**3GPP TSG RAN WG1 #107-e** **R1-2112447**

**e-Meeting, November 11th – 19th, 2021**

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| *CR-Form-v12.0* |
| **DRAFT CHANGE REQUEST** |
|  |
|  | **38.213** | **CR** |  | **rev** |  | **Current version:** | **16.7.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | Introduction of non-terrestrial network operation in NR |
|  |  |
| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** |  |  | ***Date:*** | 2021-11-29 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-17 |
|  | *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-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
|  |  |
| ***Reason for change:*** | Introduction of NTN operation in NR. |
|  |  |
| ***Summary of change:*** | Add description for enhancements on transmission time adjustments, MAC CE application time, and HARQ-ACK reporting for NTN. |
|  |  |
| ***Consequences if not approved:*** | Incomplete support for NTN operation in NR. |
|  |  |
| ***Clauses affected:*** | 4.2, 6, 7, 8.1, 8.2, 8.2A, 9.1.2, 9.1.3, 9.1.3.1, 9.1.4, 9.2.3, 10.1 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.211, TS 38.212, TS 38.214 |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\*\*\* Unchanged text is 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 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.

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 *Koffset* in *ServingCellConfigCommon* and is provided by a MAC CE command; 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 two adjacent slots overlap due to a TA command, the latter slot is reduced in duration relative to the former slot.

\*\*\* Unchanged text is 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. 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 and, if there are two RS indexes in a TCI state, the set  includes RS indexes configured with *qcl-Type* set to 'typeD' for the corresponding TCI states. The UE expects the set  to include up to two RS indexes. The UE expects single port RS in the set . The UE expects single-port or two-port CSI-RS with frequency density equal to 1 or 3 REs per RB in the set .

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  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 monitored 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  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  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  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  with corresponding L1-RSRP measurements that are larger than or equal to the Qin,LR threshold, and provides the periodic CSI-RS configuration indexes or SS/PBCH block indexes from the set  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 *K-Mac* [4, TS 38.321] or if *K-Mac* is not provided, within a window configured by *BeamFailureRecoveryConfig*. For PDCCH monitoring in a search space set provided by *recoverySearchSpaceId* and for corresponding PDSCH reception, 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, 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.

For the PCell or the PSCell, if BFR MAC CE [11, TS38.321] is transmitted 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 5.1.5 of [11, TS38.321], 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 *q*new is the SS/PBCH block index selected for the last PRACH transmission.

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. The UE can transmit in a first PUSCH MAC CE providing 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.

# 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 provided by *K-Mac* or if *K-Mac* 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].

\*\*\* Unchanged text is omitted \*\*\*

## 8.1 Random access preamble

Physical random access procedure is triggered upon request of a PRACH transmission by higher layers or by a PDCCH order. A configuration by higher layers for a PRACH transmission includes the following:

- A configuration for PRACH transmission [4, TS 38.211].

- A preamble index, a preamble SCS, , a corresponding RA-RNTI, and a PRACH resource.

A PRACH is transmitted using the selected PRACH format with transmission power ,as described in clause 7.4, on the indicated PRACH resource.

For Type-1 random access procedure, a UE is provided a number of SS/PBCH block indexes associated with one PRACH occasion and a number of contention based preambles per SS/PBCH block index per valid PRACH occasion by *ssb-perRACH-OccasionAndCB-PreamblesPerSSB*.

For Type-2 random access procedure with common configuration of PRACH occasions with Type-1 random access procedure, a UE is provided a number of SS/PBCH block indexes associated with one PRACH occasion by *ssb-perRACH-OccasionAndCB-PreamblesPerSSB* and a number of contention based preambles per SS/PBCH block index per valid PRACH occasion by *msgA-CB-PreamblesPerSSB-PerSharedRO*. The PRACH transmission can be on a subset of PRACH occasions associated with a same SS/PBCH block index within an SSB-RO mapping cycle for a UE provided with a PRACH mask index by *msgA-SSB-SharedRO-MaskIndex* according to [11, TS 38.321].

For Type-2 random access procedure with separate configuration of PRACH occasions with Type-1 random access procedure, a UE is provided a number of SS/PBCH block indexes associated with one PRACH occasion and a number of contention based preambles per SS/PBCH block index per valid PRACH occasion by *msgA-SSB-PerRACH-OccasionAndCB-PreamblesPerSSB* when provided; otherwise, by *ssb-perRACH-OccasionAndCB-PreamblesPerSSB*.

For Type-1 random access procedure, or for Type-2 random access procedure with separate configuration of PRACH occasions from Type 1 random access procedure, if , one SS/PBCH block index is mapped to consecutive valid PRACH occasions and contention based preambles with consecutive indexes associated with the SS/PBCH block index per valid PRACH occasion start from preamble index 0. If , contention based preambles with consecutive indexes associated with SS/PBCH block index , , per valid PRACH occasion start from preamble index where is provided by *totalNumberOfRA-Preambles* for Type-1 random access procedure, or by *msgA-TotalNumberOfRA-Preambles* for Type-2 random access procedure with separate configuration of PRACH occasions from a Type 1 random access procedure, and is an integer multiple of .

For Type-2 random access procedure with common configuration of PRACH occasions with Type-1 random access procedure, if , one SS/PBCH block index is mapped to consecutive valid PRACH occasions and contention based preambles with consecutive indexes associated with the SS/PBCH block index per valid PRACH occasion start from preamble index . If , contention based preambles with consecutive indexes associated with SS/PBCH block index , , per valid PRACH occasion start from preamble index , where is provided by *totalNumberOfRA-Preambles* for Type-1 random access procedure.

For link recovery, a UE is provided SS/PBCH block indexes associated with one PRACH occasion by *ssb-perRACH-Occasion* in *BeamFailureRecoveryConfig*. For a dedicated RACH configuration provided by *RACH-ConfigDedicated*, if *cfra* is provided, a UE is provided SS/PBCH block indexes associated with one PRACH occasion by *ssb-perRACH-Occasion* in *occasions*. If , one SS/PBCH block index is mapped to consecutive valid PRACH occasions. If , all consecutive SS/PBCH block indexes are associated with one PRACH occasion.

SS/PBCH block indexes provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* are mapped to valid PRACH occasions in the following order where the parameters are described in [4, TS 38.211].

- First, in increasing order of preamble indexes within a single PRACH occasion

- Second, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions

- Third, in increasing order of time resource indexes for time multiplexed PRACH occasions within a PRACH slot

- Fourth, in increasing order of indexes for PRACH slots

An association period, starting from frame 0, for mapping SS/PBCH block indexes to PRACH occasions is the smallest value in the set determined by the PRACH configuration period according Table 8.1-1 such that SS/PBCH block indexes are mapped at least once to the PRACH occasions within the association period, where a UE obtains from the value of *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon*. If after an integer number of SS/PBCH block indexes to PRACH occasions mapping cycles within the association period there is a set of PRACH occasions or PRACH preambles that are not mapped to SS/PBCH block indexes, no SS/PBCH block indexes are mapped to the set of PRACH occasions or PRACH preambles. An association pattern period includes one or more association periods and is determined so that a pattern between PRACH occasions and SS/PBCH block indexes repeats at most every 160 msec. PRACH occasions not associated with SS/PBCH block indexes after an integer number of association periods, if any, are not used for PRACH transmissions.

For a PRACH transmission by a UE triggered by a PDCCH order, the PRACH mask index field [5, TS 38.212], if the value of the random access preamble index field is not zero, indicates the PRACH occasion for the PRACH transmission where the PRACH occasions are associated with the SS/PBCH block index indicated by the SS/PBCH block index field of the PDCCH order. If the UE is provided by *Koffset* in *ServingCellConfigCommon*, the PRACH occasion is after slot where is the slot of the UL BWP for the PRACH transmission that overlaps with the end of the PDCCH order reception.

For a PRACH transmission triggered by higher layers, if *ssb-ResourceList* is provided, the PRACH mask index is indicated by *ra-ssb-OccasionMaskIndex* which indicates the PRACH occasions for the PRACH transmission where the PRACH occasions are associated with the selected SS/PBCH block index.

The PRACH occasions are mapped consecutively per corresponding SS/PBCH block index. The indexing of the PRACH occasion indicated by the mask index value is reset per mapping cycle of consecutive PRACH occasions per SS/PBCH block index. The UE selects for a PRACH transmission the PRACH occasion indicated by PRACH mask index value for the indicated SS/PBCH block index in the first available mapping cycle.

For the indicated preamble index, the ordering of the PRACH occasions is

- First, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions

- Second, in increasing order of time resource indexes for time multiplexed PRACH occasions within a PRACH slot

- Third, in increasing order of indexes for PRACH slots

For a PRACH transmission triggered upon request by higher layers, a value of *ra-OccasionList* [12, TS 38.331], if *csirs-ResourceList* is provided, indicates a list of PRACH occasions for the PRACH transmission where the PRACH occasions are associated with the selected CSI-RS index indicated by *csi-RS*. The indexing of the PRACH occasions indicated by *ra-OccasionList* is reset per association pattern period.

Table 8.1-1: Mapping between PRACH configuration period and SS/PBCH block to PRACH occasion association period

|  |  |
| --- | --- |
| PRACH configuration period (msec) | Association period (number of PRACH configuration periods) |
| 10 | {1, 2, 4, 8, 16} |
| 20 | {1, 2, 4, 8} |
| 40 | {1, 2, 4} |
| 80 | {1, 2} |
| 160 | {1} |

For paired spectrum or supplementary uplink band all PRACH occasions are valid.

For unpaired spectrum,

- if a UE is not provided *tdd-UL-DL-ConfigurationCommon*, a PRACH occasion in a PRACH slot is valid if it does not precede a SS/PBCH block in the PRACH slot and starts at least symbols after a last SS/PBCH block reception symbol, where is provided in Table 8.1-2 and, if *channelAccessMode* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where the UE does not transmit [15, TS 37.213].

- the candidate SS/PBCH block index of the SS/PBCH block corresponds to the SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* , as described in clause 4.1

- If a UE is provided *tdd-UL-DL-ConfigurationCommon*, a PRACH occasion in a PRACH slot is valid if

- it is within UL symbols, or

- it does not precede a SS/PBCH block in the PRACH slot and starts at least symbols after a last downlink symbol and at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2, and if *channelAccessMode* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where there shall not be any transmissions, as described in [15, TS 37.213]

- the candidate SS/PBCH block index of the SS/PBCH block corresponds to the SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon*, as described in clause 4.1.

For preamble format B4 [4, TS 38.211], .

Table 8.1-2: values for different preamble SCS

|  |  |
| --- | --- |
| Preamble SCS |  |
| 1.25 kHz or 5 kHz | 0 |
| 15 kHz or 30 kHz or 60 kHz or 120 kHz | 2 |

If a random access procedure is initiated by a PDCCH order, the UE, if requested by higher layers, transmits a PRACH in the selected PRACH occasion, as described in [11, TS 38.321], for which a time between the last symbol of the PDCCH order reception and the first symbol of the PRACH transmission is larger than or equal to msec, where

- is a time duration of symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] assuming corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH order and the SCS configuration of the corresponding PRACH transmission

- if the active UL BWP does not change and is defined in [10, TS 38.133] otherwise

- msec for FR1 and msec for FR2

- is a switching gap duration as defined in [6, TS 38.214]

For a PRACH transmission using 1.25 kHz or 5 kHz SCS, the UE determines assuming SCS configuration .

For single cell operation or for operation with carrier aggregation in a same frequency band, a UE does not transmit PRACH and PUSCH/PUCCH/SRS in a same slot or when a gap between the first or last symbol of a PRACH transmission in a first slot is separated by less than symbols from the last or first symbol, respectively, of a PUSCH/PUCCH/SRS transmission in a second slot where for or 1, for or , and is the SCS configuration for the active UL BWP. For a PUSCH transmission with repetition Type B, this applies to each actual repetition for PUSCH transmission [6, TS 38.214].

## 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. If the UE is provided *K-Mac*, the window starts after an additional msec where is defined in [4, TS 38.211] and is provided by *K-Mac* or if *K-Mac* 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 is expected 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, 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.

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] as defined in Table 7.3.1.1.1-4 in TS 38.212 or Table 7.3.1.1.1-4A in TS 38.212 if *ChannelAccessMode-r16* = "*semistatic*" 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 | 14, for operation without shared spectrum channel access 12, for operation with shared spectrum channel access |
| PUSCH time resource allocation | 4 |
| MCS | 4 |
| TPC command for PUSCH | 3 |
| CSI request | 1 |
| ChannelAccess-CPext | 0, for operation without shared spectrum channel access2, for operation with shared spectrum channel access |

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].

## 8.2A Random access response - Type-2 random access procedure

In response to a transmission of a PRACH and a PUSCH, or to a transmission of only a PRACH if the PRACH preamble is mapped to a valid PUSCH occasion, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding MsgB-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 PUSCH occasion corresponding to the PRACH transmission, where the symbol duration corresponds to the SCS for Type1-PDCCH CSS set. If the UE is provided *K-Mac*, the window starts after an additional msec where is defined in [4, TS 38.211] and is provided by *K-Mac* or if *K-Mac* is not provided. The length of the window in number of slots, based on the SCS for Type1-PDCCH CSS set, is provided by *msgB-ResponseWindow*.

In response to a transmission of a PRACH, if the PRACH preamble is not mapped to a valid PUSCH occasion, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding MsgB-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. The length of the window in number of slots, based on the SCS for Type1-PDCCH CSS set, is provided by *msgB-ResponseWindow*.

If the UE detects the DCI format 1\_0, with CRC scrambled by the corresponding MsgB-RNTI and LSBs of a SFN field in the DCI format 1\_0, if 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 indicate to the physical layer

- an uplink grant if the RAR message(s) is for fallbackRAR and a random access preamble identity (RAPID) associated with the PRACH transmission is identified, and the UE procedure continues as described in clauses 8.2, 8.3, and 8.4 when the UE detects a RAR UL grant, or

- transmission of a PUCCH with HARQ-ACK information having ACK value if the RAR message(s) is for successRAR, where

- a PUCCH resource for the transmission of the PUCCH is indicated by PUCCH resource indicator field of 4 bits in the successRAR from a PUCCH resource set that is provided by *pucch-ResourceCommon*

- a slot for the PUCCH transmission is indicated by a HARQ Feedback Timing Indicator field of 3 bits in the successRAR having a value from {1, 2, 3, 4, 5, 6, 7, 8} and, with reference to slots for PUCCH transmission having duration , the slot is determined as , where is a slot of the PDSCH reception, is as defined for PUSCH transmission in Table 6.1.2.1.1-5 of [6, TS 38.214] , is the SCS configuration of the active UL BWP, and is provided by *Koffset* in *ServingCellConfigCommon* or by a MAC CE command; otherwise,

- the UE does not expect the first symbol of the PUCCH transmission to be after the last symbol of the PDSCH reception by a time smaller than msec where is the PDSCH processing time for UE processing capability 1 [6, TS 38.214]

- for operation with shared spectrum channel access, a channel access type and CP extension [15, TS 37.213] for a PUCCH transmission is indicated by a ChannelAccess-CPext field in the successRAR as defined in Table 7.3.1.1.1-4 in TS 38.212 or Table 7.3.1.1.1-4A in TS 38.212 if *ChannelAccessMode-r16* = "*semistatic*" is provided

- the PUCCH transmission is with a same spatial domain transmission filter and in a same active UL BWP as a last PUSCH transmission

If the UE detects the DCI format 1\_0 with CRC scrambled by a C-RNTI and a transport block in a corresponding PDSCH within the window, the UE transmits a PUCCH with HARQ-ACK information having ACK value if the UE correctly detects the transport block or NACK value if the UE incorrectly detects the transport block and the time alignment timer is running [11, TS 38.321].

If the UE detects a DCI format 1\_0 with CRC scrambled by the corresponding MsgB-RNTI and receives a transport block within the window 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 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.

The UE does not expect to be indicated to transmit the PUCCH with the HARQ-ACK information at a time that is prior to a time when the UE applies a TA command that is provided by the transport block. If the UE does not detect the DCI format 1\_0 with CRC scrambled by the corresponding MsgB-RNTI within the window, or if the UE detects the DCI format 1\_0 with CRC scrambled by the corresponding MsgB-RNTI within the window and LSBs of a SFN field in the DCI format 1\_0, if applicable, are not same as corresponding LSBs of the SFN where the UE transmitted the 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 only PRACH according to Type-1 random access procedure or to transmit both PRACH and PUSCH according to Type-2 random access procedure [11, TS 38.321]. If requested by higher layers, the UE is expected 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 when additional PDSCH DM-RS is configured. For , the UE assumes [6, TS 38.214].

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 MsgB-RNTI within the window, or if the UE detects the 1\_0 with CRC scrambled by the corresponding MsgB-RNTI within the window and LSBs of a SFN field in the DCI format 1\_0, if 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].

## 8.3 PUSCH scheduled by RAR UL grant

An active UL BWP with SCS configuration , as described in clause 12 and in [4, TS 38.211], for a PUSCH transmission scheduled by a RAR UL grant is indicated by higher layers.

If *useInterlacePUCCH-PUSCH* is not provided by *BWP-UplinkCommon* and *BWP-UplinkDedicated*, for determining the frequency domain resource allocation for the PUSCH transmission within the active UL BWP

- if the active UL BWP and the initial UL BWP have same SCS and same CP length and the active UL BWP includes all RBs of the initial UL BWP, or the active UL BWP is the initial UL BWP, the initial UL BWP is used

- else, the RB numbering starts from the first RB of the active UL BWP and the maximum number of RBs for frequency domain resource allocation equals the number of RBs in the initial UL BWP

The frequency domain resource allocation is by uplink resource allocation type 1 [6, TS 38.214]. For an initial UL BWP size of RBs, a UE processes the frequency domain resource assignment field as follows

- if , or for operation with shared spectrum channel access if

- truncate the frequency domain resource assignment field to its least significant bits and interpret the truncated frequency resource assignment field as for the frequency resource assignment field in DCI format 0\_0 as described in [5, TS 38.212]

- else

- insert most significant bits, or for operation with shared spectrum channel access insert most significant bits, with value set to '0' after the bits to the frequency domain resource assignment field, where if the frequency hopping flag is set to '0' and is provided in Table 8.3-1 if the hopping flag bit is set to '1', and interpret the expanded frequency resource assignment field as for the frequency resource assignment field in DCI format 0\_0 as described in [5, TS 38.212]

- end if

If *useInterlacePUCCH-PUSCH* is provided by *BWP-UplinkCommon* or *BWP-UplinkDedicated*, the frequency domain resource allocation is by uplink resource allocation type 2 [6, TS 38.214]. A UE processes the frequency domain resource assignment field as follows

- truncate the frequency domain resource assignment field to the LSBs if , or to the LSBs if

- for interlace allocation of a PUSCH transmission, interpret the MSBs of the truncated frequency domain resource assignment field for the active UL BWP as for the MSBs of the frequency domain resource assignment field in DCI format 0\_0 [6, TS 38.214]

- for RB set allocation of a PUSCH transmission, the RB set of the active UL BWP is the RB set of the PRACH transmission associated with the RAR UL grant. The UE assumes that the RB set is defined as when the UE is not provided *intraCellGuardBandsUL-List* [6, TS 38.214].

A UE determines whether or not to apply transform precoding as described in [6, TS 38.214].

For a PUSCH transmission with frequency hopping scheduled by RAR UL grant or for a Msg3 PUSCH retransmission, the frequency offset for the second hop [6, TS 38.214] is given in Table 8.3-1.

Table 8.3-1: Frequency offset for second hop of PUSCH transmission with frequency hopping scheduled by RAR UL grant or of Msg3 PUSCH retransmission

|  |  |  |
| --- | --- | --- |
| Number of PRBs in initial UL BWP | Value of Hopping Bits | Frequency offset for 2nd hop |
|  | 0 |  |
| 1 |  |
|  | 00 |  |
| 01 |  |
| 10 |  |
| 11 | Reserved |

A SCS for the PUSCH transmission is provided by *subcarrierSpacing* in *BWP-UplinkCommon*. A UE transmits PRACH and the PUSCH on a same uplink carrier of a same serving cell.

A UE transmits a transport block in a PUSCH scheduled by a RAR UL grant in a corresponding RAR message using redundancy version number 0. If a TC-RNTI is provided by higher layers, the scrambling initialization of the PUSCH corresponding to the RAR UL grant in clause 8.2 is by TC-RNTI. Otherwise, the scrambling initialization of the PUSCH corresponding to the RAR UL grant in clause 8.2 is by C-RNTI. Msg3 PUSCH retransmissions, if any, of the transport block, are scheduled by a DCI format 0\_0 with CRC scrambled by a TC-RNTI provided in the corresponding RAR message [11, TS 38.321]. The UE always transmits the PUSCH scheduled by a RAR UL grant without repetitions.

With reference to slots for a PUSCH transmission scheduled by a RAR UL grant, if a UE receives a PDSCH with a RAR message ending in slot for a corresponding PRACH transmission from the UE, the UE transmits the PUSCH in slot , where and are provided in [6, TS 38.214] and is provided by *Koffset* in *ServingCellConfigCommon*; otherwise, .

The UE may assume a minimum time between the last symbol of a PDSCH reception conveying a RAR message with a RAR UL grant and the first symbol of a corresponding PUSCH transmission scheduled by the RAR UL grant is equal to msec, where is a time duration of symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured, is a time duration of symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] and, for determining the minimum time, the UE considers that and correspond to the smaller of the SCS configurations for the PDSCH and the PUSCH. For , the UE assumes [6, TS 38.214].

## 8.4 PDSCH with UE contention resolution identity

In response to a PUSCH transmission scheduled by a RAR UL grant when a UE has not been provided a C-RNTI, the UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding TC-RNTI scheduling a PDSCH that includes a UE contention resolution identity [11, TS 38.321]. In response to the PDSCH reception with the UE contention resolution identity, the UE transmits HARQ-ACK information in a PUCCH. The PUCCH transmission is within a same active UL BWP as the PUSCH transmission. A minimum time between the last symbol of the PDSCH reception and the first symbol of the corresponding PUCCH transmission with the HARQ-ACK information is equal to msec. is a time duration of symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured. For , the UE assumes [6, TS 38.214].

When detecting a DCI format in response to a PUSCH transmission scheduled by a RAR UL grant, as described in [11, TS 38.321], or corresponding PUSCH retransmission scheduled by a DCI format 0\_0 with CRC scrambled by a TC-RNTI provided in the corresponding RAR message [11, TS 38.321], the UE may assume the PDCCH carrying the DCI format has the same DM-RS antenna port quasi co-location properties, as described in [6, TS 38.214], as for a SS/PBCH block 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.

\*\*\* Unchanged text is omitted \*\*\*

### 9.1.2 Type-1 HARQ-ACK codebook determination

This clause applies if the UE is configured with *pdsch-HARQ-ACK-Codebook = semi-static*.

A UE does not expect to be configured with *pdsch-HARQ-ACK-Codebook = semi-static* for a codebook if a UE is provided *subslotLength-ForPUCCH* for the codebook.

If a UE is provided *HARQ-feedbackEnabling-disablingperHARQprocess* indicating disabled HARQ-ACK information for a HARQ process associated with a transport block in PDSCH reception occasion on serving cell , the UE reports a NACK value for a HARQ-ACK information bit corresponding to the transport block in a Type-1 HARQ-ACK codebook and does not consider the transport block as received in the determination of in clause 9.1.2.1. If the UE is also provided *PDSCH-CodeBlockGroupTransmission*, the UE reports NACK values for HARQ-ACK information bits corresponding to CBGs of the transport block in the Type-1 HARQ-ACK codebook and does not consider the CBGs as received in the determination of in clause 9.1.2.1. If the UE is also provided *HARQ-feedbackEnablingforSPSactive*, the UE considers a HARQ process associated with a transport block in a first SPS PDSCH reception, after an activation of SPS PDSCH receptions, to have enabled HARQ-ACK information and the UE provides a HARQ-ACK information bit according to a decoding outcome for the transport block in the first SPS PDSCH reception.

A UE reports HARQ-ACK information for a corresponding PDSCH reception or SPS PDSCH release only in a HARQ-ACK codebook that the UE transmits in a slot indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in a corresponding DCI format. The UE reports NACK value(s) for HARQ-ACK information bit(s) in a HARQ-ACK codebook that the UE transmits in a slot not indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in a corresponding DCI format.

If a UE is not provided *pdsch-HARQ-ACK-OneShotFeedback*, the UE does not expect to receive a PDSCH scheduled by a DCI format that the UE detects in any PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK-r16*.

If the UE is provided *pdsch-AggregationFactor-r16* in *SPS-Config* or *pdsch-AggregationFactor* in *PDSCH-Config* and no entry in *pdsch-TimeDomainAllocationList* and *pdsch-TimeDomainAllocationListDCI-1-2* includes *repetitionNumber* in *PDSCH-TimeDomainResourceAllocation-r16*, is a maximum value of *pdsch-AggregationFactor-r16* in *SPS-Config* or *pdsch-AggregationFactor* in *PDSCH-Config*; otherwise . The UE reports HARQ-ACK information for a PDSCH reception

- from DL slot to DL slot , if is provided by *pdsch-AggregationFactor* or *pdsch-AggregationFactor-r16* [6, TS 38.214], or

- from DL slot to DL slot , if the time domain resource assignment field in the DCI format scheduling the PDSCH reception indicates an entry containing *repetitionNumber,* or

- in DL slot , otherwise

only in a HARQ-ACK codebook that the UE includes in a PUCCH or PUSCH transmission in slot , where is the last UL slot overlapping with DL slot and is a number of slots indicated by the PDSCH-to-HARQ\_feedback timing indicator field in a corresponding DCI format or provided by *dl-DataToUL-ACK* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the DCI format. If the UE reports HARQ-ACK information for the PDSCH reception in a slot other than slot , the UE sets a value for each corresponding HARQ-ACK information bit to NACK.

If a UE reports HARQ-ACK information in a PUCCH only for

- a SPS PDSCH release indicated by DCI format 1\_0 with counter DAI field value of 1, or

- a PDSCH reception scheduled by DCI format 1\_0 with counter DAI field value of 1 on the PCell, or

- SPS PDSCH reception(s)

within the  occasions for candidate PDSCH receptions as determined in clause 9.1.2.1, the UE determines a HARQ-ACK codebook only for the SPS PDSCH release or only for the PDSCH reception or only for one SPS PDSCH reception according to corresponding  occasion(s) on respective serving cell(s), where the value of counter DAI in DCI format 1\_0 is according to Table 9.1.3-1 and HARQ-ACK information bits in response to more than one SPS PDSCH receptions that the UE is configured to receive are ordered according to the following pseudo-code; otherwise, the procedures in clause 9.1.2.1 and clause 9.1.2.2 for a HARQ-ACK codebook determination apply.

Set to the number of serving cells configured to the UE

Set to the number of SPS PDSCH configuration configured to the UE for serving cell

Set to the number of DL slots for SPS PDSCH reception on serving cell with HARQ-ACK information multiplexed on the PUCCH

Set – HARQ-ACK information bit index

Set – serving cell index: lower indexes correspond to lower RRC indexes of corresponding cell

while

Set – SPS PDSCH configuration index: lower indexes correspond to lower RRC indexes of corresponding SPS configurations

while

Set – slot index

while

if {

a UE is configured to receive SPS PDSCHs from slot to slot for SPS PDSCH configuration on serving cell , excluding SPS PDSCHs that are not required to be received in any slot among overlapping SPS PDSCHs, if any according to [6, TS 38.214], or based on a UE capability for a number of PDSCH receptions in a slot according to [6, TS 38.214], or due to overlapping with a set of symbols indicated as uplink by *tdd-UL-DL-ConfigurationCommon* or by *tdd-UL-DL-ConfigurationDedicated* where is provided by *pdsch-AggregationFactor-r16* in *sps-Config* or, if *pdsch-AggregationFactor-r16* is not included in *sps-Config*, by *pdsch-AggregationFactor* in *pdsch-config*, and

HARQ-ACK information for the SPS PDSCH is associated with the PUCCH

}

 = HARQ-ACK information bit for this SPS PDSCH reception

;

end if

;

end while

;

end while

;

end while

\*\*\* Unchanged text is omitted \*\*\*

### 9.1.3 Type-2 HARQ-ACK codebook determination

This clause applies if the UE is configured with *pdsch-HARQ-ACK-Codebook = dynamic* or with *pdsch-HARQ-ACK-Codebook-r16*. Unless stated otherwise, a PDSCH-to-HARQ\_feedback timing indicator field provides an applicable value.

A UE does not expect to multiplex in a Type-2 HARQ-ACK codebook HARQ-ACK information that is in response to a detection of a DCI format that does not include a counter DAI field.

If a UE is provided *HARQ-feedbackEnabling-disablingperHARQprocess* indicating disabled HARQ-ACK information for a HARQ process associated with a transport block in PDSCH reception occasion on serving cell , the UE does not multiplex a HARQ-ACK information bit corresponding to the transport block in a Type-2 HARQ-ACK codebook and does not consider the transport block as received in the determination of or of in clause 9.1.3.1. If the UE is also provided *PDSCH-CodeBlockGroupTransmission*, the UE does not multiplex HARQ-ACK information bits corresponding to CBGs of the transport block in the Type-2 HARQ-ACK codebook and does not consider the CBGs as received in the determination of in clause 9.1.3.1. If the UE is also provided *HARQ-feedbackEnablingforSPSactive*, the UE considers a HARQ process associated with a transport block in a first SPS PDSCH reception, after an activation of SPS PDSCH receptions, to have enabled HARQ-ACK information and the UE provides a HARQ-ACK information bit according to a decoding outcome for the transport block in the first SPS PDSCH reception.

If a UE receives a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK-r16*,

- if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where

- if the UE is not provided *pdsch-HARQ-ACK-Codebook-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and where the slot indicated by the value of the PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format is no later than a slot for HARQ-ACK information in response to a SPS PDSCH reception, if any, received after the PDSCH scheduled by the first DCI format.

- if the UE is provided *pdsch-HARQ-ACK-Codebook-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in clause 9.1.3.3, and where the slot indicated by the value of the PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format is no later than a slot for HARQ-ACK information in response to a SPS PDSCH reception, if any, received after the PDSCH scheduled by the first DCI format.

- if the UE is provided *pdsch-HARQ-ACK-Codebook-r16*, the UE receives the second DCI format later than the slot for HARQ-ACK information in response to a SPS PDSCH reception received after the PDSCH scheduled by the first DCI format, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in clause 9.1.3.3.

- if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback*, the first DCI format does not indicate SPS PDSCH release or SCell dormancy, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in clause 9.1.4, and where the slot indicated by the value of the PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format is no later than a slot for HARQ-ACK information in response to a SPS PDSCH reception, if any, received after the PDSCH scheduled by the first DCI format.

- if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the first DCI format does not indicate SPS PDSCH release or SCell dormancy, and the UE receives the second DCI format later than the slot for HARQ-ACK information in response to a SPS PDSCH reception received after the PDSCH scheduled by the first DCI format, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in clause 9.1.4.

- otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission.

#### 9.1.3.1 Type-2 HARQ-ACK codebook in physical uplink control channel

A UE determines monitoring occasions for PDCCH with DCI format scheduling PDSCH receptions or SPS PDSCH release or indicating SCell dormancy on an active DL BWP of a serving cell , as described in clause 10.1, and for which the UE transmits HARQ-ACK information in a same PUCCH in slot based on

- PDSCH-to-HARQ\_feedback timing indicator field values for PUCCH transmission with HARQ-ACK information in slot in response to PDSCH receptions, SPS PDSCH release or SCell dormancy indication

- slot offsets [6, TS 38.214] provided by time domain resource assignment field in a DCI format scheduling PDSCH receptions and by *pdsch-AggregationFactor*, or *pdsch-AggregationFactor-r16*, or *repetitionNumber*, when provided.

The set of PDCCH monitoring occasions for a DCI format scheduling PDSCH receptions or SPS PDSCH release or indicating SCell dormancy is defined as the union of PDCCH monitoring occasions across active DL BWPs of configured serving cells. PDCCH monitoring occasions are indexed in an ascending order of their start times. The cardinality of the set of PDCCH monitoring occasions defines a total number of PDCCH monitoring occasions.

A value of the counter downlink assignment indicator (DAI) field in DCI formats denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s), SPS PDSCH release or SCell dormancy indication associated with the DCI formats is present up to the current serving cell and current PDCCH monitoring occasion,

- first, if the UE indicates by *type2-HARQ-ACK-Codebook* support for more than one PDSCH reception on a serving cell that are scheduled from a same PDCCH monitoring occasion, in increasing order of the PDSCH reception starting time for the same {serving cell, PDCCH monitoring occasion} pair,

- second in ascending order of serving cell index, and

- third in ascending order of PDCCH monitoring occasion index , where .

If, for an active DL BWP of a serving cell, the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs, and is provided *ackNackFeedbackMode* = *joint*, the value of the counter DAI is in the order of the first CORESETs and then the second CORESETs for a same serving cell index and a same PDCCH monitoring occasion index.

The value of the total DAI, when present [5, TS 38.212], in a DCI format denotes the total number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s), SPS PDSCH release or SCell dormancy indication associated with DCI formats is present, up to the current PDCCH monitoring occasion and is updated from PDCCH monitoring occasion to PDCCH monitoring occasion. If, for an active DL BWP of a serving cell, the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs, and is provided *ackNackFeedbackMode* = *joint*, the total DAI value counts the {serving cell, PDCCH monitoring occasion}-pair(s) for both the first CORESETs and the second CORESETs.

Denote by the number of bits for the counter DAI and set . Denote by the value of the counter DAI in a DCI format scheduling PDSCH reception, SPS PDSCH release or SCell dormancy indication on serving cell in PDCCH monitoring occasion according to Table 9.1.3-1 or Table 9.1.3-1A. Denote by the value of the total DAI in a DCI format in PDCCH monitoring occasion according to Table 9.1.3-1. The UE assumes a same value of total DAI in all DCI formats that include a total DAI field in PDCCH monitoring occasion . A UE does not expect to multiplex, in a same Type-2 HARQ-ACK codebook, HARQ-ACK information that is in response to detection of DCI formats with different number of bits for the counter DAI field.

If the UE transmits HARQ-ACK information in a PUCCH in slot and for any PUCCH format, the UE determines the , for a total number of HARQ-ACK information bits, according to the following pseudo-code:

Set – PDCCH with DCI format scheduling PDSCH reception, SPS PDSCH release or SCell dormancy indication monitoring occasion index: lower index corresponds to earlier PDCCH monitoring occasion

Set

Set

Set

Set

Set to the number of serving cells configured by higher layers for the UE

- if, for an active DL BWP of a serving cell, the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs, and is provided *ackNackFeedbackMode = joint,* the serving cell is counted two times where the first time corresponds to the first CORESETs and the second time corresponds to the second CORESETs

- if the UE indicates *type2-HARQ-ACK-Codebook*, a serving cell is counted times where is the number of PDSCH receptions that can be scheduled for the serving cell by DCI formats in PDCCH receptions at a same PDCCH monitoring occasion based on the reported value of *type2-HARQ-ACK-Codebook*

Set to the number of PDCCH monitoring occasion(s)

while

Set – serving cell index: lower indexes correspond to lower RRC indexes of corresponding cell

while

if PDCCH monitoring occasion is before an active DL BWP change on serving cell or an active UL BWP change on the PCell and an active DL BWP change is not triggered in PDCCH monitoring occasion

;

else

if there is a PDSCH providing a transport block for a HARQ process with enabled HARQ-ACK information on serving cell associated with PDCCH in PDCCH monitoring occasion , or there is a PDCCH indicating SPS PDSCH release or SCell dormancy on serving cell

if

end if

if

else

end if

if *harq-ACK-SpatialBundlingPUCCH* is not provided and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for at least one configured DL BWP of at least one serving cell,

 = HARQ-ACK information bit corresponding to the first transport block of this cell

 = HARQ-ACK information bit corresponding to the second transport block of this cell

elseif *harq-ACK-SpatialBundlingPUCCH* is provided to the UE and is a monitoring occasion for PDCCH with a DCI format that supports PDSCH reception with two transport blocks and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks in at least one configured DL BWP of a serving cell,

 = binary AND operation of the HARQ-ACK information bits corresponding to the first and second transport blocks of this cell

else

 = HARQ-ACK information bit of this cell

end if

end if

end if

end while

end while

if UE does not set and

end if

if

end if

if *harq-ACK-SpatialBundlingPUCCH* is not provided to the UE and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for at least one configured DL BWP of a serving cell,

else

end if

 for any

If a UE is configured to receive SPS PDSCH and the UE multiplexes HARQ-ACK information for one activated SPS PDSCH reception in the PUCCH in slot , the UE generates one HARQ-ACK information bit associated with the SPS PDSCH reception and appends it to the HARQ-ACK information bits.

If a UE is configured to receive SPS PDSCH and the UE multiplexes HARQ-ACK information for multiple activated SPS PDSCH receptions in the PUCCH in slot , the UE generates the HARQ-ACK information as described in clause 9.1.2 and appends it to the HARQ-ACK information bits.

For a PDCCH monitoring occasion with DCI format scheduling PDSCH reception or SPS PDSCH release or indicating SCell dormancy in the active DL BWP of a serving cell, when a UE receives a PDSCH with one transport block or a SPS PDSCH release or indicating SCell dormancy and the value of *maxNrofCodeWordsScheduledByDCI* is 2, the HARQ-ACK information is associated with the first transport block and the UE generates a NACK for the second transport block if *harq-ACK-SpatialBundlingPUCCH* is not provided and generates HARQ-ACK information with value of ACK for the second transport block if *harq-ACK-SpatialBundlingPUCCH* is provided.

If a UE is not provided *PDSCH-CodeBlockGroupTransmission* for each of the serving cells, or for PDSCH receptions scheduled by a DCI format that does not support CBG-based PDSCH receptions, or for SPS PDSCH reception, or for SPS PDSCH release, or for SCell dormancy indication, and if , the UE determines a number of HARQ-ACK information bits for obtaining a transmission power for a PUCCH, as described in clause 7.2.1, as

where

- if , is the value of the counter DAI in the last DCI format scheduling PDSCH reception or indicating SPS PDSCH release or indicating SCell dormancy, for any serving cell that the UE detects within the PDCCH monitoring occasions.

- if

- if the UE does not detect any DCI format that includes a total DAI field in a last PDCCH monitoring occasion within the PDCCH monitoring occasions where the UE detects at least one DCI format scheduling PDSCH reception, indicating SPS PDSCH release or indicating SCell dormancy for any serving cell , is the value of the counter DAI in a last DCI format the UE detects in the last PDCCH monitoring occasion

- if the UE detects at least one DCI format that includes a total DAI field in a last PDCCH monitoring occasion within the PDCCH monitoring occasions where the UE detects at least one DCI format scheduling PDSCH reception, indicating SPS PDSCH release or indicating SCell dormancy for any serving cell , is the value of the total DAI in the at least one DCI format that includes a total DAI field

- if the UE does not detect any DCI format scheduling PDSCH reception, indicating SPS PDSCH release or indicating SCell dormancy for any serving cell in any of the PDCCH monitoring occasions.

- is the total number of a DCI format scheduling PDSCH reception, indicating SPS PDSCH release or indicating SCell dormancy that the UE detects within the PDCCH monitoring occasions for serving cell . if the UE does not detect any DCI format scheduling PDSCH reception, indicating SPS PDSCH release or indicating SCell dormancy for serving cell in any of the PDCCH monitoring occasions.

- if the value of *maxNrofCodeWordsScheduledByDCI* is 2 for any serving cell and *harq-ACK-SpatialBundlingPUCCH* is not provided; otherwise, .

- is the number of transport blocks the UE receives in a PDSCH scheduled by a DCI format that the UE detects in PDCCH monitoring occasion for serving cell if *harq-ACK-SpatialBundlingPUCCH* is not provided, or the number of PDSCH scheduled by a DCI format that the UE detects in PDCCH monitoring occasion for serving cell if *harq-ACK-SpatialBundlingPUCCH* is provided, or the number of DCI format that the UE detects and indicate SPS PDSCH release in PDCCH monitoring occasion for serving cell , or the number of DCI format that the UE detects and indicate SCell dormancy in PDCCH monitoring occasion for serving cell .

- is the number of SPS PDSCH receptions by the UE on serving cell for which the UE transmits corresponding HARQ-ACK information in the same PUCCH as for HARQ-ACK information corresponding to PDSCH receptions within the PDCCH monitoring occasions.

If a UE

- is provided *PDSCH-CodeBlockGroupTransmission* for serving cells; and

- is not provided *PDSCH-CodeBlockGroupTransmission*, for serving cells where

the UE determines the according to the previous pseudo-code with the following modifications

- is used for the determination of a first HARQ-ACK sub-codebook for

- SPS PDSCH release,

- SPS PDSCH reception,

- DCI format 1\_1 indicating SCell dormancy, and

- for TB-based PDSCH receptions on the serving cells and on the serving cells,

- is replaced by for the determination of a second HARQ-ACK sub-codebook corresponding to the serving cells for CBG-based PDSCH receptions, and

- if, for an active DL BWP of a serving cell, the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs, and is provided *ackNackFeedbackMode* = *joint,* the serving cell is counted as two times where the first time corresponds to the first CORESETs and the second time corresponds to the second CORESETs, and

- instead of generating one HARQ-ACK information bit per transport block for a serving cell from the serving cells, the UE generates HARQ-ACK information bits, where  is the maximum value of across all serving cells and  is the value of *maxNrofCodeWordsScheduledByDCI* for serving cell . If for a serving cell it is , the UE generates NACK for the last HARQ-ACK information bits for serving cell

- the pseudo-code operation when *harq-ACK-SpatialBundlingPUCCH* is provided is not applicable

- The counter DAI value and the total DAI value apply separately for each HARQ-ACK sub-codebook

- The UE generates the HARQ-ACK codebook by appending the second HARQ-ACK sub-codebook to the first HARQ-ACK sub-codebook

If , the UE also determines for obtaining a PUCCH transmission power, as described in clause 7.2.1, with

where

- if , is the value of the counter DAI in the last DCI format scheduling CBG-based PDSCH reception for any serving cell that the UE detects within the PDCCH monitoring occasions

- if ,, is the value of the total DAI in the last DCI format scheduling CBG-based PDSCH reception for any serving cell that the UE detects within the PDCCH monitoring occasions

- , if the UE does not detect any DCI format scheduling CBG-based PDSCH reception for any serving cell in any of the PDCCH monitoring occasions

- is the total number of DCI formats scheduling CBG-based PDSCH receptions that the UE detects within the PDCCH monitoring occasions for serving cell . if the UE does not detect any DCI format scheduling CBG-based PDSCH reception for serving cell in any of the PDCCH monitoring occasions

- is the number of CBGs the UE receives in a PDSCH scheduled by a DCI format that supports CBG-based PDSCH reception that the UE detects in PDCCH monitoring occasion for serving cell and the UE reports corresponding HARQ-ACK information in the PUCCH

Table 9.1.3-1: Value of counter DAI for and of total DAI

|  |  |  |
| --- | --- | --- |
| DAIMSB, LSB |  or  | Number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH transmission(s) associated with PDCCH or PDCCH indicating SPS PDSCH release or DCI format 1\_1 indicating SCell dormancy is present, denoted as and  |
| 0,0 | 1 |  |
| 0,1 | 2 |  |
| 1,0 | 3 |  |
| 1,1 | 4 |  |

Table 9.1.3-1A: Value of counter DAI for

|  |  |  |
| --- | --- | --- |
| **DAI** |  | **Number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH transmission(s) associated with PDCCH or PDCCH indicating SPS PDSCH release is present, denoted as and**  |
| 0 | 1 |  |
| 1 | 2 |  |

\*\*\* Unchanged text is omitted \*\*\*

### 9.1.4 Type-3 HARQ-ACK codebook determination

If a UE is provided *pdsch-HARQ-ACK-OneShotFeedback*, the UE determines HARQ-ACK information bits, for a total number of HARQ-ACK information bits, of a Type-3 HARQ-ACK codebook according to the following procedure.

Set to the number of configured serving cells

Set to the value of *nrofHARQ-ProcessesForPDSCH* for serving cell , if provided; else, set

Set to the value of *maxNrofCodeWordsScheduledByDCI* for serving cell if *harq-ACK-SpatialBundlingPUCCH* is provided and , or if *harq-ACK-SpatialBundlingPUCCH* is not provided, or if *maxCodeBlockGroupsPerTransportBlock* is provided for serving cell ; else, set

Set to the number of HARQ-ACK information bits per TB for PDSCH receptions on serving cell as described in clause 9.1.1 if *maxCodeBlockGroupsPerTransportBlock* is provided for serving cell and *pdsch-HARQ-ACK-OneShotFeedbackCBG* is provided; else, set

Set if *pdsch-HARQ-ACK-OneShotFeedbackNDI* is provided; else set

Set – serving cell index

Set – HARQ process number

Set – TB index

Set – CBG index

Set

while

while

if *HARQ-feedbackEnabling-disablingperHARQprocess* is not provided, or is provided and indicates enabled HARQ-ACK information for , or *HARQ-feedbackEnablingforSPSactive* is provided and corresponds to a transport block in a first SPS PDSCH reception after an activation of SPS PDSCH receptions

if

if

while

while

= HARQ-ACK information bit for CBG of TB for HARQ process number of serving cell , if any; else, 

end while

= NDI value indicated in the DCI format corresponding to the HARQ-ACK information bit(s) for TB for HARQ process number on serving cell , if any; else, 

end while

else

while

= HARQ-ACK information bit for TB for HARQ process of serving cell , if any; else, 

= NDI value indicated in the DCI format corresponding to the HARQ-ACK information bit(s) for TB for HARQ process number on serving cell , if any; else, 

end while

end if

else

if

while

if UE has obtained HARQ-ACK information for TB for HARQ process number on serving cell corresponding to a PDSCH reception and has not reported the HARQ-ACK information corresponding to the PDSCH reception

while

= HARQ-ACK information bit for CBG of TB for HARQ process number of serving cell

end while

else

while



end while

end if

end while

else

while

if UE has obtained HARQ-ACK information for TB for HARQ process number on serving cell corresponding to a PDSCH reception and has not reported the HARQ-ACK information corresponding to the PDSCH reception

if *harq-ACK-SpatialBundlingPUCCH* is not provided

= HARQ-ACK information bit for TB for HARQ process of serving cell

else

= binary AND operation of the HARQ-ACK information bits corresponding to first and second transport blocks for HARQ process of serving cell . If the UE receives one transport block, the UE assumes ACK for the second transport block

end if

else

= NACK

end if

end while

end if

end if

end if

end while

end while

If , when a UE receives a PDSCH with one transport block, the HARQ-ACK information is associated with the first transport block.

If a UE receives a SPS PDSCH, or a PDSCH that is scheduled by a DCI format that does not support CBG-based PDSCH receptions for a serving cell and if *maxCodeBlockGroupsPerTransportBlock* is provided for serving cell , and *pdsch-HARQ-ACK-OneShotFeedbackCBG* is provided, the UE repeats times the HARQ-ACK information for the transport block, if any, in the PDSCH.

If a UE detects a DCI format that includes a One-shot HARQ-ACK request field with value 1, the UE determines a PUCCH or a PUSCH to multiplex a Type-3 HARQ-ACK codebook for transmission in a slot as described in clauses 9.2.3 and 9.2.5. The UE multiplexes only the Type-3 HARQ-ACK codebook in the PUCCH or the PUSCH for transmission in the slot.

If

- a UE detects a DCI format that includes a One-shot HARQ-ACK request field with value 1, and

- the CRC of the DCI is scrambled by a C-RNTI or an MCS-C-RNTI, and

- *resourceAllocation* = *resourceAllocationType0* and all bits of the frequency domain resource assignment field in the DCI format are equal to 0, or

- *resourceAllocation* = *resourceAllocationType1* and all bits of the frequency domain resource assignment field in the DCI format are equal to 1, or

- *resourceAllocation = dynamicSwitch* and all bits of the frequency domain resource assignment field in the DCI format are equal to 0 or 1

the DCI format provides a request for a Type-3 HARQ-ACK codebook report and does not schedule a PDSCH reception. The UE is expected to provide HARQ-ACK information in response to the request for the Type-3 HARQ-ACK codebook after symbols from the last symbol of a PDCCH providing the DCI format, where the value of for is provided in clause 10.2 by replacing "SPS PDSCH release" with "DCI format".

If a UE multiplexes HARQ-ACK information in a PUSCH transmission, the UE generates the HARQ-ACK codebook as described in this clause except that *harq-ACK-SpatialBundlingPUCCH* is replaced by *harq-ACK-SpatialBundlingPUSCH*.

\*\*\* Unchanged text is omitted \*\*\*

### 9.2.3 UE procedure for reporting HARQ-ACK

In this clause, for the purpose of determining a PUCCH resource for a PUCCH transmission in a slot using a PUCCH resource indicator field in a DCI format that schedules a PDSCH reception, and for the purpose of determining the slot for the PUCCH transmission, a UE is assumed to generate HARQ-ACK information regardless of whether or not the PDSCH reception provides a transport block for a HARQ process with disabled HARQ-ACK information as indicated by *HARQ-feedbackEnabling-disablingperHARQprocess*, if provided. The UE determines a number of HARQ-ACK information bits as described in clauses 9.1 through 9.1.5 and a corresponding set of PUCCH resources as described in clause 9.2.1.

A UE does not expect to transmit more than one PUCCH with HARQ-ACK information in a slot per priority index, if the UE is not provided *ackNackFeedbackMode = separate*.

For DCI format 1\_0, the PDSCH-to-HARQ\_feedback timing indicator field values map to {1, 2, 3, 4, 5, 6, 7, 8}. For a DCI format, other than DCI format 1\_0 or requesting Type-3 HARQ-ACK codebook report without scheduling a PDSCH reception as described in clause 9.1.4, the PDSCH-to-HARQ\_feedback timing indicator field values, if present, map to values for a set of number of slots provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* as defined in Table 9.2.3-1.

If the UE is provided *subslotLengthForPUCCH*, is the last UL slot that overlaps with the PDSCH reception or with the PDCCH reception in case of SPS PDSCH release or in case of SCell dormancy indication or in case of the DCI format that requests Type-3 HARQ-ACK codebook report and does not schedule a PDSCH reception; otherwise, is the last UL slot that overlaps with the DL slot for the PDSCH reception or with the DL slot for the PDCCH reception in case of SPS PDSCH release or in case of SCell dormancy indication or in case of the DCI format that requests Type-3 HARQ-ACK codebook report and does not schedule a PDSCH reception.

For a SPS PDSCH reception ending in DL slot , the UE transmits the PUCCH in UL slot where is provided by the PDSCH-to-HARQ\_feedback timing indicator field, if present, in a DCI format activating the SPS PDSCH reception, and is provided by *K-Offset* in *ServingCellConfigCommon* or by a MAC CE command; otherwise, .

If the UE detects a DCI format that does not include a PDSCH-to-HARQ\_feedback timing indicator field and schedules a PDSCH reception or activates a SPS PDSCH reception ending in DL slot , the UE provides corresponding HARQ-ACK information in a PUCCH transmission within UL slot where is provided by *dl-DataToUL-ACK*, or *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* and is provided by *K-Offset* in *ServingCellConfigCommon* or by a MAC CE command; otherwise, .

If the UE detects a DCI format scheduling a PDSCH reception ending in DL slot  or if the UE detects a DCI format indicating a SPS PDSCH release or indicating SCell dormancy through a PDCCH reception ending in DL slot , or if the UE detects a DCI format that requests Type-3 HARQ-ACK codebook report and does not schedule a PDSCH reception through a PDCCH reception ending in DL slot , as described in clause 9.1.4, the UE provides corresponding HARQ-ACK information in a PUCCH transmission within UL slot , where is a number of slots and is indicated by the PDSCH-to-HARQ\_feedback timing indicator field in the DCI format, if present, or provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* and is provided by *K-Offset* in *ServingCellConfigCommon* or by a MAC CE command; otherwise, .

If the UE is provided a value by a MAC CE command, the UE applies the MAC 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 MAC CE command, is the SCS configuration of the BWP for the PUCCH transmission that is determined in the slot when the MAC CE command is applied, and is a number of slots for SCS configuration provided by *K-Mac* or if *K-Mac* is not provided.

A PUCCH transmission with HARQ-ACK information is subject to the limitations for UE transmissions described in clause 11.1 and clause 11.1.1.

Table 9.2.3-1: Mapping of PDSCH-to-HARQ\_feedback timing indicator field values to numbers of slots

|  |  |
| --- | --- |
| PDSCH-to-HARQ\_feedback timing indicator  | Number of slots  |
| 1 bit | 2 bits | 3 bits |  |
| '0' | '00' | '000' | 1st value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*  |
| '1' | '01' | '001' | 2nd value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* |
|  | '10' | '010' | 3rd value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* |
|  | '11' | '011' | 4th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* |
|  |  | '100' | 5th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* |
|  |  | '101' | 6th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* |
|  |  | '110' | 7th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* |
|  |  | '111' | 8th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* |

For a PUCCH transmission with HARQ-ACK information, a UE determines a PUCCH resource after determining a set of PUCCH resources for  HARQ-ACK information bits, as described in clause 9.2.1. The PUCCH resource determination is based on a PUCCH resource indicator field [5, TS 38.212], if present, in a last DCI format, among the DCI formats that have a value of a PDSCH-to-HARQ\_feedback timing indicator field, if present, or a value of *dl-DataToUL-ACK*, or *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* indicating a same slot for the PUCCH transmission, that the UE detects and for which the UE transmits corresponding HARQ-ACK information in the PUCCH. For PUCCH resource determination, detected DCI formats are first indexed in an ascending order across serving cells indexes for a same PDCCH monitoring occasion and are then indexed in an ascending order across PDCCH monitoring occasion indexes. For indexing DCI formats within a serving cell for a same PDCCH monitoring occasion, if the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs on an active DL BWP of a serving cell, and with *ackNackFeedbackMode* = *joint* for the active UL BWP, detected DCI formats from PDCCH receptions in the first CORESETs are indexed prior to detected DCI formats from PDCCH receptions in the second CORESETs.

The PUCCH resource indicator field values map to values of a set of PUCCH resource indexes, as defined in Table 9.2.3-2 for a PUCCH resource indicator field of 3 bits, provided by *resourceList* for PUCCH resources from a set of PUCCH resources provided by *PUCCH-ResourceSet* with a maximum of eight PUCCH resources. If the PUCCH resource indicator field includes 1 bit or 2 bits, the values map to the first two values or the first four values, respectively, of Table 9.2.3-2. If the last DCI format does not include a PUCCH resource indicator field, the first value of Table 9.2.3-2 is used.

For the first set of PUCCH resources and when the size  of *resourceList* is larger than eight, when a UE provides HARQ-ACK information in a PUCCH transmission in response to detecting a last DCI format in a PDCCH reception, among DCI formats with a value of the PDSCH-to-HARQ\_feedback timing indicator field, if present, or a value of *dl-DataToUL-ACK*, or *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17* indicating a same slot for the PUCCH transmission, the UE determines a PUCCH resource with index **, , as

 

where  is a number of CCEs in CORESET  of the PDCCH reception for the DCI format as described in clause 10.1,  is the index of a first CCE for the PDCCH reception, and is a value of the PUCCH resource indicator field in the DCI format. If the DCI format does not include a PUCCH resource indicator field, .

Table 9.2.3-2: Mapping of PUCCH resource indication field values to a PUCCH resource in a PUCCH resource set with maximum 8 PUCCH resources

|  |  |
| --- | --- |
| PUCCH resource indicator  | PUCCH resource |
| 1 bit | 2 bits | 3 bits |  |
| '0' | '00' | '000' | 1st PUCCH resource provided by *pucch-ResourceId* obtained from the 1st value of *resourceList* |
| '1' | '01' | '001' | 2nd PUCCH resource provided by *pucch-ResourceId* obtained from the 2nd value of *resourceList* |
|  | '10' | '010' | 3rd PUCCH resource provided by *pucch-ResourceId* obtained from the 3rd value of *resourceList* |
|  | '11' | '011' | 4th PUCCH resource provided by *pucch-ResourceId* obtained from the 4th value of *resourceList* |
|  |  | '100' | 5th PUCCH resource provided by *pucch-ResourceId* obtained from the 5th value of *resourceList* |
|  |  | '101' | 6th PUCCH resource provided by *pucch-ResourceId* obtained from the 6th value of *resourceList* |
|  |  | '110' | 7th PUCCH resource provided by *pucch-ResourceId* obtained from the 7th value of *resourceList* |
|  |  | '111' | 8th PUCCH resource provided by *pucch-ResourceId* obtained from the 8th value of *resourceList* |

If a UE determines a first resource for a PUCCH transmission with HARQ-ACK information corresponding only to a PDSCH reception without a corresponding PDCCH or detects a first DCI format indicating a first resource for a PUCCH transmission with corresponding HARQ-ACK information in a slot and also detects at a later time a second DCI format indicating a second resource for a PUCCH transmission with corresponding HARQ-ACK information in the slot, the UE does not expect to multiplex HARQ-ACK information corresponding to the second DCI format in a PUCCH resource in the slot if the PDCCH reception that includes the second DCI format is not earlier than  from the beginning of a first symbol of the first resource for PUCCH transmission in the slot where, and are defined in clause 4.1 of [4, TS 38.211] and corresponds to the smallest SCS configuration among the SCS configurations of the PDCCHs providing the DCI formats and the SCS configuration of the PUCCH. If *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell with the second DCI format and for all serving cells with corresponding HARQ-ACK information multiplexed in the PUCCH transmission in the slot, for ,  for ,  for ; otherwise ,  for ,  for ,  for ,  for .

If a UE is not provided *SPS-PUCCH-AN-List* and transmits HARQ-ACK information corresponding only to a PDSCH reception without a corresponding PDCCH, a PUCCH resource for corresponding PUCCH transmission with HARQ-ACK information is provided by *n1PUCCH-AN*.

If a UE transmits a PUCCH with HARQ-ACK information using PUCCH format 0, the UE determines values  and  for computing a value of cyclic shift  [4, TS 38.211] where  is provided by *initialCyclicShift* of *PUCCH-format0* or, if *initialCyclicShift* is not provided, by the initial cyclic shift index as described in clause 9.2.1 and  is determined from the value of one HARQ-ACK information bit or from the values of two HARQ-ACK information bits as in Table 9.2.3-3 and Table 9.2.3-4, respectively.

Table 9.2.3-3: Mapping of values for one HARQ-ACK information bit to sequences for PUCCH format 0

|  |  |  |
| --- | --- | --- |
| HARQ-ACK Value | 0 | 1 |
| **Sequence cyclic shift** |  |  |

Table 9.2.3-4: Mapping of values for two HARQ-ACK information bits to sequences for PUCCH format 0

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| HARQ-ACK Value | {0, 0} | {0, 1} | {1, 1} | {1, 0} |
| **Sequence cyclic shift** |  |  |  |  |

If a UE transmits a PUCCH with HARQ-ACK information using PUCCH format 1, the UE is provided a value for  by *initialCyclicShift* of *PUCCH-format1* or, if *initialCyclicShift* is not provided, by the initial cyclic shift index as described in clause 9.2.1.

If a UE transmits a PUCCH with  HARQ-ACK information bits and  bits using PUCCH format 2 or PUCCH format 3 in a PUCCH resource that includes  PRBs, the UE determines a number of PRBs  for the PUCCH transmission to be the minimum number of PRBs, that is smaller than or equal to a number of PRBs  provided respectively by *nrofPRBs* of *PUCCH-format2* or *nrofPRBs* of *PUCCH-format3* and start from the first PRB from the number of PRBs, that results to  and, if , , where , , , and  are defined in clause 9.2.5.2. For PUCCH format 3, if  is not equal  according to [4, TS 38.211],  is increased to the nearest allowed value of *nrofPRBs* for *PUCCH-format3*[12, TS 38.331]. If , the UE transmits the PUCCH over  PRBs.

If a UE is provided a first interlace of PRBs by *interlace0* in *InterlaceAllocation* and transmits a PUCCH with HARQ-ACK information bits and bits using PUCCH format 2 or PUCCH format 3, the UE transmits the PUCCH over the first interlace if ; otherwise, if the UE is provided a second interlace by *interlace1* in *PUCCH-format2* or *PUCCH-format3*, the UE transmits the PUCCH over the first and second interlaces.

\*\*\* Unchanged text is omitted \*\*\*

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

\*\*\* Unchanged text is omitted \*\*\*

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 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 state. 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 *K-Mac* or if *K-Mac* is not provided.

If the 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 *TCI-States* 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 *tci-StateID*, the CORESET index and the serving cell index are provided by a MAC CE command.