**3GPP TSG RAN WG1 #114** **R1-230xxxx**

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

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| *CR-Form-v12.2* |
| **DRAFT CHANGE REQUEST** |
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|  | **38.213** | **CR** |  | **rev** |  | **Current version:** | **17.6.0** |  |
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| *For* [***HELP***](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 MIMO Evolution for Downlink and Uplink |
|  |  |
| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_MIMO\_evo\_DL\_UL-Core |  | ***Date:*** | 2023-09-01 |
|  |  |  |  |  |
| ***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 canbe 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)* |
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| ***Reason for change:*** | Introduction of MIMO evolution for downlink and uplink in NR. |
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| ***Summary of change:*** |  Introduce support for MIMO evolution for downlink and uplink in NR.  |
|  |  |
| ***Consequences if not approved:*** | No support for MIMO evolution for downlink and uplink in NR. |
|  |  |
| ***Clauses affected:*** | 4.2, 6, 7, 7.3, 7.7.1, 8.2, 9, 9.2.1, 9.2.2, 9.2.5, 9.2.6, 10.1 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS 38.321, TS 38.331 |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\*\*\* Unchanged parts are omitted \*\*\*

## 4.2 Transmission timing adjustments

A UE can be provided a value of a timing advance offset for a serving cell by *n-TimingAdvanceOffset* for the serving cell. If for a serving cell the UE is provided two coresetPoolIndex values 0 and 1 for first and second CORESETs, or is not provided coresetPoolIndex value for first CORESETs and is provided coresetPoolIndex value of 1 for second CORESETs, the UE can be provided first and second values by *n-TimingAdvanceOffset* and *n-TimingAdvanceOffset2* for transmissions with TCI states associated with the first and second CORESETs, respectively. A UE can be provided a second value for transmissions with spatial domain filters corresponding to TCI states associated with *physCellId* different from *physCellId* for the serving cell in addition to a first value for transmissions with spatial domain filters corresponding to TCI states associated with *physCellId* for the serving cell. The first and second values correspond to first and second TAGs [11, TS 38.321] having an association indicated by *tag-Id-ptr* with first and second joint TCI states provided by *dl-OrJointTCI-StateList* or first and second UL TCI states provided by *ul*-*TCI-State-List* If the UE is not provided *n-TimingAdvanceOffset* for a serving cell, the UE determines a default value of the timing advance offset for the serving cell as described in [10, TS 38.133].

If a UE is configured with two UL carriers for a serving cell, a same timing advance offset value applies to both carriers for transmissions on the serving cell that are associated with a same TAG. The UE does not expect to apply two values for transmissions on the SUL carrier.

Upon reception of a timing advance command for a TAG, the UE adjusts uplink timing for PUSCH/SRS/PUCCH transmission on all the serving cells in the TAG based on a value that the UE expects to be same for all the serving cells in the TAG and based on the received timing advance command where the uplink timing for PUSCH/SRS/PUCCH transmissions is the same for all the serving cells in the TAG.

For a band with synchronous contiguous intra-band EN-DC in a band combination with non-applicable maximum transmit timing difference requirements as described in Note 1 of Table 7.5.3-1 of [10, TS 38.133], if the UE indicates *ul-TimingAlignmentEUTRA-NR* as 'required' and uplink transmission timing based on timing adjustment indication for a TAG from MCG and a TAG from SCG are determined to be different by the UE, the UE adjusts the transmission timing for PUSCH/SRS/PUCCH transmission on all serving cells part of the band with the synchronous contiguous intra-band EN-DC based on timing adjustment indication for a TAG from a serving cell in MCG in the band. The UE is not expected to transmit a PUSCH/SRS/PUCCH in one CG when the PUSCH/SRS/PUCCH is overlapping in time, even partially, with random access preamble transmitted in another CG.

For a SCS of kHz, the timing advance command for a TAG indicates the change of the uplink timing relative to the current uplink timing for the TAG in multiples of . The start timing of the random access preamble is described in [4, TS 38.211].

A timing advance command [11, TS 38.321] in case of random access response or in an absolute timing advance command MAC CE, , for a TAG indicates values by index values of = 0, 1, 2, ..., 3846, where an amount of the time alignment for the TAG with SCS of kHz is . is defined in [4, TS 38.211] and is relative to the SCS of the first uplink transmission from the UE after the reception of the random access response or absolute timing advance command MAC CE.

In other cases, a timing advance command [11, TS 38.321], , for a TAG indicates adjustment of a current value, , to the new value, , by index values of = 0, 1, 2,..., 63, where for a SCS of kHz, .

If a UE has multiple active UL BWPs, as described in clause 12, in a same TAG, including UL BWPs in two UL carriers of a serving cell, the timing advance command value is relative to the largest SCS of the multiple active UL BWPs. The applicable value for an UL BWP with lower SCS may be rounded to align with the timing advance granularity for the UL BWP with the lower SCS while satisfying the timing advance accuracy requirements in [10, TS 38.133].

Adjustment of an value by a positive or a negative amount indicates advancing or delaying the uplink transmission timing for the TAG by a corresponding amount, respectively.

For a timing advance command received on uplink slot and for a transmission other than a PUSCH scheduled by a RAR UL grant or a fallbackRAR UL grant as described in clause 8.2A or 8.3, or a PUCCH with HARQ-ACK information in response to a successRAR as described in clause 8.2A, the corresponding adjustment of the uplink transmission timing applies from the beginning of uplink slot where , is a time duration in msec of symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured, is a time duration in msec of symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214], is the maximum timing advance value in msec that can be provided by a TA command field of 12 bits, is the number of slots per subframe, is the subframe duration of 1 msec, and , where is provided by *cellSpecificKoffset* and is provided by a Differential Koffset MAC CE command [11, TS 38.321]; otherwise, if not respectively provided,  or . and are determined with respect to the minimum SCS among the SCSs of all configured UL BWPs for all uplink carriers in the TAG and of all configured DL BWPs for the corresponding downlink carriers. For , the UE assumes [6, TS 38.214]. Slot and are determined with respect to the minimum SCS among the SCSs of all configured UL BWPs for all uplink carriers in the TAG. is determined with respect to the minimum SCS among the SCSs of all configured UL BWPs for all uplink carriers in the TAG and for all configured initial UL BWPs provided by *initialUplinkBWP*. The uplink slot is the last slot among uplink slot(s) overlapping with the slot(s) of PDSCH reception assuming , where the PDSCH provides the timing advance command and is defined in [4, TS 38.211].

If a UE changes an active UL BWP between a time of a timing advance command reception and a time of applying a corresponding adjustment for the uplink transmission timing, the UE determines the timing advance command value based on the SCS of the new active UL BWP. If the UE changes an active UL BWP after applying an adjustment for the uplink transmission timing, the UE assumes a same absolute timing advance command value before and after the active UL BWP change.

If the received downlink timing changes and is not compensated or is only partly compensated by the uplink timing adjustment without timing advance command as described in [10, TS 38.133], the UE changes accordingly. If a UE operates with two TAGs on an active UL BWP of a serving cell, the UE expects that a difference between a first downlink timing associated with a first TAG and a second downlink timing associated with a second TAG is not larger than the CP length for the active UL BWP unless the UE indicates *larger-thanCP-capability*.

For operation with single TAG on a serving cell, if two adjacent slots overlap due to a TA command, the latter slot is reduced in duration relative to the former slot. The UE does not change during an actual transmission time window for a PUSCH or a PUCCH transmission [6, TS 38.214]. If the UE is not provided *enableSTx2PofMDCI* and operates with two TAGs on a serving cell, the UE does not expect transmissions associated with different TAGs to overlap unless the UE indicates *XYZ*; if the UE indicates *XYZ*, the UE reduces in duration a latter transmission using a first TAG to avoid overlapping with a former transmission using a second TAG.

Using higher-layer ephemeris parameters for a serving satellite, if provided, a UE pre-compensates the two-way transmission delay on the service link based on  that the UE determines using the serving satellite position and its own position. To pre-compensate the two-way transmission delay between the uplink time synchronization reference point and the serving satellite, the UE determines [4, TS 38.211] based on one-way propagation delay that the UE determines as:

where , , and are respectively provided by *ta-Common*, *ta-CommonDrift*, and *ta-CommonDriftVariant* and is provided by *epochTime* which is the epoch time of *ta-Common*, *ta-CommonDrift*, and *ta-CommonDriftVariant* [12, TS 38.331]. provides a distance at time between the serving satellite and the uplink time synchronization reference point divided by the speed of light. The uplink time synchronization reference point is the point where DL and UL are frame aligned with an offset given by .

\*\*\* Unchanged parts are omitted \*\*\*

# 6 Link recovery procedures

A UE can be provided, for each BWP of a serving cell, a set of periodic CSI-RS resource configuration indexes by *failureDetectionResourcesToAddModList* and a set of periodic CSI-RS resource configuration indexes and/or SS/PBCH block indexes by *candidateBeamRSList* or *candidateBeamRSListExt* or *candidateBeamRSSCellList* for radio link quality measurements on the BWP of the serving cell. Instead of the sets and , for each BWP of a serving cell, the UE can be provided respective two sets and of periodic CSI-RS resource configuration indexes by failureDetectionSet1 and failureDetectionSet2 that can be activated by a MAC CE [11 TS 38.321] and corresponding two sets and of periodic CSI-RS resource configuration indexes and/or SS/PBCH block indexes by *candidateBeamRS-List* and *candidateBeamRS-List2*, respectively, for radio link quality measurements on the BWP of the serving cell. The set is associated with the set and the set is associated with the set .

If the UE is not provided by *failureDetectionResourcesToAddModList* for a BWP of the serving cell, the UE determines the set to include periodic CSI-RS resource configuration indexes with same values as the RS indexes in the RS sets indicated by *TCI-State* for respective CORESETs that the UE uses for monitoring PDCCH. If the UE is not provided and for a BWP of the serving cell, the UE determines the set and to include periodic CSI-RS resource configuration indexes with same values as the RS indexes in the RS sets indicated by *TCI-State* for first and second CORESETs that the UE uses for monitoring PDCCH, respectively, where the UE is provided two coresetPoolIndex values 0 and 1 for the first and second CORESETs, or is not provided coresetPoolIndex value for the first CORESETs and is provided coresetPoolIndex value of 1 for the second CORESETs, respectively. If there are two RS indexes in a TCI state, the set or , or includes RS indexes configured with *qcl-Type* set to 'typeD' for the corresponding TCI states. If a CORESET that the UE uses for monitoring PDCCH includes two TCI states and the UE is provided *sfnSchemePdcch* set to 'sfnSchemeA' or 'sfnSchemeB', the set includes RS indexes in the RS sets associated with the two TCI states.

The UE expects the set to include up to two RS indexes. If the UE is provided or , the UE expects the set or the set to include up to a number of RS indexes indicated by *maxBFD-RS-resourcesPerSetPerBWP*. If the UE is not provided or , and if a number of active TCI states for PDCCH receptions in the first or second CORESETs is larger than , the UE determines the set or to include periodic CSI-RS resource configuration indexes with same values as the RS indexes in the RS sets associated with the active TCI states for PDCCH receptions in the first or second CORESETs corresponding to search space sets according to an ascending order for PDCCH monitoring periodicity. If more than one first or second CORESETs correspond to search space sets with same monitoring periodicity, the UE determines the order of the first or second CORESETs according to a descending order of a CORESET index.

If a UE

- is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value of 0 for first CORESETs on an active DL BWP of a serving cell,

- is provided *coresetPoolIndex* with a value of 1 for second CORESETs on the active DL BWP of the serving cells, and

- is provided *SSB-MTCAdditionalPCI*

SS/PBCH block indexes associated with a physical cell identity other than the one provided by *physCellId* in *ServingCellConfigCommon* can be provided in either or set and the corresponding or set is associated with the physical cell identity.

The UE expects single port RS in the set , or , or . The UE expects single-port or two-port CSI-RS with frequency density equal to 1 or 3 REs per RB in the set , or , or . The thresholds Qout,LR and Qin,LR correspond to the default value of *rlmInSyncOutOfSyncThreshold*, as described in [10, TS 38.133] for Qout, and to the value provided by *rsrp-ThresholdSSB* or *rsrp-ThresholdBFR*, respectively.

The physical layer in the UE assesses the radio link quality according to the set , , or , of resource configurations against the threshold Qout,LR. For the set , the UE assesses the radio link quality only according to SS/PBCH blocks on the PCell or the PSCell or periodic CSI-RS resource configurations that are quasi co-located, as described in [6, TS 38.214], with the DM-RS of PDCCH receptions by the UE. The UE applies the Qin,LR threshold to the L1-RSRP measurement obtained from a SS/PBCH block. The UE applies the Qin,LR threshold to the L1-RSRP measurement obtained for a CSI-RS resource after scaling a respective CSI-RS reception power with a value provided by *powerControlOffsetSS*.

In non-DRX mode operation, the physical layer in the UE provides an indication to higher layers when the radio link quality for all corresponding resource configurations in the set , or in the set or , that the UE uses to assess the radio link quality is worse than the threshold Qout,LR. The physical layer informs the higher layers when the radio link quality is worse than the threshold Qout,LR with a periodicity determined by the maximum between the shortest periodicity among the SS/PBCH blocks on the PCell or the PSCell and/or the periodic CSI-RS configurations in the set , , or that the UE uses to assess the radio link quality and 2 msec. In DRX mode operation, the physical layer provides an indication to higher layers when the radio link quality is worse than the threshold Qout,LR with a periodicity determined as described in [10, TS 38.133].

For the PCell or the PSCell, upon request from higher layers, the UE provides to higher layers the periodic CSI-RS configuration indexes and/or SS/PBCH block indexes from the set , or , or and the corresponding L1-RSRP measurements that are larger than or equal to the Qin,LR threshold.

For the SCell, upon request from higher layers, the UE indicates to higher layers whether there is at least one periodic CSI-RS configuration index or SS/PBCH block index from the set , or , or with corresponding L1-RSRP measurements that is larger than or equal to the Qin,LR threshold, and provides the periodic CSI-RS configuration indexes and/or SS/PBCH block indexes from the set , or , or and the corresponding L1-RSRP measurements that are larger than or equal to the Qin,LR threshold, if any.

For the PCell or the PSCell, a UE can be provided a CORESET through a link to a search space set provided by *recoverySearchSpaceId,* as described in clause 10.1, for monitoring PDCCH in the CORESET. If the UE is provided *recoverySearchSpaceId*, the UE does not expect to be provided another search space set for monitoring PDCCH in the CORESET associated with the search space set provided by *recoverySearchSpaceId*.

For the PCell or the PSCell, the UE can be provided, by *PRACH-ResourceDedicatedBFR*, a configuration for PRACH transmission as described in clause 8.1. For PRACH transmission in slot and according to antenna port quasi co-location parameters associated with periodic CSI-RS resource configuration or with SS/PBCH block associated with index provided by higher layers [11, TS 38.321], the UE monitors PDCCH in a search space set provided by *recoverySearchSpaceId* for detection of a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI starting from slot , where is the SCS configuration for the PRACH transmission and is a number of slots provided by *kmac* [12, TS 38.331] or if *kmac* is not provided, within a window configured by *BeamFailureRecoveryConfig*. For PDCCH monitoring in a search space set provided by *recoverySearchSpaceId* and for corresponding PDSCH receptions, the UE assumes the same antenna port quasi-collocation parameters as the ones associated with index until the UE receives by higher layers an activation for a TCI state or any of the parameters *tci-StatesPDCCH-ToAddList* and/or *tci-StatesPDCCH-ToReleaseList*. After the UE detects a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI in the search space set provided by *recoverySearchSpaceId*, the UE continues to monitor PDCCH candidates in the search space set provided by *recoverySearchSpaceId* until the UE receives a MAC CE activation command for a TCI state or *tci-StatesPDCCH-ToAddList* and/or *tci-StatesPDCCH-ToReleaseList.*

For the PCell or the PSCell, after 28 symbols from a last symbol of a first PDCCH reception in a search space set provided by *recoverySearchSpaceId* for which the UE detects a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI and until the UE receives an activation command for *PUCCH-SpatialRelationInfo* [11, TS 38.321] or is provided *PUCCH-SpatialRelationInfo* for PUCCH resource(s), the UE transmits a PUCCH on a same cell as the PRACH transmission using

- a same spatial filter as for the last PRACH transmission

- a power determined as described in clause 7.2.1 with , , and

For the PCell or the PSCell and for sets and , after 28 symbols from a last symbol of a first PDCCH reception in a search space set provided by *recoverySearchSpaceId* where a UE detects a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI, the UE assumes same antenna port quasi-collocation parameters as the ones associated with index for PDCCH monitoring in a CORESET with index 0.

If a UE is provided *dl-OrJointTCI-StateList* or *ul-TCI-StateList* indicating a unified TCI state for the PCell or the PSCell [6, TS 38.214], after 28 symbols from a last symbol of a first PDCCH reception in a search space set provided by *recoverySearchSpaceId* where the UE detects a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI, the UE

- if *SSB-MTC-AdditionalPCI* is not provided, monitors PDCCH in all CORESETs, and receives PDSCH and aperiodic CSI-RS resource in a CSI-RS resource set with same indicated TCI state as for the PDCCH and PDSCH, using the same antenna port quasi co-location parameters as the ones associated with the corresponding index , if any

- transmits PUSCH, PUCCH and SRS that uses a same spatial domain filter with same indicated TCI state as for the PUSCH and the PUCCH, using a same spatial domain filter as for the last PRACH transmission using the following parameters for determination of a corresponding power as described in clauses 7.1.1, 7.2.1, and 7.3.1

- the RS index for obtaining the downlink pathloss estimate

- the values of , , and the PUSCH power control adjustment state provided by *p0AlphaSetforPUSCH* associated with the smallest value of *ul-powercontrolId* for the PCell or the PSCell

- the value of and the PUCCH power control adjustment state provided by *p0AlphaSetforPUCCH* associated with the smallest value of *ul-powercontrolId* for the PCell or the PSCell

- the values of , , and the SRS power control adjustment state provided by *p0AlphaSetforSRS* associated with the smallest value of *ul-powercontrolId* for the PCell or the PSCell

For the remaining of this clause, if a PDCCH reception includes two PDCCH candidates from two linked search space sets based on *searchSpaceLinkingId*, as described in clause 10.1, the last symbol of the PDCCH reception is the last symbol of the PDCCH candidate that ends later. The PDCCH reception includes the two PDCCH candidates also when the UE is not required to monitor one of the two PDCCH candidates as described in clauses 10 (except clause 10.4), 11.1, 11.1.1 and 17.2.

For the PCell or the PSCell, if BFR MAC CE [11, TS 38.321] is provided in Msg3 or MsgA of contention based random access procedure, and if a PUCCH resource is provided with *PUCCH-SpatialRelationInfo*, after 28 symbols from the last symbol of the PDCCH reception that determines the completion of the contention based random access procedure as described in clause 5.1.4a or in clause 5.1.5 of [11, TS 38.321], the UE transmits the PUCCH on a same cell as the PRACH transmission using

- a same spatial filter as for the last PRACH transmission

- a power determined as described in clause 7.2.1 with , , and , where is the SS/PBCH block index selected for the last PRACH transmission.

If a UE is provided *dl-OrJointTCI-StateList* or *ul-TCI-StateList* indicating a unified TCI state for the PCell or the PSCell and the UE provides BFR MAC CE in Msg3 or MsgA of contention based random access procedure, after 28 symbols from the last symbol of the PDCCH reception that determines the completion of the contention based random access procedure as described in [11, TS 38.321], the UE

- if *SSB-MTC-AdditionalPCI* is not provided, monitors PDCCH in all CORESETs, and receives PDSCH and aperiodic CSI-RS resource in a CSI-RS resource set with same indicated TCI state as for the PDCCH and PDSCH using the same antenna port quasi co-location parameters as the ones associated with the corresponding index , if any

- transmits PUSCH, PUCCH and SRS that uses a same spatial domain filter with same indicated TCI state as for the PUSCH and PUCCH, using a same spatial domain filter as for the last PRACH transmission using the following parameters for determination of a corresponding power as described in clauses 7.1.1, 7.2.1, and 7.3.1

- the RS index for obtaining the downlink pathloss estimate

- the values of , , and the PUSCH power control adjustment state provided by *p0AlphaSetforPUSCH* associated with the smallest value of *ul-powercontrolId* for the PCell or the PSCell

- the value of and the PUCCH power control adjustment state provided by *p0AlphaSetforPUCCH* associated with the smallest value of *ul-powercontrolId* for the PCell or the PSCell

- the values of , , and the SRS power control adjustment state provided by *p0AlphaSetforSRS* associated with the smallest value of *ul-powercontrolId* for the PCell or the PSCell

A UE can be provided, by *schedulingRequestID-BFR-SCell*, a configuration for PUCCH transmission with a link recovery request (LRR) as described in clause 9.2.4 for the UE to transmit PUCCH [11, TS 38.321]. If the PCell or the PSCell is associated with sets and , and with sets and , the UE can be provided by *schedulingRequestID-BFR* a first configuration for PUCCH transmission with a LRR and, if the UE provides *twoLRRcapability*, the UE can be provided by *schedulingRequestID-BFR2* a second configuration for PUCCH transmission with a LRR. If the UE is provided only the first configuration, the UE transmits a PUCCH with LRR for either set or . If the UE is provided both the first and second configurations, the UE uses the first configuration to transmt a PUCCH with LRR associated with set and the second configuration to transmit a PUCCH with LRR associated with set [11, TS 38.321].

The UE can provide in a first PUSCH MAC CE index(es) for at least corresponding SCell(s) with radio link quality worse than Qout,LR, indication(s) of presence of for corresponding SCell(s), and index(es) for a periodic CSI-RS configuration or for a SS/PBCH block provided by higher layers, as described in [11, TS 38.321], if any, for corresponding SCell(s). After 28 symbols from a last symbol of a PDCCH reception with a DCI format scheduling a PUSCH transmission with a same HARQ process number as for the transmission of the first PUSCH and having a toggled NDI field value, the UE

- monitors PDCCH in all CORESETs on the SCell(s) indicated by the MAC CE using the same antenna port quasi co-location parameters as the ones associated with the corresponding index(es) , if any

- transmits PUCCH on a PUCCH-SCell using a same spatial domain filter as the one corresponding to , if any, for periodic CSI-RS or SS/PBCH block reception, as described in clause 9.2.2, and using a power determined as described in clause 7.2.1 with , , and , if

- the UE is provided *PUCCH-SpatialRelationInfo* for the PUCCH,

- a PUCCH with the LRR was either not transmitted or was transmitted on the PCell or the PSCell, and

- the PUCCH-SCell is included in the SCell(s) indicated by the MAC-CE

where the SCS configuration for the 28 symbols is the smallest of the SCS configurations of the active DL BWP for the PDCCH reception and of the active DL BWP(s) of the at least one SCell.

If a UE is provided *dl-OrJointTCI-StateList* or *ul-TCI-StateList* indicating a unified TCI state, after 28 symbols from a last symbol of a PDCCH reception with a DCI format scheduling a PUSCH transmission with a same HARQ process number as for the transmission of the first PUSCH and having a toggled NDI field value, the UE

- if *SSB-MTC-AdditionalPCI* is not provided, monitors PDCCH in all CORESETs, on the SCell (s) indicated by the MAC CE, and receives PDSCH and aperiodic CSI-RS resource in a CSI-RS resource set using the same antenna port quasi co-location parameters as the ones associated with the corresponding index , if any

- transmits PUSCH, PUCCH and SRS that uses a same spatial domain filter with same indicated TCI state as for the PUSCH and PUCCH, using a same spatial domain filter as the one corresponding to , if any, and using the following parameters for determination of a corresponding power as described in clauses 7.1.1, 7.2.1, and 7.3.1

- the RS index for obtaining the downlink pathloss estimate

- the values of , , and the PUSCH power control adjustment state provided by *p0AlphaSetforPUSCH* associated with the smallest value of *ul-powercontrolId* for the corresponding SCell

- the value of and the PUCCH power control adjustment state provided by *p0AlphaSetforPUCCH* associated with the smallest value of *ul-powercontrolId* for the corresponding SCell

- the values of , , and the SRS power control adjustment state provided by *p0AlphaSetforSRS* associated with the smallest value of *ul-powercontrolId* for the corresponding SCell

If there is at least one serving cell associated with sets and , and with sets and , the UE can provide in a second PUSCH MAC CE index(es) for cell(s) with and/or with at least one of and having radio link quality worse than Qout,LR, the index(es) of those and/or , and indication(s) of presence of and of index(es) , if any, from and/or corresponding sets and/or for the serving cells.

For serving cells associated with sets and , and with sets and , and having radio link quality worse than Qout,LR, after 28 symbols from a last symbol of a first PDCCH reception with a DCI format scheduling a PUSCH transmission with a same HARQ process number as for transmission of the second PUSCH and having a toggled NDI field value, the UE assumes antenna port quasi-collocation parameters

- corresponding to from , if any, for the first CORESETs,

- corresponding to from , if any, for the second CORESETs

where the SCS configuration for the 28 symbols is the smallest of the SCS configurations of the active DL BWP for the PDCCH reception and of the active DL BWP(s) of the serving cells.

For a serving cell associated with sets and , and with sets and , and having radio link quality worse than Qout,LR, and if a UE is provided *dl-OrJointTCI-StateList* or *TCI-UL-State* and is indicated a first *TCI-State* or *TCI-UL-State* and a second *TCI-State* or *TCI-UL-State*, after 28 symbols from a last symbol of a first PDCCH reception with a DCI format scheduling a PUSCH transmission with a same HARQ process number as for the transmission of the second PUSCH and having a toggled NDI field value, the UE

- monitors PDCCH that applies the first *TCI-State* state, and receives PDSCH and aperiodic CSI-RS resource that apply the first *TCI-State*, using same antenna port quasi co-location parameters as the ones associated with a corresponding index from , if any, on the serving cell

- monitors PDCCH that applies the second *TCI-State*, and receives PDSCH and aperiodic CSI-RS resource that apply the second *TCI-State*, on the serving cell using same antenna port quasi co-location parameters as the ones associated with a corresponding index from , if any, on the serving cell

- transmits PUSCH, PUCCH, and SRS that apply the first *TCI-State* or *TCI-UL-State* using a same spatial domain filter as the one corresponding to from , if any, on the serving cell and using the following parameters for determination of a corresponding power as described in clauses 7.1.1, 7.2.1, and 7.3.1

- the RS index from , if any, for obtaining a corresponding downlink pathloss estimate for the serving cell

- the values of , , and the PUSCH power control adjustment state provided by *p0AlphaSetforPUSCH* associated with the smallest value of *ul-powercontrolId* for the serving cell

- the value of and the PUCCH power control adjustment state provided by *p0AlphaSetforPUCCH* associated with the smallest value of *ul-powercontrolId* for the serving cell

- the values of , , and the SRS power control adjustment state provided by *p0AlphaSetforSRS* associated with the smallest value of *ul-powercontrolId* for the serving cell

- transmits PUSCH, PUCCH, and SRS that apply the second *TCI-State* or *TCI-UL-State* using a same spatial domain filter as the one corresponding to from , if any, on the serving cell and using the following parameters for determination of a corresponding power as described in clauses 7.1.1, 7.2.1, and 7.3.1

- the RS index from , if any, for obtaining a corresponding downlink pathloss estimate for the serving cell

- the values of , , and the PUSCH power control adjustment state provided by *p0AlphaSetforPUSCH* associated with the smallest value of *ul-powercontrolId* for the serving cell

- the value of and the PUCCH power control adjustment state provided by *p0AlphaSetforPUCCH* associated with the smallest value of *ul-powercontrolId* for the serving cell

- the values of , , and the SRS power control adjustment state provided by *p0AlphaSetforSRS* associated with the smallest value of *ul-powercontrolId* for the serving cell

where the SCS configuration for the 28 symbols is the smallest of the SCS configurations of the active DL BWP for the PDCCH reception and of the active DL BWP(s) of the serving cells.

For a serving cell associated with sets and , and with sets and , and having radio link quality worse than Qout,LR, and if a UE is provided two coresetPoolIndex values 0 and 1 for the first and second CORESETs, or is not provided coresetPoolIndex value for the first CORESETs and is provided coresetPoolIndex value of 1 for the second CORESETs, respectively, and the UE is provided *dl-OrJointTCI-StateList* or *TCI-UL-State*, after 28 symbols from a last symbol of a first PDCCH reception with a DCI format scheduling a PUSCH transmission with a same HARQ process number as for the transmission of the second PUSCH and having a toggled NDI field value, the UE

- monitors PDCCH in the first CORESETs, and receives PDSCH scheduled/activated by PDCCH in the first CORESETs, and aperiodic CSI-RS resource that apply a *TCI-State* specific to the first CORESETs, using same antenna port quasi co-location parameters as the ones associated with a corresponding index from , if any, for the serving cell

- monitors PDCCH in the second CORESETs, and receives PDSCH scheduled/activated by PDCCH in the second CORESETs, and aperiodic CSI-RS resource that apply a *TCI-State* specific to the second CORESETs, using the same antenna port quasi co-location parameters as the ones associated with the corresponding index from , if any, for the serving cell

- transmits PUSCH, PUCCH, and SRS that apply *TCI-State* or *TCI-UL-State* specific to the first CORESETs using a same spatial domain filter as the one corresponding to from , if any, for the serving cell and using the following parameters for determination of a corresponding power as described in clauses 7.1.1, 7.2.1, and 7.3.1

- the RS index from , if any, for obtaining a corresponding downlink pathloss estimate for the serving cell

- the values of , , and the PUSCH power control adjustment state provided by *p0AlphaSetforPUSCH* associated with the smallest value of *ul-powercontrolId* for the serving cell

- the value of and the PUCCH power control adjustment state provided by *p0AlphaSetforPUCCH* associated with the smallest value of *ul-powercontrolId* for the serving cell

- the values of , , and the SRS power control adjustment state provided by *p0AlphaSetforSRS* associated with the smallest value of *ul-powercontrolId* for the serving cell

- transmits PUSCH, PUCCH, and SRS that apply *TCI-State* or *TCI-UL-State* specific to the second CORESETs using a same spatial domain filter as the one corresponding to from , if any, for the serving cell and using the following parameters for determination of a corresponding power as described in clauses 7.1.1, 7.2.1, and 7.3.1

- the RS index from , if any, for obtaining a corresponding downlink pathloss estimate for the serving cell

- the values of , , and the PUSCH power control adjustment state provided by *p0AlphaSetforPUSCH* associated with the smallest value of *ul-powercontrolId* for the serving cell

- the value of and the PUCCH power control adjustment state provided by *p0AlphaSetforPUCCH* associated with the smallest value of *ul-powercontrolId* for the serving cell

- the values of , , and the SRS power control adjustment state provided by *p0AlphaSetforSRS* associated with the smallest value of *ul-powercontrolId* for the serving cell

where the SCS configuration for the 28 symbols is the smallest of the SCS configurations of the active DL BWP for the PDCCH reception and of the active DL BWP(s) of the serving cells.

# 7 Uplink Power control

Uplink power control determines a power for PUSCH, PUCCH, SRS, and PRACH transmissions.

A UE does not expect to simultaneously maintain more than four pathloss estimates per serving cell for all PUSCH/PUCCH/SRS transmissions as described in clauses 7.1.1, 7.2.1, and 7.3.1, except for SRS transmissions configured by *SRS-PosResourceSet* as described in clause 7.3.1. If the UE is provided a number of RS resources for pathloss estimation for PUSCH/PUCCH/SRS transmissions that is larger than 4, the UE maintains for pathloss estimation RS resources corresponding to RS resource indexes as described in clauses 7.1.1, 7.2.1, and 7.3.1. If an RS resource updated by MAC CE, as described in clauses 7.1.1, 7.2.1 and 7.3.1, is one from the RS resources the UE maintains for pathloss estimation for PUSCH/PUCCH/SRS transmissions, the UE applies the pathloss estimation based on the RS resources starting from the first slot that is after slot where is the slot where the UE would transmit a PUCCH or PUSCH with HARQ-ACK information for the PDSCH providing the MAC CE, is the SCS configuration for the PUCCH or PUSCH, respectively, that is determined in the slot when the MAC CE command is applied and is a number of slots for SCS configuration provided by *kmac* or if *kmac* is not provided*.*

A PUSCH/PUCCH/SRS/PRACH transmission occasion is defined by a slot index within a frame with system frame number , a first symbol within the slot, and a number of consecutive symbols . For a PUSCH transmission with repetition Type B, a PUSCH transmission occasion is a nominal repetition [6, TS 38.214].

In the remaining of this clause, if a UE is provided *TCI-State* in *dl-OrJointTCI-StateList* or *TCI-UL-State*, and for each indicated one or two *TCI-State* or *TCI-UL-State* of a PUSCH, PUCCH, or SRS transmission occasion as described in [6, TS 38.214]

- in clauses 7.1.1, 7.2.1, and 7.3.1, the RS index for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission is provided by pathlossReferenceRS-Id-r17 associated with or included in the indicated *TCI-State* or *TCI-UL-State* except for SRS transmission that is not provided *followUnifiedTCI-StateSRS*

- in clause 7.1.1, if *p0AlphaSetforPUSCH* is provided, the values of , , and the PUSCH power control adjustment state are provided by *p0AlphaSetforPUSCH* associated with the indicated *TCI-State* or *TCI-UL-State*

- in clause 7.2.1, if *p0AlphaSetforPUCCH* is provided, the values of and the PUCCH power control adjustment state are provided by *p0AlphaSetforPUCCH* associated with the indicated *TCI-State* or *TCI-UL-State*

- in clause 7.3.1, if *p0AlphaSetforSRS* is provided,

- if *followUnifiedTCI-StateSRS* is provided for a SRS resource set, the values of , , and SRS power control adjustment state are provided by *p0AlphaSetforSRS* associated with the indicated *TCI-State* or *TCI-UL-State*

- else, if *followUnifiedTCI-StateSRS* is not provided for a SRS resource set and for a SRS resource from the SRS resource set, the values of , , and SRS power control adjustment state are provided by *p0AlphaSetforSRS* associated with *TCI-State* or *TCI-UL-State* of an SRS resource with lowest *SRS-ResourceId* in the SRS resource set and a RS index for obtaining a pathloss estimate for the SRS transmission is provided by *pathlossReferenceRS-Id-r17* associated with or included in the *TCI-State* or *TCI-UL-State* of an SRS resource with lowest *SRS-ResourceId* in the SRS resource set

 is the sum of the component and a component *p0* provided by *SRS-ResourceSet* corresponding to the SRS resource set.

In the remaining of this clause, if a PDCCH reception by a UE includes two PDCCH candidates from corresponding search space sets, as described in clause 10.1

- a PDCCH monitoring occasion is the union of the PDCCH monitoring occasions for the two PDCCH candidates

- the end of the PDCCH reception is the end of the PDCCH candidate that ends later

The PDCCH reception includes the two PDCCH candidates also when the UE is not required to monitor one of the two PDCCH candidates as described in clauses 10 (except clause 10.4), 11.1, 11.1.1 and 17.2.

\*\*\* Unchanged parts are omitted \*\*\*

## 7.3 Sounding reference signals

For SRS,

- if a UE is provided *tdm* for an SRS resource with 8 ports in an SRS resource set with usage ‘codebook’ or ‘antennaSwitching’, the UE splits a linear value of the transmit power on active UL BWP of carrier of serving cell equally across the configured antenna ports on each symbol for SRS transmission.

- else, a UE splits a linear value of the transmit power on active UL BWP of carrier of serving cell equally across the configured antenna ports for SRS.

\*\*\* Unchanged parts are omitted \*\*\*

### 7.7.1 Type 1 PH report

If a UE determines that a Type 1 power headroom report for an activated serving cell is based on an actual PUSCH transmission then, for PUSCH transmission occasion on active UL BWP of carrier of serving cell , the UE computes the Type 1 power headroom report as

 [dB]

where , , , , , and are defined in clause 7.1.1.

If a UE is configured with multiple cells for PUSCH transmissions, where a SCS configuration on active UL BWP of carrier of serving cell is smaller than a SCS configuration on active UL BWP of carrier of serving cell , and if the UE provides a Type 1 power headroom report in a PUSCH transmission in a slot on active UL BWP that overlaps with multiple slots on active UL BWP , the UE provides a Type 1 power headroom report for the first PUSCH, if any, on the first slot of the multiple slots on active UL BWP that fully overlaps with the slot on active UL BWP . If a UE is configured with multiple cells for PUSCH transmissions, where a same SCS configuration on active UL BWP of carrier of serving cell and active UL BWP of carrier of serving cell , and if the UE provides a Type 1 power headroom report in a PUSCH transmission in a slot on active UL BWP , the UE provides a Type 1 power headroom report for the first PUSCH, if any, on the slot on active UL BWP that overlaps with the slot on active UL BWP .

If a UE is configured with multiple cells for PUSCH transmissions and provides a Type 1 power headroom report in a PUSCH transmission with PUSCH repetition Type B having a nominal repetition that spans multiple slots on active UL BWP and overlaps with one or more slots on active UL BWP , the UE provides a Type 1 power headroom report for the first PUSCH, if any, on the first slot of the one or more slots on active UL BWP that overlaps with the multiple slots of the nominal repetition on active UL BWP .

For a UE configured with EN-DC/NE-DC and capable of dynamic power sharing, if E-UTRA Dual Connectivity PHR [14, TS 36.321] is triggered, the UE provides power headroom of the first PUSCH, if any, on the determined NR slot as described in clause 7.7.

If a UE is configured with multiple cells for PUSCH transmissions, the UE does not consider for computation of a Type 1 power headroom report in a first PUSCH transmission that includes an initial transmission of transport block on active UL BWP of carrier of serving cell , a second PUSCH transmission on active UL BWP of carrier of serving cell that overlaps with the first PUSCH transmission if

- the second PUSCH transmission is scheduled by a DCI format in a PDCCH received in a second PDCCH monitoring occasion, and

- the second PDCCH monitoring occasion is after a first PDCCH monitoring occasion where the UE detects the earliest DCI format scheduling an initial transmission of a transport block after a power headroom report was triggered

or

- the second PUSCH transmission is after the first uplink symbol of the first PUSCH transmission minus *T'proc,2*=*Tproc,2* where *Tproc,2* is determined according to [6, TS 38.214] assuming *d2,1* =1, *d2,2*=0, and with *µDL* corresponding to the subcarrier spacing of the active downlink BWP of the scheduling cell for a configured grant if the first PUSCH transmission is on a configured grant after a power headroom report was triggered.

If the UE determines that a Type 1 power headroom report for an activated serving cell is based on a reference PUSCH transmission then, for PUSCH transmission occasion on active UL BWP of carrier of serving cell , the UE computes the Type 1 power headroom report as

 [dB]

where is computed assuming MPR=0 dB, A-MPR=0 dB, P-MPR=0 dB. TC = 0 dB. MPR, A-MPR, P-MPR and TC are defined in [8-1, TS 38.101-1], [8-2, TS 38.101-2] and [8-3, TS 38.101-3]. The remaining parameters are defined in clause 7.1.1 and, if *ul-powerControl* is not provided, and are obtained using and *p0-PUSCH-AlphaSetId* *=* 0, is obtained using *pusch-PathlossReferenceRS-Id =* 0, and . If *ul-powerControl* is provided, and are obtained by *p0AlphaSetforPUSCH* associated with the indicated *TCI-State* or *TCI-UL-State*, is obtained by PL-RS associated with the indicated *TCI-State* or *TCI-UL-State*.

If a UE is configured with two UL carriers for a serving cell and the UE determines a Type 1 power headroom report for the serving cell based on a reference PUSCH transmission, the UE computes a Type 1 power headroom report for the serving cell assuming a reference PUSCH transmission on the UL carrier provided by *pusch-Config*. If the UE is provided *pusch-Config* for both UL carriers, the UE computes a Type 1 power headroom report for the serving cell assuming a reference PUSCH transmission on the UL carrier provided by *pucch-Config*. If *pucch-Config* is not provided to the UE for any of the two UL carriers, the UE computes a Type 1 power headroom report for the serving cell assuming a reference PUSCH transmission on the non-supplementary UL carrier.

If a UE is not provided *twoPHRMode,* and is provided two SRS resource sets in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with *usage* set to 'codebook' or 'nonCodebook' on active UL BWP of carrier of serving cell , the UE provides one Type 1 power headroom report in a slot . If the Type 1 power headroom report is for an actual PUSCH repetition, the Type 1 power headroom report is for the first PUSCH repetition associated with the first SRS resource set or the second SRS resource set that overlaps with slot .

If a UE is provided *twoPHRMode*, and is provided two SRS resource sets in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with *usage* set to 'codebook' or 'nonCodebook' on active UL BWP of carrier of serving cell , the UE provides two Type 1 power headroom reports in a slot , where

- if the UE provides a first Type 1 power headroom report for an actual PUSCH repetition of a PUSCH transmission starting earliest in slot that is associated with one SRS resource set,

- if the UE transmits PUSCH repetitions associated with the other SRS resource set in slot , the UE provides a second Type 1 power headroom report for a first actual PUSCH repetition associated with the other SRS resource set that overlaps with slot

- else, the UE provides a second Type 1 power headroom report for a reference PUSCH transmission associated with the other SRS resource set, where

- if the other SRS resource set is the first SRS resource set, and are obtained using and *p0-PUSCH-AlphaSetId* *=* 0, is obtained using *pusch-PathlossReferenceRS-Id =* 0 if the UE is not provided *enablePL-RS-UpdateForPUSCH-SRS* or is obtained from *PUSCH-PathlossReferenceRS-Id* mapped to *sri-PUSCH-PowerControlId* = 0 of *sri-PUSCH-MappingToAddModList* if the UE is provided *enablePL-RS-UpdateForPUSCH-SRS*, and

- else, and are obtained using and *p0-PUSCH-AlphaSetId* *= 1*, is obtained using *pusch-PathlossReferenceRS-Id* = 1 if the UE is not provided *enablePL-RS-UpdateForPUSCH-SRS* or is obtained from *PUSCH-PathlossReferenceRS-Id* mapped to *sri-PUSCH-PowerControlId* = 0 of *sri-PUSCH-MappingToAddModList2* if the UE is provided *enablePL-RS-UpdateForPUSCH-SRS*, and if the UE is provided *twoPUSCH-PC-AdjustmentStates*, or if the UE is not provided *twoPUSCH-PC-AdjustmentStates*

- else, if the UE provides a Type 1 power headroom report for a reference PUSCH transmission associated with the first SRS resource set, the UE provides a Type 1 power headroom report for a reference PUSCH transmission associated with the second SRS resource set, where

- for the first Type 1 power headroom report, and are obtained using and *p0-PUSCH-AlphaSetId* *=* 0, is obtained using *pusch-PathlossReferenceRS-Id =* 0 if the UE is not provided *enablePL-RS-UpdateForPUSCH-SRS*, or is obtained from the *PUSCH-PathlossReferenceRS-Id* mapped to *sri-PUSCH-PowerControlId* = 0 of *sri-PUSCH-MappingToAddModList* if the UE is provided *enablePL-RS-UpdateForPUSCH-SRS*, and .

- for the second Type 1 power headroom report, and are obtained using and *p0-PUSCH-AlphaSetId* *= 1*, is obtained using *pusch-PathlossReferenceRS-Id = 1* if the UE is not provided *enablePL-RS-UpdateForPUSCH-SRS*,or is obtained from the *PUSCH-PathlossReferenceRS-Id* mapped to *sri-PUSCH-PowerControlId* = 0 of *sri-PUSCH-MappingToAddModList2* if the UE is provided *enablePL-RS-UpdateForPUSCH-SRS*, and if the UE is provided *twoPUSCH-PC-AdjustmentStates* or if the UE is not provided *twoPUSCH-PC-AdjustmentStates*

- if a UE is provided *dl-OrJointTCI-StateList* or *TCI-UL-State* and is indicated a first *TCI-State* or *TCI-UL-State* and a second *TCI-State* or *TCI-UL-State*, the UE provides the first or the second Type 1 power headroom reports using the *p0AlphaSetforPUSCH* and pathlossReferenceRS-Id-r17 values associated with the first *TCI-State* or *TCI-UL-State* or with the second *TCI-State* or *TCI-UL-State*, respectively, if the reference PUSCH transmission is associated with the first *TCI-State* or *TCI-UL-State* or with the second *TCI-State* or *TCI-UL-State*, respectively

If a UE is provided, for active UL BWP of carrier of serving cell ,

- *twoPHRMode*,

- two SRS resource sets in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with *usage* set to 'codebook' or 'nonCodebook',

- *dl-OrJointTCI-StateList* or *TCI-UL-State* and is indicated a first *TCI-State* or *TCI-UL-State* and a second *TCI-State* or *TCI-UL-State*, and

- *multipanelScheme*

the UE provides

- a Type 1 power headroom report and a configured maximum output power associated with the first *TCI-State* or *TCI-UL-State* for an actual PUSCH transmission using a spatial domain filter corresponding only to the first *TCI-State* or *TCI-UL-State*

- a Type 1 power headroom report and a configured maximum output power associated with the second *TCI-State* or *TCI-UL-State* for an actual PUSCH transmission using a spatial domain filter corresponding only to the second *TCI-State* or *TCI-UL-State*

- a first Type 1 power headroom report and a first configured maximum output power associated with the first *TCI-State* or *TCI-UL-State*, and a second Type 1 power headroom report and a second configured maximum output power associated with the second *TCI-State* or *TCI-UL-State*, for an actual PUSCH transmission using a spatial domain filter corresponding to the first *TCI-State* or *TCI-UL-State* and using a spatial domain filter corresponding to the second *TCI-State* or *TCI-UL-State*

\*\*\* Unchanged parts are omitted \*\*\*

## 8.2 Random access response - Type-1 random access procedure

In response to a PRACH transmission, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding RA-RNTI during a window controlled by higher layers [11, TS 38.321]. The window starts at the first symbol of the earliest CORESET the UE is configured to receive PDCCH for Type1-PDCCH CSS set, as defined in clause 10.1, that is at least one symbol, after the last symbol of the PRACH occasion corresponding to the PRACH transmission, where the symbol duration corresponds to the SCS for Type1-PDCCH CSS set as defined in clause 10.1. Ifor, as defined in [4, TS 38.211], is not zero, the window starts after an additional msec where is defined in [4, TS 38.211] and is provided by *kmac* or if *kmac* is not provided. The length of the window in number of slots, based on the SCS for Type1-PDCCH CSS set, is provided by *ra-ResponseWindow*.

If the UE detects the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI and LSBs of a SFN field in the DCI format 1\_0, if included and applicable, are same as corresponding LSBs of the SFN where the UE transmitted PRACH, and the UE receives a transport block in a corresponding PDSCH within the window, the UE passes the transport block to higher layers. The higher layers parse the transport block for a random access preamble identity (RAPID) associated with the PRACH transmission. If the higher layers identify the RAPID in RAR message(s) of the transport block, the higher layers indicate an uplink grant to the physical layer. This is referred to as random access response (RAR) UL grant in the physical layer.

If the UE does not detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window, or if the UE detects the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window and LSBs of a SFN field in the DCI format 1\_0, if included and applicable, are not same as corresponding LSBs of the SFN where the UE transmitted PRACH, or if the UE does not correctly receive the transport block in the corresponding PDSCH within the window, or if the higher layers do not identify the RAPID associated with the PRACH transmission from the UE, the higher layers can indicate to the physical layer to transmit a PRACH. If requested by higher layers, the UE shall be ready to transmit a PRACH no later than msec after the last symbol of the window, or the last symbol of the PDSCH reception, where is a time duration of symbols corresponding to a PDSCH processing time for UE processing capability 1 assuming  corresponds to the smallest SCS configuration among the SCS configurations for the PDCCH carrying the DCI format 1\_0, the corresponding PDSCH when additional PDSCH DM-RS is configured, and the corresponding PRACH. For , the UE assumes [6, TS 38.214]. For a PRACH transmission using 1.25 kHz or 5 kHz SCS, the UE determines assuming SCS configuration .

If the UE detects a DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI and LSBs of a SFN field in the DCI format 1\_0, if included and applicable, are same as corresponding LSBs of the SFN where the UE transmitted the PRACH, and the UE receives a transport block in a corresponding PDSCH, the UE may assume same DM-RS antenna port quasi co-location properties, as described in [6, TS 38.214], as for a SS/PBCH block or a CSI-RS resource the UE used for PRACH association, as described in clause 8.1, regardless of whether or not the UE is provided *TCI-State* for the CORESET where the UE receives the PDCCH with the DCI format 1\_0.

If the UE attempts to detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI in response to a PRACH transmission initiated by a PDCCH order that triggers a contention-free random access procedure for the SpCell [11, TS 38.321], the UE may assume that the PDCCH that includes the DCI format 1\_0 and the PDCCH order have same DM-RS antenna port quasi co-location properties. If the UE attempts to detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI in response to a PRACH transmission initiated by a PDCCH order that triggers a contention-free random access procedure for a secondary cell or for a cell indicated by a cell indicator field in the PDCCH order, the UE may assume the DM-RS antenna port quasi co-location properties of the CORESET associated with the Type1-PDCCH CSS set for receiving the PDCCH that includes the DCI format 1\_0 and the PDSCH scheduled by the DCI format 1\_0.

A RAR UL grant schedules a PUSCH transmission from the UE. The contents of the RAR UL grant, starting with the MSB and ending with the LSB, are given in Table 8.2-1.

If the value of the frequency hopping flag is 0, the UE transmits the PUSCH without frequency hopping; otherwise, the UE transmits the PUSCH with frequency hopping.

The UE determines the MCS of the PUSCH transmission from the first sixteen indexes of the applicable MCS index table for PUSCH as described in [6, TS 38.214].

The TPC command value is used for setting the power of the PUSCH transmission, as described in clause 7.1.1, and is interpreted according to Table 8.2-2.

The CSI request field is reserved.

The ChannelAccess-CPext field indicates a channel access type and CP extension for operation with shared spectrum channel access [15, TS 37.213] in FR1 as defined in Table 7.3.1.1.1-4 in [5, TS 38.212] or Table 7.3.1.1.1-4A in [5, TS 38.212] if *channelAccessMode* = "*semiStatic*" is provided. The ChannelAccess-CPext field indicates a channel access type for operation with shared spectrum channel access [15, TS 37.213] in FR2-2 as defined in Table 7.3.1.1.1-4B in [5, TS 38.212] if *ChannelAccessMode2-r17* is provided.

Table 8.2-1: Random Access Response Grant Content field size

|  |  |
| --- | --- |
| RAR grant field | Number of bits |
| Frequency hopping flag | 1 |
| PUSCH frequency resource allocation | 12, for operation with shared spectrum channel access in FR1 or for FR2-2 when *ChannelAccessMode2-r17* is provided14, otherwise |
| PUSCH time resource allocation | 4 |
| MCS | 4 |
| TPC command for PUSCH | 3 |
| CSI request | 1 |
| ChannelAccess-CPext | 2, for operation with shared spectrum channel access in FR1 or for FR2-2 when *ChannelAccessMode2-r17* is provided0, otherwise |

Table 8.2-2: TPC Command for PUSCH

|  |  |
| --- | --- |
| TPC Command | Value (in dB) |
| 0 | -6 |
| 1 | -4 |
| 2 | -2 |
| 3 | 0 |
| 4 | 2 |
| 5 | 4 |
| 6 | 6 |
| 7 | 8 |

Unless the UE is configured a SCS, the UE receives subsequent PDSCH using same SCS as for the PDSCH reception providing the RAR message.

If the UE does not detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window, or if the UE detects the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window and the LSBs of a SFN field in the DCI format 1\_0, if included and applicable, are not same as corresponding LSBs of the SFN where the UE transmitted the PRACH, or the UE does not correctly receive a corresponding transport block within the window, the UE procedure is as described in [11, TS 38.321].

\*\*\* Unchanged parts are omitted \*\*\*

# 9 UE procedure for reporting control information

\*\*\* Unchanged parts are omitted \*\*\*

A DCI format indicating a SPS PDSCH release, or SCell dormancy without scheduling a PDSCH reception, or indicating a TCI state update without scheduling PDSCH reception, is referred to as a DCI format having associated HARQ-ACK information without scheduling a PDSCH reception.

For the remaining of this clause, when a UE

- is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value of 0 for first CORESETs, and is provided *coresetPoolIndex* with a value of 1 for second CORESETs, on active DL BWPs of serving cells, and

- is provided *enableSTx2PofmDCI*

the UE separately determines and resolves time overlapping among first PUSCH transmissions using respective first spatial domain filters corresponding to first *TCI-State* or *TCI-UL-State* associated with the first CORESETs, and among second PUSCH transmissions using respective second spatial domain filters corresponding to second *TCI-State* or *TCI-UL-State* associated with the second CORESETs.

When a UE determines overlapping for PUCCH transmissions with SL HARQ-ACK reports and PUCCH of larger and/or smaller priority index, the UE resolves the overlapping for PUCCH transmissions with SL HARQ-ACK reports and PUCCH of each priority index as described in clause 9.2.5 and 9.2.6 before resolving the overlapping for PUCCH transmissions without SL HARQ-ACK or the overlapping for PUCCH transmissions and PUSCH transmissions.

When a UE determines overlapping for PUCCH and/or PUSCH transmissions of the same priority index other than PUCCH transmissions with SL HARQ-ACK reports before considering limitations for UE transmission as described in clauses 11.1, 11.1.1, 11.2A, 15 and 17.2 including repetitions if any,

- first, the UE resolves the overlapping for PUCCHs with repetitions as described in clause 9.2.6, if any

- second, the UE resolves the overlapping for PUCCHs without repetitions as described in clauses 9.2.5

- third, the UE resolves the overlapping for PUSCHs and PUCCHs with repetitions as described in clause 9.2.6

- fourth, the UE resolves the overlapping for PUSCHs and PUCCHs without repetitions as is subsequently described in this clause.

If a UE

- is provided *simultaneousPUCCH-PUSCH* and would transmit a PUCCH with a first priority index and PUSCHs with a second priority index that is different than the first priority index, where the PUCCH and the PUSCHs overlap in time

- can simultaneously transmit the PUCCH and the PUSCHs [18, TS 38.306],

the UE excludes the PUSCHs for resolving the time overlapping between the PUCCH and PUSCHs, where the timeline conditions are not required for the excluded PUSCHs.

\*\*\* Unchanged parts are omitted \*\*\*

The UE expects the PUCCH and PUSCH transmissions to fulfill the conditions in clause 9 and clause 9.2.5 for UCI multiplexing replacing the reference time of "end of PDSCH" with "end of the last symbol of a last PSFCH reception occasion" as described in 16.5 and *Tproc,*1 with *Tprep*.

A UE does not expect that a PUCCH carrying SL HARQ-ACK reports overlaps with PUSCH with aperiodic or semi-persistent CSI reports.

A UE does not expect to be scheduled to transmit a PUCCH or a PUSCH with smaller priority index that would overlap in time with a PUCCH of larger priority index with HARQ-ACK information only in response to a PDSCH reception without a corresponding PDCCH unless the UE is provided *uci-MuxWithDiffPrio*. A UE does not expect to be scheduled to transmit a PUCCH of smaller priority index that would overlap in time with a PUSCH of larger priority index with SP-CSI report(s) without a corresponding PDCCH unless the UE is provided *uci-MuxWithDiffPrio*.

In the remaining of this clause, a UE multiplexes UCIs with same priority index in a PUCCH or a PUSCH before considering limitations for UE transmission as described in clauses 11.1, 11.1.1, 11.2A, 15 and 17.2. A PUCCH or a PUSCH is assumed to have a same priority index as a priority index of UCIs a UE multiplexes in the PUCCH or the PUSCH.

In the remaining of this clause, the multiplexing or prioritization for overlapping channels are for overlapping channels with same priority index or for overlapping channels with a PUCCH carrying SL HARQ-ACK information unless stated otherwise.

In the remaining of this clause, if a UE is provided *subslotLengthForPUCCH* for a cell for PUCCH transmission, a slot for an associated PUCCH resource of a PUCCH transmission with HARQ-ACK information on the cell includes a number of symbols indicated by *subslotLengthForPUCCH*, unless stated otherwise.

If a UE would transmit on a serving cell a PUSCH without UL-SCH that overlaps with a PUCCH transmission on a serving cell that includes positive SR information, the UE does not transmit the PUSCH.

If a UE would transmit CSI reports on overlapping physical channels, the UE applies the priority rules described in [6, TS 38.214] for the multiplexing of CSI reports.

If a UE

- would multiplex UCI in a PUCCH transmission that overlaps with a PUSCH transmission, and

- the PUSCH and PUCCH transmissions fulfil the conditions in clause 9.2.5 for UCI multiplexing,

the UE

- multiplexes only HARQ-ACK information, if any, from the UCI in the PUSCH transmission and does not transmit the PUCCH if the UE multiplexes aperiodic or semi-persistent CSI reports in the PUSCH;

- multiplexes only HARQ-ACK information and CSI reports, if any, from the UCI in the PUSCH transmission and does not transmit the PUCCH if the UE does not multiplex aperiodic or semi-persistent CSI reports in the PUSCH.

A UE does not expect to multiplex in a PUSCH transmission in one slot with SCS configuration UCI of same type that the UE would transmit in PUCCHs in different slots with SCS configuration if .

A UE does not expect to multiplex in a PUSCH transmission or in a PUCCH transmission HARQ-ACK information that the UE would transmit in different PUCCHs of a same priority index.

A UE does not expect a PUCCH resource that results from multiplexing overlapped PUCCH resources, if applicable, to overlap with more than one PUSCHs if each of the more than one PUSCHs includes aperiodic CSI reports.

A UE does not expect to detect a DCI format scheduling a PDSCH reception or having associated HARQ-ACK information report without scheduling a PDSCH reception, and indicating a resource for a PUCCH transmission with corresponding HARQ-ACK information in a slot if the UE previously detects a DCI format scheduling a PUSCH transmission in the slot and if the UE multiplexes HARQ-ACK information in the PUSCH transmission.

If a UE multiplexes aperiodic CSI in a PUSCH and the UE would multiplex UCI that includes HARQ-ACK information in a PUCCH that overlaps with the PUSCH and the timing conditions for overlapping PUCCHs and PUSCHs in clause 9.2.5 are fulfilled, the UE multiplexes only the HARQ-ACK information in the PUSCH and does not transmit the PUCCH.

When a UE transmits multiple PUSCHs on respective serving cells in a slot with reference to slots for PUCCH transmissions and the multiple PUSCHs overlap with a PUCCH carrying UCI in the slot, the UE selects all the PUSCHs overlapping with the PUCCH as the candidate PUSCHs for UCI multiplexing within the slot.

If a UE would transmit a single PUSCH scheduled by a DCI format that includes a DAI field on a serving cell in a slot with reference to slots for PUCCH transmissions without any other PUSCH that would be transmitted on any serving cell in the slot and the UE does not determine any PUCCH carrying HARQ-ACK information in the slot, or if the UE indicates the corresponding capability *mux-HARQ-ACK-withoutPUCCH-onPUSCH* and the UE transmits multiple PUSCHs on respective serving cells in a slot with reference to slots for PUCCH transmissions and the UE does not determine any PUCCH carrying HARQ-ACK information in the slot and at least one of the multiple PUSCHs is scheduled by a DCI format that includes a DAI field, the UE selects the single PUSCH or all the multiple PUSCHs in the slot as the candidate PUSCHs for HARQ-ACK multiplexing within the slot except for any PUSCH among the multiple PUSCHs that is scheduled by a DCI format that includes a DAI field that is equal to 4 in case the UE is configured with *pdsch-HARQ-ACK-Codebook = dynamic* or with *pdsch-HARQ-ACK-Codebook-r16*, or is equal to 0 in case the UE is configured with *pdsch-HARQ-ACK-Codebook = semi-static*.

The UE determines the PUSCH for UCI multiplexing by applying the following procedure on the candidate PUSCHs as described in this clause:

- If the UE is provided *enableSTx2PofmDCI*, is provided *ackNackFeedbackMode* = *separate*, and would multiplex UCI that includes HARQ-ACK information in a PUSCH, candidate PUSCHs for the UCI multiplexing are the ones associated with same CORESETs as for a PUCCH transmission with the HARQ-ACK information.

- If the candidate PUSCHs that include first PUSCHs that are scheduled by DCI formats and second PUSCHs configured by respective *ConfiguredGrantConfig* or *semiPersistentOnPUSCH*, and the UE would multiplex UCI in one of the candidate PUSCHs, and the candidate PUSCHs fulfil the conditions in clause 9.2.5 for UCI multiplexing, the UE multiplexes the UCI in a PUSCH from the first PUSCHs.

- If the UE would multiplex UCI in one of the candidate PUSCHs and the UE does not multiplex aperiodic CSI in any of the candidate PUSCHs, the UE multiplexes the UCI in a PUSCH of the serving cell with the smallest *ServCellIndex* subject to the conditions in clause 9.2.5 for UCI multiplexing being fulfilled. If the UE transmits more than one PUSCHs in the slot on the serving cell with the smallest *ServCellIndex* that fulfil the conditions in clause 9.2.5 for UCI multiplexing, the UE multiplexes the UCI in the earliest PUSCH that the UE transmits in the slot. If the UE is provided *enableSTx2PofmDCI*, is provided *ackNackFeedbackMode* = *joint* or the UCI does not include HARQ-ACK information, and the UE would transmit two PUSCHs in the slot that start at a same symbol on the serving cell with smallest *ServCellIndex* and fulfil the conditions in clause 9.2.5 for UCI multiplexing, the UE multiplexes the UCI in the PUSCH from the two PUSCHs associated with CORESETs that the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value of 0.If a UE transmits a PUSCH over multiple slots or multiple PUSCHs over multiple slots that are scheduled by a DCI format 0\_1, and the UE would transmit a PUCCH with HARQ-ACK and/or CSI information over a single slot that overlaps with the PUSCH transmission in one or more slots of the multiple slots, and the PUSCH transmission in the one or more slots fulfills the conditions in clause 9.2.5 for multiplexing the HARQ-ACK and/or CSI information, the UE multiplexes the HARQ-ACK and/or CSI information in the PUSCH transmission in the one or more slots. The UE does not multiplex HARQ-ACK and/or CSI information in the PUSCH transmission in a slot from the multiple slots if the UE would not transmit a single-slot PUCCH with HARQ-ACK and/or CSI information in the slot in case the PUSCH transmission was absent.

If a UE transmits a PUSCH with repetition Type B and the UE would transmit a PUCCH with HARQ-ACK and/or CSI information over a single slot that overlaps with the PUSCH transmission in one or more slots, the UE expects all actual repetitions of the PUSCH transmission [6, TS 38.214] that would overlap with the PUCCH transmission to fulfill the conditions in clause 9.2.5 for multiplexing the HARQ-ACK and/or CSI information, and the UE multiplexes the HARQ-ACK and/or CSI information in the earliest actual PUSCH repetition of the PUSCH transmission that would overlap with the PUCCH transmission and includes more than one symbol. The UE does not expect that all actual repetitions that would overlap with the PUCCH transmission do not include more than one symbol.

\*\*\* Unchanged parts are omitted \*\*\*

### 9.2.1 PUCCH Resource Sets

\*\*\* Unchanged parts are omitted \*\*\*

If a UE has dedicated PUCCH resource configuration, the UE is provided by higher layers with one or more PUCCH resources.

A PUCCH resource includes the following parameters:

- a PUCCH resource index provided by *pucch-ResourceId*

- an index of the first PRB prior to frequency hopping or for no frequency hopping by *startingPRB*, if a UE is not provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*

- an index of the first PRB after frequency hopping by *secondHopPRB*, if a UE is not provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*

- an indication for intra-slot frequency hopping by *intraSlotFrequencyHopping*, if a UE is not provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*

- an index of a first interlace by *interlace0*, if a UE is provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*

- if provided, an index of a second interlace by *interlace1*, if a UE is provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*

- an index of an RB set by *rb-SetIndex*, if a UE is provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*

- an indication for applying one or both of *TCI-State* or *TCI-UL-State* by *apply-IndicatedTCIState*, if provided

- a configuration for a PUCCH format provided by *format*

For operation with shared spectrum channel access, the UE does not expect that two hops of a PUCCH transmission are in different RB sets.

The UE expects that *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon* and *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated* are provided either in all UL BWPs or in none of the UL BWPs for a serving cell.

If a UE is provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*, the UE determines available RBs for PUCCH transmissions within the active UL BWP as the intersection of RBs corresponding to an interlace index provided by *interlace0* and, if provided, *interlace1*, and RBs of an RB set provided by *rb-SetIndex*. The intersection results in RBs in the first interlace and the UE expects that is either 10 or 11. If *interlace1* is provided, the intersection results in RBs in the second interlace and the UE expects that is either 10 or 11.

\*\*\* Unchanged parts are omitted \*\*\*

### 9.2.2 PUCCH Formats for UCI transmission

If a UE is not transmitting PUSCH, and the UE is transmitting UCI, the UE transmits UCI in a PUCCH using

- PUCCH format 0 if

- the transmission is over 1 symbol or 2 symbols,

- the number of HARQ-ACK information bits with positive or negative SR (HARQ-ACK/SR bits) is 1 or 2

- PUCCH format 1 if

- the transmission is over 4 or more symbols,

- the number of HARQ-ACK/SR bits is 1 or 2

- PUCCH format 2 if

- the transmission is over 1 symbol or 2 symbols,

- the number of UCI bits is more than 2

- PUCCH format 3 if

- the transmission is over 4 or more symbols,

- the number of UCI bits is more than 2,

- the PUCCH resource does not include an orthogonal cover code, or the UE is provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*

- PUCCH format 4 if

- the transmission is over 4 or more symbols,

- the number of UCI bits is more than 2,

- the PUCCH resource includes an orthogonal cover code and the UE is not provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*

A spatial setting for a PUCCH transmission by a UE using a PUCCH resource is provided by

- an indicated *TCI-State* or *TCI-UL-State*, if provided, as described in [6, TS 38.214];

- *PUCCH-SpatialRelationInfo* if the UE is configured with a single value for *pucch-SpatialRelationInfoId*;

- as described in [11, TS 38.321], if the UE is provided multiple values for *PUCCH-SpatialRelationInfo*. The UE applies corresponding actions in [11, TS 38.321] and a corresponding setting for a spatial domain filter to transmit PUCCH in the first slot that is after slot where is the slot where the UE would transmit a PUCCH with HARQ-ACK information with ACK value corresponding to a PDSCH reception providing the *PUCCH-SpatialRelationInfo*, each slot consists of symbols as defined in [4, TS 38.211],and is the SCS configuration for the PUCCH

- If *PUCCH-SpatialRelationInfo* or the indicated *TCI-UL-State* provides *ssb-Index*, the UE transmits the PUCCH using a same spatial domain filter as for a reception of a SS/PBCH block with index provided by *ssb-Index* for a same serving cell or, if *servingCellId* is provided, for a serving cell indicated by *servingCellId*

- else if *PUCCH-SpatialRelationInfo* or the indicated *TCI-UL-State* provides *csi-RS-Index*, or the indicated *TCI-State* provides *csi-rs* configured with *qcl-Type* set to 'typeD', the UE transmits the PUCCH using a same spatial domain filter as for a reception of a CSI-RS with resource index provided by *csi-RS-Index* or csi-rs for a same serving cell or, if *servingCellId* or *cell* is provided, for a serving cell indicated by *servingCellId* or *cell*

- else *PUCCH-SpatialRelationInfo* or the indicated *TCI-UL-State* provides *srs*, the UE transmits the PUCCH using a same spatial domain filter as for a transmission of an SRS with resource index provided by *resource* for a same serving cell and/or active UL BWP or, if *servingCellId* and/or *uplinkBWP* are provided, for a serving cell indicated by *servingCellId* and/or for an UL BWP indicated by *uplinkBWP*

- an indicated *apply-IndicatedTCIState*, if provided

- if *apply-IndicatedTCIState* = ‘first’, the UE transmits a PUCCH using a spatial domain filter corresponding to a first *TCI-State* or *TCI-UL-State* of the PUCCH resource

- if *apply-IndicatedTCIState* = ‘second’, the UE transmits a PUCCH using a spatial domain filter corresponding to second *TCI-State* or *TCI-UL-State* of the PUCCH resource

- if *apply-IndicatedTCIState* = ‘both’, the UE transmits a PUCCH using respective first and second spatial domain filters corresponding to the first and the second *TCI-State* or *TCI-UL-State* of the PUCCH resource

If the UE

- is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value of 0 for first CORESETs on an active DL BWP of a serving cell, and

- is provided *coresetPoolIndex* with a value of 1 for second CORESETs on the active DL BWP of the serving cells,

the first and second *TCI-State* or *TCI-UL-State* are specific to the first and second CORESETs, respectively.

- if *multipanelSfnScheme* is provided for the PUCCH resource, the UE transmits a PUCCH using respective first and second spatial domain filters corresponding to first and second *TCI-State* or *TCI-UL-State* of the PUCCH resource

If a UE

- is not provided *pathlossReferenceRSs* in *PUCCH-PowerControl*,

- is provided *enableDefaultBeamPL-ForPUCCH*, and

- is not provided *PUCCH-SpatialRelationInfo*, and

- is not provided coresetPoolIndex value of 1 for any CORESET, or is provided coresetPoolIndex value of 1 for all CORESETs, in ControlResourceSet and no codepoint of a TCI field, if any, in a DCI format of any search space set maps to two TCI states [5, TS 38.212]

a spatial setting for a PUCCH transmission from the UE is same as a spatial setting for PDCCH receptions by the UE in the CORESET with the lowest ID on the active DL BWP of the PCell and, if the CORESET has two activated TCI states as described in clause 10.1, the UE determines the spatial setting for the PUCCH transmission based on the first TCI state. For a PUCCH transmission over multiple slots, a same spatial setting applies to the PUCCH transmission in each of the multiple slots.

A number of DMRS symbols for a PUCCH transmission using PUCCH format 3 or 4 is provided by *additionalDMRS*.

Use of /2-BPSK, instead of QPSK, for a PUCCH transmission using PUCCH format 3 or 4 is indicated by *pi2BPSK*.

A UE that has indicated a capability *beamCorrespondenceWithoutUL-BeamSweeping* set to 'supported', as described in [18, TS 38.306], can determine a spatial domain filter to be used while performing the applicable channel access procedures described in [15, TS 37.213] prior to a PUCCH transmission as follows:

- if UE is configured with a single value for *pucch-SpatialRelationInfoId* for the UL transmission, the UE may use a spatial domain filter that is same as the spatial domain filter associated with *referenceSignal* in the corresponding *pucch-SpatialRelationInfo*,

- if UE is configured with more than one value for *pucch-SpatialRelationInfoId* for the UL transmission, the UE may use a spatial domain filter that is same as the spatial domain filter associated with *referenceSignal* in the activated *pucch-SpatialRelationInfo*.

\*\*\* Unchanged parts are omitted \*\*\*

### 9.2.5 UE procedure for reporting multiple UCI types

\*\*\* Unchanged parts are omitted \*\*\*

If a UE would transmit multiple overlapping PUCCHs in a slot or overlapping PUCCH(s) and PUSCH(s) in a slot, one of the PUCCHs includes HARQ-ACK information in response to an SPS PDSCH reception, and any PUSCH is not in response to a DCI format detection, the UE expects that the first symbol of the earliest PUCCH or PUSCH satisfies the first of the previous timeline conditions with the exception that components associated to a SCS configuration for a PDCCH scheduling a PDSCH or a PUSCH are absent from the timeline conditions.

A UE does not expect a PUCCH or a PUSCH that is in response to a DCI format detection to overlap with any other PUCCH or PUSCH that does not satisfy the above timing conditions.

A UE that

- is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value of 0 for first CORESETs on active DL BWPs of serving cells, and

- is provided *coresetPoolIndex* with a value of 1 for second CORESETs on active DL BWPs of the serving cells, and

- is provided *ackNackFeedbackMode* = *separate*

does not expect a PUCCH or a PUSCH transmission triggered by a detection of a DCI format in a PDCCH received in a CORESET from the first CORESETs to overlap in time with a PUCCH or a PUSCH transmission triggered by a detection of a DCI format in a PDCCH received in a CORESET from the second CORESETs if the UE is not provided *enableSTx2PofmDCI*; else, if the UE is provided *enableSTx2PofmDCI*, the UE does not expect to transmit a PUCCH that includes HARQ-ACK information and is associated with either the first or the second CORESETs to overlap with a PUSCH transmission associated with either the second or the first CORESETs and not overlap with a PUSCH transmission associated with either the first or the second CORESETs, respectively.

\*\*\* Unchanged parts are omitted \*\*\*

### 9.2.6 PUCCH repetition procedure

A UE can be indicated to transmit a PUCCH over slots using a PUCCH resource, where

- if the PUCCH resource is indicated by a DCI format and includes *pucch-RepetitionNrofSlots*, is provided by *pucch-RepetitionNrofSlots*

- otherwise, is provided by *nrofSlots*

If the UE is provided *subslotLengthForPUCCH*, a slot for a PUCCH transmission with repetitions over slots includes a number of symbols indicated by *subslotLengthForPUCCH*.

For ,

- the UE repeats the PUCCH transmission with the UCI over slots

- if the UE is provided *multipanelSfnScheme* for the PUCCH resource, a repetition of the PUCCH transmission uses first and second spatial domain filters corresponding to first and second *TCI-State* or *TCI-UL-State* of the PUCCH resource

- a repetition of the PUCCH transmission in each of the slots has a same number of consecutive symbols, as provided by *nrofSymbols*

- a repetition of the PUCCH transmission in each of the slots has a same first symbol, as provided by *startingSymbolIndex* if *subslotLengthForPUCCH* is not provided; otherwise mod(*startingSymbolIndex*, *subslotLengthForPUCCH*)

- the UE is configured by *interslotFrequencyHopping* whether or not to perform frequency hopping for repetitions of the PUCCH transmission in different slots

- if the UE is configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is not provided *pucch-DMRS-Bundling* = 'enabled'

- the UE performs frequency hopping per slot

- the UE transmits the PUCCH starting from a first PRB, provided by *startingPRB*, in slots with even number and starting from a second PRB, provided by *secondHopPRB*, in slots with odd number. The slot indicated to the UE for the first repetition of the PUCCH transmission has number 0 and each subsequent slot until the UE transmits the PUCCH in slots is counted regardless of whether or not the UE transmits the PUCCH in the slot

- the UE does not expect to be configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot

- if the UE is configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is provided *pucch-DMRS-Bundling* = 'enabled'

- the UE performs frequency hopping per interval of consecutive slots, that start from a slot indicated to the UE and where the UE would transmit a first repetition of the PUCCH, where is the value of *pucch-FrequencyHoppingInterval*, if provided; otherwise, is the value of *pucch-TimeDomainWindowLength*

- the UE transmits the PUCCH over intervals until the UE transmits the PUCCH in slots, where the first interval has number 0 and each subsequent interval is counted regardless of whether or not the UE transmits the PUCCH in a slot

- the UE transmits the PUCCH starting from a first PRB, provided by *startingPRB*, in intervals with even number and starting from a second PRB, provided by *secondHopPRB*, in intervals of frequency hopping intervals with odd number

- the UE does not expect to be configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot

- if the UE is not configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot, the frequency hopping pattern between the first PRB and the second PRB is same within each slot

If the UE determines that, for a repetition of a PUCCH transmission in a slot, the number of symbols available for the PUCCH transmission is smaller than the value provided by *nrofSymbols* for the corresponding PUCCH format, the UE does not transmit the PUCCH repetition in the slot.

A SS/PBCH block symbol is a symbol of an SS/PBCH block with candidate SS/PBCH block index corresponding to the SS/PBCH block index indicated to a UE by *ssb-PositionsInBurst* in *SIB1* or *ssb-PositionsInBurst* in *ServingCellConfigCommon* or by *NonCellDefiningSSB* if provided or, if the UE is not provided *dl-OrJointTCI-StateList*, by *ssb-PositionsInBurst* in *SSB-MTCAdditionalPCI* associated to physical cell ID with active TCI states for PDCCH or PDSCH, or for a set of symbols of a slot corresponding to SS/PBCH blocks configured for L1 beam measurement/reporting.

For unpaired spectrum, the UE determines the slots for a PUCCH transmission starting from a slot indicated to the UE as described in clause 9.2.3 for HARQ-ACK reporting, or a slot determined as described in clause 9.2.4 for SR reporting or in clause 5.2.1.4 of [6, TS 38.214] for CSI reporting and having

- an UL symbol, as described in clause 11.1, or flexible symbol that is not SS/PBCH block symbol provided by *startingSymbolIndex* as a first symbol, and

- consecutive UL symbols, as described in clause 11.1, or flexible symbols that are not SS/PBCH block symbols, starting from the first symbol, equal to or larger than a number of symbols provided by *nrofsymbols*

For paired spectrum or supplementary uplink band, the UE determines the slots for a PUCCH transmission as the consecutive slots starting from a slot indicated to the UE as described in clause 9.2.3 for HARQ-ACK reporting, or a slot determined as described in clause 9.2.4 for SR reporting or in clause 5.2.1.4 of [6, TS 38.214] for CSI reporting.

If a UE would transmit a PUCCH over a first number of slots and the UE would transmit a PUSCH with repetition Type A or with TB processing over multiple slots over a second number of slots, and the PUCCH transmission would overlap with the PUSCH transmission in one or more slots, and the conditions in clause 9.2.5 for multiplexing the UCI in the PUSCH are satisfied in the overlapping slots, the UE transmits the PUCCH and does not transmit the PUSCH in the overlapping slots.

If a UE would transmit a PUCCH over a first number of slots and the UE would transmit a PUSCH with repetition Type B over a second number of slots, and the PUCCH transmission would overlap with actual PUSCH repetitions in one or more slots, and the conditions in clause 9.2.5 for multiplexing the UCI in the PUSCH are satisfied for the overlapping actual PUSCH repetitions, the UE transmits the PUCCH and does not transmit the overlapping actual PUSCH repetitions.

A UE does not multiplex different UCI types in a PUCCH transmission with repetitions over slots. If a UE would transmit a first PUCCH over more than one slot and at least a second PUCCH over one or more slots, and the transmissions of the first PUCCH and the second PUCCH would overlap in a number of slots then, for each slot of the number of slots and with UCI type priority of HARQ-ACK > SR > CSI with higher priority > CSI with lower priority, the UE determines an earliest first PUCCH in a slot with the order of earliest starting symbol followed by longest duration and the second PUCCHs overlapping with the earliest first PUCCH, and then performs the following

- the UE does not expect more than one PUCCH from the first PUCCH and the second PUCCHs to start at a same slot and include a UCI type with same priority

- if more than one PUCCH from the first PUCCH and the second PUCCHs include a UCI type with the same highest priority, the UE transmits the PUCCH with the highest priority starting at an earliest slot and does not transmit the other PUCCHs, otherwise,

- the UE transmits the PUCCH that includes the UCI type with the highest priority and does not transmit the PUCCHs that include the UCI type with lower priority

The UE repeats the above procedure until there is no PUCCH overlapping with any PUCCH with repetitions in the slot.

When a PUCCH resource used for repetitions of a PUCCH transmission by a UE includes

- first and second spatial settings, or first and second sets of power control parameters, as described in [11, TS 38.321] and in clauses 7 and 7.2.1, or

- first and second *TCI-State* or *TCI-UL-State* and the UE is not provided *multipanelSfnScheme*

the UE

- uses the first and second spatial settings or the first and second indicated *TCI-State* or *TCI-UL-State*, or the first and second sets of power control parameters, for first and second repetitions of the PUCCH transmission, respectively, when ,

- alternates between the first and second spatial settings or between the first and second indicated *TCI-State* or *TCI-UL-State*, or between the first and second sets of power control parameters, respectively, per repetitions of the PUCCH transmission, where if *mappingPattern* = 'cyclicMapping'; else, .

A UE does not expect a PUCCH that is in response to a DCI format detection to overlap with any other PUCCH that does not satisfy the corresponding timing conditions in clause 9.2.5.

If a UE would transmit a PUCCH over slots and the UE does not transmit the PUCCH in a slot from the slots due to overlapping with another PUCCH transmission in the slot, the UE counts the slot in the number of slots.

For DAPS operation, if a UE would transmit a PUCCH over slots on the source MCG and the UE does not transmit the PUCCH in a slot from the slots due to overlapping in time with UE transmission on the target MCG in the slot, the UE counts the slot in the number of slots.

\*\*\* Unchanged parts are omitted \*\*\*

## 10.1 UE procedure for determining physical downlink control channel assignment

\*\*\* Unchanged parts are omitted \*\*\*

For a CORESET other than a CORESET with index 0,

- if a UE has not been provided a configuration of TCI state(s) by *tci-StatesPDCCH-ToAddList* and *tci-StatesPDCCH-ToReleaseList* for the CORESET, or has been provided initial configuration of more than one TCI states for the CORESET by *tci-StatesPDCCH-ToAddList* and *tci-StatesPDCCH-ToReleaseList* and has not received a MAC CE activation command for one of the TCI states as described in [11, TS 38.321], the UE assumes that the DM-RS antenna port associated with PDCCH receptions is quasi co-located with the SS/PBCH block the UE identified during the initial access procedure, or for a most recent configured grant PUSCH transmission as described in clause 19 for a same HARQ process;

- if a UE has been provided a configuration of more than one TCI states by *tci-StatesPDCCH-ToAddList* and *tci-StatesPDCCH-ToReleaseList* for the CORESET as part of Reconfiguration with sync procedure as described in [12, TS 38.331] and has not received a MAC CE activation command for one of the TCI states as described in [11, TS 38.321], the UE assumes that the DM-RS antenna port associated with PDCCH receptions is quasi co-located with the SS/PBCH block or the CSI-RS resource the UE identified during the random access procedure initiated by the Reconfiguration with sync procedure as described in [12, TS 38.331].

For a CORESET with index 0,

- if the UE is provided *TCI-State* and *followUnifiedTCI-State* for the CORESET, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET and a DM-RS antenna port for PDSCH receptions scheduled by DCI formats provided by PDCCH receptions in the CORESET are quasi co-located with the reference signals provided by the indicated *TCI-State* [6, TS 38.214]

- else if the UE is provided *dl-OrJointTCI-StateList* and is indicated a first *TCI-State* and a second *TCI-State*, and *apply-IndicatedTCIState* for the CORESET

- if *apply-IndicatedTCIState* = ‘first’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the first *TCI-State*,

- if *apply-IndicatedTCIState* = ‘second’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the second *TCI-State*,

- if *apply-IndicatedTCIState* = ‘both’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the first and the second *TCI-State*.

- else, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with

- the one or more DL RS configured by a TCI state, where the TCI state is indicated by a MAC CE activation command for the CORESET, if any, or

- a SS/PBCH block the UE identified during a most recent random access procedure not initiated by a PDCCH order that triggers a contention-free random access procedure, if no MAC CE activation command indicating a TCI state for the CORESET is received after the most recent random access procedure, or a SS/PBCH block the UE identified during a most recent configured grant PUSCH transmission as described in clause 19.

For a CORESET other than a CORESET with index 0, if a UE is provided a single TCI state for a CORESET, or if the UE receives a MAC CE activation command for one or two of the provided TCI states for a CORESET, the UE assumes that the DM-RS antenna port associated with PDCCH receptions in the CORESET is quasi co-located with the one or more DL RS configured by the TCI states. For a CORESET with index 0, the UE expects that a CSI-RS configured with *qcl-Type* set to 'typeD' in a TCI state indicated by a MAC CE activation command for the CORESET is provided by a SS/PBCH block

- if the UE receives a MAC CE activation command for one of the TCI states, the UE applies the activation command in the first slot that is after slot where is the slot where the UE would transmit a PUCCH with HARQ-ACK information for the PDSCH providing the activation command, is the SCS configuration for the PUCCH in the slot when the activation command is applied, and is a number of slots for SCS configuration provided by *kmac* or if *kmac* is not provided.

If a UE is provided *TCI-State* in *dl-OrJointTCI-StateList*, a DM-RS antenna port for PDCCH receptionsin a CORESET, other than a CORESET with index 0, associated only with USS sets and/or Type3-PDCCH CSS sets, and a DM-RS antenna port for PDSCH receptions scheduled by DCI formats provided by PDCCH receptions in the CORESET are quasi co-located with reference signals provided by the indicated *TCI-State* [6, TS 38.214].

If a UE is provided *followUnifiedTCI-State* for a CORESET, other than a CORESET with index 0, associated at least with CSS sets other than Type3-PDCCH CSS sets, a DM-RS antenna port for PDCCH receptions in the CORESET and a DM-RS antenna port for PDSCH receptions scheduled by DCI formats provided by PDCCH receptions in the CORESET are quasi co-located with reference signals provided by the indicated *TCI-State*.

If a UE is provided *dl-OrJointTCI-StateList* and is indicated a first *TCI-State* and a second *TCI-State*, and is provided *apply-IndicatedTCIState* for a CORESET, other than a CORESET with index 0,

- if the CORESET is associated only with USS sets and/or Type3-PDCCH CSS sets

- if *apply-IndicatedTCIState* = ‘first’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the first *TCI-State*

- if *apply-IndicatedTCIState* = ‘second’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the second *TCI-State*

- if *apply-IndicatedTCIState* = ‘both’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the first *TCI-State* and the second *TCI-State*

- if the CORESET is associated at least with CSS sets other than Type3-PDCCH CSS sets,

- if *apply-IndicatedTCIState* = ‘first’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the first *TCI-State*

- if *apply-IndicatedTCIState* = ‘second’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the second *TCI-State*

- if *apply-IndicatedTCIState* = ‘both’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the reference signals provided by the first *TCI-State* and the second *TCI-State*

- if *apply-IndicatedTCIState* = ‘none’, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with the one or more DL RS configured by a TCI state indicated by a MAC CE activation command for the CORESET

If the UE is provided *dl-OrJointTCI-StateList* and

- is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value of 0 for first CORESETs on an active DL BWP of a serving cell,

- is provided *coresetPoolIndex* with a value of 1 for second CORESETs on the active DL BWP of the serving cells, and

- is provided *followUnifiedTCI-State* for the first and second CORESETs, that do not include a CORESET with index 0 and are associated only with USS sets and/or Type3-PDCCH CSS sets, or with CSS sets other than Type3-PDCCH CSS sets,

the UE assumes that DM-RS antenna ports for PDCCH receptions in the first and second CORESETs, and DM-RS antenna ports for PDSCH receptions scheduled by DCI formats provided by PDCCH receptions in the first and second CORESETs, are quasi co-located with the reference signals provided by indicated *TCI-State* specific to the first and second CORESETs, respectively.

If a UE is provided two coresetPoolIndex values 0 and 1 for first and second CORESETs, or is not provided coresetPoolIndex value for first CORESETs and is provided coresetPoolIndex value of 1 for second CORESETs, respectively, a MAC CE command activating TCI states for the first or second CORESETs [11, TS 38.321] can include *coresetPoolIndex* value 0 or 1

- if the UE is provided *SSB\_MTC\_AdditionalPCI*, the activated TCI states for the first and/or the second CORESETs are for *physCellId* from *ServingCellConfigCommon* and the activated TCI states for either the first or the second CORESETs can be for *physCellId* from *additionalPCI*.

If a UE is provided by *simultaneousTCI-UpdateList1* or *simultaneousTCI-UpdateList2* up to two lists of cells for simultaneous TCI state activation, the UE applies the antenna port quasi co-location provided by one or two *TCI-State* each with same activated *tci-StateID* value, to CORESETs with a same index in all configured DL BWPs of all configured cells in a list determined from a serving cell index, where one or two *tci-StateID*, the CORESET index, and the serving cell index are provided by a MAC CE command.

\*\*\* Unchanged parts are omitted \*\*\*