considered fulfilled without executing Test 3 in clause 5.3.2.1.1.
	FR1 TDD	PDCCH	Clause 5.3.2.2.3	If the Test 1 in Clause 5.3.2.2.3 is passed, the test coverage can be considered fulfilled without executing Test 2 in clause 5.3.2.2.1.
	FR1 FDD	PDCCH	Clause 5.3.3.1.3	If the Test 1 in Clause 5.3.3.1.3 is passed, the test coverage can be considered fulfilled without executing Test 3 in clause 5.3.3.1.1.
	FR1 TDD	PDCCH	Clause 5.3.3.2.3	If the Test 1 in Clause 5.3.3.2.3 is passed, the test coverage can be considered fulfilled without executing Test 2 in clause 5.3.3.2.1.
Validating P/SP-CSI-RS reception (*periodicAndSemi-PersistentCSI-RS-r16*)	FR1 TDD	PDSCH	Clause 5.2.2.2.15 Clause 5.2.3.2.15 Clause 5.2A.2.3 Clause 5.2A.3.3	The requirements apply only in case tested UE supporting operations in shared spectrum access and validation of P/SP-CSI-RS reception based on DCI
Supported UL channels for dynamic channel access mode (*ul-DynamicChAccess-r16*) or UL channel access for semi-static channel access mode (ul-Semi-StaticChAccess-r16) or both	FR1 TDD	PDSCH	Clause 5.2.2.2.15 Clause 5.2.3.2.15	The requirements apply only in case tested UE supports one of UL channels for dynamic channel access mode and UL channel access for semi-static channel access mode
1024QAM modulation for PDSCH for FR1 (*pdsch-1024QAM-FR1-r17* or *pdsch-1024QAM-2MIMO-FR1-r17*)	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-8) Clause 5.2.3.1.1 (Test 1-8)	
	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 1-12) Clause 5.2.3.2.1 (Test 1-12)	
		SDR	Clause 5.5.1 Clause 5.5A.1	1024QAM MCS indexes are used only if UE supports

				1024QAM for FR1 DL.
Support of neighboring LTE cell CRS-IM in DSS scenario with NR 15 kHz SCS (*CRS-IM-DSS-15kHzSCS-r17*)	FR1 FDD	PDSCH	Clause 5.2.2.1.18 Clause 5.2.3.1.17	UE can support the feature on the CC(s) in a band only if the UE indicates support of rateMatchingLTE-CRS on that band.
	FR1 TDD	PDSCH	Clause 5.2.2.2.19 Clause 5.2.3.2.18	
Support of neighboring LTE cell CRS-IM in non-DSS and 15 kHz NR SCS scenario, without the assistance of network signaling on LTE channel bandwidth (*CRS-IM-nonDSS-15kHzSCS-r17*)	FR1 FDD	PDSCH	Clause 5.2.2.1.19 (Test 2-1) Clause 5.2.3.1.18 (Test 2-1)	The UE can perform CRS-IM when MeasObjectEUTRA IE is configured, and the configured measurement gaps overlap with neighbour LTE cell PBCH position.
	FR1 TDD	PDSCH	Clause 5.2.2.2.20 (Test 2-1) Clause 5.2.3.2.19 (Test 2-1)	
Support of neighboring LTE cell CRS-IM in non-DSS and 15 kHz NR SCS scenario, with the assistance of network signaling on LTE channel bandwidth (*CRS-IM-nonDSS-NWA-15kHzSCS-r17*)	FR1 FDD	PDSCH	Clause 5.2.2.1.19 (Test 1-1) Clause 5.2.3.1.18 (Test 1-1)	If the Test 2-1 in Clause 5.2.2.1.19 is passed, the test coverage can be considered fulfilled without executing Test 1-1 in clause 5.2.2.1.19. If the Test 2-1 in Clause 5.2.3.1.18 is passed, the test coverage can be considered fulfilled without executing Test 1-1 in clause 5.2.3.1.18.
	FR1 TDD	PDSCH	Clause 5.2.2.2.20 (Test 1-1) Clause 5.2.3.2.19 (Test 1-1)	If the Test 2-1 in Clause 5.2.2.2.20 is passed, the test coverage can be considered fulfilled without executing Test 1-1 in clause 5.2.2.2.20. If the Test 2-1 in Clause 5.2.3.2.19 is passed, the test coverage can be considered fulfilled without executing Test 1-1 in clause 5.2.3.2.19.
CRS-IM in non-DSS and 30 kHz NR SCS scenario, without the assistance of network signaling on LTE channel bandwidth (*crs-IM-nonDSS-30kHzSCS-r17*)	FR1 TDD	PDSCH	Clause 5.2.2.2.20 (Test 2-2) Clause 5.2.3.2.19 (Test 2-2)	The UE can perform CRS-IM when MeasObjectEUTRA IE is configured, and the configured measurement gaps overlap with neighbour LTE cell PBCH position.
CRS-IM in non-DSS and 30 kHz NR SCS scenario, with the assistance of network signaling on LTE channel bandwidth (crs-*IM-nonDSS-NWA-30kHzSCS-r17*)	FR1 TDD	PDSCH	Clause 5.2.2.2.20 (Test 1-2) Clause 5.2.3.2.19 (Test 1-2)	If the Test 2-2 in Clause 5.2.2.2.20 is passed, the test coverage can be considered fulfilled without executing

				Test 1-2 in clause 5.2.2.2.20. If the Test 2-2 in Clause 5.2.3.2.19 is passed, the test coverage can be considered fulfilled without executing Test 1-2 in clause 5.2.3.2.19.
Support for SFN scheme A for PDCCH scheduling SFN Scheme A PDSCH *(sfn-SchemeA-r17)*	FR1 FDD	PDSCH	Clause 5.2.2.1.20 Clause 5.2.3.1.19	
	FR1 TDD	PDSCH	Clause 5.2.2.2.21 Clause 5.2.3.2.20	
Support for SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH *(sfn-SchemeB-r17)*	FR1 FDD	PDSCH	Clause 5.2.2.1.21 Clause 5.2.3.1.20	
	FR1 TDD	PDSCH	Clause 5.2.2.2.22 Clause 5.2.3.2.21	
Support for PDCCH with intra-slot repetition *(mTRP-PDCCH-Repetition-r17)*	FR1 FDD	PDCCH	Clause 5.3.2.1.5 Clause 5.3.3.1.4	
	FR1 TDD	PDCCH	Clause 5.3.2.2.5 Clause 5.3.3.2.4	

5.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

The performance requirements in Table 5.1.1.4-1 shall apply for UEs which support mandatory UE features with capability signalling only.

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

UE feature/capability [14]	Test type		Test list	Applicability notes
256QAM modulation scheme for PDSCH for FR1 (*pdsch-256QAM-FR1*)	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-3) Clause 5.2.3.1.1 (Test 1-3)	
	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 1-3) Clause 5.2.3.2.1 (Test 1-3)	
PDSCH mapping type B (*pdsch-MappingTypeB*)	FR1 FDD	PDSCH	Clause 5.2.2.1.3 Clause 5.2.3.1.3 Clause 5.2.2.1.7 Clause 5.2.3.1.7	
	FR1 TDD	PDSCH	Clause 5.2.2.2.3 Clause 5.2.3.2.3 Clause 5.2.2.2.7 Clause 5.2.3.2.7	
Rate-matching around LTE CRS (*rateMatchingLTE-CRS*)	FR1 FDD	PDSCH	Clause 5.2.2.1.4 Clause 5.2.3.1.4	For UEs supporting "Alternative additional DMRS position for co-existence with LTE CRS", if Test 1-2 is tested, the test coverage can be

	FR1 TDD	PDSCH	Clause 5.2.2.2.4 Clause 5.2.3.2.4	considered fulfilled without executing Test 1-1. Otherwise, only Test 1-1 is tested.
Supported maximum number of ports across all configured NZP-CSI-RS resources per CC (*maxConfigNumberPortsAcrossNZP-CSI-RS-PerCC*)	FR1 FDD	PDSCH	Clause 5.2.2.1.4 (Tests 1-1, 1-2) Clause 5.2.2.1.19 (Test 1-1, 2-1) Clause 5.2.3.1.1 (Tests 3-1, 4-1, 5-1) Clause 5.2.3.1.4 (Tests 1-1, 1-2) Clause 5.2.3.1.16 (Test 2-1) Clause 5.2.3.1.18 (Tests 1-1, 2-1)	The requirements apply only in case the number of NZP-CSI-RS ports in the test case satisfies UE capability on maximum number of NZP-CSI-RS ports
	FR1 TDD	PDSCH	Clause 5.2.2.2.4 (Tests 1-1, 1-2) Clause 5.2.2.2.19 (Test 1-1) Clause 5.2.2.2.20 (Tests 1-1, 1-2,2-1,2-2) Clause 5.2.3.2.1 (Test 3-1, 4-1, 5-1) Clause 5.2.3.2.4 (Tests 1-1, 1-2) Clause 5.2.3.2.17 (Test 2-1) Clause 5.2.3.2.18 (Test 1-1) Clause 5.2.3.2.19 (Test 1-1, 1-2,2-1,2-2)	
Supported maximum number of PDSCH MIMO layers (*maxNumberMIMO-LayersPDSCH*)	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Tests 2-1, 2-2, 3-1) Clause 5.2.2.1.2 Clause 5.2.3.1.1 (Tests 2-1, 2-2, 3-1, 4-1, 5-1) Clause 5.2.3.1.2	The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability
	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Tests 2-1, 2-2, 3-1) Clause 5.2.2.2.2 Clause 5.2.3.2.1 (Tests 2-1, 2-2, 3-1, 4-1, 5-1) Clause 5.2.3.2.2	
Support number of active TCI states per BWP per CC, including control and data *(maxNumberActiveTCI-PerBWP)*	FR1 FDD	PDSCH	Clause 5.2.2.1.10 (Test 1-2) Clause 5.2.3.1.10 (Test 1-2)	The requirements apply only when *maxNumberActiveTCI-PerBWP* is other than n1.
	FR1 TDD	PDSCH	Clause 5.2.2.2.10 (Test 1-2) Clause 5.2.3.2.10 (Test 1-2)	
Support for maximum number of TRS resource sets per CC which the UE can track simultaneously (*maxSimultaneousResourceSetsPerCC*)	FR1 FDD	PDSCH	Clause 5.2.2.1.10 (Test 1-2) Clause 5.2.3.1.10 (Test 1-2) Clause 5.2.2.1.11 Clause 5.2.2.1.12 Clause 5.2.2.1.13 Clause 5.2.2.1.14 Clause 5.2.3.1.11 Clause 5.2.3.1.12 Clause 5.2.3.1.13 Clause 5.2.3.1.14	The requirements apply only when *maxSimultaneousResourceSetsPerCC* ≥ 2
	FR1 TDD	PDSCH	Clause 5.2.2.2.10 (Test 1-2) Clause 5.2.3.2.10 (Test 1-2) Clause 5.2.2.2.11 Clause 5.2.2.2.12 Clause 5.2.2.2.13	

			Clause 5.2.2.2.14 Clause 5.2.3.2.11 Clause 5.2.3.2.12 Clause 5.2.3.2.13 Clause 5.2.3.2.14	

5.1.1.5 Applicability of different requirements for HST

The applicability rules for different HST requirements in section 5 are specified in Table 5.1.1.5-1, Table 5.1.1.5-2.

Table 5.1.1.5-1: Applicability of requirements for HST

If UE has passed			UE can skip			Applicability notes
Test type		Test list	Test type		Test list	
FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-6)	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-5)	
FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 1-11)	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 1-7)	
FR1 FDD	PDSCH	Clause 5.2.3.1.1 (Test 1-6)	FR1 FDD	PDSCH	Clause 5.2.3.1.1 (Test 1-5)	
FR1 TDD	PDSCH	Clause 5.2.3.2.1 (Test 1-11)	FR1 TDD	PDSCH	Clause 5.2.3.2.1 (Test 1-7)	
FR1 FDD	PDSCH	Clause 5.2.2.1.9 (Test 1-1)	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-5)	
FR1 TDD	PDSCH	Clause 5.2.2.2.9 (Test 1-1)	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 1-7 and 1-11)	
FR1 FDD	PDSCH	Clause 5.2.3.1.9 (Test 1-1)	FR1 FDD	PDSCH	Clause 5.2.3.1.1 (Test 1-5)	
FR1 TDD	PDSCH	Clause 5.2.3.2.9 (Test 1-1)	FR1 TDD	PDSCH	Clause 5.2.3.2.1 (Test 1-7 and 1-11)	
FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-7)	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-1)	
FR1 FDD	PDSCH	Clause 5.2.3.1.1 (Test 1-7)	FR1 FDD	PDSCH	Clause 5.2.3.1.1 (Test 1-1)	
FR1 FDD	PDSCH	Clause 5.2.2.1.10 (Test 1-1 or 1-2)	FR1 FDD	PDSCH	Clause 5.2.2.1.1 (Test 1-5)	
FR1 TDD	PDSCH	Clause 5.2.2.2.10 (Test 1-1 or 1-2)	FR1 TDD	PDSCH	Clause 5.2.2.2.1 (Test 1-7 and 1-11)	
FR1 FDD	PDSCH	Clause 5.2.3.1.10 (Test 1-1 or 1-2)	FR1 FDD	PDSCH	Clause 5.2.3.1.1 (Test 1-5)	
FR1 TDD	PDSCH	Clause 5.2.3.2.10 (Test 1-1 or 1-2)	FR1 TDD	PDSCH	Clause 5.2.3.2.1 (Test 1-7 and 1-11)	
FR1 FDD	PDSCH	Clause 5.2.2.1.10 (Test 1-2)	FR1 FDD	PDSCH	Clause 5.2.2.1.10 (Test 1-1)	
FR1 TDD	PDSCH	Clause 5.2.2.2.10 (Test 1-2)	FR1 TDD	PDSCH	Clause 5.2.2.2.10 (Test 1-1)	
FR1 FDD	PDSCH	Clause 5.2.3.1.10 (Test 1-2)	FR1 FDD	PDSCH	Clause 5.2.3.1.10 (Test 1-1)	
FR1 TDD	PDSCH	Clause 5.2.3.2.10 (Test 1-2)	FR1 TDD	PDSCH	Clause 5.2.3.2.10 (Test 1-1)	

Table 5.1.1.5-2: Applicability of requirements for HST Enhanced SFN Transmission schemes

If UE has passed			UE can skip			Applicability notes
Test type		Test list	Test type		Test list	
FR1 FDD	PDSCH	Clause 5.2.2.1.20	FR1 FDD	PDSCH	Clause 5.2.2.1.21	
FR1 TDD	PDSCH	Clause 5.2.2.2.21	FR1 TDD	PDSCH	Clause 5.2.2.2.22	
FR1 FDD	PDSCH	Clause 5.2.3.1.19	FR1 FDD	PDSCH	Clause 5.2.3.1.20	

FR1 TDD	PDSCH	Clause 5.2.3.2.20	FR1 TDD	PDSCH	Clause 5.2.3.2.21	

5.1.1.6 Applicability and test rules for PDSCH performance requirements with power imbalance for intra-band contiguous CA

For UE passing the FDD and TDD CA power imbalance performance requirements with 2 DL CCs as defined in sections 5.2A.2.2 and 5.2A.3.2, the test coverage can be considered fulfilled with FDD or TDD intra-band contiguous CA with 3 or more DL CCs supported by the UE. During the test, UE is required to test the supported intra-band contiguous CA configurations with 2 DL CCs covering the lowest and highest operating bands.

The channel bandwidth combination for testing is determined by following procedure:

- First select the bandwidth combinations with the same bandwidth in each carrier.
  - If there is no such bandwidth combination, select the bandwidth combinations with smallest bandwidth difference between the two carriers, and the carrier with smaller bandwidth will be used for test.
- Among the bandwidth combinations selected, select the CA combination with largest aggregated bandwidth combination.

5.1.1.7 Applicability of CA requirements

5.1.1.7.1 Definition of CA capability

The definition with respect to CA capabilities is given as in Table 5.1.1.7.1-1.

Table 5.1.1.7.1-1: Definition of CA capability

CA Capability	CA Capability Description
CA_C	Intra-band contiguous CA
CA_N	Intra-band non-contiguous CA
CA_AX	Inter-band CA (X bands)
NOTE 1: CA_C corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.1 of TS 38.101-1 [6]. CA_N corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.2 of TS 38.101-1 [6]. CA_AX corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.3 of TS 38.101-1 [6].	

5.1.1.7.2 Applicability and test rules for different CA configurations and bandwidth combination sets

The performance requirement for CA UE demodulation tests in Clause 5.2A are defined independent of CA configurations and bandwidth combination sets specified in Clause 5.5A of TS 38.101-1. For UEs supporting different CA configurations and bandwidth combination sets, the applicability and test rules are defined in Table 5.1.1.7.2-1 and Table 5.1.1.7.2-2. For simplicity, CA configuration below refers to combination of CA configuration and bandwidth combination set.

Table 5.1.1.7.2-1: Applicability and test rules for CA UE demodulation tests

Tests	CA capability where the tests apply	CA configuration from the selected CA capability where the tests apply	CA Bandwidth combination to be tested in priority order	PCell CC configuration
Test 1 in Clause 5.2A.2.1 and 5.2A.3.1	CA_C, CA_N, CA_AX	Table 5.1.1.7.2-2	Largest aggregated CA bandwidth combination	Any of CCs

Test 2 in Clause 5.2A.2.1 and 5.2A.3.1	CA_C, CA_N, CA_AX	Table 5.1.1.7.2-2	Largest aggregated CA bandwidth combination	Any of CCs
Test 3 in Clause 5.2A.2.1 and 5.2A.3.1	CA_AX	Table 5.1.1.7.2-2	Largest aggregated CA bandwidth combination	TDD CC if supported, otherwise FDD CC
Test 4 in Clause 5.2A.2.1 and 5.2A.3.1 (NOTE 2)	CA_AX	Table 5.1.1.7.2-2	Largest aggregated CA bandwidth combination	Any of CCs
Test 5 in Clause 5.2A.2.1 and 5.2A.3.1 (NOTE 3)	CA_AX	Table 5.1.1.7.2-2	Largest aggregated CA bandwidth combination	15 kHz CC if supported, otherwise 30 kHz CC
NOTE 1: In case CA_AX with different number of X is supported then one or two CA configurations are selected based on procedure from Table 5.1.1.7.2-2. NOTE 2: These scenarios are only tested for UEs which are not verified with Test 3 in Clause 5.2A.2.1 and 5.2A.3.1. NOTE 3: These scenarios are only tested for UEs which are not verified with Test 2 in Clause 5.2A.2.1 and 5.2A.3.1.				

Table 5.1.1.7.2-2: Selection of CA configurations

CA capability	Step 1	Step 2	Step 3	Step 4
CA_C or CA_N	Select the CA configurations with the maximum number of CCs, for which the supported maximum number of MIMO layers is not lower than 2.	Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 1.	N/A	N/A
CA_AX	Select the CA configurations with the maximum number of CCs, for which the supported maximum number of MIMO layers is not lower than 2.	Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 1.	Select the CA configurations with the largest number of bands and with the maximum number of CCs, for which the supported maximum number of MIMO layers is not lower than 2.	Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 3.
NOTE 1: For CA_AX capability, if CA configuration from step 2 is CA configuration with the largest number of bands then Step 3 and Step 4 are skipped. Otherwise, the two CA configurations selected from Step 2 and Step 4 are used for testing. NOTE 2: Maximum supported data rate for Step 2 and Step 4 is calculated based clause 4.1.2 of TS 38.306 [14]. NOTE 3: Tested data rate for Step 2 and Step 4 is calculated based on the equation $DataRate = 10^{-3}\sum_{j=1}^{J} TBS_j 2^{\mu_j}$ and FRCs used in the test.				

5.1.1.7.3 Applicability rule and antenna connection for CA tests with 4 RX

Within the CA configuration if any of the PCell and/or the SCells is a 2Rx supported RF band, 2 out of the 4Rx should be connected with data source from system simulator, depending on UE's declaration and AP configuration. Requirements from Clause 5.2A.2.1 are applied.

Within the CA configuration if any of the PCell and/or the SCells is a 4Rx supported RF band, all 4Rx should be connected with data source from system simulator. Requirements from Clause5.2A.3.1 are applied.

For 4Rx capable UEs, the 2Rx supported RF bands and 4Rx supported RF bands are up to UE's declaration.

5.1.1.7.4 Applicability of different requirements for HST

The applicability rules for different HST requirements in section 5 are specified in Table 5.1.1.7.4-1.

Table 5.1.1.7.4-1: Applicability of requirements for HST

If UE has passed			UE can skip			Applicability notes
Test type		Test list	Test type		Test list	
FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 3), and Clause 5.2A.2.5 (Test 1-2)	FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 2), and Clause 5.2A.2.5 (Test 1-3)	
FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 1), and Clause 5.2A.2.5 (Test 1-2)	FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 2), and Clause 5.2A.2.5 (Test 1-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 3), and Clause 5.2A.3.5 (Test 1-2)	FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 2), and Clause 5.2A.3.5 (Test 1-3),	
FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 1), and Clause 5.2A.3.5 (Test 1-2)	FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 2), and Clause 5.2A.3.5 (Test 1-1),	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 1-3)	FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 1-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 3)	FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 1-3)	FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 1-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 3)	FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 3)	FR1 2Rx	PDSCH	Clause 5.2.2.1.9 (Test 1-1), Clause 5.2.2.2.1 (Test 1-11), Clause 5.2.2.2.9 (Test 1-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 1-3)	FR1 2Rx	PDSCH	Clause 5.2.2.1.10 (Test 1-1), Clause 5.2.2.2.1 (Test 1-11), Clause 5.2.2.2.10 (Test 1-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 1)	FR1 2Rx	PDSCH	Clause 5.2.2.1.9 (Test 1-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 1-1)	FR1 2Rx	PDSCH	Clause 5.2.2.1.10 (Test 1-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 2)	FR1 2Rx	PDSCH	Clause 5.2.2.2.1 (Test 1-11), Clause 5.2.2.2.9 (Test 1-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 1-2)	FR1 2Rx	PDSCH	Clause 5.2.2.2.1 (Test 1-11), Clause 5.2.2.2.10 (Test 1-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 3)	FR1 4Rx	PDSCH	Clause 5.2.3.1.9 (Test 1-1), Clause 5.2.3.2.1 (Test 1-11), Clause 5.2.3.2.9 (Test 1-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 1-3)	FR1 4Rx	PDSCH	Clause 5.2.3.1.10 (Test 1-1), Clause 5.2.3.2.1 (Test 1-11), Clause 5.2.3.2.10 (Test 1-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 1)	FR1 4Rx	PDSCH	Clause 5.2.3.1.9 (Test 1-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 1-1)	FR1 4Rx	PDSCH	Clause 5.2.3.1.10 (Test 1-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 2)	FR1 4Rx	PDSCH	Clause 5.2.3.2.1 (Test 1-11), Clause 5.2.3.2.9 (Test 1-1)	

FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 1-2)	FR1 4Rx	PDSCH	Clause 5.2.3.2.1 (Test 1-11), Clause 5.2.3.2.10 (Test 1-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 2-1)	FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 1-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 2-2)	FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 1-2)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 2-3)	FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 1-3)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 2-1)	FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 1-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 2-2)	FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 1-2)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 2-3)	FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 1-3)	
FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 3), and Clause 5.2A.2.5 (Test 2-2)	FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 2), and Clause 5.2A.2.5 (Test 2-3)	
FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 1), and Clause 5.2A.2.5 (Test 2-2)	FR1 2Rx	PDSCH	Clause 5.2A.2.4 (Test 2), and Clause 5.2A.2.5 (Test 2-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 3), and Clause 5.2A.3.5 (Test 2-2)	FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 2), and Clause 5.2A.3.5 (Test 2-3),	
FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 1), and Clause 5.2A.3.5 (Test 2-2)	FR1 4Rx	PDSCH	Clause 5.2A.3.4 (Test 2), and Clause 5.2A.3.5 (Test 2-1),	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 2-3)	FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 2-1)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 2-3)	FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 2-1)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 2-3)	FR1 2Rx	PDSCH	Clause 5.2.2.1.10 (Test 1-1), Clause 5.2.2.2.1 (Test 1-11), Clause 5.2.2.2.10 (Test 1-1), Clause 5.2.2.1.10 (Test 1-2), Clause 5.2.2.2.10 (Test 1-2)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 2-1)	FR1 2Rx	PDSCH	Clause 5.2.2.1.10 (Test 1-1), Clause 5.2.2.1.10 (Test 1-2)	
FR1 2Rx	PDSCH	Clause 5.2A.2.5 (Test 2-2)	FR1 2Rx	PDSCH	Clause 5.2.2.2.1 (Test 1-11), Clause 5.2.2.2.10 (Test 1-1), Clause 5.2.2.2.10 (Test 1-2)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 2-3)	FR1 4Rx	PDSCH	Clause 5.2.3.1.10 (Test 1-1), Clause 5.2.3.2.1 (Test 1-11), Clause 5.2.3.2.10 (Test 1-1), Clause 5.2.3.1.10 (Test 1-2), Clause 5.2.3.2.10 (Test 1-2)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 2-1)	FR1 4Rx	PDSCH	Clause 5.2.3.1.10 (Test 1-1), Clause 5.2.3.1.10 (Test 1-2)	
FR1 4Rx	PDSCH	Clause 5.2A.3.5 (Test 2-2)	FR1 4Rx	PDSCH	Clause 5.2.3.2.1 (Test 1-11), Clause 5.2.3.2.10 (Test 1-1), Clause 5.2.3.2.10 (Test 1-2)	

Table 5.1.1.7.4-2: Applicability of requirements for HST-SFN CA test

UE feature/capability [14]	Test type	Test list	Applicability notes

Enhanced demodulation requirements for CA in HST SFN FR1 (*demodulationEnhancementCA-r17*)	FDD 15 kHz + FDD 15 kHz CA	PDSCH	Clause 5.2A.2.4 Table 5.2A.2.4-3 Clause 5.2A.3.4 Table 5.2A.3.4-3	
	TDD 30 kHz + TDD 30 kHz CA	PDSCH	Clause 5.2A.2.4 Table 5.2A.2.4-4 Clause 5.2A.3.4 Table 5.2A.3.4-4	
	FDD 15 kHz + TDD 30 kHz CA	PDSCH	Clause 5.2A.2.4 Table 5.2A.2.4-3 and Table 5.2A.2.4-4 per CC Clause 5.2A.3.4 Table 5.2A.3.4-3 and Table 5.2A.3.4-4 per CC	

5.1.1.8 Applicability of different requirements with Multi-TRxP

The applicability rules for requirements with multi-TRxP transmission schemes in section 5 are specified in Table 5.1.1.8-1.

Table 5.1.1.8-1: Applicability of requirements with Multi-TRxP Transmission

If UE has passed			UE can skip			Applicability notes
Test type		Test list	Test type		Test list	
FR1 FDD	PDSCH	Clause 5.2.2.1.12 (Test 1-1)	FR1 FDD	PDSCH	Clause 5.2.2.1.11 (Test 1-1)	
FR1 FDD	PDSCH	Clause 5.2.2.1.12 (Test 1-1)	FR1 FDD	PDSCH	Clause 5.2.2.1.13 (Test 1-1)	
FR1 FDD	PDSCH	Clause 5.2.2.1.6 (Test 1-1)	FR1 FDD	PDSCH	Clause 5.2.2.1.14 (Test 1-1)	
FR1 TDD	PDSCH	Clause 5.2.2.2.12 (Test 1-1)	FR1 TDD	PDSCH	Clause 5.2.2.2.11 (Test 1-1)	
FR1 TDD	PDSCH	Clause 5.2.2.2.12 (Test 1-1)	FR1 TDD	PDSCH	Clause 5.2.2.2.13 (Test 1-1)	
FR1 TDD	PDSCH	Clause 5.2.2.2.6 (Test 1-1)	FR1 TDD	PDSCH	Clause 5.2.2.2.14 (Test 1-1)	
FR1 FDD	PDSCH	Clause 5.2.3.1.12 (Test 1-1)	FR1 FDD	PDSCH	Clause 5.2.3.1.11 (Test 1-1)	
FR1 FDD	PDSCH	Clause 5.2.3.1.12 (Test 1-1)	FR1 FDD	PDSCH	Clause 5.2.3.1.13 (Test 1-1)	
FR1 FDD	PDSCH	Clause 5.2.3.1.6 (Test 1-1)	FR1 FDD	PDSCH	Clause 5.2.3.1.14 (Test 1-1)	
FR1 TDD	PDSCH	Clause 5.2.3.2.12 (Test 1-1)	FR1 TDD	PDSCH	Clause 5.2.3.2.11 (Test 1-1)	
FR1 TDD	PDSCH	Clause 5.2.3.2.12 (Test 1-1)	FR1 TDD	PDSCH	Clause 5.2.3.2.13 (Test 1-1)	
FR1 TDD	PDSCH	Clause 5.2.3.2.6 (Test 1-1)	FR1 TDD	PDSCH	Clause 5.2.3.2.14 (Test 1-1)	

5.1.1.9 Applicability of requirements for PDSCH on bands with shared spectrum access

Tests	Applicability notes
All tests in Clause 5.2.2.2.15 and 5.2.3.2.15	Only test the supported largest channel bandwidth.
All tests in Clause 5.2A.2.3 and 5.2A.3.3	Only test the supported largest channel bandwidth on SCell.

5.1.1.10 Applicability of requirements for PDSCH with inter cell interference

Tests	Applicability notes
All tests in Clause 5.2.2.1.15, 5.2.3.1.15, 5.2.2.2.16 and 5.2.3.2.16	If UE supporting both duplex mode TDD and FDD with 2RX, only test 1-1 in clause 5.2.2.1.15 and test 1-2 in clause 5.2.2.2.16 will be applied. If UE supporting both duplex mode TDD and FDD with 4RX, only test 1-1 in clause 5.2.3.1.15 and test 1-2 in clause 5.2.3.2.16 will be applied.

5.1.1.11 Applicability of requirements for RedCap

The performance requirements in Table 5.1.1.11-1 shall apply for UEs which support optional feature *supportOfRedCap*.

Other performance requirements mandatory for UE supporting NR operation defined in Section 5 but not included in table 5.1.1.11-1 should not be considered applicable to RedCap UEs.

Table 5.1.1.11-1: Requirements applicability for RedCap

UE capability	Test type		Test list	Applicability notes
RedCap with 1RX	FR1 FDD and HD-FDD (Note 1)	PDSCH	All tests in Clause 5.2.1.1.1	Test 1-4 in Table 5.2.1.1.1-3 is only applicable for RedCap UEs supporting 256QAM modulation scheme (*pdsch-256QAM-FR1*)
		PDCCH	All tests in Clause 5.3.1.1.1	
		PBCH	All tests in Clause 5.4.1.1	
		SDR	Clause 5.5.1	
	FR1 TDD	PDSCH	All tests in Clause 5.2.1.2.1	Test 1-4 in Table 5.2.1.2.1-3 is only applicable for RedCap UEs supporting 256QAM modulation scheme (*pdsch-256QAM-FR1*)
		PDCCH	All tests in Clause 5.3.1.2.1	
		PBCH	All tests in Clause 5.4.1.2	
		SDR	Clause 5.5.1	
RedCap with 2RX	FR1 FDD and HD-FDD (Note 1)	PDSCH	All tests in Clause 5.2.2.1.17	Test 1-3 in Table 5.2.2.1.17-3 is only applicable for RedCap UEs supporting 256QAM modulation scheme (*pdsch-256QAM-FR1*)
		PDCCH	All tests in Clause 5.3.2.1.4	
		PBCH	Clause 5.4.2.1 (Table 5.4.2.1-2 Test 1-1) Clause 5.4.2.1 (Table 5.4.2.1-3 Test 2-1)	
		SDR	Clause 5.5.1	
	FR1 TDD	PDSCH	All tests in Clause 5.2.2.2.18	Test 1-2 in Table 5.2.2.2.18-3 is only applicable for RedCap UEs supporting 256QAM modulation scheme (*pdsch-256QAM-FR1*)
		PDCCH	All tests in Clause 5.3.2.2.4	

		PBCH	Clause 5.4.2.2 (Table 5.4.2.2-4 Test 3-1) Clause 5.4.2.2 (Table 5.4.2.2-5 Test 4-1)	
		SDR	Clause 5.5.1	
Note 1: If UE support only HD-FDD in a FDD band, this UE is tested with HD-FDD mode otherwise UE is tested with full-duplex FDD mode				

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
Carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 2)	RBs	0
	Subcarrier spacing	kHz	15 or 30
DL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH	Symbols	0, 1
	Number of PRBs in CORESET		Table 5.2-2 for tested channel bandwidth and subcarrier spacing
	Number of PDCCH candidates and aggregation levels		1/AL8
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
	TCI state		TCI state #1
	PDCCH & PDCCH DMRS Precoding configuration		For number of TX = 1: No precoding; For number of TX > 1: Single Panel Type I; Randomized precoder selection for every REG bundle and updated per slot with equal probability of each applicable i_1/i_2 combination or codebook index, chosen from section 5.2.2.2.1 of TS 38.214 [12] For number of Tx>2, set “codebookMode” to 1 as defined in section 5.2.2.2.1 of TS 38.214 [12]
Cross carrier scheduling			Not configured
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k_0=0 for CSI-RS resource 1,2,3,4
	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 1 and 3 l_0 = 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 30 kHz SCS: 40 for CSI-RS resource 1,2,3,4
	CSI-RS offset	Slots	15 kHz SCS: 10 for CSI-RS resource 1 and 2

				11 for CSI-RS resource 3 and 4 30 kHz SCS: 20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	QCL info			TCI state #0
NZP CSI-RS for CSI acquisition	Row index (Note 3)			3 for 2 CSI-RS ports and 5 for 4 CSI-RS ports
	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			'No CDM' for 1 transmit antenna 'FD-CDM2' for 2 and 4 transmit antenna
	Density (ρ)			1
	CSI-RS periodicity		Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset		Slots	0
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Row index (Note 3)			5
	First subcarrier index in the PRB used for CSI-RS			$k_0 = 4$
	First OFDM symbol in the PRB used for CSI-RS			$l_0 = 12$
	Number of CSI-RS ports (X)			4
	CDM Type			'FD-CDM2'
	Density (ρ)			1
	CSI-RS periodicity		Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset		Slots	0
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size/4)*4
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
	Position of the first DMRS for PDSCH mapping type A			2
	Number of PDSCH DMRS CDM group(s) without data			1 for Rank 1 and Rank 2 tests 2 for Rank 3 and Rank 4 tests
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
PT-RS configuration				PT-RS is not configured
Maximum number of code block groups for ACK/NACK feedback				1
Maximum number of HARQ transmission				4
PUCCH HARQ ACK spaitial bundling				Not configured
Redundancy version coding sequence				{0,2,3,1}
PDSCH & PDSCH DMRS Precoding configuration				For number of TX = 1: No precoding; For number of TX > 1:Single Panel Type I; Randomized precoder selection for every PRB bundle and updated per slot, with equal probability of each applicable i_1/i_2 combination or codebook

		index, chosen from section 5.2.2.2.1 of TS 38.214 [12]. For number of Tx>2 and Rank=1 or 2, Set "codebookMode" to 1 as defined in section 5.2.2.2.1 of TS 38.214 [12]
Symbols for all unused REs		OP.1 FDD as defined in Annex A.5.1.1 OP.1 TDD as defined in Annex A.5.2.1
Physical signals, channels mapping and precoding		As specified in Annex B.4.1
Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. Note 3: Refer to Table 7.4.1.5.3-1 in [9]		

Table 5.2-2: Number of PRBs in CORESET

SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	35 MHz	40 MHz	45 MHz	50 MHz	60 MHz	80 MHz	100 MHz
15	24	48	78	102	132	156	186	216	240	270	N/A	N/A	N/A
30	6	24	36	48	60	78	90	102	114	132	162	216	270

5.2.1 1RX requirements

5.2.1.1 FDD

5.2.1.1.1 Minimum requirements for RedCap

The performance requirements are specified in Table 5.2.1.1.1-3, with the addition of test parameters in Table 5.2.1.1.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.1.1.1-1.

Table 5.2.1.1.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance under 1 receive antenna conditions and with different channel models and MCSs for RedCap	1-1, 1-2, 1-3, 1-4

Table 5.2.1.1.1-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Test 1-1 2 for other tests
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A

PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Test 1-1, 1 for other tests
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	Table 5.2-1
	CSI-RS offset	Slots	Table 5.2-1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.1.1.1-3: Minimum performance for Rank 1

Test num.	Reference channel (Note 1)	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.1 FDD R.PDSCH. 1-1.1 HD-FDD	10 / 15	QPSK, 0.30	TDLB100-400	2x1 Low	70	3.7
1-2	R.PDSCH.1-2.1 FDD R.PDSCH. 1-1.2 HD-FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x1 Low	70	12.2
1-3	R.PDSCH.1-3.5 FDD R.PDSCH. 1-1.3 HD-FDD	10 / 15	64QAM, 0.50	TDLA30-10	2x1 Low	70	16.5
1-4	R.PDSCH.1-4.2 FDD R.PDSCH. 1-1.4 HD-FDD	10 / 15	256QAM, 0.67	TDLA30-10	2x1 Low	70	25.3
Note 1: Applied reference channel depends on the supported operation mode: FDD or HD-FDD.							

5.2.1.2 TDD

5.2.1.2.1 Minimum requirements for RedCap

The performance requirements are specified in Table 5.2.1.2.1-3, with the addition of test parameters in Table 5.2.1.2.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.1.2.1-1.

Table 5.2.1.2.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs for RedCap UEs	1-1, 1-2, 1-3, 1-4

Table 5.2.1.2.1-2: Test parameters

Parameter	Unit	Value
Duplex mode		TDD

Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Test 1-1, 2 for other tests
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Test 1-1, 1 for other tests
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	First OFDM symbol in the PRB used for CSI-RS		Table 5.2-1
	CSI-RS periodicity	Slots	Table 5.2-1
	CSI-RS offset	Slots	Table 5.2-1
	Frequency Occupation		Table 5.2-1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.1.2.1-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-1.5 TDD	20 / 30	QPSK, 0.30	FR1.30-1A	TDLB100-400	2x1 Low	70	3.8
1-2	R.PDSCH.2-26.1 TDD	20 / 30	16QAM, 0.48	FR1.30-1	TDLC300-100	2x1 Low	70	12.3
1-3	R.PDSCH.2-3.5 TDD	20 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x1 Low	70	17.1
1-4	R.PDSCH.2-4.3 TDD	20 / 30	256QAM, 0.67	FR1.30-1	TDLA30-10	2x1 Low	70	25.5

5.2.2 2RX requirements

5.2.2.1 FDD

5.2.2.1.1 Minimum requirements for PDSCH Mapping Type A

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

The test purposes are specified in Table 5.2.2.1.1-1.

Table 5.2.2.1.1-1: Tests purpose

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

Table 5.2.2.1.1-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Test 1-1 2 for other tests
	Resource allocation type		Test 1-2: Type 1 with start RB = 23, L_{RBs} = 6 Other tests: Type 0
	RBG size		Test 1-2: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Tests 1-1, 1-5, 1-6, 1-7 1 for other tests
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	Test 1-5, 1-6, 1-7: 10 for CSI-RS resource 1,2,3,4. Other tests: Table 5.2-1.
	CSI-RS offset	Slots	Test 1-5, 1-6, 1-7: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4. Other tests: Table 5.2-1.
Number of HARQ Processes			8 for Test 1-4 4 for other tests
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.1-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)

1-1	R.PDSCH.1-1.1 FDD	10 / 15	QPSK, 0.30	TDLB100-400	2x2, ULA Low	70	-0.8
1-2	R.PDSCH.1-1.2 FDD	10 / 15	QPSK, 0.30	TDLC300-100	2x2, ULA Low	70	0.2
1-3	R.PDSCH.1-4.1 FDD	10 / 15	256QAM, 0.82	TDLA30-10	2x2, ULA Low	70	24.6
1-4	R.PDSCH.1-2.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	30	1.1
1-5	R.PDSCH.1-8.1 FDD	10 / 15	16QAM, 0.48	HST-750	1x2	70	6.2
1-6	R.PDSCH.1-8.2 FDD	10 / 15	64QAM, 0.43	HST-972	1x2	70	9.9
1-7	R.PDSCH.1-8.1 FDD	10 / 15	16QAM, 0.48	TDLC300-600	2x2, ULA Low	70	8.6
1-8	R.PDSCH.1-17.1 FDD	10 / 15	1024QAM, 0.79	TDLD30-5	2x2, ULA Low	70	29.5

Table 5.2.2.1.1-4: Minimum performance for Rank 2

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

Table 5.2.2.1.1-5: Minimum performance for Rank 2 and Enhanced Receiver Type 1

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

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

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

The test purposes are specified in Table 5.2.2.1.2-1.

Table 5.2.2.1.2-1: Tests purpose

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

Table 5.2.2.1.2-2: Test parameters

Parameter	Unit	Value

Duplex mode			FDD
Active DL BWP index			1
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
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for CSI acquisition	OFDM symbols in the PRB used for CSI-RS		$l_0 = 13$
	CSI-RS periodicity	Slots	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	Slots	5
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.2-3: Minimum performance for Rank 2

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

5.2.2.1.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.2.1.3-1.

Table 5.2.2.1.3-1: Tests purpose

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

Table 5.2.2.1.3-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type B
	k0		0

	Starting symbol (S)		5
	Length (L)		7
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.3-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.3 FDD	10 / 15	QPSK, 0.30	TDLA30-10	2x2, ULA Low	70	-0.9

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

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

The test purposes are specified in Table 5.2.2.1.4-1.

Table 5.2.2.1.4-1: Tests purpose

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

Table 5.2.2.1.4-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
NR UL transmission with a 7.5 kHz shift to the LTE raster			true
PDCCH configuration	Symbols with PDCCH		Symbol# 2
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2

	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Position of the first DM-RS for downlink		3
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CRS for rate matching (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	MHz	10
	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: No MBSFN is configured on LTE carrier			

Table 5.2.2.1.4-3: Minimum performance for Rank 1

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

5.2.2.1.5 Minimum requirements for PDSCH 0.001% BLER

The performance requirements are specified in Table 5.2.2.1.5-3, with the addition of test parameters in Table 5.2.2.1.5-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.5-1.

Table 5.2.2.1.5-1: Tests purpose

Purpose	Test index
Verify the PDSCH 0.001% BLER performance under 2 receive antenna conditions	1-1

Table 5.2.2.1.5-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A

PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Maximum number of HARQ transmission			1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.5-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Target BLER	SNR (dB)
1-1	R.PDSCH.1-1.4 FDD	10 / 15	QPSK, 0.59	AWGN	1x2, ULA Low	0.001%	3.2

5.2.2.1.6 Minimum requirements for PDSCH repetitions over multiple slots

The performance requirements are specified in Table 5.2.2.1.6-3, with the addition of test parameters in Table 5.2.2.1.6-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.6-1.

Table 5.2.2.1.6-1: Tests purpose

Purpose	Test index
Verify the PDSCH repetitions over multiple slots performance under 2 receive antenna conditions	1-1

Table 5.2.2.1.6-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		2
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.6-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Target BLER	SNR (dB)
1-1	R.PDSCH.1-11.1 FDD	10 / 15	16QAM, 0.54	TDLA30-10	2x2, ULA Low	1% (Note 1)	1.6
Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block.							

5.2.2.1.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2

The performance requirements are specified in Table 5.2.2.1.7-3, with the addition of test parameters in Table 5.2.2.1.7-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.7-1.

Table 5.2.2.1.7-1: Tests purpose

Purpose	Test index
Verify PDSCH mapping Type B performance and UE processing capability 2 under two receive antenna conditions	1-1

Table 5.2.2.1.7-2: Test parameters

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

Table 5.2.2.1.7-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)

1-1	R.PDSCH.1-12.1 FDD	10 / 15	QPSK, 0.30	TDLA30-10	2x2, ULA Low	70	0.8

5.2.2.1.8 Minimum requirements for PDSCH pre-emption

The performance requirements are specified in Table 5.2.2.1.8-3, with the addition of test parameters in Table 5.2.2.1.8-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.8-1.

Table 5.2.2.1.8-1: Tests purpose

Purpose	Test index
Verify the PDSCH pre-emption performance under 2 receive antenna conditions	1-1

Table 5.2.2.1.8-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDCCH configuration (Note 4)	Symbols with PDCCH		0, 1
	DCI format		2_1
	timeFrequencySet		14x1
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
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Pre-emption configuration (Note 2)	Starting symbol (S)		3
	Length (L)		2
	Pre-emption periodicity and offset (Note 3)	Slots	10/1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: Void Note 2: Interference modelled as random data on pre-empted REs. Note 3: Pre-emption is scheduled with a fixed scheduling with 10% probability within 10ms periodicity. Note 4: In addition to PDCCH configuration in Table 5.2-1.			

Table 5.2.2.1.8-3: Minimum performance for Rank 1

						Reference value

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-2.6 FDD	10 / 15	16QAM 0.64	TDLA30-10	2x2, ULA Low	70	10.5

5.2.2.1.9 Minimum requirements for PDSCH HST-SFN

The performance requirements are specified in Table 5.2.2.1.9-3, with the addition of test parameters in Table 5.2.2.1.9-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.9-1.

Table 5.2.2.1.9-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions in the HST-SFN scenario defined in B.3.2 when highSpeedDemodFlag-r16 IE [17] is configured	1-1

Table 5.2.2.1.9-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
	CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4.
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.9-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-8.3 FDD	10 / 15	16QAM, 0.48	HST-SFN	2x2	70	13.0

5.2.2.1.10 Minimum requirements for HST-DPS

The performance requirements are specified in Table 5.2.2.1.10-3, with the addition of test parameters in Table 5.2.2.1.10-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.10-1.

Table 5.2.2.1.10-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-DPS scenario defined in B.3.3	1-1, 1-2

Table 5.2.2.1.10-2: Test parameters

Parameter			Unit	Value
Duplex mode				FDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			12
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #2
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	10 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #3
NZP CSI-RS for CSI acquisition	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration

		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				4
The number of slots between PDSCH and corresponding HARQ-ACK information				2

Note 1: SSB # (k mod 2) , CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by kth RRH.

For Test 1-1, TCI state switching command scheduled by MAC CE with PDSCH configuration - MCS 4, Layer 1, StartRB 24, NumOfRB 28 is transmitted in slot #i that satisfy mod(i,2n)=n.
PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by kth RRH from:
slot# max [(2k-1)n+1+T_HARQ+T_(MAC proc)+T_firstTRS+T_(TRS proc),0]
to:
slot# (2k+1)n,
PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

For Test 1-2, TCI state switching command scheduled by MAC CE with PDSCH configuration - MCS 4, Layer 1, StartRB 24, NumOfRB 28 is transmitted in slot #i that satisfy mod(i,2n)=n.
PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by kth RRH from:
slot# max [(2k-1)n+1+T_HARQ+T_(MAC proc),0]
to:
slot# (2k+1)n
PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

Where k=0, 1, 2… is the RRH number, n = 2520 is half of the number of slots between two RRH, T_HARQ = 2 is the number of slots between PDSCH and corresponding HARQ-ACK information, T_(MAC proc) = 3 is the number of slots for MAC CE processing, T_firstTRS = 6 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, T_(TRS proc) = 2 is the number of slots for TRS processing.

Table 5.2.2.1.10-3: Minimum performance for HST-DPS

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-8.4 FDD	10 / 15	64QAM, 0.43	HST-DPS	1	2x2	70	13.4
1-2	R.PDSCH.1-8.4 FDD	10 / 15	64QAM, 0.43	HST-DPS	2	2x2	70	13.4

5.2.2.1.11 Minimum requirements for PDSCH Single-DCI based SDM scheme

The performance requirements are specified in Table 5.2.2.1.11-3, with the addition of test parameters in Table 5.2.2.1.11-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.11-1.

Table 5.2.2.1.11-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance with Single-DCI based SDM scheme under 2 receive antenna conditions	1-1,1-2

Table 5.2.2.1.11-2: Test parameters

Parameter			Unit	Value	
				TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration	TCI state			TCI State #1	
	CORESETPoolIndex			0	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	20	
	CSI-RS offset		Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
Duplex mode				FDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 1	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000	1002
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A

TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Full-overlapping	
Timing offset of the second TRxP from the first TRxP			us	-0.5 for test 1-1 2 for test 1-2	
Frequency offset of the second TRxP from the first TRxP			Hz	200 for test 1-1 0 for test 1-2	
Number of HARQ Processes				4	
The number of slots between PDSCH and corresponding HARQ-ACK information				2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity	
Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2)					

Table 5.2.2.1.11-3: Minimum performance

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition(Note 1)	Correlation matrix and antenna configuration(Note 2)	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)(Note 3)
1-1	R.PDSCH.1-3.2 FDD	10 / 15	64QAM, 0.50	TDLA30-10	2x2, ULA Low	70	20.7
1-2	R.PDSCH.1-3.2 FDD	10 / 15	64QAM, 0.50	TDLA30-10	2x2, ULA Low	70	20.1
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2 Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 with scaling factor as 1/sqrt(2) for transmitted signal from each TRxP							

5.2.2.1.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme

The performance requirements are specified in Table 5.2.2.1.12-3, with the addition of test parameters in Table 5.2.2.1.12-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.12-1.

Table 5.2.2.1.12-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance when UE is configured two different values of CORESETPoolIndex in ControlResourceSet and when UE receives multiple PDCCHs scheduling PDSCHs	1-1

Table 5.2.2.1.12-2: Test parameters

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	TCI State #2
	CORESETPoolIndex		0,1	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8

		First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8	
		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8	
		CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8		
		Density		3		
		CSI-RS periodicity	Slots	20		
		CSI-RS offset	Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8	
		QCL info		TCI state #0		
Duplex mode				FDD		
Active DL BWP index				1		
PDSCH configuration	Mapping type			Type A		
	k0			0		
	Starting symbol (S)			2		
	Length (L)			12		
	PRB bundling type			Static		
	PRB bundling size			2		
	Resource allocation type			Type 1		
	RBG size			Config2		
	VRB-to-PRB mapping type			Non-interleaved		
	VRB-to-PRB mapping interleaver bundle size			N/A		
PDSCH DMRS configuration	Antenna port indexes			{1000,1001}	{1002,1003}	
	TCI state			TCI State #1	TCI State #2	
	DMRS Type			Type 1		
	Number of additional DMRS			1		
	Maximum number of OFDM symbols for DL front loaded DMRS			1		
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A	
		QCL Type		Type A	N/A	
	Type 2 QCL information	CSI-RS resource		N/A	N/A	
		QCL Type		N/A	N/A	
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration	
		QCL Type		N/A	Type A	
	Type 2 QCL information	CSI-RS resource		N/A	N/A	
		QCL Type		N/A	N/A	
Resource allocation				Non-overlapping		
Timing offset of the second TRxP from the first TRxP			us	-0.5		
Frequency offset of the second TRxP from the first TRxP			Hz	200		
Number of HARQ Processes				4		
The number of slots between PDSCH and corresponding HARQ-ACK information				2		
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity		
Note 1: PDSCH transmission is done from both TRxPs. Transmission from TRxP #1 uses CORESETPoolIndex 0 and transmission from TRxP #2 uses CORESETPoolIndex 1						

Table 5.2.2.1.12-3: Minimum performance

	Reference channel					Reference value

Test num.			Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition(Note 1)	Correlation matrix and antenna configuration(Note 2)	Fraction of maximum throughput (%)	SNR (dB)(Note 3)
	TRxP #1	TRxP #2						
1-1	R.PDSCH.1-3.3 FDD	R.PDSCH.1-3.4 FDD	10 / 15	64QAM, 0.50	TDLA30-10	2x2, ULA Low	70	20.6
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2 Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2								

5.2.2.1.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A

The performance requirements are specified in Table 5.2.2.1.13-3, with the addition of test parameters in Table 5.2.2.1.13-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.13-1.

Table 5.2.2.1.13-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions when UE is configured with “FDMSchemeA” in “RepetitionScheme-r16” defined in clause 5.1 of TS 38.214 [12]	1-1

Table 5.2.2.1.13-2: Test parameters

Parameter			Unit	Value	
				TRxP #1 (Note 1)	TRxP #2 (Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration		TCI state		TCI State #1	
		CORESETPoolIndex		Not configured	
CSI-RS for tracking		First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
		First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
		CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
		Density		3	
		CSI-RS periodicity	Slots	20	
		CSI-RS offset	Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
		QCL info		TCI state #0	
Duplex mode				FDD	
Active DL BWP index				1	
PDSCH configuration		Mapping type		Type A	
		k0		0	
		Starting symbol (S)		2	
		Length (L)		12	
		PRB bundling type		Static	
		PRB bundling size		wideband	
		Resource allocation type		Type 0	
		RBG size		Config2	

	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000, 1001	1000, 1001
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Timing offset of the second TRxP from the first TRxP			us	-0.5	
Frequency offset of the second TRxP from the first TRxP			Hz	200	
Number of HARQ Processes				4	
The number of slots between PDSCH and corresponding HARQ-ACK information				2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.	
Note 1: PDSCH transmission is done from both TRxPs					

Table 5.2.2.1.13-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition (Note 1)	Correlation matrix and antenna configuration (Note 2)	Reference value	
						Fraction of maximum throughput (%)	SNR (dB) (Note 3)
1-1	R.PDSCH.1-2.5 FDD	10 / 15	16QAM, 0.54	TDLA30-10	2x2, ULA Low	70	17. 3
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2							

5.2.2.1.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme

The performance requirements are specified in Table 5.2.2.1.14-3, with the addition of test parameters in Table 5.2.2.1.14-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.14-1.

Table 5.2.2.1.14-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions when UE is configured with repetitionNumber-r16 with multiple slot level PDSCH transmission occasions of the same TB with two TCI states defined in clause 5.1 of TS 38.214 [12]	1-1

Table 5.2.2.1.14-2: Test parameters

Parameter			Unit	Value	
				TRxP #1 (Note 1)	TRxP #2 (Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration	TCI state			TCI State #1	
	CORESETPoolIndex			Not configured	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	20	
	CSI-RS offset		Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
Duplex mode				FDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	Repetition number			2	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 0	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000	1000
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Timing offset of the second TRxP from the first TRxP			us	2	
Frequency offset of the second TRxP from the first TRxP			Hz	200	
Number of HARQ Processes				4	
The number of slots between PDSCH and corresponding HARQ-ACK information				2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs,	

		random per slot with PRB bundling granularity.
Note 1: PDSCH transmission is done from both TRxPs		

Table 5.2.2.1.14-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition (Note 1)	Correlation matrix and antenna configuration Note 2)	Reference value	
						BLER (%)	SNR (dB) (Note 4)
1-1	R.PDSCH.1-11.2 FDD	10 / 15	16QAM, 0.54	TDLA30-10	2x2, ULA Low	1 (Note 3)	2. 9
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. Note 4: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2							

5.2.2.1.15 Minimum requirements for PDSCH with inter-cell interference

The performance requirements are specified in Table 5.2.2.1.15-3, with the addition of test parameters in Table 5.2.2.1.15-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.15-1.

Table 5.2.2.1.15-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance under 2 receive antenna conditions, when transmission from the serving cell is interfered by 1 or 2 interfering cells.	1-1, 1-2

Table 5.2.2.1.15-2: Test parameters

Parameter		Unit	Value		
			Cell 1	Cell 2	Cell 3
			Enabled	Enabled	Enabled for Test 1-1 Disabled for Test 1-2
Duplex mode			FDD		
Active DL BWP index			1		
Physical cell ID			0	1	2
Transmission rank			1	Random rank with 70% and 30% probability for rank 1 and rank 2	Random rank with 70% and 30% probability for rank 1 and rank 2 for Test 1-1 N/A for Test 1-2
Time offset to Cell1		us	N/A	3	-1
Frequency offset to Cell 1		Hz	N/A	300	-100
Interference Model			N/A	As specified in B.6.2	
INR (Note 2)		dB	N/A	7.77 for Test 1-1 7.58 for Test 1-2	2.29 for Test 1-1 N/A for Test 1-2
SSB configuration	SSB position in burst		First SSB in Slot #0	1st SSB in Slot#0 for Test 1-1 2nd SSB in Slot #0 for Test 1-2	1st SSB in Slot#0 for Test 1-1 N/A for Test 1-2
	SSB periodicity	ms	20	20	20
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
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note1: Cell 1 is the serving cell; Cells 2, 3 are interfering cells Note 2: INR is defined in Annex B.6.1			

Table 5.2.2.1.15-3: Minimum performance for PDSCH with rank 1 and with inter-cell interference

Test num	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH. 1-2.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	15.4
1-2	R.PDSCH. 1-2.1 FDD	10 / 15	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	12.5
Note 1: The propagation conditions for Cell 1, Cell 2 and Cell 3 are statistically independent. Note 2: Bandwidth/ Sub carrier spacing, Propagation Condition, Correlation matrix and antenna configuration parameters apply for each of Cell 1, Cell 2 and Cell 3.							

5.2.2.1.16 Minimum requirements for PDSCH with intra cell inter user interference

The performance requirements are specified in Table 5.2.2.1.16-3, with the addition of test parameters in Table 5.2.2.1.16-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.16-1.

Table 5.2.2.1.16-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance under 2 receive antenna conditions when the PDSCH transmission of target UE is interfered by co-scheduled UE	1-1

Table 5.2.2.1.16-2: Test parameters

Parameter		Unit	Target UE	Co-scheduled UE
Duplex mode			FDD	
Active DL BWP index			1	
PDSCH configuration	Mapping type		Type A	
	k0		0	

	Starting symbol (S)		2	
	Length (L)		12	
	PDSCH aggregation factor		1	
	PRB bundling type		Static	
	PRB bundling size		2	
	Resource allocation type		Type 0	
	RBG size		Config2	
	VRB-to-PRB mapping type		Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size		N/A	
PDSCH DMRS configuration	DMRS Type		Type 1	
	Number of additional DMRS		1	
	Maximum number of OFDM symbols for DL front loaded DMRS		1	
	Antenna ports indexes		1000	1001
	Number of PDSCH DMRS CDM group(s) without data		1	1
PDSCH & PDSCH DMRS Precoding configuration			Single Panel Type I, Randomized precoder selection for every PRB bundle and updated per slot, with equal probability of each applicable i1/i2 combination or codebook Index, chosen from section 5.2.2.2.1 of TS 38.214 [12].	Single Panel Type I, Randomized precoder selection for every PRB bundle and updated per slot, with equal probability of each applicable i1/i2 combination or codebook Index, chosen from section 5.2.2.2.1 of TS 38.214 [12].Any column of precoder matrix is not equal to any column of precoder matrix of Target UE
MU-MIMO Beamforming Model			As specified in B.4.2	
Number of HARQ Processes			4	N/A
The number of slots between PDSCH and corresponding HARQ-ACK information			2	N/A
Note 1: The DMRS scrambling ID is same for both target UE and Co-scheduled UE.				

Table 5.2.2.1.16-3: Minimum performance for PDSCH of target UE with intra-cell inter user interference

Test num	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate		Propagation condition	Correlation matrix and antenna configuration	Reference value	
			Target UE	Co-scheduled UE			Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-2.1 FDD	10 / 15	16QAM, 0.48	Random 16QAM symbols	TDLC300-100	2x2, ULA Low	70	18.0

5.2.2.1.17 Minimum requirements for RedCap

The performance requirements are specified in Table 5.2.2.1.17-3 and Table 5.2.2.1.17-4, with the addition of test parameters in Table 5.2.2.1.17-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.17-1.

Table 5.2.2.1.17-1: Tests purpose

Purpose	Test index

Verify the PDSCH mapping Type A normal performance under 2 receive antenna conditions and with different channel models, MCSs for RedCap	1-1, 1-2, 1-3, 2-1

Table 5.2.2.1.17-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Test 1-1 2 for other tests
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Test 1-1 1 for other tests
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	Table 5.2-1
	CSI-RS offset	Slots	Table 5.2-1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.17-3: Minimum performance for Rank 1

Test num.	Reference channel (Note 1)	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.1 FDD R.PDSCH. 1-1.1 HD-FDD	10 / 15	QPSK, 0.30	TDLB100-400	2x2, ULA Low	70	-0.8
1-2	R.PDSCH.1-2.1 FDD R.PDSCH. 1-1.2 HD-FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	8.1
1-3	R.PDSCH.1-4.1 FDD R.PDSCH. 1-1.5 HD-FDD	10 / 15	256QAM, 0.82	TDLA30-10	2x2, ULA Low	70	24.6
Note 1: Applied reference channel depends on the supported operation mode: FDD or HD-FDD.							

Table 5.2.2.1.17-4: Minimum performance for Rank 2

Test num.	Reference channel (Note 1)	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-3.1 FDD R.PDSCH. 1-2.1 HD-FDD	10 / 15	64QAM, 0.50	TDLA30-10	2x2, ULA Low	70	19.4
Note 1: Applied reference channel depends on the supported operation mode: FDD or HD-FDD.							

5.2.2.1.18 Minimum requirements for PDSCH CRS interference mitigation under NR-LTE coexistence scenario

The performance requirements are specified in Table 5.2.2.1.18-4, with the addition of test parameters in Table 5.2.2.1.18-2 for the serving cell and Table 5.2.2.1.18-3 for the LTE interference cells and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.18-1.

Table 5.2.2.1.18-1: Tests purpose

Purpose	Test index
Verify PDSCH CRS interference mitigation performance under 2 receive antenna conditions with CRS rate matching configured for the serving cell.	1-1

Table 5.2.2.1.18-2: Test parameters for the serving cell

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
NR UL transmission with a 7.5 kHz shift to the LTE raster			true
PDCCH configuration	Symbols with PDCCH		Symbol# 2
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Position of the first DM-RS for downlink		3
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CRS for rate matching (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	MHz	10

	Number of antenna ports		2
	v-shift		0
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: No MBSFN is configured on LTE carrier. Note 2: Network-based CRS interference mitigation is disabled on LTE carrier.			

Table 5.2.2.1.18-3: Test parameters for the LTE interference cells

Parameter		Unit	Cell 1	Cell 2
Propagation conditions and MIMO configuration (Note 1)			TDLA30-10 ULA Low	TDLA30-10 ULA Low
INR (Note 2)		dB	10.45	4.6
Cell-specific reference signals			Antenna ports 0,1	Antenna ports 0,1
Carrier centre subcarrier location			Same as the serving carrier centre subcarrier location	Same as the serving carrier centre subcarrier location
$BW_{Channel}$		MHz	10	10
Cyclic Prefix			Normal	Normal
Physical cell ID			1	2
Number of control OFDM symbols			2	2
PDSCH transmission mode			4	4
Interference model			As specified in clause B.7	As specified in clause B.7
Probability of occurrence of PDSCH data		%	20	20
Probability of occurrence of transmission rank	Rank 1	%	80	80
	Rank 2	%	20	20
Downlink power allocation	ρ_A	dB	-3	-3
	ρ_B	dB	-3	-3
	σ	dB	0	0
Precoding granularity		PRB	6	6
Time offset to the serving cell		us	3	-1
Frequency offset to the serving cell		Hz	300	-100
MBSFN			Not configured	Not configured
Network-based CRS interference mitigation			Disabled	Disabled
Note 1: The channel for the LTE interference cells and the serving cell are independent. Note 2: Defined in B.6.1.				

Table 5.2.2.1.18-4: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-7.3 FDD	10 / 15	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	11.9

5.2.2.1.19 Minimum requirements for PDSCH with inter cell CRS interference

The performance requirements are specified in Table 5.2.2.1.19-4 and Table 5.2.2.1.19-6, with the addition of test parameters in Table 5.2.2.1.19-2 and 5.2.2.1.19-3 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.19-1.

Table 5.2.2.1.19-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions when PDSCH is interfered by inter cell CRS signal	1-1 and 2-1

Table 5.2.2.1.19-2: Tests parameter for serving cell PDSCH

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.2.1.19-3: Tests parameter for interference cells

Parameter		Unit	Cell 1	Cell 2
Duplex mode			FDD	FDD
INR		dB	10.45	4.6
LTE Bandwidth (Note 5)		MHz	20	20
Carrier centre subcarrier location (Note 6)			Same as the NR serving carrier centre subcarrier location	Same as the NR serving carrier centre subcarrier location
Cyclic Prefix			Normal	Normal
Physical cell ID			1	2
CRS pattern	Number of antenna ports		4	4
	v-shift		1	2
Downlink power allocation	ρ_A	dB	-6	-6
	ρ_B	dB	-6	-6
	σ	dB	0	0
PDSCH transmission mode			TM4	TM4
PDSCH loading level		%	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-1.	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-1.
Transmission rank		%	80% and 20% probability for rank 1 and rank 2 respectively	80% and 20% probability for rank 1 and rank 2 respectively
Interference model			As specified in clause B.7	As specified in clause B.7
Time offset to the serving cell		us	3	-1

Frequency offset to the serving cell	Hz	300	-100
Propagation conditions and MIMO configuration (Note 1)		TDLA30-10 ULA Low	TDLA30-10 ULA Low
Precoding granularity	PRB	8	8
Note 1: The channel for the LTE interference cells and the serving cell are independent. Note 2: No MBSFN is configured on LTE carrier. Note 3: Network-based CRS interference mitigation is disabled on LTE carrier. Note 4: The start of transmission of LTE frame is delayed by 2 LTE subframes with respect to the start of transmission of NR frame Note 5: This parameter is informed to UE via network assistance signalling for Test 1-1 in Table 5.2.2.1.19-4. Note 6: Single entry is included in IE *LTE-NeighCellsCRS-AssistInfoList-r17* that applies for both cells for cases			

The requirements for UE capable of performing CRS-IM with the assistance of network signaling on LTE channel bandwidth are specified in Table 5.2.2.1.19-4.

Table 5.2.2.1.19-4: Minimum performance for Rank 1 with the assistance of network signaling on LTE channel bandwidth

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-18.1 FDD	10 / 15	16QAM, 0.48	TDLA30-10	4x2, ULA Low	70	11.9

The requirements for UE capable of performing CRS-IM without the assistance of network signaling on LTE channel bandwidth are specified in Table 5.2.2.1.19-6 with following test procedure:

The network configures an inter-RAT LTE measurement object of the interfering cells to the tested UE. Inter-RAT measurement is configured at the beginning of the test and applied throughout the test with gap pattern configurations in Table 5.2.2.1.19-5. PDSCH is not scheduled and throughput is not counted during 4.64s after the beginning of test. PDSCH is not scheduled in the measurement gaps.

Table 5.2.2.1.19-5: Measurement Gap configurations

Parameter	Unit	Value
Measurement Gap Length	ms	6
Measurement Gap Repetition Period	ms	40
Gap offset	ms	7
Measurement gap timeing advance	ms	0

Table 5.2.2.1.19-6: Minimum performance for Rank 1 without the assistance of network signaling on LTE channel bandwidth

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-19.1 FDD	10 / 15	16QAM, 0.48	TDLA30-10	4x2, ULA Low	70	11.9

5.2.2.1.20 Minimum requirements for HST-SFN Scheme A

The performance requirements are specified in Table 5.2.2.1.20-3, with the addition of test parameters in Table 5.2.2.1.20-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.20-1.

Table 5.2.2.1.20-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-SFN Scheme A scenario defined in B.3. 5	1-1

Table 5.2.2.1.20-2: Test parameters

Parameter			Unit	Value
Duplex mode				FDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			12
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #3
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	10 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #4
	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 9 and 11 l_0 = 8 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	10 for CSI-RS resource 9,10,11,12.
		CSI-RS offset	Slots	1 for CSI-RS resource 9 and 10 2 for CSI-RS resource 11 and 12
		QCL info		TCI state #5
NZP CSI-RS for CSI acquisition	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #5	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #6	First OFDM symbol in the PRB used for CSI-RS		l_0 = 7
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration

		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #4	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #5	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				4
The number of slots between PDSCH and corresponding HARQ-ACK information				2
Note 1: SSB # (k mod 3) , CSI-RS (for tracking) resource set # ((k mod 3) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 3) + 4) are transmitted by k^{th} RRH. Codepoint #0 is activated when UE receives PDCCH/PDSCH from RRH#3k and RRH#3k+1 with TCI States TCI state #0, TCI State #1. Codepoint #1 is activated when UE receives PDCCH/PDSCH from RRH#3k+1 and RRH#3k+2 with TCI States TCI state #1, TCI State #2. Codepoint #2 is activated when UE receives PDCCH/PDSCH from RRH#3k+2 and RRH#3k+3 with TCI States TCI state #2, TCI State #0.				

Table 5.2.2.1.20-3: Minimum performance for HST-SFN Scheme A

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-8.5 FDD	10 / 15	16QAM, 0.48	HST-SFN Scheme A	2x2	70	11.8

5.2.2.1.21 Minimum requirements for HST-SFN Scheme B

The performance requirements are specified in Table 5.2.2.1.21-3, with the addition of test parameters in Table 5.2.2.1.21-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.21-1.

Table 5.2.2.1.21-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-SFN Scheme B scenario defined in B.3.6	1-1

Table 5.2.2.1.21-2: Test parameters

Parameter			Unit	Value
Duplex mode				FDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			12
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #3
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	10 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #4
	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 9 and 11 l_0 = 8 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	10 for CSI-RS resource 9,10,11,12.
		CSI-RS offset	Slots	1 for CSI-RS resource 9 and 10 2 for CSI-RS resource 11 and 12
		QCL info		TCI state #5
NZP CSI-RS for CSI acquisition	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #5	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #6	First OFDM symbol in the PRB used for CSI-RS		l_0 = 7
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
		CSI-RS resource		N/A

	Type 2 QCL information	QCL Type		N/A
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #4	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #5	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes			4	
The number of slots between PDSCH and corresponding HARQ-ACK information			2	
Note 1: SSB # (k mod 3), CSI-RS (for tracking) resource set # ((k mod 3) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 3) + 4) are transmitted by k^{th} RRH. Codepoint#0 {TCI state #0, TCI State #1} is activated when UE receives PDCCH/PDSCH from RRH#3k and RRH#3k+1. Codepoint#1 {TCI state #1, TCI State #2} is activated when UE receives PDCCH/PDSCH from RRH#3k+1 and RRH#3k+2. Codepoint#2 {TCI state #2, TCI State #0} is activated when UE receives PDCCH/PDSCH from RRH#3k+2 and RRH#3k+3. The second indicated TCI state in each codepoint is not used for quasi co-location parameters {Doppler shift, Doppler spread}.				

Table 5.2.2.1.21-3: Minimum performance for HST-SFN Scheme B

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-8.5 FDD	10/15	16QAM, 0.48	HST-SFN-Scheme B	2x2	70	11.3

5.2.2.2 TDD

5.2.2.2.1 Minimum requirements for PDSCH Mapping Type A

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

The test purposes are specified in Table 5.2.2.2.1-1.

Table 5.2.2.2.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance 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, 1-7, 1-8, 1-9, 1-10, 1-11, 1-12, 2-1, 2-2
Verify the PDSCH mapping Type A HARQ soft combining performance under 2 receive antenna conditions.	1-4
Verify the PDSCH mapping Type A performance requirements for Enhanced Receiver Type 1 under 2 receive antenna conditions.	3-1

Table 5.2.2.2.1-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Tests 1-1, 1-8, 1-9 2 for other tests
	Resource allocation type		Test 1-2: Type 1 with start RB = 50, L_{RBs} = 6 Other tests: Type 0
	RBG size		Test 1-2: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Tests 1-1, 1-7, 1-8, 1-9, 1-10, 1-11 1 for other tests
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	First OFDM symbol in the PRB used for CSI-RS		Tests 1-8, 1-9: l_0 = 4 for CSI-RS resource 1 and 3 l_0 = 8 for CSI-RS resource 2 and 4 Other tests; Table 5.2-1.
	CSI-RS periodicity	Slots	Test 1-7, 1-10, 1-11: 20 for CSI-RS resource 1,2,3,4. Other tests: Table 5.2-1.
	CSI-RS offset	Slots	Test 1-7, 1-10, 1-11: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4. Other tests: Table 5.2-1.
	Frequency Occupation		Test 1-7, 1-10, 1-11: Start PRB 0 Number of PRB = 52 Other tests: Table 5.2-1.
Number of HARQ Processes			16 for Test 1-4 10 for Test 1-9 8 for other tests
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.2.2.1-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-1.1 TDD	40 / 30	QPSK, 0.30	FR1.30-1A	TDLB100-400	2x2, ULA Low	70	-1.1

1-2	R.PDSCH.2-1.2 TDD	40 / 30	QPSK, 0.30	FR1.30-1	TDLC300-100	2x2, ULA Low	70	0.2
1-3	R.PDSCH.2-4.1 TDD	40 / 30	256QAM, 0.82	FR1.30-1	TDLA30-10	2x2, ULA Low	70	25.3
1-4	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLC300-100	2x2, ULA Low	30	1.6
1-5	R.PDSCH.2-5.1 TDD	40 / 30	QPSK, 0.30	FR1.30-2	TDLA30-10	2x2, ULA Low	70	-0.9
1-6	R.PDSCH.2-6.1 TDD	40 / 30	QPSK, 0.30	FR1.30-3	TDLA30-10	2x2, ULA Low	70	-0.8
1-7	R.PDSCH.2-10.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	HST-1000	1x2	70	6.4
1-8	R.PDSCH.2-11.1 TDD	40 / 30	QPSK, 0.30	FR1.30-5	TDLB100-400	2x2, ULA Low	70	-1.0
1-9	R.PDSCH.2-12.1 TDD	40 / 30	QPSK, 0.30	FR1.30-6	TDLB100-400	2x2, ULA Low	70	-1.1
1-10	R.PDSCH.2-10.2 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLC300-1200	2x2	70	9.5
1-11	R.PDSCH.2-10.3 TDD	40 / 30	64QAM, 0.43	FR1.30-1	HST-1667	1x2	70	9.6
1-12	R.PDSCH.2-25.1 TDD	40 / 30	1024QAM, 0.79	FR1.30-1	TDLD30-5	2x2, ULA Low	70	29.4

Table 5.2.2.2.1-4: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.2-3.1 TDD	40 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x2, ULA Low	70	19.8
2-2	R.PDSCH.2-9.1 TDD	20 / 30	64QAM, 0.50	FR1.30-4	TDLA30-10	2x2, ULA Low	70	19.8

Table 5.2.2.2.1-5: Minimum performance for Rank 2 and Enhanced Receiver Type 1

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

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

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

The test purposes are specified in Table 5.2.2.2.2-1.

Table 5.2.2.2.2-1: Tests purpose

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

Table 5.2.2.2.2-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for CSI acquisition	OFDM symbols in the PRB used for CSI-RS		$l_0 = 13$
	CSI-RS periodicity	Slots	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	Slots	5
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.2.2.2-3: Minimum performance for Rank 2

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

5.2.2.2.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.2.2.3-1.

Table 5.2.2.2.3-1: Tests purpose

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

Table 5.2.2.2.3-2: Test parameters

Parameter	Unit	Value
Duplex mode		TDD

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

Table 5.2.2.2.3-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-1.3 TDD	40 / 30	QPSK, 0.30	FR1.30-1	TDLA30-10	2x2, ULA Low	70	-0.9

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

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

The test purposes are specified in Table 5.2.2.2.4-1.

Table 5.2.2.2.4-1: Tests purpose

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

Table 5.2.2.2.4-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
NR UL transmission with a 7.5 kHz shift to the LTE raster			true
PDCCH configuration	Symbols with PDCCH		Symbol# 2
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2

	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Position of the first DM-RS for downlink		3
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CRS for rate matching (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	MHz	10
	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: No MBSFN is configured on LTE carrier. Note 2: LTE carrier is configured with Uplink-downlink configuration 2 [Table 4.2-2, TS 36.211] and Special subframe configuration 7 [Table 4.2-1, TS 36.211]. The start of transmission of LTE frame is delayed by 2 LTE subframes with respect to the start of transmission of NR frame.			

Table 5.2.2.2.4-3: Minimum performance for Rank 1

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

5.2.2.2.5 Minimum requirements for PDSCH 0.001% BLER

The performance requirements are specified in Table 5.2.2.2.5-3, with the addition of test parameters in Table 5.2.2.2.5-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.5-1.

Table 5.2.2.2.5-1: Tests purpose

Purpose	Test index
Verify the PDSCH 0.001% BLER performance under 2 receive antenna conditions	1-1

Table 5.2.2.2.5-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12

	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Maximum number of HARQ transmission			1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Defined in Annex A.1.2 for TDD pattern FR1.30-1

Table 5.2.2.2.5-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Target BLER	SNR (dB)
1-1	R.PDSCH.2-1.4 TDD	40 / 30	QPSK, 0.59	FR1.30-1	AWGN	1x2, ULA Low	0.001%	3.3

5.2.2.2.6 Minimum requirements for PDSCH repetitions over multiple slots

The performance requirements are specified in Table 5.2.2.2.6-3, with the addition of test parameters in Table 5.2.2.2.6-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.6-1.

Table 5.2.2.2.6-1: Tests purpose

Purpose	Test index
Verify the PDSCH repetitions over multiple slots performance under 2 receive antenna conditions	1-1

Table 5.2.2.2.6-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		2
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1

	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 (Note 1)
Note 1: ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,10) = {2, 4, 6}.			

Table 5.2.2.2.6-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Target BLER	SNR (dB)
1-1	R.PDSCH.2-16.1 TDD	40 / 30	16QAM, 0.54	FR1.30-1	TDLA30-10	2x2, ULA Low	1% (Note 1)	1.4
Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block.								

5.2.2.2.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2

The performance requirements are specified in Table 5.2.2.2.7-3, with the addition of test parameters in Table 5.2.2.2.7-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.7-1.

Table 5.2.2.2.7-1: Tests purpose

Purpose	Test index
Verify PDSCH mapping Type B performance and UE processing capability 2 under two receive antenna conditions	1-1

Table 5.2.2.2.7-2: Test parameters

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

Table 5.2.2.2.7-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-17.1 TDD	40 / 30	QPSK, 0.30	FR1.30-2	TDLA30-10	2x2, ULA Low	70	0.6

5.2.2.2.8 Minimum requirements for PDSCH pre-emption

The performance requirements are specified in Table 5.2.2.2.8-3, with the addition of test parameters in Table 5.2.2.2.8-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.8-1.

Table 5.2.2.2.8-1: Tests purpose

Purpose	Test index
Verify the PDSCH pre-emption performance under 2 receive antenna conditions	1-1

Table 5.2.2.2.8-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDCCH configuration (Note 4)	Symbols with PDCCH		0, 1
	DCI format		2_1
	timeFrequencySet		14x1
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
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Pre-emption configuration (Note 2)	Starting symbol (S)		3
	Length (L)		2
	Pre-emption periodicity and offset	Slots	40/(1,12,23,34) (Note 3)
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			FR1.30-1
Note 1: Void Note 2: Interference modelled as random data on pre-empted REs. Note 3: Pre-emption is scheduled with 10% probability within 20ms periodicity. Note 4: In addition to PDCCH configuration in Table 5.2-1.			

Table 5.2.2.2.8-3: Minimum performance for Rank 1

							Reference value

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-2.6 TDD	40 / 30	16QAM 0.64	FR1.30-1	TDLA30-10	2x2, ULA Low	70	12.5

5.2.2.2.9 Minimum requirements for HST-SFN

The performance requirements are specified in Table 5.2.2.2.9-3, with the addition of test parameters in Table 5.2.2.2.9-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.9-1.

Table 5.2.2.2.9-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions in the HST-SFN scenario defined in B.3.2 when *highSpeedDemodFlag-r16* [17] is configured	1-1

Table 5.2.2.2.9-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	20 for CSI-RS resource 1,2,3,4.
	CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4.
	Frequency Occupation		Start PRB 0 Number of PRB = 52
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.2.2.9-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum	SNR (dB)

							throughput (%)	
1-1	R.PDSCH.2-10.4 TDD	40 / 30	16QAM, 0.48	FR1.30-1	HST-SFN	2x2	70	14.2

5.2.2.2.10 Minimum requirements for HST-DPS

The performance requirements are specified in Table 5.2.2.2.10-3, with the addition of test parameters in Table 5.2.2.2.10-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.10-1.

Table 5.2.2.2.10-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-DPS scenario defined in B.3.3	1-1, 1-2

Table 5.2.2.2.10-2: Test parameters

Parameter			Unit	Value
Duplex mode				TDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			Specific to each Reference channel
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3
				l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	20 for CSI-RS resource 1,2,3,4
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2
				2 for CSI-RS resource 3 and 4
		QCL info		TCI state #2
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7
				l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	20 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6
				2 for CSI-RS resource 7 and 8
		QCL info		TCI state #3
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
NZP CSI-RS for CSI acquisition	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l0 = 13
		CSI-RS periodicity	Slots	40

		CSI-RS offset	Slots	0
		QCL info		TCI state #1
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				8
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Note 1: SSB # (k mod 2), CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by kth RRH.

For Test 1-1, TCI state switching command scheduled by MAC CE with PDSCH configuration - MCS 4, Layer 1, StartRB 32, NumOfRB 74 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$.
PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by kth RRH from:
slot# $\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\,proc} + T_{firstTRS} + T_{TRS\,proc}, 0]$
to:
slot# $(2k+1)n$,
PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

For Test 1-2, TCI state switching command scheduled by MAC CE with PDSCH configuration - MCS 4, Layer 1, StartRB 32, NumOfRB 74 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$.
PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by kth RRH from:
slot# $\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\,proc}, 0]$
to:
slot# $(2k+1)n$
PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

Where k=0, 1, 2… is the RRH number, n = 5040 is half of the number of slots between two RRH, T_{HARQ} = 8 is the number of slots between PDSCH and corresponding HARQ-ACK information, $T_{MAC\,proc}$ = 6 is the number of slots for MAC CE processing, $T_{firstTRS}$ = 7 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $T_{TRS\,proc}$ = 4 is the number of slots for TRS processing.

Table 5.2.2.2.10-3: Minimum performance for HST-DPS

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
								Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-10.5 TDD	40 / 30	64QAM, 0.43	FR1.30-1	HST-DPS	1	2x2	70	13.0
1-2	R.PDSCH.2-10.5 TDD	40 / 30	64QAM, 0.43	FR1.30-1	HST-DPS	2	2x2	70	13.0

5.2.2.2.11 Minimum requirements for PDSCH Single-DCI based SDM scheme

The performance requirements are specified in Table 5.2.2.2.11-3, with the addition of test parameters in Table 5.2.2.2.11-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.11-1.

Table 5.2.2.2.11-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance with Single-DCI based SDM scheme under 2 receive antenna conditions.	1-1,1-2

Table 5.2.2.2.11-2: Test parameters

Parameter				Unit	Value	
					TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB					TRxP #1	
PDCCH configuration			TCI state		TCI State #1	
			CORESETPoolIndex		0	
CSI-RS for tracking			First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
			First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
			Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
			CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
			Density		3	
			CSI-RS periodicity	Slots	40	
			CSI-RS offset	Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
			QCL info		TCI state #0	
Duplex mode					TDD	
Active DL BWP index					1	
PDSCH configuration			Mapping type		Type A	
			k0		0	
			Starting symbol (S)		2	
			Length (L)		12	
			PRB bundling type		Static	
			PRB bundling size		2	
			Resource allocation type		Type 1	
			RBG size		Config2	
			VRB-to-PRB mapping type		Non-interleaved	
			VRB-to-PRB mapping interleaver bundle size		N/A	
PDSCH DMRS configuration			Antenna port indexes		1000	1002
			TCI state		TCI State #1	TCI State #2
			DMRS Type		Type 1	
			Number of additional DMRS		1	
			Maximum number of OFDM symbols for DL front loaded DMRS		1	
TCI State #1	Type 1 QCL information	CSI-RS resource			CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type			Type A	N/A
	Type 2 QCL information	CSI-RS resource			N/A	N/A
		QCL Type			N/A	N/A

TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Full-overlapping	
Timing offset of the second TRxP from the first TRxP			us	-0.25 for test 1-1 1 for test 1-2	
Frequency offset of the second TRxP from the first TRxP			Hz	300 for test 1-1 0 for test 1-2	
Number of HARQ Processes				8	
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.	
Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2)					

Table 5.2.2.2.11-3: Minimum performance

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition(Note 1)	Correlation matrix and antenna configuration(Note 2)	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)(Note 3)
1-1	R.PDSCH.2-3.2 TDD	40 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x2, ULA Low	70	20.2
1-2	R.PDSCH.2-3.2 TDD	40 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x2, ULA Low	70	20.0
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2 Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 with scaling factor as 1/sqrt(2) for transmitted signal from each TRxP								

5.2.2.2.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme

The performance requirements are specified in Table 5.2.2.2.12-3, with the addition of test parameters in Table 5.2.2.2.12-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.12-1.

Table 5.2.2.2.12-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance when UE is configured two different values of CORESETPoolIndex in ControlResourceSet and when UE receives multiple PDCCHs scheduling PDSCHs	1-1

Table 5.2.2.2.12-2: Test parameters

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	TCI State #2
	CORESETPoolIndex		0,1	

CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	40	
	CSI-RS offset		Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
Duplex mode				TDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 1	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			{1000,1001}	{1002,1003}
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Non-overlapping	
Timing offset of the second TRxP from the first TRxP			us	-0.25	
Frequency offset of the second TRxP from the first TRxP			Hz	300	
Number of HARQ Processes				8	
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity	
Note 1: PDSCH transmission is done from both TRxPs. Transmission from TRxP #1 uses CORESETPoolIndex 0 and transmission from TRxP #2 uses CORESETPoolIndex 1					

Table 5.2.2.2.12-3: Minimum performance

Test num.	Reference channel		Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition(Note 1)	Correlation matrix and antenna configuration(Note 2)	Reference value	
								Fraction of maximum throughput (%)	SNR (dB)(Note 3)
	TRxP #1	TRxP #2							
1-1	R.PDSCH.2-3.3 TDD	R.PDSCH.2-3.4 TDD	40 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x2, ULA Low	70	20.4
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2 Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2									

5.2.2.2.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A

The performance requirements are specified in Table 5.2.2.2.13-3, with the addition of test parameters in Table 5.2.2.2.13-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.13-1.

Table 5.2.2.2.13-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions when UE is configured with “FDMSchemeA” in “RepetitionScheme-r16” defined in clause 5.1 of TS 38.214 [12]]	1-1

Table 5.2.2.1.13-2: Test parameters

Parameter			Unit	Value	
				TRxP #1 (Note 1)	TRxP #2 (Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration		TCI state		TCI State #1	
		CORESETPoolIndex		Not configured	
CSI-RS for tracking		First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
		First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
		CDM Type		‘No CDM’ for CSI-RS resource 1,2,3,4,5,6,7,8	
		Density		3	
		CSI-RS periodicity	Slots	40	
		CSI-RS offset	Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
		QCL info		TCI state #0	
Duplex mode				TDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	

	PRB bundling type			Static	
	PRB bundling size			wideband	
	Resource allocation type			Type 0	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000, 1001	1000, 1001
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Timing offset of the second TRxP from the first TRxP			us	-0.25	
Frequency offset the second TRxP from the first TRxP			Hz	300	
Number of HARQ Processes				8	
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.	
Note 1: PDSCH transmission is done from both TRxPs					

Table 5.2.2.2.13-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition (Note 1)	Correlation matrix and antenna configuration (Note 2)	Reference value	
							Fraction of maximum throughput (%)	SNR (dB) (Note 3)
1-1	R.PDSCH.2-2.5 TDD	40 / 30	16QAM, 0.54	FR1.30-1	TDLA30-10	2x2, ULA Low	70	17.6
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2								

5.2.2.2.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme

The performance requirements are specified in Table 5.2.2.2.14-3, with the addition of test parameters in Table 5.2.2.2.14-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.14-1.

Table 5.2.2.2.14-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions when UE is configured with repetitionNumber-r16	1-1

with multiple slot level PDSCH transmission occasions of the same TB with two TCI states defined in clause 5.1 of TS 38.214 [12]	

Table 5.2.2.2.14-2: Test parameters

Parameter			Unit	Value	
				TRxP #1 (Note 1)	TRxP #2 (Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration	TCI state			TCI State #1	
	CORESETPoolIndex			Not configured	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	40	
	CSI-RS offset		Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
Duplex mode				TDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	Repetition number			2	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 0	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000	1000
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Timing offset of the second TRxP from the first TRxP			us	1	
Frequency offset of the second TRxP from the first TRxP			Hz	300	

Number of HARQ Processes		4
The number of slots between PDSCH and corresponding HARQ-ACK information		Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 (Note 2)
Precoding configuration		SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.
Note 1: PDSCH transmission is done from both TRxPs Note 2: ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,10) = {2, 4, 6}.		

Table 5.2.2.2.14-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition (Note 1)	Correlation matrix and antenna configuration (Note 2)	Reference value	
							BLER (%)	SNR (dB) (Note 4)
1-1	R.PDSCH.2-16.2 TDD	40 / 30	16QAM, 0.54	FR1.30-1	TDLA30-10	2x2, ULA Low	1 (Note 3)	2. 8
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. Note 4: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2								

5.2.2.2.15 Minimum requirements for PDSCH of PCell on band with shared spectrum access

The performance requirements are specified in Table 5.2.2.2.15-3, with the addition of test parameters in Table 5.2.2.2.15-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.15-1.

Table 5.2.2.2.15-1: Tests purpose

Purpose	Test index
Verify PDSCH performance for UE supporting operations in shared spectrum access	1-1, 1-2, 1-3, 1-4

Table 5.2.2.2.15-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
DL transmission model			As specified in B.5
Downlink Model Parameters	QCL relation between SSB positions (N_{SSB}^{QCL})		8
	Downlink transmission duration values	Slots	{2,4,6,7}
	Occupied OFDM symbols in slot other than the last slot of the downlink duration	Symbols	14
	Occupied OFDM symbols in the last slot of the downlink duration	Symbols	{6,9,12,14} (Note 1)
	Downlink period	ms	5
	LBT failure probability (p_{LBT})		0.25
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0

	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	dmrs-AdditionalPosition		pos1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: If DL Transmission duration is 2 Slot, the occupied OFDM symbols in the last slot of the downlink duration is 14.			

Table 5.2.2.2.15-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-18.1 TDD	20 / 30	16QAM, 0.48	FR1.30-7	TDLA30-10	2x2, ULA Low	70	13.8
1-2	R.PDSCH.2-18.2 TDD	40 / 30	16QAM, 0.48	FR1.30-7	TDLA30-10	2x2, ULA Low	70	14.1
1-3	R.PDSCH.2-18.3 TDD	60 / 30	16QAM, 0.48	FR1.30-7	TDLA30-10	2x2, ULA Low	70	14.2
1-4	R.PDSCH.2-18.4 TDD	80 / 30	16QAM, 0.48	FR1.30-7	TDLA30-10	2x2, ULA Low	70	14.5

5.2.2.2.16 Minimum requirements for PDSCH with inter-cell interference

The performance requirements are specified in Table 5.2.2.2.16-3, with the addition of test parameters in Table 5.2.2.2.16-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.16-1.

Table 5.2.2.2.16-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance under 2 receive antenna conditions, when transmission from the serving cell is interfered by 1 or 2 interfering cells.	1-1, 1-2

Table 5.2.2.2.16-2: Test parameters

Parameter	Unit	Value		
		Cell 1	Cell 2	Cell 3
		Enabled	Enabled	Enabled for test 1-1 Disabled for test 1-2
Duplex mode		TDD		
TDD UL-DL pattern		FR1.30-1		
Active DL BWP index		1		
Physical cell ID		0	1	2
Transmission rank		1	Random rank with 70% and 30% probability for rank 1 and rank 2	Random rank with 70% and 30% probability for rank 1 and rank 2 for Test 1-1

					N/A for Test 1-2
Time offset to Cell 1		us	N/A	1.5	-0.5
Frequency shift to Cell 1		Hz	N/A	300	-100
Interference Model			N/A	As specified in B.6.2	
INR (Note 2)		dB	N/A	7.77 for Test 1-1 7.58 for Test 1-2	2.29 for Test 1-1 N/A for Test 1-2
SSB configuration	SSB position in burst		First SSB in Slot #0	First SSB in Slot #0 for Test 1-1 Second SSB in Slot #0 for Test 1-2	First SSB in Slot #0 for Test 1-1 N/A for Test 1-2
	SSB periodicity	ms	20	20	20
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		
	RBG size		Config2		
	VRB-to-PRB mapping type		Non-interleaved		
	VRB-to-PRB mapping interleaver bundle size		N/A		
PDSCH DMRS configuration	DMRS Type		Type 1		
	Number of additional DMRS		1		
	Maximum number of OFDM symbols for DL front loaded DMRS		1		
Number of HARQ Processes			8		
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2		
Note 1: Cell 1 is the serving cell, Cell 2, 3 are interference cells. Note 2: INR is defined in Annex B.6.1					

Table 5.2.2.2.16-3: Minimum performance for PDSCH with rank 1 and with inter-cell interference

Test num	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
			Cell1			Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	TDLC300-100	2x2, ULA Low	70	15.7
1-2	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	12.6
Note 1: The propagation conditions for Cell 1, Cell 2 and Cell 3 are statistically independent. Note 2: Bandwidth/ Subcarrier spacing, Propagation Condition, Correlation matrix and antenna configuration parameters apply for each of Cell 1, Cell 2 and Cell 3.							

5.2.2.2.17 Minimum requirements for PDSCH with intra cell inter user interference

The performance requirements are specified in Table 5.2.2.2.17-3, with the addition of test parameters in Table 5.2.2.2.17-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.17-1.

Table 5.2.2.2.17-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance under 2 receive antenna conditions when the PDSCH transmission of target UE is interfered by co-scheduled UE	1-1

Table 5.2.2.2.17-2: Test parameters

Parameter		Unit	Target UE	Co-scheduled UE
Duplex mode			TDD	
Active DL BWP index			1	
PDSCH configuration	Mapping type		Type A	
	k0		0	
	Starting symbol (S)		2	
	Length (L)		12	
	PDSCH aggregation factor		1	
	PRB bundling type		Static	
	PRB bundling size		2	
	Resource allocation type		Type 0	
	RBG size		Config2	
	VRB-to-PRB mapping type		Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size		N/A	
PDSCH DMRS configuration	DMRS Type		Type 1	
	Number of additional DMRS		1	
	Maximum number of OFDM symbols for DL front loaded DMRS		1	
	Antenna ports indexes		1000	1001
	Number of PDSCH DMRS CDM group(s) without data		1	1
PDSCH & PDSCH DMRS Precoding configuration			Single Panel Type I, Randomized precoder selection for every PRB bundle and updated per slot, with equal probability of each applicable i1/i2 combination or codebook Index, chosen from section 5.2.2.2.1 of TS 38.214 [12].	Single Panel Type I, Randomized precoder selection for every PRB bundle and updated per slot, with equal probability of each applicable i1/i2 combination or codebook Index, chosen from section 5.2.2.2.1 of TS 38.214 [12].Any column of precoder matrix is not equal to any column of precoder matrix of Target UE
MU-MIMO Beamforming Model			As specified in B.4.2	
Number of HARQ Processes			8	N/A
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	N/A
Note 1: The DMRS scrambling ID is same for both target UE and Co-scheduled UE.				

Table 5.2.2.2.17-3: Minimum performance for PDSCH of target UE with intra-cell inter user interference

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate		TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
			Target UE	Co-scheduled UE				Fraction of maximum throughput (%)	SNR (dB)

1-1	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	Random 16QAM symbols	FR1.30-1	TDLC300-100	2x2, ULA Low	70	18.9

5.2.2.2.18 Minimum requirements for RedCap

The performance requirements are specified in Table 5.2.2.2.18-3 and Table 5.2.2.2.18-4, with the addition of test parameters in Table 5.2.2.2.18-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.18-1.

Table 5.2.2.2.18-1: 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 for RedCap UEs	1-1, 1-2, 1-3, 2-1

Table 5.2.2.2.18-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Test 1-1 2 for other tests
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Test 1-1 1 for other tests
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	First OFDM symbol in the PRB used for CSI-RS		Table 5.2-1
	CSI-RS periodicity	Slots	Table 5.2-1
	CSI-RS offset	Slots	Table 5.2-1
	Frequency Occupation		Table 5.2-1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.2.2.18-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum	SNR (dB)

							throughput (%)	
1-1	R.PDSCH.2-1.5 TDD	20 / 30	QPSK, 0.30	FR1.30-1A	TDLB100-400	2x2, ULA Low	70	0.2
1-2	R.PDSCH.2-4.2 TDD	20 / 30	256QAM, 0.82	FR1.30-1	TDLA30-10	2x2, ULA Low	70	25.3
1-3	R.PDSCH.2-26.1 TDD	20 / 30	16QAM, 0.48	FR1.30-1	TDLC300-100	2x2, ULA Low	70	8.1

Table 5.2.2.2.18-4: Minimum performance for Rank 2

Test num.	**Reference channel**	**Bandwidth (MHz) / Subcarrier spacing (kHz)**	**Modulation format and code rate**	**TDD UL-DL pattern**	**Propagation condition**	**Correlation matrix and antenna configuration**	**Reference value**	
							Fraction of maximum throughput (%)	**SNR (dB)**
2-1	R.PDSCH.2-27.1 TDD	20 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x2, ULA Low	70	20.1

5.2.2.2.19 Minimum requirements for PDSCH CRS interference mitigation under NR-LTE coexistence scenario

The performance requirements are specified in Table 5.2.2.2.19-4, with the addition of test parameters in Table 5.2.2.2.19-2 for the serving cell and Table 5.2.2.2.19-3 for the LTE interference cells and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.19-1.

Table 5.2.2.2.19-1: Tests purpose

Purpose	**Test index**
Verify PDSCH CRS interference mitigation performance under 2 receive antenna conditions with CRS rate matching configured for the serving cell.	1-1

Table 5.2.2.2.19-2: Tests parameters for serving cell PDSCH

Parameter		**Unit**	**Value**
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CRS for rate Matchin (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	Hz	20

	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: No MBSFN is configured on LTE carrier. Note 2: Network-based CRS interference mitigation is disabled on LTE carrier			

Table 5.2.2.2.19-3: Tests parameter for interference cells

Parameter		Unit	Cell 1	Cell 2
Duplex mode			TDD	TDD
TDD UL-DL pattern			DSUDDDSUDD S = 10D + 2G + 2U	DSUDDDSUDD S = 10D + 2G + 2U
INR (Note 1)		dB	10.45	4.6
LTE Bandwidth		MHz	20	20
Carrier centre subcarrier location			Same as the NR serving carrier centre subcarrier location	Same as the NR serving carrier centre subcarrier location
Cyclic Prefix			Normal	Normal
Physical cell ID			1	2
CRS pattern	Number of antenna ports		4	4
	v-shift		1	2
Downlink power allocation	ρ_A	dB	-6	-6
	ρ_B	dB	-6	-6
	σ	dB	0	0
PDSCH transmission mode			TM4	TM4
PDSCH loading level		%	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain.	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain.
Transmission rank		%	80% and 20% probability for rank 1 and rank 2 respectively	80% and 20% probability for rank 1 and rank 2 respectively
Interference model			As specified in clause B.7	As specified in clause B.7
Time offset to the serving cell		us	3	-1
Frequency offset to the serving cell		Hz	300	-100
Propagation conditions and MIMO configuration (Note 2)			TDLA30-10 ULA Low	TDLA30-10 ULA Low
Precoding granularity		PRB	8	8
Note 1: Defined in B.6.1 Note 2: The channel for the LTE interference cells and the serving cell are independent.				

Table 5.2.2.2.19-4: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.3 TDD	20 / 15	16QAM, 0.48	FR1.15-1	TDLA30-10	4x2, ULA Low	70	12.5

5.2.2.2.20 Minimum requirements for PDSCH with inter cell CRS interference

The performance requirements are specified in Table 5.2.2.2.20-4 and Table 5.2.2.2.20-6, with the addition of test parameters in Table 5.2.2.2.20-2 for the serving cell and Table 5.2.2.2.20-3 for the LTE interference cells and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.20-1.

Table 5.2.2.2.20-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions when PDSCH is interfered by inter cell CRS signal	1-1, 1-2, 2-1 and 2-2

Table 5.2.2.2.20-2: Tests parameters for serving cell PDSCH

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.2.2.20-3: Tests parameter for interference cells

Parameter		Unit	Cell 1	Cell 2
Duplex mode			TDD	TDD
TDD UL-DL pattern			DSUDDDSUDD S = 10D + 2G + 2U	DSUDDDSUDD S = 10D + 2G + 2U
INR (Note 5)		dB	10.45	4.6
LTE Bandwidth (Note 6)		MHz	20	20
Carrier centre subcarrier location (Note 7)			Same as the NR serving carrier centre subcarrier location	Same as the NR serving carrier centre subcarrier location
Cyclic Prefix			Normal	Normal
Physical cell ID			1	2
CRS pattern	Number of antenna ports		4	4
	v-shift		1	2
Downlink power allocation	ρ_A	dB	-6	-6
	ρ_B	dB	-6	-6
	σ	dB	0	0
PDSCH transmission mode			TM4	TM4
PDSCH loading level		%	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-1. 10% probability of occurrence of LTE data transmission in time domain, and full	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-1. 10% probability of occurrence of LTE data

		bandwidth allocation in frequency domain for test 1-2.	transmission in time domain, and full bandwidth allocation in frequency domain for test 1-2.
Transmission rank	%	80% and 20% probability for rank 1 and rank 2 respectively	80% and 20% probability for rank 1 and rank 2 respectively
Interference model		As specified in clause B.7	As specified in clause B.7
Time offset to the serving cell	us	3 for test 1-1 1.5 for test 1-2	-1 for test 1-1 -0.5 for test 1-2
Frequency offset to the serving cell	Hz	300	-100
Propagation conditions and MIMO configuration (Note 1)		TDLA30-10 ULA Low	TDLA30-10 ULA Low
Precoding granularity	PRB	8	8
Note 1: The channel for the LTE interference cells and the serving cell are independent. Note 2: No MBSFN is configured on LTE carrier. Note 3: Network-based CRS interference mitigation is disabled on LTE carrier. Note 4: The start of transmission of LTE frame is delayed by 2 LTE subframes with respect to the start of transmission of NR frame Note 5: Defined in B.6.1 Note 6: This parameter is informed to UE via network assistance signalling for Test 1-1 and 1-2 in Table 5.2.2.2.20-4. Note 7 Single entry is included in IE *LTE-NeighCellsCRS-AssistInfoList-r17* that applies for both cells for cases with network signalling assistance			

The requirements for UE capable of performing CRS-IM with the assistance of network signaling on LTE channel bandwidth are specified in Table 5.2.2.2.20-4:

Table 5.2.2.2.20-4: Minimum performance for Rank 1 with the assistance of network signaling on LTE channel bandwidth

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-4.1 TDD	20 / 15	16QAM, 0.48	FR1.15-1	TDLA30-10	4x2, ULA Low	70	12.3
1-2	R.PDSCH.2-28.1 TDD	20 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	4x2, ULA Low	70	11.7

The requirements for UE capable of performing CRS-IM without the assistance of network signaling on LTE channel bandwidth are specified in Table 5.2.2.2.20-6 with following test procedure:

The network configures an inter-RAT LTE measurement object of the interfering cells to the tested UE. Inter-RAT measurement is configured at the beginning of the test and applied throughout the test with gap pattern configurations according to Table 5.2.2.2.20-5. PDSCH is not scheduled and throughput is not counted during 4.64s after the beginning of test. PDSCH is not scheduled in the measurement gaps.

Table 5.2.2.2.20-5: Measurement Gap configurations

Parameter	Unit	Value
Measurement Gap Length (mgl)	ms	6
Measurement Gap Repetition Period (mgrp)	ms	40
Gap offset (gapoffset)	ms	1
Measurement gap timeing advance (mgta)	ms	0

Table 5.2.2.2.20-6: Minimum performance for Rank 1 without the assistance of network signaling on LTE channel bandwidth

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-4.2 TDD	20 / 15	16QAM, 0.48	FR1.15-1	TDLA30-10	4x2, ULA Low	70	12.3
2-2	R.PDSCH.2-29.1 TDD	20 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	4x2, ULA Low	70	11.7

5.2.2.2.21 Minimum requirements for HST-SFN Scheme A

The performance requirements are specified in Table 5.2.2.2.21-3, with the addition of test parameters in Table 5.2.2.2.21-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.21-1.

Table 5.2.2.2.21-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-SFN Scheme A scenario defined in B.3.5	1-1

Table 5.2.2.2.21-2: Test parameters

Parameter			Unit	Value
Duplex mode				TDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			12
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	20 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #3
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	20 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #4

	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 9 and 11 l_0 = 8 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	20 for CSI-RS resource 9,10,11,12.
		CSI-RS offset	Slots	1 for CSI-RS resource 9 and 10 2 for CSI-RS resource 11 and 12
		QCL info		TCI state #5
NZP CSI-RS for CSI acquisition	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #5	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #6	First OFDM symbol in the PRB used for CSI-RS		l_0 = 7
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #4	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #5	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				8
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: SSB # (k mod 3) , CSI-RS (for tracking) resource set # ((k mod 3) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 3) + 4) are transmitted by k^{th} RRH. Codepoint #0 is activated when UE receives PDCCH/PDSCH from RRH#3k and RRH#3k+1 with TCI States TCI state #0, TCI State #1. Codepoint #1 is activated when UE receives PDCCH/PDSCH from RRH#3k+1 and RRH#3k+2 with TCI States TCI state #1, TCI State #2. Codepoint #2 is activated when UE receives PDCCH/PDSCH from RRH#3k+2 and RRH#3k+3 with TCI States TCI state #2, TCI State #0.				

Table 5.2.2.2.21-3: Minimum performance for HST-SFN Scheme A

							Reference value

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-30.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	HST-SFN Scheme A	2x2	70	12.9

5.2.2.2.22 Minimum requirements for HST-SFN Scheme B

The performance requirements are specified in Table 5.2.2.2.22-3, with the addition of test parameters in Table 5.2.2.2.22-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.2.22-1.

Table 5.2.2.2.22-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-SFN Scheme B scenario defined in B.3.6	1-1

Table 5.2.2.2.22-2: Test parameters

Parameter			Unit	Value
Duplex mode				TDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			Specific to each Reference channel
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	20 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #3
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	20 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #4
		Frequency Occupation		Start PRB 0
				Number of PRB = 52

	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 9 and 11 l_0 = 8 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	20 for CSI-RS resource 9,10,11,12.
		CSI-RS offset	Slots	1 for CSI-RS resource 9 and 10 2 for CSI-RS resource 11 and 12
		QCL info		TCI state #5
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
NZP CSI-RS for CSI acquisition	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #5	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #6	First OFDM symbol in the PRB used for CSI-RS		l_0 = 7
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #4	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #5	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes			8	
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
Note 1: SSB # (k mod 3), CSI-RS (for tracking) resource set # ((k mod 3) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 3) + 4) are transmitted by k^{th} RRH.				

Codepoint#0 {TCI state #0, TCI State #1} is activated when UE receives PDCCH/PDSCH from RRH#3k and RRH#3k+1. Codepoint#1 {TCI state #1, TCI State #2} is activated when UE receives PDCCH/PDSCH from RRH#3k+1 and RRH#3k+2. Codepoint#2 {TCI state #2, TCI State #0} is activated when UE receives PDCCH/PDSCH from RRH#3k+2 and RRH#3k+3. The second indicated TCI state in each codepoint is not used for quasi co-location parameters {Doppler shift, Doppler spread}.

Table 5.2.2.2.22-3: Minimum performance for HST-SFN Scheme B

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-30.1 TDD	40/30	16QAM, 0.48	FR1.30-1	HST-SFN-Scheme B	2x2	70	11.8

5.2.3 4RX requirements

5.2.3.1 FDD

5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A

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

The test purposes are specified in Table 5.2.3.1.1-1.

Table 5.2.3.1.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance under 4 receive antenna conditions and with different channel models, MCSs and number of MIMO layers	1-1, 1-2, 1-3, 1-5, 1-6, 1-7, 1-8, 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 performance requirements for Enhanced Receiver Type 1 under 4 receive antenna conditions.	5-1

Table 5.2.3.1.1-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Test 1-1 wideband for Test 3-1

			2 for other tests
	Resource allocation type		Test 1-2: Type 1 with start RB = 23, L_{RBs} = 6 Other test: Type 0
	RBG size		Test 1-2: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Test 1-1, 1-5, 1-6, 1-7 1 for other tests
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	Test 1-5, 1-6, 1-7: 10 for CSI-RS resource 1,2,3,4. Other tests: Table 5.2-1.
	CSI-RS offset	Slots	Test 1-5, 1-6, 1-7: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4. Other tests: Table 5.2-1.
Number of HARQ Processes			8 for Test 1-4, 2-1 4 for other tests
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.3.1.1-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.1 FDD	10 / 15	QPSK, 0.30	TDLB100-400	2x4, ULA Low	70	-3.5
1-2	R.PDSCH.1-1.2 FDD	10 / 15	QPSK, 0.30	TDLC300-100	2x4, ULA Low	70	-2.9
1-3	R.PDSCH.1-4.1 FDD	10 / 15	256QAM, 0.82	TDLA30-10	2x4, ULA Low	70	21.0
1-4	R.PDSCH.1-2.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x4, ULA Low	30	-1.5
1-5	R.PDSCH.1-8.1 FDD	10 / 15	16QAM, 0.48	HST-750	1x4	70	3.3
1-6	R.PDSCH.1-8.2 FDD	10 / 15	64QAM, 0.43	HST-972	1x4	70	7.0
1-7	R.PDSCH.1-8.1 FDD	10 / 15	16QAM, 0.48	TDLC300-600	2x4, ULA Low	70	5.0
1-8	R.PDSCH.1-17.1 FDD	10 / 15	1024QAM, 0.79	TDLD30-5	2x4, ULA Low	70	26.3

Table 5.2.3.1.1-4: Minimum performance for Rank 2

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

Table 5.2.3.1.1-5: Minimum performance for Rank 3

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

Table 5.2.3.1.1-6: Minimum performance for Rank 4

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

Table 5.2.3.1.1-7: Minimum performance for Rank 3 and Enhanced Receiver Type 1

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

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

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

The test purposes are specified in Table 5.2.3.1.2-1.

Table 5.2.3.1.2-1: Tests purpose

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

Table 5.2.3.1.2-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
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
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for CSI acquisition	OFDM symbols in the PRB used for CSI-RS		$l_0 = 13$
	CSI-RS periodicity	Slots	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	Slots	5
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.3.1.2-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-5.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x4, ULA Low	70	9.1

5.2.3.1.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.3.1.3-1.

Table 5.2.3.1.3-1: Tests purpose

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

Table 5.2.3.1.3-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type B
	k0		0
	Starting symbol (S)		5
	Length (L)		7
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved

	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.3.1.3-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.3 FDD	10 / 15	QPSK, 0.30	TDLA30-10	2x4, ULA Low	70	-3.8

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

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

The test purposes are specified in Table 5.2.3.1.4-1.

Table 5.2.3.1.4-1: Tests purpose

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

Table 5.2.3.1.4-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
NR UL transmission with a 7.5 kHz shift to the LTE raster			true
PDCCH configuration	Symbols with PDCCH		Symbol# 2
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Position of the first DM-RS for downlink		3
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1

CRS for rate matching (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	MHz	10
	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: No MBSFN is configured on LTE carrier			

Table 5.2.3.1.4-3: Minimum performance for Rank 1

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

5.2.3.1.5 Minimum requirements for PDSCH 0.001% BLER

The performance requirements are specified in Table 5.2.3.1.5-3, with the addition of test parameters in Table 5.2.3.1.5-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.5-1.

Table 5.2.3.1.5-1: Tests purpose

Purpose	Test index
Verify the PDSCH 0.001% BLER performance under 4 receive antenna conditions	1-1

Table 5.2.3.1.5-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Maximum number of HARQ transmission			1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.3.1.5-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Target BLER	SNR (dB)
1-1	R.PDSCH.1-1.4 FDD	10 / 15	QPSK, 0.59	AWGN	1x4, ULA Low	0.001%	0.7

5.2.3.1.6 Minimum requirements for PDSCH repetitions over multiple slots

The performance requirements are specified in Table 5.2.3.1.6-3, with the addition of test parameters in Table 5.2.3.1.6-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.6-1.

Table 5.2.3.1.6-1: Tests purpose

Purpose	Test index
Verify the PDSCH repetitions over multiple slots performance under 4 receive antenna conditions	1-1

Table 5.2.3.1.6-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		2
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information			2

Table 5.2.3.1.6-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Target BLER	SNR (dB)
1-1	R.PDSCH.1-11.1 FDD	10 / 15	16QAM, 0.54	TDLA30-10	2x4, ULA Low	1% (Note 1)	-2.3
Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block.							

5.2.3.1.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2

The performance requirements are specified in Table 5.2.3.1.7-3, with the addition of test parameters in Table 5.2.3.1.7-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.7-1.

Table 5.2.3.1.7-1: Tests purpose

Purpose	Test index
PDSCH mapping Type B performance and UE processing capability 2 under four receive antenna conditions	1-1

Table 5.2.3.1.7-2: Test parameters

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

Table 5.2.3.1.7-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-12.1 FDD	10 / 15	QPSK, 0.30	TDLA30-10	2x4, ULA Low	70	-2.3

5.2.3.1.8 Minimum requirements for PDSCH pre-emption

The performance requirements are specified in Table 5.2.3.1.8-3, with the addition of test parameters in Table 5.2.3.1.8-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.8-1.

Table 5.2.3.1.8-1: Tests purpose

Purpose	Test index

Verify the PDSCH pre-emption performance under 4 receive antenna conditions	1-1

Table 5.2.3.1.8-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDCCH configuration (Note 4)	Symbols with PDCCH		0, 1
	DCI format		2_1
	timeFrequencySet		14x1
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
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Pre-emption configuration (Note 2)	Starting symbol (S)		3
	Length (L)		2
	Pre-emption periodicity and offset (Note 3)	Slots	10/1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2
Note 1: Void Note 2: Interference modelled as random data on pre-empted REs. Note 3: Pre-emption is scheduled with a fixed scheduling with 10% probability within 10ms periodicity. Note 4: In addition to PDCCH configuration in Table 5.2-1.			

Table 5.2.3.1.8-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-2.6 FDD	10 / 15	16QAM 0.64	TDLA30-10	2x4, ULA Low	70	6.6

5.2.3.1.9 Minimum requirements for PDSCH HST-SFN

The performance requirements are specified in Table 5.2.3.1.9-3, with the addition of test parameters in Table 5.2.3.1.9-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.9-1.

Table 5.2.3.1.9-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions in the HST-SFN scenario defined in B.3.2 when highSpeedDemodFlag-r16 IE [17] is configured	1-1

Table 5.2.3.1.9-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
	CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4.
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.3.1.9-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-8.3 FDD	10 / 15	16QAM, 0.48	HST-SFN	2x4	70	10.4

5.2.3.1.10 Minimum requirements for HST-DPS

The performance requirements are specified in Table 5.2.3.1.10-3, with the addition of test parameters in Table 5.2.3.1.10-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.10-1.

Table 5.2.3.1.10-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-DPS scenario defined in B.3.3	1-1, 1-2

Table 5.2.3.1.10-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDCCH configuration	TCI state		Note 1
PDSCH configuration	Mapping type		Type A
	k0		0

	Starting symbol (S)			2
	Length (L)			12
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #2
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	10 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #3
NZP CSI-RS for CSI acquisition	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				4
The number of slots between PDSCH and corresponding HARQ-ACK information				2
Note 1: SSB # (k mod 2), CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by k^{th} RRH.				

For Test 1-1, TCI state switching command scheduled by MAC CE with PDSCH configuration - MCS 4, Layer 1, StartRB 24, NumOfRB 28 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$.
PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from:
slot# $\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\ proc} + T_{firstTRS} + T_{TRS\ proc}, 0]$
to:
slot# $(2k+1)n$,
PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

For Test 1-2, TCI state switching command scheduled by MAC CE with PDSCH configuration - MCS 4, Layer 1, StartRB 24, NumOfRB 28 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$.
PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from:
slot# $\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\ proc}, 0]$
to:
slot# $(2k+1)n$
PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

Where k=0, 1, 2… is the RRH number, n = 2520 is half of the number of slots between two RRH, T_{HARQ} = 2 is the number of slots between PDSCH and corresponding HARQ-ACK information, $T_{MAC\ proc}$ = 3 is the number of slots for MAC CE processing, $T_{firstTRS}$ = 6 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $T_{TRS\ proc}$ = 2 is the number of slots for TRS processing.

Table 5.2.3.1.10-3: Minimum performance for HST-DPS

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-8.4 FDD	10 / 15	64QAM, 0.43	HST-DPS	1	2x4	70	10.6
1-2	R.PDSCH.1-8.4 FDD	10 / 15	64QAM, 0.43	HST-DPS	2	2x4	70	10.6

5.2.3.1.11 Minimum requirements for PDSCH Single-DCI based SDM scheme

The performance requirements are specified in Table 5.2.3.1.11-3, with the addition of test parameters in Table 5.2.3.1.11-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.11-1.

Table 5.2.3.1.11-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance with Single-DCI based SDM scheme under 4 receive antenna conditions	1-1,1-2

Table 5.2.3.1.11-2: Test parameters

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	
	CORESETPoolIndex		0	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3	l0 = 6 for CSI-RS resources 5 and 7

					l0 = 10 for CSI-RS resources 2 and 4	l0 = 10 for CSI-RS resources 6 and 8
		Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
		CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
		Density			3	
		CSI-RS periodicity		Slots	20	
		CSI-RS offset		Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
		QCL info			TCI state #0	
Duplex mode					FDD	
Active DL BWP index					1	
PDSCH configuration	Mapping type				Type A	
	k0				0	
	Starting symbol (S)				2	
	Length (L)				12	
	PRB bundling type				Static	
	PRB bundling size				2	
	Resource allocation type				Type 1	
	RBG size				Config2	
	VRB-to-PRB mapping type				Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size				N/A	
PDSCH DMRS configuration	Antenna port indexes				1000	1002
	TCI state				TCI State #1	TCI State #2
	DMRS Type				Type 1	
	Number of additional DMRS				1	
	Maximum number of OFDM symbols for DL front loaded DMRS				1	
TCI State #1	Type 1 QCL information	CSI-RS resource			CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type			Type A	N/A
	Type 2 QCL information	CSI-RS resource			N/A	N/A
		QCL Type			N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource			N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type			N/A	Type A
	Type 2 QCL information	CSI-RS resource			N/A	N/A
		QCL Type			N/A	N/A
Resource allocation					Full-overlapping	
Timing offset of the second TRxP from the first TRxP				us	-0.5 for test 1-1 2 for test 1-2	
Frequency offset of the second TRxP from the first TRxP				Hz	200 for test 1-1 0 for test 1-2	
Number of HARQ Processes					4	
The number of slots between PDSCH and corresponding HARQ-ACK information					2	
Precoding configuration					SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.	
Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2)						

Table 5.2.3.1.11-3: Minimum performance

						Reference value

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition(Note 1)	Correlation matrix and antenna configuration(Note 2)	Fraction of maximum throughput (%)	SNR (dB)(Note 3)
1-1	R.PDSCH.1-3.2 FDD	10 / 15	64QAM, 0.50	TDLA30-10	2x4, ULA Low	70	14.6
1-2	R.PDSCH.1-3.2 FDD	10 / 15	64QAM, 0.50	TDLA30-10	2x4, ULA Low	70	13.9
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2 Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 with scaling factor as 1/sqrt(2) for transmitted signal from each TRxP							

5.2.3.1.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme

The performance requirements are specified in Table 5.2.3.1.12-3, with the addition of test parameters in Table 5.2.3.1.12-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.12-1.

Table 5.2.3.1.12-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance when UE is configured two different values of CORESETPoolIndex in ControlResourceSet and when UE receives multiple PDCCHs scheduling PDSCHs	1-1

Table 5.2.3.1.12-2: Test parameters

Parameter			Unit	Value	
				TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration		TCI state		TCI State #1	TCI State #2
		CORESETPoolIndex		0,1	
CSI-RS for tracking		First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
		First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
		CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
		Density		3	
		CSI-RS periodicity	Slots	20	
		CSI-RS offset	Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
		QCL info		TCI state #0	
Duplex mode				FDD	
Active DL BWP index				1	
PDSCH configuration		Mapping type		Type A	
		k0		0	
		Starting symbol (S)		2	
		Length (L)		12	
		PRB bundling type		Static	
		PRB bundling size		2	
		Resource allocation type		Type 1	
		RBG size		Config2	

	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			{1000,1001}	{1002,1003}
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Non-overlapping	
Timing offset of the second TRxP from the first TRxP			us	-0.5	
Frequency offset of the second TRxP from the first TRxP			Hz	200	
Number of HARQ Processes				4	
The number of slots between PDSCH and corresponding HARQ-ACK information				2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity	
Note 1: PDSCH transmission is done from both TRxPs. Transmission from TRxP #1 uses CORESETPoolIndex 0 and transmission from TRxP #2 uses CORESETPoolIndex 1					

Table 5.2.3.1.12-3: Minimum performance

Test num.	Reference channel		Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition(Note 1)	Correlation matrix and antenna configuration(Note 2)	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)(Note 3)
1-1	R.PDSCH.1-3.3 FDD	R.PDSCH.1-3.4 FDD	10 / 15	64QAM, 0.50	TDLA30-10	2x4, ULA Low	70	14.6
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2 Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2								

5.2.3.1.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A

The performance requirements are specified in Table 5.2.3.1.13-3, with the addition of test parameters in Table 5.2.3.1.13-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.13-1.

Table 5.2.3.1.13-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions when UE is configured with “FDMSchemeA” in	1-1

“RepetitionScheme-r16” defined in clause 5.1 of TS 38.214 [12]	

Table 5.2.3.1.13-2: Test parameters

Parameter			Unit	Value	
				TRxP #1 (Note 1)	TRxP #2 (Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration	TCI state			TCI State #1	
	CORESETPoolIndex			Not configured	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	20	
	CSI-RS offset		Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
Duplex mode				FDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	PRB bundling type			Static	
	PRB bundling size			wideband	
	Resource allocation type			Type 0	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000, 1001	1000, 1001
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Timing offset of the second TRxP from the first TRxP			us	-0.5	
Frequency offset of the second TRxP from the first TRxP			Hz	200	
Number of HARQ Processes				4	

The number of slots between PDSCH and corresponding HARQ-ACK information		2
Precoding configuration		SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.
Note 1: PDSCH transmission is done from both TRxPs		

Table 5.2.3.1.13-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition (Note 1)	Correlation matrix and antenna configuration (Note 2)	Reference value	
						Fraction of maximum throughput (%)	SNR (dB) (Note 3)
1-1	R.PDSCH.1-2.5 FDD	10 / 15	16QAM, 0.54	TDLA30-10	2x4, ULA Low	70	10. 9
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2							

5.2.3.1.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme

The performance requirements are specified in Table 5.2.3.1.14-3, with the addition of test parameters in Table 5.2.3.1.14-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.14-1.

Table 5.2.3.1.14-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions when UE is configured with repetitionNumber-r16 with multiple slot level PDSCH transmission occasions of the same TB with two TCI states defined in clause 5.1 of TS 38.214 [12]	1-1

Table 5.2.3.1.14-2: Test parameters

Parameter		Unit	Value	
			TRxP #1 (Note 1)	TRxP #2 (Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	
	CORESETPoolIndex		Not configured	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density		3	
	CSI-RS periodicity	Slots	20	
	CSI-RS offset	Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
	QCL info		TCI state #0	

Duplex mode				FDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	Repetition number			2	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 0	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000	1000
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Timing offset of the second TRxP from the first TRxP			us	2	
Frequency offset of the second TRxP from the first TRxP			Hz	200	
Number of HARQ Processes				4	
The number of slots between PDSCH and corresponding HARQ-ACK information				2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.	
Note 1: PDSCH transmission is done from both TRxPs					

Table 5.2.3.1.14-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition (Note 1)	Correlation matrix and antenna configuration (Note 2)	Reference value	
						BLER (%)	SNR (dB) (Note 4)
1-1	R.PDSCH.1-11.2 FDD	10 / 15	16QAM, 0.54	TDLA30-10	2x4, ULA Low	1 (Note 3)	-0. 4
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. Note 4: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2							

5.2.3.1.15 Minimum requirements for PDSCH with inter-cell interference

The performance requirements are specified in Table 5.2.3.1.15-3, with the addition of test parameters in Table 5.2.3.1.15-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.15-1.

Table 5.2.3.1.15-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance in 4 receive antenna conditions, when the transmission from the serving cell is interfered by 1 or 2 interfering cells.	1-1, 1-2

Table 5.2.3.1.15-2: Test parameters

Parameter		Unit	Value		
			Cell 1	Cell 2	Cell 3
			Enabled	Enabled	Enabled for Test 1-1 Disabled for Test 1-2
Duplex mode			FDD		
Active DL BWP index			1		
Physical cell ID			0	1	2
Transmission rank			1	Random rank with 70% and 30% probability for rank 1 and rank 2	Random rank with 70% and 30% probability for rank 1 and rank 2 for Test 1-1 N/A for Test 1-2
Time offset to Cell 1		us	N/A	3	-1
Frequency offset to Cell 1		Hz	N/A	300	-100
Interference Model			N/A	As specified in B.6.2	
INR (Note 2)		dB	N/A	7.77 for Test 1-1 7.58 for Test 1-2	2.29 for Test 1-1 N/A for Test 1-2
SSB configuration	SSB position in burst		First SSB in Slot #0	1st SSB in Slot#0 for Test 1-1 2nd SSB in Slot #0 for Test 1-2	1st SSB in Slot#0 for Test 1-1 N/A for Test 1-2
	SSB periodicity	ms	20	20	20
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		
	RBG size		Config2		
	VRB-to-PRB mapping type		Non-interleaved		
	VRB-to-PRB mapping interleaver bundle size		N/A		
PDSCH DMRS configuration	DMRS Type		Type 1		
	Number of additional DMRS		1		
	Maximum number of OFDM symbols for DL front loaded DMRS		1		
Number of HARQ Processes			4		
The number of slots between PDSCH and corresponding HARQ-ACK information			2		

Note1: Cell 1 is the serving cell; Cells 2, 3 are interfering cells Note 2: INR is defined in Annex B.6.1

Table 5.2.3.1.15-3: Minimum performance for PDSCH with rank 1 and with inter-cell interference

Test num	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH. 1-2.1 FDD	10 / 15	16QAM, 0.48	TDLC300-100	2x4, ULA Low	70	10.1
1-2	R.PDSCH. 1-2.1 FDD	10 / 15	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	7.4
Note 1: The propagation conditions for Cell 1, Cell 2 and Cell 3 are statistically independent. Note 2: Bandwidth/ Sub carrier spacing, Propagation Condition, Correlation matrix and antenna configuration parameters apply for each of Cell 1, Cell 2 and Cell 3.							

5.2.3.1.16 Minimum requirements for PDSCH with intra-cell inter-user interference

The performance requirements are specified in Table 5.2.3.1.16-3 and Table 5.2.3.1.16-4, with the addition of test parameters in Table 5.2.3.1.16-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.16-1.

Table 5.2.3.1.16-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions, when the PDSCH transmission of target UE is interfered by co-scheduled UE.	1-1, 2-1

Table 5.2.3.1.16-2: Test parameters

Parameter		Unit	Target UE	Co-scheduled UE
Duplex mode			FDD	
Active DL BWP index			1	
PDSCH configuration	Mapping type		Type A	
	k0		0	
	Starting symbol (S)		2	
	Length (L)		12	
	PDSCH aggregation factor		1	
	PRB bundling type		Static	
	PRB bundling size		2	
	Resource allocation type		Type 0	
	RBG size		Config2	
	VRB-to-PRB mapping type		Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size		N/A	
PDSCH DMRS configuration (Note 1)	DMRS Type		Type 1	
	Number of additional DMRS		1	
	Maximum number of OFDM symbols for DL front loaded DMRS		1	
	Antenna ports indexes		{1000} for test 1-1 {1000, 1001} for test 2-1	{1001} for test 1-1 {1002, 1003} for test 2-1
	Number of PDSCH DMRS CDM group(s) without data		1 for test 1-1 2 for test 2-1	1 for test 1-1 2 for test 2-1
PDSCH & PDSCH DMRS Precoding configuration			Single Panel Type I, Randomized precoder selection for every PRB bundle and updated per slot, with equal probability	Single Panel Type I, Randomized precoder selection for every PRB bundle and updated per slot, with equal

		of each applicable i1/i2 combination or codebook Index, chosen from section 5.2.2.2.1 of TS 38.214 [12].	probability of each applicable i1/i2 combination or codebook Index, chosen from section 5.2.2.2.1 of TS 38.214 [12]. Any column of precoder matrix is not equal to any column of precoder matrix of Target UE for test 1-1 Select the precoder to ensure any column of precoder is orthogonal to any column of precoder for the target PDSCH for test 2-1
MU-MIMO Beamforming Model		As specified in B.4.2	
Number of HARQ Processes		4	N/A
The number of slots between PDSCH and corresponding HARQ-ACK information		2	N/A
Note 1: DMRS scrambling ID is the same for both target and co-scheduled UEs.			

Table5.2.3.1.16-3: Minimum performance for target UE with Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate		Propagation condition	Correlation matrix and antenna configuration	Reference value	
			Target UE	Co-scheduled UE			Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-2.1 FDD	10 / 15	16QAM, 0.48	Random 16QAM symbols	TDLC300-100	2x4, ULA Low	70	11.5

Table5.2.3.1.16-4: Minimum performance for target UE with Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate		Propagation condition	Correlation matrix and antenna configuration	Reference value	
			Target UE	Co-scheduled UE			Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.5-1.2 FDD	10 / 15	16QAM, 0.48	Random 16QAM symbols	TDLA30-10	4x4, ULA Low	70	15.3

5.2.3.1.17 Minimum requirements for PDSCH CRS interference mitigation under NR-LTE coexistence scenario

The performance requirements are specified in Table 5.2.3.1.17-4, with the addition of test parameters in Table 5.2.3.1.17-2 for the serving cell and Table 5.2.3.1.17-3 for the LTE interference cells and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.17-1.

Table 5.2.3.1.17-1: Tests purpose

Purpose	Test index
Verify PDSCH CRS interference mitigation performance under 4 receive antenna conditions with CRS rate matching configured for the serving cell.	1-1

Table 5.2.3.1.17-2: Test parameters for the serving cell

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

Table 5.2.3.1.17-3: Test parameters for the LTE interference cells

Parameter		Unit	Cell 1	Cell 2
Propagation conditions and MIMO configuration (Note 1)			TDLA30-10 ULA Low	TDLA30-10 ULA Low
INR (Note 2)		dB	10.45	4.6
Cell-specific reference signals			Antenna ports 0,1	Antenna ports 0,1
Carrier centre subcarrier location			Same as the serving carrier centre subcarrier location	Same as the serving carrier centre subcarrier location
$BW_{Channel}$		MHz	10	10
Cyclic Prefix			Normal	Normal
Physical cell ID			1	2
Number of control OFDM symbols			2	2
PDSCH transmission mode			4	4
Interference model			As specified in clause B.7	As specified in clause B.7
Probability of occurrence of PDSCH data		%	20	20
Probability of occurrence of transmission rank	Rank 1	%	80	80
	Rank 2	%	20	20
Downlink power allocation	ρ_A	dB	-3	-3
	ρ_B	dB	-3	-3
	σ	dB	0	0
Precoding granularity		PRB	6	6
Time offset to the serving cell		us	3	-1

Frequency offset to the serving cell	Hz	300	-100
MBSFN		Not configured	Not configured
Network-based CRS interference mitigation		Disabled	Disabled
Note 1: The channel for the LTE interference cells and the serving cell are independent. Note 2: Defined in B.6.1.			

Table 5.2.3.1.17-4: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-7.3 FDD	10 / 15	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.0

5.2.3.1.18 Minimum requirements for PDSCH with inter cell CRS interference

The performance requirements are specified in Table 5.2.3.1.18-4 and Table 5.2.3.1.18-6, with the addition of test parameters in Table 5.2.3.1.18-2 and 5.2.3.1.18-3 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.18-1.

Table 5.2.3.1.18-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions when PDSCH is interfered by inter cell CRS signal	1-1 and 2-1

Table 5.2.3.1.18-2: Tests parameter for serving cell PDSCH

Parameter		Unit	Value
Duplex mode			FDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between PDSCH and corresponding HARQ-ACK information			2

Table 5.2.3.1.18-3: Tests parameter for interference cells

Parameter		Unit	Cell 1	Cell 2
Duplex mode			FDD	FDD
INR		dB	10.45	4.6
LTE Bandwidth (Note 5)		MHz	20	20
Carrier centre subcarrier location (Note 6)			Same as the NR serving carrier centre subcarrier location	Same as the NR serving carrier centre subcarrier location
Cyclic Prefix			Normal	Normal
Physical cell ID			1	2
CRS pattern	Number of antenna ports		4	4
	v-shift		1	2
Downlink power allocation	ρ_A	dB	-6	-6
	ρ_B	dB	-6	-6
	σ	dB	0	0
PDSCH transmission mode			TM4	TM4
PDSCH loading level		%	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-1.	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-1.
Transmission rank		%	80% and 20% probability for rank 1 and rank 2 respectively	80% and 20% probability for rank 1 and rank 2 respectively
Interference model			As specified in clause B.7	As specified in clause B.7
Time offset to the serving cell		us	3	-1
Frequency offset to the serving cell		Hz	300	-100
Propagation conditions and MIMO configuration (Note 1)			TDLA30-10 ULA Low	TDLA30-10 ULA Low
Precoding granularity		PRB	8	8

Note 1: The channel for the LTE interference cells and the serving cell are independent.
Note 2: No MBSFN is configured on LTE carrier.
Note 3: Network-based CRS interference mitigation is disabled on LTE carrier.
Note 4: The start of transmission of LTE frame is delayed by 2 LTE subframes with respect to the start of transmission of NR frame
Note 5: This parameter is informed to UE via network assistance signalling for Test 1-1 in Table 5.2.3.1.18-4.
Note 6: Single entry is included in IE *LTE-NeighCellsCRS-AssistInfoList-r17* that applies for both cells for cases with network signalling assistance

The requirements for UE capable of performing CRS-IM with the assistance of network signalling on LTE channel bandwidth are specified in Table 5.2.3.1.18-4:

Table 5.2.3.1.18-4: Minimum performance for Rank 1 with the assistance of network signaling on LTE channel bandwidth

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-18.1 FDD	10 / 15	16QAM, 0.48	TDLA30-10	4x4, ULA Low	70	8.0

The requirements for UE capable of performing CRS-IM without the assistance of network signalling on LTE channel bandwidth are specified in Table 5.2.3.1.18-6 with following test procedure:

The network configures an inter-RAT LTE measurement object of the interfering cells to the tested UE. Inter-RAT measurement is configured at the beginning of the test and applied throughout the test with gap pattern configurations in Table 5.2.3.1.18-5. PDSCH is not scheduled and throughput is not counted during 4.64s after the beginning of test. PDSCH is not scheduled in the measurement gaps.

Table 5.2.3.1.18-5: Measurement Gap configurations

Parameter	Unit	Value
Measurement Gap Length	ms	6
Measurement Gap Repetition Period	ms	40
Gap offset	ms	7
Measurement gap timeing advance	ms	0

Table 5.2.3.1.18-6: Minimum performance for Rank 1 without the assistance of network signaling on LTE channel bandwidth

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-17.2 FDD	10 / 15	16QAM, 0.48	TDLA30-10	4x4, ULA Low	70	8.0

5.2.3.1.19 Minimum requirements for HST-SFN Scheme A

The performance requirements are specified in Table 5.2.3.1.19-3, with the addition of test parameters in Table 5.2.3.1.19-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.19-1.

Table 5.2.3.1.19-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-SFN Scheme A scenario defined in B.3.5	1-1

Table 5.2.3.1.19-2: Test parameters

Parameter			Unit	Value
Duplex mode				FDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			12
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4

		QCL info		TCI state #3
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	10 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #4
	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 9 and 11 l_0 = 8 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	10 for CSI-RS resource 9,10,11,12.
		CSI-RS offset	Slots	1 for CSI-RS resource 9 and 10 2 for CSI-RS resource 11 and 12
		QCL info		TCI state #5
NZP CSI-RS for CSI acquisition	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #5	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #6	First OFDM symbol in the PRB used for CSI-RS		l_0 = 7
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #4	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #5	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				4
The number of slots between PDSCH and corresponding HARQ-ACK information				2

Note 1: SSB # (k mod 3) , CSI-RS (for tracking) resource set # ((k mod 3) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 3) + 4) are transmitted by k^{th} RRH.
Codepoint #0 is activated when UE receives PDCCH/PDSCH from RRH#3k and RRH#3k+1 with TCI States TCI state #0, TCI State #1.
Codepoint #1 is activated when UE receives PDCCH/PDSCH from RRH#3k+1 and RRH#3k+2 with TCI States TCI state #1, TCI State #2.
Codepoint #2 is activated when UE receives PDCCH/PDSCH from RRH#3k+2 and RRH#3k+3 with TCI States TCI state #2, TCI State #0.

Table 5.2.3.1.19-3: Minimum performance for HST-SFN Scheme A

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-8.5 FDD	10 / 15	16QAM, 0.48	HST-SFN Scheme A	2x4	70	9.1

5.2.3.1.20 Minimum requirements for HST-SFN Scheme B

The performance requirements are specified in Table 5.2.3.1.20-3, with the addition of test parameters in Table 5.2.3.1.20-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.20-1.

Table 5.2.3.1.20-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-SFN Scheme B scenario defined in B.3.6	1-1

Table 5.2.3.1.20-2: Test parameters

Parameter			Unit	Value
Duplex mode				FDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			12
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	10 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #3
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	10 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #4
	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 9 and 11 l_0 = 8 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	10 for CSI-RS resource 9,10,11,12.

		CSI-RS offset	Slots	1 for CSI-RS resource 9 and 10 2 for CSI-RS resource 11 and 12
		QCL info		TCI state #5
NZP CSI-RS for CSI acquisition	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #5	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #6	First OFDM symbol in the PRB used for CSI-RS		l_0 = 7
		CSI-RS periodicity	Slots	20
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #4	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #5	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes			4	
The number of slots between PDSCH and corresponding HARQ-ACK information			2	

Note 1: SSB # (k mod 3), CSI-RS (for tracking) resource set # ((k mod 3) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 3) + 4) are transmitted by k^{th} RRH.
Codepoint#0 {TCI state #0, TCI State #1} is activated when UE receives PDCCH/PDSCH from RRH#3k and RRH#3k+1.
Codepoint#1 {TCI state #1, TCI State #2} is activated when UE receives PDCCH/PDSCH from RRH#3k+1 and RRH#3k+2.
Codepoint#2 {TCI state #2, TCI State #0} is activated when UE receives PDCCH/PDSCH from RRH#3k+2 and RRH#3k+3.
The second indicated TCI state in each codepoint is not used for quasi co-location parameters {Doppler shift, Doppler spread}.

Table 5.2.3.1.20-3: Minimum performance for HST-SFN Scheme B

						Reference value

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-8.5 FDD	10/15	16QAM, 0.48	HST-SFN-Scheme B	2x4	70	8.4

5.2.3.2 TDD

5.2.3.2.1 Minimum requirements for PDSCH Mapping Type A

The performance requirements are specified in Table 5.2.3.2.1-3, Table 5.2.3.2.1-4, Table 5.2.3.2.1-5 and Table 5.2.3.2.1-6, with the addition of test parameters in Table 5.2.3.2.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.1-1.

Table 5.2.3.2.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance 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, 1-7, 1-8, 1-9, 1-10, 1-11, 1-12, 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 performance requirements for Enhanced Receiver Type 1 under 4 receive antenna conditions.	5-1

Table 5.2.3.2.1-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		4 for Tests 1-1, 1-8, 1-9 wideband for Test 3-1 2 for other tests
	Resource allocation type		Test 1-2: Type 1 with start RB = 50, L_{RBs} = 6 Other tests: Type 0
	RBG size		Test 1-2: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2 for Tests 1-1, 1-7, 1-8, 1-9, 1-10, 1-11 1 for other tests
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	First OFDM symbol in the PRB used for CSI-RS		Tests 1-8, 1-9: l_0 = 4 for CSI-RS resource 1 and 3 l_0 = 8 for CSI-RS resource 2 and 4 Other tests; Table 5.2-1.

	CSI-RS periodicity	Slots	Test 1-7, 1-10, 1-11: 20 for CSI-RS resource 1,2,3,4. Other tests: Table 5.2-1.
	CSI-RS offset	Slots	Test 1-7, 1-10, 1-11: 1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4. Other tests: Table 5.2-1.
	Frequency Occupation		Test 1-7, 1-10, 1-11: Start PRB 0 Number of PRB = 52 Other tests: Table 5.2-1.
Number of HARQ Processes			16 for Test 1-4 10 for Test 1-9 8 for other tests
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.3.2.1-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-1.1 TDD	40 / 30	QPSK, 0.30	FR1.30-1A	TDLB100-400	2x4, ULA Low	70	-4.1
1-2	R.PDSCH.2-1.2 TDD	40 / 30	QPSK, 0.30	FR1.30-1	TDLC300-100	2x4, ULA Low	70	-2.7
1-3	R.PDSCH.2-4.1 TDD	40 / 30	256QAM, 0.82	FR1.30-1	TDLA30-10	2x4, ULA Low	70	21.6
1-4	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLC300-100	2x4, ULA Low	30	-1.2
1-5	R.PDSCH.2-5.1 TDD	40 / 30	QPSK, 0.30	FR1.30-2	TDLA30-10	2x4, ULA Low	70	-3.8
1-6	R.PDSCH.2-6.1 TDD	40 / 30	QPSK, 0.30	FR1.30-3	TDLA30-10	2x4, ULA Low	70	-3.6
1-7	R.PDSCH.2-10.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	HST-1000	1x4	70	3.4
1-8	R.PDSCH.2-11.1 TDD	40 / 30	QPSK, 0.30	FR1.30-5	TDLB100-400	2x4, ULA Low	70	-4.0
1-9	R.PDSCH.2-12.1 TDD	40 / 30	QPSK, 0.30	FR1.30-6	TDLB100-400	2x4, ULA Low	70	-4.0
1-10	R.PDSCH.2-10.2 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLC300-1200	2x4	70	5.8
1-11	R.PDSCH.2-10.3 TDD	40 / 30	64QAM, 0.43	FR1.30-1	HST-1667	1x4	70	6.8
1-12	R.PDSCH.2-25.1 TDD	40 / 30	1024QAM, 0.79	FR1.30-1	TDLD30-5	2x4, ULA Low	70	26.3

Table 5.2.3.2.1-4: Minimum performance for Rank 2

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

Table 5.2.3.2.1-5: Minimum performance for Rank 3

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

Table 5.2.3.2.1-6: Minimum performance for Rank 4

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
4-1	R.PDSCH.2-2.4 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	15.4

Table 5.2.3.2.1-7: Minimum performance for Rank 3 and Enhanced Receiver Type 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
5-1	R.PDSCH.2-2.3 TDD	40 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Medium A	70	22.9

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

The performance requirements are specified in Table 5.2.3.2.2-3, with the addition of test parameters in Table 5.2.3.2.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.2-1.

Table 5.2.3.2.2-1: Tests purpose

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

Table 5.2.3.2.2-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static

	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
NZP CSI-RS for CSI acquisition	OFDM symbols in the PRB used for CSI-RS		$l_0 = 13$
	CSI-RS periodicity	Slots	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	Slots	5
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.3.2.2-3: Minimum performance for Rank 2

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

5.2.3.2.3 Minimum requirements for PDSCH Mapping Type B

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

The test purposes are specified in Table 5.2.3.2.3-1.

Table 5.2.3.2.3-1: Tests purpose

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

Table 5.2.3.2.3-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type B
	k0		0
	Starting symbol (S)		5
	Length (L)		7
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A

PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.3.2.3-3: Minimum performance for Rank 1

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

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

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

The test purposes are specified in Table 5.2.3.2.4-1.

Table 5.2.3.2.4-1: Tests purpose

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

Table 5.2.3.2.4-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
NR UL transmission with a 7.5 kHz shift to the LTE raster			true
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9 for Test 1-1 11 for Test 1-2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Position of the first DM-RS for downlink		3
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CRS for rate matching (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	MHz	10
	Number of antenna ports		4
	v-shift		0

Number of HARQ Processes		8
The number of slots between PDSCH and corresponding HARQ-ACK information		Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: No MBSFN is configured on LTE carrier. Note 2: LTE carrier is configured with Uplink-downlink configuration 2 [Table 4.2-2, TS 36.211] and Special subframe configuration 7 [Table 4.2-1, TS 36.211]. The start of transmission of LTE frame is delayed by 2 LTE subframes with respect to the start of transmission of NR frame.		

Table 5.2.3.2.4-3: Minimum performance for Rank 1

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

5.2.3.2.5 Minimum requirements for PDSCH 0.001% BLER

The performance requirements are specified in Table 5.2.3.2.5-3, with the addition of test parameters in Table 5.2.3.2.5-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.5-1.

Table 5.2.3.2.5-1: Tests purpose

Purpose	Test index
Verify the PDSCH 0.001% BLER performance under 4 receive antenna conditions	1-1

Table 5.2.3.2.5-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Maximum number of HARQ transmission			1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Defined in Annex A.1.2 for TDD pattern FR1.30-1

Table 5.2.3.2.5-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Target BLER	SNR (dB)
1-1	R.PDSCH.2-1.4 TDD	40 / 30	QPSK, 0.59	FR1.30-1	AWGN	1x4, ULA Low	0.001%	0.7

5.2.3.2.6 Minimum requirements for PDSCH repetitions over multiple slots

The performance requirements are specified in Table 5.2.3.2.6-3, with the addition of test parameters in Table 5.2.3.2.6-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.6-1.

Table 5.2.3.2.6-1: Tests purpose

Purpose	Test index
Verify the PDSCH repetitions over multiple slots performance under 4 receive antenna conditions	1-1

Table 5.2.3.2.6-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		2
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			4
The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 (Note 1)
Note 1: ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,10) = {2, 4, 6}.			

Table 5.2.3.2.6-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Target BLER	SNR (dB)
1-1	R.PDSCH.2-16.1 TDD	40 / 30	16QAM, 0.54	FR1.30-1	TDLA30-10	2x4, ULA Low	1% (Note 1)	-2.6
Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block.								

5.2.3.2.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2

The performance requirements are specified in Table 5.2.3.2.7-3, with the addition of test parameters in Table 5.2.3.2.7-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.7-1.

Table 5.2.3.2.7-1: Tests purpose

Purpose	Test index
PDSCH mapping Type B performance and UE processing capability 2 under four receive antenna conditions	1-1

Table 5.2.3.2.7-2: Test parameters

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

Table 5.2.3.2.7-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-17.1 TDD	40 / 30	QPSK, 0.30	FR1.30-2	TDLA30-10	2x4, ULA Low	70	-2.5

5.2.3.2.8 Minimum requirements for PDSCH pre-emption

The performance requirements are specified in Table 5.2.3.2.8-3, with the addition of test parameters in Table 5.2.3.2.8-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.8-1.

Table 5.2.3.2.8-1: Tests purpose

Purpose	Test index

Verify the PDSCH pre-emption performance under 4 receive antenna conditions	1-1

Table 5.2.3.2.8-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDCCH configuration (Note 4)	Symbols with PDCCH		0, 1
	DCI format		2_1
	timeFrequencySet		14x1
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
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Pre-emption configuration (Note 2)	Starting symbol (S)		3
	Length (L)		2
	Pre-emption periodicity and offset	Slots	40/(1,12,23,34) (Note 3)
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			FR1.30-1
Note 1: Void Note 2: Interference modelled as random data on pre-empted REs. Note 3: Pre-emption is scheduled with with 10% probability with 20ms periodicity. Note 4: In addition to PDCCH configuration in Table 5.2-1.			

Table 5.2.3.2.8-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-2.6 TDD	40 / 30	16QAM 0.64	FR1.30-1	TDLA30-10	2x4, ULA Low	70	8.7

5.2.3.2.9 Minimum requirements for HST-SFN

The performance requirements are specified in Table 5.2.3.2.9-3, with the addition of test parameters in Table 5.2.3.2.9-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.9-1.

Table 5.2.3.2.9-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions in the HST-SFN scenario defined in B.3.2 when *highSpeedDemodFlag-r16* [17] is configured.	1-1

Table 5.2.3.2.9-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	20 for CSI-RS resource 1,2,3,4
	CSI-RS offset	Slots	1 for CSI-RS resource 1 and 22 for CSI-RS resource 3 and 4.
	Frequency Occupation		Start PRB 0Number of PRB = 52
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.3.2.9-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-10.4 TDD	40 / 30	16QAM, 0.48	FR1.30-1	HST-SFN	2x4	70	11.7

5.2.3.2.10 Minimum requirements for HST-DPS

The performance requirements are specified in Table 5.2.3.2.10-3, with the addition of test parameters in Table 5.2.3.2.10-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.10-1.

Table 5.2.3.2.10-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-DPS scenario defined in B.3.3	1-1, 1-2

Table 5.2.3.2.10-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDCCH configuration	TCI state		Note 1
PDSCH configuration	Mapping type		Type A

	k0			0
	Starting symbol (S)			2
	Length (L)			Specific to each Reference channel
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l0 = 5 for CSI-RS resource 1 and 3
				l0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	20 for CSI-RS resource 1,2,3,4
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2
				2 for CSI-RS resource 3 and 4
		QCL info		TCI state #2
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7
				l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	20 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6
				2 for CSI-RS resource 7 and 8
		QCL info		TCI state #3
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
NZP CSI-RS for CSI acquisition	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l0 = 12
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l0 = 13
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				8
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Note 1: SSB # (k mod 2) , CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by k[th] RRH.

For Test 1-1, TCI state switching command scheduled by MAC CE with PDSCH configuration - MCS 4, Layer 1, StartRB 32, NumOfRB 74 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$.
PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from:
slot# $\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\,proc} + T_{firstTRS} + T_{TRS\,proc}, 0]$
to:
slot# $(2k+1)n$
PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

For Test 1-2, TCI state switching command scheduled by MAC CE with PDSCH configuration - MCS 4, Layer 1, StartRB 32, NumOfRB 74 is transmitted in slot #i that satisfy $\mathrm{mod}(i, 2n) = n$.
PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from:
slot# $\max[(2k-1)n + 1 + T_{HARQ} + T_{MAC\,proc}, 0]$
to:
slot# $(2k+1)n$
PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

Where k=0, 1, 2… is the RRH number, n = 5040 is half of the number of slots between two RRH, T_{HARQ} = 8 is the number of slots between PDSCH and corresponding HARQ-ACK information, $T_{MAC\,proc}$ = 6 is the number of slots for MAC CE processing, $T_{firstTRS}$ = 7 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $T_{TRS\,proc}$ = 4 is the number of slots for TRS processing.

Table 5.2.3.2.10-3: Minimum performance for HST-DPS

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
								Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-10.5 TDD	40 / 30	64QAM, 0.43	FR1.30-1	HST-DPS	1	2x4	70	10.2
1-2	R.PDSCH.2-10.5 TDD	40 / 30	64QAM, 0.43	FR1.30-1	HST-DPS	2	2x4	70	10.2

5.2.3.2.11 Minimum requirements for PDSCH Single-DCI based SDM scheme

The performance requirements are specified in Table 5.2.3.2.11-3, with the addition of test parameters in Table 5.2.3.2.11-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.11-1.

Table 5.2.3.2.11-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance with Single-DCI based SDM scheme under 4 receive antenna conditions.	1-1,1-2

Table 5.2.3.2.11-2: Test parameters

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	
	CORESETPoolIndex		0	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3	l0 = 6 for CSI-RS resources 5 and 7

				l0 = 10 for CSI-RS resources 2 and 4	l0 = 10 for CSI-RS resources 6 and 8
		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
		CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
		Density		3	
		CSI-RS periodicity	Slots	40	
		CSI-RS offset	Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
		QCL info		TCI state #0	
Duplex mode				TDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 1	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000	1002
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Full-overlapping	
Timing offset of the second TRxP from the first TRxP			us	-0.25 for test 1-1 1 for test 1-2	
Frequency offset of the second TRxP from the first TRxP			Hz	300 for test 1-1 0 for test 1-2	
Number of HARQ Processes				8	
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.	
Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2)					

Table 5.2.3.2.11-3: Minimum performance

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition(Note 1)	Correlation matrix and antenna configuration(Note 2)	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)(Note 3)
1-1	R.PDSCH.2-3.2 TDD	40 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x4, ULA Low	70	14.5
1-2	R.PDSCH.2-3.2 TDD	40 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x4, ULA Low	70	13.9
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2 Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 with scaling factor as 1/sqrt(2) for transmitted signal from each TRxP								

5.2.3.2.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme

The performance requirements are specified in Table 5.2.3.2.12-3, with the addition of test parameters in Table 5.2.3.2.12-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.12-1.

Table 5.2.3.2.12-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance when UE is configured two different values of CORESETPoolIndex in ControlResourceSet and when UE receives multiple PDCCHs scheduling PDSCHs	1-1

Table 5.2.3.2.12-2: Test parameters

Parameter			Unit	Value	
				TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration		TCI state		TCI State #1	TCI State #2
		CORESETPoolIndex		0,1	
CSI-RS for tracking		First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
		First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
		CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
		Density		3	
		CSI-RS periodicity	Slots	40	
		CSI-RS offset	Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
		QCL info		TCI state #0	
Duplex mode				TDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	

	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 1	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			{1000,1001}	{1002,1003}
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Non-overlapping	
Timing offset of the second TRxP from the first TRxP			us	-0.25	
Frequency offset of the second TRxP from the first TRxP			Hz	300	
Number of HARQ Processes				8	
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity	
Note 1: PDSCH transmission is done from both TRxPs. Transmission from TRxP #1 uses CORESETPoolIndex 0 and transmission from TRxP #2 uses CORESETPoolIndex 1					

Table 5.2.3.2.12-3: Minimum performance

Test num.	Reference channel		Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition(Note 1)	Correlation matrix and antenna configuration(Note 2)	Reference value	
								Fraction of maximum throughput (%)	SNR (dB)(Note 3)
	TRxP #1	TRxP #2							
1-1	R.PDSCH.2-3.3 TDD	R.PDSCH.2-3.4 TDD	40 / 30	64QAM, 0.50	FR1.30-1	TDLA30-10	2x4, ULA Low	70	14. 6
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2 Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2									

5.2.3.2.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A

The performance requirements are specified in Table 5.2.3.2.13-3, with the addition of test parameters in Table 5.2.3.2.13-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.13-1.

Table 5.2.3.2.13-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions when UE is configured with “FDMSchemeA” in “RepetitionScheme-r16” defined in clause 5.1 of TS 38.214 [12]	1-1

Table 5.2.3.1.13-2: Test parameters

Parameter			Unit	Value	
				TRxP #1 (Note 1)	TRxP #2 (Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration	TCI state			TCI State #1	
	CORESETPoolIndex			Not configured	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	40	
	CSI-RS offset		Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
Duplex mode				TDD	
Active DL BWP index				1	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	PRB bundling type			Static	
	PRB bundling size			wideband	
	Resource allocation type			Type 0	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000, 1001	1000, 1001
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
		CSI-RS resource		N/A	N/A

	Type 2 QCL information	QCL Type		N/A	N/A
Timing offset of the second TRxP from the first TRxP			us	-0.25	
Frequency offset of the second TRxP from the first TRxP			Hz	300	
Number of HARQ Processes				8	
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
Precoding configuration				SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.	
Note 1: PDSCH transmission is done from both TRxPs					

Table 5.2.3.2.13-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition (Note 1)	Correlation matrix and antenna configuration (Note 2)	Reference value	
							Fraction of maximum throughput (%)	SNR (dB) (Note 3)
1-1	R.PDSCH.2-2.5 TDD	40 / 30	16QAM, 0.54	FR1.30-1	TDLA30-10	2x4, ULA Low	70	10.5
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2								

5.2.3.2.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme

The performance requirements are specified in Table 5.2.3.2.14-3, with the addition of test parameters in Table 5.2.3.2.14-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.14-1.

Table 5.2.3.2.14-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions when UE is configured with repetitionNumber-r16 with multiple slot level PDSCH transmission occasions of the same TB with two TCI states defined in clause 5.1 of TS 38.214 [12]	1-1

Table 5.2.3.2.14-2: Test parameters

Parameter		Unit	Value	
			TRxP #1 (Note 1)	TRxP #2 (Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	
	CORESETPoolIndex		Not configured	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density		3	
	CSI-RS periodicity	Slots	40	

		CSI-RS offset		Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
		QCL info			TCI state #0	
Duplex mode					TDD	
Active DL BWP index					1	
PDSCH configuration	Mapping type				Type A	
	k0				0	
	Starting symbol (S)				2	
	Length (L)				12	
	Repetition number				2	
	PRB bundling type				Static	
	PRB bundling size				2	
	Resource allocation type				Type 0	
	RBG size				Config2	
	VRB-to-PRB mapping type				Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size				N/A	
PDSCH DMRS configuration	Antenna port indexes				1000	1000
	TCI state				TCI State #1	TCI State #2
	DMRS Type				Type 1	
	Number of additional DMRS				1	
	Maximum number of OFDM symbols for DL front loaded DMRS				1	
TCI State #1	Type 1 QCL information		CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
			QCL Type		Type A	N/A
	Type 2 QCL information		CSI-RS resource		N/A	N/A
			QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information		CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
			QCL Type		N/A	Type A
	Type 2 QCL information		CSI-RS resource		N/A	N/A
			QCL Type		N/A	N/A
Timing offset of the second TRxP from the first TRxP				us	1	
Frequency offset of the second TRxP from the first TRxP				Hz	300	
Number of HARQ Processes					4	
The number of slots between PDSCH and corresponding HARQ-ACK information					Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 (Note 2)	
Precoding configuration					SP Type I, independent precoding generation is applied for both TRxPs, random per slot with PRB bundling granularity.	
Note 1: PDSCH transmission is done from both TRxPs Note 2: ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,10) = {2, 4, 6}.						

Table 5.2.3.2.14-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition (Note 1)	Correlation matrix and antenna configuration (Note 2)	Reference value	
							BLER (%)	SNR (dB) (Note 4)
1-1	R.PDSCH.2-16.2 TDD	40 / 30	16QAM, 0.54	FR1.30-1	TDLA30-10	2x4, ULA Low	1 (Note 3)	-0.5
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. Note 4: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2								

5.2.3.2.15 Minimum requirements for PDSCH of PCell on band with shared spectrum access

The performance requirements are specified in Table 5.2.3.2.15-3, with the addition of test parameters in Table 5.2.3.2.15-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.15-1.

Table 5.2.3.2.15-1: Tests purpose

Purpose	Test index
Verify PDSCH performance for UE supporting operations in shared spectrum access	1-1, 1-2, 1-3, 1-4

Table 5.2.3.2.15-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
DL transmission model			As specified in B.5
Downlink Model Parameters	QCL relation between SSB positions (N_{SSB}^{QCL})		8
	Downlink transmission duration values	Slots	{2,4,6,7}
	Occupied OFDM symbols in slot other than the last slot of the downlink duration	Symbols	14
	Occupied OFDM symbols in the last slot of the downlink duration	Symbols	{6,9,12,14} (Note 1)
	Downlink period	ms	5
	LBT failure probability (p_{LBT})		0.25
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	dmrs-AdditionalPosition		pos1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: If DL Transmission duration is 2 Slot, the occupied OFDM symbols in the last slot of the downlink duration is 14.			

Table 5.2.3.2.15-3: Minimum performance for Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-18.1 TDD	20 / 30	16QAM, 0.48	FR1.30-7	TDLA30-10	2x4, ULA Low	70	8.7

1-2	R.PDSCH.2-18.2 TDD	40 / 30	16QAM, 0.48	FR1.30-7	TDLA30-10	2x4, ULA Low	70	8.7
1-3	R.PDSCH.2-18.3 TDD	60 / 30	16QAM, 0.48	FR1.30-7	TDLA30-10	2x4, ULA Low	70	8.9
1-4	R.PDSCH.2-18.4 TDD	80 / 30	16QAM, 0.48	FR1.30-7	TDLA30-10	2x4, ULA Low	70	9.1

5.2.3.2.16 Minimum requirements for PDSCH with inter-cell interference

The performance requirements are specified in Table 5.2.3.2.16-3, with the addition of test parameters in Table 5.2.3.2.16-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.16-1.

Table 5.2.3.2.16-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance under 4 receive antenna conditions, when the PDSCH transmission from the serving cell is interfered by 1 or 2 interfering cells.	1-1, 1-2

Table 5.2.3.2.16-2: Test parameters

Parameter		Unit	Value		
			Cell 1	Cell 2	Cell 3
			Enabled	Enabled	Enabled for test 1-1 Disabled for test 1-2
Duplex mode			TDD		
TDD UL-DL pattern			FR1.30-1		
Active DL BWP index			1		
Physical cell ID			0	1	2
Transmission rank			1	Random rank with 70% and 30% probability for rank 1 and rank 2	Random rank with 70% and 30% probability for rank 1 and rank 2 for Test 1-1 N/A for Test 1-2
Time offset to Cell 1		us	N/A	1.5	-0.5
Frequency shift to Cell 1		Hz	N/A	300	-100
Interference Model			N/A	As specified in B.6.2	
INR (Note 2)		dB	N/A	7.77 for Test 1-1 7.58 for Test 1-2	2.29 for Test 1-1 N/A for Test 1-2
SSB configuration	SSB position in burst		First SSB in Slot #0	First SSB in Slot #0 for Test 1-1 Second SSB in Slot #0 for Test 1-2	First SSB in Slot #0 for Test 1-1 N/A for Test 1-2
	SSB periodicity	ms	20	20	20
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
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: Cell 1 is the serving cell, Cell 2 , 3 are interference cells. Note 2: INR is defined in Annex B.6.1			

Table 5.2.3.2.16-3: Minimum performance for PDSCH with rank 1 and with inter-cell interference

Test num	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
			Cell1			Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	TDLC300-100	2x4, ULA Low	70	10.7
1-2	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	7.6
Note 1: The propagation conditions for Cell 1, Cell 2 and Cell 3 are statistically independent. Note 2: Bandwidth/ Subcarrier spacing, Propagation Condition, Correlation matrix and antenna configuration parameters apply for each of Cell 1, Cell 2 and Cell 3.							

5.2.3.2.17 Minimum requirements for PDSCH with intra-cell inter-user interference

The performance requirements are specified in Table 5.2.3.2.17-3 and and Table 5.2.3.2.17-4, with the addition of test parameters in Table 5.2.3.2.17-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.17-1.

Table 5.2.3.2.17-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions, when the PDSCH transmission of target UE is interfered by co-scheduled UE.	1-1, 2-1

Table 5.2.3.2.17-2: Test parameters

Parameter		Unit	Target UE	Co-scheduled UE
Duplex mode			TDD	
Active DL BWP index			1	
PDSCH configuration	Mapping type		Type A	
	k0		0	
	Starting symbol (S)		2	
	Length (L)		12	
	PDSCH aggregation factor		1	
	PRB bundling type		Static	

	PRB bundling size		2	
	Resource allocation type		Type 0	
	RBG size		Config2	
	VRB-to-PRB mapping type		Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size		N/A	
PDSCH DMRS configuration (Note 1)	DMRS Type		Type 1	
	Number of additional DMRS		1	
	Maximum number of OFDM symbols for DL front loaded DMRS		1	
	Antenna ports indexes		{1000} for test 1-1 {1000, 1001} for test 2-1	{1001} for test 1-1 {1002, 1003} for test 2-1
	Number of PDSCH DMRS CDM group(s) without data		1 for test 1-1 2 for test 2-1	1 for test 1-1 2 for test 2-1
PDSCH & PDSCH DMRS Precoding configuration			Single Panel Type I, Randomized precoder selection for every PRB bundle and updated per slot, with equal probability of each applicable i1/i2 combination or codebook Index, chosen from section 5.2.2.2.1 of TS 38.214 [12].	Single Panel Type I, Randomized precoder selection for every PRB bundle and updated per slot, with equal probability of each applicable i1/i2 combination or codebook Index, chosen from section 5.2.2.2.1 of TS 38.214 [12]. Any column of precoder matrix is not equal to any column of precoder matrix of Target UE for test 1-1 Select the precoder to ensure any column of precoder is orthogonal to any column of precoder for the target PDSCH for test 2-1
MU-MIMO Beamforming Model			As specified in B.4.2	
Number of HARQ Processes			8	N/A
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	N/A
Note 1: DMRS scrambling ID is the same for both target and co-shceduled UEs.				

Table5.2.3.1.17-3: Minimum performance for target UE with Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate		TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
			Target UE	Co-scheduled UE				Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-2.1 TDD	40 / 30	16QAM, 0.48	Random 16QAM symbols	FR1.30-1	TDLC300-100	2x4, ULA Low	70	11.8

Table 5.2.3.2.17-4: Minimum performance for target UE with Rank 2

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate		TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
			Target UE	Co-scheduled UE				Fraction of maximum throughput	SNR (dB)

								(%)	
2-1	R.PDSCH.7-1.2 TDD	40 / 30	16QAM, 0.48	Random 16QAM symbols	FR1.30-1	TDLA30-10	4x4, ULA Low	70	15.5

5.2.3.2.18 Minimum requirements for PDSCH CRS interference mitigation under NR-LTE coexistence scenario

The performance requirements are specified in Table 5.2.3.2.18-4, with the addition of test parameters in Table 5.2.3.2.18-2 for the serving cell and Table 5.2.3.2.18-3 for the LTE interference cells and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.18-1.

Table 5.2.3.2.18-1: Tests purpose

Purpose	Test index
Verify PDSCH CRS interference mitigation performance under 4 receive antenna conditions with CRS rate matching configured for the serving cell.	1-1

Table 5.2.3.2.18-2: Test parameters for the serving cell

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		3
	Length (L)		9
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CRS for rate Matchin (Note 1)	LTE carrier centre subcarrier location		Same as NR carrier centre subcarrier location
	LTE carrier BW	Hz	20
	Number of antenna ports		4
	v-shift		0
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: No MBSFN is configured on LTE carrier. Note 2: Network-based CRS interference mitigation is disabled on LTE carrier			

Table 5.2.3.2.18-3: Test parameters for the LTE interference cells

Parameter	Unit	Cell 1	Cell 2
Duplex mode		TDD	TDD

TDD UL-DL pattern			DSUDDDSUDD S = 10D + 2G + 2U	DSUDDDSUDD S = 10D + 2G + 2U
INR (Note 1)		dB	10.45	4.6
LTE Bandwidth		MHz	20	20
Carrier centre subcarrier location			Same as the NR serving carrier centre subcarrier location	Same as the NR serving carrier centre subcarrier location
Cyclic Prefix			Normal	Normal
Physical cell ID			1	2
CRS pattern	Number of antenna ports		4	4
	v-shift		1	2
Downlink power allocation	ρ_A	dB	-6	-6
	ρ_B	dB	-6	-6
	σ	dB	0	0
PDSCH transmission mode			TM4	TM4
PDSCH loading level		%	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain.	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain.
Transmission rank		%	80% and 20% probability for rank 1 and rank 2 respectively	80% and 20% probability for rank 1 and rank 2 respectively
Interference model			As specified in clause B.7	As specified in clause B.7
Time offset to the serving cell		us	3	-1
Frequency offset to the serving cell		Hz	300	-100
Propagation conditions and MIMO configuration (Note 2)			TDLA30-10 ULA Low	TDLA30-10 ULA Low
Precoding granularity		PRB	8	8
Note 1: Defined in B.6.1 Note 2: The channel for the LTE interference cells and the serving cell are independent.				

Table 5.2.3.2.18-4: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-1.3 TDD	20 / 15	16QAM, 0.48	FR1.15-1	TDLA30-10	4x4, ULA Low	70	8.8

5.2.3.2.19 Minimum requirements for PDSCH with inter cell CRS interference

The performance requirements are specified in Table 5.2.3.2.19-4 and Table 5.2.3.2.19-6, with the addition of test parameters in Table 5.2.3.2.19-2 for the serving cell and Table 5.2.3.2.19-3 for the LTE interference cells and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.19-1.

Table 5.2.3.2.19-1: Tests purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions when PDSCH is interfered by inter cell CRS signal	1-1, 1-2, 2-1 and 2-2

Table 5.2.3.2.19-2: Tests parameter for serving cell PDSCH

Parameter		Unit	Value
Duplex mode			TDD
TDD UL-DL pattern			FR1.15-1
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

Table 5.2.3.2.19-3: Tests parameter for interference cells

Parameter		Unit	Cell 1	Cell 2
Duplex mode			TDD	TDD
TDD UL-DL pattern			DSUDDDSUDD S = 10D + 2G + 2U	DSUDDDSUDD S = 10D + 2G + 2U
INR		dB	10.45	4.6
LTE Bandwidth (Note 5)		MHz	20	20
Carrier centre subcarrier location (Note 6)			Same as the NR serving carrier centre subcarrier location	Same as the NR serving carrier centre subcarrier location
Cyclic Prefix			Normal	Normal
Physical cell ID			1	2
CRS pattern	Number of antenna ports		4	4
	v-shift		1	2
Downlink power allocation	ρ_A	dB	-6	-6
	ρ_B	dB	-6	-6
	σ	dB	0	0
PDSCH transmission mode			TM4	TM4
PDSCH loading level		%	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-1. 10% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-2.	20% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-1. 10% probability of occurrence of LTE data transmission in time domain, and full bandwidth allocation in frequency domain for test 1-2.
Transmission rank		%	80% and 20% probability for rank 1 and rank 2 respectively	80% and 20% probability for rank 1 and rank 2 respectively
Interference model			As specified in clause B.7	As specified in clause B.7
Time offset to the serving cell		us	3 for test 1-1	-1 for test 1-1

		1.5 for test 1-2	-0.5 for test 1-2
Frequency offset to the serving cell	Hz	300	-100
Propagation conditions and MIMO configuration (Note 1)		TDLA30-10 ULA Low	TDLA30-10 ULA Low
Precoding granularity	PRB	8	8
Note 1: The channel for the LTE interference cells and the serving cell are independent. Note 2: No MBSFN is configured on LTE carrier. Note 3: Network-based CRS interference mitigation is disabled on LTE carrier. Note 4: The start of transmission of LTE frame is delayed by 2 LTE subframes with respect to the start of transmission of NR frame Note 5: This parameter is informed to UE via network assistance signalling for Test 1-1 and 1-2 in Table 5.2.3.2.18-4. Note 6: Single entry is included in IE *LTE-NeighCellsCRS-AssistInfoList-r17* that applies for both cells for cases with network signalling assistance			

The requirements for UE capable of performing CRS-IM with the assistance of network signaling on LTE channel bandwidth are specified in Table 5.2.3.2.19-4:

Table 5.2.3.2.19-4 Minimum performance for Rank 1 with the assistance of network signaling on LTE channel bandwidth

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.1-4.1 TDD	20 / 15	16QAM, 0.48	FR1.15-1	TDLA30-10	4x4, ULA Low	70	8.6
1-2	R.PDSCH.2-28.1 TDD	20 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	8.2

The requirements for UE capable of performing CRS-IM without the assistance of network signaling on LTE channel bandwidth are specified in Table 5.2.3.2.19-6 with following test procedure:

The network configures an inter-RAT LTE measurement object of the interfering cells to the tested UE. Inter-RAT measurement is configured at the beginning of the test and applied throughout the test with gap pattern configurations according to Table 5.2.3.2.19-5. PDSCH is not scheduled and throughput is not counted during 4.64s after the beginning of test. PDSCH is not scheduled in the measurement gaps.

Table 5.2.3.2.19-5: Measurement Gap configurations

Parameter	Unit	Value
Measurement Gap Length (mgl)	ms	6
Measurement Gap Repetition Period (mgrp)	ms	40
Gap offset (gapoffset)	ms	1
Measurement gap timeing advance (mgta)	ms	0

Table 5.2.3.2.19-6: Minimum performance for Rank 1 without the assistance of network signaling on LTE channel bandwidth

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
2-1	R.PDSCH.1-4.2 TDD	20 / 15	16QAM, 0.48	FR1.15-1	TDLA30-10	4x4, ULA Low	70	8.6
2-2	R.PDSCH.2-29.1 TDD	20 / 30	16QAM, 0.48	FR1.30-1	TDLA30-10	4x4, ULA Low	70	8.2

5.2.3.2.20 Minimum requirements for HST-SFN Scheme A

The performance requirements are specified in Table 5.2.3.2.20-3, with the addition of test parameters in Table 5.2.3.2.20-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.20-1.

Table 5.2.3.2.20-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-SFN Scheme A scenario defined in B.3.5	1-1

Table 5.2.3.2.20-2: Test parameters

Parameter			Unit	Value
Duplex mode				TDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			12
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	20 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #3
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	20 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #4
	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 9 and 11 l_0 = 8 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	20 for CSI-RS resource 9,10,11,12.
		CSI-RS offset	Slots	1 for CSI-RS resource 9 and 10 2 for CSI-RS resource 11 and 12
		QCL info		TCI state #5
NZP CSI-RS for CSI acquisition	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #5	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0

		QCL info		TCI state #1
	Resource set #6	First OFDM symbol in the PRB used for CSI-RS		$l_0 = 7$
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #4	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #5	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				8
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
Note 1: SSB # (k mod 3) , CSI-RS (for tracking) resource set # ((k mod 3) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 3) + 4) are transmitted by k^{th} RRH. Codepoint #0 is activated when UE receives PDCCH/PDSCH from RRH#3k and RRH#3k+1 with TCI States TCI state #0, TCI State #1. Codepoint #1 is activated when UE receives PDCCH/PDSCH from RRH#3k+1 and RRH#3k+2 with TCI States TCI state #1, TCI State #2. Codepoint #2 is activated when UE receives PDCCH/PDSCH from RRH#3k+2 and RRH#3k+3 with TCI States TCI state #2, TCI State #0.				

Table 5.2.3.2.20-3: Minimum performance for HST-SFN Scheme A

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.2-30.1 TDD	40 / 30	16QAM, 0.48	FR1.30-1	HST-SFN Scheme A	2x4	70	10.3

5.2.3.2.21 Minimum requirements for HST-SFN Scheme B

The performance requirements are specified in Table 5.2.3.2.21-3, with the addition of test parameters in Table 5.2.3.2.21-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.21-1.

Table 5.2.3.2.21-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-SFN Scheme B scenario defined in B.3.6	1-1

Table 5.2.3.2.21-2: Test parameters

Parameter			Unit	Value
Duplex mode				TDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			Specific to each Reference channel
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	20 for CSI-RS resource 1,2,3,4.
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #3
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	20 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #4
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 9 and 11 l_0 = 8 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	20 for CSI-RS resource 9,10,11,12.
		CSI-RS offset	Slots	1 for CSI-RS resource 9 and 10 2 for CSI-RS resource 11 and 12
		QCL info		TCI state #5
		Frequency Occupation		Start PRB 0
				Number of PRB = 52
NZP CSI-RS for CSI acquisition	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0

		QCL info		TCI state #0
	Resource set #5	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #6	First OFDM symbol in the PRB used for CSI-RS		l_0 = 7
		CSI-RS periodicity	Slots	40
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #4	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #5	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes			8	
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
Note 1: SSB # (k mod 3), CSI-RS (for tracking) resource set # ((k mod 3) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 3) + 4) are transmitted by k^{th} RRH. Codepoint#0 {TCI state #0, TCI State #1} is activated when UE receives PDCCH/PDSCH from RRH#3k and RRH#3k+1. Codepoint#1 {TCI state #1, TCI State #2} is activated when UE receives PDCCH/PDSCH from RRH#3k+1 and RRH#3k+2. Codepoint#2 {TCI state #2, TCI State #0} is activated when UE receives PDCCH/PDSCH from RRH#3k+2 and RRH#3k+3. The second indicated TCI state in each codepoint is not used for quasi co-location parameters {Doppler shift, Doppler spread}.				

Table 5.2.3.2.21-3: Minimum performance for HST-SFN Scheme B

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)

1-1	R.PDSCH.2-30.1 TDD	40/30	16QAM, 0.48	FR1.30-1	HST-SFN-SchemeB	2x4	70	9.3

5.2A PDSCH demodulation requirements for CA

The parameters specified in Table 5.2-1 for PDSCH single carrier tests are reused for PDSCH CA tests unless otherwise stated.

Table 5.2A-1: Common test parameters for CA

Parameter		Unit	Value
Duplex mode			FDD and TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		FDD: 12TDD: Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			As defined in Table 5.2A-2
TDD UL-DL pattern			15kHz SCS: FR1.15-1 30kHz SCS: FR1.30-1
The number of slots between PDSCH and corresponding HARQ-ACK information			As defined in Table 5.2A-3
PUCCH format for HARQ-ACK feedback			PUCCH format 1 for cases where the number of ACK/NACK to be transmitted on single PUCCH is 2 or less. PUCCH format 3 for cases where the number of ACK/NACK to be transmitted on single PUCCH is more than 2.

Table 5.2A-2: Test parameters for number of HARQ processes

HARQ process number		CCs with the same duplex mode & SCS with Pcell	CCs with different duplex mode / SCS with Pcell
FDD 15 kHz + TDD 30 kHz CA	FDD PCell	4	8
	TDD PCell	10	8
FDD 15 kHz + TDD 15 kHz CA	FDD PCell	4	4
	TDD PCell	8	8
TDD 15 kHz + TDD 30 kHz CA	15kHz PCell	8	12
	30kHz PCell	8	8
FDD 15 kHz + FDD 15 kHz CA	FDD PCell	4	N/A
TDD 30 kHz + TDD 30 kHz CA	TDD PCell	8	N/A

Table 5.2A-3: Test parameters for K1 values

The number of slots between PDSCH and corresponding HARQ-ACK information		CCs with the same duplex mode and SCS with Pcell	CCs with different duplex mode and/or SCS with Pcell
FDD 15 kHz + TDD 30 kHz CA	FDD PCell	{2}	{2}
	TDD PCell	{8,7,6,5,5,4,3,11}	{7,5,4,11,9}
FDD 15 kHz + TDD 15 kHz CA	FDD PCell	{2}	{2}
	TDD PCell	{4,3,2,6}	{4,3,2,6,5}
TDD 15 kHz + TDD 30 kHz CA	15kHz PCell	{4,3,2,6}	{4,4,3,3,2,2,6,6}
	30kHz PCell	{8,7,6,5,5,4,3,2}	{7,5,4,11}
FDD 15 kHz + FDD 15 kHz CA	FDD PCell	{2}	N/A
TDD 30 kHz + TDD 30 kHz CA	TDD PCell	{8,7,6,5,5,4,3,2}	N/A

5.2A.1 1RX requirements

(Void)

5.2A.2 2RX requirements

5.2A.2.1 Minimum requirements

For CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.2.1-4 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.2.1-1 ~ Table 5.2A.2.1-3, with the parameters in Table 5.2A-1 ~ Table 5.2A-3 and the downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-clause do not apply for UE single carrier test.

Table 5.2A.2.1-1: Single carrier performance for FDD 15 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-9.1 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.6
10	R.PDSCH.1-2.2 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.6
15	R.PDSCH.1-9.2 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.6
20	R.PDSCH.1-9.3 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.8
25	R.PDSCH.1-9.4 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.0
30	R.PDSCH.1-9.5 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.8
35	R.PDSCH.1-10.3 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.9
40	R.PDSCH.1-10.1 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.0
45	R.PDSCH.1-10.4 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.5
50	R.PDSCH.1-10.2 FDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.4

Table 5.2A.2.1-2 Single carrier performance for TDD 15 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-2.1 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.6
10	R.PDSCH.1-2.2 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.8
15	R.PDSCH.1-2.3 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.8
20	R.PDSCH.1-2.4 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.9
25	R.PDSCH.1-2.5 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.0
30	R.PDSCH.1-3.1 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.9
40	R.PDSCH.1-3.2 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.2
50	R.PDSCH.1-3.3 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.5

Table 5.2A.2.1-3 Single carrier performance for TDD 30 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.2-13.1 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.6
10	R.PDSCH.2-13.2 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.6
15	R.PDSCH.2-13.3 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.6
20	R.PDSCH.2-13.4 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.7
25	R.PDSCH.2-13.5 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.7
30	R.PDSCH.2-14.1 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.7
40	R.PDSCH.2-2.2 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	13.9
50	R.PDSCH.2-14.2 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.1
60	R.PDSCH.2-14.3 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.0
80	R.PDSCH.2-14.4 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.5
90	R.PDSCH.2-14.5 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.3
100	R.PDSCH.2-15.1 TDD	16QAM, 0.48	TDLA30-10	2x2, ULA Low	70	14.7

Table 5.2A.2.1-4: Minimum performance for multiple CA configurations

Test number	CA duplex mode	Minimum performance requirements
1	FDD 15 kHz + FDD 15 kHz	As defined in Table 5.2A.2.1-1
2	TDD 30 kHz + TDD 30 kHz	As defined in Table 5.2A.2.1-3
3	FDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.2.1-1 and Table 5.2A.2.1-3 per CC
4	FDD 15 kHz + TDD 15 kHz	As defined in Table 5.2A.2.1-1 and Table 5.2A.2.1-2 per CC
5	TDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.2.1-2 and Table 5.2A.2.1-3 per CC

Note 1:	The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.7.

5.2A.2.2 Minimum requirements for carrier aggregation with power imbalance

The performance requirements are specified in Table 5.2A.2.2-3 and Table 5.2A.2.2-4, with the addition of test parameters in Table 5.2A.2.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2A.2.2-1.

Table 5.2A.2.2-1: Tests purpose

Purpose	Test index
Verify the ability of an intra-band adjacent carrier aggregation UE to demodulate the signal transmitted by the PCell or SCell in the presence of a stronger SCell or PCell signal on an adjacent frequency. Throughput is measured on the PCell or SCell only	

Table 5.2A.2.2-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD and TDD
Active DL BWP index			1
Propagation condition			Static propagation condition No external noise sources are applied
Antenna configuration			1x2
PDSCH configuration	Length (L)		FDD: 12TDD: 12 for DL slot, 4 for special slot
	PRB bundling size		WB
Modulation and code rate			64QAM, MCS 26
Number of HARQ Processes			FDD: 4 TDD: 8
Maximum number of HARQ transmission			1
Redundancy version coding sequence			{0}
TDD UL-DL pattern			30kHz SCS: FR1.30-1
The number of slots between PDSCH and corresponding HARQ-ACK information			As defined in Table A.1.2-2 for FR1.30-1
PUCCH format for HARQ-ACK feedback			PUCCH format 1
Overhead for TBS determination			0
SSB transmission			Slot#0 with periodicity 20ms
RB assignment			Full applicable test bandwidth as defined in Table 5.3.5-1 of TS 38.101-1 [6]

Table 5.2A.2.2-3: Minimum performance for FDD CA with 15 kHz SCS

Test Number	Bandwidth (MHz)		Reference channel		Power at antenna port (dBm/Hz)		Reference value Fraction of Maximum Throughput (%)	
	PCell	SCell	PCell	SCell	$\hat{E}_{s\_PCell}$ for PCell	$\hat{E}_{s\_SCell}$ for Scell	PCell	SCell
1	Selected Channel bandwidth as per section 5.1.1.6		Derived as per section 5.1.3.2 of TS 38.214 [12]	NA	-112	-106	85	NA

Table 5.2A.2.2-4: Minimum performance for TDD CA with 30 kHz SCS

Test Number	Bandwidth (MHz)		Reference channel		Power at antenna port (dBm/Hz)		Reference value Fraction of Maximum Throughput (%)	
	PCell	SCell	PCell	SCell	$\hat{E}_{s\_PCell}$ for PCell	$\hat{E}_{s\_SCell}$ for Scell	PCell	SCell
1	Selected Channel bandwidth as per section 5.1.1.6		Derived as per section 5.1.3.2 of TS 38.214 [12]	NA	-112	-106	85	NA

5.2A.2.3 Minimum requirements for PDSCH of SCell on band with shared spectrum access

The performance requirements for SCell on band with shared spectrum access are specified in Table 5.2.2.2.15-3, with the additional test parameters for SCell in Table 5.2.2.2.15-2, the test parameters for PCell in Table 5.2A.2.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2A.2.3-1. During the test, only the PDSCH performance of the SCell should be verified.

Table 5.2A.2.3-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance of SCell for UE supporting operations in shared spectrum access	1-1, 1-2, 1-3, 1-4

Table 5.2A.2.3-2: Test parameters for PCell

Parameter		Unit	Value
Duplex mode			TDD
Bandwidth		MHz	20
Subcarrier spacing		kHz	30
Active DL BWP index			1
TDD pattern			FR1.30-1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Dmrs-AdditionalPosition		pos1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

5.2A.2.4 Minimum requirements for HST-SFN CA

For HST-SFN CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.2.4-5 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.2.4-3 and Table 5.2A.2.4-4. Test parameters are specified in Table 5.2A.2.4-2, Table 5.2A-2, and Table 5.2A-3 with downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-clause do not apply for UE single carrier test.

The test purpose is specified in Table 5.2A.2.4-1.

Table 5.2A.2.4-1: Test purpose

Purpose	Test index
Verify PDSCH performance under 2 receive antenna conditions in the HST-SFN scenario defined in B.3.2 with CA	1,2,3

Table 5.2A.2.4-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD and TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	FDD: 10 for CSI-RS resource 1,2,3,4. TDD: 20 for CSI-RS resource 1,2,3,4.
	CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4.
Number of HARQ Processes			As defined in Table 5.2A-2
TDD UL-DL pattern			15 kHz SCS: FR1.15-1 30 kHz SCS: FR1.30-1
The number of slots between PDSCH and corresponding HARQ-ACK information			As defined in Table 5.2A-3
Number of PUCCH ResourceGroups			1
PUCCH format for HARQ-ACK feedback			PUCCH format 1 for cases with no more than 2 DL CCs PUCCH format 3 for cases with more than 2 DL CCs

Table 5.2A.2.4-3: Single carrier performance for FDD 15 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-13.1 FDD	16QAM, 0.48	HST-SFN	2x2	70	12.9

10	R.PDSCH.1-8.3 FDD	16QAM, 0.48	HST-SFN	2x2	70	13.1
15	R.PDSCH.1-13.2 FDD	16QAM, 0.48	HST-SFN	2x2	70	13.4
20	R.PDSCH.1-13.3 FDD	16QAM, 0.48	HST-SFN	2x2	70	13.9
25	R.PDSCH.1-13.4 FDD	16QAM, 0.48	HST-SFN	2x2	70	14.0
30	R.PDSCH.1-13.5 FDD	16QAM, 0.48	HST-SFN	2x2	70	13.9
35	R.PDSCH.1-14.3 FDD	16QAM, 0.48	HST-SFN	2x2	70	13.8
40	R.PDSCH.1-14.1 FDD	16QAM, 0.48	HST-SFN	2x2	70	14.0
45	R.PDSCH.1-14.4 FDD	16QAM, 0.48	HST-SFN	2x2	70	13.9
50	R.PDSCH.1-14.2 FDD	16QAM, 0.48	HST-SFN	2x2	70	14.0

Table 5.2A.2.4-4 Single carrier performance for TDD 30 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.2-19.1 TDD	16QAM, 0.48	HST-SFN	2x2	70	13.4
10	R.PDSCH.2-19.2 TDD	16QAM, 0.48	HST-SFN	2x2	70	13.7
15	R.PDSCH.2-19.3 TDD	16QAM, 0.48	HST-SFN	2x2	70	13.8
20	R.PDSCH.2-19.4 TDD	16QAM, 0.48	HST-SFN	2x2	70	13.8
25	R.PDSCH.2-19.5 TDD	16QAM, 0.48	HST-SFN	2x2	70	14.1
30	R.PDSCH.2-20.1 TDD	16QAM, 0.48	HST-SFN	2x2	70	14.4
40	R.PDSCH.2-10.4 TDD	16QAM, 0.48	HST-SFN	2x2	70	14.6
50	R.PDSCH.2-20.2 TDD	16QAM, 0.48	HST-SFN	2x2	70	14.7
60	R.PDSCH.2-20.3 TDD	16QAM, 0.48	HST-SFN	2x2	70	14.4
80	R.PDSCH.2-20.4 TDD	16QAM, 0.48	HST-SFN	2x2	70	14.9
90	R.PDSCH.2-20.5 TDD	16QAM, 0.48	HST-SFN	2x2	70	15.4
100	R.PDSCH.2-21.1 TDD	16QAM, 0.48	HST-SFN	2x2	70	14.8

Table 5.2A.2.4-5: Minimum performance for multiple CA configurations

Test number	CA duplex mode	Minimum performance requirements
1	FDD 15 kHz + FDD 15 kHz	As defined in Table 5.2A.2.4-3
2	TDD 30 kHz + TDD 30 kHz	As defined in Table 5.2A.2.4-4
3	FDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.2.4-3 and Table 5.2A.2.4-4 per CC
Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.7.		

5.2A.2.5 Minimum requirements for PDSCH HST-DPS CA

For HST-DPS CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.2.5-7 and Table 5.2A.2.5-8 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.2.5-3 ~ Table 5.2A.2.5-6, with the parameters in Table 5.2A.2.5-2, Table 5.2A-2 and Table 5.2A-3 and the downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-clause do not apply for UE single carrier test.

The test purpose is specified in Table 5.2A.2.5-1.

Table 5.2A.2.5-1: Test purpose

Purpose	Test index
Verify UE performance in the HST-DPS scenario defined in B.3.3 with CA with 1 active PDSCH TCI states	1-1, 1-2, 1-3
Verify UE performance in the HST-DPS scenario defined in B.3.3 with CA with 2 active PDSCH TCI states	2-1, 2-2, 2-3

Table 5.2A.2.5-2: Test parameters

Parameter			Unit	Value
Duplex mode				FDD and TDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			FDD: 12 TDD: Specific to each Reference channel
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB mapping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	15kHz SCS: 10 for CSI-RS resource 1,2,3,4. 30kHz SCS: 20 for CSI-RS resource 1,2,3,4
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #2
		Frequency Occupation		Start PRB 0 Number of PRB = min(52, ceil(BWP size/4)*4)
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	15kHz SCS: 10 for CSI-RS resource 5,6,7,8. 30kHz SCS: 20 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #3
		Frequency Occupation		Start PRB 0

				Number of PRB = min(52, ceil(BWP size/4)*4)
NZP CSI-RS for CSI acquisition	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	15kHz SCS:20 30kHz SCS: 40
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	15kHz SCS:20 30kHz SCS: 40
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				As defined in Table 5.2A-2
TDD UL-DL pattern				15kHz SCS: FR1.15-1 30kHz SCS: FR1.30-1
The number of slots between PDSCH and corresponding HARQ-ACK information				As defined in Table 5.2A-3
Number of PUCCH ResourceGroups				1
PUCCH format for HARQ-ACK feedback				PUCCH format 1 for cases with no more chan 2 DL CCs PUCCH format 3 for cases with more than 2 DL CCs

Note 1: SSB # (k mod 2), CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by k[th] RRH.

For Test 1-1, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i}, 2\mathrm{n}) = \mathrm{n}$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot#

$$\max[(2\mathrm{k}-1)\mathrm{n} + 1 + \mathrm{T}_{\mathrm{HARQ}} + \mathrm{T}_{\mathrm{MAC\ proc}} + \mathrm{T}_{\mathrm{firstTRS}} + \mathrm{T}_{\mathrm{TRS\ proc}}, 0]$$

to slot#

$$(2\mathrm{k}+1)\mathrm{n}$$

PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

For Test 1-2, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i}, 2\mathrm{n}) = \mathrm{n}$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot#

$$\max[(2\mathrm{k}-1)\mathrm{n} + 1 + \mathrm{T}_{\mathrm{HARQ}} + \mathrm{T}_{\mathrm{MAC\ proc}}, 0]$$

to slot#

$$(2\mathrm{k}+1)\mathrm{n}$$

PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

Where k=0, 1, 2… is the RRH number, n = 2520 is half of the number of slots between two RRH, $\mathrm{T}_{\mathrm{HARQ}}$ = 2 is the number of slots between PDSCH and corresponding HARQ-ACK information, $\mathrm{T}_{\mathrm{MAC\ proc}}$ = 3 is the number of slots for MAC CE processing, $\mathrm{T}_{\mathrm{firstTRS}}$ = 6 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $\mathrm{T}_{\mathrm{TRS\ proc}}$ = 2 is the number of slots for TRS processing.

Table 5.2A.2.5-3: Single carrier performance for FDD 15 kHz SCS for HST-DPS CA configurations with 1 active PDSCH TCI states

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-15.1	64QAM, 0.43	HST-DPS	1	2x2	70	13.2
10	R.PDSCH.1-8.4 FDD	64QAM, 0.43	HST-DPS	1	2x2	70	13.6
15	R.PDSCH.1-15.2	64QAM, 0.43	HST-DPS	1	2x2	70	13.6
20	R.PDSCH.1-15.3	64QAM, 0.43	HST-DPS	1	2x2	70	13.4
25	R.PDSCH.1-15.4	64QAM, 0.43	HST-DPS	1	2x2	70	13.6
30	R.PDSCH.1-15.5	64QAM, 0.43	HST-DPS	1	2x2	70	13.6
35	R.PDSCH.1-16.3	64QAM, 0.43	HST-DPS	1	2x2	70	13.4
40	R.PDSCH.1-16.1	64QAM, 0.43	HST-DPS	1	2x2	70	13.6
45	R.PDSCH.1-16.4	64QAM, 0.43	HST-DPS	1	2x2	70	13.4
50	R.PDSCH.1-16.2	64QAM, 0.43	HST-DPS	1	2x2	70	13.7

Table 5.2A.2.5-4: Single carrier performance for FDD 15 kHz SCS for HST-DPS CA configurations with 2 active PDSCH TCI states

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-15.1	64QAM, 0.43	HST-DPS	2	2x2	70	13.2
10	R.PDSCH.1-8.4 FDD	64QAM, 0.43	HST-DPS	2	2x2	70	13.6
15	R.PDSCH.1-15.2	64QAM, 0.43	HST-DPS	2	2x2	70	13.6
20	R.PDSCH.1-15.3	64QAM, 0.43	HST-DPS	2	2x2	70	13.4
25	R.PDSCH.1-15.4	64QAM, 0.43	HST-DPS	2	2x2	70	13.6
30	R.PDSCH.1-15.5	64QAM, 0.43	HST-DPS	2	2x2	70	13.6
35	R.PDSCH.1-16.3	64QAM, 0.43	HST-DPS	2	2x2	70	13.4
40	R.PDSCH.1-16.1	64QAM, 0.43	HST-DPS	2	2x2	70	13.6
45	R.PDSCH.1-16.4	64QAM, 0.43	HST-DPS	2	2x2	70	13.4
50	R.PDSCH.1-16.2	64QAM, 0.43	HST-DPS	2	2x2	70	13.7

Table 5.2A.2.5-5 Single carrier performance for TDD 30 kHz SCS for HST-DPS CA configurations with 1 active PDSCH TCI states

						Reference value

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.2-22.1	64QAM, 0.43	HST-DPS	1	2x2	70	13.3
10	R.PDSCH.2-22.2	64QAM, 0.43	HST-DPS	1	2x2	70	13.3
15	R.PDSCH.2-22.3	64QAM, 0.43	HST-DPS	1	2x2	70	13.2
20	R.PDSCH.2-22.4	64QAM, 0.43	HST-DPS	1	2x2	70	13.3
25	R.PDSCH.2-22.5	64QAM, 0.43	HST-DPS	1	2x2	70	13.4
30	R.PDSCH.2-23.1	64QAM, 0.43	HST-DPS	1	2x2	70	13.4
40	R.PDSCH.2-10.5 TDD	64QAM, 0.43	HST-DPS	1	2x2	70	13.3
50	R.PDSCH.2-23.2	64QAM, 0.43	HST-DPS	1	2x2	70	13.5
60	R.PDSCH.2-23.3	64QAM, 0.43	HST-DPS	1	2x2	70	13.5
80	R.PDSCH.2-23.4	64QAM, 0.43	HST-DPS	1	2x2	70	13.4
90	R.PDSCH.2-23.5	64QAM, 0.43	HST-DPS	1	2x2	70	13.6
100	R.PDSCH.2-24.1	64QAM, 0.43	HST-DPS	1	2x2	70	13.5

Table 5.2A.2.5-6 Single carrier performance for TDD 30 kHz SCS for HST-DPS CA configurations with 2 active PDSCH TCI states

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.2-22.1	64QAM, 0.43	HST-DPS	2	2x2	70	13.3
10	R.PDSCH.2-22.2	64QAM, 0.43	HST-DPS	2	2x2	70	13.3
15	R.PDSCH.2-22.3	64QAM, 0.43	HST-DPS	2	2x2	70	13.2
20	R.PDSCH.2-22.4	64QAM, 0.43	HST-DPS	2	2x2	70	13.3
25	R.PDSCH.2-22.5	64QAM, 0.43	HST-DPS	2	2x2	70	13.4
30	R.PDSCH.2-23.1	64QAM, 0.43	HST-DPS	2	2x2	70	13.4
40	R.PDSCH.2-10.5 TDD	64QAM, 0.43	HST-DPS	2	2x2	70	13.3
50	R.PDSCH.2-23.2	64QAM, 0.43	HST-DPS	2	2x2	70	13.5
60	R.PDSCH.2-23.3	64QAM, 0.43	HST-DPS	2	2x2	70	13.5
80	R.PDSCH.2-23.4	64QAM, 0.43	HST-DPS	2	2x2	70	13.4
90	R.PDSCH.2-23.5	64QAM, 0.43	HST-DPS	2	2x2	70	13.6
100	R.PDSCH.2-24.1	64QAM, 0.43	HST-DPS	2	2x2	70	13.5

Table 5.2A.2.5-7: Minimum performance for HST-DPS CA configurations with 1 active PDSCH TCI states

Test number	CA duplex mode	Minimum performance requirements
1-1	FDD 15 kHz + FDD 15 kHz	As defined in Table 5.2A.2.5-3
1-2	TDD 30 kHz + TDD 30 kHz	As defined in Table 5.2A.2.5-5
1-3	FDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.2.5-3 and Table 5.2A.2.5-5 per CC
Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.7.4.		

Table 5.2A.2.5-8: Minimum performance for HST-DPS CA configurations with 2 active PDSCH TCI states

Test number	CA duplex mode	Minimum performance requirements
2-1	FDD 15 kHz + FDD 15 kHz	As defined in Table 5.2A.2.5-4
2-2	TDD 30 kHz + TDD 30 kHz	As defined in Table 5.2A.2.5-6
2-3	FDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.2.5-4 and Table 5.2A.2.5-6 per CC
Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.7.4.		

5.2A.3 4RX requirements

5.2A.3.1 Minimum requirements

For CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.3.1-4 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.3.1-1 ~ Table 5.2A.3.1-3, with the parameters in Table 5.2A-1 ~ Table 5.2A-3 and the downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-clause do not apply for UE single carrier test.

Table 5.2A.3.1-1: Single carrier performance for FDD 15 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-9.1 FDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.5
10	R.PDSCH.1-2.2 FDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.5
15	R.PDSCH.1-9.2 FDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
20	R.PDSCH.1-9.3 FDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
25	R.PDSCH.1-9.4 FDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.7
30	R.PDSCH.1-9.5 FDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
40	R.PDSCH.1-10.1 FDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.7
50	R.PDSCH.1-10.2 FDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.9

Table 5.2A.3.1-2: Single carrier performance for TDD 15 kHz SCS for CA configurations

					Reference value

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-2.1 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.5
10	R.PDSCH.1-2.2 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
15	R.PDSCH.1-2.3 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.7
20	R.PDSCH.1-2.4 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
25	R.PDSCH.1-2.5 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.8
30	R.PDSCH.1-3.1 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
40	R.PDSCH.1-3.2 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.8
50	R.PDSCH.1-3.3 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	9.0

Table 5.2A.3.1-3: Single carrier performance for TDD 30 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.2-13.1 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.5
10	R.PDSCH.2-13.2 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.5
15	R.PDSCH.2-13.3 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.5
20	R.PDSCH.2-13.4 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
25	R.PDSCH.2-13.5 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
30	R.PDSCH.2-14.1 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.6
40	R.PDSCH.2-2.2 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.7
50	R.PDSCH.2-14.2 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.9
60	R.PDSCH.2-14.3 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	8.8
80	R.PDSCH.2-14.4 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	9.1
90	R.PDSCH.2-14.5 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	9.0
100	R.PDSCH.2-15.1 TDD	16QAM, 0.48	TDLA30-10	2x4, ULA Low	70	9.3

Table 5.2A.3.1-4: Minimum performance for multiple CA configurations

Test number	CA duplex mode	Minimum performance requirements
1	FDD 15 kHz + FDD 15 kHz	As defined in Table 5.2A.3.1-1
2	TDD 30 kHz + TDD 30 kHz	As defined in Table 5.2A.3.1-3
3	FDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.3.1-1 and Table 5.2A.3.1-3 per CC
4	FDD 15 kHz + TDD 15 kHz	As defined in Table 5.2A.3.1-1 and Table 5.2A.3.1-2 per CC
5	TDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.3.1-2 and Table 5.2A.3.1-3 per CC
Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.7.		

5.2A.3.2 Minimum requirements for carrier aggregation with power imbalance

The performance requirements are specified in Table 5.2A.3.2-3 and Table 5.2A.3.2-4, with the addition of test parameters in Table 5.2A.3.2-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2A.3.2-1.

Table 5.2A.3.2-1: Tests purpose

Purpose	Test index
Verify the ability of an intra-band adjacent carrier aggregation UE to demodulate the signal transmitted by the PCell or SCell in the presence of a stronger SCell or PCell signal on an adjacent frequency. Throughput is measured on the PCell or SCell only	

Table 5.2A.3.2-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD and TDD
Active DL BWP index			1
Propagation condition			Static propagation condition No external noise sources are applied
Antenna configuration			1x4
PDSCH configuration	Length (L)		FDD: 12TDD: 12 for DL slot, 4 for special slot
	PRB bundling size		WB
Modulation and code rate			64QAM, MCS 27
Number of HARQ Processes			FDD: 4 TDD: 8
Maximum number of HARQ transmission			1
Redundancy version coding sequence			{0}
TDD UL-DL pattern			30kHz SCS: FR1.30-1
The number of slots between PDSCH and corresponding HARQ-ACK information			As defined in Table A.1.2-2 for FR1.30-1
PUCCH format for HARQ-ACK feedback			PUCCH format 1
Overhead for TBS determination			0
SSB transmission			Slot#0 with periodicity 20ms
RB assignment			Full applicable test bandwidth as defined in Table 5.3.5-1 of TS 38.101-1 [6]

Table 5.2A.3.2-3: Minimum performance for FDD CA with 15 kHz SCS

Test Number	Bandwidth (MHz)		Reference channel		Power at antenna port (dBm/Hz)		Reference value Fraction of Maximum Throughput (%)	
	PCell	SCell	PCell	SCell	$\hat{E}_{s\_PCell}$ for PCell	$\hat{E}_{s\_SCell}$ for Scell	PCell	SCell
1	Selected Channel bandwidth as per section 5.1.1.6		Derived as per section 5.1.3.2 of TS 38.214 [12]	NA	-112	-106	85	NA

Table 5.2A.3.2-4: Minimum performance for TDD CA with 30 kHz SCS

Test Number	Bandwidth (MHz)		Reference channel		Power at antenna port (dBm/Hz)		Reference value Fraction of Maximum Throughput (%)	
	PCell	SCell	PCell	SCell	$\hat{E}_{s\_PCell}$ for PCell	$\hat{E}_{s\_SCell}$ for Scell	PCell	SCell

1	Selected Channel bandwidth as per section 5.1.1.6	Derived as per section 5.1.3.2 of TS 38.214 [12]	NA	-112	-106	85	NA

5.2A.3.3 Minimum requirements for PDSCH of SCell on band with shared spectrum access

The performance requirements for SCell on band with shared spectrum access are specified in Table 5.2.3.2.15-3, with the additional test parameters for SCell in Table 5.2.3.2.15-2, the test parameters for PCell in Table 5.2A.3.3-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2A.3.3-1. During the test, only the PDSCH performance of the SCell should be verified.

Table 5.2A.3.3-1: Tests purpose

Purpose	Test index
Verify the PDSCH performance of SCell for UE supporting operations in shared spectrum access	1-1, 1-2, 1-3, 1-4

Table 5.2A.3.3-2: Test parameters for PCell

Parameter		Unit	Value
Duplex mode			TDD
Bandwidth		MHz	20
Subcarrier spacing		kHz	30
Active DL BWP index			1
TDD pattern			FR1.30-1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Dmrs-AdditionalPosition		pos1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2

5.2A.3.4 Minimum requirements for HST-SFN CA

For HST-SFN CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.3.4-5 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.3.4-3 ~ Table 5.2A.3.4-4, with the parameters in Table 5.2A.3.4-2, Table 5.2A-2, Table 5.2A-3, and the downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-clause do not apply for UE single carrier test.

The test purpose is specified in Table 5.2A.3.4-1.

Table 5.2A.3.4-1: Test purpose

Purpose	Test index
Verify PDSCH performance under 4 receive antenna conditions in the HST-SFN scenario defined in B.3.2 with CA	1, 2, 3

Table 5.2A.3.4-2: Test parameters

Parameter		Unit	Value
Duplex mode			FDD and TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		2
	Maximum number of OFDM symbols for DL front loaded DMRS		1
CSI-RS for tracking	CSI-RS periodicity	Slots	FDD: 10 for CSI-RS resource 1,2,3,4. TDD: 20 for CSI-RS resource 1,2,3,4.
	CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4.
Number of HARQ Processes			As defined in Table 5.2A-2
TDD UL-DL pattern			15 kHz SCS: FR1.15-1 30 kHz SCS: FR1.30-1
The number of slots between PDSCH and corresponding HARQ-ACK information			As defined in Table 5.2A-3
Number of PUCCH ResourceGroups			1
PUCCH format for HARQ-ACK feedback			PUCCH format 1 for cases with no more than 2 DL CCs PUCCH format 3 for cases with more than 2 DL CCs

Table 5.2A.3.4-3: Single carrier performance for FDD 15 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-13.1 FDD	16QAM, 0.48	HST-SFN	2x4	70	10.5
10	R.PDSCH.1-8.3 FDD	16QAM, 0.48	HST-SFN	2x4	70	10.7
15	R.PDSCH.1-13.2 FDD	16QAM, 0.48	HST-SFN	2x4	70	11.1
20	R.PDSCH.1-13.3 FDD	16QAM, 0.48	HST-SFN	2x4	70	11.5
25	R.PDSCH.1-13.4 FDD	16QAM, 0.48	HST-SFN	2x4	70	11.6
30	R.PDSCH.1-13.5 FDD	16QAM, 0.48	HST-SFN	2x4	70	11.8

35	R.PDSCH.1-14.3 FDD	16QAM, 0.48	HST-SFN	2x4	70	11.7
40	R.PDSCH.1-14.1 FDD	16QAM, 0.48	HST-SFN	2x4	70	11.9
45	R.PDSCH.1-14.4 FDD	16QAM, 0.48	HST-SFN	2x4	70	11.7
50	R.PDSCH.1-14.2 FDD	16QAM, 0.48	HST-SFN	2x4	70	11.9

Table 5.2A.3.4-4: Single carrier performance for TDD 30 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.2-19.1 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.0
10	R.PDSCH.2-19.2 TDD	16QAM, 0.48	HST-SFN	2x4	70	11.8
15	R.PDSCH.2-19.3 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.1
20	R.PDSCH.2-19.4 TDD	16QAM, 0.48	HST-SFN	2x4	70	11.8
25	R.PDSCH.2-19.5 TDD	16QAM, 0.48	HST-SFN	2x4	70	11.9
30	R.PDSCH.2-20.1 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.2
40	R.PDSCH.2-10.4 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.4
50	R.PDSCH.2-20.2 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.6
60	R.PDSCH.2-20.3 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.5
80	R.PDSCH.2-20.4 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.7
90	R.PDSCH.2-20.5 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.7
100	R.PDSCH.2-21.1 TDD	16QAM, 0.48	HST-SFN	2x4	70	12.7

Table 5.2A.3.4-5: Minimum performance for multiple CA configurations

Test number	CA duplex mode	Minimum performance requirements
1	FDD 15 kHz + FDD 15 kHz	As defined in Table 5.2A.3.4-3
2	TDD 30 kHz + TDD 30 kHz	As defined in Table 5.2A.3.4-4
3	FDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.3.14-3 and Table 5.2A.3.4-4 per CC
Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in Section 5.1.1.7.		

5.2A.3.5 Minimum requirements for PDSCH HST-DPS CA

For HST-DPS CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.3.5-7 and Table 5.2A.3.5-8 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.3.5-3 - Table 5.2A.3.5-6, with the parameters in Table 5.2A.3.5-2, Table 5.2A-2 and Table 5.2A-3 and the downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-clause do not apply for UE single carrier test.

The test purpose is specified in Table 5.2A.3.5-1.

Table 5.2A.3.5-1: Test purpose

Purpose	Test index
Verify PDSCH performance of UE under 4 receive antenna conditions in the HST-DPS scenario defined in B.3.3 with CA with 1 active TCI state	1-1, 1-2, 1-3
Verify PDSCH performance of UE under 4 receive antenna conditions in the HST-DPS scenario defined in B.3.3 with CA with 2 active TCI states	2-1, 2-2, 2-3

Table 5.2A.3.5-2: Test parameters

Parameter			Unit	Value
Duplex mode				FDD and TDD
Active DL BWP index				1
PDCCH configuration	TCI state			Note 1
PDSCH configuration	Mapping type			Type A
	k0			0
	Starting symbol (S)			2
	Length (L)			FDD: 12 TDD: Specific to each Reference channel
	PDSCH aggregation factor			1
	PRB bundling type			Static
	PRB bundling size			2
	Resource allocation type			Type 0
	RBG size			Config2
	VRB-to-PRB maping type			Non-interleaved
	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 1 and 3 l_0 = 9 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	15kHz SCS: 10 for CSI-RS resource 1,2,3,4. 30kHz SCS: 20 for CSI-RS resource 1,2,3,4
		CSI-RS offset	Slots	1 for CSI-RS resource 1 and 2 2 for CSI-RS resource 3 and 4
		QCL info		TCI state #2
		Frequency Occupation		Start PRB 0 Number of PRB = min(52, ceil(BWP size/4)*4)
	Resource set #2	First OFDM symbol in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 5 and 7 l_0 = 10 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	15kHz SCS: 10 for CSI-RS resource 5,6,7,8. 30kHz SCS: 20 for CSI-RS resource 5,6,7,8.
		CSI-RS offset	Slots	1 for CSI-RS resource 5 and 6 2 for CSI-RS resource 7 and 8
		QCL info		TCI state #3
		Frequency Occupation		Start PRB 0 Number of PRB = min(52, ceil(BWP size/4)*4)
NZP CSI-RS for CSI acquisition	Resource set #3	First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	15kHz SCS:20 30kHz SCS: 40
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #4	First OFDM symbol in the PRB used for CSI-RS		l_0 = 13

		CSI-RS periodicity	Slots	15kHz SCS:20 30kHz SCS: 40
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
TCI state #2	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #3	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
Number of HARQ Processes				As defined in Table 5.2A-2
TDD UL-DL pattern				15kHz SCS: FR1.15-1 30kHz SCS: FR1.30-1
The number of slots between PDSCH and corresponding HARQ-ACK information				As defined in Table 5.2A-3
Number of PUCCH ResourceGroups				1
PUCCH format for HARQ-ACK feedback				PUCCH format 1 for cases with no more chan 2 DL CCs PUCCH format 3 for cases with more than 2 DL CCs

Note 1: SSB # (k mod 2), CSI-RS (for tracking) resource set # ((k mod 2) + 1) and CSI-RS (for CSI acquisition) resource set # ((k mod 2) + 3) are transmitted by k[th] RRH.

For Test 1-1, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i}, 2\mathrm{n}) = \mathrm{n}$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot#

$$\max[(2\mathrm{k}-1)\mathrm{n} + 1 + \mathrm{T}_{\mathrm{HARQ}} + \mathrm{T}_{\mathrm{MAC\ proc}} + \mathrm{T}_{\mathrm{firstTRS}} + \mathrm{T}_{\mathrm{TRS\ proc}}, 0]$$

to slot#

$$(2\mathrm{k}+1)\mathrm{n}$$

PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

For Test 1-2, TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i}, 2\mathrm{n}) = \mathrm{n}$. PDCCH and PDSCH associated with TCI # (k mod 2) is transmitted by k[th] RRH from slot#

$$\max[(2\mathrm{k}-1)\mathrm{n} + 1 + \mathrm{T}_{\mathrm{HARQ}} + \mathrm{T}_{\mathrm{MAC\ proc}}, 0]$$

to slot#

$$(2\mathrm{k}+1)\mathrm{n}$$

PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

Where k=0, 1, 2… is the RRH number, n = 2520 is half of the number of slots between two RRH, $\mathrm{T}_{\mathrm{HARQ}}$ = 2 is the number of slots between PDSCH and corresponding HARQ-ACK information, $\mathrm{T}_{\mathrm{MAC\ proc}}$ = 3 is the number of slots for MAC CE processing, $\mathrm{T}_{\mathrm{firstTRS}}$ = 6 is the number of slots to first TRS transmission occasion after MAC CE command is decoded by the UE, $\mathrm{T}_{\mathrm{TRS\ proc}}$ = 2 is the number of slots for TRS processing.

Table 5.2A.3.5-3: Single carrier performance for FDD 15 kHz SCS for HST-DPS CA configurations with 1 active PDSCH TCI states

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)

5	R.PDSCH.1-15.1	64QAM, 0.43	HST-DPS	1	2x4	70	10.5
10	R.PDSCH.1-8.4 FDD	64QAM, 0.43	HST-DPS	1	2x4	70	10.8
15	R.PDSCH.1-15.2	64QAM, 0.43	HST-DPS	1	2x4	70	10.7
20	R.PDSCH.1-15.3	64QAM, 0.43	HST-DPS	1	2x4	70	10.5
25	R.PDSCH.1-15.4	64QAM, 0.43	HST-DPS	1	2x4	70	10.8
30	R.PDSCH.1-15.5	64QAM, 0.43	HST-DPS	1	2x4	70	10.9
35	R.PDSCH.1-16.3	64QAM, 0.43	HST-DPS	1	2x4	70	10.6
40	R.PDSCH.1-16.1	64QAM, 0.43	HST-DPS	1	2x4	70	10.7
45	R.PDSCH.1-16.4	64QAM, 0.43	HST-DPS	1	2x4	70	10.6
50	R.PDSCH.1-16.2	64QAM, 0.43	HST-DPS	1	2x4	70	11.0

Table 5.2A.3.5-4: Single carrier performance for FDD 15 kHz SCS for HST-DPS CA configurations with 2 active PDSCH TCI states

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.1-15.1	64QAM, 0.43	HST-DPS	2	2x4	70	10.5
10	R.PDSCH.1-8.4 FDD	64QAM, 0.43	HST-DPS	2	2x4	70	10.8
15	R.PDSCH.1-15.2	64QAM, 0.43	HST-DPS	2	2x4	70	10.7
20	R.PDSCH.1-15.3	64QAM, 0.43	HST-DPS	2	2x4	70	10.5
25	R.PDSCH.1-15.4	64QAM, 0.43	HST-DPS	2	2x4	70	10.8
30	R.PDSCH.1-15.5	64QAM, 0.43	HST-DPS	2	2x4	70	10.9
35	R.PDSCH.1-16.3	64QAM, 0.43	HST-DPS	2	2x4	70	10.6
40	R.PDSCH.1-16.1	64QAM, 0.43	HST-DPS	2	2x4	70	10.7
45	R.PDSCH.1-16.4	64QAM, 0.43	HST-DPS	2	2x4	70	10.6
50	R.PDSCH.1-16.2	64QAM, 0.43	HST-DPS	2	2x4	70	11.0

Table 5.2A.3.5-5 Single carrier performance for TDD 30 kHz SCS for HST-DPS CA configurations with 1 active PDSCH TCI states

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.2-22.1	64QAM, 0.43	HST-DPS	1	2x4	70	10.4
10	R.PDSCH.2-22.2	64QAM, 0.43	HST-DPS	1	2x4	70	10.5

15	R.PDSCH.2-22.3	64QAM, 0.43	HST-DPS	1	2x4	70	10.5
20	R.PDSCH.2-22.4	64QAM, 0.43	HST-DPS	1	2x4	70	10.5
25	R.PDSCH.2-22.5	64QAM, 0.43	HST-DPS	1	2x4	70	10.6
30	R.PDSCH.2-23.1	64QAM, 0.43	HST-DPS	1	2x4	70	10.5
40	R.PDSCH.2-10.5 TDD	64QAM, 0.43	HST-DPS	1	2x4	70	10.5
50	R.PDSCH.2-23.2	64QAM, 0.43	HST-DPS	1	2x4	70	10.7
60	R.PDSCH.2-23.3	64QAM, 0.43	HST-DPS	1	2x4	70	10.7
80	R.PDSCH.2-23.4	64QAM, 0.43	HST-DPS	1	2x4	70	10.5
90	R.PDSCH.2-23.5	64QAM, 0.43	HST-DPS	1	2x4	70	10.7
100	R.PDSCH.2-24.1	64QAM, 0.43	HST-DPS	1	2x4	70	10.7

Table 5.2A.3.5-6 Single carrier performance for TDD 30 kHz SCS for HST-DPS CA configurations with 2 active PDSCH TCI states

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
						Fraction of maximum throughput (%)	SNR (dB)
5	R.PDSCH.2-22.1	64QAM, 0.43	HST-DPS	2	2x4	70	10.4
10	R.PDSCH.2-22.2	64QAM, 0.43	HST-DPS	2	2x4	70	10.5
15	R.PDSCH.2-22.3	64QAM, 0.43	HST-DPS	2	2x4	70	10.5
20	R.PDSCH.2-22.4	64QAM, 0.43	HST-DPS	2	2x4	70	10.5
25	R.PDSCH.2-22.5	64QAM, 0.43	HST-DPS	2	2x4	70	10.6
30	R.PDSCH.2-23.1	64QAM, 0.43	HST-DPS	2	2x4	70	10.5
40	R.PDSCH.2-10.5 TDD	64QAM, 0.43	HST-DPS	2	2x4	70	10.5
50	R.PDSCH.2-23.2	64QAM, 0.43	HST-DPS	2	2x4	70	10.7
60	R.PDSCH.2-23.3	64QAM, 0.43	HST-DPS	2	2x4	70	10.7
80	R.PDSCH.2-23.4	64QAM, 0.43	HST-DPS	2	2x4	70	10.5
90	R.PDSCH.2-23.5	64QAM, 0.43	HST-DPS	2	2x4	70	10.7
100	R.PDSCH.2-24.1	64QAM, 0.43	HST-DPS	2	2x4	70	10.7

Table 5.2A.3.5-7: Minimum performance for multiple CA configurations for HST-DPS with 1 active TCI state

Test number	CA duplex mode	Minimum performance requirements
1-1	FDD 15 kHz + FDD 15 kHz	As defined in Table 5.2A.3.5-3
1-2	TDD 30 kHz + TDD 30 kHz	As defined in Table 5.2A.3.5-5
1-3	FDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.3.5-3 and Table 5.2A.3.5-5 per CC
Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.7.4.		

Table 5.2A.3.5-8: Minimum performance for multiple CA configurations for HST-DPS with 2 active TCI states

Test number	CA duplex mode	Minimum performance requirements
2-1	FDD 15 kHz + FDD 15 kHz	As defined in Table 5.2A.3.5-4
2-1	TDD 30 kHz + TDD 30 kHz	As defined in Table 5.2A.3.5-6
2-3	FDD 15 kHz + TDD 30 kHz	As defined in Table 5.2A.3.5-4 and Table 5.2A.3.5-6 per CC
Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.7.4.		

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
Carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 1)		0
DL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
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
	Number of PDCCH candidates		1
	Frequency domain resource allocation for CORESET		Start from RB = 0 with contiguous RB allocation
	TCI state		TCI state #1
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k_0)		0
	First OFDM symbol in the PRB used for CSI-RS (l_0)		CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4: 8
	Number of CSI-RS ports (X)		1
	CDM Type		No CDM
	Density (ρ)		3
	CSI-RS periodicity	Slots	15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset	Slots	15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4 30 kHz SCS: 20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
	Frequency Occupation		Start PRB 0

				Number of PRB = ceil(BWP size /4)*4
	QCL info			TCI state #0
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
PDCCH & PDCCH DMRS Precoding configuration				For number of TX = 1: No precoding; For number of TX > 1: Single Panel Type I, Randomized precoder selection for every REG bundle and updated per slot with equal probability of each applicable i_1/i_2 combination or codebook index, chosen from section 5.2.2.2.1 of TS 38.214 [12].
Physical signals, channels mapping and precoding				As specified in Annex B.4.1
Symbols for all unused REs				OP.1 FDD as defined in Annex A.5.1.1 OP.1 TDD as defined in Annex A.5.2.1
The number of slots between PDSCH and corresponding HARQ-ACK information				2 for FDD For TDD, specific to each TDD UL-DL pattern and as defined in Annex A.1.2.
Note 1: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. Note 2: The high layer parameter *precoderGranularity* equals to *sameAsREG-bundle* as defined in clause 7.4.1.3 of TS 38.211 [9].				

5.3.1 1RX requirements

5.3.1.1 FDD

The parameters specified in Table 5.3.1.1-1 are valid for all FDD tests unless otherwise stated.

Table 5.3.1.1-1: Test Parameters

Parameter	Unit	

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

5.3.1.1.1 Minimum requirements for RedCap

For the parameters specified in Table 5.3.1.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.1.1.1-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.1.1.1-1: Minimum performance for UE supporting full-duplex FDD or half-duplex FDD

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10	48	1	8	R.PDCCH.1-1.3 FDD	TDLA30-10	2x1 Low	1	5.8

5.3.1.2 TDD

The parameters specified in Table 5.3.1.2-1 are valid for all TDD tests unless otherwise stated.

Table 5.3.1.2-1: Test Parameters

Parameter	Unit	
TDD UL-DL pattern		FR1.30-1
CCE to REG mapping type		interleaved
Interleaver size		3
REG bundle size		2
Shift Index		0

5.3.1.2.1 Minimum requirements for RedCap

For the parameters specified in Table 5.3.1.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 5.3.1.2.1-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.1.2.1-1: Minimum performance for PDCCH with 30 kHz SCS

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	20	48	1	4	R.PDCCH.2-1.5 TDD	TDLC300-100	1x1	1	8.6

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 Minimum requirements with 1TX antenna

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

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

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10	24	2	2	R.PDCCH.1-2.1 FDD	TDLA30-10	1x2 Low	1	8.1
2	10	24	2	2	R.PDCCH.1-2.3 FDD	TDLC300-100	1x2 Low	1	8.2
3	10	48	2	4	R.PDCCH.1-2.4 FDD	TDLA30-10	1x2 Low	1	5.5
4	10	48	1	4	R.PDCCH.1-1.1 FDD	TDLA30-10	1x2 Low	1	4.4
5	10	48	2	16	R.PDCCH.1-2.6 FDD	TDLA30-10	1x2 Low	1	-2.1

5.3.2.1.2 Minimum requirements with 2TX antenna

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

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

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10	24	2	4	R.PDCCH.1-2.2 FDD	TDLC300-100	2x2 Low	1	2.0
2	10	48	2	8	R.PDCCH.1-2.5 FDD	TDLC300-100	2x2 Low	1	-1.3
3	10	48	1	8	R.PDCCH.1-1.3 FDD	TDLA30-10	2x2 Low	1	-0.2

5.3.2.1.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

The parameters specified in Table 5.3.2.1.3-1 are valid for FDD test unless otherwise stated.

Table 5.3.2.1.3-1: Test Parameters

Parameter		Unit	1 Tx Antenna
CCE to REG mapping type			nonInterleaved
REG bundle size			6
Shift Index			0
DRX cycle		ms	10
ps-WakeUp-r16			absent
Wake-up indication bit in DCI format 2_6			1
PDCCH DCI format 2_6 configuration	PS-offset		$(T_{minimumTimeGap}+1)/2^{\mu}/0.125$

	Number of PDCCH candidates		1
	Frequency domain resource allocation for CORESET		Start from RB = 0 with contiguous RB allocation
	TCI state		TCI state #1
PDCCH configuration	Slots for PDCCH monitoring		Each slot during DRX-on period
Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability.			

For the parameters specified in Table 5.3.2.1.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 5.3.2.1.3-2. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.2.1.3-2: Minimum performance for PDCCH with 15 kHz SCS

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10	48	2	4	R.PDCCH.1-2.4 FDD	TDLA30-10	1x2 Low	1	5.5
			2	8	R.PDCCH.1-2.7 FDD				

5.3.2.1.4 Minimum requirements for RedCap

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 5.3.2.1.4-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.2.1.4-1: Minimum performance for PDCCH with 15 kHz SCS

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10	48	2	4	R.PDCCH.1-2.4 FDD	TDLA30-10	1x2 Low	1	5.5
2	10	48	1	8	R.PDCCH.1-1.3 FDD	TDLA30-10	2x2 Low	1	-0.2

5.3.2.1.5 Minimum requirements for PDCCH with intra-slot repetition

The performance requirements are specified in Table 5.3.2.1.5-2, with the addition of test parameters in Table 5.3.2.1.5-1. The downlink physical channel setup according to Annex C.3.1.

Table 5.3.2.1.5-1: Tests parameters

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	TCI State #2
	CORESETPoolIndex		0,1	
	Repetition transmission schemes		FDM	
	CCE to REG mapping type		nonInterleaved	
	REG bundle size		6	

		Time offset/Frequency offset of the second TxRP from the first TxRP		timing offset = -0.5us, frequency offset = 200Hz	
		Frequency domain resource allocation for CORSET		Frequency non-overlapping	
CSI-RS for tracking		First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
		First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
		CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
		Density		3	
		CSI-RS periodicity	Slots	20	
		CSI-RS offset	Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
		QCL info		TCI state #0	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Note: PDCCH is transmitted from both TRxP #1 and TRxP #2					

Table 5.3.2.1.5-2: Minimum performance for PDCCH with 15kHz SCS (Note 2)

Test num.	Bandwidth(MHz)	CORESETRB (Note 4)	CORESET duration	Aggregation level	Reference Channel	Propagation Condition (Note 1)	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB) (Note 3)
1	10	24	2	2	R.PDCCH.1-2.1 FDD	TDLA30-10	2x2, ULA Low	1	2.7
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Bandwidth, CORESET parameters, reference channel, Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 Note 4: CORESETs from TRxP #1 and TRxP #2 should not be overlapped									

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		Test 3: non-interleaved Other tests: interleaved	interleaved
Interleaver size		3	
REG bundle size		Test 3: 6 Other tests: 2	est 1 in Table 5.3.2.2.2-1: 6 Other tests: 2
Shift Index		0	

5.3.2.2.1 Minimum requirements with 1TX antenna

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

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

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40	102	1	2	R.PDCCH.2-1.1 TDD	TDLA30-10	1x2 Low	1	7.0
2	40	102	1	4	R.PDCCH.2-1.2 TDD	TDLC300-100	1x2 Low	1	3.0
3	40	48	2	16	R.PDCCH.2-2.1 TDD	TDLC300-100	1x2 Low	1	-3.8

5.3.2.2.2 Minimum requirements with 2TX antenna

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

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

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40	90	1	8	R.PDCCH.2-1.3 TDD	TDLC300-100	2x2 Low	1	-1.2

5.3.2.2.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

The parameters specified in Table 5.3.2.2.3-1 are valid for all TDD tests for power saving unless otherwise stated.

Table 5.3.2.2.3-1: Test Parameters

Parameter	Unit	1 Tx Antenna
TDD UL-DL pattern		FR1.30-1
CCE to REG mapping type		interleaved
Interleaver size		3
REG bundle size		2
Shift Index		0
DRX cycle	ms	10

ps-WakeUp-r16			absent
Wake-up indication bit in DCI format 2_6			1
PDCCH DCI format 2_6 configuration	PS-offset		$(T_{minimumTimeGap}+1)/2^{\mu}/0.125$
	Number of PDCCH candidates		1
	Frequency domain resource allocation for CORESET		Start from RB = 0 with contiguous RB allocation
	TCI state		TCI state #1
PDCCH configuration	Slots for PDCCH monitoring		Each slot during DRX-on period
Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability			

For the parameters specified in Table 5.3.2.2.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 5.3.2.2.3-2. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.2.2.3-2: Minimum performance with 30 kHz SCS

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40	102	1	4	R.PDCCH.2-1.2 TDD	TDLC300-100	1x2 Low	1	3.0
				8	R.PDCCH.2-1.4 TDD				

5.3.2.2.4 Minimum requirements for RedCap

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 5.3.2.2.4-1. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.2.2.4-1: Minimum performance for PDCCH with 30 kHz SCS

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	20	48	1	4	R.PDCCH.2-1.5 TDD	TDLC300-100	1x2 Low	1	3.6
2	20	48	1	8	R.PDCCH.2-1.6 TDD	TDLC300-100	2x2 Low	1	0.0

5.3.2.2.5 Minimum requirements for PDCCH with intra-slot repetition

The performance requirements are specified in Table 5.3.2.2.5-2, with the addition of test parameters in Table 5.3.2.2.5-1. The downlink physical channel setup according to Annex C.3.1.

Table 5.3.2.2.5-1: Tests parameters

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	TCI State #2
	CORESETPoolIndex		0,1	
	Repetition transmission schemes		FDM	
	CCE to REG mapping type		nonInterleaved	

		REG bundle size		6	
		Time offset/Frequency offset of the second TxRP from the first TxRP		timing offset = -0.25us, frequency offset = 300Hz	
		Frequency domain resource allocation for CORSET		Frequency non-overlapping	
CSI-RS for tracking		First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
		First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
		Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
		CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
		Density		3	
		CSI-RS periodicity	Slots	40	
		CSI-RS offset	Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
		QCL info		TCI state #0	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Note: PDCCH is transmitted from both TRxP #1 and TRxP #2					

Table 5.3.2.2.5-2: Minimum performance for PDCCH with 30kHz SCS (Note 2)

Test num.	Bandwidth(MHz)	CORESETRB (Note 4)	CORESET duration	Aggregation level	Reference Channel	Propagation Condition (Note 1)	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB) (Note 3)
1	40	48	2	2	R.PDCCH.2-2.2 TDD	TDLA30-10	2x2, ULA Low	1	3.5

Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent.
Note 2: Bandwidth, CORESET parameters, reference channel, Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2.
Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2
Note 4: CORESETs from TRxP #1 and TRxP #2 should not be overlapped

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 Minimum requirements with 1TX antenna

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

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

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10	24	2	2	R.PDCCH.1-2.1 FDD	TDLA30-10	1x4 Low	1	2.2
2	10	24	2	2	R.PDCCH.1-2.3 FDD	TDLC300-100	1x4 Low	1	2.7
3	10	48	2	4	R.PDCCH.1-2.4 FDD	TDLA30-10	1x4 Low	1	0.2
4	10	48	1	4	R.PDCCH.1-1.1 FDD	TDLA30-10	1x4 Low	1	-0.4
5	10	48	2	16	R.PDCCH.1-2.6 FDD	TDLA30-10	1x4 Medium A	1	-3.2

5.3.3.1.2 Minimum requirements with 2TX antenna

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

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

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10	24	2	4	R.PDCCH.1-2.2 FDD	TDLC300-100	2x4 Low	1	-1.9
2	10	48	2	8	R.PDCCH.1-2.5 FDD	TDLC300-100	2x4 Low	1	-4.5
3	10	48	1	4	R.PDCCH.1-1.2 FDD	TDLA30-10	2x4 Low	1	-1.0

5.3.3.1.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

The parameters specified in Table 5.3.3.1.3-1 are valid for FDD test unless otherwise stated.

Table 5.3.3.1.3-1: Test Parameters

Parameter	Unit	1 Tx Antenna
CCE to REG mapping type		nonInterleaved
REG bundle size		6

Shift Index			0
DRX cycle		ms	10
ps-WakeUp-r16			absent
Wake-up indication bit in DCI format 2_6			1
PDCCH DCI format 2_6 configuration	PS-offset		$(T_{minimumTimeGap} + 1)/2^{\mu}/0.125$
	Number of PDCCH candidates		1
	Frequency domain resource allocation for CORESET		Start from RB = 0 with contiguous RB allocation
	TCI state		TCI state #1
Slots for PDCCH monitoring			Each slot during DRX-on period
Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability.			

For the parameters specified in Table 5.3.3.1.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 5.3.3.1.3-2. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.3.1.3-2: Minimum performance for PDCCH with 15 kHz SCS

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	10	48	2	4	R.PDCCH.1-2.4 FDD	TDLA30-10	1x4 Low	1	0.2
			2	8	R.PDCCH.1-2.7 FDD				

5.3.3.1.4 Minimum requirements for PDCCH with intra-slot repetition

The performance requirements are specified in Table 5.3.3.1.4-2, with the addition of test parameters in Table 5.3.3.1.4-1. The downlink physical channel setup according to Annex C.3.1.

Table 5.3.3.1.4-1: Tests parameters

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	TCI State #2
	CORESETPoolIndex		0,1	
	Repetition transmission schemes		FDM	
	CCE to REG mapping type		nonInterleaved	
	REG bundle size		6	
	Time offset/Frequency offset of the second TxRP from the first TxRP		timing offset = -0.5us, frequency offset = 200Hz	
	Frequency domain resource allocation for CORSET		Frequency non-overlapping	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	

		Density		3		
		CSI-RS periodicity	Slots	20		
		CSI-RS offset	Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8	
		QCL info		TCI state #0		
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A	
		QCL Type		Type A	N/A	
	Type 2 QCL information	CSI-RS resource		N/A	N/A	
		QCL Type		N/A	N/A	
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration	
		QCL Type		N/A	Type A	
	Type 2 QCL information	CSI-RS resource		N/A	N/A	
		QCL Type		N/A	N/A	
Note: PDCCH is transmitted from both TRxP #1 and TRxP #2						

Table 5.3.3.1.4-2: Minimum performance for PDCCH with 15kHz SCS (Note 2)

Test num.	Bandwidth(MHz)	CORESET RB (Note 4)	CORESET duration	Aggregation level	Reference Channel	Propagation Condition (Note 1)	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB) (Note 3)
1	10	24	2	2	R.PDCCH.1-2.1 FDD	TDLA30-10	2x4, ULA Low	1	-1.2
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Bandwidth, CORESET parameters, reference channel, Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 Note 4: CORESETs from TRxP #1 and TRxP #2 should not be overlapped									

5.3.3.2 TDD

The parameters specified in Table 5.3.3.2-1 are valid for all TDD tests unless otherwise stated.

Table 5.3.3.2-1: Common Test Parameters

Parameter	Unit	1 Tx Antenna	2 Tx Antenna
TDD UL-DL pattern		FR1.30-1	
CCE to REG mapping type		Test 3: Non-interleaved Other tests: interleaved	interleaved
Interleaver size		3	
REG bundle size		Test 3: 6 Other tests: 2	6
Shift Index		0	

5.3.3.2.1 Minimum requirements with 1TX antenna

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

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

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40	102	1	2	R.PDCCH.2-1.1 TDD	TDLA30-10	1x4 Low	1	2.1
2	40	102	1	4	R.PDCCH.2-1.2 TDD	TDLC300-100	1x4 Low	1	-0.9
3	40	48	2	16	R.PDCCH.2-2.1 TDD	TDLA30-10	1x4 Medium A	1	-3.6

5.3.3.2.2 Minimum requirements with 2TX antenna

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

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

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR (dB)
1	40	90	1	8	R.PDCCH.2-1.3 TDD	TDLC300-100	2x4 Low	1	-4.3

5.3.3.2.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

For the parameters specified in Table 5.3.3.2.3-1, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 5.3.3.2.3-2. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.3.3.2.3-1: Test Parameters

Parameter		Unit	1 Tx Antenna
TDD UL-DL pattern			FR1.30-1
CCE to REG mapping type			interleaved
Interleaver size			3
REG bundle size			2
Shift Index			0
DRX cycle		ms	10
ps-WakeUp-r16			absent
Wake-up indication bit in DCI format 2_6			1
PDCCH DCI format 2_6 configuration	PS-offset		$(T_{minimumTimeGap}+1)/2^{\mu}/0.125$
	Number of PDCCH candidates		1
	Frequency domain resource allocation for CORESET		Start from RB = 0 with contiguous RB allocation
	TCI state		TCI state #1
Slots for PDCCH monitoring			Each slot during DRX-on period
Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability.			

Table 5.3.3.2.3-2: Minimum performance with 30 kHz SCS

								Reference value

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Pm-dsg (%)	SNR (dB)
1	40	102	1	4	R.PDCCH.2-1.2 TDD	TDLC300-100	1x4 Low	1	-0.9
				8	R.PDCCH.2-1.4 TDD				

5.3.3.2.4 Minimum requirements for PDCCH with intra-slot repetition

The performance requirements are specified in Table 5.3.3.2.4-2, with the addition of test parameters in Table 5.3.3.2.4-1. The downlink physical channel setup according to Annex C.3.1.

Table 5.3.3.2.4-1: Tests parameters

Parameter			Unit	Value	
				TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration	TCI state			TCI State #1	TCI State #2
	CORESETPoolIndex			0,1	
	Repetition transmission schemes			FDM	
	CCE to REG mapping type			nonInterleaved	
	REG bundle size			6	
	Time offset/Frequency offset of the second TxRP from the first TxRP			timing offset = -0.25us, frequency offset = 300Hz	
	Frequency domain resource allocation for CORSET			Frequency non-overlapping	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	40	
	CSI-RS offset		Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Note: PDCCH is transmitted from both TRxP #1 and TRxP #2					

Table 5.3.3.2.4-2: Minimum performance for PDCCH with 30kHz SCS

Test num.	Bandwidth(MHz)	CORESET RB (Note 4)	CORESET duration	Aggregation level	Reference Channel	Propagation Condition (Note 1)	Antenna configuration and correlation Matrix (Note 2)	Reference value	
								Pm-dsg (%)	SNR (dB) (Note 3)
1	40	48	2	2	R.PDCCH.2-2.2 TDD	TDLA30-10	2x4, ULA Low	1	-1.0
Note 1: The propagation conditions apply to each of TRxP #1 and TRxP #2 and are statistically independent. Note 2: Bandwidth, CORESET parameters, reference channel, Correlation matrix and antenna configuration parameters apply to each of TRxP #1 and TRxP #2. Note 3: SNR corresponds to SNR of TRxP #1 and TRxP #2 as defined in 4.4.2 Note 4: CORESETs from TRxP #1 and TRxP #2 should not be overlapped									

5.4 PBCH demodulation requirements

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

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

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

Table 5.4-1: Common test Parameters

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

5.4.1 1RX requirements

5.4.1.1 FDD

For the parameters specified in Table 5.4-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.1.1-1 in case SS/PBCH block index is not known. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.4.1.1-1: Minimum performance PBCH in case SS/PBCH block index is not known for RedCap

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
1-1	10 / 15	R.PBCH.1	TDLC300-100	1 x 1 Low	1	-2.2

5.4.1.2 TDD

Table 5.4.1.2-1: Test parameters for PBCH

Parameter	Unit	Single antenna port
TDD UL-DL pattern		FR1.30-1

For the parameters specified in Table 5.4-1 and Table 5.4.2.1-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.1.2-2 in case SS/PBCH block index is not known. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.4.1.2-2: Minimum performance PBCH in case SS/BPCH block index is not known for RedCap

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
1-1	20 / 30	R.PBCH.2	TDLA30-10	1 x 1 Low	1	-0.8

5.4.2 2RX requirements

5.4.2.1 FDD

Table 5.4.2.1-1: Void

For the parameters specified in Table 5.4-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.2.1-2 in case SS/PBCH block index is not known and below the specifies values in Table.5.4.2.1-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

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

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
1-1	10 / 15	R.PBCH.1	TDLC300-100	1 x 2 Low	1	-6.7

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

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
2-1	10 / 15	R.PBCH.1	TDLC300-100	1 x 2 Low	1	-8.3

5.4.2.2 TDD

Table 5.4.2.2-1: Test parameters for PBCH

Parameter	Unit	Single antenna port
TDD UL-DL pattern		FR1.30-1

For the parameters specified in Table 5.4-1 and Table 5.4.2.2-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.2.2-2 and Table 5.4.2.2-4 in case SS/PBCH block index is not known and below the specified values in Table 5.4.2.2-3 and Table 5.4.2.2-5 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.4.2.2-2: Minimum performance PBCH in case SS/PBCH block index is not known

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
1-1	40 / 30	R.PBCH.2	TDLA30-10	1 x 2 Low	1	-5.3

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

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
2-1	40 / 30	R.PBCH.2	TDLA30-10	1 x 2 Low	1	-6.5

Table 5.4.2.2-4: Minimum performance PBCH in case SS/BPCH block index is not known for RedCap

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
3-1	20 / 30	R.PBCH.2	TDLA30-10	1 x 2 Low	1	-5.3

Table 5.4.2.2-5 Minimum performance PBCH in case SS/BPCH block index is known for RedCap

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
4-1	20 / 30	R.PBCH.2	TDLA30-10	1 x 2 Low	1	-6.5

5.4.3 4RX requirements

5.4.3.1 FDD

Table 5.4.3.1-1: Void

For the parameters specified in Table 5.4-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.3.1-2 in case SS/PBCH block index is not known and below the specified values in Table.5.4.3.1-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.4.3.1-2: Minimum performance PBCH in case SS/PBCH block index is not known

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
1-1	10 / 15	R.PBCH.1	TDLC300-100	1 x 4 Low	1	-8.9

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

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
2-1	10 / 15	R.PBCH.1	TDLC300-100	1 x 4 Low	1	-10.9

5.4.3.2 TDD

Table 5.4.3.2-1: Test parameters for PBCH

Parameter	Unit	Single antenna port
TDD UL-DL pattern		FR1.30-1

For the parameters specified in Table 5.4-1 and Table 5.4.3.2-1 the average probability of a miss-detected PBCH (Pm-bch) shall be below the specified values in Table 5.4.3.2-2 in case SS/PBCH block index is not known and below the specified values in Table.5.4.3.2-3 in case SS/PBCH block index is known. The downlink physical setup is in accordance with Annex C.3.1.

Table 5.4.3.2-2: Minimum performance PBCH in case SS/PBCH block index is not known

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
1-1	40 / 30	R.PBCH.2	TDLA30-10	1 x 4 Low	1	-8.6

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

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR (dB)
2-1	40 / 30	R.PBCH.2	TDLA30-10	1 x 4 Low	1	-9.6

5.5 Sustained downlink data rate provided by lower layers

5.5.1 FR1 single carrier requirements

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

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

For RedCap, the requirements and procedure are defined in Clause 5.5A.1 except that the MIMO layers are configured to 2 for UE supporting 2 MIMO layers and 1 for UE supporting 1 MIMO layers for all operating band. Antenna configuration is 1x1 for UE supporting 1 layer and 2x2 for UE supporting 2 layers.

For RedCap UE with HD-FDD mode, the additional test parameters are specified in Table 5.5.1-1.

Table 5.5.1-1: Additional test parameters for HD-FDD single carrier

Parameter	Unit	Value

Duplex mode			HD-FDD
PDSCH configuration	Starting symbol (S)		1
	Length (L)		13
Number of HARQ Processes			4
Full DL slots (Note 1, Note 2)			For slots i, if mod(i, 5) = {0,1,2}
K1 value (Note 2)			4 if mod(i, 5) = 0 3 if mod(i, 5) = 1 2 if mod(i, 5) = 2
Note 1: PDSCH is scheduled only on full DL slots. Note 2: i is the slot index per frame; i = {1, 2, …, 19}.			

5.5A Sustained downlink data rate provided by lower layers

5.5A.1 FR1 CA requirements

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

Whether same requirements apply for FR1 DC>

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

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

The test parameters are determined by the following procedure:

- Select one CA bandwidth combination among all supported CA configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities that provides the largest data rate in accordance with clause 4.1.2 of TS 38.306 [14].

  - Set of per CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor in accordance with clause 4.1.2 of TS 38.306 [14].

  - When there are multiple sets of CA bandwidth combinations and UE capabilities (channel bandwidth, subcarrier spacing, number of MIMO layer, modulation format, scaling factor) with same largest data rate, select one among sets with the smallest aggregated channel bandwidth.

- For UE not capable of 1024QAM (*pdsch-1024QAM-FR1*), for each CC in CA bandwidth combination, use Table 5.5A-5 to determine MCS based on test parameters and indicated UE capabilities.

- For UE capable of 1024QAM (*pdsch-1024QAM-FR1*), for each CC in CA bandwidth combination, use Table 5.5A-6 to determine MCS based on test parameters and indicated UE capabilities if the maximum modulation format is 10. If the maximum modulation format (*supportedModulationOrderDL*) is less than 10, use Table 5.5A-5 to determine MCS based on test parameters and indicated UE capabilities.

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

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

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

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

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

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

Parameter		Unit	Value
PDSCH transmission scheme			Transmission scheme 1
EPRE ratio of PTRS to PDSCH		dB	N/A
Channel bandwidth		MHz	Channel bandwidth from selected CA bandwidth combination
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
	First DMRS position for Type A PDSCH mapping		2
Cross carrier scheduling			Not configured
Active DL BWP index			1
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 2)	RBs	0
	Subcarrier spacing	kHz	15 or 30
DL BWP configuration #1	RB offset	RBs	0
	Number of contiguous PRB		Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing
	Subcarrier spacing	kHz	15 or 30
	Cyclic prefix		Normal
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		Symbols #0
	Number of PRBs in CORESET		Table 5.5A-4
	Number of PDCCH candidates and aggregation levels		2/AL2 for 15 kHz / 5 MHz and 30 kHz / 15 MHz 2/AL4 for 15 kHz / 10 MHz, 30 kHz / 10 MHz and 30 kHz / 20 MHz 2/AL8 for other greater combinations
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
	TCI State		TCI state #1
	PDCCH & PDCCH DMRS Precoding configuration		For number of TX = 1: No precoding; For Number of Tx = 2: Single Panel Type I, Randomized precoder selection for every REG bundle and updated per slot with equal probability of precoder index 0 and 2 For Number of Tx= 4: Single Panel Type I, Randomized precoder selection for every REG bundle and updated per slot with equal probability of i_1,1 in {1,2,3,5,6,7} and i_2 in {0,2}
PDSCH configuration	Mapping type		Type A
	k0		0
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		wideband
	Resource allocation type		Type 0
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		1
	Antenna ports indexes		{1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs {1000 – 1003} for 4 Layers CCs

	Number of PDSCH DMRS CDM group(s) without data			1 for 1 layer and 2 layers CCs 2 for 4 Layers CCs
PTRS configuration				PTRS is not configured
CSI-RS for tracking	Subcarrier indexes in the PRB used for CSI-RS			k_0 = 3 for CSI-RS resource 1,2,3,4
	OFDM symbols in the PRB used for CSI-RS			l_0 = 6 for CSI-RS resource 1 and 3 l_0 = 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)			3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity		Slots	15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 30 kHz SCS: 40 for CSI-RS resource 1,2,3,4
	CSI-RS offset		Slots	15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4 30 kHz SCS: 20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size /4)*4
	QCL info			TCI state #0
NZP CSI-RS for CSI acquisition	Subcarrier indexes in the PRB used for CSI-RS			k_0 = 4
	OFDM symbols in the PRB used for CSI-RS			l_0 = 12
	Number of CSI-RS ports (X)			Same as number of transmit antenna
	CDM Type			'FD-CDM2'
	Density (ρ)			1
	CSI-RS periodicity			15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset			0
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size /4)*4
	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Subcarrier indexes in the PRB used for CSI-RS			k_0 = 0
	OFDM symbols in the PRB used for CSI-RS			l_0 = 12
	Number of CSI-RS ports (X)			4
	CDM Type			'FD-CDM2'
	Density (ρ)			1
	CSI-RS periodicity			15 kHz SCS: 20 30 kHz SCS: 40
	CSI-RS offset			0
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size/4)*4
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		N/A
		QCL Type		N/A
Maximum number of code block groups for ACK/NACK feedback				1
Maximum number of HARQ transmission				4
PUCCH HARQ ACK spaitial bundling				Not configured
Redundancy version coding sequence				{0,2,3,1}
PDSCH & PDSCH DMRS Precoding configuration				For number of TX = 1: No precoding; For number of TX > 1: Single Panel Type I; Randomized precoder selection for every PRB bundle and

			updated per slot, with equal probability of each applicable i_1/i_2 combination or codebook index, chosen from section 5.2.2.2.1 of TS 38.214 [12].
Symbols for all unused REs			OP.1 FDD as defined in Annex A.5.1.1 OP.1 TDD as defined in Annex A.5.2.1
Propagation condition			Static propagation condition No external noise sources are applied
Antenna configuration	1 layer CCs		1x1 or 1x2 or 1x4
	2 layers CCs		2x2 or 2x4
	4 layers CCs		4x4
Physical signals, channels mapping and precoding			As specified in Annex B.4.1
Es		dBm/kHz	-112 for MCS indexes in Table 5.5A-5: -110.5 For 1024QAM MCS indexes in Table 5.5A-6:
Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing			

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

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

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

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

Table 5.5A-4: Number of PRBs in CORESET

SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	35 MHz	40 MHz	45 MHz	50 MHz	60 MHz	80 MHz	100 MHz
15	24	48	78	102	132	156	186	216	240	270	N/A	N/A	N/A
30	6	24	36	48	60	78	90	102	114	132	162	216	270

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

Maximum number of PDSCH MIMO layers	Maximum modulation format	Scaling factor	MCS
1	8	1	26
1	8	0.8	21
1	8	0.75	20
1	8	0.4	11

1	6	1	27
1	6	0.8	23
1	6	0.75	22
1	6	0.4	14
1	4	1	16
1	4	0.8	16
1	4	0.75	16
1	4	0.4	10
1	2	1	9
1	2	0.8	9
1	2	0.75	9
1	2	0.4	4
2	8	1	26
2	8	0.8	21
2	8	0.75	20
2	8	0.4	11
2	6	1	27
2	6	0.8	23
2	6	0.75	22
2	6	0.4	14
2	4	1	16
2	4	0.8	16
2	4	0.75	16
2	4	0.4	10
2	2	1	9
2	2	0.8	9
2	2	0.75	9
2	2	0.4	4
4	8	1	26
4	8	0.8	23
4	8	0.75	22
4	8	0.4	12
4	6	1	27
4	6	0.8	24
4	6	0.75	23
4	6	0.4	14
4	4	1	16
4	4	0.8	16
4	4	0.75	16
4	4	0.4	11
4	2	1	9
4	2	0.8	9
4	2	0.75	9
4	2	0.4	5
Note 1: MCS Index for maximum modulation format 2,4 and 6 is based on MCS index Table 1 defined in clause 5.1.3.1 of TS 38.214 [12]			
Note 2: MCS Index for maximum modulation format 8 is based on MCS index Table 2 defined in clause 5.1.3.1 of TS 38.214 [12]			

Table 5.5A-6: 1024QAM MCS indexes for indicated UE capabilities

Supported RX antenna ports	Maximum number of PDSCH MIMO layers	Maximum modulation format	Scaling factor	MCS
2RX	1	10	1	23
	1	10	0.8	21
	1	10	0.75	19
	1	10	0.4	9
4RX	1	10	1	24
	1	10	0.8	21
	1	10	0.75	19
	1	10	0.4	9
	2	10	1	23
	2	10	0.8	21
	2	10	0.75	19

	2	10	0.4	9

Note 1: MCS Index for maximum modulation format 10 is based on MCS index Table 4 defined in clause 5.1.3.1 of TS 38.214 [12]

Note 2: For the band(s) on which UE supporting “Maximum modulation format” of 10, with 2 RX and 2 MIMO layers, the MCS index is derived from the rows with “Maximum modulation format” of 8 in Table 5.5A-5

6 CSI reporting requirements (Conducted requirements)

6.1 General

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

6.1.1 Applicability of requirements

6.1.1.1 General

The minimum performance requirements are applicable to all FR1 operating bands defined in TS 38.101-1 [6] except for test cases listed in Clause 6.2.2.2.1.3, Clause 6.2.3.2.1.3, Clause 6.2A.3.1.2 and Clause 6.2A.4.1.1 which are only applicable for FR1 bands restricted to operation with shared spectrum.

The minimum performance requirements in Clause 6 are mandatary for UE supporting NR operation, except test cases listed in Clause 6.1.1.3, 6.1.1.4, 6.1.1.5, 6.1.1.6.

If same test is listed for different UE features/capabilities in Clauses 6.1.1.3 and 6.1.1.4, then this test shall apply for UEs which support all corresponding UE features/capabilities.

6.1.1.2 Applicability of requirements for different number of RX antenna ports

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

The UE shall support 2 or 4 RX antenna ports for different RF operating bands. The operating bands, where 4 RX antenna ports shall be the baseline, are defined in clause 7.2 of TS 38.101-1 [6]. The UE requirements applicability for UEs with different number of RX antenna ports is defined in Table 6.1.1.2-1.

Table 6.1.1.2-1: Requirements applicability

Supported RX antenna ports	Test type	Test list
UE supports only 2RX	CQI	All tests in Clause 6.2.2
	PMI	All tests in Clause 6.3.2
	RI	All tests in Clause 6.4.2
UE supports only 4RX or both 2RX and 4RX	CQI	All tests in Clause 6.2.3
	PMI	All tests in Clause 6.3.3
	RI	All tests in Clause 6.4.3

6.1.1.3 Applicability of requirements for optional UE features

The performance requirements in Table 6.1.1.3-1 shall apply for UEs which support optional UE features with capability signalling only.

Table 6.1.1.3-1: Requirements applicability for optional features with UE capability signalling

UE feature/capability [14]	Test type		Test list	Applicability notes
CQI table with target BLER of 10^-5New CQI table (cqi-TableAlt)	FR1 FDD	CQI	Clause 6.2.2.1.1.2 Clause 6.2.3.1.1.2	
	FR1 TDD	CQI	Clause 6.2.2.2.1.2 Clause 6.2.3.2.1.2	
Alternative 64QAM MCS table for PDSCH New 64QAM MCS	FR1 FDD	CQI	Clause 6.2.2.1.1.2 Clause 6.2.3.1.1.2	

table for PDSCH (*dl-64QAM-MCS-TableAlt*)	FR1 TDD	CQI	Clause 6.2.2.2.1.2 Clause 6.2.3.2.1.2	
Validating P/SP-CSI-RS reception (*periodicAndSemi-PersistentCSI-RS-r16*)	FR1 TDD	CQI	Clause 6.2.2.2.1.3 Clause 6.2.3.2.1.3 Clause 6.2A.3.1.2 Clause 6.2A.4.1.1	The requirements apply only in case tested UE supporting operations in shared spectrum access and validation of P/SP-CSI-RS reception based on DCI
Supported UL channels for dynamic channel access mode (*ul-DynamicChAccess-r16*) or UL channel access for semi-static channel access mode (*ul-Semi-StaticChAccess-r16*) or both	FR1 TDD	CQI	Clause 6.2.2.2.1.3 Clause 6.2.3.2.1.3	The requirements apply only in case tested UE supports one of UL channels for dynamic channel access mode and UL channel access for semi-static channel access mode
1024QAM modulation for PDSCH for FR1 (pdsch-1024QAM-FR1-r17)	FR1 FDD	CQI	Clause 6.2.2.1.1.3 (Test 1) Clause 6.2.3.1.1.3 (Test 1)	
	FR1 TDD	CQI	Clause 6.2.2.2.1.4 (Test 1) Clause 6.2.3.2.1.4 (Test 1)	
Support of Type II codebook (*CodebookParameters* contains *type2, supportedCSI-RS-ResourceList, parameterLx, amplitudeScalingType, amplitudeSubsetRestriction*)	FR1 FDD	PMI	Clause 6.3.2.1.5 Clause 6.3.3.1.5	
	FR1 TDD	PMI	Clause 6.3.2.2.5 Clause 6.3.3.2.5	
Support of Enhanced Type II codebook with at least 16 ports per CSI-RS resource(*codebookParameters Addition-r16* contains *etype2R1-r16, supportedCSI-RS-ResourceListAdd-r16, maxNumberTxPortsPerResource*)	FR1 FDD	PMI	Clause 6.3.2.1.6 Clause 6.3.3.1.6	
	FR1 TDD	PMI	Clause 6.3.2.2.6 Clause 6.3.3.2.6	

Table 6.1.1.3-2:Void

6.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

The performance requirements in Table 6.1.1.4-1 shall apply for UEs which support mandatory UE features with capability signalling only.

Table 6.1.1.4-1: Requirements applicability for mandatory features with UE capability signalling

UE feature/capability [14]	Test type		Test list	Applicability notes
Supported maximum number of PDSCH MIMO layers (maxNumberMIMO-LayersPDSCH)	FR1 FDD	CQI	Clause 6.2.3.1.1.1	The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability
		PMI	Clause 6.3.3.1.2	
		RI	Clause 6.4.2.1 Clause 6.4.3.1	
	FR1 TDD	CQI	Clause 6.2.3.2.1.1	

		PMI	Clause 6.3.3.2.2	
		RI	Clause 6.4.2.2 Clause 6.4.3.2	
Supported maximum number of ports across all configured NZP-CSI-RS resources per CC (maxConfigNumberPortsAcross NZP-CSI-RS-PerCC)	FR1 FDD	PMI	Clause 6.3.2.1.1 Clause 6.3.2.1.2 Clause 6.3.2.1.3 Clause 6.3.2.1.4 Clause 6.3.3.1.1 Clause 6.3.3.1.2 Clause 6.3.3.1.3 Clause 6.3.3.1.4	The requirements apply only in case the number of NZP-CSI-RS ports in the test case satisfies UE capability on maximum number of NZP-CSI-RS ports
		RI	Clause 6.4.3.1 (Test 4)	
	FR1 TDD	PMI	Clause 6.3.2.2.1 Clause 6.3.2.2.2 Clause 6.3.2.2.3 Clause 6.3.2.2.4 Clause 6.3.3.2.1 Clause 6.3.3.2.2 Clause 6.3.3.2.3 Clause 6.3.3.2.4	
		RI	Clause 6.4.3.2 (Test 4)	

6.1.1.5 Applicability of Channel Quality Indicator (CQI) reporting requirements for CA

6.1.1.5.1 Applicability and test rules for different duplex modes and SCS combinations

The applicability and test rules for different duplex modes and SCS combinations are defined in Table 6.1.1.5.1-1.

Table 6.1.1.5.1-1: Applicability for different duplex modes and SCS combinations

Tests	PCell CC configuration
Test 1 in Clause 6.2A.3.1.1	TDD CC if supported, otherwise FDD CC
Test 2 in Clause 6.2A.3.1.1 (NOTE 2)	Any of CCs
Test 3 in Clause 6.2A.3.1.1	Any of CCs
NOTE 1: The test coverage can be considered fulfilled if UE passes one of the CC as PCell in Test 1. NOTE 2: These scenarios are only tested for UEs which are not verified with Test 1 in Clause 6.2A.3.1.1.	

6.1.1.5.2 Applicability and test rules for different CA configurations and bandwidth combination sets

The performance requirement for CA CQI tests in clause 6.2A are defined independent of CA configurations and bandwidth combination sets specified in clasue 5.5A in TS 38.101-1 [6].

For UEs supporting multiple CA capabilities, test any one of the supported CA capabilities with largest aggregated CA bandwidth combination. The categorization of CA capability is specified in clasue 5.1.1.7.1.

For UEs supporting multiple CA configurations from the selected CA capability, test any one of the supported CA configurations with largest aggregated CA bandwidth combination. For simplicity, the CA configuration refers to combination of CA configuration and bandwidth combination set.

A single uplink CC is configured for all tests.

6.1.1.5.3 Test coverage for different number of componenet carriers

For CA CQI tests specified in clause 6.2A, among all supported CA capabilities, if corresponding CA tests with the largest number of CCs supported by the UE are tested, the test coverage can be considered fulfilled without executing the CA tests with less than the largest number of CCs supported by the UE.

6.1.1.5.4 Applicability rule and antenna connection for CA tests with 4 RX

All the requirements specified in clause 6.2A for CA with 2 RX are applied for 4 RX capable UEs by connecting all 4 RX with data source from system simulator and reducing the signal power density by 3 dB compared to the signal power density for 2 RX in the test configurations.

6.1.1.6 Applicability of requirements for RedCap

The performance requirements in Table 6.1.1.6-1 shall apply for UEs which support optional feature *supportOfRedCap*.

Other performance requirements mandatory for UE supporting NR operation defined in Section 6 but not included in table 6.1.1.6-1 should not be considered applicable to RedCap UEs.

Table 6.1.1.6-1: Requirements applicability for RedCap

UE capability	Test type		Test list	Applicability notes
RedCap with 1RX	FR1 FDD and HD-FDD (Note 1)	CQI	All tests in Clause 6.2.1.1.1.1 All tests in Clause 6.2.1.1.2.1	
		PMI	All tests in Clause 6.3.1.1.1	
	FR1 TDD	CQI	All tests in Clause 6.2.1.2.1.1 All tests in Clause 6.2.1.2.2.1	
		PMI	All tests in Clause 6.3.1.2.1	
RedCap with 2RX	FR1 FDD and HD-FDD (Note 1)	CQI	All tests in Clause 6.2.2.1.1.4 All tests in Clause 6.2.2.1.2.4	
		PMI	Clause 6.3.2.1.1 (Test 1)	
		RI	Clause 6.4.2.1.1 (Test 1)	
	FR1 TDD	CQI	All tests in Clause 6.2.2.2.1.5 All tests in Clause 6.2.2.2.2.4	
		PMI	Clause 6.3.2.2.7 (Test 1)	
		RI	Clause 6.4.2.2.1 (Test 1)	
Note 1: If UE support only HD-FDD in a FDD band, this UE is tested with HD-FDD mode otherwise UE is tested with full-duplex FDD mode				

6.1.2 Common test parameters

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

Table 6.1.2-1: Test parameters for CSI test cases

Parameter		Unit	Value
PDSCH transmission scheme			Transmission scheme 1
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)	RBs	0
	Subcarrier spacing	kHz	15 or 30
DL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as

			specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing
Additional PDCCH Configuration for Aperiodic Reporting (Note 4)	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0,1
	Number of PDCCH candidates and aggregation levels		1/AL8
	DCI format		0_1
	TCI state		TCI state #1
	PDCCH & PDCCH DMRS Precoding configuration		Multi-path fading propagation conditions: Single Panel Type I, Random per slot with equal probability of each applicable i1, i2 combination, and with REG bundling granularity for number of Tx larger than 1
Active DL BWP index			1
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0,1
	Number of PDCCH candidates and aggregation levels		1/AL8
	DCI format		1_1
	TCI state		TCI state #1
	PDCCH & PDCCH DMRS Precoding configuration		Multi-path fading propagation conditions: Single Panel Type I, Random per slot with equal probability of each applicable i1, i2 combination, and with REG bundling granularity for number of Tx larger than 1 Static propagation conditions: Single Panel Type I, Random precoder chosen from precoder index 0 and 2, selection updated per slot
Cross carrier 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		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
	Maximum number of OFDM symbols for DL front loaded DMRS			1
	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 for CSI-RS resource 1,2,3,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)			4 for CSI-RS resource 1 and 3 8 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)			3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity		slot	15 kHz SCS: 20 for CSI-RS resource 1,2,3,4 30 kHz SCS: 40 for CSI-RS resource
	CSI-RS offset		slot	15 kHz SCS: 10 for CSI-RS resource 1 and 2 11 for CSI-RS resource 3 and 4 30 kHz SCS: 20 for CSI-RS resource 1 and 2 21 for CSI-RS resource 3 and 4
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size /4)*4
	QCL info			TCI state #0
NZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size /4)*4
	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size /4)*4
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		N/A
		QCL Type		N/A
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
		CSI-RS resource		N/A

	Type 2 QCL information	QCL Type		N/A
Number of HARQ Processes				4 For FDD 8 for TDD
PUCCH HARQ ACK spaitial bundling				Not configured
Redundancy version coding sequence				{0,2,3,1}
K1 value (PDSCH-to-HARQ-timing-indicator)				2 for FDD For FR1.30-1: 8 if mod(i,10) = 0 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 Where i is slot index per radio frame with 0~19 For FR1.30-7: 8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 4 if mod(i,10) = 4 3 if mod(i,10) = 5 2 if mod(i,10) = 6 Where i is the slot index of all slots in every 5ms i = {0,…,9}
Symbols for unused REs				OP.1 FDD as defined in Annex A.5.1.1 OP.1 TDD as defined in Annex A.5.2.1
Physical signals, channels mapping and precoding				As specified in Annex B.4.1
Note 1: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL. Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. Note 3: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. Note 4: Additional PDCCH configuration for aperiodic reporting is only for test cases with aperiodic CSI reporting configured.				

6.2 Reporting of Channel Quality Indicator (CQI)

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

6.2.1 1RX requirements

6.2.1.1 FDD

6.2.1.1.1 CQI reporting definition under AWGN conditions

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

6.2.1.1.1.1 Minimum requirement for periodic CQI reporting for RedCap

For the parameters specified in Table 6.2.1.1.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90% of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.1.1.1.1-1: CQI reporting definition test

Parameter		Unit	Test 1	Test 2
Bandwidth		MHz	10	
Subcarrier spacing		kHz	15	
Duplex Mode			FDD	
SNR		dB	5 / 6	11 / 12
Propagation channel			AWGN	
Antenna configuration			2×1 with static channel specified in Annex B.1	
Beamforming Model			As specified in Annex B.4.1	
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (*X*)		4	
	CDM Type		FD-CDM2	
	Density (ρ)		1	
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4	
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9	
	CSI-RS periodicity and offset	slot	10/5	
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)		Row 3,(6)	
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13	
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/5	
CSI-IM configuration	CSI-IM resource Type		Periodic	
	CSI-IM RE pattern		0	
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)	
	CSI-IM timeConfig periodicity and offset	slot	10/5	
ReportConfigType			Periodic	
CQI-table			Table 1	
reportQuantity			cri-RI-PMI-CQI	
timeRestrictionForChannelMeasurements			Not configured	
timeRestrictionForInterferenceMeasurements			Not configured	
cqi-FormatIndicator			Wideband	
pmi-FormatIndicator			Wideband	
Sub-band Size		RB	8	
Csi-ReportingBand			1111111	
CSI-Report periodicity and offset		slot	10/9	
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	10
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-1, TBS.1-3

6.2.1.1.2 CQI reporting under fading conditions

6.2.1.1.2.1 Minimum requirement for wideband CQI reporting for RedCap

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

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

For the parameters specified in Table 6.2.1.1.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α% of the time where α% is specified in Table 6.2.1.1.2.1-2;

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 6.2.1.1.2.1-2;

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

Table 6.2.1.1.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Subcarrier spacing		kHz	15			
Duplex Mode			FDD			
SNR		dB	9	10	15	16
Propagation channel			TDLA30-5			
Antenna configuration			2×1			
Correlation configuration			ULA high			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/5			
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)		Row 3,(6)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			

	NZP CSI-RS-timeConfig periodicity and offset	slot	10/5
CSI-IM configuration	CSI-IM resource Type		Periodic
	CSI-IM RE pattern		0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)
	CSI-IM timeConfig periodicity and offset	slot	10/5
ReportConfigType			Periodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
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	10
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-1, TBS.1-3

Table 6.2.1.1.2.1-2: Minimum requirements

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

6.2.1.2 TDD

6.2.1.2.1 CQI reporting definition under AWGN conditions

6.2.1.2.1.1 Minimum requirement for periodic CQI reporting for RedCap

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

For the parameters specified in Table 6.2.1.2.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90% of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.1.2.1.1-1: CQI reporting definition test

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	20			
Subcarrier spacing		kHz	30			
Duplex Mode			TDD			
TDD UL-DL pattern			FR1.30-1			
SNR		dB	5	6	11	12
Propagation channel			AWGN			
Antenna configuration			2×1 with static channel specified in Annex B.1			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic			
	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 1			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Wideband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	8			
Csi-ReportingBand			1111111			
CSI-Report periodicity and offset		slot	10/9			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		000001			
	RI Restriction		N/A			
Physical channel for CSI report			PUCCH			
CQI/RI/PMI delay		ms	9.5			
Maximum number of HARQ transmission			1			
Measurement channel			As specified in Table A.4-1, TBS.1-5			

6.2.1.2.2 CQI reporting under fading conditions

6.2.1.2.2.1 Minimum requirement for wideband CQI reporting for RedCap

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

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

For the parameters specified in Table 6.2.1.2.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α% of the time where α% is specified in Table 6.2.1.2.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, where γ is specified in Table 6.2.1.2.2.1-2;

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

Table 6.2.1.2.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1	Test 2		
Bandwidth		MHz	20			
Subcarrier spacing		kHz	30			
Duplex Mode			TDD			
TDD UL-DL pattern			FR1.30-1			
SNR		dB	9	10	15	16
Propagation channel			TDLA30-5			
Antenna configuration			2×1			
Correlation configuration			ULA high			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic			
	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig	slot	10/1			

	periodicity and offset		
ReportConfigType			Periodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-1, TBS.1-5

Table 6.2.1.2.2.1-2: Minimum requirements

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

6.2.2 2RX requirements

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

6.2.2.1 FDD

6.2.2.1.1 CQI reporting definition under AWGN conditions

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

6.2.2.1.1.1 Minimum requirement for periodic CQI reporting

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

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90% of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.2.1.1.1-1: CQI reporting definition test

Parameter	Unit	Test 1	Test 2
Bandwidth	MHz	10	

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

6.2.2.1.1.2 Minimum requirement for periodic CQI reporting with Table 3

For the parameters specified in Table 6.2.2.1.1.2-1, 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 10^{-5}, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 10^{-5}. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 10^{-5}, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 10^{-5}.

c) The reported CQI value according to the reference channel shall be ≥ 1.

Table 6.2.2.1.1.2-1: CQI reporting test parameters

Parameter		Unit	Test 1
Bandwidth		MHz	10
Duplex Mode			FDD
Subcarrier spacing		kHz	15
SNR		dB	1 | 2
Propagation channel			AWGN
Antenna configuration			1×2 with static channel specified in Annex B.1
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		1
	CDM Type		No CDM
	Density (ρ)		3
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 1,(0,-)
	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 resource Type		Periodic
	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 3
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
reportQuantity			cri-RI-PMI-CQI (Note 1)
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	5/0
aperiodicTriggeringOffset			Not configured
Codebook configuration			Not configured
Physical channel for CSI report			PUCCH
CQI/RI delay		ms	8
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-4, TBS.4-1
Note 1: The bitwidth of PMI for UCI on PUCCH in a case 1-port CSI-RS is configured as channel measurement resource is given in [10], section 6.3.1.1.2.			

6.2.2.1.1.3 Minimum requirement for periodic CQI reporting with Table 4

For the parameters specified in Table 6.2.2.1.1.3-1, 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, and if the reported median CQI is not the highest CQI index, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.2.1.1.3-1: CQI reporting test parameters

Parameter		Unit	Test 1
Bandwidth		MHz	10
Duplex Mode			FDD
Subcarrier spacing		kHz	15
SNR		dB	28 | 29
Propagation channel			AWGN
Antenna configuration			2×2 with static channel specified in Annex B.1
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1
CSI-IM configuration	CSI-IM resource Type		Periodic
	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 4
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	5/0
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured

	CodebookSubsetRestriction		000001
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-5, TBS.5-1

6.2.2.1.1.4 Minimum requirement for periodic CQI reporting for RedCap

For the parameters specified in Table 6.2.2.1.1.4-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90% of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.2.1.1.4-1: CQI reporting definition test

Parameter		Unit	Test 1	Test 2		
Bandwidth		MHz	10			
Subcarrier spacing		kHz	15			
Duplex Mode			FDD			
SNR		dB	8	9	14	15
Propagation channel			AWGN			
Antenna configuration			2×2 with static channel specified in Annex B.1			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/5			
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)		Row 3,(6)			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13			
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/5			
CSI-IM configuration	CSI-IM resource Type		Periodic			
	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	10/5			
ReportConfigType			Periodic			
CQI-table			Table 1			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Wideband			

pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
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	10
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-1, TBS.1-4

6.2.2.1.2 CQI reporting under fading conditions

6.2.2.1.2.1 Minimum requirement for wideband CQI reporting

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

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

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

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α% of the time where α% is specified in Table 6.2.2.1.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, where γ is specified in Table 6.2.2.1.2.1-2;

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

Table 6.2.2.1.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Subcarrier spacing		kHz	15			
Duplex Mode			FDD			
SNR		dB	6	7	12	13
Propagation channel			TDLA30-5			
Antenna configuration			2×2			
Correlation configuration			ULA high			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			

	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	CSI-IM RE pattern		0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)
	CSI-IM timeConfig periodicity and offset	slot	5/1
ReportConfigType			Periodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	5/0
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-1

Table 6.2.2.1.2.1-2: Minimum requirements

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

6.2.2.1.2.2 Minimum requirement for sub-band CQI reporting

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

The accuracy of sub-band channel CQI reporting under the frequency-selective fading conditions is determined by a double-sided percentile of the reported differential CQI offset level 0 per sub-band, and the relative increase of the throughput obtained when transmitting the transport format indicated by the corresponding reported sub-band CQI on a randomly selected sub-band among the sub-bands with the highest reported differential CQI offset level compared to the throughput when transmitting a fixed transport format according to the wideband CQI median on a randomly selected sub-band among all the sub-bands. To account for sensitivity of the input SNR the sub-band CQI reporting under frequency selective fading conditions is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.2.1.2.2-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A sub-band differential CQI offset level of 0 shall be reported at least α% of the time but less than β% of the time for each sub-band, where α and β are specified in Table 6.2.2.1.2.2-2;

b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be $\geq \gamma$, where γ is specified in Table 6.2.2.1.2.2-2;

c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to 0.02.

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

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

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Subcarrier spacing		kHz	15			
Duplex Mode			FDD			
SNR		dB	8	9	14	15
Propagation channel			Two tap model specified in Annex B.2.4 with a=1, f_D = 5Hz, and τ_d=0.45μs			
Antenna configuration			2×2			
Correlation configuration			As per Annex B.1			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic			
	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			Aperiodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Subband			

pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
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			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-5

Table 6.2.2.1.2.2-2: Minimum requirements

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

6.2.2.1.2.3 Minimum requirement for wideband CQI reporting with inter-cell interference

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible based on inter-cell interference mitigation receiver.

For the parameters specified in Table 6.2.2.1.2.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following,

a) the ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index subject to an interference source with specified INR and that obtained when transmitting the transport format indicated by each reported wideband CQI index subject to a white Gaussian noise source shall be $\geq \gamma$ where γ is specified in Table 6.2.2.1.2.3-2;

b) when transmitting the transport format indicated by each reported wideband CQI index subject to an interference source with specified INR, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

Table 6.2.2.1.2.3-1 Wideband CQI reporting test with inter-cell interference

Parameter		Unit	Test1	
			Cell 1	Cell 2
Bandwidth		MHz	10	10
Duplex Mode			FDD	FDD
Subcarrier spacing		kHz	15	15
SINR		dB	-2	-
Beamforming Model			As specified in Annex B.4.1	
Interference Model				As specified in B.6.2
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic
	Number of CSI-RS ports (*X*)		4	4
	CDM Type		FD-CDM2	FD-CDM2

	Density (ρ)		1	1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4	Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9	9
	CSI-RS periodicity and offset	slot	5/1	Same as serving cell
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic	Periodic
	Number of CSI-RS ports (*X*)		2	1
	CDM Type		FD-CDM2	noCDM
	Density (ρ)		1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3(6, -)	Row 2(6, -)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13	13
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	Same as serving cell
CSI-IM configuration	CSI-IM resource Type		Periodic	Periodic
	CSI-IM RE pattern		0	0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)	(6, 9)
	CSI-IM timeConfig periodicity and offset	slot	5/1	Same as serving cell
ReportConfigType			Periodic	Not configured
CQI-table			Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	Not configured
timeRestrictionForChannelMeasurements			Not configured	Not configured
timeRestrictionForInterferenceMeasurements			Not configured	Not configured
cqi-FormatIndicator			Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband
Sub-band Size		RB	8	-
Csi-ReportingBand			1111111	Not configured
CSI-Report periodicity and offset		slot	5/0	Not configured
aperiodicTriggeringOffset			Not configured	Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured	Not configured
	CodebookSubsetRestriction		000001	Not configured
	RI Restriction		N/A	Not configured
Physical channel for CSI report			PUCCH	Not configured
CQI/RI/PMI delay		ms	8	Not configured
Maximum number of HARQ transmission			1	Not configured
Measurement channel			As specified in Table A.4-2, TBS.2-1	-
INR (Note 6)		dB	N/A	10.04
Propagation condition			TDLA30-5	AWGN
Antenna configuration			2×2	1×2
Correlation configuration			ULA Low	N/A

Note 1: The respective received power spectral density of each interfering cell relative to N_{oc}' is defined by its associated INR value as specified in clause B.6.1.

Note 2: Two cells are considered in which Cell 1 is the serving cell and Cell 2 is the interfering cell. Interfering cell is fully loaded.

Note 3: Both cells are time-synchronous.

Note 4: Static channel is used for the interference model. In case for white Gaussian noise model Cell 2 is not present.

Note 5: SINR corresponds to $\hat{E}_s / N_{oc}'$ of Cell 1 as defined in clause 4.4.5.

Note 6: INR is defined in clause B.6.1.

Table 6.2.2.1.2.3-2 Minimum requirements

Parameters	Test 1
γ	1.9

6.2.2.1.2.4 Minimum requirement for wideband CQI reporting for RedCap

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

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

For the parameters specified in Table 6.2.2.1.2.4-1 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 6.2.2.1.2.4-2;

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 6.2.2.1.2.4-2;

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 6.2.2.1.2.4-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
SNR		dB	6 | 7
Propagation channel			TDLA30-5
Antenna configuration			2×2
Correlation configuration			ULA high
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	10/5
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)		Row 3,(6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/5
CSI-IM configuration	CSI-IM resource Type		Periodic
	CSI-IM RE pattern		0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)

	CSI-IM timeConfig periodicity and offset	slot	10/5
ReportConfigType			Periodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
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	10
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-1, TBS.1-3

Table 6.2.2.1.2.4-2: Minimum requirements

Parameters	Test 1
α [%]	20
γ	1.05

6.2.2.2 TDD

6.2.2.2.1 CQI reporting definition under AWGN conditions

6.2.2.2.1.1 Minimum requirement for periodic CQI reporting

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

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

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90% of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.2.2.1.1-1: CQI reporting definition test

Parameter	Unit	Test 1	Test 2
Bandwidth	MHz	40	
Subcarrier spacing	kHz	30	
Duplex Mode		TDD	

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

6.2.2.2.1.2 Minimum requirement for periodic CQI reporting with Table 3

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

For the parameters specified in Table 6.2.2.2.1.2-1, 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 10^{-5}, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 10^{-5}. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 10^{-5}, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 10^{-5}.

c) The reported CQI value according to the reference channel shall be ≥ 1.

Table 6.2.2.2.1.2-1: CQI reporting test parameters

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD UL-DL pattern			FR1.30-1
SNR		dB	1 | 2
Propagation channel			AWGN
Antenna configuration			1×2 with static channel specified in Annex B.1
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		1
	CDM Type		No CDM
	Density (ρ)		3
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 1,(0,-)
	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 resource Type		Periodic
	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 3
reportQuantity			cri-RI-PMI-CQI (Note 1)
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
aperiodicTriggeringOffset			Not configured
Codebook configuration			Not configured

Physical channel for CSI report		PUCCH
CQI/RI delay	ms	9.5
Maximum number of HARQ transmission		1
Measurement channel		As specified in Table A.4-4, TBS.4-2
Note 1: The bitwidth of PMI for UCI on PUCCH in a case 1-port CSI-RS is configured as channel measurement resource is given in [10], section 6.3.1.1.2.		

6.2.2.2.1.3 Minimum requirement for CQI reporting for PCell on band with shared spectrum access

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] for PCell on band with shared spectrum access. For each Downlink Transmission Duration the transmission power offset is randomly chosen between [0, +6] dB and 2 sets of CQI reports are obtained for each transmission power offset. 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 each power offset. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.2.2.1.3-1, and using the downlink physical channels specified in Annex A.4, the minimum requirements are specified by the following:

a) For each transmission power offset 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) For each transmission power offset, 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. For each transmission power offset, 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.

c) The absolute difference in median CQI for each of transmission power offset shall be ≥ 2.

Table 6.2.2.2.1.3-1: CQI reporting test parameters for PCell on band with shared spectrum access

Parameter		Unit	Test 1	
Bandwidth		MHz	20	
Subcarrier spacing		kHz	30	
Duplex Mode			TDD	
Downlink Transmission Model			As specified in Annex B.5	
Downlink Transmission Model Parameters	Downlink period	ms	5	
	LBT failure probability (p_{LBT})		0.25	
	Downlink transmission duration values set	slot	{4,6,7}	
	Occupied OFDM symbols in slot other than the last slot of the downlink duration	symbol	14	
	Occupied OFDM symbols in the last slot set of the downlink duration	symbol	14	
TDD UL-DL pattern			FR1.30-7	
SNR		dB	8	9
$\widehat{E_s}$ for power offset 1		dBm/Hz	-112	
$\widehat{E_s}$ for power offset 2		dBm/Hz	-106	
Propagation channel			AWGN	
Antenna configuration			2×2 with static channel specified in Annex B.1	
Beamforming Model			As specified in Annex B.4.1	
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic	
	Number of CSI-RS ports (*X*)		4	
	CDM Type		FD-CDM2	
	Density (ρ)		1	

	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 3, 6
	First OFDM symbol in the PRB used for CSI-RS (l_0)		3
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset	slot	0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			configured
timeRestrictionForInterferenceMeasurements			configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			7
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggrtSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		010000
	RI Restriction		N/A
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-8

6.2.2.2.1.4 Minimum requirement for periodic CQI reporting with Table 4

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

For the parameters specified in Table 6.2.2.2.1.4-1, 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, and if the reported median CQI is not the highest CQI index, 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 6.2.2.2.1.4-1: CQI reporting definition test

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD UL-DL pattern			FR1.30-1
SNR		dB	28 | 29
Propagation channel			AWGN
Antenna configuration			2×2 with static channel specified in Annex B.1
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	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 4
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
aperiodicTriggeringOffset			Not configured

Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-5, TBS.5-2

6.2.2.2.1.5 Minimum requirement for periodic CQI reporting for RedCap

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

For the parameters specified in Table 6.2.2.2.1.5-1, 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 6.2.2.2.1.5-1: CQI reporting definition test

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	20			
Subcarrier spacing		kHz	30			
Duplex Mode			TDD			
TDD UL-DL pattern			FR1.30-1			
SNR		dB	8	9	14	15
Propagation channel			AWGN			
Antenna configuration			2×2 with static channel specified in Annex B.1			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	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 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		010000
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-1, TBS.1-6

6.2.2.2.2 CQI reporting under fading conditions

6.2.2.2.2.1 Minimum requirement for wideband CQI reporting

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

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

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

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α% of the time where α% is specified in Table 6.2.2.2.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, where γ is specified in Table 6.2.2.2.2.1-2;

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

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

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

Table 6.2.2.2.2.1-2: Minimum requirements

Parameters	Test 1	Test 2

α [%]	20	20
γ	1.05	1.05

6.2.2.2.2.2 Minimum requirement for sub-band CQI reporting

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

The accuracy of sub-band channel CQI reporting under the frequency-selective fading conditions is determined by a double-sided percentile of the reported differential CQI offset level 0 per sub-band, and the relative increase of the throughput obtained when transmitting the transport format indicated by the corresponding reported sub-band CQI on a randomly selected sub-band among the sub-bands with the highest reported differential CQI offset level compared to the throughput when transmitting a fixed transport format according to the wideband CQI median on a randomly selected sub-band among all the sub-bands. To account for sensitivity of the input SNR the sub-band CQI reporting under frequency selective fading conditions is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.2.2.2.2-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A sub-band differential CQI offset level of 0 shall be reported at least α% of the time but less than β% of the time for each sub-band, where α and β are specified in Table 6.2.2.2.2.2-2;

b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be $\geq \gamma$, where γ is specified in Table 6.2.2.2.2.2-2;

c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to 0.02.

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

Table 6.2.2.2.2.2-1: Sub-band CQI reporting test under frequency-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	40			
Subcarrier spacing		kHz	30			
Duplex Mode			TDD			
TDD UL-DL pattern			FR1.30-1			
SNR		dB	8	9	14	15
Propagation channel			Two tap model specified in Annex B.2.4 with a=1, f_D = 5Hz, and τ_d=0.1125μs			
Antenna configuration			2×2			
Correlation configuration			As per Annex B.1			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			

	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	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			Aperiodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Subband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
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			PUSCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-6

Table 6.2.2.2.2.2-2: Minimum requirements

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

6.2.2.2.2.3 Minimum requirement for wideband CQI reporting with inter-cell interference

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible based on inter-cell interference mitigation receiver.

For the parameters specified in Table 6.2.2.2.2.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following,

a) the ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index subject to an interference source with specified INR and that obtained when transmitting the transport

format indicated by each reported wideband CQI index subject to a white Gaussian noise source shall be ≥ γ where γ is specified in Table 6.2.2.2.2.3-2;

b) when transmitting the transport format indicated by each reported wideband CQI index subject to an interference source with specified INR, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

Table 6.2.2.2.2.3-1: Wideband CQI reporting test with inter-cell interference (TDD)

Parameter			Unit	Test 1	
				Cell 1	Cell 2
Bandwidth			MHz	40	40
Duplex Mode				TDD	TDD
Subcarrier spacing			kHz	30	30
TDD UL-DL pattern				FR1.30-1	FR1.30-1
SINR			dB	-2	-
Beamforming Model				As specified in Annex B.4.1	
Interference Model					As specified in B.6.2
ZP CSI-RS configuration		CSI-RS resource Type		Periodic	Periodic
		Number of CSI-RS ports (*X*)		2	1
		CDM Type		FD-CDM2	noCDM
		Density (ρ)		1	1
		First subcarrier index in the PRB used for CSI-RS (k_0)		Row 3(8)	Row 2(8)
		First OFDM symbol in the PRB used for CSI-RS (l_0)		9	9
		CSI-RS periodicity and offset	slot	10/1	Same as serving cell
NZP CSI-RS for CSI acquisition		CSI-RS resource Type		Periodic	Periodic
		Number of CSI-RS ports (*X*)		2	1
		CDM Type		FD-CDM2	noCDM
		Density (ρ)		1	1
		First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3(6, -)	Row 2(6, -)
		First OFDM symbol in the PRB used for CSI-RS (l_0)		13	13
		NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	Same as serving cell
CSI-IM configuration		CSI-IM resource Type		Periodic	Periodic
		CSI-IM RE pattern		0	0
		CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)	(6,9)
		CSI-IM timeConfig periodicity and offset	slot	10/1	Same as serving cell
ReportConfigType				Periodic	Not configured
CQI-table				Table 2	Table 2
reportQuantity				cri-RI-PMI-CQI	Not configured
timeRestrictionForChannelMeasurements				Not configured	Not configured
timeRestrictionForInterferenceMeasurements				Not configured	Not configured
cqi-FormatIndicator				Wideband	Wideband
pmi-FormatIndicator				Wideband	Wideband
Sub-band Size			RB	16	
Csi-ReportingBand				1111111	Not configured
CSI-Report periodicity and offset			slot	10/9	Not configured
aperiodicTriggeringOffset				Not configured	Not configured
Codebook configuration		Codebook Type		typeI-SinglePanel	typeI-SinglePanel
		Codebook Mode		1	1
		(CodebookConfig-N1,CodebookConfig-N2)		Not configured	Not configured
		CodebookSubsetRestriction		000001	Not configured

RI Restriction		N/A	Not configured
Physical channel for CSI report		PUCCH	Not configured
CQI/RI/PMI delay	ms	9.5	Not configured
Maximum number of HARQ transmission		1	Not configured
Measurement channel		As specified in Table A.4-2, TBS.2-3	
INR	dB	N/A	10.04
Propagation condition		TDLA30-5	AWGN
Antenna configuration		2×2	1×2
Correlation configuration		ULA Low	N/A

Note 1: The respective received power spectral density of each interfering cell relative to N_{oc}' is defined by its associated INR value as specified in clause B.6.1.
Note 2: Two cells are considered in which Cell 1 is the serving cell and Cell 2 is the interfering cell. Interfering cell is fully loaded.
Note 3: Both cells are time-synchronous.
Note 4: Static channel is used for the interference model. In case for white Gaussian noise model Cell 2 is not present.
Note 5: SINR corresponds to $\hat{E}_s / N_{oc}'$ of Cell 1 as defined in clause 4.4.5.
Note 6: INR corresponds to Cell 2 is defined in clause B.6.1

Table 6.2.2.2.2.3-2: Minimum requirement (TDD)

Parameters	Test 1
γ	1.9

6.2.2.2.2.4 Minimum requirement for wideband CQI reporting for RedCap

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

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

For the parameters specified in Table 6.2.2.2.2.4-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α% of the time where α% is specified in Table 6.2.2.2.2.4-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, where γ is specified in Table 6.2.2.2.2.4-2;

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

Table 6.2.2.2.2.4-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter	Unit	Test 1	
Bandwidth	MHz	20	
Subcarrier spacing	kHz	30	
Duplex Mode		TDD	
TDD UL-DL pattern		FR1.30-1	
SNR	dB	6	7
Propagation channel		TDLA30-5	
Antenna configuration		2×2	

Correlation configuration			ULA high
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	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 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-1, TBS.1-5

Table 6.2.2.2.2.4-2: Minimum requirements

Parameters	Test 1
α [%]	20
γ	1.05

6.2.3 4RX requirements

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

6.2.3.1 FDD

6.2.3.1.1 CQI reporting definition under AWGN conditions

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

6.2.3.1.1.1 Minimum requirement for period CQI reporting

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

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90 % of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.3.1.1.1-1: CQI reporting definition test

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Subcarrier spacing		kHz	15			
Duplex Mode			FDD			
SNR		dB	5	6	11	12
Propagation channel			AWGN			
Antenna configuration			2×4 with static channel specified in Annex B.1			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic			
	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	5/1			
ReportConfigType			Periodic			
CQI-table			Table 2			

reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	5/0
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		010000
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-2

6.2.3.1.1.2 Minimum requirement for period CQI reporting with Table 3

For the parameters specified in Table 6.2.3.1.1.2-1, 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 10^{-5}, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 10^{-5}. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 10^{-5}, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 10^{-5}.

c) The reported CQI value according to the reference channel shall be ≥ 1.

Table 6.2.3.1.1.2-1: CQI reporting test parameters

Parameter		Unit	Test 1	
Bandwidth		MHz	10	
Subcarrier spacing		kHz	15	
Duplex Mode			FDD	
SNR		dB	-2	-1
Propagation channel			AWGN	
Antenna configuration			1×4 with static channel specified in Annex B.1	
Beamforming Model			As specified in Annex B.4.1	
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (*X*)		4	
	CDM Type		FD-CDM2	
	Density (ρ)		1	
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4	
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9	
	CSI-RS periodicity and offset	slot	5/1	
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (*X*)		1	
	CDM Type		No CDM	
	Density (ρ)		3	
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 1,(0,-)	

	First OFDM symbol in the PRB used for CSI-RS (l_0)		1
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1
CSI-IM configuration	CSI-IM resource Type		Periodic
	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 3
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
reportQuantity			cri-RI-PMI-CQI (Note 1)
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	5/0
aperiodicTriggeringOffset			Not configured
Codebook configuration			Not configured
Physical channel for CSI report			PUCCH
CQI/RI delay		ms	8
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-4, TBS.4-1
Note 1: The bitwidth of PMI for UCI on PUCCH in a case 1-port CSI-RS is configured as channel measurement resource is given in [10], section 6.3.1.1.2.			

6.2.3.1.1.3 Minimum requirement for periodic CQI reporting with Table 4

For the parameters specified in Table 6.2.3.1.1.3-1, 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, and if the reported median CQI is not the highest CQI index, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.3.1.1.3-1: CQI reporting test parameters

Parameter		Unit	Test 1	
Bandwidth		MHz	10	
Duplex Mode			FDD	
Subcarrier spacing		kHz	15	
SNR		dB	25	26
Propagation channel			AWGN	
Antenna configuration			2×4 with static channel specified in Annex B.1	
Beamforming Model			As specified in Annex B.4.1	
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (*X*)		4	
	CDM Type		FD-CDM2	
	Density (ρ)		1	
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4	
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9	

	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3,(6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1
CSI-IM configuration	CSI-IM resource Type		Periodic
	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 4
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
Csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	5/0
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-5, TBS.5-1

6.2.3.1.2 CQI reporting under fading conditions

6.2.3.1.2.1 Minimum requirement for wideband CQI reporting

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

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

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

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α% of the time where α% is specified in Table 6.2.3.1.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, where γ is specified in Table 6.2.3.1.2.1-2;

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

Table 6.2.3.1.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Subcarrier spacing		kHz	15			
Duplex Mode			FDD			
SNR		dB	3	4	9	10
Propagation channel			TDLA30-5			
Antenna configuration			2×4			
Correlation configuration			XP High			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (*X*)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic			
	CSI-IM RE pattern		0			
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)			
	CSI-IM timeConfig periodicity and offset	slot	5/1			
ReportConfigType			Periodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Wideband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	8			
csi-ReportingBand			1111111			
CSI-Report periodicity and offset		slot	5/0			
aperiodicTriggeringOffset			Not configured			
Codebook configuration	Codebook Type		typeI-SinglePanel			
	Codebook Mode		1			
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured			
	CodebookSubsetRestriction		000001			
	RI Restriction		N/A			
Physical channel for CSI report			PUCCH			
CQI/RI/PMI delay		ms	8			
Maximum number of HARQ transmission			1			
Measurement channel			As specified in Table A.4-2, TBS.2-1			

Table 6.2.3.1.2.1-2: Minimum requirements

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

6.2.3.1.2.2 Minimum requirement for sub-band CQI reporting

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

The accuracy of sub-band channel CQI reporting under the frequency-selective fading conditions is determined by a double-sided percentile of the reported differential CQI offset level 0 per sub-band, and the relative increase of the throughput obtained when transmitting the transport format indicated by the corresponding reported sub-band CQI on a randomly selected sub-band among the sub-bands with the highest reported differential CQI offset level compared to the throughput when transmitting a fixed transport format according to the wideband CQI median on a randomly selected sub-band among all the sub-bands. To account for sensitivity of the input SNR the sub-band CQI reporting under frequency selective fading conditions is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

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

a) A sub-band differential CQI offset level of 0 shall be reported at least α% of the time but less than β% of the time for each sub-band, where α and β are specified in Table 6.2.3.1.2.2-2;

b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be $\geq \gamma$, where γ is specified in Table 6.2.3.1.2.2-2;

c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to 0.02.

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

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

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	10			
Subcarrier spacing		kHz	15			
Duplex Mode			FDD			
SNR		dB	5	6	11	12
Propagation channel			Two tap model specified in Annex B.2.4 with a=1, f_D = 5Hz, and τ_d=0.45μs			
Antenna configuration			2×4			
Correlation configuration			As per Annex B.1			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	5/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		2			
	CDM Type		FD-CDM2			

	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	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			Aperiodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Subband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
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			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-5

Table 6.2.3.1.2.2-2: Minimum requirements

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

6.2.3.1.2.3 Minimum requirement for wideband CQI reporting with inter-cell interference

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible based on inter-cell interference mitigation receiver.

For the parameters specified in Table 6.2.3.1.2.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following,

a) the ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index subject to an interference source with specified INR and that obtained when transmitting the transport

format indicated by each reported wideband CQI index subject to a white Gaussian noise source shall be ≥ γ where γ is specified in Table 6.2.3.1.2.3-2;

b) when transmitting the transport format indicated by each reported wideband CQI index subject to an interference source with specified INR, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

Table 6.2.3.1.2.3-1 Wideband CQI reporting test with inter-cell interference

Parameter			Unit	Test1	
				Cell 1	Cell 2
Bandwidth			MHz	10	10
Duplex Mode				FDD	FDD
Subcarrier spacing			kHz	15	15
SINR			dB	-2	-
Beamforming Model				As specified in Annex B.4.1	
Interference Model					As specified in B.6.2
ZP CSI-RS configuration		CSI-RS resource Type		Periodic	Periodic
		Number of CSI-RS ports (*X*)		4	4
		CDM Type		FD-CDM2	FD-CDM2
		Density (ρ)		1	1
		First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4	Row 5,4
		First OFDM symbol in the PRB used for CSI-RS (l_0)		9	9
		CSI-RS periodicity and offset	slot	5/1	Same as serving cell
NZP CSI-RS for CSI acquisition		CSI-RS resource Type		Periodic	Periodic
		Number of CSI-RS ports (*X*)		2	1
		CDM Type		FD-CDM2	noCDM
		Density (ρ)		1	1
		First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3(6, -)	Row 2(6, -)
		First OFDM symbol in the PRB used for CSI-RS (l_0)		13	13
		NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	Same as serving cell
CSI-IM configuration		CSI-IM resource Type		Periodic	Periodic
		CSI-IM RE pattern		0	0
		CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)	(6, 9)
		CSI-IM timeConfig periodicity and offset	slot	5/1	Same as serving cell
ReportConfigType				Periodic	Not configured
CQI-table				Table 2	Table 2
reportQuantity				cri-RI-PMI-CQI	Not configured
timeRestrictionForChannelMeasurements				Not configured	Not configured
timeRestrictionForInterferenceMeasurements				Not configured	Not configured
cqi-FormatIndicator				Wideband	Wideband
pmi-FormatIndicator				Wideband	Wideband
Sub-band Size			RB	8	-
Csi-ReportingBand				1111111	Not configured
CSI-Report periodicity and offset			slot	5/0	Not configured
aperiodicTriggeringOffset				Not configured	Not configured
Codebook configuration		Codebook Type		typeI-SinglePanel	typeI-SinglePanel
		Codebook Mode		1	1
		(CodebookConfig-N1,CodebookConfig-N2)		Not configured	Not configured
		CodebookSubsetRestriction		000001	Not configured
		RI Restriction		N/A	Not configured

Physical channel for CSI report		PUCCH	Not configured
CQI/RI/PMI delay	ms	8	Not configured
Maximum number of HARQ transmission		1	Not configured
Measurement channel		As specified in Table A.4-2, TBS.2-1	-
INR (Note 6)	dB	N/A	10.04
Propagation condition		TDLA30-5	AWGN
Antenna configuration		2×4	1×4
Correlation configuration		ULA Low	N/A

Note 1: The respective received power spectral density of each interfering cell relative to N_{oc}' is defined by its associated INR value as specified in clause B.6.1.
Note 2: Two cells are considered in which Cell 1 is the serving cell and Cell 2 is the interfering cell. Interfering cell is fully loaded.
Note 3: Both cells are time-synchronous.
Note 4: Static channel is used for the interference model. In case for white Gaussian noise model Cell 2 is not present.
Note 5: SINR corresponds to $\widehat{E}_s / N_{oc}'$ of Cell 1 as defined in clause 4.4.5.
Note 6: INR is defined in clause B.6.1.

Table 6.2.3.1.2.3-2: Minimum requirements

Parameters	Test 1
γ	2.0

6.2.3.2 TDD

6.2.3.2.1 CQI reporting definition under AWGN

6.2.3.2.1.1 Minimum requirement for CQI periodic reporting

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS38.214 [12]. The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

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

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90% of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.3.2.1.1-1: CQI reporting definition test

Parameter	Unit	Test 1		Test 2	
Bandwidth	MHz	40			
Subcarrier spacing	kHz	30			
Duplex Mode		TDD			
TDD UL-DL pattern		FR1.30-1			
SNR	dB	5	6	11	12
Propagation channel		AWGN			
Antenna configuration		2×4 with static channel specified in Annex B.1			

Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	CSI-IM RE pattern		0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)
	CSI-IM timeConfig periodicity and offset	slot	10/1
ReportConfigType			Periodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		010000
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-4

6.2.3.2.1.2 Minimum requirement for CQI periodic reporting with Table 3

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS38.214 [12]. The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.3.2.1.2-1, 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 10^{-5}, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 10^{-5}. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 10^{-5}, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 10^{-5}.

c) The reported CQI value according to the reference channel shall be ≥ 1.

Table 6.2.3.2.1.2-1: CQI reporting test parameters

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD UL-DL pattern			FR1.30-1
SNR		dB	-2 | -1
Propagation channel			AWGN
Antenna configuration			1×4 with static channel specified in Annex B.1
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		1
	CDM Type		No CDM
	Density (ρ)		3
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 1,(0,-)
	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 resource Type		Periodic
	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 3
reportQuantity			cri-RI-PMI-CQI (Note 1)
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
aperiodicTriggeringOffset			Not configured
Codebook configuration			Not configured
Physical channel for CSI report			PUCCH
CQI/RI delay		ms	9.5

Maximum number of HARQ transmission		1
Measurement channel		As specified in Table A.4-4, TBS.4-2
Note 1: The bitwidth of PMI for UCI on PUCCH in a case 1-port CSI-RS is configured as channel measurement resource is given in [10], section 6.3.1.1.2.		

6.2.3.2.1.3 Minimum requirement for CQI reporting for PCell on band with shared spectrum access

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] for PCell on band with shared spectrum access. For each Downlink Transmission Duration the transmission power offset is randomly chosen between [0, +6] dB and 2 sets of CQI reports are obtained for each transmission power offset. 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 each power offset. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.3.2.1.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) For each transmission power offset 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) For each transmission power offset, 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. For each transmission power offset, 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.

c) The absolute difference in median CQI for each of transmission power offset shall be ≥ 2.

Table 6.2.3.2.1.3-1: CQI reporting test parameters for PCell on band with shared spectrum access

Parameter		Unit	Test 1	
Bandwidth		MHz	20	
Subcarrier spacing		kHz	30	
Duplex Mode			TDD	
Downlink Transmission Model			As specified in Annex B.5	
Downlink Transmission Model Parameters	Downlink period		5	
	LBT failure probability (p_{LBT})		0.25	
	Downlink transmission duration values set		{4,6,7}	
	Occupied OFDM symbols in slot other than the last slot of the downlink duration		14	
	Occupied OFDM symbols in the last slot set of the downlink duration		14	
TDD UL-DL pattern			FR1.30-7	
SNR		dB	5	6
$\widehat{E_s}$ for power offset 1		dBm/Hz	-112	
$\widehat{E_s}$ for power offset 2		dBm/Hz	-106	
Propagation channel			AWGN	
Antenna configuration			2×4 with static channel specified in Annex B.1	
Beamforming Model			As specified in Annex B.4.1	
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic	
	Number of CSI-RS ports (*X*)		4	
	CDM Type		FD-CDM2	
	Density (ρ)		1	
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4	

	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		Row 3, 6
	First OFDM symbol in the PRB used for CSI-RS (l_0)		3
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			configured
timeRestrictionForInterferenceMeasurements			configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			7
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggrtSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		010000
	RI Restriction		N/A
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-8

6.2.3.2.1.4 Minimum requirement for CQI periodic reporting with Table 4

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS38.214 [12]. The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.3.2.1.4-1, 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, and if the reported median CQI is not the highest CQI index, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.3.2.1.4-1: CQI reporting definition test

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD UL-DL pattern			FR1.30-1
SNR		dB	25 | 26
Propagation channel			AWGN
Antenna configuration			2×4 with static channel specified in Annex B.1
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	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 4
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
aperiodicTriggeringOffset			Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		000001
	RI Restriction		N/A

Physical channel for CSI report		PUCCH
CQI/RI/PMI delay	ms	9.5
Maximum number of HARQ transmission		1
Measurement channel		As specified in Table A.4-5, TBS.5-2

6.2.3.2.2 CQI reporting under fading conditions

6.2.3.2.2.1 Minimum requirement for wideband CQI reporting

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

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

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

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α% of the time where α% is specified in Table 6.2.3.2.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be $\geq \gamma$, where γ is specified in Table 6.2.3.2.2.1-2;

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

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

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

Table6.2.3.2.2.1-2: Minimum requirements

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

6.2.3.2.2.2 Minimum requirement for sub-band CQI reporting

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

The accuracy of sub-band channel CQI reporting under the frequency-selective fading conditions is determined by a double-sided percentile of the reported differential CQI offset level 0 per sub-band, and the relative increase of the throughput obtained when transmitting the transport format indicated by the corresponding reported sub-band CQI on a randomly selected sub-band among the sub-bands with the highest reported differential CQI offset level compared to the throughput when transmitting a fixed transport format according to the wideband CQI median on a randomly selected sub-band among all the sub-bands. To account for sensitivity of the input SNR the sub-band CQI reporting under frequency selective fading conditions is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.3.2.2.2-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A sub-band differential CQI offset level of 0 shall be reported at least α% of the time but less than β% of the time for each sub-band, where α and β are specified in Table 6.2.3.2.2.2-2;

b) The ratio of the throughput obtained when transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level and that obtained when

transmitting the transport format indicated by the reported wideband CQI median on a randomly selected sub-band among all the sub-bands shall be ≥ γ, where γ is specified in Table 6.2.3.2.2.2-2;

c) When transmitting the corresponding transport format on a randomly selected sub-band among the sub-bands with the highest differential CQI offset level, the average BLER for the indicated transport format shall be greater than or equal to 0.02.

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

Table 6.2.3.2.2.2-1: Sub-band CQI reporting test under frequency-selective fading conditions

Parameter		Unit	Test 1		Test 2	
Bandwidth		MHz	40			
Subcarrier spacing		kHz	30			
Duplex Mode			TDD			
TDD UL-DL pattern			FR1.30-1			
SNR		dB	5	6	11	12
Propagation channel			Two tap model specified in Annex B.2.4 with a=1, f_D = 5Hz, and τ_d=0.1125μs			
Antenna configuration			2×4			
Correlation configuration			As per Annex B.1			
Beamforming Model			As specified in Annex B.4.1			
ZP CSI-RS configuration	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		4			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4			
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9			
	CSI-RS periodicity and offset	slot	10/1			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic			
	Number of CSI-RS ports (X)		2			
	CDM Type		FD-CDM2			
	Density (ρ)		1			
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic			
	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			Aperiodic			
CQI-table			Table 2			
reportQuantity			cri-RI-PMI-CQI			
timeRestrictionForChannelMeasurements			Not configured			
timeRestrictionForInterferenceMeasurements			Not configured			
cqi-FormatIndicator			Subband			
pmi-FormatIndicator			Wideband			
Sub-band Size		RB	16			
csi-ReportingBand			1111111			
CSI-Report periodicity and offset		slot	Not configured			
Aperiodic Report Slot Offset			8			
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0			
reportTriggerSize			1			

CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
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			PUSCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-6

Table 6.2.3.2.2.2-2: Minimum requirements

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

6.2.3.2.2.3 Minimum requirement for wideband CQI reporting with inter-cell interference

The purpose of the requirements is to verify that the UE is tracking the channel variations and selecting the largest transport format possible based on inter-cell interference mitigation receiver.

For the parameters specified in Table 6.2.3.2.2.3-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following,

a) the ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index subject to an interference source with specified INR and that obtained when transmitting the transport format indicated by each reported wideband CQI index subject to a white Gaussian noise source shall be ≥ γ where γ is specified in Table 6.2.3.2.2.3-2;

b) when transmitting the transport format indicated by each reported wideband CQI index subject to an interference source with specified INR, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

Table 6.2.3.2.2.3-1: Wideband CQI reporting test with inter-cell interference (TDD)

Parameter		Unit	Test 1	
			Cell 1	Cell 2
Bandwidth		MHz	40	40
Duplex Mode			TDD	TDD
Subcarrier spacing		kHz	30	30
TDD UL-DL pattern			FR1.30-1	FR1.30-1
SINR		dB	-2	-
Beamforming Model			As specified in Annex B.4.1	
Interference Model				As specified in B.6.2
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic
	Number of CSI-RS ports (*X*)		2	1
	CDM Type		FD-CDM2	noCDM
	Density (ρ)		1	1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 3(8)	Row 2(8)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9	9
	CSI-RS	slot	10/1	Same as serving cell

	periodicity and offset			
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic	Periodic
	Number of CSI-RS ports (*X*)		2	1
	CDM Type		FD-CDM2	noCDM
	Density (ρ)		1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3(6, -)	Row 2(6, -)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13	13
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	Same as serving cell
CSI-IM configuration	CSI-IM resource Type		Periodic	Periodic
	CSI-IM RE pattern		0	0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)	(6,9)
	CSI-IM timeConfig periodicity and offset	slot	10/1	Same as serving cell
ReportConfigType			Periodic	Not configured
CQI-table			Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	Not configured
timeRestrictionForChannelMeasurements			Not configured	Not configured
timeRestrictionForInterferenceMeasurements			Not configured	Not configured
cqi-FormatIndicator			Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband
Sub-band Size		RB	16	
Csi-ReportingBand			1111111	Not configured
CSI-Report periodicity and offset		slot	10/9	Not configured
aperiodicTriggeringOffset			Not configured	Not configured
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured	Not configured
	CodebookSubsetRestriction		000001	Not configured
	RI Restriction		N/A	Not configured
Physical channel for CSI report			PUCCH	Not configured
CQI/RI/PMI delay		ms	9.5	Not configured
Maximum number of HARQ transmission			1	Not configured
Measurement channel			As specified in Table A.4-2, TBS.2-3	
INR		dB	N/A	10.04
Propagation condition			TDLA30-5	AWGN
Antenna configuration			2×4	1×4
Correlation configuration			ULA Low	N/A

Note 1: The respective received power spectral density of each interfering cell relative to N_{oc}' is defined by its associated INR value as specified in clause B.6.1.
Note 2: Two cells are considered in which Cell 1 is the serving cell and Cell 2 is the interfering cell. Interfering cell is fully loaded.
Note 3: Both cells are time-synchronous.
Note 4: Static channel is used for the interference model. In case for white Gaussian noise model Cell 2 is not present.
Note 5: SINR corresponds to $\hat{E}_s / N_{oc}'$ of Cell 1 as defined in clause 4.4.5.
Note 6: NR corresponds to Cell 2 is defined in clause B.6.1.

Table 6.2.3.2.2.3-2: Minimum requirement (TDD)

Parameters	Test 1
γ	2.0

6.2A Reporting of Channel Quality Indicator (CQI) for CA

6.2A.1 General

This clause includes the requirements for the reporting of channel quality indicator (CQI) with the UE configured for CA. The purpose is to verify that the CQI is correctly reported in accordance with the CQI definition given in TS 38.214 [12] for each CC with multiple cells configured for periodic reporting.

6.2A.2 1RX requirements

(Void)

6.2A.3 2RX requirements

6.2A.3.1 CQI reporting definition under AWGN conditions

6.2A.3.1.1 Minimum requirement for periodic CQI reporting

For each CA CQI reporting test defined in Table 6.2A.3.1.1-6, the test requirements and the test parameters are defined as below.

For each CC, the test parameters are specified in Table 6.2A.3.1.1-1. The additional parameters specified in Table 6.2A.3.1.1-2 are applicable for tests on FDD CC. The additional parameters specified in Table 6.2A.3.1.1-3 are applicable for tests on TDD CC.

For CA with 2 DL CC, for the SNR configuration specified in Table 6.2A.3.1.1-4, and using the downlink physical channels specified in Annex C.3.1 on each CC, the difference between the wideband CQI indices of PCell and SCell reported shall be such that

$$\text{wideband CQI}_{\text{PCell}} - \text{wideband CQI}_{\text{SCell}} \geq 2$$

for more than 90% of the time.

For CA with 3 or more DL CC, for the SNR configuration specified in Table 6.2A.3.1.1-5, and using the downlink physical channels specified in Annex C.3.1 on each cell, the difference between the wideband CQI indices of PCell and SCell1 reported, and the difference between the wideband CQI indices of SCell1 and SCell2, 3… reported shall be such that

$$\text{wideband CQI}_{\text{PCell}} - \text{wideband CQI}_{\text{SCell1}} \geq 2$$

$$\text{wideband CQI}_{\text{SCell1}} - \text{wideband CQI}_{\text{SCell2, 3...}} \geq 2$$

for more than 90% of the time.

Table 6.2A.3.1.1-1: CA CQI reporting test parameters for FDD and TDD CC

Parameter		Unit	Value
Propagation channel			AWGN
Antenna configuration			1×2 with static channel specified in Annex B.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5, 4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		1
	CDM Type		No CDM
	Density (ρ)		1

	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 2, 6
	First OFDM symbol in the PRB used for CSI-RS (l_0)		13
CSI-IM configuration	CSI-IM resource Type		Periodic
	CSI-IM RE pattern		0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)
ReportConfigType			Periodic
CQI-table			Table 2
reportQuantity			cri-RI-PMI-CQI (Note 1)
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Csi-ReportingBand			1111111
aperiodicTriggeringOffset			Not configured
Codebook configuration			Not configured
Physical channel for CSI report			PUCCH
Maximum number of HARQ transmission			1
Measurement channel			Derived as per section 5.1.3.2 of TS 38.214 [12]
Note 1: The bitwidth of PMI for UCI on PUCCH in a case 1-port CSI-RS is configured as channel measurement resource is given in [10], section 6.3.1.1.2.			

Table 6.2A.3.1.1-2: Additional test parameters for FDD CC

Parameter		Unit	Value
Duplex Mode			FDD
Subcarrier spacing		kHz	15
ZP CSI-RS configuration	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1
			10/1 if configured as SCell with TDD PCell (Test1)
CSI-IM configuration	CSI-IM timeConfig periodicity and offset	slot	5/1
CSI-Report periodicity and offset		slot	5/0 if configured as PCell
			5/1 if configured as SCell with FDD PCell (Test2)
			20/18 if configured as SCell with TDD PCell (Test1)
CQI/RI/PMI delay		ms	8 if configured as PCell
			12 if configured as SCell
Sub-band Size		RB	8 for 5MHz and 10MHz, 16 for 15MHz, 20MHz and 25MHz, 32 for 30MHz, 35MHz, 40MHz, 45MHz and 50MHz
Note 1: NZP CSI-RS periodicity/offset slots are based on the carrier SCS and CSI reporting periodicity/offset slots are based on the PCell SCS.			

Table 6.2A.3.1.1-3: Additional test parameters for TDD CC

Parameter		Unit	Value
Duplex Mode			TDD
Subcarrier spacing		kHz	30
TDD UL-DL pattern			FR1.30-1
ZP CSI-RS configuration	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1 if configured as SCell with FDD PCell (Test1)
			20/1

CSI-IM configuration	CSI-IM timeConfig periodicity and offset	slot	10/1
CSI-Report periodicity and offset		slot	20/19 if configured as PCell
			20/18 if configured as SCell with TDD PCell (Test3)
			5/1 if configured as SCell with FDD PCell (Test1)
CQI/RI/PMI delay		ms	14.5 if configured as PCell
			12.5 if configured as SCell with TDD PCell (Test3)
			9.5 if configured as SCell with FDD PCell (Test1)
Sub-band Size		RB	8 for 10MHz, 15MHz, 20MHz and 25MHz, 16 for 30MHz, 40MHz and 50MHz, 32 for 60MHz, 80MHz, 90MHz and 100MHz
Note 1: NZP CSI-RS periodicity/offset slots are based on the carrier SCS and CSI reporting periodicity/offset slots are based on the PCell SCS.			

Table 6.2A.3.1.1-4: SNR configurations for 2 DL CA

Parameter	PCell	SCell
SNR (dB)	10.0	4.0

Table 6.2A.3.1.1-5: SNR configurations for 3 or more DL CA

Parameter	PCell	SCell1	SCell2, 3…
SNR (dB)	12.0	6.0	0.0

Table 6.2A.3.1.1-6: List of CA CQI reporting test

Test number	CA duplex mode and SCS combination
1	FDD 15 kHz + TDD 30 kHz
2	FDD 15 kHz + FDD 15 kHz
3	TDD 30 kHz + TDD 30 kHz
Note 1: The applicability of requirements for different CA duplex modes, SCSs, is defined in 6.1.1.5.1. Note 2: The applicability of requirements for different CA configurations and bandwidth combination sets is defined in 6.1.1.5.2.	

6.2A.3.1.2 Minimum requirement for CQI reporting for SCell on band with shared spectrum access

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] for Scell on band with shared spectrum access. For each downlink transmission duration the transmission power offset is randomly chosen between [0, +6] dB and 2 sets of CQI reports are obtained for each transmission power offset. 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 each power offset. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2A.3.1.2-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) For each transmission power offset 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) For each transmission power offset, 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. For each transmission power offset, 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.

c) The absolute difference in median CQI for each of transmission power offset shall be ≥ 2.

The test parameters for configuring the PCell are specified in Table 6.2A.3.1.2-2, but requirements are only applicable to SCell on band with shared spectrum access. CSI reporting configuration parameters for SCell are configured on PCell and CSI reports are transmitted on PCell.

Table 6.2A.3.1.2-1: CQI reporting test parameters for SCell on band with shared spectrum access

Parameter		Unit	Test 1	
Bandwidth		MHz	20	
Subcarrier spacing		kHz	30	
Duplex Mode			TDD	
Downlink Transmission Model			As specified in Annex B.5	
Downlink Transmission Model Parameters	Downlink period	ms	5	
	LBT failure probability (p_{LBT})		0.25	
	Downlink transmission duration values set	slot	{4,6,7}	
	Occupied OFDM symbols in slot other than the last slot of the downlink duration	symbols	14	
	Occupied OFDM symbols in the last slot of the downlink duration	symbols	14	
TDD UL-DL pattern			FR1.30-7	
SNR		dB	8	9
$\widehat{E_s}$ for power offset 1		dBm/Hz	-112	
$\widehat{E_s}$ for power offset 2		dBm/Hz	-106	
Propagation channel			AWGN	
Antenna configuration			2×2 with static channel specified in Annex B.1	
Beamforming Model			As specified in Annex B.4.1	
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	
	Number of CSI-RS ports (*X*)		4	
	CDM Type		FD-CDM2	
	Density (ρ)		1	
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4	
	First OFDM symbol in the PRB used for CSI-RS (l_0)		9	
	CSI-RS periodicity and offset	slot	10/1	
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic	
	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)		3	
	NZP CSI-RS-timeConfig periodicity and offset	slot	Not configured	
	aperiodicTriggeringOffset		0	
CSI-IM configuration	CSI-IM resource Type		Aperiodic	
	CSI-IM RE pattern		0	
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)	
	CSI-IM timeConfig periodicity and offset	slot	Not configured	
Codebook configuration	Codebook Type		typeI-SinglePanel	
	Codebook Mode		1	
	(CodebookConfig-N1,CodebookConfig-N2)		Not configured	

	CodebookSubsetRestriction		010000
	RI Restriction		N/A
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-8

Table 6.2A.3.1.2-2: Configuration parameters for PCell

Parameter	Unit	Test 1
Bandwidth	MHz	20
Subcarrier spacing	kHz	30
Duplex Mode		TDD
TDD UL-DL pattern		FR1.30-1
Propagation channel		AWGN
Antenna configuration		2×2 with static channel specified in Annex B.1
Beamforming Model		As specified in Annex B.4.1
ReportConfigType		Aperiodic
CQI-table		Table 2
reportQuantity		cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements		configured
timeRestrictionForInterferenceMeasurements		configured
cqi-FormatIndicator		Wideband
pmi-FormatIndicator		Wideband
Sub-band Size	RB	8
Csi-ReportingBand		1111111
CSI-Report periodicity and offset	slot	Not configured
aperiodicTriggeringOffset		7
CSI request		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize		1
CSI-AperiodicTriggerStateList		One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Physical channel for CSI report		PUSCH

6.2A.4 4RX requirements

6.2A.4.1 CQI reporting definition under AWGN conditions

6.2A.4.1.1 Minimum requirement for CQI reporting for SCell on band with shared spectrum access

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] for Scell on band with shared spectrum access. For each downlink transmission duration the transmission power offset is randomly chosen between [0, +6] dB and 2 sets of CQI reports are obtained for each transmission power offset. 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 each power offset. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2A.4.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) For each transmission power offset 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) For each transmission power offset, 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. For each transmission power offset, 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.

c) The absolute difference in median CQI for each of transmission power offset shall be ≥ 2.

The test parameters for configuring the PCell are specified in Table 6.2A.4.1.1-2, but requirements are only applicable to SCell on band with shared spectrum access. CSI reporting configuration parameters for SCell are configured on PCell and CSI reports are transmitted on PCell.

Table 6.2A.4.1.1-1: CQI reporting test parameters for SCell on band with shared spectrum access

Parameter			Unit	Test 1
Bandwidth			MHz	20
Subcarrier spacing			kHz	30
Duplex Mode				TDD
Downlink Transmission Model				As specified in Annex B.5
Downlink Transmission Model Parameters		Downlink period	ms	5
		LBT failure probability (p_{LBT})		0.25
		Downlink transmission duration values set	slot	{4,6,7}
		Occupied OFDM symbols in slot other than the last slot of the downlink duration	symbols	14
		Occupied OFDM symbols in the last slot of the downlink duration	symbols	14
TDD UL-DL pattern				FR1.30-7
SNR			dB	5 | 6
$\widehat{E_s}$ for power offset 1			dBm/Hz	-112
$\widehat{E_s}$ for power offset 2			dBm/Hz	-106
Propagation channel				AWGN
Antenna configuration				2×4 with static channel specified in Annex B.1
Beamforming Model				As specified in Annex B.4.1
ZP CSI-RS configuration		CSI-RS resource Type		Periodic
		Number of CSI-RS ports (*X*)		4
		CDM Type		FD-CDM2
		Density (ρ)		1
		First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,4
		First OFDM symbol in the PRB used for CSI-RS (l_0)		9
		CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition		CSI-RS resource Type		Aperiodic
		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)		3
		NZP CSI-RS-timeConfig periodicity and offset	slot	Not configured
		aperiodicTriggeringOffset		0
CSI-IM configuration		CSI-IM resource Type		Aperiodic
		CSI-IM RE pattern		0
		CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4, 9)
		CSI-IM timeConfig periodicity and offset	slot	Not configured
Codebook configuration		Codebook Type		typeI-SinglePanel
		Codebook Mode		1

	(CodebookConfig-N1,CodebookConfig-N2)		Not configured
	CodebookSubsetRestriction		010000
	RI Restriction		N/A
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-2, TBS.2-8

Table 6.2A.4.1.1-2: Configuration parameters for PCell

Parameter	Unit	Test 1
Bandwidth	MHz	20
Subcarrier spacing	kHz	30
Duplex Mode		TDD
TDD UL-DL pattern		FR1.30-1
Propagation channel		AWGN
Antenna configuration		2×4 with static channel specified in Annex B.1
Beamforming Model		As specified in Annex B.4.1
ReportConfigType		Aperiodic
CQI-table		Table 2
reportQuantity		cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements		configured
timeRestrictionForInterferenceMeasurements		configured
cqi-FormatIndicator		Wideband
pmi-FormatIndicator		Wideband
Sub-band Size	RB	8
Csi-ReportingBand		1111111
CSI-Report periodicity and offset	slot	Not configured
aperiodicTriggeringOffset		7
CSI request		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize		1
CSI-AperiodicTriggerStateList		One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Physical channel for CSI report		PUSCH

6.3 Reporting of Precoding Matrix Indicator (PMI)

The minimum performance requirements of PMI reporting are defined based on the precoding gain, expressed as the relative increase in throughput when the transmitter is configured according to the UE reported PMI compared to the case when the transmitter is using random precoding, respectively. When the transmitter uses random precoding, for each PDSCH allocation a precoder is randomly generated with equal probability of each applicable i_1 and i_2 combination and applied to the PDSCH. A fixed transport format (FRC) is configured for all requirements.

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

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

In the definition of γ, for 4TX, 8TX, 16TX, and 32TX PMI requirements, t_{ue} is 90 % of the maximum throughput obtained at SNR_{ue} using the precoders configured according to the UE reports, and t_{rnd} is the throughput measured at SNR_{ue} with random precoding.

The requirements for transmission scheme 1 with higher layer parameter *codebookType* set to 'typeII' or 'typeII-r16' are specified in terms of the ratio:

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

In the definition of γ, for 16TX PMI requirements, $t_{ue,follow1,follow2}$ is 90 % of the maximum throughput obtained at $SNR_{follow1,follow2}$ using the precoders configured according to the UE reports, and $t_{rnd1,rnd2}$ is the throughput measured at $SNR_{follow1,follow2}$ with random precoding.

6.3.1 1RX requirements

6.3.1.1 FDD

6.3.1.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook for RedCap

For the parameters specified in Table 6.3.1.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.1.1.1-2.

Table 6.3.1.1.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High ULA 4 x 1
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9)
	CSI-RS periodicity 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)		Row 4, (0)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)
	CSI-RS periodicity and offset		Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured

ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			3
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6
Maximum number of HARQ transmission			4
Measurement channel (Note 4)			R.PDSCH.1-6.1 FDD R.PDSCH.1-3.1 HD-FDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-3), this reported PMI cannot be applied at the gNB downlink before slot#(n+3). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.1.3. Note 4: Applied reference channel depends on the supported operation mode: FDD or HD-FDD			

Table 6.3.1.1.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.1.2 TDD

6.3.1.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook for RedCap

For the parameters specified in Table 6.3.1.2.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.1.2.1-2.

Table 6.3.1.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	20
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configuration			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High ULA 4 x 1
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		Row 4, (0)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)
	CSI-RS periodicity and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1

CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.4 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot #n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.1.3.			

Table 6.3.2.2.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.2 2RX requirements

6.3.2.1 FDD

6.3.2.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.2.1.1-1: Test parameters (single layer)

Parameter	Unit	Test 1
Bandwidth	MHz	10
Subcarrier spacing	kHz	15
Duplex Mode		FDD
Propagation channel		TDLA30-5
Antenna configuration		High XP 4 x 2 (N1,N2) = (2,1)

Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9)
	CSI-RS periodicity 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)		Row 4, (0)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)
	CSI-RS periodicity and offset		Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			4 for FDD 3 for HD-FDD
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6
Maximum number of HARQ transmission			4

Measurement channel (Note 4)		R.PDSCH.1-6.1 FDD R.PDSCH.1-3.1 HD-FDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding		Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-3), this reported PMI cannot be applied at the gNB downlink before slot#(n+3). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3. Note 4: Applied reference channel depends on the supported operation mode: FDD or HD-FDD.		

Table 6.3.2.1.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.2.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High XP 8 x 2 (N1,N2) = (4,1)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		(5)
	CSI-RS periodicity and offset	slot	Not configured

	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		0x FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.2
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.2.1.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

6.3.2.1.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLC300-5
Antenna configuration			High XP 16 x 2 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured

cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Subband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubset Restriction		0x FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with i1 wideband granularity and i2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.2.1.3-2: Minimum requirement

Parameter	Test 1
γ	2.5

6.3.2.1.4 Single PMI with 32TX TypeI-SinglePanel Codebook

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

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

Parameter	Unit	Test 1
Bandwidth	MHz	10
Subcarrier spacing	kHz	15
Duplex Mode		FDD

Propagation channel			TDLA30-5
Antenna configuration			High XP 32 x 2 (N1,N2) = (4,4)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		32
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 17, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, 12)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,4)

	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.2.1.4-2: Minimum requirement

Parameter	Test 1
γ	5.0

6.3.2.1.5 Multiple PMI with 16TX TypeII Codebook

For the parameters specified in Table 6.3.2.1.5-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.5-2.

Table 6.3.2.1.5-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			XP Medium 16 x 2 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured

	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Subband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeII
	L (*numberOfBeams*)		2
	N_{PSK} (*phaseAlphabetSize*)		8
	subbandAmplitude		True
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x 7FF FFFF FFFF FFFF FFFF
	RI Restriction (typeII-RI-Restriction)		10
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3

PDSCH & PDSCH DMRS Precoding configuration for random Precoding		Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with i_1 wideband granularity and i_2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.2.1.3-1. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test.		

Table 6.3.2.1.5-2: Minimum requirement

Parameter	Test 1
γ	1.9

6.3.2.1.6 Multiple PMI with 16TX Enhanced Type II Codebook

For the parameters specified in Table 6.3.2.1.6-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.6-2.

Table 6.3.2.1.6-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			XP Medium 16 x 2 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)

	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Not configured
Sub-band Size		RB	4
csi-ReportingBand			1111111111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeII-r16
	paramCombination-r16		6 (L =4, p_v =1/2, β=1/2)
	R*(numberOfPMISubbandsPerCQISubband-r16)*		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x 7FF FFFF FFFF FFFF FFFF
	RI Restriction (typeII-RI-Restriction-r16)		0010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with i_1 wideband granularity and i_2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. The random precoder			

	generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.2.1.3-1.
Note 2:	If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4).
Note 3:	Randomization of the dual-cluster beam directions shall be used as specified in AnnexB.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test.

Table 6.3.2.1.6-2: Minimum requirement

Parameter	Test 1
γ	2.2

6.3.2.1.7 Single PMI with 8 ports TypeI-SinglePanel Codebook for Single-DCI based transmission scheme

For the parameters specified in Table 6.3.2.1.7-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.1.7-2.

Table 6.3.2.1.7-1: Test parameters (dual-layer)

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	
	CORESETPoolIndex		0	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density		3	
	CSI-RS periodicity	Slots	20	
	CSI-RS offset	Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
	QCL info		TCI state #0	
Duplex mode			FDD	
Bandwidth		MHz	10	
Subcarrier spacing		kHz	15	
Active DL BWP index			1	
Propagation channel			TDLA30-10	
Antenna configuration per TRxP			High XP 8 x 2 (N1,N2) = (4,1)	
Beamforming Model			As specified in Annex B.4.1 (Note 4)	
PDSCH configuration	Mapping type		Type A	
	k0		0	
	Starting symbol (S)		2	
	Length (L)		12	
	PRB bundling type		Static	
	PRB bundling size		2	
	Resource allocation type		Type 1	
	RBG size		Config2	
	VRB-to-PRB mapping type		Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size		N/A	

PDSCH DMRS configuration	Antenna port indexes			1000	1002
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Full-overlapping	
Timing offset of the second TRxP from the first TRxP			us	0	
Frequency offset of the second TRxP from the first TRxP			Hz	0	
Number of HARQ Processes				4	
The number of slots between PDSCH and corresponding HARQ-ACK information				2	
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 ID			Resource #9	Resource #10
	CSI-RS resource Type			Aperiodic	Aperiodic
	Number of CSI-RS ports (*X*)			8	8
	CDM Type			CDM4 (FD2, TD2)	CDM4 (FD2, TD2)
	Density (ρ)			1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)			Row 8, (4,6)	Row 8, (4,6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)			(5)	(9)
	CSI-RS periodicity and offset		slot	Not configured	Not configured
	aperiodicTriggeringOffset			0	0
CSI-IM configuration	CSI-IM resource Type			Aperiodic	
	CSI-IM RE pattern			Pattern 0	
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})			(4,9)	
	CSI-IM timeConfig periodicity and offset		slot	Not configured	
ReportConfigType				Aperiodic	
CQI-table				Table 1	
reportQuantity				cri-RI-PMI-CQI	
csi-ReportMode				Mode1	
numberOfSingleTRP-CSI-Mode1				$X = 0$	
CMR pairing and grouping				CMR group #1: {NZP CSI-RS resource #9}, with $K_1 = 1$ CMR group #2: {NZP CSI-RS resource #10}, with $K_2 = 1$	

			CMR paring: {NZP CSI-RS resource #9, NZP CSI-RS resource #10}
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	CodebookType		typeI-SinglePanel
	CodebookMode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		0x FFFF
	RI Restriction		00000001 (1 MIMO layer per TRxP)
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.4
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2) Note 2: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 3: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 4: Randomization of the principle beam direction per TRxP shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.2.1.7-2: Minimum requirement

Parameter	Test 1
γ	1.6

6.3.2.2 TDD

6.3.2.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.2.2.1-1: Test parameters (single layer)

Parameter	Unit	Test 1
Bandwidth	MHz	40
Subcarrier spacing	kHz	30
Duplex Mode		TDD

TDD DL-UL configuration			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 2 (N1,N2) = (2,1)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		Row 4, (0)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)
	CSI-RS periodicity and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		11111111

	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.1 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot #n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.2.2.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.2.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 8 x 2 (N1,N2) = (4,1)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		(5)
	CSI-RS periodicity and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForIChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		0x FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.2 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity

Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination.

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

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

Table 6.3.2.2.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

6.3.2.2.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLC300-5
Antenna configuration			High XP 16 x 2 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0

	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForIChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Subband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubset Restriction		0x FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.3 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with i1 wideband granularity and i2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.2.2.3-2: Minimum requirement

Parameter	Test 1
γ	2.5

6.3.2.2.4 Single PMI with 32TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 32 x 2 (N1,N2) = (4,4)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		32
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 17, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, 12)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForIChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8

CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,4)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.3 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.2.2.4-2: Minimum requirement

Parameter	Test 1
γ	5.0

6.3.2.2.5 Multiple PMI with 16TX TypeII Codebook

For the parameters specified in Table 6.3.2.2.5-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.5-2.

Table 6.3.2.2.5-1: Test parameters (dual-layer)

Parameter	Unit	Test 1
Bandwidth	MHz	40
Subcarrier spacing	kHz	30
Duplex Mode		TDD
TDD DL-UL configurations		FR1.30-1 as specified in Annex A
Propagation channel		TDLA30-5

Antenna configuration			XP Medium 16 x 2 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForIChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Subband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeII
	L (*numberOfBeams*)		2
	N_{PSK} (*phaseAlphabetSize*)		8
	subbandAmplitude		True

	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x 7FF FFFF FFFF FFFF FFFF
	RI Restriction (typeII-RI-Restriction)		10
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.3 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with i_1 wideband granularity and i_2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.2.2.3-1. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test.			

Table 6.3.2.2.5-2: Minimum requirement

Parameter	Test 1
□	1.9

6.3.2.2.6 Multiple PMI with 16Tx Enhanced Type II Codebook

For the parameters specified in Table 6.3.2.2.6-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.6-2.

Table 6.3.2.2.6-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			XP Medium 16 x 2 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)

	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForIChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Not configured
Sub-band Size		RB	8
csi-ReportingBand			11111111111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeII-r16
	paramCombination-r16		6 (L =4, p_v =1/2, β=1/2)
	R*(numberOfPMISubbandsPerCQISubband-r16)*		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x 7FF FFFF FFFF FFFF FFFF
	RI Restriction (typeII-RI-Restriction-r16)		0010
Physical channel for CSI report			PUSCH

CQI/RI/PMI delay	ms	6.5
Maximum number of HARQ transmission		4
Measurement channel		R.PDSCH.2-8.3 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding		Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with i_1 wideband granularity and i_2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.2.2.3-1. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test.		

Table 6.3.2.2.6-2: Minimum requirement

Parameter	Test 1
γ	2.2

6.3.2.2.7 Single PMI with 4TX TypeI-SinglePanel Codebook for RedCap

For the parameters specified in Table 6.3.2.2.7-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.7-2.

Table 6.3.2.2.7-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	20
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configuration			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 2 (N1,N2) = (2,1)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		Row 4, (0)

	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)
	CSI-RS periodicity and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.4 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity

Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination.

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

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

Table 6.3.2.2.7-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.2.2.8 Single PMI with 8 ports TypeI-SinglePanel Codebook for Single-DCI based transmission scheme

For the parameters specified in Table 6.3.2.2.8-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.2.2.8-2.

Table 6.3.2.2.8-1: Test parameters (dual-layer)

Parameter			Unit	Value	
				TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration	TCI state			TCI State #1	
	CORESETPoolIndex			0	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	40	
	CSI-RS offset		Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
Duplex mode				TDD	
Bandwidth			MHz	40	
Subcarrier spacing			kHz	30	
TDD DL-UL configurations				FR1.30-1 as specified in Annex A	
Active DL BWP index				1	
Propagation channel				TDLA30-10	
Antenna configuration per TRxP				High XP 8 x 2 $(N1,N2) = (4,1)$	
Beamforming Model				As specified in Annex B.4.1 (Note 4)	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 1	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000	1002
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS	N/A

				for tracking' configuration	
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Full-overlapping	
Timing offset of the second TRxP from the first TRxP			us	0	
Frequency offset of the second TRxP from the first TRxP			Hz	0	
Number of HARQ Processes				8	
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
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 ID			Resource #9	Resource #10
	CSI-RS resource Type			Aperiodic	Aperiodic
	Number of CSI-RS ports (*X*)			8	8
	CDM Type			CDM4 (FD2, TD2)	CDM4 (FD2, TD2)
	Density (ρ)			1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)			Row 8, (4,6)	Row 8, (4,6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)			(5)	(9)
	CSI-RS periodicity and offset		slot	Not configured	Not configured
	aperiodicTriggeringOffset			0	0
CSI-IM configuration	CSI-IM resource Type			Aperiodic	
	CSI-IM RE pattern			Pattern 0	
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})			(4,9)	
	CSI-IM timeConfig periodicity and offset		slot	Not configured	
ReportConfigType				Aperiodic	
CQI-table				Table 1	
reportQuantity				cri-RI-PMI-CQI	
csi-ReportMode				Mode1	
numberOfSingleTRP-CSI-Mode1				$X = 0$	
CMR pairing and grouping				CMR group #1: {NZP CSI-RS resource #9}, with $K_1 = 1$ CMR group #2: {NZP CSI-RS resource #10}, with $K_2 = 1$ CMR paring: {NZP CSI-RS resource #9, NZP CSI-RS resource #10}	
timeRestrictionForChannelMeasurements				Not configured	
timeRestrictionForInterferenceMeasurements				Not configured	
cqi-FormatIndicator				Wideband	
pmi-FormatIndicator				Wideband	
Sub-band Size			RB	8	
csi-ReportingBand				1111111	
CSI-Report periodicity and offset			slot	Not configured	

Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	CodebookType		typeI-SinglePanel
	CodebookMode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		0x FFFF
	RI Restriction		00000001 (1 MIMO layer per TRxP)
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.5 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2) Note 2: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 3: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 4: Randomization of the principle beam direction per TRxP shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.2.2.8-2: Minimum requirement

Parameter	Test 1
γ	1.6

6.3.3 4RX requirements

6.3.3.1 FDD

6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.3.1.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 4 (N1,N2) = (2,1)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4

	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		Row 4, (0)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)
	CSI-RS periodicity and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			4
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.1 FDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each

		applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-3), this reported PMI cannot be applied at the gNB downlink before slot#(n+3). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.		

Table 6.3.3.1.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High XP 8 x 4 (N1,N2) = (4,1)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		(5)

	CSI-RS periodicity and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubset Restriction		0x FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.2 FDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity

Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination.

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

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

Table 6.3.3.1.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

6.3.3.1.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLC300-5
Antenna configuration			High XP 16 x 4 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured

ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Subband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubset Restriction		0x FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3 FDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with i1 wideband granularity and i2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.3.1.3-2: Minimum requirement

Parameter	Test 1
γ	3.0

6.3.3.1.4 Single PMI with 32TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			High XP 32 x 4 (N1,N2) = (4,4)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		32
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 17, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, 12)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured

Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,4)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubset Restriction		0x FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3 FDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.3.1.4-2: Minimum requirement

Parameter	Test 1
γ	7.0

6.3.3.1.5 Multiple PMI with 16TX TypeII Codebook

For the parameters specified in Table 6.3.3.1.5-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.5-2.

Table 6.3.3.1.5-1: Test parameters (dual-layer)

Parameter	Unit	Test 1
Bandwidth	MHz	10
Subcarrier spacing	kHz	15
Duplex Mode		FDD
Propagation channel		TDLA30-5
Antenna configuration		XP Medium 16 x 4 (N1,N2) = (4,2)
Beamforming Model		As specified in Annex B.4.1

ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Subband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeII
	L (*numberOfBeams*)		2
	N_{PSK} (*phaseAlphabetSize*)		8
	subbandAmplitude		True

	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x 7FF FFFF FFFF FFFF FFFF
	RI Restriction (typeII-RI-Restriction)		10
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with i_1 wideband granularity and i_2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.3.1.3-1. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test.			

Table 6.3.3.1.5-2: Minimum requirement

Parameter	Test 1
γ	1.9

6.3.3.1.6 Multiple PMI with 16Tx Enhanced Type II Codebook

For the parameters specified in Table 6.3.3.1.6-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.6-2.

Table 6.3.3.1.6-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
Propagation channel			TDLA30-5
Antenna configuration			XP Medium 16 x 4 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)

	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Not configured
Sub-band Size		RB	4
csi-ReportingBand			1111111111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeII-r16
	paramCombination-r16		6 (L =4, p_v =1/2, β=1/2)
	R*(numberOfPMISubbandsPerCQISubband-r16)*		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x 7FF FFFF FFFF FFFF FFFF

	RI Restriction (typeII-RI-Restriction-r16)		0010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.3
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with i_1 wideband granularity and i_2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.3.1.3-1. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test.			

Table 6.3.3.1.6-2: Minimum requirement

Parameter	Test 1
γ	2.2

6.3.3.1.7 Single PMI with 8 ports TypeI-SinglePanel Codebook for Single-DCI based transmission scheme

For the parameters specified in Table 6.3.3.1.7-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.1.7-2.

Table 6.3.3.1.7-1: Test parameters (dual-layer)

Parameter		Unit	Value	
			TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB			TRxP #1	
PDCCH configuration	TCI state		TCI State #1	
	CORESETPoolIndex		0	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS		l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density		3	
	CSI-RS periodicity	Slots	20	
	CSI-RS offset	Slots	10 for CSI-RS resources 1 and 2 11 for CSI-RS resources 3 and 4	10 for CSI-RS resources 5 and 6 11 for CSI-RS resources 7 and 8
	QCL info		TCI state #0	
Duplex mode			FDD	
Bandwidth		MHz	10	

Subcarrier spacing			kHz	15	
Active DL BWP index				1	
Propagation channel				TDLA30-10	
Antenna configuration per TRxP				High XP 8 x 4 (N1,N2) = (4,1)	
Beamforming Model				As specified in Annex B.4.1 (Note 4)	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 1	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000	1002
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration	N/A
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Full-overlapping	
Timing offset of the second TRxP from the first TRxP			us	0	
Frequency offset of the second TRxP from the first TRxP			Hz	0	
Number of HARQ Processes				4	
The number of slots between PDSCH and corresponding HARQ-ACK information				2	
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 ID			Resource #9	Resource #10
	CSI-RS resource Type			Aperiodic	Aperiodic
	Number of CSI-RS ports (*X*)			8	8
	CDM Type			CDM4 (FD2, TD2)	CDM4 (FD2, TD2)
	Density (ρ)			1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)			Row 8, (4,6)	Row 8, (4,6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)			(5)	(9)
	CSI-RS periodicity and offset		slot	Not configured	Not configured
	aperiodicTriggeringOffset			0	0

CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
csi-ReportMode			Mode1
numberOfSingleTRP-CSI-Mode1			$X = 0$
CMR pairing and grouping			CMR group #1: {NZP CSI-RS resource #9}, with $K_1 = 1$ CMR group #2: {NZP CSI-RS resource #10}, with $K_2 = 1$ CMR paring: {NZP CSI-RS resource #9, NZP CSI-RS resource #10}
timeRestrictionForChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	CodebookType		typeI-SinglePanel
	CodebookMode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		0x FFFF
	RI Restriction		00000001 (1 MIMO layer per TRxP)
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	8
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.1-6.4
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity

Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2)
Note 2: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (1 ms granularity) with equal probability of each applicable i_1, i_2 combination.
Note 3: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4).
Note 4: Randomization of the principle beam direction per TRxP shall be used as specified in Annex B.2.3.2.3.

Table 6.3.3.1.7-2: Minimum requirement

Parameter	Test 1
γ	1.6

6.3.3.2 TDD

6.3.3.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook

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

Table 6.3.3.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configuration			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 4 x 4 (N1,N2) = (2,1)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, 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		Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured

timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(2,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		11111111
	RI Restriction		00000001
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	5.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.1 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.3.2.1-2: Minimum requirement

Parameter	Test 1
γ	1.3

6.3.3.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook

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

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

Parameter	Unit	Test 1
Bandwidth	MHz	40
Subcarrier spacing	kHz	30
Duplex Mode		TDD

TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 8 x 4 (N1,N2) = (4,1)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		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)		(5)
	CSI-RS periodicity and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannnelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1

CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubset Restriction		0x FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.2 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.3.2.2-2: Minimum requirement

Parameter	Test 1
γ	1.5

6.3.3.2.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook

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

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

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

	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannnelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Subband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)

	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.3 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with i1 wideband granularity and i2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.3.2.3-2: Minimum requirement

Parameter	Test 1
γ	3.0

6.3.3.2.4 Single PMI with 32TX TypeI-SinglePanel Codebook

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

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

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			High XP 32 x 4 (N1,N2) = (4,4)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB		(9,-)

	used for CSI-RS (l_0, l_1)		
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (X)		32
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 17, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, 12)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannnelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,4)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubset Restriction		0x FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF

	RI Restriction		00000010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.3 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.3.2.4-2: Minimum requirement

Parameter	Test 1
γ	7.0

6.3.3.2.5 Multiple PMI with 16TX TypeII Codebook

For the parameters specified in Table 6.3.3.2.5-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.5-2.

Table 6.3.3.2.5-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			XP Medium 16 x 4 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1

	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
CSI-IM configuration	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForIChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Subband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeII
	L (*numberOfBeams*)		2
	N_{PSK} (*phaseAlphabetSize*)		8
	subbandAmplitude		True
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x 7FF FFFF FFFF FFFF FFFF
	RI Restriction (typeII-RI-Restriction)		10
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.3 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with i_1 wideband granularity and i_2 subband granularity
Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal			

	probability of each applicable i_1, i_2 combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.3.2.3-1.
Note 2:	If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6).
Note 3:	Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test.

Table 6.3.3.2.5-2: Minimum requirement

Parameter	Test 1
γ	1.8

6.3.3.2.6 Multiple PMI with 16Tx Enhanced Type II Codebook

For the parameters specified in Table 6.3.3.2.6-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.6-2.

Table 6.3.3.2.6-1: Test parameters (dual-layer)

Parameter		Unit	Test 1
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD DL-UL configurations			FR1.30-1 as specified in Annex A
Propagation channel			TDLA30-5
Antenna configuration			XP Medium 16 x 4 (N1,N2) = (4,2)
Beamforming Model			As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS interval and offset	slot	Not configured
	ZP CSI-RS trigger		1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (*X*)		16
	CDM Type		CDM4 (FD2, TD2)
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1, k_2, k_3)		Row 12, (2, 4, 6, 8)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(5, -)
	CSI-RS interval and offset	slot	Not configured
	aperiodicTriggeringOffset		0
	CSI-IM resource Type		Aperiodic
	CSI-IM RE pattern		Pattern 0

CSI-IM configuration	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig interval and offset	slot	Not configured
ReportConfigType			Aperiodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForIChannelMeasurements			Not configured
timeRestrictionForInterferenceMeasurements			Not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Not configured
Sub-band Size		RB	8
csi-ReportingBand			11111111111111
CSI-Report interval and offset		slot	Not configured
Aperiodic Report Slot Offset			8
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeII-r16
	paramCombination-r16		6 (L =4, p_v =1/2, β=1/2)
	R*(numberOfPMISubbandsPerCQISubband-r16)*		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,2)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,4)
	CodebookSubsetRestriction		0x 7FF FFFF FFFF FFFF FFFF
	RI Restriction (typeII-RI-Restriction-r16)		0010
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.3 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with i_1 wideband granularity and i_2 subband granularity

Note 1: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. The random precoder generation shall follow 'typeI-SinglePanel' codebook configuration as specified in table 6.3.3.2.3-1.

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

Note 3: Randomization of the dual-cluster beam directions shall be used as specified in Annex B.2.3.2.3A. The value of relative power ratio (p) shall be fixed as 1 during the test.

Table 6.3.3.2.6-2: Minimum requirement

Parameter	Test 1
γ	2.2

6.3.3.2.7 Single PMI with 8 ports TypeI-SinglePanel Codebook for Single-DCI based transmission scheme

For the parameters specified in Table 6.3.3.2.7-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.3.3.2.7-2.

Table 6.3.3.2.7-1: Test parameters (dual-layer)

Parameter			Unit	Value	
				TRxP #1(Note 1)	TRxP #2(Note 1)
Transmit TRxP of SSB				TRxP #1	
PDCCH configuration	TCI state			TCI State #1	
	CORESETPoolIndex			0	
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS			k0=0 for CSI-RS resources 1,2,3,4	k0=1 for CSI-RS resources 5,6,7,8
	First OFDM symbol in the PRB used for CSI-RS			l0 = 6 for CSI-RS resources 1 and 3 l0 = 10 for CSI-RS resources 2 and 4	l0 = 6 for CSI-RS resources 5 and 7 l0 = 10 for CSI-RS resources 6 and 8
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4	1 for CSI-RS resource 5,6,7,8
	CDM Type			'No CDM' for CSI-RS resource 1,2,3,4,5,6,7,8	
	Density			3	
	CSI-RS periodicity		Slots	40	
	CSI-RS offset		Slots	20 for CSI-RS resources 1 and 2 21 for CSI-RS resources 3 and 4	20 for CSI-RS resources 5 and 6 21 for CSI-RS resources 7 and 8
	QCL info			TCI state #0	
Duplex mode				TDD	
Bandwidth			MHz	40	
Subcarrier spacing			kHz	30	
TDD DL-UL configurations				FR1.30-1 as specified in Annex A	
Active DL BWP index				1	
Propagation channel				TDLA30-10	
Antenna configuration per TRxP				High XP 8 x 4 $(N1,N2) = (4,1)$	
Beamforming Model				As specified in Annex B.4.1 (Note 4)	
PDSCH configuration	Mapping type			Type A	
	k0			0	
	Starting symbol (S)			2	
	Length (L)			12	
	PRB bundling type			Static	
	PRB bundling size			2	
	Resource allocation type			Type 1	
	RBG size			Config2	
	VRB-to-PRB mapping type			Non-interleaved	
	VRB-to-PRB mapping interleaver bundle size			N/A	
PDSCH DMRS configuration	Antenna port indexes			1000	1002
	TCI state			TCI State #1	TCI State #2
	DMRS Type			Type 1	
	Number of additional DMRS			1	
	Maximum number of OFDM symbols for DL front loaded DMRS			1	
TCI State #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS	N/A

				for tracking' configuration	
		QCL Type		Type A	N/A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
TCI State #2	Type 1 QCL information	CSI-RS resource		N/A	CSI-RS resource 5 from 'CSI-RS for tracking' configuration
		QCL Type		N/A	Type A
	Type 2 QCL information	CSI-RS resource		N/A	N/A
		QCL Type		N/A	N/A
Resource allocation				Full-overlapping	
Timing offset of the second TRxP from the first TRxP			us	0	
Frequency offset of the second TRxP from the first TRxP			Hz	0	
Number of HARQ Processes				8	
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.2	
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 ID			Resource #9	Resource #10
	CSI-RS resource Type			Aperiodic	Aperiodic
	Number of CSI-RS ports (*X*)			8	8
	CDM Type			CDM4 (FD2, TD2)	CDM4 (FD2, TD2)
	Density (ρ)			1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)			Row 8, (4,6)	Row 8, (4,6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)			(5)	(9)
	CSI-RS periodicity and offset		slot	Not configured	Not configured
	aperiodicTriggeringOffset			0	0
CSI-IM configuration	CSI-IM resource Type			Aperiodic	
	CSI-IM RE pattern			Pattern 0	
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})			(4,9)	
	CSI-IM timeConfig periodicity and offset		slot	Not configured	
ReportConfigType				Aperiodic	
CQI-table				Table 1	
reportQuantity				cri-RI-PMI-CQI	
csi-ReportMode				Mode1	
numberOfSingleTRP-CSI-Mode1				$X = 0$	
CMR pairing and grouping				CMR group #1: {NZP CSI-RS resource #9}, with $K_1 = 1$ CMR group #2: {NZP CSI-RS resource #10}, with $K_2 = 1$ CMR paring: {NZP CSI-RS resource #9, NZP CSI-RS resource #10}	
timeRestrictionForChannelMeasurements				Not configured	
timeRestrictionForInterferenceMeasurements				Not configured	
cqi-FormatIndicator				Wideband	
pmi-FormatIndicator				Wideband	
Sub-band Size			RB	8	
csi-ReportingBand				1111111	
CSI-Report periodicity and offset			slot	Not configured	

Aperiodic Report Slot Offset			5
CSI request			1 in slots i, where mod(i, 10) = 1, otherwise it is equal to 0
reportTriggerSize			1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	CodebookType		typeI-SinglePanel
	CodebookMode		1
	(CodebookConfig-N1,CodebookConfig-N2)		(4,1)
	(CodebookConfig-O1,CodebookConfig-O2)		(4,1)
	CodebookSubsetRestriction		0x FFFF
	RI Restriction		00000001 (1 MIMO layer per TRxP)
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
Maximum number of HARQ transmission			4
Measurement channel			R.PDSCH.2-8.5 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i_1, i_2 combination, and with Wideband granularity
Note 1: PDSCH transmission is done from both TRxPs (PDSCH Layer 0 is transmitted from TRxP #1 and PDSCH layer 1 is transmitted from TRxP #2) Note 2: When Throughput is measured using random precoder selection, the precoder shall be updated in each slot (0.5 ms granularity) with equal probability of each applicable i_1, i_2 combination. Note 3: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6). Note 4: Randomization of the principle beam direction per TRxP shall be used as specified in Annex B.2.3.2.3.			

Table 6.3.3.2.7-2: Minimum requirement

Parameter	Test 1
γ	1.6

6.4 Reporting of Rank Indicator (RI)

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

6.4.1 1RX requirements

(Void)

6.4.2 2RX requirements

6.4.2.1 FDD

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

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

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

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

Table 6.4.2.1-1: RI Test (FDD)

Parameter		Unit	Test 1	Test 2	Test 3
Bandwidth		MHz	10	10	10
Subcarrier spacing		kHz	15	15	15
Duplex Mode			FDD	FDD	FDD
SNR		dB	0	20	20
Propagation channel			TDLA30-5	TDLA30-5	TDLA30-5
Antenna configuration			ULA Low 2x2	ULA Low 2x2	ULA High 2x2
Beamforming Model			As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		4	4	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)	Row 5,(4)	Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)	(9)	(9)
	CSI-RS periodicity and offset	slot	5/1	5/1	5/1
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)		Row 3 (6)	Row 3 (6)	Row 3 (6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)	(13)	(13)
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	5/1	5/1
CSI-IM configuration	CSI-IM resource Type		Periodic	Periodic	Periodic
	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	5/1	5/1	5/1
ReportConfigType			Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured	not configured	not configured
timeRestrictionForInterferenceMeasurements			not configured	not configured	not configured
cqi-FormatIndicator			Wideband	Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband	Wideband
Sub-band Size		RB	8	8	8
csi-ReportingBand			1111111	1111111	1111111
CSI-Report periodicity and offset		slot	5/0	5/0	5/0
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1	1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A	N/A	N/A
	CodebookSubsetRestriction		010000 for fixed rank 2, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank
	RI Restriction		N/A	N/A	N/A
Physical channel for CSI report			PUCCH	PUCCH	PUCCH
CQI/RI/PMI delay		ms	8	8	8
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
Note 1: Measurements channels are specified in Table A.4-2. TBS.2-1 is used for Rank 1 case. TBS.2-2 is used for Rank 2 case.				

Table 6.4.2.1-2: Minimum requirement (FDD)

	Test 1	Test 2	Test 3
γ_1	N/A	1.05	0.9
γ_2	1.0	N/A	N/A

6.4.2.1.1 Minimum requirements for RedCap

The minimum performance requirement in Table 6.4.2.1.1-2 is defined as the ratio of the throughput obtained when transmitting based on UE reported RI and that obtained when transmitting with fixed rank 1 shall be $\geq \gamma_1$.

For the parameters specified in Table 6.4.2.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.4.2.1.1-2.

Table 6.4.2.1.1-1: RI Test (FDD)

Parameter		Unit	Test 1
Bandwidth		MHz	10
Subcarrier spacing		kHz	15
Duplex Mode			FDD
SNR		dB	20
Propagation channel			TDLA30-5
Antenna configuration			ULA Low 2x2
Beamforming Model			As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	10/5
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)		Row 3 (6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/5
CSI-IM configuration	CSI-IM resource Type		Periodic
	CSI-IM RE pattern		0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	10/5
ReportConfigType			Periodic
CQI-table			Table 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured
timeRestrictionForInterferenceMeasurements			not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband

Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A
	CodebookSubsetRestriction		000011 for fixed rank 1, 010011 for following rank
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	10
Maximum number of HARQ transmission			1
RI Configuration			Fixed RI = 1 and follow RI
Note 1: Measurement channels are specified in Table A.4-1. TBS.1-3 is used for Rank 1 case. TBS.1-4 is used for Rank 2 case.			

Table 6.4.2.1.1-2: Minimum requirement (FDD)

	Test 1
γ_1	1.05

6.4.2.2 TDD

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

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

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

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

Table 6.4.2.2-1: RI Test (TDD)

Parameter		**Unit**	**Test 1**	**Test 2**	**Test 3**
Bandwidth		MHz	40	40	40
Subcarrier spacing		kHz	30	30	30
Duplex Mode			TDD	TDD	TDD
TDD Slot Configuration			FR1.30-1	FR1.30-1	FR1.30-1
SNR		dB	0	20	20
Propagation channel			TDLA30-5	TDLA30-5	TDLA30-5
Antenna configuration			ULA Low 2x2	ULA Low 2x2	ULA High 2x2
Beamforming Model			As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (X)		4	4	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)	Row 5,(4)	Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)	(9)	(9)
	CSI-RS periodicity and offset	slot	10/1	10/1	10/1
	CSI-RS resource Type		Periodic	Periodic	Periodic

NZP CSI-RS for CSI acquisition	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)		Row 3 (6)	Row 3 (6)	Row 3 (6)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)	(13)	(13)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	10/1	10/1
CSI-IM configuration	CSI-IM resource Type		Periodic	Periodic	Periodic
	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	10/1	10/1	10/1
ReportConfigType			Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured	not configured	not configured
timeRestrictionForInterferenceMeasurements			not configured	not configured	not configured
cqi-FormatIndicator			Wideband	Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband	Wideband
Sub-band Size		RB	16	16	16
csi-ReportingBand			1111111	1111111	1111111
CSI-Report periodicity and offset		slot	10/9	10/9	10/9
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1	1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A	N/A	N/A
	CodebookSubsetRestriction		010000 for fixed rank 2, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank
	RI Restriction		N/A	N/A	N/A
Physical channel for CSI report			PUCCH	PUCCH	PUCCH
CQI/RI/PMI delay		ms	9.5	9.5	9.5
Maximum number of HARQ transmission			1	1	1
RI Configuration			Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI
Note 1: Measurements channels are specified in Table A.4-2. TBS.2-3 is used for Rank 1 case. TBS.2-4 is used for Rank 2 case.					

Table 6.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
γ_1	N/A	1.05	0.9
γ_2	1.0	N/A	N/A

6.4.2.2.1 Minimum requirements for RedCap

The minimum performance requirement in Table 6.4.2.2.1-2 is defined as the ratio of the throughput obtained when transmitting based on UE reported RI and that obtained when transmitting with fixed rank 1 shall be $\geq \gamma_1$.

For the parameters specified in Table 6.4.2.2.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.4.2.2.1-2.

Table 6.4.2.2.1-1: RI Test (TDD)

Parameter	Unit	Test 1

Bandwidth		MHz	20
Subcarrier spacing		kHz	30
Duplex Mode			TDD
TDD Slot Configuration			FR1.30-1
SNR		dB	20
Propagation channel			TDLA30-5
Antenna configuration			ULA Low 2x2
Beamforming Model			As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0)		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 resource Type		Periodic
	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 1
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured
timeRestrictionForInterferenceMeasurements			not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/9
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A
	CodebookSubsetRestriction		000011 for fixed rank 1, 010011 for following rank
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	9.5
Maximum number of HARQ transmission			1
RI Configuration			Fixed RI = 1 and follow RI
Note 1: Measurement channels are specified in Table A.4-1. TBS.1-5 is used for Rank 1 case. TBS.1-6 is used for Rank 2 case.			

Table 6.4.2.2.1-2: Minimum requirement (TDD)

	Test 1
γ_1	1.05

6.4.3 4RX requirements

6.4.3.1 FDD

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

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

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

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

Table 6.4.3.1-1: RI Test (FDD)

Parameter		Unit	Test 1	Test 2	Test 3	Test 4
Bandwidth		MHz	10	10	10	10
Subcarrier spacing		kHz	15	15	15	15
Duplex Mode			FDD	FDD	FDD	FDD
SNR		dB	-2	16	16	22
Propagation channel			TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna configuration			ULA Low 2x4	ULA Low 2x4	ULA High 2x4	ULA Low 4x4
Beamforming Model			As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		4	4	4	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)	Row 5,(4)	Row 5,(4)	Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)	(9)	(9)	(9)
	CSI-RS periodicity and offset	slot	5/1	5/1	5/1	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		2	2	2	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 3 (6)	Row 3 (6)	Row 3 (6)	Row 4 (0)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)	(13)	(13)	(13)
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1	5/1	5/1	5/1
CSI-IM configuration	CSI-IM resource Type		Periodic	Periodic	Periodic	Periodic
	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0	Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)	(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	5/1	5/1	5/1	5/1
ReportConfigType			Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured	not configured	not configured	not configured

timeRestrictionForInterferenceMeasurements			not configured	not configured	not configured	not configured
cqi-FormatIndicator			Wideband	Wideband	Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband	Wideband	Wideband
Sub-band Size		RB	8	8	8	8
csi-ReportingBand			1111111	1111111	1111111	1111111
CSI-Report periodicity and offset		slot	5/0	5/0	5/0	5/0
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1	1	1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A	N/A	N/A	(2,1)
	CodebookSubsetRestriction		010000 for fixed rank 2, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank	11111111
	RI Restriction		N/A	N/A	N/A	00000010 for fixed Rank 2 and 00001111 for follow RI
Physical channel for CSI report			PUCCH	PUCCH	PUCCH	PUCCH
CQI/RI/PMI delay		ms	8	8	8	8
Maximum number of HARQ transmission			1	1	1	1
RI Configuration			Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 2 and follow RI
Note 1: Measurements channels are specified in Table A.4-2 and Table A.4-3. TBS.2-1 is used for Rank 1 case. TBS.2-2 is used for Rank 2 case. TBS.3-1 is used for Rank 3 case. TBS.3-2 is used for Rank 4 case.						

Table 6.4.3.1-2: Minimum requirement (FDD)

	Test 1	Test 2	Test 3	Test 4
γ_1	N/A	1.05	0.9	N/A
γ_2	0.9	N/A	N/A	0.9

6.4.3.2 TDD

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

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

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

For the parameters specified in Table 6.4.3.2-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified in Table 6.4.3.2-2.

Table 6.4.3.2-1: RI Test (TDD)

Parameter		Unit	Test 1	Test 2	Test 3	Test 4
Bandwidth		MHz	40	40	40	40
Subcarrier spacing		kHz	30	30	30	30
Duplex Mode			TDD	TDD	TDD	TDD
TDD Slot Configuration			FR1.30-1	FR1.30-1	FR1.30-1	FR1.30-1
SNR		dB	-2	16	16	22
Propagation channel			TDLA30-5	TDLA30-5	TDLA30-5	TDLA30-5
Antenna configuration			ULA Low 2x4	ULA Low 2x4	ULA High 2x4	ULA Low 4x4
Beamforming Model			As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		4	4	4	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2

	Density (ρ)		1	1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 5,(4)	Row 5,(4)	Row 5,(4)	Row 5,(4)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(9)	(9)	(9)	(9)
	CSI-RS periodicity and offset	slot	10/1	10/1	10/1	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic	Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		2	2	2	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0)		Row 3 (6)	Row 3 (6)	Row 3 (6)	Row 4 (0)
	First OFDM symbol in the PRB used for CSI-RS (l_0)		(13)	(13)	(13)	(13)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1	10/1	10/1	10/1
CSI-IM configuration	CSI-IM resource Type		Periodic	Periodic	Periodic	Periodic
	CSI-IM RE pattern		Pattern 0	Pattern 0	Pattern 0	Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)	(4,9)	(4,9)	(4,9)
	CSI-IM timeConfig periodicity and offset	slot	10/1	10/1	10/1	10/1
ReportConfigType			Periodic	Periodic	Periodic	Periodic
CQI-table			Table 2	Table 2	Table 2	Table 2
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured	not configured	not configured	not configured
timeRestrictionForInterferenceMeasurements			not configured	not configured	not configured	not configured
cqi-FormatIndicator			Wideband	Wideband	Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband	Wideband	Wideband
Sub-band Size		RB	16	16	16	16
csi-ReportingBand			1111111	1111111	1111111	1111111
CSI-Report periodicity and offset		slot	10/9	10/9	10/9	10/9
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1	1	1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A	N/A	N/A	(2,1)
	CodebookSubsetRestriction		010000 for fixed rank 2, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank	11111111
	RI Restriction		N/A	N/A	N/A	00000010 for fixed Rank 2 and 00001111 for follow RI
Physical channel for CSI report			PUCCH	PUCCH	PUCCH	PUCCH
CQI/RI/PMI delay		ms	9.5	9.5	9.5	9.5
Maximum number of HARQ transmission			1	1	1	1
RI Configuration			Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 2 and follow RI
Note 1: Measurements channels are specified in Table A.4-2 and Table A.4-3. TBS.2-3 is used for Rank 1 case. TBS.2-4 is used for Rank 2 case. TBS.3-3 is used for Rank 3 case. TBS.3-4 is used for Rank 4 case.						

Table 6.4.3.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3	Test 4
γ_1	N/A	1.05	0.9	N/A
γ_2	0.9	N/A	N/A	0.9

7 Demodulation performance requirements (Radiated requirements)

7.1 General

7.1.1 Applicability of requirements

7.1.1.1 General

The minimum performance requirements are applicable to the FR2 operating bands defined in TS 38.101-2 [7].. The minimum requirements for FR2-1 is applicable for F_{DL_high} not exceeding 48200 MHz. Additional applicability rules for certain operating bands are specified in Clause 7.1.1.6 and 7.1.1.8.

The minimum performance requirements in Clause 7 are mandatary for UE supporting NR operation, except test cases listed in Clause 7.1.1.3, 7.1.1.4, 7.1.1.5, 7.1.1.7.

If same test is listed for different UE features/capabilities in Clauses 7.1.1.3 and 7.1.1.4, then this test shall apply for UEs which support all corresponding UE features/capabilities.

7.1.1.2 Applicability of requirements for different number of RX antenna ports

UE shall support 2 RX ports for different RF operating bands. The UE requirements applicability is defined in Table 7.1.1.2-1.

Table 7.1.1.2-1: Requirements applicability

Supported RX antenna ports	Test type	Test list
UE supports 2RX antenna ports	PDSCH	All tests in Clause 7.2.2
	PDCCH	All tests in Clause 7.3.2
	PBCH	All tests in Clause 7.4.2

7.1.1.3 Applicability of requirements for optional UE features

The performance requirements in Table 7.1.1.3-1 shall apply for UEs which support optional UE features only.

Table 7.1.1.3-1: Requirements applicability for optional UE features

UE feature/capability [14]	Test type		Test list	Applicability notes
SU-MIMO Interference Mitigation advanced receiver	FR2-1 TDD	PDSCH	Clause 7.2.2.2.1 (Test 3-1)	
Basic DL NR-NR CA operation (*supportedBandCombinationList*)	NR CA	SDR	Clause 7.5A.1	1) Up to 16 DL carriers 2) Same numerology across carrier for data/control channel at a given time
PDSCH repetitions over multiple slots *(pdsch-RepetitionMultiSlots)*	FR2-1 TDD	PDSCH	Clause 7.2.2.2.2	
DRX Adaptation (*drx-Adaptation-r16*)	FR2-1 TDD	PDCCH	Clause 7.3.2.2.3	If the Test 3-1 in Clause 7.3.2.2.3 is passed, the test coverage can be considered fulfilled without executing Test 1-2 in clause 7.3.2.2.1.
Alternative 64QAM MCS table for PDSCHNew 64QAM MCS table for PDSCH (*dl-64QAM-MCS-TableAlt*)	FR2 TDD	PDSCH	Clause 7.2.2.2.2	
256QAM for PDSCH (*pdsch-256QAM-FR2*)	FR2-1 TDD	PDSCH	Clause 7.2.2.2.1 (Test 1-4)	

256QAM for PDSCH (*pdsch-256QAM-FR2*)	FR2-1 TDD	SDR	Clause 7.5A.1	For UE capable of *pdsch-256QAM-FR2* for certain band(s), *mcs-Table* is configured to '64QAM' for SDR test.
Support of FR2 HST operation [(FR2 UE power class PC6 signalling is used to indicate support of feature group)]	FR2-1 TDD	PDSCH	[Clause 7.2.2.2.4]	
Support of Single Carrier operations with 120kHz SCS for FR2-2 (*initialAccessSSB-120kHz-r17)*	FR2-2 TDD	PDSCH	Clause 7.2.2.2.1 (Table 7.2.2.2.1-6: Test 4-1, 4-2, 4-3, 4-4)	
		PDCCH	Clause 7.3.2.2 (Table 7.3.2.2.1-2: Test 1a-1, 1a-2, 1a-3) (Table 7.3.2.2.2-2, Test 3-1, 3-2)	
		PBCH	Clause 7.4.2.2 (Table 7.4.2.2-2: Test 3)	
Support of 480kHz SCS for FR2-2 (*ul-FR2-2-SCS-480kHz-r17* and *initialAccessSSB-480kHz-r17)*	FR2-2 TDD	PDSCH	Clause 7.2.2.2.1 (Table 7.2.2.2.1-6: Test 4-5, 4-6)	
		PDCCH	Clause 7.3.2.2 (Table 7.3.2.2.1-2: Test 1a-4) (Table 7.3.2.2.2-2, Test 3-3)	
		PBCH	Clause 7.4.2.2 (Table 7.4.2.2-2: Test 4)	

7.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

The performance requirements in Table 7.1.1.4-1 shall apply for UEs which support mandatory UE features with capability signalling only.

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

UE feature/capability [14]	Test type		Test list	Applicability notes
Supported maximum number of PDSCH MIMO layers (*maxNumberMIMO-LayersPDSCH)*	FR2 TDD	PDSCH	Clause 7.2.2.2.1 (Tests from 2-1 to 2-6)	The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability
Support of PT-RS with one antenna port for DL reception (*onePortsPTRS*)	FR2 TDD	PDSCH	Clause 7.2	
		SDR	Clause 7.5.1 Clause 7.5A.1	
PCell operation on FR2 (*pCell-FR2*)	FR2 TDD	SDR	Clause 7.5A.1	
PDSCH mapping type B (*pdsch-MappingTypeB*)	FR2 TDD	PDSCH	Clause 7.2.2.2.3	

Support number of active TCI states per BWP per CC, including control and data (maxNumberActiveTCI-PerBWP)	FR2 TDD	PDSCH	Clause 7.2.2.2.4 (Test 1-2)	The requirements apply only when maxNumberActiveTCI-PerBWP is other than n1.

7.1.1.5 Applicability of CA requirements

7.1.1.5.1 Definition of CA capability

The definition with respect to CA capabilities is given as in Table 7.1.1.5.1-1.

Table 7.1.1.5.1-1: Definition of CA capability

CA Capability	CA Capability Description
CA_C	Intra-band contiguous CA
CA_N	Intra-band non-contiguous CA
CA_AX	Inter-band CA (X bands)
NOTE 1: CA_C corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.1 of TS 38.101-2 [7]. CA_N corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.2 of TS 38.101-2 [7]. CA_AX corresponds to NR CA configurations and bandwidth combination sets defined in Clause 5.5A.3 of TS 38.101-2 [7].	

7.1.1.5.2 Applicability and test rules for different CA configurations and bandwidth combination sets

The performance requirement for CA UE demodulation tests in Clause 7.2A are defined independent of CA configurations and bandwidth combination sets specified in Clause 5.5A of TS 38.101-2. For UEs supporting different CA configurations and bandwidth combination sets, the applicability and test rules are defined in Table 7.1.1.5.2-1 and Table 7.1.1.5.2-2. For simplicity, CA configuration below refers to combination of CA configuration and bandwidth combination set.

Table 7.1.1.5.2-1: Applicability and test rules for CA UE demodulation tests

Tests	CA capability where the tests apply	CA configuration from the selected CA capability where the tests apply	CA Bandwidth combination to be tested in priority order	PCell CC configuration
Test 1 in Clause 7.2A.2.1	CA_C, CA_N, CA_AX	Table 7.1.1.5.2-2	Largest aggregated CA bandwidth combination	Any of CCs

Table 7.1.1.5.2-2: Selection of CA configurations

CA capability	Step 1	Step 2	Step 3
CA_C or CA_N or CA_AX	Select CA configuration(s), which contain all CA bandwidth combinations requiring SNR below test equipment maximum achievable SNR	Select the CA configurations with the maximum number of CCs, for which the supported maximum number of MIMO layers is not lower than 2, among all the selected CA configurations from Step 1.	Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 2.
NOTE 1: Maximum supported data rate for Step 3 is calculated based clause 4.1.2 of TS 38.306 [14] NOTE 2: Tested data rate for Step 3 is calculated based on the equation $DataRate = 10^{-3}\sum_{j=1}^{J} TBS_j 2^{\mu_j}$ and FRCs used in the test.			

7.1.1.6 Applicability of requirements for operating bands in FR2-1

The applicability rules for FR2-1 operating bands are specified in Table 7.1.1.6-1.

Table 7.1.1.6-1: Requirements applicability for operating bands in FR2-1

Test type		Test list	Applicability notes
FR2-1 TDD	PDSCH	Clause 7.2.2.2.1 (Test 1-4)	The requirements are applicable for bands with F_{DL_high} higher than 40000 MHz and lower than 48200 MHz with additional margin as 1.5 dB.
	PDSCH	Clause 7.2.2.2.1 (Test 2-6) Clause 7.2.2.2.1 (Test 3-1)	The requirements are applicable for bands with F_{DL_high} higher than 40000 MHz and lower than 48200 MHz with additional margin as 0.5 dB.

7.1.1.7 Applicability of requirements for RedCap

The performance requirements in Table 7.1.1.7-1 shall apply for UEs which support optional feature *supportOfRedCap*.

Table 7.1.1.7-1: Requirements applicability for RedCap

UE capability	Test type		Test list	Applicability notes
RedCap with 2RX	FR2 TDD	PDSCH	Clause 7.2.2.2.1 (Tests 1-1, 2-2, and 2-6)	
		PDCCH	Clause 7.3.2.2.1 (Test 1-2) Clause 7.3.2.2.2 (Test 2-1)	
		PBCH	Clause 7.4.2.2 (Table 7.4.2.2-2 Tests 1 and 2) Clause 7.4.2.2 (Table 7.4.2.2-3 Tests 1 and 2)	
		SDR	Clause 7.5.1	

7.1.1.8 Applicability of requirements for operating bands in FR2-2

The requirements in Table 7.1.1.8-1 are applicable for bands with F_{DL_high} higher than 52600 MHz and lower than 71000 MHz;

Other performance requirements mandatory for UE supporting NR operation defined in Section 7 but not included in Table 7.1.1.8-1 should not be considered applicable to FR2-2 bands;

Table 7.1.1.8-1: Requirements applicability for operating bands in FR2-2

Test type		Test list	Applicability notes
FR2-2 TDD	PDSCH	Clause 7.2.2.2.1 (All Tests in Table 7.2.2.2.1-6)	The requirements apply if the device supports initial access on FR2-2 frequencies, or if it supports both Single Carrier and CA_AX (FR1+FR2-2) operations;
	PDCCH	Clause 7.3.2.2 (All Tests in Table 7.3.2.2.1-2) (All tests in Table 7.3.2.2.2-2)	
	PBCH	Clause 7.4.2.2 (Table 7.4.2.2-2: Tests 3, 4)	

7.2 PDSCH demodulation requirements

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

Table 7.2-1: Common Test Parameters

Parameter		Unit	Value
PDSCH transmission scheme			Transmission scheme 1
PTRS *epre-Ratio*			0
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 2)	RBs	0
	Subcarrier spacing	kHz	60 or 120 or 480
DL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing
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 for 120 KHz SCS (Xs, Ys) = (4, 1) for 480 KHz SCS
	Symbols with PDCCH		0
	Number of PRBs in CORESET		Table 7.2-2 for tested channel bandwidth and subcarrier spacing
	Number of PDCCH candidates and aggregation levels		1/AL8
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1_1
	TCI state		TCI state #1
	PDCCH & PDCCH DMRS Precoding configuration		For number of TX = 1: No precoding; For number of TX > 1: Single Panel Type I, Randomized precoder selection for every REG bundle and updated per slot with equal probability of each applicable i_1/i_2 combination or codebook index, chosen from section 5.2.2.2.1 of TS 38.214 [12].
Cross carrier scheduling			Not configured
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k_0)		0 for CSI-RS resource 1,2,3,4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		6 for CSI-RS resource 1 and 3 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4

	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resource 1,2,3,4 120 kHz SCS: 160 for CSI-RS resource 1,2,3,4 480 kHz SCS: 640 for CSI-RS resource 1, 2, 3, 4
	CSI-RS offset	Slots	60 kHz SCS: 40 for CSI-RS resource 1 and 2 41 for CSI-RS resource 3 and 4 120 kHz SCS: 80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4 480 kHz SCS: 320 for CSI-RS resource 1 and 2 321 for CSI-RS resource 3 and 4
	Frequency Occupation		Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	QCL info		TCI state #0
NZP CSI-RS for CSI acquisition	Row index (Note 3)		3 for 2 CSI-RS ports and 5 for 4 CSI-RS ports
	First subcarrier index in the PRB used for CSI-RS (k_0)		0
	First OFDM symbol in the PRB used for CSI-RS (l_0)		12
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	CSI-RS periodicity	Slots	60 kHz SCS: 80 120 kHz SCS: 160 480 kHz SCS: 640
	CSI-RS offset		0
	Frequency Occupation		Start PRB 0 Number of PRB = ceil(BWP size/4) *4
	QCL info		TCI state #1
ZP CSI-RS for CSI acquisition	Row index (Note 3)		5
	First subcarrier index in the PRB used for CSI-RS (k_0)		4
	First OFDM symbol in the PRB used for CSI-RS (l_0)		12
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	CSI-RS periodicity	Slots	60 kHz SCS: 80 120 kHz SCS: 160 480 kHz SCS: 640
	CSI-RS offset		0
	Frequency Occupation		Start PRB 0 Number of PRB = ceil(BWP size/4) *4
CSI-RS for beam refinement	First subcarrier index in the PRB used for CSI-RS		k_0=0 for CSI-RS resource 1,2
	First OFDM symbol in the PRB used for CSI-RS		l_0 = 8 for CSI-RS resource 1

				I_0 = 9 for CSI-RS resource 2
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2
	CDM Type			'No CDM' for CSI-RS resource 1,2
	Density (ρ)			3 for CSI-RS resource 1,2
	CSI-RS periodicity		Slots	60 kHz SCS: 80 for CSI-RS resource 1,2 120 kHz SCS: 160 for CSI-RS resource 1,2 480 kHz SCS: 640 for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	Repetition			ON
	QCL info			TCI state #1
PDSCH DMRS configuration	Antenna ports indexes			{1000} for Rank 1 tests {1000, 1001} for Rank 2 tests
	Position of the first DMRS for PDSCH mapping type A			2
	Number of PDSCH DMRS CDM group(s) without data			1
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
PTRS (Note 4)	Frequency density (K_{PT-RS})			2
	Time density (L_{PT-RS})			1
	Resource Element Offset			2
Maximum number of code block groups for ACK/NACK feedback				1
Maximum number of HARQ transmission				120 KHz SCS: 4 480 KHz SCS: 16
PUCCH HARQ ACK spaitial bundling				Not configured
Redundancy version coding sequence				{0,2,3,1}
PDSCH & PDSCH DMRS Precoding configuration				For number of TX = 1: No precoding; For number of TX > 1: Single Panel Type I, Randomized precoder selection with Wideband size and updated per slot, with equal probability of each applicable i_1/i_2 combination or codebook

		index, chosen from section 5.2.2.2.1 of TS 38.214 [12].
Symbols for all unused REs		OP.1 FDD as defined in Annex A.5.1.1 for FR2-1 tests OP.1 TDD as defined in Annex A.5.2.1 for FR2-1 tests No OCNG symbols on unused REs for FR2-2 with 120kHz. For test 4-5 in Table 7.2.2.2.1-6: OP.1 TDD with Data Region for first symbol of slots with PDSCH without PDCCH No OCNG symbols on other unused REs For test 4-6 in Table 7.2.2.2.1-6: OP.1 TDD with Data Region with the same RB allocation as PDSCH for two symbols of slots with PDSCH without PDCCH No OCNG symbols on other unused REs
Physical signals, channels mapping and precoding		As specified in Annex B.4.1
Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing. Note 3: Refer to Table 7.4.1.5.3-1 in [9] . Note 4: The *frequencyDensity* and *timeDensity* in *phaseTrackingRS* are configured. The actual PT-RS configuration depends on the scheduled MCS according to section 5.1.6.3 from TS 38.214[12].		

Table 7.2-2: Number of PRBs in CORESET

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

7.2.1 1RX requirements

(Void)

7.2.2 2RX requirements

7.2.2.1 FDD

(Void)

7.2.2.2 TDD

7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A

For PDSCH Type-A scheduling, the requirements are specified in Table 7.2.2.2.1-3, 7.2.2.2.1-4, 7.2.2.2.1-5, and 7.2.2.2.1-6 with the addition of the parameters in Table 7.2.2.2.1-2 and the downlink physical channel setup according to Annex C.5.1. The purpose is to verify the performance of PDSCH Type-A scheduling.

The test purposes are specified in Table 7.2.2.2.1-1.

Table 7.2.2.2.1-1: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance in FR2-1 under 2 receive antenna conditions and with different channel models, MCSs andnumber of MIMO layers in FR2-1.	1-1, 1-3, 1-4, 2-1, 2-2, 2-3, 2-4, 2-5, 2-6
Verify the PDSCH mapping Type A HARQ soft combining performance in FR2-1 under 2 receive antenna conditions.	1-2
Verify the PDSCH mapping Type A performance requirements for Enhanced Receiver Type 1 in FR2-1 under 2 receive antenna conditions.	3-1
Verify the PDSCH mapping Type A normal performance in FR2-2 under 2 receive antenna conditions and with different channel models, MCSs	4-1, 4-2, 4-3, 4-4, 4-5, 4-6

Table 7.2.2.2.1-2: Test Parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
CSI-RS for tracking	First OFDM symbol in the PRB used for CSI-RS (l_0)		For Test 1-1 and 1-2: 3 for CSI-RS resource 1 and 3 7 for CSI-RS resource 2 and 4
	CSI-RS offset	Slots	For Test 1-2: 82 for CSI-RS resource 1 and 2 83 for CSI-RS resource 3 and 4
PDCCH configuration	Number of PDCCH candidates and aggregation levels		1/AL4 for Test 1-4, 2-3, and 4-6 1/AL8 for other tests
	Symbols with PDCCH		0,1 for Test 4-6 0 for other tests
	Number of PRBs in CORESET		18 for Test 4-6 Table 7.2-2 for other tests
PDSCH configuration	Mapping type		Type A
	k0		For 120kHz SCS: 0 For 480kHz SCS: k0={0,1} for DCI transmitted in slot i=322 : k0={0,1,2} for DCI transmitted in slot i={1} k0={0,1,2,8} for DCI transmitted in slot mod(i,40)=12

			k0={0,1,2,3} for DCI transmitted in slot mod(i,40)={4,8,21,25,29}, where i is slot index per 2 frames
	Starting symbol (S)		2 for Test case 4-6 1 for other Tests
	Length (L)		Specific to each Reference channel as defined in A.3.2.2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		wideband for Test 1-1, 2 for other tests
	Resource allocation type		Test 2-1: Type 1 with start RB = 30, L_{RBs} = 6 Test 4-6: Type 1 with start RB = 24, L_{RBs} = 20 Other tests: Type 0
	RBG size		Test 2-1: N/A Other tests: Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8 for Test 1-1, 1-3, 1-4, 2-2, 2-4, 4-1, 4-2, 4-4, 10 for Test 2-1, 2-3, 2-5, 2-6, 3-1 16 for Test 1-2, 4-3, 4-5, 4-6
The number of slots between PDSCH and corresponding HARQ-ACK information			As defined in Annex A.1.3

Table 7.2.2.2.1-3: Minimum performance for Rank 1 (FRC) for FR2-1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR_{BB} (dB)
1-1	R.PDSCH.5-1.1 TDD	100 / 120	QPSK, 0.30	FR2.120-1A	TDLC60-300	2x2 ULA Low	70	-0.4
1-2	R.PDSCH.5-2.1 TDD	100 / 120	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	30	1.7
1-3	R.PDSCH.5-3.1 TDD	100 / 120	64QAM, 0.46	FR2.120-1	TDLA30-300	2x2 XPL Medium	70	12.4
1-4	R.PDSCH.5-10.1 TDD	50 / 120	256QAM 0.67	FR2.120-1	TDLD30-75	2x2 ULA Low	70	20.2

Table 7.2.2.2.1-4: Minimum performance for Rank 2 (FRC) for FR2-1

							Reference value

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Fraction of maximum throughput (%)	SNR_{BB} (dB)
2-1	R.PDSCH.5-4.1 TDD	100 / 120	QPSK, 0.30	FR2.120-2	TDLA30-75	2x2 ULA Low	70	4.1
2-2	R.PDSCH.5-2.2 TDD	100 / 120	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	14.4
2-3	R.PDSCH.5-5.2 TDD	50 / 120	16QAM,0.48	FR2.120-2	TDLA30-75	2x2 ULA Low	70	14.0
2-4	R.PDSCH.5-2.3 TDD	200 / 120	16QAM, 0.48	FR2.120-1	TDLA30-300	2x2 ULA Low	70	14.2
2-5	R.PDSCH.4-1.1 TDD	50 / 60	16QAM, 0.48	FR2.60-1	TDLA30-75	2x2 ULA Low	70	14.3
2-6	R.PDSCH.5-6.1 TDD	100 / 120	64QAM, 0.43	FR2.120-2	TDLA30-75	2x2 ULA Low	70	18.6

Table 7.2.2.2.1-5: Minimum performance for Rank 2 (FRC) for Enhanced Receiver Type 1 for FR2-1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR_{BB} (dB)
3-1	R.PDSCH.5-5.1 TDD	100 / 120	16QAM, 0.48	FR2.120-2	TDLA30-75	2x2 ULA Medium	70	19.0

Table 7.2.2.2.1-6: Minimum performance for Rank 1 (FRC) for FR2-2

Test num	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of max through-put (%)	SNR_{BB} (dB)
4-1	R.PDSCH.5-1.1 TDD	100 / 120	QPSK, 0.30	FR2.120-1	TDLA30-650	2x2 ULA Low	70	0.9
4-2	R.PDSCH.5-2.1 TDD	100 / 120	16QAM, 0.48	FR2.120-1	TDLA30-200	2x2 ULA Low	70	9.0
4-3	R.PDSCH.5-2.1 TDD	100 / 120	16QAM, 0.48	FR2.120-1	TDLA30-650	2x2 ULA Low	30	2.7
4-4	R.PDSCH.5-3.2 TDD	100 / 120	64QAM, 0.43	FR2.120-1	TDLD30-200	2x2 ULA Low	70	11.6
4-5	R.PDSCH.8-1.1 TDD	400 / 480	QPSK, 0.30	FR2.480-1	TDLA10-200	2x2 ULA Low	70	1.0
4-6	R.PDSCH.8-2.1 TDD	400 / 480	16QAM 0.48	FR2.480-1	TDLD10-200	2x2 ULA Low	70	8.3

7.2.2.2.2 Minimum requirements for PDSCH repetitions over multiple slots

For PDSCH with slot aggregation, the requirements are specified in Table 7.2.2.2.2-3, additional parameters in Table 7.2.2.2.2-2 and the downlink physical channel setup according to Annex C.5.1.

The test purpose is specified in Table 7.2.2.2.2-1.

Table 7.2.2.2.2-1: Test purpose

Purpose	Test index
Verify the PDSCH repetitions over multiple slots performance under 2 receive antenna conditions	1-1

Table 7.2.2.2.2-2: Test Parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		1
	Length (L)		13
	PDSCH aggregation factor		2
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			2
The number of slots between final repetition of PDSCH and corresponding HARQ-ACK information			As defined in Annex A.1.3 (Note 1)
Note 1: ACK/NACK feedback is generated for PDSCH on slot i, where mod(i,4) = 1, where i is the slot index per frame; i = {0,...,79}			

Table 7.2.2.2.2-3: Minimum performance for Rank 1 (FRC)

Test num	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Target BLER	SNR (dB)
1-1	R.PDSCH.5-11.1 TDD	100 / 120	16QAM, 0.37	FR2.120-2	TDLA30-75	2x2 ULA Low	1% (Note 1)	-1.1
Note 1: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block.								

7.2.2.2.3 Minimum requirements for PDSCH Mapping Type B

The performance requirements are specified in Table 7.2.2.2.3-3, with the addition of test parameters in Table 7.2.2.2. 3-2 and the downlink physical channel setup according to Annex C.5.1. The purpose is to verify the performance of PDSCH Type B scheduling.

The test purposes are specified in Table 7.2.2.2.3-1.

Table 7.2.2.2.3-1: Test purpose

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

Table 7.2.2.2.3-2: Test parameters

Parameter	Unit	Value
Duplex mode		TDD
Active DL BWP index		1

PDCCH configuration	Number of PDCCH candidates and aggregation levels		1/AL8
PDSCH configuration	Mapping type		Type B
	k0		0
	Starting symbol (S)		1
	Length (L)		2
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		0
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.3

Table 7.2.2.2.3-3: Minimum performance for Rank 1

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH. 5-1.2 TDD	100 / 120	QPSK, 0.30	FR2.120-1	TDLA30-75	2x2, ULA Low	70	1.3

7.2.2.2.4 Minimum requirements for HST-DPS

The performance requirements are specified in Table 7.2.2.2.4-3, with the addition of test parameters in Table 7.2.2.2.4-2 and the downlink physical channel setup according to Annex C.5.1.

The test purposes are specified in Table 7.2.2.2.4-1.

Table 7.2.2.2.4-1: Tests purpose

Purpose	Test index
Verify UE performance in the HST-DPS scenario defined in B.3.3	1-1, 1-2

Table 7.2.2.2.4-2: Test parameters

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDCCH configuration	TCI state		Note 1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		1
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved

	VRB-to-PRB mapping interleaver bundle size			N/A
	TCI state			Note 1
PDSCH DMRS configuration	DMRS Type			Type 1
	Number of additional DMRS			2
	Maximum number of OFDM symbols for DL front loaded DMRS			1
CSI-RS for tracking	Resource set #1	First subcarrier index in the PRB used for CSI-RS (*k0*)		0 for CSI-RS resource 1,2,3,4
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 2 for CSI-RS resource 1 and 3
				l_0 = 6 for CSI-RS resource 2 and 4
		CSI-RS periodicity	Slots	80 for CSI-RS resource 1,2,3,4
		CSI-RS offset	Slots	2 for CSI-RS resource 1 and 2
				3 for CSI-RS resource 3 and 4
		QCL info		TCI state #4
		Frequency Occupation		Start PRB 0
				Number of PRB =ceil(BWP size/4)*4
	Resource set #2	First subcarrier index in the PRB used for CSI-RS (*k0*)		0 for CSI-RS resource 5,6,7,8
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 5 and 7
				l_0 = 8 for CSI-RS resource 6 and 8
		CSI-RS periodicity	Slots	80 for CSI-RS resource 5,6,7,8
		CSI-RS offset	Slots	5 for CSI-RS resource 5 and 6
				6 for CSI-RS resource 7 and 8
		QCL info		TCI state #5
		Frequency Occupation		Start PRB 0
				Number of PRB =ceil(BWP size/4)*4
	Resource set #3	First subcarrier index in the PRB used for CSI-RS (*k0*)		1 for CSI-RS resource 9,10,11,12
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 9 and 11
				l_0 = 9 for CSI-RS resource 10 and 12
		CSI-RS periodicity	Slots	80 for CSI-RS resource 9,10,11,12
		CSI-RS offset	Slots	5 for CSI-RS resource 9 and 10
				6 for CSI-RS resource 11 and 12
		QCL info		TCI state #6
		Frequency Occupation		Start PRB 0
				Number of PRB =ceil(BWP size/4)*4
	Resource set #4	First subcarrier index in the PRB used for CSI-RS (*k0*)		1 for CSI-RS resource 13,14,15,16
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 13 and 15
				l_0 = 8 for CSI-RS resource 14 and 16
		CSI-RS periodicity	Slots	80 for CSI-RS resource 13,14,15,16
		CSI-RS offset	Slots	5 for CSI-RS resource 13 and 14
				6 for CSI-RS resource 15 and 16
		QCL info		TCI state #7

		Frequency Occupation		Start PRB 0
				Number of PRB =ceil(BWP size/4)*4
	Resource set #13 (Note2)	First subcarrier index in the PRB used for CSI-RS (*k0*)		2 for CSI-RS resource 17,18,19,20
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 17 and 19
				l_0 = 9 for CSI-RS resource 18 and 20
		CSI-RS periodicity	Slots	80 for CSI-RS resource 17,18,19,20
		CSI-RS offset	Slots	5 for CSI-RS resource 17 and 18
				6 for CSI-RS resource 19 and 20
		QCL info		TCI state #12
		Frequency Occupation		Start PRB 0
				Number of PRB =ceil(BWP size/4)*4
	Resource set #14 (Note2)	First subcarrier index in the PRB used for CSI-RS (*k0*)		2 for CSI-RS resource 21,22,23,24
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 21 and 23
				l_0 = 8 for CSI-RS resource 22 and 24
		CSI-RS periodicity	Slots	80 for CSI-RS resource 21,22,23,24
		CSI-RS offset	Slots	5 for CSI-RS resource 21 and 22
				6 for CSI-RS resource 23 and 24
		QCL info		TCI state #13
		Frequency Occupation		Start PRB 0
				Number of PRB =ceil(BWP size/4)*4
	Resource set #15 (Note2)	First subcarrier index in the PRB used for CSI-RS (*k0*)		3 for CSI-RS resource 25,26,27,28
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 5 for CSI-RS resource 25 and 27
				l_0 = 9 for CSI-RS resource 26 and 28
		CSI-RS periodicity	Slots	80 for CSI-RS resource 25,26,27,28
		CSI-RS offset	Slots	5 for CSI-RS resource 25 and 26
				6 for CSI-RS resource 27 and 28
		QCL info		TCI state #14
		Frequency Occupation		Start PRB 0
				Number of PRB =ceil(BWP size/4)*4
	Resource set #16 (Note2)	First subcarrier index in the PRB used for CSI-RS (*k0*)		3 for CSI-RS resource 29,30,31,32
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 4 for CSI-RS resource 29 and 31
				l_0 = 8 for CSI-RS resource 30 and 32
		CSI-RS periodicity	Slots	80 for CSI-RS resource 29,30,31,32
		CSI-RS offset	Slots	5 for CSI-RS resource 29 and 30
				6 for CSI-RS resource 31 and 32

		QCL info		TCI state #15
		Frequency Occupation		Start PRB 0
				Number of PRB =ceil(BWP size/4)*4
NZP CSI-RS for CSI acquisition	Resource set #5	First subcarrier index in the PRB used for CSI-RS (*k0*)		0
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #6	First subcarrier index in the PRB used for CSI-RS (*k0*)		2
		First OFDM symbol in the PRB used for CSI-RS		l0 = 12
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #7	First subcarrier index in the PRB used for CSI-RS (*k0*)		4
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 12
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
	Resource set #8	First subcarrier index in the PRB used for CSI-RS (*k0*)		6
		First OFDM symbol in the PRB used for CSI-RS		l0 = 12
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	0
		QCL info		TCI state #3
	Resource set #17 (Note2)	First subcarrier index in the PRB used for CSI-RS (*k0*)		0
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	1
		QCL info		TCI state #8
	Resource set #18 (Note2)	First subcarrier index in the PRB used for CSI-RS (*k0*)		2
		First OFDM symbol in the PRB used for CSI-RS		l0 = 13
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	1
		QCL info		TCI state #9
	Resource set #19 (Note2)	First subcarrier index in the PRB used for CSI-RS (*k0*)		4
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 13
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	1
		QCL info		TCI state #10
	Resource set #20 (Note2)	First subcarrier index in the PRB used for CSI-RS (*k0*)		6
		First OFDM symbol in the PRB used for CSI-RS		l0 = 13
		CSI-RS periodicity	Slots	160

		CSI-RS offset	Slots	1
		QCL info		TCI state #11
CSI-RS for beam refinement	Resource set #9	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resource 1,2
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 8 for CSI-RS resource 1 l_0 = 9 for CSI-RS resource 2
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	0
		QCL info		TCI state #0
	Resource set #10	First subcarrier index in the PRB used for CSI-RS		k0=1 for CSI-RS resource 3,4
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 8 for CSI-RS resource 3 l_0 = 9 for CSI-RS resource 4
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	0
		QCL info		TCI state #1
	Resource set #11	First subcarrier index in the PRB used for CSI-RS		k0=2 for CSI-RS resource 5,6
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 8 for CSI-RS resource 5 l_0 = 9 for CSI-RS resource 6
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	0
		QCL info		TCI state #2
	Resource set #12	First subcarrier index in the PRB used for CSI-RS		k0=3 for CSI-RS resource 7,8
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 8 for CSI-RS resource 7 l_0 = 9 for CSI-RS resource 8
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	0
		QCL info		TCI state #3
	Resource set #21 (Note2)	First subcarrier index in the PRB used for CSI-RS		k0=0 for CSI-RS resource 9,10
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 10 for CSI-RS resource 9 l_0 = 11 for CSI-RS resource 10
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	1
		QCL info		TCI state #8
	Resource set #22 (Note2)	First subcarrier index in the PRB used for CSI-RS		k0=1 for CSI-RS resource 11,12
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 10 for CSI-RS resource 11 l_0 = 11 for CSI-RS resource 12
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	1
		QCL info		TCI state #9
	Resource set #23 (Note2)	First subcarrier index in the PRB used for CSI-RS		k0=2 for CSI-RS resource 13,14
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 10 for CSI-RS resource 13 l_0 = 11 for CSI-RS resource 14
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	1
		QCL info		TCI state #10
	Resource set #24 (Note2)	First subcarrier index in the PRB used for CSI-RS		k0=3 for CSI-RS resource 15,16
		First OFDM symbol in the PRB used for CSI-RS		l_0 = 10 for CSI-RS resource 15 l_0 = 11 for CSI-RS resource 16
		CSI-RS periodicity	Slots	160
		CSI-RS offset	Slots	1
		QCL info		TCI state #11
TCI state #0	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking Resource set #1' configuration
		QCL Type		Type D

TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 5 from 'CSI-RS for tracking Resource set #2' configuration
		QCL Type		Type D
TCI state #2	Type 1 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 9 from 'CSI-RS for tracking Resource set #3' configuration
		QCL Type		Type D
TCI state #3	Type 1 QCL information	CSI-RS resource		CSI-RS resource 13 from 'CSI-RS for tracking Resource set #4' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 13 from 'CSI-RS for tracking Resource set #4' configuration
		QCL Type		Type D
TCI state #8 (Note2)	Type 1 QCL information	CSI-RS resource		CSI-RS resource 17 from 'CSI-RS for tracking Resource set #13' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 17 from 'CSI-RS for tracking Resource set #13' configuration
		QCL Type		Type D
TCI state #9 (Note2)	Type 1 QCL information	CSI-RS resource		CSI-RS resource 21 from 'CSI-RS for tracking Resource set #14' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 21 from 'CSI-RS for tracking Resource set #14' configuration
		QCL Type		Type D
TCI state #10 (Note2)	Type 1 QCL information	CSI-RS resource		CSI-RS resource 25 from 'CSI-RS for tracking Resource set #15' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 25 from 'CSI-RS for tracking Resource set #15' configuration
		QCL Type		Type D
TCI state #11 (Note2)	Type 1 QCL information	CSI-RS resource		CSI-RS resource 29 from 'CSI-RS for tracking Resource set #16' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 29 from 'CSI-RS for tracking Resource set #16' configuration
		QCL Type		Type D
TCI state #4	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #5	Type 1 QCL information	SSB index		SSB #1
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #1
		QCL Type		Type D
TCI state #6	Type 1 QCL information	SSB index		SSB #2
		QCL Type		Type C

	Type 2 QCL information	SSB index		SSB #2
		QCL Type		Type D
TCI state #7	Type 1 QCL information	SSB index		SSB #3
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #3
		QCL Type		Type D
TCI state #12 (Note2)	Type 1 QCL information	SSB index		SSB #4
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #4
		QCL Type		Type D
TCI state #13 (Note2)	Type 1 QCL information	SSB index		SSB #5
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #5
		QCL Type		Type D
TCI state #14 (Note2)	Type 1 QCL information	SSB index		SSB #6
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #6
		QCL Type		Type D
TCI state #15 (Note2)	Type 1 QCL information	SSB index		SSB #7
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #7
		QCL Type		Type D
Number of HARQ Processes				8
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.3

Note 1: For Test 1-1, SSB # (2k mod 8) , CSI-RS (for tracking) resource set # ((k mod 4)+1), CSI-RS (for CSI acquisition) resource set # ((k mod 4) + 5) and CSI-RS (for beam refinement) resource set # ((k mod 4) + 9) are transmitted by k[th] RRH; SSB # ((2k mod 8)+1) , CSI-RS (for tracking) resource set # ((k mod 4) + 13), CSI-RS (for CSI acquisition) resource set # ((k mod 4) + 17) and CSI-RS (for beam refinement) resource set # ((k mod 4) + 21) are transmitted by k[th] RRH. TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i},\mathrm{n}) = 0$ (i≠0).

PDCCH and PDSCH associated with TCI # (k mod 4) is transmitted by k[th] RRH from slot#

$$\begin{cases} 0 & ,k = 1 \\ (2\mathrm{k}-2)\mathrm{n} + 1 + \mathrm{T}_{\mathrm{HARQ}} + \mathrm{T}_{\mathrm{MAC\ proc}} + \mathrm{T}_{\mathrm{firstSSB}} + \mathrm{T}_{\mathrm{SSB\ proc}} + \mathrm{T}_{\mathrm{firstTRSafterSSB}} + \mathrm{T}_{\mathrm{TRS\ proc}} & ,k = 2,3,4 \ldots \end{cases}$$

to slot#

$$[(2\mathrm{k}-1)\mathrm{n}], k = 1,2,3 \ldots,$$

PDCCH and PDSCH associated with TCI # ((k mod 4)+8) is transmitted by k[th] RRH from slot#

$$\left[(2\mathrm{k}+1)\mathrm{n} + 1 + \mathrm{T}_{\mathrm{HARQ}} + \mathrm{T}_{\mathrm{MAC\ proc}} + \mathrm{T}_{\mathrm{firstSSB}} + \mathrm{T}_{\mathrm{SSB\ proc}} + \mathrm{T}_{\mathrm{firstTRSafterSSB}} + \mathrm{T}_{\mathrm{TRS\ proc}}\right], k = 0,1,2 \ldots$$

to slot#

$$[2(\mathrm{k}+1)\mathrm{n}], k = 0,1,2 \ldots,$$

where k is the RRH number, n = 28800 is half of the number of slots between two RRH, $\mathrm{T}_{\mathrm{HARQ}}$ = 4 is the number of slots between PDSCH and corresponding HARQ-ACK information, $\mathrm{T}_{\mathrm{MAC\ proc}}$ = 24 is the number of slots for MAC CE processing, $\mathrm{T}_{\mathrm{firstSSB}}$ = 132 is the number of slots to first SSB transmission occasion after MAC CE command is decoded by the UE, $\mathrm{T}_{\mathrm{SSB\ proc}}$= 16 is the number of slots for SSB processing, $\mathrm{T}_{\mathrm{firstTRSafterSSB}}$ = 66 is the number of slots to first TRS transmission occasion after first SSB is processed by the UE, $\mathrm{T}_{\mathrm{TRSproc}}$= 16 is the number of slots for TRS processing.

PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.

For Test 1-2, SSB # (k mod 4) , CSI-RS (for tracking) resource set # ((k mod 4)+1), CSI-RS (for CSI acquisition) resource set # ((k mod 4) + 5) and CSI-RS (for beam refinement) resource set # ((k mod 4) + 9) are transmitted by k[th] RRH. TCI state switching command scheduled by MAC CE with MCS 4 is transmitted in slot #i that satisfy $\mathrm{mod}(\mathrm{i},\mathrm{n}) = 0$.

PDCCH and PDSCH associated with TCI # (k mod 4) is transmitted by k[th] RRH from slot#

$$\begin{cases} 0 & ,k = 1 \\ (\mathrm{k}-1)\mathrm{n} + 2 + \mathrm{T}_{\mathrm{HARQ}} + \mathrm{T}_{\mathrm{MAC\ proc}} & ,k = 2,3,4 \ldots \end{cases}$$

to slot#

$$[\mathrm{k} * \mathrm{n}], k = 1,2,3 \ldots,$$

where k is the RRH number, n = 57600 is the number of slots between two RRH, $\mathrm{T}_{\mathrm{HARQ}}$ = 4 is the number of slots between PDSCH and corresponding HARQ-ACK information, $\mathrm{T}_{\mathrm{MAC\ proc}}$ = 24 is the number of slots for MAC CE processing.

PDCCH and PDSCH are DTXed in other slots in which throughput statistics are not considered.
Note 2: Only configured for Test 1-1.

Table 7.2.2.2.4-3: Minimum performance for HST-DPS

Test num.	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation format and code rate	TDD UL-DL pattern	Propagation condition	Number of active PDSCH TCI states	Correlation matrix and antenna configuration	Reference value	
								Fraction of maximum throughput (%)	SNR (dB)
1-1	R.PDSCH.5-12.2 TDD	200 / 120	64QAM, 0.43	FR2.120-1	HST-DPS-FR2-BI-B	1	2x2	70	13.9
1-2	R.PDSCH.5-12.1 TDD	200 / 120	64QAM, 0.43	FR2.120-1	HST-DPS-FR2-UNI-A	2	2x2	70	13.7

7.2A PDSCH demodulation requirements for CA

The parameters specified in Table 7.2-1 for PDSCH single carrier tests are reused for PDSCH CA test unless otherwise stated.

7.2A.1 1RX requirements

(Void)

7.2A.2 2RX requirements

7.2A.2.1 Minimum requirements

For CA with different numbers of DL component carriers, the requirements are defined in Table 7.2A.2.1-3 based on the single carrier requirements for different bandwidth specified in Table 7.2A.2.1-2, with the parameters in Table 7.2A.2.1-1 and the downlink physical channel setup according to Annex C.5.1. The performance requirements specified in this sub-cluase do not apply for UE single carrier test.

Table 7.2A.2.1-1: Test parameters for CA

Parameter		Unit	Value
Duplex mode			TDD
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		1
	Length (L)		Specific to each Reference channel
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0

	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
TDD UL-DL pattern			120kHz SCS: FR2.120-1
The number of slots between PDSCH and corresponding HARQ-ACK information			As defined in Annex A.1.3

Table 7.2A.2.1-2: Single carrier performance for TDD 120 kHz SCS for CA configurations

Bandwidth (MHz)	Reference channel	Modulation format and code rate	Propagation condition	Correlation matrix and antenna configuration	Reference value	
					Fraction of maximum throughput (%)	SNR (dB)
50	R.PDSCH.5-9.1 TDD	16QAM, 0.33	TDLA30-75	2x2, ULA Low	70	10.4
100	R.PDSCH.5-9.2 TDD	16QAM, 0.33	TDLA30-75	2x2, ULA Low	70	10.2
200	R.PDSCH.5-9.3 TDD	16QAM, 0.33	TDLA30-75	2x2, ULA Low	70	10.3
400	R.PDSCH.5-9.4 TDD	16QAM, 0.33	TDLA30-75	2x2, ULA Low	70	10.3

Table 7.2A.2.1-3: Minimum performance for multiple CA configurations

Test number	CA duplex mode	Minimum performance requirements
1	TDD 120 kHz + TDD 120 kHz	As defined in Table 7.2A.2.1-2
Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 7.1.1.5.		

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
Carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 1)		0
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
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Number of PDCCH candidates		1
	Frequency domain resource allocation for CORESET		Start from RB = 0 with contiguous RB allocation
	TCI state		TCI state #1
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k0)		0

	First OFDM symbol in the PRB used for CSI-RS (l0)			CSI-RS resource 1: 4 CSI-RS resource 2: 8 CSI-RS resource 3: 4 CSI-RS resource 4: 8
	Number of CSI-RS ports (X)			1
	CDM Type			No CDM
	Density (ρ)			3
	CSI-RS periodicity		Slots	160
	CSI-RS offset		Slots	80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	QCL info			TCI state #0
NZP CSI-RS for beam refinement	First subcarrier index in the PRB used for CSI-RS (k0)			0
	First OFDM symbol in the PRB used for CSI-RS (l0)			CSI-RS resource 1: 8 CSI-RS resource 2: 9
	Number of CSI-RS ports (X)			1
	CDM Type			No CDM
	Density (ρ)			3
	CSI-RS periodicity		Slots	120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size/4) *4
	Repetition			ON
	QCL info			TCI state #1
PDCCH & PDCCH DMRS Precoding configuration				For number of TX = 1: No precoding; For number of TX > 1: Single Panel Type I, Randomized precoder selection for every REG bundle and updated per slot with equal probability of each applicable i_1/i_2 combination or codebook index, chosen from section 5.2.2.2.1 of TS 38.214 [12].
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for

				tracking' configuration
		QCL Type		Type D
Symbols for all unused REs				OP.1 FDD as defined in Annex A.5.1.1 OP.1 TDD as defined in Annex A.5.2.1
The number of slots between PDSCH and corresponding HARQ-ACK information				Specific to each TDD UL-DL pattern and as defined in Annex A.1.3.
Note 1: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. Note 2: The high layer parameter *precoderGranularity* equals to *sameAsREG-bundle* as defined in clause 7.4.1.3 of TS 38.211 [9]				

7.3.1 1RX requirements

(Void)

7.3.2 2RX requirements

7.3.2.1 FDD

(Void)

7.3.2.2 TDD

The parameters specified in Table 7.3.2.2-1 and 7.3.2.2-2 are valid for all TDD tests unless otherwise stated.

Table 7.3.2.2-1: Test Parameters with 120kHz for FR2

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: Test Parameters with 480kHz for FR2-2

Parameter		Unit	1 Tx Antenna	2 Tx Antenna
TDD UL-DL pattern			FR2.480-1	
CCE to REG mapping type			Interleaved	
REG bundle size			6	2
Interleaver size			2	3
Shift index			0	
PDCCH configuration	Slots for PDCCH monitoring		Every 4th slot	
CSI-RS for tracking	CSI Periodicity	Slots	640	
	CSI-RS offset	Slots	320 for CSI-RS resource 1 and 2 321 for CSI-RS resource 3 and 4	
NZP CSI-RS for beam refinement	CSI-RS periodicity	Slots	640 for CSI-RS resource 1,2	

7.3.2.2.1 Minimum requirements with 1TX antenna

For the parameters specified in Table 7.3.2.2-1 and 7.3.2.2-2, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 7.3.2.2.1-1 and 7.3.2.2.1-2. The downlink physical setup is in accordance with Annex C.5.1.

Table 7.3.2.2.1-1: Minimum performance requirements with 120 kHz SCS for FR2-1

Test number	Bandwidth (MHz)	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	60	1	2	R.PDCCH.5-1.1 TDD	TDLA30-75	1x2 Low	1	6.4
1-2	100	60	1	4	R.PDCCH.5-1.2 TDD	TDLA30-300	1x2 Low	1	3.0

Table 7.3.2.2.1-2: Minimum performance requirements for FR2-2

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR_{BB} (dB)
1a-1	100/120	60	1	2	R.PDCCH.5-1.1 TDD	TDLA30-200	1x2 Low	1	6.6
1a-2	100/120	60	1	4	R.PDCCH.5-1.2 TDD	TDLA30-650	1x2 Low	1	3.9
1a-3	400/480	60	1	8	R.PDCCH.6-1.1 TDD	TDLA10-200	1x2 Low	1	1.2

7.3.2.2.2 Minimum requirements with 2TX antenna

For the parameters specified in Table 7.3.2.2-1 and 7.3.2.2-2, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 7.3.2.2.2-1 and 7.3.2.2.2-2. The downlink physical setup is in accordance with Annex C.5.1.

Table 7.3.2.2.2-1: Minimum performance requirements with 120 kHz SCS for FR2-1

Test number	Bandwidth (MHz)	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	60	1	8	R.PDCCH.5-1.3 TDD	TDLA30-75	2x2 Low	1	0.1
2-2	100	60	2	16	R.PDCCH.5-2.1 TDD	TDLA30-75	2x2 Low	1	-3.0

Table 7.3.2.2.2-2: Minimum performance requirements for FR2-2

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR_{BB} (dB)
3-1	100/120	60	1	8	R.PDCCH.5-1.3 TDD	TDLA30-200	2x2 Low	1	0.1
3-2	100/120	60	2	16	R.PDCCH.5-2.1 TDD	TDLA30-650	2x2 Low	1	-3.1

3-3	400/480	60	2	16	R.PDCCH.6-2.1 TDD	TDLA10-200	2x2 Low	1	-2.9

7.3.2.2.3 Minimum requirements for power saving

During the test the UE shall monitor the *DCI format 2_6* PDCCH in DRX off state and decide whether to receive the following PDCCH in DRX on period.

The parameters specified in Table 7.3.2.2.3-1 are valid for normal PDCCH in DRX on period and PDCCH in DRX off period.

Table 7.3.2.2.3-1: Test Parameters

Parameter		Unit	1 Tx Antenna
TDD UL-DL pattern			FR2.120-1
CCE to REG mapping type			Interleaved
REG bundle size			6
Interleaver size			2
Shift index			0
DRX cycle		ms	10
ps-WakeUp-r16			absent
Wake-up indication bit in DCI format 2_6			1
PDCCH DCI format 2_6 configuration	PS-offset		$(T_{minimumTimeGap}+1)/2^{\mu}/0.125$
	Number of PDCCH candidates		1
	Frequency domain resource allocation for CORESET		Start from RB = 0 with contiguous RB allocation
	TCI state		TCI state #1
PDCCH configuration	Slots for PDCCH monitoring		Each slot during DRX-on period
Note: $T_{minimumTimeGap}$ is signaled as a part of *drx-Adaptation-r16* UE capability.			

For the parameters specified in Table 7.3.2.2.3-2, the average probability of a missed downlink scheduling grant (Pm-dsg) observed on PDCCH during DRX on shall be below the specified value in Table 7.3.2.2.3-2. The downlink physical setup is in accordance with Annex C.5.1.

Table 7.3.2.2.3-2: Minimum performance requirements with 120 kHz SCS

Test number	Bandwidth (MHz)	CORESET RB	CORESET duration	Aggregation level	Reference Channel	Propagation Condition	Antenna configuration and correlation Matrix	Reference value	
								Pm-dsg (%)	SNR_{BB} (dB)
3-1	100	60	1	4	R.PDCCH.5-1.2 TDD	TDLA30-300	1x2 Low	1	3.0
				8	R.PDCCH.5-1.4 TDD				

7.4 PBCH demodulation requirements

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

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

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

7.4.1 1RX requirements

(Void)

7.4.2 2RX requirements

7.4.2.1 FDD

(Void)

7.4.2.2 TDD

Table 7.4.2.2-1: Test parameters for PBCH

Parameter	Unit	Single antenna port
Physical Cell ID		0
Cyclic prefix		Normal
Number of SS/PBCH blocks within an SS burst set periodicity		1
SS/PBCH block index Note1		0
SS/PBCH block periodicity	ms	20
TDD UL-DL pattern Note2		FR2.120-1 for Tests 1-1,1-2,1-3 in Table 7.4.2.2-2 and Tests 2-1, 2-2 in Table 7.4.2.2.3 FR2.480-1 for Test 1-4 in Table 7.4.2.2-2
Note 1: as specified in clause 4.1 of TS 38.213 [11] Note 2: as specified in clause 11.1 of TS 38.213 [11]		

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

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

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	SNR_{BB} (dB)
1-1	100 / 120	R.PBCH.5	TDLA30-300	1 x 2 Low	1	-6.3
1-2	100 / 240	R.PBCH.6	TDLA30-75	1 x 2 Low	1	-6.1
1-3	100 / 120	R.PBCH.5	TDLA30-650	1 x 2 Low	1	-4.5
1-4	400 / 480	R.PBCH.7	TDLA10-200	1 x 2 Low	1	-3.9

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

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	Reference channel	Propagation condition	Antenna configuration and correlation matrix	Reference value	
					Pm-bch (%)	PBCH SNR (dB)
2-1	100 / 120	R.PBCH.5	TDLA30-300	1 x 2 Low	1	-7.9
2-2	100 / 240	R.PBCH.6	TDLA30-75	1 x 2 Low	1	-7.6

7.5 Sustained downlink data rate provided by lower layers

7.5.1 FR2 single carrier requirements

The requirements in this clause are applicable to the FR2 single carrier case.

The requirements and procedure defined in Clause 7.5A.1 apply using operating band instead of CA configuration, and bandwidth instead of bandwidth combination.

For RedCap, the requirements and procedure are defined in Clause 7.5A.1 except that the MIMO layers are configured to 2 for UE supporting 2 MIMO layers and 1 for UE supporting 1 MIMO layers for all operating band. Antenna configuration is 1x2 for UE supporting 1 layer and 2x2 for UE supporting 2 layers.

7.5A Sustained downlink data rate provided by lower layers

7.5A.1 FR2 CA requirements

The Sustained Data Rate (SDR) requirements in this clause are applicable to the FR2 CA.

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

The test parameters are determined by the following procedure:

- Step 1: Calculate the date rate for all supported CA configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities:
  - Use Table 7.5A.1-3 to determine the MCS (=MCS1) achieving the largest data rate [clause 4.1.2 of TS 38.306 [14]] based on UE capabilities.
  - Use Table 7.5A.1-4 to determine the largest MCS (=MCS2) requiring SNR below test equipment maximum achievable SNR for that CA configuration.
  - Compute the data rate for CA configuration using the MCS = min(MCS1,MCS2) and the following equation for each CC in CA bandwidth combination.

$$DataRate = 10^{-3} \sum_{j=1}^{J} TBS_j 2^{\mu_j}$$

where

J is the number of aggregated component carriers in CA bandwidth combination

TBS_j is the total number of DL-SCH transport block bits calculated based on methodology in Clause 5.1.3.2 of TS 38.214 [12] and using parameters from Table 7.5A.1-1

μ_j is provided in Clause 4.2 of TS 38.211 for different subcarrier spacing values

- Step 2: Choose the CA bandwidth combination among all supported CA configurations that achieves maximum data rate in step 1 among all UE capabilities.
  - Set of per CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor in accordance with clause 4.1.2 of TS 38.306 [14].
  - When there are multiple sets of CA bandwidth combinations and UE capabilities (channel bandwidth, subcarrier spacing, number of MIMO layer, modulation format, scaling factor) with same data rate, select one among sets with the smallest aggregated channel bandwidth.
- Step 3: For each CC in chosen CA bandwidth combination, use determined MCS for each CC in step 1 for that CA configuration based on test parameters and indicated UE capabilities.

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

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

The test parameters are specified in Table 7.5A.1-1.

Unless otherwise stated, no user data is scheduled on slot #0, 40 and 41 within 20 ms for SCS 60 kHz.

Unless otherwise stated, no user data is scheduled on slot #0, 80 and 81 within 20 ms for SCS 120 kHz.

Table 7.5A.1-1: Test parameters for FR2 TDD

Parameter		Unit	Value
PDSCH transmission scheme			Transmission scheme 1
PTRS epre-Ratio			0
Channel bandwidth		MHz	Channel bandwidth from selected CA bandwidth combination
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
	First DMRS position for Type A PDSCH mapping		2
Cross carrier scheduling			Not configured
Active DL BWP index			1
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)	RBs	0
	Subcarrier spacing	kHz	60 or 120
DL BWP configuration #1	RB Offset		0
	Number of contiguous PRB		Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing
	Subcarrier spacing	kHz	60 or 120
	Cyclic prefix		Normal
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		Symbols #0
	Number of PRBs in CORESET		Table 7.5A.1-2
	Number of PDCCH candidates and aggregation levels		2/AL2 for 120 kHz / 50 MHz 2/AL4 for 60 kHz / 50 MHz, 120 kHz / 100 MHz 2/AL8 for other greater combinations
	CCE-to-REG mapping type		Non-interleaved
	DCI format		1-1
	TCI State		TCI state #1
	PDCCH &PDCCH DMRS Precoding configuration		For number of TX = 1: No precoding; For number of TX > 1: Single Panel Type I, Randomized precoder selection for every REG bundle and updated per slot with equal probability of precoder index 0 and 2
PDSCH configuration	Mapping type		Type A
	k0		0
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		wideband
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
	Starting symbol (S)		1
	Length (L)		13
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	Length		1
	Antenna ports indexes		{1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs

	Number of PDSCH DMRS CDM group(s) without data		1
PTRS (Note 4)	Frequency density (K_{PT-RS})		2
	Time density (L_{PT-RS})		1
CSI-RS for tracking	Subcarrier indexes in the PRB used for CSI-RS		k_0 = 3 for CSI-RS resource 1,2,3,4
	OFDM symbols in the PRB used for CSI-RS		l_0 = 6 for CSI-RS resource 1 and 3 l_0 = 10 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2,3,4
	CDM Type		'No CDM' for CSI-RS resource 1,2,3,4
	Density (ρ)		3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resource 1,2,3,4 120 kHz SCS: 160 for CSI-RS resource 1,2,3,4
	CSI-RS offset	Slots	60 kHz SCS: 40 for CSI-RS resource 1 and 2 41 for CSI-RS resource 3 and 4 120 kHz SCS: 80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4
	Frequency Occupation		Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	QCL info		TCI state #0
NZP CSI-RS for CSI acquisition	Subcarrier indexes in the PRB used for CSI-RS		k_0 = 4
	OFDM symbols in the PRB used for CSI-RS		l_0 = 13
	Number of CSI-RS ports (X)		Same as number of transmit antenna
	CDM Type		'FD-CDM2'
	Density (ρ)		1
	CSI-RS periodicity	Slots	60 kHz SCS: 80 120 kHz SCS: 160
	CSI-RS offset		0
	Frequency Occupation		Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	QCL info		TCI state #1
ZP CSI-RS for CSI acquisition	Subcarrier indexes in the PRB used for CSI-RS		k_0 = 0
	OFDM symbols in the PRB used for CSI-RS		l_0 = 12
	Number of CSI-RS ports (X)		4
	CDM Type		'FD-CDM2'
	Density (ρ)		1
	CSI-RS periodicity	Slots	60 kHz SCS: 80 120 kHz SCS: 160
	CSI-RS offset		0
	Frequency Occupation		Start PRB 0 Number of PRB = ceil(BWP size/4)*4
CSI-RS for beam refinement	First subcarrier index in the PRB used for CSI-RS		k_0=0 for CSI-RS resource 1,2
	First OFDM symbol in the PRB used for CSI-RS		l_0 = 8 for CSI-RS resource 1 l_0 = 9 for CSI-RS resource 2
	Number of CSI-RS ports (X)		1 for CSI-RS resource 1,2
	CDM Type		'No CDM' for CSI-RS resource 1,2
	Density (ρ)		3 for CSI-RS resource 1,2
	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resource 1,2 120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset	Slots	0 for CSI-RS resource 1,2
	Frequency Occupation		Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	Repetition		ON
	QCL info		TCI state #1

TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A
	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
Maximum number of code block groups for ACK/NACK feedback				1
Number of HARQ Processes				10 for FR2.60-1 and 8 for FR2.120-1
K1 value				Specific to each UL-DL pattern
Maximum number of HARQ transmission				4
PUCCH HARQ ACK spaitial bundling				Not configured
Redundancy version coding sequence				{0,2,3,1}
TDD UL-DL pattern				60 kHz SCS: FR2.60-1 120 kHz SCS: FR2.120-1
PDSCH & PDSCH DMRS Precoding configuration				Single Panel Type I, Precoder index 0 per slot with Wideband granularity for Rank 2
Symbols for all unused REs				OP.1 FDD as defined in Annex A.5.1.1 OP.1 TDD as defined in Annex A.5.2.1
Propagation condition				Static propagation condition No external noise sources are applied
Antenna configuration	1 layer CCs			1x2
	2 layers CCs			2x2
Physical signals, channels mapping and precoding				As specified in Annex B.4.1
Note 1: PDSCH is scheduled only on full DL slots not containing SSB or TRS. Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. Note 3: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing. Note 4: The *frequencyDensity* and *timeDensity* in *phaseTrackingRS* are configured. The actual PT-RS configuration depends on the scheduled MCS according to section 5.1.6.3 from TS 38.214[12].				

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

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

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

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

2	6	0.8	23
2	6	0.75	22
2	6	0.4	14
2	4	1	16
2	4	0.8	16
2	4	0.75	16
2	4	0.4	10
2	2	1	9
2	2	0.8	9
2	2	0.75	9
2	2	0.4	4
Note 1: For the band(s) on which UE supporting “Maximum modulation format” of 8, the MCS index is derived from the rows with “Maximum modulation format” of 6. Note 2: MCS Index is based on MCS index Table 1 defined in clause 5.1.3.1 of TS 38.214 [12].			

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

MCS Index (Note 1)	SNR_{BB}(dB) for maximum number of PDSCH MIMO Layers = 1	SNR_{BB}(dB) for maximum number of PDSCH MIMO Layers = 2
13	6.2	9.0
14	7.2	9.9
15	8.2	10.9
16	8.7	11.6
17	10.1	13.2
18	10.7	13.7
19	11.7	14.7
20	12.7	15.6
21	13.6	16.5
22	14.8	17.6
23	15.6	18.6
24	16.9	19.7
25	18.3	21.2
26	19.3	22.3
27	20.5	23.3
Note 1: MCS Index is based on MCS index Table 1 defined in clause 5.1.3.1 of TS 38.214 [12].		

8 CSI reporting requirements (Radiated requirements)

8.1 General

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

8.1.1 Applicability of requirements

8.1.1.1 General

The minimum performance requirements are applicable to the FR2 operating bands defined in TS 38.101-2 [7] with F_{DL_high} not exceeding 48200 MHz.

The minimum performance requirements in Clause 8 are mandatory for UE supporting NR operation, except test cases listed in Clause 8.1.1.3, 8.1.1.4, 8.1.1.5, 8.1.1.6.

If same test is listed for different UE features/capabilities in Clauses 8.1.1.3 and 8.1.1.4, then this test shall apply for UEs which support all corresponding UE features/capabilities.

8.1.1.2 Applicability of requirements for different number of RX antenna ports

UE shall support 2 RX ports for different RF operating bands. The UE requirements applicability is defined in Table 8.1.1.2-1.

Table 8.1.1.2-1: Requirements applicability

Supported RX antenna ports	Test type	Test list
UE supports 2RX antenna	CQI	All tests in Clause 8.2.2
	PMI	All tests in Clause 8.3.2
	RI	All tests in Clause 8.4.2

8.1.1.3 Applicability of requirements for optional UE features

The performance requirements in Table 8.1.1.3-1 shall apply for UEs which support optional UE features only.

Table 8.1.1.3-1: Requirements applicability for optional UE features

UE feature/capability [14]	Test type		Test list	Applicability notes
256QAM modulation scheme for PDSCH for FR2 (*pdsch-256QAM-FR2*)	FR2 TDD	CQI	Clause 8.2.2.2. 2.1 (Tests 3 and 4)	The test coverage can be considered fulfilled without executing of Test 1 and 2 from Clause 8.2.2.2. 2.1 if UE passes Test 3 and 4 from Clause 8.2.2.2.2.1

8.1.1.4 Applicability of requirements for mandatory UE features with capability signalling

The performance requirements in Table 8.1.1.4-1 shall apply for UEs which support mandatory UE features with capability signalling only.

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

UE feature/capability [14]	Test type		Test list	Applicability notes
Supported maximum number of PDSCH MIMO layers (*maxNumberMIMO-LayersPDSCH)*	FR2 TDD	CQI	Clause 8.2.2.2.1.1	The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability
		RI	Clause 8.4.2.2	
Support of 1 port PTRS (*onePortsPTRS*)	FR2 TDD	CQI	Clause 8.2	
		PMI	Clause 8.3	
		RI	Clause 8.4	

8.1.1.5 Applicability of Channel Quality Indicator (CQI) reporting requirements for CA

8.1.1.5.1 Applicability and test rules for different CA configurations and bandwidth combination sets

The performance requirement for CA CQI tests in clause 8.2A are defined independent of CA configurations and bandwidth combination sets specified in clause5.5A in TS 38.101-2 [7].

For UEs supporting multiple CA capabilities, test any one of the supported CA capabilities with largest aggregated CA bandwidth combination. The categorization of CA capability is specified in clause 7.1.1.5.1.

For UEs supporting multiple CA configurations from the selected CA capability, test any one of the supported CA configurations with largest aggregated CA bandwidth combination. For simplicity, the CA configuration refers to combination of CA configuration and bandwidth combination set.

A single uplink CC is configured for all tests.

8.1.1.5.2 Test coverage for different number of componenet carriers

For CA CQI tests specified in clause 8.2A, among all supported CA capabilities, if corresponding CA tests with the largest number of CCs supported by the UE are tested, the test coverage can be considered fulfilled without executing the CA tests with less than the largest number of CCs supported by the UE.

8.1.1.6 Applicability of requirements for RedCap

The performance requirements in Table 8.1.1.6-1 shall apply for UEs which support optional feature *supportOfRedCap*.

Table 8.1.1.6-1: Requirements applicability for RedCap

UE capability	Test type		Test list	Applicability notes
RedCap with 2RX	FR2 TDD	CQI	Clause 8.2.2.2.1.1 (Tests 1 and 2) Clause 8.2.2.2.2.1 (Test 1)	
		PMI	Clause 8.3.2.2.1 (Tests 2)	
		RI	Clause 8.4.2.2 (Test 2)	

8.1.2 Common test parameters

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

Table 8.1.2-1: Test parameters for CSI test cases

Parameter		Unit	Value
PDSCH transmission scheme			Transmission scheme 1
Duplex Mode			TDD
PTRS *epre-Ratio*			0
Actual carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 3)	RBs	0
	Subcarrier spacing	kHz	120
DL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing
Active DL BWP index			1
Common serving cell parameters	Physical Cell ID		0
	SSB position in burst		First SSB in Slot #0
	SSB periodicity	ms	20
PDCCH configuration	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0,1

	Number of PDCCH candidates and aggregation levels		1/AL8
	DCI format		1_1
	TCI state		TCI state #1
	PDCCH & PDCCH DMRS Precoding configuration		Multi-path fading propagation conditions: Single Panel Type I, Random per slot with equal probability of each applicable i1, i2 combination, and with REG bundling granularity for number of Tx larger than 1 Static propagation conditions: Single Panel Type I, Random precoder chosen from precoder index 0 and 2, selection updated per slot
Additional PDCCH Configuration for Aperiodic Reporting (Note 4)	Slots for PDCCH monitoring		Each slot
	Symbols with PDCCH		0,1
	Number of PDCCH candidates and aggregation levels		1/AL8
	DCI format		0_1
	TCI state		TCI state #1
	PDCCH & PDCCH DMRS Precoding configuration		Multi-path fading propagation conditions: Single Panel Type I, Random per slot with equal probability of each applicable i1, i2 combination, and with REG bundling granularity for number of Tx larger than 1
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		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1
	Number of additional DMRS		1
	DMRS ports indexes		{1000} for Rank1 {1000,1001} for Rank2
	Maximum number of OFDM symbols for DL front loaded DMRS		1
	Number of PDSCH DMRS CDM group(s) without data		2
PTRS (Note 5)	Frequency density (K_{PT-RS})		2

	Time density (L_{PT-RS})			1
	Resource Element Offset			2
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)			4 for CSI-RS resource 1 and 3 8 for CSI-RS resource 2 and 4
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2,3,4
	CDM Type			No CDM for CSI-RS resource 1,2,3,4
	Density (ρ)			3 for CSI-RS resource 1,2,3,4
	CSI-RS periodicity		slot	120kHz SCS: 160 for CSI-RS resource 1,2,3,4
	CSI-RS offset		slot	120 kHz SCS: 80 for CSI-RS resource 1 and 2 81 for CSI-RS resource 3 and 4
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size /4)*4
	QCL info			TCI state #0
NZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size/4)*4
	QCL info			TCI state #1
ZP CSI-RS for CSI acquisition	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size /4)*4
CSI-RS for beam refinement	First subcarrier index in the PRB used for CSI-RS			k_0=0 for CSI-RS resource 1,2
	First OFDM symbol in the PRB used for CSI-RS			l_0 = 8 for CSI-RS resource 1 l_0 = 9 for CSI-RS resource 2
	Number of CSI-RS ports (X)			1 for CSI-RS resource 1,2
	CDM Type			'No CDM' for CSI-RS resource 1,2
	Density (ρ)			3 for CSI-RS resource 1,2
	CSI-RS periodicity		Slots	120 kHz SCS: 160 for CSI-RS resource 1,2
	CSI-RS offset		Slots	0 for CSI-RS resource 1,2
	Frequency Occupation			Start PRB 0 Number of PRB = ceil(BWP size /4)*4
	Repetition			ON
	QCL info			TCI state #1
TCI state #0	Type 1 QCL information	SSB index		SSB #0
		QCL Type		Type C
	Type 2 QCL information	SSB index		SSB #0
		QCL Type		Type D
TCI state #1	Type 1 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type A

	Type 2 QCL information	CSI-RS resource		CSI-RS resource 1 from 'CSI-RS for tracking' configuration
		QCL Type		Type D
Number of HARQ Processes				8
PUCCH HARQ ACK spaitial bundling				Not configured
Redundancy version coding sequence				{0,2,3,1}
K1 value (PDSCH-to-HARQ-timing-indicator)				For FR2.120-1: 3 if mod (i.5) = 0, 6 if mod(i,5) = 2 For FR2.120-2: 11 if mod(i,8) = 0, 7]if mod(i,8) = 4, 6]if mod(i,8) = 5, where i is slot index per radio fame with values 0-79.
Symbols for unused REs				OP.1 FDD as defined in Annex A.5.1.1 OP.1 TDD as defined in Annex A.5.2.1
Physical signals, channels mapping and precoding				As specified in Annex B.4.1
Note 1: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL. Note 2: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission. Note 3: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-2 [7] for tested channel bandwidth and subcarrier spacing. Note 4: Additional PDCCH configuration for aperiodic reporting is only for test cases with aperiodic CSI reporting configured. Note 5: The *frequencyDensity* and *timeDensity* in *phaseTrackingRS* are configured. The actual PT-RS configuration depends on the scheduled MCS according to section 5.1.6.3 from TS 38.214[12].				

8.2 Reporting of Channel Quality Indicator (CQI)

8.2.1 1RX requirements

(Void)

8.2.2 2RX requirements

8.2.2.1 FDD

(Void)

8.2.2.2 TDD

8.2.2.2.1 CQI reporting under AWGN conditions

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

8.2.2.2.1.1 Minimum requirement for periodic CQI reporting

For the parameters specified in Table 8.2.2.2.1.1-1 and Table 8.2.2.2.1.1-2, and using the downlink physical channels specified in Annex C.5.1, the minimum requirements are specified by the following:

a) the reported CQI value shall be in the range of ±1 of the reported median more than 90% of the time;

b) if the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, the BLER using the transport format indicated by the (median CQI + 1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, the BLER using transport format indicated by (median CQI – 1) shall be less than or equal to 0.1.

Table 8.2.2.2.1.1-1 Test parameters for FR2-1

Parameter		Unit	Test 1	Test 2
Bandwidth		MHz	100	
Subcarrier spacing		kHz	120	
Duplex Mode			TDD	
TDD Slot Configuration			FR2.120-2 Annex A.1.3	
SNR_{BB}		dB	8 | 9	14 | 15
Propagation channel			AWGN	
Antenna configuration			2×2 with static channel specified in Annex B.1	
Beamforming Model			As specified in Annex B.4.1	
ZP CSI-RS configuration	CSI-RS resource Type		*Periodic*	
	Number of CSI-RS ports (*X*)		4	
	CDM Type		*FD-CDM2*	
	Density (ρ)		1	
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		8	
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		13	
	CSI-RS periodicity and offset	slot	8/1	
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)		6	
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		13	
	NZP CSI-RS-timeConfig periodicity and offset	slot	8/1	
CSI-IM configuration	CSI-IM resource Type		Periodic	
	CSI-IM RE pattern		1	
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(8, 13)	
	CSI-IM timeConfig periodicity and offset	slot	8/1	
ReportConfigType			*Periodic*	
CQI-table			Table 1	
reportQuantity			*cri-RI-PMI-CQI*	
timeRestrictionForChannelMeasurements			*Not configured*	
timeRestrictionForInterferenceMeasurements			*Not configured*	
cqi-FormatIndicator			*Wideband*	
pmi-FormatIndicator			*Wideband*	
Sub-band Size		RB	8	
csi-ReportingBand			111111111	
CSI-Report periodicity and offset		slot	8/3	
aperiodicTriggeringOffset			*Not configured*	
Codebook configuration	Codebook Type		*typeI-SinglePanel*	
	Codebook Mode		1	
	(CodebookConfig-N1,CodebookConfig-N2)		*Not configured*	

	CodebookSubsetRestriction		010000
	RI Restriction		N/A
Physical channel for CSI report			PUCCH
CQI/RI/PMI delay		ms	8.375
Maximum number of HARQ transmission			1
Measurement channel			As specified in Table A.4-1, TBS.1-2

Table 8.2.2.2.1.1-2 Test parameters for FR2-2

Parameter		Unit	Test 1	Test 2
Bandwidth		MHz	100	
Subcarrier spacing		kHz	120	
Duplex Mode			TDD	
TDD Slot Configuration			FR2.120-2 Annex A.1.3	
SNR_{BB}		dB	0	1	7	8
Propagation channel			AWGN	
Antenna configuration			2×2 with static channel specified in Annex B.1	
Beamforming Model			As specified in Annex B.4.1	
ZP CSI-RS configuration	CSI-RS resource Type		*Periodic*	
	Number of CSI-RS ports (*X*)		4	
	CDM Type		*FD-CDM2*	
	Density (ρ)		1	
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		8	
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		13	
	CSI-RS periodicity and offset	slot	8/1	
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)		6	
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		13	
	NZP CSI-RS-timeConfig periodicity and offset	slot	8/1	
CSI-IM configuration	CSI-IM resource Type		Periodic	
	CSI-IM RE pattern		1	
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(8, 13)	
	CSI-IM timeConfig periodicity and offset	slot	8/1	
ReportConfigType			*Periodic*	
CQI-table			Table 1	
reportQuantity			*cri-RI-PMI-CQI*	
timeRestrictionForChannelMeasurements			*Not configured*	
timeRestrictionForInterferenceMeasurements			*Not configured*	
cqi-FormatIndicator			*Wideband*	
pmi-FormatIndicator			*Wideband*	
Sub-band Size		RB	8	
csi-ReportingBand			111111111	
CSI-Report periodicity and offset		slot	8/3	
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	8.375
Maximum number of HARQ transmission		1
Measurement channel		As specified in Table A.4-1, TBS.1-1

8.2.2.2.2 CQI reporting under fading conditions

8.2.2.2.2.1 Minimum requirement for wideband CQI reporting

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

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

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

a) a CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least α % of the time, where α% is specified in Table 8.2.2.2.2.1-2;

b) the ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ γ, where γ is specified in Table 8.2.2.2.2.1-2;

c) when transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater or equal to 0.01.

Table 8.2.2.2.2.1-1 Test parameters

Parameter		Unit	Test 1		Test 2		Test 3		Test 4	
Bandwidth		MHz	100				50			
Subcarrier spacing		kHz	120							
Duplex Mode			TDD							
TDD Slot Configuration			FR2.120-2 Annex A.1.3							
SNR_{BB}		dB	6	7	12	13	7	8	20	21
Propagation channel			TDLA30-35							
Antenna configuration			2×2 ULA High							
Beamforming Model			As specified in Annex B.4.1							
ZP CSI-RS configuration	CSI-RS resource Type		*Periodic*							
	Number of CSI-RS ports (*X*)		4							
	CDM Type		*FD-CDM2*							
	Density (ρ)		1							
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		8							
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		13							
	CSI-RS periodicity and offset	slot	8/1							
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		*Aperiodic*							
	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)		6							
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		13							
	NZP CSI-RS-timeConfig periodicity and offset	slot	Not configured							

	aperiodicTriggeringOffset		0	
CSI-IM configuration	CSI-IM resource Type		Aperiodic	
	CSI-IM RE pattern		1	
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(8, 13)	
	CSI-IM timeConfig periodicity and offset	slot	Not configured	
ReportConfigType			*Aperiodic*	
CQI-table			Table 1	Table 2
reportQuantity			*cri-RI-PMI-CQI*	
timeRestrictionForChannelMeasurements			*Not configured*	
timeRestrictionForInterferenceMeasurements			*Not configured*	
cqi-FormatIndicator			*Wideband*	
pmi-FormatIndicator			*Wideband*	
Sub-band Size		RB	8	
csi-ReportingBand			111111111	1111
CSI-Report periodicity and offset		slot	Not configured	
Aperiodic Report Slot Offset			6	
CSI request			1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0	
reportTriggerSize			1	
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM	
Codebook configuration	Codebook Type		*typeI-SinglePanel*	
	Codebook Mode		1	
	(CodebookConfig-N1,CodebookConfig-N2)		*Not configured*	
	CodebookSubsetRestriction		000001	
	RI Restriction		N/A	
Physical channel for CSI report			PUSCH	
CQI/RI/PMI delay		ms	1.375	
Maximum number of HARQ transmission			1	
Measurement channel			As specified in Table A.4-1, TBS.1-1	As specified in Table A.4-2, TBS.2-7

Table 8.2.2.2.2.1-2 Minimum requirements

	Test 1	**Test 2**	**Test 3**	**Test 4**
α [%]	2	2	2	2
γ	1.05	1.05	1.05	1.05

8.2A Reporting of Channel Quality Indicator (CQI) for CA

8.2A.1 General

This clause includes the requirements for the reporting of channel quality indicator (CQI) with the UE configured for CA. The purpose is to verify that the CQI is correctly reported in accordance with the CQI definition given in TS 38.214 [12] for each CC with multiple cells configured for periodic reporting.

8.2A.2 1RX requirements

(Void)

8.2A.3 2RX requirements

8.2A.3.1 CQI reporting definition under AWGN conditions

8.2A.3.1.1 Minimum requirement for periodic CQI reporting

For the CA CQI reporting test defined in Table 8.2A.3.1.1-4, the test requirements and the test parameters are defined as below.

For each CC, the test parameters are specified in Table 8.2A.3.1.1-1.

For CA with 2 DL CC, for the SNR configuration specified in Table 8.2A.3.1.1-2, and using the downlink physical channels specified in Annex C.5.1 on each CC, the difference between the wideband CQI indices of PCell and SCell reported shall be such that

$$\text{wideband CQI}_{\text{PCell}} - \text{wideband CQI}_{\text{SCell}} \geq 2$$

for more than 90% of the time.

For CA with 3 or more DL CC, for the SNR configuration specified in Table 8.2A.3.1.1-3, and using the downlink physical channels specified in Annex C.5.1 on each cell, the difference between the wideband CQI indices of PCell and SCell1 reported, and the difference between the wideband CQI indices of SCell1 and SCell2, 3… reported shall be such that

$$\text{wideband CQI}_{\text{PCell}} - \text{wideband CQI}_{\text{SCell1}} \geq 2$$

$$\text{wideband CQI}_{\text{SCell1}} - \text{wideband CQI}_{\text{SCell2, 3...}} \geq 2$$

for more than 90% of the time.

Table 8.2A.3.1.1-1: CA CQI reporting test parameters for each CC

Parameter		Unit	Value
Subcarrier spacing		kHz	120
Duplex Mode			TDD
TDD Slot Configuration			FR2.120-2 Annex A.1.3
Propagation channel			AWGN
Antenna configuration			1×2 with static channel specified in Annex B.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		8
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		13
	CSI-RS periodicity and offset	slot	8/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (*X*)		1
	CDM Type		No CDM
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		6
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		13
	NZP CSI-RS-timeConfig periodicity and offset	slot	8/1
CSI-IM configuration	CSI-IM resource Type		Periodic
	CSI-IM RE pattern		1
	CSI-IM Resource Mapping ($k_{\text{CSI-IM}}$,$l_{\text{CSI-IM}}$)		(8, 13)
	CSI-IM timeConfig periodicity and offset	slot	8/1
ReportConfigType			Periodic

CQI-table		Table 1
reportQuantity		cri-RI-PMI-CQI (Note 1)
timeRestrictionForChannelMeasurements		Not configured
timeRestrictionForInterferenceMeasurements		Not configured
cqi-FormatIndicator		Wideband
pmi-FormatIndicator		Wideband
Sub-band Size	RB	8 for 50MHz, 100MHz, 16 for 200MHz, 32 for 400MHz
csi-ReportingBand		111111111
CSI-Report periodicity and offset	slot	8/3
aperiodicTriggeringOffset		Not configured
Codebook configuration		Not configured
Physical channel for CSI report		PUCCH
CQI/RI/PMI delay	ms	8.375
Maximum number of HARQ transmission		1
Measurement channel		Derived as per section 5.1.3.2 of TS 38.214 [12]
Note 1: The bitwidth of PMI for UCI on PUCCH in a case 1-port CSI-RS is configured as channel measurement resource is given in [10], section 6.3.1.1.2.		

Table 8.2A.3.1.1-2: SNR configurations for 2 DL CA

Parameter	PCell	SCell
SNR (dB)	10.0	4.0

Table 8.2A.3.1.1-3: SNR configurations for 3 or more DL CA

Parameter	PCell	SCell1	SCell2, 3…
SNR (dB)	12.0	6.0	0.0

Table 8.2A.3.1.1-4: List of CA CQI reporting test

Test number	CA duplex mode and SCS combination
1	TDD 120 kHz + TDD 120 kHz
Note 1: The applicability of requirements for different CA configurations and bandwidth combination sets is defined in 8.1.1.5.1.	

8.3 Reporting of Precoding Matrix Indicator (PMI)

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

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

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

In the definition of γ, for 2TX PMI requirements, t_{ue} is 90 % of the maximum throughput obtained at SNR_{ue} using the precoders configured according to the UE reports, and t_{rnd} is the throughput measured at SNR_{ue} with random precoding.

8.3.1 1RX requirements

(Void)

8.3.2 2RX requirements

8.3.2.1 FDD

(Void)

8.3.2.2 TDD

8.3.2.2.1 Single PMI with 2TX TypeI-SinglePanel Codebook

For the parameters specified in Table 8.3.2.2.1-1, and using the downlink physical channels specified in Annex C.5.1, the minimum requirements are specified in Table 8.3.2.2.1-2.

Table 8.3.2.2.1-1: Test parameters (single layer)

Parameter		Unit	Test 1	Test 2
Bandwidth		MHz	100	100
Subcarrier spacing		kHz	120	120
TDD DL-UL configuration			FR2.120-2 as specified in Annex A.1.3	FR2.120-1 as specified in Annex A.1.3
Propagation channel			TDLA30-35	TDLA30-35
Antenna configuration			2 x 2 ULA Low	2 x 2 ULA Low
Beamforming Model			As specified in Annex B.4.1	As specified in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic
	Number of CSI-RS ports (*X*)		4	4
	CDM Type		FD-CDM2	FD-CDM2
	Density (ρ)		1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 4, (8,-)	Row 4, (8,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)	(13,-)
	CSI-RS periodicity and offset	slot	8/1	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic	Aperiodic
	Number of CSI-RS ports (*X*)		2	2
	CDM Type		FD-CDM2	FD-CDM2
	Density (ρ)		1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3, (6,-)	Row 3, (6,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)	(13,-)
	CSI-RS periodicity and offset	slot	Not configured	Not configured

	aperiodicTriggering Offset		0	0
CSI-IM configuration	CSI-IM resource Type		Aperiodic	Aperiodic
	CSI-IM RE pattern		Pattern 1	Pattern 1
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(8,13)	(8,13)
	CSI-IM timeConfig periodicity and offset	slot	Not configured	Not configured
ReportConfigType			Aperiodic	Aperiodic
CQI-table			Table 1	Table 1
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			Not configured	Not configured
timeRestrictionForInterferenceMeasurements			Not configured	Not configured
cqi-FormatIndicator			Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband
Sub-band Size		RB	8	8
csi-ReportingBand			111111111	111111111
CSI-Report periodicity and offset		slot	Not configured	Not configured
Aperiodic Report Slot Offset			6	8
CSI request			1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0	1 in slots i, where mod(i, 5) = 1, otherwise it is equal to 0
reportTriggerSize			1	1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM	One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A	N/A
	CodebookSubsetRestriction		001111	001111
	RI Restriction		N/A	N/A
Physical channel for CSI report			PUSCH	PUSCH
CQI/RI/PMI delay		ms	1.375	1.75
Maximum number of HARQ transmission			4	4
Measurement channel			R.PDSCH.5-8.1 TDD	R.PDSCH.5-7.1 TDD
PDSCH & PDSCH DMRS Precoding configuration for random Precoding			Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable codebook index, chosen from section 5.2.2.2.1 of	

		TS 38.214 [12], and with Wideband granularity
Note 1: For random precoder selection, the precoder shall be updated in each slot (0.125 ms granularity). Note 2: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation at a downlink slot not later than slot#(n-4)], this reported PMI cannot be applied at the gNB downlink before slot#(n+4)]. Note 3: Randomization of the principle beam direction shall be used as specified in Annex B.2.3.2.3.		

Table 8.3.2.2.1-2: Minimum requirement

Parameter	Test 1	Test 2
γ	1.05	1.05

8.4 Reporting of Rank Indicator (RI)

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

8.4.1 1RX requirements

(Void)

8.4.2 2RX requirements

8.4.2.1 FDD

(Void)

8.4.2.2 TDD

The minimum performance requirement in Table 8.4.2.2-2 is defined as

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

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

For the parameters specified in Table 8.4.2.2-1, and using the downlink physical channels specified in Annex C.5.1, the minimum requirements are specified in Table 8.4.2.2-2.

Table 8.4.2.2-1: RI Test (TDD)

Parameter		Unit	Test 1	Test 2	Test 3
Bandwidth		MHz	100	100	100
Subcarrier spacing		kHz	120	120	120
Duplex Mode			TDD	TDD	TDD
TDD Slot Configuration			FR2.120-2	FR2.120-2	FR2.120-2
SNR		dB	0	16	16
Propagation channel			TDLA30-35	TDLA30-35	TDLA30-35
Antenna configuration			ULA Low 2x2	ULA Low 2x2	XP High 2x2
Beamforming Model			As defined in Annex B.4.1	As defined in Annex B.4.1	As defined in Annex B.4.1
ZP CSI-RS configuration	CSI-RS resource Type		Periodic	Periodic	Periodic
	Number of CSI-RS ports (*X*)		4	4	4
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2

	Density (ρ)		1	1	1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 4, (8,-)	Row 4, (8,-)	Row 4, (8,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)	(13,-)	(13,-)
	CSI-RS periodicity and offset	slot	8/1	8/1	8/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic	Aperiodic	Aperiodic
	Number of CSI-RS ports (*X*)		2	2	2
	CDM Type		FD-CDM2	FD-CDM2	FD-CDM2
	Density (ρ)		1	1	1
	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	Not configured	Not configured	Not configured
	aperiodicTriggeringOffset		0	0	0
CSI-IM configuration	CSI-IM resource Type		Periodic	Periodic	Periodic
	CSI-IM RE pattern		Pattern 1	Pattern 1	Pattern 1
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(8,13)	(8,13)	(8,13)
	CSI-IM timeConfig periodicity and offset	slot	Not configured	Not configured	Not configured
ReportConfigType			Apperiodic	Apperiodic	Apperiodic
CQI-table			Table 1	Table 1	Table 1
reportQuantity			cri-RI-PMI-CQI	cri-RI-PMI-CQI	cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured	not configured	not configured
timeRestrictionForInterferenceMeasurements			not configured	not configured	not configured
cqi-FormatIndicator			Wideband	Wideband	Wideband
pmi-FormatIndicator			Wideband	Wideband	Wideband
Sub-band Size		RB	8	8	8
csi-ReportingBand			111111111	111111111	111111111
CSI-Report periodicity and offset		slot	Not configured	Not configured	Not configured
Aperiodic Report Slot Offset			6	6	6
CSI request			1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0	1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0	1 in slots i, where mod(i, 8) = 1, otherwise it is equal to 0
reportTriggerSize			1	1	1
CSI-AperiodicTriggerStateList			One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM	One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM	One State with one Associated Report Configuration Associated Report Configuration contains pointers to NZP CSI-RS and CSI-IM
Codebook configuration	Codebook Type		typeI-SinglePanel	typeI-SinglePanel	typeI-SinglePanel
	Codebook Mode		1	1	1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A	N/A	N/A
	CodebookSubsetRestriction		010000 for fixed rank 2, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank	000011 for fixed rank 1, 010011 for following rank

	RI Restriction		N/A	N/A	N/A
Physical channel for CSI report			PUSCH	PUSCH	PUSCH
CQI/RI/PMI delay		ms	1.375	1.375	1.375
Maximum number of HARQ transmission			1	1	1
RI Configuration			Fixed RI = 2 and follow RI	Fixed RI = 1 and follow RI	Fixed RI = 1 and follow RI
Note 1: Measurements channels are specified in Table A.4-1. TBS.1-1 is used for Rank 1 case. TBS.1-2 is used for Rank 2 case.					

Table 8.4.2.2-2: Minimum requirement (TDD)

	Test 1	Test 2	Test 3
γ_1	N/A	1.05	1.05
γ_2	1.0	N/A	N/A

9 Demodulation performance requirements for interworking

9.1 General

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

9.1.1 Applicability of requirements

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

- For UEs supporting both SA and NSA,
  - The performance requirements specified in Clause 5 will be verified only for SA except for the sustained downlink data rate test specified in Clause 5.5 and 5.5A.
  - The performance requirements specified in Clause 7 will be verified only for SA except for the sustained downlink data rate test specified in Clause 7.5 and 7.5A.
  - The sustained downlink data rate tests specified in Clauses 5.5, 5.5A and 7.5, 7.5A for SA and in Clause 9.4B for NSA are verified separately.
- The FR1 EN-DC test cases with the NR TDD DL-UL configurations which are not aligned with LTE's can be tested on the corresponding EN-DC band combinations where UE supports simultaneous transmission and reception.
- For UEs supporting NR FR1 CA and/or NR CA including FR1 and FR2, the requirements applicability is specified in Table 9.1.1-1.

Table 9.1.1-1: Requirements applicability for UEs supporting NR FR2 CA and NR CA including FR1 and FR2

Supported scenarios	Requirements
NR FR2 CA	Clause 7.5A
NR CA including FR1 and FR2	Clause 9.4A.1, 9.3A.1
Both NR FR2 CA and NR CA including FR1 and FR2	Clause 7.5A

- For UEs supporting EN-DC including FR2 and/or EN-DC including FR1 and FR2, the requirements applicability is specified in Table 9.1.1-2.

Table 9.1.1-2: Requirements applicability for UEs supporting EN-DC including FR2 and EN-DC including FR1 and FR2

Supported scenarios	SDR requirements	PDSCH requirements	PDCCH requirements
EN-DC including FR2	Clause 9.4B.1.2	Clause 9.2B.1.2	Clause 9.3B.1.2
EN-DC including FR1 and FR2	Clause 9.4B.1.3	Clause 9.2B.1.3	Clause 9.3B.1.3
Both EN-DC including FR2 and EN-DC including FR1 and FR2	Clause 9.4B.1.2	Clause 9.2B.1.2	Clause 9.3B.1.2

- For UEs supporting NR-DC including FR1 and FR2, if the FR2 requirements in Clause 7.2 and Clause 7.3 are tested, the test coverage can be considered fulfilled without executing requirements in Clause 9.2B.2 and Clause 9.3B.2.
- For UEs supporting NR-DC between FR1 and FR2, if requirements in Clause 9.4A.1 are tested under same or higher data rate as in Clause 9.4B.2, the test coverage can be considered fulfilled without executing the requirements in Clause 9.4B.2.
- For UEs supporting NE-DC and EN-DC, the test coverage of demodulation performance requirements can be considered fulfilled, if the demodulation requirements in Clause 5 and Clause 9.4B.1 are executed for UE under test in the standalone mode.
- For UEs supporting NE-DC and not supporting EN-DC, the test coverage of demodulation performance requirements can be considered fulfilled, if the demodulation requirements in Clause 5 and Clause 9.4B.3 are executed for UE under test.
- For UEs supporting NGEN-DC, the test coverage of demodulation performance requirements can be considered fulfilled, if the demodulation requirements in Clause 5 and Clause 9.4B.1 are executed for UE under test.
- For UEs supporting FR1 intra-band contiguous and non-contiguous EN-DC, the requirements applicability is specified in Table 9.1.1-3.

Table 9.1.1-3: Requirements applicability for UE supporting FR1 intra-band and inter-band EN-DC

	Inter-band scenarios are not supported	UE indicates “interBandContiguousMRDC” (Note 1, Note 2)	UE does not indicate “interBandContiguousMRDC” (Note 1, Note 3)
Intra-band scenarios are not supported	N/A	Clause 9.5B.1.1 is executed for inter-band EN-DC scenarios	Clause 9.5B.1.2 is executed for inter-band EN-DC scenarios
UE does not indicate “intraBandENDC-Support” or UE indicates “both” in “intraBandENDC-Support” (Note 4)	Clause 9.5B.1.1 is only executed for intra-band EN-DC scenarios	Clause 9.5B.1.1 is executed for both intra-band and inter-band EN-DC scenarios	Clause 9.5B.1.1 is only executed for intra-band EN-DC scenarios
UE indicates “non-contiguous” in “intraBandENDC-Support” (Note 5)	Clause 9.5B.1.2 is only executed for intra-band EN-DC scenarios	Clause 9.5B.1.1 is executed for inter-band EN-DC scenarios	Clause 9.5B.1.2 is executed for both intra-band and inter-band EN-DC scenarios

Note 1: Requirements are applicable to intra-band scenarios and only inter-band scenarios from Table 5.5B.4.1-1 of TS 38.101-3 [8] for which Note 4 is applied.
Note 2: UE supports both intra-band contiguous and non-contiguous EN-DC requirements for supported inter-band EN-DC combinations.
Note 3: UE supports intra-band non-contiguous EN-DC requirements for supported inter-band EN-DC combinations.
Note 4: UE supports intra-band contiguous EN-DC, or both intra-band contiguous and non-contiguous EN-DC for supported intra-band EN-DC combinations.
Note 5: UE supports only intra-band non-contiguous EN-DC for supported intra-band EN-DC combinations.

9.1.1.1 Applicability of requirements for optional UE features

Table 9.1.1.1-1: Void

The applicability rule defined in Clause 5.1.1.3 shall be applied for performance requirements in Clauses 9.2B.1.1 and 9.4B.1.1.

The applicability rule defined in Clause 7.1.1.3 shall be applied for performance requirements in Clauses 9.2B.1.2, 9.4A.1, 9.4B.1.2 and 9.4B.1.3.

The performance requirements in Table 9.1.1.1-2 shall apply for UEs which support optional UE features only.

Table 9.1.1.1-2 Requirements applicability for optional UE features

UE feature/capability [14]	Test type		Test list
Support of 480kHz SCS for FR2-2 (*ul-FR2-2-SCS-480kHz-r17)*	FR2-2 TDD	PDSCH	Clause 9.2A.1.1 (Table 9.2A.1-5: Test 1-5, 1-6)
		PDCCH	Clause 9.3A.1.1

9.1.1.2 Applicability of requirements for mandatory UE features with capability signalling

The applicability rule defined in Clause 5.1.1.4 shall be applied for performance requirements in Clauses 9.2B.1.1 and 9.4B.1.1.

The applicability rule defined in Clause 7.1.1.4 shall be applied for performance requirements in Clauses 9.2B.1.2, 9.4A.1, 9.4B.1.2 and 9.4B.1.3.

9.1.1.3 Applicability of requirements for operating bands in FR2-2

The requirements in Table 9.1.1.3-1 are applicable for bands with F_{DL_high} higher than 52600 MHz and lower than 71000 MHz;

Other performance requirements mandatory for UE supporting NR operation defined in Section 9 but not included in Table 9.1.1.3-1 should not be considered applicable to FR2-2 bands;

Table 9.1.1.3-1: Requirements applicability for operating bands in FR2-2

Test type		Test list	Applicability notes
FR2-2 TDD	PDSCH	Clause 9.2A.1.1 (Table 9.2A.1-5: Test 1-2)	The requirements apply if the device supports initial access on FR2-2 frequencies, or if it supports both Single Carrier and CA_AX (FR1+FR2-2) operations;
		Clause 9.2A.1.1 (All Tests in Table 9.2A.1-5, except for Test 1-2)	The requirements apply if the device supports CA_AX (FR1+FR2-2) operations in FR2-2 and not initial access on FR2-2 frequencies.
	PDCCH	Clause 9.3A.1.1	

9.1.2 E-UTRA Cell setup

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

9.1.2.1 FDD

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

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

Table 9.1.2.1-1: Common Test Parameters (FDD)

Parameter	Unit	Value
Cyclic prefix		Normal
Physical Cell ID		0
Number of PDCCH symbols	symbols	1
PHICH Ng (Note 1)		1
PHICH duration		Normal
Number of HARQ processes per component carrier	Processes	8
Maximum number of HARQ transmission		4
Redundancy version coding sequence		{0,0,1,2} for 64QAM
Propagation condition		Static propagation condition No external noise sources are applied
Transmission mode		1
Transmission time difference between E-UTRA cell and NR cell(s)	µs	0
Antenna configuration		All NR cells are in FR1: 1x2 Any NR cell is in FR2: 1 Tx[Note 1]
Codebook subset restriction		10
Symbols for all unused REs		OCNG in Annex A.5
Note 1: As the link can be provided over the air, the UE Rx antenna configuration is not relevant for the test configuration and has no impact on the test implementation.		

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

Test setup	Bandwidth (MHz)	Downlink power allocation (dB)		
		ρ_A	ρ_B	σ
1	5	0	0	0
2	10	0	0	0
3	15	0	0	0
4	20	0	0	0

9.1.2.2 TDD

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

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

Table 9.1.2.2-1: Common Test Parameters (TDD)

Parameter	Unit	Value
UL DL configuration		2 (Note1)
Special subframe configuration		7
Number of PDCCH symbols	symbols	1
PHICH Ng (Note 3)		1
PHICH duration		Normal
Cyclic prefix		Normal
Cell ID		0
Maximum number of HARQ transmission		4
Redundancy version coding sequence		{0,0,1,2} for 64QAM
Propagation condition		Static propagation condition No external noise sources are applied
Transmission mode		1
Transmission time difference between E-UTRA cell and NR cell(s)	µs	0
Antenna configuration		All NR cells are in FR1: 1x2 Any NR cell is in FR2: 1 Tx[Note 2]
Codebook subset restriction		10
Symbols for all unused REs		OCNG in Annex A.5

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

Note 2: As the link can be provided over the air, the UE Rx antenna configuration is not relevant for the test configuration and has no impact on the test implementation.

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

Test setup	Bandwidth (MHz)	Downlink power allocation (dB)		
		ρ_A	ρ_B	σ
1	10	0	0	0
2	15	0	0	0
3	20	0	0	0

9.2 PDSCH Demodulation

9.2A PDSCH demodulation for CA

9.2A.1 NR CA between FR1 and FR2

9.2A.1.1 NR CA between FR1 and FR2-2

The performance requirements for SCell on FR2-2 band are specified in Table 9.2A.1-5. The test parameters for SCell are specified in Table 7.2.2.2.1-2 with additional change of PDSCH resource allocation type specified in Table 9.2A.1-1:

Table 9.2A.1-1: PDSCH resource allocation type

Test numer	Allocation Type	Start RB	L_{RBs}
1-1	Type 1	98	66
1-2			
1-3			
1-4			
1-6		24	20
1-5[Note1]	Type 0	N/A	N/A
Note 1: Full BWP is allocated for PDSCH			

The test parameters for PCell in Table 9.2A.1-3 and the downlink physical channel setup according to Annex C.3.1. In this test, Pcell is in FR1 and Scell is in FR2-2 and only requirements for Scell should be verified.

The test purposes are specified in Table 9.2A.1-2.

Table 9.2A.1-2: Tests purpose

Purpose	Test index
Verify the PDSCH mapping Type A normal performance in FR2-2 Scell CC in CA between FR1 and FR2-2 under 2 receive antenna conditions and with different channel models, MCSs and number of MIMO layers	1-1,1-2,1-3,1-4,1-5,1-6

Table 9.2A.1-3: Test parameters for PCell

Parameter		Unit	Value
Duplex mode			TDD
Bandwidth		MHz	40
Subcarrier spacing		kHz	30
TDD pattern			FR1.30-1
Active DL BWP index			1
PDSCH configuration	Mapping type		Type A
	k0		0
	Starting symbol (S)		2
	Length (L)		12
	PDSCH aggregation factor		1
	PRB bundling type		Static
	PRB bundling size		2
	Resource allocation type		Type 0
	RBG size		Config2
	VRB-to-PRB mapping type		Non-interleaved
	VRB-to-PRB mapping interleaver bundle size		N/A
PDSCH DMRS configuration	DMRS Type		Type 1

	Dmrs-AdditionalPosition		pos1
	Maximum number of OFDM symbols for DL front loaded DMRS		1
Number of HARQ Processes			8
The number of slots between PDSCH and corresponding HARQ-ACK information			Specific to each TDD UL-DL pattern and as defined in Annex A.1.2
PUCCH format for HARQ-ACK feedback			PUCCH format 3

Table 9.2A.1-4: K1 values for each CC

Cells	K1 values
Pcell CC	{8,7,6,5,4,3,2}
SCell CC with 120kHz	{8,8,8,8,7,7,7,7}
SCell CC with 480kHz (Note 1)	{8,8,8,7}
Note 1: One k1 value applies for 4 TBs scheduledby one DCI	

Table 9.2A.1-5: Minimum performance for Rank 1 (FRC) in Scell CC

Test num	Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Modulation and code rate	TDD UL-DL pattern	Propagation condition	Correlation matrix and antenna configuration	Reference value	
							Fraction of max through-put (%)	SNR_{BB} (dB)
1-1	R.PDSCH.5-12.1 TDD	400 / 120	QPSK, 0.30	FR2.120-1	TDLA30-650	2x2 ULA Low	70	0.9
1-2	R.PDSCH.5-13.1 TDD	400 / 120	16QAM, 0.48	FR2.120-1	TDLA30-200	2x2 ULA Low	70	9.0
1-3	R.PDSCH.5-13.1	400 / 120	16QAM, 0.48	FR2.120-1	TDLA30-650	2x2 ULA Low	30	2.7
1-4	R.PDSCH.5-14.1 TDD	400 / 120	64QAM, 0.43	FR2.120-1	TDLD30-200	2x2 ULA Low	70	11.6
1-5	R.PDSCH.8-3.1 TDD	400 / 480	QPSK, 0.30	FR2.480-1	TDLA10-200	2x2 ULA Low	70	1.0
1-6	R.PDSCH.8-4.1 TDD	400 / 480	16QAM 0.48	FR2.480-1	TDLD10-200	2x2 ULA Low	70	8.3

9.2B PDSCH demodulation for DC

9.2B.1 EN-DC

9.2B.1.1 EN-DC within FR1

9.2B.1.1.1 PDSCH

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PDSCH demodulation performance requirements for NR are specified in Clause 5.2. During the test, only the PDSCH performance on the NR cell(s) shall be verified.

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

9.2B.1.2.1 PDSCH

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

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

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PDSCH demodulation performance requirements for NR are specified in Clause 9.2B.1.1 and Clause 9.2B.1.2. During the test, only the PDSCH performance on the NR cell(s) on FR2 carriers shall be verified.

9.2B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2. The PDSCH demodulation performance requirements for NR FR2 cell(s) are specified in Clause 7.2. During the test, only the PDSCH performance on FR2 NR cell(s) shall be verified.

9.3 PDCCH demodulation

9.3A PDCCH demodulation for CA

9.3A.1 NR CA between FR1 and FR2

9.3A.1.1 NR CA between FR1 and FR2-2

The test setup for FR1 PCell is specified in Table 9.2A.1-3. The NR PDCCH demodulation performance requirements for NR are specified in Clause 7.3. During the test, only the PDCCH performance on the FR2-2 carrier shall be verified.

9.3B PDCCH demodulation for DC

9.3B.1 EN-DC

9.3B.1.1 EN-DC within FR1

9.3B.1.1.1 PDCCH

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PDCCH demodulation performance requirements for NR are specified in Clause 5.3. During the test, only the PDCCH performance on the single NR cell shall be verified.

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

9.3B.1.2.1 PDCCH

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

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

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PDCCH demodulation performance requirements are specified in Clause 9.3B.1.1 and Clause 9.3B.1.2. During the test, only the PDCCH performance on the NR cell(s) on FR2 carriers shall be verified.

9.3B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2. The PDCCH demodulation performance requirements for NR FR2 cell are specified in Clause 7.3. During the test, only the PDCCH performance on FR2 NR cell shall be verified.

9.4 Void

9.4A SDR test for CA

9.4A.1 NR CA between FR1 and FR2

The Sustained Data Rate (SDR) requirements in this clause are applicable to the NR CA between FR1 and FR2 NR carriers.

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

The test parameters are determined by the following procedure:

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

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

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

9.4B SDR test for DC

9.4B.1 EN-DC

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

9.4B.1.1 EN-DC within FR1

9.4B.1.1.1 SDR test

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

The purpose of the test is to verify that the Layer 1 and Layer 2 correctly process in a sustained manner the received packets corresponding to the maximum data rate indicated by UE capabilities. The sustained downlink data rate shall be

verified in terms of the success rate of delivered PDCP SDU(s) by Layer 2. The test case below specifies the RF conditions and the required success rate of delivered TB by Layer 1 to meet the sustained data rate requirement.

The test parameters are determined by the following procedure:

- Select one EN-DC bandwidth combination among all supported EN-DC configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities that provides the largest data rate [in accordance with clause 4.1.2 of TS 38.306 [14]].
  - Set of per NR CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor in accordance with clause 4.1.2 of TS 38.306 [14].
  - Set of per E-UTRA CC UE capabilities includes channel bandwidth, number of PDSCH MIMO layers and modulation format in accordance with clause 4.1.2 of TS 38.306 [14].
  - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with same largest data rate, select one among sets with the smallest aggregated channel bandwidth.
- For each NR FR1 CC in EN-DC bandwidth combination, use Table 5.5A-5 and Table 5.5A-6 in Clause 5.5A to determine MCS based on test parameters and indicated UE capabilities.
- For each E-UTRA CC in EN-DC bandwidth combination, use Table 9.4B.1.1.1-2 and Table 9.4B.1.1.1-3 to determine FRC based on test parameters and indicated UE capabilities.

The test setup for E-UTRA Pcell is specified in Clause 9.1.2 and Table 9.4B.1.1.1-1. The NR SDR tests setup is specified in Clause 5.5A. During the test, the PDSCH performance on both the NR cell(s) and LTE cell(s) shall be verified.

The TB success rate shall be higher than 85% when NR PDSCH is scheduled with MCS defined for the selected EN-DC bandwidth combination and with the downlink physical channel setup according to Annex C.3.1 and when E-UTRA PDSCH is scheduled with FRC defined for the selected EN-DC bandwidth combination and with the downlink physical channel setup according to Annex C.3.2 from TS 36.101 [4]. The TB success rate of delivered PDCP SDU(s) by Layer2 is defined according to the different DRB type: Split bearer, MCG or SCG bearer.

- For the configuration of DRB type of Split bearer, the TB success rate across CGs is defined as TB success rate = 100%*NDL_correct_rx/ (NDL_newtx + NDL_retx), where NDL_newtx is the number of newly transmitted DL transport blocks, NDL_retx is the number of retransmitted DL transport blocks, and NDL_correct_rx is the number of correctly received DL transport blocks. All the above numbers of transmitted, retransmitted or correctly received DL transport blocks are calculated as the sum of the numbers of DL transport blocks across all the CGs used for DC transmission or reception.
- For the configuration of DRB type of MCG or SCG bearer, the TB success rate across CGs is defined as TB success rate = 100%*NDL_correct_rx/ (NDL_newtx + NDL_retx), where NDL_newtx is the number of newly transmitted DL transport blocks, NDL_retx is the number of retransmitted DL transport blocks, and DL_correct_rx is the number of correctly received DL transport blocks. All the above numbers of transmitted, retransmitted or correctly received DL transport blocks are calculated as the sum of the numbers of DL transport blocks per CG used for DC.

Table 9.4B.1.1.1-1: Additional test setup for E-UTRA CC

Parameter	Unit	Value
Inter-TTI Distance		1
Number of OFDM symbols for PDCCH per component carrier	OFDM symbols	1
Cross carrier scheduling		Not configured
Propagation condition		Static propagation condition No external noise sources are applied
$\hat{E}_s$ at antenna port	dBm/15kHz	-85
Antenna configuration	2 layer CC	2x2 or 2x4
	4 layer CC	4x4
Codebook subset restriction	2 layer CC	10
	4 layer CC	1000
Downlink power	2 layer CC	ρ_A = -3dB, ρ_B = -3dB, σ = 0dB

allocation	4 layer CC	ρ_A = -6dB, ρ_B = -6dB, σ = 3dB

Table 9.4B.1.1.1-2: E-UTRA FRC for SDR test (FDD)

MIMO layer	Bandwidth	Reference channel		
		64QAM	256QAM	1024QAM
2 layer	5	R.PDSCH.4-1.1 FDD	R.PDSCH.4-3.1 FDD	R.PDSCH.4-5.1 FDD
	10	R.PDSCH.4-1.2 FDD	R.PDSCH.4-3.2 FDD	R.PDSCH.4-5.2 FDD
	15	R.PDSCH.4-1.3 FDD	R.PDSCH.4-3.3 FDD	R.PDSCH.4-5.3 FDD
	20	R.PDSCH.4-1.4 FDD	R.PDSCH.4-3.4 FDD	R.PDSCH.4-5.4 FDD
4 layer	5	R.PDSCH.4-2.1 FDD	R.PDSCH.4-4.1 FDD	R.PDSCH.4-6.1 FDD
	10	R.PDSCH.4-2.2 FDD	R.PDSCH.4-4.2 FDD	R.PDSCH.4-6.2 FDD
	15	R.PDSCH.4-2.3 FDD	R.PDSCH.4-4.3 FDD	R.PDSCH.4-6.3 FDD
	20	R.PDSCH.4-2.4 FDD	R.PDSCH.4-4.4 FDD	R.PDSCH.4-6.4 FDD

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

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

9.4B.1.2 EN-DC including FR2 NR carrier

9.4B.1.2.1 SDR test

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

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

The test parameters are determined by the following procedure:

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

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

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

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

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

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

The test parameters are determined by the following procedure:

- Step 1: Calculate the NR FR1 data rate for EN-DC bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported EN-DC configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
  - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 2: Calculate the NR FR2 data rate for EN-DC bandwidth combinations, using a procedure from Clause 7.5A, for all supported EN-DC configurations and set of per NR component carrier (CC) UE capabilities among all supported UE capabilities:
  - Set of per NR CC UE capabilities includes a channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor as defined in clause 4.1.2 of TS 38.306 [14].
- Step 3: Calculate the E-UTRA data rate for EN-DC bandwidth combinations, using a procedure from clause 4.1.2 of TS 38.306 [14], for all supported EN-DC configurations and set of per E-UTRA component carrier (CC) UE capabilities among all supported UE capabilities:
  - Set of per E-UTRA CC UE capabilities includes a channel bandwidth, number of PDSCH MIMO layers and modulation format as defined in clause 4.1.2 of TS 38.306 [14].
- Step 4: Select the EN-DC bandwidth combination among all supported EN-DC configurations that achieves the maximum total data rate in steps 1, 2 and 3 among all UE capabilities:
  - When there are multiple sets of EN-DC bandwidth combinations and UE capabilities with the same largest data rate, select a single set among sets with the smallest aggregated channel bandwidth.
- Step 5: For each NR FR2 CC in the selected EN-DC bandwidth combination, use MCS determined in step 2 for that EN-DC bandwidth combination based on test parameters and indicated UE capabilities.

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

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

9.4B.2 NR DC between FR1 and FR2

The methodology for selection of tested NR DC bandwidth combination and the requirements are specified in Clause 9.4A.1.

9.4B.3 NE-DC

9.4B.3.1 NE-DC within FR1

The methodology for selection of tested NE-DC bandwidth combination and the requirements are specified in Clause 9.4B.1.1.

9.5B PDSCH demodulation for DC with power imbalance

9.5B.1 EN-DC

9.5B.1.1 Intra-band contiguous EN-DC within FR1

9.5B.1.1.1 PDSCH

The requirements in this section verify the ability of intra-band contiguous EN-DC UE to demodulate the signal transmitted by the NR SCG in the presence of a stronger E-UTRA MCG. The parameters specified in Table 5.2A.2.2-2 and Table 5.2A.3.2-2 are valid for all intra-band contiguous EN-DC power imbalance tests unless otherwise stated. The test setup for each E-UTRA MCG CC is specified in Clause 9.1.2. During the test, only the PDSCH performance on the NR SCG CC shall be verified.

The test parameters of channel bandwidth and allocated resource blocks are determined by the following procedure:

- Step 1: First select the CBW combinations with the same BWs between E-UTRA MCG carrier(s) and NR SCG carrier. If there is no such CBW combination, go to Step 1a. Otherwise go to step 2.
  - Step 1a: Select the CBW combinations that the BW of NR SCG carrier is smaller than the BW of E-UTRA MCG carrier(s). If there is no such CBW combination, go to Step 1c.
  - Step 1b: Among the CBW combinations selected from Step 1a, select the CBW combinations with the smallest CBW difference between NR SCG carrier and E-UTRA MCG carrier(s). Go to step 2.
  - Step 1c: Select the EN-DC combinations with smallest CBW difference between the NR SCG carrier and E-UTRA MCG carrier(s). Go to step 2.
- Step 2: Among the CBW combinations selected from Step 1, select the EN-DC combination with the largest aggregated CBW.
  - When the BW of NR SCG carrier is smaller than or equal to the BW of E-UTRA MCG carrier(s), test full allocated PRBs
  - When the BW of NR SCG carrier is larger than the BW of E-UTRA MCG carrier(s), test partial allocated PRBs, and the PRB number for testing equals to the PRB number in the full bandwidth of E-UTRA MCG carrier(s).
    - If frequency of NR SCG carrier is higher than E-UTRA MCG carrier, then the test RBs will be allocated on the highest part of NR SCG carrier.
    - If frequency of NR SCG carrier is lower than E-UTRA MCG carrier, then the test RBs will be allocated on the lowest part of NR SCG carrier.

The performance requirements are specified in Table 9.5B.1.1.1-1 and Table 9.5B.1.1.1-2. The downlink physical channel setup according to Annex C.3.1.

Table 9.5B.1.1.1-1: Minimum performance for FDD EN-DC with 15kHz SCS

Test Number	Bandwidth (MHz)	Reference channel	Power at antenna port (dBm/Hz)	Reference value Fraction of Maximum

						Throughput (%)	
	NR SCG CC	E-UTRA MCG CC (Note 1)	NR SCG CC	E-UTRA MCG CC	NR SCG CC	E-UTRA MCG CC (Note 1)	NR SCG CC
1	Selected EN-DC combination as per the test procedure	NA	Derived as per section 5.1.3.2 of TS 38.214 [12]	-106	-112	NA	85
Note 1: The number of E-UTRA MCG carriers depend on the intra-band and inter-band contiguous EN-DC configuration and bandwidth combination set							

Table 9.5B.1.1.1-2: Minimum performance for TDD EN-DC with 30kHz SCS

Test Number	Bandwidth (MHz)	Reference channel		Power at antenna port (dBm/Hz)		Reference value Fraction of Maximum Throughput (%)	
	NR SCG CC	E-UTRA MCG CC (Note 1)	NR SCG CC	E-UTRA MCG CC	NR SCG CC	E-UTRA MCG CC (Note 1)	NR SCG CC
1	Selected EN-DC combination as per the test procedure	NA	Derived as per section 5.1.3.2 of TS 38.214 [12]	-106	-112	NA	85
Note 1: The number of E-UTRA MCG carriers depend on the intra-band and inter-band contiguous EN-DC configuration and bandwidth combination set							

9.5B.1.2 Intra-band non-contiguous EN-DC within FR1

9.5B.1.2.1 PDSCH

The requirements in this section verify the ability of intra-band non-contiguous EN-DC UE to demodulate the signal transmitted by the NR SCG in the presence of a stronger E-UTRA MCG. The parameters specified in Table 5.2A.2.2-2 and Table 5.2A.3.2-2 are valid for all intra-band non-contiguous EN-DC power imbalance tests unless otherwise stated. The test setup for each E-UTRA MCG CC is specified in Clause 9.1.2. During the test, only the PDSCH performance on the NR SCG CC shall be verified.

The test parameters of channel bandwidth and allocated resource blocks are determined by the following procedure:

- Step 1: First select the CBW combinations with the same BWs between E-UTRA MCG carrier(s) and NR SCG carrier. If there is no such CBW combination, go to Step 1a. Otherwise go to step 2.
  - Step 1a: Select the CBW combinations that the BW of NR SCG carrier is smaller than the BW of E-UTRA MCG carrier(s). If there is no such CBW combination, go to Step 1c.
  - Step 1b: Among the CBW combinations selected from Step 1a, select the CBW combinations with the smallest CBW difference between NR SCG carrier and E-UTRA MCG carrier(s). Go to step 2.
  - Step 1c: Select the EN-DC combinations with smallest CBW difference between the NR SCG carrier and E-UTRA MCG carrier(s). Go to step 2.
- Step 2: Among the CBW combinations selected from Step 1, select the EN-DC combination with the largest aggregated CBW.
  - When the BW of NR SCG carrier is smaller than or equal to the BW of E-UTRA MCG carrier(s), test full allocated PRBs
  - When the BW of NR SCG carrier is larger than the BW of E-UTRA MCG carrier(s), test partial allocated PRBs, and the PRB number for testing equals to the PRB number in the full bandwidth of E-UTRA MCG carrier(s).

- If frequency of NR SCG carrier is higher than E-UTRA MCG carrier, then the test RBs will be allocated on the highest part of NR SCG carrier.
- If frequency of NR SCG carrier is lower than E-UTRA MCG carrier, then the test RBs will be allocated on the lowest part of NR SCG carrier.

The performance requirements are specified in Table 9.5B.1.2.1-1 and Table 9.5B.1.2.1-2. The downlink physical channel setup according to Annex C.3.1.

Table 9.5B.1.2.1-1: Minimum performance for FDD EN-DC with 15kHz SCS

Test Number	Bandwidth (MHz)	Reference channel		Power at antenna port (dBm/Hz)		Reference value Fraction of Maximum Throughput (%)	
	NR SCG CC	E-UTRA MCG CC (Note 1)	NR SCG CC	E-UTRA MCG CC	NR SCG CC	E-UTRA MCG CC (Note 1)	NR SCG CC
1	Selected EN-DC combination as per the test procedure	NA	Derived as per section 5.1.3.2 of TS 38.214 [12]	-106	-112	NA	85
Note 1: The number of E-UTRA MCG carriers depend on the intra-band and inter-band non-contiguous EN-DC configuration and bandwidth combination set							

Table 9.5B.1.2.1-2: Minimum performance for TDD EN-DC with 30kHz SCS

Test Number	Bandwidth (MHz)	Reference channel		Power at antenna port (dBm/Hz)		Reference value Fraction of Maximum Throughput (%)	
	NR SCG CC	E-UTRA MCG CC (Note 1)	NR SCG CC	E-UTRA MCG CC	NR SCG CC	E-UTRA MCG CC (Note 1)	NR SCG CC
1	Selected EN-DC combination as per the test procedure	NA	Derived as per section 5.1.3.2 of TS 38.214 [12]	-106	-112	NA	85
Note 1: The number of E-UTRA MCG carriers depend on the intra-band and inter-band non-contiguous EN-DC configuration and bandwidth combination set							

10 CSI reporting requirements for interworking

10.1 General

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

The definition of frequency ranges (FR1 and FR2) are specified in Table 5.1-1 of TS 38.101-3 [8].

10.1.1 Applicability of requirements

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

- For UEs supporting both SA and NSA,

- The performance requirements specified in Clause 6 will be verified only for SA.
- The performance requirements specified in Clause 8 will be verified only for SA.

- The FR1 EN-DC test cases with the NR TDD DL-UL configurations which are not aligned with LTE's can be tested on the corresponding EN-DC band combinations where UE supports simultaneous transmission and reception.
- For UEs supporting NR-DC including FR1 and FR2, if the FR2 requirements in Clause 8.2, Clause 8.3 and Clause 8.4 are tested, the test coverage can be considered fulfilled without executing requirements in Clause 10.2B.2, Clause 10.3B.2 and Clause 10.4B.2.
- For UEs supporting NE-DC, the test coverage of CSI reporting requirements can be considered fulfilled, if the CSI reporting requirements in Clause 6 are executed for UE under test in the standalone mode.
- For UEs supporting NGEN-DC, the test coverage of CSI reporting requirements can be considered fulfilled, if the CSI reporting requirements in Clause 6 are executed for UE under test.
- For UEs supporting EN-DC including FR2 and/or EN-DC including FR1 and FR2, the requirements applicability is specified in Table 10.1.1-1.

Table 10.1.1-1: Requirements applicability for UEs supporting EN-DC including FR2 and/or EN-DC including FR1 and FR2

Supported scenarios	CQI requirements	PMI requirements	RI requirements
EN-DC including FR2	Clause 10.2B.1.2	Clause 10.3B.1.2	Clause 10.4B.1.2
EN-DC including FR1 and FR2	Clause 10.2B.1.3	Clause 10.3B.1.3	Clause 10.4B.1.3
Both EN-DC including FR2 and EN-DC including FR1 and FR2	Clause 10.2B.1.2	Clause 10.3B.1.2	Clause 10.4B.1.2

10.1.1.1 Applicability of requirements for optional UE features

Table 10.1.1.1-1: Void

10.1.1.2 Applicability of requirements for mandatory UE features with capability signalling

The applicability rule defined in Clause 6.1.1.4 shall be applied for performance requirements in Clauses 10.2B.1.1, 10.3B.1.1 and 10.4B.1.1.

The applicability rule defined in Clause 8.1.1.4 shall be applied for performance requirements in Clauses 10.2B.1.2, 10.3B.1.2 and 10.4B.1.2.

10.2 Reporting of Channel Quality Indicator (CQI)

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

10.2A.1 NR CA between FR1 and FR2

10.2A.1.1 NR CA between FR1 and FR2-2

The test setup for FR1 PCell is specified in Table 9.2A.1-3. The NR CQI reporting requirements are specified in Clause 8.2. During the test, only the performance based on NR requirements on the NR cell(s) on FR2-2 carrier shall be verified.

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

10.2B.1 EN-DC

10.2B.1.1 EN-DC within FR1

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR CQI reporting requirements are specified in Clause 6.2. During the test, only the performance based on NR requirements on the NR cell(s) shall be verified.

10.2B.1.2 EN-DC including FR2 NR carrier

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR CQI reporting requirements are specified in Clause 8.2. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

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

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR CQI reporting requirements are specified in Clause 10.2B.1.1 and Clause 10.2B.1.2. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

10.2B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2. The test setup for FR2 cell is specified in Clause 8.1.2 and Clause 8.2. The NR CQI reporting requirements are specified in Clause 8.2. During the test, only the CQI performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

10.3 Reporting of Precoding Matrix Indicator (PMI)

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

(Void)

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

10.3B.1 EN-DC

10.3B.1.1 EN-DC within FR1

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

10.3B.1.2 EN-DC including NR FR2 carrier

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

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

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PMI reporting requirements are specified in Clause 10.3B.1.1 and Clause 10.3B.1.2. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

10.3B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2. The test setup for FR2 cell is specified in Clause 8.1.2 and Clause 8.3. The PMI reporting requirements are specified in Clause 8.3. During the test, only the PMI performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

10.4 Reporting of Rank Indicator (RI)

10.4A Reporting of Rank Indicator (RI) for CA

10.4B Reporting of Rank Indicator (RI) for DC

10.4B.1 EN-DC

10.4B.1.1 EN-DC within FR1

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR RI reporting requirements are specified in Clause 6.4. During the test, only the performance based on NR requirements on the NR cell(s) shall be verified.

10.4B.1.2 EN-DC including NR FR2 carrier

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR RI reporting requirements are specified in Clause 8.4. During the test, only the performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

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

The test setup for E-UTRA PCell is specified in Clause 9.1.2. The NR PMI reporting requirements are specified in Clause 10.4B.1.1 and Clause 10.4B.1.2. During the test, only the performance based on the NR requirements on the NR cell(s) on FR2 carriers shall be verified.

10.4B.2 NR DC between FR1 and FR2

The test setup for FR1 PCell is specified in Table 5.5A-1 with antenna configuration 1x2.The test setup for FR2 cell is specified in Clause 8.1.2 and Clause 8.4. The NR RI reporting requirements for NR FR2 cell are specified in Clause 8.4. During the test, only the RI performance based on NR requirements on the NR cell(s) on FR2 carriers shall be verified.

11 V2X requirements

This clause contains the performance requirements for the sidelink physical channels specified for V2X Sidelink Communication.

11.1 Demodulation performance requirements (Conducted requirements)

11.1.1 General

11.1.1.1 Applicability of requirements

11.1.1.1.1 General

The minimum performance requirements are applicable to all V2X operating bands defined in TS 38.101-1[6] Clause 5.2E.

The minimum performance requirements in Clause 11.1 are mandatory for UE supporting NR SL operation (*sl-Reception-r16*), except test cases listed in Clauses 11.1.1.1.2.

11.1.1.1.2 Applicability of requirements for mandatory UE V2X features with capability signalling

The performance requirements in Table 11.1.1.1.2-1 shall apply for V2X UEs which support mandatory UE features with capability signalling only.

Table 11.1.1.1.2-1: Requirements applicability for mandatory features with UE capability signalling

UE feature/capability [14]	Test type		Test list	Applicability notes
Support of synchronization sources for NR sidelink (*sync-Sidelink-r16*)	FR1	PSSCH	Clause 11.1.2.1.1 Clause 11.1.6.1.1 Clause 11.1.7.1.1	
		PSCCH	Clause 11.1.3.1.1 Clause 11.1.8.1.1	
		PSBCH	Clause 11.1.4.1.1	
		PSFCH	Clause 11.1.5.1.1 Clause 11.1.9.1.1	
Supports of PSFCH format 0 (*psfch-FormatZeroSidelink-r16)*	FR1	PSSCH	Clause 11.1.2.1.1 Clause 11.1.6.1.1 Clause 11.1.7.1.1	
		PSCCH	Clause 11.1.3.1.1 Clause 11.1.8.1.1	
		PSFCH	Clause 11.1.5.1.1 Clause 11.1.9.1.1	

11.1.1.2 Common test parameters

Parameters specified in Table 11.1.1.2-1 are applied for all test cases in this clause unless otherwise stated.

Table 11.1.1.2-1: Common test parameters

Parameter		Unit	Value
Carrier configuration	Offset between Point A and the lowest usable subcarrier on this carrier (Note 1)	RBs	0
	Subcarrier spacing	kHz	30
SL BWP configuration #1	Cyclic prefix		Normal
	RB offset	RBs	0
	Number of contiguous PRB	PRBs	Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested

			channel bandwidth and subcarrier spacing
PT-RS configuration			PT-RS is not configured
Resource pool configuration	PSCCH Time resource	Symbols	2
	PSCCH Frequency resource	PRBs	10
	PSFCH number of cyclic shift pairs		n1
	PSFCH hopping ID		0
	PSFCH candidate resource type		allocSubCH
	Set of PRBs for PSFCH transmission		ones(1,100) for 40 MHz and ones(1,50) for 20 MHz
	PSSCH RSRP threshold		66 (infinity dBm)
	Synchronization reference		GNSS
	Subchannel size	PRBs	10
	Number of sub-channels		5 for 20 MHz and 10 for 40 MHz
	Start PRB for first sub-channel		0
	Time resource bitmap		ones(1, 160)
Note 1: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing.			

11.1.2 PSSCH demodulation requirements

11.1.2.1 2Rx requirements

11.1.2.1.1 Minimum requirements

The purpose of the requirements in this subclause is to verify the PSSCH for V2X demodulation performance with a single active PSSCH link.

The minimum requirements are specified in Table 11.1.2.1.1-2 with the test parameters specified in Table 11.1.2.1.1-1. In this test scenario, GNSS or GNSS-equivalent synchronization source is used and sidelink UE 1 transmits PSCCH and PSSCH.

Table 11.1.2.1.1-1: Test parameters

Parameter		Unit	Value		
			Test 1	Test 2	Test 3
Active cell(s)			None		
Sidelink UE 1	Sidelink transmissions		PSCCH + PSSCH		
	PSSCH DMRS pattern (Note 1)		{3,4}	{2,3}	{2,2}
	Index of sub-channel allocation		[0,1]	[0,1]	[0]
	Timing offset (Note 2)	μs	CP/2-12*64*Tc		
	Frequency offset (Note 3)	Hz	+600		
	Synchronization		GNSS or GNSS-equivalent		
	Antenna configuration		1x2 Low		
PSFCH resource period		Slot	4	4	4
MinTimeGapPSFCH		Slot	3	3	3
Note 1: {x, y}: x and y means the number of DMRS symbols for slot with PSFCH transmission and without PSFCH transmission, respectively. Note 2: Time offset of transmitted Sidelink UE signal with respect to GNSS referring timing. Note 3: Frequency offset of transmitted Sidelink UE signal with respect to GNSS reference frequency.					

Table 11.1.2.1.1-2: Minimum performance

Test num.	Reference channel	Bandwidth (MHz)/ Subcarrier spacing(kHz)	Modulation format and code rate	Propagation condition	Reference value	
					PSSCH BLER (%)	SNR(dB) of PSSCH
1	R.PSSCH.2-1.1	20 / 30	QPSK, 0.30	TDLA30-2700	10%	3.4
2	R.PSSCH.2-1.2	20 / 30	16QAM, 0.37	TDLA30-1400		8.8
3	R.PSSCH.2-1.3	20 / 30	64QAM, 0.43	TDLA30-180		14.8

11.1.3 PSCCH demodulation requirements

11.1.3.1 2Rx requirements

11.1.3.1.1 Minimum requirements

The purpose of the requirements in this subclause is to verify the PSCCH for V2X demodulation performance with a single active PSSCH link.

The minimum requirements are specified in Table 11.1.3.1.1-2 with the test parameters specified in Table 11.1.3.1.1-1. In this test scenario, GNSS or GNSS-equivalent synchronization source is used and Sidelink UE 1 transmits PSCCH and PSSCH.

Table 11.1.3.1.1-1: Test Parameters

Parameter		Unit	Test 1
Active cell(s)			None
Sidelink UE 1	Sidelink Transmissions		PSCCH+PSSCH
	Timing offset (Note 1)	μs	CP/2-12*64*Tc
	Frequency offset (Note 2)	Hz	+600
	Synchronization		GNSS or GNSS-equivalent
	Antenna configuration		1x2 Low
	PSSCH RMC		R.PSSCH.2-1.1
NOTE 1: Time offset of transmitted Sidelink UE signal with respect to GNSS reference timing. NOTE 2: Frequency offset of transmitted Sidelink UE signal with respect to GNSS reference frequency. NOTE 3: OCC index i for PSCCH DMRS is randomly selected from {0, 1, 2} for each PSCCH transmission.			

Table 11.1.3.1.1-2: Minimum performance

Test number	PSCCH Reference channel	Bandwidth (MHz) / Subcarrier spacing (kHz)	Propagation condition	Reference value	
				Probability of missed PSCCH (%)	SNR (dB) of PSCCH
1	R.PSCCH.2-1.1	20 / 30	TDLA30-1400	1	4.7

11.1.4 PSBCH demodulation requirements

11.1.4.1 2Rx requirements

11.1.4.1.1 Minimum requirements

The purpose of the requirements in this subclause is to verify the PSBCH demodulation performance with a single active link.

The minimum requirements are specified in Table 11.1.4.1.1-2 with the test parameters specified in Table 11.1.4.1.1-1. The Sidelink UE 1 transmits PSBCH to tested UE and tested UE is synchronized to SLSS of Sidelink UE 1.

Table 11.1.4.1.1-1: Test Parameters

Parameter		Unit	Test 1
Active cell(s)			None
Sidelink UE 1	Sidelink Transmissions		SLSS+PSBCH (Note 3)
	slssid		0
	Time offset (Note 1)	μs	0
	Frequency offset (Note 2)	Hz	0
	Synchronization source		GNSS
	Antenna configuration		1x2 Low
Note 1: Time offset of transmitted Sidelink UE 1 signal with respect to GNSS reference timing.			

Note 2:	Frequency offset of transmitted Sidelink UE 1 signal with respect to GNSS reference frequency.
Note 3:	PSBCH transmits together with corresponding SLSS in the same slot.

Table 11.1.4.1.1-2: Minimum performance

Test number	Bandwidth (MHz) / Subcarrier spacing (kHz)	PSBCH Reference channel	Propagation condition	Reference value	
				Probability of missed PSBCH (%)	SNR (dB)
1	20 / 30	R.PSBCH.2-1	TDLA30-180	1	0.1

11.1.5 PSFCH demodulation requirements

11.1.5.1 2Rx requirements

11.1.5.1.1 Minimum requirements

11.1.5.1.1.1 NACK missed detection requirements

The NACK missed detection probability is the probability of not detecting an NACK when an NACK was sent. The test parameters are configured in table 11.1.5.1.1.1-1.

Table 11.1.5.1.1.1-1: Test Parameters

Parameter	unit	Test 1
Allocated resource blocks	RB	1
The number of PSFCH symbols (Note 1)	symbol	2
Number of information bits	bit	1
Synchronization source		GNSS
Timing offset (Note 2)	μs	CP/2-12*64*Tc
Frequency offset (Note 3)	Hz	600
PSFCH resource period	Slots	1
Antenna configuration		1x2 Low
Note 1: First symbol is included. First symbol is used for AGC and not used for demodulation. Note 2: Time offset of transmitted Sidelink UE signal with respect to GNSS referring timing. Note 3: Frequency offset of transmitted Sidelink UE signal with respect to GNSS reference frequency.		

The NACK missed detection probability shall not exceed 1% at the SNR given in table 11.1.5.1.1.1-2.

Table 11.1.5.1.1.1-2: Minimum requirements

Test num.	Bandwidth (MHz) / Subcarrier spacing (kHz)	Propagation condition	Reference value	
			NACK missed detection probability (%)	SNR (dB)
1	20 / 30	TDLA30-180	1	9.5

11.1.5.1.1.2 DTX to NACK requirements

The DTX to NACK probability, i.e. the probability that NACK is detected when nothing was sent:

$$\text{Prob}(\text{PSFCH DTX} \rightarrow \text{NACK bits}) = \frac{\#(false\ NACK\ bits)}{\#(\text{PSFCH DTX}) * \#(NACK\ bits)}$$

where:

- #(false NACK bits) denotes the number of detected NACK bits.

- #(NACK bits) denotes the number of encoded bits per slot
- #(PSFCH DTX) denotes the number of DTX occasions

The test parameters are configured in table 11.1.5.1.1.1-1.

The DTX to NACK probability shall not exceed 1%.

11.1.6 Power imbalance performance with two links

11.1.6.1 2RX requirements

11.1.6.1.1 Minimum requirements

The purpose of this test is to check the demodulation performance when receiving PSSCH transmissions from two Sidelink UEs with power imbalance in one slot.

The minimum requirements are specified in Table 11.1.6.1.1-2 with the test parameters specified in Table 11.1.6.1.1-1. The Sidelink UE 1 and 2 are synchronized to GNSS or GNSS-equivalent synchronization reference.

Table 11.1.6.1.1-1: Test Parameters

Parameter		Unit	Test 1
Active cell(s)			None
Active Sidelink UE(s)			Sidelink UE 1, Sidelink UE 2
Sidelink UE 1	Sidelink Transmissions		PSCCH + PSSCH
	PSSCH DMRS pattern(Note 1)		{2,3}
	Sub-channel allocation		Sub-channel 0
	Time offset (Note 2)	μs	0
	Frequency offset (Note 3)	Hz	0
	Antenna configuration		1x2 Low
	PSFCH periodicity	Slots	4
	MinTimeGapPSFCH	Slots	3
Sidelink UE 2	Sidelink Transmissions		PSCCH + PSSCH
	PSSCH DMRS pattern(Note 1)		{2,3}
	Sub-channel allocation		Sub-channnel 3
	Time offset (Note 2)	μs	0
	Frequency offset (Note 3)	Hz	0
	Antenna configuration		1x2 Low
	PSFCH periodicity	Slots	4
	MinTimeGapPSFCH	Slots	3
Note 1: {x, y}: x and y means the number of DMRS symbols for slot with PSFCH transmission and without PSFCH transmission, respectively. Note 2: Time offset of transmitted Sidelink UE signal with respect to GNSS reference timing. Note 3: Frequency offset of transmitted Sidelink UE signal with respect to GNSS reference frequency.			

Table 11.1.6.1.1-2: Minimum performance

Test number	Bandwidth (MHz)/ Subcarrier spacing(kHz)	Sidelink UE	PSSCH Reference channel	Modulation format and code rate	Propagation condition	Reference value	
						PSSCH BLER (%)	SNR (dB) of PSSCH
1	20 / 30	1	R.PSSCH.2-1.4	QPSK, 0.30	AWGN	(Note 1)	30.35
		2	R.PSSCH.2-1.4	QPSK, 0.30	AWGN	10	4.8
Note 1: There is no BLER requirement for Sidelink UE 1.							

11.1.7 HARQ buffer soft combining test

11.1.7.1 2Rx requirement

11.1.7.1.1 Minimum requirement

The purpose of this test is to verify the maximum number of HARQ processes per TTI supported by the V2X UE.

The minimum requirement is specified in Table 11.1.7.1.1-2 with the test parameters specified in Table 11.1.7.1.1-1.

Table 11.1.7.1.1-1: Test Parameters

Parameter		Unit	Test 1
Active cell(s)			None
Active Sidelink UE(s)			Sidelink UE i, 0 ≤ i < *n* (Note 1,2)
Sidelink UE i, 0 ≤ i < *n*	Sidelink Transmissions		PSCCH + PSSCH
	PSSCH DMRS pattern		{2}
	Time gap between initial transmission and retransmission	Slots	k (Note 3)
	Timing offset (Note 4)	μs	0
	Frequency offset (Note 5)	Hz	0
	Synchronization source		GNSS or GNSS-equivalent
	Antenna configuration		1x2 Low
	Redundancy version coding sequence		{0,2}
PSFCH resource period		Slots	1

Note 1: *n* is the number of HARQ process UE can support (based on IE harq-RxProcessSidelink)
Note 2: When *n* = 16 or 24, sidelink UEs transmit one by one circularly for every slot;
When *n*=32, the first 31 UEs transmit signal one by one circularly for every slot and in the first subchannel, and the 32nd UE transmits signal in the first slot but in the second subchannel;
When *n*=48, the first 31 UEs transmit signal one by one circularly for every slot and in the first subchannel, the next 17 UEs transmit signal in the same slot as the first 17 UEs but in the second subchannel;
When *n*=64, first 31 UEs transmit signal one by one circularly for every slot and in the first subchannel, the next 31 UEs transmit signal one by one circularly for every slot and in the second subchannel, the last 2 UEs transmit signal in the same slot as the first 2 UEs in the third subchannel
Note 3: *k* = *n* if *n* < 32, otherwise *k* = 31
Note 4: Time offset of transmitted Sidelink UE signal with respect to GNSS reference timing.
Note 5: Frequency offset of transmitted Sidelink UE signal with respect to GNSS reference frequency.

Table 11.1.7.1.1-2: Minimum performance

Test num.	Bandwidth (MHz) / Subcarrier spacing(kHz)	PSSCH Reference channel	Propagation condition	Reference value	
				PSSCH BLER (%)	SNR (dB) of PSSCH
1	20 / 30	R.PSSCH.2-1.5	AWGN	5	10.9

11.1.8 PSCCH decoding capability test

11.1.8.1 2RX requirements

11.1.8.1.1 Minimum requirements

The purpose of this test is to verify the maximum number of received PSCCHs per TTI supported by the V2X UE.

The minimum requirements are specified in Table 11.1.8.1.1-2 with the test parameters specified in Table 11.1.8.1.1-1 and the test procedure is specified as follows:

- 10 UEs transmit PSCCHs and corresponding PSSCHs to the tested UE per slot with each UE occupying one subchannel.

- x UEs transmit PSCCHs and corresponding PSSCHs with high priority level on x subchannels that are randomly selected from 10 subchannels per slot and 10-x UEs transmit PSCCHs and corresponding PSSCHs with low priority level on the remaining subchannels. The indication of priority level specified in Clause 5.4.3.3 of TS 23.287 [12] and Clause 5.22.1.3.1 of TS 38.321 [8] is included in PSCCH.

Where x equals to:

- The number of PSFCH(s) resources that the tested UE can transmit in a slot (i.e. IE *psfch-TxNumber* specified in clause 4.2.16.1.6 of TS 38.306 [14]) if the number of PSFCH(s) resources that the tested UE can transmit in a slot is less than 10

- 10, otherwise.

The probability of PSCCH miss detection is calculated as follows:

$$Prob(PSCCH\ miss\ detection\ ) = \frac{\#(missing\ ACK/\mathrm{NACK})}{\#(Tx\ high\ priority\ PSCCH/PSSCH)}$$

Where:

- # (Tx high priority PSCCH/PSSCH) denotes the total number of transmitted PSCCH/PSSCH with high priority level.

- # (missing ACK/NACK) denotes the total number of missing ACK/NACK with high priority.

Table 11.1.8.1.1-1: Test Parameters

Parameter			Unit	Value
Member ID (Note 1)				0
Sidelink UE i, 0 ≤ i ≤ 9 (Note 5)	Sidelink Transmissions			PSCCH + PSSCH
	Timing offset (Note 2)		μs	0
	Frequency offset (Note 3)		Hz	0
	Synchronization source			GNSS
	Propagation Channel			Static propagation condition without external noise
	Antenna configuration			1x2 Low
	PSSCH RMC			R.PSSCH.2-1.4
	PSCCH RMC (Note 4)			R.PSCCH.2-1.1
	Source ID			0
	PSFCH periodicity		Slots	1
	MinTimeGapPSFCH		Slots	2
	PSFCH Resource (Note 6)	RB index		10*i
		CS pair index		0
Note 1: Member ID is an identifier uniquely identifying a member. Note 2: Time offset of transmitted Sidelink UE signal with respect to GNSS reference timing. Note 3: Frequency offset of transmitted Sidelink UE signal with respect to GNSS reference frequency. Note 4: OCC index for PSCCH DMRS is randomly selected between {0, 1, 2} for each PSCCH transmission as per in Clause 8.4.1.3.2 of TS 38.211[9]. Note 5: Each UE occupies one sub-channel so that all sub-channels are filled. Note 6: The mapping procedure of PSSCH resource and PSFCH resource is specified in Clause 16.3 of TS 38.213 [11].				

Table 11.1.8.1.1-2: Minimum performance

Test Number	Bandwidth (MHz) / Subcarrier spacing(kHz)	PSCCH Reference channel	Propagation Channel	Reference value
				Probability of missed PSCCH (%)
1	40 / 30	R.PSCCH.2-1.1	Static propagation condition without external noise	1

11.1.9 PSFCH decoding capability test

11.1.9.1 2RX requirements

11.1.9.1.1 Minimum requirements

The purpose of this test is to verify the maximum number of PSFCHs received by UE per slot in group cast scenario by using ACK/NACK feedback mode. In each slot, a group of UEs transmits PSFCHs to the tested UE. Information transmitted in each PSFCH is randomly selected from Option A, Option B and Option C with probability of 50%, 25% and 25% respectively. Transmitted PSFCHs are related to one PSSCH which is transmitted by tested UE and occupies all the subchannels.

- Option A: All the UEs in the group transmit ACKs
- Option B: One UE transmits NACK and the rest of UEs transmit ACKs. The PSFCH resource index with NACK is random per slot
- Option C: One UE transmits nothing (i.e.DTX) and the rest of UEs transmit ACKs. The PSFCH resource index of the DTX is random per slot.

The minimum requirements are specified in Table 11.1.9.1.1-2 with the test parameters specified in Table 11.1.9.1.1-1

Table 11.1.9.1.1-1: Test parameters

Parameter		Unit	Test 1
HARQ-ACK information			ACK or NACK
Source ID of tested UE			0
Sidelink UE i, 0 ≤ i ≤ N-1(Note 3)	Sidelink transmissions for		PSFCH
	Timing offset (Note 1)	μs	0
	Frequency offset (Note 2)	Hz	0
	Synchronization source		GNSS or GNSS-equivalent
	Propagation Channel		Static propagation condition No external noise sources are applied
	Antenna configuration		1x2 Low
	Member ID(Note 4)		i
	PSFCH resource allocation(Note 5)		N UEs transmit PSFCHs one by one on each RB with CS pair index 0. i.e. UE 0 transmits PSFCH on RB 0, UE 1 transmits PSFCH on RB 1,…, UE (N-1) transmits PSFCH on RB N-1
	PSFCH periodicity	Slots	1

Note 1: Time offset of transmitted Sidelink UE signal with respect to GNSS reference timing.
Note 2: Frequency offset of transmitted Sidelink UE signal with respect to GNSS reference frequency.
Note 3: N equals to the number of PSFCH(s) resources that UE can receive in a slot as specified in Clause 4.2.16.1.6 of TS 38.306[14](IE *psfch-RxNumber*)) .
Note 4: Member ID is an identifier uniquely identifying a member
Note 5: All PSFCHs in a slot are corresponding to one PSSCH that occupies all sub channels.

Table 11.1.9.1.1-2: Minimum requirement

Test Number	Bandwidth (MHz) / Subcarrier spacing(kHz)	Propagation Channel	Reference value	
			Probability of success detection slot with ACK only (%)	Probability of success detection slot with NACK or DTX (%)
1	40 / 30	Static propagation condition without external noise	99	99

Note 1: The probability of success detection slot with ACK only is the probability that the corresponding PSSCH is not retransmitted when Option A is selected.
Note 2: The probability of success detection slot with NACK or DTX is the probability that the corresponding PSSCH is retransmitted when Option B or option C is selected.

Annex A (normative): Measurement channels

A.1 General

A.1.1 Throughput definition

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

A.1.2 TDD UL-DL configurations for FR1

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

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

Parameter		Unit	UL-DL pattern
			FR1.15-1
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
referenceSubcarrierSpacing		kHz	15
pattern1	*dl-UL-TransmissionPeriodicity*	ms	5
	nrofDownlinkSlots		3
	nrofDownlinkSymbols		10
	nrofUplinkSlot		1
	nrofUplinkSymbols		2
The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3)			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 configuration 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	DDDSUUDDDD	DSUU	DS_1S_2U
Special Slot Configuration (Note 2)			6D+4G+4U	10D+2G+2U	10D+2G+2U	6D+4G+4U	12D+2G	S1: 10D+2G+2U S2: 12D+2G+0U
referenceSubcarrierSpacing		kHz	30	30	30	30	30	30
pattern1								
	dl-UL-TransmissionPeriodicity	ms	5	2.5	2.5	3	2	1
	nrofDownlinkSlots		7	3	3	3	1	1
	nrofDownlinkSymbols		6	10	10	6	12	10
	nrofUplinkSlot		2	1	1	2	2	0
	nrofUplinkSymbols		4	2	2	4	0	2
pattern2								
	dl-UL-TransmissionPeriodicity	ms	N/A	N/A	2.5	2	N/A	1
	nrofDownlinkSlots		N/A	N/A	2	4	N/A	0
	nrofDownlinkSymbols		N/A	N/A	10	0	N/A	12
	nrofUplinkSlot		N/A	N/A	2	0	N/A	1
	nrofUplinkSymbols		N/A	N/A	2	0	N/A	0
The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6	4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3	4 if mod(i,10) = 0 3 if mod(i,10) = 1 2 if mod(i,10) = 2 5 if mod(i,10) = 3 3 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7	5 if mod(i,10) = 0 4 if mod(i,10) = 1 3 if mod(i,10) = 2 2 if mod(i,10) = 3 8 if mod(i,10) = 6 7 if mod(i,10) = 7 6 if mod(i,10) = 8 5 if mod(i,10) = 9	3 if mod(i,4) = 0 2 if mod(i,4) = 1	3 if mod(i,4) = 0 2 if mod(i,4) = 1 3 if mod(i,4) = 2

		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}							

Table A.1.2-2a: TDD UL-DL configuration for SCS 30 kHz for DCI-based dynamic UL/DL detection

Parameter		Unit	UL-DL pattern
			FR1.30-1A
TDD Slot Configuration pattern (Note 1)			7DS2U
Special Slot Configuration (Note 2)			6D+4G+4U
referenceSubcarrierSpacing		kHz	N/A
pattern1 (Note 4)			
	dl-UL-TransmissionPeriodicity	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
PDCCH DCI Configuration	DCI Format		1-1 for slot indices with mod(i,10) = 0,1,2,3,4,5,6,7
	Scheduled Grant		Symbol 2-13 for slot indices with mod(i,10) = 0,1,2,3,4,5,6 and Symbol 2-5 for slot indices with mod(i,10) = 7
The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3) (PDSCH-to-HARQ-timing-indicator)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G and U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,19} Note 4: Do not configure *tdd-UL-DL-ConfigurationCommon* using RRC configuration			

Table A.1.2-2b: TDD UL-DL configuration for SCS 30 kHz for PDSCH on band with shared spectrum access

Parameter		Unit	UL-DL pattern
			FR1.30-7
TDD Slot Configuration pattern (Note 1)			7DS2U
Special Slot Configuration (Note 2)			6D+4G+4U
referenceSubcarrierSpacing		kHz	30
Pattern 1	*dl-UL-TransmissionPeriodicity*	ms	5
	nrofDownlinkSlots	slot	7
	nrofDownlinkSymbols	symbol	6
	nrofUplinkSlot	slot	2
	nrofUplinkSymbols	symbol	4
Pattern 2	*dl-UL-TransmissionPeriodicity*	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 4 if mod(i,10) = 4

		3 if mod(i,10) = 5 2 if mod(i,10) = 6
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 of all slots in every 5ms i = {0,…,9}Note 4: The slot i, mod (i,10)=9 is idle slot with no UL transmission.		

A.1.3 TDD UL-DL configurations for FR2

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

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

Parameter		Unit	UL-DL pattern
			FR2.60-1
TDD Slot Configuration pattern (Note 1)			DDSU
Special Slot Configuration (Note 2)			11D+3G+0U
referenceSubcarrierSpacing		kHz	60
pattern1	*dl-UL-TransmissionPeriodicity*	ms	1
	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0
The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3)			3 if mod(i,4) = 0 2 if mod(i,4) = 1 5 if mod(i,4) = 2
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,39}			

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

Parameter		Unit	UL-DL pattern	
			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
referenceSubcarrierSpacing		kHz	120	120
pattern1	*dl-UL-TransmissionPeriodicity*	ms	0.625	0.5
	nrofDownlinkSlots		3	2
	nrofDownlinkSymbols		10	11
	nrofUplinkSlot		1	1
	nrofUplinkSymbols		2	0
The number of slots between PDSCH and corresponding HARQ-ACK information(Note 3)			4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3	3 if mod(i,4) = 0 2 if mod(i,4) = 1 5 if mod(i,4) = 2
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,79}				

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

Parameter	Unit	UL-DL pattern
		FR2.120-1A
TDD Slot Configuration pattern (Note 1)		DDDSU
Special Slot Configuration (Note 2)		10D+2G+2U
referenceSubcarrierSpacing	kHz	N/A

pattern1 (Note 4)	*dl-UL-TransmissionPeriodicity*	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
PDCCH DCI Configuration	DCI Format		1-1 for slot indices with mod(i,5) = 0,1,2,3
	Scheduled Grant		Symbol 1-13 for slot indices with mod(i,5) = 0,1,2 and Symbol 1-9 for slot indices with mod(i,5) = 3
The number of slots between PDSCH and corresponding HARQ-ACK information(Note 3)			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 and U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,79} Note 4: Do not configure *tdd-UL-DL-ConfigurationCommon* using RRC configuration.			

Table A.1.3-3: TDD UL-DL configuration for SCS 480 kHz

Parameter		Unit	UL-DL pattern	
			FR2.480-1	
TDD Slot Configuration pattern (Note 1)			DDDDDDDDDDDDDS1S2UUUU	
Special Slot Configuration (Note 2)			S1:12D+2G+0U S2: 0D+6G+8U	
referenceSubcarrierSpacing		kHz	480	
pattern1	*dl-UL-TransmissionPeriodicity*	ms	0.625	
	nrofDownlinkSlots		14	
	nrofDownlinkSymbols		12	
	nrofUplinkSlot		4	
	nrofUplinkSymbols		8	
The number of slots between PDSCH and corresponding HARQ-ACK information(Note 3)			19-mod(i,40) if mod(i,40) =0,1,…,11 39-mod(i,40) if mod(i,40) =12,13,14,20,21,…, 31	
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,…,319}				

A.2 Void

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

A.3 DL reference measurement channels

A.3.1 General

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

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

Unless otherwise stated, SIB1 transmission shall only be scheduled during call setup to avoid SIB1 and PDSCH transmissions in the same slot.

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	12	
Allocated slots per 2 frames	Slots	19	19	19	19	
MCS table		64QAM	64QAM	64QAM	64QAMLowSE	
MCS index		4	4	4	14	
Modulation		QPSK	QPSK	QPSK	QPSK	
Target Coding Rate		0.30	0.30	0.30	0.59	
Number of MIMO layers		1	1	1	1	
Number of DMRS REs		18	12	12	12	
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	3904	480	2280	8064	
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	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	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	13104	
For Slots i =1,…, 9, 12, …, 19	Bits	13104	1584	7488	13728	
Max. Throughput averaged over 2 frames	Mbps	3.709	0.456	2.166	7.661	
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	R.PDSCH.1-2.5 FDD	R.PDSCH.1-2.6 FDD
Channel bandwidth	MHz	10	10	10	10	10	10
Subcarrier spacing	kHz	15	15	15	15	15	15
Number of allocated resource blocks	PRBs	52	52	52	52	52	52
Number of consecutive PDSCH symbols		12	12	12	12	12	12
Allocated slots per 2 frames	Slots	19	19	19	19	19	19
MCS table		64QAM	64QAM	64QAM	64QAM	64QAMLowSE	64QAM
MCS index		13	13	13	13	19	16
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.54	0.64
Number of MIMO layers		1	2	3	4	2	1
Number of DMRS REs		12	12	24	24	12	12
Overhead for TBS determination		0	0	0	0	0	0
Information Bit Payload per Slot							
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	13064	26120	35856	48168	29704	17424
Transport block CRC per Slot							
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	24	24	24	24	24	24
Number of Code Blocks per Slot							
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	CBs	2	4	5	6	4	3
Binary Channel Bits Per Slot							

For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 10, 11	Bits	26208	52416	71136	94848	49920	26208
For Slots i = 1,…, 9, 12, …, 19	Bits	27456	54912	74880	99840	54912	27456
Max. Throughput averaged over 2 frames	Mbps	12.411	24.814	34.063	45.760	28.219	16.553
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	R.PDSCH.1-3.2 FDD	R.PDSCH.1-3.3 FDD	R.PDSCH.1-3.4 FDD	R.PDSCH.1-3.5 FDD
Channel bandwidth	MHz	10	10	10	10	10
Subcarrier spacing	kHz	15	15	15	15	15
Number of allocated resource blocks	PRBs	52	52	26 (Note 3)	26 (Note 4)	52
Number of consecutive PDSCH symbols		12	12	12	12	12
Allocated slots per 2 frames	Slots	19	19	19	19	19
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		19	19	19	19	19
Modulation		64QAM	64QAM	64QAM	64QAM	64QAM
Target Coding Rate		0.51	0.51	0.51	0.51	0.51
Number of MIMO layers		2	2	2	2	1
Number of DMRS REs		12	24	24	24	12
Overhead for TBS determination		0	0	0	0	0
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	42016	37896	18960	18960	21000
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	24	24	24	24	24
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	CBs	5	5	3	3	3
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 10, 11	Bits	78624	67392	33696	33696	39312
For Slots i = 1,…, 9, 12, …, 19	Bits	82368	74880	37440	37440	41184
Max. Throughput averaged over 2 frames	Mbps	39.915	36.001	18.012	18.012	19.950
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: PDSCH is scheduled in PRB numbers from 0 to 25. Note 4: PDSCH is scheduled in PRB numbers from 26 to 51.						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-4.1 FDD	R.PDSCH.1-4.2 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	19	19			
MCS table		256QAM	256QAM			
MCS index		24	20			
Modulation		256QAM	256QAM			
Target Coding Rate		0.82	0.67			
Number of MIMO layers		1	1			
Number of DMRS REs		12	12			
Overhead for TBS determination		0	0			
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A			
For Slots i = 1,…, 19	Bits	45096	36896			
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A			
For Slots i = 1,…, 19	Bits	24	24			
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A			
For Slots i = 1,…, 19	CBs	6	5			
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A			
For Slots i = 10, 11	Bits	52416	52416			
For Slots i = 1,…, 9, 12, …, 19	Bits	54912	54912			
Max. Throughput averaged over 2 frames	Mbps	42.841	35.051			
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	R.PDSCH.1-6.3 FDD	R.PDSCH.1-6.4 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	15	15	15	15	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		13	13	20	13	
Modulation		16QAM	16QAM	64QAM	16QAM	
Target Coding Rate		0.48	0.48	0.55	0.48	
Number of MIMO layer		1	2	2	2	
Number of DMRS REs (Note 3)		24	24	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 CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A	N/A	N/A	N/A	
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..19}	Bits	12040	24072	40976	24072	
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A	N/A	N/A	N/A	
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, 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 CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A	N/A	N/A	N/A	
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..,19}	CBs	2	3	5	3	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A	N/A	N/A	N/A	
For Slots i = 10	Bits	23712	47424	71136	44928	
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..9,11,…,19}	Bits	24960	49920	74880	49920	
Max. Throughput averaged over 2 frames	Mbps	9.030	18.054	30.732	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

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-7.1 FDD	R.PDSCH.1-7.2 FDD	R.PDSCH.1-7.3 FDD		
Channel bandwidth	MHz	10	10	10		
Subcarrier spacing	kHz	15	15	15		
Number of allocated resource blocks	PRBs	52	52	52		
Number of consecutive PDSCH symbols		9	11	9		

Allocated slots per 2 frames	Slots	16	16	16		
MCS table		64QAM	64QAM	64QAM		
MCS index		4	4	13		
Modulation		QPSK	QPSK	16QAM		
Target Coding Rate		0.30	0.30	0.48		
Number of MIMO layers		1	1	1		
Number of DMRS REs		12	12	12		
Overhead for TBS determination		18	18	12		
Information Bit Payload per Slot						
For Slots i = 0,5,10,15	Bits	N/A	N/A	N/A		
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	Bits	2472	3240	8456		
Transport block CRC per Slot						
For Slots i = 0,5,10,15	Bits	N/A	N/A	N/A		
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	Bits	16	16	24		
Number of Code Blocks per Slot						
For Slots i = 0,5,10,15	CBs	N/A	N/A	N/A		
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	CBs	1	1	2		
Binary Channel Bits Per Slot						
For Slots i = 0,5,10,15	Bits	N/A	N/A	N/A		
For Slots i = 11	Bits	7760	10256	16224		
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {1,…, 9, 12, …, 19}	Bits	8384	10880	17472		
Max. Throughput averaged over 2 frames	Mbps	1.978	2.592	6.764		
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: No user data is scheduled on slots with LTE PBCH/PSS/SSS						

Table A.3.2.1.1-8: PDSCH Reference Channel for FDD HST scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-8.1 FDD	R.PDSCH.1-8.2 FDD	R.PDSCH.1-8.3 FDD	R.PDSCH.1-8.4 FDD	R.PDSCH.1-8.5 FDD
Channel bandwidth	MHz	10	10	10	10	10
Subcarrier spacing	kHz	15	15	15	15	15
Number of allocated resource blocks	PRBs	52	52	52	52	52
Number of consecutive PDSCH symbols		12	12	12	12	12
Allocated slots per 2 frames	Slots	19	19	19	19	19
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	17	13	17	13
Modulation		16QAM	64QAM	16QAM	64QAM	16QAM
Target Coding Rate		0.48	0.43	0.48	0.43	0.48
Number of MIMO layers		1	1	2	2	2
Number of DMRS REs		18	18	18	18	18
Overhead for TBS determination		0	0	0	0	0
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	12552	16896	25104	33816	25104
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	24	24	24	24	24
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	CBs	2	3	3	5	5
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,2,11,12	Bits	24960	37440	49920	74880	47424

For Slots i = 3,…, 10, 13, …, 19	Bits	26208	39312	52416	78624	52416
Max. Throughput averaged over 2 frames	Mbps	11.924	16.0512	23.8488	32.1252	23.8488
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.3.2.1.1-9: PDSCH Reference Channel for FDD CC and CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-9.1 FDD	R.PDSCH.1-9.2 FDD	R.PDSCH.1-9.3 FDD	R.PDSCH.1-9.4 FDD	R.PDSCH.1-9.5 FDD
Channel bandwidth	MHz	5	15	20	25	30
Subcarrier spacing	kHz	15	15	15	15	15
Number of allocated resource blocks	PRBs	25	79	106	133	160
Number of consecutive PDSCH symbols		12	12	12	12	12
Allocated slots per 2 frames	Slots	19	19	19	19	19
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	13	13	13
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.48
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs		12	12	12	12	12
Overhead for TBS determination		0	0	0	0	0
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	12552	39936	53288	67584	79896
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	24	24	24	24	24
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	CBs	2	5	7	9	10
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 10, 11	Bits	25200	79632	106848	134064	161280
For Slots i =1,…, 9, 12, …, 19	Bits	26400	83424	111936	140448	168960
Max. Throughput averaged over 2 frames	Mbps	11.924	37.939	50.624	64.205	75.901
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.3.2.1.1-10: PDSCH Reference Channel for FDD CC and CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-10.1 FDD	R.PDSCH.1-10.2 FDD	R.PDSCH.1-10.3 FDD	R.PDSCH.1-10.4 FDD	
Channel bandwidth	MHz	40	50	35	45	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	216	270	188	242	
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		2	2	2	2	

Number of DMRS REs		12	12	12	12	
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	108552	135296	94248	122976	
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	13	17	12	15	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 10, 11	Bits	217728	272160	189504	243936	
For Slots i =1,…, 9, 12, …, 19	Bits	228096	285120	198528	255552	
Max. Throughput averaged over 2 frames	Mbps	103.124	128.531	89.536	116.827	
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.3.2.1.1-11: PDSCH Reference Channel for FDD

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-11.1 FDD	R.PDSCH.1-11.2 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	18	18			
MCS table		64QAMLowSE	64QAMLowSE			
MCS index		19	19			
Modulation		16QAM	16QAM			
Target Coding Rate		0.54	0.54			
Number of MIMO layers		1	1			
Number of DMRS REs		12	12			
Overhead for TBS determination		0	0			
Information Bit Payload per Slot						
For Slot i = 0,1	Bits	N/A	N/A			
For Slots i = 2,…, 19	Bits	14856	14856			
Transport block CRC per Slot						
For Slot i = 0,1	Bits	N/A	N/A			
For Slots i = 2,…, 19	Bits	24	24			
Number of Code Blocks per Slot						
For Slot i = 0,1	CBs	N/A	N/A			
For Slots i = 2,…, 19	CBs	2	2			
Binary Channel Bits Per Slot						
For Slot i = 0,1	Bits	N/A	N/A			
For Slots i = 10, 11	Bits	26208	24960			
For Slots i =2,…, 9, 12, …, 19	Bits	27456	27456			
Max. Throughput averaged over 2 frames	Mbps	6.685 (NOTE 3)	6.685 (NOTE 4)			
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: Throughput is calculated under assumption of aggregation factor 2. Note 4: Throughput is calculated under assumption of repetition number 2						

Table A.3.2.1.1-12: PDSCH Reference Channel for FDD

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-12.1 FDD				
Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH symbols		2				
Allocated slots per 2 frames	Slots	19				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.3				
Number of MIMO layers		1				
Number of DMRS REs		6				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	576				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	16				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,…, 19	CBs	1				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 10, 11	Bits	1872				
For Slots i =1,…, 9, 12, …, 19	Bits	1872				
Max. Throughput averaged over 2 frames	Mbps	0.547				
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.3.2.1.1-13: PDSCH Reference Channel for FDD HST-SFN with CA scenario

Parameter	Unit	Values				
Reference channel		R.PDSCH.1-13.1 FDD	R.PDSCH.1-13.2 FDD	R.PDSCH.1-13.3 FDD	R.PDSCH.1-13.4 FDD	R.PDSCH.1-13.5 FDD
Channel bandwidth	MHz	5	15	20	25	30
Subcarrier spacing	kHz	15	15	15	15	15
Number of allocated resource blocks	PRBs	25	79	106	133	160
Number of consecutive PDSCH symbols		12	12	12	12	12
Allocated slots per 2 frames	Slots	19	19	19	19	19
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	13	13	13
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.48
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs		18	18	18	18	18
Overhead for TBS determination		0	0	0	0	0
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	12040	37896	51216	64552	77896
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	24	24	24	24	24
Number of Code Blocks per Slot						

For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	CBs	2	5	7	8	10
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,2,11,12 (Note 3)	Bits	24000	77136	104352	131568	158784
For Slots i = 3,…, 10, 13, …, 19	Bits	25200	79632	106848	134064	161280
Max. Throughput averaged over 2 frames	Mbps	11.438	36.001	48.655	61.324	74.001
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.1.1-14: PDSCH Reference Channel for FDD HST-SFN with CA scenario

Parameter	Unit	Values				
Reference channel		R.PDSCH.1-14.1 FDD	R.PDSCH.1-14.2 FDD	R.PDSCH.1-14.3 FDD	R.PDSCH.1-14.4 FDD	
Channel bandwidth	MHz	40	50	35	45	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	216	270	188	242	
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		2	2	2	2	
Number of DMRS REs		18	18	18	18	
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	104496	131176	90176	116792	
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	13	16	11	14	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,2,11,12 (Note 3)	Bits	215232	269664	187008	241440	
For Slots i = 3,…, 10, 13, …, 19	Bits	217728	272160	189504	243936	
Max. Throughput averaged over 2 frames	Mbps	99.271	124.617	85.667	110.952	
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.1.1-15: PDSCH Reference Channel for FDD HST-DPS with CA scenario

Parameter	Unit	Values				
Reference channel		R.PDSCH.1-15.1 FDD	R.PDSCH.1-15.2 FDD	R.PDSCH.1-15.3 FDD	R.PDSCH.1-15.4 FDD	R.PDSCH.1-15.5 FDD
Channel bandwidth	MHz	5	15	20	25	30

Subcarrier spacing	kHz	15	15	15	15	15
Number of allocated resource blocks	PRBs	25	79	106	133	160
Number of consecutive PDSCH symbols		12	12	12	12	12
Allocated slots per 2 frames	Slots	19	19	19	19	19
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		17	17	17	17	17
Modulation		64QAM	64QAM	64QAM	64QAM	64QAM
Target Coding Rate		0.43	0.43	0.43	0.43	0.43
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs		18	18	18	18	18
Overhead for TBS determination		0	0	0	0	0
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	16136	51216	67584	86040	104496
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	24	24	24	24	24
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	CBs	2	7	9	11	13
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,2,11,12 (Note 3)	Bits	36000	115704	156528	197352	238176
For Slots i = 3,…, 10, 13, …, 19	Bits	37800	119448	160272	201096	241920
Max. Throughput averaged over 2 frames	Mbps	15.3292	48.655	64.2048	81.738	99.2712
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.1.1-16: PDSCH Reference Channel for FDD HST-DPS with CA scenario

Parameter	Unit	Values				
Reference channel		R.PDSCH.1-16.1 FDD	R.PDSCH.1-16.2 FDD	R.PDSCH.1-16.3 FDD	R.PDSCH.1-16.4 FDD	
Channel bandwidth	MHz	40	50	35	45	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	216	270	188	242	
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		17	17	17	17	
Modulation		64QAM	64QAM	64QAM	64QAM	
Target Coding Rate		0.43	0.43	0.43	0.43	
Number of MIMO layers		2	2	2	2	
Number of DMRS REs		18	18	18	18	
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	139376	176208	120936	155776	
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	17	21	15	19	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,2,11,12 (Note 3)	Bits	322848	404496	280512	362160	
For Slots i = 3,…, 10, 13, …, 19	Bits	326592	408240	284256	365904	
Max. Throughput averaged over 2 frames	Mbps	132.407	167.3976	114.8892	147.9872	
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.1.1-17: PDSCH Reference Channel for FDD (1024QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-17.1 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		1024QAM				
MCS index		23				
Modulation		1024QAM				
Target Coding Rate		0.79				
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	54296				
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	7				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 10, 11	Bits	65520				
For Slots i =1,…, 9, 12, …, 19	Bits	68640				
Max. Throughput averaged over 2 frames	Mbps	51.581				
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.3.2.1.1-18: PDSCH Reference Channel for FDD CRS interference mitigation for NR scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-18.1 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	16				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots i = 0,5,10,15	Bits	N/A				
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	Bits	13064				
Transport block CRC per Slot						
For Slots i = 0,5,10,15	Bits	N/A				
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	Bits	24				
Number of Code Blocks per Slot						
For Slots i = 0,5,10,15	CBs	N/A				
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	CBs	2				
Binary Channel Bits Per Slot						
For Slots i = 0,5,10,15	Bits	N/A				
For Slots i = 11	Bits	22880				
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {1,…, 9, 12, …, 19}	Bits	24128				
Max. Throughput averaged over 2 frames	Mbps	10.4512				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: No user data is scheduled on slots with PBCH/PSS/SSS on the interference LTE cell						

Table A.3.2.1.1-19: PDSCH Reference Channel for FDD CRS interference mitigation for NR scenario for inter-RAT measurement enabled

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-19.1 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 4 frames	Slots	26				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs		12				
For Slots i = 0,5,10,15,20,25,30,35		N/A				
For Slots in meauresment gao i= 7,8,9,10,11,12		N/A				
For Slots i, if mod(i, 5) = {1,2,3,4} and i≠7,8,9,11,12		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots i = 0,5,10,15,20,25,30,35	Bits	N/A				
For Slots in meauresment gao i= 7,8,9,10,11,12	Bits	N/A				

For Slots i, if mod(i, 5) = {1,2,3,4} and i≠7,8,9,11,12	Bits	13064				
Transport block CRC per Slot						
For Slots i = 0,5,10,15,20,25,30,35	Bits	N/A				
For Slots in meauresment gao i= 7,8,9,10,11,12	Bits	N/A				
For Slots i, if mod(i, 5) = {1,2,3,4} and i≠7,8,9,11,12	Bits	24				
Number of Code Blocks per Slot						
For Slots i = 0,5,10,15,20,25,30,35	CBs	N/A				
For Slots in meauresment gao i= 7,8,9,10,11,12	CBs	N/A				
For Slots i, if mod(i, 5) = {1,2,3,4} and i≠7,8,9,11,12	CBs	2				
Binary Channel Bits Per Slot						
For Slots i = 0,5,10,15,20,25,30,35	Bits	N/A				
For Slots in meauresment gao i= 7,8,9,10,11,12		N/A				
For Slots i = {11, 31}		22880				
For Slots i, if mod(i, 5) = {1,2,3,4} and i≠7,8,9,11,12,31	Bits	24128				
Max. Throughput averaged over 4 frames	Mbps	8.4916				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 4 frames Note 3: No user data is scheduled on slots with PBCH/PSS/SSS on the interference LTE cell Note 4: No user data is scheduled on slots used for measurement						

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,…, 39	Bits	40976				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 39	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,…, 39	CBs	5				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 20, 21	Bits	77112				
For Slots i = 1,…, 19, 22, …, 39	Bits	80784				
Max. Throughput averaged over 2 frames	Mbps	79.903				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms						

Note 2: Slot i is slot index per 2 frames

A.3.2.1.3 Reference measurement channels for SCS 60 kHz FR1

A.3.2.1.4 Reference measurement channels for E-UTRA

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-1.1 FDD	R.PDSCH.4-1.2 FDD	R.PDSCH.4-1.3 FDD	R.PDSCH.4-1.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		9	10	10	10
Modulation		64QAM	64QAM	64QAM	64QAM
Coding Rate					
For Sub-Frames 1,2,3,4,6,7,8,9,		0.85	0.85	0.85	0.88
For Sub-Frame 5		N/A	0.89	0.91	0.87
For Sub-Frame 0		0.83	0.90	0.88	0.90
Information Bit Payload (Note 3)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	18336	36696	55056	75376
For Sub-Frame 5	Bits	N/A	35160	52752	71112
For Sub-Frame 0	Bits	15840	36696	55056	75376
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 1,2,3,4,6,7,8,9	CBs	3	6	9	13
For Sub-Frame 5	CBs	N/A	6	9	12
For Sub-Frame 0	CBs	3	6	9	13
Binary Channel Bits (Note 3)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	21600	43200	64800	86400
For Sub-Frame 5	Bits	N/A	39744	60480	82080
For Sub-Frame 0	Bits	19152	40752	62352	83952
Number of layers		2	2	2	2
Max. Throughput averaged over 1 frame (Note 3)	Mbps	16.253	36.542	54.826	74.950

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

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-2.1 FDD	R.PDSCH.4-2.2 FDD	R.PDSCH.4-2.3 FDD	R.PDSCH.4-2.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		9	10	10	10
Modulation		64QAM	64QAM	64QAM	64QAM
Coding Rate					
For Sub-Frames 1,2,3,4,6,7,8,9,		0.78	0.78	0.77	0.79
For Sub-Frame 5		N/A	0.80	0.79	0.81
For Sub-Frame 0		0.85	0.83	0.8	0.81
Information Bit Payload (Note 3)					

For Sub-Frames 1,2,3,4,6,7,8,9	Bits	31704	63776	93800	128496
For Sub-Frame 5	Bits	N/A	59256	90816	124464
For Sub-Frame 0	Bits	30576	63776	93800	128496
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 1,2,3,4,6,7,8,9	CBs	6	11	16	21
For Sub-Frame 5	CBs	N/A	10	15	21
For Sub-Frame 0	CBs	5	11	16	21
Binary Channel Bits (Note 3)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	40800	81600	122400	163200
For Sub-Frame 5	Bits	N/A	74976	114144	154944
For Sub-Frame 0	Bits	36192	76992	117792	158592
Number of layers		4	4	4	4
Max. Throughput averaged over 1 frame (Note 3)	Mbps	28.421	63.324	93.502	128.093

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

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-3.1 FDD	R.PDSCH.4-3.2 FDD	R.PDSCH.4-3.3 FDD	R.PDSCH.4-3.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		10	10	10	10
Modulation		256QAM	256QAM	256QAM	256QAM
Coding Rate					
For Sub-Frames 3,4,8,9		0.85	0.85	0.88	0.85
For Sub-Frames 1,2,6,7		0.77	0.74	0.74	0.74
For Sub-Frame 5		0.79	0.77	0.77	0.75
For Sub-Frame 0		0.84	0.78	0.77	0.76
Information Bit Payload (Note 3)					
For Sub-Frames 3,4,8,9	Bits	24496	48936	75376	97896
For Sub-Frames 1,2,6,7	Bits	21384	42368	63776	84760
For Sub-Frame 5	Bits	19848	40576	61664	81176
For Sub-Frame 0	Bits	21384	42368	63776	84760
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 3,4,8,9	CBs	4	8	13	16
For Sub-Frames 1,2,6,7	CBs	4	7	11	14
For Sub-Frame 5	CBs	4	7	11	14
For Sub-Frame 0	CBs	4	7	11	14
Binary Channel Bits (Note 3)					
For Sub-Frames 3,4,8,9	Bits	28800	57600	86400	115200
For Sub-Frames 1,2,6,7	Bits	28800	57600	86400	115200
For Sub-Frame 5	Bits	25344	52992	80640	109440
For Sub-Frame 0	Bits	25536	54336	83136	111936
Number of layers		2	2	2	2
Max. Throughput averaged over 1 frame (Note 3)	Mbps	22.475	44.816	68.205	89.656

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: Given per component carrier per codeword.

Note 4: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 5: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks n_{PRB} = 2..24 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-4.1 FDD	R.PDSCH.4-4.2 FDD	R.PDSCH.4-4.3 FDD	R.PDSCH.4-4.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		10	10	10	10
Modulation		256QAM	256QAM	256QAM	256QAM
Coding Rate					
For Sub-Frames 3,4,8,9		0.85	0.78	0.79	0.78
For Sub-Frames 1,2,6,7		0.77	0.78	0.79	0.78
For Sub-Frame 5		0.79	0.82	0.82	0.786
For Sub-Frame 0		0.84	0.83	0.82	0.80
Information Bit Payload (Note 3)					
For Sub-Frames 3,4,8,9	Bits	42368	84760	128496	169544
For Sub-Frames 1,2,6,7	Bits	42368	84760	128496	169544
For Sub-Frame 5	Bits	39232	81176	124464	161760
For Sub-Frame 0	Bits	39232	84760	128496	169544
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 3,4,8,9	CBs	7	14	21	28
For Sub-Frames 1,2,6,7	CBs	7	14	21	28
For Sub-Frame 5	CBs	7	14	21	27
For Sub-Frame 0	CBs	7	14	21	28
Binary Channel Bits (Note 3)					
For Sub-Frames 3,4,8,9	Bits	54400	108800	163200	217600
For Sub-Frames 1,2,6,7	Bits	54400	108800	163200	217600
For Sub-Frame 5	Bits	47744	99968	152192	206592
For Sub-Frame 0	Bits	48256	102656	157056	211456
Number of layers		4	4	4	4
Max. Throughput averaged over 1 frame (Note 3)	Mbps	41.741	84.4016	128.093	168.766

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

Table A.3.2.1.4-5: PDSCH Reference Channel for sustained data-rate test (1024QAM, 2 MIMO layers)

Parameter	Unit	Value

Reference channel		R.PDSCH.4-5.1 FDD	R.PDSCH.4-5.2 FDD	R.PDSCH.4-5.3 FDD	R.PDSCH.4-5.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		10	10	10	10
Modulation		1024QAM	1024QAM	1024QAM	1024QAM
Coding Rate					
For Sub-Frames 3,4,8,9		0.76	0.73	0.75	0.76
For Sub-Frames 1,2,6,7		0.76	0.73	0.75	0.76
For Sub-Frame 5		0.80	0.77	0.78	0.77
For Sub-Frame 0		0.86	0.78	0.78	0.79
Information Bit Payload (Note 3)					
For Sub-Frames 3,4,8,9	Bits	27376	52752	81176	110136
For Sub-Frames 1,2,6,7	Bits	27376	52752	81176	110136
For Sub-Frame 5	Bits	25456	51024	78704	105528
For Sub-Frame 0	Bits	27376	52752	81176	110136
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 3,4,8,9	CBs	5	9	14	18
For Sub-Frames 1,2,6,7	CBs	5	9	14	18
For Sub-Frame 5	CBs	5	9	13	18
For Sub-Frame 0	CBs	5	9	14	18
Binary Channel Bits (Note 3)					
For Sub-Frames 3,4,8,9	Bits	36000	72000	108000	144000
For Sub-Frames 1,2,6,7	Bits	36000	72000	108000	144000
For Sub-Frame 5	Bits	31680	66240	100800	136800
For Sub-Frame 0	Bits	31920	67920	103920	139920
Number of layers		2	2	2	2
Max. Throughput averaged over 1 frame (Note 3)	Mbps	27.18	52.58	80.93	109.68

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

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-6.1 FDD	R.PDSCH.4-6.2 FDD	R.PDSCH.4-6.3 FDD	R.PDSCH.4-6.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		10	10	10	10
Modulation		1024QAM	1024QAM	1024QAM	1024QAM
Coding Rate					
For Sub-Frames 3,4,8,9		0.78	0.81	0.79	0.81
For Sub-Frames 1,2,6,7		0.78	0.81	0.79	0.81
For Sub-Frame 5		0.82	0.81	0.83	0.82
For Sub-Frame 0		0.87	0.86	0.82	0.83
Information Bit Payload (Note 3)					
For Sub-Frames 3,4,8,9	Bits	52752	110136	161760	220296
For Sub-Frames 1,2,6,7	Bits	52752	110136	161760	220296
For Sub-Frame 5	Bits	48936	101840	157432	211936
For Sub-Frame 0	Bits	52752	110136	161760	220296

Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 3,4,8,9	CBs	9	18	27	36
For Sub-Frames 1,2,6,7	CBs	9	18	27	36
For Sub-Frame 5	CBs	8	17	26	35
For Sub-Frame 0	CBs	9	18	27	36
Binary Channel Bits (Note 3)					
For Sub-Frames 3,4,8,9	Bits	68000	136000	204000	272000
For Sub-Frames 1,2,6,7	Bits	68000	136000	204000	272000
For Sub-Frame 5	Bits	59680	124960	190240	258240
For Sub-Frame 0	Bits	60320	128320	196320	264320
Number of layers		4	4	4	4
Max. Throughput averaged over 1 frame (Note 3)	Mbps	52.37	109.31	161.33	219.46

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

A.3.2.1.5 Reference measurement channels for Intra-cell Inter-UE interference scenario

Table A.3.2.1.5-1: PDSCH Reference Channel for FDD Intra-cell Inter-UE interference scenario

Parameter	Unit	Value				
Reference channel		(Void)	R.PDSCH.5-1.2 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			24			
Overhead for TBS determination			0			
Information Bit Payload per Slot						
For Slot i = 0	Bits		N/A			
For Slots i = 1,…, 19	Bits		24072			
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		3			
Binary Channel Bits Per Slot						
For Slot i = 0	Bits		N/A			
For Slots i = 10, 11	Bits		47424			
For Slots i = 1,…, 9, 12, …, 19	Bits		49920			

Max. Throughput averaged over 2 frames	Mbps		22.868			
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

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-1.1 TDD	R.PDSCH.1-1.2 TDD	R.PDSCH.1-1.3 TDD		
Channel bandwidth	MHz	10	10	20		
Subcarrier spacing	kHz	15	15	15		
Allocated resource blocks	PRBs	52	52	106		
Number of consecutive PDSCH symbols						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}		N/A	N/A	N/A		
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}		9	11	9		
Allocated slots per 2 frames		7	7	7		
MCS table		64QAM	64QAM	64QAM		
MCS index		4	4	13		
Modulation		QPSK	QPSK	16QAM		
Target Coding Rate		0.30	0.30	0.48		
Number of MIMO layers		1	1	1		
Number of DMRS REs						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}		N/A	N/A	N/A		
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}		12	12	12		
Overhead for TBS determination		18	18	18		
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	Bits	2472	3240	15880		
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	Bits	16	16	24		
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	CBs	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	CBs	1	1	2		
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A	N/A	N/A		
For Slots i = 10, 11	Bits	7760	10256	31760		
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,9,12,…,19}	Bits	8384	10880	34304		
Max. Throughput averaged over 2 frames	Mbps	0.865	1.134	5.558		
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: No user data is scheduled on slots with LTE PBCH/PSS/SSS						

Table A.3.2.2.1-2: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.15-1 and CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-2.1 TDD	R.PDSCH.1-2.2 TDD	R.PDSCH.1-2.3 TDD	R.PDSCH.1-2.4 TDD	R.PDSCH.1-2.5 TDD
Channel bandwidth	MHz	5	10	15	20	25
Subcarrier spacing	kHz	15	15	15	15	15
Number of allocated resource blocks	PRBs	25	52	79	106	133
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		8	8	8	8	8
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12	12	12	12	12
Allocated slots per 2 frames	Slots	15	15	15	15	15
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	13	13	13
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.48
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		12	12	12	12	12
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12	12	12	12	12
Overhead for TBS determination		0	0	0	0	0
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	8064	16896	25608	33816	43032
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	Bits	12552	26120	39936	53288	67584
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	24	24	24	24	24
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	Bits	24	24	24	24	24
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	CBs	1	3	4	5	6
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	CBs	2	4	5	7	9
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 10, 11	Bits	25200	52416	79632	106848	134064
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	16800	34944	53088	71232	89376
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,9,12,…,19}	Bits	26400	54912	83424	111936	140448
Max. Throughput averaged over 2 frames	Mbps	8.516	17.745	27.086	36.072	45.778
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.3.2.2.1-3: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.15-1 and CA scenario

Parameter	Unit	Value

Reference channel		R.PDSCH.1-3.1 TDD	R.PDSCH.1-3.2 TDD	R.PDSCH.1-3.3 TDD		
Channel bandwidth	MHz	30	40	50		
Subcarrier spacing	kHz	15	15	15		
Number of allocated resource blocks	PRBs	160	216	270		
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		8	8	8		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12	12	12		
Allocated slots per 2 frames	Slots	15	15	15		
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		2	2	2		
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		12	12	12		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12	12	12		
Overhead for TBS determination		0	0	0		
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	51216	69672	86040		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	Bits	79896	108552	135296		
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	24	24	24		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	Bits	24	24	24		
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	CBs	7	9	11		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	CBs	10	13	17		
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A		
For Slots i = 10, 11	Bits	161280	217728	272160		
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	107520	145152	181440		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,9,12,…,19}	Bits	168960	228096	285120		
Max. Throughput averaged over 2 frames	Mbps	54.186	73.638	91.621		
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.3.2.2.1-4: PDSCH Reference Channel for TDD CRS interference mitigation for NR scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-4.1 TDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	15				
Allocated resource blocks	PRBs	106				

Number of consecutive PDSCH symbols						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}		N/A				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12				
Allocated slots per 2 frames		7				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}		N/A				
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A				
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	Bits	26632				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A				
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	CBs	N/A				
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	CBs	4				
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A				
For Slots i = 10, 11	Bits	53424				
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,9,12,…,19}	Bits	55968				
Max. Throughput averaged over 2 frames	Mbps	9.3212				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: No user data is scheduled on slots with PBCH/PSS/SSS on the interference LTE cell						

Table A.3.2.2.1-5: PDSCH Reference Channel for TDD CRS interference mitigation for NR scenario for inter-RAT measurement enabled

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-4.2 TDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	15				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slots i = {2,12,22,32}		N/A				
For Slots i= {0,20}		N/A				
For Slots in meauresment gao i= {1,2,3,4,5,6}		N/A				
For Slots i, if mod(i, 5) = {3,4}		N/A				
For Slots i, if mod(i, 5) = {0,1,2} and i≠{0,1,2,20}		12				
Allocated slots per 4 frames		16				
MCS table		64QAM				

MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs						
For Slots i = {2,12,22,32}		N/A				
For Slots i= {0,20}		N/A				
For Slots in meauresment gao i= {1,2,3,4,5,6}		N/A				
For Slots i, if mod(i, 5) = {3,4}		N/A				
For Slots i, if mod(i, 5) = {0,1,2} and i≠{0,1,2,20}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots i = {2,12,22,32}	Bits	N/A				
For Slots i= {0,20}	Bits	N/A				
For Slots in meauresment gao i= {1,2,3,4,5,6}	Bits	N/A				
For Slots i, if mod(i, 5) = {3,4}	Bits	N/A				
For Slots i, if mod(i, 5) = {0,1,2} and i≠{0,1,2,20}		26632				
Transport block CRC per Slot						
For Slots i = {2,12,22,32}	Bits	N/A				
For Slots i= {0,20}	Bits	N/A				
For Slots in meauresment gao i= {1,2,3,4,5,6}	Bits	N/A				
For Slots i, if mod(i, 5) = {3,4}	Bits	N/A				
For Slots i, if mod(i, 5) = {0,1,2} and i≠{0,1,2,20}		24				
Number of Code Blocks per Slot						
For Slots i = {2,12,22,32}	CBs	N/A				
For Slots i= {0,20}	CBs	N/A				
For Slots in meauresment gao i= {1,2,3,4,5,6}	CBs	N/A				
For Slots i, if mod(i, 5) = {3,4}	CBs	N/A				
For Slots i, if mod(i, 5) = {0,1,2} and i≠{0,1,2,20}		4				
Binary Channel Bits Per Slot						
For Slots i = {2,12,22,32}	Bits	N/A				
For Slots i= {0,20}	Bits	N/A				
For Slots in meauresment gao i= {1,2,3,4,5,6}	Bits	N/A				
For Slots i, if mod(i, 5) = {3,4}	Bits	N/A				
For Slots i = {10,11,30,31}	Bits	47936				
For Slots i, if mod(i, 5) = {0,1,2} and i≠{0,1,2,11,20,31}	Bits	49184				
Max. Throughput averaged over 4frames	Mbps	11.9844				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 4 frames Note 3: No user data is scheduled on slots with PBCH/PSS/SSS on the interference LTE cell Note 4: No user data is scheduled on slots used for measurement						

A.3.2.2.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-1.1 TDD	R.PDSCH.2-1.2 TDD	R.PDSCH.2-1.3 TDD	R.PDSCH.2-1.4 TDD	R.PDSCH.2-1.5 TDD
Channel bandwidth	MHz	40	40	40	40	20
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	106	6	106	106	51

Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	4	N/A	N/A	4
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	7	12	12
Allocated slots per 2 frames		31	31	27	27	31
MCS table		64QAM	64QAM	64QAM	64QAMLowSE	64QAM
MCS index		4	4	4	14	4
Modulation		QPSK	QPSK	QPSK	QPSK	QPSK
Target Coding Rate		0.30	0.30	0.30	0.59	0.30
Number of MIMO layers		1	1	1	1	1
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	N/A	N/A	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18	12	12	12	18
Overhead for TBS determination		0	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	2664	144	N/A	N/A	1288
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	8064	480	4608	16392	3840
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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16	16	N/A	N/A	16
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24	16	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	1	1	N/A	N/A	1
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	1	1	1	2	1
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 20, 21	Bits	25440	1512	13992	26712	12240
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	8904	504	N/A	N/A	4284
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	27984	12852

Max. Throughput averaged over 2 frames	Mbps	11.419	0.677	6.221	22.129	5.442
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	R.PDSCH.2-2.5 TDD	R.PDSCH.2-2.6 TDD
Channel bandwidth	MHz	40	40	40	40	40	40
Subcarrier spacing	kHz	30	30	30	30	30	30
Allocated resource blocks	PRBs	106	106	106	106	106	106
Number of consecutive PDSCH symbols							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	4	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	12	12
Allocated slots per 2 frames		31	31	31	31	31	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAMLowSE	64QAM
MCS index		13	13	13	13	19	16
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.54	0.64
Number of MIMO layers		1	2	3	4	2	1
Number of DMRS Res							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	12	12	6	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	24	24	12	12
Overhead for TBS determination		0	0	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	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	8456	16896	22032	29192	19464	11528

For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	26632	53288	73776	98376	60456	35856
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	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	24	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	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	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	2	3	3	4	3	2
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	4	7	9	12	8	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	N/A	N/A	N/A	N/A
For Slots i = 20, 21	Bits	53424	106848	145008	193344	106848	53424
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	17808	35616	45792	61056	35616	17808
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	111936	55968
Max. Throughput averaged over 2 frames	Mbps	37.644	75.318	104.004	138.646	85.508	50.711
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	R.PDSCH.2-3.3 TDD	R.PDSCH.2-3.4 TDD	R.PDSCH.2-3.5 TDD
Channel bandwidth	MHz	40	40	40	40	20
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	106	106	53 (Note 3)	53 (Note 4)	51
Number of consecutive PDSCH symbols						

For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	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	12
Allocated slots per 2 frames		31	31	31	31	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		19	19	19	19	19
Modulation		64QAM	64QAM	64QAM	64QAM	64QAM
Target Coding Rate		0.51	0.51	0.51	0.51	0.51
Number of MIMO layers		2	2	2	2	1
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	12	12	12	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	24	24	24	12
Overhead for TBS determination		0	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	27144	23040	11528	11528	6528
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	83976	77896	38936	38936	20496
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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	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	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	4	3	2	2	1
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	10	10	5	5	3
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	N/A
For Slots i = 20, 21	Bits	160272	145008	68688	72504	38556
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	53424	45792	22896	22896	12852
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	167904	152640	76320	76320	40392
Max. Throughput averaged over 2 frames	Mbps	118.796	109.768	54.869	54.869	28.975
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: PDSCH is scheduled in PRB numbers from 0 to 52. Note 4: PDSCH is scheduled in PRB numbers from 53 to 105.						

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	R.PDSCH.2-4.2 TDD	R.PDSCH.2-4.3 TDD		
Channel bandwidth	MHz	40	20	20		
Subcarrier spacing	kHz	30	30	30		
Allocated resource blocks	PRBs	106	51	51		
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A		
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		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		
Allocated slots per 2 frames		31	31	31		
MCS table		256QAM	256QAM	256QAM		
MCS index		24	24	20		
Modulation		256QAM	256QAM	256QAM		
Target Coding Rate		0.82	0.82	0.67		
Number of MIMO layers		1	1	1		
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A		
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	6		
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	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	29192	14088	11528		
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	92200	44040	35856		
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	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		
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	4	2	2		
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	11	6	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	N/A		
For Slots i = 20, 21	Bits	106848	51408	51408		
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	35616	17136	17136		
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	111936	53856	53856		
Max. Throughput averaged over 2 frames	Mbps	130.308	62.272	50.711		
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 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39}		N/A				
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 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39}		N/A				
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 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}		N/A				
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 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}		12				
For Slot i, if mod(i, 10) = {0,1,2,5,6} for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
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 Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
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 Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16896				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	53288				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	3				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	7				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {0,5} for i from {1,…,19,22,…,39}	Bits	103456				
For Slots i = 20	Bits	98368				
For Slots i = 21	Bits	106848				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	35616				
For Slot i, if mod(i, 10) = {1,2,3,4,6} for i from {1,…,19,22,…,39}	Bits	111936				
Max. Throughput averaged over 2 frames	Mbps	75.318				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms						

Note 2: Slot i is slot index per 2 frames

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-8.1 TDD	R.PDSCH.2-8.2 TDD	R.PDSCH.2-8.3 TDD	R.PDSCH.2-8.4 TDD	R.PDSCH.2-8.5 TDD
Channel bandwidth	MHz	40	40	40	20	40
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	106	106	106	51	106
Number of consecutive PDSCH symbols		12	12	12	12	12
Allocated slots per 2 frames		23	23	23	23	23
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	20	13	13
Modulation		16QAM	16QAM	64QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.55	0.48	0.48
Number of MIMO layers		1	2	2	1	2
Number of DMRS REs (Note 3)		24	24	24	24	24
Overhead for TBS determination		0	0	0	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	N/A	N/A	N/A
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i = 20	Bits	24576	49176	83976	11784	49176
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	24576	49176	83976	11784	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	N/A	N/A	N/A
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i = 20	Bits	24	24	24	24	24
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	24	24	24	24	24
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	N/A
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	N/A
For Slot i = 20	CBs	3	6	10	2	6
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	CBs	3	6	10	2	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	N/A	N/A	N/A
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i = 20	Bits	48226	96672	145008	23256	91584
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	50880	101760	152640	24480	101760
Max. Throughput averaged over 2 frames	Mbps	28.2624	56.5524	96.5724	13.5516	56.5524

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data

Table A.3.2.2.2-9: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-4 (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-9.1 TDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	51				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}		4				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}		12				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		19				
Modulation		64QAM				
Target Coding Rate		0.51				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}		6				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}	Bits	13064				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}	Bits	40976				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}	CBs	2				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}	CBs	5				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}	Bits	N/A				
For Slots i = 20, 21	Bits	77112				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}	Bits	25704				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,19,22,…,39}	Bits	80784				

Max. Throughput averaged over 2 frames	Mbps	57.930				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-10.1 TDD	R.PDSCH.2-10.2 TDD	R.PDSCH.2-10.3 TDD	R.PDSCH.2-10.4 TDD	R.PDSCH.2-10.5 TDD
Channel bandwidth	MHz	40	40	40	40	40
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	106	106	106	106	106
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	N/A	4	N/A	4
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	12	12	12
Allocated slots per 2 frames		31	27	31	27	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	17	13	17
Modulation		16QAM	16QAM	64QAM	16QAM	64QAM
Target Coding Rate		0.48	0.48	0.43	0.48	0.43
Number of MIMO layers		1	1	1	2	2
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	N/A	6	N/A	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18	18	18	18	18
Overhead for TBS determination		0	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	8456	N/A	11528	N/A	23040
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	25608	25608	33816	51216	67584
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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	N/A	24	N/A	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	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	2	N/A	2	N/A	3
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	4	4	5	7	9

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	N/A
For Slots i = 1,2,21,22 (Note 3)	Bits	52176	52176	78264	104352	156528
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	17808	N/A	26712	N/A	53424
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	53424	53424	80136	106848	160272
Max. Throughput averaged over 2 frames	Mbps	36.262	34.5708	47.9572	69.1416	95.8464
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation.						

Table A.3.2.2.2-11: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-5

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-11.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}		12				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}		10				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}		18				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}		18				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	Bits	8064				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	Bits	6528				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	Bits	24				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	CBs	1				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	CBs	1				
Binary Channel Bits Per Slot						

For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}	Bits	N/A				
For Slot i = 20	Bits	25440				
For Slot i = 21	Bits	20352				
For Slot i, if mod(i, 4) = 0 for i from {1,…,19,22,…,39}	Bits	26712				
For Slot i, if mod(i, 4) = 1 for i from {0,…,19,22,…,39}	Bits	21624				
Max. Throughput averaged over 2 frames	Mbps	6.893				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-12.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}		12				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}		8				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}		10				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}		18				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}		18				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}		18				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	Bits	8064				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	Bits	4992				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}	Bits	6528				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	Bits	24				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}	CBs	N/A				

For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	CBs	1				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	CBs	1				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}	CBs	1				
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}	Bits	N/A				
For Slot i = 20	Bits	25440				
For Slot i = 21	Bits	15264				
For Slot i, if mod(i, 4) = 0 for i from {1,…,19,22,…,39}	Bits	26712				
For Slot i, if mod(i, 4) = 1 for i from {1,…,19,22,…,39}	Bits	16536				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}	Bits	21624				
Max. Throughput averaged over 2 frames	Mbps	9.389				
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.3.2.2.2-13: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-13.1 TDD	R.PDSCH.2-13.2 TDD	R.PDSCH.2-13.3 TDD	R.PDSCH.2-13.4 TDD	R.PDSCH.2-13.5 TDD
Channel bandwidth	MHz	5	10	15	20	25
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	11	24	38	51	65
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	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	12
Allocated slots per 2 frames		31	31	31	31	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	13	13	13
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.48
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs						
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	6	6	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	12	12	12
Overhead for TBS determination		0	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	1800	3840	6144	8192	10504
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	5504	12040	18960	25608	32776
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	N/A

For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16	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	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	1	1	1	1	2
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	1	2	3	4	4
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	N/A
For Slots i = 20, 21	Bits	11088	24192	38304	51408	65520
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	3696	8064	12768	17136	21840
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	11616	25344	40128	53856	68640
Max. Throughput averaged over 2 frames	Mbps	7.790	17.022	26.825	36.209	46.348
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.3.2.2.2-14: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-14.1 TDD	R.PDSCH.2-14.2 TDD	R.PDSCH.2-14.3 TDD	R.PDSCH.2-14.4 TDD	R.PDSCH.2-14.5 TDD
Channel bandwidth	MHz	30	50	60	80	90
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	78	133	162	217	245
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	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	12
Allocated slots per 2 frames		31	31	31	31	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	13	13	13
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.48
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs						
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	6	6	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	12	12	12
Overhead for TBS determination		0	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	N/A

For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	12552	21504	26120	34816	38936
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	38936	67584	81976	110632	122976
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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	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	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	2	3	4	5	5
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	5	9	10	14	15
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	N/A
For Slots i = 20, 21	Bits	78624	134064	163296	218736	246960
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	26208	44688	54432	72912	82320
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	82368	140448	171072	229152	258720
Max. Throughput averaged over 2 frames	Mbps	55.074	95.539	115.892	156.316	173.805
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.3.2.2.2-15: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-15.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	273				
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	44040				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	139376				
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	6				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	17				
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	275184				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	91728				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	288288				
Max. Throughput averaged over 2 frames	Mbps	196.966				
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.3.2.2.2-16: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-16.1 TDD	R.PDSCH.2-16.2 TDD			
Channel bandwidth	MHz	40	40			
Subcarrier spacing	kHz	30	30			
Allocated resource blocks	PRBs	106	106			
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 10) = {0, 7} for i from {0,…,39}		N/A	N/A			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39}		12	12			
Allocated slots per 2 frames		24	24			
MCS table		64QAMLowSE	64QAMLowSE			
MCS index		19	19			
Modulation		16QAM	16QAM			

Target Coding Rate		0.54	0.54			
Number of MIMO layers		1	1			
Number of DMRS REs						
For Slot i, if mod(i, 10) = {0, 7} for i from {0,…,39}		N/A	N/A			
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 Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39}	Bits	N/A	N/A			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39}	Bits	30216	30216			
Transport block CRC per Slot						
For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39}	Bits	N/A	N/A			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39}	Bits	24	24			
Number of Code Blocks per Slot						
For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39}	CBs	N/A	N/A			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39}	CBs	4	4			
Binary Channel Bits Per Slot						
For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39}	Bits	N/A	N/A			
For Slot i = 21	Bits	53424	50880			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	55968	55968			
Max. Throughput averaged over 2 frames	Mbps	18.130 (NOTE 3)	18.130 (NOTE 4)			
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: Throughput is calculated under assumption of aggregation factor 2. Note 4: Throughput is calculated under assumption of repetition number 2						

Table A.3.2.2.2-17: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-2

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-17.1 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}		2				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}		N/A				
Allocated slots per 2 frames		8				
MCS table						
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.3				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}		6				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}		N/A				
Overhead for TBS determination		0				
Information Bit Payload per Slot						

For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	1160				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	Bits	N/A				
Transport block CRC per Slot						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	16				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	Bits	N/A				
Number of Code Blocks per Slot						
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	N/A				
Binary Channel Bits Per Slot						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	3816				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	Bits	N/A				
Max. Throughput averaged over 2 frames	Mbps	0.464				
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.3.2.2.2-18: PDSCH Reference Channel for PDSCH on band with shared spectrum access with TDD UL-DL pattern FR1.30-7

Parameter	Unit	Value			
Reference channel		R.PDSCH.2-18.1 TDD	R.PDSCH.2-18.2 TDD	R.PDSCH.2-18.3 TDD	R.PDSCH.2-18.4 TDD
Channel bandwidth	MHz	20	40	60	80
Subcarrier spacing	kHz	30	30	30	30
Allocated resource blocks	PRBs	51	106	162	217
Number of consecutive PDSCH symbols					
For Slot 0 and slot i, if mod(i, 10) =7 for i from {0,…,39}		N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5)	symbol	{4,7,10,12}	{4,7,10,12}	{4,7,10,12}	{4,7,10,12}
For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5)	symbol	12	12	12	12
3 Allocated slots per 2 frames	slot	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		2	2	2	2
Number of DMRS REs					
For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5)	symbol	{6, 6,12,12}	{6, 6,12,12}	{6, 6,12,12}	{6, 6,12,12}
For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5)	symbol	12	12	12	12
Overhead for TBS determination		0	0	0	0

Information Bit Payload per Slot					
For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5)	Bits	{8192,14088, 16392,25608}	{16896,29192, 44040,53288}	{26120,45096, 67584,81976,}	{34816,60456, 90176,110632}
For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5)	Bits	25608	53288	81976	110632
Transport block CRC per Slot					
For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} (Note 5)	Bits	24	24	24	24
Number of Code Blocks per Slot					
For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5)	CBs	{1,2,4,4}	{3,4,6,7}	{4,6,9,10}	{5,8,11,14}
For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5)	CBs	4	7	10	14
Binary Channel Bits Per Slot					
For Slot 0 and slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {3, 5, 6} for i from {1,…,39} (Note 3, 5)	Bits	{17136,29376, 44064,53865}	{35616,61056, 91854,11193}	{54432,93312, 139968,171072}	{72912,124992, 187488,229152}
For Slot i, if mod(i, 10) = {0, 1, 2, 4} for i from {1,…,39} (Note 5)	Bits	53865	111936	171073	229152

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: For {a1,a2,a3,a4 }, a1, a2, a3 and a4 stand for the setup when the number of OFDM symbols is 6,9,12,14 respectively. It applies only to the last slot within the Downlink Transmission duration (specified in Annex B.5). For all other slots the setup when the number of OFDM symbols is 14 should apply.
Note 4: The slot i, mod (i,10)=9 is idle slot with no UL transmission.
Note 5: The per Slot value applies only to slots included within the Downlink Transmission duration. For all other slots not included in the Downlink Transmission Duration, N/A should apply

Table A.3.2.2.2-19: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST-SFN with CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-19.1 TDD	R.PDSCH.2-19.2 TDD	R.PDSCH.2-19.3 TDD	R.PDSCH.2-19.4 TDD	R.PDSCH.2-19.5 TDD
Channel bandwidth	MHz	5	10	15	20	25
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	11	24	38	51	65
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A

For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	12	12	12
Allocated slots per 2 frames		27	27	27	27	27
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	13	13	13
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.48
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18	18	18	18	18
Overhead for TBS determination		0	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	5248	11528	18432	24576	31240
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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	1	2	3	3	4
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	N/A
For Slots i = 1,2,21,22 (Note 3)	Bits	10560	23040	36480	48960	63024
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	11088	24192	38304	51408	65520
Max. Throughput averaged over 2 frames	Mbps	7.0848	15.5628	24.8832	33.1776	42.174
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.2.2-20: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST-SFN with CA scenario

Parameter	Unit	Value

Reference channel		R.PDSCH.2-20.1 TDD	R.PDSCH.2-20.2 TDD	R.PDSCH.2-20.3 TDD	R.PDSCH.2-20.4 TDD	R.PDSCH.2-20.5 TDD
Channel bandwidth	MHz	30	50	60	80	90
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	78	133	162	217	245
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	12	12	12
Allocated slots per 2 frames		27	27	27	27	27
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	13	13	13
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.48
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18	18	18	18	18
Overhead for TBS determination		0	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	37896	64552	77896	104496	118896
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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	5	8	10	13	15
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	N/A
For Slots i = 1,2,21,22 (Note 3)	Bits	76128	131568	160800	216240	244464
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	78624	134064	163296	218736	246960
Max. Throughput averaged over 2 frames	Mbps	51.1596	87.1452	105.1596	141.0696	160.5096
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.

Table A.3.2.2.2-21: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST-SFN with CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-21.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	273				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A				
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		27				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	131176				
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	N/A				
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	N/A				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	16				
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 = 1,2,21,22 (Note 3)	Bits	272688				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	275184				
Max. Throughput averaged over 2 frames	Mbps	177.0876				
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.2.2-22: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST-DPS with CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-22.1 TDD	R.PDSCH.2-22.2 TDD	R.PDSCH.2-22.3 TDD	R.PDSCH.2-22.4 TDD	R.PDSCH.2-22.5 TDD
Channel bandwidth	MHz	5	10	15	20	25
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	11	24	38	51	65
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	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	12
Allocated slots per 2 frames		31	31	31	31	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		17	17	17	17	17
Modulation		64QAM	64QAM	64QAM	64QAM	64QAM
Target Coding Rate		0.43	0.43	0.43	0.43	0.43
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	6	6	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18	18	18	18	18
Overhead for TBS determination		0	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	2408	5120	8192	11016	14088
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	7040	15624	24576	32776	42016
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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16	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	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	1	1	1	2	2
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	1	2	3	4	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	N/A	N/A	N/A
For Slots i = 1,2,21,22 (Note 3)	Bits	15840	34560	54270	73440	94536
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	5544	12096	19152	25704	32760
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	16632	36288	57456	77112	98280
Max. Throughput averaged over 2 frames	Mbps	9.9856	22.1164	34.816	46.4508	59.5392
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.2.2-23: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST-DPS with CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-23.1 TDD	R.PDSCH.2-23.2 TDD	R.PDSCH.2-23.3 TDD	R.PDSCH.2-23.4 TDD	R.PDSCH.2-23.5 TDD
Channel bandwidth	MHz	30	50	60	80	90
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	78	133	162	217	245
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	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	12
Allocated slots per 2 frames		31	31	31	31	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		17	17	17	17	17
Modulation		64QAM	64QAM	64QAM	64QAM	64QAM
Target Coding Rate		0.43	0.43	0.43	0.43	0.43
Number of MIMO layers		2	2	2	2	2
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	6	6	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18	18	18	18	18
Overhead for TBS determination		0	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16896	28680	34816	47112	53288

For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	50184	86040	104496	139376	159880
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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	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	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	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	3	4	5	6	7
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	6	11	13	17	19
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	N/A
For Slots i = 1,2,21,22 (Note 3)	Bits	114192	197352	241200	324360	366696
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	39312	67032	81648	109368	123480
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	117936	201096	244944	328104	370440
Max. Throughput averaged over 2 frames	Mbps	71.1276	121.89	148.0328	197.58	226.4956
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.2.2-24: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST-DPS with CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-24.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	273				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
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		17				
Modulation		64QAM				
Target Coding Rate		0.43				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
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}		18				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	58384				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	176208				
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	7				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	21				
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 = 1,2,21,22 (Note 3)	Bits	409032				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	137592				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	412776				
Max. Throughput averaged over 2 frames	Mbps	249.5576				
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52.						

Table A.3.2.2.2-25: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (1024QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-25.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
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		1024QAM				
MCS index		23				
Modulation		1024QAM				

Target Coding Rate		0.79				
Number of MIMO layers		1				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
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	34816				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	110632				
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	5				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	14				
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	133560				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	44520				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	139920				
Max. Throughput averaged over 2 frames	Mbps	156.316				
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.3.2.2.2-26: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (16QAM)

Parameter	Unit	Value					
Reference channel		R.PDSCH.2-26.1 TDD					
Channel bandwidth	MHz	20					
Subcarrier spacing	kHz	30					
Allocated resource blocks	PRBs	51					
Number of consecutive PDSCH symbols							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A					
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4					

For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12					
Allocated slots per 2 frames		31					
MCS table		64QAM					
MCS index		13					
Modulation		16QAM					
Target Coding Rate		0.48					
Number of MIMO layers		1					
Number of DMRS Res							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A					
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	4096					
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	12808					
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	1					
For Slot i, if mod(i, 10) =	CBs	2					

{0,1,2,3,4,5,6} for i from {1,…,39}							
Binary Channel Bits Per Slot							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A					
For Slots i = 20, 21	Bits	25704					
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	8568					
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	26928					
Max. Throughput averaged over 2 frames	Mbps	18.110					
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.3.2.2.2-27: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-27.1 TDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	51				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		19				
Modulation		64QAM				
Target Coding Rate		0.51				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
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	13064				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	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				
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	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				
For Slots i = 20, 21	Bits	77112				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	25704				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	80784				
Max. Throughput averaged over 2 frames	Mbps	57.930				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: PDSCH is scheduled in PRB numbers from 0 to 52. Note 4: PDSCH is scheduled in PRB numbers from 53 to 105.						

Table A.3.2.2.2-28: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 with overlapping spectrum for LTE and NR

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-28.1 TDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	51				
Number of consecutive PDSCH symbols						
For Slot 0 and Slot i, if mod(i, 20) = {4,5,7,8,9,17,18,19} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 20) = {0,1,2,3,6,10,11,12,13,14,15,16} for i from {1,…,39}		12				
Allocated slots per 2 frames		23				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot 0 and Slot i, if mod(i, 20) = {4,5,7,8,9,17,18,19} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 20) = {0,1,2,3,6,10,11,12,13,14,15,16} 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, 20) = {4,5,7,8,9,17,18,19,} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 20) = {0,1,2,3,6,10,11,12,13,14,15,16} for i from {1,…,39}	Bits	12808				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 20) = {4,5,7,8,9,17,18,19,} for i from {0,…,39}	Bits	N/A				

For Slot i, if mod(i, 20) ={0,1,2,3,6,10,11,12,13,14,15,16} for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 20) = {4,5,7,8,9,17,18,19} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 20) = {0,1,2,3,6,10,11,12,13,14,15,16} for i from {1,…,39}	CBs	2				
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 20) = {4,5,7,8,9,17,18,19} for i from {0,…,39}	Bits	N/A				
For Slots i = 10, 11	Bits	25704				
For Slot i, if mod(i, 20) = {0,1,2,3,6,10,11,12,13,14,15,16} for i from {1,..,9,12,...39}	Bits	26928				
Max. Throughput averaged over 2 frames	Mbps	14.7292				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 40 ms. Note 2: Slot i is slot index per 2 frames. Note 3: No PDSCH data scheduling on slots with LTE PBCH/PSS/SSS.						

Table A.3.2.2.2-29 : PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 with overlapping spectrum for LTE and NR for inter-RAT measurement enabled

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-29.1 TDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	51				
Number of consecutive PDSCH symbols						
For Slots i={5,6,16,25,26,36,45,46,56,65,66,76}		N/A				
For Slots i={0,40}		N/A				
For i,if mod(i,10)={8,9}		N/A				
For Slots in meauresment gap i= {2,3,4,5,6,7,8,9,10,11,12,13}		N/A				
For i,if mod(i,10)=7 and i≠7		4				
For i, if mod(I,10)={0,1,2,3,4,5,6} and i ≠{0,2,3,4,5,6,10,11,12,13,16,25,26,36,40,45,46,56,65,66,76}		12				
Allocated slots per 4 frames		42				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs						
For Slots i={5,6,16,25,26,36,45,46,56,65,66,76}		N/A				
For Slots i={0,40}		N/A				
For i,if mod(i,10)={8,9}		N/A				
For Slots in meauresment gap i= {2,3,4,5,6,7,8,9,10,11,12,13}		N/A				
For i,if mod(i,10)=7 and i≠7		4				
For i, if mod(I,10)={0,1,2,3,4,5,6} and i ≠{0,2,3,4,5,6,10,11,12,13,16,25,26,36,40,45,46,56,65,66,76}		12				
Information Bit Payload per Slot						
For Slots i={5,6,16,25,26,36,45,46,56,65,66,76}		N/A				
For Slots i={0,40}		N/A				
For i,if mod(i,10)={8,9}		N/A				
For Slots in meauresment gap i= {2,3,4,5,6,7,8,9,10,11,12,13}		N/A				
For i,if mod(i,10)=7 and i≠7		8456				
For i, if mod(I,10)={0,1,2,3,4,5,6} and i ≠{0,2,3,4,5,6,10,11,12,13,16,25,26,36,40,45,46,56,65,66,76}		12808				

Number of Code Blocks per Slot						
For Slots i={5,6,16,25,26,36,45,46,56,65,66,76}		N/A				
For Slots i={0,40}		N/A				
For i,if mod(i,10)={8,9}		N/A				
For Slots in meauresment gap i= {2,3,4,5,6,7,8,9,10,11,12,13}		N/A				
For i,if mod(i,10)=7 and i≠7		2				
For i, if mod(I,10)={0,1,2,3,4,5,6} and i ≠{0,2,3,4,5,6,10,11,12,13,16,25,26,36,40,45,46,56,65,66,76}		2				
Binary Channel Bits Per Slot						
For Slots i={5,6,16,25,26,36,45,46,56,65,66,76}		N/A				
For Slots i={0,40}		N/A				
For i,if mod(i,10)={8,9}		N/A				
		N/A				
For i,if mod(i,10)=7 and i≠7		17808				
For i={20,21,60,61}		25704				
For i, if mod(I,10)={0,1,2,3,4,5,6} and i ≠{0,2,3,4,5,6,10,11,12,13,16,25,26,36,40,45,46,56,65,66,76}		26928				
Max. Throughput averaged over 4frames	Mbps	12.6868				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 4 frames Note 3: No user data is scheduled on slots with PBCH/PSS/SSS on the interference LTE cell Note 4: No user data is scheduled on slots used for measurement						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-30.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A				
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		27				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from	Bits	51216				

{1,…,39}						
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	N/A				
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	N/A				
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 Slots i = 1,2,21,22 (Note 3)	Bits	101856				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	106848				
Max. Throughput averaged over 2 frames	Mbps	69.1416				
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: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation.						

A.3.2.2.3 Reference measurement channels for SCS 60 kHz FR1

A.3.2.2.4 Reference measurement channels for SCS 60 kHz FR2

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.4-1.1 TDD				
Channel bandwidth	MHz	50				
Subcarrier spacing	kHz	60				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}		10				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}		13				
Allocated slots per 2 frames		59				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS REs						
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}		12				

For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}	Bits	25608				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}	Bits	34816				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}	Bits	24				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}	CBs	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}	CBs	4				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}	CBs	5				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}	Bits	N/A				
For Slot i = 40, 41	Bits	69960				
For Slot i, if mod(i, 4) = 2 for i from {4,…, 79}	Bits	54912				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,39,42,…,79}	Bits	73128				
Max. Throughput averaged over 2 frames	Mbps	93.499				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

A.3.2.2.5 Reference measurement channels for SCS 120 kHz FR2

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-1.1 TDD	R.PDSCH.5-1.2 TDD			
Channel bandwidth	MHz	100	100			
Subcarrier spacing	kHz	120	120			
Allocated resource blocks	PRBs	66	66			
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		9	2			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		13	2			
Allocated slots per 2 frames		127	127			
MCS table		64QAM	64QAM			
MCS index		4	4			
Modulation		QPSK	QPSK			
Target Coding Rate		0.30	0.30			
Number of MIMO layers		1	1			
Number of DMRS REs						

For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		12	6			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		12	6			
Overhead for TBS determination		6	0			
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			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	3624	736			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	5504	736			
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			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	16	16			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	24	16			
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			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	1	1			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	1	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	N/A			
For Slots i = 80, 81	Bits	17490	2310			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	12210	2310			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,82,…,159}	Bits	18282	2310			
Max. Throughput averaged over 2 frames	Mbps	31.942	4.673			
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 Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A	N/A		
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 Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A	N/A		
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	36564	69960	139920		
For Slots i = 82	Bits	34980	73128	146256		
For Slots i = 83	Bits	22836	48840	97680		
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	24420	48840	97680		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,84,…,159}	Bits	36564	73128	146256		
Max. Throughput averaged over 2 frames	Mbps	100.799	201.434	403.096		
Note 1: SS/PBCH block is transmitted 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	R.PDSCH.5-3.2 TDD			
Channel bandwidth	MHz	100	100			
Subcarrier spacing	kHz	120	120			
Allocated resource blocks	PRBs	66	66			
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A			
For Slots i = 80, 81		13	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		9	9			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		13	13			
Allocated slots per 2 frames		127	125			
MCS table		64QAM	64QAM			
MCS index		18	17			
Modulation		64QAM	64QAM			
Target Coding Rate		0.46	0.43			

Number of MIMO layers		1	1			
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A			
For Slots i = 80, 81		12	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		12	12			
For Slot i, if mod(i, 5) = {0,1,2} 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, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A			
For Slots i = 80, 81	Bits	25104	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	16136	15112			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	25104	23568			
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			
For Slots i = 80, 81	Bits	24	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	24	24			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	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			
For Slots i = 80, 81	CBs	3	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	2	TBA			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	3	TBA			
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			
For Slots i = 80, 81	Bits	52740	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	36630	35640			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,82,…,159}	Bits	54846	54648			
Max. Throughput averaged over 2 frames	Mbps	145.062	136.1272			
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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A				
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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A				
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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A	N/A			
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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A	N/A			
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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A				
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 Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		12				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	34816				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	Bits	47112				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	24				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	CBs	5				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	CBs	6				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i = 80, 81	Bits	114940				
For Slot i, if mod(i, 4) = 2 for i from {4,…, 159}	Bits	82368				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79,82,…,159}	Bits	109692				
Max. Throughput averaged over 2 frames	Mbps	255.724				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

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

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-7.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames		63				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs (Note 3)		24				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159}	Bits	N/A				

For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	14344				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159}	Bits	14344				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	24				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159}	CBs	N/A				
For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159}	CBs	N/A				
For Slot i = 80	CBs	2				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159}	CBs	2				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	28776				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159}	Bits	30360				
Max. Throughput averaged over 2 frames	Mbps	45.1836				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data						

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

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

For CSI-RS Slot i, if mod(i,8) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	24				
For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	CBs	N/A				
For CSI-RS Slot i, if mod(i,8) =1 for i from {0,…,159}	CBs	N/A				
For Slot i = 80	CBs	2				
For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159}	CBs	2				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i,8) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	28776				
For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159}	Bits	30360				
Max. Throughput averaged over 2 frames	Mbps	42.3148				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data						

Table A.3.2.2.5-9: PDSCH Reference Channel for TDD CC with UL-DL pattern FR2.120-1 and CA scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-9.1 TDD	R.PDSCH.5-9.2 TDD	R.PDSCH.5-9.3 TDD	R.PDSCH.5-9.4 TDD	
Channel bandwidth	MHz	50	100	200	400	
Subcarrier spacing	kHz	120	120	120	120	
Allocated resource blocks	PRBs	32	66	132	264	
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		9	9	9	9	
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		13	13	13	13	
Allocated slots per 2 frames		127	127	127	127	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		10	10	10	10	
Modulation		16QAM	16QAM	16QAM	16QAM	
Target Coding Rate		0.33	0.33	0.33	0.33	
Number of MIMO layers		2	2	2	2	
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		12	12	12	12	
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		12	12	12	12	
Overhead for TBS determination		6	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	N/A	
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	7680	15880	31752	63528	
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	11784	24072	48168	96264	
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	N/A	

For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	24	24	24	24	
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	24	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	N/A	
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	1	2	4	8	
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	2	3	6	12	
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	N/A	
For Slots i = 80, 81	Bits	33920	69960	139920	279840	
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	23680	48840	97680	195360	
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,84,…,159}	Bits	35456	73128	146256	292512	
Max. Throughput averaged over 2 frames	Mbps	68.262	139.750	279.601	558.899	
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.3.2.2.5-10: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 (256QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-10.1 TDD				
Channel bandwidth	MHz	50				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	32				
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		256QAM				
MCS index		20				
Modulation		256QAM				
Target Coding Rate		0.67				
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	15368				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	23568				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	24				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	24				
Number of Code Blocks per Slot						

For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	2				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	3				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slots i = 80, 81	Bits	33920				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	23680				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,82,…,159}	Bits	35456				
Max. Throughput averaged over 2 frames	Mbps	136.537				
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.3.2.2.5-11: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-11.1 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) = {0,1} for i from {2,…,159}		13				
Allocated slots per 2 frames		78				
MCS table		64QAMLowSE				
MCS index		16				
Modulation		16QAM				
Target Coding Rate		0.37				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}	Bits	13320				
Transport block CRC per Slot						
For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}	CBs	2				
Binary Channel Bits Per Slot						
For Slots 0,1 and Slot i, if mod(i, 4) = {2, 3} for i from {0,…,159}	Bits	N/A				
For Slot i = 80, 81	Bits	34980				
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}	Bits	36564				
Max. Throughput averaged over 2 frames	Mbps	25.974 (Note 3)				
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: Throughput is calculated under assumption of aggregation factor 2.

Table A.3.2.2.5-12: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 and HST-DPS scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-12.1 TDD	R.PDSCH.5-12.2 TDD			
Channel bandwidth	MHz	200	200			
Subcarrier spacing	kHz	120	120			
Allocated resource blocks	PRBs	132	132			
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {4,…, 159}		9	9			
For Slot i, if mod(i, 5) = {0,1,2} for i from {5,…,159}		13	13			
For Slot i=1		N/A (Note 1)	N/A(Note 4)			
For Slot i=2		13	N/A (Note 4)			
For Slot i=3		9	N/A (Note 4)			
Allocated slots per 2 frames		126	124			
MCS table		64QAM	64QAM			
MCS index		17	17			
Modulation		64QAM	64QAM			
Target Coding Rate		0.43	0.43			
Number of MIMO layers		2	2			
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {4,…, 159}		18	18			
For Slot i, if mod(i, 5) = {0,1,2} for i from {5,…,159}		18	18			
For Slot i = 1		N/A (Note 1)	N/A (Note 4)			
For Slot i=2		18	N/A (Note 4)			
For Slot i=3		18	N/A (Note 4)			
Overhead for TBS determination		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			
For Slot i, if mod(i, 5) = 3 for i from {4,…, 159}	Bits	57376	57376			
For Slot i, if mod(i, 5) = {0,1,2} for i from {5,…,159}	Bits	90176	90176			
For Slot i = 1	Bits	N/A (Note 1)	N/A (Note 4)			
For Slot i=2	Bits	90176	N/A (Note 4)			
For Slot i=3	Bits	57376	N/A (Note 4)			
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			
For Slot i, if mod(i, 5) = 3 for i from {4,…, 159}	Bits	24	24			
For Slot i, if mod(i, 5) = {0,1,2} for i from {5,…,159}	Bits	24	24			
For Slot i = 1	Bits	N/A (Note 1)	N/A (Note 4)			
For Slot i = 2	Bits	24	N/A (Note 4)			
For Slot i = 3	Bits	24	N/A (Note 4)			
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			
For Slot i, if mod(i, 5) = 3 for i from {4,…, 159}	CBs	7	7			

For Slot i, if mod(i, 5) = {0,1,2} for i from {5,…,159}	CBs	11	11			
For Slot i = 1	CBs	N/A (Note 1)	N/A (Note 4)			
For Slot i=2	CBs	11	N/A (Note 4)			
For Slot i=3	CBs	7	N/A (Note 4)			
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			
For Slots i = 5 and 85 (Note 3)	Bits	195696	181968			
For Slots i = 6 and 86 (Note 3)	Bits	137808	137808			
For Slot i, if mod(i, 5) = 3 for i from {8,…,84, 87,..., 159}	Bits	146520	146520			
For Slot i, if mod(i, 5) = {0,1,2} for i from {7,…,84,87,…, 159}	Bits	210672	210672			
For Slot i = 1	Bits	N/A (Note 1)	N/A (Note 4)			
For Slot i= 2	Bits	210672	N/A (Note 4)			
For Slot i= 3	Bits	137808	N/A (Note 4)			
Max. Throughput averaged over 2 frames	Mbps	515.62	508.25			
Note 1: SS/PBCH block is transmitted in slot #0 and slot #1 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: Binary Channel Bits are calculated under assumption of 52 PRBs TRS allocation when the number of allocated resource blocks are more than 52. Note 4: SS/PBCH block is transmitted in slot #0, slot #1, slot #2 and slot #3 with periodicity 20ms						

Table A.3.2.2.5-13: Reference measurement channels for FR1+FR2-2 CA with 120 kHz SCS (QPSK)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-12.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slot i mod 40= {4,9,10,…,39}		N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}		9				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81		13				
Allocated slots per 2 frames		29				
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 mod 40= {4,9,10,…,39}		N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}		12				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	Bits	3624				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	Bits	5504				
Transport block CRC per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	Bits	16				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	Bits	24				

Number of Code Blocks per Slot						
For Slot i mod 40= {4,9,10,…,39}	CBs	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	CBs	1				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	CBs	1				
Binary Channel Bits Per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81	Bits	N/A				
For Slots i mod 40= {3,8}	Bits	12210				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81		18282				
Max. Throughput averaged over 2 frames	Mbps	7.229				
Note 1: Slot i is slot index per 160 slots						

Table A.3.2.2.5-14: Reference measurement channels for FR1+FR2-2 CA with 120 kHz SCS (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-13.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slot i mod 40= {4,9,10,…,39}		N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}		9				
For Slot i mod 40= {0,1,2,5,6,7} and i≠80,81		13				
Allocated slots per 2 frames		29				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i mod 40= {4,9,10,…,39}		N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}		12				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	Bits	11272				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	Bits	17424				
Transport block CRC per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	Bits	24				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	Bits	24				
Number of Code Blocks per Slot						
For Slot i mod 40= {4,9,10,…,39}	CBs	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	CBs	2				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	CBs	3				
Binary Channel Bits Per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81	Bits	N/A				

For Slots i mod 40= {3,8}	Bits	24420				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81		36564				
Max. Throughput averaged over 2 frames	Mbps	22.804				
Note 1: Slot i is slot index per 160 slots						

Table A.3.2.2.5-15: Reference measurement channels for FR1+FR2-2 CA with 120 kHz SCS (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-14.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slot i mod 40= {4,9,10,…,39}		N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}		9				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81		13				
Allocated slots per 2 frames		29				
MCS table		64QAM				
MCS index		17				
Modulation		64QAM				
Target Coding Rate		0.43				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i mod 40= {4,9,10,…,39}		N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}		12				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	Bits	15112				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	Bits	23568				
Transport block CRC per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	Bits	24				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	Bits	24				
Number of Code Blocks per Slot						
For Slot i mod 40= {4,9,10,…,39}	CBs	N/A				
For Slot i=0,80,81		N/A				
For Slots i mod 40= {3,8}	CBs	2				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81	CBs	3				
Binary Channel Bits Per Slot						
For Slot i mod 40= {4,9,10,…,39}	Bits	N/A				
For Slot i=0,80,81	Bits	N/A				
For Slots i mod 40= {3,8}	Bits	36630				
For Slot i mod 40= {0,1,2,5,6,7} and i≠0,80,81		54846				
Max. Throughput averaged over 2 frames	Mbps	30.791				
Note 1: Slot i is slot index per 160 slots						

A.3.2.2.6 Reference measurement channels for E-UTRA

Table A.3.2.2.6-1: PDSCH Reference Channel for sustained data-rate test (64QAM, 2 MIMO layers)

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

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

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-2.1 TDD	R.PDSCH.6-2.2 TDD	R.PDSCH.6-2.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		64QAM	64QAM	64QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	

For Sub-Frames 3,4,8,9		0.78	0.77	0.79	
For Sub-Frame 5		0.79	0.79	0.80	
For Sub-Frame 0		0.82	0.79	0.81	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	Bits	63776	93800	128496	
For Sub-Frame 5	Bits	59256	90816	124464	
For Sub-Frame 0	Bits	63776	93800	128496	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	CBs	11	16	21	
For Sub-Frame 5	CBs	10	15	21	
For Sub-Frame 0	CBs	11	16	21	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	Bits	81600	122400	163200	
For Sub-Frame 5	Bits	75840	115008	155808	
For Sub-Frame 0	Bits	77856	118656	159456	
Number of layers		4	4	4	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	37.813	55.981	76.694	
Note 1: 1 symbol allocated to PDCCH for all tests. Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15]. Note 3: As per Table 4.2-2 in TS 36.211 [15]. Note 4: Given per component carrier per codeword. Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit). Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths. Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9. Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9. Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.					

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-3.1 TDD	R.PDSCH.6-3.2 TDD	R.PDSCH.6-3.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		256QAM	256QAM	256QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.74	0.79	0.74	
For Sub-Frames 8,9		0.85	0.88	0.85	
For Sub-Frame 5		0.76	0.76	0.74	
For Sub-Frame 0		0.78	0.77	0.76	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	42368	63776	84760	
For Sub-Frames 8,9	Bits	48936	75376	97896	
For Sub-Frame 5	Bits	40576	61664	81176	
For Sub-Frame 0	Bits	42368	63776	84760	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4	CBs	7	11	14	
For Sub-Frames 8,9	CBs	8	13	16	
For Sub-Frame 5	CBs	7	11	14	

For Sub-Frame 0	CBs	7	11	14	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	57600	86400	115200	
For Sub-Frames 8,9	Bits	57600	86400	115200	
For Sub-Frame 5	Bits	53568	81216	110016	
For Sub-Frame 0	Bits	54912	83712	112512	
Number of layers		2	2	2	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	26.555	40.374	53.125	

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

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-4.1 TDD	R.PDSCH.6-4.2 TDD	R.PDSCH.6-4.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		256QAM	256QAM	256QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.78	0.79	0.78	
For Sub-Frames 8,9		0.78	0.79	0.78	
For Sub-Frame 5		0.81	0.82	0.78	
For Sub-Frame 0		0.82	0.82	0.80	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	84760	128496	169544	
For Sub-Frames 8,9	Bits	84760	128496	169544	
For Sub-Frame 5	Bits	81176	124464	161760	
For Sub-Frame 0	Bits	84760	128496	169544	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4	CBs	14	21	28	
For Sub-Frames 8,9	CBs	14	21	28	
For Sub-Frame 5	CBs	14	21	27	
For Sub-Frame 0	CBs	14	21	28	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	108800	163200	217600	
For Sub-Frames 8,9	Bits	108800	163200	217600	
For Sub-Frame 5	Bits	101120	153344	207744	
For Sub-Frame 0	Bits	103808	158208	212608	
Number of layers		4	4	4	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	50.498	76.694	100.948	

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [15].
Note 3: As per Table 4.2-2 in TS 36.211 [15].

Note 4: Given per component carrier per codeword.
Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-5.1 TDD	R.PDSCH.6-5.2 TDD	R.PDSCH.6-5.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		1024QAM	1024QAM	1024QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.76	0.75	0.76	
For Sub-Frames 8,9		0.76	0.75	0.76	
For Sub-Frame 5		0.76	0.78	0.77	
For Sub-Frame 0		0.80	0.78	0.78	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	55056	81176	110136	
For Sub-Frames 8,9	Bits	55056	81176	110136	
For Sub-Frame 5	Bits	51024	78704	105528	
For Sub-Frame 0	Bits	55056	81176	110136	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4	CBs	9	14	18	
For Sub-Frames 8,9	CBs	9	14	18	
For Sub-Frame 5	CBs	9	13	18	
For Sub-Frame 0	CBs	9	14	18	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	72000	108000	144000	
For Sub-Frames 8,9	Bits	72000	108000	144000	
For Sub-Frame 5	Bits	66960	101520	137520	
For Sub-Frame 0	Bits	68640	104640	140640	
Number of layers		2	2	2	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	32.630	48.458	65.621	

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

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

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-6.1 TDD	R.PDSCH.6-6.2 TDD	R.PDSCH.6-6.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		1024QAM	1024QAM	1024QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.81	0.79	0.81	
For Sub-Frames 8,9		0.81	0.79	0.81	
For Sub-Frame 5		0.81	0.82	0.82	
For Sub-Frame 0		0.85	0.82	0.83	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	110136	161760	220296	
For Sub-Frames 8,9	Bits	110136	161760	220296	
For Sub-Frame 5	Bits	101840	157432	211936	
For Sub-Frame 0	Bits	110136	161760	220296	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4	CBs	18	27	36	
For Sub-Frames 8,9	CBs	18	27	36	
For Sub-Frame 5	CBs	17	26	35	
For Sub-Frame 0	CBs	18	27	36	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	136000	204000	272000	
For Sub-Frames 8,9	Bits	136000	204000	272000	
For Sub-Frame 5	Bits	126400	191680	259680	
For Sub-Frame 0	Bits	129760	197760	265760	
Number of layers		2	2	2	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	65.252	96.623	131.342	

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

A.3.2.2.7 Reference measurement channels for Intra-cell Inter-UE interference scenario

Table A.3.2.2.7-1: PDSCH Reference Channel for TDD Intra-cell Inter-UE interference scenario

Parameter	Unit	Value				
Reference channel		(Void)	R.PDSCH.7-1.2 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}			12			
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}			24			
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		14600			
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits		49176			
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		6			
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		96672			
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits		30528			
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits		101760			
Max. Throughput averaged over 2 frames	Mbps		69.308			
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

A.3.2.2.8 Reference measurement channels for SCS 480 kHz FR2-2

Table A.3.2.2.8-1: PDSCH Reference Channel for TDD UL-DL pattern FR2.480-1 (QPSK)

Parameter	Unit	Value				
Reference channel		R.PDSCH.8-1.1 TDD				
Channel bandwidth	MHz	400				
Subcarrier spacing	kHz	480				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						

For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}		N/A				
For Slots i = 320, 321		N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}		11				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}		13				
Allocated slots per 2 frames		477				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}		N/A				
For Slots i = 320, 321		N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}		12				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}	Bits	N/A				
For Slots i = 320, 321	Bits	N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}	Bits	4480				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}	Bits	5504				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}	Bits	N/A				
For Slots i = 320, 321	Bits	N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}	Bits	24				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}	CBs	N/A				
For Slots i = 320, 321	CBs	N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}	CBs	1				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}	CBs	1				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}	Bits	N/A				
For Slots i = 320, 321	Bits	N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}	Bits	15048				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}	Bits	18216				
Max. Throughput averaged over 2 frames	Mbps	129.632				
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.3.2.2.8-2: PDSCH Reference Channel for TDD UL-DL pattern FR2.480-1 (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.8-2.1 TDD				
Channel bandwidth	MHz	400				

Subcarrier spacing	kHz	480				
Allocated resource blocks	PRBs	20				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}		N/A				
For Slots i = 320, 321		N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}		10				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}		12				
Allocated slots per 2 frames		477				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}		N/A				
For Slots i = 320, 321		N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}		12				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}	Bits	N/A				
For Slots i = 320, 321	Bits	N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}	Bits	3904				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}	Bits	4736				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}	Bits	N/A				
For Slots i = 320, 321	Bits	N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}	Bits	24				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}	CBs	N/A				
For Slots i = 320, 321	CBs	N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}	CBs	1				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}	CBs	1				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 20) = {15,16,17,18,19} for i from {0,…,639}	Bits	N/A				
For Slots i = 320, 321	Bits	N/A				
For Slot i, if mod(i, 20) = 14 for i from {0,…, 639}	Bits	8160				
For Slot i, if mod(i, 5) = {0,1…13} for i from {1,…,639}	Bits	10080				
Max. Throughput averaged over 2 frames	Mbps	111.6224				
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.3.2.2.8.3: Reference measurement channels for FR1+FR2-2 CA with 480 kHz SCS (QPSK)

Parameter	Unit	Value				
Reference channel		R.PDSCH.8-3.1 TDD				
Channel bandwidth	MHz	400				
Subcarrier spacing	kHz	480				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slot i mod 160= {14,15,16,17,18,19,21,…,159}		N/A				
For Slot i=0,320,321		N/A				
For Slots i mod160= 14		11				
For Slot i mod 160= {0,1,2,…,12,20} and i≠ 0,320,321		13				
Allocated slots per 640 slots		57				
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 mod 160= {14,15,16,17,18,19,21,…,159}		N/A				
For Slot i=0,320,321		N/A				
For Slots i mod 160= 14		12				
For Slot i mod 160= {0,1,2,…,12,20} and i≠ 0,320,321		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slot i mod 160= {14,15,16,17,18,19,21,…,159}	Bits	N/A				
For Slot i=0,320,321	Bits	N/A				
For Slots i mod 160=14	Bits	4480				
For Slot i mod 160= {0,1,2,…,12,20} and i≠ 0,320,321		5504				
Transport block CRC per Slot						
For Slot i mod 160= {14,15,16,17,18,19,21,…,159}	Bits	N/A				
For Slot i=0,320,321	Bits	N/A				
For Slots i= 14	Bits	24				
For Slot i mod 160= {0,1,2,…,12,20} and i≠ 0,320,321		24				
Number of Code Blocks per Slot						
For Slot i mod 160= {14,15,16,17,18,19,21,…,159}	CBs	N/A				
For Slot i=0,320,321	CBs	N/A				
For Slots i mod 160= 14	CBs	1				
For Slot i mod 160= {0,1,2,…,12,20} and i≠ 0,320,321	CBs	1				
Binary Channel Bits Per Slot						
For Slot i mod 160= {14,15,16,17,18,19,21,…,159}	Bits	N/A				
For Slot i=0,320,321	Bits	N/A				
For Slots i mod 160= 14	Bits	15048				
For Slot i mod 160= {0,1,2,…,12,20} and i≠ 0,320,321		18216				
Max. Throughput averaged over 2 frames	Mbps	15.482				
Note 1: Slot i is slot index per 640 slots						

Table A.3.2.2.8.4: Reference measurement channels for FR1+FR2-2 CA with 480 kHz SCS (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.8-4.1 TDD				
Channel bandwidth	MHz	400				
Subcarrier spacing	kHz	480				
Allocated resource blocks	PRBs	20				
Number of consecutive PDSCH symbols						
For Slot i mod 160= {15,16,17,18,19,21,…,159}		N/A				
For Slot i=0,320,321		N/A				
For Slots i mod 160= 14		10				
For Slot i mod 160= {0,1,2,…,13,20} and i≠ 0,320,321		12				
Allocated slots per 2 frames		57				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i mod 160= {15,16,17,18,19,21,…,159}		N/A				
For Slot i=0,320,321		N/A				
For Slots i mod 160= 14		12				
For Slot i mod 160= {0,1,2,…,13,20} and i≠ 0,320,321		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slot i mod 160= {15,16,17,18,19,21,…,159}	Bits	N/A				
For Slot i=0,320,321	Bits	N/A				
For Slots i mod 160= 14	Bits	3904				
For Slot i mod 160= {0,1,2,…,13,20} and i≠ 0,320,321		4736				
Transport block CRC per Slot						
For Slot i mod 160= {15,16,17,18,19,21,…,159}	Bits	N/A				
For Slot i=0,320,321	Bits	N/A				
For Slots i mod 160= 14	Bits	24				
For Slot i mod 160= {0,1,2,…,13,20} and i≠ 0,320,321		24				
Number of Code Blocks per Slot						
For Slot i mod 160= {15,16,17,18,19,21,…,159}	CBs	N/A				
For Slot i=0,320,321	CBs	N/A				
For Slots i mod 160= 14	CBs	1				
For Slot i mod 160= {0,1,2,…,13,20} and i≠ 0,320,321	CBs	1				
Binary Channel Bits Per Slot						
For Slot i mod 160= {15,16,17,18,19,21,…,159}	Bits	N/A				
For Slot i=0,320,321	Bits	N/A				
For Slots i mod 160= 14	Bits	8160				
For Slot i mod 160= {0,1,2,…,13,20} and i≠ 0,320,321		10080				
Max. Throughput averaged over 40 slots	Mbps	13.331				
Note 1: Slot i is slot index per 640 slots						

A.3.2.3 HD-FDD

A.3.2.3.1 Reference measurement channels for SCS 15 kHz FR1

Table A.3.2.3.1-1: PDSCH Reference Channel for HD-FDD

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-1.1 HD-FDD	R.PDSCH.1-1.2 HD-FDD	R.PDSCH.1-1.3 HD-FDD	R.PDSCH.1-1.4 HD-FDD	R.PDSCH.1-1.5 HD-FDD
Channel bandwidth	MHz	10	10	10	10	10
Subcarrier spacing	kHz	15	15	15	15	15
Number of allocated resource blocks	PRBs	52	52	52	52	52
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		8	8	8	8	8
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12	12	12	12	12
Allocated slots per 2 frames	Slots	15	15	15	15	15
MCS table		64QAM	64QAM	64QAM	256QAM	256QAM
MCS index		4	13	19	20	24
Modulation		QPSK	16QAM	64QAM	256QAM	256QAM
Target Coding Rate		0.30	0.48	0.51	0.67	0.82
Number of MIMO layers		1	1	1	1	1
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		18	12	12	12	12
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		18	12	12	12	12
Overhead for TBS determination		0	0	0	0	0
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	2472	8456	13320	23040	28680
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	Bits	3904	13064	21000	36896	45096
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	24	24	24	24	24
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	Bits	24	24	24	24	24
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	CBs	1	2	2	3	4
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	CBs	1	2	3	5	6
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 10, 11	Bits	12480	26208	39312	52416	52416
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	8112	17472	26208	34944	34944
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,9,12,…,19}	Bits	13104	27456	41184	54912	54912
Max. Throughput averaged over 2 frames	Mbps	2.642	11.489	14.214	24.901	30.539
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.3.2.3.1-2: PDSCH Reference Channel for HD-FDD

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-2.1 HD-FDD				
Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		8				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12				
Allocated slots per 2 frames	Slots	15				
MCS table		64QAM				
MCS index		19				
Modulation		64QAM				
Target Coding Rate		0.51				
Number of MIMO layers		2				
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		12				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	26632				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	Bits	42016				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	24				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	CBs	4				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}	CBs	5				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 10, 11	Bits	78624				
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}	Bits	52416				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,9,12,…,19}	Bits	82368				
Max. Throughput averaged over 2 frames	Mbps	28.435				
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.3.2.3.1-3: PDSCH Reference Channel for HD-FDD PMI reporting requirements

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-3.1 HD-FDD				

Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		8				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…,19}		12				
Allocated slots per 2 frames	Slots	11				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layer		1				
Number of DMRS REs (Note 3)		24				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A				
For Non CSI-RS Slot i, if mod (i,5) =3, i={0,..19}	Bits	7168				
For Non CSI-RS Slot i, if mod (i,5) ={0,2}, i={1,..19}	Bits	12040				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A				
For Non CSI-RS Slot i, if mod (i,5) =3, i={0,..19}	Bits	24				
For Non CSI-RS Slot i, if mod (i,5) ={0,2}, i={1,..19}	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A				
For Non CSI-RS Slot i, if mod (i,5) =3, i={0,..,19}	CBs	1				
For Non CSI-RS Slot i, if mod (i,5) ={0,2}, i={1,..,19}	CBs	2				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A				
For Slots i = 10	Bits	23712				
For Non CSI-RS Slot i, if mod (i,5) =3, i={0,..,19}	Bits	14976				
For Non CSI-RS Slot i, if mod (i,5) ={0,2}, i={1,..9,11,…,19}	Bits	24960				
Max. Throughput averaged over 2 frames	Mbps	5.648				
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	52	52			

Table A.3.3.1.1-2: PDCCH Reference Channel (Time domain allocation 2 symbols)

Parameter	Unit	Value						
Reference channel		R.PDCCH.1-2.1 FDD	R.PDCCH.1-2.2 FDD	R.PDCCH.1-2.3 FDD	R.PDCCH.1-2.4 FDD	R.PDCCH.1-2.5 FDD	R.PDCCH.1-2.6 FDD	R.PDCCH.1-2.7 FDD
Subcarrier spacing	kHz	15	15	15	15	15	15	15
CORESET frequency domain allocation		24	24	24	48	48	48	48
CORESET time domain allocation		2	2	2	2	2	2	2
Aggregation level		2	4	2	4	8	16	8
DCI Format		1_0	1_0	1_1	1_1	1_1	1_0	2_6
Payload (without CRC)	Bits	39	39	52	52	52	39	12

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	52	52			

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

Parameter	Unit	Value					
Reference channel		R.PDCCH.1-2.1 TDD	R.PDCCH.1-2.2 TDD	R.PDCCH.1-2.3 TDD	R.PDCCH.1-2.4 TDD	R.PDCCH.1-2.5 TDD	R.PDCCH.1-2.6 TDD
Subcarrier spacing	kHz	15	15	15	15	15	15
CORESET frequency domain allocation		24	24	24	48	48	48
CORESET time domain allocation		2	2	2	2	2	2
Aggregation level		2	4	2	4	8	16
DCI Format		1_0	1_0	1_1	1_1	1_1	1_0

Payload (without CRC)	Bits	39	39	52	52	52	39

A.3.3.2.2 Reference measurement channels for SCS 30 kHz FR1

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

Parameter	Unit	Value					
Reference channel		R.PDCCH.2-1.1 TDD	R.PDCCH.2-1.2 TDD	R.PDCCH.2-1.3 TDD	R.PDCCH.2-1.4 TDD	R.PDCCH.2-1.5 TDD	R.PDCCH.2-1.6 TDD
Subcarrier spacing	kHz	30	30	30	30	30	30
CORESET frequency domain allocation		102	102	90	102	48	48
CORESET time domain allocation		1	1	1	1	1	1
Aggregation level		2	4	8	8	4	8
DCI Format		1_0	1_1	1_1	2_6	1_1	1_1
Payload (without CRC)	Bits	41	53	53	12	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	R.PDCCH.2-2.2 TDD				
Subcarrier spacing	kHz	30	30				
CORESET frequency domain allocation		48	48				
CORESET time domain allocation		2	2				
Aggregation level		16	2				
DCI Format		1_0	1_0				
Payload (without CRC)	Bits	41	41				

A.3.3.2.3 Reference measurement channels for SCS 60 kHz FR1

A.3.3.2.4 Reference measurement channels for SCS 60 kHz FR2

A.3.3.2.5 Reference measurement channels for SCS 120 kHz FR2

Table A.3.3.2.5-1: PDCCH Reference Channels (Time domain allocation 1 symbol)

Parameter	Unit	Value					
Reference channel		R.PDCCH.5-1.1 TDD	R.PDCCH.5-1.2 TDD	R.PDCCH.5-1.3 TDD	R.PDCCH.5-1.4 TDD		
Subcarrier spacing	kHz	120	120	120	120		
CORESET frequency domain allocation		60	60	60	60		
CORESET time domain allocation		1	1	1	1		

Aggregation level		2	4	8	8		
DCI Format		1_0	1_1	1_1	2_6		
Payload (without CRC)	Bits	40	56	56	12		

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.3.3.2.6 Reference measurement channels for SCS 480 kHz FR2-2

Table A.3.3.2.6-1: PDCCH Reference Channels (Time domain allocation 1 symbol)

Parameter	Unit	Value					
Reference channel		R.PDCCH.6-1.1 TDD					
Subcarrier spacing	kHz	480					
CORESET frequency domain allocation		60					
CORESET time domain allocation		1					
Aggregation level		8					
DCI Format		1_1					
Payload (without CRC)	Bits	56					

Table A.3.3.2.6-2: PDCCH Reference Channel (Time domain allocation 2 symbols)

Parameter	Unit	Value					
Reference channel		R.PDCCH.6-2.1 TDD					
Subcarrier spacing	kHz	480					
CORESET frequency domain allocation		60					
CORESET time domain allocation		2					
Aggregation level		16					
DCI Format		1_0					
Payload (without CRC)	Bits	40					

A.3.4 Reference measurement channels for PBCH demodulation requirements

A.3.4.1 Reference measurement channels for FR1

Table A.3.4.1-1: PBCH Reference Channel

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

A.3.4.2 Reference measurement channels for FR2

Table A.3.4.2-1: PBCH Reference Channel

Parameter	Unit	Value	
Reference channels		R.PBCH.5	R.PBCH.7
SS/PBCH block subcarrier spacing	kHz	120	480
Modulation		QPSK	QPSK
Target coding rate		56/864	56/864
Payload (without CRC and timing related PBCH payload bits)	bits	24	24

A.4 CSI reference measurement channels

This clause defines the DL signal applicable to the reporting of channel state information (Clauses 6 and 8).

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

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

TBS Scheme				TBS.1-1	TBS.1-2	TBS.1-3	TBS.1-4	TBS.1-5	TBS.1-6
MCS table				64QAM					
Number of allocated PDSCH resource blocks				66	66	52	52	51	51
Number of consecutive PDSCH symbols				12	12	12	12	12	12
Number of PDSCH MIMO layers				1	2	1	2	1	2
Number of DMRS REs (Note 1)				24	24	24	24	24	24
Overhead for TBS determination				6	6	0	0	0	0
Available RE-s				7590	7590	6240	6240	6120	6120
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot					
0	OOR	OOR	OOR	N/A	N/A	N/A	N/A	N/A	N/A
1	0.2344	0	QPSK	1800	3624	1480	2976	1480	2856
2	0.2344	0		1800	3624	1480	2976	1480	2856
3	0.3770	2		2856	5640	2408	4744	2408	4616
4	0.6016	4		4480	8968	3752	7424	3752	7296
5	0.8770	6		6528	13064	5504	11016	5376	10760
6	1.1758	8		8712	17928	7296	14600	7168	14344
7	1.4766	11	16QAM	11016	22032	9224	18432	8968	17928
8	1.9141	13		14344	28680	12040	24072	11784	23568
9	2.4063	15		17928	35856	15112	30216	14600	29192
10	2.7305	18	64QAM	20496	40976	16896	33816	16896	33816

11	3.3223	20		25104	50184	20496	40976	20496	40976
12	3.9023	22		29192	58384	24576	49176	24072	48168
13	4.5234	24		33816	67584	28168	56368	27656	55304
14	5.1152	26		38936	77896	31752	63528	31240	62504
15	5.5547	28		42016	83976	34816	69672	33816	67584
Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 2: PDSCH is not scheduled on slots containing CSI-RS for tracking, CSI-RS for CSI acquisition and CSI-RS for beam refinement or slots which are not full DL Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-1 of TS 38.214 [12]									

Table A.4-2: Mapping of CQI Index to Information Bit payload (CQI table 2, Rank 1 and Rank 2)

TBS Scheme				TBS.2-1	TBS.2-2	TBS.2-3	TBS.2-4	TBS.2-5	TBS.2-6	TBS.2-7	TBS.2-8
MCS table				256QAM							
Number of allocated PDSCH resource blocks				52	52	106	106	8	16	32	51
Number of consecutive PDSCH symbols				12	12	12	12	12	12	12	12
Number of PDSCH MIMO layers				1	2	1	2	1	1	1	2
Number of DMRS REs (Note 1)				24	24	24	24	24	24	24	24
Overhead for TBS determination				0	0	0	0	0	0	6	0
Available RE-s for PDSCH				6240	6240	12720	12720	960	1920	3680	6120
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot							
0	OOR	OOR	OOR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	0.2344	0	QPSK	1480	2976	2976	5896	224	456	848	2856
2	0.3770	1		2408	4744	4744	9480	368	736	1416	4616
3	0.8770	3		5504	11016	11016	22536	848	1736	3240	10760
4	1.4766	5	16QAM	9224	18432	18960	37896	1416	2856	5376	17928
5	1.9141	7		12040	24072	24576	49176	1864	3752	6912	23568
6	2.4063	9		15112	30216	30728	61480	2408	4608	8712	29192
7	2.7305	11	64QAM	16896	33816	34816	69672	2600	5248	9992	33816
8	3.3223	13		20496	40976	42016	83976	3240	6400	12040	40976
9	3.9023	15		24576	49176	49176	98376	3752	7424	14344	48168
10	4.5234	17		28168	56368	57376	114776	4352	8712	16392	55304
11	5.1152	19		31752	63528	65576	131176	4864	9736	18432	62504
12	5.5547	21	256QAM	34816	69672	69672	139376	5248	10760	20496	67584
13	6.2266	23		38936	77896	79896	159880	6016	12040	22536	75792
14	6.9141	25		43032	86040	88064	176208	6656	13320	25104	83976
15	7.4063	27		46104	92200	94248	188576	7040	14088	27144	90176
Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 2: PDSCH is not scheduled on slots containing CSI-RS for tracking, CSI-RS for CSI acquisition and CSI-RS for beam refinement or slots which are not full DL Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-2 of TS 38.214 [12]											

Table A.4-3: Mapping of CQI Index to Information Bit payload (CQI table 2, Rank 3 and Rank 4)

TBS Scheme	TBS.3-1	TBS.3-2	TBS.3-3	TBS.3-4		
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	3	4	3	4		
Number of DMRS REs (Note 1)	24	24	24	24		
Overhead for TBS determination	0	0	0	0		

Available RE-s for PDSCH				6240	6240	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	0.2344	0	QPSK	4360	5896	8976	11784		
2	0.3770	1		7048	9480	14344	18976		
3	0.8770	3		16392	22032	33816	45096		
4	1.4766	5	16QAM	27656	36896	56368	75792		
5	1.9141	7		35856	48168	73776	98376		
6	2.4063	9		45096	60456	92200	122976		
7	2.7305	11	64QAM	51216	67584	104496	139376		
8	3.3223	13		62504	81976	127080	167976		
9	3.9023	15		73776	98376	147576	196776		
10	4.5234	17		83976	112648	172176	229576		
11	5.1152	19		96264	127080	196776	262376		
12	5.5547	21	256QAM	104496	139376	213176	278776		
13	6.2266	23		116792	155776	237776	319784		
14	6.9141	25		129128	172176	262376	352440		
15	7.4063	27		139376	184424	278776	376896		
Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 2: PDSCH is not scheduled on slots containing CSI-RS for tracking, CSI-RS for CSI acquisition and CSI-RS for beam refinement or slots which are not full DL Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-2 of TS 38.214 [12]									

Table A.4-4: Mapping of CQI Index to Information Bit payload (CQI table 3)

TBS Scheme				TBS.4-1	TBS.4-2				
MCS table				64QAMLowSE					
Number of allocated PDSCH resource blocks				52	106				
Number of consecutive PDSCH symbols				12	12				
Number of PDSCH MIMO layers				1	1				
Number of DMRS REs (Note 1)				24	24				
Overhead for TBS determination				0	0				
Available RE-s for PDSCH				6240	12720				
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot					
0	OOR	OOR	OOR	N/A	N/A				
1	0.0586	0	QPSK	368	768				
2	0.0977	2		608	1256				
3	0.1523	4		984	2024				
4	0.2344	6		1480	2976				
5	0.3770	8		2408	4744				
6	0.6016	10		3752	7680				
7	0.8770	12		5504	11016				
8	1.1758	14		7296	14856				
9	1.4766	16	16QAM	9224	18960				
10	1.9141	18		12040	24576				
11	2.4063	20		15112	30728				
12	2.7305	22	64QAM	16896	34816				
13	3.3223	24		20496	42016				
14	3.9023	26		24576	49176				
15	4.5234	28		28168	57376				
Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 2: PDSCH is not scheduled on slots containing CSI-RS for tracking and CSI-RS for CSI acquisition or slots which are not full DL Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity									

Table A.4-5: Mapping of CQI Index to Information Bit payload (CQI table 4)

TBS Scheme	TBS.5-1	TBS.5-2				
MCS table	1024QAM					
Number of allocated PDSCH resource blocks	52	106				
Number of consecutive PDSCH symbols	12	12				

Number of PDSCH MIMO layers				1	1				
Number of DMRS REs (Note 1)				24	24				
Overhead for TBS determination				0	0				
Available RE-s				6240	12720				
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot					
0	OOR	OOR	OOR	N/A	N/A				
1	0.2344	0	QPSK	1480	2976				
2	0.377	1		2408	4744				
3	0.877	2		5504	11016				
4	1.4766	3	16QAM	9224	18960				
5	2.4063	5		15112	30728				
6	3.3223	8	64QAM	20496	42016				
7	3.9023	10		24576	49176				
8	4.5234	12		28168	57376				
9	5.1152	14		31752	65576				
10	5.5547	16	256QAM	34816	69672				
11	6.2266	18		38936	79896				
12	6.9141	20		43032	88064				
13	7.4063	22		46104	94248				
14	8.3301	24	1024QAM	52224	106576				
15	9.2578	26		57376	116792				
Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 2: PDSCH is not scheduled on slots containing CSI-RS for tracking, CSI-RS for CSI acquisition and CSI-RS for beam refinement or slots which are not full DL Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-4 of TS 38.214 [12]									

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, and excluding REs in all the available PDSCH DMRS CDM groups, 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, and excluding REs in all the available PDSCH DMRS CDM groups, in channel bandwidth.		

A.6 SL reference measurement channels

A.6.1 General

The transport block size (TBS) determination procedure is described in clause 8.1.3 of TS 38.214 [12].

A.6.2 Reference measurement channels for PSSCH performance requirements

A.6.2.1 Reference measurement channels for SCS 15 kHz FR1

A.6.2.2 Reference measurement channels for SCS 30 kHz FR1

Table A.6.2.2-1: PSSCH Reference Channel

Parameter		Unit	Value				
Reference channel			R.PSSCH.2-1.1	R.PSSCH.2-1.2	R.PSSCH.2-1.3	R.PSSCH.2-1.4	R.PSSCH.2-1.5
Channel bandwidth		MHz	20	20	20	20	20
Subcarrier spacing		kHz	30	30	30	30	30
Allocated resource blocks		RB	20	20	10	10	10
CP-OFDM symbols for slot with PSFCH(Note 1)			9	9	9	9	9
CP-OFDM symbols for slot without PSFCH(Note 2)			12	12	12	12	-
Modulation order			QPSK	16QAM	64QAM	QPSK	64QAM
MCS index			4	11	17	4	27
Number of MIMO layers			1	1	1	1	1
Number of DMRS REs			21	15	12	15	12
Number of REs for SCI format 1-A			240	240	240	240	240
	Payloads	Bits	35	35	35	35	35

2nd stage SCI format 2-A configuration	α		1	1	1	1	1
	β_{offset}		3.5	5	5	3.5	2.5
Overhead for TBS determination			0	0	0	0	0
Transport Block Size for slot with PSFCH		Bits	704	1800	984	208	3496
Transport Block Size for slot without PSFCH		Bits	1128	2856	1928	432	-
Transport block CRC		Bits	24	24	24	24	16
Maximum number of HARQ transmissions			1	1	1	1	2
Binary Channel Bits for slots with PSFCH			2304	4848	2232	744	3816
Binary Channel Bits for slots without PSFCH		Bits	3744	7728	4392	1464	-
Note 1: OFDM symbols is for PSCCH/PSSCH transmission not including first symbol (AGC), PSFCH symbols, and guard symbols. Note 2: OFDM symbols is for PSCCH/PSSCH transmission not including first symbol (AGC) and guard symbols.							

A.6.3 Reference measurement channels for PSCCH performance requirements

A.6.3.1 Reference measurement channels for SCS 15 kHz FR1

A.6.3.2 Reference measurement channels for SCS 30 kHz FR1

Table A.6.3.2-1: PSCCH Reference Channel

Parameter	Unit	Value
Reference channel		R.PSCCH.2-1.1
Allocated resource blocks	PRBs	10
OFDM Symbols per slot (Note 2)	Symbols	2
Modulation		QPSK
Payload (without CRC)	Bits	26
CRC	Bits	24
SCI Format		1-A
Binary Channel Bits	Bits	180
NOTE 1: The first OFDM symbol of a PSSCH and its associated PSCCH is duplicated as described in clauses 8.3.1.5 and 8.3.2.3 of TS 38.211. This symbol is used for AGC and not used for demodulation. NOTE 2: First OFDM symbol is not included.		

A.6.4 Reference measurement for PSBCH performance requirements

A.6.4.1 Reference measurement channels for SCS 15 kHz FR1

A.6.4.2 Reference measurement channels for SCS 30 kHz FR1

Table A.6.4.2-1: PSBCH Reference Channel

Parameter	Unit	Value
Reference channel		R.PSBCH.2-1
Channel bandwidth	MHz	20
Allocated resource blocks	PRBs	11
CP-OFDM Symbols per slot (see Note 1)	Symbols	8
Modulation		QPSK

Transport Block Size (without CRC)	Bits	32
Transport block CRC	Bits	24
Binary Channel Bits	Bits	1782
Note 1: PSBCH transmissions are rate-matched for 9 CP-OFDM symbols per slot. The first symbol is used for AGC and the last symbol is gap and shall not be used for PSBCH transmission as per TS 38.211.		

Annex B (normative): Propagation conditions

B.1 Static propagation condition

B.1.0 UE Receiver with 1Rx

For 2 port transmission the channel matrix is defined in the frequency domain by

$$\mathbf{H} = [1 \quad 1]..$$

For 4 port transmission the channel matrix is defined in the frequency domain by

$$\mathbf{H} = [1 \quad 1 \quad j \quad j]$$

For 8 port transmission the channel matrix is defined in the frequency domain by

$$\mathbf{H} = [1 \quad 1 \quad 1 \quad 1 \quad j \quad j \quad j \quad j]$$

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).

Initial channel matrix for LOS component of TDL-D channel model is equal to channel matrix of Static propagation conditions in Clause B.1.

B.2.1 Delay profiles

The delay profiles are simplified from the TR 38.901 [5] TDL models. The simplification steps are shown below for information. These steps are only used when new delay profiles are created. Otherwise, the delay profiles specified in B.2.1.1 and B.2.1.2 can be used as such.

Step 1: Use the original TDL model from TR 38.901[5].

Step 2: Re-order the taps in ascending delays

Step 3: Perform delay scaling according to the procedure described in clause 7.7.3 in TR 38.901 [5].

Step 4: Apply the quantization to the delay resolution 5 ns or 2ns as described in Table B.2.1.2-1. 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 for 5ns resolution or 16 taps for 2ns resolution as described in Table B.2.1.2-1 in the quantized model, merge the taps as follows

- Find the weakest tap from all taps (both merged and unmerged taps are considered)

- If there are two or more taps having the same value and are the weakest, select the tap with the smallest delay as the weakest tap.

- When the weakest tap is the first delay tap, merge taps as follows
  - Update the power of the first delay tap as the linear power sum of the weakest tap and the second delay tap.
  - Remove the second delay tap.
- When the weakest tap is the last delay tap, merge taps as follows
  - Update the power of the last delay tap as the linear power sum of the second-to-last tap and the last tap.
  - Remove the second-to-last tap.
- Otherwise
  - For each side of the weakest tap, identify the neighbour tap that has the smaller delay difference to the weakest tap.
    - When the delay difference between the weakest tap and the identified neighbour tap on one side equals the delay difference between the weakest tap and the identified neighbour tap on the other side.
      - Select the neighbour tap that is weaker in power for merging.
    - Otherwise, select the neighbour tap that has smaller delay difference for merging.
  - To merge, the power of the merged tap is the linear sum of the power of the weakest tap and the selected tap.
  - When the selected tap is the first tap, the location of the merged tap is the location of the first tap. The weakest tap is removed.
  - When the selected tap is the last tap, the location of the merged tap is the location of the last tap. The weakest tap is removed.
  - Otherwise, the location of the merged tap is based on the average delay of the weakest tap and selected tap. If the average delay is on the sampling grid, the location of the merged tap is the average delay. Merge two parallel taps with different delays (average delay, sum power) starting from the weakest ones. Otherwise, the location of the merged tap is rounded towards the direction of the selected tap (e.g. For 5ns resolution, 10 ns & 20 ns → 15 ns, 10 ns & 25 ns → 20 ns, if 25 ns had higher or equal power; 15 ns, if 10 ns had higher power). The weakest tap and the selected tap are removed.
- Repeat step 6 until the final number of taps is 12 or 16.

Step 7: Round the amplitudes of taps to one decimal (e.g. -8.78 dB → -8.8 dB)

Step 8: If the delay spread has slightly changed due to the tap merge, adjust the final delay spread by increasing or decreasing the power of the last tap so that the delay spread is corrected.

Step 9: Re-normalize tap powers such that the strongest tap is at 0dB.

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

Note: For Step 5 and Step 6, the power values are expressed in the linear domain using 6 digits of precision. The operations are in the linear domain.

Note: Delay profile for TDLD30 and TDLD10 is generated under assumption that Steps 1-8 are applied for taps with Rayleigh distribution.

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
TDLD30	10	30 ns	375 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

Table B.2.1.1-5 TDLD30 (DS = 30 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-0.2	LOS path
	0	-12.4	Rayleigh
2	20	-21	Rayleigh
3	40	-16.7	Rayleigh
4	55	-18.3	Rayleigh
5	80	-21.9	Rayleigh
6	120	-27.8	Rayleigh
7	240	-23.6	Rayleigh
8	285	-24.8	Rayleigh
9	290	-30.0	Rayleigh
10	375	-27.6	Rayleigh
Note 1: Tap #1 follows a Ricean distribution.			

B.2.1.2 Delay profiles for FR2

The delay profiles for FR2 are specified in B.2.1.2-1 and the tapped delay line models are specified in Tables B.2.1.2-2 to Table B.2.1.2-6.

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
TDLD30	10	30 ns	375 ns	5 ns
TDLA10 (NOTE 1)	16	10 ns	96 ns	2 ns
TDLD10 (NOTE 1)	10	10 ns	126 ns	2 ns
NOTE 1: The delay profile is applicable only for channel bandwidths > 200 MHz.				

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

Table B.2.1.2-4 TDLD30 (DS = 30 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-0.2	LOS path
	0	-12.4	Rayleigh
2	20	-21	Rayleigh
3	40	-16.7	Rayleigh
4	55	-18.3	Rayleigh
5	80	-21.9	Rayleigh
6	120	-27.8	Rayleigh
7	240	-23.6	Rayleigh
8	285	-24.8	Rayleigh
9	290	-30.0	Rayleigh
10	375	-27.6	Rayleigh
Note 1: Tap #1 follows a Rician distribution.			

Table B.2.1.2-5 TDLA10 (DS = 10 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-16.1	Rayleigh
2	4	0	Rayleigh
3	6	-4	Rayleigh
4	8	-10.2	Rayleigh
5	16	-18.6	Rayleigh
6	18	-9.3	Rayleigh
7	22	-13.7	Rayleigh
8	24	-17.9	Rayleigh
9	26	-13.5	Rayleigh
10	30	-14	Rayleigh
11	40	-15.4	Rayleigh
12	44	-18.9	Rayleigh
13	46	-21.0	Rayleigh
14	48	-21.6	Rayleigh
15	50	-19.3	Rayleigh
16	96	-25.9	Rayleigh

Table B.2.1.2-6 TDLD10 (DS = 10 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-0.2	LOS
	0	-12.4	Rayleigh
2	6	-21.1	Rayleigh
3	14	-16.7	Rayleigh
4	18	-18.3	Rayleigh
5	26	-22	Rayleigh
6	40	-27.9	Rayleigh
7	80	-23.7	Rayleigh
8	94	-24.9	Rayleigh
9	98	-30.0	Rayleigh
10	126	-27.7	Rayleigh
Note 1: Tap #1 follows a Rician distribution.			

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>. TDLC<DS>-<Doppler> or TDLD<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
TDLA30-180	TDLA30	180 Hz
TDLA30-1400	TDLA30	1400 Hz
TDLA30-2700	TDLA30	2700 Hz
TDLB100-400	TDLB100	400 Hz
TDLC300-100	TDLC300	100 Hz
TDLC300-600	TDLC300	600 Hz
TDLC300-1200	TDLC300	1200 Hz
TDLD30-5	TDLD30	5 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
TDLD30-75	TDLD30	75 Hz

B.2.3 MIMO Channel Correlation Matrices

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

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

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

B.2.3.1.1 Definition of MIMO Correlation Matrices

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

Table B.2.3.1.1-1: gNB correlation matrix

	One antenna	Two antennas	Four antennas

gNB Correlation	$R_{gNB}=1$	$R_{gNB}=\begin{pmatrix}1 & \alpha\\ \alpha^* & 1\end{pmatrix}$	$R_{gNB}=\begin{pmatrix}1 & \alpha^{1/9} & \alpha^{4/9} & \alpha\\ \alpha^{1/9*} & 1 & \alpha^{1/9} & \alpha^{4/9}\\ \alpha^{4/9*} & \alpha^{1/9*} & 1 & \alpha^{1/9}\\ \alpha^* & \alpha^{4/9*} & \alpha^{1/9*} & 1\end{pmatrix}$

Table B.2.3.1.1-2 defines the correlation matrix for the UE:

Table B.2.3.1.1-2: UE correlation matrix

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

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 Table B.2.3.1.2-2, B.2.3.1.2-3, B.2.3.1.2-4 and B.2.3.1.2-5 as below.

The values in Table B.2.3.1.2-2 have been adjusted for the 4x2 and 4x4 high correlation cases to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision. This is done using the equation:

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

Where the value "a" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 4x1 high correlation and 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	$R_{high} = \begin{pmatrix} 1 & 0.9 & 0.9 & 0.81 \\ 0.9 & 1 & 0.81 & 0.9 \\ 0.9 & 0.81 & 1 & 0.9 \\ 0.81 & 0.9 & 0.9 & 1 \end{pmatrix}$
4x1 case	$R_{high} = \begin{pmatrix} 1.0000 & 0.9883 & 0.9542 & 0.8999 \\ 0.9883 & 1.0000 & 0.9883 & 0.9542 \\ 0.9542 & 0.9883 & 1.0000 & 0.9883 \\ 0.8999 & 0.9542 & 0.9883 & 1.0000 \end{pmatrix}$
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

1x4 case	$R_{medium\ A} = \begin{bmatrix} 1 & 0.9000 & 0.6561 & 0.3874 \\ 0.9000 & 1 & 0.9000 & 0.6561 \\ 0.6561 & 0.9000 & 1 & 0.9000 \\ 0.3874 & 0.6561 & 0.9000 & 1 \end{bmatrix}$
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.2.3.1.3 Beam steering approach

The beam steering approach defined in B.2.3.2.3 is applied, where the random channel matrix H is calculated by letting $N_2 = 1$ and replacing $D_{\theta_{k,1},\theta_{k,2}}$ by:

$$D_{\theta_{k,1},\theta_{k,2}} = D_{\theta_{k,1}}(N_1)$$

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

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

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

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

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

- P is the number of polarization groups.

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

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

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

$$P(a,b) = \begin{cases} 1 & for \quad a = (j-1)Nr + i \quad and \quad b = 2(j-1)Nr + i, \qquad i = 1,\cdots,Nr,\ j = 1,\cdots Nt/2 \\ 1 & for \quad a = (j-1)Nr + i \quad and \quad b = 2(j - Nt/2)Nr - Nr + i, \quad i = 1,\cdots,Nr,\ j = Nt/2 + 1,\cdots,Nt \cdot \\ 0 & otherwise \end{cases}$$

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 B.2.3.2.

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

$$R_{gNB} = R_{gNB\_Dim1} \otimes R_{gNB\_Dim2}$$

where

- - R_{gNB_Dim1} 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,

$$R_{UE} = 1.$$

- For 2 antenna elements with the same polarization,

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

B.2.3.2.2 MIMO Correlation Matrices using cross polarized antennas

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

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

Correlation Model	α_1	α_2	β	γ
Medium Correlation	0.3	0.3	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 are defined in Table B.2.3.2.2-2 and Table B.2.3.2.2-3 as below.

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

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

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

Where the value "a" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 8(4,1,2)x2 high spatial correlation case, a=0.00010. For the 16 (4,2,2)x2 high spatial correlation case, a=0.00012.

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

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

4(2,1,2)x2 case

$$R_{high}=\begin{bmatrix} 1.0000 & 0.0000 & 0.9000 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.9000 & 0.0000 & 0.3000 & 0.0000 & 0.2700 \\ 0.9000 & 0.0000 & 1.0000 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.9000 & 0.0000 & 1.0000 & 0.0000 & 0.2700 & 0.0000 & 0.3000 \\ -0.3000 & 0.0000 & -0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9000 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9000 \\ -0.2700 & 0.0000 & -0.3000 & 0.0000 & 0.9000 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.9000 & 0.0000 & 1.0000 \end{bmatrix}$$

2(1,1,2)x4 case

$$R_{high}=\begin{bmatrix} 1.0000 & 0.9000 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 \\ 0.9000 & 1.0000 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.3000 & 0.2700 \\ 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.2700 & 0.3000 \\ -0.3000 & -0.2700 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 \\ -0.2700 & -0.3000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 1.0000 & 0.9000 \\ 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 \end{bmatrix}$$

4(2,1,2)x4 case

$R_{high} =$

1.0000	0.9000	0.0000	0.0000	0.9000	0.8100	0.0000	0.0000	-0.3000	-0.2700	0.0000	0.0000	-0.2700	-0.2430	0.0000	0.0000
0.9000	1.0000	0.0000	0.0000	0.8100	0.9000	0.0000	0.0000	-0.2700	-0.3000	0.0000	0.0000	-0.2430	-0.2700	0.0000	0.0000
0.0000	0.0000	1.0000	0.9000	0.0000	0.0000	0.9000	0.8100	0.0000	0.0000	0.3000	0.2700	0.0000	0.0000	0.2700	0.2430
0.0000	0.0000	0.9000	1.0000	0.0000	0.0000	0.8100	0.9000	0.0000	0.0000	0.2700	0.3000	0.0000	0.0000	0.2430	0.2700
0.9000	0.8100	0.0000	0.0000	1.0000	0.9000	0.0000	0.0000	-0.2700	-0.2430	0.0000	0.0000	-0.3000	-0.2700	0.0000	0.0000
0.8100	0.9000	0.0000	0.0000	0.9000	1.0000	0.0000	0.0000	-0.2430	-0.2700	0.0000	0.0000	-0.2700	-0.3000	0.0000	0.0000
0.0000	0.0000	0.9000	0.8100	0.0000	0.0000	1.0000	0.9000	0.0000	0.0000	0.2700	0.2430	0.0000	0.0000	0.3000	0.2700
0.0000	0.0000	0.8100	0.9000	0.0000	0.0000	0.9000	1.0000	0.0000	0.0000	0.2430	0.2700	0.0000	0.0000	0.2700	0.3000
-0.3000	-0.2700	0.0000	0.0000	-0.2700	-0.2430	0.0000	0.0000	1.0000	0.9000	0.0000	0.0000	0.9000	0.8100	0.0000	0.0000
-0.2700	-0.3000	0.0000	0.0000	-0.2430	-0.2700	0.0000	0.0000	0.9000	1.0000	0.0000	0.0000	0.8100	0.9000	0.0000	0.0000
0.0000	0.0000	0.3000	0.2700	0.0000	0.0000	0.2700	0.2430	0.0000	0.0000	1.0000	0.9000	0.0000	0.0000	0.9000	0.8100
0.0000	0.0000	0.2700	0.3000	0.0000	0.0000	0.2430	0.2700	0.0000	0.0000	0.9000	1.0000	0.0000	0.0000	0.8100	0.9000
-0.2700	-0.2430	0.0000	0.0000	-0.3000	-0.2700	0.0000	0.0000	0.9000	0.8100	0.0000	0.0000	1.0000	0.9000	0.0000	0.0000
-0.2430	-0.2700	0.0000	0.0000	-0.2700	-0.3000	0.0000	0.0000	0.8100	0.9000	0.0000	0.0000	0.9000	1.0000	0.0000	0.0000
0.0000	0.0000	0.2700	0.2430	0.0000	0.0000	0.3000	0.2700	0.0000	0.0000	0.9000	0.8100	0.0000	0.0000	1.0000	0.9000
0.0000	0.0000	0.2430	0.2700	0.0000	0.0000	0.2700	0.3000	0.0000	0.0000	0.8100	0.9000	0.0000	0.0000	0.9000	1.0000

8(4,1,2)x2 case

$R_{high} =$

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

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

2(1,1,2)x2 case	$R_{medium} = \begin{bmatrix} 1.0000 & 0.0000 & -0.2000 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.2000 \\ -0.2000 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2000 & 0.0000 & 1.0000 \end{bmatrix}$

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

16(4,2,2)x2 case	$R_{high} = \begin{bmatrix} A & B \\ C & D \end{bmatrix}$, where $A = D = \begin{bmatrix} 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.8999 & 0.0000 & 0.8099 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.8999 & 0.0000 & 0.8099 \\ 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8099 & 0.0000 & 0.8999 & 0.0000 \\ 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8099 & 0.0000 & 0.8999 \\ 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 \\ 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 0.9541 & 0.0000 & 0.8587 \\ 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 \\ 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8587 & 0.0000 & 0.9541 \\ 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 \\ 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 & 0.9882 & 0.0000 & 0.8894 \\ 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 \\ 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 & 0.8894 & 0.0000 & 0.9882 \\ 0.8999 & 0.0000 & 0.8099 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 & 0.0000 \\ 0.0000 & 0.8999 & 0.0000 & 0.8099 & 0.0000 & 0.9541 & 0.0000 & 0.8587 & 0.0000 & 0.9882 & 0.0000 & 0.8894 & 0.0000 & 1.0000 & 0.0000 & 0.8999 \\ 0.8099 & 0.0000 & 0.8999 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.8099 & 0.0000 & 0.8999 & 0.0000 & 0.8587 & 0.0000 & 0.9541 & 0.0000 & 0.8894 & 0.0000 & 0.9882 & 0.0000 & 0.8999 & 0.0000 & 1.0000 \end{bmatrix}$ $B = C = \begin{bmatrix} -0.3000 & 0.0000 & -0.2700 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.2862 & 0.0000 & -0.2576 & 0.0000 & -0.2700 & 0.0000 & -0.2430 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.2862 & 0.0000 & 0.2576 & 0.0000 & 0.2700 & 0.0000 & 0.2430 \\ -0.2700 & 0.0000 & -0.3000 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2576 & 0.0000 & -0.2862 & 0.0000 & -0.2430 & 0.0000 & 0.2700 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2576 & 0.0000 & 0.2862 & 0.0000 & 0.2430 & 0.0000 & 0.2700 \\ -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.2862 & 0.0000 & -0.2576 & 0.0000 \\ 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.2862 & 0.0000 & 0.2576 \\ -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2576 & 0.0000 & -0.2862 & 0.0000 \\ 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2576 & 0.0000 & 0.2862 \\ -0.2862 & 0.0000 & -0.2576 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 \\ 0.0000 & 0.2862 & 0.0000 & 0.2576 & 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 0.2965 & 0.0000 & 0.2668 \\ -0.2576 & 0.0000 & -0.2862 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 \\ 0.0000 & 0.2576 & 0.0000 & 0.2862 & 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.2668 & 0.0000 & 0.2965 \\ -0.2700 & 0.0000 & -0.2430 & 0.0000 & -0.2862 & 0.0000 & -0.2576 & 0.0000 & -0.2965 & 0.0000 & -0.2668 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & .00000 \\ 0.0000 & 0.2700 & 0.0000 & 0.2430 & 0.0000 & 0.2862 & 0.0000 & 0.2576 & 0.0000 & 0.2965 & 0.0000 & 0.2668 & 0.0000 & 0.3000 & 0.0000 & 0.2700 \\ -0.2430 & 0.0000 & -0.2700 & 0.0000 & -0.2576 & 0.0000 & -0.2862 & 0.0000 & -0.2668 & 0.0000 & -0.2965 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.2430 & 0.0000 & 0.2700 & 0.0000 & 0.2576 & 0.0000 & 0.2862 & 0.0000 & 0.2668 & 0.0000 & 0.2965 & 0.0000 & 0.2700 & 0.0000 & 0.3000 \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 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 $\theta_{k,i}=\theta_{0,i}+\Delta\theta k$, 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.2.3.2.3-1, and k is the linear increment of $2^{-\mu}$ for every slot throughout the simulation, the index $i=1,2$ stands for first dimension and second dimension respectively.
- W is the precoding matrix for Nt transmission antennas,
- y is the received signal, x is the transmitted signal, and n is AWGN.
- μ corresponds to subcarrier spacing configuration, $\Delta f=2^{\mu}\cdot 15[\text{kHz}]$

For the 1D cross-polarized antenna array at gNB, the corresponding random channel matrix H can be calculated by letting N_2=1, i.e.,

$$D_{\theta_{k,1}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes D_{\theta_{k,1}}(N_1)$$

Table B.2.3.2.3-1: The step of phase variation

Variation Step	Value (rad/ms)
$\Delta\theta$	1.2566×10^{-3}

B.2.3.2.3A Beam steering approach with dual cluster beams

For the 2D cross-polarized antenna array at gNB, given the channel spatial correlation matrix in B.2.3.2.1 and B.2.3.2.2, the corresponding random channel matrix *H* can be calculated. The signal model for the *k*-th slot is denoted as

$$y = \left[\sqrt{\frac{1}{1+p^2}} H_m D^{(m)}_{\theta_{k,1},\theta_{k,2}} + \sqrt{\frac{p^2}{1+p^2}} H_s D^{(s)}_{\theta_{k,1},\theta_{k,2}} \right] Wx + n$$

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_m, H_s are independent channels for the first beam and second beam with the Nr xNt channel matrix per subcarrier.
- $D^{(m)}_{\theta_{k,1},\theta_{k,2}}$, $D^{(s)}_{\theta_{k,1},\theta_{k,2}}$ are the steering matrix for first beam and second beam
- $D_{\theta_{k,1}}(N_1)$ 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 infirst 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,
- p is the relative power ratio of the second beam to the first beam, the value of p is specific to a test case,

For 1 antenna element of the same polarization in one direction, $D_{\theta_{k,i}}(1) = 1$.

For 2 antenna elements of 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 of 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 of 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.2.3.2.3A-1, and k is the linear increment of $2^{-\mu}$ for every slot throughout the simulation, the index $i=1,2$ stands for first dimension and second dimension respectively.
- W is the precoding matrix for Nt transmission antennas,
- y is the received signal, x is the transmitted signal, and n is AWGN.
- μ corresponds to subcarrier spacing configuration, $\Delta f = 2^{\mu}\cdot 15[\text{kHz}]$

For the 1D cross-polarized antenna array at gNB, the corresponding random channel matrix H can be calculated by letting N_2=1, i.e.,

$$D_{\theta_{k,1}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes D_{\theta_{k,1}}(N_1)$$

Table B.2.3.2.3A-1: The step of phase variation

Variation Step	Value (rad/subframe)
$\Delta\theta^{(m)}$	1.2566×10^{-3}
$\Delta\theta^{(s)}$	2.5132×10^{-3}

B.2.4 Two-tap propagation conditions for CQI tests

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

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

in continuous time (t,τ) representation, with τ_d the delay, a constant value of a and f_D the Doppler frequency. The same $h(t,\tau)$ is used to describe the fading channel between every pair of Tx and Rx.

B.3 High Speed Train Scenario

B.3.1 Single Tap Channel Profile

The high speed train condition for the test of the baseband performance is a non fading propagation channel with one tap. Doppler shift is given by

$$f_s(t) = f_d \cos\theta(t) \qquad \text{(B.3.1.1)}$$

where $f_s(t)$ is the Doppler shift and f_d is the maximum Doppler frequency. The cosine of angle $\theta(t)$ is given by

$$\cos\theta(t) = \frac{D_s/2 - vt}{\sqrt{D_{\min}{}^2 + (D_s/2 - vt)^2}}, \quad 0 \le t \le D_s/v \qquad \text{(B.3.1.2)}$$

$$\cos\theta(t) = \frac{-1.5D_s + vt}{\sqrt{D_{\min}{}^2 + (-1.5D_s + vt)^2}}, \quad D_s/v < t \le 2D_s/v \qquad \text{(B.3.1.3)}$$

$$\cos\theta(t) = \cos\theta(t \bmod (2D_s/v)), \quad t > 2D_s/v \qquad \text{(B.3.1.4)}$$

where $D_s/2$ is the initial distance of the train from gNB, and $D_{\min}$ is gNB Railway track distance, both in meters; v is the velocity of the train in m/s, t is time in seconds.

Doppler shift and cosine angle are given by equation B.3.1.1 and B.3.1.2-B.3.1.4 respectively, where the required input parameters listed in Table B.3.1-1 and the resulting Doppler shift shown in Figures B.3.1-1, B.3.1-2, B.3.1-3, B.3.1-4 are applied for all frequency bands.

Table B.3.1-1: High speed train scenario

Parameter	Value			
	HST-750	HST-972	HST-1000	HST-1667
D_s	300 m	300 m	300 m	300 m
$D_{\min}$	2 m	2 m	2 m	2 m
v	300 km/h	500 km/h	300 km/h	500 km/h
f_d	750 Hz for 15 kHz SCS test	972 Hz for 15 kHz SCS test	1000 Hz for 30 kHz SCS test	1667 Hz for 30 kHz SCS test

Note 1: Parameters for HST conditions in Table B.3.1-1 including f_d and Doppler shift trajectories presented on figures B.3.1-1 for 750 Hz and B.3.1-3 for 972 Hz for 15 kHz SCS and figures B.3.1-2 for 1000 Hz and B.3.1-4 for 1667 Hz for 30 kHz SCS are applied for performance verification in all frequency bands.

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

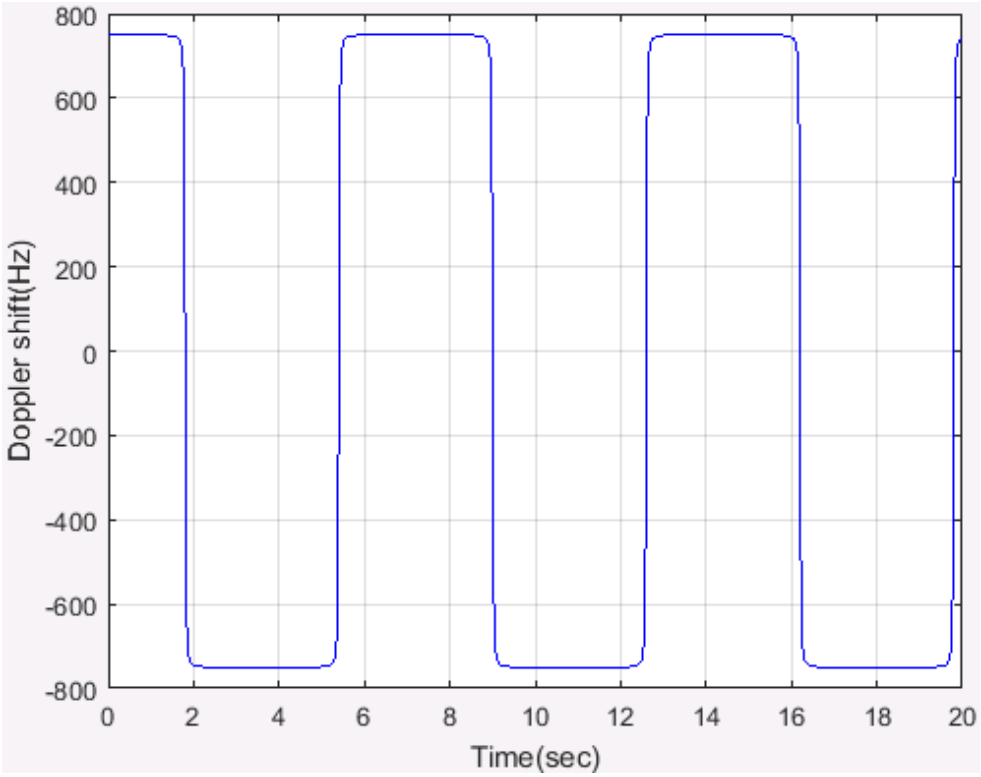

Figure B.3.1-1: Doppler shift trajectory (f_d = 750 Hz)

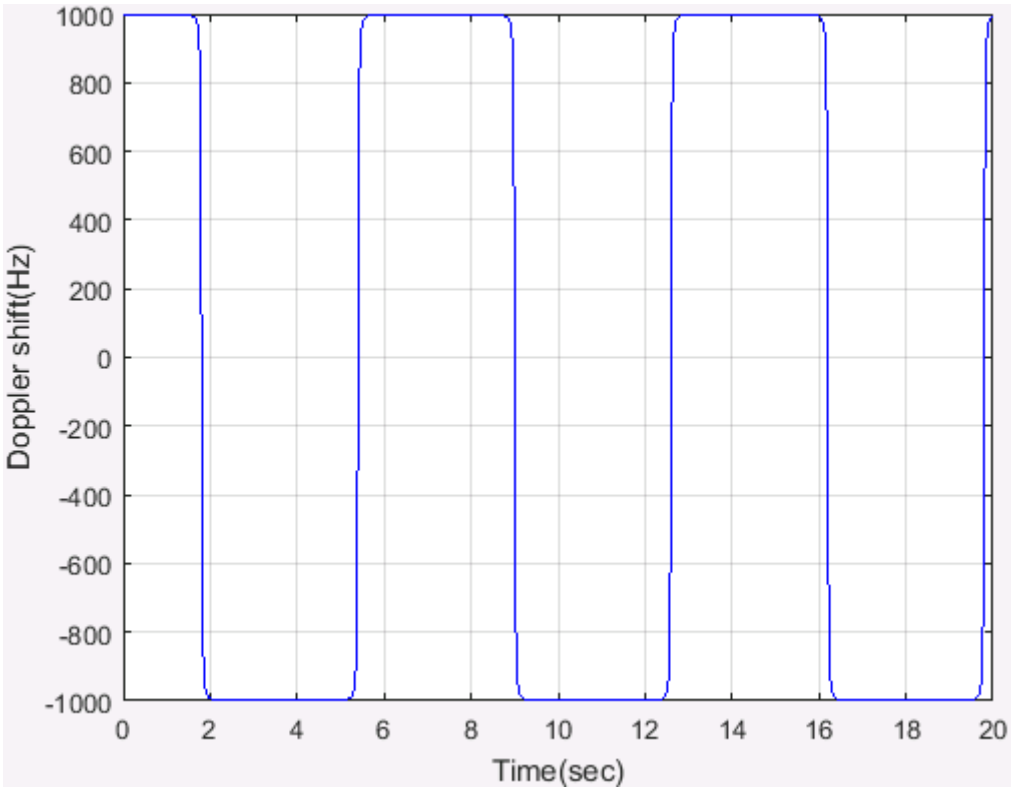

Figure B.3.1-2: Doppler shift trajectory (f_d = 1000 Hz)

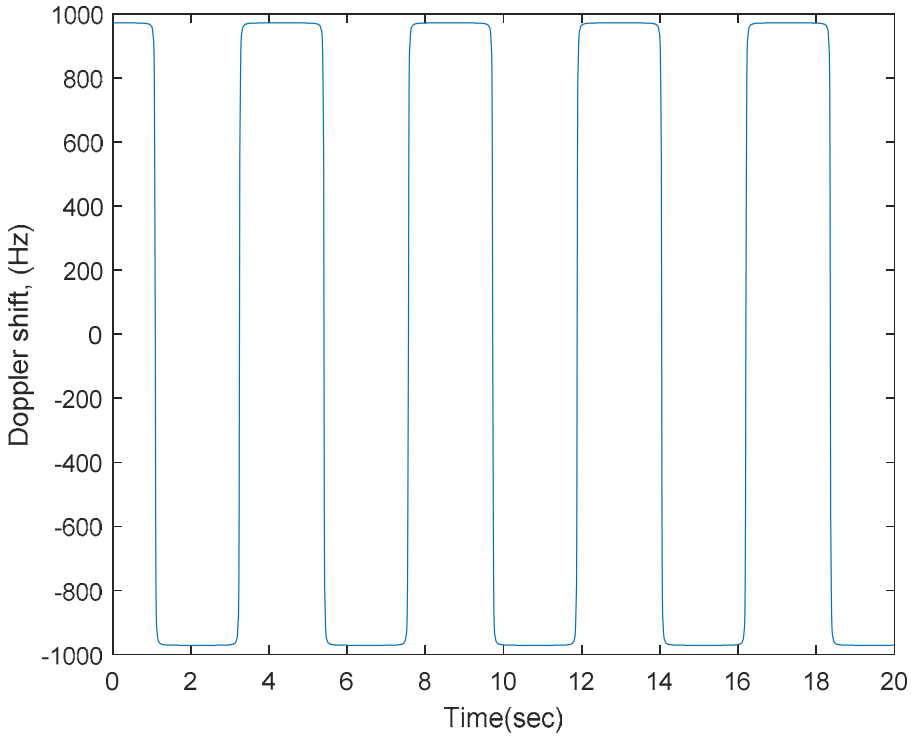

Figure B.3.1-3: Doppler shift trajectory (f_d = 972 Hz)

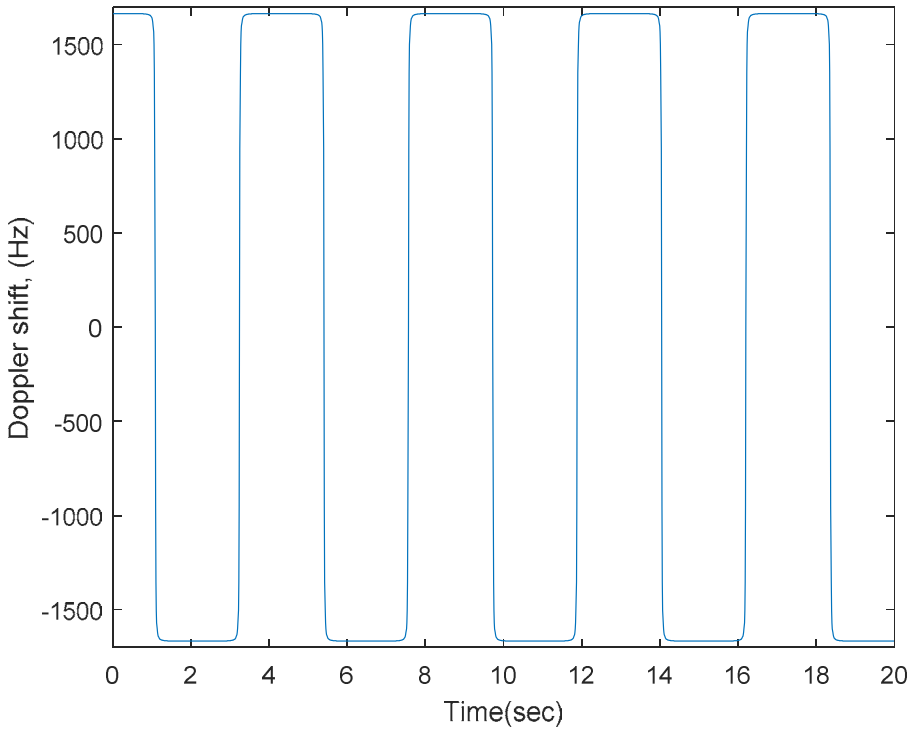

Figure B.3.1-4: Doppler shift trajectory (f_d = 1667 Hz)

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

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

Static channel matrix will be used as defined in Annex B.1.

B.3.2 HST-SFN Channel Profile

There is an infinite number of RRHs distributed equidistantly along the track with the same Cell ID as depicted in figure B.3.2-1.

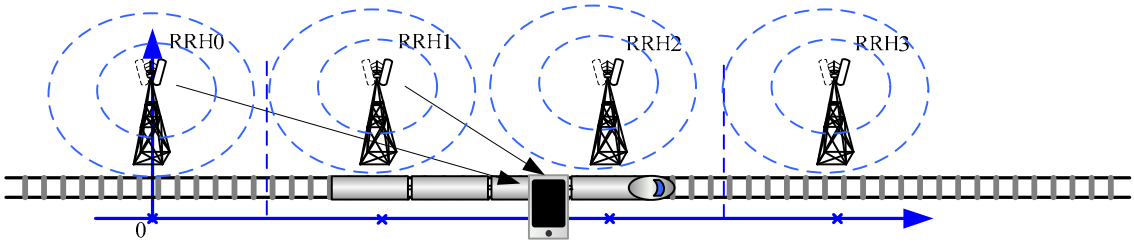

Figure B.3.2-1: Deployment of HST-SFN

The location of RRH k is given as:

$$x_k = k*D_s + j*D_{\min} \quad \text{(B.3.2.1)}$$

where: $k \in [-\infty, \infty]$, $j = sqrt(-1)$ and $D_{\min}$ is the distance between the RRHs and railway track, while D_s is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = a + j*0 \quad \text{(B.3.2.2)}$$

where: $a \in [0, \infty]$ and a means distance in meters, which means the train is right on the track.

The HST-SFN scenario for the test of the baseband performance is a non fading propagation channel with four taps, namely the four nearest RRHs. Thus, RRH k is visible for the train only in the range:

$$k*D_s - 2*D_s \le a < k*D_s + 2*D_s \quad \text{(B.3.2.3)}$$

Power level P_k (dB) for the signal from k^{th} RRH, normalized to the total power received from all visible RRHs, is given by:

$$P_k = -20\lg\left(\left|y - x_k\right|\right) - 10\lg\left(\sum_{i \in \{i | i*D_S - 2*D_S \le a < i*D_S + 2*D_S\}} \frac{1}{\left|y - x_i\right|^2}\right) \text{ for } k*D_s - 2*D_s \le a < k*D_s + 2*D_s \quad \text{(B.3.2.4)}$$

Doppler shift $F_{D,k}$ (Hz) from k^{th} RRH is given by:

$$F_{D,k} = f_d \times real\left[-\frac{y - x_k}{|y - x_k|}\right] \text{ for } kD_s - 2D_s \le a < kD_s + 2D_s \quad \text{(B.3.2.5)}$$

The relative delay T_k (s) for the signal from k^{th} RRH can be derived as:

$$T_k = \frac{|y - x_k|}{C} \text{ for } k*D_s - 2*D_s \le a < k*D_s + 2*D_s \quad \text{(B.3.2.6)}$$

In the above f_d (Hz) is the maximum Doppler frequency as given in Table B.3.2-1, and C (m/s) is the velocity of light.

Power level, Doppler shift and relative delay are given by equations B.3.2.4 ~ B.3.2.6 respectively, where the required input parameters listed in table B.3.2-1 and the resulting Doppler shift shown in Figures B.3.2-3 and B.3.2-4 are applied for all frequency bands.

Table B.3.2-1: HST-SFN scenario

Parameter	Value
D_s	700 m
$D_{\min}$	150 m
v	500 km/h
f_d	870 Hz for 15 kHz SCS test; 1667 Hz for 30 kHz SCS test

NOTE 1: The trajectories of relative power, Doppler shifts and absolute delays presented in Figures B.3.2-2, B.3.2-3, B.3.2-4 and B.3.2-5 are derived from the equations B.3.2.4 ~ B.3.2.6 respectively, v is the velocity of the train.

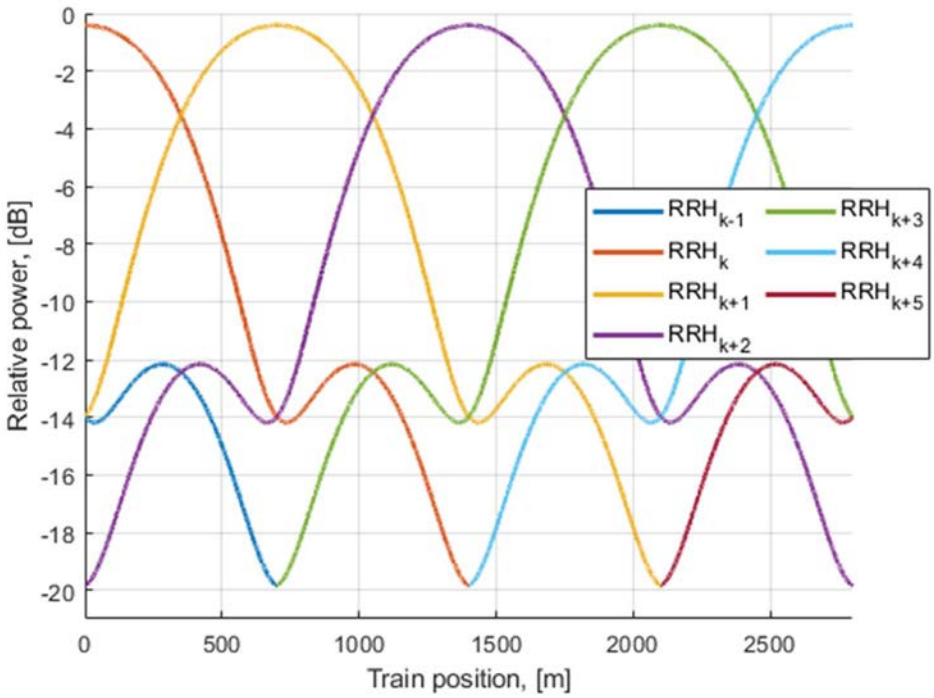

Figure B.3.2-2 Relative power level trajectories

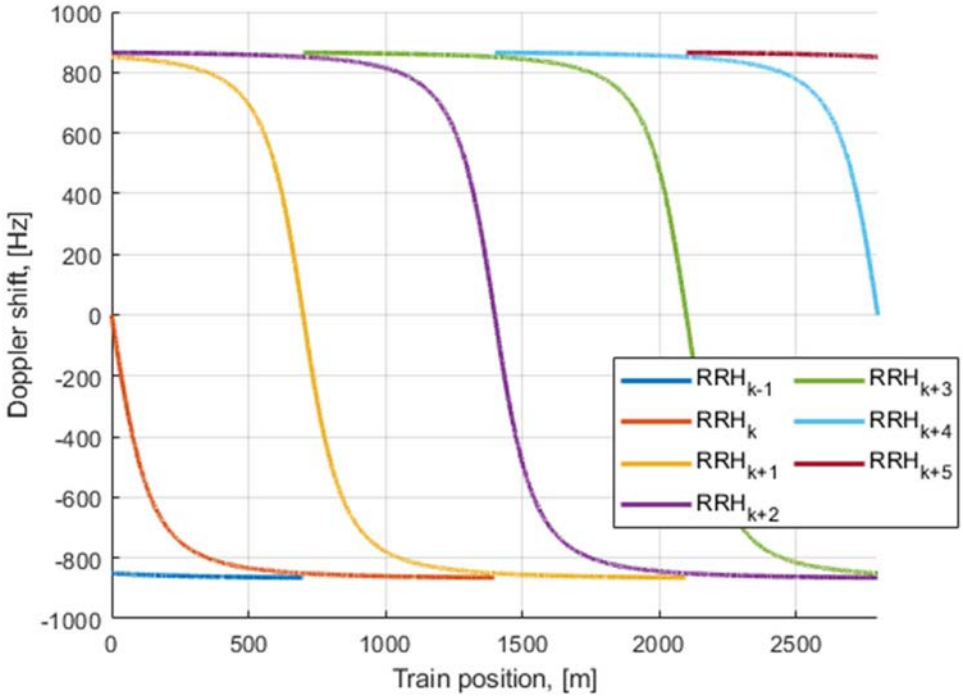

Figure B.3.2-3 Doppler shift trajectories (f_d = 870 Hz)

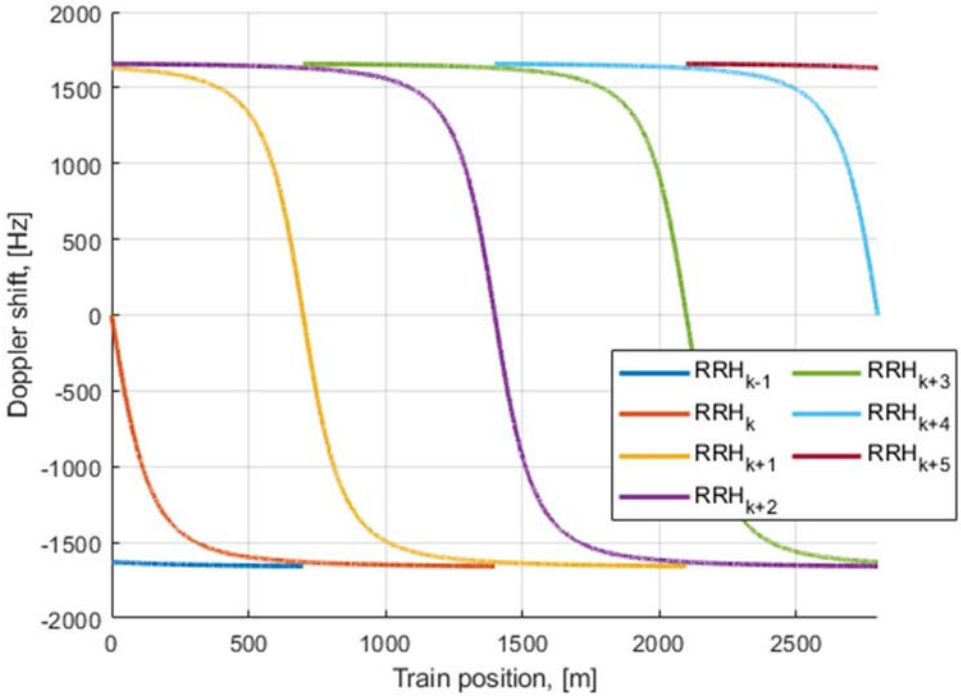

Figure B.3.2-4 Doppler shift trajectories (f_d = 1667 Hz)

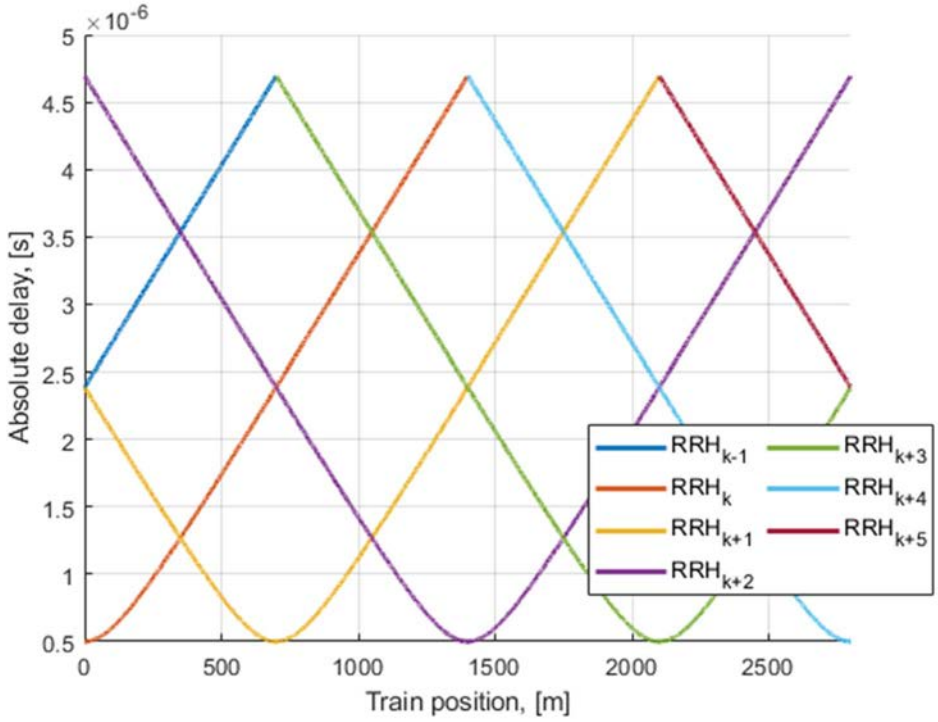

Figure B.3.2-5 Absolute delay trajectories

Static channel matrix will be used as defined in Annex B.1.

B.3.3 HST-DPS Channel Profile

There is an infinite number of RRHs distributed equidistantly along the railway track with the same Cell ID as illustrated in Figure B.3.3-1.

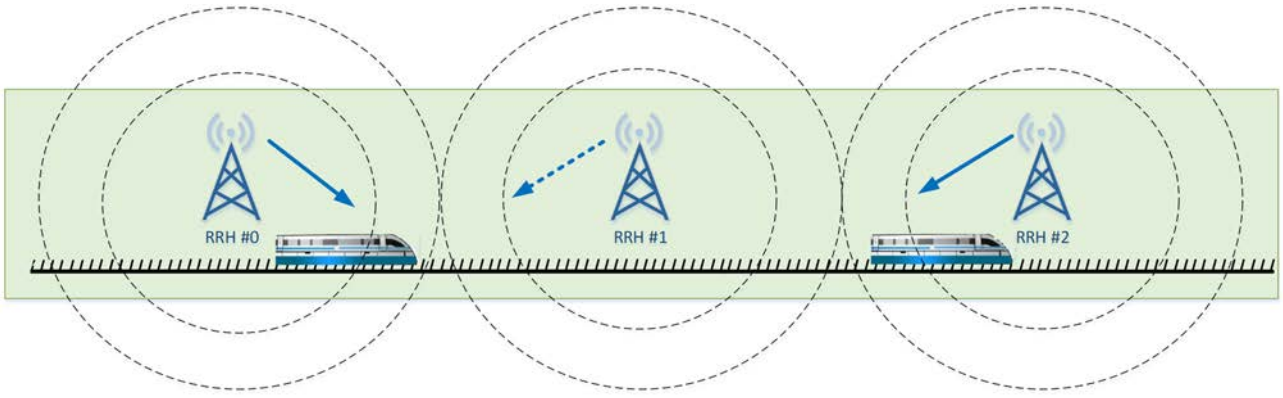

Figure B.3.3-1: Deployment of HST-DPS

The location of RRH *k* is given as:

$$x_k = k * D_s + j * D_{\min} \quad \text{(B.3.3.1)}$$

where: $k \in [-\infty, \infty]$, $j = sqrt(-1)$ and $D_{\min}$ is the distance between the RRHs and railway track, while D_s is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = a + j * 0 \quad \text{(B.3.3.2)}$$

where: $a \in [0, \infty]$ and *a* means distance in meters, which means the train is right on the track.

The HST DPS multi-RRH scenario for the test of the baseband performance is a single tap propagation channel at each time with switching of transmission point in the middle point between two RRHs. As shown in Figures B.3.3-2 and B.3.3-4, RRH *k* is visible for the train only in the range:

$$k * D_s - D_s \leq a < k * D_s + D_s \quad \text{(B.3.3.3)}$$

However, as shown in Figures B.3.3-3 and B.3.3-5, RRH k is considered for PDSCH and PDCCH signal transmission only in the range:

$$\boldsymbol{k * D_s - \frac{D_s}{2} < a \leq k * D_s + \frac{D_s}{2}} \quad \textbf{(B.3.3.4)}$$

Propagation delay difference are not considered between signals from different RRHs.

Power level P_k (dB) for the signal from each RRH equals to 0. Doppler shift $F_{D,k}$ (Hz) from k^{th} RRH is given by:

$$F_{D,k} = f_d \times real\left[-\frac{y - x_k}{|y - x_k|}\right] \quad \text{for} k * D_s - \frac{D_s}{2} < a \leq k * D_s + \frac{D_s}{2} \quad \text{(B.3.3. 5)}$$

In the above f_d (Hz) is the maximum Doppler frequency as given in Table B.3.3-1, and C (m/s) is the velocity of light.

Doppler shift is given by equation B.3.3.5, where the required input parameters listed in table B.3.3-1 and the resulting Doppler shift shown in Figures B.3.3-2 ~ B.3.3-5 are applied for all frequency bands.

Table B.3.3-1: HST-DPS scenario

Parameter	Value
D_s	700 m
$D_{\min}$	150 m
v	500 km/h
f_d	870 Hz for 15 kHz SCS test; 1667 Hz for 30 kHz SCS test

NOTE 1: *v* is the velocity of the train.

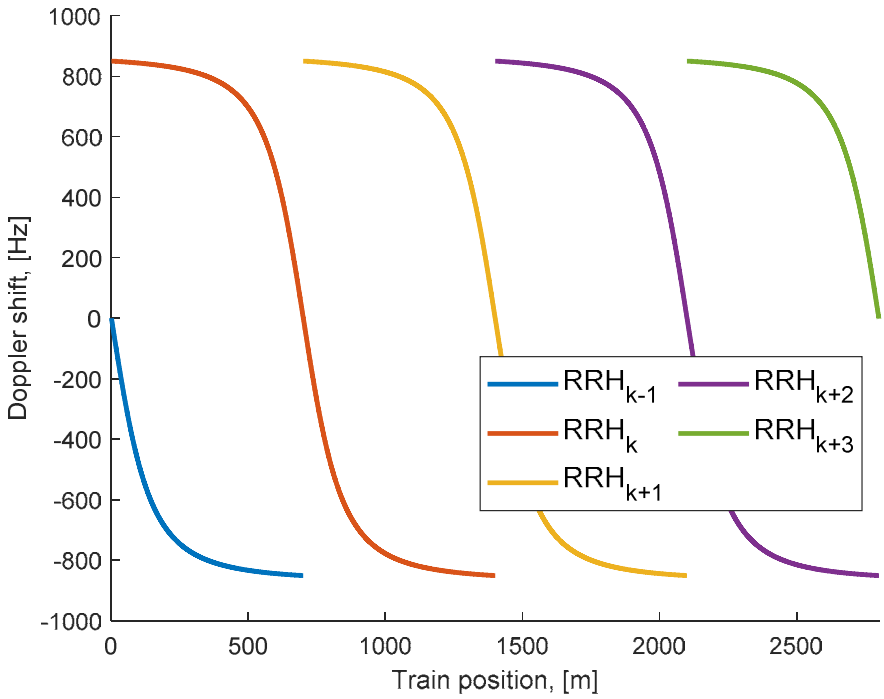

Figure B.3.3-2 Doppler shift trajectory (f_d = 870 Hz) showing visibility of each RRH

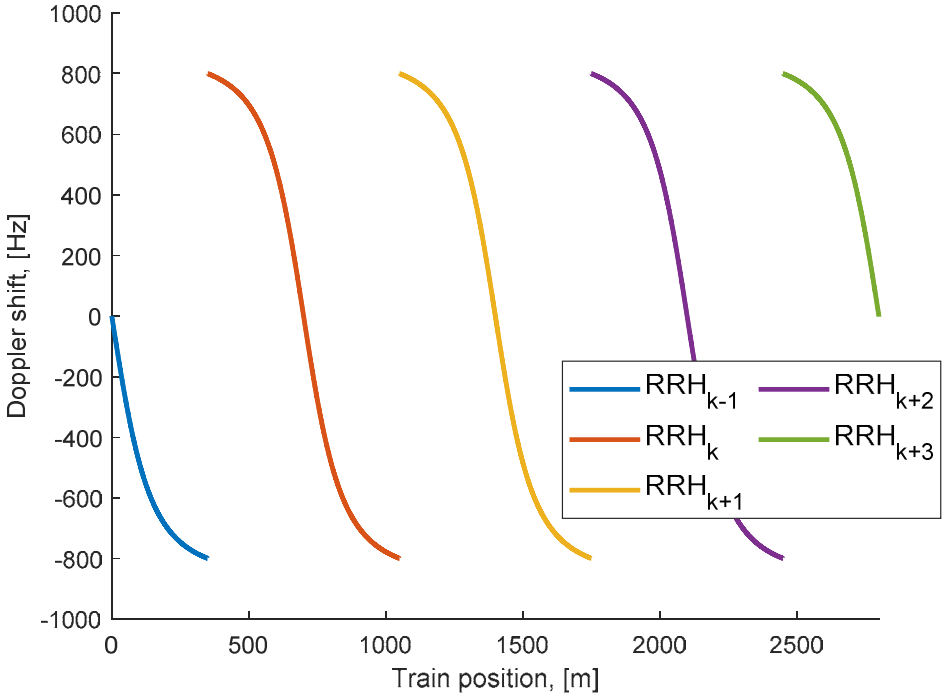

Figure B.3.3-3 Doppler shift trajectory (f_d = 870 Hz) as seen by PDCCH and PDSCH for each RRH

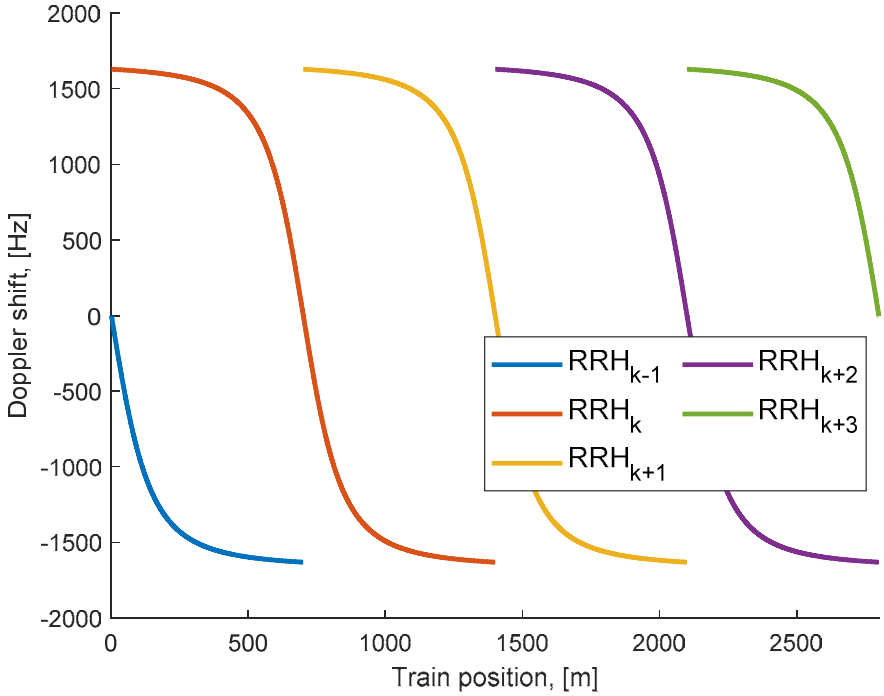

Figure B.3.3-4 Doppler shift trajectory (f_d = 1667 Hz) showing visibility of each RRH

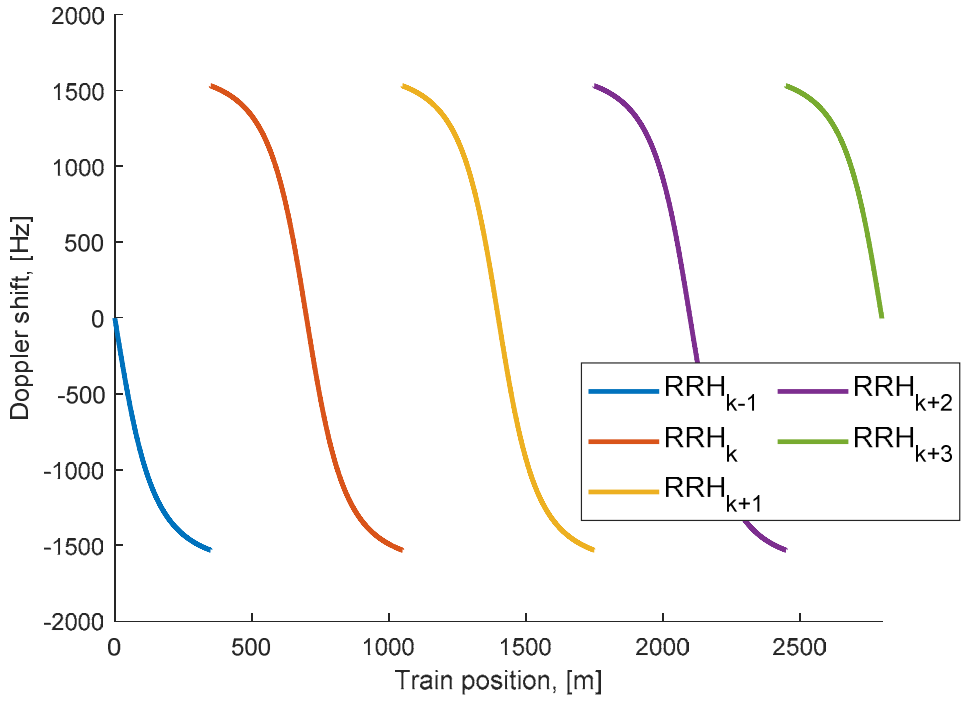

Figure B.3.3-5 Doppler shift trajectory (f_d = 1667 Hz) as seen by PDCCH and PDSCH for each RRH

Static channel matrix will be used as defined in Annex B.1.

B.3.4 FR2 HST-DPS Channel Profile

There is an infinite number of RRHs distributed equidistantly along the railway track with the same Cell ID as illustrated in Figure B.3.4.1-1 for Unidirectional and Figure B.3.4.2-1 for Bidirectional.

The location of RRH *k* is given as:

$$x_k = k * D_s + j * D_{min} \quad \text{(B.3.4.1)}$$

where: $k \in [-\infty, \infty]$, $j = sqrt(-1)$ and D_{min} is the distance between the RRHs and railway track, while D_s is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = a + j * 0 \quad \text{(B.3.4.2)}$$

where: $a \in [0, \infty]$ and *a* means distance in meters, which means the train is right on the track. $a = vt$ where *v* (m/s) is the moving speed of the train.

B.3.4.1 Unidirectional Deployment Channel Profile

The FR2 HST DPS Unidirectional Deployment Channel Profile is a single tap propagation channel, switching transmission point between adjacent RRHs when the UE reaches a distance equal to D_{S_offset} from the serving RRH as illustrated in Figure B.3.4.1-1:

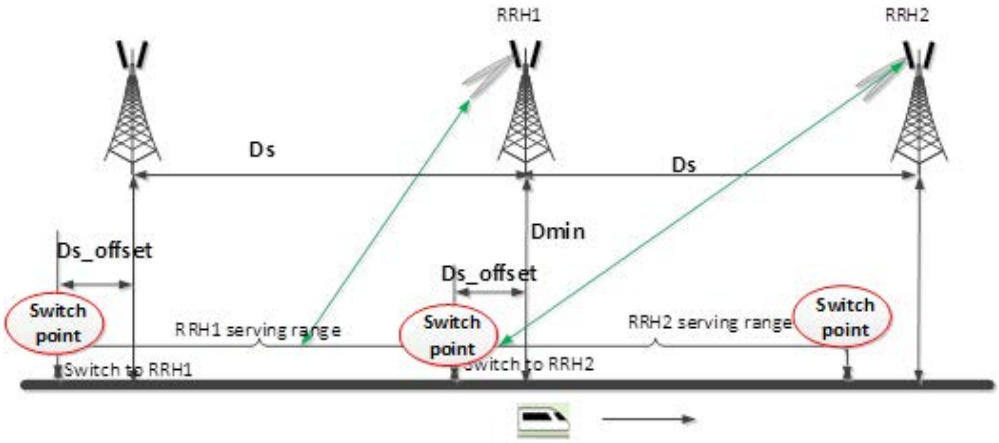

Figure B.3.4.1-1: Unidirectional deployment of FR2 HST-DPS

RRH *k* is visible for the train only in the range:

$$(k-2)*D_s - D_{s\_offset} \le a < k*D_s \quad \text{(B.3.4.1.1)}$$

However, RRH k is considered for PDSCH and PDCCH signal transmission only in the range:

$$(k-1)*D_s - D_{s\_offset} < \boldsymbol{a} \le k*D_s - D_{s\_offset} \quad \text{(B.3.4.1.2)}$$

Propagation delay difference are not considered between signals from different RRHs.

Power level P_k (dB) for the signal from each RRH equals to 0. Doppler shift $f_s(t) = f_d \cos\theta(t)$ (Hz) is given by:

$$\cos\theta(\mathrm{t}) = \frac{D_{s\_offset}+D_s-vt}{\sqrt{D_{min}^2+\left(D_{s\_offset}+D_s-vt\right)^2}},\ 0 < t \le \frac{D_s}{v}$$

$$cos\theta(t) = cos\theta\left(t \bmod \left(\frac{D_s}{v}\right)\right),\ t > D_s/v \quad \text{(B.3.4.1.3)}$$

Doppler shift is given by equation B.3.4.1.3, where the required input parameters listed in table B.3.4.1-1 and the resulting Doppler shift shown in Figures B.3.4.1-2 and B.3.4.1-3 are applied for all frequency bands.

Table B.3.4.1-1: FR2 HST-DPS Unidirectional scenario

Parameter	Value
	HST-DPS-FR2-UNI-A
D_s	700 m
D_{s_offset}	10 m
D_{min}	10 m
v	350 km/h
f_d	9722 Hz

Static channel matrix will be used as defined in Annex B.1.

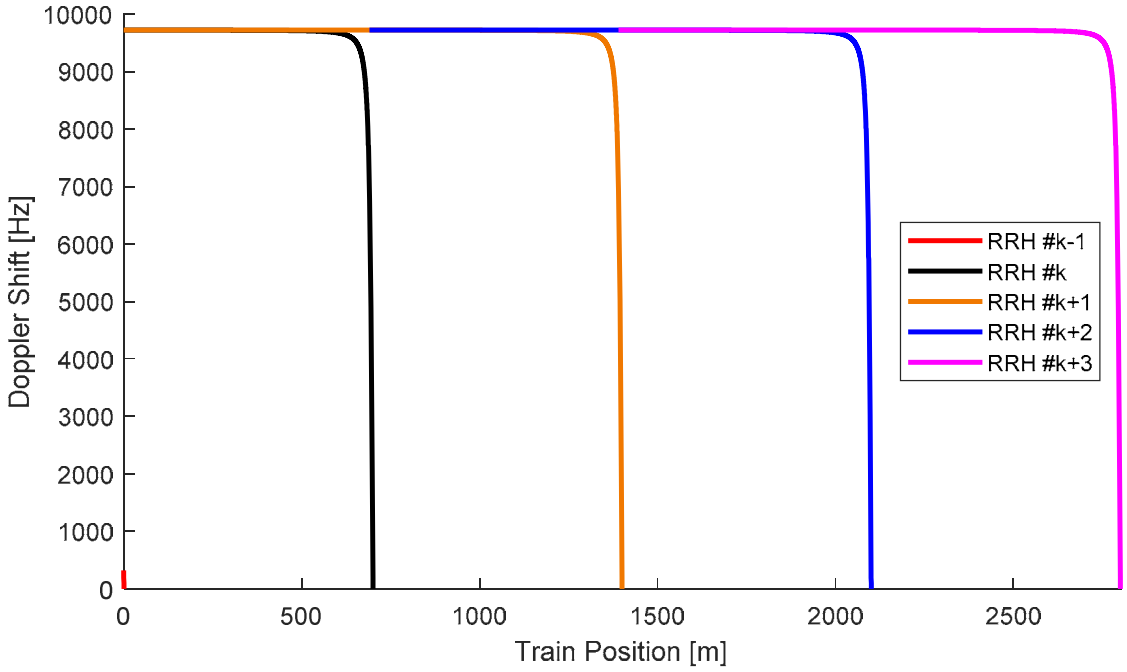

Figure B.3.4.1-2: Doppler shift trajectory (f_d = 9722 Hz) showing visibility of each RRH for FR2 HST-DPS Unidirectional scenario

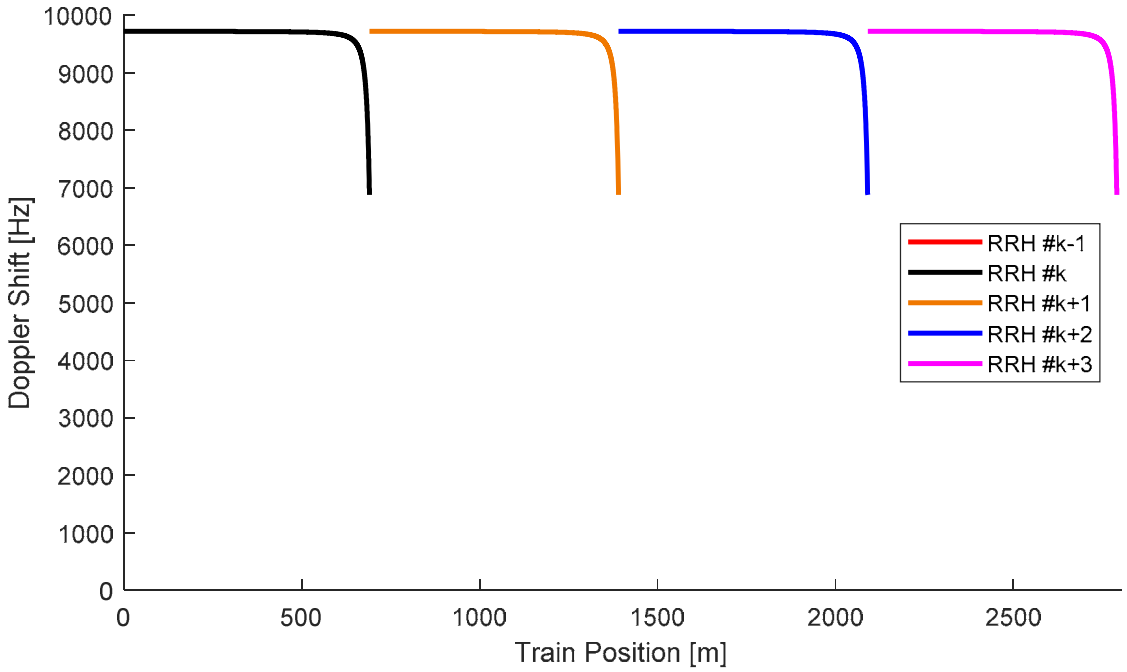

Figure B.3.4.1-3: Doppler shift trajectory (f_d = 9722 Hz) as seen by PDCCH and PDSCH for each RRH for FR2 HST-DPS Unidirectional scenario

B.3.4.2 Bidirectional Deployment Channel Profile

The FR2 HST DPS Bidirectional Deployment Channel Profile is a single tap propagation channel, switching transmission point between adjacent RRHs as illustrated in Figure B.3.4.2-1:

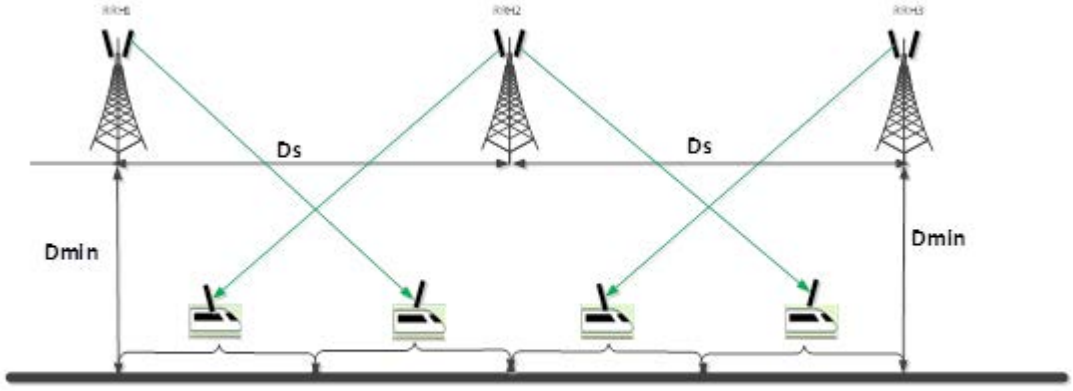

Figure B.3.4.2-1: Bidirectional deployment of FR2 HST-DPS

As shown in Figures B.3.4.2-1, RRH *k* is visible for the train only in the range:

$$k * D_s - D_s \leq a < k * D_s + D_s \quad \text{(B.3.4.2.1)}$$

However, as shown in Figures B.3.3-3 and B.3.3-5, RRH k is considered for PDSCH and PDCCH signal transmission only in the range:

$$(\boldsymbol{k}-\boldsymbol{1}) * \boldsymbol{D_s} \ < \boldsymbol{a} \leq \boldsymbol{k} * \boldsymbol{D_s} - \frac{\boldsymbol{D_s}}{\boldsymbol{2}};\ \ \boldsymbol{k} * \boldsymbol{D_s} + \frac{\boldsymbol{D_s}}{\boldsymbol{2}} \ < \boldsymbol{a} \leq (\boldsymbol{k}+\boldsymbol{1}) * \boldsymbol{D_s} \quad \text{(B.3.4.2.2)}$$

Note that UE is receiving PDSCH and PDCCH from the 2nd-nearest RRH. Propagation delay difference are not considered between signals from different RRHs.

Power level P_k (dB) for the signal from each RRH equals to 0. Doppler shift $f_s(t) = f_d \cos\theta(t)$ (Hz) is given by:

$$\cos\theta(t) = \frac{D_s - vt}{\sqrt{D_{min}^2 + (D_s - vt)^2}},\ \ 0 < t \leq (0.5 * D_s)/v$$

$$\cos\theta(t) = -\frac{vt}{\sqrt{D_{min}^2 + (vt)^2}},\ \ (0.5 * D_s)/v < t \leq D_s/v$$

$$\cos\theta\left(t \bmod \left(\frac{D_s}{v}\right)\right),\quad t > D_s/v \quad \text{(B.3.4.2.3)}$$

Doppler shift is given by equation B.3.4.2.3, where the required input parameters listed in table B.3.4.2-1 and the resulting Doppler shift shown in Figures B.3.4.2-2 and B.3.4.2-3 are applied for all frequency bands.

Table B.3.4.2-1: FR2 HST-DPS Bidirectional scenario

Parameter	Value
	HST-DPS-FR2-BI-B
D_s	700 m
$D_{\min}$	150 m
v	350 km/h
f_d	9722 Hz

Static channel matrix will be used as defined in Annex B.1.

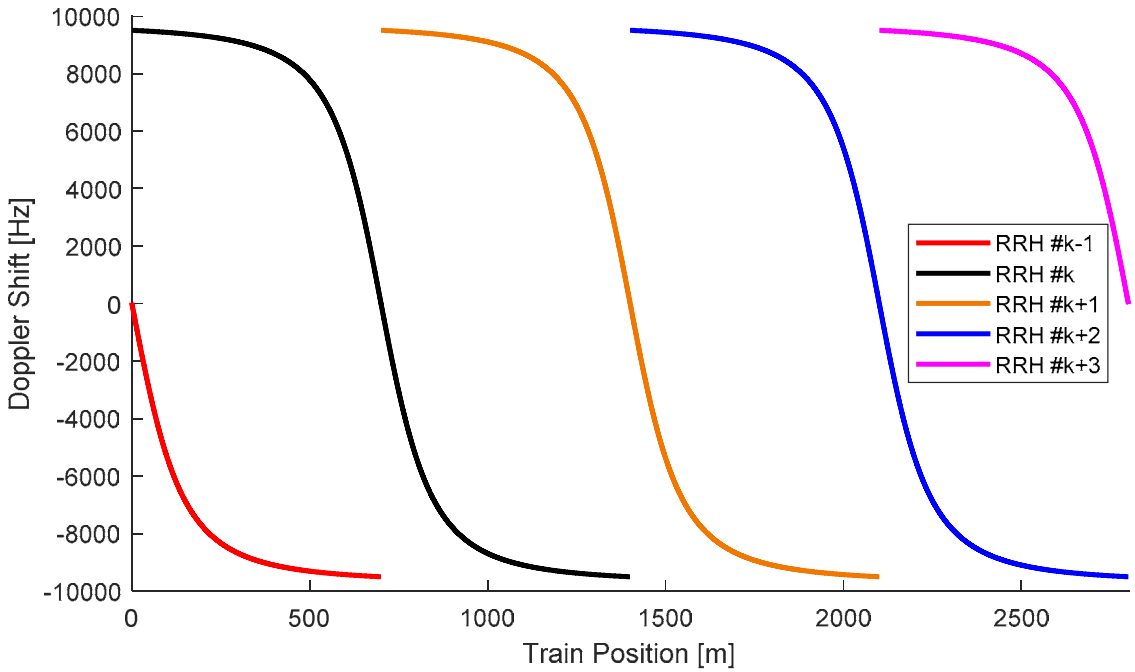

Figure B.3.4.2-2: Doppler shift trajectory (f_d = 9722 Hz) showing visibility of each RRH for FR2 HST-DPS Bidirectional scenario

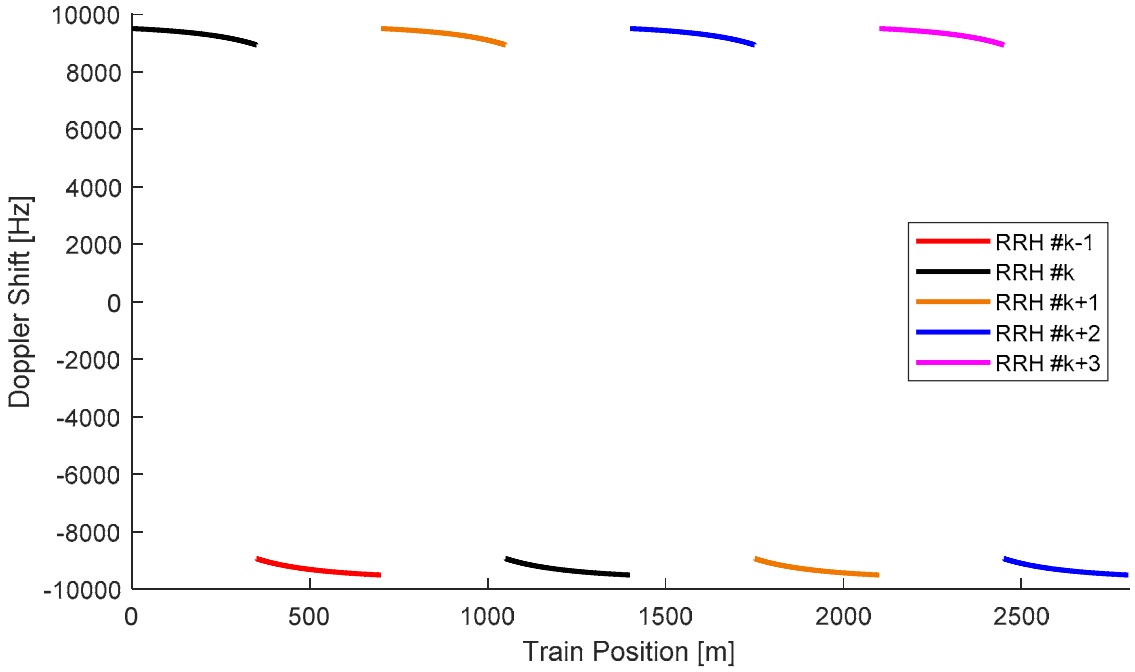

Figure B.3.4.2-3: Doppler shift trajectory (f_d = 9722 Hz) as seen by PDCCH and PDSCH for each RRH for FR2 HST-DPS Bidirectional scenario

B.3.5 HST-SFN Scheme A Channel Profile

There is an infinite number of RRHs distributed equidistantly along the railway track with the same Cell ID as illustrated in Figure B.3.5-1. The PDCCH/PDSCH are transmitted in SFN manner and TRS are transmitted in TRP specific manner as illustrated in Figure B.3.5-1.

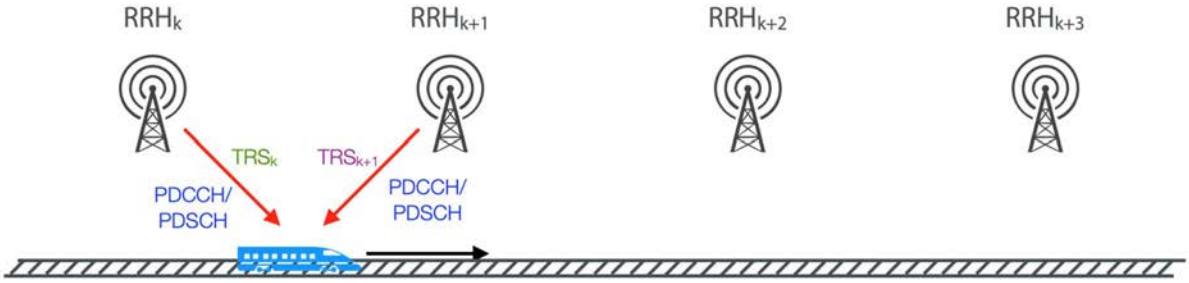

Figure B.3.5-1: Deployment of HST-SFN Scheme A

The location of RRH *k* is given as:

$$x_k = k * D_s + j * D_{min} \quad \text{(B.3.5.1)}$$

where: $k \in [-\infty, \infty]$, $j = sqrt(-1)$ and D_{min} is the distance between the RRHs and railway track, while D_s is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = \mathrm{a} + \mathrm{j} * 0 \quad \text{(B.3.5.2)}$$

where: $a \in [0, \infty]$ and *a* means distance in meters, which means the train is right on the track.

The HST Scheme A scenario for the test of the baseband performance is a non-fading propagation channel with two taps, namely the two nearest RRHs. Thus, RRH *k* is visible for the train only in the range:

$$k * D_s - D_s \leq a < k * D_s + D_s \quad \text{(B.3.5.3)}$$

Power level P_k (dB) for the signal from k^{th} RRH, normalized to the total power received from all visible RRHs, is given by:

$$P_k = -20\log(|y - x_k|) - 10log\left(\sum_{i \in \{i | i * D_s - D_s \leq a < i * D_s + D_s\}} \frac{1}{|y - x_i|^2}\right) \text{ for } k * D_s - D_s \leq a < k * D_s + D_s$$

(B.3.5.4)

Doppler shift $F_{D,k}$ (Hz) from k^{th} RRH for TRS_k, PDCCH, PDSCH as shown in figure B.3.5-1 is given by:

$$F_{D,k} = f_c * real\left(-v * \frac{(y - x_k)}{|y - x_k| * C}\right) \quad \text{for} \quad k * D_s - D_s \leq a < k * D_s + D_s$$

(B.3.5.5)

The relative delay T_k (s) for the signal from k^{th} RRH can be derived as:

$$T_k = \frac{|y - x_k|}{C} \quad \text{for} \quad k * D_s - D_s \leq a < k * D_s + D_s \quad \text{(B.3.5.6)}$$

In the above *v* (m/s) is the moving speed of the train, f_C (Hz) is the center frequency, and *C* (m/s) is the velocity of light.

Power level, Doppler shift and relative delay are given by equations B.3.5.4 ~ B.3.5.6 respectively, where the required input parameters listed in table B.3.5-1 and the resulting Doppler shift shown in Figures B.3.5-3 and B.3.5-4 are applied for all frequency bands.

Table B.3.5-1: HST-SFN scenario

Parameter	Value
D_s	700 m
$D_{\min}$	150 m
v	500 km/h
f_d	870 Hz for 15 kHz SCS test; 1667 Hz for 30 kHz SCS test

NOTE 1: Equation B.3.5.5 is a general formula for Doppler shift calculation. When defining the requirement for FR1 HST, max Doppler shifts f_d which corresponds to fc*v/C in equation B.3.5.5 are selected as defined in Table B.3.5-1 for HST-SFN Scheme A scenario.

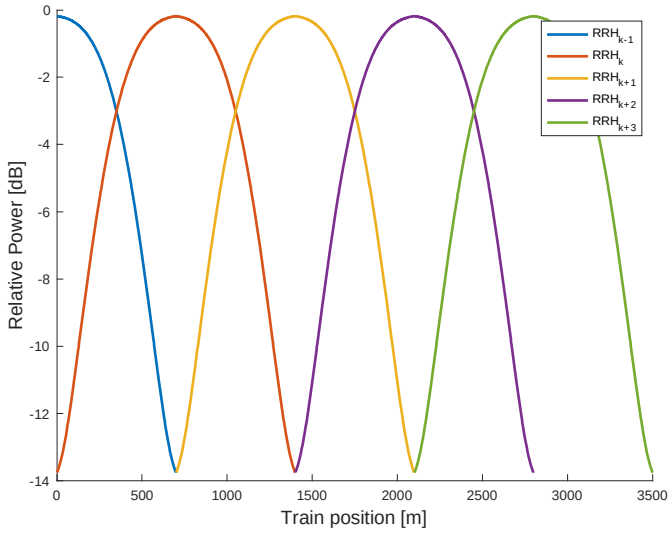

Figure B.3.5-2 Relative power level trajectories

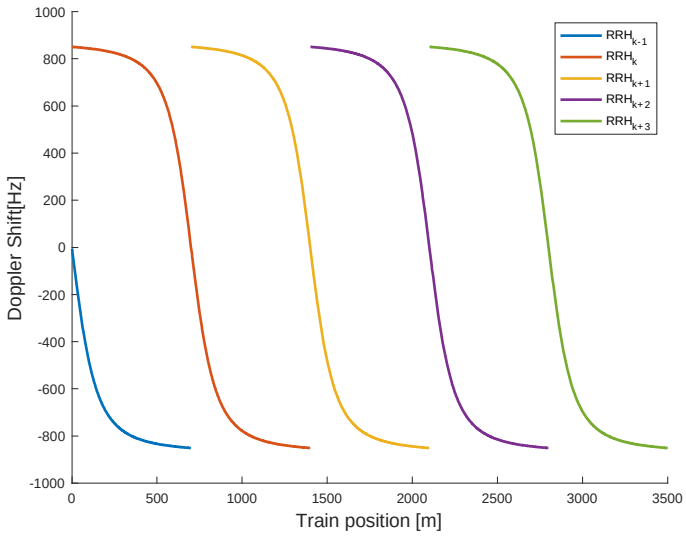

Figure B.3.5-3 Doppler shift trajectory (f_d= 870 Hz) showing visibility of each RRH

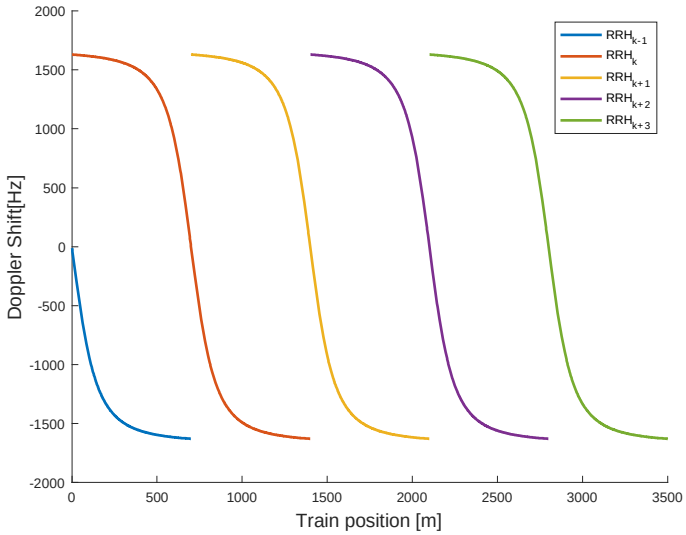

Figure B.3.5-4 Doppler shift trajectory (f_d = 1667 Hz) showing visibility of each RRH

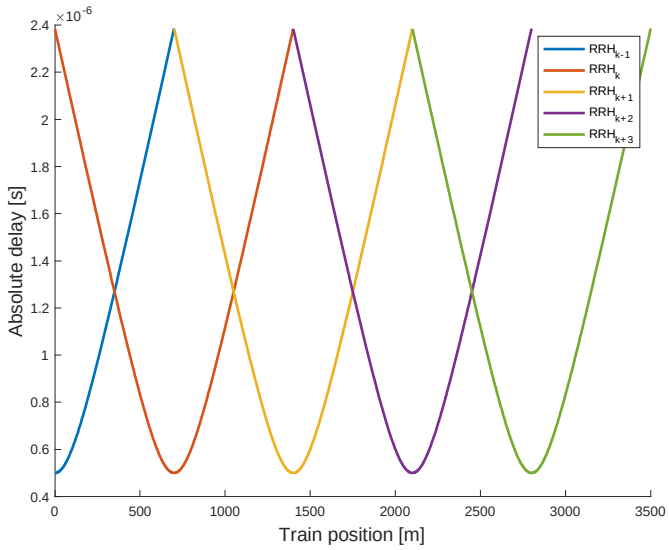

Figure B.3.5-5 Absolute delay trajectories

Static channel matrix will be used as defined in Annex B.1.

B.3.6 HST-SFN Scheme B Channel Profile

There is an infinite number of RRHs distributed equidistantly along the track with the same Cell ID as depicted in figure B.3.6-1. The PDCCH/PDSCH are transmitted in SFN manner from two RRHs and TRS are transmitted in RRH specific manner as illustrated in Figure B.3.6-1.

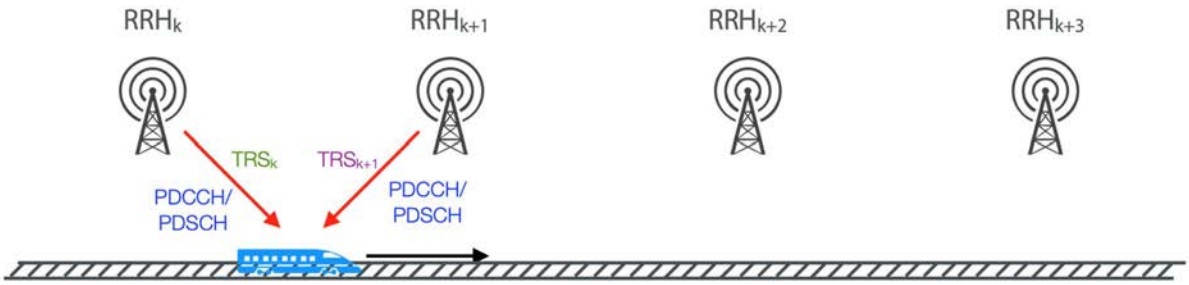

Figure B.3.6-1: Deployment of HST-SFN Scheme B

The location of RRH *k* is given as:

$$x_k = k * D_s + j * D_{min} \quad \text{(B.3.6.1)}$$

where: $k \in [-\infty, +\infty]$, $j = sqrt(-1)$ and D_{min} is the distance between the RRHs and railway track, while D_s is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = a + j * 0 \quad \text{(B.3.6.2)}$$

where: $a \in [0, +\infty]$ and *a* means distance in meters, which means the train is right on the track.

The HST-SFN Scheme B scenario for the test of the baseband performance is a non-fading propagation channel with two taps, namely the two nearest RRHs. Thus, RRH *k* is visible for the train only in the range:

$$k * D_s - D_s \le a < k * D_s + D_s \quad \text{(B.3.6.3)}$$

Power level P_k (dB) for the signal from k^{th} RRH, normalized to the total power received from all visible RRHs, is given by:

$$P_k = -20\log(|y - x_k|) - 10log\left(\sum_{i\in\{i|i*D_s - D_s \le a < i*D_s + D_s\}} \frac{1}{|y-x_i|^2}\right) for \;\; k*D_s - D_s \le a < k*D_s + D_s \quad \text{(B.3.6.4)}$$

Doppler shift $F_{D,k}$ (Hz) from k^{th} RRH for TRS_k, PDCCH and PDSCH transmission and Doppler shift $F_{D,k+1}$ (Hz) from $(k+1)^{th}$ RRH for PDCCH and PDSCH transmission as illustrated in Figure B.3.6-1 is given by:

$$\begin{cases} F_{D,k} = f_c \times real\left[-v \times \frac{y - x_k}{|y - x_k| \times C}\right] \\ F_{D,k+1} = F_{D,k} \end{cases} \text{ for } \; k * D_s \le a < k * D_s + D_s \quad \text{(B.3.6.5)}$$

The relative delay T_k (s) for the signal from k^{th} RRH can be derived as:

$$T_k = \frac{|y - x_k|}{C} \text{ for } \; k * D_s - D_s \le a < k * D_s + D_s \quad \text{(B.3.6.6)}$$

In the above *v* (m/s) is the moving speed of the train, f_C (Hz) is the center frequency, and *C* (m/s) is the velocity of light.

Power level, Doppler shift and relative delay are given by equations B.3.6.4 ~ B.3.6.6 respectively, where the required input parameters listed in table B.3.6-1 and the resulting Doppler shift shown in Figures B.3.6-3 and B.3.6-4 are applied for all frequency bands.

Table B.3.6-1: HST-SFN Scheme B scenario

Parameter	Value
	HST-SFN-SchemeB
D_s	700 m
D_{min}	150 m
v	500 km/h

f_d	870 Hz for 15 kHz SCS test; 1667 Hz for 30 kHz SCS test

NOTE 1: The trajectories of ralative power, Doppler shifts and absolute delays presented in Figures B.3.6-2, B.3.6-3, B.3.6-4 and B.3.6-5 are derived from the equations B.3.6.4 ~ B.3.6.6 respectively.

NOTE 2: Equation B.3.6.5 is a general formula for Doppler shift calculation. When defining the requirement for FR1 HST, max Doppler shifts fd which corresponds to fc*v/C in equation B.3.6.5 are selected as defined in Table B.3.6-1 for HST-SFN scenario.

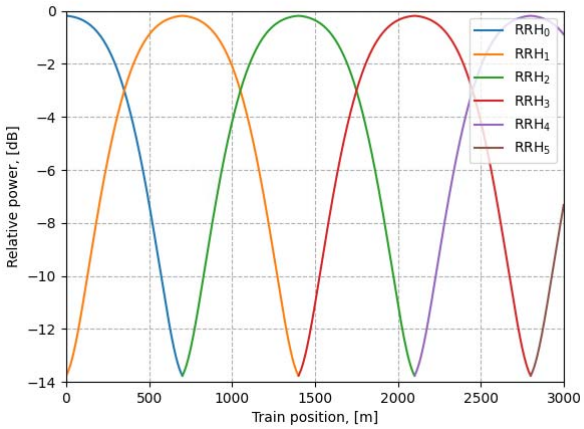

Figure B.3.6-2 Relative power level trajectories

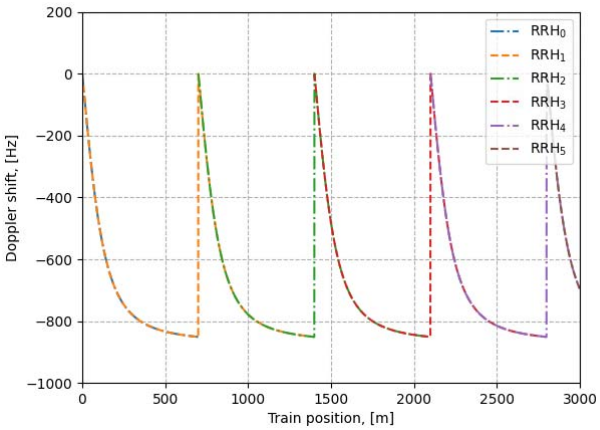

Figure B.3.6-3 Doppler shift trajectories (f_d = 870 Hz)

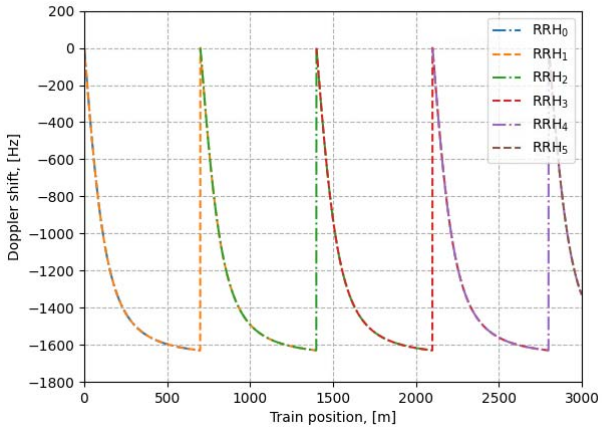

Figure B.3.6-4 Doppler shift trajectories (f_d = 1667 Hz)

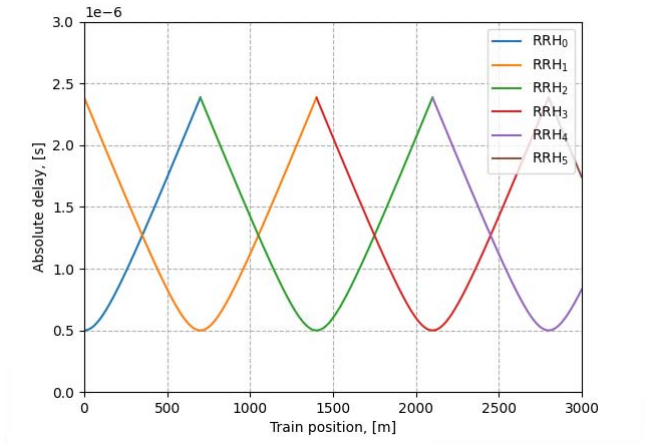

Figure B.3.6-5 Absolute delay trajectories

Static channel matrix will be used as defined in Annex B.1.

B.4 Physical signals, channels mapping and precoding

B.4.1 General

Unless otherwise stated, the transmission on antenna port(s) $p = p_0, p_0 + 1, \ldots, p_0 + N_p - 1$ is defined by using a precoder matrix $W(i)$ of size $N_{ANT} \times N_p$, where N_{ANT} is the number of physical transmit antenna elements configured per test , N_p is the number of ports for a reference signal or physical channel configured per test, and p_0 is the first port for that reference signal or physical channel as defined in clauses 7.3 and 7.4 in TS 38.211 [9]. This precoder takes as an input a block of signals for antenna port(s) $p = p_0, p_0 + 1, \ldots, p_0 + N_p - 1$, $y^{(p)}(i) = \left[y^{(p_0)}(i) \quad y^{(p_0+1)}(i) \quad \ldots \quad y^{(p_0+N_p-1)}(i)\right]^T$, $i = 0,1,\ldots,M^{\text{ap}}_{\text{symb}} - 1$, with $M^{\text{ap}}_{\text{symb}}$ being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals $y^{(q)}_{bf}(i) = \left[y^{(0)}_{bf}(i) \quad y^{(1)}_{bf}(i) \quad \ldots \quad y^{(N_{ANT}-1)}_{bf}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair (k, l) as per the test configuration but transmitted on different physical antenna elements:

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

For Clause 6 and 8, the transmission of PDCCH and PDCCH DMRS on antenna port $p = p_0$ is defined by using a precoder matrix $W(i)$ of size 2x1. This precoder takes as an input a block of signals for antenna port(s) $p = p_0$, $y^{(p)}(i) = y^{(p_0)}(i)$ and generates a block of signals $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i) \quad y_{bf}^{\left(\frac{N_{ANT}}{2}\right)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair (k,l) as per the test configuration but transmitted on different physical antenna elements:

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

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

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

The physical antenna elements are identified by indices $j = 0,1,\ldots,N_{ANT}-1$, where N_{ANT} is the number of physical antenna elements configured per test.

Modulation symbols $y^{(p)}(i)$ with $p \in \{4000\}$ (i.e. PSS, SSS, PBCH and DM-RS for PBCH) are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}$ for CSI-RS resources which configured for tracking with one port are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}$ for CSI-RS resources which configured for beam refinement with one port are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}^{(p)}$ for NZP CSI-RS which configured for CSI acquisition with $p \in \{p_0, p_0+1,\ldots,p_0+N_{CSI}-1\}$ are mapped to the physical antenna index $j = p - p_0$ where N_{CSI} is the number of NZP CSI-RS ports configured per test.

B.4.2 Beamforming for MU-MIMO

The transmission on antenna port(s) $p'_n = p_n, p_n+1,\ldots,p_n+N_P^{(n)}-1,\ n = 0,1,\ldots,N-1$ with N being the number of co-scheduled UEs allocated for different antenna ports in one RE is defined by using a precoder matrix $W_n(i)$ of size $N_{ANT} \times N_p^{(n)}$, where N_{ANT} is the number of physical transmit antenna elements configured per test , $N_p^{(n)}$ is the number of ports for UE *n* for a reference signal or physical channel configured per test, $W_n(i)$ is the precoder matrix for UE *n* which is specific to the test case configuration, and p_n is the first port for UE *n* for that reference signal or physical channel as defined in clauses 7.3 and 7.4 in TS 38.211 [9]. This precoder takes as an input a block of signals for antenna port(s) $p'_n = p_n, p_n+1,\ldots,p_n+N_P^{(n)}-1,\ y^{(p'_n)}(i) = \left[y^{(p_n)}(i) \quad y^{(p_n+1)}(i) \quad \ldots \quad y^{\left(p_n+N_p^{(n)}-1\right)}(i)\right]^T,\ i = 0,1,\ldots,M_{symb}^{ap}$, with M_{symb}^{ap} being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i) \quad y_{bf}^{(1)}(i) \quad \ldots \quad y_{bf}^{(N_{ANT}-1)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair (k,l) as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = \sum_{n=0}^{N-1} W_n(i)y^{(p'_n)}(i)$$

The $W_n(i)$ is specific to test case configuration and defined to maintain the average per UE signal power as $N_P^{(n)} / \sum_n^{N-1} N_P^{(n)}$

B.5 Downlink Transmission Model for requirements on bands with shared spectrum access

This clause provides a description of the Downlink Transmission Model to be used in PDSCH Demodulation and CQI reporting performance tests on bands with shared spectrum access.

The model as designed in the following applies to both configurations for *channelAccessMode*=’semiStatic’ or ‘dynamic’.

B.5.1 Downlink Transmission Model for bands with shared spectrum access

The Downlink Period for performance tests on bands with shared spectrum access is defined as the duration included in the Test Configuration Parameters.

For tests configured with the RRC Parameter *channelAccessMode*=’semiStatic’, the duration of the Fixed Frame Period (FFP) equals the duration of the Downlink Period.

For each Downlink Period, the downlink signal to be transmitted is allocated according to the steps listed below:

1. Select the Downlink Transmission Duration in number of slots, randomly and with equally distributed probability, from the set of possible Downlink Transmission Duration values as included in the Test Configuration Parameters;

    a. This duration includes occupied OFDM symbols and non-occupied OFDM symbols within the Downlink Transmission;

2. Depending on the Downlink Transmission Duration chosen in the previous step:

    b. If the Downlink Transmission Duration equals 2 slots, all the OFDM symbols in both slots are fully allocated to downlink transmission, else;

    c. If the Downlink Transmission Duration is larger than 2 slots, the configuration of occupied symbols in the last slot included in the downlink duration is selected in number of symbols, randomly and with equally distributed probability, from the set of possible ‘Occupied OFDM symbols in the last slot of the downlink duration’ as included in the Test Configuration Parameters;

For each Downlink Period, the last Slot is not scheduled for downlink transmission. This is to comply with the Idle period requirement in case of *channelAccessMode*=’semiStatic’, and to align the test setup. In the case of *channelAccessMode*=’semiStatic’, it can be assumed that the Channel Occupancy Time (COT) covers the entire duration of the Downlink Period except for the last slot.

For each Downlink Period, a uniform random variable from [0, 1] is generated. If the random variable is less than the p_{LBT} value included in the Test Configuration Parameters, the entire Downlink Period duration is muted across the entire bandwidth. This applies to all the signals that were scheduled for transmission, including but not limited to PDSCH, PDCCH, SSB, TRS, CSI-RS, etc.

B.6 Interference model for PDSCH requirements with intercell interference

B.6.1 Interference to Noise ratio (INR)

Each interfering cell involved in PDSCH performance requirements with intercell interference is characterized by its associated interferer to noise ratio (INR) value:

$$INR_i = \frac{\sum_{j=1}^{N_{RX}} I_{or(i)}^{(j)}}{\sum_{j=1}^{N_{RX}} N_{oc}^{(j)}}$$

where $I_{or(i)}^{(j)}$ is the average received power spectral density from the i-th strongest interfering cell involved in the requirement scenario on the j-th antenna connector and N_{oc} is the average power spectral density of a white noise source consistent with definition provided in section [4.4.3/4.5.3].

B.6.2 Interference model for PDSCH requirements

This subclause provides synchronous network deployment interference model for each explicitly modelled interfering cell in the requirement scenario. In each subframe, each interfering cell shall transmit 16 QAM based randomly modulated data over the entire PDSCH region and over the full transmission bandwidth of the specified reference measurement channel. Transmitted physical channels shall include SSB and TRS/CSI-RS as specified in requirements section.

Transmission rank of the interfering cell shall be randomly determined with probabilities as specified in the requirements. The rank configuration will be independent for each interfering cell

For each slot a single precoding matrix for the number of layers υ associated to the selected rank shall be selected randomly from Table 5.2.2.2.1-1 of TS 38.214 [12] with PRB bundling size as given in the requirements.

The generic beamforming model in subclause B.4.1 shall be applied assuming number of antenna ports as specified in the requirement scenario.

Random precoding with selected rank and precoding matrices for each slot shall be applied to 16 QAM randomly modulated layer symbols including the demodulation reference symbols over antenna port 1000 when the rank is one and antenna ports 1000, 1001 when the rank is two. DMRS type 1 with front loaded single symbol and one additional DMRS position with FDM applied between DMRS and data (number of CDM groups without data is 1)

For REs in the control region, random precoding for the number of Tx antenna ports in the requirement scenario shall be applied to QPSK randomly modulated symbols. The EPRE ratio of these REs shall be as defined for PDCCH in Annex C.3.1

B.7 Interference model for PDSCH requirements with LTE-NR spectrum sharing

This clause provides interference modelling for each explicitly modelled LTE interfering cell. Each interfering cell involved in PDSCH performance requirements for LTE-NR spectrum sharing is characterized by its associated interferer to noise ratio (INR) value as defined in B.6.1.

In each subframe, each interfering cell shall transmit 16QAM randomly modulated data over the entire PDSCH region and over the full t7ransmission bandwidth according to the probabilities of occurrence. Transmitted physical channels

shall include PSS, SSS and PBCH. Probabilities of occurrence of LTE PDSCH in each subframe are as specified in requirements.

For each subframe, a transmission rank shall be randomly determined independently from interfering cells. Probabilities of occurrence of each possible transmission rank are as specified in requirements.

For each subframe, a precoding matrix for the number of layers υ associated to the selected rank shall be selected randomly from Table 6.3.4.2.3-1 of TS 36.211 [15]. Note that codebook index 0 shall be excluded from random precoder selection when the number of layers is $\upsilon = 2$.

Precoding for spatial multiplexing with CRS for the number of antenna ports shall be applied to 16QAM randomly modulated layer symbols, as specified in subclause 6.3.4.2.1 of TS 36.211 [15] with the selected precoding matrices for each subframe.

For unallocated REs in the control region, precoding for transmit diversity for the number of antenna ports in the simulation scenario shall be applied to QPSK randomly modulated layer symbols, as specified in subclause 6.3.4.3 of TS 36.211 [15]. The EPRE ratio for these REs shall be as defined for PDCCH in Annex C.3.2 of TS 36.101 [4].

Annex C (normative): Downlink physical channels

C.1 General

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

C.2 Setup (Conducted)

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

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

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

C.3 Connection (Conducted)

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

C.3.1 Measurement of Performance requirements

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

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

Parameter	Unit	Value (Note 2)
SSS transmit power	W	Test specific
EPRE ratio of PSS to SSS	dB	0
EPRE ratio of PBCH to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS	dB	0
EPRE ratio of PDCCH to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH to SSS	dB	0
EPRE ratio of PDSCH to PDSCH DMRS	dB	Test specific (Note 1)
EPRE ratio of CSI-RS to SSS	dB	-10*log10(L) (Note 3)
EPRE ratio of OCNG to SSS	dB	0
EPRE ratio of PDCCH OCNG to SSS	dB	0
EPRE ratio of LTE CRS to NR SSS	dB	0 (Note 4)
Note 1: Value is derived from Table 4.1-1 in TS 38.214 [12] based on "Number of DM-RS CDM groups without data" and "DMRS Type" parameters specified for each test. Note 2: The value is the energy of per RE for a single antenna port before pre-coding. Note 3: $L \in \{1,2,4,8\}$ is the CDM group size of NZP CSI-RS specified for each test.		

Note 4: It is only applicable to LTE-NR coexistence tests.

C.4 Setup (Radiated)

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

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

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

C.5 Connection (Radiated)

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

C.5.1 Measurement of Receiver Characteristics

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

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

Parameter	Unit	Value (Note 2)
SSS transmit power	W	Test specific
EPRE ratio of PSS to SSS	dB	0
EPRE ratio of PBCH to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS	dB	0
EPRE ratio of PDCCH to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH to SSS	dB	0
EPRE ratio of PDSCH to PDSCH DMRS	dB	Test specific (Note 1)
EPRE ratio of CSI-RS to SSS	dB	-10*log10(L) (Note 3)
EPRE ratio of PTRS to PDSCH	dB	Test specific
EPRE ratio of OCNG to SSS	dB	0
EPRE ratio of PDCCH OCNG to SSS	dB	0
Note 1: Value is derived from Table 4.1-1 in TS 38.214 [12] based on "Number of DM-RS CDM groups without data" and "DMRS Type" parameters specified for each test. Note 2: The value is the energy of per RE for a single antenna port before pre-coding. Note 3: $L \in \{1,2,4,8\}$ is the CDM group size of NZP CSI-RS specified for each test. Note 4: Value is derived from Table 4.1-2 in TS 38.214 [12] based on “The number of PDSCH layers” and “*epre-Ratio*” parameters specified for each test.		

Annex D (informative): Void

Annex E (normative): Environmental conditions

E.1 General

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

E.2 Environmental (Conducted)

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

E.2.1 Temperature

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

Table E.2.1-1: Temperature conditions

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

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

E.2.2 Voltage

The UE shall fulfil all the requirements in the voltage range defined in Table E.2.2-1.

Table E.2.2-1: Voltage conditions

Power source	Normal conditions voltage
AC mains	nominal
Regulated lead acid battery	1,1 * nominal
Non regulated batteries: Leclanché Lithium Mercury/nickel & cadmium	 Nominal 1,1 * Nominal Nominal

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

E.2.3 Vibration

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

Table E.2.3-1: Vibration conditions

Frequency	ASD (Acceleration Spectral Density) random vibration
5 Hz to 20 Hz	0,96 m^2/s^3
20 Hz to 500 Hz	0,96 m^2/s^3 at 20 Hz, thereafter –3 dB/Octave

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

E.3 Environmental (Radiated)

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

E.3.1 Temperature

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

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

Table E.3.1-1: Temperature conditions

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

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

E.3.2 Voltage

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

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

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

Table E.3.2-1: Voltage conditions

Power source	Normal conditions voltage
AC mains	nominal
Regulated lead acid battery	1,1 * nominal
Non regulated batteries: Leclanché Lithium Mercury/nickel & cadmium	 Nominal 1,1 * Nominal Nominal

Outside this voltage range the UE if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 of TS 38.101-2 [7] for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

E.3.3 Void

Annex F (informative): Void

Annex G (informative): Void

Annex H (informative): Void

Annex I (informative): Void

Annex J (informative): Void

Annex K (informative): Void

Annex L (informative): Change history

Change history							
Date	**Meeting**	**tDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2018-07	RAN4 AH18-07	R4-1809554				Draft skeleton	0.0.1
2018-08	RAN4#88	R4-1811357				Skeleton update	0.0.2
2018-10	RAN4#88 bis	R4-1814237				Approved Text Proposal in RAN4#88bis: R4-1814053, "TP on performance specification 38.101-4 Chapter 4 general part" R4-1814054, "TP to TS 38.101-4: FR1 PDSCH demodulation requirements (5.2)" R4-1813924, "TP for introducing FR1 PDCCH requirements in TS 38.101-4 clause 5.3" R4-1814058, "TP for 38.101-4 section 6.3 FR1 PMI test cases" R4-1814060, "Draft TP on FR1 Rank Indication Reporting Performance Requirements" R4-1814055, "Draft TP on FR2 PDSCH Demodulation Performance Requirements" R4-1814022, "TP to TS38.101-4 Section 7.3: PDCCH demodulation requirements" R4-1814059, "TP for 38.101-4 section 8.3 FR2 PMI test cases" R4-1814061, "Draft TP on FR2 Rank Indication Reporting Performance Requirements" R4-1813925, "TP for introducing demodulation performance requirements for interworking TS 38.101-4 section 9" R4-1814052, "TP for 38.101-4 section 10 CSI test cases of interworking" R4-1814066, "TP on channel models for TS38.101-4" R4-1814023, "TP to TS38.101-4 Annex C: Downlink physical channels" R4-1814024, "TP to TS38.101-4 Annex E: Environmental conditions"	0.1.0
2018-11	RAN4#89	R4-1816559				Approved Text Proposal in RAN4#89: R4-1814053, "TP on performance specification 38.101-4 Chapter 4 general part" R4-1814487, "TP for TS38.101-4 section 2 (Reference)" R4-1814488, "TP for TS38.101-4 section 3 (Definitions, symbols and abbreviations)" R4-1814579, "TP to TS 38.101-4: Annex A Measurement channels – PDSCH" R4-1814580, "TP to TS 38.101-4: Annex A Measurement channels - DL Control" R4-1814581, "TP to TS 38.101-4: Annex A Measurement channels – CSI" R4-1816395, "FR2 demod: Noc, Band groups and Ref point - TP for TS 38.101-4" R4-1816692, "TP to TS 38.101-4: Requirements applicability" R4-1816693, "TP for performance requirements for interworking (9)" R4-1816694, "TP to TS 38.101-4: FR1 PDSCH demodulation requirements (5.2)" R4-1816695, "Draft TP on FR2 PDSCH Demodulation Performance Requirements" R4-1816697, "TP for updating FR1 PDCCH requirements in TS 38.101-4 section 5.3" R4-1816699, "TP to TS 38.101-4: 5.4 FR1 PBCH demodulation requirements" R4-1816700, "TP to TS 38.101-4: 7.4 FR2 PBCH demodulation requirements" R4-1816701, "TP of introduction of FR1 CQI requirement (6.2)" R4-1816702, "TP to TS 38.101-4: FR2 CQI requirements (8.2)" R4-1816703, "Draft TP on FR1 Rank Indication Reporting Performance Requirements" R4-1816704, "Draft TP on FR2 Rank Indication Reporting Performance Requirements" R4-1816705, "TP for TS 38.101-4 FR1 PMI test requirement" R4-1816706, "TP to TS 38.101-4 FR2 PMI requirements" R4-1816712, "TP to TS 38.101-4: FR1 SDR requirements (5.5) "	0.2.0

						R4-1816713, "TP to TS38.101-4 Section 7.3: PDCCH demodulation requirements" R4-1816714, "TP for propagation conditions in TS 38.104-4(Annex B)"	
2018-12	RAN#82	RP-182408				V1.0.0 is submitted to RAN for 1-step approval	1.0.0
2018-12	RAN#82	RP-182704				V1.0.1 with editorial changes	1.0.1
2018-12	RAN#82					Approved by plenary – Rel-15 spec under change control	15.0.0
2019-03	RAN#83	RP-190403	0001		B	CR on UE demodulation and CSI requirements for 38.101-4 This CR comboines all the endorsed draft CRs as list below: General sections R4-1902427, Draft CR on NR UE demodulation requirements applicability (Intel Corporation) R4-1902576, Draft CR on General Applicability of Requirements (Qualcomm Incorporated) R4-1902412, Editorial cleanup of FR2 Radiated Requirements General section (ANRITSU) PDSCH R4-1902414, Draft CR on FR1 normal PDSCH demodulation requirements (Intel Corporation) R4-1902415, Draft CR on FR2 PDSCH Requirements (Qualcomm Incorporated) R4-1902411, Draft CR on FR1 SDR requirements (Intel Corporation) PDCCH R4-1902416 Draft CR for updating FR1 PDCCH performance requirements in TS38.101-4Huawei, HiSilicon R4-1902423 Draft CR for updating FR2 PDCCH performance requirements in TS38.101-4 section 7.3 CATT PBCH R4-1902420, Draft CR on 2Rx PBCH demodulation requirement for FR1 (CMCC) R4-1902421, Draft CR on 4Rx PBCH demodulation requirements for FR1 (CMCC) R4-1902422, Draft CR on 2Rx PBCH demodulation requirement for FR2 (CMCC) CSI R4-1902418, Draft CR on FR2 CSI Reporting Tests (Qualcomm Incorporated) R4-1902419, Draft CR on FR1 CSI Reporting Tests (Qualcomm Incorporated) R4-1900105, Draft CR on NR CSI reporting (Intel Corporation) R4-1902058, Draft CR for update of FR1 CQI reporting test (Huawei, HiSilicon) R4-1902059, Draft CR for update of FR2 CQI reporting test (Intel) R4-1902426, Draft CR for PMI test cases: 6.2, 8.2, A.3.2.2.2, A.3.2.2.5 (Samsung) R4-1902425, Draft CR for FR1 and FR2 RI test cases (Qualcomm) Annex R4-1900369, Draft CR on PDSCH FRC (Intel Corporation) R4-1900370, Draft CR on PDCCH FRC (Intel Corporation) R4-1902424, Corrections to 38.101-4 clause B.2.1 Delay profile calculation (Huawei, HiSilicon) R4-1902575, Draft CR on Beamforming Model (Qualcomm) Additional modifications: - Compared to endorsed CR R4-1902414, requirements for several FR1 PDSCH test cases were modified to correct stat error - Correct the format for Annex A.x - Correct table number under PDSCH section 5.2.3.1.3 - Some minor editorial changes Editorial changes after RAN#83 To align the annex numbering with other specifications (TS 38.101-x series), annexes J and K were added and Change history was numbered as annex L.	15.1.0
2019-06	RAN#84	RP-191240	0002		B	CR to TS 38.101-4: Implementation of endorsed draft CRs from RAN4#90bis and RAN4#91 endorsed draft CRs from RAN4#90bis R4-1902885, Draft CR on DL power allocation for TS 38.101-4 R4-1903387, Draft CR for adding applicable rules on CSI test cases: 6, 8, 10 R4-1903471, Draft CR on PBCH requirements R4-1904750, draftCR on RMC for demod requirement for 38.101-4 R4-1904751, Clarification on step 5 and step 6 for delay profiles calculation in B.2.1	15.2.0

						R4-1904756, Draft CR on FR1 normal PDSCH demodulation requirements R4-1904757, Draft CR on FR2 PDSCH Demodulation Performance Tests R4-1904758, Draft CR on EN-DC SDR requirements R4-1904759, Addition of alternative TDD configuration for UE demodulation requirements R4-1904765, Draft CR on FR2 PDCCH demodulation requirements R4-1904766, draftCR: Updates to FR1 PDCCH demodulation requirements R4-1904767, Draft CR for Beamforming model: Annex B.4.1 R4-1904768, Draft CR for modification on CSI test cases: 6, 8, 10 R4-1904776, Draft CR on FR1 SDR requirements R4-1904777, Draft CR on FR2 SDR Requirements R4-1904778, Draft CR on PDSCH DL RMC R4-1904779, Draft CR to TS38.101-4: Correction to FR1 CSI test cases R4-1904780, Draft CR to TS38.101-4: Correction to FR2 CSI test cases R4-1904796, Draft CR to 38.101-4 on applicable SNR level for FR2 R4-1904833, Draft CR to TS 38.101-4 on SNR, Es and Noc setup endorsed draft CRs from RAN4#91 R4-1906069, Draft CR on PBCH requirements R4-1906706, Editorial corrections for 38.101-4 PBCH tables R4-1907194, Draft CR on Noc and Es setup R4-1907293, Draft CR to TS38.101-4 for FR2 SDR test cases R4-1907294, draftCR: Introduce single-tap HST channel model in TS 38.101-4 R4-1907295, draftCR: updates to FR2 PDSCH test parameters R4-1907296, draftCR: updates to FRC for demodulation performance R4-1907297, draftCR: updates to FR1 CQI reporting test cases in section 6.2 R4-1907298, Draft CR to 38.101-4 on Applicability of requirements R4-1907299, Draft CR to 38.101-4 on Demodulation requirements for interworking R4-1907300, Draft CR to 38.101-4 on CSI requirements for interworking R4-1907301, Draft CR on FR1 normal PDSCH demodulation requirements R4-1907302, Draft CR on PDSCH FRC R4-1907303, Draft CR on FR2 CSI Reporting tests R4-1907304, Editorial corrections for 38.101-4 PDCCH tables R4-1907307, draftCR: updates to FR1 PDSCH test parameters R4-1907308, Draft CR on EN-DC SDR requirements R4-1907309, Draft CR to TS38.101-4 on adding FRC for sub-band CQI test cases R4-1907310, Draft CR to TS38.101-4: Environmental conditions (Annex E) R4-1907315, Draft CR on SDR requirements for NR CA between FR1 and FR2	
2019-09	RAN#85	RP-192022	0008		F	CR to TS 38.101-4: Implementation of endorsed draft CRs from RAN4#92 (Rel-15) R4-1907978, Update of Noc values for Power class 2 demodulation test R4-1908202, Draft CR to TS 38.101-4: Environmental conditions R4-1908215, Draft CR to TS 38.101-4: Clarification of PTRS configuration for FR2 tests R4-1908217, Draft CR to TS 38.101-4: DL power configuration in radiated tests R4-1908517, Draft CR to TS 38.101-4: Corrections of FRC for FR2 PMI tests R4-1909250, Editorial change to correct TDD measurement channels R4-1909252, Editorial correction to PBCH requirements R4-1909253, Editorial correction to PDSCH reference channels R4-1909862, draft CR: updates to FR2 PDSCH test parameters R4-1909864, draftCR: Introduce single-tap HST channel model in TS 38.101-4 R4-1910020, Antenna configuration for LTE cell in EN-DC R4-1910021, DraftCR to 38.101-4 : Corrections to Interworking requirements R4-1910023, Draft CR to TS 38.101-4: Enhanced SU-MIMO receiver definition	15.3.0

						R4-1910024, draftCR: addition of test applicability for features with UE capability R4-1910053, Draft CR on corrections and missing parameters for PDSCH demodulation performance tests R4-1910054, Draft CR to TS 38.101-4: NR FR1 PDSCH requirements finalization R4-1910055, Draft CR to TS 38.101-4: Corrections for SDR requirements R4-1910056, Editorial correction to formatting on SDR table R4-1910057, draft CR: updates to FR1 PDSCH test parameters R4-1910058, Draft CR on corrections for PDCCH demodulation performance tests R4-1910060, Draft CR on corrections for CSI Reporting performance tests R4-1910061, Draft CR on updates to FR1 CSI reporting test R4-1910062, Draft CR on updates to FR2 CSI reporting test R4-1910129, Draft CR to TS 38.101-4: Applicability of minimum requirements R4-1910563, Updates to NR PDCCH test parameters	
2019-12	RAN#86	RP-192998	0009	2	F	CR to TS 38.101-4: Corrections for applicability rules (R15)	15.4.0
2019-12	RAN#86	RP-192998	0010		F	CR to TS 38.101-4: Editorial corrections for PDSCH RMC (R15)	15.4.0
2019-12	RAN#86	RP-192998	0011		B	CR to TS 38.101-4: Introduction of NE-DC and NR-DC SDR requirements (R15)	15.4.0
2019-12	RAN#86	RP-192998	0014	1	F	CR on corrections for MIMO Correlation Matrices	15.4.0
2019-12	RAN#86	RP-192998	0015	1	F	CR on corrections for FR1 PDSCH demodulation performance tests	15.4.0
2019-12	RAN#86	RP-192998	0016	1	F	CR on corrections for FR2 PDSCH demodulation performance tests	15.4.0
2019-12	RAN#86	RP-192998	0017	1	F	CR on corrections for FR1 CSI Reporting performance tests	15.4.0
2019-12	RAN#86	RP-192998	0018	1	F	CR on corrections for FR2 CSI Reporting performance tests	15.4.0
2019-12	RAN#86	RP-192998	0019		F	Editorial change on reference PDCCH payload size	15.4.0
2019-12	RAN#86	RP-192998	0021	1	F	Editorial CR to correct PMI test cases	15.4.0
2019-12	RAN#86	RP-192998	0023	1	F	CR for TS38.101-4: Angle of arrival for radiated UE demodulation testing	15.4.0
2019-12	RAN#86	RP-192998	0024		F	CR on demodulation performance requirements for EN-DC including FR1 and FR2 CCs	15.4.0
2019-12	RAN#86	RP-192998	0025		F	CR: Correction on NR PDCCH demodulation performance requirements	15.4.0
2019-12	RAN#86	RP-192998	0026		F	CR on CSI reporting requirements for EN-DC including FR1 and FR2 CCs	15.4.0
2019-12	RAN#86	RP-192998	0027	1	B	CR on NE-DC and NGEN-DC performance requirements	15.4.0
2019-12	RAN#86	RP-192998	0028	1	B	CR on NR-DC performance requirements	15.4.0
2019-12	RAN#86	RP-192998	0029		F	CR: Updates to NR RMC for UE performance requirements	15.4.0
2019-12	RAN#86	RP-192998	0030	1	F	CR: Updates to NR EN-DC SDR tests	15.4.0
2020-03	RAN#87	RP-200397	0031	1	F	Clarification of Random PMI when testing	15.5.0
2020-03	RAN#87	RP-200397	0032	1	F	Correction to 5.3.3 4Rx PDCCH Demod Requirements	15.5.0
2020-03	RAN#87	RP-200397	0033	1	F	CR on corrections for FR1 PDSCH demodulation performance tests	15.5.0
2020-03	RAN#87	RP-200397	0034	1	F	CR to TS 38.101-4: Editorial corrections (R15)	15.5.0
2020-03	RAN#87	RP-200397	0037		F	CR on number of NZP CSI-RS ports for RI reporting test in a TDD 4Rx test case	15.5.0
2020-03	RAN#87	RP-200397	0038		F	CR: Updates to NR PDSCH test parameters (Rel-15)	15.5.0
2020-03	RAN#87	RP-200379	0035		B	CR to TS 38.101-4: LTE-NR coexistence requirements for TDD mode (R16)	16.0.0
2020-06	RAN#88	RP-200985	0040		A	CR to Aperiodic Report Slot Offset for CQI report	16.1.0
2020-06	RAN#88	RP-200985	0044		A	CR to TS 38.101-4: Beamforming clarification (R16)	16.1.0
2020-06	RAN#88	RP-201043	0045		F	CR to TS 38.101-4: CR on TDD LTE-NR coexistence requirements finalization	16.1.0
2020-06	RAN#88	RP-200985	0047		A	CR to TS 38.101-4: MIMO correlation matrices definition (R16)	16.1.0
2020-06	RAN#88	RP-200985	0054		A	CR for correction of Angle of Arrival for Radiated Requirements in section 4	16.1.0
2020-06	RAN#88	RP-200985	0055		A	CR: updates to NR CSI test	16.1.0
2020-06	RAN#88	RP-201048	0042	1	F	CR on max MIMO layer assumption in TS38.101-4	16.1.0
2020-06	RAN#88	RP-200985	0056		A	Update of DL physical channels definitions	16.1.0
2020-06	RAN#88	RP-200985	0057		A	CR: clarification on EPRE ratio definition	16.1.0
2020-09	RAN#89	RP-201512	0059		A	CR to ZP-CSI-RS configuration	16.2.0
2020-09	RAN#89	RP-201512	0061		A	CR to 2Rx PDSCH mapping type B	16.2.0
2020-09	RAN#89	RP-201499	0074		B	CR for TS 38.101-4: Applicability for NR PMI requirements with Tx ports larger than 8 and up to 32	16.2.0
2020-09	RAN#89	RP-201499	0075		B	Addition of Rel-16 SP Type I PMI tests, FRCs, and spatial correlation matrices	16.2.0
2020-09	RAN#89	RP-201512	0078		A	CR on Corrections in 38.101-4	16.2.0
2020-12	RAN#90	RP-202489	0080		A	Update of Noc for NR operating bands in FR2	16.3.0
2020-12	RAN#90	RP-202489	0082		A	Correction to FR1 Aperiodic CSI Reporting	16.3.0
2020-12	RAN#90	RP-202489	0084		A	Correction to FR2 PMI Aperiodic CSI Reporting	16.3.0
2020-12	RAN#90	RP-202416	0085	1	B	CR on requirements with slot aggregation in FR2	16.3.0

2020-12	RAN#90	RP-202423	0088		B	Draft CR on FRC for Normal NR CA demodulation requirements	16.3.0
2020-12	RAN#90	RP-202422	0090	1	B	CR to TS 38.101-4: HST-SFN FDD performance requirements	16.3.0
2020-12	RAN#90	RP-202422	0091	1	B	CR to TS 38.101-4: Propagation conditions for HST scenarios	16.3.0
2020-12	RAN#90	RP-202422	0092	1	B	CR on HST-SFN requirements for TDD	16.3.0
2020-12	RAN#90	RP-202423	0093	1	B	Introduction of NR PDSCH FR1 CA 2Rx performance requirements	16.3.0
2020-12	RAN#90	RP-202423	0094	1	B	CR: FR1 EN-DC power imbalance requirements	16.3.0
2020-12	RAN#90	RP-202422	0097	1	B	CR on HST DPS requirements	16.3.0
2020-12	RAN#90	RP-202422	0098	1	B	CR on HST single-tap and HST multi-path fading requirements	16.3.0
2020-12	RAN#90	RP-202422	0099	1	B	CR on applicability rules for HST scenarios	16.3.0
2020-12	RAN#90	RP-202416	0100	1	B	CR to TS 38.101-4: Addition of UE performance requirements for FR1 URLLC PDSCH repetitions over multiple slots	16.3.0
2020-12	RAN#90	RP-202416	0102	1	B	CR to TS 38.101-4: Applicability rules for URLLC UE demodulation requirements	16.3.0
2020-12	RAN#90	RP-202423	0103	1	B	CR: Introduction of performance requirements for NR FR1 PDSCH CA with 4Rx	16.3.0
2020-12	RAN#90	RP-202423	0105	1	B	CR: Addition of power imbalance requirements for intra-band contiguous CA and intra-band EN-DC	16.3.0
2020-12	RAN#90	RP-202423	0108	1	B	CR on Applicability rules for Normal NR CA demodulation requirements	16.3.0
2020-12	RAN#90	RP-202416	0109		B	CR on FRC for UE Ultra-low BLER requirements	16.3.0
2020-12	RAN#90	RP-202416	0110	1	B	CR on FRC for UE Higher BLER requirements	16.3.0
2020-12	RAN#90	RP-202416	0111	1	B	CR to TS 38.101-4: Performance requirements for URLLC High BLER feature tests	16.3.0
2020-12	RAN#90	RP-202416	0112	1	B	CR to TS 38.101-4: Performance requirements for URLLC PDSCH 0.001% BLER	16.3.0
2020-12	RAN#90	RP-202422	0113	1	B	CR to TS38.101-4: Addition of Rel-16 HST FRCs	16.3.0
2020-12	RAN#90	RP-202489	0117		A	CR: Updates OCNG pattern reference (Rel-16)	16.3.0
2020-12	RAN#90	RP-202489	0119	1	A	CR: Correction on OCNG pattern	16.3.0
2020-12	RAN#90	RP-202422	0120	2	B	CR on FDD HST Single-Tap and Multipath Fading Requirements	16.3.0
2020-12	RAN#90	RP-202416	0121	2	B	CR on FR1 PDSCH Mapping Type B and Processing Capability 2 Requirements	16.3.0
2020-12	RAN#90	RP-202423	0122		B	CR on FR2 PDSCH CA Requirements	16.3.0
2020-12	RAN#90	RP-202423	0123		F	CR to TS 38.101-4: on gamma values for SP Type I PMI requirements	16.3.0
2021-03	RAN#91	RP-210078	0124	1	F	CR on FDD HST Single-Tap and Multipath Fading Requirements	16.4.0
2021-03	RAN#91	RP-210068	0126	1	B	CR to 38-101-4 on CQI reporting requirements for URLLC	16.4.0
2021-03	RAN#91	RP-210068	0127	1	F	CR to 38.101-4 on requirements with slot aggreagation in FR2	16.4.0
2021-03	RAN#91	RP-210064	0128	1	B	CR to 38.101-4 for eMIMO demod requirements - General and Applicability rule	16.4.0
2021-03	RAN#91	RP-210066	0129	1	B	CR for TS38.101-4, test for FR2 PDCCH DCI format 2_6 demodulation	16.4.0
2021-03	RAN#91	RP-210065	0130		F	CR for NR PDSCH FR1 CA 2Rx performance requirements	16.4.0
2021-03	RAN#91	RP-210066	0131	1	B	CR for TS38.101-4, test for FR1 TDD PDCCH DCI format 2_6 demodulation	16.4.0
2021-03	RAN#91	RP-210067	0133	1	B	CR on adding applicability, requirements and measurement channel for FR2 DL 256QAM CQI reporting test under fading condition	16.4.0
2021-03	RAN#91	RP-210065	0134		B	CR: Adding applicability and requirements for FR1 and FR2 CA CQI reporting test	16.4.0
2021-03	RAN#91	RP-210064	0135	2	B	Introduction of PMI test cases with Rel-16 eType II codebook	16.4.0
2021-03	RAN#91	RP-210065	0136	2	B	Introduction of PMI test cases with Rel-15 Type II codebook	16.4.0
2021-03	RAN#91	RP-210068	0137		F	CR to 38.101-4 on FRC table update for URLLC ultra low BLER requirements	16.4.0
2021-03	RAN#91	RP-210067	0138	1	F	CR on demodulation performance requirements for DL 256QAM for FR2	16.4.0
2021-03	RAN#91	RP-210068	0139	1	B	CR on FRC for URLLC UE Higher BLER requirements	16.4.0
2021-03	RAN#91	RP-210067	0140	1	B	CR on simplified TDL-D channel model for FR2 DL 256QAM demodulation requirements	16.4.0
2021-03	RAN#91	RP-210067	0141	1	B	CR on applicability rules and FRC for FR2 DL 256QAM CQI requirements	16.4.0
2021-03	RAN#91	RP-210065	0142	1	B	CR on applicability rules for Normal NR CA requirements	16.4.0
2021-03	RAN#91	RP-210064	0143	1	B	CR to TS 38.101-4: Performance requirements single-DCI based multi-TRP Repetition Tx schemes	16.4.0
2021-03	RAN#91	RP-210067	0144		B	CR on applicability and FRC for PDSCH normal demodulation for DL 256QAM for FR2	16.4.0
2021-03	RAN#91	RP-210067	0145	1	B	CR on SDR requirements for DL 256QAM for FR2	16.4.0
2021-03	RAN#91	RP-210078	0146		F	CR on update TRS and CSI-RS transmission for HST DPS requirements	16.4.0
2021-03	RAN#91	RP-210064	0147	1	B	CR for 38.101-4 Introduction of PDSCH requirement with Single-DCI based SDM scheme	16.4.0
2021-03	RAN#91	RP-210064	0148	2	B	CR for 38.101-4 Introduction of PDSCH requirement with Multi-DCI based multi-TRP transmission schemes	16.4.0
2021-03	RAN#91	RP-210065	0149	1	B	CR for 38.101-4 Applicablity of PMI reporting test with Tx ports larger than 8 and up to 32	16.4.0

2021-03	RAN#91	RP-210065	0150	1	B	CR for 38.101-4 Applicablity of PMI reporting test of eType II codebook	16.4.0
2021-03	RAN#91	RP-210068	0151	1	F	CR to TS 38.101-4 Correction of UE performance requirements for FR1 URLLC PDSCH repetitions over multiple slots.	16.4.0
2021-03	RAN#91	RP-210068	0152	1	B	CR to TS38.101-4 Applicability rules for URLLC CSI requirements	16.4.0
2021-03	RAN#91	RP-210065	0153		F	CR: Updates to power imbalance for CA	16.4.0
2021-03	RAN#91	RP-210066	0154	1	F	CR on Fixed reference channel for power saving performance	16.4.0
2021-03	RAN#91	RP-210065	0156		F	Correction of title on 16Tx port subband PMI reporting	16.4.0
2021-03	RAN#91	RP-210116	0158		A	Correction of CQI test parameters and FRC for UE demodulation test	16.4.0
2021-03	RAN#91	RP-210064	0159	1	B	CR: FRC for eMIMO sDCI/mDCI-based PDSCH transmission	16.4.0
2021-03	RAN#91	RP-210068	0160	1	B	CR on FRC for Ultra low BLER UE CQI requirements	16.4.0
2021-03	RAN#91	RP-210116	0162		A	CR on FRC for NR RI requirements (Rel-16)	16.4.0
2021-03	RAN#91	RP-210068	0164	1	F	CR to TS 38.101-4: Performance requirements for URLLC PDSCH 0.001% BLER	16.4.0
2021-03	RAN#91	RP-210068	0165	1	F	CR to TS 38.101-4: Performance requirements for URLLC High BLER feature tests	16.4.0
2021-03	RAN#91	RP-210068	0166	1	F	CR on FR1 PDSCH Mapping Type B and Processing Capability 2 Requirements	16.4.0
2021-03	RAN#91	RP-210116	0168		A	CR on corrections for LTE-NR Co-existence tests and OCNG pattern	16.4.0
2021-03	RAN#91	RP-210116	0170		A	CR to 38.101-4 on update to CSI reporting test parameters for Aperiodic reporting (R16)	16.4.0
2021-03	RAN#91	RP-210066	0171		F	CR for TS38.101-4, test for FR1 FDD PDCCH DCI format 2_6 demodulation	16.4.0
2021-03	RAN#91	RP-210065	0172		F	CR: Update on test applicability rule for EN-DC power imbalance	16.4.0

Change history

Date	Meeting	tDoc	CR	Rev	Cat	Subject/Comment	New version
2021-03	RAN#91	RP-200379	0155		B	Introduction of Noc for PC5 in n257/n258	17.0.0
2021-06	RAN#92e	RP-211084	0179		A	CR to the definition of explicitly HARQ feedback timing in DCI format 1_0 for PDCCH demodulation tests	17.1.0
2021-06	RAN#92e	RP-211084	0182		A	Noc levels for FR2 demodulation test cases	17.1.0
2021-06	RAN#92e	RP-211100	0185	1	A	CR on finalization on the FR2 256QAM CQI report test case	17.1.0
2021-06	RAN#92e	RP-211086	0188		A	CR on NR UE demodulation performance requirements maintenance (R17)	17.1.0
2021-06	RAN#92e	RP-211104	0190		A	CR to TS 38.101-4: Performance requirements for single-DCI based multi-TRP Repetition Tx schemes (R17)	17.1.0
2021-06	RAN#92e	RP-211104	0192		A	CR to TS 38.101-4: HST-DPS channel model clarification (R17)	17.1.0
2021-06	RAN#92e	RP-211104	0194		A	Corrections to align the description of PMI test cases with TS 38.214	17.1.0
2021-06	RAN#92e	RP-211104	0202		A	CR to 38.101-4 on URLLC requirements for PDSCH slot aggregation in FR2 - R17	17.1.0
2021-06	RAN#92e	RP-211104	0204		A	CR to 38.101-4 on CQI Reporting requirements with Table3 - R17	17.1.0
2021-06	RAN#92e	RP-211104	0206		A	CR to 38.101-4 on TRS config update for HST-DPS test cases- R17	17.1.0
2021-06	RAN#92e	RP-211104	0209		A	CR on HST-SFN requirements for TDD	17.1.0
2021-06	RAN#92e	RP-211101	0211		A	Big CR: Introduction of Rel-16 NR V2X demodulation performance requirements	17.1.0
2021-06	RAN#92e	RP-211105	0214		A	Clear up CR for Rel-16 eMIMO PMI test cases	17.1.0
2021-06	RAN#92e	RP-211105	0216		A	Correction on PMI test cases with Rel-15 Type I, TypeII codebook	17.1.0
2021-06	RAN#92e	RP-211106	0218		A	CR on corrections of PDCCH-WUS requirements	17.1.0
2021-06	RAN#92e	RP-211088	0221		A	CR: Updates to PDSCH requirements and CSI requirements (Rel-17)	17.1.0
2021-06	RAN#92e	RP-211120	0223	1	B	CR on UE demodulation and CSI repopting for 35MHz and 45MHz channel bandwidth for FR1 FDD (Rel-17)	17.1.0
2021-06	RAN#92e	RP-211108	0225		A	CR on correction of FRC for HST (Rel-17)	17.1.0
2021-06	RAN#92e	RP-211108	0227		A	CR on removal of square brackets for HST requirements (Rel-17)	17.1.0
2021-06	RAN#92e	RP-211100	0230		A	CR on correction of FRC for DL 256QAM (Rel-17)	17.1.0
2021-06	RAN#92e	RP-211100	0232		A	CR on correction of FR2 256QAM CQI applicability rules (Rel-17)	17.1.0
2021-06	RAN#92e	RP-211104	0234	1	F	CR to TS 38.101-4: Cleanup of UE performance requirements for FR1 URLLC PDSCH repetitions over multiple slots	17.1.0
2021-06	RAN#92e	RP-211108	0237		A	CR for 38.101-4: Updates on PDSCH requirement with Single-DCI based SDM scheme	17.1.0
2021-06	RAN#92e	RP-211108	0238		A	CR for 38.101-4: Updates on PDSCH requirement with Multi-DCI based transmission scheme	17.1.0
2021-06	RAN#92e	RP-211088	0241		A	Correction of variable name for PMI test metric	17.1.0
2021-06	RAN#92e	RP-211109	0244		F	Removal of [] from Noc power level for n257/n258 PC5	17.1.0
2021-06	RAN#92e	RP-211109	0246		A	Finalization of URLLC pre-emption and mapping type B requirements	17.1.0
2021-06	RAN#92e	RP-211109	0248		A	CR: Correction of the applicability of requirements	17.1.0
2021-06	RAN#92e	RP-211100	0253		A	CR on clarification of TDL-D channel model (R17)	17.1.0
2021-06	RAN#92e	RP-211110	0254		A	CR on Applicability Rule for TDD LTE-NR Coexistence Tests	17.1.0
2021-06	RAN#92e	RP-211091	0260		A	CR to TS 38.101-4: Editorial corrections (R17)	17.1.0

2021-06	RAN#92e	RP-211104	0261	1	A	CR to TS 38.101-4: FRC index update and Editorial corrections (R17)	17.1.0
2021-06	RAN#92e	RP-211094	0266	1	A	Big CR for the Introduction of NR-U UE Demodulation Requirements (PDSCH and CQI)	17.1.0
2021-09	RAN#93e	RP-211913	0267		F	Correction of Noc power level for n257/n258 PC5	17.2.0
2021-09	RAN#93e	RP-211909	0268		F	CR on UE demodulation and CSI reporting for 35MHz and 45MHz channel bandwidth for FR1 FDD	17.2.0
2021-09	RAN#93e	RP-211898	0269		B	CR: TS 38.101-4: n262 demodulation requirements	17.2.0
2021-09	RAN#93e	RP-211924	0272		A	Big CR for TS 38.101-4 Maintenance (Rel-17, CAT A)	17.2.0
2021-12	RAN#94e	RP-212836	0273	1	F	CR: Applicability of FR2 demodulation requirements to n262	17.3.0
2021-12	RAN#94e	RP-212833	0274	1	B	CR: Introduction of Noc power level for n259 PC5	17.3.0
2021-12	RAN#94e	RP-212846	0277		A	Big CR for TS 38.101-4 Maintenance (Rel-17, CAT A)	17.3.0
2022-03	RAN#95	RP-220372	0278		B	Big CR to 38.101-4: Introduction of FR1 HST demodulation requirements	17.4.0
2022-03	RAN#95	RP-220337	0281		F	Big CR for TS 38.101-4 Maintenance (Rel-17, CAT F)	17.4.0
2022-06	RAN#96	RP-221680	0282		B	Big CR on FR2 HST UE demodulation requirement for TS 38.101-4	17.5.0
2022-06	RAN#96	RP-221675	0287		B	Big CR to 38.101-4: Introduction of FR1 1024QAM UE demodulation and CQI reporting requirements	17.5.0
2022-06	RAN#96	RP-221665	0290		A	Big CR for TS 38.101-4 Maintenance (Rel-17, CAT A)	17.5.0
2022-06	RAN#96	RP-221680	0291		F	Big CR to 38.101-4: Introduction of FR1 HST demodulation requirements	17.5.0
2022-06	RAN#96	RP-221674	0292		B	Big CR for inter-cell MMSE-IRC	17.5.0
2022-09	RAN#97	RP-222041	0294		F	Big CR on FR2 HST UE demodulation requirement for TS 38.101-4	17.6.0
2022-09	RAN#97	RP-222049	0295		B	BigCR for IRC for intra cell inter user MMSE receiver requirements	17.6.0
2022-09	RAN#97	RP-222034	0298	1	F	Correction CR for 1024QAM UE Demod Requirements	17.6.0
2022-09	RAN#97	RP-222049	0299		B	Big CR for inter-cell MMSE-IRC	17.6.0
2022-09	RAN#97	RP-222049	0300		B	Big CR for CRS-IM	17.6.0
2022-09	RAN#97	RP-222056	0301		B	Big CR to 38.101-4: Introduction of RedCap UE demodulation and CSI reporting requirements	17.6.0
2022-09	RAN#97	RP-222025	0304		F	Big CR for TS 38.101-4 Maintenance (Rel-17, CAT F)	17.6.0
2022-09	RAN#97	RP-222041	0305		F	Big CR to 38.101-4 for Rel-17 FR1 HST maintenance (Rel-17, CAT F)	17.6.0
2022-12	RAN#98-e	RP-223308	0306	1	F	CR on maintenance of PDSCH CRS-IM demod requirements	17.7.0
2022-12	RAN#98-e	RP-223308	0307	1	F	CR on maintenance on PDSCH 4Rx demod requirements for MU-MIMO IRC	17.7.0
2022-12	RAN#98-e	RP-223297	0312		A	Correction to LTE-NR coexistence requirements	17.7.0
2022-12	RAN#98-e	RP-223308	0313	1	F	CR for Maintenance of PDSCH demod requirements with inter-cell interference	17.7.0
2022-12	RAN#98-e	RP-223297	0315		A	CR to dl-DataToUL-ACK for PDSCH demod CA TCs	17.7.0
2022-12	RAN#98-e	RP-223297	0317		A	CR to TS38.101-4, Corrections to NR-U (Rel-17)	17.7.0
2022-12	RAN#98-e	RP-223310	0319		B	Big CR on UE demodulation and CSI requirement for FeMIMO	17.7.0
2022-12	RAN#98-e	RP-223301	0320		F	Big CR to 38.101-4: Correction of RedCap UE demodulation and CSI reporting requirements	17.7.0
2022-12	RAN#98-e	RP-223308	0324	1	F	CR on modification on Rel-17 CRS-IM performance requirements in TS 38.101-4	17.7.0
2022-12	RAN#98-e	RP-223297	0326		A	CR on corrections to parameters of Rel-17 V2X HARQ buffer test in TS 38.101-4	17.7.0
2022-12	RAN#98-e	RP-223297	0328		A	CR on corrections to parameters of Rel-17 NR-U test in TS 38.101-4	17.7.0
2022-12	RAN#98-e	RP-223293	0332		A	CR for 38.101-4 on correction of FR2 PBCH Test Parameters	17.7.0
2023-03	RAN#99	RP-230513	0333	1	F	Maintenance of R17 demodulation performance requirements for NR_demod_enh2-Perf	17.8.0
2023-03	RAN#99	RP-230518	0334		F	CR to TS38.101-4, Corrections to RedCap CSI requirements	17.8.0
2023-03	RAN#99	RP-230514	0338	1	F	correction CR on UE demodulation and CSI requirement for FeMIMO	17.8.0
2023-03	RAN#99	RP-230514	0340		A	FR1 HST demod test description correction R17 mirror	17.8.0
2023-03	RAN#99	RP-230518	0341		F	Miscellaneous corrections to RedCap requirements	17.8.0
2023-03	RAN#99	RP-230505	0344		A	CR: Updates to precoder configuration for PDSCH, PDCCH and SDR tests in TS 38.101-4 (Rel-17)	17.8.0
2023-03	RAN#99	RP-230499	0347		A	CR: Updates to V2X FRC in TS 38.101-4 (Rel-17)	17.8.0
2023-03	RAN#99	RP-230510	0353		B	BigCR on FR2-2 UE demodulation performance requirements in TS 38.101-4	17.8.0
2023-06	RAN#100	RP-231357	0355		A	Cat.A - Correction CR for the Report Quantity for CQI Reporting Tests with 1TX	17.9.0
2023-06	RAN#100	RP-231357	0359		A	CR to Candidate CCEs of SDR SA DL-CA	17.9.0
2023-06	RAN#100	RP-231343	0360		F	Correction CR for 1024QAM Demod Requirements applicability	17.9.0
2023-06	RAN#100	RP-231350	0361		F	Clean up R17 RedCap Demod Requirements	17.9.0
2023-06	RAN#100	RP-231347	0362		F	CR for 38.101-4: PDCCH requirements for FR2-2	17.9.0
2023-06	RAN#100	RP-231347	0365	1	F	CR for 38.101-4: Correction of wrongly placed section for FR2-2	17.9.0
2023-06	RAN#100	RP-231350	0366		F	CR: Editorial correction of PDCCH demodulation requirements for RedCap	17.9.0
2023-06	RAN#100	RP-231358	0369		A	CR on 38.101-4: Update PDSCH and PDCCH codebook configurations in 4Tx tests (Rel-17)	17.9.0

2023-06	RAN#100	RP-231351	0371		A	CR on 38.101-4 Introduction of channel model paramters definition specified for V2X requirements (Rel-17)	17.9.0
2023-06	RAN#100	RP-231347	0372	1	F	CR on 38.101-4: Updates to FR2-2 UE performance requirements	17.9.0
2023-06	RAN#100	RP-231354	0374		A	Correction for HST test setup from Rel-16 (TS 38.101-4, Rel-17)	17.9.0
2023-06	RAN#100	RP-231347	0378	1	F	CR to 38.101-4 for brackets removal and fixing typos	17.9.0
2023-06	RAN#100	RP-231347	0379	1	F	Update to FR2 delay profiles	17.9.0
2023-06	RAN#100	RP-231350	0381		F	Correction for HST FR1 test setup from Rel-17 (TS 38.101-4, Rel-17)	17.9.0
2023-06	RAN#100	RP-231354	0382		F	Correction for HST FR2 test setup from Rel-17 (TS 38.101-4, Rel-17)	17.9.0
2023-06	RAN#100	RP-231346	0383		F	Correction for HST SFN scheme A and B test setup from Rel-17 (TS 38.101-4, Rel-17)	17.9.0
2023-09	RAN#101	RP-232489	0385		F	CR to 38.101-4: Corrections to channel model parameters for FR1 (Rel-17)	17.10.0
2023-09	RAN#101	RP-232489	0387		F	[NR_demod_enh2-Perf, NR_redcap-Perf] CR to PDSCH requirements and RMCs for SCS 30kHz FR1	17.10.0
2023-09	RAN#101	RP-232499	0403		A	[NR_unlic-Perf] Add clarification to simulation parameters for SSB Q Factor (Rel.17 - Cat. A)	17.10.0
2023-09	RAN#101	RP-232502	0417	1	F	[NR_newRAT-Perf] CR on correction of FRC definition (TS38.101-4, Rel-17)	17.10.0
2023-09	RAN#101	RP-232490	0413	1	F	[NR_HST_FR1_enh-Perf] CR on HST-SFN CA UE capability (TS38.101-4, Rel-17)	17.10.0
2023-09	RAN#101	RP-232490	0410	1	F	[NR_ext_to_71GHz-Perf] CR on 38.101-4 Update TDD UL-DL configuration for FR2-2 480kHz SCS (Rel-17)	17.10.0
2023-09	RAN#101	RP-232491	0396	1	F	Correction CR on Rel-17 FR2 HST test setup and FRC	17.10.0
2023-09	RAN#101	RP-232497	0405	1	F	[NR_redcap-Perf] Align Measurement channel to test rank in CQI Redcap tests (Rel.17 - Cat F)	17.10.0
2023-12	RAN#102	RP-233333	0423		A	[NR_newRAT-Perf] CR to TS38.101-4 Corrections to test parameters for CSI test cases (Rel-17)	17.11.0
2023-12	RAN#102	RP-233333	0431		A	[NR_newRAT-Perf] CR for 38.101-4 on correction of wrong table number (Rel-17, Cat A)	17.11.0
2023-12	RAN#102	RP-233346	0434		A	[NR_HST] HST-SFN and HST-DPS model clarification-R17mirror	17.11.0
2023-12	RAN#102	RP-233338	0437		A	[NR_L1enh_URLLC-Perf] CR to Report quantity for CQI Reporting tests with 1Tx	17.11.0
2023-12	RAN#102	RP-233350	0445		F	Correction of CSI FR1 RMC table foramt for CQI table 1	17.11.0
2023-12	RAN#102	RP-233334	0449		A	Corrections on test parameters for PDSCH test	17.11.0
2023-12	RAN#102	RP-233338	0454		A	CR on 38.101-4 Correcting applicability for FR2 multi-slot repetition test case (Rel-17)	17.11.0
2023-12	RAN#102	RP-233336	0464		A	Sidelink demodulation typo fixed	17.11.0
2023-12	RAN#102	RP-233335	0441	1	A	[NR_newRAT-Perf, NR_redcap-Perf] CR on 38.101-4 general applicablity of requirements (Rel-17)	17.11.0
2023-12	RAN#102	RP-233345	0443	1	F	[NR_ext_to_71GHz-Perf] CR on 38.101-4 general applicablity of requirements (Rel-17)	17.11.0
2023-12	RAN#102	RP-233345	0451	1	F	CR on 38.101-4 Correction on test paramters for FR2-2 PDSCH test with 480kHz	17.11.0
2023-12	RAN#102	RP-233350	0458	1	F	CR to align Rank on TDD Redcap CQI Tests - [Rel.17 Cat.F]	17.11.0
2023-12	RAN#102	RP-233346	0463	1	F	[NR_HST_FR1_enh] HST-DPS model clarification (CA)	17.11.0
2024-03	RAN#103	RP-240558	0475		A	(NR_DL256QAM_FR2-Perf) Correction to 256QAM CQI reporting	17.12.0
2024-03	RAN#103	RP-240558	0505		F	(NR_DL1024QAM_FR1-Perf) Include 1024QAM Table in ENDC Demod Requirements (R17)(Cat.F)	17.12.0
2024-03	RAN#103	RP-240558	0478	1	F	(NR_DL1024QAM_FR1-Perf) Add New Es value for EVM=2.5% (R17)(Cat.F)	17.12.0
2024-03	RAN#103	RP-240559	0477		F	(NR_HST_FR2-Perf) FR2 HST DPS Model Clarification (R17)(Cat.F)	17.12.0
2024-03	RAN#103	RP-240559	0498	2	F	(NR_ext_to_71GHz-Perf) CR on 38.101-4 Correction on test paramters for FR2-2 PDSCH test with 480kHz	17.12.0
2024-03	RAN#103	RP-240567	0469		A	(NR_newRAT-Perf) Correction to FR2 SDR requirements	17.12.0
2024-03	RAN#103	RP-240569	0503	1	F	(NR_newRAT-Perf) CR to TS38.101-4: Corrections on FRC definition (Rel-17)	17.12.0
2024-03	RAN#103	RP-240571	0479		F	(NR_perf_enh-Perf) Correct FRC for R.PDSCH.1-18.1 FDD (R17)(Cat.F)	17.12.0
2024-03	RAN#103	RP-240573	0487		F	(NR_redcap-Perf) CR on 38.101-4 Correction on applicability rules for RedCap requirements	17.12.0
2024-03	RAN#103	RP-240573	0499	1	F	(NR_redcap-Perf) CR to TS38.101-4: Corrections on RedCap SDR test cases (Rel-17)	17.12.0
2024-03	RAN#103	RP-240576	0493	1	F	(NR_unlic-Perf) Correction of configuration for NR-U CQI reporting requirements (R17)	17.12.0
2024-06	RAN#104	RP-241397	0515		A	(NR_HST-Perf) CR to FR1 HST-DPS on TCI state switching scheduling	17.13.0
2024-06	RAN#104	RP-241384	0522		A	(NR_newRAT-Perf) Editorial CR to Rename sub-clauses under PDCCH requirements	17.13.0
2024-06	RAN#104	RP-241396	0527		F	Corrections on the FRC for Table A.3.2.2.2-29	17.13.0
2024-06	RAN#104	RP-241396	0533		F	(NR_demod_enh2-Perf) CR to 38.101-4 Correction on FRC for CRS-IM requirement	17.13.0

2024-06	RAN#104	RP-241399	0518	1	F	(NR_perf_enh-Perf) Editorial CR change to combine tables for requirements applicability for optional UE features	17.13.0
2024-06	RAN#104	RP-241396	0548	1	F	[NR_DL1024QAM_FR1-Perf] Updates to CQI reporting definition test metric under AWGN for 1024QAM test	17.13.0
2024-06	RAN#104	RP-241396	0551	1	F	[NR_demod_enh2-Perf] CR for 38.101-4 Introduction of applicability rules	17.13.0
2024-09	RAN#105	RP-242161	0568	1	F	(NR_DL1024QAM_FR1-Perf) CR for TS38.101-4, corrections to CodebookSubsetRestriction on 1024QAM CQI requirements	17.14.0
2024-09	RAN#105	RP-242161	0582	1	F	(NR_demod_enh2) CR for 38.101-4 on corrections of RMC references	17.14.0
2024-09	RAN#105	RP-242176	0592	1	A	(NR_newRAT-Perf) CR to Rel-17 38.101-4 Frequency domain granularity of random PMI for PMI requirements	17.14.0
2024-09	RAN#105	RP-242185	0596	-	F	(NR_redcap) Correction of applicability of RedCap UE demodulation requirements	17.14.0
2024-09	RAN#105	RP-242161	0599	1	F	(NR_demod_enh2-Perf) Corrections on CQI requirements with inter-cell interference	17.14.0
2024-09	RAN#105	RP-242167	0602	-	A	(NR_HST-Perf) Corrections on NR HST test parameters	17.14.0
2024-09	RAN#105	RP-242185	0608	-	F	(NR_redcap-Perf) CR for 38.101-4: Corrections on RedCap PMI test setup	17.14.0
2024-09	RAN#105	RP-242176	0619	-	A	(NR_newRAT-Perf) CR on PTRS configuration for UE demodulation requirements	17.14.0
2024-09	RAN#105	RP-242183	0626	-	F	(NR_perf_enh-Perf) Correction CR on applicability of FR1 demodulation requirements (Rel-17)	17.14.0
2024-09	RAN#105	RP-242176	0637	1	D	(NR_newRAT-Perf) Editorial CR to 38.101-4 on PBCH requirements to unify table numbering format	17.14.0

History

Document history		
V17.4.0	April 2022	Publication
V17.5.0	August 2022	Publication
V17.6.0	October 2022	Publication
V17.7.0	January 2023	Publication
V17.8.0	May 2023	Publication
V17.9.0	July 2023	Publication
V17.10.0	October 2023	Publication
V17.11.0	February 2024	Publication
V17.12.0	May 2024	Publication
V17.13.0	August 2024	Publication
V17.14.0	October 2024	Publication