**3GPP TSG- Meeting #**

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| *CR-Form-v12.1* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  | | | | | | | | |
| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** |  | | | | | | | | | |
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| ***Source to WG:*** |  | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** |  | | | | |  | ***Date:*** | | | 2021-11-01 |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***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:*** | | Introduction of additional enhancements for LTE-MTC. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Support for LTE-MTC features according to RAN1 agreements:  - Additional PDSCH and HARQ-ACK scheduling delay for introduction of 14-HARQ processes in DL, for HD-FDD Cat M1 UEs | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | No support of additional enhancements for LTE-MTC. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 7, 7.1.7.2, 7.1.11, 7.3.1 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **x** |  | Other core specifications | | | | TS 36.211, TS 36.212 | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

<Unchanged parts are omitted>

# 7 Physical downlink shared channel related procedures

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

- When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells', 'serving cell', and 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell or serving cells belonging to the MCG respectively unless stated otherwise. The terms 'subframe' and 'subframes' refer to subframe or subframes belonging to MCG.

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

If a UE is configured with *dl-TTI-Length*, and PDSCH is received in a slot, the term 'slot/subslot' refers to a slot in this clause.

If the UE is configured with *dl-TTI-Length*, and PDSCH is received in a subslot, the term 'slot/subslot' refers to a subslot in this clause.

If a UE is configured with a LAA Scell, the UE shall apply the procedures described in this clause assuming frame structure type 1 for the LAA Scell unless stated otherwise.

For FDD,

- if the UE supports *ce-pdsch-tenProcesses* and is configured with CEModeA and higher layer parameter *ce-pdsch-tenProcesses-config* set to '*On*' there shall be a maximum of 10 downlink HARQ processes per serving cell;

- if the BL/CE UE is configured with higher layer parameter *ce-PDSCH-14HARQ-Config*, and configured with CEModeA, there shall be a maximum of 14 downlink HARQ processes per serving cell.

- 16 downlink HARQ processes per serving cell configured with higher layer parameter *dl-TTI-Length*

- otherwise, there shall be a maximum of 8 downlink HARQ processes per serving cell.

For FDD-TDD and primary cell frame structure type 1, there shall be a maximum of

- 16 downlink HARQ processes per serving cell configured with higher layer parameter *dl-TTI-Length*

- 8 downlink HARQ processes per serving cell, otherwise.

For TDD and a UE not configured with the parameter *EIMTA-MainConfigServCell-r12* for any serving cell,, if the UE is configured with one serving cell, or if the UE is configured with more than one serving cell and the TDD UL/DL configuration of all the configured serving cells is the same, the maximum number of downlink HARQ processes per serving cell configured with higher layer parameter *dl-TTI-Length* shall be 16, otherwise determined by the UL/DL configuration (Table 4.2-2 of [3]), as indicated in Table 7-1.

For TDD, if a UE is configured with more than one serving cell and if the TDD UL/DL configuration of at least two configured serving cells is not the same, or if the UE is configured with the parameter *EIMTA-MainConfigServCell-r12* for at least one serving cell, or for FDD-TDD and primary cell frame structure type 2 and serving cell frame structure type 2, the maximum number of downlink HARQ processes for a serving cell configured with higher layer parameter *dl-TTI-Length* shall be 16*,* otherwise determined as indicated in Table 7-1, wherein the "TDD UL/DL configuration" in Table 7-1 refers to the DL-reference UL/DL configuration for the serving cell (as defined in Clause 10.2).

For FDD-TDD and primary cell frame structure type 2 and serving cell frame structure type 1, the maximum number of downlink HARQ processes for the serving cell configured with higher layer parameter *dl-TTI-Length* shall be 16*,* otherwise determined by the DL-reference UL/DL configuration for the serving cell (as defined in Clause 10.2), as indicated in Table 7-2.

A BL/CE UE configured with CEModeB is not expected to support more than 4 downlink HARQ processes if the UE is configured with higher layer parameter *ce-PDSCH-MultiTB-Config,* 2 downlink HARQ processes otherwise.

For TDD and a BL/CE configured with CEModeA, the maximum number of downlink HARQ processes for a serving cell shall be determined as indicated in Table 7-3.

For a UE configured with EN-DC/NE-DC, if serving cell frame structure type 1 and if the UE is configured with *tdm-PatternConfig/tdm-PatternConfigNE-DC* for the serving cell, or if the UE is configured with *tdm-PatternConfig2* for a serving cell with EN-DC, the maximum number of downlink HARQ processes for the serving cell shall be determined by DL-reference UL/DL configuration given by *tdm-PatternConfig/tdm-PatternConfigNE-DC*/*tdm-PatternConfig2* for the serving cell*,* as indicated in Table 7-2.

For a UE configured with EN-DC/NE-DC and more than one serving cells, if primary cell frame structure type 1 and if the UE is configured with *tdm-PatternConfig/tdm-PatternConfigNE-DC* for the primary cell, or if the UE is configured with *tdm-PatternConfig2* for a primary cell with EN-DC, the maximum number of downlink HARQ processes for each secondary cell is equal to the maximum number of downlink HARQ processes for the primary cell.

The dedicated broadcast HARQ process defined in [8] is not counted as part of the maximum number of HARQ processes for FDD, TDD and FDD-TDD.

Table 7-1: Maximum number of DL HARQ processes for TDD

|  |  |
| --- | --- |
| TDD UL/DL configuration | Maximum number of HARQ processes |
| 0 | 4 |
| 1 | 7 |
| 2 | 10 |
| 3 | 9 |
| 4 | 12 |
| 5 | 15 |
| 6 | 6 |

Table 7-2: Maximum number of DL HARQ processes for FDD-TDD, primary cell frame structure type 2, and serving cell frame structure type 1

|  |  |
| --- | --- |
| **DL-reference UL/DL**  **Configuration** | **Maximum number of HARQ processes** |
| 0 | 10 |
| 1 | 11 |
| 2 | 12 |
| 3 | 15 |
| 4 | 16 |
| 5 | 16 |
| 6 | 12 |

Table 7-3: Maximum number of DL HARQ processes for TDD  
(UE configured with CEModeA)

|  |  |
| --- | --- |
| TDD UL/DL configuration | Maximum number of HARQ processes |
| 0 | 6 |
| 1 | 9 |
| 2 | 12 |
| 3 | 11 |
| 4 | 14 |
| 5 | 16 |
| 6 | 8 |

<Unchanged parts are omitted>

#### 7.1.7.2 Transport block size determination

For BL/CE UEs configured with CEModeA, is used in place of in the rest of this Clause



If the DCI CRC is scrambled by P-RNTI, RA-RNTI, or SI-RNTI then

- for DCI format 1A or DCI format 6-1A:

- the UE shall set the TBS index () equal to and determine its TBS by the procedure in Clause 7.1.7.2.1 for .



- for DCI format 1C and DCI format 6-2:

- the UE shall set the TBS index () equal to and determine its TBS from Table 7.1.7.2.3-1.



else if the DCI CRC is scrambled by SC-RNTI then

- the UE shall set the TBS index () equal to and determine its TBS from Table 7.1.7.2.3-1.



else if the higher layer parameter *altMCS-Table* is configured, and for DCI format 1/1B/1D/2/2A/2B/2C/2D with CRC scrambled by C-RNTI

- for , the UE shall first determine the TBS index () usingand Table 7.1.7.1-1C except if the transport block is disabled in DCI formats 2, 2A, 2B, 2C and 2D as specified below. When , if the UE is scheduled by DCI formats 1/1B/2/2A and is configured with b33 in *tbsIndexAlt2*,  is 33B; otherwise  is 33. For a transport block that is not mapped to more than single-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.1. For a transport block that is mapped to two-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.2. For a transport block that is mapped to three-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.4. For a transport block that is mapped to four-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.5.

- for , the TBS is assumed to be as determined from DCI transported in the latest PDCCH/EPDCCH for the same transport block using .

- In DCI formats 2, 2A, 2B, 2C and 2D a transport block is disabled if  and if *rvidx* = 1 otherwise the transport block is enabled.

else if the higher layer parameter *altCQI-Table-r12* is configured, then

- for DCI format 1A with CRC scrambled by C-RNTI and for DCI format 1/1A/2/2A/2B/2C/2D with CRC scrambled by SPS C-RNTI:

- for , the UE shall first determine the TBS index () usingand Table 7.1.7.1-1 except if the transport block is disabled in DCI formats 2, 2A, 2B, 2C and 2D as specified below. For a transport block that is not mapped to more than single-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.1.



- for, the TBS is assumed to be as determined from DCI transported in the latest PDCCH/EPDCCH for the same transport block using . If there is no PDCCH/EPDCCH for the same transport block using, and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH/EPDCCH.



- In DCI formats 2, 2A, 2B, 2C and 2D a transport block is disabled if and if *rvidx* = 1 otherwise the transport block is enabled.



- for DCI format 1/1B/1D/2/2A/2B/2C/2D with CRC scrambled by C-RNTI

- for , the UE shall first determine the TBS index () usingand Table 7.1.7.1-1A except if the transport block is disabled in DCI formats 2, 2A, 2B, 2C and 2D as specified below. When , if the UE is scheduled by DCI formats 2C/2D and is configured with a33 in *tbsIndexAlt*, is 33A, or if the UE is scheduled by DCI formats 1/1B/2/2A and is configured with b33 in *tbsIndexAlt2*, is 33B; otherwise is 33. For a transport block that is not mapped to more than single-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.1. For a transport block that is mapped to two-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.2. For a transport block that is mapped to three-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.4. For a transport block that is mapped to four-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.5.



- for , the TBS is assumed to be as determined from DCI transported in the latest PDCCH/EPDCCH for the same transport block using .



- In DCI formats 2, 2A, 2B, 2C and 2D a transport block is disabled if and if *rvidx* = 1 otherwise the transport block is enabled.



else if the higher layer parameter *altCQI-Table-STTI-r15* is configured, then

- for DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G with CRC scrambled by SPS C-RNTI:

- for , the UE shall determine the TBS index () using by the procedure in Clause 7.1.7.

- for, the TBS is assumed to be as determined from DCI transported in the latest PDCCH/SPDCCH for the same transport block using . If there is no PDCCH/SPDCCH for the same transport block using, and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH/SPDCCH.

- for DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G with CRC scrambled by C-RNTI

- for , the UE shall first determine the TBS index () usingand Table 7.1.7.1-1A. When , if the UE is scheduled by DCI formats 7-1F/7-1G and is configured with a33 in *tbsIndexAlt-STTI*, is 33A, or if the UE is scheduled by DCI formats 7-1D/7-1C/7-1B and is configured with b33 in *tbsIndexAlt2-STTI*, is 33B; otherwise is 33.When ,  is 33. The TBS is determined by the procedure in Clause 7.1.7.



- for , the TBS is assumed to be as determined from DCI transported in the latest PDCCH/SPDCCH for the same transport block using .

else if the higher layer parameter *altCQI-Table-1024QAM-r15* is configured, then

- for DCI format 1A with CRC scrambled by C-RNTI and for DCI format 1/1A/2/2A/2B/2C/2D with CRC scrambled by SPS C-RNTI:

- for , the UE shall first determine the TBS index () usingand Table 7.1.7.1-1. For a transport block, the TBS is determined by the procedure in Clause 7.1.7.2.1.



- for , the TBS is assumed to be as determined from DCI transported in the latest PDCCH/EPDCCH for the same transport block using . If there is no PDCCH/EPDCCH for the same transport block using , and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH/EPDCCH.



- for DCI format 1/1B/1D/2/2A/2B/2C/2D with CRC scrambled by C-RNTI;

- for , the UE shall first determine the TBS index () usingand Table 7.1.7.1-1B except if the transport block is disabled in DCI formats 2, 2A, 2B, 2C and 2D as specified below. When , if the UE is scheduled by DCI formats 2C/2D and is configured with a33 in *tbsIndexAlt*, is 33A, or if the UE is scheduled by DCI formats 1/1B/2/2A and is configured with b33 in *tbsIndexAlt2*, is 33B; otherwise is 33. When , if the UE is configured with a37 in *tbsIndexAlt3*, is 37A, otherwise is 37. For a transport block that is not mapped to more than single-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.1. For a transport block that is mapped to two-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.2. For a transport block that is mapped to three-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.4. For a transport block that is mapped to four-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.5.



- for , the TBS is assumed to be as determined from DCI transported in the latest PDCCH/EPDCCH for the same transport block using . If there is no PDCCH/EPDCCH for the same transport block using , and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH/EPDCCH.



- In DCI formats 2, 2A, 2B, 2C and 2D a transport block is disabled if and if *rvidx* = 1 otherwise the transport block is enabled.



else if the higher layer parameter *altCQI-Table-1024QAM-STTI\_r15* is configured, then

- for DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G with CRC scrambled by C-RNTI or SPS C-RNTI;

- for , the UE shall first determine the TBS index () usingand Table 7.1.7.1-1B. When , if the UE is scheduled by DCI formats 7-1F/7-1G and is configured with a33 in *tbsIndexAlt-STTI*, is 33A, or if the UE is scheduled by DCI formats 7-1B/7-1C/7-1D and is configured with b33 in *tbsIndexAlt2-STTI*, is 33B; otherwise is 33. When , if the UE is scheduled by DCI formats 7-1F/7-1G and is configured with a37 in *tbsIndexAlt3-STTI*, is 37A, otherwise is 37. For a transport block that is not mapped to more than single-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7 and 7.1.7.2.1. For a transport block that is mapped to two-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7 and 7.1.7.2.2. For a transport block that is mapped to three-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7 and 7.1.7.2.4. For a transport block that is mapped to four-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7 and 7.1.7.2.5.



- for , the TBS is assumed to be as determined from DCI transported in the latest PDCCH/SPDCCH for the same transport block using . If there is no PDCCH/SPDCCH for the same transport block using , and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH/SPDCCH.



else if the UE supports *ce-pdsch-pusch-maxBandwidth* with value ≥5MHz, or if the UE is configured with higher layer parameter *ce-PDSCH-64QAM-Config-r15* and the MPDCCH DCI format 6-1A is mapped onto the UE specific search space and the repetition number field in the DCI indicates PDSCH repetition level 1,

- for, the TBS is assumed to be as determined from DCI transported in the latest MPDCCH for the same transport block using . If there is no MPDCCH for the same transport block using, and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment MPDCCH.

- forthe UE shall first determine the TBS index () usingand Table 7.1.7.1-1



- if the UE is configured with higher layer parameter *ce-pdsch-maxBandwidth-config* with value 5MHz or if the UE is configured with higher layer parameter *pdsch-MaxBandwidth-SC-MTCH* with value 24 PRBs

- For CEModeA,

- if the UE is configured with higher layer parameter *ce-PDSCH-64QAM-Config-r15* and the MPDCCH DCI format 6-1A is mapped onto the UE specific search space and the repetition number field in the DCI indicates PDSCH repetition level 1,

- set  to the TBS determined by the procedure in Clause 7.1.7.2.1,

- 

- otherwise, TBS is determined by the procedure in Clause 7.1.7.2.8 for



- For CEModeB, TBS is determined by the procedure in Clause 7.1.7.2.8 for



- if the UE is configured with higher layer parameter *ce-pdsch-maxBandwidth-config* with value > 5MHz

- For CEModeA,

- if the UE is configured with higher layer parameter *ce-PDSCH-64QAM-Config-r15* and the MPDCCH DCI format 6-1A is mapped onto the UE specific search space and the repetition number field in the DCI indicates PDSCH repetition level 1,

- set  to the TBS determined by the procedure in Clause 7.1.7.2.1,

- 

- otherwise, TBS is determined by the procedure in Clause 7.1.7.2.1 for



- For CEModeB, TBS is determined by the procedure in Clause 7.1.7.2.1 for



- otherwise,

- if the UE is configured with higher layer parameter *ce-PDSCH-64QAM-Config-r15* and the MPDCCH DCI format 6-1A is mapped onto the UE specific search space and the repetition number field in the DCI indicates PDSCH repetition level 1,

- set  to the TBS determined by the procedure in Clause 7.1.7.2.1,

- if UE is configured with higher layer parameter *ce-PDSCH-maxTBS*, otherwise

- otherwise

- TBS is determined by the procedure in Clause 7.1.7.2.1

else

- for, the UE shall first determine the TBS index () usingand Table 7.1.7.1-1 except if the transport block is disabled in DCI formats 2, 2A, 2B, 2C and 2D as specified below. When , if the UE is scheduled by DCI formats 2C/2D and is configured with a26 in *tbsIndexAlt*, is 26A; otherwise is 26. For a transport block that is not mapped to more than single-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.1. For a transport block that is mapped to two-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.2. For a transport block that is mapped to three-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.4. For a transport block that is mapped to four-layer spatial multiplexing, the TBS is determined by the procedure in Clause 7.1.7.2.5.



- for, the TBS is assumed to be as determined from DCI transported in the latest PDCCH/EPDCCH for the same transport block using . If there is no PDCCH/EPDCCH for the same transport block using, and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH/EPDCCH.



- In DCI formats 2, 2A, 2B, 2C and 2D a transport block is disabled if and if *rvidx* = 1 otherwise the transport block is enabled.



For a BL/CE UE, if the UE is configured with higher layer parameter *ce-PDSCH-MultiTB-Config* and multiple TB, , are scheduled in the corresponding DCI with CRC scrambled by C-RNTI, the HARQ process ID for each of the scheduled  TBs are determined from the value of the 'HARQ index with offset' in the 'Scheduling TBs for Unicast' field for CEmodeA or the HARQ index in the 'Scheduling TBs for Unicast' field for CEmodeB in the corresponding DCI which is a combinatorial index *r* defined as , where

- the set , (**) contains the sorted HARQ process IDs and  is the extended binomial coefficient, resulting in unique label ,

- is the offset value as defined in 5.3.3.1.12 of [4] for CE mode A, and for CEmodeB,

-  is the number of scheduled TB, and

-  if UE is configured with CEModeA, and  if UE is configured with CEModeB,

-  if UE is configured with CEModeA, and 'Multi-TB HARQ processes group' field is present and set to '1' in the corresponding DCI,  otherwise.

For a BL/CE UE, if the UE is configured with higher layer parameter *ce-PDSCH-MultiTB-Config* and TBs are scheduled in the corresponding DCI with CRC scrambled by C-RNTI, the HARQ process IDs for each scheduled TB are , , where

-  if UE is configured with CEModeA, and  if UE is configured with CEModeB,

- if UE is configured with CEModeA, and 'Multi-TB HARQ processes group' field is present and set to '1' in the corresponding DCI,  otherwise.

The NDI and HARQ process ID, as signalled on PDCCH/EPDCCH/MPDCCH/SPDCCH, and the TBS, as determined above, shall be delivered to higher layers.

<Unchanged parts are omitted>

### 7.1.11 PDSCH subframe assignment for BL/CE UE

A BL/CE UE shall upon detection of a MPDCCH with DCI format 6-1A/6-1B/6-2 intended for the UE, decode the corresponding PDSCH in subframe(s) *n+ki* with *i = 0, 1, …, NTBN-1* according to the MPDCCH, where

- subframe *n* is the last subframe in which the MPDCCH is transmitted and is determined from the starting subframe of MPDCCH transmission and the DCI subframe repetition number field in the corresponding DCI;

- the value of is the number of scheduled TB determined in the corresponding DCI if present, otherwise;

- the value of  is determined by the repetition number field in the corresponding DCI, where  are given in Table 7.1.11-1, Table 7.1.11-2 and Table 7.1.11-3, respectively

- if the UE is configured with higher layer parameter *multiTB-Gap* and the PDSCH corresponds to an MPDCCH with DCI CRC scrambled by G-RNTI,

- subframe(s) *ni* = *n+ki* with *i=0,1,…, NTBN-1* are *NTBN* BL/CE DL subframe(s), where, subframe *n+x* is the second BL/CE DL subframe after subframe *n*, and for , subframe is the first BL/CE DL subframe after subframe , where is given by higher layer parameter *multiTB-Gap*, and .

- otherwise,

- subframe(s) *ni* = *n+ki* with *i=0,1,…, NTBN-1* are *NTBN* consecutive BL/CE DL subframe(s), where , and subframe *n+x* is the *j*th BL/CE DL subframe after subframe *n*, and *j* is given by the value of the PDSCH scheduling delay as defined in [4] if the UE is configured with CEModeA and 'PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ' field is present in the corresponding DCI, *j*=2 otherwise.

- for ,

- if the UE is configured with higher layer parameter *interleaving* in *ce-PDSCH-MultiTB-Config*, and PDSCH corresponding to a MPDCCH with DCI CRC scrambled by C-RNTI and where  for BL/CE UE configured with CEModeA,  for BL/CE UE configured with CEModeB,

- BL/CE DL subframes  with  are associated with TB*r+*1 ,

- otherwise,

- BL/CE DL subframes  with  are associated with TB*r+*1 ,.

For BL/CE UEs, and for a PDSCH transmission starting in subframe *n+k0* without a corresponding MPDCCH, the UE shall decode the PDSCH transmission in subframe(s) *n+ki* with *i = 0, 1, …, N-1,* where

- subframe(s) *n+ki* with *i=0,1,…,N-1* are *N* consecutive BL/CE DL subframe(s), where *0≤k0<k1<…,kN-1* and the value of is determined by the repetition number field in the activation DCI, where  are given in Table 7.1.11-1, Table 7.1.11-2 and Table 7.1.11-3, respectively.



If PDSCH carrying *SystemInformationBlockType1-BR* is transmitted in one narrowband in subframe *n+ki*, a BL/CE UE shall assume any other PDSCH in the same narrowband in the subframe *n+ki* is dropped. If PDSCH carrying SI message is transmitted in one narrowband in subframe *n+ki*, a BL/CE UE shall assume any other PDSCH not carrying *SystemInformationBlockType1-BR* in the same narrowband in the subframe *n+ki* is dropped.

For single antenna port (port 0), transmit diversity and closed-loop spatial multiplexing transmission schemes, if a PDSCH is transmitted in BL/CE DL subframe *n+ki* and BL/CE DL subframe *n+ki* is configured as an MBSFN subframe, a BL/CE UE shall assume that the PDSCH in subframe *n+ki* is dropped.

For PDSCH assigned by MPDCCH with DCI CRC scrambled by G-RNTI and DCI Format 6-1A, the UE shall use the higher layer parameter *pdsch-maxNumRepetitionCEmodeA-SC-MTCH* instead of *pdsch-maxNumRepetitionCEmodeA* in Table 7.1.11-1.

For PDSCH assigned by MPDCCH with DCI CRC scrambled by G-RNTI and DCI Format 6-1B, the UE shall use the higher layer parameter *pdsch-maxNumRepetitionCEmodeB-SC-MTCH* instead of *pdsch-maxNumRepetitionCEmodeB* in Table 7.1.11-2.

For a BL/CE UE in half-duplex FDD operation, if the UE is configured with CEModeA, and configured with higher layer parameter *ce-HARQ-AckBundling*, and 'HARQ-ACK bundling flag' in the corresponding DCI is set to 1, the UE shall assume .



Table 7.1.11-1: PDSCH repetition levels (DCI Format 6-1A)

|  |  |
| --- | --- |
| Higher layer parameter  '*pdsch-maxNumRepetitionCEmodeA*' |  |
| Not configured | {1,2,4,8} |
| 16 | {1,4,8,16} |
| 32 | {1,4,16,32} |

Table 7.1.11-2: PDSCH repetition levels (DCI Format 6-1B)

|  |  |
| --- | --- |
| Higher layer parameter  '*pdsch-maxNumRepetitionCEmodeB*' |  |
| Not configured | {4,8,16,32,64,128,256,512} |
| 192 | {1,4,8,16,32,64,128,192} |
| 256 | {4,8,16,32,64,128,192,256} |
| 384 | {4,16,32,64,128,192,256,384} |
| 512 | {4,16,64,128,192,256,384,512} |
| 768 | {8,32,128,192,256,384,512,768} |
| 1024 | {4,8,16,64,128,256,512,1024} |
| 1536 | {4,16,64,256,512,768,1024,1536} |
| 2048 | {4,16,64,128,256,512,1024,2048} |

Table 7.1.11-3: PDSCH repetition levels (DCI Format 6-2)

|  |  |
| --- | --- |
| 2-bit "DCI subframe repetition number"  field in DCI Format 6-2 |  |
| 00 | {1,2,4,8,16,32,64,128} |
| 01 | {4,8,16,32,64,128,192,256} |
| 10 | {32,64,128,192,256,384,512,768} |
| 11 | {192,256,384,512,768,1024,1536,2048} |

<Unchanged parts are omitted>

### 7.3.1 FDD HARQ-ACK reporting procedure

For FDD with PUCCH format 1a/1b transmission, when both HARQ-ACK and SR are transmitted in the same sub-frame/slot, a UE shall transmit the HARQ-ACK on its assigned HARQ-ACK PUCCH format 1a/1b resource for a negative SR transmission and transmit the HARQ-ACK on its assigned SR PUCCH resource for a positive SR transmission.

For FDD with PUCCH format 1a transmission, when both HARQ-ACK and SR are transmitted in the same subslot, a UE shall transmit the HARQ-ACK bit according to Table 7.3.1-0A;

Table 7.3.1-0A: PUCCH format 1a resource for transmission of HARQ-ACK bit and SR

|  |  |  |
| --- | --- | --- |
| HARQ-ACK | SR transmission | Resource for HARQ-ACK bits transmission |
| ACK/NACK | negative | HARQ-ACK PUCCH format 1a resource |
| NACK | positive | The first SR PUCCH resource value configured by the higher layers |
| ACK | positive | The second SR PUCCH resource value configured by the higher layers |

for FDD with PUCCH format 1b transmission, when both HARQ-ACK and SR are transmitted in the same subslot, a UE shall transmit the HARQ-ACK bits according to Table 7.3.1-0B;

Table 7.3.1-0B: PUCCH format 1b resource for transmission of HARQ-ACK bits

|  |  |  |  |
| --- | --- | --- | --- |
| HARQ-ACK(0) | HARQ-ACK(1) | SR transmission | Resource for HARQ-ACK bits transmission |
| ACK/NACK | ACK/NACK | negative | HARQ-ACK PUCCH format 1b resource |
| NACK | NACK | positive | The first SR PUCCH resource value configured by the higher layers |
| ACK | NACK | positive | The second SR PUCCH resource value configured by the higher layers |
| NACK | ACK | positive | The third SR PUCCH resource value configured by the higher layers |
| ACK | ACK | positive | The fourth SR PUCCH resource value configured by the higher layers |

where SR PUCCH resources are configured by higher layer parameter *sr-SubslotSPUCCH-Resource*, and HARQ-ACK(j), *j=0, 1* denotes the ACK/NACK response for a transport block or SPS release PDCCH/EPDCCH/SPDCCH associated with serving cell c.

For FDD with PUCCH format 1b with channel selection, when both HARQ-ACK and SR are transmitted in the same sub-frame a UE shall transmit the HARQ-ACK on its assigned HARQ-ACK PUCCH resource with channel selection as defined in Clause 10.1.2.2.1 for a negative SR transmission and transmit one HARQ-ACK bit per serving cell on its assigned SR PUCCH resource for a positive SR transmission according to the following:

* if only one transport block or a PDCCH/EPDCCH indicating downlink SPS release is detected on a serving cell, the HARQ-ACK bit for the serving cell is the HARQ-ACK bit corresponding to the transport block or the PDCCH/EPDCCH indicating downlink SPS release;
* if two transport blocks are received on a serving cell, the HARQ-ACK bit for the serving cell is generated by spatially bundling the HARQ-ACK bits corresponding to the transport blocks;
* if neither PDSCH transmission for which HARQ-ACK response shall be provided nor PDCCH/EPDCCH indicating downlink SPS release is detected for a serving cell, the HARQ-ACK bit for the serving cell is set to NACK;

and the HARQ-ACK bits for the primary cell and the secondary cell are mapped to  and , respectively, where  and  are specified in Clause 5.4.1 in [3].

For FDD, when a PUCCH format 3/4/5 transmission of HARQ-ACK coincides with a subframe/slot/subslot configured to the UE by higher layers for transmission of a scheduling request, the UE shall multiplex HARQ-ACK and SR bits on HARQ-ACK PUCCH resource as defined in Clause 5.2.3.1 in [4], unless the HARQ-ACK corresponds to a subframe-PDSCH transmission on the primary cell only or a PDCCH/EPDCCH indicating downlink SPS release on the primary cell only, in which case the SR shall be transmitted as for FDD with PUCCH format 1a/1b.

For a non-BL/CE UE for FDD and for a PUSCH transmission, a UE shall not transmit HARQ-ACK on PUSCH in subframe/slot/subslot *n* if the UE does not receive PDSCH or PDCCH/SPDCCH indicating downlink SPS release in

- subframe *n-* for subframe-PDSCH or in subframe  for PDCCH indicating downlink SPS release



- slot *n-4* for slot-PDSCH

- subslot for subslot-SPDSCH if the higher layer parameter *ul-TTI-Length* is set to 'subslot'



- any of the subslot numbers listed in Table 10.1-1 if the higher layer parameter *ul-TTI-Length* is set to 'slot' and slot-PUSCH is transmitted in subframe 

For a BL/CE UE, for FDD and for a PUSCH transmission scheduled by an MPDCCH where the last transmission of the MPDCCH is in subframe *n-4*, a UE shall not transmit HARQ-ACK on PUSCH in subframe *n* if there is no PDSCH or MPDCCH indicating downlink SPS release transmitted to the UE in subframe *n-4* where the last transmission of the PDSCH or MPDCCH indicating downlink SPS release is in subframe *n-4*.

When only a positive SR is transmitted using subframe-PUCCH, a UE shall use PUCCH Format 1 for the SR resource as defined in Clause 5.4.1 in [3].

When only a positive SR is transmitted using slot/subslot-PUCCH, a UE shall use PUCCH Format 1 for the first SR resource configured by higher layers as defined in Clause 5.4A.2 in [3].

If a UE is configured with higher layer parameter *codebooksizeDetermination-r13 = dai* and PDSCH is associated with DCI format 1/1A/1B/1D/2/2A/2B/2C/2D, the following HARQ-ACK reporting procedure applies to subframe-PDSCH operation. If a UE is configured with higher layer parameter *codebooksizeDeterminationsSTTI-r15 = dai* and PDSCH is associated with DCI format 7-1A/7-1B/7-1C/7-1D/7-1F/7-1G, the following HARQ-ACK reporting procedure applies to slot/subslot-PDSCH operation.

If a UE is configured with higher layer parameter *codebooksizeDetermination-r13 = dai* or with higher layer parameter *codebooksizeDeterminationsSTTI-r15 = dai*, for FDD and a subframe/subslot *n*, the value of the counter Downlink Assignment Indicator (DAI) in DCI format 1/1A/1B/1D/2/2A/2B/2C/2D/7-1A/7-1B/7-1C/7-1D/7-1F/7-1G denotes the accumulative number of {serving cell, subframe/slot/subslot}-pair(s) with PDSCH transmission(s) associated with PDCCH/EPDCCH/SPDCCH and serving cell with PDCCH/EPDCCH/SPDCCH indicating downlink SPS release, up to the present serving cell and present subframe/slot/subslot, first in increasing order of serving cell index and then in increasing order of subframe/slot/subslot index; the value of the total DAI in DCI format 1/1A/1B/1D/2/2A/2B/2C/2D/7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G denotes the total number of {serving cell, subframe/slot/subslot}-pair(s) with PDSCH transmission(s) associated with PDCCH/EPDCCH/SPDCCH (s) and serving cell with PDCCH/EPDCCH/SPDCCH indicating downlink SPS release. Denote  as the value of the counter DAI in DCI format 1/1A/1B/1D/2/2A/2B/2C/2D/7-1A/7-1B/7-1C/7-1D/7-1F/7-1G scheduling PDSCH transmission or indicating downlink SPS release for serving cell *c* in subframe/slot/subslot *s* within the set of subframe(s)/slot(s)/subslot(s) for which HARQ-ACK response shall be provided in subframe/slot/subslot *n*, according to table 7.3.1-1. Denote  as the value of the total DAI, according to Table 7.3.1-1. The UE shall assume a same value of total DAI in all PDCCH/EPDCCH/SPDCCH scheduling PDSCH transmission(s) and PDCCH/EPDCCH/SPDCCH indicating downlink SPS release in a subframe/slot/subslot.

If a UE is configured with higher layer parameter *codebooksizeDetermination-r13 = dai* or with higher layer parameter *codebooksizeDeterminationsSTTI-r15 = dai* and if the UE transmits HARQ-ACK using PUCCH format 3 or PUCCH format 4 or PUCCH format 5 in subframe/slot/subslot *n*, the UE shall determine the according to the following pseudo-code:



Set *c = 0* – cell index: lower indices correspond to lower RRC indices of corresponding cell

Set *s = 0*

Set *j = 0*

Set



Set



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



Set *S* = 3 for subslot PDSCH operation with higher layer parameter *dl-TTI-Length=*'*subslot*'and *ul-TTI-Length=*'*slot*'; *S* = 2 for subframe-PDSCH operation with the higher layer parameter *shortProcessingTime* configured; 1 otherwise

while s < *S*

while *c* < 

if there is a PDSCH on serving cell *c* associated with PDCCH/EPDCCH/SPDCCH or there is a PDCCH/EPDCCH/SPDCCH indicating downlink SPS release on serving cell *c* for which HARQ-ACK is transmitted in subframe/slot/subslot *n*, or

if 



end if

if 

j = j+1

end if



if the higher layer parameter *spatialBundlingPUCCH* is set *FALSE* and the UE is configured with a transmission mode supporting two transport blocks in at least one configured serving cell and HARQ-ACK is not to be transmitted on subslot-PUCCH,

= HARQ-ACK bit corresponding to the first codeword of this cell



= HARQ-ACK bit corresponding to the second codeword of this cell



elseif the higher layer parameter *spatialBundlingPUCCH* is set *TRUE* and the UE is configured with a transmission mode supporting two transport blocks in at least one configured serving cell or HARQ-ACK is to be transmitted on subslot-PUCCH,

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



else

= HARQ-ACK bit for subframe/slot/subslot s of this cell.



end if

end if

*c* = *c* + 1

end while

s = s + 1

end while

if 

j = j+1

end if

if the higher layer parameter *spatialBundlingPUCCH* is set *FALSE* and the UE is configured with a transmission mode supporting two transport blocks in at least one configured serving cell and HARQ-ACK is not to be transmitted on subslot-PUCCH,



else



end if

for any



if SPS PDSCH transmission is activated for a UE and the UE is configured to receive SPS PDSCH in subframe/slot ** or in subslot 



= HARQ-ACK bit associated with the SPS PDSCH transmission



end if

For a UE configured with higher layer parameter *codebooksizeDetermination-r13 = dai* or with higher layer parameter *codebooksizeDeterminationsSTTI-r15 = dai*, if the UE transmits HARQ-ACK on PUSCH in a subframe/slot/subslot, the UE shall determine the according to the above procedure as if the UE transmits HARQ-ACK using PUCCH format 3 or PUCCH format 4 or PUCCH format 5, except that the higher layer parameter *spatialBundlingPUCCH* is replaced by *spatialBundlingPUSCH*.



Table 7.3.1-1: Value of counter DAI and total DAI

|  |  |  |
| --- | --- | --- |
| DAI MSB, LSB | or | Number of serving cells with PDSCH transmission associated with PDCCH/EPDCCH/SPDCCH and serving cell with PDCCH/EPDCCH/SPDCCH indicating DL SPS release |
| 0,0 | 1 | 1 or 5 or 9 or 13 or 17 or 21 or 25 or 29 |
| 0,1 | 2 | 2 or 6 or 10 or 14 or 18 or 22 or 26 or 30 |
| 1,0 | 3 | 3 or 7 or 11 or 15 or 19 or 23 or 27 or 31 |
| 1,1 | 4 | 0 or 4 or 8 or 12 or 16 or 20 or 24 or 28 or 32 |

If a UE is configured with higher layer parameter *codebooksizeDetermination-r13 = cc* or with higher layer parameter *codebooksizeDeterminationsSTTI-r15 = cc* and if the UE transmits HARQ-ACK using PUCCH format 4 or PUCCH format 5 in subframe/slot/subslot *n*, the UE shall determine the according to the pseudo-code in Clause 5.2.3.1 for subframe-PUCCH transmission and Clause 5.2.3.1A for slot/subslot-PUCCH transmission in [4].



For a UE configured with higher layer parameter *codebooksizeDetermination-r13 = cc* or with higher layer parameter *codebooksizeDeterminationsSTTI-r15 = cc*, if the UE transmits HARQ-ACK on PUSCH in a subframe/slot/subslot, the UE shall determine the according to the pseudo-code in Clause 5.2.2.6 in [4].



For a BL/CE UE with higher layer parameter *ce-PDSCH-14HARQ-Config* not configured, for PDSCH transmission in subframe *n-k*, if the UE is in half-duplex FDD operation and is configured with CEModeA and higher layer parameter *ce-HARQ-AckBundling* and the 'HARQ-ACK bundling flag' in the corresponding DCI is set to 1, or if the UE is configured with higher layer parameter *ce-SchedulingEnhancement*,

- if the 'HARQ-ACK delay' field in the corresponding DCI indicates value *k*, the UE shall determine the subframe *n* as the HARQ-ACK transmission subframe.

- the HARQ-ACK delay value *k* is determined from the corresponding DCI based on the higher layer parameters according to Table 7.3.1-2.

For a BL/CE UE with higher layer parameter *ce-PDSCH-14HARQ-Config* configured, for PDSCH transmission in subframe *n-k*, if the UE is in half-duplex FDD operation and is configured with CEModeA, and 'PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ' field is present in the corresponding DCI,

- if the HARQ-ACK delay value, as defined in [4], in the corresponding DCI indicates value *k*, the UE shall determine the subframe *n* as the HARQ-ACK transmission subframe.

For a BL/CE UE in half-duplex FDD operation, if the UE is configured with CEModeA, and if the UE is configured with higher layer parameter *ce-HARQ-AckBundling* and the 'HARQ-ACK bundling flag' in the corresponding DCI is set to 1,

- for HARQ-ACK transmission in subframe *n*, the UE shall generate one HARQ-ACK bit by performing a logical AND operation of HARQ-ACKs across all BL/CE DL subframes for which subframe *n* is the 'HARQ-ACK transmission subframe'.



- if subframe *n-k1* is the most recent subframe for which subframe *n* is the 'HARQ-ACK transmission subframe', and if the 'Transport blocks in a bundle' field in the corresponding DCI for PDSCH transmission in subframe *n-k1* indicates a number of transport blocks in a bundle other than , the UE shall generate a NACK for HARQ-ACK transmission in subframe *n*.



- if the UE has received *W* PDSCH transmissions before subframe *n*, and if the UE is expected to transmit HARQ-ACK for the *W* PDSCH transmissions in subframes , the UE is not expected to receive a new PDSCH transmission in subframe *n*, where *W*=10 if higher layer parameter *ce-pdsch-tenProcesses-config* is set to '*On*', *W*=12 if higher layer parameter *ce-PDSCH-14HARQ-Config* is configured, and *W*=8 otherwise.



- if the UE is expected to transmit HARQ-ACK for the PDSCH transmissions received before subframe *n* in subframes , the UE is not expected to receive a new PDSCH transmission in subframe *n* for which the HARQ-ACK is to be transmitted in subframe



Table 7.3.1-2: HARQ-ACK delay for BL/CE UE in CEModeA

|  |  |  |
| --- | --- | --- |
| 'HARQ-ACK delay' field in DCI | HARQ-ACK delay value when *'ce-SchedulingEnhancement'* set to *'range1'* | HARQ-ACK delay value when *'ce-SchedulingEnhancement'* set to *'range2',* or *'ce-SchedulingEnhancement'* is not configured and *'ce-HARQ-AckBundling'* is set |
| 000 | 4 | 4 |
| 001 | 5 | 5 |
| 010 | 7 | 6 |
| 011 | 9 | 7 |
| 100 | 11 | 8 |
| 101 | 13 | 9 |
| 110 | 15 | 10 |
| 111 | 17 | 11 |

<Unchanged parts are omitted>