**3GPP TSG RAN WG1 #113** **R1-230xxxx**

**Incheon, Korea, May 22nd – 26th, 2023**

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| *CR-Form-v12.2* |
| **DRAFT CHANGE REQUEST** |
|  |
|  | **38.213** | **CR** |  | **rev** |  | **Current version:** | **17.5.0** |  |
|  |
| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network |  |

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| ***Title:***  |  Introduction of multi-carrier enhancements for NR |
|  |  |
| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_MC\_Enh-Core |  | ***Date:*** | 2023-06-04 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | Introduction of multi-carrier enhancements. |
|  |  |
| ***Summary of change:*** | Introduce support of scheduling on more than one cells with a single DCI format. |
|  |  |
| ***Consequences if not approved:*** | No support for scheduling on more than one cells with a single DCI format. |
|  |  |
| ***Clauses affected:*** | 9, 9.A, 9.1.2, 9.1.2.1, 9.1.2.2, 9.1.3.1, 9.1.3.2, 9.1.4, 9.1.5, 9.2.3, 9.2.5.2, 9.3, 10.1, 10.4, 12 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS 38.212, TS 38.214, TS 38.331 |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

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

# 9 UE procedure for reporting control information

If a UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG.

- When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells' , 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell, serving cells belonging to the MCG respectively.

- When the procedures are applied for SCG, the terms 'secondary cell', 'secondary cells', 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells (not including PSCell), serving cell, serving cells belonging to the SCG respectively. The term 'primary cell' in this clause refers to the PSCell of the SCG.

If a UE is configured with a PUCCH-SCell, the UE shall apply the procedures described in this clause for both primary PUCCH group and secondary PUCCH group

- When the procedures are applied for the primary PUCCH group, the terms 'secondary cell', 'secondary cells' , 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell, serving cells belonging to the primary PUCCH group respectively.

- When the procedures are applied for secondary PUCCH group, the terms 'secondary cell', 'secondary cells', 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells (not including the PUCCH-SCell), serving cell, serving cells belonging to the secondary PUCCH group respectively. The term 'primary cell' in this clause refers to the PUCCH-SCell of the secondary PUCCH group. If *pdsch-HARQ-ACK-Codebook-secondaryPUCCHgroup-r16* is provided, *pdsch-HARQ-ACK-Codebook* is replaced by *pdsch-HARQ-ACK-Codebook-secondaryPUCCHgroup-r16*. If *harq-ACK-SpatialBundlingPUCCH-secondaryPUCCHgroup* is provided, *harq-ACK-SpatialBundlingPUCCH* is replaced by *harq-ACK-SpatialBundlingPUCCH-secondaryPUCCHgroup*. If *harq-ACK-SpatialBundlingPUSCH-secondaryPUCCHgroup* is provided, *harq-ACK-SpatialBundlingPUSCH* is replaced by *harq-ACK-SpatialBundlingPUSCH-secondaryPUCCHgroup*. If *uci-MuxWithDiffPrioSecondaryPUCCHgroup* is provided, *uci-MuxWithDiffPrio* is replaced by *uci-MuxWithDiffPrioSecondaryPUCCHgroup*. If *simultaneousPUCCH-PUSCH-secondaryPUCCHgroup* is provided, *simultaneousPUCCH-PUSCH* is replaced by *simultaneousPUCCH-PUSCH-SecondaryPUCCHgroup*.If *pucch-sSCellSecondaryPUCCHgroup* is provided, *pucch-sSCell* is replaced by *pucch-sSCellSecondaryPUCCHgroup*. If *pucch-sSCellPatternSecondaryPUCCHgroup* is provided, *pucch-sSCellPattern* is replaced by *pucch-sSCellPatternSecondaryPUCCHgroup*. If *pucch-sSCellDynSecondaryPUCCHgroup* is provided, *pucch-sSCellDyn* is replaced by *pucch-sSCellDynSecondaryPUCCHgroup*. If *pdsch-HARQ-ACK-EnhType3SecondaryToAddModList* is provided, *pdsch-HARQ-ACK-EnhType3ToAddModList* is replaced by *pdsch-HARQ-ACK-EnhType3SecondaryToAddModList*. If *pdsch-HARQ-ACK-RetxSecondaryPUCCHgroup* is provided, *pdsch-HARQ-ACK-Retx* is replaced by *pdsch-HARQ-ACK-RetxSecondaryPUCCHgroup*.

If a UE is provided *MC-DCI-SetofCells* for scheduling by a DCI format PDSCH receptions or PUSCH transmissions on serving cells from a set of more than one serving cells, the UE expects the more than one serving cells to be in a same PUCCH group. The UE provides HARQ-ACK information in a same HARQ-ACK codebook for sets of cells that are associated with a same PUCCH group.

For unpaired spectrum operation, if a UE is provided a PUCCH-sSCell as described in clause 9.A, the UE shall apply the procedures described in this clause for both the primary cell and the PUCCH-sSCell.

If a UE is provided *pdsch-HARQ-ACK-CodebookList-r16*, *pdsch-HARQ-ACK-Codebook* is replaced by the relevant entry in *pdsch-HARQ-ACK-CodebookList-r16*.

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

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

- the start of the PDCCH reception is the start of the earlier PDCCH candidate

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

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

In the remaining of this clause, a last DCI format is from a set of detected DCI formats for which the UE would provide HARQ-ACK information in a PUCCH in a same slot. Detected DCI formats are first indexed in ascending order across indexes of respective scheduled cells for a same PDCCH monitoring occasion, and are then indexed in ascending order across indexes of PDCCH monitoring occasions. For indexing a detected DCI format associated with two or more scheduled cells, a respective scheduled cell is the one with the smallest index among the two or more scheduled cells. For a PDCCH monitoring occasion and a scheduled cell, if a 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 is provided *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.

If a UE

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

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

- is provided *ackNackFeedbackMode* = *separate*

the UE shall separately apply the procedures described in clauses 9.1 and 9.2.3 for reporting HARQ-ACK information associated with the first CORESETs on active DL BWP of the serving cells and for reporting HARQ-ACK information associated with the second CORESETs on active DL BWP of the serving cells, and the UE does not expect to be provided with *subslotLengthForPUCCH* or to be indicated by *pdsch-HARQ-ACK-CodebookList* to generate two HARQ-ACK codebooks on active DL BWP of the serving cells. HARQ-ACK information reporting is associated with a CORESET through a reception of a PDCCH with a DCI format triggering the reporting of the HARQ-ACK information by the UE.

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

If a UE is provided *subslotLengthForPUCCH* in a *PUCCH-Config* of a given priority index, in a slot of symbols [4, TS 38.211] with HARQ-ACK, the UE does not expect that HARQ-ACK information in response to SPS PDSCH reception(s) only (if any) or SR (if any) of the given priority index in a slot of *subslotLengthForPUCCH* symbols is moved to a different slot of *subslotLengthForPUCCH* symbols after multiplexing overlapping PUCCHs.

If in an active DL BWP a UE monitors PDCCH for detection of DCI format that includes a priority indicator field, a priority index can be provided by the priority indicator field. If a UE indicates a capability to monitor, in an active DL BWP, PDCCH for detection of DCI format that includes a priority indicator field, the DCI format can schedule PUSCH transmissions of any priority, or PDSCH receptions and/or trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority, and DCI format 1\_1 or DCI format 1\_2 with a Transmission Configuration Indication field can indicate a TCI state update and trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority.

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

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

## 9.A PUCCH cell switching

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

If a UE is provided *pucch-sSCellDyn* or *pucch-sSCellDynDCI-1-2* or *pucch-sSCellDynDCI-1-3*, a corresponding DCI format associated with generation of HARQ-ACK information by the UE can include a PUCCH cell indicator field [5, TS 38.212] with a value of '0' or a value of '1' indicating, respectively, whether a PUCCH transmission with the HARQ-ACK information by the UE is on the PCell or on the PUCCH-sSCell. When the UE transmits a PUCCH with HARQ-ACK information that is associated only with SPS PDSCH receptions, the UE transmits the PUCCH on the PCell. The UE does not expect the PUCCH cell indicator field to indicate the PUCCH-sSCell for a PUCCH transmission in a slot that overlaps with a slot on the PCell where the UE would transmit another PUCCH of same or different priority index.

A UE transmits a PUCCH on a PUCCH-sSCell with a power that the UE determines as described in clause 7.2.1, where the UE applies

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

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

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

If a UE reports HARQ-ACK information associated with a G-RNTI for multicast or a G-CS-RNTI with disabled HARQ-ACK information, as described in clause 18, a value of the HARQ-ACK information is a UE implementation choice.

A UE reports HARQ-ACK information for a corresponding PDSCH reception or SPS PDSCH release or TCI state update 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 or provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-r17* or *dl-DataToUL-ACK-DCI-1-2-r17* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the DCI format as described in clause 9.2.3. 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* and *dl-DataToUL-ACK-r17*.

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

- an UL slot overlapping with the end of the PDSCH reception in DL slot if the UE is provided *subslotLengthForPUCCH* for the HARQ-ACK codebook

- the UL slot is on the primary cell if the UE is provided *pucch-sSCellPattern*; otherwise, the UL slot is on the serving cell of the PUCCH transmission

- the last UL slot for PUCCH transmission overlapping with DL slot if the UE is not provided *subslotLengthForPUCCH* for the HARQ-ACK codebook

- the last UL slot is on the primary cell if the UE is provided *pucch-sSCellPattern*; otherwise, the last UL slot is on the serving cell of the PUCCH transmission

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* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-r17* or *dl-DataToUL-ACK-DCI-1-2-r17* 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.

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

#### 9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel

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

Set to the cardinality of

Set – index of row in set

if slot starts at a same time as or after a slot for an active DL BWP change on serving cell or an active UL BWP change on the serving cell of PUCCH transmission if the UE is provided *pucch-sSCellDyn* or *pucch-sSCellDynDCI-1-2* or *pucch-sSCellDynDCI-1-3*, or an active UL BWP change on the PCell if the UE is not provided *pucch-sSCellDyn* and *pucch-sSCellDynDCI-1-2* and *pucch-sSCellDynDCI-1-3,* and slot is before the slot for the active DL BWP change on serving cell or the active UL BWP change on the serving cell of PUCCH transmission, or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and slot overlaps with UL slot , , where is a DL slot with a smallest index among DL slots overlapping with UL slot ,

;

else

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

Set to the cardinality of

Set – index of row in set

if slot starts at a same time as or after a slot for an active DL BWP change on serving cell or an active UL BWP change on the serving cell of PUCCH transmission if the UE is provided *pucch-sSCellDyn* or *pucch-sSCellDynDCI-1-2* or *pucch-sSCellDynDCI-1-3*, or an active UL BWP change on the PCell if the UE is not provided *pucch-sSCellDyn* and *pucch-sSCellDynDCI-1-2* or *pucch-sSCellDynDCI-1-3*, and slot is before the slot for the active DL BWP change on serving cell or the active UL BWP change on the serving cell of PUCCH transmission where is a DL slot with a smallest index among DL slots overlapping with UL slot , or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and slot overlaps with UL slot , ,

;

else

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

A UE does not expect to detect a DCI format switching a DL BWP within symbols prior to a first symbol of a PUCCH transmission where the UE multiplexes HARQ-ACK information, where is defined in clause 9.2.3.

If a UE is provided *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-r17* or *dl-DataToUL-ACK-DCI-1-2-r17*, the UE does not expect to be indicated by DCI format 1\_0 a slot timing value for transmission of HARQ-ACK information that does not belong to the intersection of the set of slot timing values {1, 2, 3, 4, 5, 6, 7, 8} for SCS configuration of PUCCH transmission , {7, 8, 12, 16, 20, 24, 28, 32} for , and {13, 16, 24, 32, 40, 48, 56, 64} for , and the set of slot timing values provided by for the active DL BWP of a corresponding serving cell.

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

#### 9.1.2.2 Type-1 HARQ-ACK codebook in physical uplink shared channel

If a UE is not provided *pdsch-HARQ-ACK-Codebook = 'semi-static'* for unicast or multicast HARQ-ACK information, the UE does not multiplex the unicast or multicast HARQ-ACK information in the PUSCH transmission, respectively.

If a UE is provided *pdsch-HARQ-ACK-Codebook = 'semi-static'* for unicast and/or multicast HARQ-ACK information, and would multiplex HARQ-ACK information in a PUSCH transmission that is not scheduled by a DCI format or is scheduled by a DCI format that does not include a DAI field, then

- if the UE has not received any PDSCH or SPS PDSCH release or TCI state update that the UE multiplexes corresponding HARQ-ACK information in the PUSCH, based on a value of a respective PDSCH-to-HARQ\_feedback timing indicator field in a DCI format scheduling the PDSCH reception or the SPS PDSCH release or the TCI state update, or on the value of *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-r17* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in DCI format 1\_1 or on the value of *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-DCI-1-2-r17* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in DCI format 1\_2 and the UE is provided *pdsch-HARQ-ACK-Codebook = 'semi-static'* for unicast HARQ-ACK information, or on the value of *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-r17* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in DCI format 1\_3, or on the value of *dl-DataToUL-ACK* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in DCI format 4\_2 and the UE is provided *pdsch-HARQ-ACK-Codebook = 'semi-static'* for multicast HARQ-ACK information, in any of the occasions for candidate PDSCH receptions by a DCI format or SPS PDSCH on any serving cell , as described in clause 9.1.2.1, the UE does not multiplex HARQ-ACK information in the PUSCH transmission

- else the UE generates the HARQ-ACK codebook as described in clause 9.1.2.1, except that *harq-ACK-SpatialBundlingPUCCH* is replaced by *harq-ACK-SpatialBundlingPUSCH*, unless the UE receives only a SPS PDSCH release, or only SPS PDSCH receptions, or only a PDSCH that is scheduled by DCI format 1\_0 with a counter DAI field value of 1 if the UE is provided *pdsch-HARQ-ACK-Codebook = 'semi-static'* for unicast HARQ-ACK information, or is scheduled by DCI format 4\_1 with a counter DAI field value of 1 if the UE is provided *pdsch-HARQ-ACK-Codebook = 'semi-static'* for multicast HARQ-ACK information, on the PCell in the occasions for candidate PDSCH receptions in which case the UE generates HARQ-ACK information only for the SPS PDSCH release or only for the PDSCH reception as described in clause 9.1.2.

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

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

If a UE is configured to monitor PDCCH for multicast DCI formats with CRC scrambled by one or more G-RNTIs for multicast or G-CS-RNTIs that the UE generates a Type-2 HARQ-ACK codebook, the UE separately applies the procedures in this clause per G-RNTI for multicast or per G-CS-RNTI except the procedures for SPS PDSCHs and determines the Type-2 HARQ-ACK codebook by concatenating the Type-2 HARQ-ACK codebook for unicast DCI formats excluding the unicast DCI format activating SPS PDSCH receptions, followed by the HARQ-ACK codebooks for the multicast DCI formats in ascending order of the corresponding G-RNTI values, followed by the HARQ-ACK codebooks for the multicast DCI formats in ascending order of the corresponding G-CS-RNTI values excluding the multicast DCI format activating SPS PDSCH receptions, followed by the HARQ-ACK codebooks for unicast and multicast SPS PDSCH receptions.

A UE determines monitoring occasions for PDCCH with DCI format scheduling PDSCH receptions, or having associated HARQ-ACK information without scheduling PDSCH reception, 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, or a *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-r17* or *dl-DataToUL-ACK-DCI-1-2-r17* value if the PDSCH-to-HARQ\_feedback timing indicator field is not present in a DCI format, for PUCCH transmission with HARQ-ACK information in slot , as described in clause 9.2.3, in response to PDSCH receptions, or in response to a DCI format having associated HARQ-ACK information without scheduling PDSCH reception

- 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 DCI formats scheduling PDSCH receptions, or having associated HARQ-ACK information without scheduling PDSCH reception, 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. PDCCH monitoring occasions are separately counted for a DCI format scheduling a PDSCH reception on a single serving cell and for a DCI format scheduling PDSCH receptions on more than one serving cells and corresponding values of can be different.

A value of the counter downlink assignment indicator (DAI) field in DCI formats, each scheduling PDSCH receptions on respective single serving cells with associated HARQ-ACK information, or having associated HARQ-ACK information without scheduling a PDSCH reception, in a same HARQ-ACK codebook denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pairs in which PDSCH receptions, excluding PDSCH receptions that provide only transport blocks for HARQ processes associated with disabled HARQ-ACK information if *downlinkHARQ-FeedbackDisabled* is provided or PDSCH receptions scheduled by DCI formats associated with G-RNTI/G-CS-RNTI with disabled HARQ-ACK information, or HARQ-ACK information bits that are not in response for PDSCH receptions, associated with the DCI formats, excluding the SPS activation DCI, 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 .

A value of the counter DAI field in DCI formats, each scheduling PDSCH receptions on respective more than one serving cells with associated HARQ-ACK information in a same HARQ-ACK codebook, denotes the accumulative number of {serving cell with smallest index from the more than one serving cells, PDCCH monitoring occasion}-pairs in which PDSCH receptions are present up to the current more than one serving cells and current PDCCH monitoring occasion,

- first, if the UE indicates by *type2-HARQ-ACK-Codebook* support for more than one PDSCH receptions 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 with smallest index from the more than one serving cells, PDCCH monitoring occasion} pair,

- second in ascending order of the smallest serving cell index from the more than one serving cells, 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), excluding PDSCH receptions that provide only transport blocks for HARQ processes associated with disabled HARQ-ACK information if *downlinkHARQ-FeedbackDisabled* is provided, or HARQ-ACK information that does not correspond to PDSCH receptions, associated with DCI formats, excluding the SPS activation DCI, 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, or having associated HARQ-ACK information without scheduling PDSCH reception, 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.

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

If and , 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 more than one PDSCH receptions for any serving cell from the serving cells with TBG-based HARQ-ACK information or with TB-based HARQ-ACK information that the UE detects within the PDCCH monitoring occasions

- if , is the value of the total DAI in the last DCI format scheduling more than one PDSCH receptions with TBG-based HARQ-ACK information or with TB-based HARQ-ACK information for any serving cell from the serving cells that the UE detects within the PDCCH monitoring occasions

- , if the UE does not detect any DCI format scheduling more than one PDSCH receptions with TBG-based HARQ-ACK information or with TB-based HARQ-ACK information for any serving cell from the serving cells in any of the PDCCH monitoring occasions

- is the total number of DCI formats scheduling more than one PDSCH receptions with TBG-based HARQ-ACK information or with TB-based HARQ-ACK information for any serving cell from the serving cells that the UE detects within the PDCCH monitoring occasions for serving cell . if the UE does not detect any DCI format scheduling more than one PDSCH receptions for serving cell in any of the PDCCH monitoring occasions

- if *harq-ACK-SpatialBundlingPUCCH* is provided,

- if *nrofHARQ-BundlingGroups* is provided, is the number of PDSCH groups that include at least one PDSCH not overlapping with a UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* if provided, that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH

- if *nrofHARQ-BundlingGroups* is not provided, is the number of PDSCHs that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH

- if *harq-ACK-SpatialBundlingPUCCH* is not provided,

- if *nrofHARQ-BundlingGroups* is provided, is the number of TBGs including at least one PDSCH not overlapping with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated* if provided, that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH

- if *nrofHARQ-BundlingGroups* is not provided, is the number of transport blocks in PDSCHs that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH.

If a UE is provided by *MC-DCI-SetofCellsToAddModList* a number of sets of serving cells and is provided USS sets to monitor PDCCH for detection of DCI format 1\_3, the UE separately applies the following procedures for determining a corresponding second Type-2 HARQ-ACK sub-codebook for scheduling cells associated with DCI format 1\_3 scheduling PDSCH receptions on more than one serving cells from a set of serving cells from the procedures for determining a first Type-2 HARQ-ACK sub-codebook for scheduling cells associated with DCI formats that do not schedule PDSCH receptions on more than one serving cells. The UE concatenates the second Type-2 HARQ-ACK sub-codebook to a first Type-2 sub-codebook that the UE determines in association with unicast SPS PDSCH receptions or with any unicast DCI format scheduling PDSCH reception on a single serving cell, or having associated HARQ-ACK information without scheduling a PDSCH reception as described in this clause.

Denote by the number of bits for the counter DAI field in DCI format 1\_3 and set . Denote by the value of the counter DAI in a DCI format 1\_3 scheduling PDSCH receptions on more than one cells from the set of serving cells with index , 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 DCI format 1\_3 scheduling PDSCH receptions on more than one cells in PDCCH monitoring occasion according to Table 9.1.3-1. The UE assumes a same value of total DAI in all DCI formats 1\_3 in PDCCH monitoring occasion that schedule more than one PDSCH receptions on respective more than one serving cells from a set of serving cells.

The UE determines the , for a total number of HARQ-ACK information bits in the second Type-2 HARQ-ACK sub-codebook according to the following pseudo-code.

Set to the maximum number of serving cells in *ScheduledCell-ListDCI-1-3* of a set of serving cells provided by *MC-DCI-SetofCells*, across the number of sets of serving cells, that can be scheduled PDSCH receptions by DCI format 1\_3

Set to the maximum total number of TBs in PDSCH receptions that can be scheduled by a DCI format 1\_3 over more than one serving cells in a set of serving cells across the number of sets of serving cells

Set to the number of sets of serving cells *MC-DCI-SetofCells* in a PUCCH group

Set – index of sets of serving cells,

Set to the index of a serving cell, in a set of indexes of serving cells arranged in ascending order, from the set of serving cells,

Set – PDCCH monitoring occasion index for detection of a DCI format 1\_3 scheduling PDSCH receptions on serving cells from a set of serving cells: lower index corresponds to earlier PDCCH monitoring occasion

Set

Set

Set

Set

Set to the number of PDCCH monitoring occasions

while

if *harq-ACK-SpatialBundlingPUCCH* is not provided,

while

if there is more than one PDSCH on a serving cell from the set of serving cells associated with PDCCH in PDCCH monitoring occasion

if

;

end if

;

if

;

else

;

end if

;

;

while

if the UE is scheduled PDSCH reception on serving cell, if any, of set

if *maxNrofCodeWordsScheduledByDCI* is 2 for serving cell, if any, of set

 = 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

;

else

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

;

end if

end if

;

end while

end if

;

while

= NACK;

;

end while

end while

;

else

while

if there is more than one PDSCH providing a transport block for a HARQ process with enabled HARQ-ACK information on a serving cell from the set of serving cells associated with PDCCH in PDCCH monitoring occasion

if

;

end if

;

if

;

else

;

end if

;

;

while

if the UE is scheduled PDSCH reception for transport blocks with enabled HARQ-ACK information on serving cell, if any, of set

if *maxNrofCodeWordsScheduledByDCI* is 2 for serving cell

if the PDSCH reception provides two transport blocks

 = 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 corresponding to the first transport block of this cell

 end if

else

 = HARQ-ACK information bit of this cell

end if

;

end if

;

end while

end if

;

while

= NACK;

;

end while

end while

;

end if

;

end while

;

if UE does not set and

;

end if

;

if

;

end if

if *harq-ACK-SpatialBundlingPUCCH* is not provided,

else

end if

 for any .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 generating a HARQ-ACK information bit without scheduling a PDSCH reception or providing TCI state update is present, or number of PDCCH monitoring occasions associated with PDCCH for scheduling PDSCH receptions on more than one cells, 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 generating a HARQ-ACK information bit without scheduling a PDSCH reception or providing TCI state update is present, denoted as and  |
| 0 | 1 |  |
| 1 | 2 |  |

#### 9.1.3.2 Type-2 HARQ-ACK codebook in physical uplink shared channel

In this clause, a DAI field is either the one corresponding to unicast HARQ-ACK information and associated PDSCH receptions or DCI formats, or is the one corresponding to multicast HARQ-ACK information and associated PDSCH receptions or DCI formats, as described in [5, TS 38.212].

If a UE would multiplex HARQ-ACK information in a PUSCH transmission that is not scheduled by a DCI format or is scheduled by a DCI format that does not include a DAI field, then

- if the UE has not received any PDCCH within the monitoring occasions for DCI formats scheduling PDSCH receptions, or providing a DCI format having associated HARQ-ACK information without scheduling a PDSCH reception, on any serving cell and the UE does not have HARQ-ACK information in response to a SPS PDSCH reception to multiplex in the PUSCH, as described in clause 9.1.3.1, the UE does not multiplex HARQ-ACK information in the PUSCH transmission;

- else, the UE generates the HARQ-ACK codebook as described in clause 9.1.3.1, except that *harq-ACK-SpatialBundlingPUCCH* is replaced by *harq-ACK-SpatialBundlingPUSCH*.

If a UE multiplexes HARQ-ACK information in a PUSCH transmission that is scheduled by a DCI format that includes a DAI field, the UE generates the HARQ-ACK codebook as described in clause 9.1.3.1, with the following modifications:

- For the pseudo-code for the HARQ-ACK codebook generation in clause 9.1.3.1, after the completion of the and loops, the UE sets where is the value of the DAI field according to Table 9.1.3-2

*-* if the UE multiplexes HARQ-ACK information associated with more than one G-RNTIs for multicast, is applicable to each of the more than one G-RNTIs for multicast.

- For the case of first and second HARQ-ACK sub-codebooks, the DCI format includes a first DAI field corresponding to the first HARQ-ACK sub-codebook and a second DAI field corresponding to the second HARQ-ACK sub-codebook

*- harq-ACK-SpatialBundlingPUCCH* is replaced by *harq-ACK-SpatialBundlingPUSCH*.

If a UE is not provided *PDSCH-CodeBlockGroupTransmission* and the UE is scheduled for a PUSCH transmission by DCI format that includes a DAI field with value and the UE has not received any PDCCH within the monitoring occasions for a DCI format scheduling PDSCH receptions providing transport blocks with enabled HARQ-ACK information or having associated HARQ-ACK information without scheduling PDSCH receptions on any serving cell , and the UE does not have HARQ-ACK information in response to a SPS PDSCH reception to multiplex in the PUSCH as described in clause 9.1.3.1, the UE does not multiplex HARQ-ACK information in the PUSCH transmission.

If a UE is provided *PDSCH-CodeBlockGroupTransmission* and the UE is scheduled for a PUSCH transmission by DCI format that includes a DAI field with first value or with second value and the UE has not received any PDCCH within the monitoring occasions for a DCI format scheduling PDSCH reception providing a transport block with enabled HARQ-ACK information or having associated HARQ-ACK information without scheduling PDSCH reception on any serving cell , and the UE does not have HARQ-ACK information in response to a SPS PDSCH reception to multiplex in the PUSCH, as described in clause 9.1.3.1, the UE does not multiplex HARQ-ACK information for the first sub-codebook or for the second sub-codebook, respectively, in the PUSCH transmission.

Table 9.1.3-2: Value of DAI

|  |  |  |
| --- | --- | --- |
| DAIMSB, LSB |   | Number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH transmission(s) associated with PDCCH or PDCCH indicating SPS PDSCH release or providing TCI state update or DCI format 1\_1 indicating SCell dormancy is present, or number of PDCCH monitoring occasions associated with PDCCH for scheduling PDSCH receptions on more than one cells, denoted as and  |
| 0,0 | 1 |  |
| 0,1 | 2 |  |
| 1,0 | 3 |  |
| 1,1 | 4 |  |

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

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

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

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. If the UE is provided *pdsch-HARQ-ACK-EnhType3ToAddModList* and the DCI format includes an enhanced Type 3 codebook indicator field that provides a value for *pdsch-HARQ-ACK-EnhType3Index*, the UE determines a number of indicated serving cells and a number of indicated HARQ processes for each indicated serving cell from the entry in *pdsch-HARQ-ACK-EnhType3ToAddModList* corresponding to the *pdsch-HARQ-ACK-EnhType3Index* value. If the DCI format does not include the enhanced Type 3 codebook indicator field, the *pdsch-HARQ-ACK-EnhType3Index* value is provided by the value of the MCS field for transport block 1 if the DCI format is DCI format 1\_1 or 1\_3, or of the MCS field if the DCI format is DCI format 1\_2. 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*.

### 9.1.5 HARQ-ACK codebook retransmission

With reference to slots of PUCCH transmissions on the primary cell and for Type-1 or Type-2 HARQ-ACK codebooks, a UE that transmitted or would transmit a PUCCH or a PUSCH with a first HARQ-ACK codebook in slot can be indicated by a DCI format with CRC scrambled by a C-RNTI or a MCS-C-RNTI that does not schedule a PDSCH reception [4, TS 38.212] and is received in a PDCCH ending in slot , to transmit a PUCCH with the first HARQ-ACK codebook in slot , where slot is after slot . The UE determines and a resource for the PUCCH transmission as described in clauses 9.2.3 and 9.2.5. If the UE is provided a periodic cell switching pattern for PUCCH transmissions by *pucch-sSCellPattern*, the UE further determines a corresponding cell based on the periodic cell switching pattern as described in clause 9.A.

If the HARQ-ACK retransmission indicator field value in a DCI format is '1', the UE determines slot as where is determined by a one-to-one mapping in ascending order among the values of the MCS field for transport block 1 if the DCI format is DCI format 1\_1 or 1\_3, or of the MCS field if the DCI format is DCI format 1\_2 and the values from -7 to 24. If the DCI format includes a priority indicator field having a value, a priority value of first HARQ-ACK information in the first HARQ-ACK codebook is same as the value of the priority indicator field; otherwise, the priority value of the first HARQ-ACK information is zero.

If a UE

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

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

- is provided *ackNackFeedbackMode* = *separate*

the first HARQ-ACK codebook is associated with the first CORESETs or with the second CORESETs, as described in clause 9, when the UE receives the PDCCH providing the DCI format in a CORESET from the first CORESETs or from the second CORESETs, respectively.

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

### 9.2.3 UE procedure for reporting HARQ-ACK

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

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 SCS configuration of PUCCH transmission , to {7, 8, 12, 16, 20, 24, 28, 32} for , and to {13, 16, 24, 32, 40, 48, 56, 64} for . For a unicast 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-ACK-DCI-1-2*, or *dl-DataToUL-ACK-r17,* or *dl-DataToUL-ACK-DCI-1-2-r17* as defined in Table 9.2.3-1. If the DCI format indicates a cell for the PUCCH transmission, as described in clause 9.A, the PDSCH-to-HARQ\_feedback timing indicator field value maps to slots of the active UL BWP of the cell; otherwise, the PDSCH-to-HARQ\_feedback timing indicator field value maps to slots of the active UL BWP of the PCell. For DCI format 4\_1, the PDSCH-to-HARQ\_feedback timing indicator field values are provided by *dl-DataToUL-ACK-MulticastDCI-Format4-1* or, if *dl-DataToUL-ACK-MulticastDCI-Format4-1* is not provided, by {1, 2, 3, 4, 5, 6, 7, 8}. For DCI format 4\_2, the PDSCH-to-HARQ\_feedback timing indicator field values are provided by *dl-DataToUL-ACK* from *pucch-ConfigMulticast1/pucch-ConfigurationListMulticast1* or *pucch-ConfigMulticast2/pucch-ConfigurationListMulticast2.*

The following apply to the PCell if the UE is provided *pucch-sSCellPattern*; otherwise, the following apply to the serving cell of the PUCCH transmission. If the UE is provided *subslotLengthForPUCCH*, is the last UL slot for PUCCH transmission that overlaps with a PDSCH reception or with a PDCCH reception providing a DCI format having associated HARQ-ACK information without scheduling a PDSCH reception; otherwise, is the last UL slot for PUCCH transmission that overlaps with the DL slot for the PDSCH reception or with the DL slot for the PDCCH reception in case of a DCI format that triggers a HARQ-ACK information 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.

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-ACK-DCI-1-2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1*.

If the UE detects a DCI format scheduling a number of PDSCH receptions ending in DL slot  or if the UE detects a DCI format generating a HARQ-ACK information bit and does not schedule a PDSCH reception through a PDCCH reception ending in DL slot , 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-ACK-DCI-1-2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1*.

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*, *dl-DataToUL-ACK-DCI-1-2*, *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1* |
| '1' | '01' | '001' | 2nd value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACK-DCI-1-2*, *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1* |
|  | '10' | '010' | 3rd value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACK-DCI-1-2*, *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1* |
|  | '11' | '011' | 4th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACK-DCI-1-2*, *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1* |
|  |  | '100' | 5th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACK-DCI-1-2*, *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1* |
|  |  | '101' | 6th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACK-DCI-1-2*, *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1* |
|  |  | '110' | 7th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACK-DCI-1-2*, *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1* |
|  |  | '111' | 8th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACK-DCI-1-2*, *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1* |

For a PUCCH transmission with HARQ-ACK information, a UE determines a PUCCH resource on the cell of the PUCCH transmission, as described in clause 9.A, 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, excluding the SPS activation DCI, 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-ACK-DCI-1-2*, or *dl-DataToUL-ACK-r17,* or *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1*, 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.

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-ACK-DCI-1-2*, or *dl-DataToUL-ACK-r17,* or *dl-DataToUL-ACK-DCI-1-2-r17*, or *dl-DataToUL-ACK-MulticastDCI-Format4-1*, indicating a same slot for the PUCCH transmission, the UE determines a PUCCH resource with index , , as

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

#### 9.2.5.2 UE procedure for multiplexing HARQ-ACK/SR/CSI in a PUCCH

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

If a UE has HARQ-ACK, SR and wideband or sub-band CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 2, or the UE has HARQ-ACK, SR and wideband CSI reports [6, TS 38.214] to transmit and the UE determines a PUCCH resource with PUCCH format 3 or PUCCH format 4, where

- the UE determines the PUCCH resource using the PUCCH resource indicator field [5, TS 38.212] in a last of a number of DCI formats with 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-ACK-DCI-1-2*, or *dl-DataToUL-ACK-r17,* or *dl-DataToUL-ACK-DCI-1-2-r17*, indicating a same slot for the PUCCH transmission, from a PUCCH resource set provided to the UE for HARQ-ACK transmission, and

- the UE determines the PUCCH resource set as described in clause 9.2.1 and clause 9.2.3 for  UCI bits

and

- if , the UE transmits the HARQ-ACK, SR, and CSI reports bits by selecting the minimum number of the PRBs satisfying as described in clauses 9.2.3 and 9.2.5.1;

- else, the UE selects CSI report(s), from the CSI reports, for transmission together with HARQ-ACK and SR in ascending priority value [6, TS 38.214], where the value of satisfies and , where is a number of CRC bits corresponding to UCI bits, and is a number of CRC bits corresponding to UCI bits.

If a UE is provided a first interlace of PRBs by *interlace0* in *InterlaceAllocation*, the UE has HARQ-ACK, SR and wideband or sub-band CSI reports to transmit, and the UE determines a PUCCH resource with PUCCH format 2, or the UE has HARQ-ACK, SR and wideband CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 3, where

- the UE determines the PUCCH resource using the PUCCH resource indicator field in a last of a number of DCI formats with a value of a PDSCH-to-HARQ\_feedback timing indicator field, or a value provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-r17* or *dl-DataToUL-ACK-DCI-1-2-r17* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in a DCI format, indicating a same slot for the PUCCH transmission, from a PUCCH resource set provided to the UE for HARQ-ACK transmission, and

- the UE determines the PUCCH resource set as described in clauses 9.2.1 and 9.2.3 for UCI bits

and

- if , the UE transmits the HARQ-ACK, SR, and CSI reports bits in a PUCCH over the first interlace

- else, if the UE is provided a second interlace of PRBs by *interlace1* and if , the UE transmits the HARQ-ACK, SR, and CSI reports bits in a PUCCH over both the first and second interlaces

- else, the procedure is same as the corresponding one when the UE is provided *PUCCH-ResourceSet* by replacing with , or, if the UE is provided *interlace1*, by .

If a UE has HARQ-ACK, SR and sub-band CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 3 or PUCCH format 4, where

- the UE determines the PUCCH resource using the PUCCH resource indicator field [5, TS 38.212] in a last of a number of DCI formats with a value of a PDSCH-to-HARQ\_feedback timing indicator field indicating a same slot for the PUCCH transmission, or by a value provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-r17* or *dl-DataToUL-ACK-DCI-1-2-r17* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the last DCI format, from a PUCCH resource set provided to the UE for HARQ-ACK transmission, and

- the UE determines the PUCCH resource set as described in clause 9.2.1 and clause 9.2.3 for  UCI bits

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

If a UE is provided a first interlace of PRBs by *interlace0* in *InterlaceAllocation*, the UE has HARQ-ACK, SR and sub-band CSI reports to transmit, and the UE determines a PUCCH resource with PUCCH format 3, where

- the UE determines the PUCCH resource using the PUCCH resource indicator field in a last of a number of DCI formats that have a value of a PDSCH-to-HARQ\_feedback timing indicator field indicating a same slot for the PUCCH transmission, or a value provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-r17* or *dl-DataToUL-ACK-DCI-1-2-r17* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the last DCI format, from a PUCCH resource set provided to the UE for HARQ-ACK transmission, and

- the UE determines the PUCCH resource set as described in clauses 9.2.1 and 9.2.3 for UCI bits

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

## 9.3 UCI reporting in physical uplink shared channel

Offset values are defined for a UE to determine a number of resources for multiplexing HARQ-ACK information and for multiplexing CSI reports in a PUSCH. Offset values are also defined for multiplexing CG-UCI [5, TS 38.212] in a CG-PUSCH. The offset values are signalled to a UE either by a DCI format scheduling the PUSCH transmission or by higher layers.

If a DCI format that does not include a beta\_offset indicator field schedules the PUSCH transmission from the UE and the UE is provided *betaOffsets = 'semiStatic'*, the UE applies the , , and values that are provided by *betaOffsets = 'semiStatic'* for the corresponding HARQ-ACK information, Part 1 CSI reports and Part 2 CSI reports. If the PUSCH transmission has priority 0 or priority 1 and the UE is configured by *uci-MuxWithDiffPrio* to multiplex HARQ-ACK information of priority 1 or priority 0, respectively, and if the UE multiplexes HARQ-ACK information of priority 1 or priority 0, the UE applies corresponding or provided by *betaOffsetCrossPri1* *= 'semiStatic'* for DCI formats 0\_0/0\_1, by *betaOffsetsCrossPri1DCI-0-2= 'semiStatic'* for DCI format 0\_2 and by *betaOffsetsCrossPri1DCI-0-3= 'semiStatic'* for DCI format 0\_3, or by *betaOffsetCrossPri0 = 'semiStatic'* for DCI format 0\_0/0\_1, by *betaOffsetsCrossPri0DCI-0-2= 'semiStatic'* for DCI format 0\_2, and by *betaOffsetsCrossPri0DCI-0-3= 'semiStatic'* for DCI format 0\_3, respectively.

If the PUSCH transmission is with a configured grant and the UE is provided *CG-UCI-OnPUSCH= 'semiStatic'*, the UE applies the , , and values that are provided by *CG-UCI-OnPUSCH = 'semiStatic'* for the corresponding HARQ-ACK information, Part 1 CSI reports and Part 2 CSI reports. If the PUSCH transmission has priority 0 or priority 1 and the UE is configured by *uci-MuxWithDiffPrio* to multiplex HARQ-ACK information of priority 1 or priority 0, respectively, and if the UE multiplexes HARQ-ACK information of priority 1 or priority 0, the UE applies corresponding or provided by *cg-betaOffsetsCrossPri1* *= 'semiStatic'* or *cg-betaOffsetsCrossPri0 = 'semiStatic'*, respectively.

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

Offsets for multiplexing HARQ-ACK information with priority 0 in a PUSCH transmission with priority 1 are configured to values according to Table 9.3-1. The first, second and third values provided by any of *BetaOffsetsCrossPri0, betaOffsetsCrossPri0DCI-0-2, or* *cg-betaOffsetsCrossPri0* respectively provide indexes , , and for the UE to use if the UE multiplexes up to 2 bits, more than 2 and up to 11 bits, and more than 11 bits of HARQ-ACK information with priority 0 in the PUSCH transmission with priority 1, respectively.

Offsets for multiplexing HARQ-ACK information with priority 1 in a PUSCH transmission with priority 0 are configured to values according to Table 9.3-1. The first, second and third values provided by any of *BetaOffsetsCrossPri1, betaOffsetsCrossPri1DCI-0-2, betaOffsetsCrossPri1DCI-0-3*, or *cg-betaOffsetsCrossPri1* respectively provide indexes , , and for the UE to use if the UE multiplexes up to 2 bits, more than 2 and up to 11 bits, and more than 11 bits of HARQ-ACK information with priority 1 in the PUSCH transmission with priority 0, respectively.

Part 1 CSI report and Part 2 CSI report offsets and , respectively, are configured to values according to Table 9.3-2. The *betaOffsetCSI-Part1-Index1* and *betaOffsetCSI-Part2-Index1* respectively provide indexes and for the UE to use if the UE multiplexes up to 11 bits for Part 1 CSI reports or Part 2 CSI reports in the PUSCH. The *betaOffsetCSI-Part1-Index2* and *betaOffsetCSI-Part2-Index2* respectively provide indexes or for the UE to use if the UE multiplexes more than 11 bits for Part 1 CSI reports or Part 2 CSI reports in the PUSCH.

If a DCI format that includes a beta\_offset indicator field with one bit or two bits, as configured by *uci-OnPUSCH* or *UCI-OnPUSCH-DCI-0-2* or *UCI-OnPUSCH-DCI-0-3*, schedules the PUSCH transmission from the UE, the UE is provided by each of {*betaOffsetACK-Index1*, *betaOffsetACK-Index2*, *betaOffsetACK-Index3*}, the {first, second, third} values provided by *BetaOffsetsCrossPri0* or *betaOffsetsCrossPri0DCI-0-2* or *betaOffsetsCrossPri0DCI-0-3*, and the {first, second, third} values provided by *BetaOffsetsCrossPri1* or *betaOffsetsCrossPri1DCI-0-2* or *betaOffsetsCrossPri1DCI-0-3*, a set of two or four indexes from Table 9.3-1 for multiplexing HARQ-ACK information in the PUSCH transmission and by each of {*betaOffsetCSI-Part1-Index1*, *betaOffsetCSI-Part1-Index2*} a set of two or four indexes, and by each of {*betaOffsetCSI-Part2-Index1*, *betaOffsetCSI-Part2-Index2*} a set of two or four indexes from Table 9.3-2, respectively, for multiplexing Part 1 CSI reports and Part 2 CSI reports, respectively, in the PUSCH transmission. The beta\_offset indicator field indicates a value and/or a value, and/or a value, a value and a value from the respective sets of values, with the mapping defined in Table 9.3-3 and in Table 9.3-3A. If the PUSCH transmission has priority 0 or priority 1, and the UE is provided *uci-MuxWithDiffPrio*, and the UE multiplexes HARQ-ACK information of priority 1 or priority 0 in the PUSCH, the UE applies the {first, second, third} values provided by *betaOffsetCrossPri1* *= 'dynamic'* for DCI format 0\_1, *betaOffsetsCrossPri1DCI-0-2= 'dynamic'* for DCI format 0\_2, or *betaOffsetsCrossPri1DCI-0-3= 'dynamic'* for DCI format 0\_3, or applies the {first, second, third} values provided by *betaOffsetCrossPri0 = 'dynamic'* for DCI format 0\_1, *betaOffsetsCrossPri0DCI-0-2= 'dynamic'* for DCI format 0\_2, or *betaOffsetsCrossPri0DCI-0-3= 'dynamic'* for DCI format 0\_3.

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

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

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

For each DL BWP configured to a UE in a serving cell, the UE is provided by higher layers with search space sets where, for each search space set from the search space sets, the UE is provided the following by *SearchSpace*:

- a search space set index , , by *searchSpaceId*

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

- if search space set is a USS set,

- an indication by *dci-Formats* to monitor PDCCH candidates either for DCI format 0\_0 and DCI format 1\_0, or for DCI format 0\_1 and DCI format 1\_1, or

- an indication by *dci-FormatsExt* to monitor PDCCH candidates for DCI format 0\_2 and DCI format 1\_2, or for DCI format 0\_1, DCI format 1\_1, DCI format 0\_2, and DCI format 1\_2, or

- an indication by *dci-FormatsMC* to monitor PDCCH candidates for one or both of DCI format 0\_3 and DCI format 1\_3, or

- an indication by *dci-FormatsSL* to monitor PDCCH candidates for DCI format 0\_0 and DCI format 1\_0, or for DCI format 0\_1 and DCI format 1\_1, or for DCI format 3\_0, or for DCI format 3\_1, or for DCI format 3\_0 and DCI format 3\_1

- a bitmap by *freqMonitorLocations*, if provided, to indicate an index of one or more RB sets for the search space set , where the MSB in the bitmap corresponds to RB set in the DL BWP. For RB set indicated in the bitmap, the first PRB of the frequency domain monitoring location confined within the RB set is given by , where is the index of first common RB of the RB set [6, TS 38.214], and is provided by *rb-Offset* or if *rb-Offset* is not provided. For each RB set with a corresponding value of 1 in the bitmap, the frequency domain resource allocation pattern for the monitoring location is determined based on the first bits in *frequencyDomainResources* provided by the associated CORESET configuration.

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

If a UE is configured with *CrossCarrierSchedulingConfig* for a serving cell, the carrier indicator field value corresponds to the value indicated by *cif-InSchedulingCell* in *CrossCarrierSchedulingConfig.* If a UE is configured with *MC-DCI-SetofCells* for a set of serving cells, the UE can be provided *nCI-Value* for the set of serving cells *.*

For an active DL BWP of a serving cell on which a UE monitors PDCCH candidates in a USS, if the UE is not configured with a carrier indicator field, the UE monitors the PDCCH candidates without carrier indicator field. For an active DL BWP of a serving cell on which a UE monitors PDCCH candidates in a USS, if a UE is configured with a carrier indicator field, the UE monitors the PDCCH candidates with carrier indicator field.

A UE does not expect to monitor PDCCH candidates on an active DL BWP of a secondary cell if the UE is configured to monitor PDCCH candidates for detection of DCI formats scheduling on that secondary cell in another serving cell. For the active DL BWP of a serving cell on which the UE monitors PDCCH candidates, the UE monitors PDCCH candidates at least for the same serving cell.

For a search space set associated with CORESET , the CCE indexes for aggregation level corresponding to PDCCH candidate of the search space set in slot for an active DL BWP of a serving cell corresponding to carrier indicator field value , or corresponding to value of *nCI-Value* associated with a set of serving cells *MC-DCI-SetofCells*, are given by

where

for any CSS, ;

for a USS, , , for , for , for , and ;

;

 is the number of CCEs, numbered from 0 to , in CORESET and, if any, per RB set;

 is

- the carrier indicator field value, if provided by *cif-InSchedulingCell* in *CrossCarrierSchedulingConfig* for the serving cell on which PDCCH is monitored, except for scheduling of the serving cell from the same serving cell in which case ;

- the *nCI-Value*, if provided, for the set of serving cells *MC-DCI-SetofCells*;

- otherwise, including for any CSS,

, where is the number of PDCCH candidates the UE is configured to monitor for aggregation level of a search space set for a serving cell corresponding to or for a cell set corresponding to ;

for any CSS, ;

for a USS, is the maximum of over all configured values for a CCE aggregation level of search space set ;

the RNTI value used for is the C-RNTI.

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

A UE that

- is configured for operation with carrier aggregation, and

- indicates support of search space sharing through *searchSpaceSharingCA-UL* or through *searchSpaceSharingCA-DL*, and

- has a PDCCH candidate with CCE aggregation level in CORESET associated with search space set of a scheduling cell for detection of a first DCI format, other than DCI format 0\_0 or DCI format 1\_0, having a first size and scheduling

- PUSCH transmission or configured grant Type 2 PUSCH release on serving cell , or

- PDSCH reception or having associated HARQ-ACK information without scheduling PDSCH reception on serving cell

can receive a corresponding PDCCH through a PDCCH candidate with CCE aggregation level in CORESET associated with search space set of the scheduling cell for detection of a second DCI format having a second size and associated with scheduling on serving cell if the first size and the second size are same and if neither of search space sets and includes *searchSpaceLinkingId*.

A UE expects to monitor PDCCH candidates for up to 4 sizes of DCI formats that include up to 3 sizes of DCI formats with CRC scrambled by C-RNTI per serving cell. The UE counts a number of sizes for DCI formats per serving cell based on a number of configured PDCCH candidates in respective search space sets for the corresponding active DL BWP. If the UE monitors PDCCH candidates for detection of one or both of DCI format 0\_3 and DCI format 1\_3 for scheduling on serving cells from a set of serving cells, the serving cell for counting the size of one or both DCI format 0\_3 and DCI format 1\_3, respectively, is

- the scheduling cell, if the scheduling cell is included in the set of serving cells and the UE is provided search space sets for the PDCCH candidates only on the scheduling cell

- a serving cell from the set of serving cells, if search space sets with same *searchSpaceId* for one or both of DCI format 0\_3 and DCI format 1\_3, respectively, are provided on the serving cell and on the scheduling cell. A UE does not expect to detect, in a same PDCCH monitoring occasion, a DCI format with CRC scrambled by a SI-RNTI, RA-RNTI, MsgB-RNTI, TC-RNTI, P-RNTI, C-RNTI, CS-RNTI, MCS-RNTI, MCCH-RNTI, G-RNTI, or G-CS-RNTI and a DCI format with CRC scrambled by a SL-RNTI or a SL-CS-RNTI for scheduling respective PDSCH reception and PSSCH transmission on a same serving cell.

A PDCCH candidate with index for a search space set using a set of CCEs in a CORESET on the active DL BWP for serving cell , or for set of serving cells associated with *nCI-Value* having value , is not counted for monitoring if there is a PDCCH candidate with index for a search space set , or if there is a PDCCH candidate with index and , in the CORESET on the active DL BWP for serving cell , or for set of serving cells , respectively, using a same set of CCEs, the PDCCH candidates have identical scrambling, and the corresponding DCI formats for the PDCCH candidates have a same size; otherwise, the PDCCH candidate with index is counted for monitoring.

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

Table 10.1-2 provides the maximum number of monitored PDCCH candidates, , per slot for a UE in a DL BWP with SCS configuration for operation with a single serving cell.

Table 10.1-2: Maximum number of monitored PDCCH candidates per slot for a DL BWP with SCS configuration for a single serving cell

|  |  |
| --- | --- |
|  | Maximum number of monitored PDCCH candidates per slot and per serving cell  |
| 0 | 44 |
| 1 | 36 |
| 2 | 22 |
| 3 | 20 |

Table 10.1-2A provides the maximum number of monitored PDCCH candidates, , per span for a UE in a DL BWP with SCS configuration for operation with a single serving cell.

Table 10.1-2A: Maximum number of monitored PDCCH candidates in a span for combination for a DL BWP with SCS configuration for a single serving cell

|  |  |
| --- | --- |
|  | Maximum number of monitored PDCCH candidates per span for combination and per serving cell  |
|  | (2, 2) | (4, 3) | (7, 3) |
| 0 | 14 | 28 | 44 |
| 1 | 12 | 24 | 36 |

Table 10.1-2B provides the maximum number of monitored PDCCH candidates, , per group of slots for combination for a UE in a DL BWP with SCS configuration for operation with a single serving cell.

Table 10.1-2B: Maximum number of monitored PDCCH candidates per group of slots for combination for a DL BWP with SCS configuration for a single serving cell

|  |  |
| --- | --- |
|  | Maximum number of monitored PDCCH candidates in a group of slots per combination and per serving cell  |
|  | (4, 1) | (4, 2) | (8, 1) | (8, 4) |
| 5 | 20 | 20 | - | - |
| 6 | 10 | 10 | 20 | 20 |

Table 10.1-3 provides the maximum number of non-overlapped CCEs, , for a DL BWP with SCS configuration that a UE is expected to monitor corresponding PDCCH candidates per slot for operation with a single serving cell.

CCEs for PDCCH candidates are non-overlapped if they correspond to

- different CORESET indexes, or

- different first symbols for the reception of the respective PDCCH candidates.

Table 10.1-3: Maximum number of non-overlapped CCEs per slot for a DL BWP with SCS configuration for a single serving cell

|  |  |
| --- | --- |
|  | Maximum number of non-overlapped CCEs per slot and per serving cell  |
| 0 | 56 |
| 1 | 56 |
| 2 | 48 |
| 3 | 32 |

Table 10.1-3A provides the maximum number of non-overlapped CCEs, , for a DL BWP with SCS configuration that a UE is expected to monitor corresponding PDCCH candidates per span for operation with a single serving cell.

Table 10.1-3A: Maximum number of non-overlapped CCEs in a span for combination for a DL BWP with SCS configuration for a single serving cell

|  |  |
| --- | --- |
|  | Maximum number of non-overlapped CCEs per span for combination and per serving cell  |
|  | (2, 2) | (4, 3) | (7, 3) |
| 0 | 18 | 36 | 56 |
| 1 | 18 | 36 | 56 |

Table 10.1-3B provides the maximum number of non-overlapped CCEs, , for a DL BWP with SCS configuration that a UE is expected to monitor corresponding PDCCH candidates per group of slots for combination for operation with a single serving cell.

Table 10.1-3B: Maximum number of non-overlapped CCEs in a group of slots for any combination for a DL BWP with SCS configuration for a single serving cell

|  |  |
| --- | --- |
|  | Maximum number of non-overlapped CCEs in a group of slots per combination and per serving cell  |
|  | (4, 1) | (4, 2) | (8, 1) | (8, 4) |
| 5 | 32 | 32 | - | - |
| 6 | 16 | 16 | 32 | 32 |

In the following, if a UE monitors PDCCH candidates for detection of one or both of DCI format 0\_3 and DCI format 1\_3 for scheduling on serving cells from a set of serving cells, the serving cell for counting the PDCCH candidates and a corresponding number of non-overlapping CCEs is

- the scheduling cell, if the scheduling cell is included in the set of serving cells and the UE is provided search space sets for the PDCCH candidates only on the scheduling cell

- a serving cell from the set of serving cells, if search space sets with same *searchSpaceId* for one or both of DCI format 0\_3 and DCI format 1\_3, respectively, are provided on the serving cell and on the scheduling cell. If a UE

- does not report *pdcch-BlindDetectionCA, pdcch-BlindDetectionCA1*, *pdcch-BlindDetectionCA2*, or *pdcch-BlindDetectionCA3*, or is not provided *BDFactorR*,

- reports *pdcch-BlindDetectionCA*, *pdcch-BlindDetectionCA1*, *pdcch-BlindDetectionCA2*, or *pdcch-BlindDetectionCA3*, the UE can be indicated by *BDFactorR* either or

If a UE is configured with downlink cells for which the UE is not provided *monitoringCapabilityConfig,* or is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and is not provided *CORESETPoolIndex*, with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration where , the UE is not required to monitor, on the active DL BWPs of the scheduling cells,

- more than PDCCH candidates or more than non-overlapped CCEs per slot for each scheduled cell when the scheduling cell is from the downlink cells, or

- more than PDCCH candidates or more than non-overlapped CCEs per slot for each scheduled cell when the scheduling cell is from the downlink cells

- more than PDCCH candidates or more than non-overlapped CCEs per slot for CORESETs with same *coresetPoolIndex* value for each scheduled cell when the scheduling cell is from the downlink cells

 is replaced by , if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability*. is replaced by , if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability.* is replaced by , if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability*.

If a UE

- is configured with downlink cells for which the UE is not provided *monitoringCapabilityConfig,* or is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and is not provided *coresetPoolIndex*,

- with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cell(s) using SCS configuration , where , and

- a DL BWP of an activated cell is the active DL BWP of the activated cell, and a DL BWP of a deactivated cell is the DL BWP with index provided by *firstActiveDownlinkBWP-Id* for the deactivated cell,

the UE is not required to monitor more than  PDCCH candidates or more than non-overlapped CCEs per slot on the active DL BWP(s) of scheduling cell(s) from the downlink cells. is replaced by if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability*. is replaced by , if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability.* is replaced by . If a UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability*.

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

## 10.4 Search space set group switching and skipping of PDCCH monitoring

A UE can be provided

- a group index for a respective Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList* for PDCCH monitoring on a serving cell,

- a group index for a respective Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList-r17* for PDCCH monitoring on an active DL BWP of a serving cell.

If the UE is not provided *searchSpaceGroupIdList* or *searchSpaceGroupIdList-r17* for a search space set, the following procedures that are based on search space set group switching are not applicable for PDCCH monitoring according to the search space set.

A UE can be provided a set of durations by *PDCCHSkippingDurationList* for Type3-PDCCH CSS set or USS set for PDCCH monitoring on an active DL BWP of a serving cell. If the UE is not provided *PDCCHSkippingDurationList*, the following procedures related to skipping of PDCCH monitoring are not applicable.

If a UE is provided *cellGroupsForSwitchList*, indicating one or more groups of serving cells, the following procedures apply to all serving cells within each group; otherwise, the following procedures apply only to a serving cell for which the UE is provided *searchSpaceGroupIdList*.

When a UE is provided *searchSpaceGroupIdList*, the UE resets PDCCH monitoring according to search space sets with group index 0, if provided by *searchSpaceGroupIdList*.

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

A UE determines a slot and a symbol in the slot to start or stop PDCCH monitoring according to search space sets for a serving cell that the UE is provided *searchSpaceGroupIdList* or, if *cellGroupsForSwitchList* is provided, for a set of serving cells, based on the largest if the SCS configuration among all configured DL BWPs in the set of serving cells equals to 6, otherwise, based on the smallest SCS configuration among all configured DL BWPs in the serving cell or in the set of serving cells and, if any, in the serving cell where the UE receives a PDCCH and detects a corresponding DCI format 2\_0 triggering the start or stop of PDCCH monitoring according to search space sets.

A UE can be provided a set of durations by *PDCCHSkippingDurationList* for PDCCH monitoring on an active DL BWP of a serving cell and, if the UE is not provided *searchSpaceGroupIdList-r17* on the active DL BWP of the serving cell, a DCI format that schedules PUSCH transmission, and a DCI format that schedules PDSCH receptions can include a PDCCH monitoring adaptation field of 1 bit or of 2 bits.

If the field has 1 bit and for PDCCH monitoring by the UE according to Type3-PDCCH CSS sets or USS sets on the active DL BWP of the serving cell

- a '0' value for the bit indicates no skipping in PDCCH monitoring

- a '1' value for the bit indicates skipping PDCCH monitoring for a duration provided by the first value in the set of durations

If the field has 2 bits and for PDCCH monitoring by the UE according to Type3-PDCCH CSS sets or USS sets on the active DL BWP of the serving cell

- a '00' value for the bits indicates no skipping in PDCCH monitoring

- a '01' value for the bits indicates skipping PDCCH monitoring for a duration provided by the first value in the set of durations

- a '10' value for the bits indicates skipping PDCCH monitoring for a duration provided by the second value in the set of durations

- a '11' value for the bits indicates skipping PDCCH monitoring for a duration provided by the third value in the set of durations, if any; otherwise, if the set of durations includes two values, a use of the '11' value is reserved

A UE can be provided group indexes for a Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList-r17* for PDCCH monitoring on an active DL BWP of a serving cell and, if the UE is not provided *PDCCHSkippingDurationList* for the active DL BWP of the serving cell, a DCI format that schedules PUSCH transmissions and a DCI format that schedules PDSCH receptions can include a PDCCH monitoring adaptation field of 1 bit or of 2 bits for the serving cell.

If the field has 1 bit and for PDCCH monitoring by the UE according to Type3-PDCCH CSS sets or USS sets on the active DL BWP of the serving cell

- a '0' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 0 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

- a '1' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with other group indexes, if any, and the UE sets the timer value to the one provided by *searchSpaceSwitchTimer-r17*, if provided

If the field has 2 bits and for PDCCH monitoring by the UE according to Type3-PDCCH CSS sets or USS sets on the active DL BWP of the serving cell

- a '00' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 0 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

- a '01' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with other group indexes, if any, and the UE sets the timer value to the one provided by *searchSpaceSwitchTimer-r17*, if provided

- a '10' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 2 and stop of PDCCH monitoring according to search space sets with other group indexes, if any, and the UE sets the timer value to the one provided by *searchSpaceSwitchTimer-r17*, if provided

- a '11' value is reserved

A UE can be provided a set of durations by *PDCCHSkippingDurationList* and group indexes for a Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList-r17* for PDCCH monitoring on an active DL BWP of a serving cell and, a DCI format that schedules PUSCH transmissions, and a DCI format that schedules PDSCH receptions can include a PDCCH monitoring adaptation field of 2 bits.

If the set of durations includes one value and for PDCCH monitoring by the UE according to Type3-PDCCH CSS sets or USS sets on the active DL BWP of the serving cell

- a '00' value for the bits indicates start of PDCCH monitoring according to search space sets with group index 0 and stop of PDCCH monitoring according to search space sets with group index 1, if any

- a '01' value for the bits indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with group index 0, if any, and the UE sets the timer value to the one provided by *searchSpaceSwitchTimer-r17*, if provided

- a '10' value for the bits indicates skipping PDCCH monitoring for a duration provided by the value in the set of durations

- a '11' value is reserved

If the set of durations includes two values and for PDCCH monitoring by the UE according to Type3-PDCCH CSS sets or USS sets on active DL BWP of the serving cell

- a '00' value for the bits indicates start of PDCCH monitoring according to search space sets with group index 0 and stop of PDCCH monitoring according to search space sets with group index 1, if any

- a '01' value for the bits indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with group index 0, if any, and the UE sets the timer value to the one provided by *searchSpaceSwitchTimer-r17*, if provided

- a '10' value for the bits indicates skipping PDCCH monitoring for a duration provided by the first value in the set of durations

- a '11' value for the bits indicates skipping PDCCH monitoring for a duration provided by the second value in the set of durations

When the PDCCH monitoring adaptation field indicates to a UE to start PDCCH monitoring according to search space sets with a first group index and stop PDCCH monitoring according to search space sets with a second group index, the UE applies the indication

- at the beginning of a first slot that is at least symbols after the last symbol of the PDCCH reception providing the DCI format with the PDCCH monitoring adaptation field when ,

- at the beginning of a first slot, of a slot group of slots, that is at least symbols after the last symbol of the PDCCH reception providing the DCI format with the PDCCH monitoring adaptation field when

When the PDCCH monitoring adaptation field indicates to a UE to skip PDCCH monitoring for a duration on the active DL BWP of a serving cell, the UE starts skipping of PDCCH monitoring at the beginning of a first slot that is after the last symbol of the PDCCH reception providing the DCI format with the PDCCH monitoring adaptation field. If the UE transmits a PUCCH providing a positive SR after the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of the serving cell, the UE resumes PDCCH monitoring starting at the beginning of a first slot that is after a last symbol of the PUCCH transmission in all serving cells of the corresponding Cell Group. During the time of *ra-ResponseWindow* or *msgB-ResponseWindow* or the duration where *ra-ContentionResolutionTimer* is running, the UE shall not skip PDCCH monitoring on SpCell. If UE transmits a RACH due to positive SR, the UE shall not skip PDCCH monitoring on any serving cell of the corresponding Cell Group during the time of *ra-ResponseWindow* or *msgB-ResponseWindow* or the duration where *ra-ContentionResolutionTimer* is running. If the DRX group of the serving cell is configured and enters outside Active Time, the UE terminates PDCCH skipping for the serving cell.

If the UE changes to a new active DL BWP of the serving cell by the expiration of *bwp-InactivityTimer*, the UE

- resumes PDCCH monitoring according to the search space sets on the new active BWP of the serving cell when UE is in a PDCCH skipping duration, if the UE is not provided *searchSpaceGroupIdList-r17* on the new active DL BWP

- monitors PDCCH according to search space sets with group index 0 on the new active BWP of the serving cell, if the UE is provided *searchSpaceGroupIdList-r17*.

If a UE is provided group indexes for a Type3-PDCCH CSS set or a USS set by *searchSpaceGroupIdList-r17* and a timer value by *searchSpaceSwitchTimer-r17* for PDCCH monitoring an active DL BWP of on a serving cell and the timer is running, the UE

- resets the timer after a slot of the active DL BWP of the serving cell if the UE detects a DCI format in a PDCCH reception in the slot for with CRC scrambled by C-RNTI/CS-RNTI/MCS-C-RNTI

- otherwise, decrements the timer value by one after a slot of the active DL BWP of the serving cell

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

# 12 Bandwidth part operation

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

If a bandwidth part indicator field is configured in a DCI format, the bandwidth part indicator field value indicates the active DL BWP, from the configured DL BWP set, for DL receptions as described in [5, TS 38.212]. If a bandwidth part indicator field is configured in a DCI format, the bandwidth part indicator field value indicates the active UL BWP, from the configured UL BWP set, for UL transmissions as described in [5, TS 38.212]. If a bandwidth part indicator field is configured in a DCI format and indicates an UL BWP or a DL BWP different from the active UL BWP or DL BWP, respectively, the UE shall

- for each information field in the DCI format

- if the size of the information field is smaller than the one required for the DCI format interpretation for the UL BWP or DL BWP that is indicated by the bandwidth part indicator, the UE prepends zeros to the information field until its size is the one required for the interpretation of the information field for the UL BWP or DL BWP prior to interpreting the DCI format information fields, respectively

- if the size of the information field is larger than the one required for the DCI format interpretation for the UL BWP or DL BWP that is indicated by the bandwidth part indicator, the UE uses a number of least significant bits of the DCI format equal to the one required for the UL BWP or DL BWP indicated by bandwidth part indicator prior to interpreting the DCI format information fields, respectively

- set the active UL BWP or DL BWP to the UL BWP or DL BWP indicated by the bandwidth part indicator in the DCI format

If a bandwidth part indicator field is configured in a DCI format 0\_1 and indicates an active UL BWP with different SCS configuration , or with different number of RB sets, than a current active UL BWP, the UE determines an uplink frequency domain resource allocation Type 2 based on bits and bits that are generated by independently truncating or padding the MSBs and the LSBs [6, TS 38.214] of the frequency domain resource assignment field of the DCI format 0\_1, where truncation starts from the MSBs of the X bits or the Y bits, zero-padding prepends zeros to the X bits or the Y bits, and

- if the indicated active UL BWP has SCS configuration and the current active BWP has SCS configuration , the MSBs are truncated to bits, or

- if the indicated active UL BWP has SCS configuration and the current active BWP has SCS configuration , the MSBs are zero-padded to bits

- otherwise, the MSBs are unchanged

and

- the LSBs are truncated or zero-padded to bits where is a number of RB sets configured for the indicated active UL BWP

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