**3GPP TSG-RAN WG1 Meeting #114 *R1-2306330***

**Toulouse, France, August 21st – 25th, 2023**

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| *CR-Form-v12.2* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.214** | **CR** | **-** | **rev** | **-** | **Current version:** | **17.6.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Introduction of specification support for MIMO enhancements on CSI | | | | | | |
|  |  | | | | | | |
| ***Source to WG:*** | Nokia | | | | | | |
| ***Source to TSG:*** |  | | | | | | |
|  |  | | | | | | |
| ***Work item code:*** | NR\_MIMO\_evo\_DL\_UL | | |  | ***Date:*** | | 2023-09-08 |
|  |  | |  | |  | |  |
| ***Category:*** | **B** |  | | | ***Release:*** | | Rel-18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | |
| ***Reason for change:*** | | Introduction of specification support for MIMO Evolution for Downlink and Uplink. | | | | | |
|  | |  | | | | | |
| ***Summary of change:*** | | This document is introducing specification support for CSI | | | | | |
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| ***Consequences if not approved:*** | Specification does not support MIMO Evolution for Downlink and Uplink. | | | |
|  |  | | | |
| ***Clauses affected:*** | 3.3, 5.1.6.1.1, 5.2.1, 5.2.1.1, 5.2.1.2, 5.2.1.4, 5.2.1.4.1, 5.2.1.4.2, 5.2.1.4.5 (new), 5.2.1.6, 5.2.2.2.8 (new), 5.2.2.2.9 (new), 5.2.2.2.10 (new), 5.2.2.2.11 (new), 5.2.2.3.1, 5.2.2.5.1c (new), 5.2.3, 5.4 | | | |
|  |  | | | |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  | Other core specifications | TS/TR ... CR ... |
| ***affected:*** |  | **X** | Test specifications | TS/TR ... CR ... |
| ***(show related CRs)*** |  | **X** | O&M Specifications | TS/TR ... CR ... |
|  |  | | | |
| ***Other comments:*** |  | | | |
|  |  | | | |
| ***This CR's revision history:*** |  | | | |

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## 3.3 Abbreviations

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

BWP Bandwidth part

CBG Code block group

CJT Coherent Joint Transmission

CLI Cross Link Interference

CP Cyclic prefix

CQI Channel quality indicator

CPU CSI processing unit

CRB Common resource block

CRC Cyclic redundancy check

CRI CSI-RS Resource Indicator

CSI Channel state information

CSI-RS Channel state information reference signal

CSI-RSRP CSI reference signal received power

CSI-RSRQ CSI reference signal received quality

CSI-SINR CSI signal-to-noise and interference ratio

CW Codeword

DCI Downlink control information

DL Downlink

DM-RS Demodulation reference signals

DRX Discontinuous Reception

EPRE Energy per resource element

IAB-MT Integrated Access and Backhaul – Mobile Terminal

L1-RSRP Layer 1 reference signal received power

LI Layer Indicator

MCS Modulation and coding scheme

NCJT Non-Coherent Joint Transmission

PDCCH Physical downlink control channel

PDSCH Physical downlink shared channel

PSS Primary Synchronisation signal

PUCCH Physical uplink control channel

QCL Quasi co-location

PMI Precoding Matrix Indicator

PRB Physical resource block

PRG Precoding resource block group

PRS Positioning reference signal

PT-RS Phase-tracking reference signal

RB Resource block

RBG Resource block group

RI Rank Indicator

RIV Resource indicator value

RS Reference signal

SCI Sidelink control information

SLIV Start and length indicator value

SR Scheduling Request

SRS Sounding reference signal

SS Synchronisation signal

SSS Secondary Synchronisation signal

SS-RSRP SS reference signal received power

SS-RSRQ SS reference signal received quality

SS-SINR SS signal-to-noise and interference ratio

TB Transport Block

TCI Transmission Configuration Indicator

TDM Time division multiplexing

TDCP Time Domain Channel Properties

UE User equipment

UL Uplink

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### 5.1.6 UE procedure for receiving reference signals

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5.1.6.1.1 CSI-RS for tracking

A UE in RRC connected mode is expected to receive the higher layer UE specific configuration of a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*.

For a *NZP-CSI-RS-ResourceSet* configured with the higher layer parameter *trs-Info*, the UE shall assume the antenna port with the same port index of the configured NZP CSI-RS resources in the *NZP-CSI-RS-ResourceSet* is the same.

- For frequency range 1, the UE may be configured with one or more NZP CSI-RS set(s), where a *NZP-CSI-RS-ResourceSet* consists of four periodic NZP CSI-RS resources in two consecutive slots with two periodic NZP CSI-RS resources in each slot. If no two consecutive slots are indicated as downlink slots by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigDedicated*, then the UE may be configured with one or more NZP CSI-RS set(s), where a *NZP-CSI-RS-ResourceSet* consists of two periodic NZP CSI-RS resources in one slot.

- For frequency range 2 the UE may be configured with one or more NZP CSI-RS set(s), where a *NZP-CSI-RS-ResourceSet* consists of two periodic CSI-RS resources in one slot or with a *NZP-CSI-RS-ResourceSet* of four periodic NZP CSI-RS resources in two consecutive slots with two periodic NZP CSI-RS resources in each slot.

A UE configured with *NZP-CSI-RS-ResourceSet(s)* configured with higher layer parameter *trs-Info* may have the CSI-RS resources configured as:

- Periodic, with the CSI-RS resources in the *NZP-CSI-RS-ResourceSet* configured with same periodicity, bandwidth and subcarrier location.

- Periodic CSI-RS resource in one set and aperiodic CSI-RS resources in a second set, with the aperiodic CSI-RS and periodic CSI-RS resource having the same bandwidth (with same RB location) and the aperiodic CSI-RS being configured with *qcl-Type* set to 'typeA' and 'typeD', where applicable, with the periodic CSI-RS resources. For frequency range 2, the UE does not expect that the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is smaller than *beamSwitchTiming* + *d* in CSI-RS symbols*,* where *beamSwitchTiming* is UE reported value defined in [13, TS 38.306], the reported value is one of the values of {14, 28, 48}, and the beam switching timing delay *d* is defined in Table 5.2.1.5.1a-1 if µPDCCH < µCSIRS , else *d* is zero. The UE shall expect that the periodic CSI-RS resource set and aperiodic CSI-RS resource set are configured with the same number of CSI-RS resources and with the same number of CSI-RS resources in a slot. For the aperiodic CSI-RS resource set if triggered, and if the associated periodic CSI-RS resource set is configured with four periodic CSI-RS resources with two consecutive slots with two periodic CSI-RS resources in each slot, the higher layer parameter *aperiodicTriggeringOffset* indicates the triggering offset for the first slot for the first two CSI-RS resources in the set.

A UE does not expect to be configured with a *CSI-ReportConfig* that is linked to a *CSI-ResourceConfig* containing an *NZP-CSI-RS-ResourceSet* configured with *trs-Info* and with the *CSI-ReportConfig* configured with the higher layer parameter *timeRestrictionForChannelMeasurements* set to 'configured'.

A UE does not expect to be configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to other than 'tdcp' or 'none' for aperiodic NZP CSI-RS resource set configured with *trs-Info.*

A UE does not expect to be configured with a *CSI-ReportConfig* for periodic NZP CSI-RS resource set configured with *trs-Info*, except for *reportQuantity* set to 'tdcp'.

A UE does not expect to be configured with a *NZP-CSI-RS-ResourceSet* configured both with *trs-Info* and *repetition*.

Each CSI-RS resource, defined in Clause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *NZP-CSI-RS-Resource* with the following restrictions:

- the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), as defined by higher layer parameter *CSI-RS-resourceMapping*, is given by one of

- , , or for frequency range 1 and frequency range 2,

- , , , , ,  or  for frequency range 2.

- a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211] and higher layer parameter *density* configured by *CSI-RS-ResourceMapping.*

- if carrier , , and the carrier is configured in paired spectrum, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is *X* resource blocks, where resource blocks if the UE indicates *trs-AddBW-Set1* for the *trs-AdditionalBandwidth* capability for CSI-RS for tracking or *addBW-Set1* for the *aperiodicCSI-RS*-*AdditionalBandwidth* capability for aperiodic CSI-RS for fast SCell activation and if the UE indicates *trs-AddBW-Set2* for the *AdditionalBandwidth* capability for CSI-RS for tracking or *addBW-Set2* for the *aperiodicCSI-RS*-*AdditionalBandwidth* capability for aperiodic CSI-RS for fast SCell activation; in these cases, if the UE is configured with CSI-RS comprising X<52 resource blocks, the UE does not expect that the total number of PRBs allocated for DL transmissions but not overlapped with the PRBs carrying CSI-RS for tracking is more than 4, where all CSI-RS resource configurations shall span the same set of resource blocks; otherwise, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and resource blocks, or is equal to resource blocks. For operation with shared spectrum channel access in FR1, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and resource blocks, or is equal to resource blocks.

- the UE is not expected to be configured with the periodicity of  slots if the bandwidth of CSI-RS resource is larger than 52 resource blocks.

- the periodicity and slot offset for periodic NZP CSI-RS resources, as given by the higher layer parameter *periodicityAndOffset* configured b*y NZP-CSI-RS-Resource*, is one of slots where 10, 20, 40, or 80 and where µ is defined in Clause 4.3 of [4, TS 38.211].

- same *powerControlOffset* and *powerControlOffsetSS* given by*NZP-CSI-RS-Resource* value across all resources.

A UE in RRC\_IDLE or RRC\_INACTIVE can receive a higher layer configuration of TRS occasions via a *trs-ResourceSetConfig*.

- For frequency range 1, the UE may be configured with one or more TRS resource set(s), where each TRS resource set configured by a *TRS-ResourceSet* consists of four periodic NZP CSI-RS resources in two consecutive slots with two periodic NZP CSI-RS resources in each slot. If no two consecutive slots are indicated as downlink slots by *tdd-UL-DL-ConfigurationCommon*, then the UE may be configured with one or more TRS resource set(s), where a *TRS-ResourceSet* consists of two periodic NZP CSI-RS resources in one slot.

- For frequency range 2 the UE may be configured with one or more TRS resource set(s), where each TRS resource set configured by a *TRS-ResourceSet* consists of two periodic NZP CSI-RS resources in one slot or by a *TRS-ResourceSet* of four periodic NZP CSI-RS resources in two consecutive slots with two periodic NZP CSI-RS resources in each slot.

Each NZP CSI-RS resource, defined in Clause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *TRS-ResourceSet* with the following restrictions for a UE in RRC\_IDLE or RRC\_INACTIVE:

- the number of periodic NZP CSI-RS resources configured by a *TRS-ResourceSet* is given by *nrofResources*

- the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), is one of

- , , or for frequency range 1 and frequency range 2,

- , , , , ,  or  for frequency range 2.

- where the first symbol location in a slot is indicated by *firstOFDMSymbolInTimeDomain* in the *TRS-ResourceSet* and the second symbol location in a slot is *firstOFDMSymbolInTimeDomain +* 4

- a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211]*.*

- the bandwidth and the frequency location of the NZP CSI-RS resource, is given by the higher layer parameter *nrofRBs*, *startingRB* and *frequencyDomainAllocation* in a *TRS-ResourceSet* and applies to all resources in a *TRS-ResourceSet*. Bandwidth, *nrofRBs*, and the initial CRB index, *startingRB*, of the NZP CSI-RS resource configured by *TRS-ResourceSet* are not restricted by initial DL BWP.

- UE is not required to receive TRS occasions outside the initial DL BWP.

- the periodicity for periodic NZP CSI-RS resources, is given by the higher layer parameter *periodicityAndOffset* configured b*y* a *TRS-ResourceSet*, is one of slots where 10, 20, 40, or 80 and where µ is defined in Clause 4.3 of [4, TS 38.211], applies to all resources in a *TRS-ResourceSet*. The slot offset given by the higher layer parameter *periodicityAndOffset* configured b*y* a *TRS-ResourceSet* provides the location of the first slot containing the periodic NZP CSI-RS resources configured by b*y* a *TRS-ResourceSet.*

- the UE does not expect the *TRS-ResourceSet* to be configured with the periodicity of  slots if the bandwidth of NZP CSI-RS resource is larger than 52 resource blocks.

- the UE may assume the sub-carrier spacing of the NZP CSI-RS resources configured by *TRS-ResourceSet* to be same as the sub-carrier spacing of the initial DL BWP.

- *powerControlOffsetSS* given bya *TRS-ResourceSet* applies to all resources in a *TRS-ResourceSet*.

- the QCL information for periodic NZP CSI-RS resources, is given by the higher layer parameter *ssb-Index* configured by a *TRS-ResourceSet*, is a SS/PBCH block, applies to all resources in a *TRS-ResourceSet*.

- One or more scrambling IDs according to *scramblingID-Info* where if a single *scramblingIDforCommon* is configured, it applies to all NZP-CSI-RS resources in the resource set, otherwise, each NZP-CSI-RS resource is provided with a scrambling IDs according to *scramblingIDperResourceListWith2* or *scramblingIDperResourceListWith4*.

- the UE may assume the following quasi co-location type(s):

- 'typeC' with an SS/PBCH block and, when applicable, 'typeD' with the same SS/PBCH block.

For each *TRS-ResourceSet* the index of the associated bit in TRS availability indication field [5, TS 38.212], is given by the higher layer parameter *indBitID*.

<omitted text>

### 5.2.1 Channel state information framework

The procedures on aperiodic CSI reporting described in this clause assume that the CSI reporting is triggered by DCI format 0\_1, but they equally apply to CSI reporting triggered by DCI format 0\_2, by applying the higher layer parameter *reportTriggerSizeDCI-0-2* instead of *reportTriggerSize*.

The time and frequency resources that can be used by the UE to report CSI are controlled by the gNB. CSI may consist of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), CSI-RS resource indicator (CRI), SS/PBCH Block Resource indicator (SSBRI), layer indicator (LI), rank indicator (RI), L1-RSRP, L1-SINR, CapabilityIndex or time-domain channel properties (TDCP).

For CQI, PMI, CRI, SSBRI, LI, RI, L1-RSRP, L1-SINR, CapabilityIndex, TDCP a UE is configured by higher layers with N≥1 *CSI-ReportConfig* Reporting Settings, M≥1 *CSI-ResourceConfig* Resource Settings, and one or two list(s) of trigger states (given by the higher layer parameters *CSI-AperiodicTriggerStateList* and *CSI-SemiPersistentOnPUSCH-TriggerStateList*). Each trigger state in *CSI-AperiodicTriggerStateList* contains a list of associated *CSI-ReportConfigs* indicating the Resource Set IDs for channel and optionally for interference. Each trigger state in *CSI-SemiPersistentOnPUSCH-TriggerStateList* contains one associated *CSI-ReportConfig*.

#### 5.2.1.1 Reporting settings

Each Reporting Setting *CSI-ReportConfig* is associated with a single downlink BWP (indicated by higher layer parameter *BWP-Id*) given in the associated *CSI-ResourceConfig* for channel measurement and contains the parameter(s) for one CSI reporting band: codebook configuration including codebook subset restriction, time-domain behavior, frequency granularity for CQI and PMI, measurement restriction configurations, and the CSI-related quantities to be reported by the UE such as the layer indicator (LI), L1-RSRP, L1-SINR, CRI, SSBRI (SSB Resource Indicator), CapabilityIndex and TDCP.

The time domain behavior of the *CSI-ReportConfig* is indicated by the higher layer parameter *reportConfigType* and can be set to 'aperiodic', 'semiPersistentOnPUCCH', 'semiPersistentOnPUSCH', or 'periodic'. For 'periodic' and 'semiPersistentOnPUCCH'/'semiPersistentOnPUSCH' CSI reporting, the configured periodicity and slot offset applies in the numerology of the UL BWP in which the CSI report is configured to be transmitted on. The higher layer parameter *reportQuantity* indicates the CSI-related, L1-RSRP-related, L1-SINR-related, CapabilityIndex-related or TDCP-related quantities to report. The *reportFreqConfiguration* indicates the reporting granularity in the frequency domain, including the CSI reporting band and if PMI/CQI reporting is wideband or sub-band. The *timeRestrictionForChannelMeasurements* parameter in *CSI-ReportConfig* can be configured to enable time domain restriction for channel measurements and *timeRestrictionForInterferenceMeasurements* can be configured to enable time domain restriction for interference measurements. The *CSI-ReportConfig* can also contain *CodebookConfig*, which contains configuration parameters for Type-I, Type II, Enhanced Type II CSI, Further Enhanced Type II Port Selection, Enhanced Type II for coherent joint transmission (CJT), Further Enhanced Type II Port Selection for CJT, Enhanced Type II for predicted PMI, or Further Enhanced Type II Port Selection for predicted PMI including codebook subset restriction when applicable, and configurations of group-based reporting. A UE is not expected to be configured with a CSI report setting associated with a dormant DL BWP if the *reportConfigType* is set to ‘aperiodic’.

#### 5.2.1.2 Resource settings

Each CSI Resource Setting *CSI-ResourceConfig* contains a configuration of a list of S≥1 CSI Resource Sets (given by higher layer parameter *csi-RS-ResourceSetList*), where the list is comprised of references to either or both of NZP CSI-RS resource set(s) and SS/PBCH block set(s) or the list is comprised of references to CSI-IM resource set(s). Each CSI Resource Setting is located in the DL BWP identified by the higher layer parameter *BWP-id*, and all CSI Resource Settings linked to a CSI Report Setting have the same DL BWP.

The time domain behavior of the CSI-RS resources within a CSI Resource Setting are indicated by the higher layer parameter *resourceType* and can be set to aperiodic, periodic, or semi-persistent. For periodic and semi-persistent CSI Resource Settings, when the UE is configured with *groupBasedBeamReporting-r17*, the number of CSI Resource Sets configured is S=2, otherwise the number of CSI-RS Resource Sets configured is limited to S=1, except for periodic CSI Resource Settings, when the UE is configured with TDCP reporting, for which the number of CSI-RS Resource Sets in the CSI Resource Setting for channel measurement is and all the CSI-RS Resource Sets are configured with the higher layer parameter *trs-Info*. For periodic and semi-persistent CSI Resource Settings, the configured periodicity and slot offset is given in the numerology of its associated DL BWP, as given by *BWP-id.* When a UE is configured with multiple *CSI-ResourceConfigs* consisting the same NZP CSI-RS resource ID, the same time domain behavior shall be configured for the *CSI-ResourceConfigs*. When a UE is configured with multiple *CSI-ResourceConfigs* consisting the same CSI-IM resource ID, the same time-domain behavior shall be configured for the *CSI-ResourceConfigs*. All CSI Resource Settings linked to a CSI Report Setting shall have the same time domain behavior.

The following are configured via higher layer signaling for one or more CSI Resource Settings for channel and interference measurement:

- CSI-IM resource for interference measurement as described in Clause 5.2.2.4.

- NZP CSI-RS resource for interference measurement as described in Clause 5.2.2.3.1.

- NZP CSI-RS resource for channel measurement as described in Clause 5.2.2.3.1.

The UE may assume that the NZP CSI-RS resource(s) for channel measurement and the CSI-IM resource(s) for interference measurement configured for one CSI reporting are resource-wise QCLed with respect to 'typeD'. When NZP CSI-RS resource(s) is used for interference measurement, the UE may assume that the NZP CSI-RS resource for channel measurement and the CSI- IM resource or NZP CSI-RS resource(s) for interference measurement configured for one CSI reporting are QCLed with respect to 'typeD'.

For TDCP measurement, one aperiodic or periodic CSI Resource Setting is configured, and the Resource Setting is for channel measurement on CSI-RS for tracking.

For L1-SINR measurement:

- When one Resource Setting is configured, the Resource Setting (given by higher layer parameter *resourcesForChannelMeasurement*) is for channel and interference measurement on NZP CSI-RS for L1-SINR computation. UE may assume that same 1 port NZP CSI-RS resource(s) with density 3 REs/RB is used for both channel and interference measurements.

- When two Resource Settings are configured, the first one Resource Setting (given by higher layer parameter *resourcesForChannelMeasurement*) is for channel measurement on SSB or NZP CSI-RS and the second one (given by either higher layer parameter *csi-IM-ResourcesForInterference* or higher layer parameter *nzp-CSI-RS-ResourcesForInterference*) is for interference measurement performed on CSI-IM or on 1 port NZP CSI-RS with density 3 REs/RB, where each SSB or NZP CSI-RS resource for channel measurement is associated with one CSI-IM resource or one NZP CSI-RS resource for interference measurement by the ordering of the SSB or NZP CSI-RS resource for channel measurement and CSI-IM resource or NZP CSI-RS resource for interference measurement in the corresponding resource sets. The number of SSB(s) or CSI-RS resources for channel measurement equals to the number of CSI-IM resources or the number of NZP CSI-RS resource for interference measurement.

- UE may apply the SSB, or 'typeD' RS configured with *qcl-Type* set to 'typeD' to the NZP CSI-RS resource for channel measurement, as the reference RS for determining 'typeD' assumption for the corresponding CSI-IM resource or the corresponding NZP CSI-RS resource for interference measurement configured for one CSI reporting.

- UE may expect that the NZP CSI-RS resource set for channel measurement and the NZP-CSI-RS resource set for interference measurement, if any, are configured with the higher layer parameter *repetition*.

#### 5.2.1.3 (void)

5.2.1.4 Reporting configurations

The UE shall calculate CSI parameters (if reported) assuming the following dependencies between CSI parameters (if reported)

- LI shall be calculated conditioned on the reported CQI, PMI, RI and CRI

- CQI shall be calculated conditioned on the reported PMI, RI and CRI

- PMI shall be calculated conditioned on the reported RI and CRI

- RI shall be calculated conditioned on the reported CRI.

The Reporting configuration for CSI can be aperiodic (using PUSCH), periodic (using PUCCH) or semi-persistent (using PUCCH, and DCI activated PUSCH). The CSI-RS Resources can be periodic, semi-persistent, or aperiodic. Table 5.2.1.4-1 shows the supported combinations of CSI Reporting configurations and CSI-RS Resource configurations and how the CSI Reporting is triggered for each CSI-RS Resource configuration. Periodic CSI-RS is configured by higher layers. Semi-persistent CSI-RS is activated and deactivated as described in Clause 5.2.1.5.2. Aperiodic CSI-RS is configured and triggered/activated as described in Clause 5.2.1.5.1.

**Table 5.2.1.4-1: Triggering/Activation of CSI Reporting for the possible CSI-RS Configurations.**

|  |  |  |  |
| --- | --- | --- | --- |
| **CSI-RS Configuration** | **Periodic CSI Reporting** | **Semi-Persistent CSI Reporting** | **Aperiodic CSI Reporting** |
| Periodic CSI-RS | No dynamic triggering/activation | For reporting on PUCCH, the UE receives an activation command, as described in clause 6.1.3.16 of [10, TS 38.321]; for reporting on PUSCH, the UE receives triggering on DCI | Triggered by DCI; additionally, subselection indication as described in clause 6.1.3.13 of [10, TS 38.321] possible as defined in Clause 5.2.1.5.1. |
| Semi-Persistent CSI-RS | Not Supported | For reporting on PUCCH, the UE receives an activation command, as described in clause 6.1.3.16 of [10, TS 38.321]; for reporting on PUSCH, the UE receives triggering on DCI | Triggered by DCI; additionally, subselection indication as described in clause 6.1.3.13 of [10, TS 38.321] possible as defined in Clause 5.2.1.5.1. |
| Aperiodic CSI-RS | Not Supported | Not Supported | Triggered by DCI; additionally, subselection indication as described in clause 6.1.3.13 of [10, TS 38.321] possible as defined in Clause 5.2.1.5.1. |

When the UE is configured with higher layer parameter *NZP-CSI-RS-ResourceSet* and when the higher layer parameter *repetition* is set to 'off', the UE shall determine a CRI from the supported set of CRI values as defined in Clause 6.3.1.1.2 of [5, TS 38.212] and report the number in each CRI report. When the higher layer parameter *repetition* for a CSI-RS Resource Set for channel measurement is set to 'on', CRI for the CSI-RS Resource Set for channel measurement is not reported. CRI reporting is not supported when the higher layer parameter *codebookType* is set to 'typeII', 'typeII-PortSelection', 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'.

For a periodic or semi-persistent CSI report on PUCCH, the periodicity (measured in slots) and the slot offset are configured by the higher layer parameter *reportSlotConfig*. Unless specified otherwise, the UE shall transmit the CSI report in frames with SFN and slot number within the frame satisfying

where is the SCS configuration of the UL BWP the CSI report is transmitted on.

For a semi-persistent CSI report on PUSCH, the periodicity (measured in slots) is configured by the higher layer parameter *reportSlotConfig.* Unless specified otherwise, the UE shall transmit the CSI report in frames with SFN and slot number within the frame satisfying

where and are the SFN and slot number within the frame respectively of the initial semi-persistent PUSCH transmission according to the activating DCI.

For a semi-persistent or aperiodic CSI report on PUSCH, the allowed slot offsets are configured by the following higher layer parameters:

- if triggered/activated by DCI format 0\_2 and the higher layer parameter *reportSlotOffsetListDCI-0-2* or *reportSlotOffsetListDCI-0-2-r17* is configured, the allowed slot offsets are configured by *reportSlotOffsetListDCI-0-2* or *reportSlotOffsetListDCI-0-2-r17*, and

- if triggered/activated by DCI format 0\_1 and the higher layer parameter *reportSlotOffsetListDCI-0-1* or *reportSlotOffsetListDCI-0-2-r17* is configured, the allowed slot offsets are configured by *reportSlotOffsetListDCI-0-1* or *reportSlotOffsetListDCI-0-2-r17,* and

- otherwise, the allowed slot offsets are configured by the higher layer parameter *reportSlotOffsetList* or *reportSlotOffsetList-r17*.

The offset is selected in the activating/triggering DCI.

For CSI reporting, a UE can be configured via higher layer signaling with one out of two possible subband sizes, where a subband is defined as  contiguous PRBs and depends on the total number of PRBs in the bandwidth part according to Table 5.2.1.4-2.

**Table 5.2.1.4-2: Configurable subband sizes**

|  |  |
| --- | --- |
| **Bandwidth part (PRBs)** | **Subband size (PRBs)** |
| 24 – 72 | 4, 8 |
| 73 – 144 | 8, 16 |
| 145 – 275 | 16, 32 |

The *reportFreqConfiguration* contained in a *CSI-ReportConfig* indicates the frequency granularity of the CSI Report. A CSI Reporting Setting configuration defines a CSI reporting band as a subset of subbands of the bandwidth part, where the *reportFreqConfiguration* indicates:

- the *csi-ReportingBand* as a contiguous or non-contiguous subset of subbands in the bandwidth part for which CSI shall be reported.

- A UE is not expected to be configured with *csi-ReportingBand* which contains a subband where a CSI-RS resource linked to the CSI Report setting has the frequency density of each CSI-RS port per PRB in the subband less than the configured density of the CSI-RS resource.

- If a CSI-IM resource is linked to the CSI Report Setting, a UE is not expected to be configured with *csi-ReportingBand* which contains a subband where not all PRBs in the subband have the CSI-IM REs present.

- wideband CQI or subband CQI reporting, as configured by the higher layer parameter *cqi-FormatIndicator*. When wideband CQI reporting is configured, a wideband CQI is reported for each codeword for the entire CSI reporting band. When subband CQI reporting is configured, one CQI for each codeword is reported for each subband in the CSI reporting band.

- wideband PMI or subband PMI reporting as configured by the higher layer parameter *pmi-FormatIndicator*. When wideband PMI reporting is configured, a wideband PMI is reported for the entire CSI reporting band. When subband PMI reporting is configured, except with 2 antenna ports, a single wideband indication (*i1* in Clause 5.2.2.2) is reported for the entire CSI reporting band and one subband indication (*i2* in clause 5.2.2.2) is reported for each subband in the CSI reporting band. When subband PMIs are configured with 2 antenna ports, a PMI is reported for each subband in the CSI reporting band.

- a UE is not expected to be configured with *pmi-FormatIndicator* if *codebookType* is set to 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'.

A CSI Reporting Setting is said to have a wideband frequency-granularity if

- *reportQuantity* is set to 'cri-RI-PMI-CQI', or 'cri-RI-LI-PMI-CQI', *cqi-FormatIndicator* is set to 'widebandCQI' and *pmi-FormatIndicator* is set to 'widebandPMI', or

- *reportQuantity* is set to 'cri-RI-PMI-CQI', *codebookType* is set to 'typeII-PortSelection-r17', 'typeII-CJT-PortSelection-r18' or 'typeII-Doppler-PortSelection-r18' with and *cqi-FormatIndicator* is set to 'widebandCQI', or

- *reportQuantity* is set to 'cri-RI-i1' or

- *reportQuantity* is set to 'cri-RI-CQI' or 'cri-RI-i1-CQI' and *cqi-FormatIndicator* is set to 'widebandCQI', or

- *reportQuantity* is set to 'cri-RSRP' or 'ssb-Index-RSRP' or 'cri-SINR', or 'ssb-Index-SINR' or 'cri-RSRP-Index' or 'ssb-Index-RSRP-Index' or 'cri-SINR-Index', or 'ssb-Index-SINR-Index', or

- *reportQuantity* is set to 'tdcp'

otherwise, the CSI Reporting Setting is said to have a subband frequency-granularity.

A CSI Reporting Setting with *codebookType* set to 'typeI-SinglePanel' and the corresponding CSI-RS Resource Set for channel measurement configured with two Resource Groups and Resource Pairs, as described in clause 5.2.1.4.1, can be configured with wideband frequency-granularity only if *csi-ReportMode* is set to 'Mode1' and *numberOfSingleTRP-CSI-Mode1* is set to , as described in clause 5.2.1.4.2.

If the UE is configured with a CSI Reporting Setting for a bandwidth part with fewer than 24 PRBs, the CSI reporting setting is expected to have a wideband frequency-granularity, and, if applicable, the higher layer parameter *codebookType* is set to 'typeI-SinglePanel'.

The first subband size is given by  and the last subband size given by  if  and if 

If a UE is configured with semi-persistent CSI reporting, the UE shall report CSIwhen both CSI-IM and NZP CSI-RS resources are configured as periodic or semi-persistent. If a UE is configured with aperiodic CSI reporting, the UE shall report CSIwhen both CSI-IM and NZP CSI-RS resources are configured as periodic, semi-persistent or aperiodic.

A UE configured with DCI format 0\_1 or 0\_2 does not expect to be triggered with multiple CSI reports with the same *CSI-ReportConfigId*.

5.2.1.4.1 Resource Setting configuration

For aperiodic CSI, each trigger state configured using the higher layer parameter *CSI-AperiodicTriggerState* is associated with one or multiple *CSI-ReportConfig* where the *CSI-ReportConfig* not configured with *groupBasedBeamReporting-r17* is linked to periodic, or semi-persistent, or aperiodic resource setting(s):

- When one Resource Setting is configured, the Resource Setting (given by higher layer parameter *resourcesForChannelMeasurement*) is for channel measurement for L1-RSRP or for channel and interference measurement for L1-SINR computation.

- When two Resource Settings are configured, the first one Resource Setting (given by higher layer parameter *resourcesForChannelMeasurement*) is for channel measurement and the second one (given by either higher layer parameter *csi-IM-ResourcesForInterference* or higher layer parameter *nzp-CSI-RS-ResourcesForInterference*) is for interference measurement performed on CSI-IM or on NZP CSI-RS.

- When three Resource Settings are configured, the first Resource Setting (higher layer parameter *resourcesForChannelMeasurement*) is for channel measurement, the second one (given by higher layer parameter *csi-IM-ResourcesForInterference*) is for CSI-IM based interference measurement and the third one (given by higher layer parameter *nzp-CSI-RS-ResourcesForInterference*) is for NZP CSI-RS based interference measurement.

For aperiodic CSI, and for periodic and semi-persistent CSI resource settings, each trigger state configured using the higher layer parameter *CSI-AperiodicTriggerState* is associated with one or multiple *CSI-ReportConfig* where the *CSI-ReportConfig* configured with *groupBasedBeamReporting-r17* is linked to periodic or semi-persistent, setting(s):

- When one Resource Setting is configured, the Resource setting is given by *resourcesForChannelMeasurement* for L1-RSRP measurement. In such a case, the number of configured CSI Resource Sets in the Resource Setting is S=2

For aperiodic CSI, and for aperiodic CSI resource settings, each trigger state configured using the higher layer parameter *CSI-AperiodicTriggerState* is associated with one or multiple *CSI-ReportConfig* where the *CSI-ReportConfig* configured with *groupBasedBeamReporting-r17* is associated with *resourcesForChannel* and *resourcesForChannel2*, which correspond to first and second resource sets, respectively, for L1-RSRP measurement.

For semi-persistent or periodic CSI, each *CSI-ReportConfig* is linked to periodic or semi-persistent Resource Setting(s):

- When one Resource Setting (given by higher layer parameter *resourcesForChannelMeasurement*) is configured, the Resource Setting is for channel measurement for L1-RSRP or for channel and interference measurement for L1-SINR computation.

- When two Resource Settings are configured, the first Resource Setting (given by higher layer parameter *resourcesForChannelMeasurement*) is for channel measurement and the second Resource Setting (given by higher layer parameter *csi-IM-ResourcesForInterference*) is used for interference measurement performed on CSI-IM. For L1-SINR computation, the second Resource Setting (given by higher layer parameter *csi-IM-ResourcesForInterference* or higher layer parameter *nzp-CSI-RS-ResourceForInterference*) is used for interference measurement performed on CSI-IM or on NZP CSI-RS.

For aperiodic CSI, a UE configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'tdcp' is expected to be configured with one CSI Resource Setting (given by higher layer parameter *resourcesForChannelMeasurement*). The CSI Resource Setting can be configured with *trs-Info* and it may be periodic, with CSI-RS Resource Sets or aperiodic, with a single CSI-RS Resource Set. The support of or 3 is subject to UE capability indication. For a periodic *CSI-ResourceConfig*, the UE can assume that all the CSI-RS resources in the CSI-RS Resource Sets share the same QCL-TypeA/C and, if applicable, TypeD. The UE expects that all the CSI-RS resources in the CSI-RS Resource Set(s) are configured with the same bandwidth and subcarrier locations.

A UE is not expected to be configured with more than one CSI-RS resource in resource set for channel measurement for a *CSI-ReportConfig* with the higher layer parameter *codebookType* set to 'typeII', 'typeII-PortSelection', 'typeII-r16', 'typeII-PortSelection-r16', or 'typeII-PortSelection-r17'. A UE is not expected to be configured with more than 64 NZP CSI-RS resources and/or SS/PBCH block resources in resource setting for channel measurement for a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'none', 'cri-RI-CQI', 'cri-RSRP', 'ssb-Index-RSRP', 'cri-SINR' or 'ssb-Index-SINR', 'cri-RSRP- Index', 'ssb-Index-RSRP- Index', 'cri-SINR- Index' or 'ssb-Index-SINR- Index'. If interference measurement is performed on CSI-IM, each CSI-RS resource for channel measurement is resource-wise associated with a CSI-IM resource by the ordering of the CSI-RS resource and CSI-IM resource in the corresponding resource sets. The number of CSI-RS resources for channel measurement equals to the number of CSI-IM resources.

A UE configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI' and *codebookType* set to 'typeII-CJT-r18' or 'typeII-CJT-PortSelection-r18' is expected to be configured with CSI-RS resources in a resource set for channel measurement. If interference measurement is performed on CSI-IM, only one resource is configured in the corresponding *csi-IM-ResourceSet*.

A UE configured with a *CSI-ReportConfig* with the higher layer parameter *N4* and *reportQuantity* set to 'cri-RI-PMI-CQI', is expected to be configured with aperiodic CSI-RS resources or with a single periodic or semi-persistent CSI-RS resource in the resource set for channel measurement. For an aperiodic CSI-RS resource set for channel measurement, the CSI-RS resources are triggered by the same triggering instance and the separation between two consecutive CSI-RS resources is slots, which is configured by higher layer parameter in the *NZP-CSI-RS-ResourceSet*. The UE shall assume that the antenna port with the same port index of the aperiodic CSI-RS resources is the same. If interference measurement is performed on CSI-IM, only one resource is configured in the corresponding *csi-IM-ResourceSet*.

An NZP CSI-RS Resource Set for channel measurement with resources can be configured with two Resource Groups, with resources in Group 1 and resources in Group 2, such that , and with Resource Pairs. Each Resource Pair consists of one resource from Group 1 and one resource from Group 2. The same resource can be associated with two Resource Pairs in frequency range 1 but not in frequency range 2.

Except for L1-SINR, if interference measurement is performed on NZP CSI-RS, a UE does not expect to be configured with more than one NZP CSI-RS resource in the associated resource set within the resource setting for interference measurement. Except for L1-SINR, the UE configured with the higher layer parameter *nzp-CSI-RS-ResourcesForInterference* may expect no more than 18 NZP CSI-RS ports configured in a NZP CSI-RS resource set.

For CSI measurement(s) other than L1-SINR, a UE assumes:

- each NZP CSI-RS port configured for interference measurement corresponds to an interference transmission layer.

- all interference transmission layers on NZP CSI-RS ports for interference measurement take into account the associated EPRE ratios configured in 5.2.2.3.1;

- other interference signal on REs of NZP CSI-RS resource for channel measurement, NZP CSI-RS resource for interference measurement, or CSI-IM resource for interference measurement.

For L1-SINR measurement with dedicated interference measurement resources, a UE assumes:

- the total received power on dedicated NZP CSI-RS resource for interference measurement or dedicated CSI-IM resource for interference measurement corresponds to interference and noise.

5.2.1.4.2 Report Quantity configurations

A UE may be configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to either 'none', 'cri-RI-PMI-CQI ', 'cri-RI-i1', 'cri-RI-i1-CQI', 'cri-RI-CQI', 'cri-RSRP', 'cri-SINR', 'ssb-Index-RSRP', 'ssb-Index-SINR', 'cri-RI-LI-PMI-CQI', 'cri-RSRP- Index', 'ssb-Index-RSRP- Index', 'cri-SINR- Index', 'ssb-Index-SINR- Index' or 'tdcp'.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'none', then the UE shall not report any quantity for the *CSI-ReportConfig*.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI', or 'cri-RI-LI-PMI-CQI', the UE shall report a preferred precoder matrix for the entire reporting band, or a preferred precoder matrix per subband, according to Clause 5.2.2.2.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-i1',

- the UE expects, for that *CSI-ReportConfig,* to be configured with higher layer parameter *codebookType* set to 'typeI-SinglePanel' and *pmi-FormatIndicator* set to 'widebandPMI'and,

- the UE shall report a PMI consisting of a single wideband indication ( in Clause 5.2.2.2.1) for the entire CSI reporting band.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-i1-CQI',

- the UE expects, for that *CSI-ReportConfig,* to be configured with higher layer parameter *codebookType* set to 'typeI-SinglePanel' and *pmi-FormatIndicator* set to 'widebandPMI'and,

- the UE shall report a PMI consisting of a single wideband indication ( in Clause 5.2.2.2.1) for the entire CSI reporting band. The CQI is calculated conditioned on the reported assuming PDSCH transmission with  precoders (corresponding to the same but different  in Clause 5.2.2.2.1), where the UE assumes that one precoder is randomly selected from the set of  precoders for each PRG on PDSCH, where the PRG size for CQI calculation is configured by the higher layer parameter *pdsch-BundleSizeForCSI*.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-CQI',

- if the UE is configured with higher layer parameter *non-PMI-PortIndication* contained in a *CSI-ReportConfig,* *r* ports are indicated in the order of layer ordering for rank *r* and each CSI-RS resource in the CSI resource setting is linked to the *CSI-ReportConfig* based on the order of the associated *NZP-CSI-RS-ResourceId* in the linked CSI resource setting for channel measurement given by higher layer parameter *resourcesForChannelMeasurement*. The configured higher layer parameter *non-PMI-PortIndication* contains a sequence  of port indices, where  are the CSI-RS port indices associated with rank ν and  where is the number of ports in the CSI-RS resource. The UE shall only report RI corresponding to the configured fields of *PortIndexFor8Ranks*.

- if the UE is not configured with higher layer parameter *non-PMI-PortIndication,* the UE assumes, for each CSI-RS resource in the CSI resource setting linked to the *CSI-ReportConfig*, that the CSI-RS port indices  are associated with ranks  where  is the number of ports in the CSI-RS resource.

- When calculating the CQI for a rank, the UE shall use the ports indicated for that rank for the selected CSI-RS resource. The precoder for the indicated ports shall be assumed to be the identity matrix scaled by .

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RSRP', 'ssb-Index-RSRP', 'cri-RSRP- Index' or 'ssb-Index-RSRP- Index',

- if the UE is configured with the higher layer parameter *groupBasedBeamReporting* set to 'disabled', the UE is not required to update measurements for more than 64 CSI-RS and/or SSB resources, and the UE shall report in a single report *nrofReportedRS* (higher layer configured) different CRI or SSBRI for each report setting.

- if the UE is configured with the higher layer parameter *groupBasedBeamReporting* set to 'enabled', the UE is not required to update measurements for more than 64 CSI-RS and/or SSB resources, and the UE shall report in a single reporting instance two different CRI or SSBRI for each report setting, where CSI-RS and/or SSB resources can be received simultaneously by the UE either with a single spatial domain receive filter, or with multiple simultaneous spatial domain receive filters.

- if the UE is configured with the higher layer parameter *groupBasedBeamReporting-r17*, the UE is not required to update measurements for more than 64 CSI-RS and/or SSB resources, and the UE shall report in a single reporting instance *nrofReportedGroups,* if configured, group(s) of two CRIs or SSBRIs selecting one CSI-RS or SSB from each of the two CSI Resource Sets for the report setting, where CSI-RS and/or SSB resources of each group can be received simultaneously by the UE.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-SINR', 'ssb-Index-SINR', 'cri-SINR- Index' or 'ssb-Index-SINR- Index',

- if the UE is configured with the higher layer parameter *groupBasedBeamReporting* set to 'disabled', the UE shall report in a single report *nrofReportedRS* (higher layer configured) different CRI or SSBRI for each report setting.

- if the UE is configured with the higher layer parameter *groupBasedBeamReporting* set to 'enabled', the UE shall report in a single reporting instance two different CRI or SSBRI for each report setting, where CSI-RS and/or SSB resources can be received simultaneously by the UE.If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'tdcp'

- the value of is configured by higher layer parameter *Y*, and delay values, , are configured by higher layer parameter *D*, such that the UE is expected to report the amplitude of TDCP measurement, as defined in Clause 5.1 of [7, TS 38.215], for each of the configured delays. Values of can be configured subject to UE capability. The configurable delay values are , , where the value is restricted to subcarrier spacing configuration , the values other than are applicable to subcarrier spacing configurations , and where the values can be configured subject to UE capability, with .

- For , if the higher layer parameter *phase* is configured, the UE is expected to report the amplitude and phase of TDCP measurement for each of the configured delays, if supported by UE capability.

Except for a *CSI-ReportConfig* configured with *reportQuantity* set to 'cri-RI-PMI-CQI' and *codebookType* set to 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18', or 'typeII-Doppler-PortSelection-r18', if the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RSRP', 'cri-RI-PMI-CQI ', 'cri-RI-i1', 'cri-RI-i1-CQI', 'cri-RI-CQI', 'cri-RI-LI-PMI-CQI', 'cri-SINR', or 'cri-SINR- Index ', and resources are configured in the corresponding resource set for channel measurement, then the UE shall derive the CSI parameters other than CRI conditioned on the reported CRI, where CRI *k* (*k* ≥ 0) corresponds to the configured (*k*+1)-th entry of associated *nzp-CSI-RS-Resources* in the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement, and (*k*+1)-th entry of associated *csi-IM-Resource* in the corresponding *csi-IM-ResourceSet* (if configured) or (*k*+1)-th entry of associated *nzp-CSI-RS-Resources* in the corresponding *NZP-CSI-RS-ResourceSet* (if configured for *CSI-ReportConfig* with *reportQuantity* set to 'cri-SINR' or 'cri-SINR- Index ') for interference measurement. If CSI-RS resources are configured, each resource shall contain at most 16 CSI-RS ports. If CSI-RS resources are configured, each resource shall contain at most 8 CSI-RS ports.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI', *codebookType* set to 'typeII-CJT-r18' or 'typeII-CJT-PortSelection-r18' and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is configured with resources, each resource can contain, at most, 32 CSI-RS ports.

Subject to UE capability, a UE configured with a *CSI-ReportConfig* with the higher layer parameter *N4* and *reportQuantity* set to 'cri-RI-PMI-CQI' is assumed to support UE-side CSI prediction. The reported PMI indicates predicted precoder matrices associated with consecutive slot intervals, each with duration of slots, where the value of is configured by higher layer parameter *N4*. If the UE is configured with an aperiodic CSI-RS resource set for channel measurement, the value, in number of slots, of the time unit is configured by higher layer parameter *d*, where is defined in Clause 5.2.1.4.1. If the UE is configured with a periodic or semi-persistent CSI-RS resource set for channel measurement, the value of is equal to the periodicity of the CSI-RS resource. The earliest of the slot intervals starts at slot , where is the uplink slot in which the CSI is reported and the slot offset is configured by higher layer parameter *delta,* where defined in Clause 5.2.2.5 and the value can be configured subject to UE capability.

- For , the UE is expected to report a predicted PMI for slot interval and the slot offset value can be configured only for . A UE can be configured with if the higher layer parameter *codebookType* is set to 'typeII-Doppler-r18', or 'typeII-Doppler-PortSelection-r18'.

- The reported CQI is associated with slot and the reported PMI.

- For , the UE is expected to report a PMI which indicates predicted precoder matrices associated with slot intervals , for . A UE can be configured with if the higher layer parameter *codebookType* is set to 'typeII-Doppler-r18'.

- The UE is configured by higher layer parameter *TDCQI* to report CQIs for each subband in the CSI reporting band, if *cqi-FormatIndicator* is set to 'subbandCQI', or CQIs for the entire CSI reporting band, if *cqi-FormatIndicator* is set to 'widebandCQI'. For , the second CQI includes a 4-bit wideband CQI index and, if subband CQI reporting is configured, a 2-bit subband CQI index, calculated independently from the first CQI, as described in Clause 5.2.2.1, and the two CQIs are reported in the same CSI report.

- If the higher layer parameter *TDCQI* is set to '1-1', and the CQI is associated with slot and the precoder matrices for slot interval .

- If the higher layer parameter *TDCQI* is set to '1-2', and the CQI is associated with slot and the precoder matrices for slot interval and with slot and the precoder matrices for slot interval .

- If the higher layer parameter *TDCQI* is set to '2', . The first CQI is associated with slot and the precoder matrices for slot interval . The second CQI is associated with slot and the precoder matrices for slot interval .

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI', or 'cri-RI-LI-PMI-CQI' and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is configured with resources, two Resource Groups with resources in Group 1, resources in Group 2, , and Resource Pairs:

- each resource can contain, subject to UE capability, at most 32 CSI-RS ports. For two Resource Groups with resources (i=1,2), if , the resource in NZP-CSI-RS-ResourceSet shall contain at most 32 CSI-RS ports; if , each resource in NZP-CSI-RS-ResourceSet shall contain at most 16 CSI-RS ports; if , each resource in NZP-CSI-RS-ResourceSet shall contain at most 8 CSI-RS ports.

- each of the Resource Pairs is associated to a CRI value.

- The *CSI-ReportConfig* may be configured with higher layer parameter *sharedCMR*. and are the numbers of resources associated to a CRI value, other than the *N* CRIs defined above, in Group 1 and Group 2, respectively, with , such that the total number of CRI values configured for the *CSI-ReportConfig* is .

- If the higher layer parameter *csi-ReportMode* is set to 'Mode1' and the higher layer parameter *numberOfSingleTRP-CSI-Mode1* is set to , ; otherwise,

- if the higher layer parameter *csi-ReportMode* is set to 'Mode1' and the higher layer parameter *numberOfSingleTRP-CSI-Mode1* is set to , or if *csi-ReportMode* is set to 'Mode2',

- if *sharedCMR* is configured: and ; otherwise

- if *sharedCMR* is not configured, only the resources in Group 1 and Group 2 that are not referred to in any Resource Pair are associated to *M* CRI values other than the *N* CRIs defined above.

- If interference measurement is performed on CSI-IM, resources are configured in the corresponding *csi-IM-ResourceSet*. The resources for channel measurement defined above are resource-wise associated with the first CSI-IM resources by the ordering of the CSI-RS resources and CSI-IM resources in the corresponding Resource Set. The Resource Pairs for channel measurement are associated to the last CSI-IM resources by the ordering of the CSI-RS Resource Pairs and CSI-IM resources in the CSI-IM Resource Set. The UE may assume that the two CSI-RS resources for channel measurement in a Resource Pair and the associated CSI-IM resource for interference measurement are resource-wise QCLed with respect to 'typeD'.

- The UE is not expected to be configured with NZP CSI-RS for interference measurement other than the NZP CSI-RS resources for channel measurement configured in the Resource Pairs.

- The UE expects, for that *CSI-ReportConfig,* to be configured with higher layer parameter *codebookType* set to 'typeI-SinglePanel', and

- The UE shall derive the CSI parameters other than CRI(s) conditioned on the reported CRI(s), as follows:

- If the higher layer parameter *csi-ReportMode* is set to 'Mode1' and the higher layer parameter *numberOfSingleTRP-CSI-Mode1* is set to , CRI(s) are reported:

- one CRI corresponds to the configured -th entry of the associated Resource Pairs in the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the corresponding CSI-IM Resource Set, if configured. The UE shall report two RIs, two PMIs, two LIs (if configured), associated to the resource in Group 1 and the resource in Group 2, respectively, of the -th Resource Pair, and one CQI; and

- if , one CRI () corresponds to the configured -th entry of the associated resources in the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the corresponding CSI-IM Resource Set, if configured. The UE shall report one RI, one PMI, one LI (if configured) and one or two CQIs conditioned on CRI ; or

- if , one CRI corresponds to the configured -th entry of the associated resources in Group 1 of the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the associated resources in the corresponding CSI-IM Resource Set, if configured, and one CRI corresponds to the configured -th entry of the associated resources in Group 2 of the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the corresponding CSI-IM Resource Set, if configured. The UE shall report one RI, one PMI, one LI (if configured) and one or two CQIs conditioned on CRI and one RI, one PMI, one LI (if configured) and one or two CQIs conditioned on CRI .

- If the higher layer parameter *csi-ReportMode* is set to 'Mode2', one CRI is reported, which corresponds to the -th entry of the resources or Resource Pairs in the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the associated resources in the corresponding CSI-IM Resource Set, if configured. The first codepoints of the CRI correspond to resources associated to Group 1 and Group 2. The last codepoints of the CRI correspond to the configured Resource Pairs. The UE shall report one RI, one PMI, one LI, if configured, and one or two CQIs conditioned on CRI if ; or two RIs, two PMIs, two LIs, if configured, associated to the resource in Group 1 and the resource in Group 2, respectively, of the -th Resource Pair, and one CQI, otherwise.

- For a reported CRI corresponding to an entry of the Resource Pairs configured in the corresponding CSI-RS Resource Set for channel measurement:

- the UE shall not report a total number of layers larger than four.

- the two RIs are reported with a joint RI index corresponding to one of the four rank combinations: .

- The *CodebookConfig* in *CSI-ReportConfig* can be configured with two RI restriction parameters. One parameter applies to a reported RI when conditioned on a CRI corresponding to an entry of the CSI-RS resources defined above. Another parameter applies to a reported joint RI index when conditioned on a CRI corresponding to an entry of the Resource Pairs and indicates one or more of the four rank combinations that are allowed to correspond to the reported PMIs and RIs.

- The *CodebookConfig* in *CSI-ReportConfig* can be configured with two Codebook Subset Restrictions. The first restriction applies to a reported PMI associated to a CSI-RS resource in Group 1. The second restriction applies to a reported PMI associated to a CSI-RS resource in Group 2.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'ssb-Index-RSRP' or 'ssb-Index-RSRP- Index', the UE shall report SSBRI, where SSBRI *k* (*k* ≥ 0) corresponds to the configured (*k*+1)-th entry of the associated *csi-SSB-ResourceList* in the corresponding *CSI-SSB-ResourceSet.*

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'ssb-Index-SINR' or 'ssb-Index-SINR- Index', the UE shall derive L1-SINR conditioned on the reported SSBRI, where SSBRI *k* (*k* ≥ 0) corresponds to the configured (*k*+1)-th entry of the associated *csi-SSB-ResourceList* in the corresponding *CSI-SSB-ResourceSet* for channel measurement, and (*k*+1)-th entry of associated *csi-IM-Resource* in the corresponding *csi-IM-ResourceSet* (if configured) or (*k*+1)-th entry of associated *nzp-CSI-RS-Resources* in the corresponding *NZP-CSI-RS-ResourceSet* (if configured) for interference measurement.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI', ' cri-RI-i1', 'cri-RI-i1-CQI', 'cri-RI-CQI' or 'cri-RI-LI-PMI-CQI', then the UE is not expected to be configured with more than 8 CSI-RS resources in a CSI-RS resource set contained within a resource setting that is linked to the *CSI-ReportConfig*, except when the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *N4*, *reportQuantity* set to 'cri-RI-PMI-CQI' and the corresponding CSI-RS resource set for channel measurement is aperiodic with resources.

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-LI-PMI-CQI', UE does not expect the *CSI-ReportConfig* to be configured with higher layer parameter *codebookType* set to 'typeII-r16' or 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'.

If the UE is configured with a *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to 'cri-RSRP', 'cri-SINR', 'none', 'cri-RSRP- Index' or 'cri-SINR- Index and the *CSI-ReportConfig* is linked to a resource setting configured with the higher layer parameter *resourceType* set to 'aperiodic', then the UE is not expected to be configured with more than 16 CSI-RS resources in a CSI-RS resource set contained within the resource setting.

The LI indicates which column of the precoder matrix of the reported PMI corresponds to the strongest layer of the codeword corresponding to the largest reported wideband CQI. If two wideband CQIs are reported and have equal value, the LI corresponds to strongest layer of the first codeword. If the UE is configured with a *CSI-ReportConfig* with *reportQuantity* set to 'cri-RI-LI-PMI-CQI' and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is configured with two Resource Groups and Resource Pairs, and the UE reports a CRI associated to a Resource Pair, and a rank combination , the first LI indicates which column of the precoder matrix of the first reported PMI corresponds to the strongest of the first layers of the codeword and the second LI indicates which column of the precoder matrix of the second reported PMI corresponds to the strongest of the last layers of the codeword.

For operation with shared spectrum channel access in FR1, or in FR2-2 when the UE is provided *ChannelAccessMode2-r17* = '*enabled*', if the UE is configured with a *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI ', 'cri-RI-i1', 'cri-RI-i1-CQI', 'cri-RI-CQI' or 'cri-RI-LI-PMI-CQI', the UE shall derive:

- the CSI parameters without averaging two or more instances of any periodic or semi-persistent *nzp-CSI-RS-Resources* in the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement or for interference measurement located in different DL transmissions,

- the instances of the *nzp-CSI-RS-Resources* are not in the same channel occupancy duration indicated by DCI format 2\_0, if the UE is provided at least one of *SlotFormatIndicator* or co*-DurationList*; or

- the instances of the *nzp-CSI-RS-Resources* occur within a set of consecutive symbols which are not all occupied by PDSCH(s) and/or aperiodic CSI-RS(s) indicated by DCI formats, if any, and the corresponding PDCCH(s), if the UE is neither provided with *CO-DurationsPerCell* nor *SlotFormatIndicator*, but is provided with *csi-RS-ValidationWithDCI*

- the interference measurements for computing CSI value based on periodic/semi-persistent CSI-IM measured only in OFDM symbol(s) that fulfill the same conditions under which the UE is expected to receive periodic/semi-persistent CSI-RS as described in Clause 11.1 and Clause 11.1.1 of [6, TS 38.213].

If the UE is configured with the higher layer parameter *SSB-MTC-AdditionalPCI*, the UE is allowed to report in a single reporting instance up to four SSBRIs for each report setting, where SSB resources are associated with PCI indices referring to the PCI of the serving cell and PCI(s) different from the PCI of the serving cell within the set of PCIs configured.

<omitted text>

##### 5.2.1.4.5 TDCP Reporting

For a *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to ‘tdcp’ and higher layer parameters and , the reported TDCP amplitude(s) corresponding to the configured delays are indicated by

and the corresponding amplitude values are obtained from: , for , where the mapping from to is given in Table 5.2.1.4.5-1.

**Table 5.2.1.4.5-1: Mapping of elements of : to TDCP amplitudes:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | |  |  | | | 0 |  | | 1 |  | | 2 |  | | 3 |  | | |  |  | | --- | --- | |  |  | | | 4 |  | | 5 |  | | 6 |  | | 7 |  | | |  |  | | --- | --- | |  |  | | | 8 |  | | 9 |  | | 10 |  | | 11 |  | | |  |  | | --- | --- | |  |  | | | 12 |  | | 13 |  | | 14 |  | | 15 |  | |

For , if the higher layer parameter *phase* is configured, the reported TDCP phases are indicated by

and the corresponding phase values are given by: .

<omitted text>

5.2.1.6 CSI processing criteria

The UE indicates the number of supported simultaneous CSI calculations with parameter *simultaneousCSI-ReportsPerCC* in a component carrier, and *simultaneousCSI-ReportsAllCC* across all component carriers. If a UE supports simultaneous CSI calculations it is said to have CSI processing units for processing CSI reports. If *L* CPUs are occupied for calculation of CSI reports in a given OFDM symbol, the UE has unoccupied CPUs. If *N* CSI reports start occupying their respective CPUs on the same OFDM symbol on which CPUs are unoccupied, where each CSI report corresponds to , the UE is not required to update the requested CSI reports with lowest priority (according to Clause 5.2.5), where is the largest value such that holds.

A UE is not expected to be configured with an aperiodic CSI trigger state containing more than Reporting Settings. Processing of a CSI report occupies a number of CPUs for a number of symbols as follows:

- for a CSI report with *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to 'none' and *CSI-RS-ResourceSet* with higher layer parameter *trs-Info* configured

- for a CSI report with *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to 'cri-RSRP', 'ssb-Index-RSRP', 'cri-SINR', 'ssb-Index-SINR', 'cri-RSRP- Index', 'ssb-Index-RSRP- Index', 'cri-SINR- Index', 'ssb-Index-SINR- Index ' or 'none' (and *CSI-RS-ResourceSet* with higher layer parameter *trs-Info* not configured)

- , for a CSI report with *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to 'tdcp' and with number of delays configured by higher layer parameter *Y*, where the value of is reported by UE capability.

- for a CSI report with *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI', 'cri-RI-i1', 'cri-RI-i1-CQI', 'cri-RI-CQI', or 'cri-RI-LI-PMI-CQI',

- if max{ *µPDCCH*, *µCSI-RS, µUL*} ≤ 3, and if a CSI report is aperiodically triggered without transmitting a PUSCH with either transport block or HARQ-ACK or both when *L* = 0 CPUs are occupied, where the CSI corresponds to a single CSI with wideband frequency-granularity and to at most 4 CSI-RS ports in a single resource without CRI report and where *codebookType* is set to 'typeI-SinglePanel' or where *reportQuantity* is set to 'cri-RI-CQI', ,

- if a *CSI-ReportConfig* is configured with *codebookType* set to 'typeI-SinglePanel' and the corresponding CSI-RS Resource Set for channel measurement is configured with two Resource Groups and Resource Pairs, , where is the number of CPUs occupied by a pair of CMRs subject to *mTRP-CSI-numCPU-r17* and is defined in clause 5.2.1.4.2,

- if a *CSI-ReportConfig* is configured with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI', *codebookType* set to 'typeII-CJT-r18' or 'typeII-CJT-PortSelection-r18' and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is configured with resources, , where is reported by UE capability indication,

- if a *CSI-ReportConfig* is configured with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI' and with *codebookType* set to 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18',

- if the corresponding CSI-RS Resource Set for channel measurement is aperiodic and configured with CSI-RS resources, , where is reported by UE capability indication,

- if the corresponding CSI-RS Resource Set for channel measurement is periodic or semi-persistent and configured with a single CSI-RS resource, for and , for , where the value of is configured by the higher layer parameter *N4*, and is reported by UE capability indication,

- otherwise, , where is the number of CSI-RS resources in the CSI-RS resource set for channel measurement.

For a CSI report with *CSI-ReportConfig* with higher layer parameter *reportQuantity* not set to 'none', the CPU(s) are occupied for a number of OFDM symbols as follows:

- A periodic or semi-persistent CSI report (excluding an initial semi-persistent CSI report on PUSCH after the PDCCH triggering the report) occupies CPU(s) from the first symbol of the earliest one of each CSI-RS/CSI-IM/SSB resource for channel or interference measurement, respective latest CSI-RS/CSI-IM/SSB occasion no later than the corresponding CSI reference resource, until the last symbol of the configured PUSCH/PUCCH carrying the report.

- An aperiodic CSI report occupies CPU(s) from the first symbol after the PDCCH triggering the CSI report until the last symbol of the scheduled PUSCH carrying the report. When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the purpose of determining the CPU occupation duration, the PDCCH candidate that ends later in time is used.

- An initial semi-persistent CSI report on PUSCH after the PDCCH trigger occupies CPU(s) from the first symbol after the PDCCH until the last symbol of the scheduled PUSCH carrying the report. When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the purpose of determining the CPU occupation duration, the PDCCH candidate that ends later in time is used.

For a CSI report with *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to 'none' and *CSI-RS-ResourceSet* with higher layer parameter *trs-Info* not configured, the CPU(s) are occupied for a number of OFDM symbols as follows:

- A semi-persistent CSI report (excluding an initial semi-persistent CSI report on PUSCH after the PDCCH triggering the report) occupies CPU(s) from the first symbol of the earliest one of each transmission occasion of periodic or semi-persistent CSI-RS/SSB resource for channel measurement for L1-RSRP computation, until symbols after the last symbol of the latest one of the CSI-RS/SSB resource for channel measurement for L1-RSRP computation in each transmission occasion.

- An aperiodic CSI report occupies CPU(s) from the first symbol after the PDCCH triggering the CSI report until the last symbol between symbols after the first symbol after the PDCCH triggering the CSI report and symbols after the last symbol of the latest one of each CSI-RS/SSB resource for channel measurement for L1-RSRP computation.

where are defined in the table 5.4-2.

In any slot, the UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active BWPs than reported as capability. NZP CSI-RS resource is active in a duration of time defined as follows. For aperiodic CSI-RS, starting from the end of the PDCCH containing the request and ending at the end of the scheduled PUSCH containing the report associated with this aperiodic CSI-RS. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinking*, for the purpose of determining the NZP CSI-RS resource active duration, the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used. For semi-persistent CSI-RS, starting from the end of when the activation command is applied, and ending at the end of when the deactivation command is applied. For periodic CSI-RS, starting when the periodic CSI-RS is configured by higher layer signalling, and ending when the periodic CSI-RS configuration is released.

If a CSI-RS resource is referred *N* times by one or more CSI Reporting Settings, the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are counted *N* times.

For a CSI-RS Resource Set for channel measurement configured with two Resource Groups and Resource Pairs, if a CSI-RS resource is referred times by one of the CSI-RS resources, where is defined in clause 5.2.1.4.2, and/or one or two Resource Pairs, the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are counted times.

For a periodic or semi-persistent CSI-RS resource in a CSI-RS resource set for channel measurement linked to a *CSI-ReportConfig* configured with the higher layer parameter *codebookType* set to 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18', the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are counted times, where the value of is indicated by UE capability.

<omitted text>

### 5.2.2 Channel state information

<omitted text>

5.2.2.2.8 Enhanced Type II codebook for CJT

For 4 antenna ports {3000, 3001, …, 3003}, 8 antenna ports {3000, 3001, …, 3007}, 12 antenna ports {3000, 3001, …, 3011}, 16 antenna ports {3000, 3001, …, 3015}, 24 antenna ports {3000, 3001, …, 3023}, and 32 antenna ports {3000, 3001, …, 3031} per CSI-RS resource, and the UE configured with CSI-RS resources in a resource set for channel measurement and with higher layer parameter *codebookType* set to 'typeII-CJT-r18'

- the values of , and , are the same for all CSI-RS resources and configured with the higher layer parameter. The supported configurations of for a given number of CSI-RS ports and the corresponding values of are given in Table 5.2.2.2.1-2. The number of CSI-RS ports, , is for each of the CSI-RS resources.

- A set of combinations of values of is configured by the higher layer parameter *paramCombination-CJT-L-r18*, where the value of is configured by the higher layer parameter *numberOfSDCombinations* and the mapping is given in Table 5.2.2.2.8-1, with the value of corresponding to CSI-RS resource , for . A single value of and is configured by the higher layer parameter *paramCombination-CJT-r18*, where the mapping is given in Table 5.2.2.2.8-2. The configurable combinations of and are marked with 'x' in Table 5.2.2.2.8-3.

- The UE is not expected to be configured with *paramCombination-CJT-L-r18* equal to

- 2, 3, 5, 6, 7, 9, 10, 11, 12, 14, 15 or 16 when ,

- 3 when

- 3 when higher layer parameter *typeII-CJT-RI-Restriction-r18* is configured with for any .

- 3 when .

- If , the UE is expected to select one of the configured combinations of and report the index of the selected combination, where the index value 0 corresponds to the first configured combination and the index value corresponds to the -th configured combination. If , a single combination of is configured and the selection is not reported.

**Table 5.2.2.2.8-1: Codebook parameter configurations for**

|  |  |  |
| --- | --- | --- |
|  | *paramCombination-CJT-L-r18* |  |
| 1 | 1 | {2} |
| 2 | {4} |
| 3 | {6} |
| 2 | 4 | {2,2} |
| 5 | {2,4} |
| 6 | {4,2} |
| 7 | {4,4} |
| 3 | 8 | {2,2,2} |
| 9 | {2,2,4} |
| 10 | {2,4,2} |
| 11 | {4,2,2} |
| 12 | {4,4,4} |
| 4 | 13 | {2,2,2,2} |
| 14 | {2,2,2,4} |
| 15 | {2,2,4,4} |
| 16 | {4,4,4,4} |

**Table 5.2.2.2.8-2: Codebook parameter configurations for**

|  |  |  |  |
| --- | --- | --- | --- |
| *paramCombination-CJT-r18* |  | |  |
|  |  |
| 1 | 1/8 | 1/16 | ¼ |
| 2 | 1/8 | 1/16 | ½ |
| 3 | ¼ | 1/8 | ¼ |
| 4 | ¼ | 1/8 | ½ |
| 5 | ¼ | ¼ | ¾ |
| 6 | ½ | ¼ | ½ |
| 7 | ½ | ½ | ½ |

**Table 5.2.2.2.8-3: Configurable combinations of and**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *paramCombination-CJT-L-r18* | *paramCombination-CJT-r18* | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 |  |  | x | x |  |  |  |
| 2 |  |  | x | x | x | x |  |
| 3 |  |  |  | x | x |  |  |
| 4 | x |  |  |  |  |  |  |
| 5 | x |  |  |  |  |  |  |
| 6 | x |  |  |  |  |  |  |
| 7 |  | x |  | x |  |  | x |
| 8 | x | x |  |  |  |  |  |
| 9 | x | x |  |  |  |  |  |
| 10 | x | x |  |  |  |  |  |
| 11 | x | x |  |  |  |  |  |
| 12 | x | x | x | x | x |  | x |
| 13 | x |  |  |  |  |  |  |
| 14 | x |  |  |  |  |  |  |
| 15 |  |  |  | x | x |  |  |
| 16 |  | x |  | x | x |  |  |

- The value of is configured with the higher-layer parameter *numberOfPMI-SubbandsPerCQI-Subband-CJT-r18*, where and the corresponding value of are defined as in clause 5.2.2.2.5.

- The UE shall report the RI value according to the configured higher layer parameter *typeII-CJT-RI-Restriction-r18*. The UE shall not report . The bitmap parameter *typeII-CJT-RI-Restriction-r18* forms the bit sequence where is the LSB and is the MSB. When is zero, , PMI and RI reporting are not allowed to correspond to any precoder associated with layers.

- The UE may be configured with higher layer parameter *restrictedCMR-Selection*. If *restrictedCMR-Selection* is configured, the number of selected CSI-RS resources is . Otherwise, the UE is expected to select CSI-RS resources, with , and the selection is reported with an -bit bitmap, , where the CSI-RS resources are mapped from bit to bit by their ordering in the resource set and the first of the selected CSI-RS resources corresponds to the nonzero bit with lowest index.

The PMI value for the selected CSI-RS resources corresponds to the codebook indices of and where

The precoding matrices indicated by the PMI are determined from vectors, where are the indices of the selected CSI-RS resources in increasing order, such that , and are the corresponding values from the selected combination of .

The vectors, , , corresponding to the -th selected CSI-RS resource, for , are indicated by , , where

and

Let

and

the index , for the -th selected CSI-RS resource, , is obtained from the indices + , , as described in Clause 5.2.2.2.3 for the indicator , obtained from the indices + , . Vector is then derived from the indices and , as described in Clause 5.2.2.2.3 for vector , derived from indices , .

The vectors, , , for layer are common for all the selected CSI-RS resources and are indicated by (for ) and , which are obtained as described in Clause 5.2.2.2.5, where is derived from the selected vectors identified by the indices , . The vectors’ elements are given by

for , and .

If the higher layer parameter *codebookMode* is set to 'mode1', an offset is reported for the -th selected CSI-RS resource, with , relative to the first of the selected CSI-RS resources. The reported offsets are common for all layers and are indicated by , given by

where the value of is configured by higher layer parameter *numberOfO3*. The offsets are represented by

If *codebookMode* is set to 'mode2’, the offset indicator, , is not reported and for .

The reference amplitude coefficient indicator , for layer , is given by

The reference amplitude coefficients for layer are represented by

and the mapping from , to is given in Table 5.2.2.2.5-2.

The amplitude coefficient indicator , for layer , is given by

The amplitude coefficients for layer are represented by

and the mapping from to is given in Table 5.2.2.2.5-3.

The phase coefficient indicator , for , is given by

The phase coefficients for layer are represented by

and the mapping from to is given by

Let . The bitmap whose nonzero bits identify which coefficients in and are reported for layer , is indicated by

Let be the number of nonzero coefficients for layer , the total number of nonzero coefficients is reported and given by .

The indices of , and are associated to the selected CSI-RS resources.

Let and be the indices which identify the strongest coefficient of layer , for , *i.e.*, the element of , where the indices , are such that . The codebook indices of are remapped with respect to as , such that , after remapping. The index is remapped with respect to as , such that the index of the strongest coefficient is , for each layer , after remapping. The indices of , and indicate amplitude coefficients, phase coefficients and bitmap after remapping.

The strongest coefficient of layer is identified by

and is obtained as follows, where, for , and index is such that

The amplitude and phase coefficient indicators are reported as follows:

- , , and , for . The reference amplitude, , amplitude coefficient, and phase coefficient,, are not reported for .

- The reference amplitude, , is reported for .

- The amplitude coefficients, , for which , , are reported.

- The phase coefficients, , for which , , are reported.

- The remaining amplitude coefficients, , are not reported.

- The remaining phase coefficients, , are not reported.

The codebooks for 1-4 layers are given in Table 5.2.2.2.8-4, where , is the index associated with the precoding matrix, is the layer index, and where, for coefficients with , amplitude and phase are set to zero, *i.e.*, and .

**Table 5.2.2.2.8-4: Codebook for 1-layer. 2-layer, 3-layer and 4-layer CSI reporting using antenna ports 3000 to 2999+*P*CSI‑RS of selected CSI-RS resources**

|  |  |
| --- | --- |
| **Layers** |  |
|
|  |  |
|  |  |
|  |  |
|  |  |
| Where  , ,  and the mappings from to , , , , , , , , , and from to , , , , , , , , , , , are as described above, including the ranges of the constituent indices of and . | |

The bitmap parameter *n1-n2-codebookSubsetRestriction-CJT-r18* is configured per CSI-RS resource and for at least one of the CSI-RS resources, and it is configured as described in Clause 5.2.2.2.5, where only the bit values ‘00’ or ‘11’ of Table 5.2.2.2.5-6 are configurable. If parameter *n1-n2-codebookSubsetRestriction-CJT-r18* is not configured for a CSI-RS resource, no restriction is applied to the selection of vectors corresponding to that resource.

5.2.2.2.9 Further enhanced Type II port selection codebook for CJT

For 4 antenna ports {3000, 3001, …, 3003}, 8 antenna ports {3000, 3001, …, 3007}, 12 antenna ports {3000, 3001, …, 3011}, 16 antenna ports {3000, 3001, …, 3015}, 24 antenna ports {3000, 3001, …, 3023}, and 32 antenna ports {3000, 3001, …, 3031} per CSI-RS resource, the UE configured with CSI-RS resources in a resource set for channel measurement and with higher layer parameter *codebookType* set to 'typeII-CJT-PortSelection-r18'

- the number of CSI-RS ports for each CSI-RS resource, , is configured as in clause 5.2.2.2.4.

- A set of combinations of values of is configured by the higher layer parameter *paramCombination-CJT-PS-alpha-r18*, where the value of is configured by the higher layer parameter *numberOfSDCombinations-PS* and the mapping is given in Table 5.2.2.2.9-1, with the value of corresponding to CSI-RS resource , for . A single value of and is configured by the higher layer parameter *paramCombination-CJT-PS-r18*, where the mapping is given in Table 5.2.2.2.9-2. The configurable combinations of and are marked with 'x' in Table 5.2.2.2.9-3.

- The UE is not expected to be configured with *paramCombination-CJT-PS-alpha-r18* equal to

- 2, 7, 10, 11 or 12 when ,

- 3, 8, 16 or 20 when *paramCombination-CJT-PS-r18* is configured to 4 or 5 and ,

- 1, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 17, 18 or 19 when and higher layer parameter t*ypeII-CJT-PS-RI-Restriction-r18* is configured with for any .

- If , the UE is expected to select one of the configured combinations of and report the index of the selected combination, where the index value 0 corresponds to the first configured combination and the index value corresponds to the -th configured combination. If , a single combination of is configured and the selection is not reported.

**Table 5.2.2.2.9-1: Codebook parameter configurations for**

|  |  |  |
| --- | --- | --- |
|  | *paramCombination-CJT-PS-alpha-r18* |  |
| 1 | 1 | {1/2} |
| 2 | {3/4} |
| 3 | {1} |
| 2 | 4 | {1/2,1/2} |
| 5 | {1/2,1} |
| 6 | {1,1/2} |
| 7 | {3/4,3/4} |
| 8 | {1,1} |
| 3 | 9 | {1/2,1/2,1/2} |
| 10 | {1/2,1/2,3/4} |
| 11 | {1/2,3/4,1/2} |
| 12 | {3/4,1/2,1/2} |
| 13 | {1/2,1/2,1} |
| 14 | {1/2,1,1/2} |
| 15 | {1,1/2,1/2} |
| 16 | {1,1,1} |
| 4 | 17 | {1/2,1/2,1/2,1/2} |
| 18 | {1/2,1/2,1/2,1} |
| 19 | {1/2,1/2,1,1} |
| 20 | {1,1,1,1} |

**Table 5.2.2.2.9-2: Codebook parameter configurations for**

|  |  |  |
| --- | --- | --- |
| *paramCombination-CJT-PS-r18* |  |  |
| 1 | 1 | ½ |
| 2 | 1 | ¾ |
| 3 | 1 | 1 |
| 4 | 2 | ½ |
| 5 | 2 | ¾ |

**Table 5.2.2.2.9-3: Configurable combinations of and**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *paramCombination-CJT-PS-alpha-r18* | *paramCombination-CJT-PS-r18* | | | | |
| 1 | 2 | 3 | 4 | 5 |
| 1 |  |  |  | x |  |
| 2 | x |  |  | x |  |
| 3 | x | x | x | x | x |
| 4 | x |  |  | x |  |
| 5 | x |  |  |  |  |
| 6 | x |  |  |  |  |
| 7 |  | x |  |  |  |
| 8 |  | x |  | x |  |
| 9 | x |  |  | x |  |
| 10 | x |  |  |  |  |
| 11 | x |  |  |  |  |
| 12 | x |  |  |  |  |
| 13 |  | x |  | x |  |
| 14 |  | x |  | x |  |
| 15 |  | x |  | x |  |
| 16 |  | x |  |  | x |
| 17 | x |  |  |  |  |
| 18 | x |  |  |  |  |
| 19 |  | x | x | x |  |
| 20 |  |  | x |  |  |

- The value of is configured with the higher-layer parameter *valueOfN-CJT-r18*, when .

- The value of is configured with the higher-layer parameter *numberOfPMI-SubbandsPerCQI-Subband-CJT-PS-r18*, when , and when , where and the corresponding value of are defined as in clause 5.2.2.2.5.

- The UE shall report the RI value according to the configured higher layer parameter *typeII-CJT-PS-RI-Restriction-r18*. The UE shall not report . The bitmap parameter *typeII-CJT-PS-RI-Restriction-r18* forms the bit sequence , where is the LSB and is the MSB. When is zero, , PMI and RI reporting are not allowed to correspond to any precoder associated with layers.

- The UE may be configured with higher layer parameter *restrictedCMR-Selection*. If *restrictedCMR-Selection* is configured, the number of selected CSI-RS resources is . Otherwise, the UE is expected to select CSI-RS resources, with , and the selection is reported with an -bit bitmap, , where the CSI-RS resources are mapped from bit to bit by their ordering in the resource set and the first of the selected CSI-RS resources corresponds to the nonzero bit with lowest index.

The PMI value for the selected CSI-RS resources corresponds to the codebook indices of and where

The precoding matrices indicated by the PMI are determined from vectors, where are the indices of the selected CSI-RS resources in increasing order, such that , and , , where are the corresponding values from the selected combination of .

ports are selected from the ports of the -th selected CSI-RS resource, for , based on vectors, , , which are indicated by , where

Let

the index , for the -th selected CSI-RS resource, , is obtained from the elements of , as described in Clause 5.2.2.2.7 for the indicator , obtained from the elements of . Vector is a -element column vector containing a value of 1 in the element of index and zeros elsewhere, and where the first element is the element of index 0.

- If for the -th selected CSI-RS resource, , for , and is not reported.

The vectors, , , are common for all the selected CSI-RS resources and are identified by , where

with the indices assigned such that increases with . is indicated by the index , when and , where

- If , or and , is not reported.

- If and , the nonzero offset between and is reported with assuming that (reference for the offset) is 0. The nonzero offset values are mapped to the index values of in increasing order with offset value 1 mapped to index value '0'.

The vectors’ elements are given by

for , and .

If the higher layer parameter *codebookMode* is set to 'mode1', an offset is reported for the -th selected CSI-RS resource, with , relative to the first of the selected CSI-RS resources. The reported offsets are common for all layers and are indicated by , given by

where the value of is configured by higher layer parameter *numberOfO3*. The offsets are represented by

If *codebookMode* is set to 'mode2’, the offset indicator, , is not reported and for .

The reference amplitude coefficient indicator , for layer , is given by

The reference amplitude coefficients for layer are represented by

and the mapping from to is given in Table 5.2.2.2.5-2.

The amplitude coefficient indicator , for layer , is given by

The amplitude coefficients for layer are represented by

and the mapping from to is given in Table 5.2.2.2.5-3.

The phase coefficient indicator , for , is given by

The phase coefficients for layer are represented by

and the mapping from to is given by

Let . The bitmap whose nonzero bits identify which coefficients in and are reported for layer , is indicated by

Let be the number of nonzero coefficients for layer , the total number of nonzero coefficients is reported and given by .

- If and , is not reported, for .

The indices of , and are associated to the selected CSI-RS resources.

Let and be the indices which identify the strongest coefficient of layer , for , *i.e.*, the element of , where the indices , are such that . The strongest coefficient of layer is identified by the index

which is found from

The amplitude and phase coefficient indicators are reported as follows:

- , , and , for . The reference amplitude, , amplitude coefficient, and phase coefficient,, are not reported for .

- The reference amplitude, , is reported for .

- The amplitude coefficients, , for which , , are reported.

- The phase coefficients, , for which , , are reported.

- The remaining amplitude coefficients, , are not reported.

- The remaining phase coefficients, , are not reported.

The codebooks for 1-4 layers are given in Table 5.2.2.2.9-4, where , is the index associated with the precoding matrix, is the layer index, and where, for coefficients with , amplitude and phase are set to zero, *i.e.*, and .

**Table 5.2.2.2.9-4: Codebook for 1-layer. 2-layer, 3-layer and 4-layer CSI reporting using antenna ports 3000 to 2999+*P*CSI‑RS of selected CSI-RS resources**

|  |  |
| --- | --- |
| **Layers** |  |
|
|  |  |
|  |  |
|  |  |
|  |  |
| Where  and the mappings from to, , and from to , , , , , , , , , , , are as described above, including the ranges of the constituent indices of and . | |

5.2.2.2.10 Enhanced Type II codebook for predicted PMI

For 4 antenna ports {3000, 3001, …, 3003}, 8 antenna ports {3000, 3001, …, 3007}, 12 antenna ports {3000, 3001, …, 3011}, 16 antenna ports {3000, 3001, …, 3015}, 24 antenna ports {3000, 3001, …, 3023}, and 32 antenna ports {3000, 3001, …, 3031} per CSI-RS resource, the UE configured with aperiodic CSI-RS resources or with a single periodic or semi-persistent CSI-RS resource in the resource set for channel measurement and with *codebookType* set to 'typeII-Doppler-r18'

- The values of and are configured with the higher layer parameter *n1-n2‑codebookSubsetRestriction-Doppler-r18*. The supported configurations of for a given number of CSI-RS ports and the corresponding values of are given in Table 5.2.2.2.1-2. The number of CSI-RS ports, , is .

- The values of , and are determined by the higher layer parameter *paramCombination-Doppler-r18*, where the mapping is given in Table 5.2.2.2.10-1.

- The UE is not expected to be configured with *paramCombination-Doppler-r18* equal to

- 4, 5, 6, 7, 8, or 9 when ,

- 8 or 9 when

- 8 or 9 when higher layer parameter t*ypeII-Doppler-RI-Restriction-r18* is configured with for any .

- 8 or 9 when .

**Table 5.2.2.2.10-1: Codebook parameter configurations for and**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *paramCombination-Doppler-r18* |  |  | |  |
|  |  |
| 1 | 2 | 1/8 | 1/16 | ¼ |
| 2 | 2 | ¼ | 1/8 | ½ |
| 3 | 4 | ¼ | 1/8 | ¼ |
| 4 | 4 | ¼ | ¼ | ¼ |
| 5 | 4 | ¼ | ¼ | ½ |
| 6 | 4 | ¼ | ¼ | ¾ |
| 7 | 4 | ½ | ¼ | ½ |
| 8 | 6 | ¼ | - | ½ |
| 9 | 6 | ¼ | - | ¾ |

- The value of is configured with the higher-layer parameter *numberOfPMI-SubbandsPerCQI-Subband-Doppler-r18*, where and the corresponding value of are defined as in clause 5.2.2.2.5.

- The UE shall report the RI value according to the configured higher layer parameter *typeII-Doppler-RI-Restriction-r18*. The UE shall not report . The bitmap parameter *typeII-Doppler-RI-Restriction-r18* forms the bit sequence where is the LSB and is the MSB. When is zero, , PMI and RI reporting are not allowed to correspond to any precoder associated with layers.

- The value of is configured by the higher layer parameter *N4*, such that the PMI indicates precoder matrices for each of the consecutive slot intervals of duration slots, as defined in Clause 5.2.1.4.2.

If , the PMI value corresponds to the codebook indices of and as described in Clause 5.2.2.2.5 and the precoder matrices for 1-4 layers are obtained from the PMI codebook as in Table 5.2.2.2.5-5.

If , the PMI value corresponds to the codebook indices of and , where

The precoding matrices indicated by the PMI are determined from vectors, where .

The vectors, , indicated by , and the vectors, , , for layer , indicated by (for ) and , are obtained as in Clause 5.2.2.2.5.

The vectors, , , for layer are identified by , where

with the indices assigned such that increases with . is indicated by the index , for layer , where

- If , , for layer are not reported.

- If, the nonzero offset between and is reported with assuming that (reference for the offset) is 0. The nonzero offset values are mapped to the index values of in increasing order with offset value 1 mapped to index value '0'.

The vectors’ elements are given by

for , and .

The reference amplitude coefficient indicator , for layer , is given by

The reference amplitude coefficients for layer are represented by

and the mapping from to is given in Table 5.2.2.2.5-2.

The amplitude coefficient indicator , for layer , is given by

The amplitude coefficients for layer are represented by

and the mapping from to is given in Table 5.2.2.2.5-3.

The phase coefficient indicator , for , is given by

The phase coefficients for layer are represented by

and the mapping from to is given by

Let . The bitmap whose nonzero bits identify which coefficients in and are reported for layer , is indicated by

Let be the number of nonzero coefficients for layer , the total number of nonzero coefficients is reported and given by .

The indices of , and are associated to the codebook indices in .

Let , and be the indices which identify the strongest coefficient of layer , for , *i.e.*, the element of . The codebook indices of are remapped with respect to as , such that , after remapping. The index is remapped with respect to as , such that the index of the strongest coefficient is (), after remapping. The indices of , and indicate amplitude coefficients, phase coefficients and bitmap after remapping.

The strongest coefficient of layer is identified by , which is obtained as follows, where, for , and index is such that

The amplitude and phase coefficient indicators are reported as follows:

- , , and , for . The reference amplitude, , amplitude coefficient, and phase coefficient,, are not reported for .

- The reference amplitude, , is reported for .

- The amplitude coefficients, , for which , , are reported.

- The phase coefficients, , for which , are reported.

- The remaining amplitude coefficients, , are not reported.

- The remaining phase coefficients, , are not reported.

The codebooks for 1-4 layers are given in Table 5.2.2.2.10-2, where , are the indices associated with the precoding matrix, is the layer index, and where, for coefficients with , amplitude and phase are set to zero, *i.e.*, and .

**Table 5.2.2.2.10-2: Codebook for 1-layer. 2-layer, 3-layer and 4-layer CSI reporting using antenna ports 3000 to 2999+*P*CSI‑RS**

|  |  |
| --- | --- |
| **Layers** |  |
|
|  |  |
|  |  |
|  |  |
|  |  |
| Where  and the mappings from to , , , , , , , , , , , and from to , , , , , , , , , , , are as described above, including the ranges of the constituent indices of and . | |

The bitmap parameter *n1-n2-codebookSubsetRestriction-Doppler-r18* is configured as described in Clause 5.2.2.2.5, where only the bit values ‘00’ or ‘11’ of Table 5.2.2.2.5-6 are configurable.5.2.2.2.11 Further enhanced Type II port selection codebook for predicted PMI

For 4 antenna ports {3000, 3001, …, 3003}, 8 antenna ports {3000, 3001, …, 3007}, 12 antenna ports {3000, 3001, …, 3011}, 16 antenna ports {3000, 3001, …, 3015}, 24 antenna ports {3000, 3001, …, 3023}, and 32 antenna ports {3000, 3001, …, 3031} per CSI-RS resource, the UE configured with aperiodic CSI-RS resources or with a single periodic or semi-persistent CSI-RS resource in the resource set for channel measurement and with *codebookType* set to 'typeII-Doppler-PortSelection-r18'

- the number of CSI-RS ports, , is configured as in clause 5.2.2.2.4.

- The values , and are determined by the higher layer parameter *paramCombination-Doppler-PS-r18*, where the mapping is given in Table 5.2.2.2.7-1 and the applicable configuration restrictions are described in Clause 5.2.2.2.7.

- The parameter is configured with the higher-layer parameter *valueOfN-Doppler-r18*, when .

- The parameter is configured with the higher-layer parameter *numberOfPMI-SubbandsPerCQI-Subband-Doppler-PS-r18*, when , and when , where and the corresponding value of parameter are defined as in clause 5.2.2.2.5.

- The UE shall report the RI value according to the configured higher layer parameter *typeII-Doppler-PS-RI-Restriction-r18*. The UE shall not report . The bitmap parameter *typeII-Doppler-RI-Restriction-r18* forms the bit sequence where is the LSB and is the MSB. When is zero, , PMI and RI reporting are not allowed to correspond to any precoder associated with layers.

- The value of is configured by the higher layer parameter *N4*, such that the PMI indicates precoder matrices for one slot interval of duration slots, as defined in Clause 5.2.1.4.2.

The PMI value corresponds to the codebook indices of and as described in Clause 5.2.2.2.7 and the precoder matrices for 1-4 layers are obtained from the PMI codebook as in Table 5.2.2.2.7-3.

5.2.2.3 Reference signal (CSI-RS)

5.2.2.3.1 NZP CSI-RS

The UE can be configured with one or more NZP CSI-RS resource set configuration(s) as indicated by the higher layer parameters *CSI-ResourceConfig,* and *NZP-CSI-RS-ResourceSet.* Each NZP CSI-RS resource set consists of *K*≥1 NZP CSI-RS resource(s).

The following parameters for which the UE shall assume non-zero transmission power for CSI-RS resource are configured via the higher layer parameter *NZP-CSI-RS-Resource, CSI-ResourceConfig* and *NZP-CSI-RS-ResourceSet* for each CSI-RS resource configuration:

- *nzp-CSI-RS-ResourceId* determines CSI-RS resource configuration identity.

- *periodicityAndOffset* defines the CSI-RS periodicity and slot offset for periodic/semi-persistent CSI-RS. All the CSI-RS resources within one set are configured with the same periodicity, while the slot offset can be same or different for different CSI-RS resources.

- *resourceMapping* defines the number of ports, CDM-type, and OFDM symbol and subcarrier occupancy of the CSI-RS resource within a slot that are given in Clause 7.4.1.5 of [4, TS 38.211].

- *nrofPorts* in *resourceMapping* defines the number of CSI-RS ports, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211].

- *density* in *resourceMapping* defines CSI-RS frequency density of each CSI-RS port per PRB, and CSI-RS PRB offset in case of the density value of 1/2, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211]. For density 1/2, the odd/even PRB allocation indicated in *density* is with respect to the common resource block grid.

- *cdm-Type* in *resourceMapping* defines CDM values and pattern, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211].

*- powerControlOffset*: which is the assumed ratio of PDSCH EPRE to NZP CSI-RS EPRE when UE derives CSI feedback and takes values in the range of [-8, 15] dB with 1 dB step size. For CQI calculation based on a pair of NZP CSI-RS resources, *powerControlOffset* of each NZP CSI-RS resource in the pair of NZP CSI-RS resources for channel measurement is the assumed ratio of EPRE when UE derives CSI feedback and takes values in the range of [-8, 15] dB with 1 dB step size.

*- powerControlOffsetSS*: which is the assumed ratio of NZP CSI-RS EPRE to SS/PBCH block EPRE.

- *scramblingID* defines scrambling ID of CSI-RSwith length of 10 bits.

- *BWP-Id* in *CSI-ResourceConfig* defines which bandwidth part the configured CSI-RS is located in.

- *repetition* in *NZP-CSI-RS-ResourceSet* is associated with a CSI-RS resource set and defines whether UE can assume the CSI-RS resources within the NZP CSI-RS Resource Set are transmitted with the same downlink spatial domain transmission filter or not as described in Clause 5.1.6.1.2. and can be configured only when the higher layer parameter *reportQuantity* associated with all the reporting settings linked with the CSI-RS resource set is set to 'cri-RSRP', 'cri-SINR', 'cri-RSRP- Index', 'cri-SINR- Index' or 'none'.

- *qcl-InfoPeriodicCSI-RS* contains a reference to a *TCI-State* indicating QCL source RS(s) and QCL type(s). If the *TCI-State* is configured with a reference to an RS configured with *qcl-Type* set to 'typeD' association, that RS may be an SS/PBCH block located in the same or different CC/DL BWP or a CSI-RS resource configured as periodic located in the same or different CC/DL BWP. The reference RS may additionally be an SS/PBCH block associated with a PCI different from the PCI of the serving cell.

- *trs-Info* in *NZP-CSI-RS-ResourceSet* is associated with a CSI-RS resource set and for which the UE can assume that the antenna port with the same port index of the configured NZP CSI-RS resources in the *NZP-CSI-RS-ResourceSet* is the same as described in Clause 5.1.6.1.1 and can be configured when reporting setting is not configured or when the higher layer parameter *reportQuantity* associated with all the reporting settings linked with the CSI-RS resource set is set to 'tdcp' or 'none'.

All CSI-RS resources within one set are configured with same *density* and same *nrofPorts*, except for the NZP CSI-RS resources used for interference measurement.

The UE expects that all the CSI-RS resources of a resource set are configured with the same starting RB and number of RBs and the same *cdm-type*.

For a CSI-RS Resource Set for channel measurement configured with two Resource Groups and Resource Pairs, the slot offsets of the two resources in a Resource Pair are configured within slots, without DL/UL switching in between the two resources, where implies that the two resources are configured in the same slot, and implies that the two resources are configured within two adjacent slots.

For a *NZP-CSI-RS-ResourceSet* for channel measurement with resources and linked to a *CSI-ReportConfig* configured with *codebookType* set to 'typeII-CJT-r18' or 'typeII-CJT-PortSelection-r18', the slot offsets of the CSI-RS resources are configured within slots, without DL/UL switching in between the two resources, where implies that the resources are configured in the same slot, and implies that the resources are configured within two adjacent slots.

The bandwidth and initial common resource block (CRB) index of a CSI-RS resource within a BWP, as defined in Clause 7.4.1.5 of [4, TS 38.211], are determined based on the higher layer parameters *nrofRBs* and *startingRB*, respectively, within the CSI-FrequencyOccupation IE configured by the higher layer parameter *freqBand* within the *CSI-RS-ResourceMapping* IE. Both *nrofRBs* and *startingRB* are configured as integer multiples of 4 RBs, and the reference point for *startingRB* is CRB 0 on the common resource block grid. If the UE shall assume that the initial CRB index of the CSI-RS resource is , otherwise . If , the UE shall assume that the bandwidth of the CSI-RS resource is , otherwise . In all cases, the UE shall expect that .

<omitted text>

5.2.2.5 CSI reference resource definition

The CSI reference resource for a serving cell is defined as follows:

- In the frequency domain, the CSI reference resource is defined by the group of downlink physical resource blocks corresponding to the band to which the derived CSI relates.

- In the time domain, the CSI reference resource for a CSI reporting in uplink slot *n'* is defined by a single downlink slot *,* where is a parameter configured by higher layer as specified in clause 4.2 of [6 TS 38.213], and where is the subcarrier spacing configuration for with a value of 0 for frequency range 1,

- where and and are the subcarrier spacing configurations for DL and UL, respectively, and and  are determined by higher-layer configured ca-SlotOffset for the cells transmitting the uplink and downlink, as defined in clause 4.5 of [4, TS 38.211]

- where for periodic and semi-persistent CSI reporting

- if a single CSI-RS/SSB resource is configured for channel measurement *nCSI\_ref* is the smallest value greater than or equal to , such that it corresponds to a valid downlink slot, or

- if multiple CSI-RS/SSB resources are configured for channel measurement *nCSI\_ref* is the smallest value greater than or equal to , such that it corresponds to a valid downlink slot.

- where for aperiodic CSI reporting, if the UE is indicated by the DCI to report CSI in the same slot as the CSI request, *nCSI\_ref* is such that the reference resource is in the same valid downlink slot as the corresponding CSI request, otherwise *nCSI\_ref* is the smallest value greater than or equal to , such that slot *n*- *nCSI\_ref* corresponds to a valid downlink slot, where *Z'* corresponds to the delay requirement as defined in Clause 5.4.

- when periodic or semi-persistent CSI-RS/CSI-IM or SSB is used for channel/interference measurements, the UE is not expected to measure channel/interference on the CSI-RS/CSI-IM/SSB whose last OFDM symbol is received up to *Z'* symbols before transmission time of the first OFDM symbol of the aperiodic CSI reporting.

A slot in a serving cell shall be considered to be a valid downlink slot if:

- it comprises at least one higher layer configured downlink or flexible symbol, and

- it does not fall within a configured measurement gap for that UE

If there is no valid downlink slot for the CSI reference resource corresponding to a CSI Report Setting in a serving cell, CSI reporting is omitted for the serving cell in uplink slot *n'*.

After the CSI report (re)configuration, serving cell activation, BWP change, or activation of SP-CSI, the UE reports a CSI report only after receiving at least one CSI-RS transmission occasion for channel measurement and CSI-RS and/or CSI-IM occasion for interference measurement no later than CSI reference resource and drops the report otherwise.

For a *CSI-ReportConfig* configured with *codebookType* set to 'typeII-CJT-r18' or 'typeII-CJT-PortSelection-r18', the UE reports a CSI report only after receiving at least one CSI-RS transmission occasion for each of the CSI-RS resources in the corresponding CSI-RS Resource Set for channel measurement and/or one CSI-IM occasion for interference measurement no later than the CSI reference resource and within the same DRX Active Time, when DRX is configured, and drops the report otherwise.

For a *CSI-ReportConfig* configured with *codebookType* set to 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18', the UE reports a CSI report only if receiving at least one aperiodic or periodic or semipersistent consecutive CSI-RS transmission occasions for each CSI-RS resource in the corresponding CSI-RS Resource Set for channel measurement and/or one CSI-IM occasion for interference measurement no later than the CSI reference resource and within the same DRX Active Time, when DRX is configured, and drops the report otherwise. The value of is indicated by UE capability, as defined in clause 5.2.1.6.

When DRX is configured, the UE reports a CSI report only if receiving at least one CSI-RS transmission occasion for channel measurement and CSI-RS and/or CSI-IM occasion for interference measurement in DRX Active Time no later than CSI reference resource and drops the report otherwise. When DRX is configured and the CSI-RS Resource Set for channel measurement corresponding to a CSI report is configured with two Resource Groups and Resource Pairs, as described in clause 5.2.1.4.1, the UE reports a CSI report only if receiving at least one CSI-RS transmission occasion for each CSI-RS resource in a Resource Pair within the same DRX Active Time no later than CSI reference resource and drops the report otherwise. When the UE is configured to monitor DCI format 2\_6 and if the UE configured by higher layer parameter *ps-TransmitOtherPeriodicCSI* to report CSI with the higher layer parameter *reportConfigType* set to 'periodic' and *reportQuantity* set to quantities other than 'cri-RSRP', 'ssb-Index-RSRP', 'cri-RSRP- Index', and 'ssb-Index-RSRP- Index ' when *drx-onDurationTimer* is not started, the UE shall report CSI during the time duration indicated by *drx-onDurationTimer* in *DRX-Config* also outside active time according to the procedure described in Clause 5.2.1.4 if receiving at least one CSI-RS transmission occasion for channel measurement and CSI-RS and/or CSI-IM occasion for interference measurement during the time duration indicated by *drx-onDurationTimer* in *DRX-Config* outside DRX active time or in DRX Active Time no later than CSI reference resource and drops the report otherwise. When the UE is configured to monitor DCI format 2\_6 and if the UE configured by higher layer parameter *ps-TransmitPeriodicL1-RSRP* to report L1-RSRP with the higher layer parameter *reportConfigType* set to 'periodic' and *reportQuantity* set to 'cri-RSRP', 'ssb-Index-RSRP', 'cri-RSRP- Index', or 'ssb-Index-RSRP- Index' when *drx-onDurationTimer* is not started, the UE shall report L1-RSRP during the time duration indicated by *drx-onDurationTimer* in *DRX-Config* also outside active time according to the procedure described in clause 5.2.1.4 and when *reportQuantity* set to '*cri-RSRP' or 'cri-RSRP*- *Index'* if receiving at least one CSI-RS transmission occasion for channel measurement during the time duration indicated by *drx-onDurationTimer* in *DRX-Config* outside DRX active time or in DRX Active Time no later than CSI reference resource and drops the report otherwise.

When deriving CSI feedback, the UE is not expected that a NZP CSI -RS resource for channel measurement overlaps with CSI-IM resource for interference measurement or NZP CSI -RS resource for interference measurement.

5.2.2.5.1 UE assumptions for CQI/PMI/RI calculation

If configured to report CQI index, in the CSI reference resource, the UE shall assume the following for the purpose of deriving the CQI index, and if also configured, for deriving PMI and RI:

- The first 2 OFDM symbols are occupied by control signaling.

- The number of PDSCH and DM-RS symbols is equal to 12.

- The same bandwidth part subcarrier spacing configured as for the PDSCH reception

- The bandwidth as configured for the corresponding CQI report.

- The IAB-MT shall only assume the frequency resources as indicated by the DL TX power adjustment MAC CE, if indicated for the slot of the CSI reference resource by DL Tx Power Adjustment MAC CE as described in [10, TS 38.321].

- The reference resource uses the CP length and subcarrier spacing configured for PDSCH reception

- No resource elements used by primary or secondary synchronization signals or PBCH.

- Redundancy Version 0.

- The ratio of PDSCH EPRE to CSI-RS EPRE is as given in Clause 5.2.2.3.1.

- In addition, the IAB-MT shall apply the provided DL TX power adjustment, if indicated for the slot of the CSI reference resource by DL Tx Power Adjustment MAC CE as described in [10, TS 38.321].

- Assume no REs allocated for NZP CSI-RS and ZP CSI-RS.

- Assume the same number of front-loaded DM-RS symbols as the maximum front-loaded symbols configured by the higher layer parameter *maxLength* in *DMRS-DownlinkConfig.*

- Assume the same number of additional DM-RS symbols as the additional symbols configured by the higher layer parameter *dmrs-AdditionalPosition*.

- Assume the PDSCH symbols are not containing DM-RS.

- Assume PRB bundling size of 2 PRBs.

- The PDSCH transmission scheme where the UE may assume that PDSCH transmission would be performed with up to 8 transmission layers as defined in Clause 7.3.1.4 of [4, TS 38.211]. For CQI calculation, the UE should assume that PDSCH signals on antenna ports in the set [1000,…, 1000+ν-1] for ν layers would result in signals equivalent to corresponding symbols transmitted on antenna ports [3000,…, 3000+*P*-1], as given by

where  is a vector of PDSCH symbols from the layer mapping defined in Clause 7.3.1.4 of [4, TS 38.211],  is the number of CSI-RS ports. If only one CSI-RS port is configured, *W(i)* is 1. If the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to either 'cri-RI-PMI-CQI' or 'cri-RI-LI-PMI-CQI', *W(i)* is the precoding matrix corresponding to the reported PMI applicable to *x(i)*. If the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to 'cri-RI-CQI', *W(i)* is the precoding matrix corresponding to the procedure described in Clause 5.2.1.4.2. If the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to 'cri-RI-i1-CQI', *W(i)* is the precoding matrix corresponding to the reported i1 according to the procedure described in Clause 5.2.1.4.2. The corresponding PDSCH signals transmitted on antenna ports [3000,…,3000 + *P* - 1] would have a ratio of EPRE to CSI-RS EPRE equal to the ratio given in Clause 5.2.2.3.1.

5.2.2.5.1a UE assumptions for CQI/PMI/RI calculation for NCJT

If the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to either 'cri-RI-PMI-CQI' or 'cri-RI-LI-PMI-CQI', the corresponding CSI-RS Resource Set for channel measurement is configured with two Resource Groups and Resource Pairs, as described in clause 5.2.1.4.1, the reported CRI corresponds to an entry of the Resource Pairs, and the reported rank combination is , as described in clause 5.2.1.4.2, for CQI calculation, the UE should assume that

- PDSCH signals on antenna ports in the set for layers would result in signals equivalent to corresponding symbols transmitted on antenna ports of the Group 1 CSI-RS resource in the Resource Pair indicated by the CRI, and PDSCH signals on antenna ports in the set for layers would result in signals equivalent to corresponding symbols transmitted on antenna ports of the Group 2 CSI-RS resource in the Resource Pair indicated by the CRI, as given by

where , are the two precoding matrices corresponding to the two reported PMIs applicable to , as described in clause 5.2.1.4.2; and the indices are associated to the two Resource Groups configured in the corresponding CSI-RS Resource Set for channel measurement; that the signals , , fully overlap in time and frequency, and that, for the calculation of RI, PMI and LI (if configured) of layers, , the interference from the other layers is derived from channel measurement and precoding matrix corresponding to the other layers.

- The UE shall assume that the corresponding PDSCH signals for layers transmitted on the antenna ports of the CSI-RS resource in Group would have a ratio of EPRE to CSI-RS EPRE equal to the *powerControlOffset* of the respective CSI-RS resource, for .

5.2.2.5.1b UE assumptions for CQI/PMI/RI calculation for CJT

If the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to 'cri-RI-PMI-CQI', the higher layer parameter *codebookType* is set to 'typeII-CJT-r18' or ' typeII-CJT-PortSelection-r18', and the corresponding CSI-RS Resource Set for channel measurement is configured with CSI-RS resources, for CQI calculation

- a UE should assume PDSCH signals on antenna ports in the set for layers would result in signals equivalent to corresponding symbols transmitted on antenna ports of each of the selected CSI-RS resources, as given by

where is the precoding matrix corresponding to the procedure described in Clause 5.2.2.2.8 and 5.2.2.2.9 for *codebookType* set to 'typeII-CJT-r18' and ' typeII-CJT-PortSelection-r18', respectively, and are the indices of the selected CSI-RS resources in increasing order, such that . A UE should assume that the signals , , fully overlap in time and frequency.

- a UE can assume that the PDSCH signals for layers transmitted on the antenna ports of CSI-RS resource would have the same ratio of EPRE to CSI-RS EPRE for all , equal to the *powerControlOffset* of the respective CSI-RS resource.5.2.2.5.1c UE assumptions for CQI/PMI/RI calculation for predicted CSI

If the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to 'cri-RI-PMI-CQI', the higher layer parameter *codebookType* is set to 'typeII-Doppler-r18' or ' typeII-Doppler-PortSelection-r18', and the corresponding CSI-RS Resource Set for channel measurement is aperiodic with CSI-RS resources, for CQI calculation, a UE can assume the same ratio of EPRE to CSI-RS EPRE for all configured CSI-RS resources.

5.2.3 CSI reporting using PUSCH

A UE shall perform aperiodic CSI reporting using PUSCH on serving cell c upon successful decoding of a DCI format 0\_1 or DCI format 0\_2 which triggers an aperiodic CSI trigger state.

When a DCI format 0\_1 schedules two PUSCH allocations, the aperiodic CSI report is carried on the second scheduled PUSCH. When a DCI format 0\_1 schedules more than two PUSCH allocations, the aperiodic CSI report is carried on the penultimate scheduled PUSCH.

An aperiodic CSI report carried on the PUSCH supports wideband, and sub-band frequency granularities. An aperiodic CSI report carried on the PUSCH supports Type I, Type II, Enhanced Type II, Further Enhanced Type II Port Selection, Enhanced Type II for CJT, Further Enhanced Type II Port Selection for CJT, Enhanced Type II for predicted PMI, Further Enhanced Type II Port Selection for predicted PMI and TDCP reporting.

A UE shall perform semi-persistent CSI reporting on the PUSCH upon successful decoding of a DCI format 0\_1 or DCI format 0\_2 which activates a semi-persistent CSI trigger state. DCI format 0\_1 and DCI format 0\_2 contains a CSI request field which indicates the semi-persistent CSI trigger state to activate or deactivate. Semi-persistent CSI reporting on the PUSCH supports Type I, Type II with wideband, and sub-band frequency granularities, Enhanced Type II, Further Enhanced Type II Port Selection CSI, Enhanced Type II for CJT, Further Enhanced Type II Port Selection for CJT, Enhanced Type II for predicted PMI and Further Enhanced Type II Port Selection for predicted PMI. The PUSCH resources and MCS shall be allocated semi-persistently by an uplink DCI.

CSI reporting on PUSCH can be multiplexed with uplink data on PUSCH except that semi-persistent CSI reporting on PUSCH activated by a DCI format is not expected to be multiplexed with uplink data on the PUSCH. CSI reporting on PUSCH can also be performed without any multiplexing with uplink data from the UE.

Type I CSI feedback is supported for CSI Reporting on PUSCH. Type I wideband and sub-band CSI is supported for CSI Reporting on the PUSCH. Type II CSI is supported for CSI Reporting on the PUSCH.

For Type I, Type II, Enhanced Type II, Further Enhanced Type II Port Selection CSI, Enhanced Type II for CJT, Further Enhanced Type II Port Selection for CJT, Enhanced Type II for predicted PMI and Further Enhanced Type II Port Selection for predicted PMI feedback on PUSCH, a CSI report comprises of two parts. Part 1 has a fixed payload size and is used to identify the number of information bits in Part 2. Part 1 shall be transmitted in its entirety before Part 2.

- For Type I CSI feedback, Part 1 contains RI (if reported), CRI (if reported), CQI for the first codeword (if reported). Part 2 contains PMI (if reported), LI (if reported) and contains the CQI for the second codeword (if reported) when RI is larger than 4. For a *CSI-ReportConfig* configured with *codebookType* set to 'typeI-SinglePanel' and the corresponding CSI-RS Resource Set for channel measurement configured with two Resource Groups and Resource Pairs, Part 1 contains RI(s), CRI(s), CQI(s) for the first codeword and is zero padded to a fixed payload size (if needed). Part 2 contains the CQI(s) for the second codeword (if reported) when RI is larger than 4, LIs (if reported) and PMI(s).

- For Type II CSI feedback, Part 1 contains RI (if reported), CQI, and an indication of the number of non-zero wideband amplitude coefficients per layer for the Type II CSI (see Clause 5.2.2.2.3). The fields of Part 1 – RI (if reported), CQI, and the indication of the number of non-zero wideband amplitude coefficients for each layer – are separately encoded. Part 2 contains the PMI and LI (if reported) of the Type II CSI. The elements of , (if reported) and (if reported) are reported in the increasing order of their indices, , where the element of the lowest index is mapped to the most significant bits and the element of the highest index is mapped to the least significant bits. Part 1 and 2 are separately encoded.

- For Enhanced Type II CSI feedback (see Clause 5.2.2.2.5), Further Enhanced Type II Port Selection CSI feedback (see Clause 5.2.2.2.7), Enhanced Type II for predicted PMI with (see Clause 5.2.2.2.10) and Further Enhanced Type II Port Selection for predicted PMI (see Clause 5.2.2.2.11), Part 1 contains RI (if reported), CQI, and the total number of reported non-zero amplitude coefficients across layers. The fields of Part 1 – RI (if reported), CQI, and the total number of reported non-zero amplitude coefficients across layers – are separately encoded. Part 2 contains the PMI of the Enhanced Type II, Further Enhanced Type II Port Selection CSI, Enhanced Type II for predicted PMI with or Further Enhanced Type II Port Selection for predicted PMI. Part 1 and 2 are separately encoded.

- For Enhanced Type II for CJT (see Clause 5.2.2.2.8) and Further Enhanced Type II Port Selection for CJT (see Clause 5.2.2.2.9), Part 1 contains RI (if reported), CQI, the total number of reported non-zero amplitude coefficients across layers, the bitmap selecting CSI-RS resources (if reported) and the selected combination of (if reported). The fields of Part 1 – RI (if reported), CQI, the total number of reported non-zero amplitude coefficients across layers, the bitmap selecting CSI-RS resources (if reported) and the selected combination of (if reported) – are separately encoded. Part 2 contains the PMI of the Enhanced Type II for CJT or Further Enhanced Type II Port Selection for CJT. Part 1 and 2 are separately encoded.

- For Enhanced Type II for predicted PMI with (see Clause 5.2.2.2.10), Part 1 contains RI (if reported), the CQI (if the higher layer parameter *TDCQI* is set to '1-1' or '1-2') or the first CQI (if the higher layer parameter *TDCQI* is set to '2') and the total number of reported non-zero amplitude coefficients across layers. The fields of Part 1 – RI (if reported), CQI, and the total number of reported non-zero amplitude coefficients across layers – are separately encoded. Part 2 contains the second CQI (if the higher layer parameter *TDCQI* is set to '2') and the PMI of the Enhanced Type II for predicted PMI. Part 1 and 2 are separately encoded.

A Type II CSI report that is carried on the PUSCH shall be computed independently from any Type II CSI report that is carried on the PUCCH formats 3 or 4 (see Clause 5.2.4 and 5.2.2).

When the higher layer parameter *reportQuantity* is configured with one of the values 'cri-RSRP', 'ssb-Index-RSRP', 'cri-SINR' or 'ssb-Index-SINR', or 'cri-RSRP-Index', 'ssb-Index-RSRP-Index ', 'cri-SINR-Index ', 'ssb-Index-SINR-Index', 'tdcp', the CSI feedback consists of a single part.

For both Type I and Type II reports configured for PUCCH but transmitted on PUSCH, the determination of the payload for CSI part 1 and CSI part 2 follows that of PUCCH as described in Clause 5.2.4.

When CSI reporting on PUSCH comprises two parts, the UE may omit a portion of the Part 2 CSI. Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where  is the number of CSI reports configured to be carried on the PUSCH. Priority 0 is the highest priority and priority  is the lowest priority and the CSI report *n* corresponds to the CSI report with the *n*th smallest Prii,CSI(*y,k,c,s*) value among the  CSI reports as defined in Clause 5.2.5. The subbands for a given CSI report *n* indicated by the higher layer parameter *csi-ReportingBand* with value '1' are numbered continuously in increasing order with the lowest subband of *csi-ReportingBand* with value set to '1' as subband 0. When omitting Part 2 CSI information for a particular priority level, the UE shall omit all of the information at that priority level.

- For Enhanced Type II and Enhanced Type II for predicted PMI configured with higher layer parameter , for a given CSI report , each reported element of and , indexed by and , is associated with a priority value , with with , , and , and where is defined in Clause 5.2.2.2.5. The element with the highest priority has the lowest associated value . Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where

- Group 0 includes indices (if reported), (if reported) and ().

- Group 1 includes indices (if reported), (if reported), the highest priority elements of , , the highest priority elements of and the highest priority elements of ().

- Group 2 includes the lowest priority elements of , the lowest priority elements of and the lowest priority elements of ().

- For Further Enhanced Type II Port Selection and Further Enhanced Type II Port Selection for predicted PMI, for a given CSI report , each reported element of and , indexed by , and , is associated with a priority value , with , and . The element with the highest priority has the lowest associated value . Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where:

- Group 0 includes (if reported), () and (if reported).

- Group 1 includes the highest priority elements of (if reported), , the highest priority elements of and the highest priority elements of ().

- Group 2 includes the lowest priority elements of (if reported), the lowest priority elements of and the lowest priority elements of ().

- For Enhanced Type II for CJT reports, for a given CSI report , each reported element of and , indexed by , and , is associated with a priority value , with , for , , and , and where and are defined in Clause 5.2.2.2.8. The element with the highest priority has the lowest associated value . Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where

- Group 0 includes indices (if reported), (if reported) and ().

- Group 1 includes indices (if reported), (if reported), the highest priority elements of , , the highest priority elements of , the highest priority elements of () and (if reported).

- Group 2 includes the lowest priority elements of , the lowest priority elements of and the lowest priority elements of ().

- For Further Enhanced Type II Port Selection for CJT reports, for a given CSI report , each reported element of and , indexed by , , and , is associated with a priority value , for , , and , and where is defined in Clause 5.2.2.2.8. The element with the highest priority has the lowest associated value . Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where:

- Group 0 includes (if reported), () and (if reported).

- Group 1 includes the highest priority elements of (if reported), , the highest priority elements of , the highest priority elements of () and (if reported).

- Group 2 includes the lowest priority elements of (if reported), the lowest priority elements of and the lowest priority elements of ().

- For Enhanced Type II for predicted PMI configured with , for a given CSI report , each reported element of and , indexed by , and , is associated with a priority value , for , , and . The element with the highest priority has the lowest associated value . Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where

- Group 0 includes indices (if reported), (if reported), () and the second wideband CQI (if reported).

- Group 1 includes indices (if reported), (if reported), the highest priority elements of , , the highest priority elements of , the highest priority elements of (), (if reported) and the second subband CQI of even subbands (if reported).

- Group 2 includes the lowest priority elements of , the lowest priority elements of , the lowest priority elements of () and the second subband CQI of odd subbands (if reported).

**Table 5.2.3-1: Priority reporting levels for Part 2 CSI**

|  |
| --- |
| Priority 0:  For CSI reports 1 to , Group 0 CSI for CSI reports configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 wideband CSI for CSI reports configured otherwise |
| Priority 1:  Group 1 CSI for CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for CSI report 1, if configured otherwise |
| Priority 2:  Group 2 CSI for CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for CSI report 1, if configured otherwise |
| Priority 3:  Group 1 CSI for CSI report 2, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for CSI report 2, if configured otherwise |
| Priority 4:  Group 2 CSI for CSI report 2, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'. Part 2 subband CSI of odd subbands for CSI report 2, if configured otherwise |
| ⁞ |
| Priority :  Group 1 CSI for CSI report , if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for CSI report , if configured otherwise |
| Priority :  Group 2 CSI for CSI report , if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for CSI report , if configured otherwise |

When the UE is scheduled to transmit a transport block on PUSCH not using repetition type B multiplexed with a CSI report(s), Part 2 CSI is omitted only when  is larger than , where parameters , , , , , , , , and are defined in Clause 6.3.2.4 of [5, TS 38.212].

Part 2 CSI is omitted level by level, beginning with the lowest priority level until the lowest priority level is reached which causes the  to be less than or equal to .

When the UE is scheduled to transmit a transport block on PUSCH using repetition type B multiplexed with a CSI report(s), Part 2 CSI is omitted only when

is larger than

,

where parameters , , , , , , , , , , , and are defined in Clause 6.3.2.4 of [5, TS 38.212].

Part 2 CSI is omitted level by level, beginning with the lowest priority level until the lowest priority level is reached which causes

to be less than or equal to

.

When part 2 CSI is transmitted on PUSCH with no transport block, lower priority bits are omitted until Part 2 CSI code rate, which is given by where , , are given in clause 6.3.2.4 of [5, 38.212] before HARQ-ACK puncturing part 2 CSI if any, is below a threshold code rate lower than one, where



- is the CSI offset value from Table 9.3-2 of [6, TS 38.213]

- *R* is signaled code rate in DCI

If the UE is in an active semi-persistent CSI reporting configuration on PUSCH, the CSI reporting is deactivated when either the downlink BWP or the uplink BWP is changed. Another activation command is required to enable the semi-persistent CSI reporting.

<omitted text>

5.2.5 Priority rules for CSI reports

For two overlapping PUSCHs, the priority rules in this clause are applied for physical channels with same priority index according to clause 9 in [6, TS 38.213].

CSI reports are associated with a priority value where

-  for aperiodic CSI reports to be carried on PUSCH  for semi-persistent CSI reports to be carried on PUSCH,  for semi-persistent CSI reports to be carried on PUCCH and  for periodic CSI reports to be carried on PUCCH;

-  for CSI reports carrying L1-RSRP or L1-SINR and  for CSI reports not carrying L1-RSRP or L1-SINR;

- *c* is the serving cell index and is the value of the higher layer parameter *maxNrofServingCells*;

- *s* is the *reportConfigID* andis the value of the higher layer parameter *maxNrofCSI-ReportConfigurations.*

A first CSI report is said to have priority over second CSI report if the associated  value is lower for the first report than for the second report.

Two CSI reports are said to collide if the time occupancy of the physical channels scheduled to carry the CSI reports overlap in at least one OFDM symbol and are transmitted on the same carrier. When a UE is configured to transmit two colliding CSI reports,

- if *y* values are different between the two CSI reports, the following rules apply except for the case when one of the *y* value is 2 and the other *y* value is 3 (for CSI reports transmitted on PUSCH, as described in Clause 5.2.3; for CSI reports transmitted on PUCCH, as described in Clause 5.2.4):

- The CSI report with higher  value shall not be sent by the UE.

- otherwise, the two CSI reports are multiplexed or either is dropped based on the priority values, as described in Clause 9.2.5.2 in [6, TS 38.213].

If a semi-persistent CSI report to be carried on PUSCH overlaps in time with PUSCH data transmission in one or more symbols on the same carrier, and if the earliest symbol of these PUSCH channels starts no earlier than N2+d2,1 symbols after the last symbol of the DCI scheduling the PUSCH where d2,1 is the maximum of the d2,1 associated with the PUSCH carrying semi-persistent CSI report and the PUSCH with data transmission, the CSI report shall not be transmitted by the UE. Otherwise, if the timeline requirement is not satisfied this is an error case.

If a UE would transmit a first PUSCH that includes semi-persistent CSI reports and a second PUSCH that includes an UL-SCH on the same carrier, and the first PUSCH transmission would overlap in time with the second PUSCH transmission, the UE does not transmit the first PUSCH and transmits the second PUSCH. The UE expects that the first and second PUSCH transmissions satisfy the above timing conditions for PUSCH transmissions that overlap in time when at least one of the first or second PUSCH transmissions is in response to a DCI format detection by the UE.

<omitted text>

5.4 UE CSI computation time

When the *CSI request* field on a DCI triggers a CSI report(s) on PUSCH, the UE shall provide a valid CSI report for the *n*-th triggered report,

- if the first uplink symbol to carry the corresponding CSI report(s) including the effect of the timing advance, starts no earlier than at symbol *Zref*, and

- if the first uplink symbol to carry the *n*-th CSI report including the effect of the timing advance, starts no earlier than at symbol *Z'ref(n),*

where *Zref* is defined as the next uplink symbol with its CP starting  after the end of the last symbol of the PDCCH triggering the CSI report(s), and where *Z'ref(n),* is defined as the next uplink symbol with its CP starting after the end of the last symbol in time of the latest of: aperiodic CSI-RS resource for channel measurements, aperiodic CSI-IM used for interference measurements, and aperiodic NZP CSI-RS for interference measurement, when aperiodic CSI-RS is used for channel measurement for the *n*-th triggered CSI report, and where *Tswitch* is defined in clause 6.4 and is applied only if of table 5.4-1 is applied.

If the PUSCH indicated by the DCI is overlapping with another PUCCH or PUSCH, then the CSI report(s) are multiplexed following the procedure in clause 9.2.5 of [6, TS 38.213] and clause 5.2.5 when applicable, otherwise the CSI report(s) are transmitted on the PUSCH indicated by the DCI.

When the *CSI request* field on a DCI triggers a CSI report(s) on PUSCH, if the first uplink symbol to carry the corresponding CSI report(s) including the effect of the timing advance, starts earlier than at symbol *Zref*,

- the UE may ignore the scheduling DCI if no HARQ-ACK or transport block is multiplexed on the PUSCH.

When the *CSI request* field on a DCI triggers a CSI report(s) on PUSCH, if the first uplink symbol to carry the *n*-th CSI report including the effect of the timing advance, starts earlier than at symbol *Z'ref(n),*

- the UE may ignore the scheduling DCI if the number of triggered reports is one and no HARQ-ACK or transport block is multiplexed on the PUSCH

- Otherwise, the UE is not required to update the CSI for the *n*-th triggered CSI report.

When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the purpose of determining the last symbol of the PDCCH triggering the CSI report(s), the PDCCH candidate that ends later in time is used.

*Z,* *Z'* and *µ* are defined as:

and , where *M* is the number of updated CSI report(s) according to Clause 5.2.1.6, corresponds to the *m*-th updated CSI report and is defined as

- of the table 5.4-1 if max{ *µPDCCH*, *µCSI-RS, µUL*} ≤ 3 and if the CSI is triggered without a PUSCH with either transport block or HARQ-ACK or both when *L* = 0 CPUs are occupied (according to Clause 5.2.1.6) and the CSI to be transmitted is a single CSI and corresponds to wideband frequency-granularity where the CSI corresponds to at most 4 CSI-RS ports in a single resource without CRI report and where *CodebookType* is set to 'typeI-SinglePanel' or where *reportQuantity* is set to 'cri-RI-CQI', or

- of the table 5.4-2 if the CSI to be transmitted corresponds to wideband frequency-granularity where the CSI corresponds to at most 4 CSI-RS ports in a single resource without CRI report and where *CodebookType* is set to 'typeI-SinglePanel' or where *reportQuantity* is set to 'cri-RI-CQI', or

- of the table 5.4-2 if the CSI to be transmitted corresponds to wideband frequency-granularity where the *reportQuantity* is set to 'ssb-Index-SINR', 'cri-SINR', 'ssb-Index-SINR- Index ', or 'cri-SINR- Index ', or

- of the table 5.4-2 if *reportQuantity* is set to 'cri-RSRP', 'ssb-Index-RSRP', 'cri-RSRP- Index' or 'ssb-Index-RSRP- Index ', is according to UE reported capability *beamReportTiming* and *KBl* is according to UE reported capability *beamSwitchTiming* as defined in [13, TS 38.306], or

- or , according to UE reported capability, with of table 5.4-2, if *codebookType* is set to 'typeII-CJT-r18' or 'typeII-CJT-PortSelection-r18' and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is configured with resources, or

- , with of table 5.4-2, if the CSI report is configured with , *codebookType* is set to ‘typeII-Doppler-r18’ or ‘typeII-Doppler-PortSelection-r18’ and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is aperiodic with CSI-RS resources, or

- , with of table 5.4-2, if the CSI report is configured with , *codebookType* is set to ‘typeII-Doppler-r18’ or ‘typeII-Doppler-PortSelection-r18’ and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is periodic or semi-persistent with a single CSI-RS resource, or

- or , according to UE reported capability, with of table 5.4-2, if the CSI report is configured with , *codebookType* is set to ‘typeII-Doppler-r18’ and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is aperiodic with CSI-RS resources, or

- or , according to UE reported capability, with of table 5.4-2, if the CSI report is configured with , *codebookType* is set to ‘typeII-Doppler-r18’ and the corresponding *NZP-CSI-RS-ResourceSet* for channel measurement is periodic or semi-persistent with a single CSI-RS resource, or

- of table 5.4-2 otherwise.

*- µ* of table 5.4-1 and table 5.4-2 corresponds to the min (*µPDCCH*, *µCSI-RS, µUL*) where the *µPDCCH* corresponds to the subcarrier spacing of the PDCCH with which the DCI was transmitted and *µUL* corresponds to the subcarrier spacing of the PUSCH with which the CSI report is to be transmitted and *µCSI-RS* corresponds to the minimum subcarrier spacing of the aperiodic CSI-RS triggered by the DCI

**Table 5.4-1: CSI computation delay requirement 1**

|  |  |  |
| --- | --- | --- |
|  | ***Z1* [symbols]** | |
| *Z1* | *Z'1* |
| 0 | 10 | 8 |
| 1 | 13 | 11 |
| 2 | 25 | 21 |
| 3 | 43 | 36 |

**Table 5.4-2: CSI computation delay requirement 2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | ***Z1* [symbols]** | | ***Z2* [symbols]** | | ***Z3* [symbols]** | |
| *Z1* | *Z'1* | *Z2* | *Z'2* | *Z3* | *Z'3* |
| 0 | 22 | 16 | 40 | 37 | 22 | *X*0 |
| 1 | 33 | 30 | 72 | 69 | 33 | *X*1 |
| 2 | 44 | 42 | 141 | 140 | min(44,*X*2+ KB1) | *X*2 |
| 3 | 97 | 85 | 152 | 140 | min(97, *X*3+ KB2) | *X*3 |
| 5 | 388 | 340 | 608 | 560 | min(388, X5+ KB3) | *X5* |
| 6 | 776 | 680 | 1216 | 1120 | min(776, X6+ KB4) | *X6* |

<omitted text>