**3GPP TSG- Meeting #**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  | | | | | | | | |
| *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:*** | Clarification of the SPS PDSCH activation and PUCCH resource selection for the 1st SPS PDSCH | | | | | | | | | |
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| ***Source to WG:*** |  | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_L1enh\_URLLC-Core | | | | |  | ***Date:*** | | |  |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **A** |  | | | | | ***Release:*** | | |  |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | During RAN1#107 and RAN1#107bis in the Rel-17 PUCCH coverage enhancements discussion the question of whether the 1st SPS PDSCH transmitted in response of the SPS PDSCH activation should be considered as an SPS-PDSCH (PDSCH without a corresponding PDCCH), or a “regular” dynamic-grant-scheduled PDSCH that has a corresponding PDCCH. RAN1#108 discussed the issue, identified that two possible interpretations exist and proceeded to clarify the specification. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Clarify in 9.1.3.1 that   * DAI field of the DL SPS activation DCI is to be ignored * The SPS-PDSCH “associated with a corresponding activation DCI” is considered as SPS-PDSCH in HARQ-ACK information multiplexing to the HARQ-ACK information bits.   Clarify in 9.2.3 that   * The PUCCH resource determination procedure excludes the PUCCH Resource Indication field in the SPS PDSCH activation DCI * The PUCCH resource determination for the SPS-PDSCH “associated with the corresponding activation DCI” follows the RRC-configured *n1PUCCH-AN*, or *SPS-PUCCH-AN-List* like all the subsequent SPS-PDSCHs do. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | It is not clear whether the 1st PDSCH the SPS-PDSCH activation DCI points to is considered an SPS-PDSCH or dynamically granted PDSCH. This leads to different understandings in how the HARQ-ACK for the 1st PDSCH is to be transmitted.  Isolated impact analysis: The CR impacts the HARQ-ACK transmission associated with the 1st SPS PDSCH that is triggered by the DL SPS activation DCI.   * If the gNB is implemented according to the CR, and the UE is not, or vice versa, the two nodes have a different understanding of the PUCCH resource to transmit the HARQ-ACK for the 1st PDSCH leading to loss of the HARQ-ACK of the activation DCI and failure for the gNB to detect that the UE has DL SPS activated. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 9.1.3.1, 9.2.3 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | | The CR is for Rel-16. Rel-15 UE/gNB may also implement the same change  RAN1 discussion summary in R1-2202833 | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

\*\*\*\*\* Unaffected subclauses 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 that the UE generates a Type-2 HARQ-ACK codebook, the UE separately applies the procedures in this clause per G-RNTI and determines the Type-2 HARQ-ACK codebook by concatenating the Type-2 HARQ-ACK codebook for unicast DCI formats followed by the HARQ-ACK codebooks for the multicast DCI formats in ascending order of the corresponding G-RNTI values.

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-ForDCI-Format1-2* 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.

A value of the counter downlink assignment indicator (DAI) field in DCI formats denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pairs in which PDSCH receptions, 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 .

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), 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.

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, or having associated HARQ-ACK information without scheduling a PDSCH reception, 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 providing a DCI format associated with HARQ-ACK information without scheduling PDSCH reception 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, including the ones associated with the corresponding activation DCI, 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, including the ones associated with the corresponding activation DCI, 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.

The UE generates HARQ-ACK information with ACK value in response to a detection of a DCI format that does not trigger a Type-3 HARQ-ACK codebook report and has associated HARQ-ACK information without scheduling a PDSCH reception.

For a PDCCH monitoring occasion with DCI format scheduling PDSCH reception, or having associated HARQ-ACK information without scheduling a PDSCH reception, in the active DL BWP of a serving cell, when a UE receives a PDSCH with one transport block, or detects a DCI format having associated HARQ-ACK information without scheduling PDSCH reception, 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 any 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 a DCI format having associated HARQ-ACK information without scheduling PDSCH reception, 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

- is a number of serving cells where the UE is configured to receive unicast PDSCHs

- is a number of serving cells where the UE is configured to receive multicast PDSCHs for a G-RNTI or a G-CS-RNTI

- is a total number of G-RNTIs or G-CS-RNTIs configured to the UE

- is the number of PDCCH monitoring occasions for unicast DCI formats

- is the number of PDCCH monitoring occasions for multicast DCI formats with CRC scrambled by G-RNTI or G-CS-RNTI

- where the number of bits for the counter DAI field in unicast DCI formats

- where the number of bits for the counter DAI field in multicast DCI formats with CRC scrambled by G-RNTI or G-CS-RNTI

- if , is the value of the counter DAI in the last DCI format scheduling PDSCH reception or having associated HARQ-ACK information without scheduling PDSCH reception, that the UE detects within the PDCCH monitoring occasions.

- if , is the value of the counter DAI in the last multicast DCI format with G-RNTI , or G-CS-RNTI , scheduling PDSCH reception or having associated HARQ-ACK information without scheduling a PDSCH reception, that the UE detects within the PDCCH monitoring occasions

- if or if

- if the UE does not detect any DCI format that includes a total DAI field in a last PDCCH monitoring occasion within the or PDCCH monitoring occasions where the UE detects at least one DCI format scheduling PDSCH reception, or having associated HARQ-ACK information without scheduling PDSCH reception, for any serving cell , or , respectively, 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 or , for G-RNTI or G-CS-RNTI , PDCCH monitoring occasions where the UE detects at least one DCI format scheduling PDSCH reception, or having associated HARQ-ACK information without scheduling PDSCH reception, for any serving cell , or , respectively, is the value of the total DAI in the at least one DCI format that includes a total DAI field

- or if the UE does not detect any DCI format scheduling PDSCH reception, or having associated HARQ-ACK information without scheduling PDSCH reception, for any serving cell in any of the or PDCCH monitoring occasions, respectively.

- or , for G-RNTI or G-CS-RNTI , is the total number of DCI formats scheduling PDSCH receptions, or having associated HARQ-ACK information without scheduling a PDSCH reception, that the UE detects within the or PDCCH monitoring occasions, respectively, for serving cell . or if the UE does not detect any DCI format scheduling PDSCH reception, or having associated HARQ-ACK information without scheduling PDSCH reception, for serving cell in any of the or , respectively,PDCCH monitoring occasions.

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

- .

- or , for G-RNTI or G-CS-RNTI , 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 formats that the UE detects and have associated a HARQ-ACK information without scheduling PDSCH reception in PDCCH monitoring occasion for serving cell .

- or , for G-RNTI or G-CS-RNTI , 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 or PDCCH monitoring occasions, respectively.

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 reception,

- a DCI format having associated HARQ-ACK information without scheduling PDSCH reception,

- TCI state update, and

- 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 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

If a UE is not provided *numberOfHARQ-BundlingGroups*, detects a first DCI format scheduling one PDSCH reception or having associated HARQ-ACK information without scheduling a PDSCH reception, if any, and a second DCI format scheduling more than one PDSCH reception on a serving cell from the serving cells, if any, and the UE would provide corresponding HARQ-ACK information in a same PUCCH, the UE determines the according to the previous pseudo-code with the following modifications

- the UE determines a first HARQ-ACK sub-codebook based on each detected DCI format scheduling one PDSCH reception or having associated HARQ-ACK information without scheduling a PDSCH reception, or SPS PDSCH receptions, if any, and

- the UE determines a second HARQ-ACK sub-codebook based on each detected DCI format scheduling more than one PDSCH reception, and

- instead of generating one HARQ-ACK information bit per transport block for serving cell , the UE generates HARQ-ACK information bits where is the maximum value of across all serving cells, is a maximum number of PDSCH receptions that can be scheduled by a DCI format on serving cell as described in [6, TS 38.214], and is the value of *maxNrofCodeWordsScheduledByDCI* for serving cell . The UE generates the HARQ-ACK information bits in ascending order of the PDSCHs, including any PDSCH that the UE does not receive in a slot as described in clause 11.1. If, for serving cell , the UE detects a DCI format that schedules PDSCH receptions and , the UE generates NACK for the last HARQ-ACK information bits

- The pseudo-code operation when *PDSCH-CodeBlockGroupTransmission* 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 a UE is provided *numberOfHARQ-BundlingGroups* for a serving cell , the UE generates HARQ-ACK information over transport block groups (TBGs) for PDSCH receptions where, for a maximum number of PDSCH receptions scheduled by a DCI format on the serving cell, a maximum number of TBGs is provided by *numberOfHARQ-BundlingGroups*. If the UE detects a DCI format scheduling PDSCH receptions on the serving cell , the UE generates HARQ-ACK information bits for first TBs and, if applicable, generates HARQ-ACK information bits for second TBs in the PDSCH receptions as described in clause 9.1.1 by setting and .

If a UE

- is provided *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* and, if provided, *numberOfHARQ-BundlingGroups* with value for serving cells; and

- is not provided *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* or is provided *numberOfHARQ-BundlingGroups* with value , 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 reception,

- any DCI format having associated HARQ-ACK information without scheduling PDSCH reception, and

- PDSCH reception scheduled by a DCI format scheduling one PDSCH

- PDSCH reception with for TBG-based HARQ-ACK information on the serving cells,

- is replaced by for the determination of a second HARQ-ACK sub-codebook corresponding to the serving cells for TBG-based HARQ-ACK information, or for TB-based HARQ-ACK information corresponding to multiple PDSCH receptions scheduled by a single DCI format, 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 between across all serving cells if the UE is provided *numberOfHARQ-BundlingGroups*, and across all serving cells where the UE is not provided *numberOfHARQ-BundlingGroups*, and is the value of *maxNrofCodeWordsScheduledByDCI* for serving cell . If for a serving cell where the UE is provided *numberOfHARQ-BundlingGroups*, it is , the UE generates NACK for the last HARQ-ACK information bits for serving cell . If for a serving cell where the UE is not provided *numberOfHARQ-BundlingGroups*, it is , the UE generates NACK for the last HARQ-ACK information bits for serving cell .

- The pseudo-code operation when *PDSCH-CodeBlockGroupTransmission* 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.

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

|  |  |  |
| --- | --- | --- |
| DAI MSB, 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, 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 |  |

\*\*\*\*\* Unaffected subclauses 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 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-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-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 multicast DCI formats, the PDSCH-to-HARQ\_feedback timing indicator field values are provided by *dl-DataToUL-ACK-MulticastDciFormat4\_1* or, if *dl-DataToUL-ACK-MulticastDciFormat4\_1* is not provided, by {1, 2, 3, 4, 5, 6, 7, 8}.

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 the last UL slot for PUCCH transmission that overlaps with slot and 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 the last UL slot for PUCCH transmission that overlaps with slot and is provided by *dl-DataToUL-ACK*, or *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_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 the last UL slot for PUCCH transmission that overlaps with slot and 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*, or *dl-DataToUL-ACK-MulticastDciFormat4\_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-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_1* | |
| '1' | '01' | '001' | 2nd value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_1* | |
|  | '10' | '010' | 3rd value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_1* | |
|  | '11' | '011' | 4th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, *dl-DataToUL-ACK-MulticastDciFormat4\_1* | |
|  |  | '100' | 5th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_1* | |
|  |  | '101' | 6th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_1* | |
|  |  | '110' | 7th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_1* | |
|  |  | '111' | 8th value provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, *dl-DataToUL-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_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-ACKForDCIFormat1\_2*, or *dl-DataToUL-ACK-r17,* or *dl-DataToUL-ACK-MulticastDciFormat4\_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. 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,* or *dl-DataToUL-ACK-MulticastDciFormat4\_1*, 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. When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1, the CORESET is associated with the search space set having the smaller index. 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 , for , and 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, which includes the first SPS PDSCH reception associated with the corresponding activation DCI, 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* [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.

\*\*\*\*\* Unaffected subclauses omitted \*\*\*\*\*